ROBOTICS

Product manual

IRBT 2005

Trace back information:
Workspace 24D version a12
Checked in 2024-12-25
Skribenta version 5.6.018

Product manual

IRBT 2005

IRC5

Document ID: 3HAC051130-001

Revision: M

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

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

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

This manual and parts thereof must not be reproduced or copied without ABB's written permission.

Keep for future reference.

Additional copies of this manual may be obtained from ABB.

Original instructions.

Table of contents

Overview of this manual 9
Product documentation 12
How to read the product manual 14

1 Safety 15

1.1 Safety information 15
1.1.1 Limitation of liability 15
1.1.2 Requirements on personnel 16
1.2 Safety signals and symbols 17
1.2.1 Safety signals in the manual 17
1.2.2 Safety symbols on manipulator labels 19
1.3 Robot stopping functions 25
1.4 Safety during installation and commissioning 26
1.5 Safety during operation 29
1.6 Safety during maintenance and repair 30
1.6.1 Safety during maintenance and repair 30
1.6.2 Emergency release of the robot axes 33
1.6.3 Brake testing 34
1.7 Safety during troubleshooting 35
1.8 Safety during decommissioning 36

2 Installation and commissioning 37

2.1 Before starting the track motion 37
2.2 Operating requirements 38
2.3 Unpacking 40
2.3.1 Acceptance inspection 40
2.3.2 Storage 41
2.3.3 Unpacking 43
2.3.4 Lifting the track motion 44
2.3.4.1 Actions before lifting 44
2.3.4.2 Lifting and moving track motion IRBT 2005 45
2.3.4.3 Lifting weight 50
2.3.4.4 Lifting cable chain 51
2.3.5 Technical data for track motion 56
2.3.6 Measures of the carriage table 66
2.3.7 The unit is sensitive to ESD 70
2.4 On-site installation 71
2.4.1 Foundation 71
2.4.2 Mounting bolts 72
2.4.3 Hole configuration 73
2.4.4 Track motion IRBT 2005 overview 75
2.4.5 Assembling the sections of the track motion IRBT 2005 (Longer than 9 m) 76
2.4.6 Positioning the stand 85
2.4.7 Geometric alignment of track motion IRBT 2005 89
2.4.8 Moving the carriage manually 92
2.4.9 Connecting long tracks 96
2.4.10 Assembling the pedestal (option) 101
2.5 Assembling the manipulator and cable tray 103
2.5.1 Assembling the manipulator 103
2.5.2 Mounting of manipulator on the track 107
2.5.3 Changing manipulator orientation 110
2.5.4 Assembling the cable tray 113
2.6 Electrical installation 115
2.6.1 The cabling from the controller 115
2.6.2 Connections 117
2.6.2.1 Introduction 117

2.6.2.2 Connectors on controller, IRC5 118
2.6.3 Inspection of cables and covers prior to start-up 119
2.7 Software installation 120
2.7.1 Starting the system for the first time 120
2.7.2 Creating and downloading a system 121
2.7.3 Setting upper and lower software limits for the track 123
2.7.4 Base frame configuration 130
2.7.4.1 Introduction 130
2.7.4.2 Configuration examples 132
2.7.5 Configuration of additional load 136
2.8 Lubrication 137
2.8.1 Replacing the grease cartridge in grease pump MEMOLUB® EPS 137
2.8.2 Configuration of grease pump MEMOLUB® 141
2.9 Commissioning 142
2.9.1 Check list for IRBT 2005 before commissioning 142
2.10 Test run after installation, maintenance, or repair 145

3 Maintenance 147

3.1 Introduction 147
3.2 Maintenance schedule and expected component life 148
3.2.1 Specification of maintenance intervals 148
3.2.2 Maintenance schedule 149
3.2.3 Gearbox oil 151
3.2.4 Expected component life 152
3.3 Activities 100 km or 1 month 153
3.3.1 Cleaning the racks 153
3.3.2 Cleaning the linear guides 155
3.4 Activities 1 month 157
3.4.1 Inspecting the automatic lubrication system 157
3.4.2 Emergency stop and stroke limit system 160
3.4.3 Inspecting the cables and connectors 161
3.5 Activities 3 months 162
3.5.1 Inspecting the cable chain 162
3.5.2 Inspecting the felt gear 166
3.6 Activities 12 months 167
3.6.1 Inspecting the cables and connectors 167
3.6.2 Inspecting the mechanical stops 168
3.6.3 Inspecting the gear wheel, gearbox and backlash 169
3.6.4 Adjusting the leveling 171
3.7 Activities 36 months 172
3.7.1 Replacing SMB battery 172

4 Repair 175

4.1 Introduction 175
4.2 Cut the paint or surface on the robot before replacing parts 176
4.3 Replacing the linear guides 177
4.4 Replacing the ball bearing blocks 180
4.5 Replacing the racks 185
4.6 Replacing the mechanical stops 188
4.7 Replacing the motor, gearbox and gear wheel 190
4.7.1 Replacing the motor 190
4.7.2 Replacing the gearbox 202
4.7.3 Replacing the gear wheel 214
4.8 Adjusting the gearbox backlash 227
4.9 Replacing the felt gear 231
4.9.1 Replacing the felt gear 231
4.10 Replacing the cable chain and cables 239
4.10.1 Replacing the cable chain 239
4.10.2 Replacing the side links and glide shoes 248

4.10.3 Replacing the cables 251
4.10.4 Replacing the lubrication sensor and sensor cable 259
4.11 Replacing SMB board 263

5 Calibration 265

5.1 Overview 265
5.2 Fine calibration 266
5.3 Update revolution counters 267
5.4 Defining base frame 268

6 Decommissioning 269

6.1 Introduction to decommissioning 269
6.2 Environmental information 270

7 Reference information 273

7.1 Introduction 273
7.2 Applicable standards 274
7.3 Unit conversion 276
7.4 Screw joints 277
7.5 Standard tools 280
7.6 Special tools 281
7.7 Lifting accessories and lifting instructions 282
7.8 HILTI adhesive anchor 283

8 Spare parts 287

8.1 Spare part lists and illustrations 287

9 Circuit diagrams 289

Index 291

This page is intentionally left blank

Overview of this manual

About this manual

This manual contains instructions for:

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

Usage

This manual should be used during:

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

Who should read this manual?

This manual is intended for:

- installation personnel
- maintenance personnel
- repair personnel.

Prerequisites

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

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

Product manual scope

The manual covers covers all variants and designs of the IRBT 2005. Some variants and designs may have been removed from the business offer and are no longer available for purchase.

Organization of chapters

The manual is organized in the following chapters:

Chapter	Contents
Safety	Safety information that must be read through before performing any installation or service work on robot. Contains general safety aspects as well as more specific information on how to avoid personal injuries and damage to the product.
Installation and commissioning	Required information about lifting and installation of the track and installation of cabling. Information about how to get the system running, including information about some of the important parameters to set.
Maintenance	Step-by-step procedures that describe how to perform maintenance of the track. Based on a maintenance schedule that may be used to plan periodical maintenance.

Continues on next page

Continued

Chapter	Contents
Repair	Step-by-step procedures that describe how to perform repair activities of the track. Based on available spare parts.
Calibration	Information about calibration of the system.
Decommissioning	Environmental information about the track and its components.
Spare parts	Reference to the spare part list for the robot.
Circuit diagram	Reference to the circuit diagram for the robot.

References

Documentation referred to in the manual is listed in the table below.

Document name	Document ID
Product manual, spare parts - IRBT 2005	*3HAC051132-001*
Product specification - IRBT 2005	*3HAC051131-001*
Safety manual for robot - Manipulator and IRC5 or OmniCore controller [i]	*3HAC031045-001*
Product manual - IRC5	*3HAC047136-001*
Operating manual - IRC5 with FlexPendant	*3HAC050941-001*
Operating manual - Calibration Pendulum	*3HAC16578-1*
Operating manual - Service Information System	*3HAC050944-001*
Application manual - Additional axes and standalone controller	*3HAC051016-001*
Technical reference manual - Lubrication in gearboxes	*3HAC042927-001*
Technical reference manual - System parameters	*3HAC050948-001*

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

Revisions

Revision	Description
-	First edition.
A	This revision contains the following updates: • Grease name change (Longtime PD 0 → Tribol GR 100-0 PD) • Corrected the contents on delivery. See *Contents on page 43*. • Added bolts to prevent carriage slipping during the transportation, which must be removed before track assembly. See *Assembling sections on page 78*. • Modified information of track dimensions. See *Dimensions on page 60*. • Modified the procedure how to shorten a long track. See *Removing sections if too long on page 81*. • Minor changes.
B	Published in release R16.2. The following updates are made in this revision: • Corrected the procedures of refitting the carriage to the drive train bracket. • Added tightening torque to screws when refitting. • Corrected the screws for fastening track to base to M16x125 mm. See *Hole configuration on page 73*.

Continues on next page

Revision	Description
	• Added section *Configuration of grease pump MEMOLUB® on page 141*. • Modified the replacing procedure for linear guide. See *Replacing the linear guides on page 177*. • Minor changes.
C	Published in release R17.1. The following updates are made in this revision: • Remove grease Tribol GR 100-0 PD.
D	Published in release R17.2. The following updates are made in this revision: • Updated list of applicable standards. • Added replacement procedure of SMB battery and SMB board. • Added sensor alert as a checking interval for the lubricant level of the automatic lubrication system. • Added configuration of additional load.
E	Published in release R18.1. The following updates are made in this revision: • Added section, Cut the paint or surface on the robot before replacing parts. • Safety restructured. • Information about myABB Business Portal added.
F	Published in release R18.2. The following updates are made in this revision: • Removed information about Documentation DVD, which is replaced by myABB Business Portal.
G	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 176*. • Added warning about grease for linear guides. • Added cable arrangement layout for tracks working with IRB 1600, IRB 2600, or IRB 4600 and the CP/CS option also selected.
H	Published in release R20C. The following updates are made in this revision: • Added note to transfers for formulas of calculating track motion weight, in which the transfers can be replaced by lifters. See *Weight of track motion and number of joined sections in transport on page 62*. • Added procedure how to install the pedestal to track motion. See *Assembling the pedestal (option) on page 101*. • Added note about the drill size of leveling screw.
J	Published in release R22D. The following updates are made in this revision: • Added installation procedure of insulation kit for track motion with arc welding options.
K	Published in release R23A. The following updates are made in this revision: • Updated the maintenance activity requirements for racks and linear guides.
L	Published in release R23D. The following updates are made in this revision: • Added replacement of lubrication sensor and sensor cable.
M	Published in release R24D. The following updates are made in this revision: • Updated forces data.

Product documentation

Categories for user documentation from ABB Robotics

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

Tip

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

Product manuals

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

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

Technical reference manuals

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

Application manuals

Specific applications (for example software or hardware options) are described in **Application manuals**. An application manual can describe one or several applications.

An application manual generally contains information about:

- The purpose of the application (what it does and when it is useful).
- What is included (for example cables, I/O boards, RAPID instructions, system parameters, software).
- How to install included or required hardware.
- How to use the application.

Continues on next page

- Examples of how to use the application.

Operating manuals

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

How to read the product manual

Reading the procedures

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

References to figures

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

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

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

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

References to required equipment

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

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

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

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

Safety information

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

Read more in the chapter *Safety on page 15*.

Illustrations

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

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

1 Safety

1.1 Safety information

1.1.1 Limitation of liability

Limitation of liability

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

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

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

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

Spare parts and equipment

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

1.1.2 Requirements on personnel

General

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

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

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

Personal protective equipment

Use personal protective equipment, as stated in the instructions.

1.2 Safety signals and symbols

1.2.1 Safety signals in the manual

Introduction to safety signals

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

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

Hazard levels

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

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

Continues on next page

1.2.1 Safety signals in the manual
Continued

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 19*.

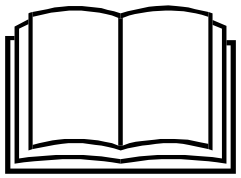
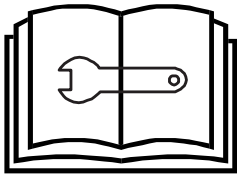
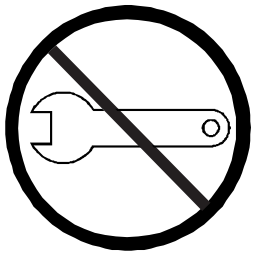
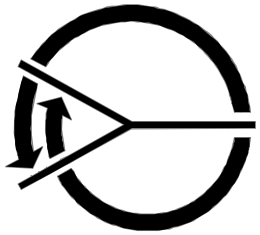
The information labels can contain information in text.

Symbols on safety labels

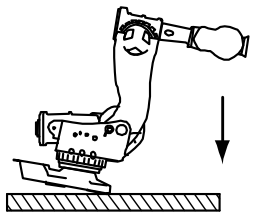
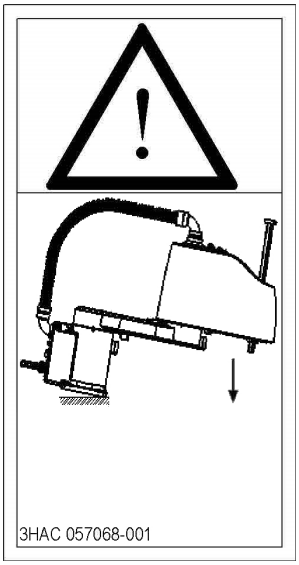
Symbol	Description
 xx0900000812	**Warning!** Warns that an accident *may* occur if the instructions are not followed that can lead to serious injury, possibly fatal, and/or great damage to the product. It applies to warnings that apply to danger with, for example, contact with high voltage electrical 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

1.2.2 Safety symbols on manipulator labels
Continued

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.

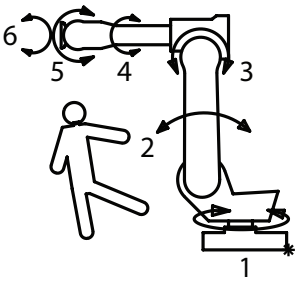
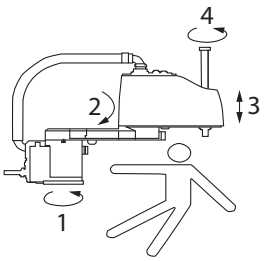
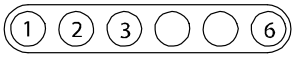
Continues on next page

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.

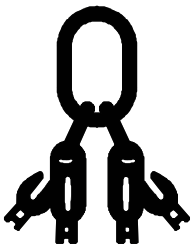
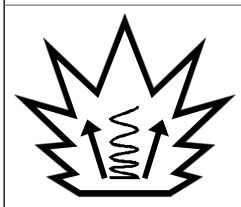
Continues on next page

1.2.2 Safety symbols on manipulator labels

Continued

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

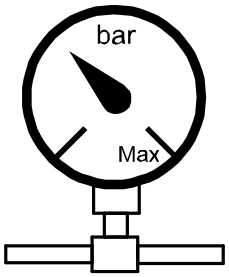
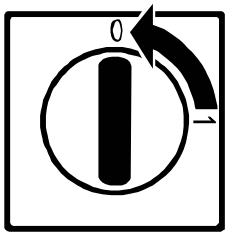
Continues on next page

Symbol	Description
 xx0900000821	**Lifting bolt**
 xx1000001242	**Adjustable chain sling with shortener**
 xx0900000822	**Lifting of robot**
 xx0900000823	**Oil** Can be used in combination with prohibition if oil is not allowed.
 xx0900000824	**Mechanical stop**
 xx1000001144	**No mechanical stop**
 xx0900000825	**Stored energy** Warns that this part contains stored energy. Used in combination with *Do not disassemble* symbol.

Continues on next page

1.2.2 Safety symbols on manipulator labels

Continued

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

1.3 Robot stopping functions

Protective stop and emergency stop

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

For more information see:

- *Product manual - IRC5*

1.4 Safety during installation and commissioning

National or regional regulations

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

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

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

Layout

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

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

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

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

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

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

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

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

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

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

Allergenic material

See *Environmental information on page 270* for specification of allergenic materials in the product, if any.

Securing the robot to the foundation

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

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

Continues on next page

Using lifting accessories and other external equipment

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

Electrical safety

Incoming mains must be installed to fulfill national regulations.

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

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

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

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

Note

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

Safety devices

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

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

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

Other hazards

A robot may perform unexpected limited movement.

WARNING

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

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

- Water
- Compressed air
- Hydraulics

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

Continues on next page

Pneumatic or hydraulic related hazards

Note

The pressure in the complete pneumatic or hydraulic systems must be released before service and maintenance.

All components in the robot system that remain pressurized after switching off the power to the robot must be marked with clearly visible drain facilities and a warning sign that indicates the hazard of stored energy.

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

Dump valves should be used in case of emergency.

Shot bolts should be used to prevent tools, etc., from falling due to gravity.

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

Verify the safety functions

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

1.5 Safety during operation

Automatic operation

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

Unexpected movement of robot arm

WARNING

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

A robot may perform unexpected limited movement.

WARNING

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

1.6 Safety during maintenance and repair

1.6.1 Safety during maintenance and repair

General

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

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

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

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

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

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

Hot surfaces

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

Allergic reaction

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

Gearbox lubricants (oil or grease)

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

Note

Take special care when handling hot lubricants.

Warning	Description	Elimination/Action
 **Hot oil or grease**	Changing and draining gearbox oil or grease may require handling hot lubricant heated up to 90 °C.	Make sure that protective gear like goggles and gloves are always worn during this activity.

Continues on next page

Warning	Description	Elimination/Action
 **Allergic reaction**	When working with lubricants there is a risk of an allergic reaction.	Make sure that protective gear like goggles and gloves are always worn.
 **Possible pressure build-up in gearbox**	When opening the oil or grease plug, there may be pressure present in the gearbox, causing hot lubricant to spray from the opening.	Open the plug carefully and keep away from the opening. Do not overfill the gearbox when filling. Put oil absorbent cloth, bags or paper at appropriate locations to catch any oil residues. Use appropriate protective gear such as heat-resistant gloves, goggles/protective visor, or a body suit if necessary.
 **Do not overfill**	Overfilling of gearbox lubricant can lead to internal over-pressure inside the gearbox which in turn may: • damage seals and gaskets • completely press out seals and gaskets • prevent the robot from moving freely.	Make sure not to overfill the gearbox when filling it with oil or grease. After filling, verify that the level is correct.
 **Do not mix types of oil**	Mixing types of oil may cause severe damage to the gearbox.	When filling gearbox oil, do not mix different types of oil unless specified in the instructions. Always use the type of oil specified for the product.
 **Oil residues**	Oil residues might be present in a drained gearbox and spilled when separating a motor and gearbox during repair.	Make sure that protective gear like goggles/protective visor, gloves and arm protection are always worn during this activity. Put oil absorbent cloth, bags or paper at appropriate locations to catch any oil residues.
 **Heat up the oil**	Warm oil drains quicker than cold oil.	Run the robot before changing the gearbox oil, if possible.
 **Specified amount depends on drained volume**	The specified amount of oil or grease is based on the total volume of the gearbox. When changing the lubricant, the amount refilled may differ from the specified amount, depending on how much has previously been drained from the gearbox.	After filling, verify that the level is correct.

Continues on next page

1.6.1 Safety during maintenance and repair
Continued

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

Hazards related to batteries

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

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

Do not short circuit, recharge, puncture, incinerate, crush, immerse, force discharge or expose to temperatures above the declared operating temperature range of the product. Risk of fire or explosion.

Operating temperatures are listed in *Operating requirements on page 38*.

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:

- *Moving the carriage manually on page 92*.

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

Increased injury

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

DANGER

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

Make sure no personnel is near or beneath the robot.

1.6.3 Brake testing

When to test

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

How to test

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

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

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

Note

It is recommended to run the service routine *BrakeCheck* as part of the regular maintenance, see the operating manual for the robot controller.

For robots with the option SafeMove, the *Cyclic Brake Check* routine is recommended. See the manual for SafeMove in *References on page 10*.

1.7 Safety during troubleshooting

General

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

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

DANGER

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

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

WARNING

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

A robot may perform unexpected limited movement.

WARNING

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

Related information

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

1.8 Safety during decommissioning

General

See section *Decommissioning on page 269*.

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 Before starting the track motion

Do this before starting the track motion

The following steps should be carried out before starting the track motion IRBT 2005.

	Action	Reference
1	Unpack the track.	Compare the delivery checklist to the identification plates and verify for acceptance according to *Acceptance inspection on page 40* and *Lifting and moving track motion IRBT 2005 on page 45*.
2	Read through and follow the information and instructions for on-site installation of the track.	*On-site installation on page 71*
3	Align and level the track.	Correct the track motion according to *Geometric alignment of track motion IRBT 2005 on page 89*.
4	Assemble the cable tray and manipulator (for robot track).	*Assembling the manipulator and cable tray on page 103*
5	Install the cable chain and connect all cables.	*Electrical installation on page 115*
6	Verify covers and cable chain.	*Inspection of cables and covers prior to start-up on page 119*
7	Connect voltage to the system.	*Electrical installation on page 115*
8	Start up the system.	*Starting the system for the first time on page 120*
9	Load software to the system.	*Creating and downloading a system on page 121*
10	Update the revolution counters.	*Update revolution counters on page 267*

2.2 Operating requirements

Protection standards

Standard Track Motion IP65 for mechanical parts and main electrical connections.

Explosive environments

The track motion cannot be located or operated in an explosive environment.

Ambient temperature

Description	Standard/Option	Temperature
Track motion during operation	Standard	+5°C[i] (41°F) to + 50°C (122°F)
For the controller	Standard/Option	See *Product specification - Controller IRC5 with FlexPendant*

[i] At low environmental temperature < 10° C is, as with any other machine, a warm-up phase recommended to be run with the robot. Otherwise there is a risk that the robot stops or run with lower performance due to temperature dependent oil- and grease viscosity.

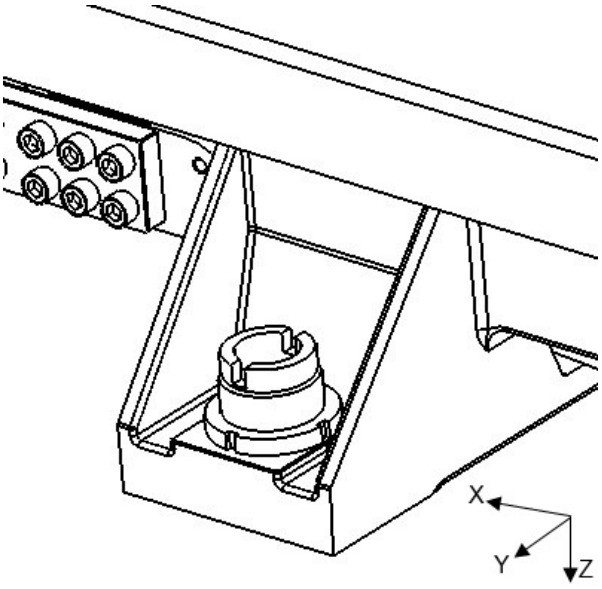
Relative humidity

Description	Relative humidity
Complete track during transportation and storage	Max. 95% at constant temperature
Complete track during operation	Max. 95% at constant temperature

Continues on next page

Forces

Maximum floor loads in relation to the base coordination system are indicated per each foot of the section, see the following figure.



xx1400000039

Robot	Endurance load in operation (kN)		Max. load at emergency stop (kN)	
	Fxy	Fz	Fxy	Fz
IRB 1600 without pedestal	±0.75	1.25±2.25	±1.75	2.0±4.0
IRB 1600 with 1000 mm pedestal	±0.75	2.5±4.5	±1.75	3.0±9.0
IRB 2600 without pedestal	±1.5	2.5±4.0	±3.5	3.0±7.0
IRB 2600 with 1000 mm pedestal	±1.5	3.0±5.5	±3.5	3.0±11.0
IRB 4600 without pedestal	±1.5	3.0±7.0	±3.5	3.0±14.5
IRB 4600 with 250 mm pedestal	±1.5	3.0±7.0	±3.5	3.0±15.0

Note

If doing fatigure calculations with combined tension (Fz) and shear loads (Fxy), the shear loads (Fxy) are allowed to be reduced with a factor 0.7.

2.3 Unpacking

2.3.1 Acceptance inspection

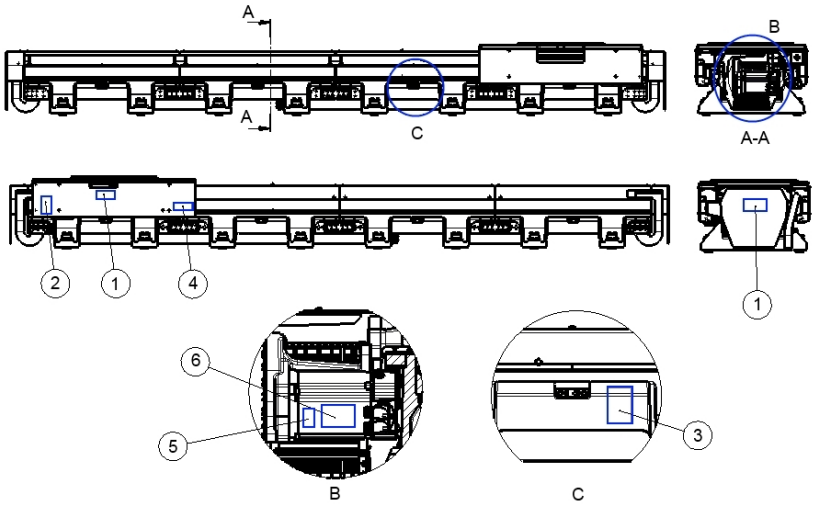
Identification plate

Tip

Always try to determine if the goods are as ordered, and that the package is not damaged before unpacking.

To identify the delivery, inspect the identification plates and compare them to the delivery note.

The identification plates are shown in the figure.



xx1500000228

1	ABB logo
2	Rating label
3	Calibration label
4	Lifting label
5	Warning label
6	Instruction plate

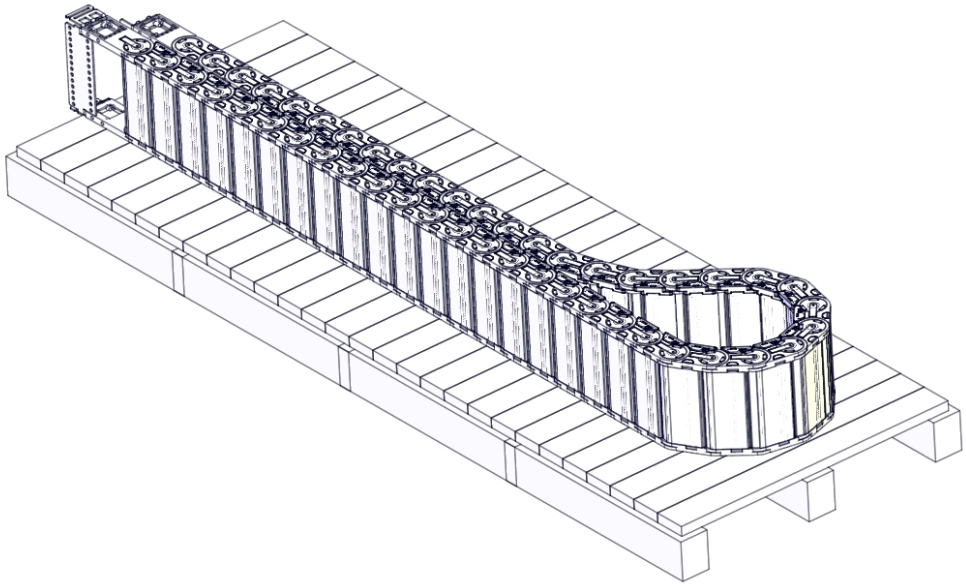
2.3.2 Storage

Storing the cable chain

There are two methods for storing spare/not in use cable chains.

Method 1: folded in half

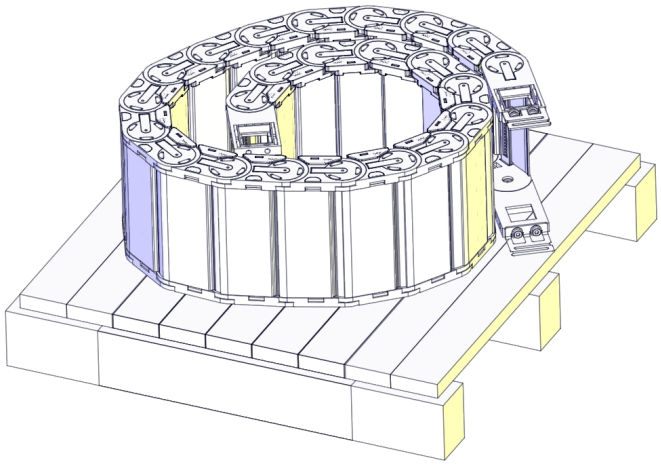
For complete chains with strapping in place and the strapping plates attached to the chains, the chain can only be folded in half. The chain can either be folded so that the chain is lying on itself or laid on its side.



xx1300000884

Method 2: rolled up

For complete chains with or without strapping in place or strapping in place and the strapping plate not connected to the chain, the chain can be rolled up and stored lying on its side.



xx1300000885

Continues on next page

2.3.2 Storage
Continued

Moving the cable chain from storage

To move the chain from storage to track, see *Lifting cable chain on page 51*.

2.3.3 Unpacking

Inspection

The track motion IRBT 2005 has been pre-assembled in ABB factory. For delivery and storage's convenience, it would be divided into several segments as an unit depending on the length of the track when delivered.

The track IRBT 2005 is wrapped in plastic. Unpack the track and inspect for any visible transport damage. If the track motion is damaged, contact ABB.

Contents

As standard, the track motion IRBT 2005 includes the following on delivery:

- Track motion IRBT 2005 segments depending on the length

Cleaning

Before transport, the track motion IRBT 2005 has been protected against rust by a thin film of oil that has been applied before packing.

Note

Do not clean any of the pre-lubricated linear guide and rack.

	Action	Illustration/Note
1	Wipe off any surplus oil using a lint-free cloth.	

2.3.4 Lifting the track motion

2.3.4.1 Actions before lifting

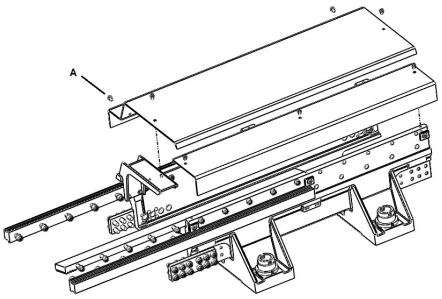
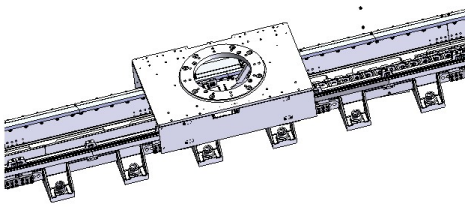
Removing cover plates

Before lifting the track motion, always remove the pre-mounted cover plates and rack plates.

WARNING

Never attempt to lift the track motion IRBT 2005 if the carriage is not in the centered position.

Preparations before lifting

	Action	Illustration/Note
1	Remove the M6 socket head cap screws holding the cover plates and rack plates using standard tools.	 xx1500000127 A M6x12 Screw DIN6921, 9ADA181-11 (7pcs)
2	If the carriage is not in the centered position, move it by hand to the midpoint of the track.	 xx1500000129 For details, see *Moving the carriage manually on page 92*.

2.3.4.2 Lifting and moving track motion IRBT 2005

Actions before lifting

CAUTION

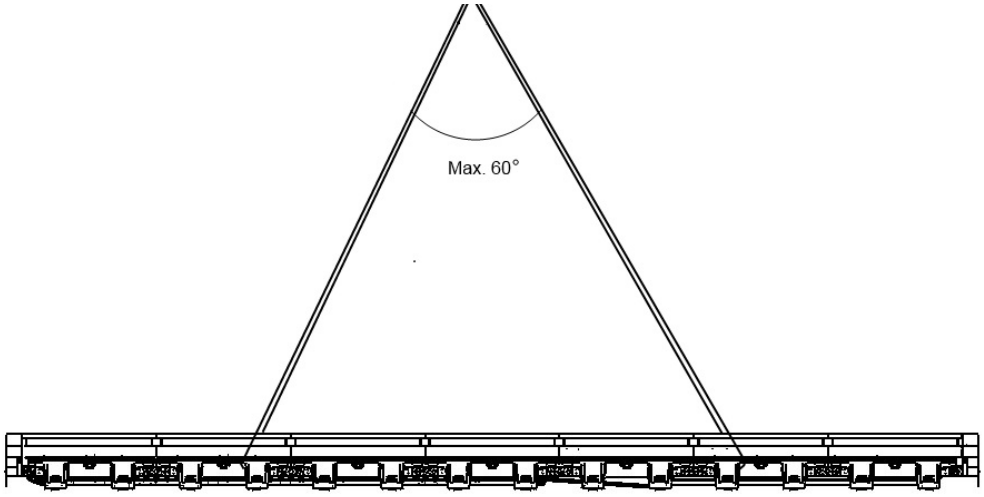
Read through the safety instructions carefully, before the track motion IRBT 2005 is unpacked and installed.

WARNING

Never lift the track IRBT 2005 in segments longer than 9 meters. If the track is longer, the track has to be disassembled into smaller segments.

Never lift the track IRBT 2005 using an overhead crane without first removing the cover plates.

Lifting zones



xx1400000234

WARNING

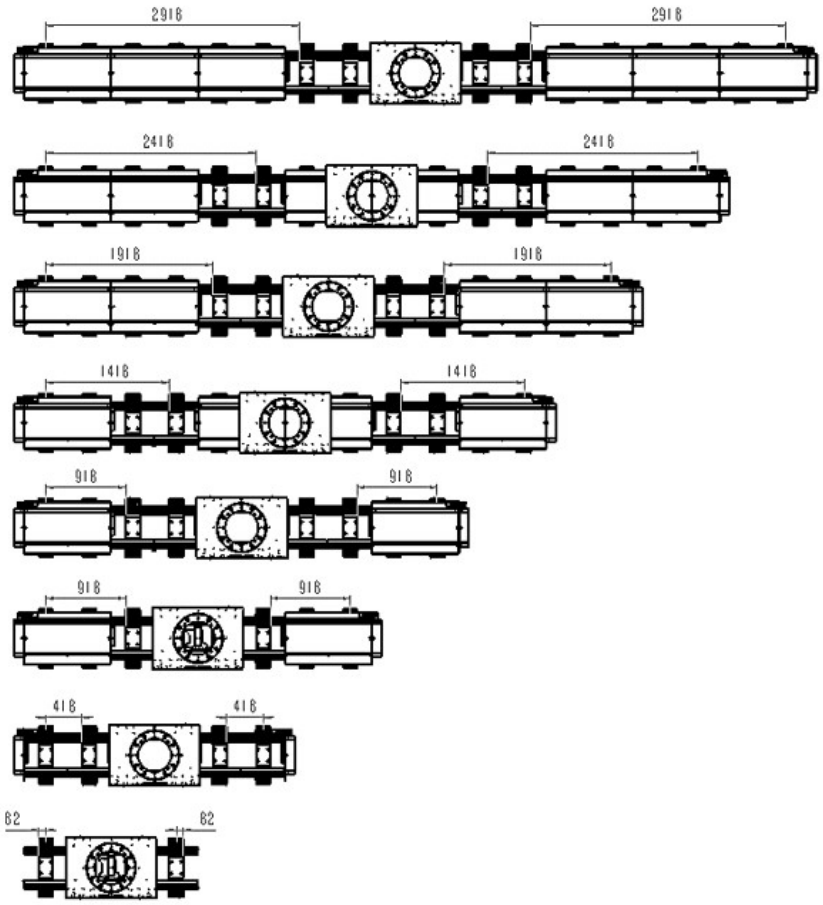
Never place lifting straps wider than a combined angel of max. 60°.

Continues on next page

2.3.4.2 Lifting and moving track motion IRBT 2005
Continued

2-9 sections lift

The illustration shows the stand feet on the track motion IRBT 2005 where the lifting straps should be placed.



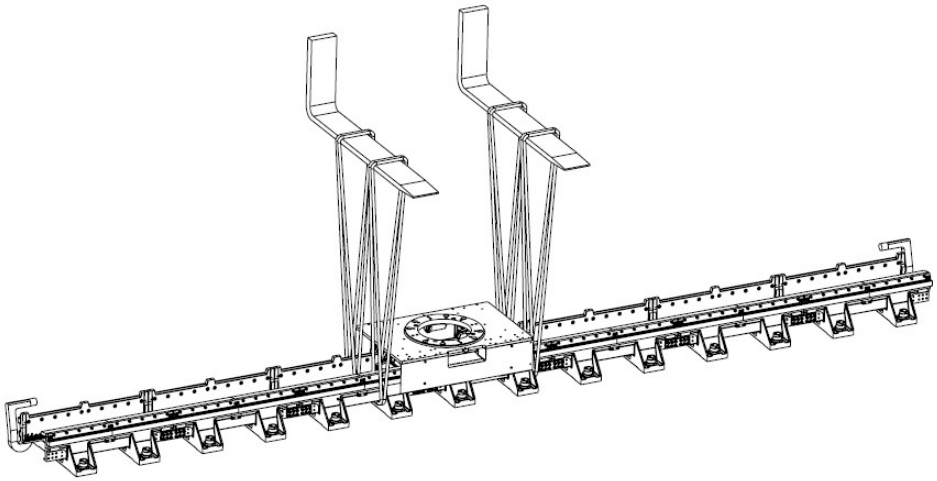
xx1500000593

Track motion length	Lifting stand foot from left	Lifting stand foot from right
9 sections	(7) distance 2918 mm	(7) distance 2918 mm
8 sections	(6) distance 2418 mm	(6) distance 2418 mm
7 sections	(5) distance 1918 mm	(5) distance 1918 mm
6 sections	(4) distance 1418 mm	(4) distance 1418 mm
5 sections	(3) distance 918 mm	(3) distance 918 mm
4 sections	(3) distance 918 mm	(3) distance 918 mm
3 sections	(2) distance 418 mm	(2) distance 418 mm
2 sections	(1) distance 82 mm	(1) distance 82 mm

Continues on next page

Lifting using fork lift

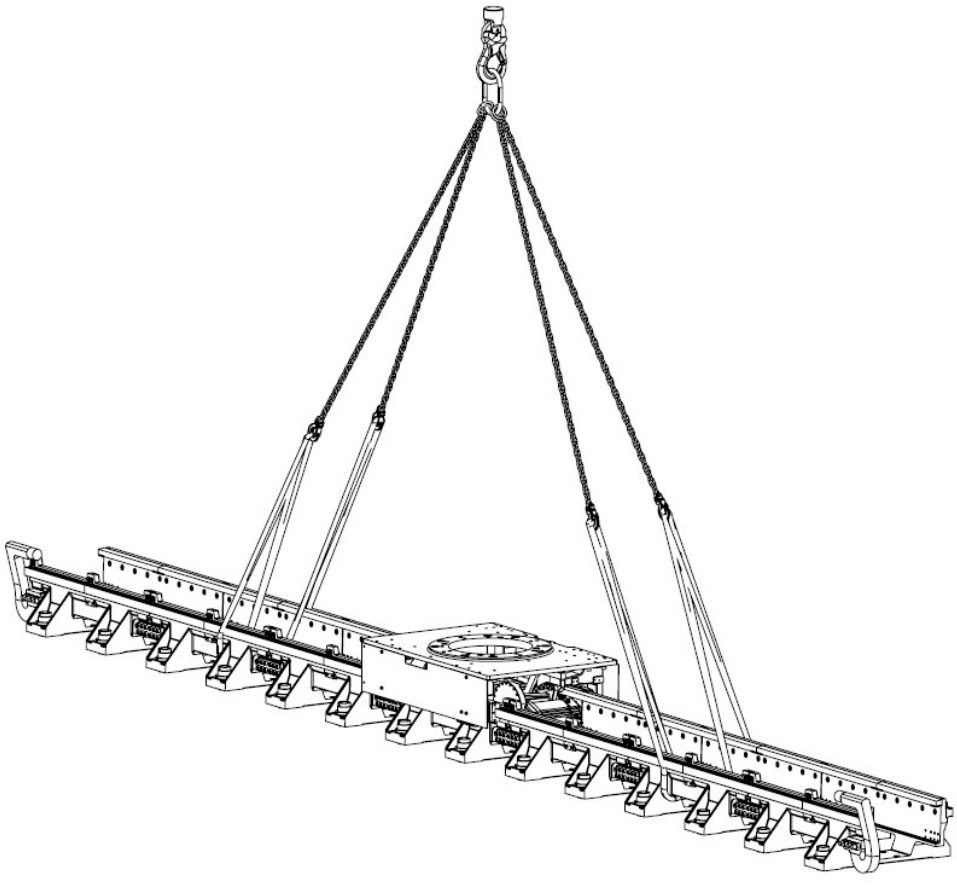
Proceed as follows to lift the track motion IRBT 2005 using the fork lift.



xx1500000591

Lifting using an overhead crane

Proceed as follows to lift the track motion IRBT 2005 using an overhead crane.



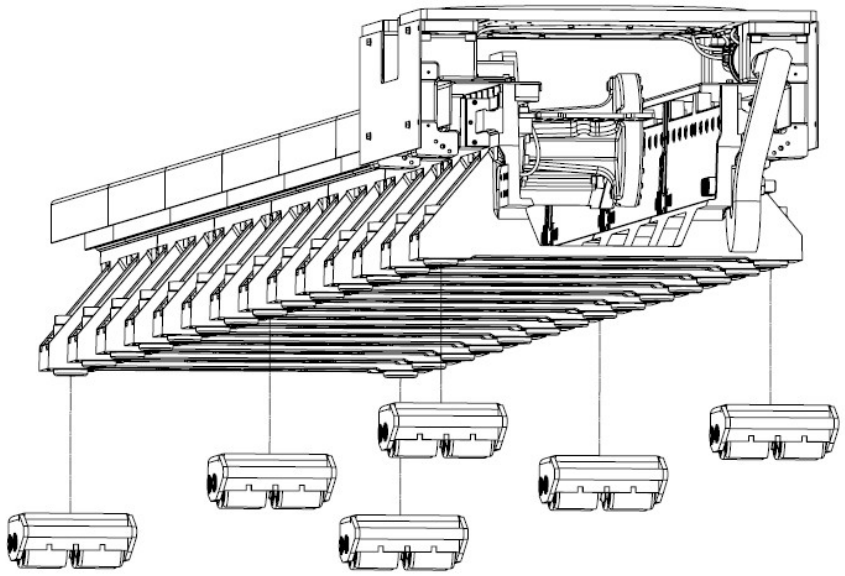
xx1500000592

Continues on next page

2.3.4.2 Lifting and moving track motion IRBT 2005
Continued

Moving the track motion using roller dollies

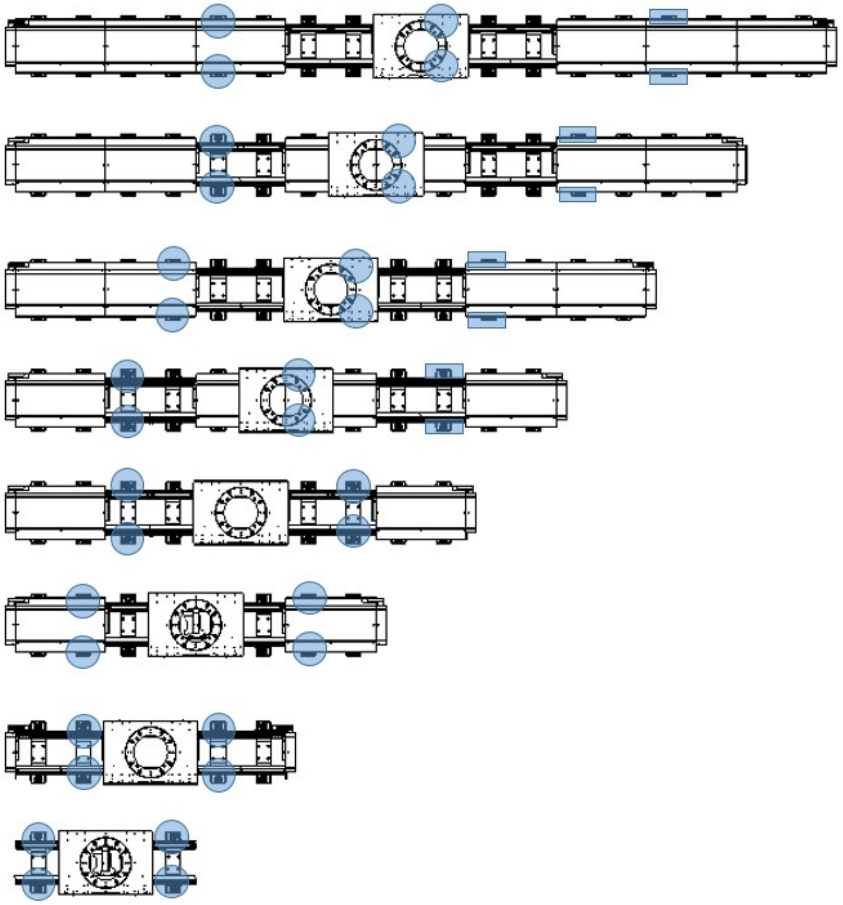
Lift the IRBT 2005 according to lifting instructions, and place roller dollies under the stand's ground plates. Depending on the length of the track motion, the number of roller dollies varies. See table for information.



xx1500000594

Continues on next page

The type of roller dolly and the placement of the two types is shown in the following illustration and table.



xx1500000595

Track motion length	Roller dollies with steering	Fixed roller dollies
9 sections	4 pcs	2 pcs
8 sections	4 pcs	2 pcs
7 sections	4 pcs	2 pcs
6 sections	4 pcs	2 pcs
5 sections	4 pcs	-
4 sections	4 pcs	-
3 sections	4 pcs	-
2 sections	4 pcs	-

2.3.4.3 Lifting weight

Track motion IRBT 2005 weight

For accurate weight, read the identification plates on the track motion IRBT 2005. The positions of the identification plates are described in *Identification plate on page 40*.

The weights are also listed in *Weight of single carriage track on page 62* and *Weight of double carriage track on page 63*.

WARNING

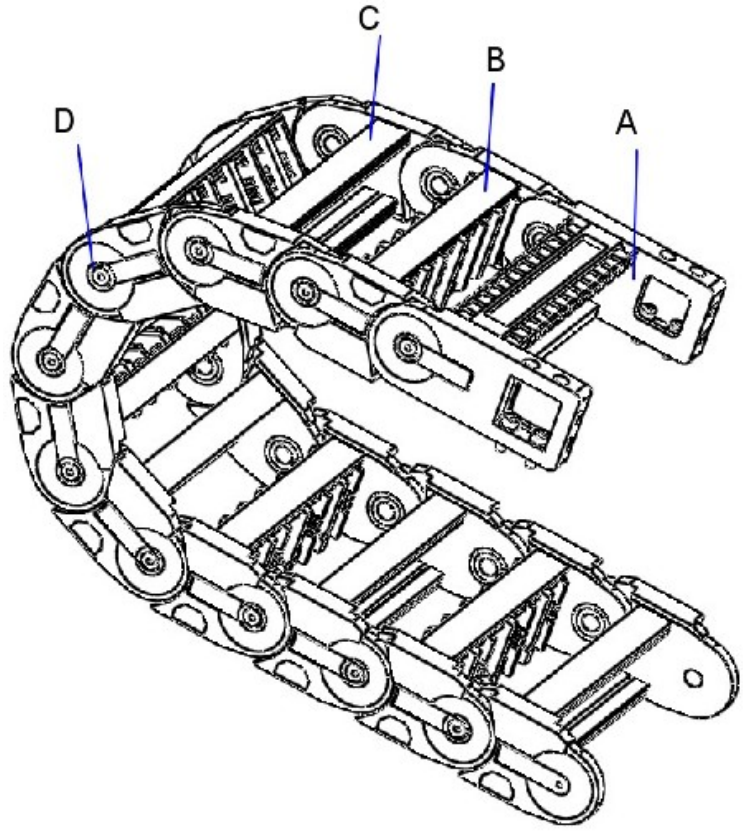
Never lift the track IRBT 2005 in segments longer than 9 meters. If the track is longer, the track has to be disassembled into smaller segments.

Never lift the track IRBT 2005 using an overhead crane without first removing the cover plates.

2.3.4.4 Lifting cable chain

Illustration, cable chain and cable tray made of sheet metal

The figure shows the cable chain and the cable trays designed for the internal and external cable chains.

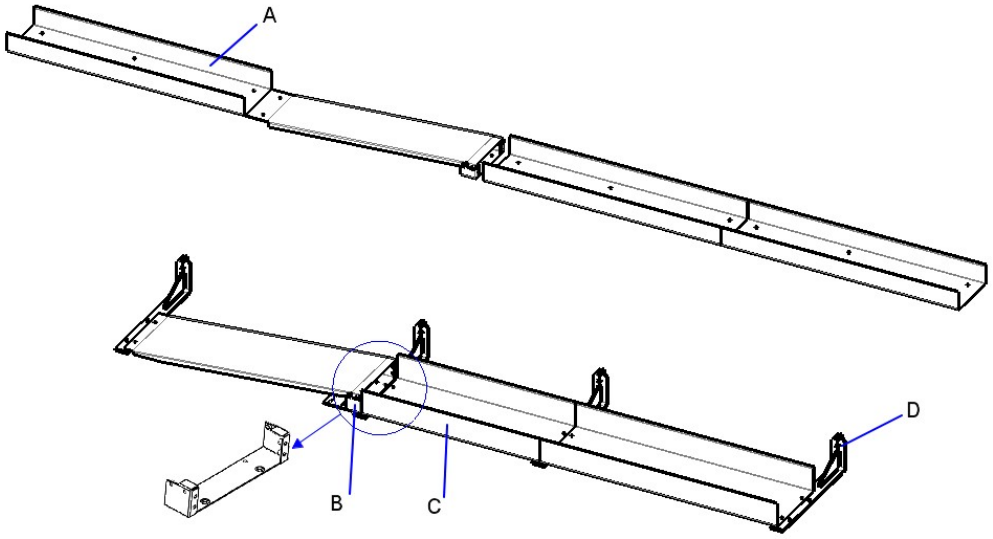


xx1400000479

Item	Description
A	Cable chain end unit
B	Cable chain pitch, with divider
C	Cable chain pitch, no divider
D	Cable chain, 10 links

Continues on next page

2.3.4.4 Lifting cable chain
Continued



xx1400000522

Item	Description
A	Cable tray, 1 m
B	External chain raiser
C	External tray 1.45 m unit
D	External tray bracket unit

Plan the job

Cable chains are easily damaged through improper handling. Chains longer than 4 meters are heavy and cumbersome to move. In order to prevent personal injury and damage to the chain, make sure to pay attention while handling.

Read the procedure thoroughly before installing the chain and plan the job in advance, in regard to the actual installation site.

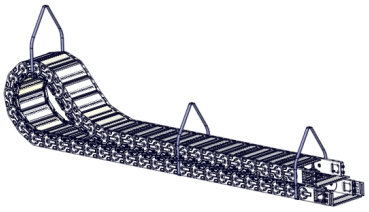
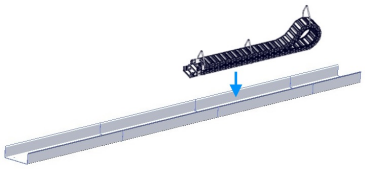
To move the chain from storage to track, use one of the methods described in this section. Method 2 requires an overhead crane.

Required equipment

Equipment	Art. No.	Note
Lifting slings, standard	-	Quantity depends on track length. Required if using lifting method 1.
Lifting sling, extra wide (50 mm)	-	Required if using lifting method 2.
Overhead crane	-	

Continues on next page

Method 1: lifting the cable chain that is folded in half

	Action	Illustration/Note
1	**CAUTION** Without cables, the internal cable chain weighs 3.4 kg / meterand the external cable chain weighs 8 kg / meter. All lifting accessories used must be sized accordingly!	
2	Place the chain so that it is folded in half lying flat.	 xx1300000887
3	Place lifting slings on the two ends and in the middle. If the folded chain is longer than 4 meters then extra lifting slings should be placed so that the chain is supported every two meters. **Note** This illustration for the procedure is for lifting external cable chain. Procedure for lifting internal cable chain is the same with this procedure.	
4	Lift the cable chain to the installation position above the cable tray. The chain should be placed so that both ends are in the middle of the track.	 xx1400001937
5	There is no space for the lifting slings to stay fitted to the chain once it is lowered into the tray, therefore these must be removed before the cable chain is placed inside the tray. Lower the fixed and movable ends first, then continue lowering bit by bit until the complete chain is fitted into the tray, while at the same time removing the lifting slings one by one.	

CAUTION

Make sure that the cable chain cannot come into contact with any moving parts.

Method 2: lifting the cable chain that is rolled

This procedure requires an overhead crane.

CAUTION

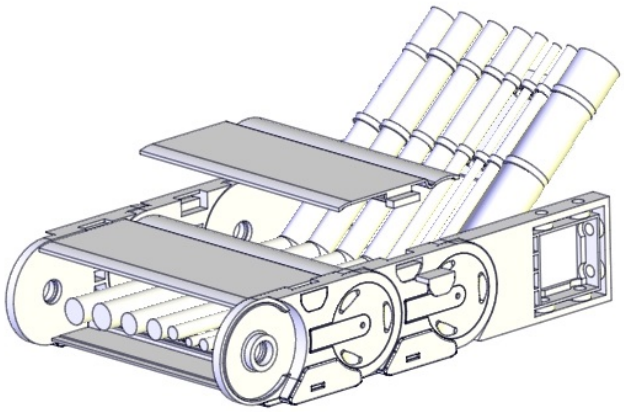
Without cables, the internal cable chain weights 3.4 kg / meter and the external cable chain weights 8 kg / meter. All lifting accessories used must be sized accordingly!

