ROBOTICS

Product manual

Motor Units and Gear Units

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Product manual

MU 80, MU 100, MU 200, MU 250, MU 300, MU 400
MTD 250, MTD 500, MTD 750, MTD 2000, MTD 5000
MID 500, MID 1000

IRC5

Document ID: 3HAC040148-001

Revision: R

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Original instructions.

Table of contents

Overview of this manual

About this manual

This manual contains instructions for:

- Mechanical and electrical installation of the motor units and gear units.
- Maintenance of the motor units and gear units.
- Mechanical and electrical repair of the motor units and gear units.

Usage

This manual should be used during:

- Installation, from installation and connection, to making them 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 motor units and gear units. Some variants and designs may have been removed from the business offer and are no longer available for purchase.

References

Reference	Document ID
Product manual, spare parts - Motor Units and Gear Units	*3HAC040278-001*
Circuit diagram - Motor Units and Gear Units	*3HAC039887-001*
Product specification - Motor Units and Gear Units	*3HAC040147-001*
Safety manual for robot - Manipulator and IRC5 or OmniCore controller i	*3HAC031045-001*
Product manual - IRC5 IRC5 with main computer DSQC 639.	*3HAC021313-001*
Product manual - IRC5 IRC5 with main computer DSQC1000.	*3HAC047136-001*
Product manual - IRC5 Panel Mounted Controller	*3HAC027707-001*

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Reference	Document ID
Product manual - IRC5 Compact	*3HAC035738-001*
Operating manual - IRC5 with FlexPendant	*3HAC050941-001*
Operating manual - RobotStudio	*3HAC032104-001*
Technical reference manual - System parameters	*3HAC050948-001*
Application manual - Additional axes and stand alone controller	*3HAC051016-001*
Application manual - TuneMaster	*3HAC063590-001*

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

Revisions

Revision	Description
-	First revision. MU 100, MU 200, and MU 300 replaces MU10, MU20, and MU30.
A	The following additions and corrections are made: • Added information to use locking mechanism for MID units, see *Installing gear units on page 44*. • Added information about acceleration torque limit for motor units, see *Loading configuration files on page 71*. • Added descriptions of the abbreviations.
B	The following additions and corrections are made: • Added *Tuning the thermal supervision on page 83*. • Added information about batteries. • Added *Changing the cable harness in the controller on page 70*.
C	The following additions and corrections are made: • The formula for acceleration and deceleration values is corrected, see *Dimensioning gear units on page 79*. • Corrected the quality of attachment screws for gear units, see *Installing gear units on page 44*. • Added *Lubricating the current collector on page 93*. • Added *Changing the cable harness in the controller on page 70*. • Added *Make sure that the main power has been switched off! on page ?*. • A new SMB unit and battery is introduced, with longer battery lifetime.
D	The following additions and corrections are made: • The values for $T_{maxgear}$ is updated with physical units, see *Dimensioning gear units on page 79*.
E	Minor corrections.
F	• Updated the path to the template files, see *Loading configuration files on page 71*.
G	Published in release R17.1. The following updates are done in this revision: • Added MU 250. • Added information about Add-In in **Installation Manager**, see *Loading configuration files on page 71*.
H	Published in release R17.2. The following updates are made in this revision: • Caution about removing metal residues added in sections about SMB boards. • Updated list of applicable standards. • Added MU 80.

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Revision	Description
J	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.
K	Published in release R18.2. The following updates are made in this revision: • Changed cable routing for motor power cables on gear unit GU MTD750. • Updated description about assembling transmission elements, see *Assembly by pressing on the pinion on page 62*.
L	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 95*. • New article numbers for manipulator cables in section *Fastening cables on page 47*.
M	Published in release 19C. The following updates are made in this revision: • Added sections *Connections for SC/DC (DM) on page 52*, *Open and close the pivot frame on page 53*, and *Retrofit an interface to the IRC5 controller on page 55*.
N	Published in release 19C. The following updates are made in this revision: • Section about brake release tool added, se *Releasing the brakes during installation on page 42*.
P	Published in release 22A. The following updates are made in this revision: • Alignment of the Y axis.
Q	Published in release 22C. The following updates are made in this revision: • Added section *Installing a system with MU/GU on page 73*.
R	Published in release 22D. The following updates are done in this revision: • Information about the article number on delivery documents is added to the product description.

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1 Safety

1.1 Safety information

1.1.1 Limitation of liability

Limitation of liability

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

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

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

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

Spare parts and equipment

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

1.1.2 Requirements on personnel

General

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

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

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

Personal protective equipment

Use personal protective equipment, as stated in the instructions.

1.2 Safety signals and symbols

1.2.1 Safety signals in the manual

Introduction to safety signals

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

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

Hazard levels

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

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

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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 15*.

The information labels can contain information in text.

Symbols on safety labels

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

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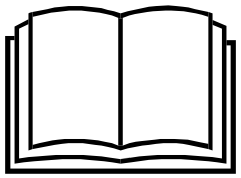
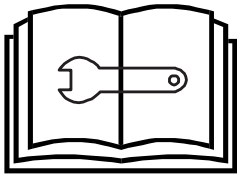
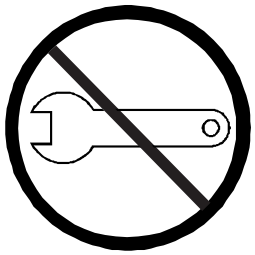
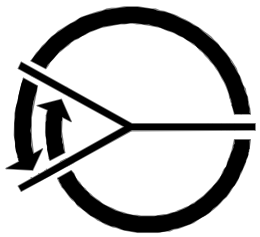
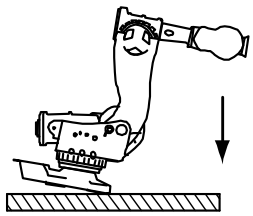
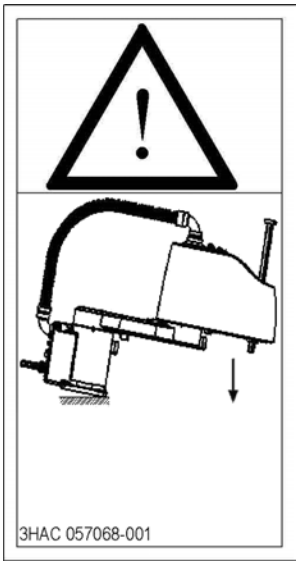
1.2.2 Safety symbols on manipulator labels
Continued

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.