Continues on next page

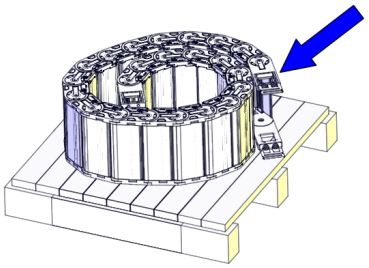
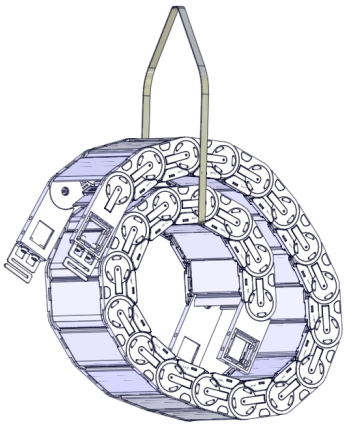
2.3.4.4 Lifting cable chain
Continued

Note

For external cable chain, in order to keep the correct length for long chains that are to be rolled, the strapping plate as well as the first cover and clips are removed. Refit these parts during installation.



xx1400001938

	Action	Illustration/Note
1	With the chain lying on its side, secure the loose end to ensure that the chain can not unroll during the lift.	 xx1300000888
2	Lift the chain so that it is standing upright and insert a wide lifting sling (50 mm) through the center of the chain.	 xx1300000889
3	Lift the cable chain to the installation position above the cable tray. The chain should be placed so that both ends are in the middle of the track.	
4	Lower the cable chain into the cable tray. The ends of the chain should be in the middle of the track.	

Continues on next page

CAUTION

Make sure that the cable chain cannot come into contact with any moving parts.

2.3.5 Technical data for track motion

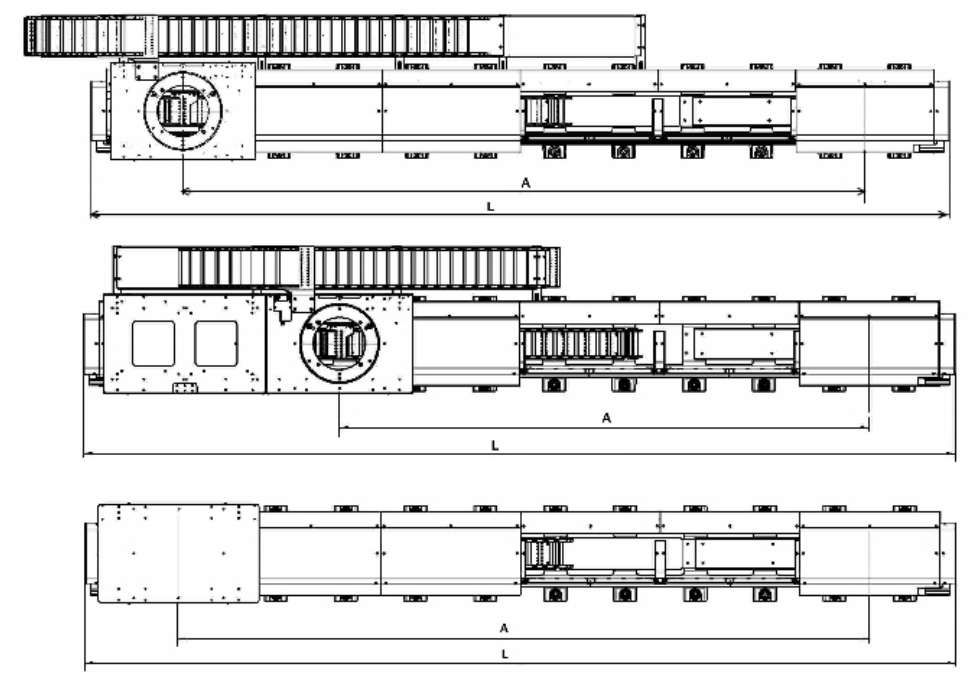
Travel length

The travel length of the IRBT 2005 track motion varies based on the carriage type and carriage quantity.

Carriage type	Carriage quantity	Description	Travel length (m) [i]
Robot track	Single carriage	Robot	0.8 to 19.8 (in steps of 1 m)
	Single carriage	Robot with extra plate	1.7 to 18.7 (in steps of 1 m)
	Double carriages	Robot + Robot	1.6 to 18.6 (in steps of 1 m)
	Double carriages	Robot + Robot with extra plate	1.4 to 17.4 (in steps of 1 m)
	Double carriages	Robot with extra plate + Robot with extra plate	1.3 to 16.3 (in steps of 1 m)
Transfer track	Single carriage/multiple carriages	Transfer	0.8 to 19.8 (in steps of 1 m) For every independent transfer track with a single carriage

[i] Travel length is the maximum distance that the carriage(s) can move.

Single carriage

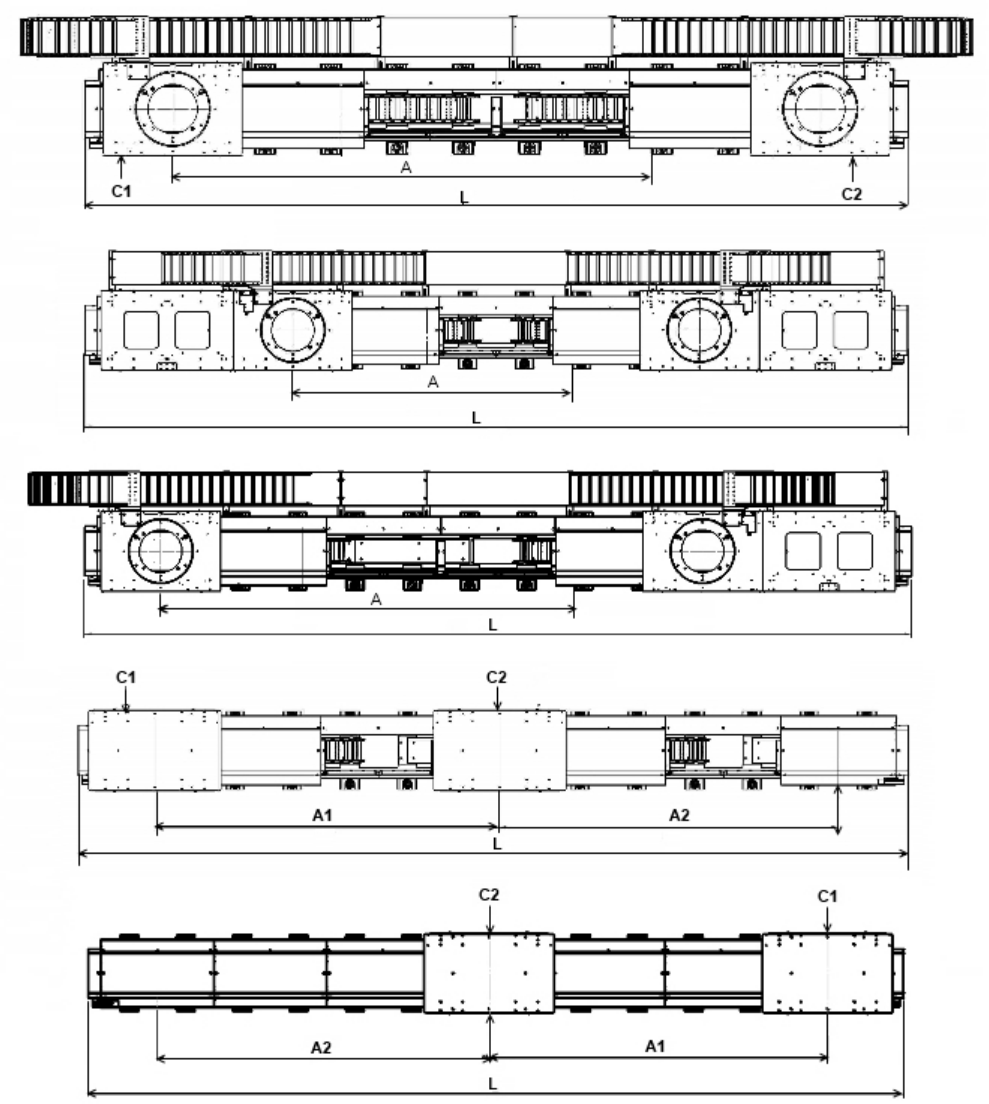


xx1500001397

Item	Description
L	Total length of linear guide = 230 + 1000 x N mm, in which N indicates the number of sections.
A	Travel length (in mm)

Continues on next page

Double carriages



xx1500001396

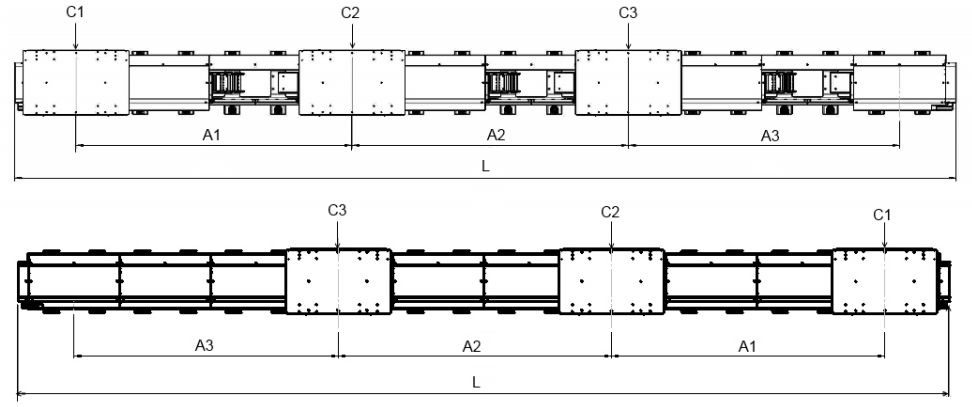
Item	Description
L	Total length of linear guide = 230 + 1000 x N mm, in which N indicates the number of sections.
A	Travel length (in mm) of one carriage on the robot track Note: The two carriages on the robot track have the same travel length.
A1	Travel length (in mm) of carriage 1 on the transfer track
A2	Travel length (in mm) of carriage 2 on the transfer track
C1	Carriage 1 For robot track, this carriage is always in standard mounting. For transfer track, refer to *Mounting of manipulator on the track on page 107* to acquire the mounting direction, standard or mirrored, of the carriage.

Continues on next page

2.3.5 Technical data for track motion
Continued

Item	Description
C2	Carriage 2 For robot track, this carriage is always in mirrored mounting. For transfer track, refer to *Mounting of manipulator on the track on page 107* to acquire the mounting direction, standard or mirrored, of the carriage.

Multiple carriages for transfer track



xx1500001398

Item	Description
L	Total length of linear guide = 230 + 1000 x N mm, in which N indicates the number of sections.
A1	Travel length (in mm) of carriage 1 on the transfer track
A2	Travel length (in mm) of carriage 2 on the transfer track
A3	Travel length (in mm) of carriage 3 on the transfer track
C1	Carriage 1 For transfer track, refer to *Mounting of manipulator on the track on page 107* to acquire the mounting direction, standard or mirrored, of the carriage.
C2	Carriage 2 For transfer track, refer to *Mounting of manipulator on the track on page 107* to acquire the mounting direction, standard or mirrored, of the carriage.
C3	Carriage 3 For transfer track, refer to *Mounting of manipulator on the track on page 107* to acquire the mounting direction, standard or mirrored, of the carriage.

Required space for track installation

Note

The following tables only provide the space that the track motion itself requires. There is possibilities that additional spaces are required at the ends of the track motion at the installation site. In this case, add spaces as required.

Formula for required space

Required space for the track is calculated using the following formula:

Continues on next page

Required space (mm) = 230 + (1000 x N)

In which, N indicates the number of sections.

Required space for installation of single carriage track - without external cable chain

The following table describes the required spaces for the installation of the tracks in different travel lengths without the external cable chain.

Travel length (m) [i]		Sections (pcs)	Required space for installation (m) [ii] [iii]
Robot/Transfer	Robot with extra plate	Value of N	
0.8	N/A	2	2.23
1.8	N/A	3	3.23
2.8	1.7	4	4.23
3.8	2.7	5	5.23
4.8	3.7	6	6.23
5.8	4.7	7	7.23
6.8	5.7	8	8.23
7.8	6.7	9	9.23
8.8	7.7	10	10.23
9.8	8.7	11	11.23
10.8	9.7	12	12.23
11.8	10.7	13	13.23
12.8	11.7	14	14.23
13.8	12.7	15	15.23
14.8	13.7	16	16.23
15.8	14.7	17	17.23
16.8	15.7	18	18.23
17.8	16.7	19	19.23
18.8	17.7	20	20.23
19.8	18.7	21	21.23

i The travel length is described in *Travel length on page 56*.
ii The measurement for the required space is valid when not using the external cable chain.
iii How to calculate the required space is described in *Formula for required space on page 58*.

Required space for installation of double carriage track - without external cable chain

The following table describes the required spaces for the installation of double carriage tracks in different travel lengths without the external cable chain.

Travel length (m) [i]			Sections (pcs)	Required space for installation (m) [ii] [iii]
Robot + Robot	Robot + Robot with extra plate	Robot with extra plate + Robot with extra plate	Value of N	
1.6	N/A	N/A	4	4.23
2.6	1.4	N/A	5	5.23

Continues on next page

2.3.5 Technical data for track motion

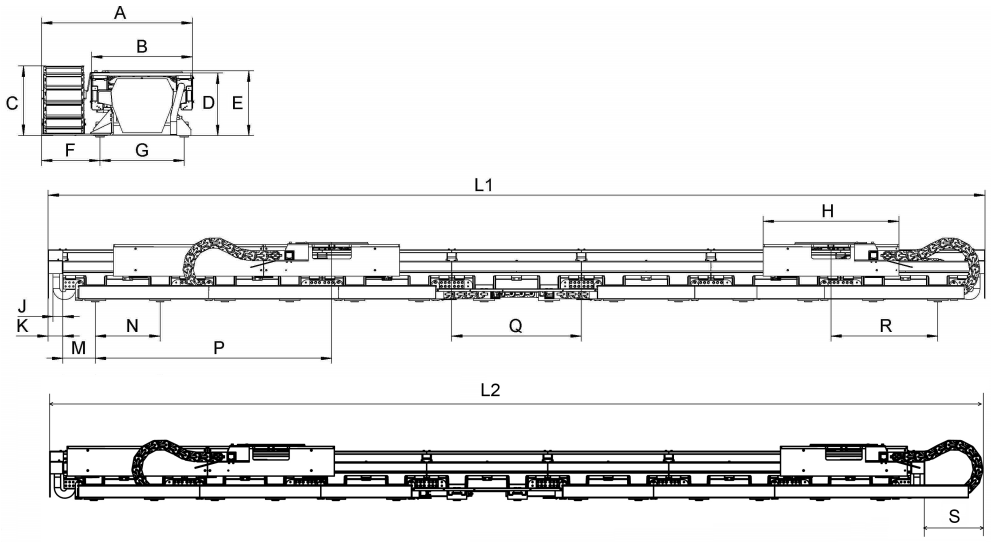
Continued

Travel length (m) [i]			Sections (pcs)	Required space for installation (m) [ii iii]
Robot + Robot	Robot + Robot with extra plate	Robot with extra plate + Robot with extra plate	Value of N	
3.6	2.4	1.3	6	6.23
4.6	3.4	2.3	7	7.23
5.6	4.4	3.3	8	8.23
6.6	5.4	4.3	9	9.23
7.6	6.4	5.3	10	10.23
8.6	7.4	6.3	11	11.23
9.6	8.4	7.3	12	12.23
10.6	9.4	8.3	13	13.23
11.6	10.4	9.3	14	14.23
12.6	11.4	10.3	15	15.23
13.6	12.4	11.3	16	16.23
14.8	13.4	12.3	17	17.23
15.6	14.4	13.3	18	18.23
16.6	15.4	14.3	19	19.23
17.6	16.4	15.3	20	20.23
18.6	17.4	16.3	21	21.23

i The travel length is described in *Travel length on page 56*.
ii The measurement for the required space is valid when not using the external cable chain.
iii How to calculate the required space is described in *Formula for required space on page 58*.

Dimensions

Without FlexLifter



xx1400000180

Continues on next page

Item	Description	Value (unit: mm)			
		Robot	Robot with extra plate	Transfer	External cable chain
A	Total width with external cable chain	1048			N/A
B	Total width	700			N/A
C	Height	N/A			490
D		N/A		435	N/A
E		450		N/A	N/A
F	Width from the outer edge of external cable chain to its nearby foot center	406			N/A
G	Width (foot print)	584			N/A
H	Carriage table length	1048	2209	1150	N/A
J	Distance between edges of the rack and mechanical stop	75.5			N/A
K	End cover	115			N/A
M	Distance between the rack edge and its nearest foot	250			N/A
N	Distance between two feet	500			N/A
Q	Section length	1000			N/A
P	Width from the center of first foot to the center of carriage table at calibration position	824.5	N/A	824.5	N/A
R		N/A	1824.5	N/A	N/A
S	Length of the external cable chain that exceeds the end of the track	N/A			0-490 [i]
L1	Total length of the track with internal cable chain	230 + (N x 1000) [ii] In which, N indicates the number of sections			N/A
L2	Total length of the track without external cable chain or with external cable chain but the chain does not exceed the end of the track [iii]	230 + (N x 1000) [ii] In which, N indicates the number of sections			N/A
	Total length of the track with one external cable chain exceeding the end of the track [iii]	720 + (N x 1000) [ii] In which, N indicates the number of sections			N/A
	Total length of the track with double external cable chains exceeding the end of the track [iii]	1210 + (N x 1000) [ii] In which, N indicates the number of sections			N/A

i For robot with extra plate, the external cable chain cannot exceed the end of the track.

ii The total length of IRBT 2005 depends on the quantity of modules, each of which is 1000 mm long. IRBT 2005 can be assembled with a minimum of 2 modules and a maximum of 110 modules.

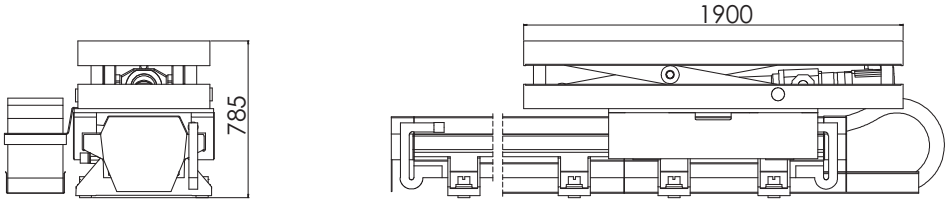
iii For details about the track with or without external cable chain and how the external cable chain exceeds the end of the track, see *Double carriages on page 57*.

Continues on next page

2.3.5 Technical data for track motion
Continued

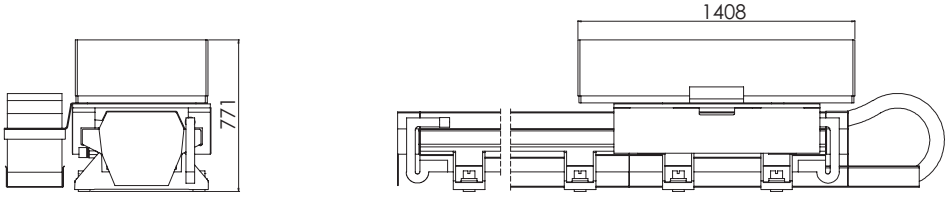
With FlexLifter

FlexLifter IRL 600



xx1700001514

FlexLifter IRL 100/190



xx1700001515

Note

Other dimensions are the same as those of the track motion without FlexLifter.

Weight of track motion and number of joined sections in transport

Formula for weight of track motion

Carriage quantity	Weight (Unit: kg; N indicates the number of sections)
Robot	W = 232 + 202 x N
Robot with extra plate	W = 375 + 202 x N
Transfer	W = 249 + 202 x N
Robot + Robot	W = 232 x 2 + 202 x N
Root + Robot with extra plate	W = (232 + 375) + 202 x N
Robot with extra plate + Robot with extra plate	W = 375 x 2 + 202 x N
Transfer + Transfer	W = 249 x 2 + 202 x N
Transfer + Transfer + Transfer	W = 249 x 3 + 202 x N
Parts prepared for lifters[i]	W = 126 +202 x N

i In scenarios where a lifter is to be installed on the track motion, weight of parts prepared for lifters must be used for calculation. One set of prepare parts weighs 126 kg. The complete weight of the track motion has to be calculated based on the actual sets of the prepare parts.
For details about the lifter weight, see respective lifter product manual.

Weight of single carriage track

Sections (pcs)	Joined sections in transport	Weight (kg)		
Value of N		Robot	Robot with extra plate	Transfer
2	1	636	779	653

Continues on next page

Sections (pcs)	Joined sections in transport	Weight (kg)		
Value of N		Robot	Robot with extra plate	Transfer
3	1	838	981	855
4	1	1040	1183	1057
5	1	1242	1385	1259
6	1	1444	1587	1461
7	1	1646	1789	1663
8	1	1848	1991	1865
9	1	2050	2193	2067
10	2	2252	2395	2269
11	2	2454	2597	2471
12	2	2656	2799	2673
13	2	2858	3001	2875
14	2	3060	3203	3077
15	2	3262	3405	3279
16	2	3464	3607	3481
17	2	3666	3809	3683
18	3	3868	4011	3885
19	3	4070	4213	4087
20	3	4272	4415	4289
21	3	4474	4617	4491

Weight of double carriage track

Sections (pcs)	Joined sections in transport	Weight (kg)			
Value of N		Robot + Robot	Robot + Robot with extra plate	Robot with extra plate + Robot with extra plate	Transfer + Transfer
4	1	1272	1415	1558	1306
5	1	1474	1617	1760	1508
6	1	1676	1819	1962	1710
7	1	1878	2021	2164	1912
8	1	2080	2223	2366	2114
9	1	2282	2425	2568	2316
10	2	2484	2627	2770	2518
11	2	2686	2829	2972	2720
12	2	2888	3031	3174	2922
13	2	3090	3233	3376	3124
14	2	3292	3435	3578	3326
15	2	3494	3637	3780	3528

Continues on next page

2.3.5 Technical data for track motion
Continued

Sections (pcs)	Joined sections in transport	Weight (kg)			
Value of N		Robot + Robot	Robot + Robot with extra plate	Robot with extra plate + Robot with extra plate	Transfer + Transfer
16	2	3696	3839	4184	3730
17	2	3898	4041	3982	3932
18	3	4100	4243	4386	4134
19	3	4302	4445	4588	4336
20	3	4504	4647	4790	4538
21	3	4706	4849	4992	4740

Weight of triple carriage transfer track

Sections (pcs)	Joined sections in transport	Weight (kg)
Value of N		Transfer + Transfer + Transfer
4	1	1555
5	1	1757
6	1	1959
7	1	2161
8	1	2363
9	1	2565
10	2	2767
11	2	2969
12	2	3171
13	2	3373
14	2	3575
15	2	3777
16	2	3979
17	2	4181
18	3	4383
19	3	4585
20	3	4787
21	3	4989

Weight of pedestal

Pedestal height (mm)[i]	Weight (kg)
250	70
500	95
750	165

Continues on next page

Pedestal height (mm)[i]	Weight (kg)
1000	190

[i] Heights 500, 750 and 1000 are unavailable for IRB 4600.

Airborne noise level

The sound pressure level outside the working space is less than 76 dB (A) / 1 m.

Power consumption at maximum load

Type of movement	IR(B)T
ISO Cube	Within specification for respective robot

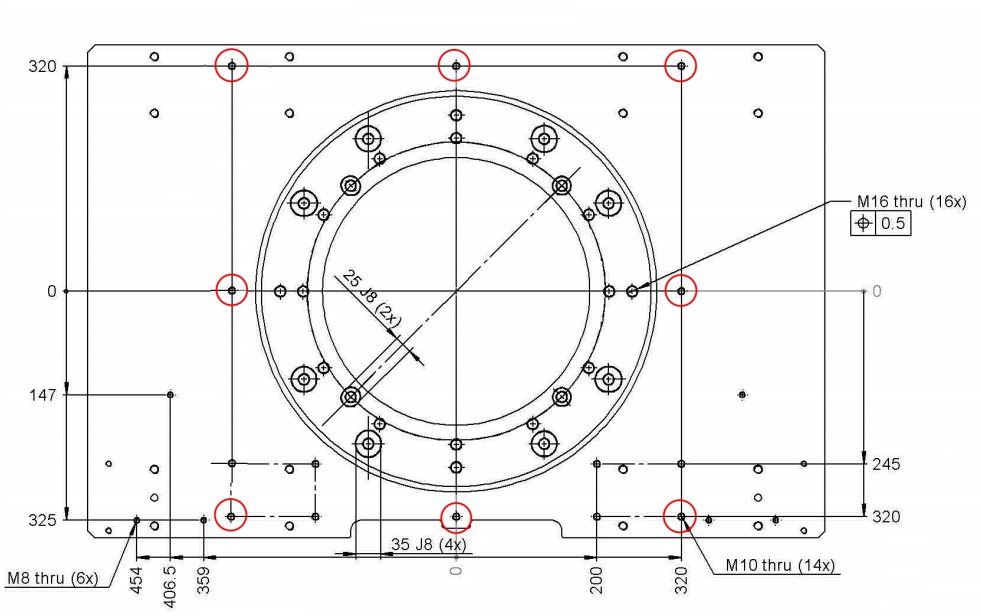
2.3.6 Measures of the carriage table

Robot carriage table

The robot carriage table is available to various robot models and the bolting patterns of the table match those of the robots. The robot carriage table is symmetrically designed to allow different manipulator mounting orientations (in line, 90 degrees, 180 degrees or 270 degrees) regardless of the table orientation.

Use the hole configuration for the manipulator when designing fixtures to be used on the track. The figures below show the dimensions of the robot carriage table in mm. Both tables on double carriage track are the same.

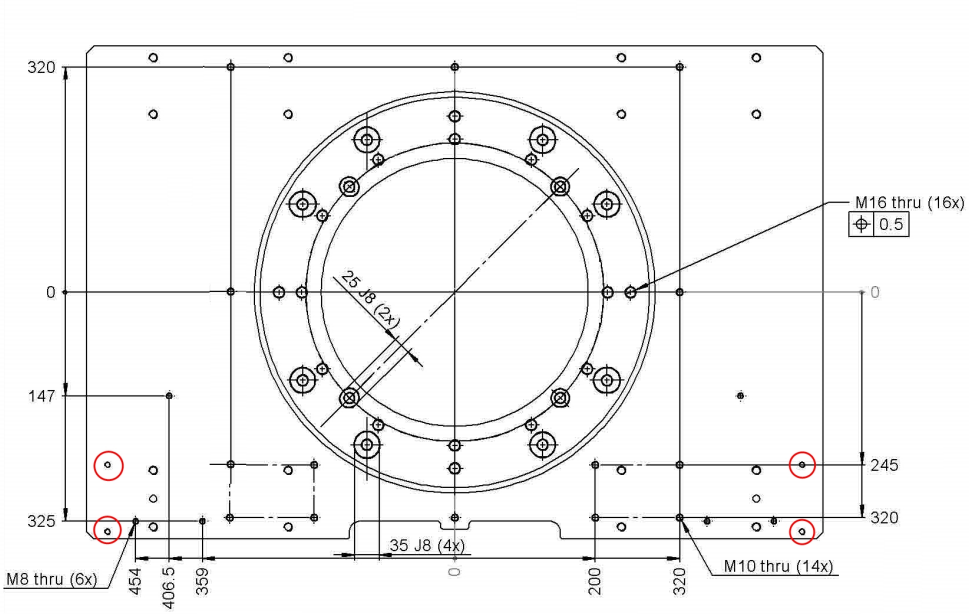
Eight M10 holes circled in the following figure are available for fastening the fixture on the carriage.



xx1400000467

Continues on next page

Two holes at each side of the carriage table, circled in the following figure, are available for ground cables.

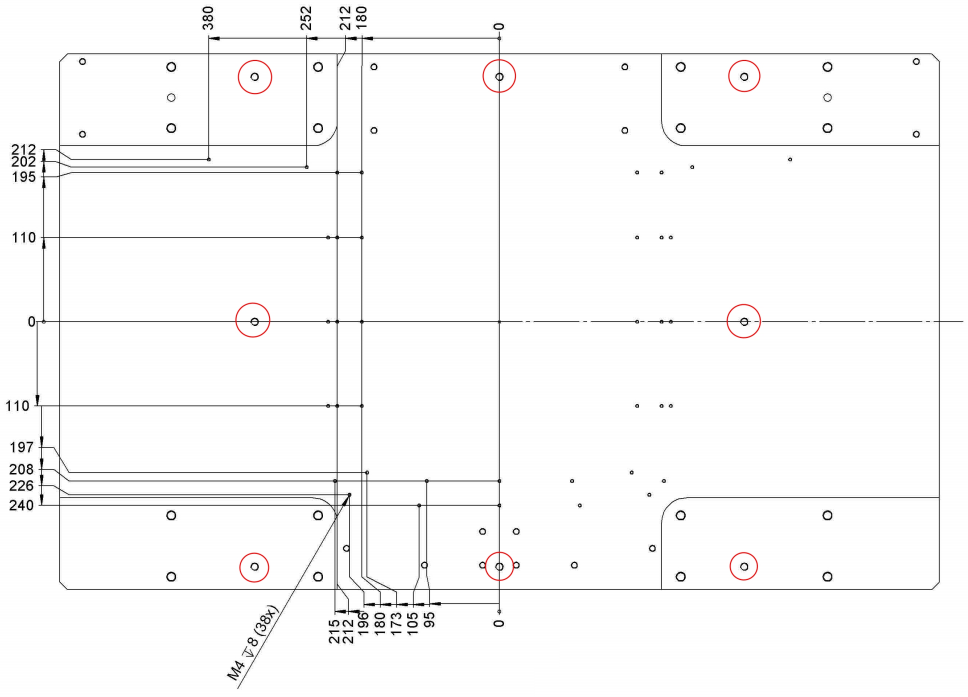


xx1500001610

Transfer carriage table

The figure below shows the dimensions of the transfer carriage table in mm.

Eight M10 holes circled in the following figure are available for fastening the fixture on the carriage.



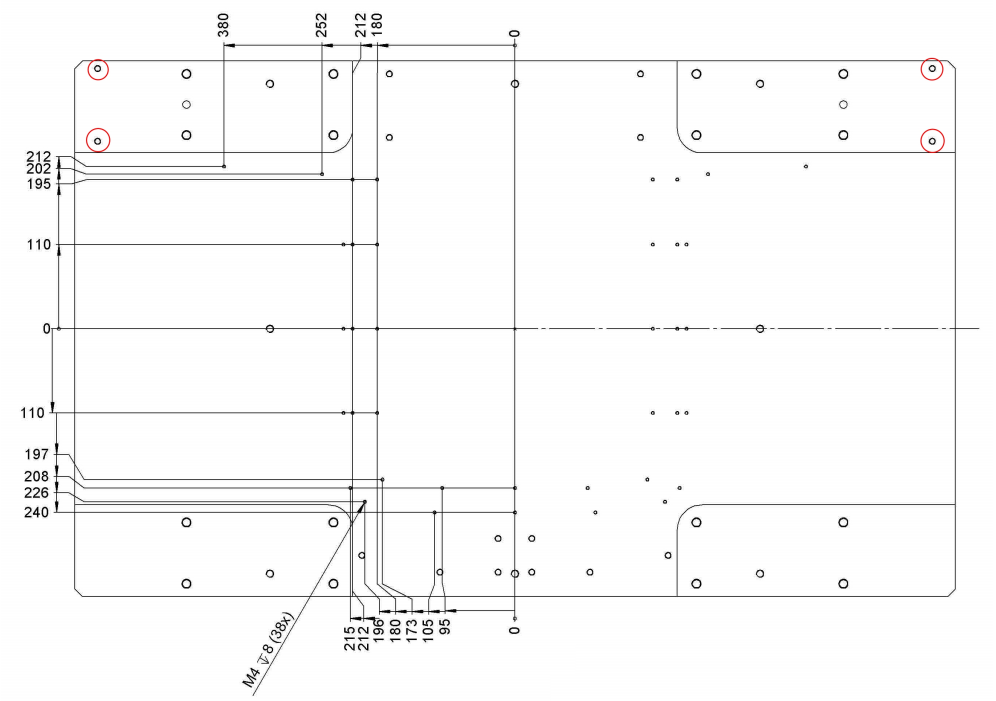
xx1400001407

Continues on next page

2.3.6 Measures of the carriage table

Continued

Two holes at each side of the carriage table, circled in the following figure, are available for ground cables.

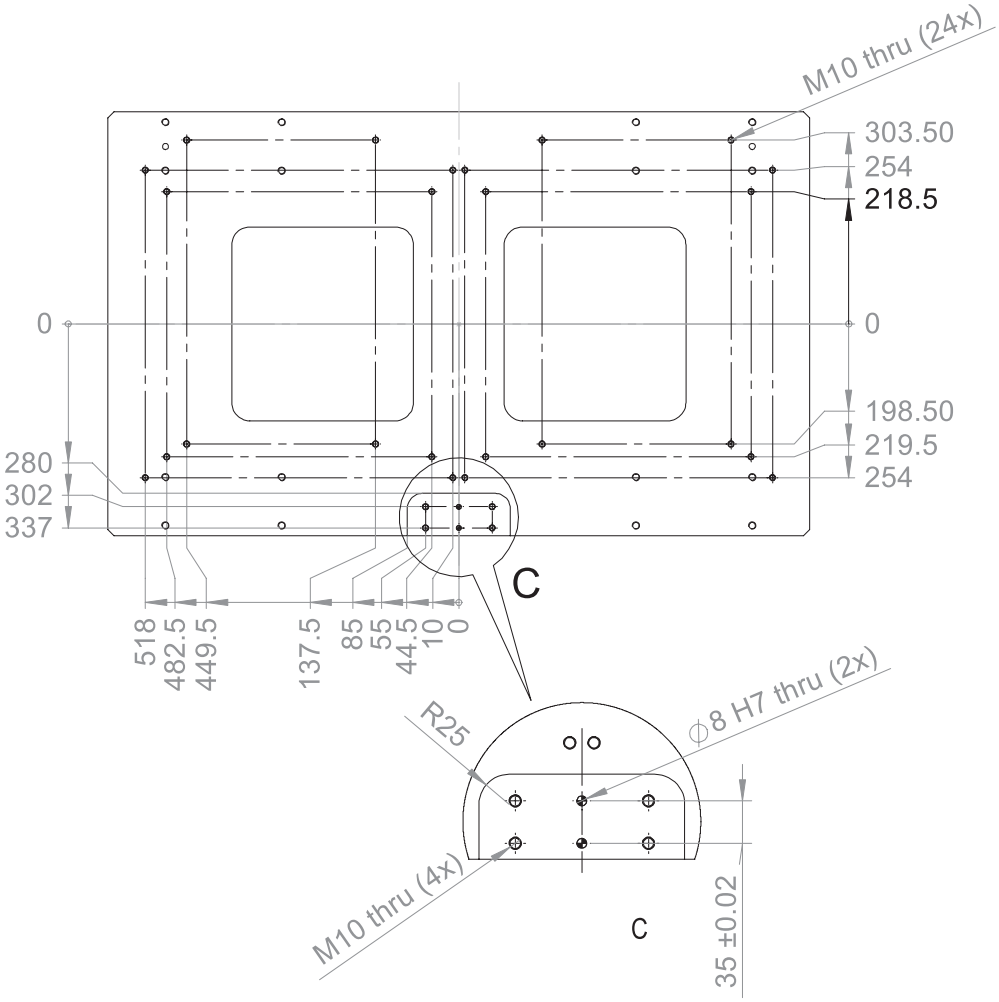


xx1500001611

Continues on next page

Extra plate

The figure below shows the dimensions of the extra plate in mm.



xx1400000462

Robot pedestal

The robot pedestal is designed to fix the robot.

The pedestal has two height models, 250 mm and 500 mm. Users can choose the suitable pedestal/pedestal combination to meet their requirements. The following height models can be provided by the pedestal/pedestal combination: 250 mm, 500 mm, 750 mm and 1000 mm.

Note

500mm, 750 mm and 1000 mm risers are not applicable to IRB 4600.

2.3.7 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.

2.4 On-site installation

2.4.1 Foundation

Robustness

The foundation must withstand the static loads caused by the weight of the equipment and the dynamic loads generated by the movement of the carriage and the manipulator. The minimum thickness of the concrete floor is 175 mm.

The concrete quality class must be at least C20/25 (or B25) to insure a good resistance of the anchor. Class C30/37 (or B35) is advisable.

The concrete compressive strength can be tested according to the European norm EN 206-1.

Inclination and flatness

The leveling of the track is done by screwing / unscrewing the M60 screws. However, in order to insure a good leveling, the foundation must be designed so that the track IRBT 2005 can be fitted without the incline exceeding 0.5 mm/m in the direction of travel and 0.2 mm/m across this. The leveling screws can also compensate a poor flatness of the slab and small bumps up to 10 mm. However, the surface under the leveling screw must be flat. A concrete surfacing grinder should be used to correct the flatness locally if necessary.

Maximum payload

The following table shows the maximum load that can be placed on the top plate of a carriage. At this maximum load, the following load would be distributed to each leveling screw.

Load	IRBT 2005
Max. load	The weight of IRBT 2005 payload + pedestal + 50 kg
Load on each leveling screw	Max. load/(2 x N), N is the number of sections

For weight of robots, see the product manual for the respective robot.

Maximum floor load

See the maximum floor loads in section *Forces*.

2.4.2 Mounting bolts

Mounting bolts

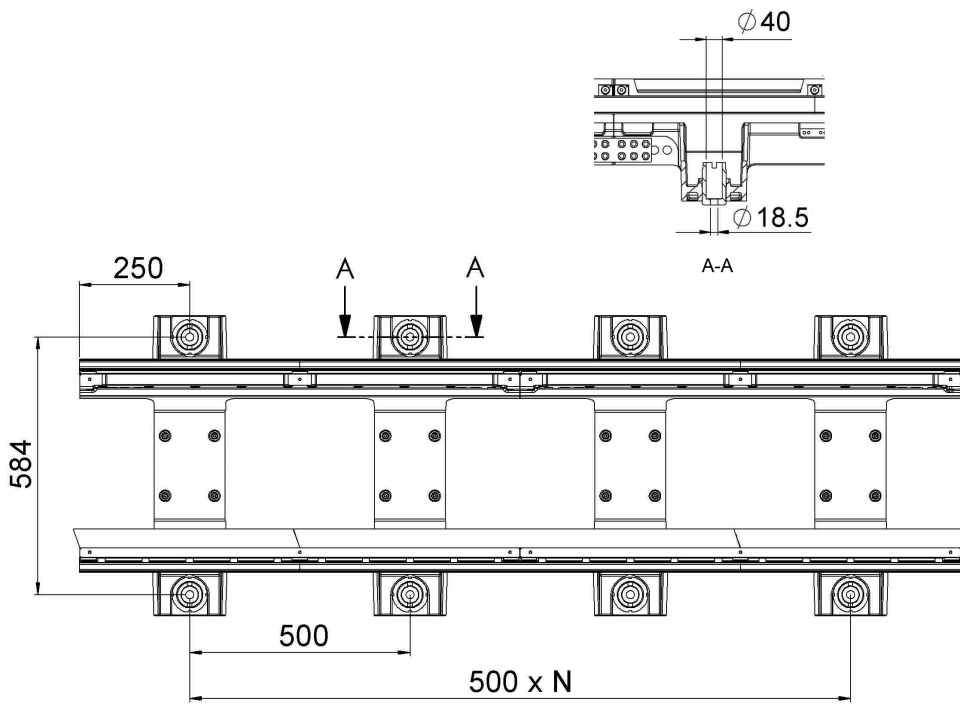
Chemical anchor bolts, bolting towards steel foundation, are recommended to secure the track motion IRBT 2005 to the floor. However, the mounting bolts are not supplied since they must be selected on the basis of the material the foundation is made of.

Choose mounting bolts so that they:

- Are suitable for the foundation.
- Can bear the dynamic loads.
- Are able to bear the combined dynamic loads that can occur when the manipulator and carriage move.
- Fit in the holes in the stand, Ø18.5 mm.

2.4.3 Hole configuration

Dimension



xx1400001434

The table describes the value of N in the figure above with different travel lengths.

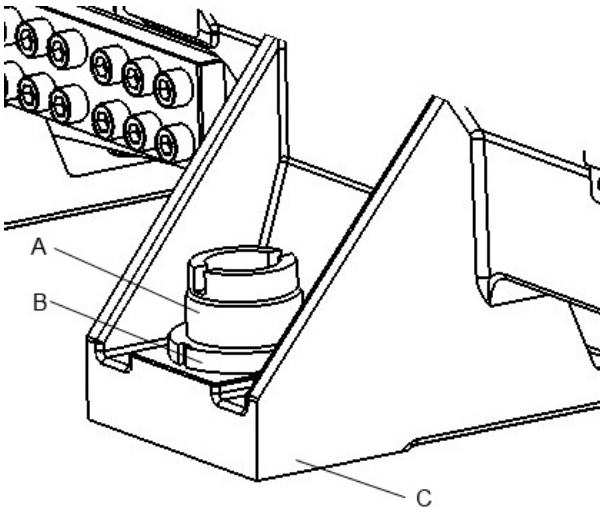
Travel length	Total length of the stand	Quantity N
2.8 / 1.6 m	4 m	4
3.8 / 2.6 m	5 m	5
4.8 / 3.6 m	6 m	6
etc.		

Continues on next page

2.4.3 Hole configuration
Continued

Hole configuration

The stands have leveling screws for adjusting the level of the track.



xx1400000649

Item	Art.	Art. No.	Note
A	Lifting threaded block M60x2,00	3HAW108201422	Leveling screw
B	Slotted nut KM12 for leveling screw	3HAWC100857	Fitting nut
C	-	-	Stand

Screws for fastening track to base

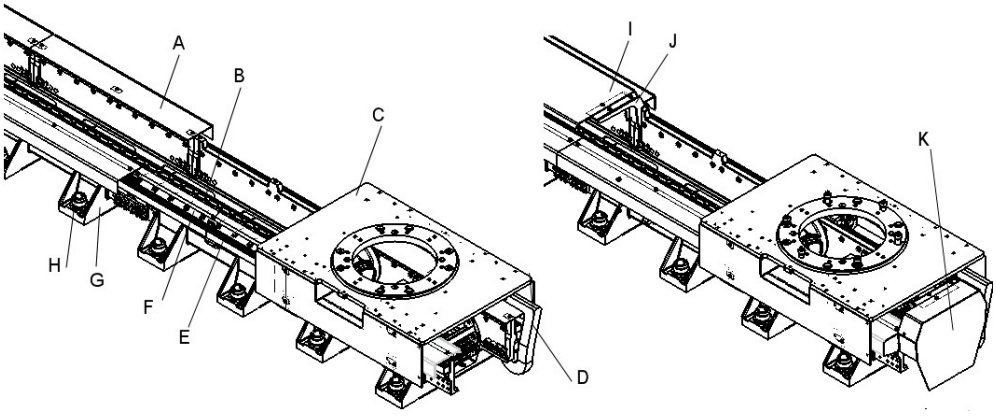
Attachment screws are not provided on delivery. Following table lists the recommended specification for the attachment screws. Users need to prepare the corresponding screws according to the actual application.

Foundation condition[i]	Recommended screw/washer specification
Steel structure	Screw: M16x50, ISO 4762, class 12.9 Washer: M16, DIN6796 Tightening torque: 300 Nm
Concrete floor	Screw: M16x190 (HAS 5.8, Hilti), valid length no less than 125 mm Tightening torque: 80 Nm

i The type and dimension of screws depend on the foundation conditions. See description for maximum floor loads in *Forces*.

2.4.4 Track motion IRBT 2005 overview

Track motion overview



xx1400000178

Pos	Description	Pos	Description
A	Rack cover	G	Section
B	Cable chain	H	Leveling screw
C	Carriage	I	Top cover
D	Mechanical stop	J	Top cover support
E	Linear guide	K	End cover
F	Rack		

CAUTION

Do not step on the cable chain or top cover; otherwise, injure and/or damage to the product may occur.

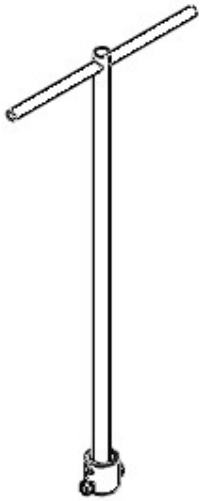
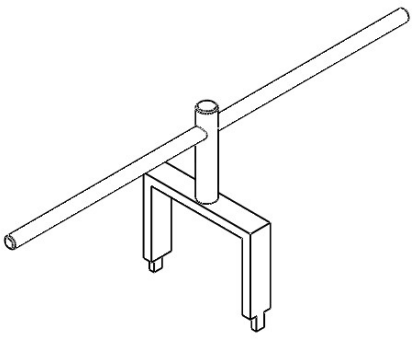
2.4.5 Assembling the sections of the track motion IRBT 2005 (Longer than 9 m)

Required equipment

Standard tools

Quantity	Tool
1	Ring-open-end spanner 8 - 22 mm
1	Small flat tip screwdriver
1	Torque wrench 10 -140 Nm
1	Ratchet head for torque wrench 1/2"

Special tools

Quantity	Description	Art. No.	Illustration
2	Rack clamps	-	
1	Leveling tool	3HAC054535-001	
1	Locking nut adjustment tool	3HAC054534-001	

Continues on next page

Quantity	Description	Art. No.	Illustration
1	Calibration pin	3HAW107700354	

Procedures of assembly

The track motion is separated into 9 meter track segments when delivered. Tracks longer than 9 meters are divided and delivered in segments as described in *Weight of track motion and number of joined sections in transport on page 62* and *Required space for track installation on page 58*. Use the following procedure to assemble the sections of the track motion IRBT 2005.

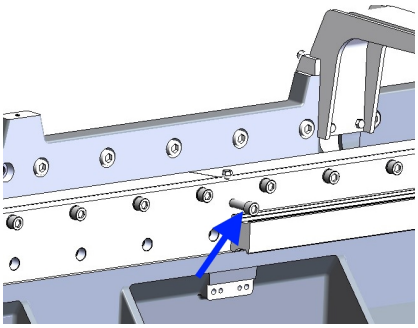
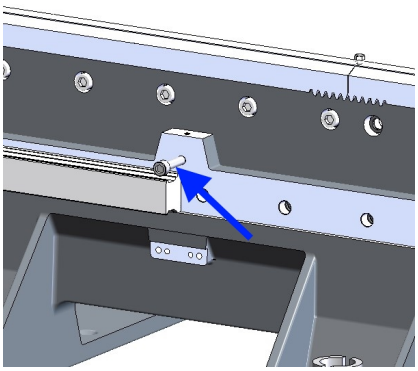
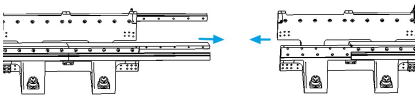
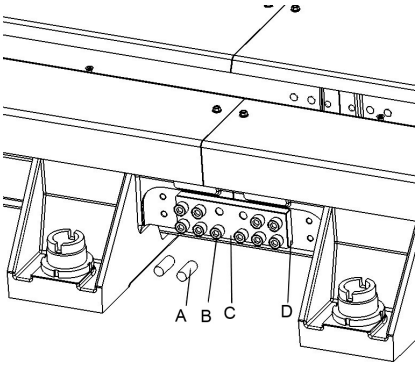
Positioning the sections

	Action	Illustration/Note
1	Mark up the required position of each IRBT 2005 section on floor.	**Note** Make sure that the floor is clean before the assembly.
2	Position the pre-assembled track sections according to the markup.	
3	Level the 9-meter track sections with the M60 leveling screws as described in *Geometric alignment of track motion IRBT 2005 on page 89*.	

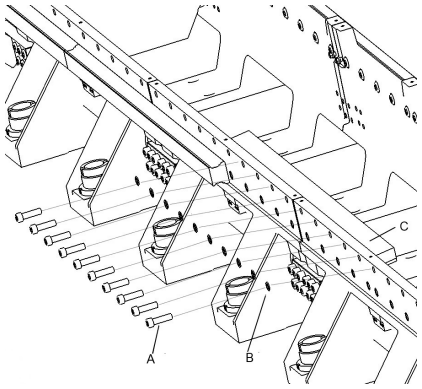
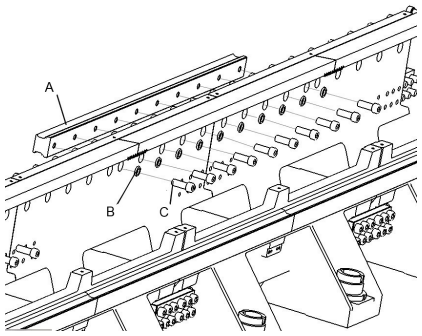
Continues on next page

2.4.5 Assembling the sections of the track motion IRBT 2005 (Longer than 9 m)
Continued

Assembling sections

	Action	Illustration/Note
1	Remove the bolts. **Note** To avoid the carriages from derailing during shipping, a bolt is fastened to the end of the linear guide rails on both sides of the track. These bolts act as temporary stops and must be removed before assembling the two halves.	 xx1500003181  xx1400001955
2	Fit one track section to the other at a position between the rack and linear guide.	 xx1400000469
3	Fit two positioning pins (A) using a hammer. In order to reach the same acceptable accuracy as in the manufacturing process, the joint bracket is drilled with two Ø 16-mm through holes and must be inserted with the two pins during assembling.	 xx1400001935 A Ø 16 mm positioning pin (2 pcs) B M12x40 Hex socket head cap screw, 3HAB3409-67 (10 pieces on each side) C Plate washer, 3HAC045077-001 D Joint bracket, 3HEA801652-001
4	Connect the sections with joint brackets (D) by fitting screws (B) and plate washers(C). Set the screw joint loosely. **Note** Do not tighten the screws yet.	

Continues on next page

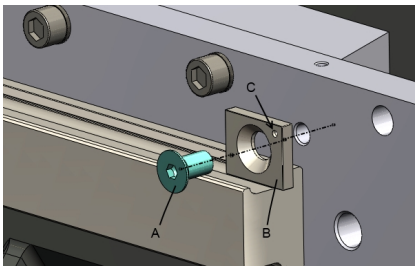
	Action	Illustration/Note
5	Fit racks on sections using screws and washers. Use a torque wrench. See *Screw joints on page 277*.	 xx1400000227 A M10x40 Hex socket head cap screw, 3HAB3409-50 B Ø17xØ11x2 Washer, 3HAB4233-1 C Rack
6	Install the racks. When the alignment is correct, tighten the screws one by one.	Tightening torque: 70 Nm **Note** Use the clamping and mounting racks at the ends of the rack section to make sure that the racks are tightly pushed against the section and perfectly aligned with each other. Use standard tools, slightly tighten.
7	Use a brush to lubricate the racks.	
8	Fit the linear guides on sections by fitting the screws and plain washer.	 xx1400000228 A Linear guide. 1000 mm: 3HAC045755-001, 500 mm: 3HAC045755-002 B Ø 12 x Ø 32 x 4 Plain washer for rail, 3HAC047749-001 C M12x35 Hex socket head cap screw, 3HAB3409-66 Tightening torque: 125 Nm

Continues on next page

2.4.5 Assembling the sections of the track motion IRBT 2005 (Longer than 9 m)
Continued

	Action	Illustration/Note
9	Slightly tighten all the screws of the linear guides and finalize the horizontal alignment of the IRBT 2005 as described in *Geometric alignment of track motion IRBT 2005 on page 89*.	

Inspecting clearance between linear guides

	Action	Illustration/Note
1	Unscrew one block from the carriage and use it to verify the linear guide alignment: if the linear guides are correctly aligned, you should sense no "step" while passing the railways junction. If a step is felt, push the rail against the section and verify that there is no clearance between the rails.	
2	If clearance is found to be over 0.7 mm, adjust the fixing screws of the linear guides to limit the clearance into allowed scope.	**Note** The installation holes of the linear guides are of the oval shape which allows the fine tuning of the linear guides in the x direction.
3	Secure the square locking washers with screws. **Note** Start fixing lock washers from the rear end.	 xx1400001751 A M10x20 Hex socket countersunk screw DIN7991, 3HAC051482-001 B Square locking washer, 3HEA802935-001 C Upper right mark Tightening torque: 40 Nm
4	When the alignment is correct, tighten the fixing screws of linear guides one by one.	Tightening torque: 40 Nm
5	If necessary, re-assemble the block in the carriage bracket. For how to disassemble and assemble ball bearing blocks, see *Replacing the ball bearing blocks on page 180*.	Tightening torque: 10 Nm
6	Use a brush to lubricate the linear guides.	

Tightening the join brackets

	Action	Illustration/Note
1	Tighten the joint brackets with the fixing screws.	Tightening torque: 100 Nm

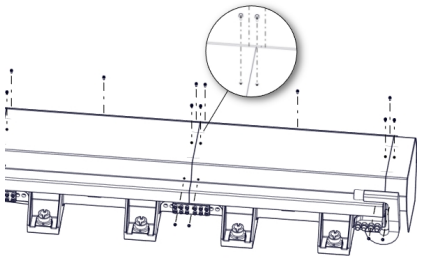
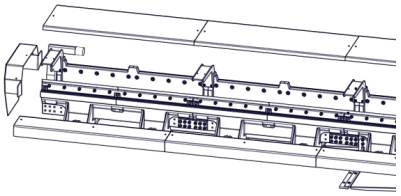
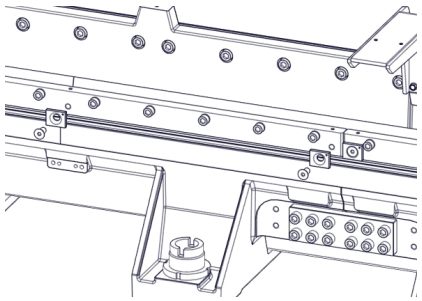
Continues on next page

Removing sections if too long

Use this procedure to remove sections if the track is too long, until the required track length is achieved.