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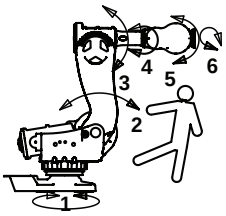
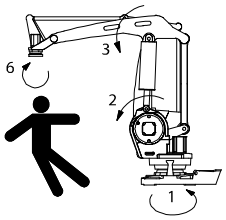
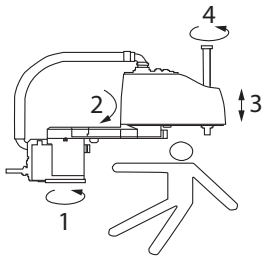
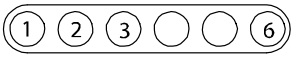
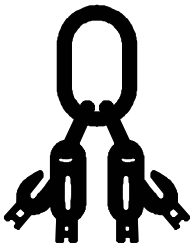
1.2.2 Safety symbols on manipulator labels

Continued

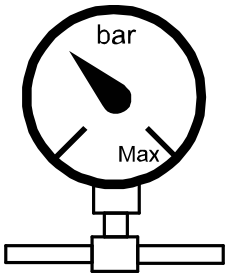
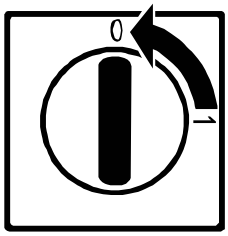
Symbol	Description
 xx0900000818  xx1300001087	**Heat** Risk of heat that can cause burns. (Both signs are used)
 xx0900000819  xx1000001141  xx1500002616	**Moving robot** The robot can move unexpectedly.

Continues on next page

Symbol	Description
 xx0900000820  xx1000001140	**Brake release buttons**
 xx0900000821	**Lifting bolt**
 xx1000001242	**Chain sling with shortener**
 xx0900000822	**Lifting of robot**
 xx0900000823	**Oil** Can be used in combination with prohibition if oil is not allowed.
 xx0900000824	**Mechanical stop**

Continues on next page

1.2.2 Safety symbols on manipulator labels
Continued

Symbol	Description
 xx1000001144	**No mechanical stop**
 xx0900000825	**Stored energy** Warns that this part contains stored energy. Used in combination with *Do not disassemble* symbol.
 xx0900000826	**Pressure** Warns that this part is pressurized. Usually contains additional text with the pressure level.
 xx0900000827	**Shut off with handle** Use the power switch on the controller.
 xx1400002648	**Do not step** Warns that stepping on these parts can cause damage to the parts.

1.3 Robot stopping functions

Protective stop and emergency stop

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

For more information see:

- *Product manual - IRC5*

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 100* for specification of allergenic materials in the product, if any.

Securing the robot to the foundation

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

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

Continues on next page

Electrical safety

Incoming mains must be installed to fulfill national regulations.

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

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

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

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

Note

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

Safety devices

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

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

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

Other hazards

A robot may perform unexpected limited movement.

WARNING

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

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

- Water
- Compressed air
- Hydraulics

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

Verify the safety functions

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

1.5 Safety during operation

Automatic operation

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

Unexpected movement of robot arm

WARNING

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

A robot may perform unexpected limited movement.

WARNING

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

1.6 Safety during maintenance and repair

1.6.1 Safety during maintenance and repair

General

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

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

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

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

Make sure that there are no loose screws, turnings, or other unexpected parts remaining after work on the robot has been performed.

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

Hot surfaces

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

Allergic reaction

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

Gearbox lubricants (oil or grease)

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

Note

Take special care when handling hot lubricants.

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

Continues on next page

1.6.1 Safety during maintenance and repair
Continued

Warning	Description	Elimination/Action
 **Allergic reaction**	When working with lubricants there is a risk of an allergic reaction.	Make sure that protective gear like goggles and gloves are always worn.
 **Possible pressure build-up in gearbox**	When opening the oil or grease plug, there may be pressure present in the gearbox, causing lubricant to spray from the opening.	Open the plug carefully and keep away from the opening. Do not overfill the gearbox when filling.
 **Do not overfill**	Overfilling of gearbox lubricant can lead to internal over-pressure inside the gearbox which in turn may: • damage seals and gaskets • completely press out seals and gaskets • prevent the robot from moving freely.	Make sure not to overfill the gearbox when filling it with oil or grease. After filling, verify that the level is correct.
 **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.

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.

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.

Continues on next page

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 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 7*.

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 99*.

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 Product overview

2.1 Introduction to motor units and gear units

Product overview

The motor units and gear units function as additional axes in the robot. They are controlled by drive units mounted in the robot controller. The units are designed for optimal performance, installation, and application.

The motor units and gear units use much of the same components and are therefore described together.

Article numbers used on delivery documents

The products described in this document are delivered with an article number (3HEA802613-006) that is a collective number used on the delivery documents. This article number does not necessarily match the number printed on the label on the product.

SMB box

The SMB box (optional) contains a serial measurement board (with battery backup) and brake release buttons (optional).

Note that if the motor unit is used in an arc welding station, the SMB box must always be insulated from the weld circuit. See *Insulation in arc welding stations on page 67*.

Axis selector

The axis selector (optional) is mounted in the robot controller and makes it possible to cut the power for selected connected external units. The function is controlled by instructions in the robot program.

2.2 Motor units

Introduction

The motor units are specially designed for ABB's robots and can be used for peripherals requiring servo steered motors that are synchronized with the robot movements.

MU variants

The following motor unit variants are available:

- MU 80
- MU 100
- MU 200
- MU 250
- MU 300
- MU 400

MU stands for *motor unit*.

Product overview

The motor units consist of:

- Motor
- SMB box (optional)
- Axis selector (optional)
- Cables

Prerequisites

- IRC5 requires 3 phase power.
- *Electronic Position Switches* can be used with one motor.
- *SafeMove* can be used with up to three motors.