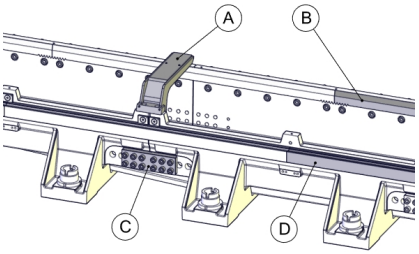
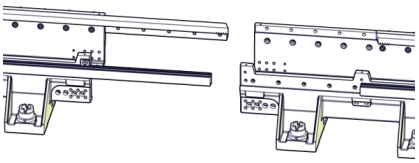
Tip

If sections need to be removed during the first-time assembly after delivery, it is OK to remove from any track segment. If sections need to be removed from an existed track, it is recommended to remove from the track end.

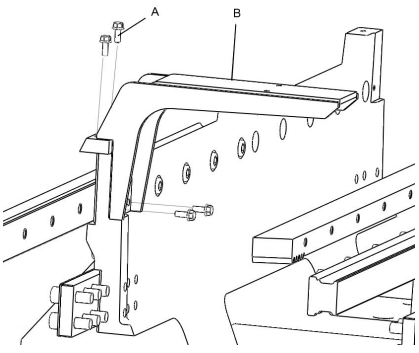
	Action	Illustration/Note
1	If required, press the brake release button to manually move the carriage sideways.	See *Moving the carriage manually on page 92*.
2	Remove cover screws.	 xx1500003251
3	Remove the covers of the sections to be removed. **Note** End covers need to be removed only when sections are to be removed from the track end.	 xx1500003252
4	Remove the square locking washers and screws, which clamp the linear guides at the junction.	 xx1500003253

Continues on next page

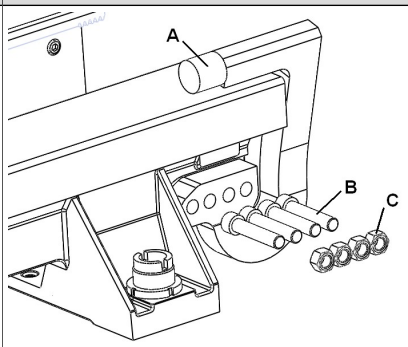
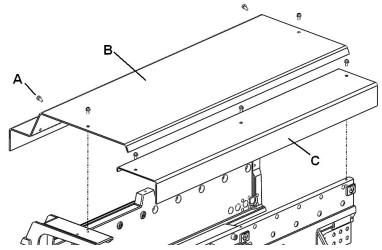
2.4.5 Assembling the sections of the track motion IRBT 2005 (Longer than 9 m)
Continued

	Action	Illustration/Note
5	Remove the top cover support, linear guides, the joint brackets and the rack by removing the screws.	 xx1500003254 A Top cover support B Rack C Joint bracket D Linear guides
6	Remove the excessive section.	 xx1500003255
7	Connect the shortened section modules with the next section module. See *Assembling sections on page 78*.	

Fitting covers

	Action	Illustration/Note
1	Fit the top cover support with screws.	 xx1400000229 A M6x16 Screw DIN6921, 9ADA181-12 Tightening torque: 10 Nm B Top cover support

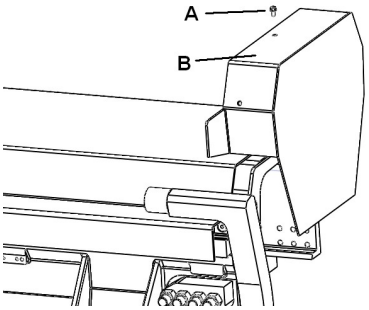
Continues on next page

	Action	Illustration/Note
2	Secure the two bumpers at the end of the track by screws and washers.	 xx1400000230 A Bumper, 3HEA801665-001 B M12x40 Hex socket head cap screw, 3HAB3409-206 Tightening torque: 79 Nm C Hexagon nut, 9ADA267-11
3	Release the carriage brake and push the carriage manually along the length of its stroke. Verify that the cable chain lies in the center of the track and does not collide with any other fixed parts. See section *Moving the carriage manually on page 92* for instructions on how to release the motor brake.	
4	Fit the rack covers (C) on top of the section with screws (A) and fix the top cover (B) on the top cover support with screws (A).	 xx1400000231 A M6x12 Screw DIN6921, 9ADA181-11 (7 pcs) Tightening torque: 10 Nm B Top cover of the track C Rack cover of the track

Continues on next page

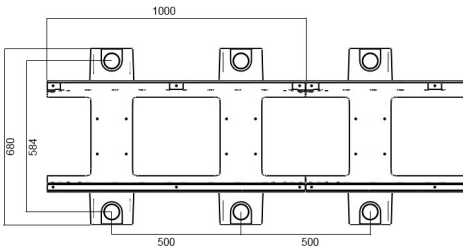
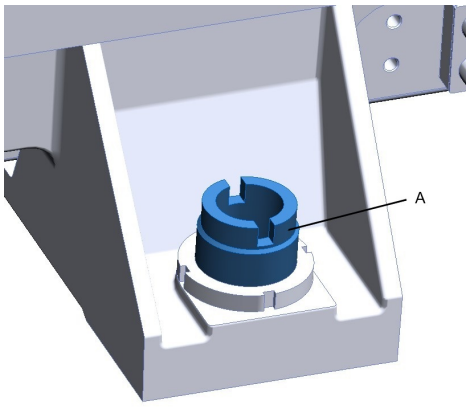
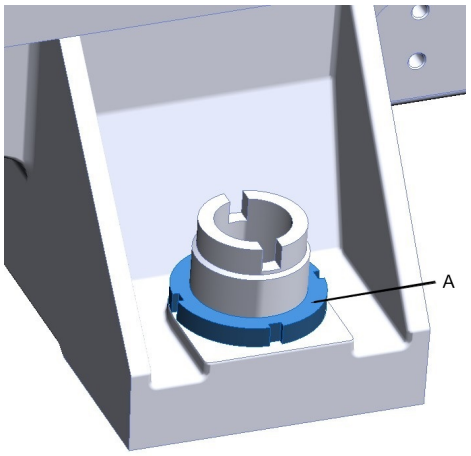
2.4.5 Assembling the sections of the track motion IRBT 2005 (Longer than 9 m)

Continued

	Action	Illustration/Note
5	Fit the top screw of the end covers if this option is ordered.	 xx1400001828 A M6x12 Screw DIN6921, 9ADA181-11 (7 pcs) Tightening torque: 10 Nm B End cover of the track
6	Release the carriage brake again and push the carriage manually along the length of its stroke. Verify that no covers come into contact with the moving carriage.	

2.4.6 Positioning the stand

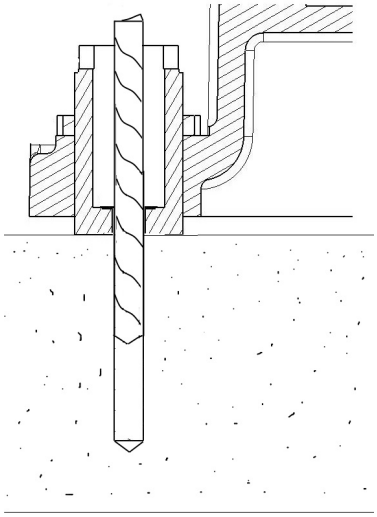
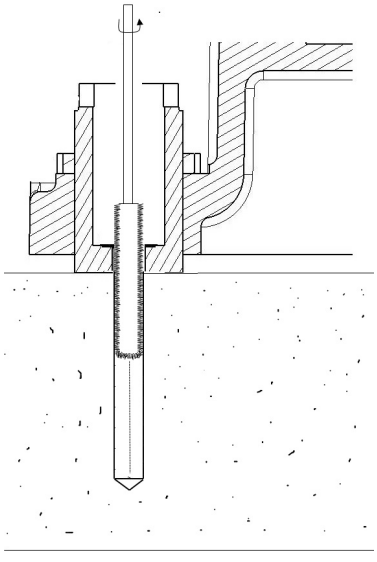
Positioning the stands

	Action	Illustration/Note
1	Position the sections in the intended work site. If more than one section is used, assemble them as described in *Assembling the sections of the track motion IRBT 2005 (Longer than 9 m) on page 76*.	 xx1400001410
2	Adjust the horizontality of the IRBT 2005 with the M60 leveling screw using the leveling tool (Art. No. 3HAC054535-001).	 xx1400000463 A Leveling screw
3	Make sure that all the leveling screws are touching the floor.	
4	Tighten the M60 fitting nuts using the nut adjustment tool (Art. No. 3HAC054534-001).	 xx1400000464 A Fitting nut

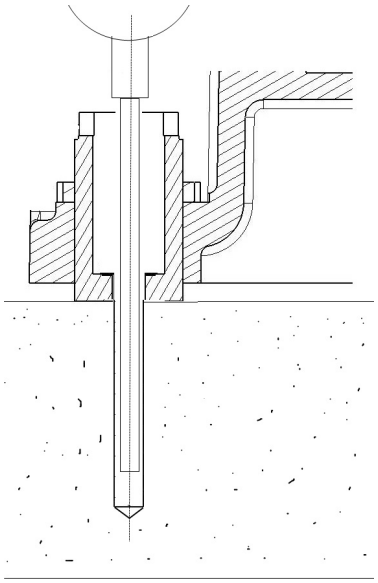
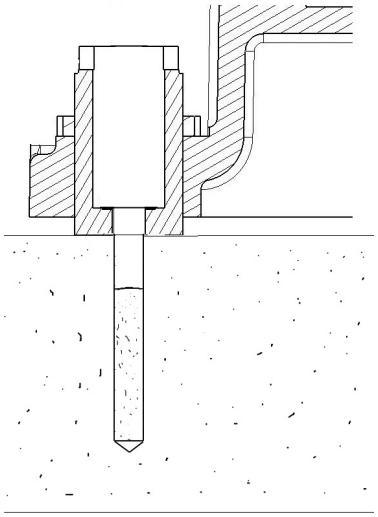
Continues on next page

2.4.6 Positioning the stand
Continued

Securing the sections

	Action	Illustration/Note
1	Drill a hole in the floor through the leveling screw: Ø 18.5 mm, 125 mm deep. **Note** It is recommended to use metric drills M16. If British Drills are used, the hole needs to be enlarged.	 xx1400000582
2	Brush the inside of the hole.	 xx1400000583

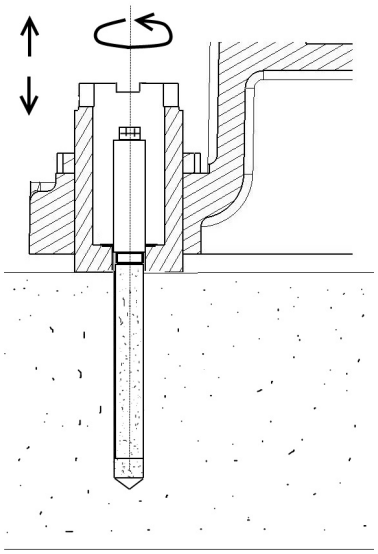
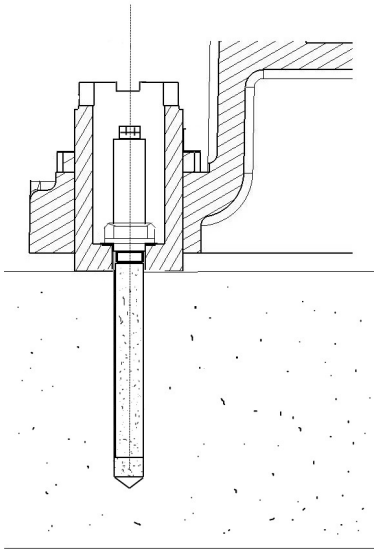
Continues on next page

	Action	Illustration/Note
3	Remove the dust after brushing the hole with a vacuum cleaner.	 xx1400000584
4	Introduce a glass capsule in the hole after verifying that the liquid inside the capsule is fluid.	 xx1400000585
5	Insert the HILTI tool supplied with the anchor kit in the chuck of a handheld electric punch drill. Insert the triangular extremity of the threaded rod in the HILTI tool.	

Continues on next page

2.4.6 Positioning the stand

Continued

	Action	Illustration/Note
6	Insert the rod in the hole and start the rotation + punching at 1000 rpm. The capsule will break and the rotating rod is mixing the melange. **Note** The hardening time before tightening depends on the ambient temperature: 2 hours < 10 °C ambient 1 hour < 20 °C ambient 40 minutes > 20 °C ambient.	 xx1400000586
7	If necessary, refine the adjustment of the track leveling using the M60 screws, and then tighten the M16 notched nuts. See *Geometric alignment of track motion IRBT 2005 on page 89*.	
8	Use the supplied washers, then tighten the nuts.	 xx1400000587 Tightening torque: 160 Nm

WARNING

It is of the utmost importance that all screw joints be tightened with the correct torque. Failure to do so may result in damage to the equipment or personal.

2.4.7 Geometric alignment of track motion IRBT 2005

Align the track geometrically with a laser level

Note

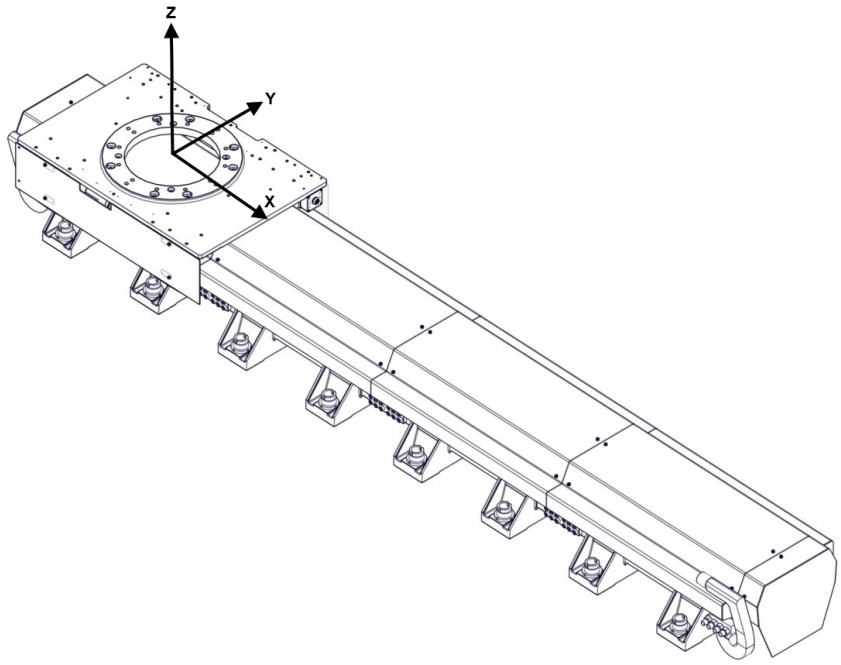
The origin of coordinates is located in the manipulator's base zero.

The geometric alignment of the track motion is done in order to adjust the carriage horizontally along the entire travel length. Use a laser level.

Required equipment

Equipment	Art. No.	Note
Laser level	-	

Directions



xx1400001830

Track alignment in different directions

Note

The origin of coordinates is located in the manipulator's base zero.

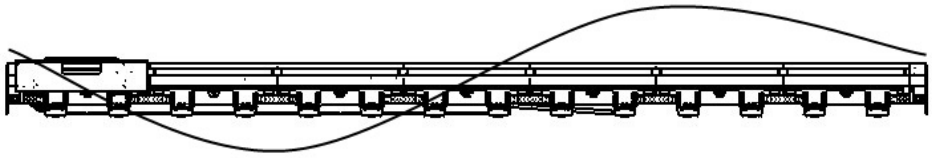
Continues on next page

2.4.7 Geometric alignment of track motion IRBT 2005
Continued

Alignment in Z direction

The figure shows the possible variation along the Z-axis.

The track should be laser aligned to within 0.2 mm from the origin per meter, along the entire X-axis.

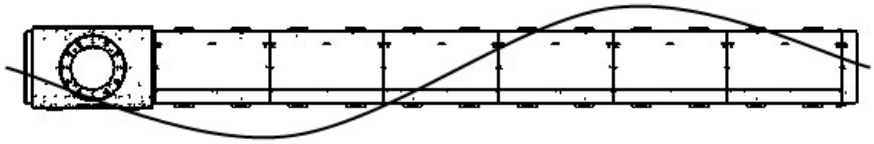


xx1400001473

Alignment in Y direction

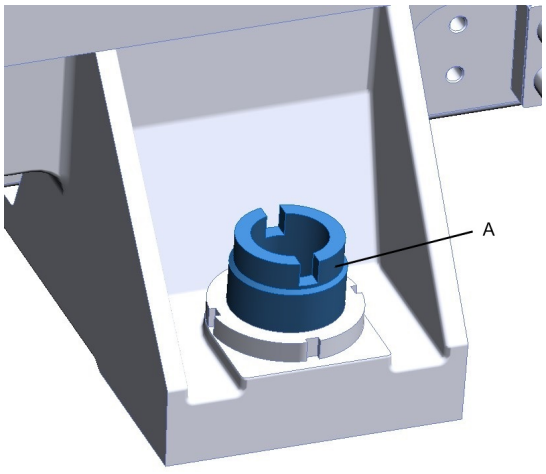
The figure shows the possible variation along the Y-axis.

The track should be laser aligned to within 0.5 mm from the origin per meter, along the entire X-axis.

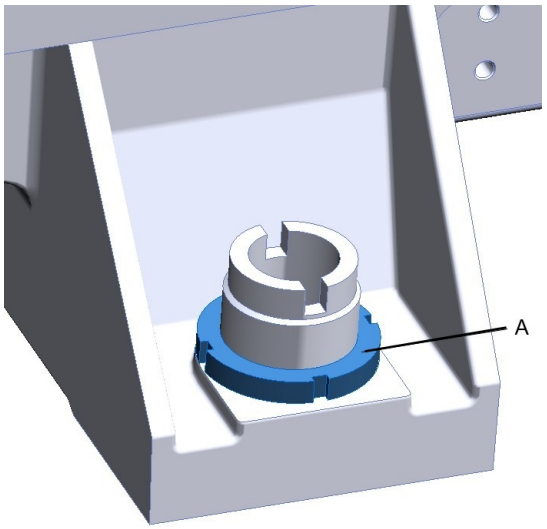


xx1400001474

Leveling screw adjustment method

	Action	Illustration/Note
1	Screw the leveling screw (A) in or out to raise or lower the machining in question.	 xx1400000463 A Leveling screw

Continues on next page

	Action	Illustration/Note
2	Tighten the fitting nut when the level of the complete track is adjusted.	 xx1400000464 A Fitting nut

2.4.8 Moving the carriage manually

Releasing the brake

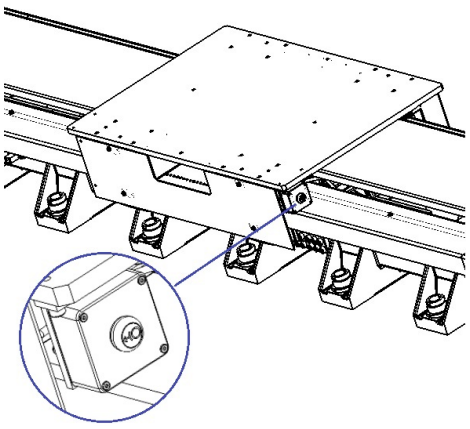
The carriage can be moved manually to another position on the track if necessary by connecting the power cable to the controller and releasing the brake.

It is recommended that the carriage is manually moved along its complete stroke after being installed and before running the track using the IRC5. This is to ensure that there is no risk of collision other equipment in the vicinity of the track.

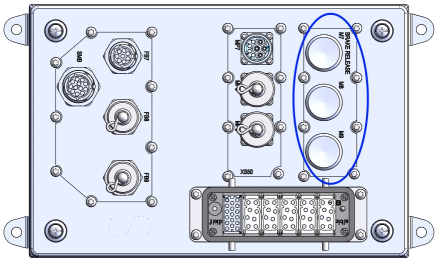
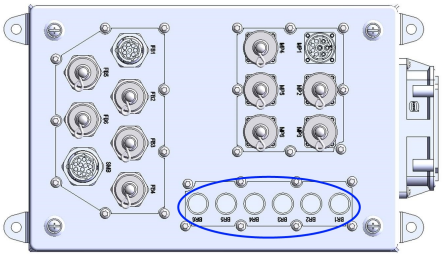
If there is no voltage to the motor, 24 VDC can be connected directly to the motor as described in *Releasing the brake with external 24 V DC on page 93*.

Note

If the carriage is moved manually, without connection to the IRC5 but by simply connecting directly 24 V DC to the motor to release the brake, a recalibration is needed.

	Action	Illustration/Note
1	Connect all cables to the controller as described in *The cabling from the controller on page 115*.	
2	Start up the controller as described in *Connectors on controller, IRC5 on page 118*.	
3	Release the holding brake by pressing the brake release button on the carriage and keep it pressed.	 xx1400000465

Continues on next page

	Action	Illustration/Note
4	For the transfer track with 3-axis or 6-axis SMB box, you can also: Release the holding brake on a particular axis by pressing the corresponding button and keeping it pressed. **Note** The buttons are numbered according to the numbers of the axes.	Brake release buttons on 3-axis SMB box:  xx1500000765 Brake release buttons on 6-axis SMB box:  xx1500000766
5	Push the carriage to the desired location by hand.	
6	The brake will function again as soon as the button is released.	

Note

Care should be taken when moving the track manually. There is a risk of severe injury to hands near the calibration pin, as well as at the location where the rack and pinion mesh.

Users should remain clear of these locations when moving the track.

Releasing the brake with external 24 V DC

If there is no voltage to the motor, 24 V DC can be connected directly to the brake release.

Note

If the carriage is moved manually, without connection to the IRC5 but by simply connecting directly 24 V DC to the motor to release the brake, a recalibration is needed.

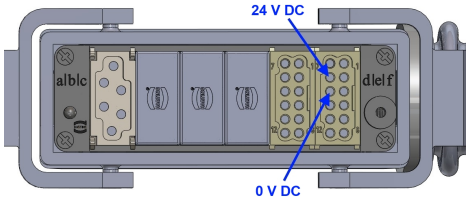
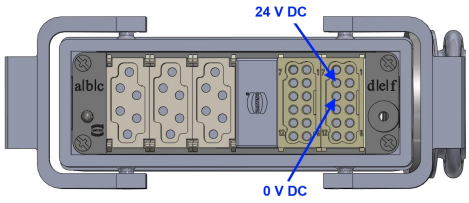
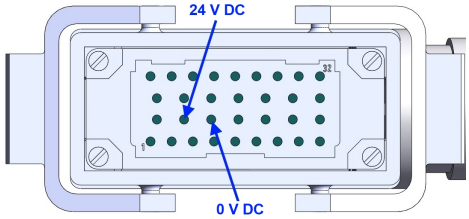
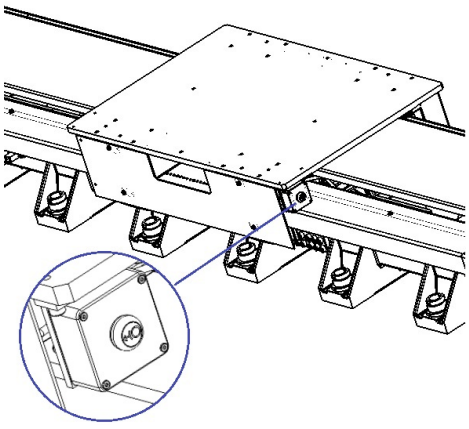
CAUTION

The motor brakes on the track motion IRBT 2005 are phase dependent. Incorrect polarity and unstable connection can cause damage to vital parts.

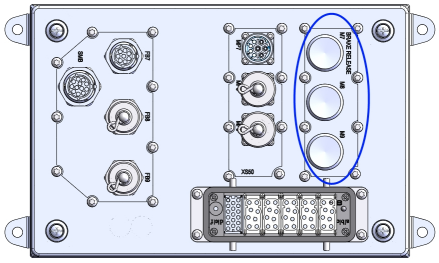
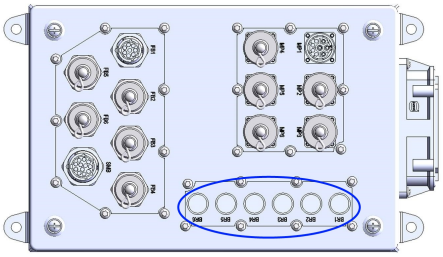
Continues on next page

2.4.8 Moving the carriage manually

Continued

	Action	Illustration/Note
1	For the robot track and transfer track with 3-axis SMB box: Disconnect the power cable connector XP7 from the controller.	For the location of the connector XP7, see *Single Cabinet Controller on page 118*.
2	For the transfer track with 6-axis SMB box: Disconnect the power cable connector XP1 from the controller.	For the location of the connector XP1, see *Single Cabinet Controller on page 118*.
3	Connect the external 24 V DC power supply to the power cable connector. • Connect 24 V DC to pin f.8 (for connector XP7) or XP1.11 (for connector XP1) • Connect 0 V DC to pin f.9 (for connector XP7) or XP1.12 (for connector XP1) **Note** Be careful not to interchange the 24 V and 0 V 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.	Pin location on connector XP7 for the robot track:  xx1500000762 Pin location on connector XP7 for the transfer track with 3-axis SMB box:  xx1500000763 Pin location on connector XP1 for the transfer track with 6-axis SMB box:  xx1500000764
4	Release the holding brake by pressing the brake release button on the carriage, which is shown in the figure, and keeping it depressed.	 xx1400000465

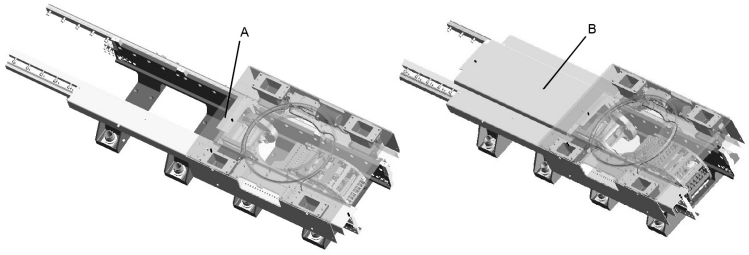
Continues on next page

	Action	Illustration/Note
5	For the transfer track with 3-axis or 6-axis SMB box, you can also: Release the holding brake on a particular axis by pressing the corresponding button on the 3-axis or 6-axis SMB box and keeping it depressed.	Brake release buttons on 3-axis SMB box:  xx1500000765 Brake release buttons on 6-axis SMB box:  xx1500000766 **Note** The 3-axis SMB box has three buttons for controlling the axes brakes, and the 6-axis SMB box has six buttons. The buttons are numbered according to the numbers of the axes.
6	Push the carriage to the desired location by hand.	
7	The brake will function again as soon as the button is released.	

2.4.9 Connecting long tracks

Track extension

The track extension is an extension to an existing track. There are two types of track extension: covered track extension and standard track extension. Extensions are applied for the transfer track.



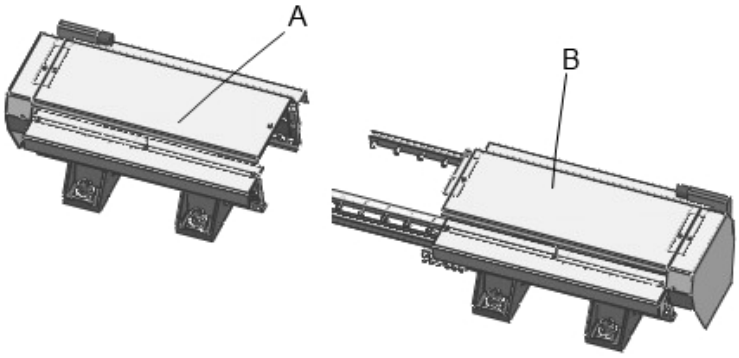
xx1400002677

A	Standard track extension
B	Covered track extension

Procedures of long track connection

Removing one end section of the track

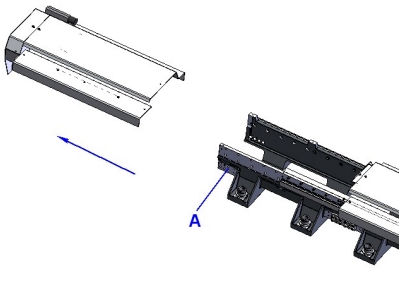
A track motion has two end sections (A and B in the following figure). Remove one of the end section as required.



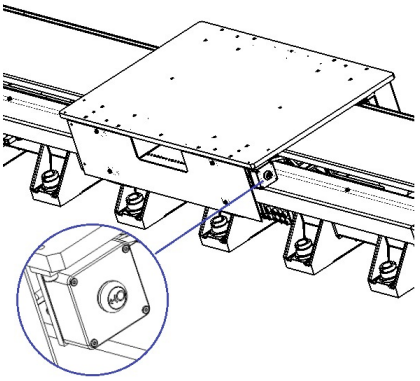
xx1400002676

	Action	Illustration/Note
1	Remove the top cover and rack cover of the end section.	

Continues on next page

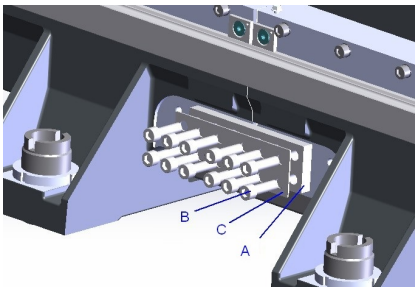
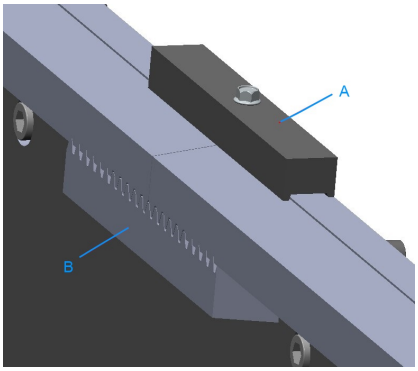
	Action	Illustration/Note
2	Remove the top cover support, joint bracket, and mechinical stop, and the last 0.5 m linear guides and racks on the end section. In this case, the extension section can be connected directly to the stand of the end section without removing the whole end section.	 xx1400002678 A Stand of end section

Connecting the extension section to existing track

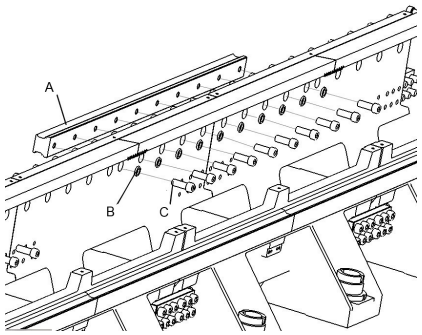
	Action	Illustration/Note
1	Lift the extension section to desired location. Part of the section should be inserted between the rack and linear guide on the original track section.	Lifting is specified in *Lifting and moving track motion IRBT 2005 on page 45*.
2	Press the brake release button of extension section as shown in the figure.	 xx1400000465
3	Push the carriage by hand to show the rack and linear guide of extension section.	
4	Removed the cover on extension section if the section is covered track extension.	
5	Remove the bolts that are used as temporary stops on both sides of the extension section. **WARNING** A track that is divided in sections has a bolt fastened to the end of the linear guides on both sides of the track in order to avoid the carriages from derailing during shipping. The bolts act as temporary stops and **must be removed** before assembling the sections.	

Continues on next page

2.4.9 Connecting long tracks
Continued

	Action	Illustration/Note
6	Connect the section with joint brackets (A) by fitting screws (B) and plate washers(C). Set the screw joint loosely. **Note** Do not tighten the screws yet.	 xx1500000500 A Joint bracket, 3HEA801652-001 B M12x40 Hex socket head cap screw, 3HAB3409-67 (12 pieces on each side) C Plate washer, 3HAC045077-001
7	Install the racks. Fit the companion rack fix block and companion rack to the section and the rack to make sure the racks are positioned correctly in vertical plane.	 xx1400002156 A Companion rack fix block, 3HAC054531-001 B Companion rack, 3HAC054532-001
8	Fit the clamping tools at both ends of the rack to make sure that the racks are aligned with each other.	 xx1400000184 **Note** This clamping tool is for reference only. Prepare clamping tools based on actual situation.

Continues on next page

	Action	Illustration/Note
9	Push the rack against the section mounting surface, make sure the alignments are correct and then tighten the screws one by one.	Tightening torque: 40 Nm **Note** Use the clamping and mounting racks at the ends of the rack section to make sure that the racks are tightly pushed against the section and perfectly aligned with each other. Use standard tools, slightly tighten.
10	Use a brush to lubricate the racks.	
11	Fit the linear guides and inspect linear guides gap.	
12	If the gap is found to be over 0.7 mm, you should adjust the gap of adjacent linear guide or more linear guide until gap between all linear guides are less than 0.7 mm.	
13	Fit the linear guides on sections by fitting the screws and plain washer.	 xx1400000228 A Linear guide. 1000 mm: 3HAC045755-001, 500 mm: 3HAC045755-002 B Ø12xØ32x4 Washer for rail, 3HAC047749-001 C M12x35 Hex socket head cap screw, 3HAB3409-66 Tightening torque: 140 Nm
14	**Note** Use the rail pressing tool to make sure that the linear guides are pushed against the section mounting surface. Make sure the lower edge of the linear guide rests against the mating surface of the section without gap.	

Continues on next page

2.4.9 Connecting long tracks
Continued

Refitting the end section of the track

	Action	Illustration/Note
1	Refit top cover support, linear guides, joint brackets, mechanical stop, and the rack at the end side. **Note** You should make sure the rack alignments are correct and the linear guides gap all less than 0.7 mm.	
2	Refit all the covers to be refitted.	

Securing the connected long track to the floor

1 After assembly, all the leveling screws should touch the floor. Adjust if necessary and tighten the locking nut. See *Positioning the stands on page 85*.
2 Move the carriage all along the track way, and verify the leveling with a leveling device or a laser tracker. The levelness of the top plate must be satisfying in the translation direction, but also cross section. For how to adjust the leveling of the track, see *Geometric alignment of track motion IRBT 2005 on page 89*. If you have moved the carriage manually, you probably need to initialize the resolver position, see *Update revolution counters on page 267*.
3 Drill the holes in the floor through the leveling screws opening and install the anchors and secure the sections to the floor. See *Securing the sections on page 86*.

2.4.10 Assembling the pedestal (option)

Overview

The pedestal, if ordered, is not mounted to the track motion at delivery.

Install the pedestal to the track motion according to this section.

Required equipment

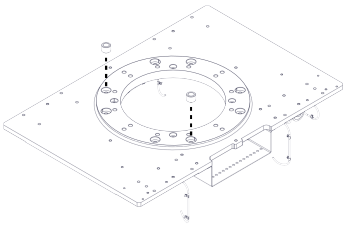
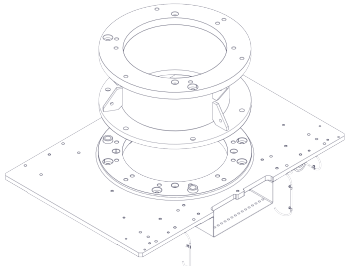
Equipment	Article number	Note
Lifting eye, M16	-	2 pcs
Lifting slings	-	Lifting capacity according to pedestal weight.

Weight of pedestal

Pedestal height (mm)[i]	Weight (kg)
250	70
500	95
750	165
1000	190

[i] Heights 500, 750 and 1000 are unavailable for IRB 4600.

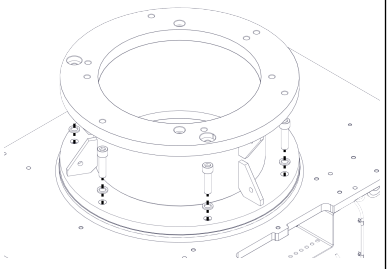
Assembling the pedestal

	Action	Note
1	Fit guide sleeves to the track motion. Pay attention to the location.	Guide sleeve (2 pcs)  xx2000001768
2	Fit lifting eyes to the pedestal.	Lifting eye, M16 (2 pcs)
3	Lift the pedestal to the mounting position using lifting slings and lower the pedestal to the track motion.	The following is a pedestal example.  xx2000001769

Continues on next page

2.4.10 Assembling the pedestal (option)

Continued

	Action	Note
4	Secure the pedestal with attachment screws and washers.	Hex socket head cap screw M16x60, Steel 12.9 Gle 603 (6 pcs) Plain washer 17x30x3, Steel-A3F (6 pcs) Tightening torque: 250 Nm  xx2000001770

2.5 Assembling the manipulator and cable tray

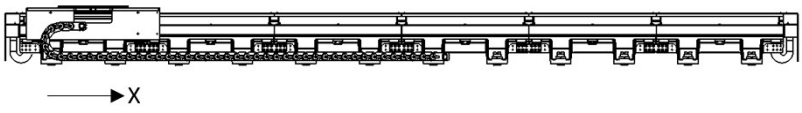
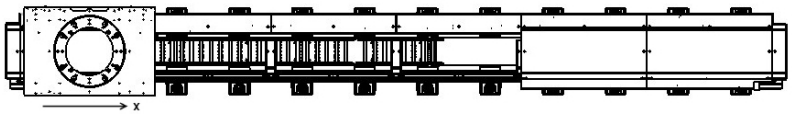
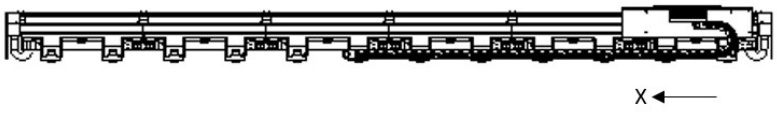
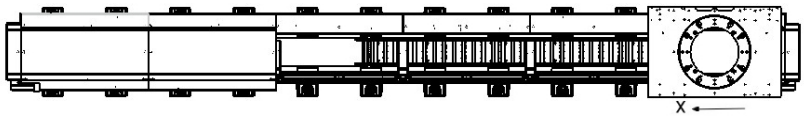
2.5.1 Assembling the manipulator

Overview

When IRBT 2005 is associated with an IRB robot, it behaves like an integrated 7th axis. However, the robot controller must fulfill some requirements to get an optimum integration. IRBT 2005 has been designed for ABB IRC5 controller. For how to link the robot to the track and how to orient the manipulator, see *Software installation on page 120*.

Cable chain orientation

There are two orientations to fit the cable chain.

Standard cable chain orientation	Side view:  xx1500000597 Top view:  xx1400001952
Mirrored cable chain orientation	Side view:  xx1500000630 Top view:  xx1400001951

Robot capacity

The following table shows the robot capability of IRBT 2005.

Standard pedestals are generally allowed between the IRBT 2005 carriage and the robot but their height is limited and dependent on the type of the IRBT 2005 and the type of robot.

Continues on next page

2.5.1 Assembling the manipulator
Continued

The following table defines what types of pedestals are applicable for the corresponding robot. x means that the pedestal is applicable.

Robot	250 mm pedestal	500 mm pedestal	750 mm pedestal	1000 mm pedestal
IRB 1520	x	x	x	x
IRB 1600	x	x	x	x
IRB 2600	x	x	x	x
IRB 4600	x	N/A	N/A	N/A

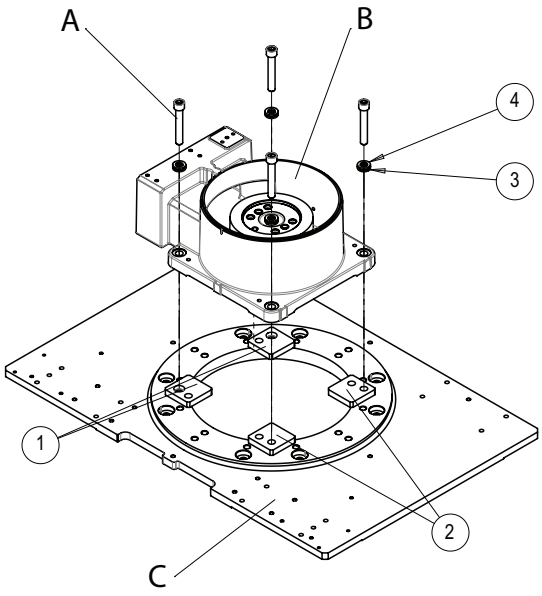
Installing the insulation kit

Insulation kits are delivered with the IRBT 2005 when arc welding options 1436-X or 1449-X are selected. The type of the actual delivered insulation kit depends on the selected robot type.

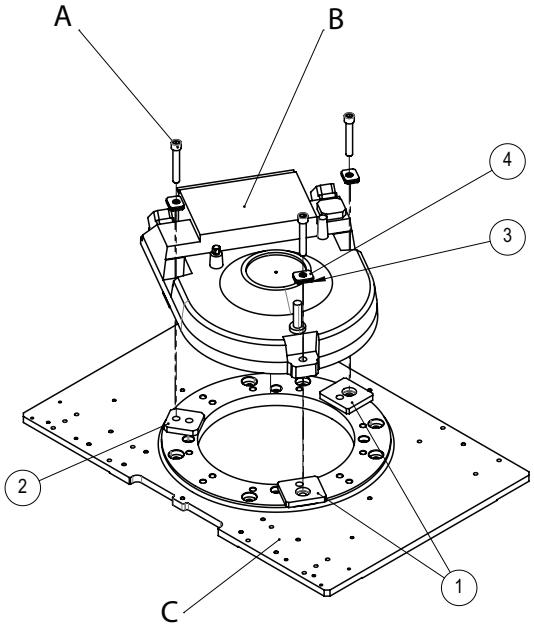
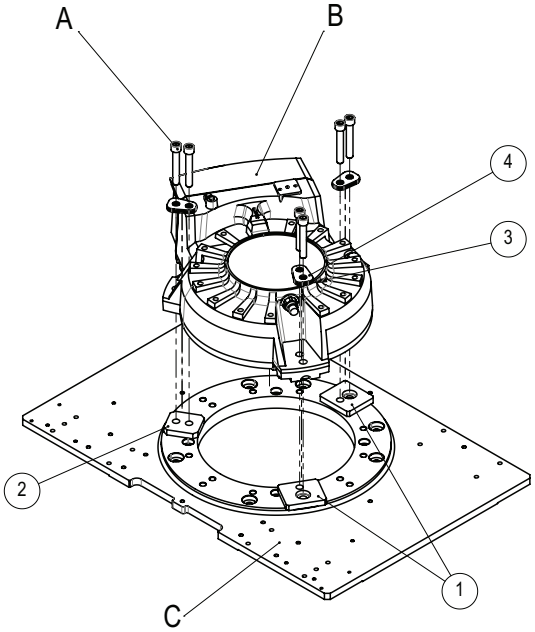
Required parts and quantity

Robot type	Parts in insulation kit							
	Bottom insulation washer with pin hole		Bottom insulation washer w/o pin hole		Top insulation washer		Top washer	
	Part No.	Qty.	Part No.	Qty.	Part No.	Qty.	Part No.	Qty.
IRB 1520	3HAC063356-001	2	3HAC063357-001	2	3HAC063358-001	4	3HAC063359-001	4
IRB 1600	3HAC063350-001	2	3HAC063351-001	1	3HAC063354-001	3	3HAC063355-001	3
IRB 2600/4600	3HAC063350-001	2	3HAC063351-001	1	3HAC063352-001	3	3HAC063353-001	3

Procedure

Robot type	Installation illustration
IRB 1520	 xx2200001616

Continues on next page

Robot type	Installation illustration
IRB 1600	 xx2200001617
IRB 2600/4600	 xx2200001618

	Action
1	Place the bottom insulation washers with pin hole (1) on the mounting plate (C) of the track motion or the pedestal installed on the track motion.
2	Place the bottom insulation washers w/o pin hole (2) on the mounting plate (C) of the track motion or the pedestal installed on the track motion.

Continues on next page

2.5.1 Assembling the manipulator

Continued

	Action
3	Lift the robot to the mounting position on the track motion using necessary lifting tools. Position the robot and make sure the attachment holes on the robot base (B) are aligned with the bottom insulation washers. See the figures in previous table for reference.
4	Put top insulation washers (3) and top washers (4), and then secure the robot with M16 bolts (A).

2.5.2 Mounting of manipulator on the track

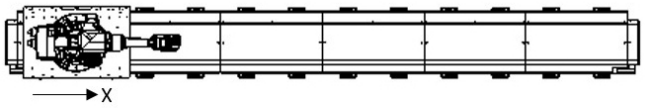
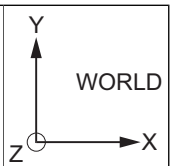
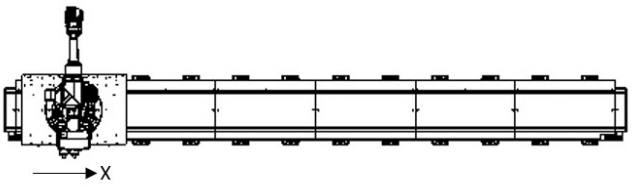
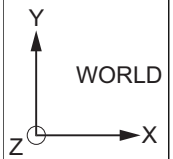
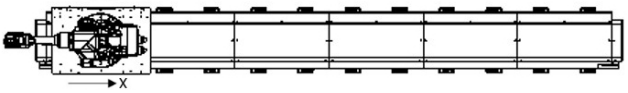
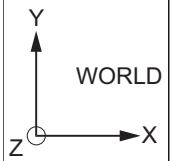
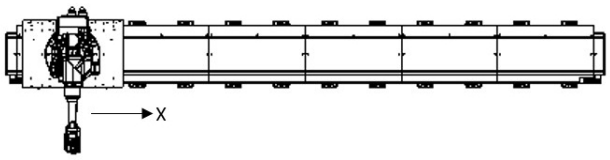
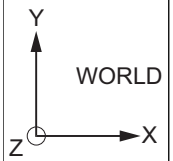
General

The manipulator can be mounted in four directions, 0 degrees (in line), 90 degrees, 180 degrees, and 270 degrees with the cable chain standard or mirrored. Other mounting orientations are not allowed. The world coordinate system is shown in the following figures.

Robot orientation with standard cable chain

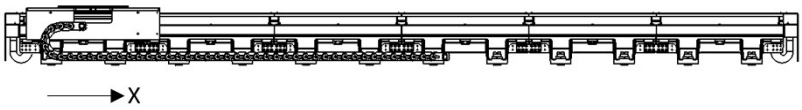
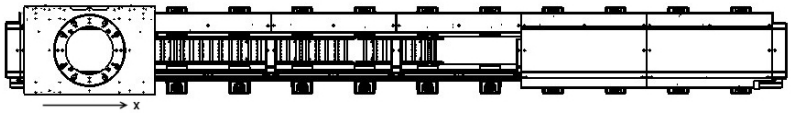
Following figures illustrate the manipulator mounted in different directions with the standard cable chain.

The positive X direction is the positive motion direction of the track. The positive Y direction is the direction of the cabling outlet on the carriage.

0 degrees (in line)	 xx1400001911	 xx1500000928
+90 degrees	 xx1400001912	 xx1500000928
+180 degrees	 xx1400001909	 xx1500000928
+270 degrees	 xx1400001910	 xx1500000928

Continues on next page

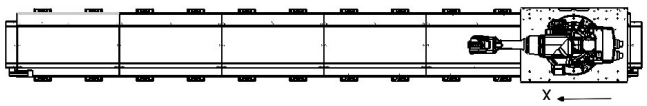
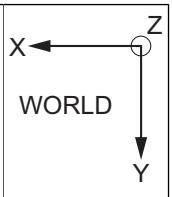
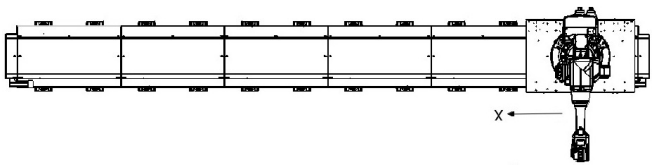
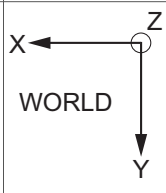
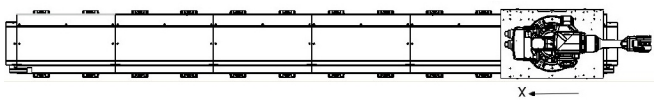
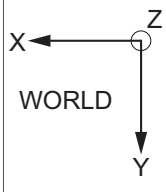
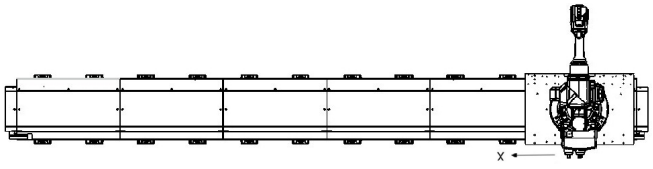
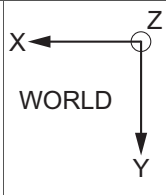
2.5.2 Mounting of manipulator on the track
Continued

Standard cable chain	Side view:  xx1500000597 Top view:  xx1400001952

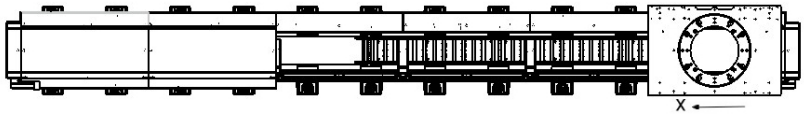
Robot orientation with mirrored cable chain

Following figures illustrate the manipulator mounted in different directions with the mirrored cable chain.

The positive X direction is the positive motion direction of the track. The positive Y direction is the opposite direction of the cabling outlet on the carriage.

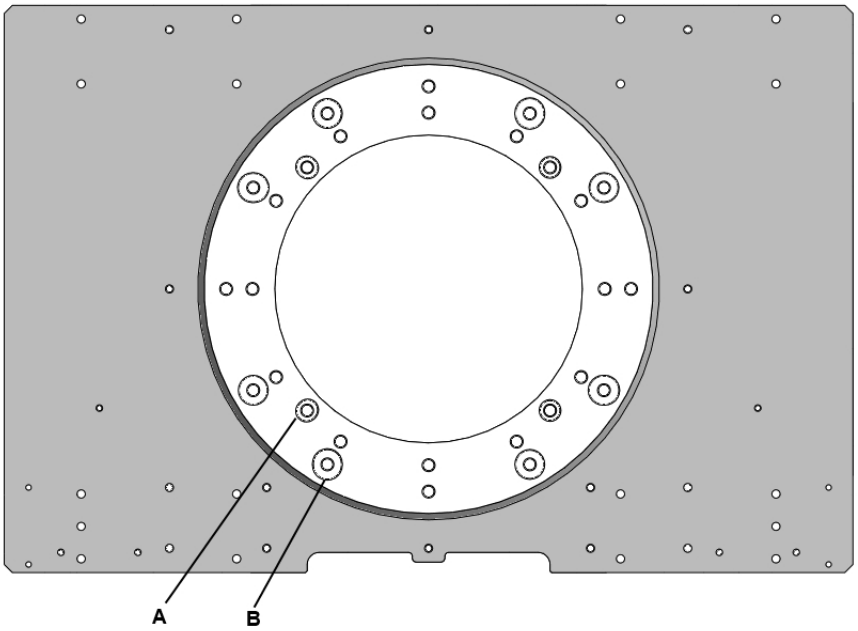
0 degrees (in line)	 xx1500000631	 xx1500000927
+90 degrees	 xx1500000632	 xx1500000927
+180 degrees	 xx1500000633	 xx1500000927
+270 degrees	 xx1500000634	 xx1500000927

Continues on next page

Mirrored cable chain	Side view:  xx1500000630 Top view:  xx1400001951

Assembly position

The following figure shows guide bushing assembly positions on the carriage table of the robot track.



xx1400002680

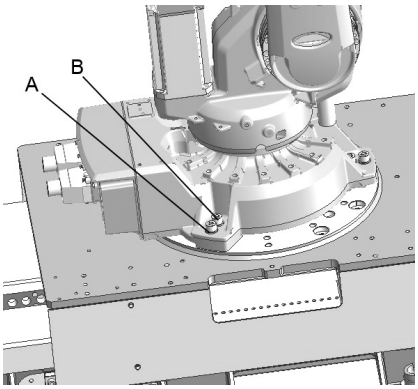
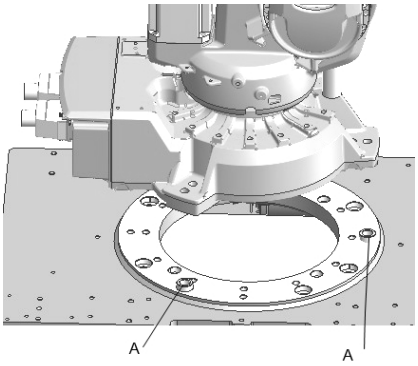
A	Guide bushing fitting hole for IRB 1520
B	Guide bushing fitting hole for IRB 1600/2600/4600

2.5.3 Changing manipulator orientation

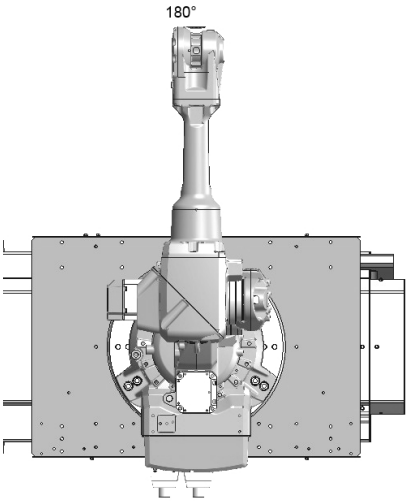
Required equipment

Quantity	Tool
1	Socket head cap 2.5-17 mm

Procedures of changing the orientation of robot without pedestal

	Action	Illustration/Note
1	Remove the securing screws and plain washers in the holes of robot base.	 xx1400002679 A M16x70 hexagon socket head cap screws class 12.9 (6 pcs) Tightening torque: 250 Nm B Plain washer (6 pcs)
2	Lift the robot to other position.	For how to lift the robot, according to robot product manual.
3	Fit two guide bushings to the hole on the carriage table of the robot track according to the orientation of robot. For the guide bushing assembly positions, see *Assembly position on page 109*.	 xx1400002681 A Guide bushing
4	Guide the robot gently, using the screws while lowering it into its fitting position.	Make sure the robot base is correctly fitted onto the guide bushings.

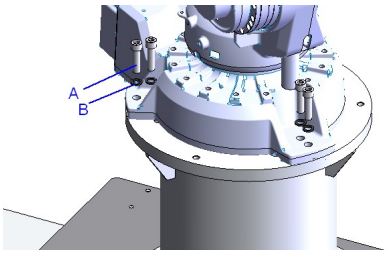
Continues on next page

	Action	Illustration/Note
5	Fit the securing screws and plain washers in the attachment holes of the base.	 xx1400002682
6	Tighten the bolts in a criss-cross pattern to ensure that the base is not distorted.	

Procedures of changing the orientation of robot with pedestal

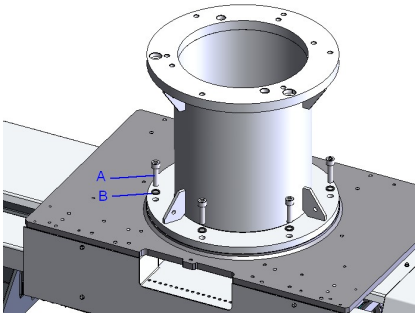
Note

The robot is installed on the pedestal with a fixed orientation. To change the orientation of robot with the pedestal, remove the robot from the pedestal first and then adjust the pedestal orientation.

	Action	Illustration/Note
1	Remove the securing screws and plain washers in the holes of robot base.	 XX1500000490 A M16x60 Hex socket head cap screw, 3HAB3409-86 (6 pcs) B Ø30xØ17x3 plain washer, 3HAA1001-186 (6 pcs)
2	Lift the robot from the pedestal to other position.	For how to lift the robot, according to robot product manual.

Continues on next page

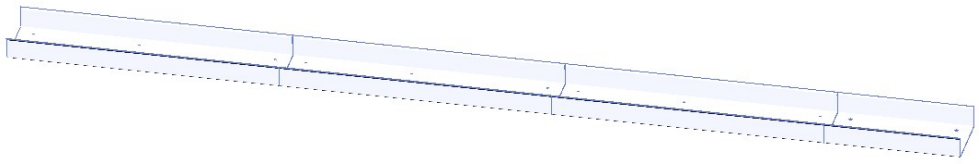
2.5.3 Changing manipulator orientation
Continued

	Action	Illustration/Note
3	Remove the screws and plain washers in the holes of the pedestal.	 xx1500000485 A M16x60 Hex socket head cap screw, 3HAB3409-86 (6 pcs) B Ø30xØ17x3 plain washer, 3HAA1001-186 (6 pcs)
4	Fit two guide bushings to the hole on the carriage table of the robot track according to the orientation of robot. For the guide bushing assembly positions, see *Assembly position on page 109*.	
5	Guide the pedestal gently, using the screws while lowering it into its fitting position.	Make sure the pedestal is correctly fitted onto the guide bushings.
6	Refit the securing screws and plain washers in the attachment holes of the pedestal.	
7	Lift the robot back and gently put it onto the pedestal. Refit the securing screws and plain washers in the attachment holes of the robot base.	
8	Tighten the bolts in a criss-cross pattern to ensure that the base is not distorted.	

2.5.4 Assembling the cable tray

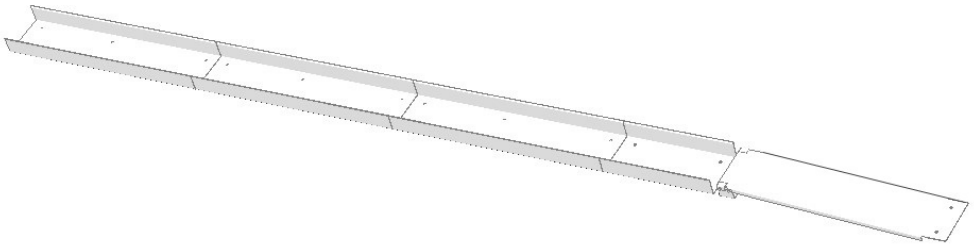
Overview

The cable tray made for the cable chain is made of sheet metals, fastened to the track machinings by screws directly or to brackets and thereby forming a tray.



xx1400001579

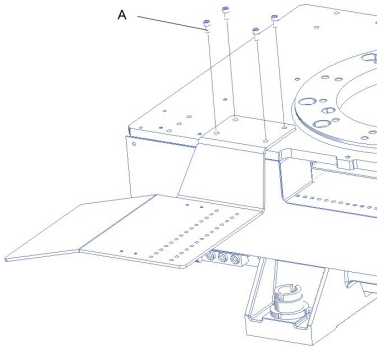
For track travel length shorter than 6 m, the cable tray is plain. While for track travel length equal to 5 m or larger than 5 m, a slope tray is needed to reduce the friction between the cable chain when the moving end of the cable chain moves passing the fixed end.



xx1400001580

Installing the cable tray

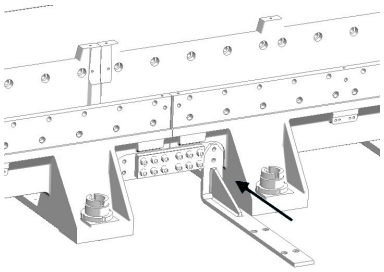
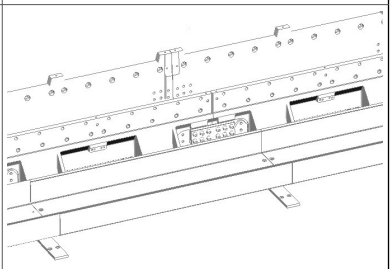
Installing the external cable tray

	Action	Illustration/Note
1	Fix the connection bracket for the external cable tray on the top plate of the carriage by screws.	 xx1400001936 A M10x30 Hex socket head cap screw, 3HAB3409-51 (4 pcs) Tightening torque: 47 Nm

Continues on next page

2.5.4 Assembling the cable tray

Continued

	Action	Illustration/Note
2	Fit the bottom bracket for external cable tray to the track.	 xx1400001582
3	Place the cable tray onto the brackets.	 xx1400001583
4	Fasten the external cable tray with screws.	M6x12 Torx counters. head screw, 9ADA624-5 Tightening torque: 10 Nm

2.6 Electrical installation

2.6.1 The cabling from the controller

Cable run

Cabling between the control equipment and the track motion should be run through cable conduits on the floor.

Connection points

For the robot track, connectors that connecting cable harness from the carriage (flexible cables) with cable harness from the controller (floor cables) are freely positioned on the ground.

For the transfer track, the SMB box is used as the connection between the cable harness from the track (flexible cables) and the cable harness from the controller (floor cables).

CAUTION

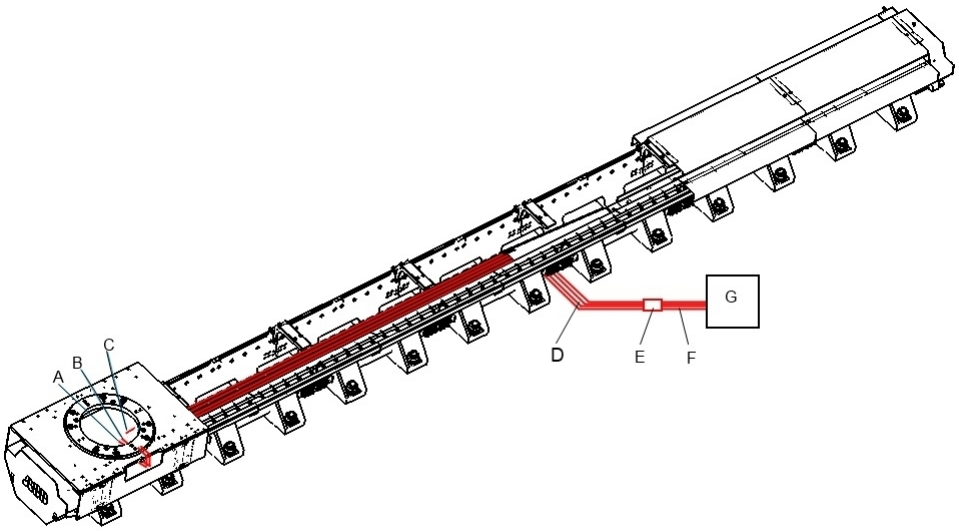
The floor cables must be grounded based on the requirements described in section *Circuit diagrams on page 289*. Single-stranded copper wires with a diameter larger than 7 mm are recommended to be used as customer grounding cables, which will connect the cable grounding (Art. No.: 3HAC046927) of the track.

Continues on next page

2.6.1 The cabling from the controller

Continued

The following illustration is based on the robot track.



xx1400001286

A	Robot or conveyor power cable
B	Signal cables
C	IRBT Power cables
D	Flexible cable harness from the carriage • Power cables for track, robot or lifter etc. (A,C, etc.) • Motor, manipulator signal cables (B) • Other cables: cable grounding and hoses etc.
E	Connectors connecting cable harness from the carriage and cable harness from the controller.[i]
F	Floor cables from the controller • Power cable, available for IRC5 • Signal cable, available for IRC5
G	Controller, available for IRC5

[i] For the transfer track, this would be an SMB box.

2.6.2 Connections

2.6.2.1 Introduction

Connections

The wiring diagrams are described in section *Circuit diagrams on page 289*.

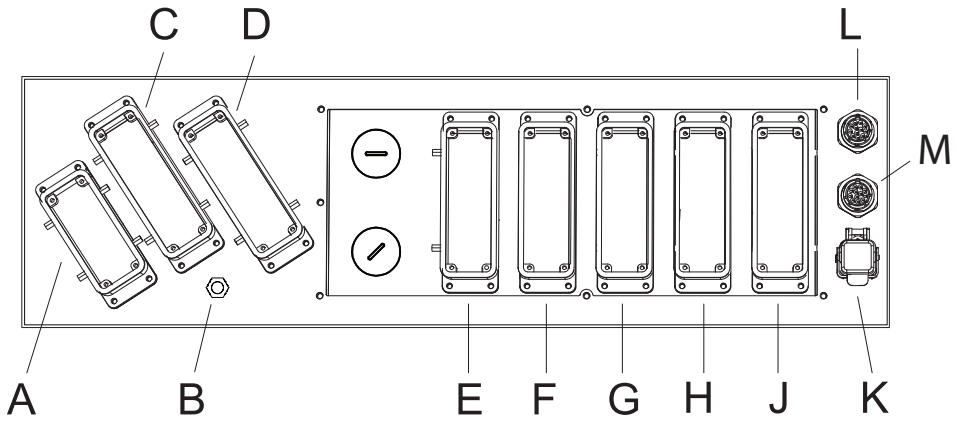
2.6.2.2 Connectors on controller, IRC5

General

The following section describes the connectors on the respective front panels of the IRC5 controller. These are described below, and detailed in section *Connectors on controller* in *Product manual - IRC5*.

Single Cabinet Controller

The following details the connection interface on the Single Cabinet Controller.



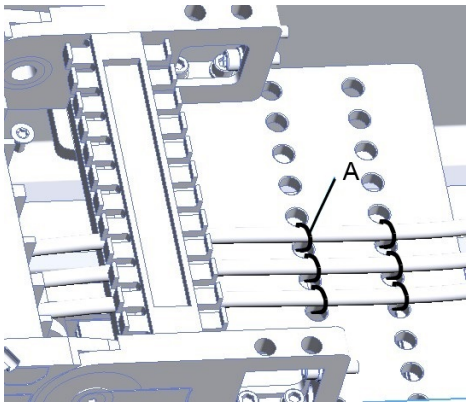
xx0500001852

	Description
A	XP.0 Mains connection
B	Earth connection point
C	XS.1 Robot power connection
D	XS.7 Additional axes power connection
E	XS.13/XS.5 Customer power/signals external connection
F	XS.10 Customer options
G	XS.11 Customer options
H	XS.12 Customer options
J	X3 Customer safety signals
K	XS.28 Network connection
L	XS.41 Additional axes SMB connection
M	XS.2 Robot SMB connection

2.6.3 Inspection of cables and covers prior to start-up

Procedures of inspecting cables and covers

Use this procedure to inspect and adjust cables and covers before the track is commissioned.

	Action	Illustration/Note
1	Make sure there is no risk of collision between the cables and covers and the covers are well tightened.	
2	Make sure all cables are well secured and without risk for premature wear against plates or additional equipment. The cables exiting the chain, on both the moving and fixed end, need to be strapped individually at least twice in order to strain relief correctly. If there are not enough holes available in the connection plates for individual strapping, the cables should be secured in such a way that they can not move.	 xx1400001676 A Cable straps Suitable cable ties are specified in *Required equipment on page 252*.
3	Make sure no floor cables are in risk of collision with moving parts.	

Guide channel inspection

Inspection	Yes	No
Guide channel free of foreign objects?		
Channel internal width > 2 mm and < 6 mm than chain outside width?		
Channel joints arranged flush and unobstructed?		
Guide channel running parallel to the moving end guide?		

2.7 Software installation

2.7.1 Starting the system for the first time

General

Make sure that all steps of the physical installation is completed, see *Before starting the track motion on page 37*.

How to start the controller for the first time after the physical installation has been completed is described in *Operating manual - Getting started, IRC5 and RobotStudio*.

System status after startup

After startup, only the manipulator is configured in the controller. It will not be possible to jog or program using the track motion.

To activate the track motion, it is necessary to use RobotStudio to create a new system with the track motion settings and download the new system to the robot controller, see *Creating and downloading a system on page 121*.

2.7.2 Creating and downloading a system

Introduction

The PC application RobotStudio is used for creating and downloading systems to the controller.

The procedure how to create and download a system is different depending on if the controller is installed with RobotWare 5 or RobotWare 6. RobotStudio version 6 or later supports both procedures.

Note

The track motion IRBT 2005 is only supported by RobotWare 6 and later.

In RobotStudio, use Installation Manager to create and modify systems with RobotWare 6 and later.

For more information, see *Operating manual - RobotStudio*.

Before modifying the system

Before modifying the system it is recommended to take a backup of the system and put all axes of the robot and any external axes are in their zero positions.

Creating a system

In RobotWare 6, the track motion is loaded as an Add-In. The track motion Add-In does not require a license.

Use this procedure to create and modify the system.

	Action
1	Create a new system based on the existing system using the Installation Manager in RobotStudio.
2	In the **Products** tab, click **Add** and select the *RobotWare* and *TrackMotion* product manifests.
3	In the **Licenses** tab, add the license for RobotWare. The track motion does not require a license.
4	In the **Options** tab, **Drive Modules** pane, add the additional drive unit (ADU) that controls your track motion.
5	In the **Options** tab, **Drive Modules** pane, select and modify the options that suits your track motion. For example track motion type, robot orientation etc.
6	Complete the Installation Manager wizard.
7	Apply the changes to the system and restart the controller.
8	Load the necessary system parameters, system modules, and program modules from the backup and restart the controller. **Note** Do not restore the old motion configuration file *moc.cfg*, this will remove the track motion settings. Instead, use **Load parameters and replace duplicates** from the **Configuration** window on the FlexPendant **Control Panel**.
9	Update the revolution counters, see *Update revolution counters on page 267*.

Continues on next page

2.7.2 Creating and downloading a system
Continued

	Action
10	Set the software limits for the track, see *Setting upper and lower software limits for the track on page 123*. **Note** Note that the default length of the track is set very short, for safety reasons, and has to be updated to the correct length.
11	Verify that the selected robot orientation on the track motion matches the physical configuration, see *Base frame configuration on page 130*.

For more detailed instructions on using the Installation Manager, see *Operating manual - RobotStudio*.

2.7.3 Setting upper and lower software limits for the track

Introduction

The upper and lower software limits of the track are software limits that prevent the track from being jogged beyond the mechanical limit of the track. They are the physical displacement distance from the zero position to the limit position in meters. This depends on the length of the track, and the location of the calibration pin (also referred to as the zero position of the track).

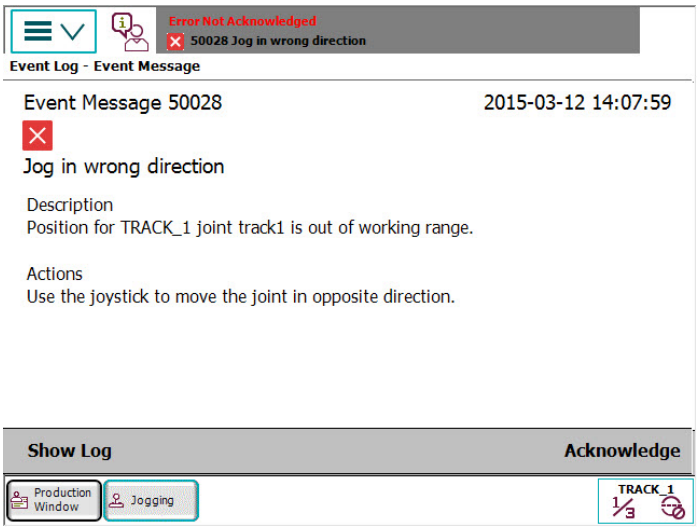
The limits are defined in the system parameters, in the topic *Motion*, type *Arm*. The upper limit is called *Upper Joint Bound*, and the lower limit is called *Lower Joint Bound*. Both are expressed in meters.

In the following example, the upper limit is set to 5.8 m and the lower limit is set to -0.5 m.

```
ARM : -upper_joint_bound 5.8 -lower_joint_bound -0.5
```

Example

The following screenshot shows an example of the error message that is generated when the track is jogged beyond its software limit.



xx1400001913

Changing the limits

WARNING

This is an important safety feature to prevent damage to the track. Make sure that the track direction has first been set and the track has been calibrated before performing this step, see *Fine calibration on page 266*.

Use this procedure to change the limits using the FlexPendant.

	Action	Note
1	From the ABB menu, tap **Control Panel**.	
2	Tap **Configuration**.	

Continues on next page

2.7.3 Setting upper and lower software limits for the track
Continued

	Action	Note
3	Under **Topics**, tap **Motion**.	
4	Select **Arm**.	
5	Select the mechanical unit.	
6	Change the values for the parameters **Upper joint bound** and **Lower Joint bound**.	
7	Tap **OK** to save the change and then restart the controller.	

Examples of correct values for the software limits

The following tables show configuration values for *Upper Joint Bound* and *Lower Joint Bound* for a number of different configurations

Single robot carriage and signal transfer carriage

Track L (mm)	Modules	Travel L (m)	*Upper Joint Bound* (m)	*Lower Joint Bound* (m)
2230	2	0.85	0.35	-0.5
3230	3	1.85	1.35	-0.5
4230	4	2.85	2.35	-0.5
5230	5	3.85	3.35	-0.5
6230	6	4.85	4.35	-0.5
7230	7	5.85	5.35	-0.5
8230	8	6.85	6.35	-0.5
9230	9	7.85	7.35	-0.5
10230	10	8.85	8.35	-0.5
11230	11	9.85	9.35	-0.5
12230	12	10.85	10.35	-0.5
13230	13	11.85	11.35	-0.5
14230	14	12.85	12.35	-0.5
15230	15	13.85	13.35	-0.5
16230	16	14.85	14.35	-0.5
17230	17	15.85	15.35	-0.5
18230	18	16.85	16.35	-0.5
19230	19	17.85	17.35	-0.5
20230	20	18.85	18.35	-0.5
21230	21	19.85	19.35	-0.5

Single robot carriage with extra plate

Total L (mm)	Modules	Travel L (m)	*Upper Joint Bound* (m)	*Lower Joint Bound* (m)
4230	4	1.69	1.35	-0.34
5230	5	2.69	2.35	-0.34

Continues on next page

Total L (mm)	Modules	Travel L (m)	*Upper Joint Bound* (m)	*Lower Joint Bound* (m)
6230	6	3.69	3.35	-0.34
7230	7	4.69	4.35	-0.34
8230	8	5.69	5.35	-0.34
9230	9	6.69	6.35	-0.34
10230	10	7.69	7.35	-0.34
11230	11	8.69	8.35	-0.34
12230	12	9.69	9.35	-0.34
13230	13	10.69	10.35	-0.34
14230	14	11.69	11.35	-0.34
15230	15	12.69	12.35	-0.34
16230	16	13.69	13.35	-0.34
17230	17	14.69	14.35	-0.34
18230	18	15.69	15.35	-0.34
19230	19	16.69	16.35	-0.34
20230	20	17.69	17.35	-0.34
21230	21	18.69	18.35	-0.34

Double robot carriages

Total L (mm)	Modules	Travel L (m)	*Upper Joint Bound* (m)	*Lower Joint Bound* (m)
4230	4	1.60	1.1	-0.5
5230	5	2.60	2.1	-0.5
6230	6	3.60	3.1	-0.5
7230	7	4.60	4.1	-0.5
8230	8	5.60	5.1	-0.5
9230	9	6.60	6.1	-0.5
10230	10	7.60	7.1	-0.5
11230	11	8.60	8.1	-0.5
12230	12	9.60	9.1	-0.5
13230	13	10.60	10.1	-0.5
14230	14	11.60	11.1	-0.5
15230	15	12.60	12.1	-0.5
16230	16	13.60	13.1	-0.5
17230	17	14.60	14.1	-0.5
18230	18	15.60	15.1	-0.5
19230	19	16.60	16.1	-0.5
20230	20	17.60	17.1	-0.5
21230	21	18.60	18.1	-0.5

Continues on next page

2.7.3 Setting upper and lower software limits for the track
Continued

Double robot carriages both with extra plate

Total L (mm)	Modules	Travel L (m)	*Upper Joint Bound* (m)	*Lower Joint Bound* (m)
6230	6	1.28	0.94	-0.34
7230	7	2.28	1.94	-0.34
8230	8	3.28	2.94	-0.34
9230	9	4.28	3.94	-0.34
10230	10	5.28	4.94	-0.34
11230	11	6.28	5.94	-0.34
12230	12	7.28	6.94	-0.34
13230	13	8.28	7.94	-0.34
14230	14	9.28	8.94	-0.34
15230	15	10.28	9.94	-0.34
16230	16	11.28	10.94	-0.34
17230	17	12.28	11.94	-0.34
18230	18	13.28	12.94	-0.34
19230	19	14.28	13.94	-0.34
20230	20	15.28	14.94	-0.34
21230	21	16.28	15.94	-0.34

Single robot carriage and single robot carriage with extra plate

Track L (mm)	Modules	Travel L (m)	Robot *Upper Joint Bound* (m)	Robot *Lower Joint Bound* (m)	Extra plate *Upper Joint Bound* (m)	Extra plate *Lower Joint Bound* (m)
5230	5	1.44	0.9	-0.5	1.1	-0.34
6230	6	2.44	1.9	-0.5	2.1	-0.34
7230	7	3.44	2.9	-0.5	3.1	-0.34
8230	8	4.44	3.9	-0.5	4.1	-0.34
9230	9	5.44	4.9	-0.5	5.1	-0.34
10230	10	6.44	5.9	-0.5	6.1	-0.34
11230	11	7.44	6.9	-0.5	7.1	-0.34
12230	12	8.44	7.9	-0.5	8.1	-0.34
13230	13	9.44	8.9	-0.5	9.1	-0.34
14230	14	10.44	9.9	-0.5	10.1	-0.34
15230	15	11.44	10.9	-0.5	11.1	-0.34
16230	16	12.44	11.9	-0.5	12.1	-0.34
17230	17	13.44	12.9	-0.5	13.1	-0.34
18230	18	14.44	13.9	-0.5	14.1	-0.34
19230	19	15.44	14.9	-0.5	15.1	-0.34
20230	20	16.44	15.9	-0.5	16.1	-0.34

Continues on next page

Track L (mm)	Modules	Travel L (m)	Robot *Upper Joint Bound* (m)	Robot *Lower Joint Bound* (m)	Extra plate *Upper Joint Bound* (m)	Extra plate *Lower Joint Bound* (m)
21230	21	17.44	16.9	-0.5	17.1	-0.34

Multi transfer carriages (one module overlap)

Travel L (m)	*Upper Joint Bound* (m)	*Lower Joint Bound* (m)
0.85	0.35	-0.5
1.85	1.35	-0.5
2.85	2.35	-0.5
3.85	3.35	-0.5
4.85	4.35	-0.5
5.85	5.35	-0.5
6.85	6.35	-0.5
7.85	7.35	-0.5
8.85	8.35	-0.5
9.85	9.35	-0.5
10.85	10.35	-0.5
11.85	11.35	-0.5
12.85	12.35	-0.5
13.85	13.35	-0.5
14.85	14.35	-0.5
15.85	15.35	-0.5
16.85	16.35	-0.5
17.85	17.35	-0.5
18.85	18.35	-0.5
19.85	19.35	-0.5

Identifying the upper and lower limits by experiment

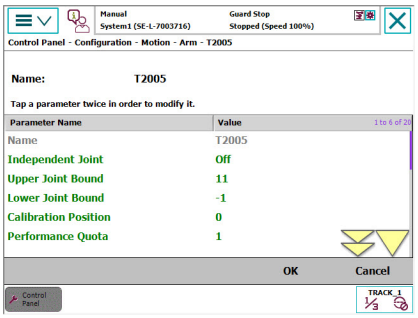
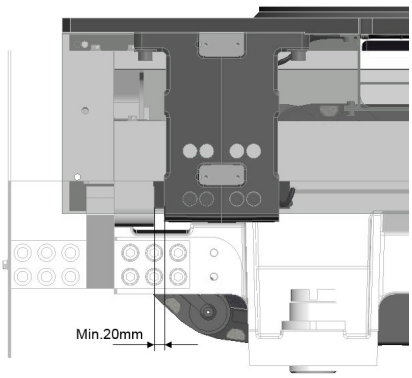
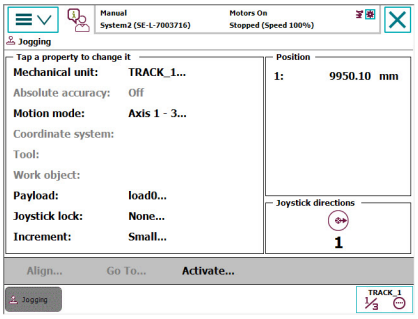
If the actual value of the limit is not known, it is possible to jog the track to the desired limit position, and then read the limit value from the FlexPendant.

	Action	Note
1	Before beginning, make sure that the revolution counter for the IRBT 2005 is updated.	

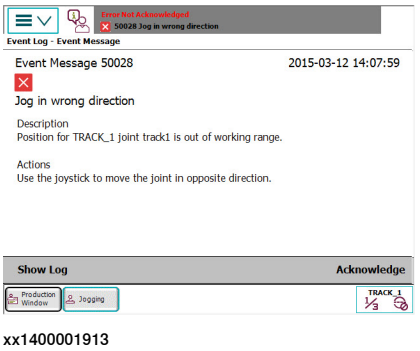
Continues on next page

2.7.3 Setting upper and lower software limits for the track

Continued

	Action	Note
2	The upper and lower limit monitoring is active when in manual mode, thus it is first necessary increase the current limit to beyond the mechanical stop. This will then allow the track to be jogged without error up to the desired limit position. `ARM : -upper_joint_bound 11 -lower_joint_bound -1` **WARNING** If the actual track length is 10 meters in the positive direction of movement, and -0.060 meter in the negative direction, then first set the upper bound to 11 meters and the lower bound to -1 meters.	 xx1400001921
3	Restart the controller.	
4	Jog the mechanical unit to the desired limit position as shown in the figure. **Note** A minimum distance of 20 mm should be used between where the software limit is set and the actual mechanical stop.	 xx1400001923
5	In the jogging window, read the current position for the track motion. **Note** The distance is shown in millimeters.	
6	Update the limit value in the MOC file. (In this example it is 9950.1 mm.) `ARM: -upper_joint_bound 9.950 -lower_joint_bound -1`	 xx1400001922
7	Restart the controller.	

Continues on next page

	Action	Note
8	Set the jogging speed to 20% and test the software limit. If the software limit has been set correctly, the following error should be generated, see the figure. **WARNING** This step should be carried out with great care. If the software limit has not been set correctly the mechanical unit may hit the mechanical hard stop.	 xx1400001913
9	Repeat the previous steps for the other limit.	

2.7.4 Base frame configuration

2.7.4.1 Introduction

General

To ensure that the robot works properly in linear on its track motion, it is necessary that the orientation of the robot relative to the track is properly declared.

If the customer installation differs from the default selections available in Installation Manager it might be necessary to change the orientation of the robot relative to the track according to the examples below, see *Configuration examples on page 132*.

Mounting directions

The manipulator can be mounted in four directions, in line, 90 degrees, 180 degrees and 270 degrees with the cable chain standard or mirrored, shown in the following figures. Other mounting orientations are not allowed.

For more information, see *Mounting of manipulator on the track on page 107*.

System parameters

This is a brief description of the parameters used when configuring the base frame for robots on track motion. For more information, see the respective parameter in *Technical reference manual - System parameters*.

Robot

These parameters belongs to the type *Robot* in the topic *Motion*.

Parameter	Description
Base Frame x Base Frame y Base Frame z	*Base Frame x,y,z* defines the direction of the robot base frame position in relation to the world frame (in meters).
Base Frame q1 Base Frame q2 Base Frame q3 Base Frame q4	*Base Frame q1-q4* defines the quaternions of the robot base frame orientation in relation to the world frame.
Gamma Rotation	*Gamma Rotation* defines the orientation of the robot foot on the travel carriage. **Note** The *Gamma Rotation* parameter is useful only for robots on track when the 7 axes high performance motion parameter is set. This parameter is not used for all robot types.

Single

These parameters belongs to the type *Single* in the topic *Motion*.

Parameter	Description
Base Frame x Base Frame y Base Frame z	*Base Frame x,y,z* defines the direction of the track motion base frame position in relation to the world frame (in meters).

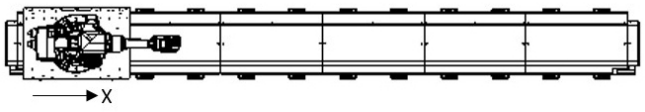
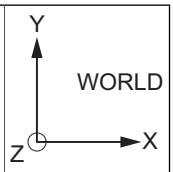
Continues on next page

Parameter	Description
Base Frame q1 Base Frame q2 Base Frame q3 Base Frame q4	*Base Frame q1-q4* defines the quaternions of the track motion base frame orientation in relation to the world frame.
Use Joint	*Use Joint* defines which joint data to use for the track motion.

2.7.4.2 Configuration examples

Standard cable chain

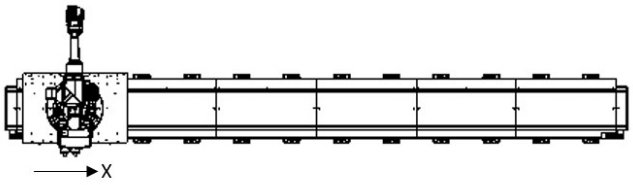
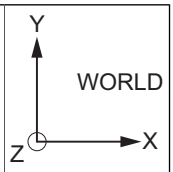
IRB 0° (in line) in relation to the World coordinate system

0 degrees (in line)	 xx1400001911	 xx1500000928

- Positive travel direction x in World coordinates
- Standard travel direction

Parameter	Robot (*ROB_1*)	Track motion (*TRACK_1*)
Base Frame q1	1	1
Base Frame q2	0	0
Base Frame q3	0	0
Base Frame q4	0	0
Gamma Rotation	0	-
Use Joint	-	track1

IRB rotated 90° in relation to the World coordinate system

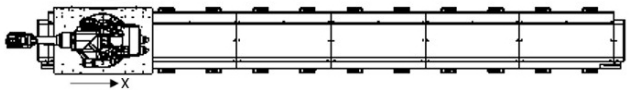
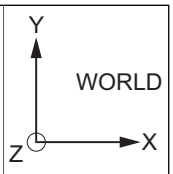
+90 degrees	 xx1400001912	 xx1500000928

- Positive travel direction x in World coordinates
- Standard travel direction

Parameter	Robot (*ROB_1*)	Track motion (*TRACK_1*)
Base Frame q1	0.707107	1
Base Frame q2	0	0
Base Frame q3	0	0
Base Frame q4	0.707107	0
Gamma Rotation	1.570796	-
Use Joint	-	track1

Continues on next page

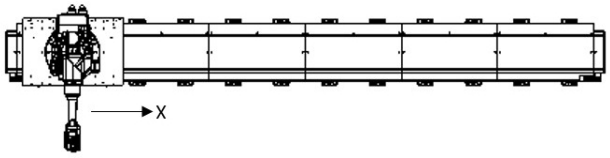
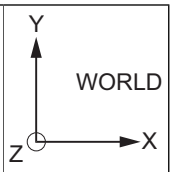
IRB rotated 180° in relation to the World coordinate system

+180 degrees	 xx1400001909	 xx1500000928

- Positive travel direction x in World coordinates
- Standard travel direction

Parameter	Robot (*ROB_1*)	Track motion (*TRACK_1*)
Base Frame q1	0	1
Base Frame q2	0	0
Base Frame q3	0	0
Base Frame q4	1	0
Gamma Rotation	3.141593	-
Use Joint	-	track1

IRB rotated 270° in relation to the World coordinate system

+270 degrees	 xx1400001910	 xx1500000928

- Positive travel direction x in World coordinates
- Standard travel direction

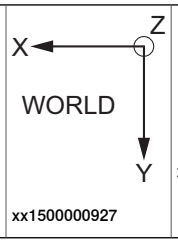
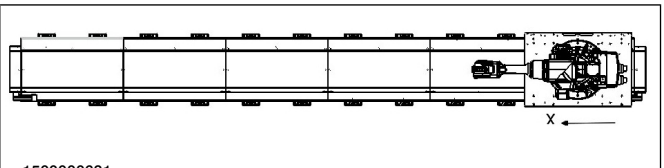
Parameter	Robot (*ROB_1*)	Track motion (*TRACK_1*)
Base Frame q1	0.707107	1
Base Frame q2	0	0
Base Frame q3	0	0
Base Frame q4	-0.707107	0
Gamma Rotation	-1.570796	-
Use Joint	-	track1

Continues on next page

2.7.4.2 Configuration examples
Continued

Mirrored cable chain

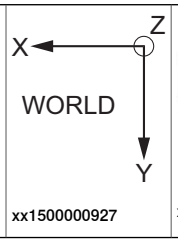
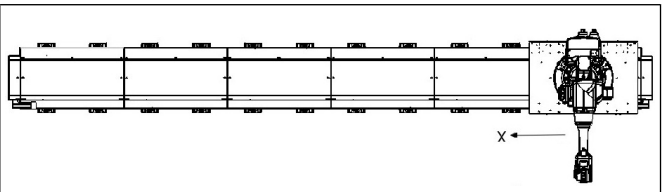
IRB in line 0° in relation to the World coordinate system

0 degrees (in line)	 xx1500000927	 xx1500000631

- Positive travel direction x in World coordinates
- Mirrored travel direction

Parameter	Robot (*ROB_1*)	Track motion (*TRACK_1*)
Base Frame q1	1	1
Base Frame q2	0	0
Base Frame q3	0	0
Base Frame q4	0	0
Gamma Rotation	0	-
Use Joint	-	track1-lin

IRB rotated 90° in relation to the World coordinate system

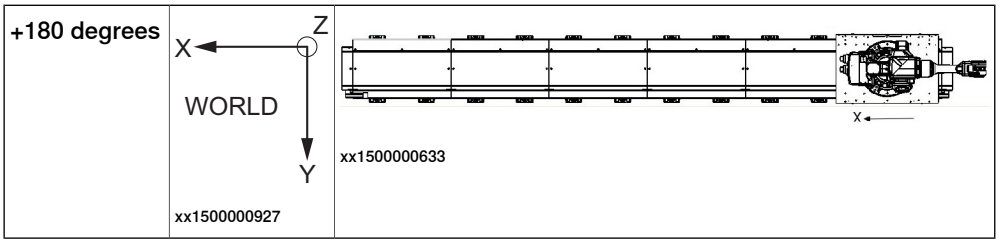
+90 degrees	 xx1500000927	 xx1500000632

- Positive travel direction x in World coordinates
- Mirrored travel direction

Parameter	Robot (*ROB_1*)	Track motion (*TRACK_1*)
Base Frame q1	0.707107	1
Base Frame q2	0	0
Base Frame q3	0	0
Base Frame q4	0.707107	0
Gamma Rotation	1.570796	-
Use Joint	-	track1-lin

Continues on next page

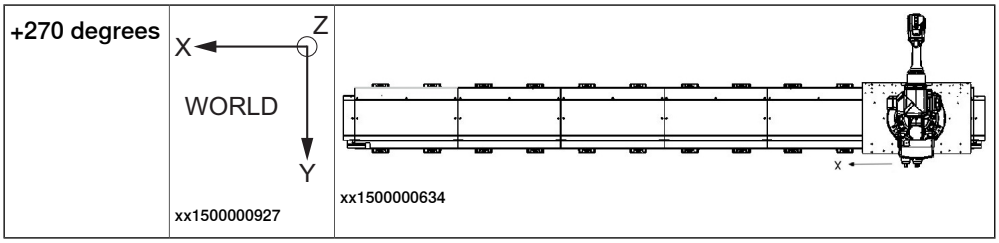
IRB rotated 180° in relation to the World coordinate system



- Positive travel direction x in World coordinates
- Mirrored travel direction

Parameter	Robot (*ROB_1*)	Track motion (*TRACK_1*)
Base Frame q1	0	1
Base Frame q2	0	0
Base Frame q3	0	0
Base Frame q4	1	0
Gamma Rotation	3.141593	-
Use Joint	-	track1-lin

IRB rotated 270° in relation to the World coordinate system



- Positive travel direction x in World coordinates
- Mirrored travel direction

Parameter	Robot (*ROB_1*)	Track motion (*TRACK_1*)
Base Frame q1	0.707107	1
Base Frame q2	0	0
Base Frame q3	0	0
Base Frame q4	-0.707107	0
Gamma Rotation	-1.570796	-
Use Joint	-	track1-lin

2.7.5 Configuration of additional load

Introduction

It is important that the load which is carried by the track motion is correct defined. There is no need for the user to make any updates of the system parameters. The definition of the following equipment is handled by the system, via Installation Manager, during the boot process.

- The standard pedestals with the height of 250 mm, 500 mm, 1000 mm and 1750 mm.
- The additional carriage plate.
- The robot.

However, if for example an arc welding power source is fitted on the additional carriage plate, then the system parameter *Arm Load t1_load_1* must be updated with the correct center of gravity and mass.

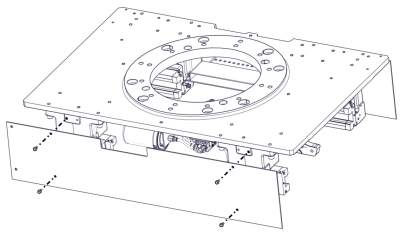
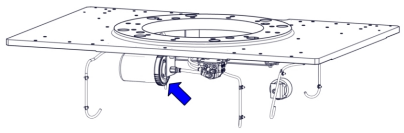
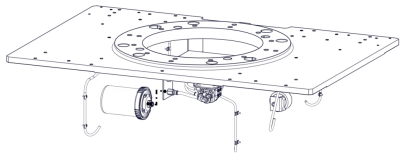
2.8 Lubrication

2.8.1 Replacing the grease cartridge in grease pump MEMOLUB® EPS

Overview

This section is based on the MEMOLUB® EPS user manual. It details how to replace the grease cartridge.

Removing the grease cartridge

	Action	Illustration/Note
1	Remove the carriage side covers.	 xx1500001620
2	Disconnect the cartridge power cable from the connector bracket on the carriage.	 xx1500000130
3	Screw the complete cartridge counterclockwise to remove it from its holder on the carriage.	 xx1500000131

Opening the grease pump

	Action	Illustration/Note
1	Place the grease pump on a flat and clean surface.	

Continues on next page

2.8.1 Replacing the grease cartridge in grease pump MEMOLUB® EPS
Continued

	Action	Illustration/Note
2	Push firmly with one hand on top of the grease pump. With the other hand, hold the black base and turn counterclockwise.	 xx1400001570
3	Pull the transparent housing and open it.	

Closing the grease pump

	Action	Illustration/Note
1	Hold the cranked black base, put on the transparent housing and turn it clockwise.	 xx1400001571
2	When the closed position is reached you should hear a "click".	

Installing a new grease cartridge

Respect the following instructions to replace the grease cartridge:

	Action	Illustration/Note
1	Open the MEMOLUB® as described before.	
2	Pull-up the black rubber seal. Fill-in the MEMOLUB® with a manual grease pump. This manual operation is required only if the MEMOLUB® has been used without a cartridge, if the previous cartridge has run out of grease. Place the pump nipple at the entry of the MEMOLUB®, and pump until you see grease coming out at the outlet. Two strokes of the manual pump are usually enough.	 xx1400001572

Continues on next page

	Action	Illustration/Note
3	Remove the paper disc from the replacement cartridge. Fill-in the required dates: "Started" and "Replace before". The "replace before" date is depending on the MEMOLUB® program. Put the paper disc back in place in order to see the instructions when the MEMOLUB® is closed.	 xx1400001574
4	Press softly on the cartridge until the grease comes out, to avoid injecting air into the pump.	 xx1400001575
5	Place the cartridge at the inlet of the pump. verify that the cartridge is correctly inserted in the inlet of the pump.	 xx1400001577
6	Place the spring and the compression disc inside the transparent bell. Put the bell back in place and verify that the compression disc is correctly lying on the top of the cartridge surface.	 xx1400001576
7	Close the MEMOLUB® as described before.	

Continues on next page

2.8.1 Replacing the grease cartridge in grease pump MEMOLUB® EPS
Continued

Test the grease pump MEMOLUB® (verify function)

CAUTION

It is important that you run this test cycle only if a cartridge is in place, otherwise you will fill the pump with air.

To verify that the grease pump is working well after a maintenance operation, press one of the 3 connectors located on the base during a few seconds. The grease pump is starting a dispensing cycle. The completion of the cycle means that the battery and the control board of the grease pump are working well.

xx1400001578

2.8.2 Configuration of grease pump MEMOLUB®

Overview

This section is based on the MEMOLUB® installation instructions. It details how to configure the grease pump MEMOLUB®.

Configuration

The grease pump MEMOLUB® is set through combination of 3 plastic rings: black (Ø50 mm), white (Ø44 mm) and red (Ø38 mm).

The table shows the frequency of strokes and the duration of a 240 mm cartridge at different combinations.

50 mm  xx1600001020	44 mm xx1600001021	38 mm  xx1600001022	Frequency hour(s)	Duration of a 240 mm cartridge month(s)
x			48	24
	x		24	12
x	x		16	8
		x	12	6
x		x	6	3
	x	x	2	1
x	x	x	1	1/2

Set of rings

The figure shows the 3 rings disassembled from the grease pump MEMOLUB®.

xx1600001023

2.9 Commissioning

2.9.1 Check list for IRBT 2005 before commissioning

Cables/hoses

Verify that...	Description
No stretch of the power and signal cables for the motor.	It is common to see these cables stretched, stood on, or with other cables resting on them.
Inspect the shielding	Stretched cables will inevitably affect the shielding and cause feedback issues and other damage.
No movement of the cable	If there is movement in the cables then they could get trapped and damaged.
Verify the length	If the length is excessive, it indicates that the orientation of robot is different to what was initially ordered. If cables have excessive length and are not strapped at all, cables could easily get caught and damaged in the dead stop.
Fixed position with straps.	If the cables are not fixed properly then they can easily get caught and damaged.
Is shielding visible?	Cables need to be tied to prevent this from happening. Spare ABB cable also needs to be tied out of the way.
Cables secured and not hanging loosely.	Robot cables need securing because they are loose down to the cable chain and could easily get damaged.

Cable chain

Verify that...	Description
Working correct in the entire length	Does the robot carrier run up and down the entire length of track without hitting the trunking, guarding etc?
No damage	Is there any damage to the cable chain such as step damage, twisted sections or brackets, etc?
Correct cable hoses length inside.	Ensure cables are not twisted, too tight or too loose inside cable chain.
Correctly secured with ties both ends and white marked.	Ensure that each cable is individually cable tied and identified using white marker to indicate movement.
Fixed position with straps.	If the cables are not fixed properly then they can easily get caught and damaged.
Each cable is individually tied and marked up correctly	-

Cable tray

Verify that...	Description
No wear against in or outside of the cable tray	Is there any wear on the inside or outside of the cable chain from being twisted and rubbing against cable tray?
Correctly tightened	Has the channel been secured correctly to the provided brackets?

Continues on next page

Verify that...	Description
No step damage	Is there any step damage to any of the cable chain channel or support brackets, are they twisted causing cable chain to wear?
Verify fixing screws	Has the fixing screws been attached to the cable tray?

Lubrication system

Verify that...	Description
Sufficient quantity of grease in the can	When the low level light is on then the grease unit needs to be filled.
No leakage at the pump/under the track/ball bearing blocks	Ensure that each connection for the grease pipe work is not damaged or leaking grease.

Guiderail and ball bearing blocks

Verify that...	Description
Make sure that all ball bearing blocks and also the entire travel length of the guide-rail receive grease in a proper quantity.	This can be verified by inspecting each individual bearing to ensure there is grease visible around them and by inspecting the guiderails also.
In case of suspected problem look after jumping marks at the end of each section.	When carrying out visual inspection it is also very important to feel along guiderails where the ball elements run to ensure that there are not any markings.

Track foundation

Verify that...	Description
Correct size bolts used	-
Track feet correctly packed to the floor	Stretched cables will inevitably affect the shielding and cause feedback issues and other damage.
Secured without movement	If there is movement in the cables then they could get trapped and damaged.

Gear rack

Verify that...	Description
The space and level between the gear racks is appropriate	-
All bolts are fitted	-
The torque on the bolts is appropri-ate	-

Guiderail

Verify that...	Description
Verify the space and the level between the guiderails	-
Verify that the locking washers have the mark up in the right corner	Must ensure correct as these washers determine the guiderails are mechanically level across the track sections.

Continues on next page

2.9.1 Check list for IRBT 2005 before commissioning
Continued

Verify that...	Description
Verify the torque on the bolts	-

Connection bracket

Verify that...	Description
Verify that all brackets are in correct position	Brackets which connect track sections are dowelled and number identified to prevent incorrect fitting.
Verify that all bolts and the locking pins are fitted and have the right torque.	-

2.10 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.

This page is intentionally left blank

3 Maintenance

3.1 Introduction

Structure of this chapter

This chapter describes all the maintenance activities recommended for the IRBT 2005.

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

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

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

Safety information

Observe all safety information before conducting any maintenance work.

There are general safety aspects that must be read through, as well as more specific safety information that describes the danger and safety risks when performing the procedures. Read the chapter *Safety on page 15* before performing any maintenance work.

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

Note

If the IRBT 2005 is connected to power, always make sure that the IRBT 2005 is connected to protective earth and a residual current device (RCD) before starting any maintenance work.

For more information see:

- *Product manual - IRC5*
- *Connection points on page 115*.

3.2 Maintenance schedule and expected component life

3.2.1 Specification of maintenance intervals

Introduction

The intervals are specified in different ways depending on the type of maintenance activity to be carried out and the working conditions of the IRBT 2005:

- 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.
- Travel distance: specified in kilometers. Intense use means more frequent maintenance activities.

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

3.2.2 Maintenance schedule

General

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

Non-predictable situations also give rise to inspections of the track. 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 152*

Activities and intervals, standard equipment

The table below specifies the required maintenance activities and intervals.

Maintenance activity	Equipment	Interval
Inspection and cleaning (when necessary)	Rack and linear guides	Every 100 km or every 1 month
Inspection	Cable chain	Every 3 months
Inspection	Felt gear	Every 3 months
Inspection	Cables and connectors at robot base, track motor and interchange to floor cable	Every 12 months
Inspection	Mechanical stops	Every 12 months
Inspection	Gear wheel, gearbox and backlash	Every 12 months
Inspection	Fitting bolts	Every 12 months
Adjustment of leveling	Complete track	Every 12 months
Replacement	Linear guide	When expected life is reached or if disturbances occur.
Replacement	Ball bearing blocks	When linear guides are replaced.
Replacement	Felt gear, gear wheel, gearbox and racks	When play can not be adjusted to specified [i] level.
Replacement	Glide shoes [ii]	When gliding surface thickness is 1.5 mm or less. [iii]
Replacement	Battery pack, measurement system of type RMU101 or RMU102 (3-pole battery contact)	36 months or battery low alert [iv]
Replacement	Battery pack, measurement system with 2-pole battery contact, e.g. DSQC633A	Battery low alert [v]
Check the level	Automatic lubrication system	Every 1 month or sensor alert (option 1475-1 Oil Detection sensor) [vi].

i The play is specified in *Adjusting the gearbox backlash on page 227*.

ii Glide shoes have been introduced to simplify and reduce the time associated with changing links.

iii The first glide shoes to wear out will be located at the point where the chain first makes contact with itself during operation.

Continues on next page

3.2.2 Maintenance schedule

Continued

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* for instructions.

vi The connector is available only when the option 1475-1 Oil Detection sensor is chosen. To make the sensor alert effective, the customer has to connect the sensor to the control device and configure the alert by self.

3.2.3 Gearbox oil

Where to find information about gearbox oil

Please see *Technical reference manual - Lubrication in gearboxes* (*3HAC042927-001*) for information about gearbox oil.

3.2.4 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

Component	Expected life[i]	Note
Cables	2,000,000 cycles[ii]	See note[iii]
Cable chain[iv]	Whichever occurs first: 2,000,000 cycles[v] or 18,000,000 gliding meters[vi] + addition 18,000,000 gliding meters if gliding shoes are changed .	
Gearbox	40,000 hours	
Ball bearing blocks	80,000,000 meters	

i The expected life of all componets is provided based on the typical cycle.

A typical cycle includes the robot IRB 2600 and track movement, starting from the initial position (A) and going to maximum extension (B), and back (A). The cycle is a 12-meter movement (from A to B to A, two 6-meter strokes) in 1 minute with the maximum acceleration 2.5 m/s^2 and maximum payload 1.2 tons. Deviations from this cycle will result in differences in expected life!

ii The track is dimensioned for a life of 4 years (302,400 cycles per year) in a normal application

iii The expected life can also be affected by assemblage of cabling other than standard options.

iv Due to process cycle variation and varying lengths of tracks the chains' lifetime is calculated on two parameters, gliding meters and bending cycles. When maximum limit of either parameter is reached the complete chain and or cables should be replaced.

In order to maximize the chains lifetime ensure to optimize the software and cell layout to reduce the amount of travel and cycles.

v A cycle is comprised of two strokes / changes in direction.

vi A gliding meter is described as the chain making contact with itself or the glide bars. Chains on tracks shorter than 6 meters travel distance do not have gliding contact.

3.3 Activities 100 km or 1 month

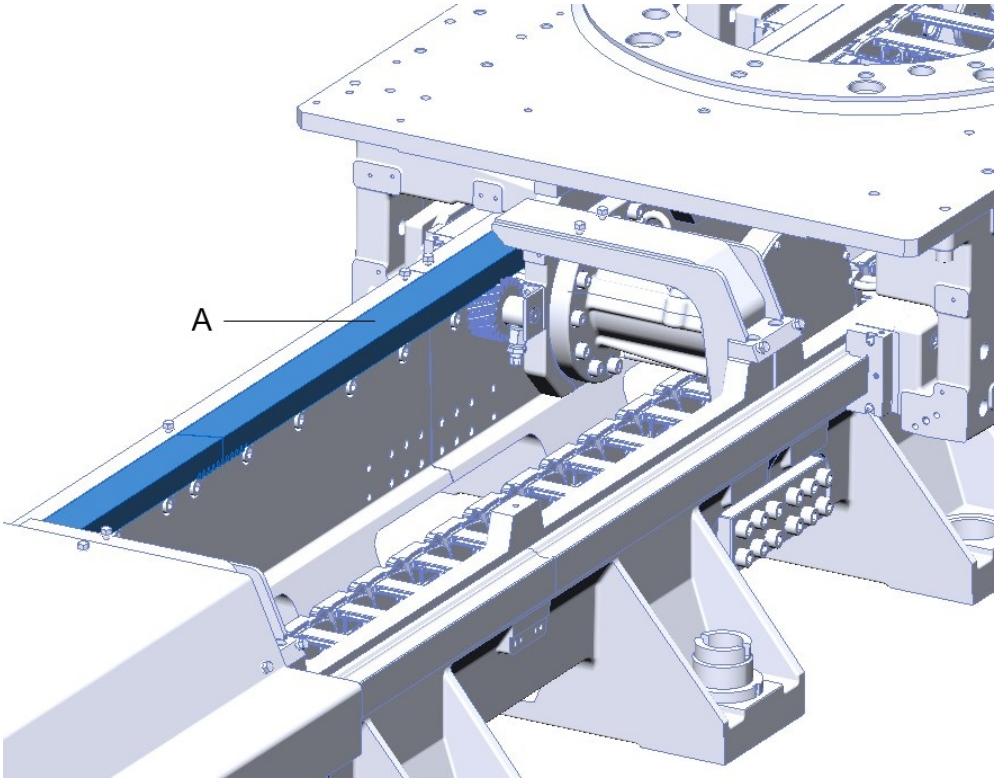
3.3.1 Cleaning the racks

General

The racks should be inspected every 100 km or 1 month. If dirtiness or debris is found, follow the instructions to clean.

Location

The racks are located as shown in figure.



xx1400000461

A	Rack

Required equipment

When you clean the racks, it is necessary to lubricate the racks manually. Use one of the recommended lubricants:

Equipment	Note
Lubricant	KLÜBER Microlube GB0 **WARNING** The grease used causes serious eye irritation and may cause an allergic skin reaction.

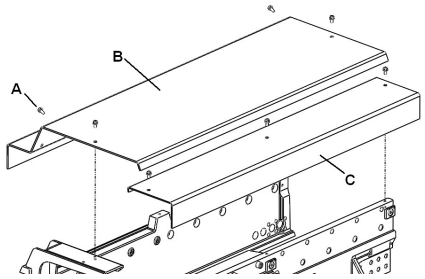
Continues on next page

3.3.1 Cleaning the racks
Continued

Equipment	Note
Lubricant	TOTAL Multis EP 0
Lint free cloth	

Lubricating the racks

Use this procedure to lubricate the racks and pinion.