Technical data

Motor unit	Weight [kg]
MU 80	1.37
MU 100	4.4
MU 200	9.3
MU 250	13.2
MU 300	15
MU 400	27

2.3 Gear units

Introduction

The gear units are divided in two categories, MTD and MID.

The number in the variant name describes the handling capacity.

MTD variants

The rotary unit MTD is a modular unit, developed specifically for robot applications and is intended for positioning the workpiece.

- MTD 250
- MTD 500
- MTD 750
- MTD 2000
- MTD 5000

MTD stands for *mechanical turning* unit (D is a generation label).

MID variants

The station interchange unit MID is a modular unit specifically developed for robot applications and is intended for indexed movement.

- MID 500
- MID 1000

MID stands for *mechanical interchange* unit (D is a generation label).

Product overview

The gear unit consists of:

- Gearbox
- Motor
- SMB box (optional)
- Axis selector (optional)
- Cables
- Drive Module with modified cable harness (optional)

Technical data

Gear unit	Weight [kg]
MTD 250	70
MTD 500	180
MTD 750	180
MTD 2000	340
MTD 5000	770
MID 500	170
MID 1000	395

2.4 Basic approach

Introduction to basic approach

Depending on the application and system, the setting up procedure for the motor unit or gear unit differs. This manual describes the basic approach and refers to other manuals for more information.

Setting up motor units and gear units

Use this procedure to set up motor units or gear units.

1. Mount the motor unit or gear unit, and the SMB box. Connect cables.

   For motor units, see *Installing motor units on page 41*.

   For gear units, see *Installing gear units on page 44*.
2. Load the configuration files, see *Loading configuration files on page 71*.
3. Testrun with loads. If needed, tune the configuration data, see *Tuning on page 80*.
4. Calibrate, see *Calibration on page 81*.
5. Tune the thermal supervision, see *Tuning the thermal supervision on page 83*.

Related information

Application manual - Additional axes and stand alone controller.

Operating manual - IRC5 with FlexPendant.

Operating manual - RobotStudio.

2.5 Scenarios

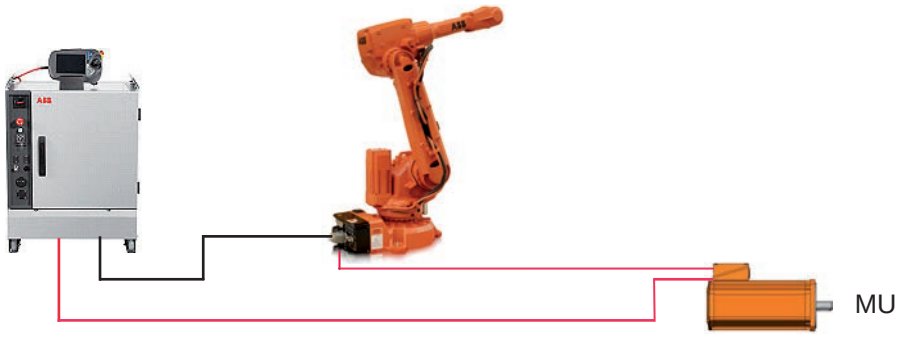
Introduction

Below are different scenarios described for installation of the units. The axis selector, available as an option inside the controller, allowing to cut the power to the motor units and gear units, will not be shown in the scenarios below.

Motor units

Scenario A, Lean concept:

- One motor unit
- No SMB box
- Motor power connected to the IRC5 controller and resolver connected to FB7 at manipulator.



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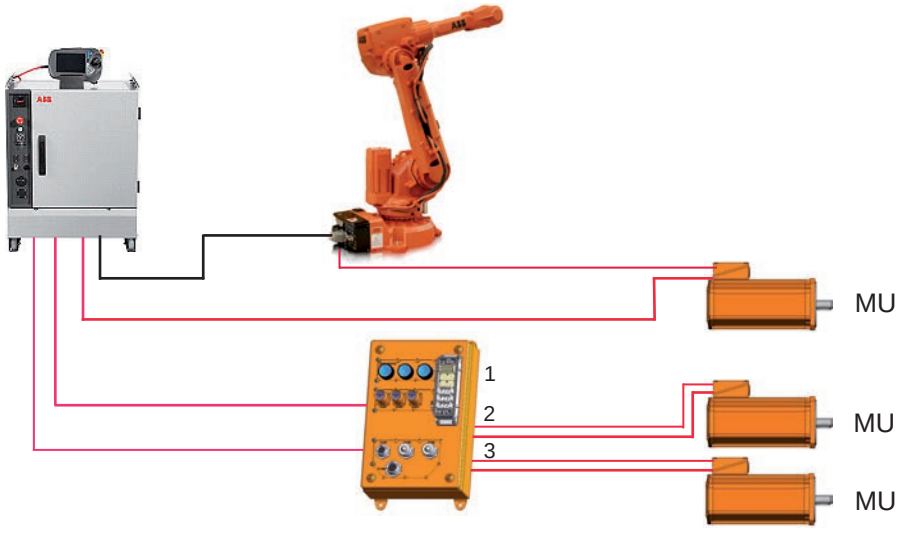
Scenario B:

- One motor unit connected to the IRC5 controller, according to Lean concept above
- SMB box connected to the IRC5 controller
- Two motor units connected to SMB box



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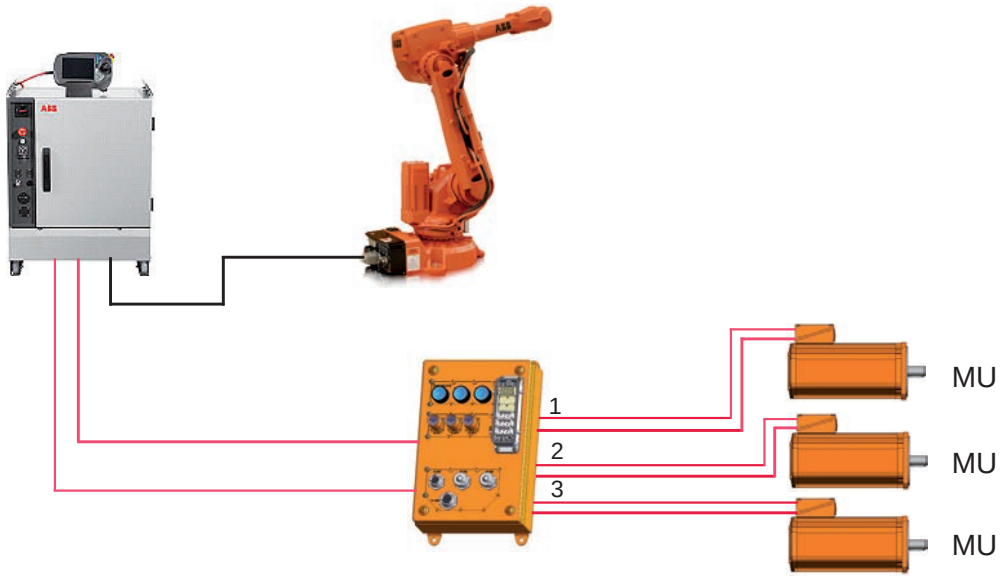
Scenario C:

- SMB box connected to the IRC5 controller
- Three motor units connected to one SMB box



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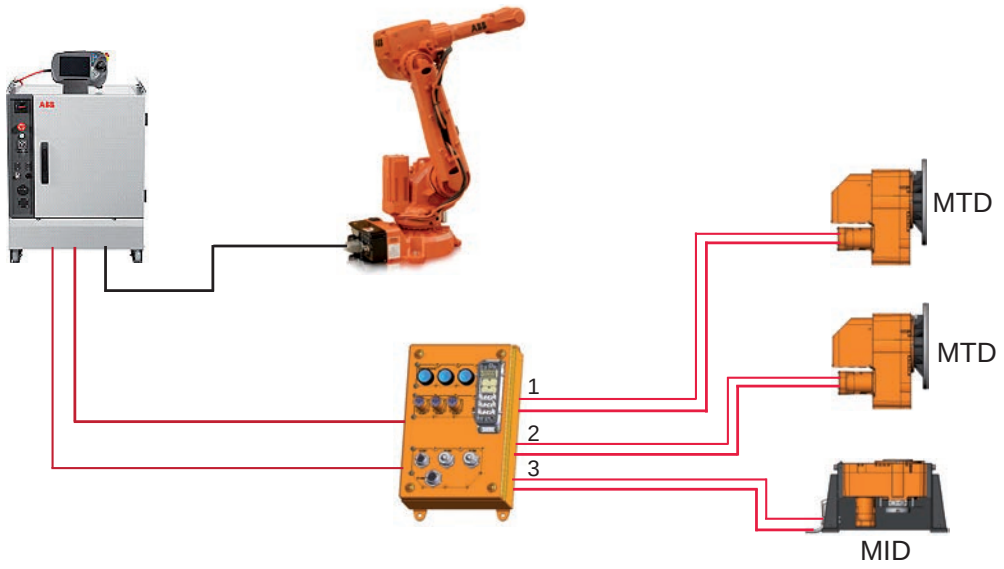
Gear units

Scenario A:

- SMB box connected to the IRC5 controller
- Three gear units connected to one SMB box



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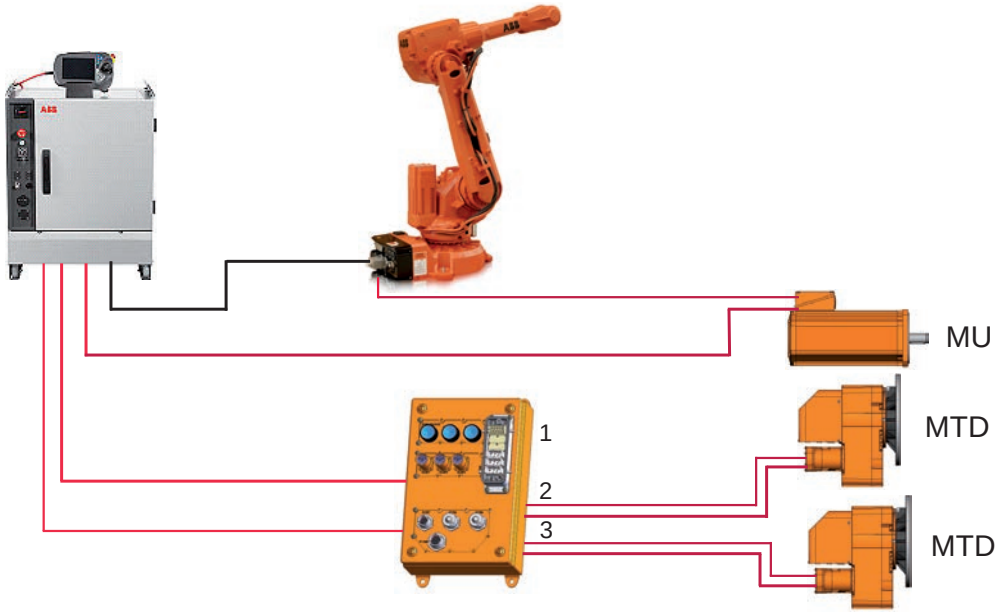
Scenario B:

- One motor unit connected to the IRC5 controller, according to Lean concept
- SMB box connected to the IRC5 controller
- Two gear units connected to one SMB box