	Action	Illustration/Note
1	Remove IRBT 2005 upper covers and rack covers.	 xx1400000231 A Screw DIN6921 M6x12 B Top cover of the track C Rack cover of the track
2	Inspect the racks and the pinion, clean them if necessary.	**Note** Use lint free cloth.
3	Use a brush to lubricate the racks.	
4	Refit the covers.	

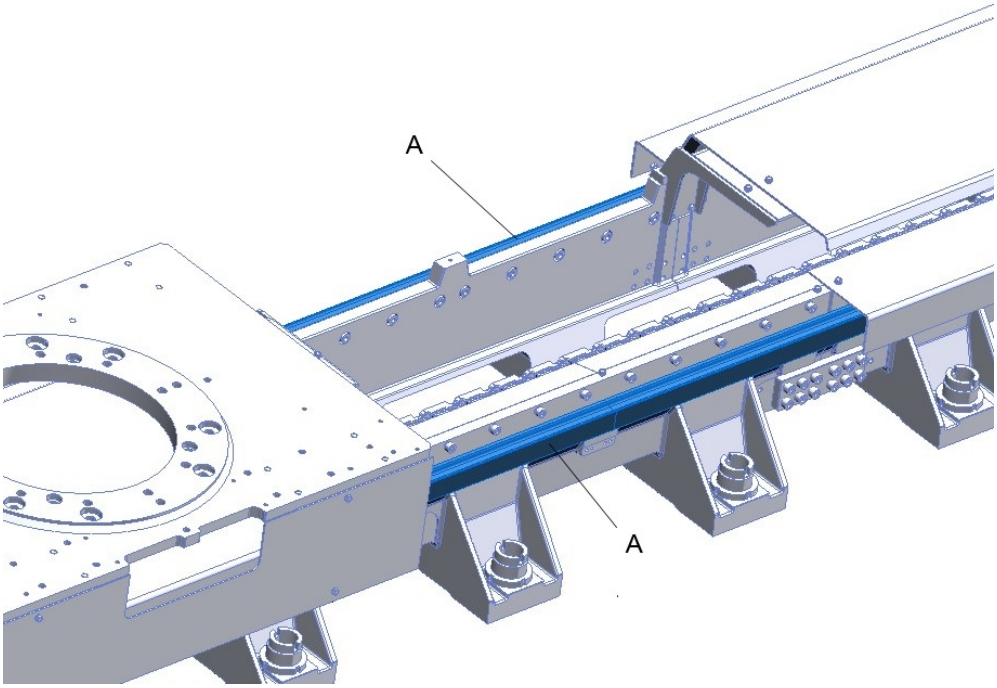
3.3.2 Cleaning the linear guides

General

The linear guides should be inspected every 100 km or 1 month. If dirtiness or debris is found, follow the instructions to clean

Location of linear guides

The linear guides are located as shown in figure.



xx1400000466

A	linear guides

Required equipment

When you clean the linear guides, it is necessary to lubricate them manually. Use one of the recommended lubricants:

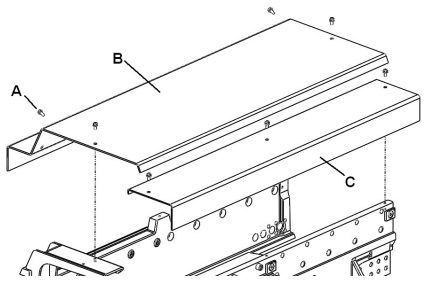
Equipment	Note
Lubricant	KLÜBER Microlube GB0 **WARNING** The grease used causes serious eye irritation and may cause an allergic skin reaction.
Lubricant	TOTAL Multis EP 0
Lint free cloth	

Continues on next page

3.3.2 Cleaning the linear guides
Continued

Cleaning the linear guides

Use this procedure to clean and, if necessary, lubrication of the linear guides.

	Action	Illustration/Note
1	Remove IRBT 2005 upper covers and rack covers.	 xx1400000231 A Screw DIN6921 M6x12 B Top cover of the track C Rack cover of the track
2	Inspect the linear guides, clean them if necessary.	**Note** Use lint free cloth.
3	If you have cleaned them, use a brush to lubricate the linear guides.	
4	Move the carriage back and forth and repeat step 3.	
5	Refit the covers.	

3.4 Activities 1 month

3.4.1 Inspecting the automatic lubrication system

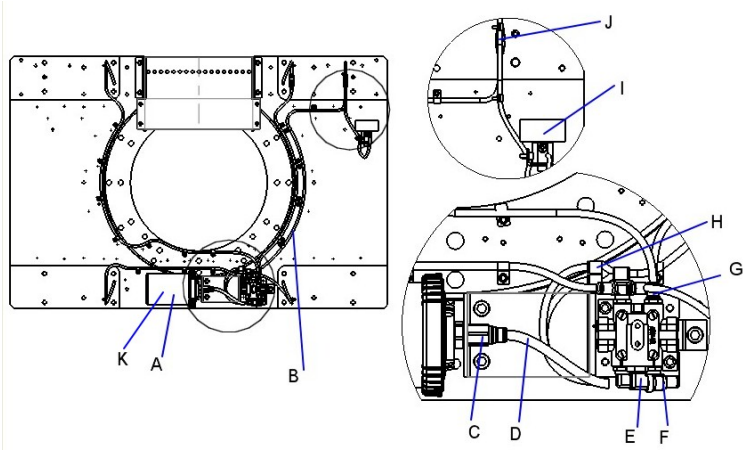
Overview

There is an automatic lubrication system in IRBT 2005. An electric pump will deliver the correct quantity of grease from a cartridge to the ball bearing blocks and to the pinion at required time intervals (one cycle per day). The grease is pushed in the piping by the pump; a valve is sequencing the distribution to each port.

The level of the lubricant should be inspected once a month, even though the system should apply the lubricant equally over a longer period.

Location of lubrication system

The lubrication system is located as shown in the figure.



xx1400000478

Pos	Description
A	Lubrication pump EPS 240
B	Polyamide tube 4x6
C	Straight adaptor F1/4-D8
D	Polyamide tube 6x8
E	Male stud elbow (white brass) D8 G1/4
F	Male stud elbow (white brass) D6 G1/8
G	Male stud straight (white brass) D6 G1/8
H	Y fitting D6-D6
I	Inline fitting-D6
J	Felt gear set
K	Grease package 240 CC

Continues on next page

3.4.1 Inspecting the automatic lubrication system
Continued

Required equipment

Required tool

Equipment	Art. No.	Note
Standard toolkit	-	Content is defined in section *Standard tools on page 280*.
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.

Required lubricant

WARNING

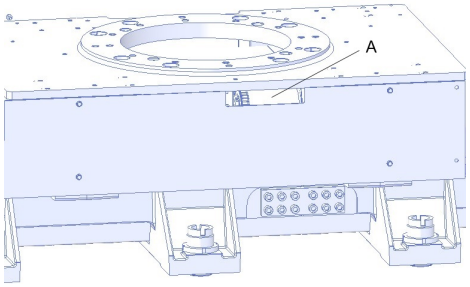
Use lithium soap flowable grease, class NLGI 0, with a mineral oil base, doped with EP (extreme pressure) additives. The base oil viscosity must be ISO VG68 to ISO VG 100.

Grease doped with EP additives is absolutely necessary, due to high loads on blocks.

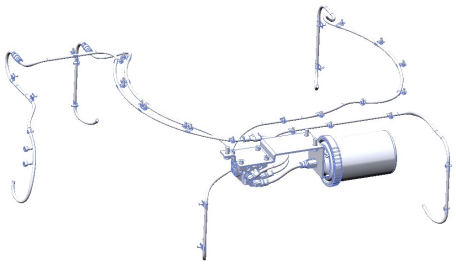
Equipment	Note
Lubricant	KLÜBER Microlube GB0 **WARNING** The grease used causes serious eye irritation and may cause an allergic skin reaction.
Lubricant	TOTAL Multis EP 0

Inspecting the grease level and inspecting the pipes

Use this procedure to inspect the grease level and inspect the pipes of the lubrication system.

	Action	Illustration/Note
1	Locate the cartridge.	
2	Check the level of lubricant, if necessary replace the cartridge. For information about cartridge replacement, see *Replacing the grease cartridge in grease pump MEMOLUB® EPS on page 137*.	 xx1400001754 A Checking lubrication cup level through the notch

Continues on next page

	Action	Illustration/Note
3	Check that no pipe has been damaged, and that the grease is arriving to each block and at the pinion lube tube.	 xx1400001585

Checking the performance

The automatic lubrication system should be checked that it can work properly. For information about checking Memolub function, see *Test the grease pump MEMOLUB® (verify function) on page 140*.

3.4.2 Emergency stop and stroke limit system

General

It is recommended to ensure the emergency stop and stroke limit system effectiveness every month.

Motor brake

The procedure below details how to ensure the effectiveness of the motor brake in case of emergency stop.

	Action	Illustration/Note
1	Ensure that the IRBT 2005 is powered, but not moving.	
2	Press the emergency stop button.	
3	The brake is applied; you should hear the noise in the motor area.	
4	Try to push the carriage manually.	
5	If the brake is correctly applied, it is not possible to move the carriage manually.	
6	Proceed with the required validations in the control system to switch back to auto mode.	

Verification of the effectiveness of the stroke limit system

A software limit prevents the carriage from moving beyond its acceptable upper and lower stroke limits.

The procedure below details how to ensure the software stroke limit is working correctly:

	Action	Illustration/Note
1	Switch the IRC5 to manual mode.	
2	With the teach pendant, try to jog the carriage to both ends.	
3	If the software limits are functional, it should not be possible to go beyond the defined upper or lower end position, and it should not be possible to reach the hard stops.	

3.4.3 Inspecting the cables and connectors

WARNING

Turn off all electric power and pneumatic pressure supplies to the robot and for IRBT 2005.

Inspecting the cables

Use this procedure to check the cables.

	Action	Illustration/Note
1	Check if any cables have been damaged through wear or pinching. If damaged then replace the cable.	
2	Check if any cables rub against sharp edges. If so, route the cable so that it runs freely.	Replace the cable, remove the cause of the wear, or route the cable in a different way.
3	Check strain relief of cables and hoses. Marking should be close to the corresponding strap. If not, pull the hose/cable to the correct position and strap it.	

Inspecting the connectors

Check that the connectors at the robot base, track motor and interchange to the floor cable are firmly secured and that there is no damage of cable outlet.

Inspecting the cable chain

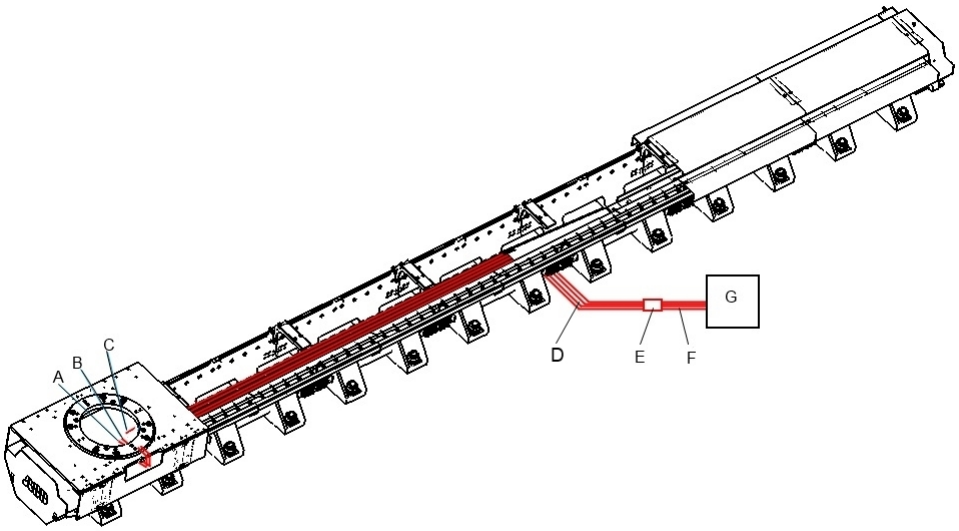
Once a month check that the cable track shows no trace of excessive wear due to rub on a fixed part. If one element is damaged, it is possible to replace it without removing the whole chain from IRBT 2005.

3.5 Activities 3 months

3.5.1 Inspecting the cable chain

Location of harness

The track cable harness is totally located in the cable chain.



xx1400001286

A	Customer cables
B	Track motor and manipulator power cables
C	Signal cables for the manipulator and IRBT 2005 track motor
D	Cable chain
E	Cable connectors or SMB box connecting cables from the track and from IRC5 controller
F	Floor cables from the controller
G	IRC5 controller

Required equipment

Equipment	Art. No.	Note
Visual inspection	-	
Cable ties	21662055-3	Needed if the cable strapping needs to be improved. Use heavy duty cable ties with minimum width: 4.9 mm.
Locking liquid	-	Loctite 243 Used if loose screws are detected.

Continues on next page

Checking the emergency stop

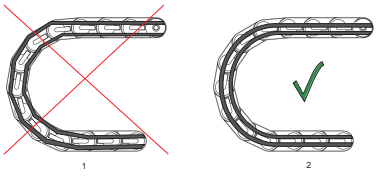
	Action	Illustration/Note
1	Allow the track motion to stop.	
2	Press the emergency stop button.	
3	Try to start the track.	

Inspecting the connection plates

	Action	Illustration/Note
1	Check and rectify the cables are tied on the connection plates tightly and neatly.	

Inspecting the cable chain

Inspecting the cables

	Action	Illustration/Note
1	Move the carriage to one end and open the covers on the outside bend.	
2	Check that the cables are in the neutral axis (center line of the link) of the chain as shown in the figure. If cables are found to be too loose or too tight then they need to be adjusted.	 xx1200000518
3	Repeat the check of the cables in the neutral axis with the carriage in the middle and at the other end.	
4	Make an overall inspection of the cables. If a cable is found to corkscrew it needs to be replaced immediately. If cables have worn through the outer cover they must be replaced. Some dust can be expected from the cables as they rub against the dividers in the chain.	

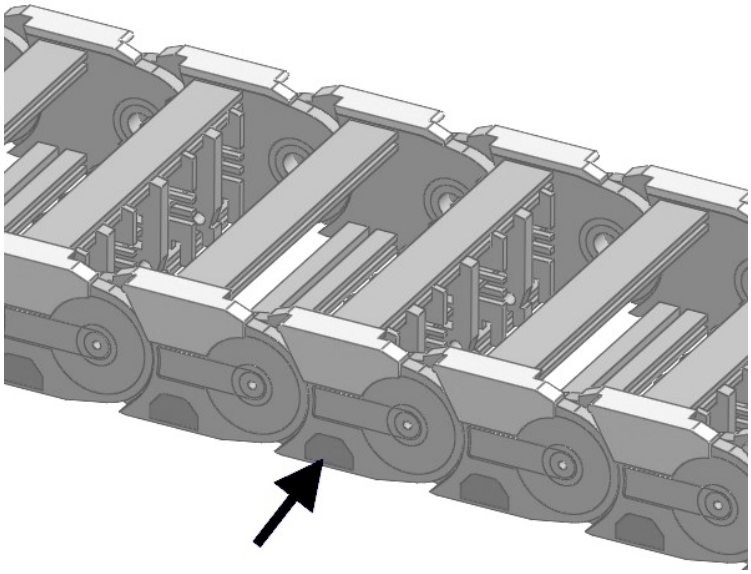
Continues on next page

3.5.1 Inspecting the cable chain

Continued

Location of the glide shoes

The figure shows the location of the glide shoes on the cable chain.



xx1400002683

Inspecting the glide shoes

	Action	Illustration/Note
1	Check the thickness of the glide shoes. If it is less than 1.5 mm the glide shoes must be replaced. Normally only the glide shoes in the area that make first contact when the chain transitions into gliding mode need to be checked. However due to process cycle variation in factories it is recommended to check all the glide shoes for the first inspection and note the point of wear for the next inspection.	
2	Make an overall inspection of the glide shoes. Replace broken or missing shoes.	See *Refitting the glide shoes on page 250*.

Inspecting the strapping

	Action	Illustration/Note
1	Check that strapping is in place. Each cable is required to be individually strapped down, and not bunched together. If insufficient holes are available in the connection plates for individual strapping with cable ties, the cables should be secured in such a way that they cannot move. Only use heavy duty cable ties, specified in *Required equipment on page 162*. If strapping has been replaced ensure that a paint pen is used to mark both sides of the cable tie.	

Continues on next page

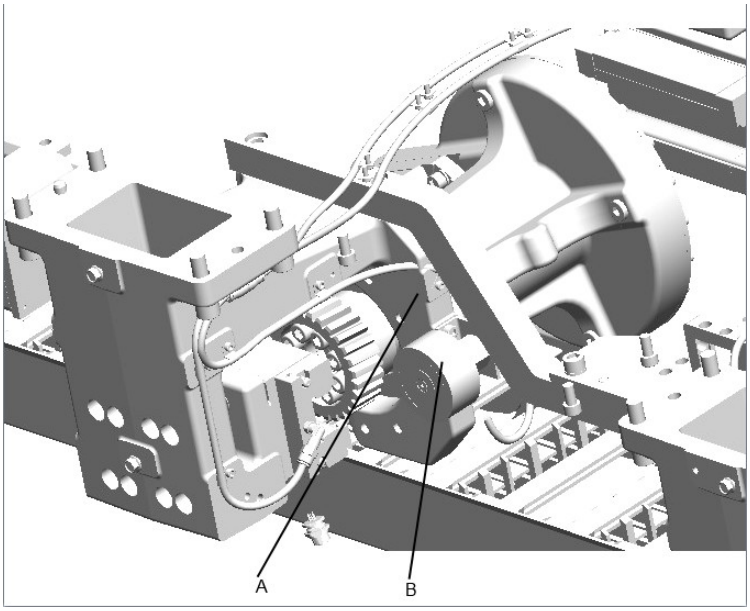
Inspecting the fasteners

	Action	Illustration/Note
1	Check bolts and screws on the attaching plates and brackets. If found to be loose they need to be removed, have locking liquid applied to them and then be refitted and tightened.	Loctite 243

3.5.2 Inspecting the felt gear

Location of felt gear

The felt gear is located as shown in figure.



xx1400002641

A	Gearbox
B	Felt gear

Required equipment

Equipment	Art. No.	Note
Standard toolkit	-	Content is defined in section *Standard tools on page 280*.

Inspecting the felt gear

	Action	Illustration/Note
1	Inspect the felt gear. If damaged, replace it. See *Replacing the felt gear on page 231*.	

3.6 Activities 12 months

3.6.1 Inspecting the cables and connectors

Required equipment

Equipment	Art. No.	Note
Visual inspection	-	

Inspecting the connectors

Use this procedure to check the connectors.

	Action	Illustration/Note
1	Check that the connectors at the robot base, track motor and interchange to the floor cable are correctly fitted and that there is no risk of loose connections.	

Inspecting the cables

Use this procedure to check the cables.

	Action	Illustration/Note
1	Check if any cables have been damaged through wear or pinching. If damaged then replace the cable.	
2	Check if any cables rub against sharp edges. If so, route the cable so that it runs freely.	See cable routing in *Replacing the cables on page 251*.
3	Check strain relief of cables and hoses. Marking should be close to the corresponding strap. If not, pull the hose/cable to the correct position and strap it.	

Fault finding

The following information is provided to assist fault finding.

Cables that have failed due to incorrect installation typically show the following symptoms:

- Knotting of conductors underneath the cable jacket.
- Cables twist around one another within a cable carriage system.
- Cables are sticking out between the cable carriage crossbars and getting caught in the bend radius.
- Cables entangled with other cables and crossbars tearing them apart.
- Loss of conductivity through simple breaking of cable conductors.

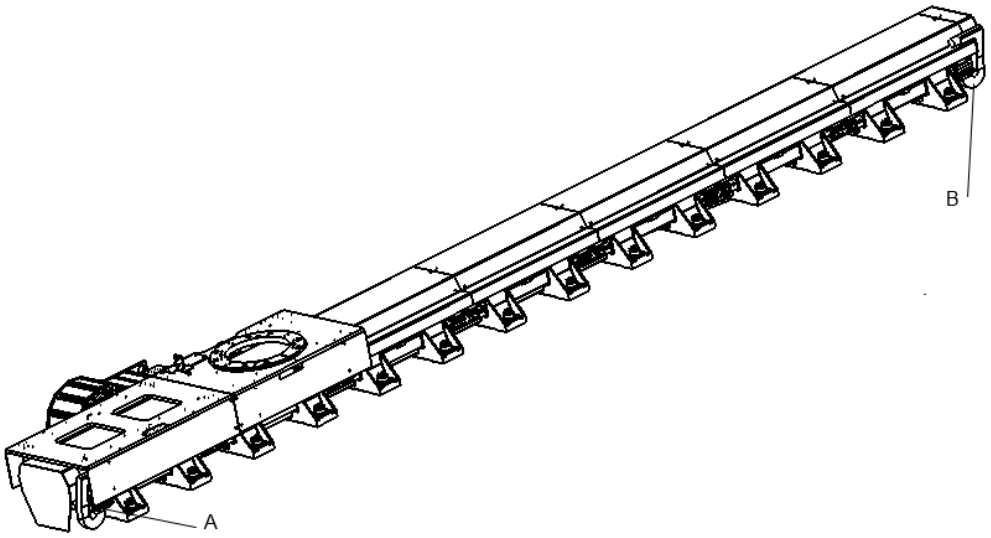
Common causes of cable failure when operating in a cable chain:

- Cables used are not designed for use in continuous flexing operation.
- Cables are packed too tight inside the carriage cavities.
- Cables are not properly adjusted (see *Inspection of cables and covers prior to start-up on page 119*).

3.6.2 Inspecting the mechanical stops

Location of mechanical stops

The mechanical stops are located as shown in figure.



xx1400001282

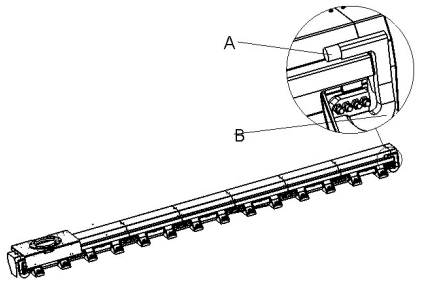
A	Mechanical stops left
B	Mechanical stops right

Required equipment

Equipment	Art. No.	Note
Visual inspection	-	

Inspecting the mechanical stops

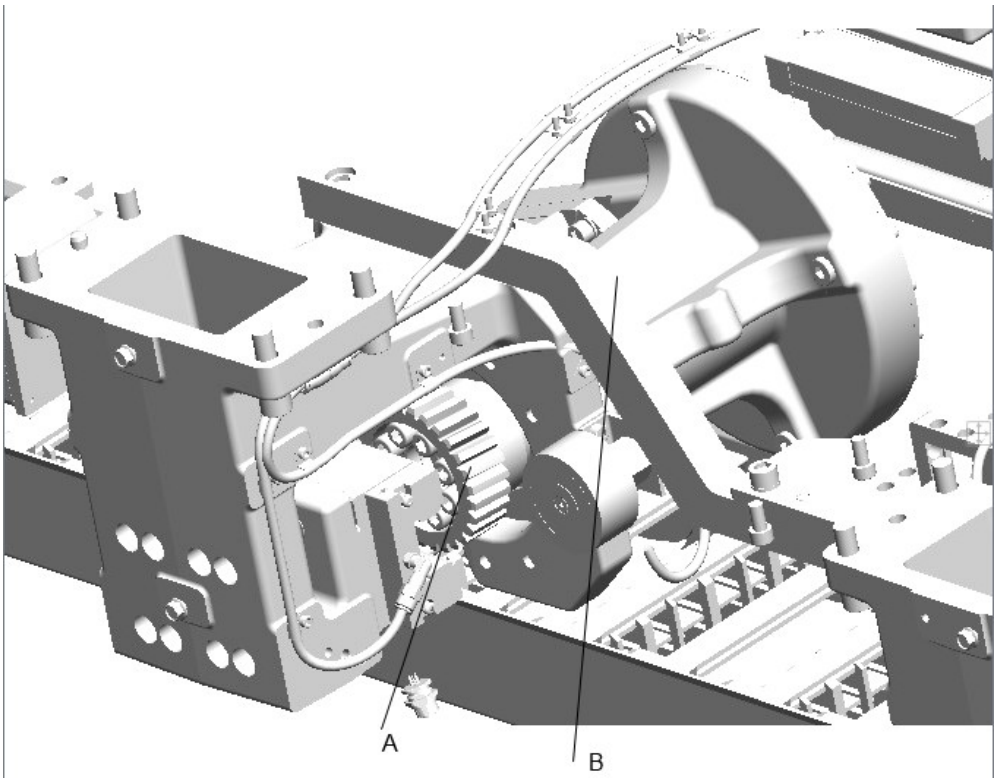
Use this procedure to inspect the mechanical stops.

	Action	Illustration/Note
1	Visually inspect the bumpers on mechanical stops for damage.	 xx1400001283 A Bumper B Mechanical stop
2	If the mechanical stops are damaged, replace them.	

3.6.3 Inspecting the gear wheel, gearbox and backlash

Location of gear wheel and gearbox

The gear wheel and gearbox are located as shown in figure.



xx1400001284

A	Gear wheel
B	Gearbox

Required equipment

Equipment	Art. No.	Note
Standard toolkit	-	Content is defined in section *Standard tools on page 280*.

Inspecting the gear wheel, gearbox and backlash

Use this procedure to inspect the gear wheel, gearbox and backlash.

	Action	Illustration/Note
1	Loosen the carriage from the drive train bracket.	
2	Remove the drive train.	
3	Inspect the backlash, gear wheel and gearbox.	
4	If backlash is improper, adjust it. See *Adjusting the gearbox backlash on page 227*.	

Continues on next page

3.6.3 Inspecting the gear wheel, gearbox and backlash
Continued

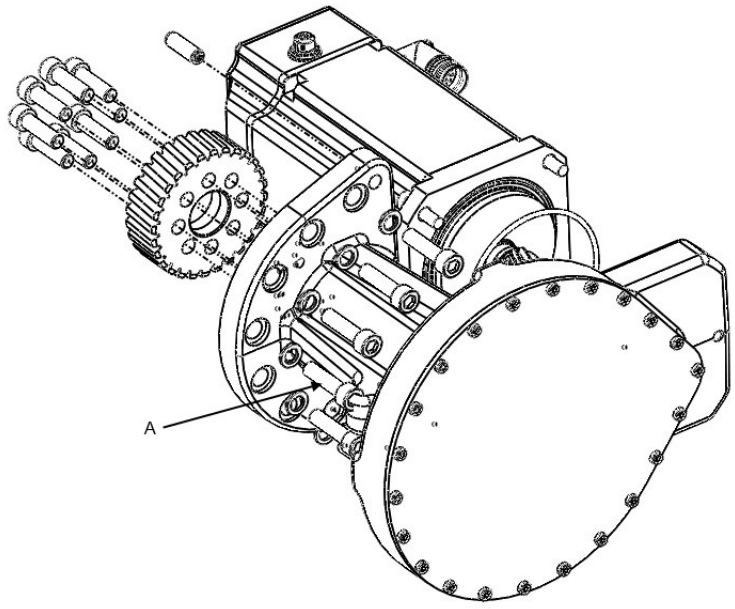
	Action	Illustration/Note
5	If gear wheel or gearbox is damaged, replace it. See *Replacing the gear wheel on page 214* and *Replacing the gearbox on page 202*.	

Verification of the tightening torque

Every year, remove the necessary IRBT 2005 and carriage side covers and make sure that the tightening torque of the eight M10x40 class 12.9 hex socket head cap screws that secure the gear to the bracket is 70 Nm.

Location of tightening screws

The eight screws are located as shown in figure.



xx1400001285

A Eight M10x40 hex socket head cap screws, class 12.9. 3HAB3409-50

Required equipment

Equipment	Art. No.	Note
Standard toolkit	-	Content is defined in section *Standard tools on page 280*.

Inspecting the tightening torque of screws

Use this procedure to inspect the tightening torque of the eight M10x40 hex socket head cap screws.

	Action	Illustration/Note
1	Remove the necessary track covers and carriage side covers.	
2	Use a torque wrench to check that the tightening torque of the screws that secure the gear to the bracket is 70 Nm.	Screw specification: M10x40 hexagon socket head cap screw, class 12.9

3.6.4 Adjusting the leveling

Adjusting the leveling

Follow the procedure in *Geometric alignment of track motion IRBT 2005 on page 89* to adjust the leveling on the track.

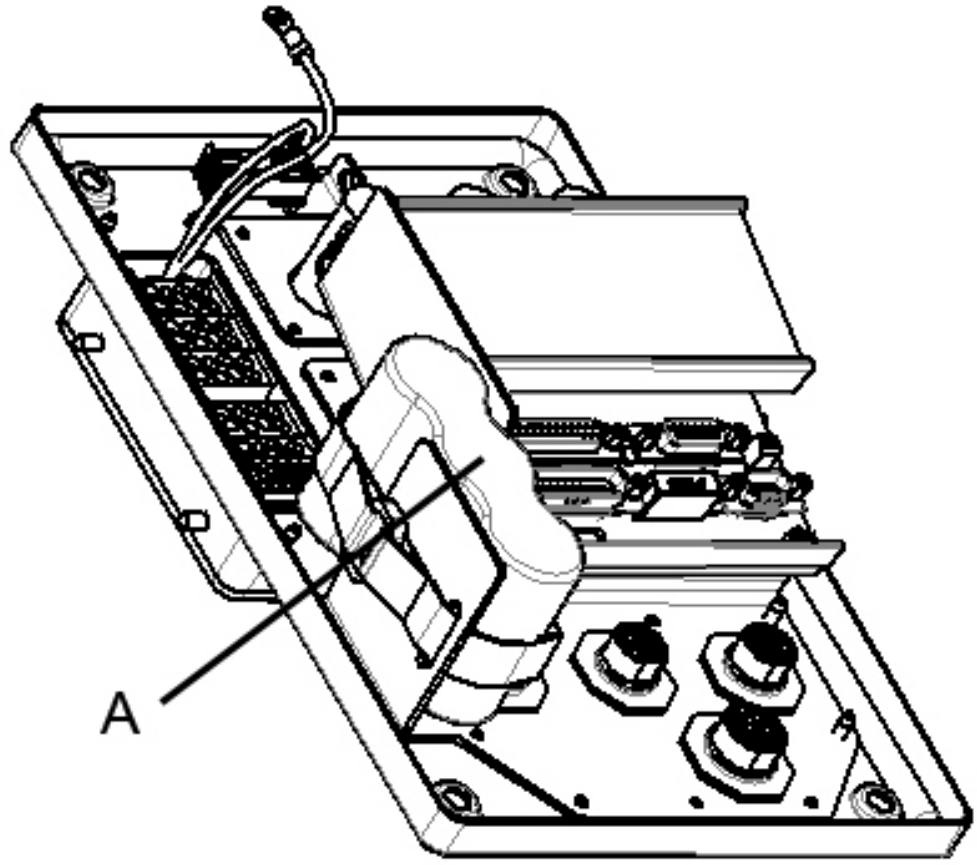
3.7 Activities 36 months

3.7.1 Replacing SMB battery

WARNING

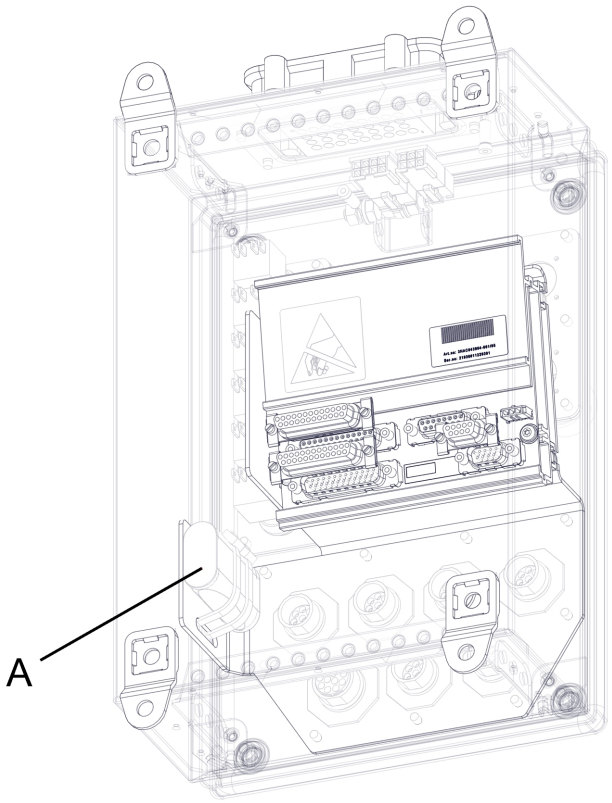
See safety instructions for batteries, *Hazards related to batteries on page 32*.

Location of SMB battery



xx1000001415

Continues on next page



xx1700001329

A	SMB battery

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!

Replacing SMB battery

Use this procedure to replace the SMB battery.

	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.	

Continues on next page

3.7.1 Replacing SMB battery

Continued

	Action	Information
2	 xx0200000023  **WARNING** 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 70*	
3	Open the cover on the SMB box.  **CAUTION** Clean cover from metal residues before opening. Metal residues can cause shortage on the boards which can result in hazardous failures.	
4	Pull out the *battery* and disconnect the battery cable.	
5	Fit the new *battery* and connect the battery cable.	
6	Close the SMB box.	
7	Update the revolution counters.	See *Calibration on page 265*.
8	Dispose of the old battery.	See *Environmental information on page 270*.

4 Repair

4.1 Introduction

Structure of this chapter

This chapter describes repair activities for the IRBT 2005. 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 IRBT 2005, 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 15* before commencing any service work.

Note

If the IRBT 2005 is connected to power, always make sure that the IRBT 2005 is connected to protective earth and a residual current device (RCD) before starting any repair work.

For more information see:

- *Product manual - IRC5*

CAUTION

Do not step on the cable chain or top cover; otherwise, injure and/or damage to the product may occur.

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

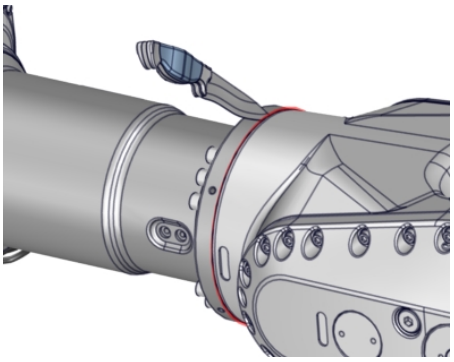
General

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

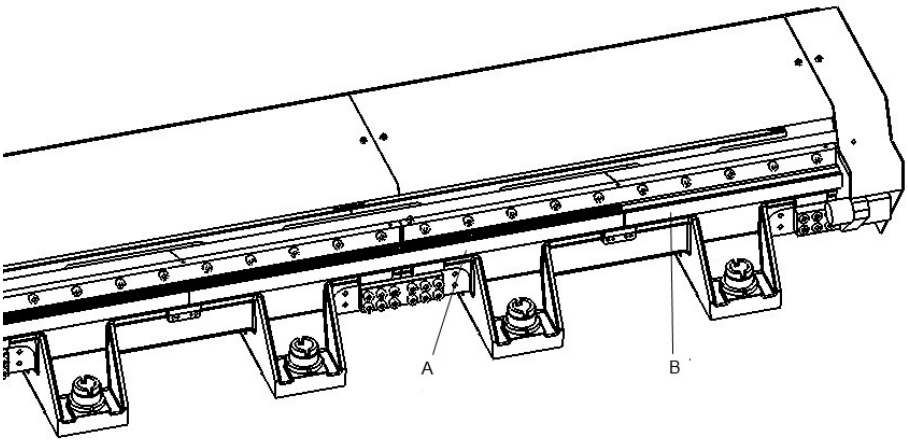
Removing

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

4.3 Replacing the linear guides

Location of linear guides

The figure below shows the location of the linear guides:



xx1400001288

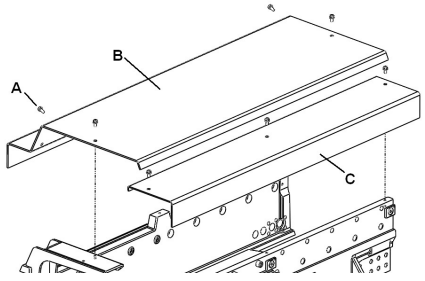
A	1000 mm linear guide
B	500 mm linear guide

Required equipment

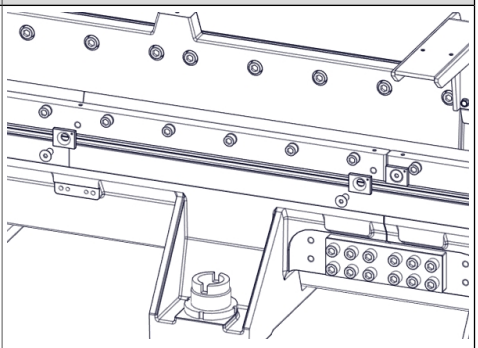
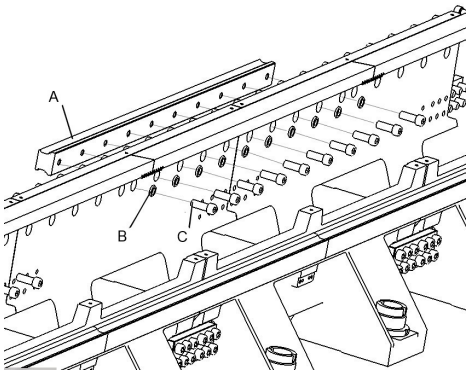
Equipment	Note
Linear guides	Spare part number is specified in *Spare parts on page 287*.
Standard toolkit	Content is defined in section *Standard tools on page 280*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.

Removing the linear guides

Use this procedure to remove the linear guides.

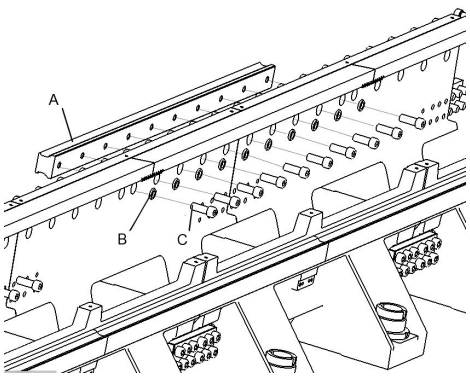
	Action	Illustration/Note
1	Remove all necessary IRBT 2005 top covers (B) and rack covers (C) around the linear guide to be replaced by removing screws (A).	 xx1400000231

Continues on next page

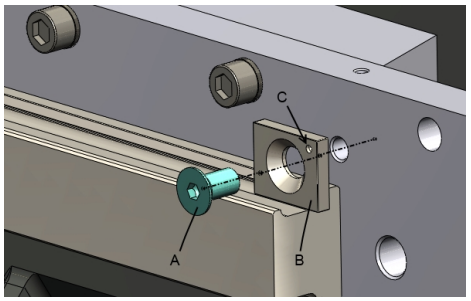
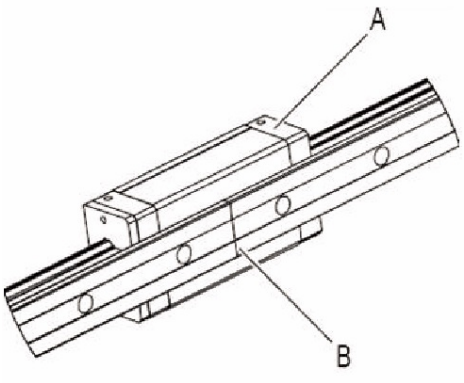
	Action	Illustration/Note
2	Remove the square locking washers and screws, which clamp the to-be-removed linear guides.	 xx1500003253
3	Remove the linear guide by removing the screws and washers.	 xx1400000228 A Linear guide B Ø 12xØ 32x4 Washer for rail, I3HAC047749-001 C M12x35 Hex socket head cap screw, 3HAB3409-66

Refitting the linear guides

Use this procedure to refit the linear guides.

	Action	Illustration/Note
1	Fit the linear guide by securing the screws and plain washers. Use standard tools, slightly tighten.	 xx1400000228 A Linear guide B Ø 12xØ 32x4 Washer for rail, 3HAC047749-001 C M12x35 Hex socket head cap screw, 3HAB3409-66

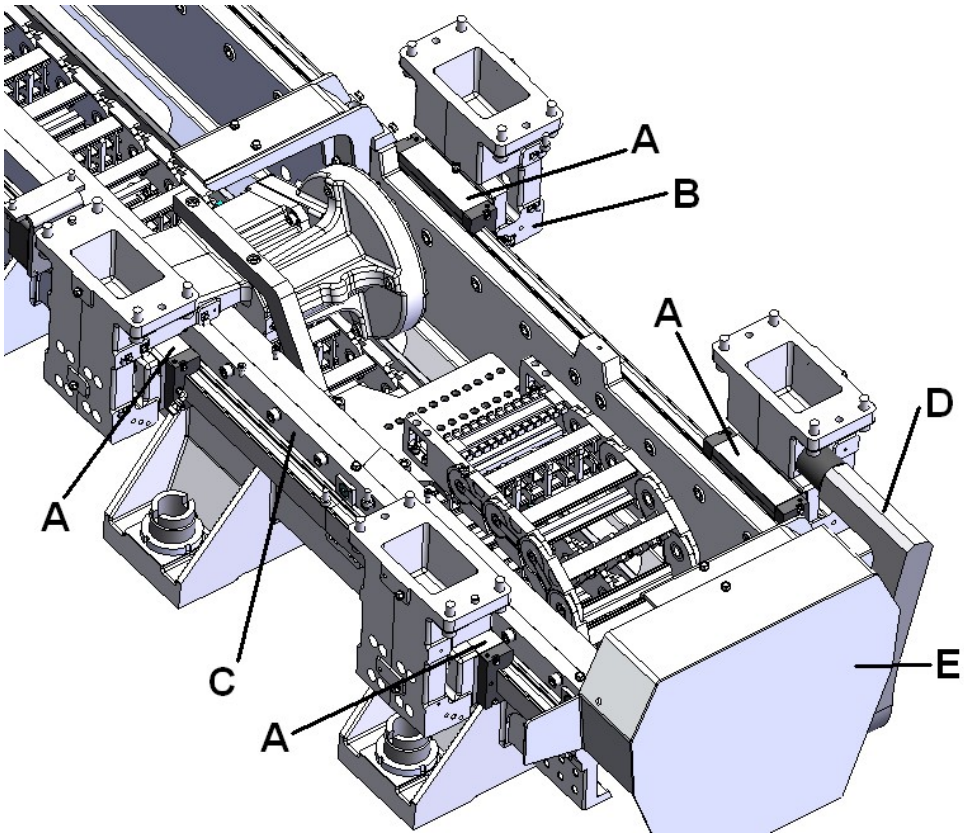
Continues on next page

	Action	Illustration/Note
2	Fit the square locking washer with screws. Use standard tools, slightly tighten.	 xx1400001751 A M10x20 Hex socket countersunk screw DIN7991, 3HAC051482-001 B Square locking washer, 3HEA802935-001 C Ensure this mark is on the upper right corner of the lock washer
3	Feel with a finger at the section joint to check the alignment of the linear guide: if the linear guides are correctly aligned, you should sense no "step" while passing the linear guide's junction.	 xx1400001752 A Ball bearing block B Linear guide
4	If "step" is felt, loose linear guides slightly and use a plastic hammer striking the linear guides slightly along the direction of the track until gaps between all linear guides are less than 0.7 mm.	
5	Make sure that the guide rail is aligned, and then tighten the screw to locking washer.	Once you have tightened a screw, mark it with a white marker. Tightening torque: 45 Nm  xx1400001752
6	Tighten the hex socket head cap screws M12x35.	Tightening torque: 125 Nm
7	Fit the covers.	

4.4 Replacing the ball bearing blocks

Location of ball bearing blocks

The figure below shows the location of the ball bearing blocks and other key parts:



xx1400000459

Item	Name
A	Ball bearing blocks
B	Carriage bracket
C	linear guide
D	Mechanical stop
E	End cover

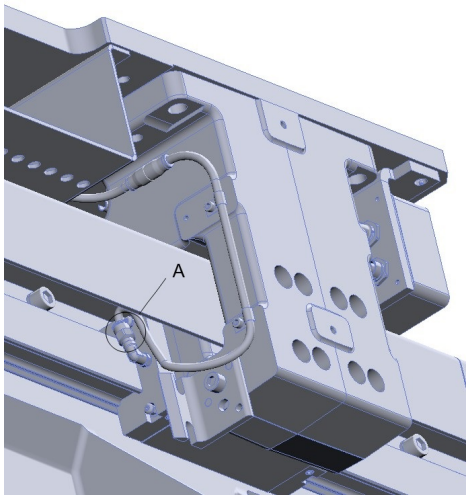
Required equipment

Equipment	Note
Ball bearings block	Spare part number is specified in *Spare parts on page 287*.
Standard toolkit	The content is defined in *Standard tools on page 280*.
Jack > 2t	
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.

Continues on next page

Removing the ball bearing block

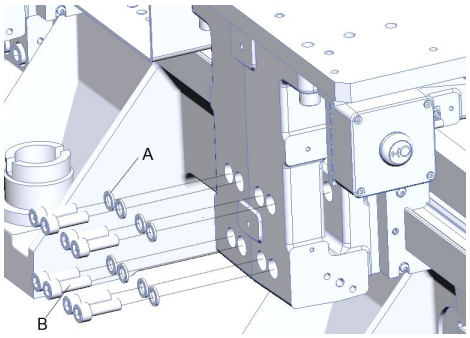
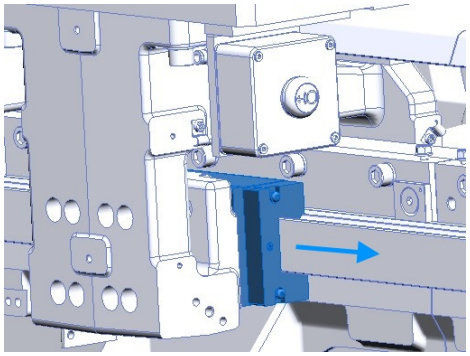
Use this procedure to remove the ball bearing block.

	Action	Illustration/Note
1	Remove the necessary carriage side cover, rack covers, the end cover (if present) and the mechanical stop.	
2	**WARNING** Turn off all electric power and pneumatic pressure supplies to the robot and for IRBT 2005.	
3	Disconnect the lubrication tube connector for the ball bearing block.	 xx1400001679 A Lubrication tube connector
4	Use a jack to secure the height of the carriage plate (don't rise it more than 1 mm). **WARNING** Rising the carriage more than 1 mm can seriously damage the remaining three ball bearing blocks.	

Continues on next page

4.4 Replacing the ball bearing blocks

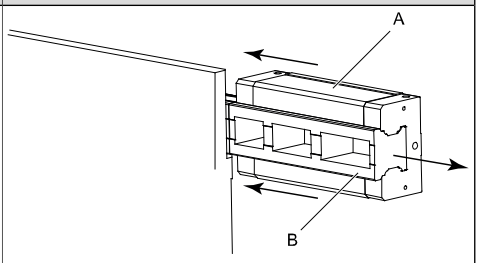
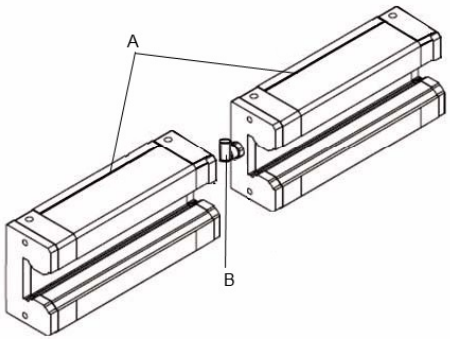
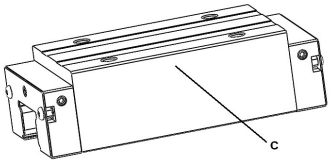
Continued

	Action	Illustration/Note
5	Remove the screws and washers.	 xx1400001701 A Ø17xØ11x2 Washer, 3HAB4233-1 (8 pcs) B M10x30 Hex socket head cap screw, 3HAB3409-51 (8 pcs)
6	Let the ball bearing block slide out of the bracket and linear guide.	 xx1400001702

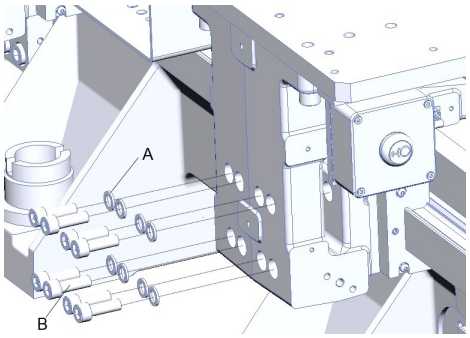
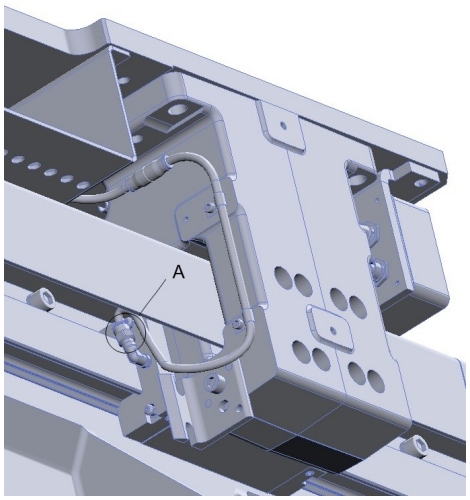
Refitting the ball bearing block

	Action	Illustration/Note
1	Remove the standard screws delivered with the block and replace with the grease pipe fitting taken from the old block.	

Continues on next page

	Action	Illustration/Note
2	Insert the new ball bearing block (A) onto the rail meanwhile the black plastic protection (B) is pushed out.	 xx1400001704 A Ball bearing block B Plastic protection **Note** Do not remove the black plastic protection of the bearings until you slide the block onto the rail. They will come out automatically. **Note** The fittings (B) must be on the inside of the carriage, and the machined reference surface (A) must be on the upper face of the block.   A Machined reference surface B Fittings C The other surface of the block has no reference line.

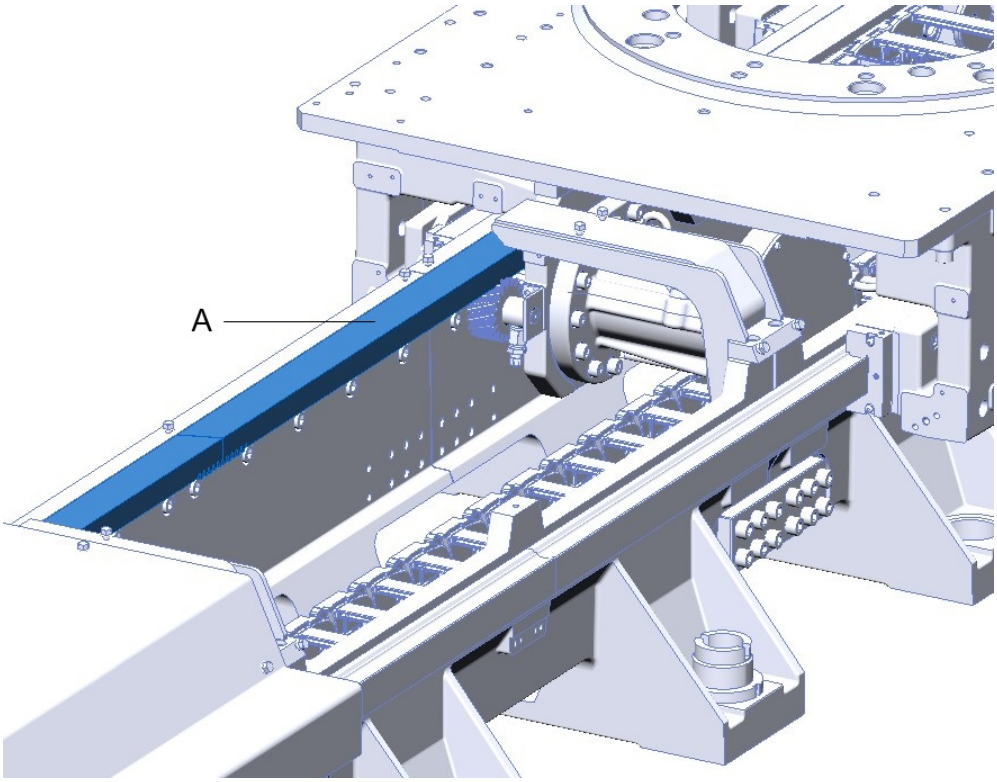
Continues on next page

	Action	Illustration/Note
3	Let the bearings block slide into the bracket and tighten the screws and washers.	 xx1400001701 A Ø17xØ11x2 Washer, 3HAB4233-1 (8 pcs) B M10x30 Hex socket head cap screw, 3HAB3409-51 (8 pcs) Tightening torque: 70 Nm
4	Remove the jack.	
5	Reconnect the lubrication pipe connector to the fitting of the ball bearing block.	 xx1400001679 A Lubrication pipe connector
6	Refit the mechanical stop and the covers.	
7	Calibrate the track motion if the ball bearing block at the drive unit bracket has been replaced.	See *Fine calibration on page 266*.
8	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *Test run after installation, maintenance, or repair on page 145*.	

4.5 Replacing the racks

Location of the rack

The racks are located as shown in the figure.



xx1400000461

A	Rack

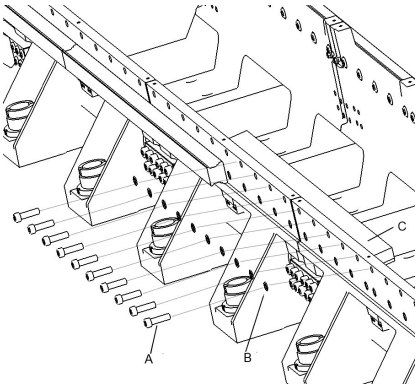
Required equipment

Equipment	Art. No.	Note
Rack		Spare part number is specified in *Spare parts on page 287*.
Standard toolkit		The content is defined in *Standard tools on page 280*.
Companion rack fix block	3HAC054531-001	
Companion rack	3HAC054532-001	
Rack clamps	3HAW107700357	
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	-	These procedures include references to the tools required.