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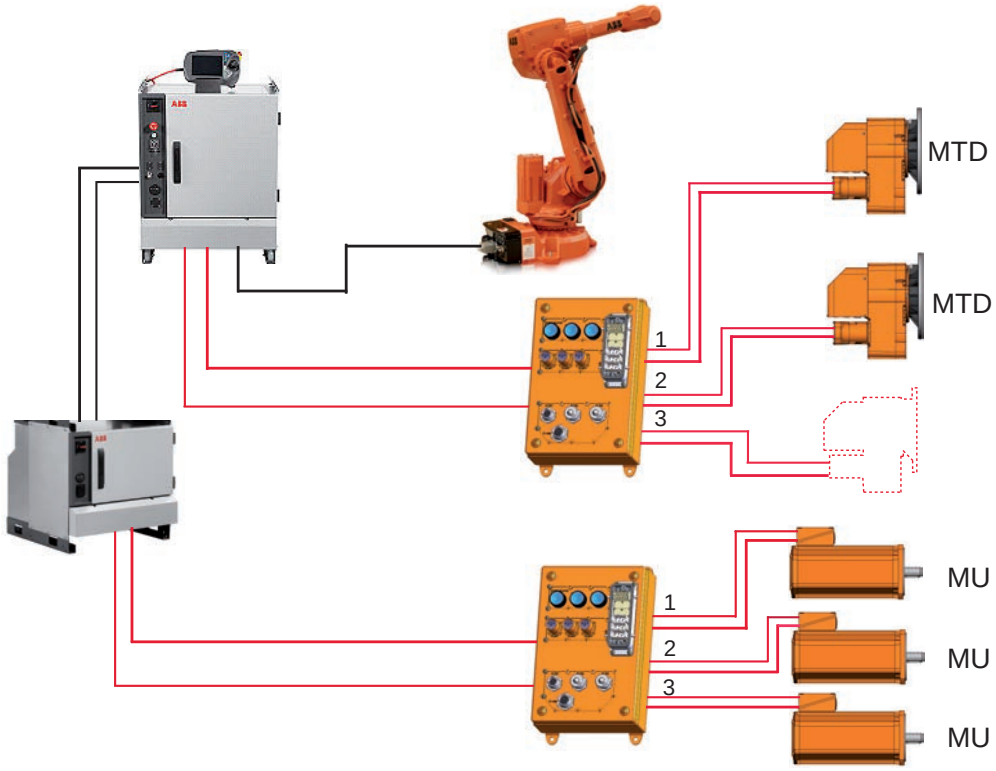
2.5 Scenarios
Continued

Scenario C:

- One SMB box connected to the IRC5 controller
- Two gear units connected to the IRC5 controller, through the SMB box
- One SMB box connected to IRC5 drive module
- Three motor units connected to the IRC5 drive module through the SMB box



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2.6 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.

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3 Installation

3.1 Installing motor units

Attachment screws

The table shows tightening torques for the attachment screws of the motor units. The values are valid for non-lubricated screws. All screws should be of quality 8.8.

Motor unit	Screw	Tightening torque [Nm] ±10%
MU 80	M4	4
MU 100	M6	10
MU 200	M8	24
MU 250	M8	24
MU 300	M8	24
MU 400	M10	47

Use washers with minimum hardness 200HV (190HB).

Prerequisites

CAUTION

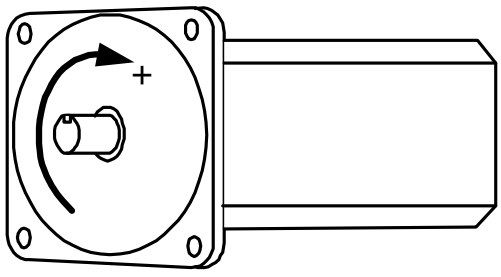
Never overheat the motor. The winding temperature must not exceed 140° C. Check that the temperature on the motor frame is lower than 100°C.

WARNING

If the motor unit is used in an arc welding station, the SMB box must always be insulated from the weld circuit. See *Insulation in arc welding stations on page 67*.

Motor connection

Positive electric rotation R ->S ->T -> (U, V, W) results in positive mechanical rotation defined as clockwise direction, seen from the drive shaft side. See illustration below.



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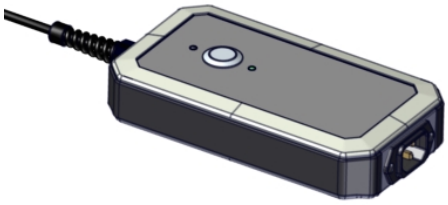
Releasing the brakes during installation

To release the motor brake during installation, use the brake release tool.

	Action	Note
1	**DANGER** Make sure that all supplies for electrical power, hydraulic pressure, and air pressure are turned off.	
2	Release the brakes of the motor with the brake release tool. 1 Turn off the brake release tool. 2 Connect the brake release tool connector to the motor. 3 Release the brakes by turning on the brake release tool and pressing the brake release button on the tool. **DANGER** Handling the tool incorrectly will cause serious injury. Read and follow enclosed user instructions for the tool. **WARNING** Electrical damage to the motor may occur if 24V is supplied to the motor connector for more than 30 seconds. Use the specified brake release tool to eliminate the risk.	Brake release tool: 3HAC081310-001 User instructions are enclosed with the tool.  xx2100000666

Installing motor units

Use this procedure to install motor units. For cable connections, see *Fastening cables on page 47*.

	Action	Information
1	Fit the motor in position and secure it with its attachments screws. **CAUTION** When fitting the motor pinion, make sure not to use high force or other methods that can damage the pinion, shaft, or resolver. See *Assembling motor axis and transmission element on page 61*.	**CAUTION** If using the motor unit in direct contact with oil or grease, make sure that the running conditions are suitable for the motor sealing.
2	Disconnect the brake release tool.	
3	If using an SMB box, fit and secure the box.	If there is a risk of return currents, then the box must be isolated, see *Insulation in arc welding stations on page 67*.

Continues on next page

	Action	Information
4	If using a separate drive module cabinet, connect the cable included with the cabinet.	Assembly instructions are included in the kit.
5	Connect the power cable from the controller or SMB box to the motor. **Note** Fasten the M23 connector fully. See *Fastening cables on page 47*. **Note** Turn the connectors to avoid breaking the cables. See *Fastening cables on page 47*.	If the controller is not prepared for motor units, then the connector must be replaced, see *Changing the cable harness in the controller on page 70*.
6	Connect the resolver cable from the robot or SMB box to the motor.	
7	If using an SMB box, connect the SMB cable from the controller to the SMB box.	
8	Mark the cables.	
9	Test the brake release buttons.	See *Testing the brake release buttons on page 66*.

CAUTION

Make sure that the thermal supervision is properly tuned, see *Tuning the thermal supervision on page 83*.

3.2 Installing gear units

Attachment screws

The tables show the attachment screws and tightening torques for the gear units. All screws should be of quality 12.9.

MTD

Gear unit	Screw	Tightening torque [Nm] ±10%	Minimum thread length in gearbox [mm]
MTD 250	M12	120	29
MTD 500	M20	550	47
MTD 750	M20	550	47
MTD 2000	M20	550	50
MTD 5000	M24	950	37

MID

The maximum floor loads in relation to the base coordination system for the MID units are described in *Product specification - Motor Units and Gear Units*.

Gear unit	Screw
MID 500	M16
MID 1000	M20

Prerequisites

CAUTION

Never overheat the motor. The winding temperature must not exceed 140°C. Check that the temperature on the motor frame is lower than 100°C.

WARNING

If the gear unit is used in an arc welding station, the SMB box must always be insulated from the weld circuit. The gearbox is isolated from the motor. See *Insulation in arc welding stations on page 67*.

Installing gear units

Use this procedure to install gear units. For cable connections, see *Fastening cables on page 47*.

	Action	Information
1	Fit the gear unit in position and secure it with its attachments screws.	**WARNING** The gear unit is heavy. Always use properly sized lifting accessories.

Continues on next page

	Action	Information
2	If using an SMB box, fit and secure the box.	If there is a risk of return currents, then the box must be isolated, see *Insulation in arc welding stations on page 67*.
3	If using a separate drive module cabinet, connect the cable included with the cabinet.	Assembly instructions are included in the kit.
4	Connect the power cable from the controller or SMB box to the gear unit.	**Note** Fasten the M23 connectors fully. See *Fastening cables on page 47*.
5	Connect the resolver cable from the robot or SMB box to the gear unit.	
6	If using an SMB box, connect the SMB cable from the controller to the SMB box.	
7	If using drive module cabinet: • Assemble the cable kit (3HAC040089-001) according to the instructions delivered with the cable kit. • Connect cables to the controller cabinet. • Connect cables to the SMB box. • Connect cables from the SMB box to the motor units.	
8	Mark the cables.	
9	Install a current collector.	
10	Test the brake release buttons.	See *Testing the brake release buttons on page 66*.
11	Fit and secure the flange to the equipment to be controlled by the gear unit.	

CAUTION

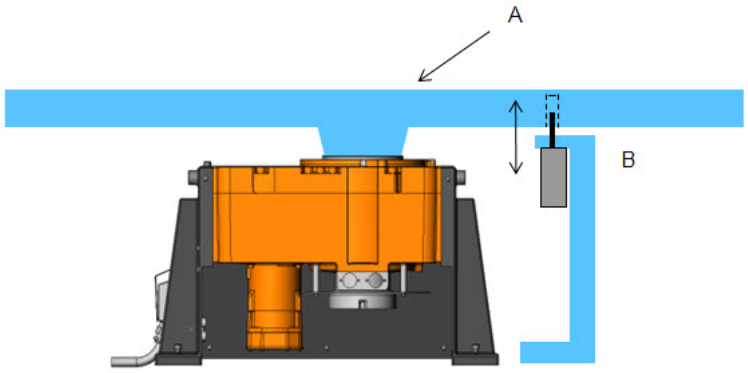
Make sure that the thermal supervision is properly tuned, see *Tuning the thermal supervision on page 83*.

Continues on next page

Recommendations for MID units

The station interchange units have endless rotation and are delivered without a locking mechanism. ABB recommends using a pneumatic, externally operated locking pin for locking, to reduce the risk of collision with the end stop. This also relieves the pressure on the station interchange unit.

Example



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A	Locally made swing frame
B	Pneumatic plunch

3.3 Fastening cables

Protecting cables

Protect all flexible cables from weld spatter.

Place the cables so the risk of mechanical wear is minimized.

M23 connectors

Wobble the M23 connector body while tightening the connectors to make sure that they are fully fastened.

Cable markings

Cable connections are marked with default names on delivery. Add suitable labels or other markings during installation to simplify maintenance.

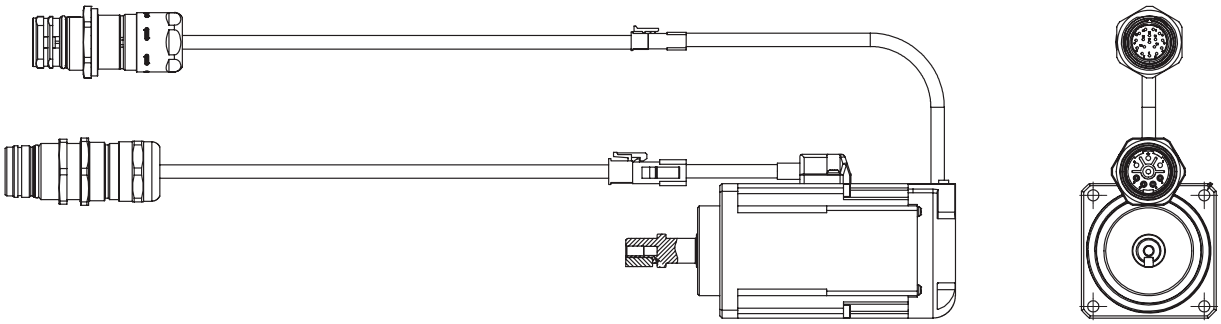
Cable connection	Marking
Motor power cables	MP
Feedback cables	FB

SMB cable

The key pin in plug SMB bus cable (3HAC068917-001, 3HAC068918-001, 3HAC068920-001) must be removed when connecting to XS41 or XS41.2 in the IRC5 controller.

Extended cables for MU 80

MU 80 provides extended power and signal cables.



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3.3 Fastening cables
Continued

Cable lengths are allowed to be shorted by cutting off the connector MP/FB by customers. Always refer to the tables below to prepare new connectors.

Extended power cable

xx1700001372

A	MP
B	MP (M23)

The following table lists the materials used for making new connector MP. The materials are delivered with the MU 80.

Item	Component article number	Qty.
1	3HAC026336-004	1
2	3HAC026345-002	2
3	3HAC026345-001	4

The following table shows the connection between connector MP and connector MP(M23).

Wire type	Description	Pin on Connect-or MP	Pin on Connect-or MP(M23)
1.5 mm^2 wire	U	1	3
1.5 mm^2 wire	V	3	1
1.5 mm^2 wire	W	5	4
1.5 mm^2 wire, GNYE	PE	2	PE
0.5 mm^2 wire	Brake +	4	A
0.5 mm^2 wire	Brake 0V	6	B

Continues on next page

Extended signal cable

xx1700001373

A	FB
B	FB(M23)

The following table lists the materials used for making new connector FB. The materials are delivered with the MU 80.