Continues on next page

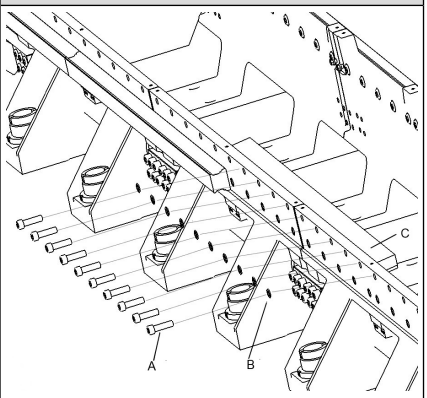
Removing the racks

Use the procedure to remove the racks.

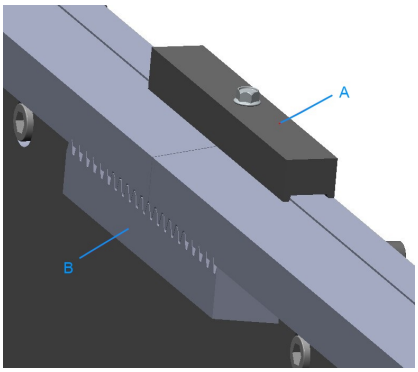
	Action	Illustration/Note
1	Remove the necessary carriage side cover, rack covers, the end cover (if present) and the mechanical stop.	
2	Remove screws and plain washers that hold the rack to the sections.	 xx1400000227 A M10x40 Hex socket head cap screw, 3HAB3409-50 B Ø 17xØ 11x2 Washer, 3HAB4233-1 C Rack

Refitting the racks

Use the procedure to refit the racks:

	Action	Illustration/Note
1	Fit the rack with the screws and washers. Do not tighten the screws yet.	 xx1400000227 A M10x40 hexagon head bolt, class 12.9 B Ø17xØ11x2 washers C Rack

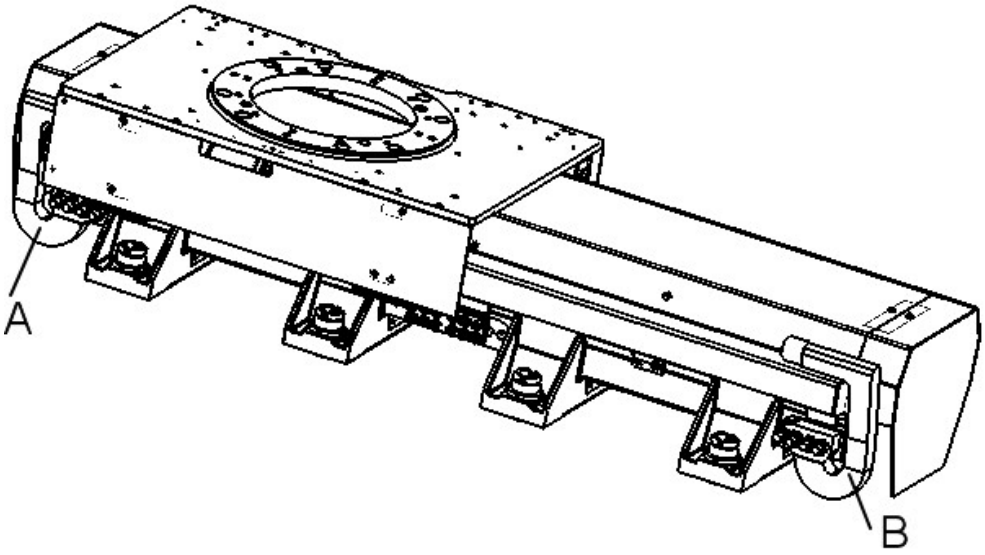
Continues on next page

	Action	Illustration/Note
2	Fit the alignment tool to the section and the rack to make sure the racks are positioned correctly in vertical plane.	 xx1400002156
3	Fit the clamping tools at both ends of the rack to make sure that the racks are aligned with each other.	 xx1400000184
4	Push the rack against the section mounting surface, make sure the alignments are correct and then tighten the screws one by one.	Tightening torque: 70 Nm
5	Loosen the screws of the rack located next to the replaced rack, fit the clamping tool to the junction in order to align the loosened rack to the rack located next to it and then re-tighten the screws. Repeat with following racks until all racks are aligned with each other.	
6	Once you have tightened a screw, mark it with a white marker.	 xx1400001752
7	Refit the covers.	

4.6 Replacing the mechanical stops

Location of mechanical stops

The mechanical stops are located at both end of the track. Two mechanical stops are used on each side of the track end to buffer the impact from the carriage if the carriage moves outside of the software limit of the track.



xx1400000499

A	Mechanical stops, left
B	Mechanical stops, right

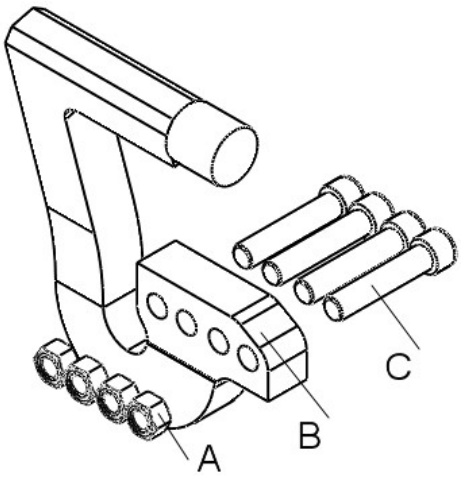
Required equipment

Equipment	Note
Mechanical stops	Spare part number is specified in *Spare parts on page 287*.
Standard toolkit	The content is defined in *Standard tools on page 280*.

Continues on next page

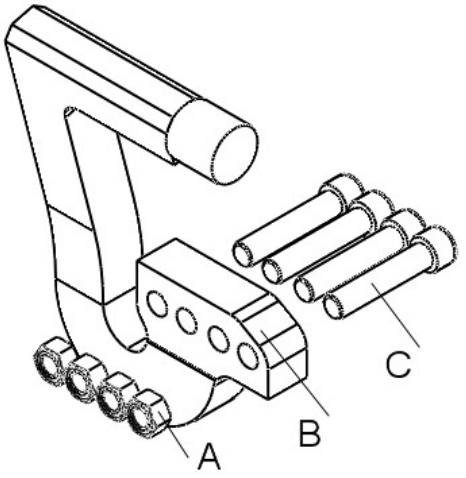
Removing the mechanical stops

Use this procedure to remove the mechanical stops.

	Action	Illustration/Note
1	If the mechanical stops (B) are damaged, remove the mechanical stop by removing hexagon nuts (A) and screws (C).	 xx1400002686 A M20 hexagon nut, 9ADA267-11 B Mechanical stop C M20x100 Hex socket head cap screw, 3HAB3409-206

Refitting the mechanical stops

Use this procedure to refit the mechanical stops.

	Action	Illustration/Note
1	Fit the screws (C) and nuts (A).	 xx1400002686 A M20 hexagon nut, 9ADA267-11 B Mechanical stop C M20x100 Hex socket head cap screw, 3HAB3409-206 Tightening torque: 90 Nm

4.7 Replacing the motor, gearbox and gear wheel

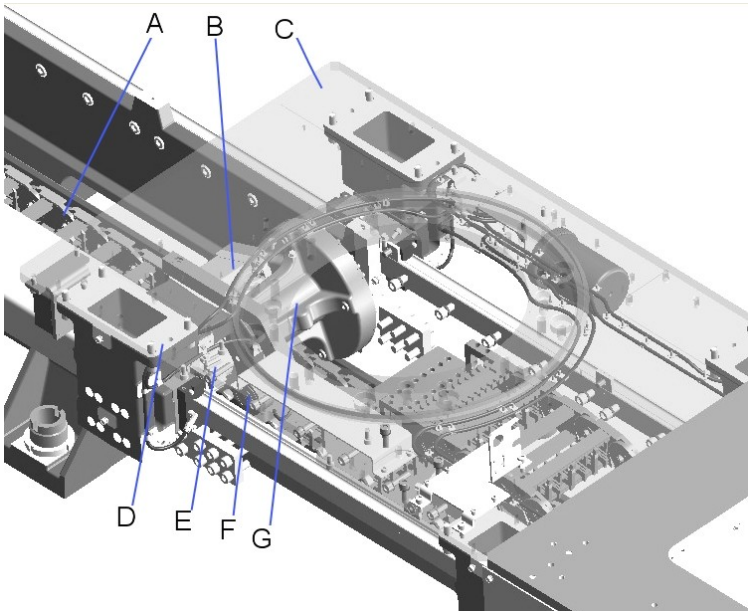
4.7.1 Replacing the motor

Location of motor and gear

Users can choose to change the whole geared motor unit to reduce down time or only change the malfunctioned gear or motor. It is recommended to have two technicians to work together.

To replace the motor and/or the gear, it is possible to remove the motor bracket from the top plate and then push the carriage away. It is recommended to have two technicians to work together.

The figure below shows how to push the carriage away from the motor bracket and expose the motor, gearbox, gear wheel, felt gear and cable chain connection point. This makes the following components accessible for maintenance:



xx1400002684

Item	Name
A	Cable chain - remains stationery
B	Motor - remains stationery
C	Carriage - pushed away
D	Motor bracket - remains stationery
E	Gear wheel - remains stationery
F	Felt gear - remains stationery
G	Gearbox - remains stationery

Continues on next page

Required equipment

Equipment	Art. No.	Note
Standard toolkit	-	The content is defined in *Standard tools on page 280*.
Torque wrench	-	The tightening torque of the M10x40 hex socket head cap screw that secure the gear to the bracket is 70 Nm. There are also specific tightening torques for the motor shaft and gear assembly. See the details in maintenance instructions.
M6 screws of different lengths. For example: M6x10, M6x15, M6x35 1 thick washer inside diameter 6 mm 1 spacer 30 mm long, inside diameter no smaller than the pin diameter (10 mm), and outside diameter no bigger that the thick washer outside diameter.	-	For the cylindrical pin extraction. The following figures are for your reference about how to use the equipment.  xx1500000635  xx1500000636  xx1500000637

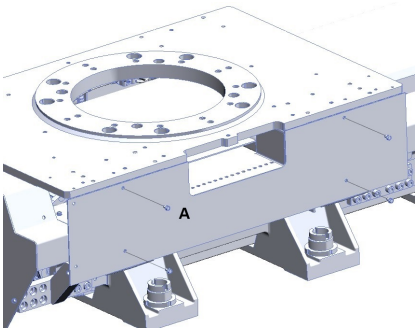
Continues on next page

4.7.1 Replacing the motor

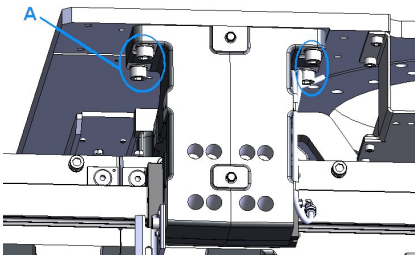
Continued

Removing the motor

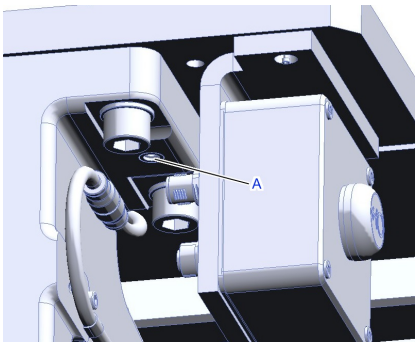
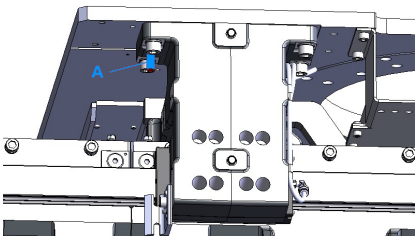
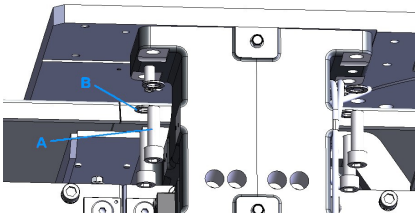
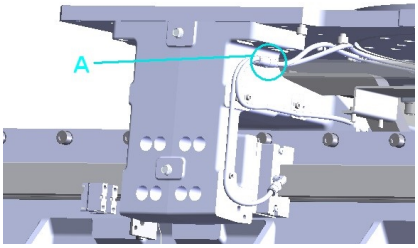
Preparation

	Action	Illustration/Note
1	**WARNING** Turn off all electric power and pneumatic pressure supplies to the robot and for IRBT 2005.	
2	Remove the side cover of the carriage.	 xx1400001587 A M6x12 Screw DIN6921, 9ADA181-11 (4 pcs)

Loosening the carriage from the drive train bracket

	Action	Illustration/Note
1	Remove the bracket for brake release. Cut the cable ties that secure the brake release cables.	
2	Loosen the screws. Use a ratchet wrench.	 xx1400001588 A M12x40 Hex socket head cap screws, 3HAB3409-67 (4 pcs)

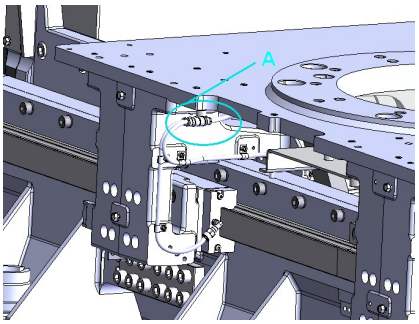
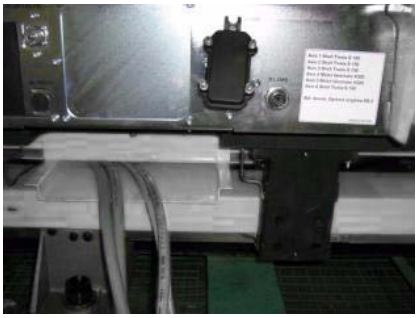
Continues on next page

	Action	Illustration/Note
3	Extraction of the cylindrical pin: Place the spacer on the cylindrical pin, insert the longest screw with the thick washer and screw it to start extracting the pin. Use shorter screws when necessary.	 xx1400001589 A 10x32 cylindrical pin For details about how to use the equipment for cylindrical pin extraction, see *Required equipment on page 191*.
4	Stop when the cylindrical pin is extracted from the top plate. **Note** It is not necessary to extract the pin from the bracket.	 xx1400001590 A Φ10x32 cylindrical pin with threaded hole, 3HAC043986-001
5	Remove the screws and plain washers. Use a ratchet wrench.	 xx1400001591 A M12x40 Hex socket head cap screw, 3HAB3409-67 (4 pcs) B Ø21xØ13x2 Washer, 3HAA1001-632 (4 pcs)
6	Disconnect the lubrication tube from the fitting of the ball bearing block to release the tube from the drive train bracket (the tube will be pushed away along with the carriage).	 xx1400001592 A Lubrication tube connector

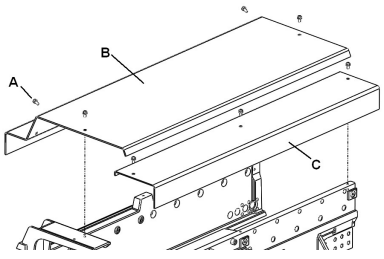
Continues on next page

4.7.1 Replacing the motor

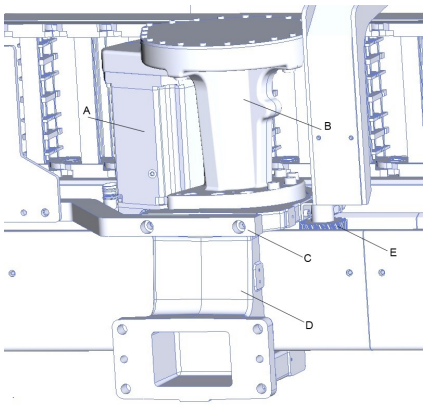
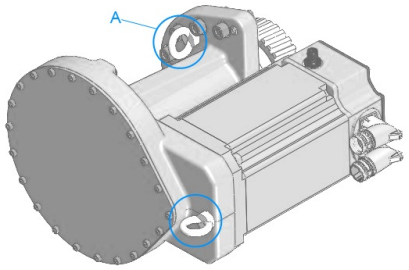
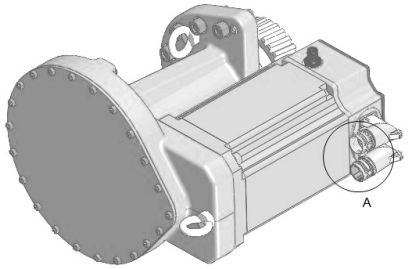
Continued

	Action	Illustration/Note
7	Disconnect the lubrication tube connector from the fitting of the pinion (the tube will be pushed away along with the carriage). Remove the top cover if necessary.	 xx1400001596 A Lubrication tube connector
8	Disconnect the cables from the tooling or robot fitted on the carriage. Remove the upper part of the cable tray so that the connectors can pass through.	 xx1400001593
9	Push the carriage away from the drive train bracket. The bracket, gear and pinion, motor, cable chain support and cable chain, stay stationery.	**Note** Pay attention to the cables and their connectors: You must guide them through the cable tray while you push the carriage away.

Removing the drive train

	Action	Illustration/Note
1	Remove the covers above the drive train.	 xx1400000231

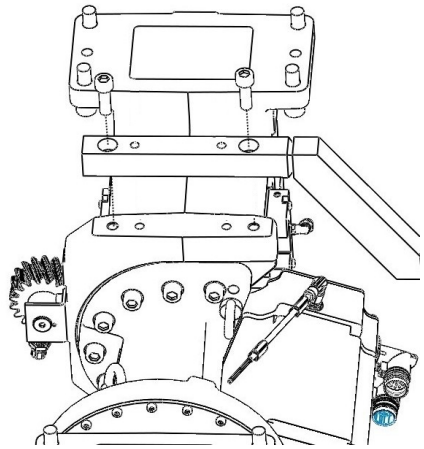
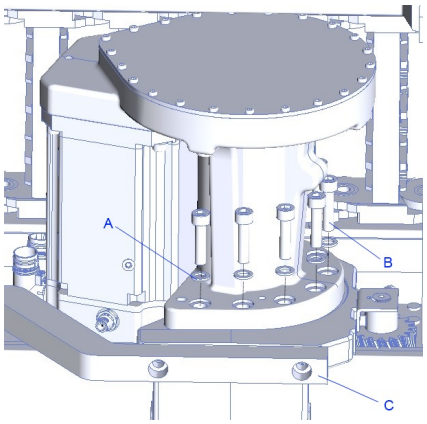
Continues on next page

	Action	Illustration/Note
2	The drive train is now accessible.	 xx1400001610 **A** Motor **B** Gear **C** Cable chain connection plate **D** Motor bracket **E** Pinion
3	Fit two eye bolts on the drive train for lifting.	 xx1400001626 **A** M8 eye bolt (2 pcs)
4	Disconnect the power and resolver connectors from the motor. Guide the cables in the tray area.	 xx1400001625

Continues on next page

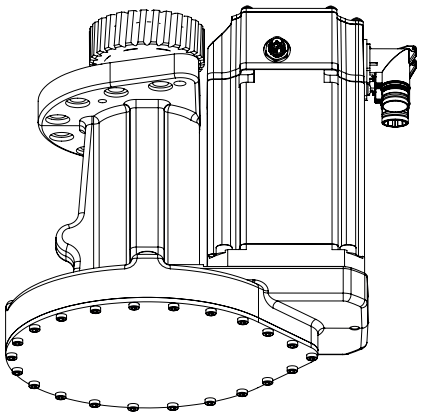
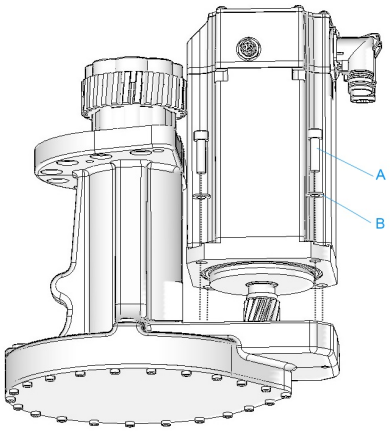
4.7.1 Replacing the motor

Continued

	Action	Illustration/Note
5	For the mirrored cable chain orientation, remove the cable chain support by removing the two screws.	 xx1400002143
6	Remove all but two of the drive train installation screws and plain washers.	
7	Attach lifting chains to the eye bolts and unload the weight of the drive train using an overhead crane.	
8	Remove the remaining two screws from the drive train.	
9	Remove the drive train from the bracket. **CAUTION** The drive train weighs 33 kg. All lifting accessories used must be sized accordingly!	 xx1400001627 A Ø 17xØ 11x2 washer, 3HAB4233-1 B M10x40 hex socket head cap installation screw, 3HAB3409-50 C Cable chain support

Continues on next page

Removing the motor

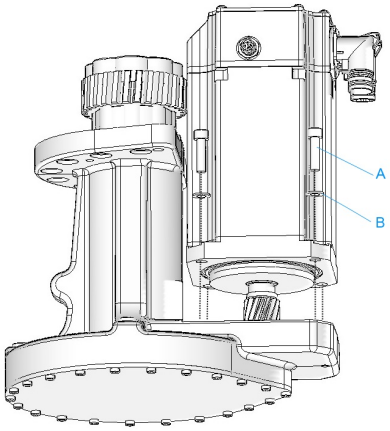
	Action	Illustration/Note
1	Place the removed drive train in a vertical position, with the driving side facing downwards.	 xx1400001628
2	Remove the motor by unscrewing the screws and removing washers.	 xx1400001639 A M8x30 Hex socket head cap screw, 9ADA183-38 (4 pcs) B Ø13xØ8.4x1.6 plain washer, 9ADA312-7 (4 pcs)

Continues on next page

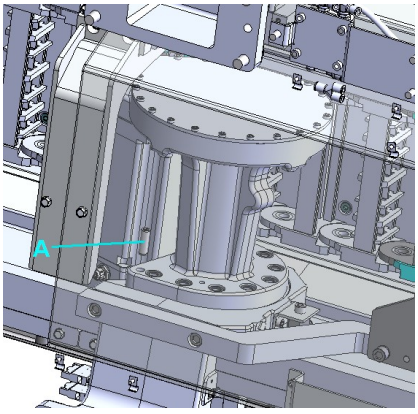
4.7.1 Replacing the motor
Continued

Refitting the motor

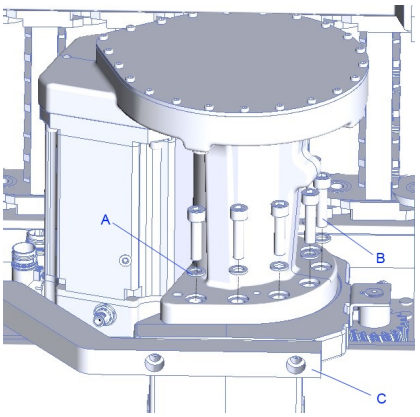
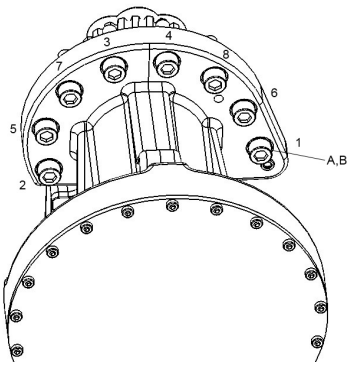
Refitting the motor

	Action	Illustration/Note
1	Fit the new motor on the gearbox unit with screws and washers. **Tip** The motor integrates the driving pinion (article No. 3HAC047333-001) and O-ring (article No. 3HAB3772-110) as a complete spare part.	 xx1400001639 A M8x30 hex socket head cap screws, 9ADA183-38 (4 pcs). Tightening torque: 15 Nm B Ø13xØ8.4x1.6 plain washer, 9ADA312-7 (4 pcs) **Note** The correct orientation of the motor is with the connectors pointing outwards, as shown in the figure.

Refitting the drive train

	Action	Illustration/Note
1	Fit the locating cylindrical pin to the motor using a rubber mallet. Insert it completely.	 xx1400001637 A Ø10x32 Cylindrical pin with threaded hole, 3HAC043986-001

Continues on next page

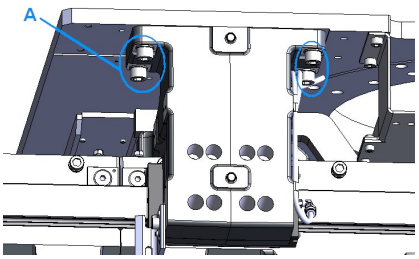
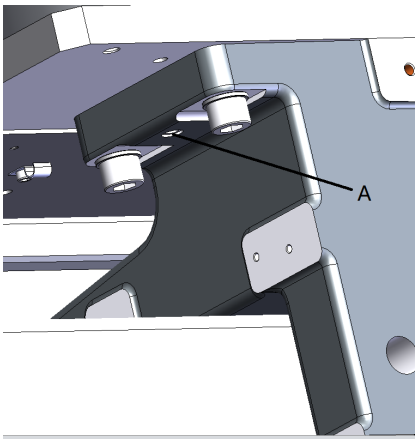
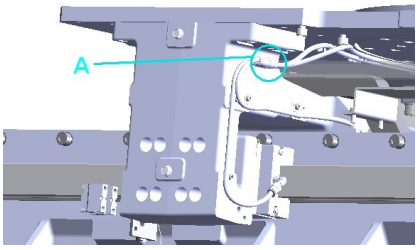
	Action	Illustration/Note
2	**CAUTION** The motor weighs 11 kg. All lifting accessories used must be sized accordingly! Attach the lifting chains to the eye bolts on the motor and lift the motor into position on the track with guidance from the locating cylindrical pin.	
3	Fit the drive train on the drive train bracket with the screws and plain washers. **Note** Do not tighten the screws yet.	 xx1400001627 A Ø 17xØ 11x2 washer, 3HAB4233-1 B M10x40 hex socket head cap installation screw, 3HAB3409-50 (8 pcs) C Cable chain support
4	Adjust the backlash of the gear motor. For how to adjust the gear motor backlash, see *Adjusting the gearbox backlash on page 227*.	
5	Tighten the screws and plain washers in sequence shown in the illustration.	 xx1400001630 Tightening torque: 70 Nm
6	For the mirrored cable chain orientation, refit the cable chain support with two screws.	
7	Reconnect the power and signal cables to the motor.	

Continues on next page

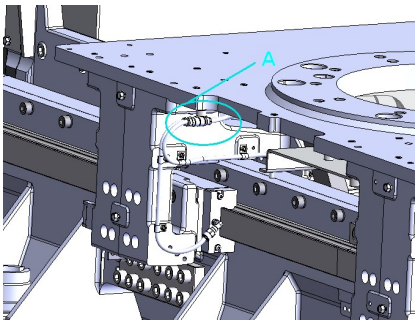
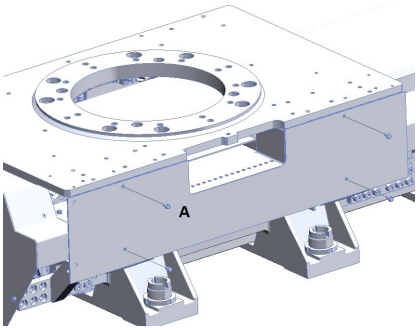
4.7.1 Replacing the motor

Continued

Reinstalling the carriage to the drive train bracket

	Action	Illustration/Note
1	Push the carriage back above the drive train.	
2	Fit the carriage to the drive train bracket with the screws. **Note** Do not tighten the screws yet.	 xx1400001588 A M12x40 Hex socket head cap screws, 3HAB3409-67 (4 pcs)
3	Adjust the position of the carriage until the cylindrical pin in the 10 mm positioning hole of the drive train bracket can be inserted into the positioning hole in the top plate of the carriage.	 xx2400001005 A Ø10x32 Cylindrical pin with threaded hole, 3HAC043986-001
4	Tighten the screws.	Tightening torque: 100 Nm
5	Connect the lubrication tube connectors of the ball bearing block.	 xx1400001592 A Lubrication tube connector

Continues on next page

	Action	Illustration/Note
6	Connect the lubrication tube connector of the pinion.	 xx1400001596 A Lubrication tube connector
7	Connect the cables from the tooling or robot fitted on the carriage. If necessary, remove the upper part of the cable tray so that the connectors can pass through.	
8	Refit the bracket for brake release and secure brake release cables with cable ties.	
9	Refit the side cover of the carriage.	 xx1400001587 A M6x12 Screw DIN6921, 9ADA181-11 (4 pcs)
10	Refit the top cover.	

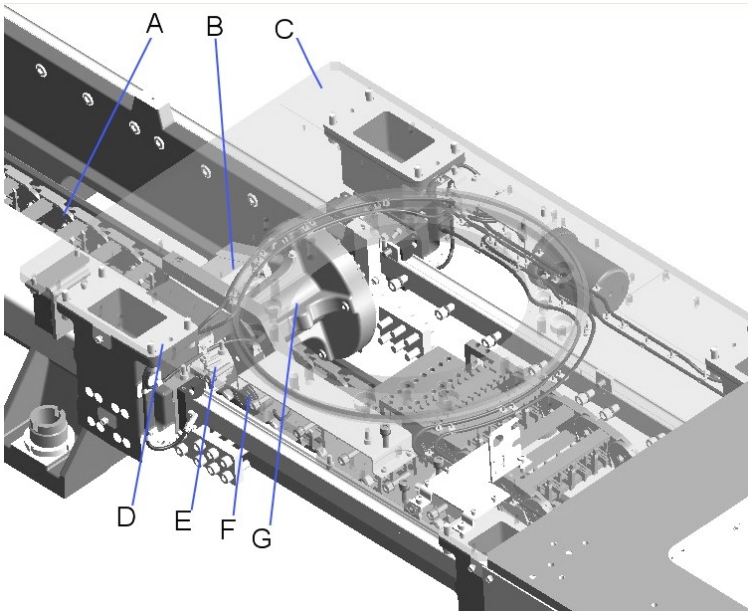
4.7.2 Replacing the gearbox

Location of motor and gear

Users can choose to change the whole geared motor unit to reduce down time or only change the malfunctioned gear or motor. It is recommended to have two technicians to work together.

To replace the motor and/or the gear, it is possible to remove the motor bracket from the top plate and then push the carriage away. It is recommended to have two technicians to work together.

The figure below shows how to push the carriage away from the motor bracket and expose the motor, gearbox, gear wheel, felt gear and cable chain connection point. This makes the following components accessible for maintenance:



xx1400002684

Item	Name
A	Cable chain - remains stationery
B	Motor - remains stationery
C	Carriage - pushed away
D	Motor bracket - remains stationery
E	Gear wheel - remains stationery
F	Felt gear - remains stationery
G	Gearbox - remains stationery

Required equipment

Equipment	Art. No.	Note
Standard toolkit	-	The content is defined in *Standard tools on page 280*.

Continues on next page

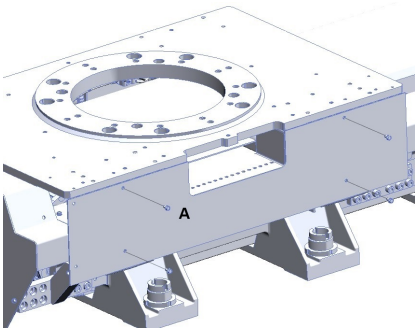
Equipment	Art. No.	Note
Torque wrench	-	The tightening torque of the M10x40 hex socket head cap screw that secure the gear to the bracket is 70 Nm. There are also specific tightening torques for the motor shaft and gear assembly. See the details in maintenance instructions.
M6 screws of different lengths. For example: M6x10, M6x15, M6x35 1 thick washer inside diameter 6 mm 1 spacer 30 mm long, inside diameter no smaller than the pin diameter (10 mm), and outside diameter no bigger that the thick washer outside diameter.	-	For the cylindrical pin extraction. The following figures are for your reference about how to use the equipment.  xx1500000635  xx1500000636  xx1500000637

Continues on next page

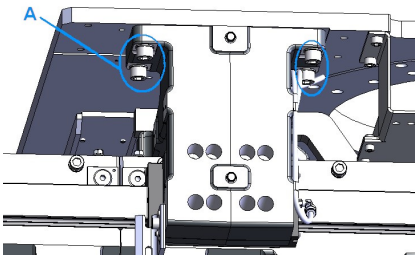
4.7.2 Replacing the gearbox
Continued

Removing the gearbox

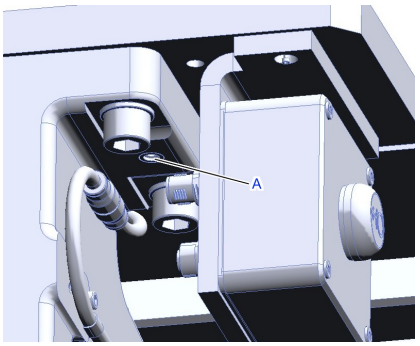
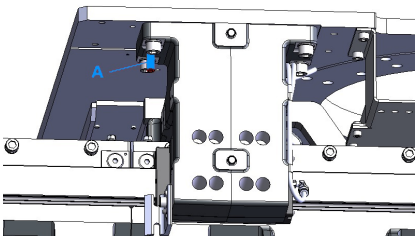
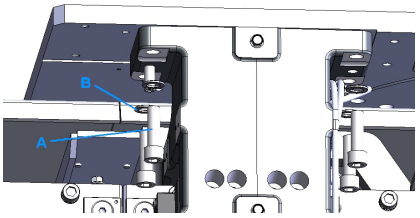
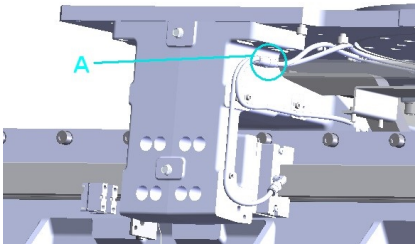
Preparation

	Action	Illustration/Note
1	**WARNING** Turn off all electric power and pneumatic pressure supplies to the robot and for IRBT 2005.	
2	Remove the side cover of the carriage.	 xx1400001587 A M6x12 Screw DIN6921, 9ADA181-11 (4 pcs)

Loosening the carriage from the drive train bracket

	Action	Illustration/Note
1	Remove the bracket for brake release. Cut the cable ties that secure the brake release cables.	
2	Loosen the screws. Use a ratchet wrench.	 xx1400001588 A M12x40 Hex socket head cap screws, 3HAB3409-67 (4 pcs)

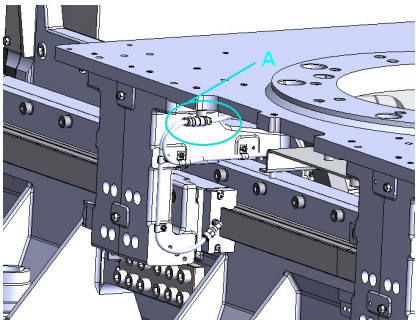
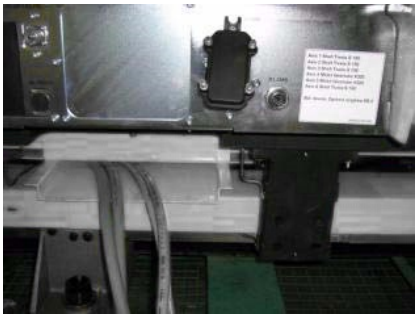
Continues on next page

	Action	Illustration/Note
3	Extraction of the cylindrical pin: Place the spacer on the cylindrical pin, insert the longest screw with the thick washer and screw it to start extracting the pin. Use shorter screws when necessary.	 xx1400001589 A 10x32 cylindrical pin For details about how to use the equipment for cylindrical pin extraction, see *Required equipment on page 202*.
4	Stop when the cylindrical pin is extracted from the top plate. **Note** It is not necessary to extract the pin from the bracket.	 xx1400001590 A Φ10x32 cylindrical pin with threaded hole, 3HAC043986-001
5	Remove the screws and plain washers. Use a ratchet wrench.	 xx1400001591 A M12x40 Hex socket head cap screw, 3HAB3409-67 (4 pcs) B Ø21xØ13x2 Washer, 3HAA1001-632 (4 pcs)
6	Disconnect the lubrication tube from the fitting of the ball bearing block to release the tube from the drive train bracket (the tube will be pushed away along with the carriage).	 xx1400001592 A Lubrication tube connector

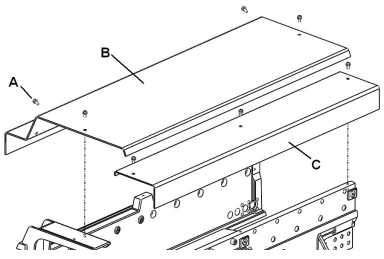
Continues on next page

4.7.2 Replacing the gearbox

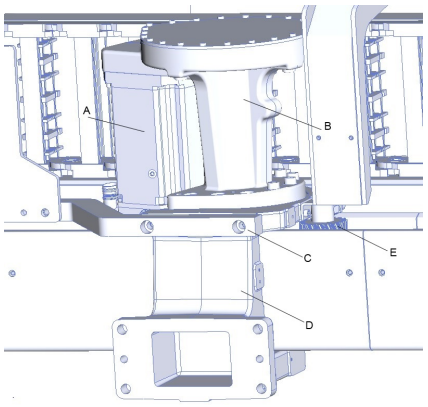
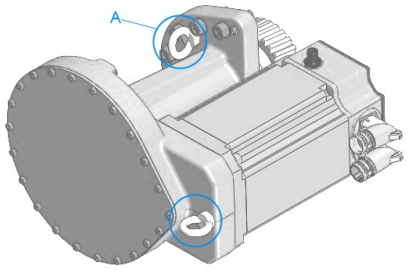
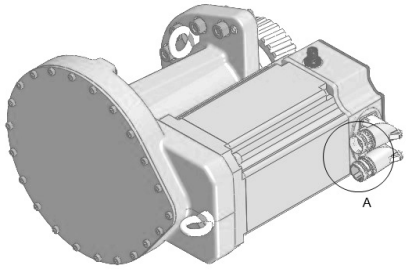
Continued

	Action	Illustration/Note
7	Disconnect the lubrication tube connector from the fitting of the pinion (the tube will be pushed away along with the carriage). Remove the top cover if necessary.	 xx1400001596 A Lubrication tube connector
8	Disconnect the cables from the tooling or robot fitted on the carriage. Remove the upper part of the cable tray so that the connectors can pass through.	 xx1400001593
9	Push the carriage away from the drive train bracket. The bracket, gear and pinion, motor, cable chain support and cable chain, stay stationery.	**Note** Pay attention to the cables and their connectors: You must guide them through the cable tray while you push the carriage away.

Removing the drive train

	Action	Illustration/Note
1	Remove the covers above the drive train.	 xx1400000231

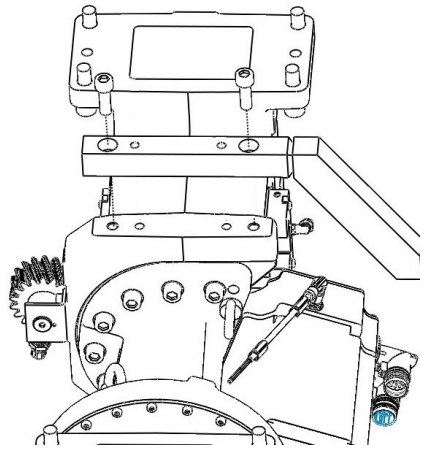
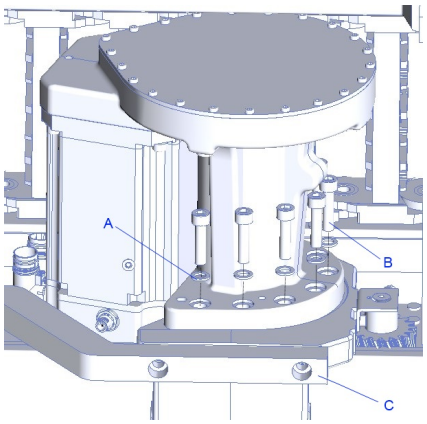
Continues on next page

	Action	Illustration/Note
2	The drive train is now accessible.	 xx1400001610 A Motor B Gear C Cable chain connection plate D Motor bracket E Pinion
3	Fit two eye bolts on the drive train for lifting.	 xx1400001626 A M8 eye bolt (2 pcs)
4	Disconnect the power and resolver connectors from the motor. Guide the cables in the tray area.	 xx1400001625

Continues on next page

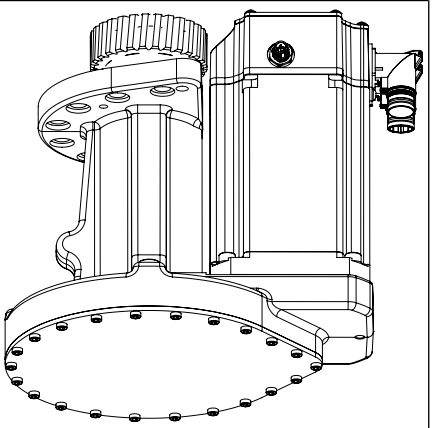
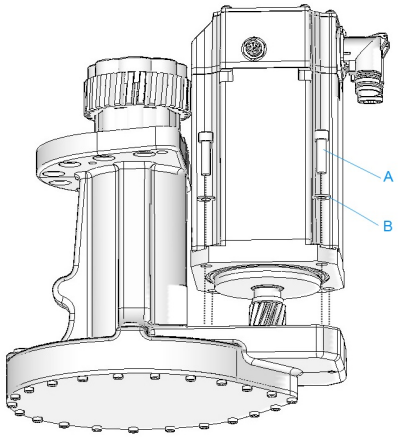
4.7.2 Replacing the gearbox

Continued

	Action	Illustration/Note
5	For the mirrored cable chain orientation, remove the cable chain support by removing the two screws.	 xx1400002143
6	Remove all but two of the drive train installation screws and plain washers.	
7	Attach lifting chains to the eye bolts and unload the weight of the drive train using an overhead crane.	
8	Remove the remaining two screws from the drive train.	
9	Remove the drive train from the bracket. **CAUTION** The drive train weighs 33 kg. All lifting accessories used must be sized accordingly!	 xx1400001627 A Ø 17xØ 11x2 washer, 3HAB4233-1 B M10x40 hex socket head cap installation screw, 3HAB3409-50 C Cable chain support

Continues on next page

Removing the gearbox

	Action	Illustration/Note
1	Place the removed drive train in a vertical position, with the driving side facing downwards.	 xx1400001628
2	Remove the motor by unscrewing the four M8x30 hex socket head cap screws (Art. No. 9ADA183-38).	 xx1400001639

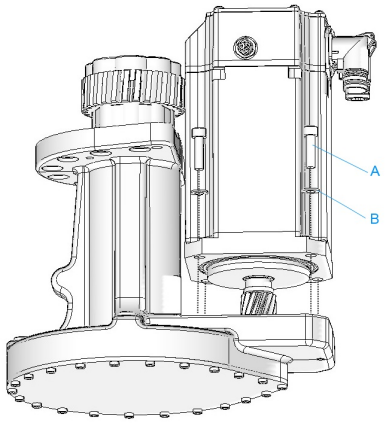
Refitting the gearbox

Refitting the gearbox

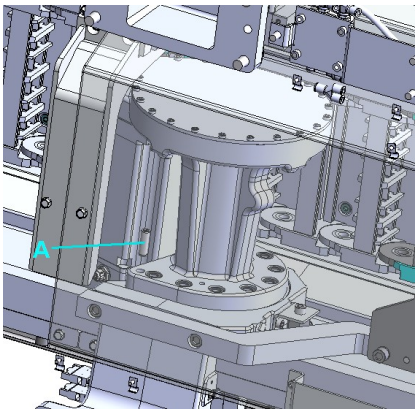
	Action	Illustration/Note
1	Inject lubricant into the gearbox until it is filled.	

Continues on next page

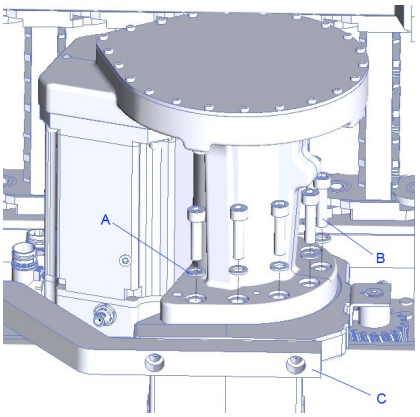
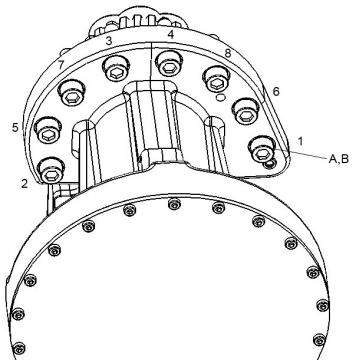
4.7.2 Replacing the gearbox
Continued

	Action	Illustration/Note
2	Fit the motor to the new gearbox with screws and washers. **Tip** The motor integrates with the driving pinion and O-ring as a complete spare part.	 xx1400001639 A M8x30 M8x30 hex socket head cap screw, 9ADA183-38 B 13x8.4x1.6 washer, 9ADA312-7 Tightening torque: 24 Nm

Refitting the drive train

	Action	Illustration/Note
1	Fit the locating cylindrical pin to the motor using a rubber mallet. Insert it completely.	 xx1400001637 A Ø10x32 Cylindrical pin with threaded hole, 3HAC043986-001
2	**CAUTION** The motor weighs 11 kg. All lifting accessories used must be sized accordingly! Attach the lifting chains to the eye bolts on the motor and lift the motor into position on the track with guidance from the locating cylindrical pin.	

Continues on next page

	Action	Illustration/Note
3	Fit the drive train on the drive train bracket with the screws and plain washers. **Note** Do not tighten the screws yet.	 xx1400001627 A Ø 17xØ 11x2 washer, 3HAB4233-1 B M10x40 hex socket head cap installation screw, 3HAB3409-50 (8 pcs) C Cable chain support
4	Adjust the backlash of the gear motor. For how to adjust the gear motor backlash, see *Adjusting the gearbox backlash on page 227*.	
5	Tighten the screws and plain washers in sequence shown in the illustration.	 xx1400001630 Tightening torque: 70 Nm
6	For the mirrored cable chain orientation, refit the cable chain support with two screws.	
7	Reconnect the power and signal cables to the motor.	

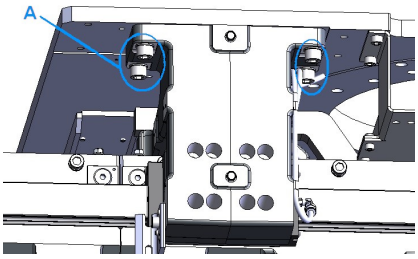
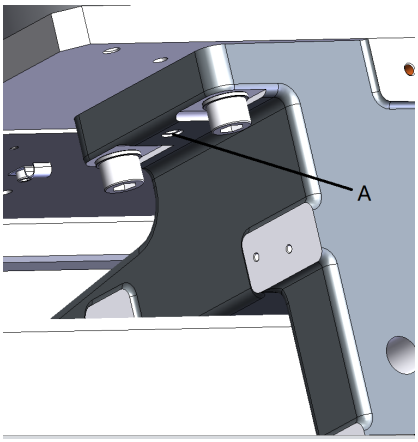
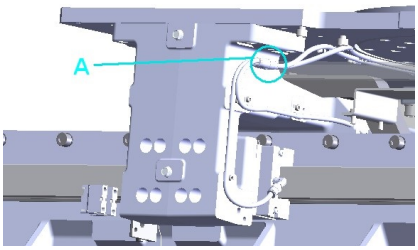
Reinstalling the carriage to the drive train bracket

	Action	Illustration/Note
1	Push the carriage back above the drive train.	

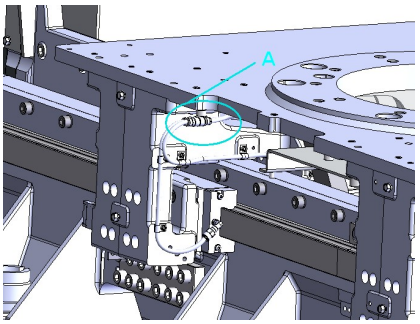
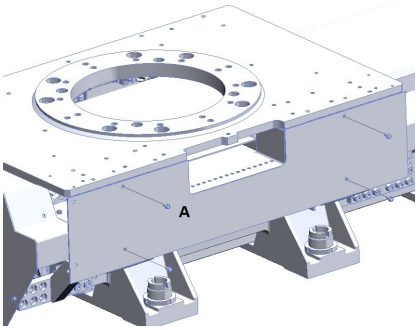
Continues on next page

4.7.2 Replacing the gearbox

Continued

	Action	Illustration/Note
2	Fit the carriage to the drive train bracket with the screws. **Note** Do not tighten the screws yet.	 xx1400001588 A M12x40 Hex socket head cap screws, 3HAB3409-67 (4 pcs)
3	Adjust the position of the carriage until the cylindrical pin in the 10 mm positioning hole of the drive train bracket can be inserted into the positioning hole in the top plate of the carriage.	 xx2400001005 A Ø10x32 Cylindrical pin with threaded hole, 3HAC043986-001
4	Tighten the screws.	Tightening torque: 100 Nm
5	Connect the lubrication tube connectors of the ball bearing block.	 xx1400001592 A Lubrication tube connector

Continues on next page

	Action	Illustration/Note
6	Connect the lubrication tube connector of the pinion.	 xx1400001596 A Lubrication tube connector
7	Connect the cables from the tooling or robot fitted on the carriage. If necessary, remove the upper part of the cable tray so that the connectors can pass through.	
8	Refit the bracket for brake release and secure brake release cables with cable ties.	
9	Refit the side cover of the carriage.	 xx1400001587 A M6x12 Screw DIN6921, 9ADA181-11 (4 pcs)
10	Refit the top cover.	

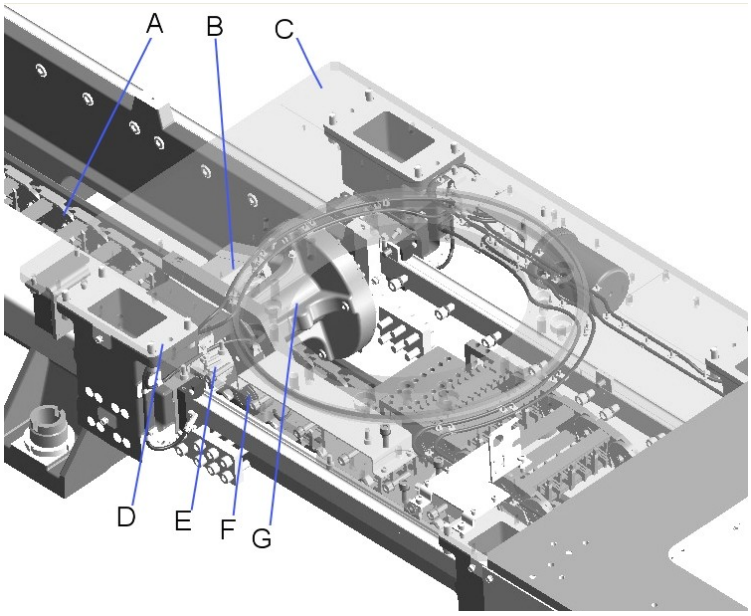
4.7.3 Replacing the gear wheel

Location of motor and gear

Users can choose to change the whole geared motor unit to reduce down time or only change the malfunctioned gear or motor. It is recommended to have two technicians to work together.

To replace the motor and/or the gear, it is possible to remove the motor bracket from the top plate and then push the carriage away. It is recommended to have two technicians to work together.

The figure below shows how to push the carriage away from the motor bracket and expose the motor, gearbox, gear wheel, felt gear and cable chain connection point. This makes the following components accessible for maintenance:



xx1400002684

Item	Name
A	Cable chain - remains stationery
B	Motor - remains stationery
C	Carriage - pushed away
D	Motor bracket - remains stationery
E	Gear wheel - remains stationery
F	Felt gear - remains stationery
G	Gearbox - remains stationery

Required equipment

Equipment	Art. No.	Note
Standard toolkit	-	The content is defined in *Standard tools on page 280*.

Continues on next page

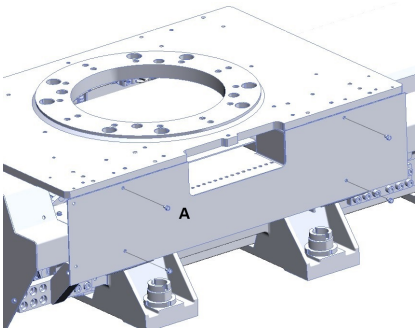
Equipment	Art. No.	Note
Torque wrench	-	The tightening torque of the M10x40 hex socket head cap screw that secure the gear to the bracket is 70 Nm. There are also specific tightening torques for the motor shaft and gear assembly. See the details in maintenance instructions.
M6 screws of different lengths. For example: M6x10, M6x15, M6x35 1 thick washer inside diameter 6 mm 1 spacer 30 mm long, inside diameter no smaller than the pin diameter (10 mm), and outside diameter no bigger that the thick washer outside diameter.	-	For the cylindrical pin extraction. The following figures are for your reference about how to use the equipment.  xx1500000635  xx1500000636  xx1500000637

Continues on next page

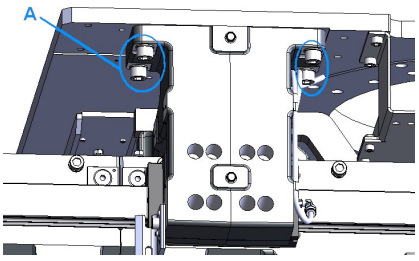
4.7.3 Replacing the gear wheel
Continued

Removing the gear wheel

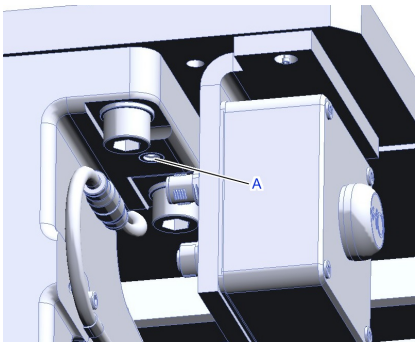
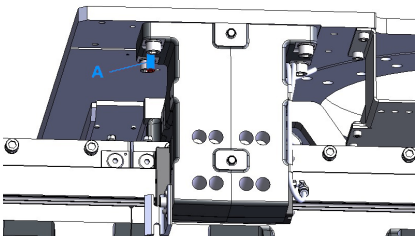
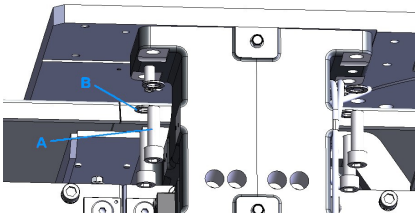
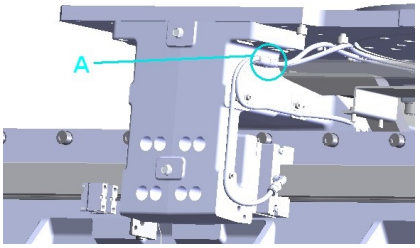
Preparation

	Action	Illustration/Note
1	**WARNING** Turn off all electric power and pneumatic pressure supplies to the robot and for IRBT 2005.	
2	Remove the side cover of the carriage.	 xx1400001587 A M6x12 Screw DIN6921, 9ADA181-11 (4 pcs)

Loosening the carriage from the drive train bracket

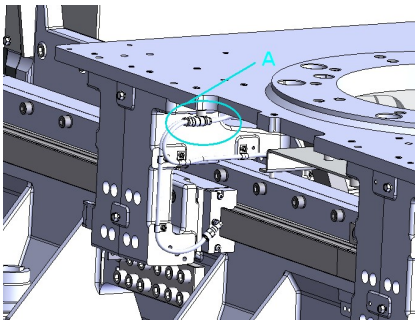
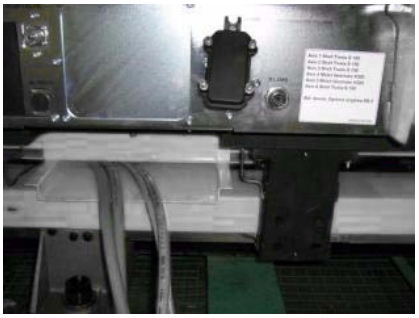
	Action	Illustration/Note
1	Remove the bracket for brake release. Cut the cable ties that secure the brake release cables.	
2	Loosen the screws. Use a ratchet wrench.	 xx1400001588 A M12x40 Hex socket head cap screws, 3HAB3409-67 (4 pcs)

Continues on next page

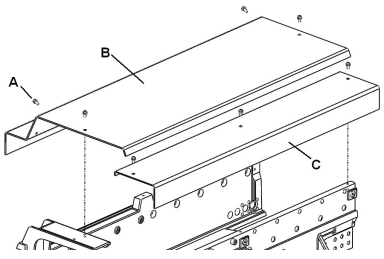
	Action	Illustration/Note
3	Extraction of the cylindrical pin: Place the spacer on the cylindrical pin, insert the longest screw with the thick washer and screw it to start extracting the pin. Use shorter screws when necessary.	 xx1400001589 A 10x32 cylindrical pin For details about how to use the equipment for cylindrical pin extraction, see *Required equipment on page 214*.
4	Stop when the cylindrical pin is extracted from the top plate. **Note** It is not necessary to extract the pin from the bracket.	 xx1400001590 A Φ10x32 cylindrical pin with threaded hole, 3HAC043986-001
5	Remove the screws and plain washers. Use a ratchet wrench.	 xx1400001591 A M12x40 Hex socket head cap screw, 3HAB3409-67 (4 pcs) B Ø21xØ13x2 Washer, 3HAA1001-632 (4 pcs)
6	Disconnect the lubrication tube from the fitting of the ball bearing block to release the tube from the drive train bracket (the tube will be pushed away along with the carriage).	 xx1400001592 A Lubrication tube connector

Continues on next page

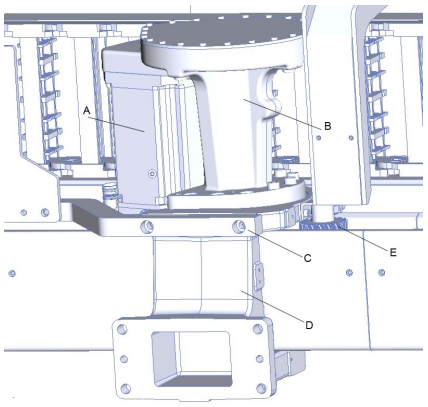
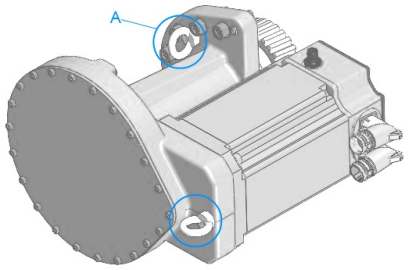
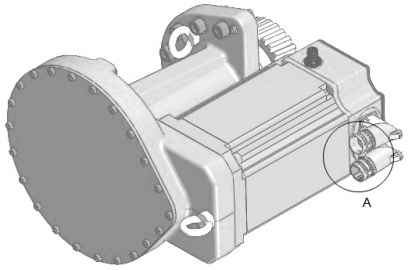
4.7.3 Replacing the gear wheel
Continued

	Action	Illustration/Note
7	Disconnect the lubrication tube connector from the fitting of the pinion (the tube will be pushed away along with the carriage). Remove the top cover if necessary.	 xx1400001596 A Lubrication tube connector
8	Disconnect the cables from the tooling or robot fitted on the carriage. Remove the upper part of the cable tray so that the connectors can pass through.	 xx1400001593
9	Push the carriage away from the drive train bracket. The bracket, gear and pinion, motor, cable chain support and cable chain, stay stationery.	**Note** Pay attention to the cables and their connectors: You must guide them through the cable tray while you push the carriage away.

Removing the drive train

	Action	Illustration/Note
1	Remove the covers above the drive train.	 xx1400000231

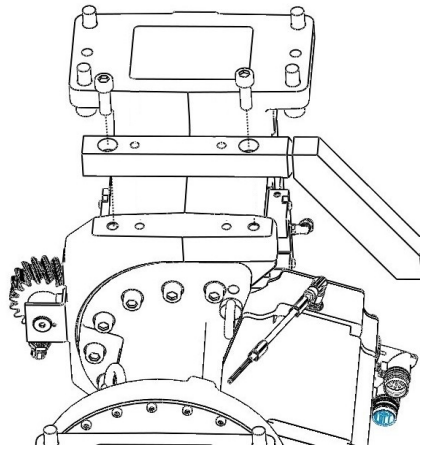
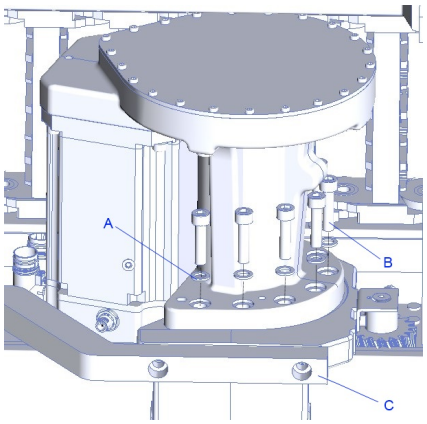
Continues on next page

	Action	Illustration/Note
2	The drive train is now accessible.	 xx1400001610 A Motor B Gear C Cable chain connection plate D Motor bracket E Pinion
3	Fit two eye bolts on the drive train for lifting.	 xx1400001626 A M8 eye bolt (2 pcs)
4	Disconnect the power and resolver connectors from the motor. Guide the cables in the tray area.	 xx1400001625

Continues on next page

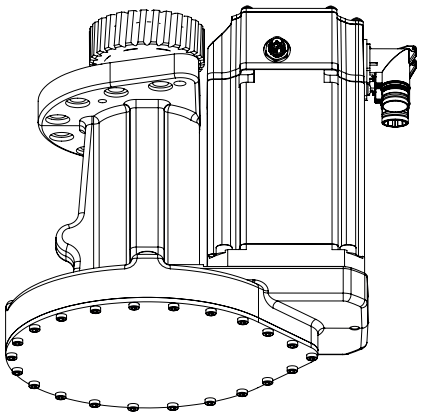
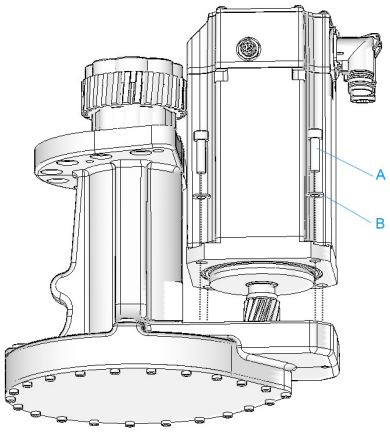
4.7.3 Replacing the gear wheel

Continued

	Action	Illustration/Note
5	For the mirrored cable chain orientation, remove the cable chain support by removing the two screws.	 xx1400002143
6	Remove all but two of the drive train installation screws and plain washers.	
7	Attach lifting chains to the eye bolts and unload the weight of the drive train using an overhead crane.	
8	Remove the remaining two screws from the drive train.	
9	Remove the drive train from the bracket. **CAUTION** The drive train weighs 33 kg. All lifting accessories used must be sized accordingly!	 xx1400001627 A Ø 17xØ 11x2 washer, 3HAB4233-1 B M10x40 hex socket head cap installation screw, 3HAB3409-50 C Cable chain support

Continues on next page

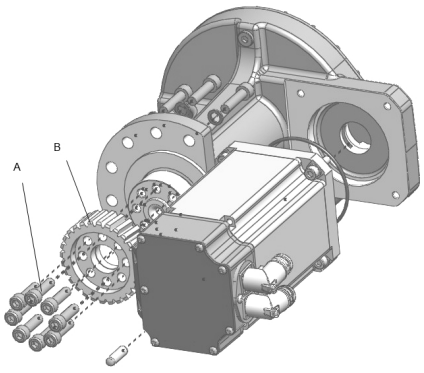
Removing the motor

	Action	Illustration/Note
1	Place the removed drive train in a vertical position, with the driving side facing downwards.	 xx1400001628
2	Remove the motor by unscrewing the screws and removing washers.	 xx1400001639 A M8x30 Hex socket head cap screw, 9ADA183-38 (4 pcs) B Ø13xØ8.4x1.6 plain washer, 9ADA312-7 (4 pcs)

Continues on next page

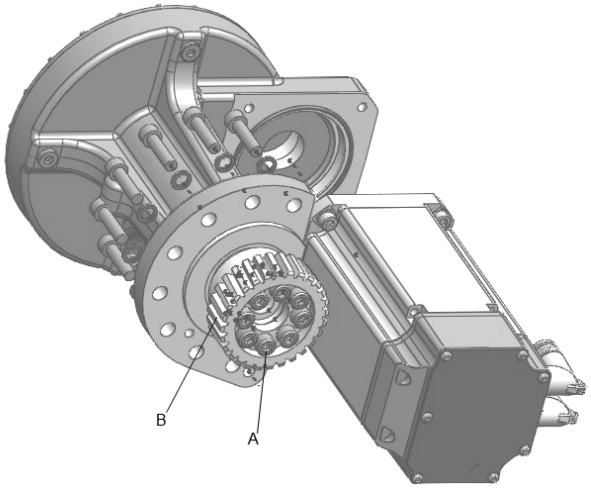
4.7.3 Replacing the gear wheel
Continued

Removing the gear wheel

	Action	Illustration/Note
1	Remove the screws from gear wheel.	 xx1400002644 A M10x35 Hex socket head cap screw, 3HAB3409-52 B Pinion on rack, 3HAC047375-001

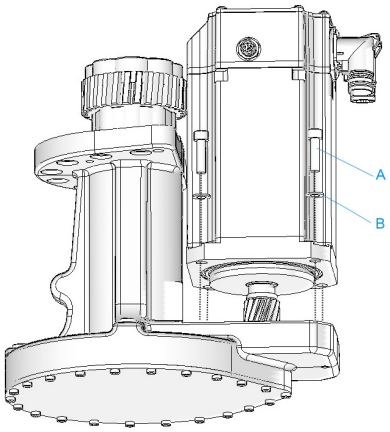
Refitting the gear wheel

Refitting the gear wheel

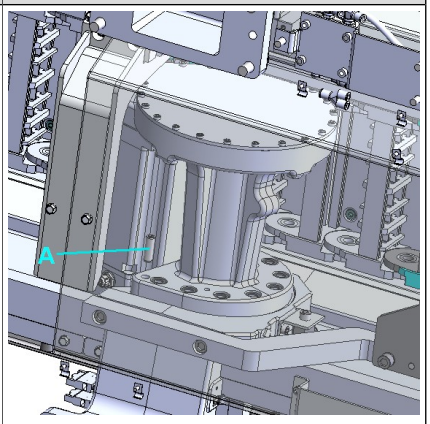
	Action	Illustration/Note
1	Tighten the screws.	 xx1400002645 A M10x35 Hex socket head cap screw, 3HAB3409-52 Tightening torque: 70 Nm B Pinion on rack, 3HAC047375-001

Continues on next page

Refitting the motor

	Action	Illustration/Note
1	Fit the new motor on the gearbox unit with screws and washers. **Tip** The motor integrates the driving pinion (article No. 3HAC047333-001) and O-ring (article No. 3HAB3772-110) as a complete spare part.	 xx1400001639 A M8x30 hex socket head cap screws, 9ADA183-38 (4 pcs). Tightening torque: 15 Nm B Ø13xØ8.4x1.6 plain washer, 9ADA312-7 (4 pcs) **Note** The correct orientation of the motor is with the connectors pointing outwards, as shown in the figure.

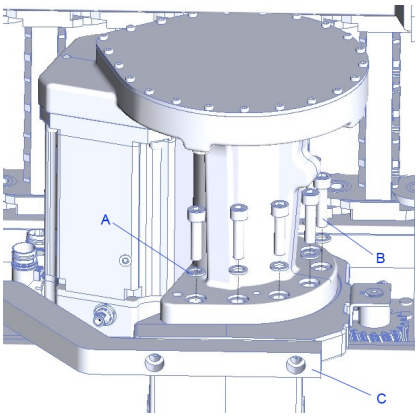
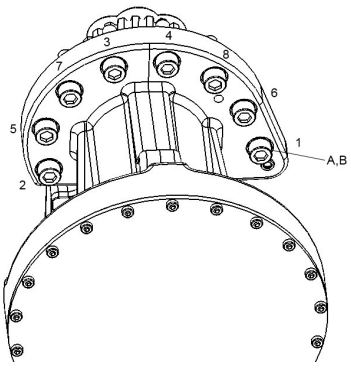
Refitting the drive train

	Action	Illustration/Note
1	Fit the locating cylindrical pin to the motor using a rubber mallet. Insert it completely.	 xx1400001637 A Ø10x32 Cylindrical pin with threaded hole, 3HAC043986-001

Continues on next page

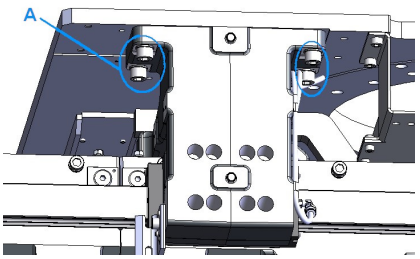
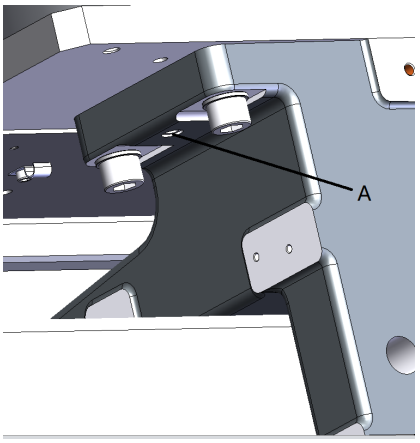
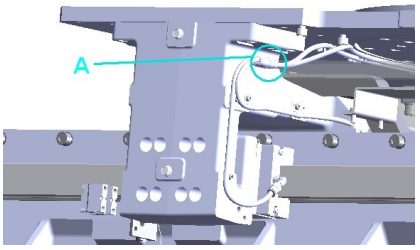
4.7.3 Replacing the gear wheel

Continued

	Action	Illustration/Note
2	**CAUTION** The motor weighs 11 kg. All lifting accessories used must be sized accordingly! Attach the lifting chains to the eye bolts on the motor and lift the motor into position on the track with guidance from the locating cylindrical pin.	
3	Fit the drive train on the drive train bracket with the screws and plain washers. **Note** Do not tighten the screws yet.	 xx1400001627 A Ø 17xØ 11x2 washer, 3HAB4233-1 B M10x40 hex socket head cap installation screw, 3HAB3409-50 (8 pcs) C Cable chain support
4	Adjust the backlash of the gear motor. For how to adjust the gear motor backlash, see *Adjusting the gearbox backlash on page 227*.	
5	Tighten the screws and plain washers in sequence shown in the illustration.	 xx1400001630 Tightening torque: 70 Nm
6	For the mirrored cable chain orientation, refit the cable chain support with two screws.	
7	Reconnect the power and signal cables to the motor.	

Continues on next page

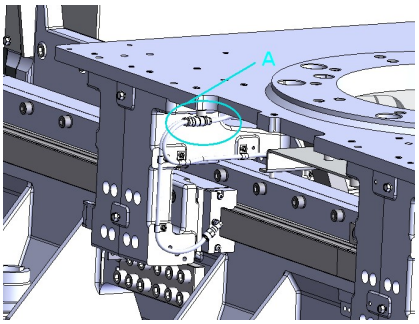
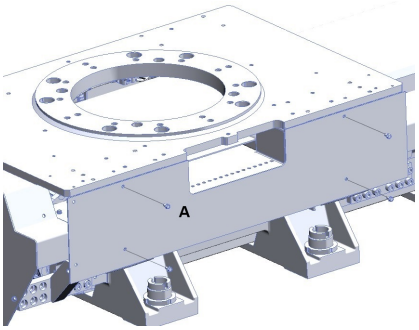
Reinstalling the carriage to the drive train bracket

	Action	Illustration/Note
1	Push the carriage back above the drive train.	
2	Fit the carriage to the drive train bracket with the screws. **Note** Do not tighten the screws yet.	 xx1400001588 A M12x40 Hex socket head cap screws, 3HAB3409-67 (4 pcs)
3	Adjust the position of the carriage until the cylindrical pin in the 10 mm positioning hole of the drive train bracket can be inserted into the positioning hole in the top plate of the carriage.	 xx2400001005 A Ø10x32 Cylindrical pin with threaded hole, 3HAC043986-001
4	Tighten the screws.	Tightening torque: 100 Nm
5	Connect the lubrication tube connectors of the ball bearing block.	 xx1400001592 A Lubrication tube connector

Continues on next page

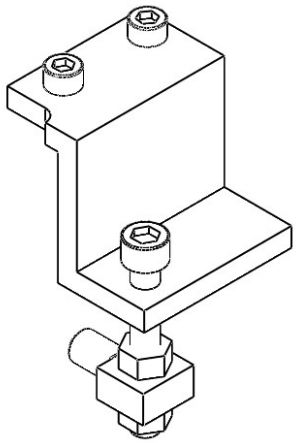
4.7.3 Replacing the gear wheel

Continued

	Action	Illustration/Note
6	Connect the lubrication tube connector of the pinion.	 xx1400001596 A Lubrication tube connector
7	Connect the cables from the tooling or robot fitted on the carriage. If necessary, remove the upper part of the cable tray so that the connectors can pass through.	
8	Refit the bracket for brake release and secure brake release cables with cable ties.	
9	Refit the side cover of the carriage.	 xx1400001587 A M6x12 Screw DIN6921, 9ADA181-11 (4 pcs)
10	Refit the top cover.	

4.8 Adjusting the gearbox backlash

Required equipment

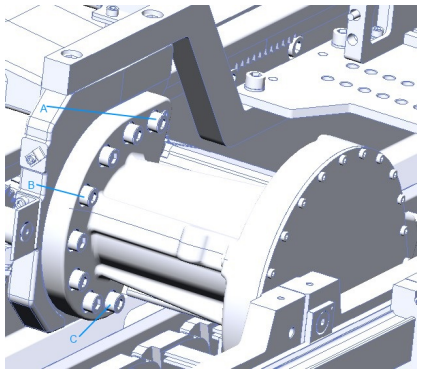
Equipment	Art. No.	Illustration
Backlash adjustment tool	3HAC054528-001	

Adjusting the gearbox backlash

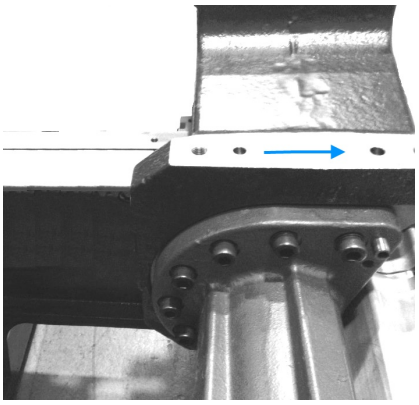
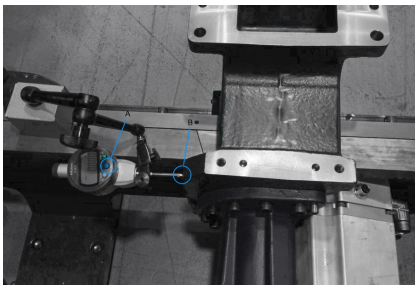
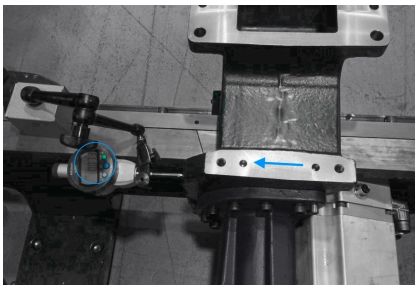
Use this procedure to adjust the gearbox backlash.

Note

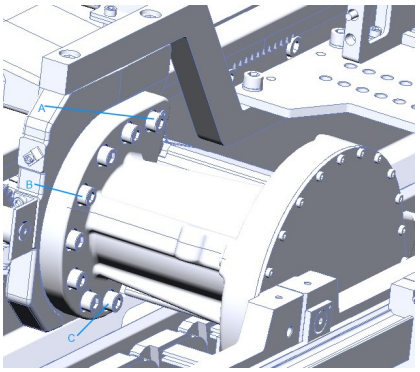
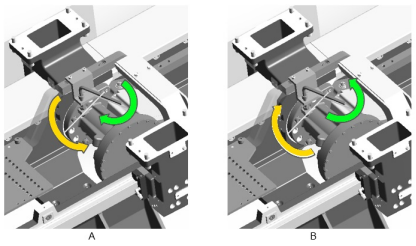
All fixing screws of the gearbox must be loosened before adjusting the backlash.

	Action	Illustration/Note
1	Tighten the locking screws (A), (B) and (C).	 xx1400001661 A Locking screw B Locking screw C Locking screw Tightening torque: 70 Nm

Continues on next page

	Action	Illustration/Note
2	Push the carriage by hand until the gear wheel is in contact with the next cog on the gear rack.	 xx1400001631 X+ direction
3	Fit the indicator clock until the tip of the indicator (B) is in vertical contact with the gear motor unit.	 xx1400001632 A Reset button B Tip of the indicator
4	Reset the indicator clock by pressing the reset button (A).	
5	Push the carriage or the drive unit by hand in the opposite direction until the gear wheel is in contact with the next cog on the gear rack.	 xx1400001633 X- direction
6	Check the reading on the indicator clock.	**Note** The indicator should show data between 0.07-0.13 mm.
7	Push the carriage 1000 mm.	X+ direction
8	Continue with step *2* to step *7*.	

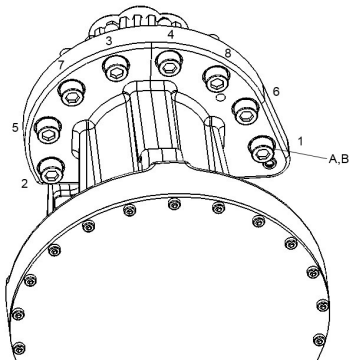
Continues on next page

	Action	Illustration/Note
9	If the gap is OK, tighten the locking screws (A), (B) and (C) in figure.	 xx1400001661 A Locking screw B Locking screw C Locking screw Tightening torque: 70 Nm
10	If the gap is not OK, loosen locking screws (A), (B) and (C) to adjust the gear motor using the adjustment tool. Then repeat step *1* to step .	 xx1500000406 A Pinion far from rack B Pinion close to rack **Tip** If the data is too large, lift the gear motor a little and then secure the three lock screws. If the data is too small, lower the gear motor a little and then secure the three lock screws. **Note** During adjustment, note that the cable chain should be assembled and cables to motor should be connected.

Continues on next page

4.8 Adjusting the gearbox backlash

Continued

	Action	Illustration/Note
11	Tighten all the screws and plain washer in a spread sequence.	 xx1400001630 A M10x40 Hex socket head cap screw, 3HAB3409-50 B Ø17xØ11x2 Washer, 3HAB4233-1 Tightening torque: 70 Nm
12	Calibrate the track motion. Use previously measured reference values for the zero position.	See *Fine calibration on page 266*.

4.9 Replacing the felt gear

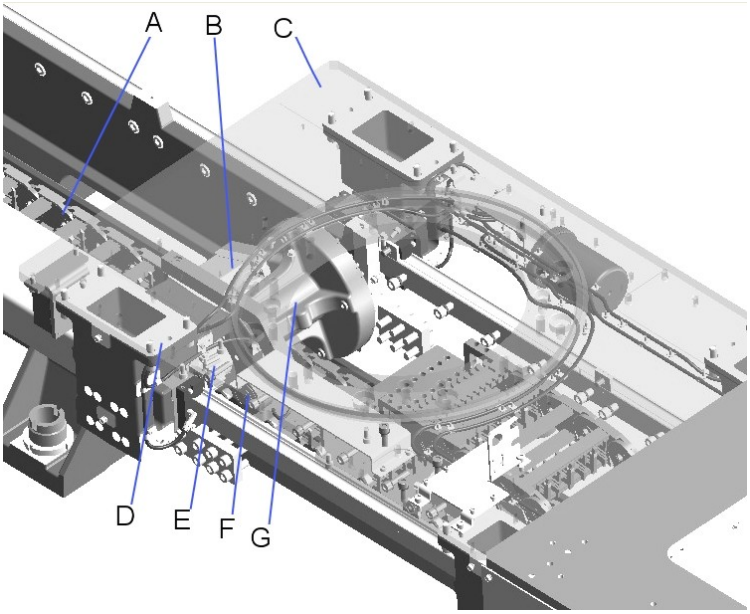
4.9.1 Replacing the felt gear

Location of motor and gear

Users can choose to change the whole geared motor unit to reduce down time or only change the malfunctioned gear or motor. It is recommended to have two technicians to work together.

To replace the motor and/or the gear, it is possible to remove the motor bracket from the top plate and then push the carriage away. It is recommended to have two technicians to work together.

The figure below shows how to push the carriage away from the motor bracket and expose the motor, gearbox, gear wheel, felt gear and cable chain connection point. This makes the following components accessible for maintenance:



xx1400002684

Item	Name
A	Cable chain - remains stationery
B	Motor - remains stationery
C	Carriage - pushed away
D	Motor bracket - remains stationery
E	Gear wheel - remains stationery
F	Felt gear - remains stationery
G	Gearbox - remains stationery

Continues on next page

4.9.1 Replacing the felt gear
Continued

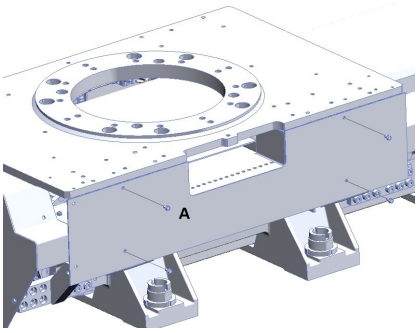
Required equipment

Equipment	Art. No.	Note
Standard toolkit	-	The content is defined in *Standard tools on page 280*.
Torque wrench	-	The tightening torque of the M10x40 hex socket head cap screw that secure the gear to the bracket is 70 Nm. There are also specific tightening torques for the motor shaft and gear assembly. See the details in maintenance instructions.
M6 screws of different lengths. For example: M6x10, M6x15, M6x35 1 thick washer inside diameter 6 mm 1 spacer 30 mm long, inside diameter no smaller than the pin diameter (10 mm), and outside diameter no bigger that the thick washer outside diameter.	-	For the cylindrical pin extraction. The following figures are for your reference about how to use the equipment.  xx1500000635  xx1500000636  xx1500000637

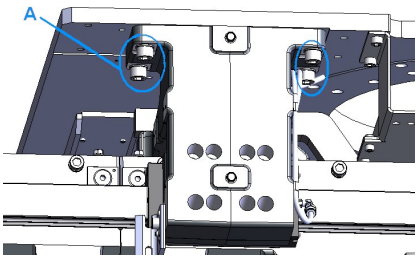
Continues on next page

Removing the felt gear

Preparation

	Action	Illustration/Note
1	**WARNING** Turn off all electric power and pneumatic pressure supplies to the robot and for IRBT 2005.	
2	Remove the side cover of the carriage.	 xx1400001587 A M6x12 Screw DIN6921, 9ADA181-11 (4 pcs)

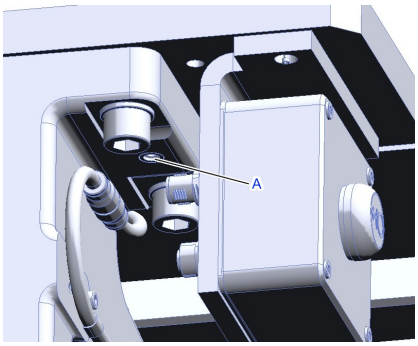
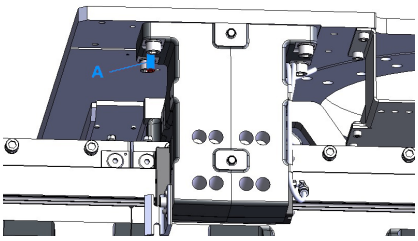
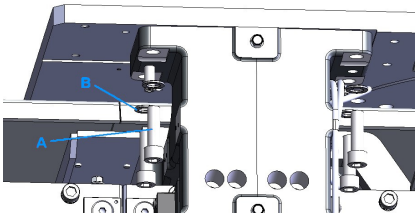
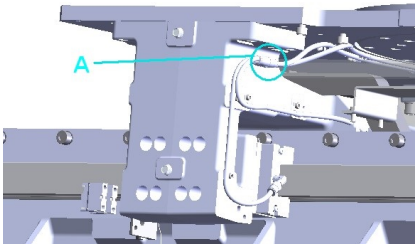
Loosening the carriage from the drive train bracket

	Action	Illustration/Note
1	Remove the bracket for brake release. Cut the cable ties that secure the brake release cables.	
2	Loosen the screws. Use a ratchet wrench.	 xx1400001588 A M12x40 Hex socket head cap screws, 3HAB3409-67 (4 pcs)

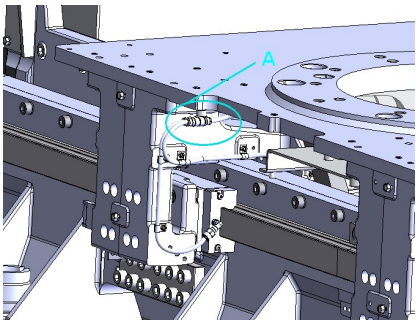
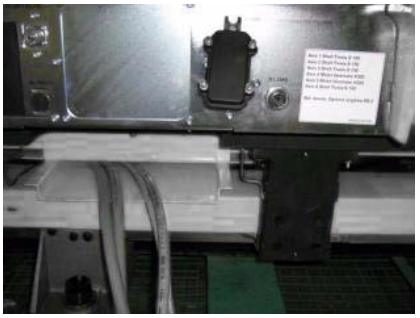
Continues on next page

4.9.1 Replacing the felt gear

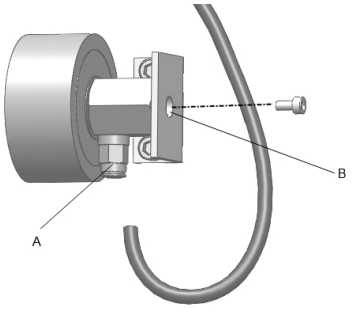
Continued

	Action	Illustration/Note
3	Extraction of the cylindrical pin: Place the spacer on the cylindrical pin, insert the longest screw with the thick washer and screw it to start extracting the pin. Use shorter screws when necessary.	 xx1400001589 A 10x32 cylindrical pin For details about how to use the equipment for cylindrical pin extraction, see *Required equipment on page 232*.
4	Stop when the cylindrical pin is extracted from the top plate. **Note** It is not necessary to extract the pin from the bracket.	 xx1400001590 A Φ10x32 cylindrical pin with threaded hole, 3HAC043986-001
5	Remove the screws and plain washers. Use a ratchet wrench.	 xx1400001591 A M12x40 Hex socket head cap screw, 3HAB3409-67 (4 pcs) B Ø21xØ13x2 Washer, 3HAA1001-632 (4 pcs)
6	Disconnect the lubrication tube from the fitting of the ball bearing block to release the tube from the drive train bracket (the tube will be pushed away along with the carriage).	 xx1400001592 A Lubrication tube connector

Continues on next page

	Action	Illustration/Note
7	Disconnect the lubrication tube connector from the fitting of the pinion (the tube will be pushed away along with the carriage). Remove the top cover if necessary.	 xx1400001596 A Lubrication tube connector
8	Disconnect the cables from the tooling or robot fitted on the carriage. Remove the upper part of the cable tray so that the connectors can pass through.	 xx1400001593
9	Push the carriage away from the drive train bracket. The bracket, gear and pinion, motor, cable chain support and cable chain, stay stationery.	**Note** Pay attention to the cables and their connectors: You must guide them through the cable tray while you push the carriage away.

Removing the felt gear

	Action	Illustration/Note
1	For the standard cable chain orientation, remove the cable chain support by removing the two screws.	
2	Disconnect the lubrication tube from the felt gear tube connector.	 xx1400002642 A Felt gear lubrication tube connnector B M8x20 Hex socket head cap screw, on felt gear bracket
3	Remove the screw from the felt gear bracket.	

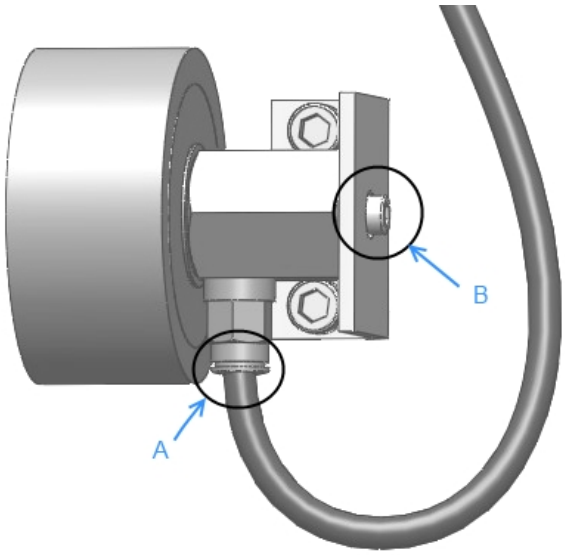
Continues on next page

4.9.1 Replacing the felt gear
Continued

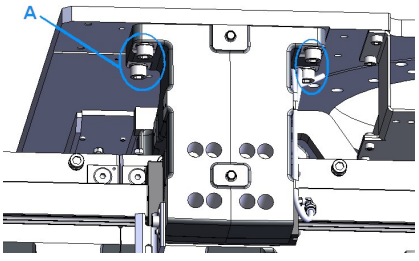
	Action	Illustration/Note
4	Remove the felt gear from the bracket.	

Refitting the felt gear

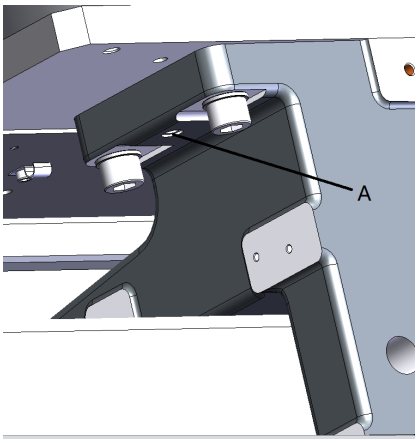
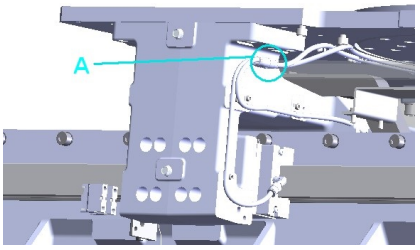
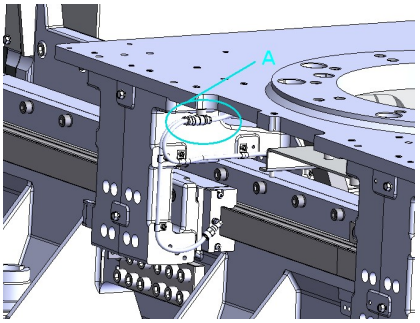
Refitting the felt gear

	Action	Illustration/Note
1	Tighten the screw as shown in the illustration.	 xx1400002643 A Felt gear lubrication tube connnector B M8x20 Hex socket head cap screw, on felt gear bracket
2	Refit the lubrication tube to the felt gear tube connector.	
3	For the standard cable chain orientation, refit the cable chain support with two screws.	

Reinstalling the carriage to the drive train bracket

	Action	Illustration/Note
1	Push the carriage back above the drive train.	
2	Fit the carriage to the drive train bracket with the screws. **Note** Do not tighten the screws yet.	 xx1400001588 A M12x40 Hex socket head cap screws, 3HAB3409-67 (4 pcs)

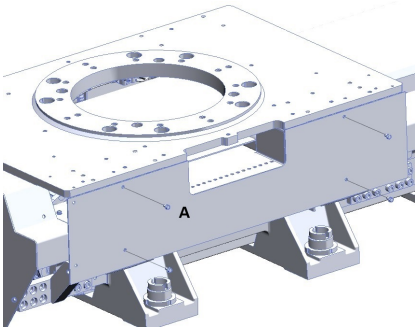
Continues on next page

	Action	Illustration/Note
3	Adjust the position of the carriage until the cylindrical pin in the 10 mm positioning hole of the drive train bracket can be inserted into the positioning hole in the top plate of the carriage.	 xx2400001005 A Ø10x32 Cylindrical pin with threaded hole, 3HAC043986-001
4	Tighten the screws.	Tightening torque: 100 Nm
5	Connect the lubrication tube connectors of the ball bearing block.	 xx1400001592 A Lubrication tube connector
6	Connect the lubrication tube connector of the pinion.	 xx1400001596 A Lubrication tube connector
7	Connect the cables from the tooling or robot fitted on the carriage. If necessary, remove the upper part of the cable tray so that the connectors can pass through.	
8	Refit the bracket for brake release and secure brake release cables with cable ties.	

Continues on next page

4.9.1 Replacing the felt gear

Continued

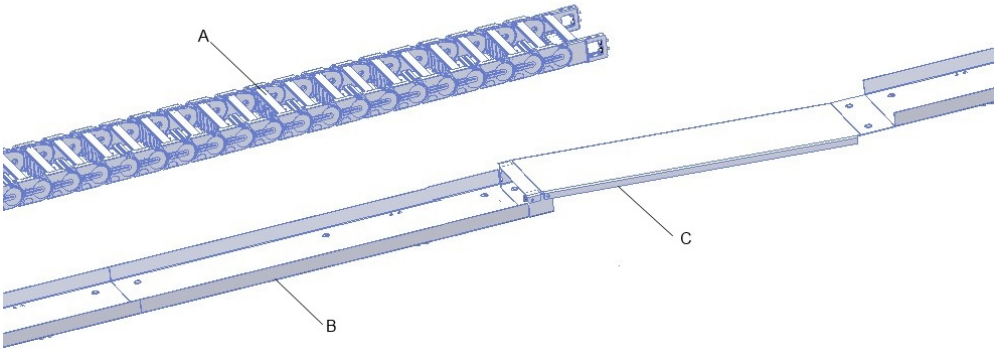
	Action	Illustration/Note
9	Refit the side cover of the carriage.	 xx1400001587 A M6x12 Screw DIN6921, 9ADA181-11 (4 pcs)
10	Refit the top cover.	

4.10 Replacing the cable chain and cables

4.10.1 Replacing the cable chain

Location of the cable chain

The figure shows the cable chain and the cable tray designed for the cable chain.



xx1400000742

A	Cable chain
B	Sheet metal
C	Sloped sheet metal used when the track travel length is no less than 5 m

Required equipment

Equipment	Note
Cable chain	Spare part number is specified in *Spare parts on page 287*.
Cable chain parts	Spare part number is specified in *Spare parts on page 287*.
Locking liquid	Loctite 243
Plastic clips	Replace if damaged.
NYLOC nuts	Replace with new nuts, if removed. NYLOC nuts can only be used once.
Standard toolkit	Content is defined in section *Standard tools on page 280*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.
Circuit diagram	See *Circuit diagrams on page 289*.

Moving away the carriage

	Action	Illustration/Note
1	Remove all cover plates.	

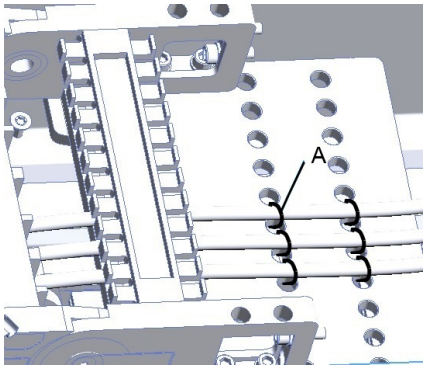
Continues on next page

4.10.1 Replacing the cable chain
Continued

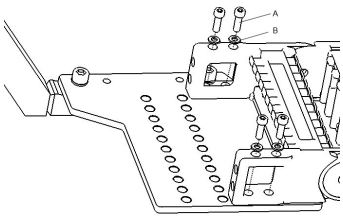
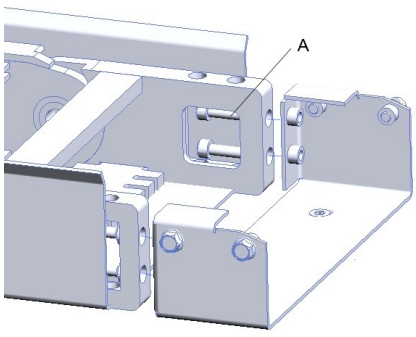
	Action	Illustration/Note
2	Move the carriage so that the drive train and the grease distribution block is away from the fixed end of the cable chain.	
3	**WARNING** Turn off all electric power and pneumatic pressure supplies to the robot and for the track motion.	
4	Remove the brake release unit and cut the straps that hold the brake release cables to the carriage.	
5	Remove the bracket at the cable outlet.	
6	Loosen the carriage from the drive train bracket by removing the screws.	
7	Move away the carriage to access the movable end of the cable chain. **CAUTION** Be careful not to damage the brake release cables.	

Removing the cable chain

Removing the internal cable chain

	Action	Illustration/Note
1	Remove all cover plates.	
2	Move the carriage in order to have it positioned just above the fixed point of the cable chain.	
3	**WARNING** Turn off all electric power and pneumatic pressure supplies to the robot and IRBT 2005.	
4	Take a note of how the cabling is strapped on the carriage. Pay special attention to how the IRB power cable is routed.	
5	Make a marking on the moving end of the chain to show its location relative to the connecting plate. This will facilitate alignment during refitting.	 xx1400001676

Continues on next page

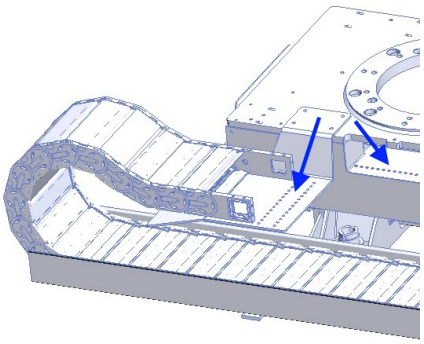
	Action	Illustration/Note
6	Disconnect the power and signal cable, and the media hose, on the carriage. **CAUTION** Cooling water may run out. Protect the connectors from getting wet.	
7	Disconnect the connectors for power, signal and media hose at the fixing end of the cable chain. **Note** Water may spill out.	
8	Cut off straps that securing the cables to the connection plate on the carriage.	
9	Move away the carriage.	See *Moving away the carriage on page 239*.
10	Remove the four screws and four plain washers that hold the moving end of the cable chain to the connecting plate on the carriage.	 xx1400000523 A M6x20 Hex socket head cap screw, 9ADA183-25 B Ø12xØ6.4x1.6 Plain washer, 9ADA312-6
11	Remove screws at the fixed end of the cable chain.	 xx1400001980 A M6x20 Hex socket head cap screw, 9ADA183-25
12	Pull the complete cable chain out.	

Continues on next page

4.10.1 Replacing the cable chain

Continued

Removing the external cable chain

	Action	Illustration/Note
1	Move the carriage so that the drive train and the grease distribution block is away from the fixed end of the cable chain.	
2	**WARNING** Turn off all electric power and pneumatic pressure supplies to the robot and IRBT 2005.	
3	Take a note of how the cabling is strapped on the carriage. Pay special attention to how the IRB power cable is routed.	
4	Remove the strapping that ties the cabling to the carriage.	
5	Disconnect the power and signal cable, and the media hose on the carriage. **CAUTION** Cooling water may run out. Protect the connectors from getting wet.	
6	Disconnect the connectors for power, signal and media at the floor end of the cable chain. **Note** Water may spill out.	
7	Make a marking on the moving end of the chain to show its location relative to the connecting plate. This will facilitate alignment during refitting.	 xx1400002001
8	Cut off straps that securing the cables to the connection plates on the carriage.	
9	Cut off straps that securing the cables to the connection plate on the external cable tray.	
10	Loosen the two screws that hold the cable chain to the connecting plate on the carriage.	
11	Loosen the two screws of the fixed end of the cable chain.	

Continues on next page

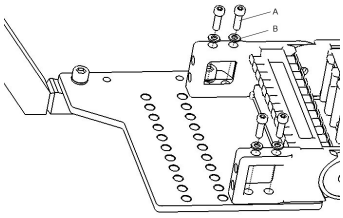
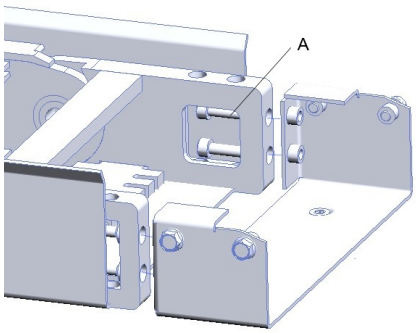
	Action	Illustration/Note
12	Roll out the cable chain away from the carriage. **Tip** Roll the cable chain and bundle it to be able to lift it away. If it is short it can be two folded and lifted away.	

Lifting the cable chain

Lift the cable chain and make the two connectors of the cable chain above the middle of the track track. For how to lift the cable chain, see *Lifting cable chain on page 51*.

Refitting the cable chain

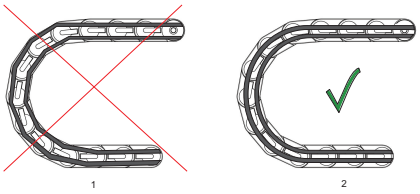
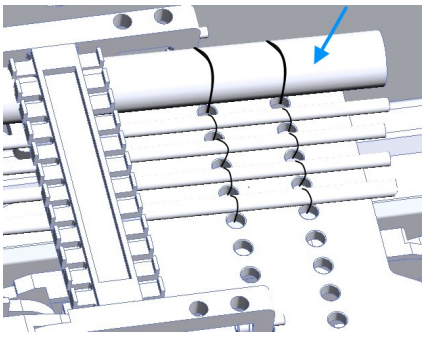
Refitting the internal cable chain

	Action	Illustration/Note
1	Remove top covers of the track.	
2	Secure the movable end of the cable chain by securing the four screws and four plain washers that hold the moving end of the cable chain to the connecting plate on the carriage.	 xx1400000523 A M6x20 Hex socket head cap screw, 9ADA183-25 B Ø12xØ6.4x1.6 Plain washer, 9ADA312-6
3	Secure the fixing end of the cable chain on the cable tray by screws.	 xx1400001980 A M6x20 Hex socket head cap screw, 9ADA183-25

Continues on next page

4.10.1 Replacing the cable chain

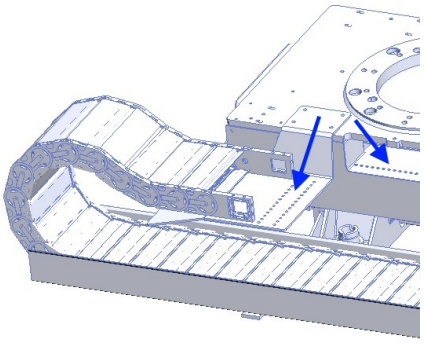
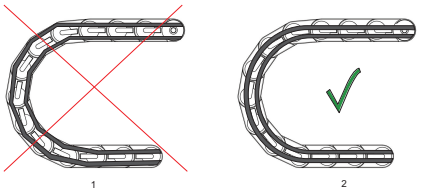
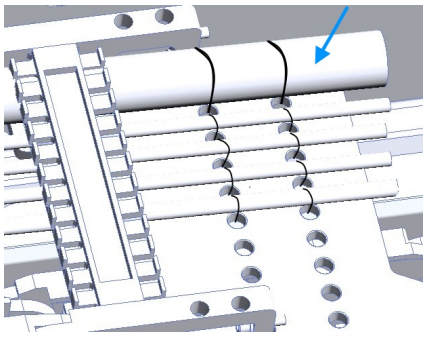
Continued

	Action	Illustration/Note
4	Connect the power and signal cable, and the media hose on the carriage. **CAUTION** Cooling water may run out if there is a media hose. Protect the connectors from getting wet.	
5	Connect the connectors for power, signal and media hose at the fixing end of the cable chain.	
6	Move back the carriage.	See *Moving back the carriage on page 246*.
7	Securing the cables to the connection plate on the carriage with cable straps. Make sure the cable route is the same with before.	
8	Check that all cable(s) and/or hose(s) are not installed too tight or too loose inside the carriage system. Optimally, aim for the neutral axis (center line of the link) of the chain as shown in the figure. To ensure that the cables are in the neutral axis, move the carriage to one end and open the links in the bend of the chain. Adjust cable length as necessary, move the carriage to the opposite side and recheck.	 xx1200000518
9	Connect power cable and signal cable on the carriage. **Note** It is essential to start with the stiffest cable and to strap it into position in order to have room for it without interference from the rest of the harness. See the illustration.	 xx1400001755
10	Connect fixing side cabling and hoses with floor cables.	
11	Refit top covers.	

Refitting the external cable chain

	Action	Illustration/Note
1	Move the carriage to the gliding side of the cable tray.	

Continues on next page

	Action	Illustration/Note
2	Place the cable chain into the cable tray. If using lifting slings, ensure that these are removed before lowering the chain into the tray so as not to bend the tray. **CAUTION** Cable chains are easily damaged through improper handling. See *Lifting cable chain on page 51* for important information about how to handle and lift the cable chain into the cable tray.	
3	Fasten the two screws that hold the cable chain to the connecting plate on the carriage.	
4	Fasten the two screws of the fixed end of the cable chain.	
5	Bound straps that securing the cables to the connection plates on the carriage. Make sure the relative position of the cables to the connection plate is the same with before.	 xx1400002001
6	Bound straps that securing the cables to the connection plate on the external cable tray. Make sure the relative position of the cables to the connection plate is the same with before.	
7	Check that all cable(s) and/or hose(s) are not installed too tight or too loose inside the carriage system. Optimally, aim for the neutral axis (center line of the link) of the chain as shown in the figure. To ensure that the cables are in the neutral axis, move the carriage to one end and open the links in the bend of the chain. Adjust cable length as necessary, move the carriage to the opposite side and recheck.	 xx1200000518
8	Connect power cable and signal cable on the carriage. **Note** It is essential to start with the stiffest cable and to strap it into position in order to have room for it without interference from the rest of the harness.	 xx1400001755

Continues on next page

4.10.1 Replacing the cable chain
Continued

	Action	Illustration/Note
9	Connect fixing side cabling and hoses with floor cables.	

Test run

	Action	Illustration/Note
1	Switch on the power.	
2	Run a few strokes in jogging mode and check that the chain is gliding properly upon itself and is correctly adjusted sideways.	
3	Run the system at low speed and insure that everything runs freely and smoothly without the chain, cables and/or hoses binding.	
4	Adjust the chain position or alignment, if needed.	
5	Adjust the position and length of cables and/or hoses, if needed.	
6	If adjustments are made, repeat steps *3* to *5*.	
7	Tighten all screws.	
8	The track is now ready to be powered up to full speed and duty cycle. Check the tightening torque on fastening screws after 500 cycles. Adjust, if needed. The use of serrated lock washers, snap rings and other locking means is not permitted in this part of the track.	

Moving back the carriage

	Action	Illustration/Note
1	Move back the carriage and secure it to the drive train bracket with the screws.	
2	Refit the brake release unit and strap the brake release cables to the carriage.	
3	Refit the covers.	See *Fitting covers on page 82*.
4	Mark the cables with a paint pen on both sides of the strapping.	
5	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *Test run after installation, maintenance, or repair on page 145*.	
6	Perform a test run before powering up the track to full speed and duty cycle.	See *Test run on page 257*.

Continues on next page

Adjusting the cable tray for spare part chains that are longer than the original

Chains longer than the original chain can be installed on single carriage tracks. In order to do this the fixed point of the chain will need to be moved, to allow for the extra length. Ensure that the replacement chain is not longer than twice the track length.

Principle of creating more space for a longer cable chain

The cable chain is fastened to the fixing connector at the middle of the cable tray. By moving the fixing connector forwards, and thereby moving the fixed point forwards, more space is created in the cable tray to suit for a longer cable chain.