Item	Component article number	Qty.
1	3HAC6996-8	1
2	3HAC6962-3	6

The following table shows the connection between connector FB and connector FB(M23).

Wire type	Description	Pin on Connector FB	Pin on Connector FB(M23)
Pair 1 BK, AWG24	X	5	1
Pair 1 WHBK, AWG24	X 0V	1	3
Pair 1 BN, AWG24	Y	6	4
Pair 1 WHBN, AWG24	Y 0V	2	2
Pair 1 RD, AWG24	EXC 0V	7	8
Pair 1 WHRD, AWG24	EXC	3	7

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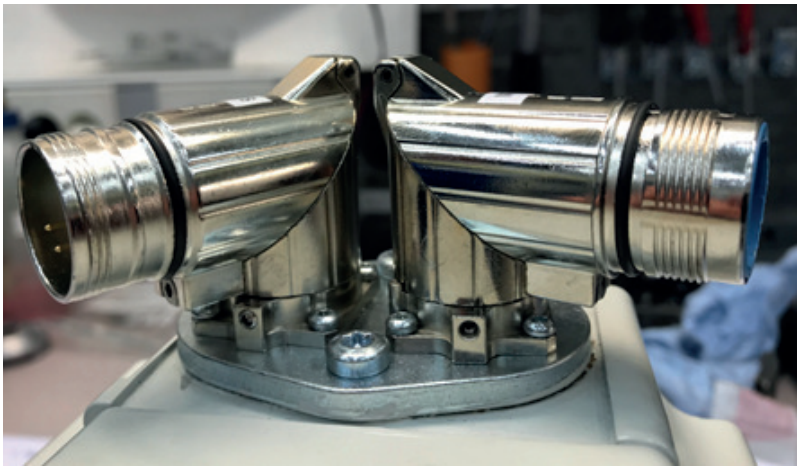
Cable routing for motor power cable GU MTD750

The motor cables for GU MTD750 are possible to turn approximately 45 degrees outwards, to avoid breaking the cables.



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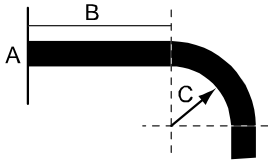
Limitations

The following limitations apply when installing and fastening cables for the motor units or gear units to get best performance and durability.

Bending

Make sure that cables are not bent too close to the fastening points or too sharply.



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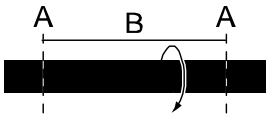
A	Fastening point or connector
B	Minimum distance from fastening point to bend is 100mm
C	Minimum bending radius is 100mm

Twisting

The minimum length between the fastening points is 900mm if the cable will be twisted ±180°.



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A	Fastening points or connectors
B	Minimum length is 900mm

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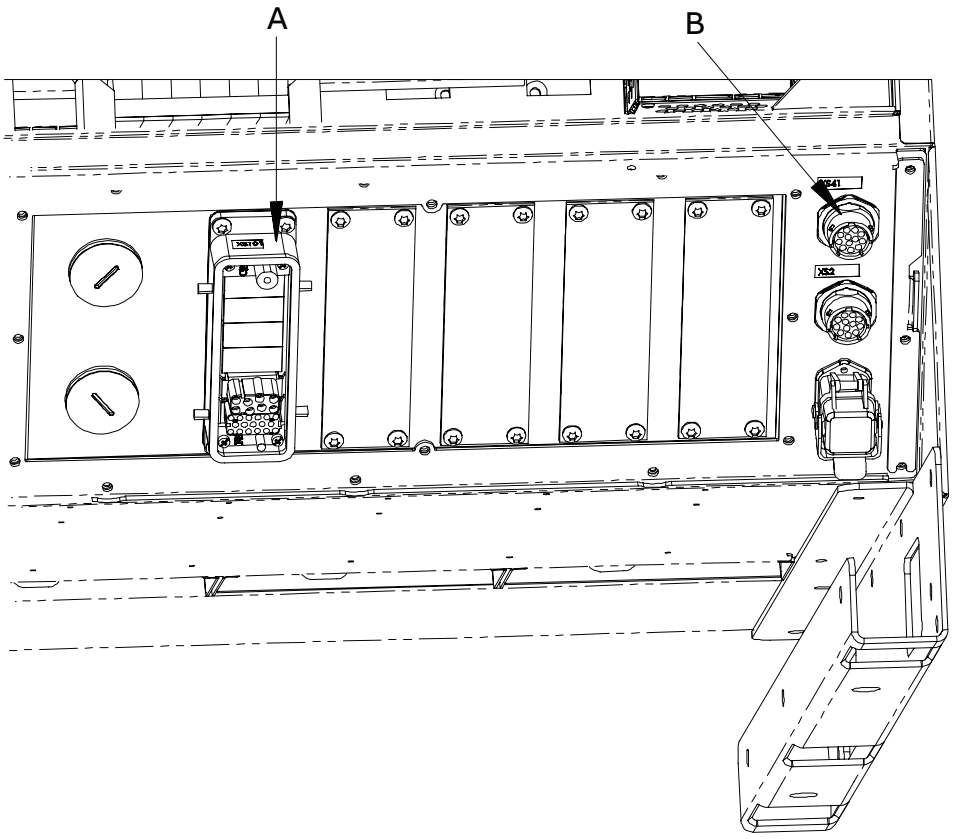
Fastening straps

Do not over-tighten cables when fastening them with straps.

3.4 Connections for SC/DC (DM)

Outputs for MU/GU



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A	XS 102	Motor power
B	XS 41	Resolver signals

3.5 Open and close the pivot frame

Overview

In order to access the components behind the axis selector unit, the pivot frame must be opened.

DANGER

Before doing any work inside the cabinet, disconnect the mains power. For more information, see *Electrical safety on page 23*.