More brackets and sheet metals may need to be swapped around if the chain is excessively long.

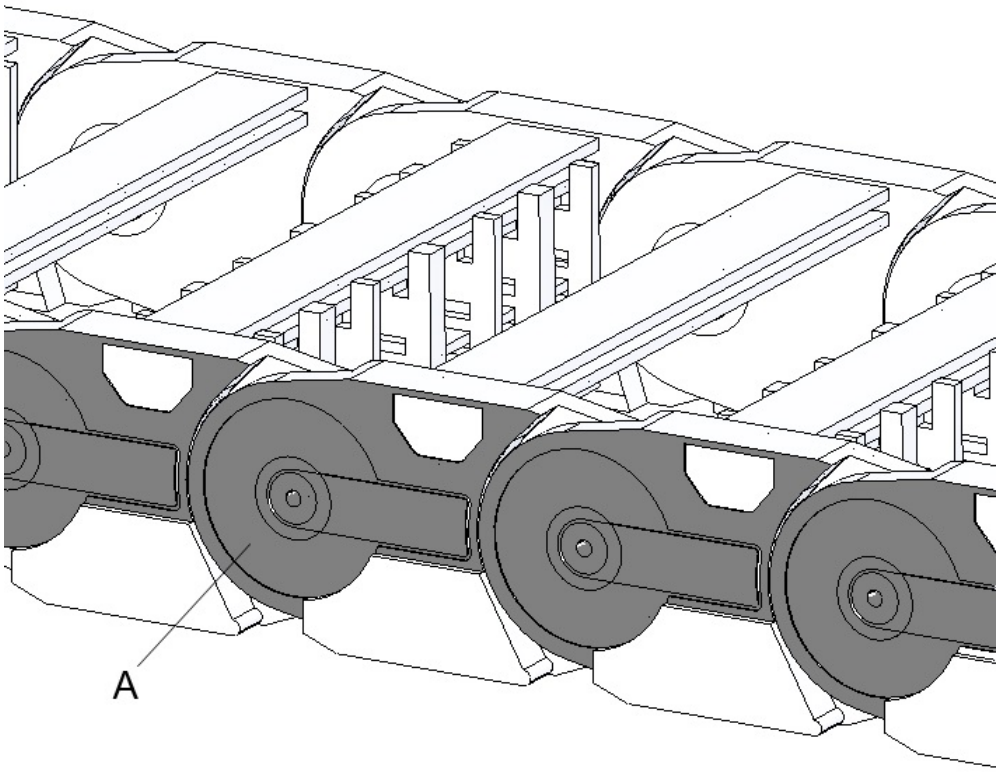
Adjusting the cable tray

	Action	Illustration/Note
1	Remove the old cable chain.	See *Removing the cable chain on page 240*.
2	Fit the new cable chain to the cable tray.	See *Lifting cable chain on page 51*.
3	Attach the cable chain at both the fixed and moving end.	
4	Move the carriage back and forth to both mechanical stops to ensure the chain is the correct length.	
5	Complete the installation of the new cable chain.	See *Refitting the cable chain on page 243*.

4.10.2 Replacing the side links and glide shoes

Location of the side links

The figure shows the location of the side links on the cable chain.



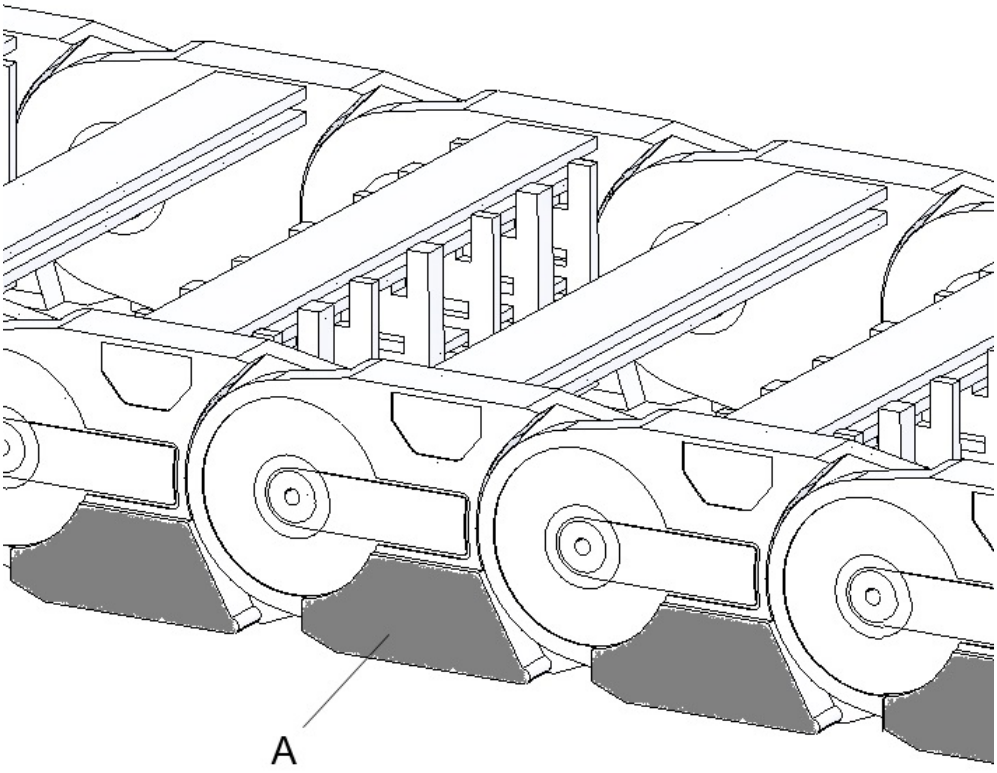
xx1400001677

A	Side link

Continues on next page

Location of the glide shoes

The figure shows the location of the glide shoes on the cable chain.



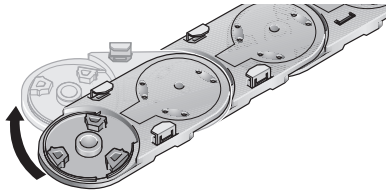
xx1400001678

A	Gliding shoe

Required equipment

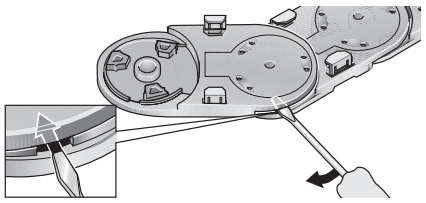
Equipment	Note
Side link	Spare part number is specified in *Spare parts on page 287*.
Glide shoes	Spare part number is specified in *Spare parts on page 287*.
Standard toolkit	Content is defined in section *Standard tools on page 280*.

Removing the side link

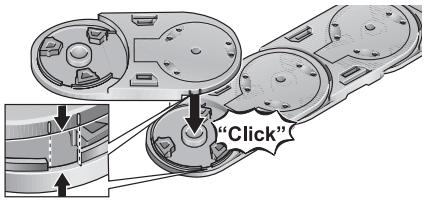
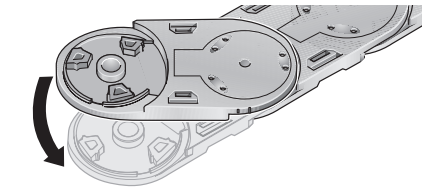
	Action	Illustration/Note
1	Bend the links until two marks on the side line up.	 xx1300000939

Continues on next page

4.10.2 Replacing the side links and glide shoes
Continued

	Action	Illustration/Note
2	Separate the two links by inserting a screwdriver and pushing down until the links separate.	 xx1300000940

Refitting the side link

	Action	Illustration/Note
1	Position the links so that the two marks on the side line up. Press the links together until they snap together.	 xx1300000941
2	Rotate the link to "close" it.	 xx1300000942

Refitting the glide shoes

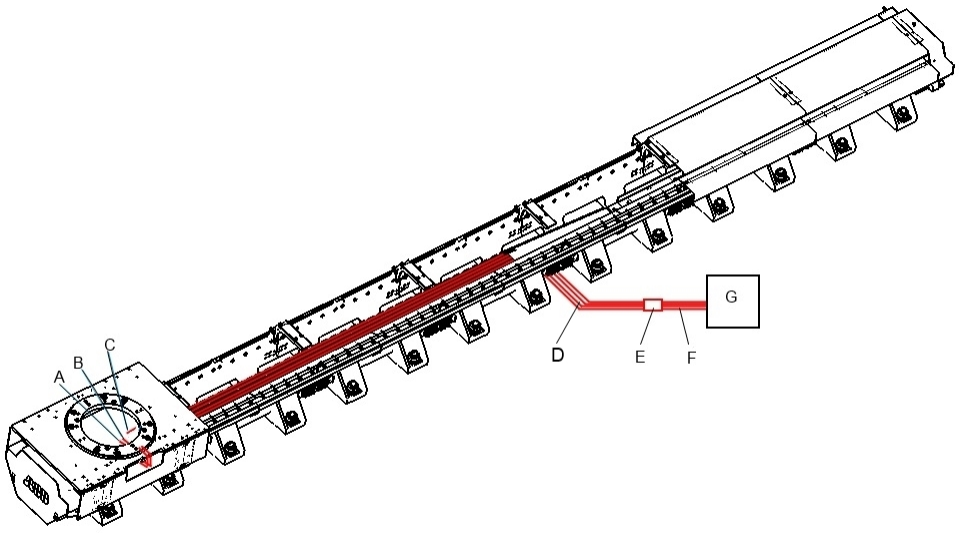
	Action	Illustration/Note
1	Remove the glide shoes by pushing in the clips with a screwdriver and then pulling out the glide shoes.	
2	Refit the glide shoes by pushing it into place until it snaps.	

4.10.3 Replacing the cables

Location of cables

Cable layout, robot track

The following illustration is based on the robot track.



xx1400001286

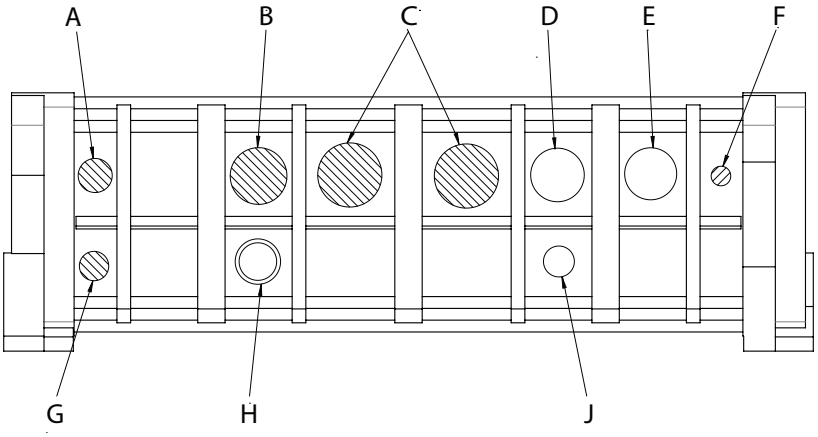
A	Robot or conveyor power cable
B	Signal cables
C	IRBT Power cables
D	Flexible cable harness from the carriage • Power cables for track, robot or lifter etc. (A,C, etc.) • Motor, manipulator signal cables (B) • Other cables: hoses etc.
E	Connectors connecting cable harness from the carriage and cable harness from the controller. [i]
F	Floor cables from the controller • Power cable, available for IRC5 • Signal cable, available for IRC5
G	Controller, available for IRC5

[i] For transfer application, this would be a SMB box.

Continues on next page

4.10.3 Replacing the cables
Continued

If the IRBT 2005 is used together with IRB 1600, IRB 2600 or IRB 4600, and the CP/CS option is also selected, the cables must be arranged according to the following layout.



xx1900000829

A	Robot signal cable
B	Track power cable
C	Robot power cable
D	CP cable
E	CS cable
F	Oil detection sensor cable (available when option 1475-1, 1479-1 or 1483-1 is selected)
G	Grounding cable
H	Air hose (available when option 1477-1, 1481-1 or 1485-1 is selected)
J	Fieldbus cable (available only for the track working with IRB 2600 or IRB 4600, and when option 1478-x, 1482-x or 1486-x is selected)

Cable layout, transfer track

Cable layout in the transfer track is similar with the robot track. Robot power and signal cables are replaced by transfer track power and signal cables. Flexible cables are connected with floor cables by an SMB box.

Cable layout, extra plate

Cable layout in the track with extra plate is similar with the robot track. While more extra plate-related cables are added and routed through cable chain.

Required equipment

Equipment	Art. No.	Note
Cables	Spare part number is specified in *Spare parts on page 287*.	Cables must be designed for use in continuous flexing operation.
Cable chain parts	Spare part number is specified in *Spare parts on page 287*.	

Continues on next page

Equipment	Art. No.	Note
Cable ties	21662055-3	Use heavy duty cable ties with minimum width: 4.9 mm.
Standard toolkit	-	Content is defined in section *Standard tools on page 280*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram	-	See *Circuit diagrams on page 289*.

Moving away the carriage

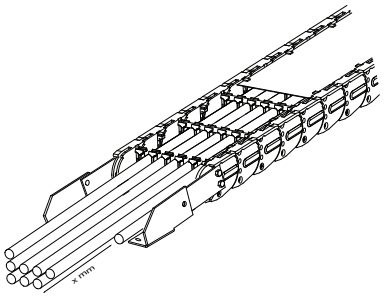
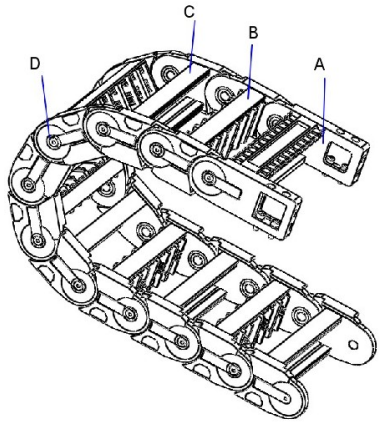
	Action	Illustration/Note
1	Remove all cover plates.	
2	Move the carriage so that the drive train and the grease distribution block is away from the fixed end of the cable chain.	
3	**WARNING** Turn off all electric power and pneumatic pressure supplies to the robot and for the track.	
4	Remove the brake release unit and cut the straps that hold the brake release cables to the carriage.	
5	Remove the bracket at the cable outlet.	
6	Loosen the carriage from the drive train bracket by removing the screws.	
7	Move away the carriage to access the movable end of the cable chain. **CAUTION** Be careful not to damage the brake release cables.	

Removing the cable

	Action	Illustration/Note
1	Disconnect the motor cables and cut the cable straps.	
2	Loosen the movable end of the cable chain from the connecting plate by removing the screws.	
3	Unfold the bend so that the cable chain is flat.	
4	Lift the cable chain. For details, see *Lifting cable chain on page 51*.	

Continues on next page

4.10.3 Replacing the cables
Continued

	Action	Illustration/Note
5	Make a note of the placement of the damaged cable in the cable chain, before removing the cable. This will facilitate refitting.	 xx1100000785
6	Before removing damaged cables, measure the length of the damaged cable projecting from the end of the cable chain. This will facilitate refitting.	
7	Remove the damaged cables from the tie wrap plates. **Tip** Before removing damaged cables, note down the location on tie wrap plate. This will facilitate refitting.	 xx1400000479 A Cable chain B Tie wrap plate C Separator for cables D Cable chain link
8	Remove the cable to be replaced.	

Refitting the cable

Note

Correct placement of cables in the cable chain is vital and will prevent unnecessary wear of the cables. Also the following matters must be considered:

- Keep unlike components apart, that is separate power and signals.
- Keep unlike cable or hose jacket materials apart.
- Only put cables of similar size in the same compartments.
- Do not remove dividers.
- If replacing a cable, check that other cables are in good condition and that they are not twisted.
- Do not pack the cables too tight inside the carriage cavities.

Continues on next page

CAUTION

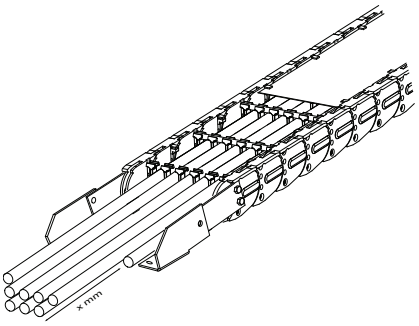
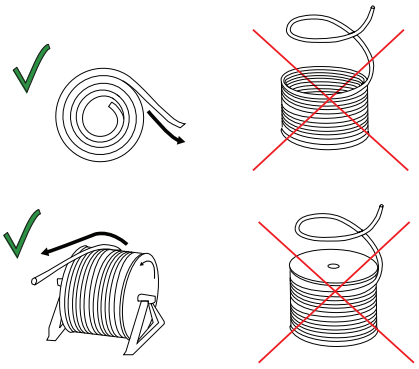
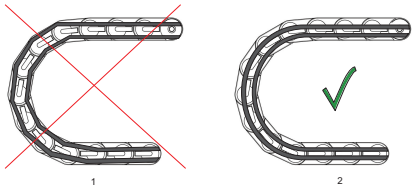
Adding cables that are not covered in the standard layouts could seriously reduce the expected component life of the chain.

	Action	Illustration/Note
1	Strap the connectors together, in order to facilitate insertion of them under the carriage.	
2	Fold the cable chain and insert the moving end under the carriage to its support plate at the drive unit. In the same time, guide the connectors through the cable outlet at the side of the carriage.	
3	Fit the moving end of the cable chain to the connecting plate with four screws and washers.	
4	Refit the upper part of the cable tray to the cable outlet if it is dismantled.	
5	Reconnect the motor cables.	

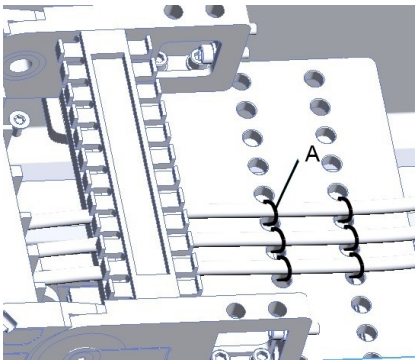
Continues on next page

4.10.3 Replacing the cables

Continued

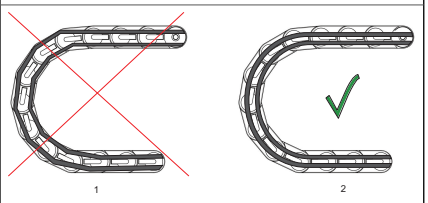
	Action	Illustration/Note
6	Fit the new cable(s), use the same length projecting from the cable chain as for the damaged cable.	 xx1100000785 See placement of all cables in *Location of cables on page 251*. **Note** When installing cables or hoses into the carriage system, they should be laid into the carriage without twist. Cables or hoses should not be simply pulled off the reel. Instead, they should be properly uncoiled as shown in the figure below.  xx1200000517
7	Check that all cable(s) and/or hose(s) are not installed too tight or too loose inside the carriage system when clamping them into place. Optimally, aim for the neutral axis (center line of the link) of the chain as shown in the figure. To ensure that the cables are in the neutral axis, move the carriage to one end and open the links in the bend of the chain. Adjust cable length as necessary, move the carriage to the opposite side and recheck.	 xx1200000518 Wrong: If cables bend radius is too big or installed incorrectly it forces the cable to push against the inner or outer sides of the chain. Right: if correctly installed the cable should fit comfortably in the chains cavity

Continues on next page

	Action	Illustration/Note
8	Strap the new cable(s) and connect it/them to the moving end plate firstly.	 xx1400001676 A Cable straps Suitable cable ties are specified in *Required equipment on page 252*.

Test run

Use this procedure to check the installation of the cabling.

	Action	Illustration/Note
1	Run the system at low speed and insure that everything runs freely and smoothly without the carriage, cables and/or hoses binding.	
2	After 50 cycles, check that the cables and hoses are not installed too tight (stretched between carriage bars) or too loose (hanging on the carriage bars). Optimally, aim for the center line of the link of the carriage system, as shown in the figure. Strap the new cable(s) and connect it/them to the fix end plate if all cables are in the right position as shown in the picture. Strap the fix end if cables/hoses are in the right positon.	 xx1200000518
3	Adjust the carriage position or alignment, if needed.	
4	Adjust the position and length of cables and/or hoses, if needed.	
5	If adjustments are made, repeat steps *1* to *4*.	
6	Tighten all screws.	
7	The track is now ready to be powered up to full speed and duty cycle. Check the tightening torque on fastening screws after 500 cycles. Adjust, if needed. Periodically check to see if the cable strain relief is still in place.	

Moving back the carriage

	Action	Illustration/Note
1	Move back the carriage and secure it to the drive train bracket with the screws.	

Continues on next page

4.10.3 Replacing the cables

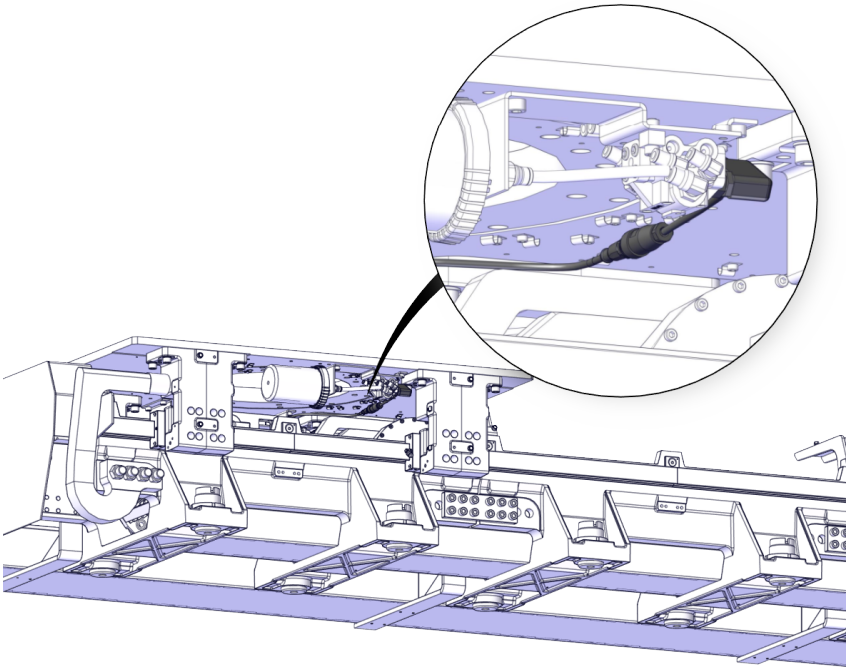
Continued

	Action	Illustration/Note
2	Refit the brake release unit and strap the brake release cables to the carriage.	
3	Refit the covers.	See *Fitting covers on page 82*.
4	Mark the cables with a paint pen on both sides of the strapping.	
5	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *Test run after installation, maintenance, or repair on page 145*.	
6	Perform a test run before powering up the track to full speed and duty cycle.	See *Test run on page 257*.

4.10.4 Replacing the lubrication sensor and sensor cable

Location of lubrication sensor and sensor cable

The figure shows the location of the lubrication sensor and its cable which is available if the track motion IRBT 2005 has the option Grease Detection sensor selected.



xx2300001653

Required equipment

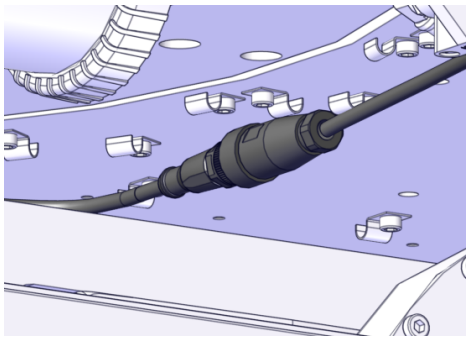
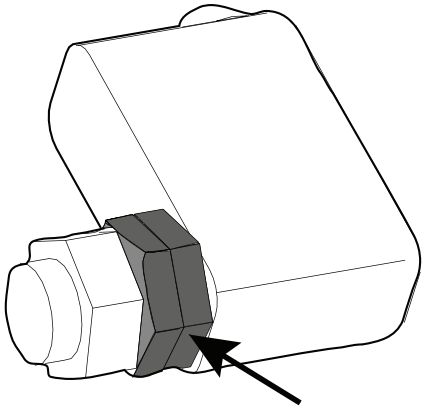
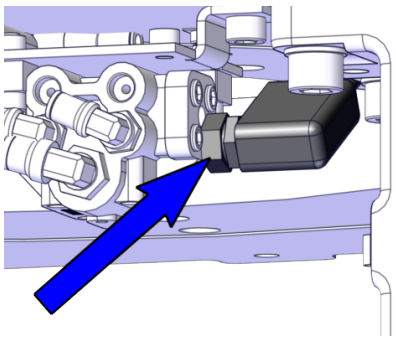
Equipment	Art. No.	Note
Lubrication sensor cable	Spare part number is specified in *Spare parts on page 287*.	
Standard toolkit	-	Content is defined in section *Standard tools on page 280*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram	-	See *Circuit diagrams on page 289*.

Continues on next page

4.10.4 Replacing the lubrication sensor and sensor cable
Continued

Removing the lubrication sensor and sensor cable

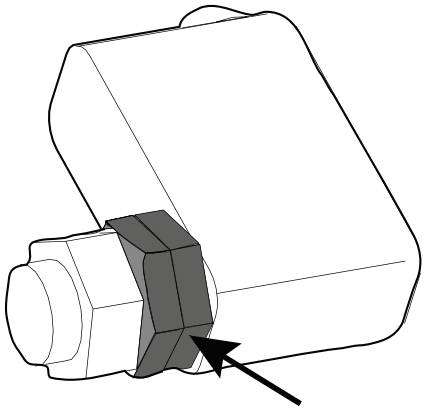
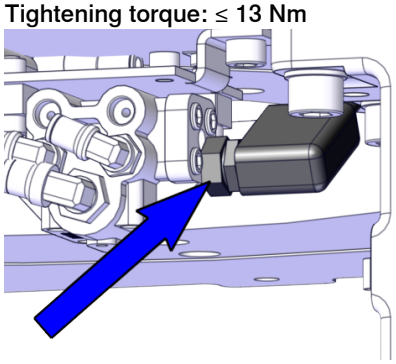
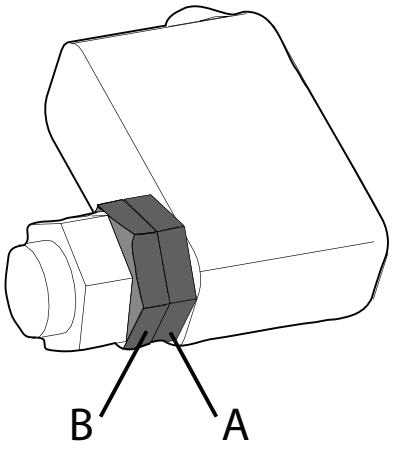
Use this procedure to remove the lubrication sensor and sensor cable.

	Action	Illustration/Note
1	Remove the necessary carriage side cover, rack covers, the end cover (if present) and the mechanical stop.	
2	**WARNING** Turn off all electric power and pneumatic pressure supplies to the robot and for IRBT 2005.	
3	Unscrew and remove the sensor cable connector.	 xx2300001654
4	Loosen the two hexagon screws to release the lubrication sensor.	 xx2300001656
5	Remove the sensor from the distributor.	 xx2300001655

Continues on next page

Refitting the lubrication sensor and sensor cable

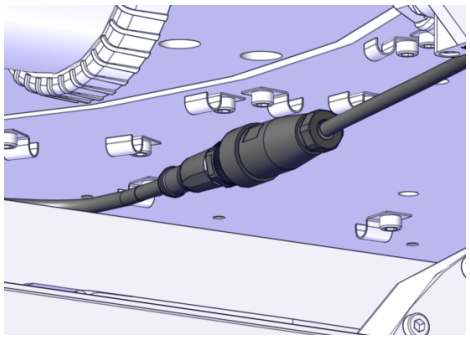
Use this procedure to refit the lubrication sensor and sensor cable.

	Action	Illustration/Note
1	Place the two hexagon screws before refitting the sensor. Do not tighten yet.	 xx2300001656
2	Refit the sensor and orient it to a proper position.	Tightening torque: ≤ 13 Nm  xx2300001655
3	Tighten the hexagon screw A to fix the sensor, and then tighten the hexagon screw B to secure the fixing. **Note** Pay attention to the sensor orientation. If improper, loosen the screws to reorient the sensor and then tighten again.	 xx2300001689

Continues on next page

4.10.4 Replacing the lubrication sensor and sensor cable

Continued

	Action	Illustration/Note
4	Reconnect and tighten the sensor cable connector by screwing it.	 xx2300001654
5	Refit the mechanical stop and the covers.	
6	Calibrate the track motion if the ball bearing block at the drive unit bracket has been replaced.	See *Fine calibration on page 266*.
7	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *Test run after installation, maintenance, or repair on page 145*.	

4.11 Replacing SMB board

WARNING

See safety instructions for batteries, *Hazards related to batteries on page 32*.

Required equipment

Note

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

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

Removing the SMB board

Use this procedure to remove the SMB board in the SMB box.

	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	 xx0200000023 **WARNING** 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 70*	
3	Open the cover on the SMB box. **CAUTION** Clean cover from metal residues before opening. Metal residues can cause shortage on the boards which can result in hazardous failures.	
4	Disconnect the cables.	
5	Remove the screws holding the plate.	
6	Pull out the plate.	
7	Loosen the screws holding the SMB board.	

Continues on next page

	Action	Information
8	Pull out the SMB board.	
9	Dispose of the old SMB board.	See *Environmental information on page 270*.

Refitting the SMB board

Use this procedure to refit the SMB board in the SMB box.

	Action	Information
1	Place the new SMB board on the mounting plate.	
2	Fasten the screws fully.	
3	Refit the plate and fasten the screws fully.	Cross tighten the screws to make sure the sealing is tight.
4	Connect the cables and close the cover.	
5	Update the revolution counters.	See *Calibration on page 265*.

5 Calibration

5.1 Overview

General

This chapter includes general information about different calibration methods and also details procedures that do not require specific calibration equipment.

When the robot system must be recalibrated, it is done according to the documentation enclosed with the calibration tools.

WARNING

Make sure no persons are on IRBT 2005 when the carriage is in motion. Also make sure that IRBT 2005's cover plates are free from loose objects, otherwise they can get trapped between the carriage and the plates.

Note

IRBT 2005 does not need to be calibrated during restart. The resolvers only need to be calibrated when commissioning the system.

When to calibrate

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

The resolver values are changed

If resolver values are changed, the robot must be recalibrated using the calibration methods supplied by ABB. Calibrate the track carefully with standard calibration.

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

This is detailed in *Fine calibration on page 266*.

The revolution counter memory is lost

If the revolution counter memory is lost, the counters must be updated. See *Update revolution counters on page 267*. 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 track is rebuilt

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

This is detailed in *Fine calibration on page 266*.

5.2 Fine calibration

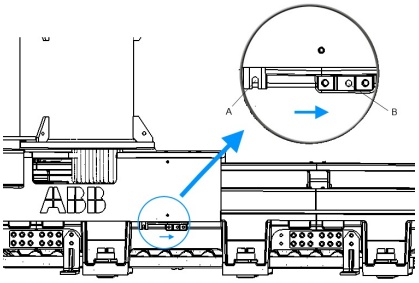
General

This procedure must be applied at the first start or after mechanical intervention (motor change, gearbox).

Required equipment

Equipment	Art. No.	Note
Calibration tool	3HAC054533-001	Φ8 calibration pin

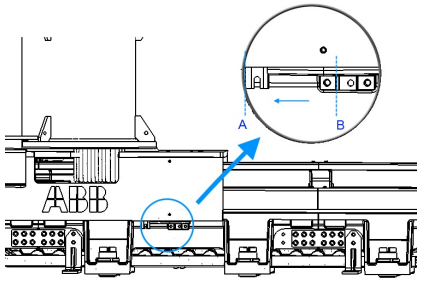
Fine calibrating

	Action	Illustration/Note
1	Using the FlexPendant, jog the carriage close to the calibration gauge position.	
2	Move the track until the calibration notch on the carriage line up with the calibration hole on the section.	 xx1400000570 A: Calibration notch on the carriage B: Calibration hole on the section
3	Insert the calibration pin. A dowel pin diameter 8mm can also be used.	
4	Tap **ABB** on the top left of the FlexPendant.	
5	Tap **Calibration**.	
6	Select the desired mechanical unit.	
7	Tap **Fine calibration**.	
8	Select the desired axis.	
9	Tap **Calibrate**.	

5.3 Update revolution counters

Procedure

This procedure must be applied if revolution counter value is loss for the track.

	Action	Illustration/Note
1	Align the sharp edge of the moving part of the calibration marker with the line of the fixed part calibration marker.	 xx1400000595 A: Calibration sharp edge of the moving part B: Calibration sharp edge of the fixed part
2	Tap **ABB** on the top left of the FlexPendant.	
3	Tap **Calibration**.	
4	Select the desired mechanical unit.	
5	Tap **Update revolution counters**.	
6	Select the desired axis.	
7	Tap **Update**.	

5.4 Defining base frame

General

To run coordinated axes, the base frame must be defined. See *Application manual - Additional axes and standalone controller* (*Coordinated track motion*).

6 Decommissioning

6.1 Introduction to decommissioning

Introduction

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

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

> **Note**
>
> The decommissioning process shall be preceded by a risk assessment.

Disposal of materials used in the robot

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

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

See also *Environmental information on page 270*.

Transportation

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

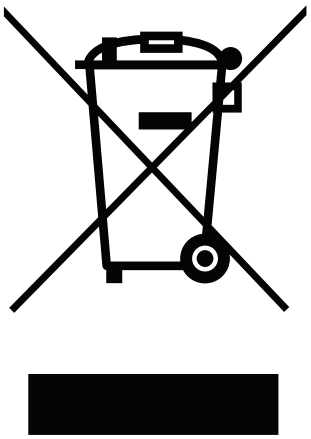
6.2 Environmental information

Introduction

ABB robots contain components in different materials. During decommissioning, all materials shall be dismantled, recycled, or reused responsibly, according to the relevant laws and industrial standards. Robots or parts that can be reused or upcycled helps to reduce the usage of natural resources.

Disposal symbol

The following symbol indicates that the product must not be disposed of as common garbage. Handle each product according to local regulations for the respective content (see table below).



xx1800000058

Materials used in the product

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

Dispose components properly according to local regulations to prevent health or environmental hazards.

Material	Example application
Aluminium	Covers
Batteries, Lithium	Serial measurement board
Cast iron/nodular iron	Track section
Copper	Cables, motors
Neodymium	Brakes, motors
Oil, grease	Gearbox
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.

This page is intentionally left blank

7 Reference information

7.1 Introduction

General

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

7.2 Applicable standards

Note

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

General

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

Normative standards as referred to from ISO 10218-1

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

Deviations from ISO 10218-1:2011 for IRBT 2005

Deviations from the standard are motivated for IRBT 2005 in the table below.

Requirement	Deviation for IRBT 2005	Motivation
§5.12.1 Limiting the range of motion by adjustable stops (§5.12.2) or by safety functions (§5.12.3).	IRBT 2005 does not have adjustable mechanical stops.	The track motion is designed as segments, which can be reduced to limit the range of motion.

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	Industrial robots and robot Systems - General safety requirements

Continues on next page

Other standards used in design

Standard	Description
ISO 9787:2013	Robots and robotic devices -- Coordinate systems and motion nomenclatures
IEC 61000-6-2	Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments
IEC 61000-6-4	Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments
ISO 13732-1:2006	Ergonomics of the thermal environment - Part 1
IEC 60974-1:2012 [i]	Arc welding equipment - Part 1: Welding power sources
IEC 60974-10:2014 [i]	Arc welding equipment - Part 10: EMC requirements
ISO 14644-1:2015 [ii]	Classification of air cleanliness
IEC 60529:1989 + A2:2013	Degrees of protection provided by enclosures (IP code)

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

7.3 Unit conversion

Converter table

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

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

7.4 Screw joints

General

This section describes how to tighten the various types of screw joints on ABB robots.

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

UNBRAKO screws

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

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

Gleitmo treated screws

Gleitmo is a special surface treatment to reduce the friction when tightening the screw joint. It is recommended by ABB for M6-M20 screw joints. Screws treated with Gleitmo may be reused 3-4 times before the coating disappears. After this the screw must be discarded and replaced with a new one.

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

Generally, screws are lubricated with *Gleitmo 603* mixed with *Geomet 500* or *Geomet 702* in proportion 1:3. *Geomet* thickness varies according to screw dimensions, refer to the following.

Dimension	Lubricant	Geomet thickness
M6-M20 (any length except M20x60)	*Gleitmo 603* + *Geomet 500*	3-5 µm
M6-M20 (any length except M20x60)	*Gleitmo 603* + *Geomet 720*	3-5 µm
M20x60	*Gleitmo 603* + *Geomet 500*	8-12 µm
M20x60	*Gleitmo 603* + *Geomet 720*	6-10 µm

Screws lubricated in other ways

Screws lubricated with Molykote 1000 or Molykote P1900 should *only* be used when specified in the repair, maintenance or installation procedure descriptions.

In such cases, proceed as follows:

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

Continues on next page

Lubricant	Article number
Molykote 1000 (molybdenum disulphide grease)	3HAC042472-001
Molykote P1900 (molybdenum disulphide grease)	3HAC070875-001

Tightening torque

Before tightening any screw, note the following:

- Determine whether a **standard** tightening torque or **special** torque is to be applied. The **standard torques** are specified in the following tables. Any **special torques** are specified in the repair, maintenance or installation procedure descriptions. **Any special torque specified overrides the standard torque!**
- Use the *correct tightening torque* for each type of screw joint.
- Only use *correctly calibrated* torque keys.
- Always *tighten the joint by hand,* and never use pneumatic tools.
- Use the *correct tightening technique*, that is *do not* jerk. Tighten the screw in a slow, flowing motion.
- Maximum allowed total deviation from the specified value is **10%**!

Tightening torque for oil-lubricated screws with slotted or cross-recess head screws

The following table specifies the recommended standard tightening torque for *oil-lubricated screws* with *slotted or cross-recess head screws.*

Note

A special torque specified in the repair, maintenance or installation procedure overrides the standard torque.

Tightening torque for oil-lubricated screws with allen head screws

The following table specifies the recommended standard tightening torque for *oil-lubricated screws* with *allen head screws.*

Note

A special torque specified in the repair, maintenance or installation procedure overrides the standard torque.

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

Continues on next page

Dimension	Tightening torque (Nm) Class 8.8, oil-lubricated	Tightening torque (Nm) Class 10.9, oil-lubricated	Tightening torque (Nm) Class 12.9, oil-lubricated
M24	680	960	1150

Tightening torque for lubricated screws (Molykote, Gleitmo or equivalent) with allen head screws

The following table specifies the recommended standard tightening torque for *screws lubricated with Molycote 1000, Gleitmo 603 or equivalent* with *allen head screws.*

Note

A special torque specified in the repair, maintenance or installation procedure overrides the standard torque.

Dimension	Tightening torque (Nm) Class 10.9, lubricated [i]	Tightening torque (Nm) Class 12.9, lubricated [i]
M5		8
M6		14
M8	28	35
M10	55	70
M12	96	120
M16	235	300
M20	460	550
M24	790	950

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

7.5 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 tools

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 10-120 Nm
1	Ratchet head for torque wrench 1/2
1	Hex bit socket head cap no. 5 socket 1/2", bit length=20 mm
1	Hex bit socket head cap no. 6 socket 1/2", bit length=20 mm
1	Hex bit socket head cap no. 8 socket 1/2", bit length=20 mm
1	Plastic mallet
1	Small screwdriver

7.6 Special tools

Extra toolkit

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 280* and special tools listed directly in the instructions and also gathered in this section.

Special tools

Qty	Tool	Art. No.	Note
1	Backlash adjustment tool	3HAC054528-001	
1	Calibration pin	3HAC054533-001	
1	Companion rack	3HAC054532-001	
1	Companion rack fix block	3HAC054531-001	
1	Laser tracker	3HAW107700357	
1	Leveling tool	3HAC054535-001	
1	Locking nut adjustment tool	3HAC054534-001	
2	Rack clamp		The actual rack clamp to be used should be prepared based on actual situation.

7.7 Lifting accessories and lifting instructions

General

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

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

The instructions delivered with the lifting accessories should be stored for later reference.

7.8 HILTI adhesive anchor

Overview

HVU with HAS/HAS-E rod adhesive anchor

Mortar system	Benefits
 Hilti HVU foil capsule  HAS HAS-R HAS-HCR rod  HAS-E HAS-E R HAS-E HCR rod	- suitable for non-cracked concrete C 20/25 to C 50/60 - high loading capacity - suitable for dry and water saturated concrete - large diameter applications - high corrosion resistant

xx1400000489

Basic data (for a single anchor)

All data in this section applies to:

- Correct setting (See setting instruction)
- No edge distance and spacing influence
- Steel failure
- Base material thickness, as specified in the table
- One typical embedment depth, as specified in the table
- One anchor material, as specified in the tables
- Concrete C 20/25, fck,cube = 25 N/mm²
- Temperate range I (min. base material temperature -40°C, max. long term/short term base material temperature: +24°C/40°C)
- Installation temperature range -5°C to +40°C

M16 anchor	
Typical embedment depth [mm] [i]	125
Base material thickness [mm]	210
Carbon steel, strength class	5.8
Mean ultimate resistance:concrete C 20/25 – fck,cube = 25 N/mm², anchor HAS Tensile NRu,m HAS [kN]	75,6
Mean ultimate resistance:concrete C 20/25 – fck,cube = 25 N/mm², anchor HAS Shear VRu,m HAS [kN]	37,8
Characteristic resistance: concrete C 20/25 – fck,cube = 25 N/mm², anchor HAS Tensile NRk HAS [kN]	60,0
Design resistance: concrete C 20/25 – fck,cube = 25 N/mm², anchor HAS Shear VRk HAS [kN]	36,0
Recommended loads [ii]: concrete C 20/25 – fck,cube = 25 N/mm², anchor HAS Tensile NRd HAS [kN]	40,0

Continues on next page

7.8 HILTI adhesive anchor

Continued

M16 anchor	
Recommended loads: concrete C 20/25 – fck,cube = 25 N/mm², anchor HAS Shear VRd HAS [kN]	28,8

i The allowed range of embedment depth is shown in the setting details. The corresponding load values can be calculated according to the simplified design method.

ii With overall partial safety factor for action = 1,4. The partial safety factors for action depend on the type of loading and shall be taken from national regulations.

Basic design tensile resistance

Design steel resistance $N_{Rd,s}$

			Data according ETA-05/0255, issue 2011-06-23							
Anchor size			M8	M10	M12	M16	M20	M24	M27	M30
$N_{Rd,s}$	HAS-(E)(F) 5.8	[kN]	11,3	17,3	25,3	48,0	74,7	106,7	-	-
	HAS-(E)(F) 8.8	[kN]	18,0	28,0	40,7	76,7	119,3	170,7	231,3	281,3
	HAS-(E)-R	[kN]	12,3	19,8	28,3	54,0	84,0	119,8	75,9	92,0
	HAS-(E)-HCR	[kN]	18,0	28,0	40,7	76,7	119,3	106,7	-	-

Design combined pull-out and concrete cone resistance $N_{Rd,p} = N^0_{Rd,p} \cdot f_{B,p} \cdot f_{h,p}$

			Data according ETA-05/0255, issue 2011-06-23							
Anchor size			M8	M10	M12	M16	M20	M24	M27	M30
Typical embedment depth $h_{ef,typ}$ [mm]			80	90	110	125	170	200	210	270
$N^0_{Rd,p}$	Temperature range I	[kN]	16,7	23,3	33,3	40,0	76,7	93,3	133,3	166,7
$N^0_{Rd,p}$	Temperature range II	[kN]	13,3	16,7	26,7	33,3	50,0	76,7	93,3	113,3
$N^0_{Rd,p}$	Temperature range III	[kN]	6,0	8,0	10,7	16,7	26,7	40,0	50,0	50,0

xx1400000488

Service temperature range

Hilti HVU adhesive may be applied in the temperature ranges given below. An elevated base material temperature may lead to a reduction of the design bond resistance.

Temperature range	Base material temperature	Maximum long term base material temperature [i]	Maximum short term base material temperature [ii]
Temperature range 1	-40 °C to +40 °C	+24 °C	+40 °C
Temperature range 2	-40 °C to +80 °C	+50 °C	+80 °C
Temperature range 3	-40 °C to +120 °C	+72 °C	+120 °C

i Long-term elevated base material temperatures are roughly constant over significant periods of time.

ii Short-term elevated base material temperatures are those that occur over brief intervals, e.g. as a result of diurnal cycling.

Continues on next page

Material

Mechanical properties of HAS

			Data according ETA-05/0255, issue 2011-06-23							
Anchor size			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Nominal tensile strength f_{uk}	HAS-(E)(F) 5.8	[N/mm²]	500	500	500	500	500	500	-	-
	HAS-(E)(F) 8.8	[N/mm²]	800	800	800	800	800	800	800	800
	HAS-(E)R	[N/mm²]	700	700	700	700	700	700	500	500
	HAS-(E)HCR	[N/mm²]	800	800	800	800	800	700	-	-
Yield strength f_{yk}	HAS-(E)(F) 5.8	[N/mm²]	400	400	400	400	400	400	-	-
	HAS-(E)(F) 8.8	[N/mm²]	640	640	640	640	640	640	640	640
	HAS –(E)R	[N/mm²]	450	450	450	450	450	450	210	210
	HAS –(E)HCR	[N/mm²]	640	640	640	640	640	400	-	-
Stressed cross-section A_s	HAS	[mm²]	32,8	52,3	76,2	144	225	324	427	519
Moment of resistance W	HAS	[mm³]	27,0	54,1	93,8	244	474	809	1274	1706

Material quality

Part	Material
Threaded rod HAS-(E)(F) M8-M24	Strength class 5.8, A_5 > 8% ductile steel galvanized ≥ 5 µm (F) hot dipped galvanized ≥ 45 µm,
Threaded rod HAS-(E)F M8-M30	Strength class 8.8, A_5 > 8% ductile steel galvanized ≥ 5 µm, (F) hot dipped galvanized ≥ 45 µm,
Threaded rod HAS-(E)R	Stainless steel grade A4, A_5 > 8% ductile strength class 70 for ≤ M24 and class 50 for M27 to M30, 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362
Threaded rod HAS-(E)HCR	High corrosion resistant steel, 1.4529; 1.4565 strength ≤ M20: R_m = 800 N/mm², $R_{p\,0.2}$ = 640 N/mm², A_5 > 8% ductile M24: R_m = 700 N/mm², $R_{p\,0.2}$ = 400 N/mm², A_5 > 8% ductile
Washer ISO 7089	Steel galvanized, hot dipped galvanized, Stainless steel, 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362 High corrosion resistant steel, 1.4529; 1.4565
Nut EN ISO 4032	Strength class 8, steel galvanized ≥ 5 µm, hot dipped galvanized ≥ 45 µm, Strength class 70, stainless steel grade A4, 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362 Strength class 70, high corrosion resistant steel, 1.4529; 1.4565

xx1400000490

Installation

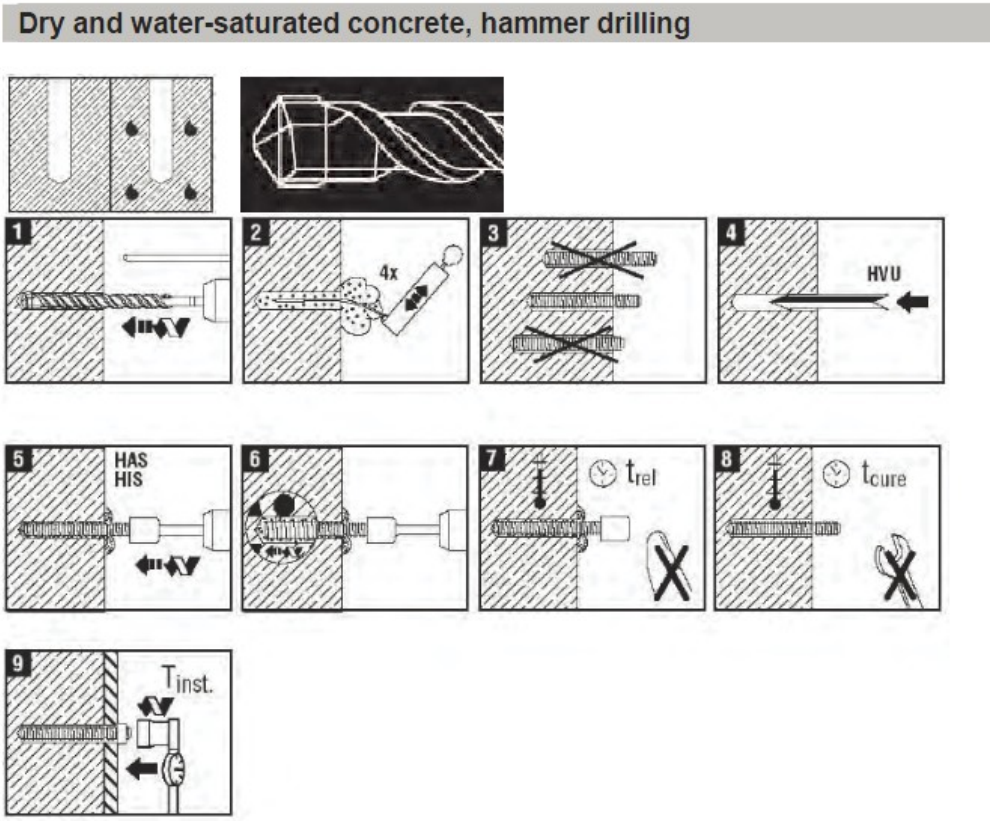
Installation equipment

Anchor size	M16
Rotary hammer	TE 2 - TE 16
Other tools	blow out pump or compressed air gun, setting tools

Continues on next page

7.8 HILTI adhesive anchor
Continued

Installation



xx1400000487

For detailed information on installation see instruction for use given with the package of the product.

For technical data for anchors in diamond drilled holes contact the Hilti Technical advisory service.

Curing time for general conditions

Temperature of the base material	Curing time before anchor can be fully loaded
20 °C to 40 °C	20 minutes
10 °C to 19 °C	30 minutes
0 °C to 9 °C	1 hour
-5 °C to - 1 °C	5 hour

8 Spare parts

8.1 Spare part lists and illustrations

Location

Spare parts and exploded views are not included in the manual but delivered as a separate document for registered users on myABB Business Portal, *www.abb.com/myABB*.

Tip

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

This page is intentionally left blank

9 Circuit diagrams

Overview

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

See the article numbers in the tables below.

Controllers

Product	Article numbers for circuit diagrams
Circuit diagram - IRC5 (drive system 09)	*3HAC024480-005*
Circuit diagram - IRC5	*3HAC024480-011*
Circuit diagram - IRC 5 Compact	*3HAC031403-003*
Circuit diagram - IRC5 Panel Mounted Controller	*3HAC026871-006*
Circuit diagram - IRC5 Panel Mounted Controller	*3HAC026871-020*
Circuit diagram - Euromap 67, design 14	*3HAC024120-005*

Robots

Product	Article numbers for circuit diagrams
Circuit diagram - IRB 1520	*3HAC039498-007*
Circuit diagram - IRB 1600/1660	*3HAC021351-003*
Circuit diagram - IRB 2600	*3HAC029570-007*
Circuit diagram - IRB 4600	*3HAC029038-003*

IRBT 2005

Product	Article numbers for circuit diagrams
Medium Track Motion IRBT 2005	3HAC051586-001

This page is intentionally left blank

Index

A
allergenic material, 26
aluminum
  disposal, 270
assessment of hazards and risks, 26

B
base frame, 130
batteries
  disposal, 270
battery pack
  replacing, interval, 149
brakes
  testing function, 34

C
cabinet lock, 27
calibration
  when to calibrate, 265
carbon dioxide extinguisher, 27
cast iron
  disposal, 270
climbing on robot, 30
copper
  disposal, 270

E
environmental information, 270
ESD
  damage elimination, 70
  sensitive equipment, 70

F
fire extinguishing, 27

G
grease, 30
  disposal, 270

H
hanging
  installed hanging, 26
hazard levels, 17
hazardous material, 270
height
  installed at a height, 26
hot surfaces, 30
HRA, 26

I
integrator responsibility, 26

L
labels
  robot, 19
limitation of liability, 15
Lithium
  disposal, 270
lock and tag, 27
lubricants, 30

N
national regulations, 26
neodymium
  disposal, 270
nodular iron
  disposal, 270

O
oil, 30
  disposal, 270
original spare parts, 15

P
pedestal
  installed on pedestal, 26
personnel
  requirements, 16
plastic
  disposal, 270
PPE, 16
product standards, 274
protective equipment, 16
protective wear, 16

R
recycling, 270
regional regulations, 26
release brakes, 33
replacements, report, 175
replacing, 263
  SMB battery, 172
  SMB board, 263
report replacements, 175
responsibility and validity, 15
risk of burns, 30
robot
  labels, 19
  symbols, 19
rubber
  disposal, 270

S
safety
  brake testing, 34
  ESD, 70
  fire extinguishing, 27
  release robot axes, 33
  signals, 17
  signals in manual, 17
  symbols, 17
  symbols on robot, 19
  test run, 145
safety devices, 27
safety hazard
  hydraulic system, 28
  pneumatic system, 28
safety signals
  in manual, 17
safety standards, 274
screw joints, 277
setting the base frame, 130
shipping, 269
signals
  safety, 17
SMB battery
  replacing, 172
SMB board, 263
standards, 274
  ANSI, 274
  CAN, 274
  EN IEC, 274

EN ISO, 274
steel
disposal, 270
symbols
safety, 17
system integrator requirements, 26

T
testing
brakes, 34
transportation, 269
troubleshooting
safety, 35

U
upcycling, 270
users
requirements, 16

V
validity and responsibility, 15

ABB AB
Robotics & Discrete Automation
S-721 68 VÄSTERÅS, Sweden
Telephone +46 10-732 50 00

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

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

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

abb.com/robotics

3HAC051130-001, Rev M, en