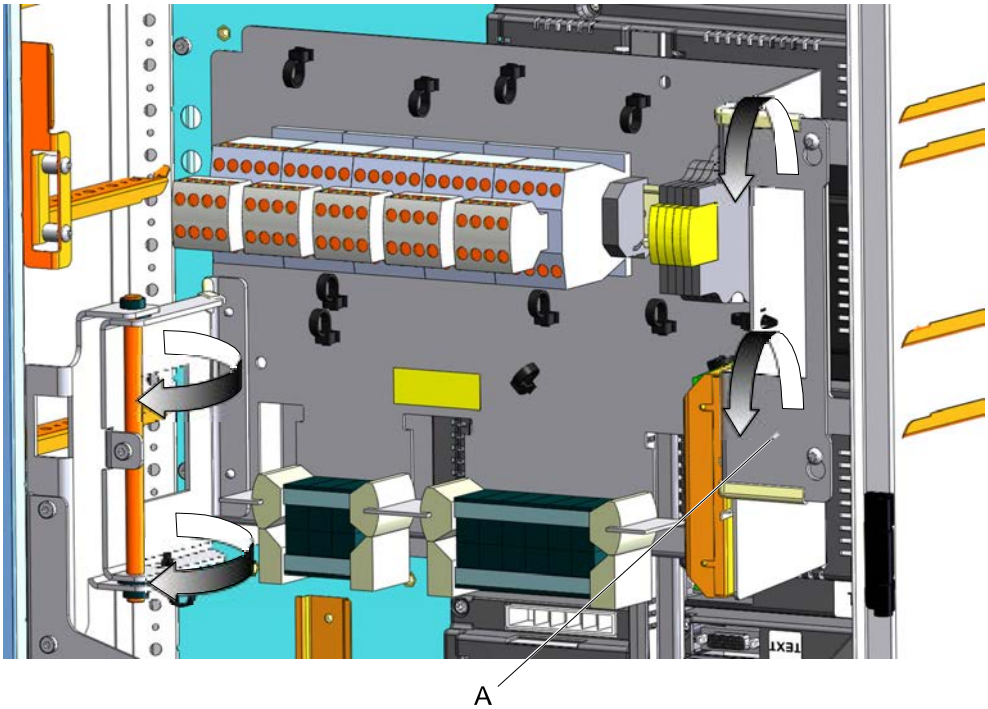
WARNING

The unit is sensitive to ESD. Before handling the unit, see *The unit is sensitive to ESD on page 39*.

Note

Note that the wiring to the pivot frame must be detached before the pivot frame is opened.

Opening the pivot frame



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	Action	Information
1	Open the controller cabinet.	
2	Disconnect the cables on the axis selector unit.	

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3.5 Open and close the pivot frame
Continued

	Action	Information
3	Lift (A) to open the pivot frame with the axis selector plate.	
4	Pull out the pivot frame so that it is fully extended.	

Closing the pivot frame

	Action	Information
1	Secure the pivot frame with the axis selector plate by tightening the two locking screws (pos. A).	
2	Fit the cables on the axis selector unit.	

3.6 Retrofit an interface to the IRC5 controller

Introduction

The below procedure describes how to retrofit an interface for motor units and gear units to an IRC5 controller with drive system 09.

Prerequisites

- An IRC5 Single controller drive system 09 with additional drive units.

  The option *Prepared for MU/GU (946-1)* is strongly recommended.

  > **Note**
  >
  > If the standalone controller was ordered without the option *Prepared for MU/GU*, then one mounting rail is missing. One extra rail is delivered with the MU/GU interface and it is necessary to remove the axis computer and the main drive module to attach the rail.

- The "backbone" harness, *3HAC049197-001 Ext.Axis Brake Harness*, must be installed in the controller.

  Since 2015 all systems with any additional axis are delivered with this new harness. If it is missing the system has to be upgraded before installing the retrofit option.

Part list

There is no retrofit kit available. Instead, place a new order for options *1313-1 Axis selector* and *1340-1 Harness, axis selector*.

Required tools and equipment

Equipment	Article number	Note
Standard toolkit	-	Content is defined in section *Standard toolkit on page 109*.

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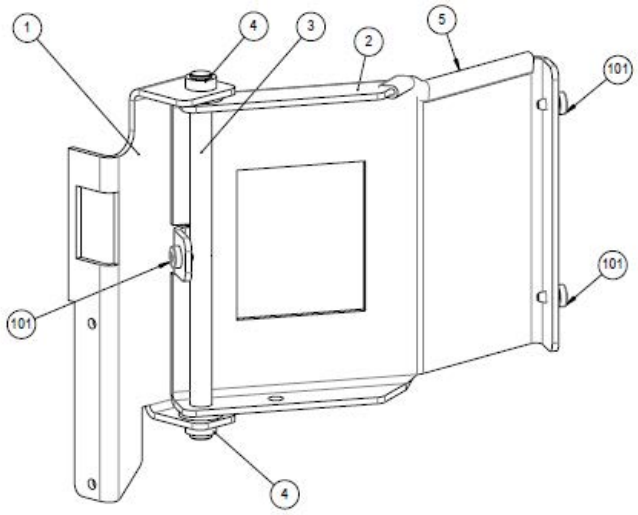
Assemble the hinge



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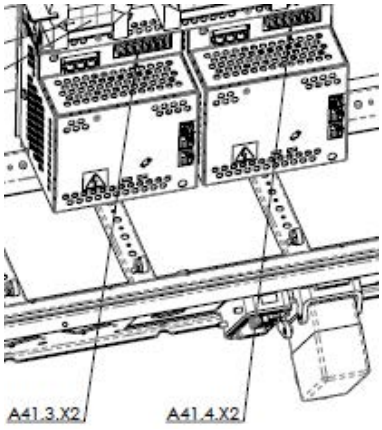
1	Bracket
2	Arm
3	Shaft
4	Plastic bushing
5	Profile
101	Fastite screw

	Action	Note
1	Assemble the plastic bushings in the bracket. **Note** Assemble the bushings from the inside.	 xx1600000455
2	Fit the arm and mount the shaft through the bushings. The bushings are often tight so it is recommended to carefully use a plastic hammer.	
3	Lock the shaft with a screw.	

Continues on next page

	Action	Note
4	Assemble two screws in the rear end of the arm. Do not tighten the screws completely, make sure to leave about 2 mm free space.	

Assemble the interface

	Action	Note
1	Attach the harness drive unit to the additional drive units.	 xx1600000456
2	Attach the SMB2 cable to the X5 connector on the axis computer.	 xx1600000457

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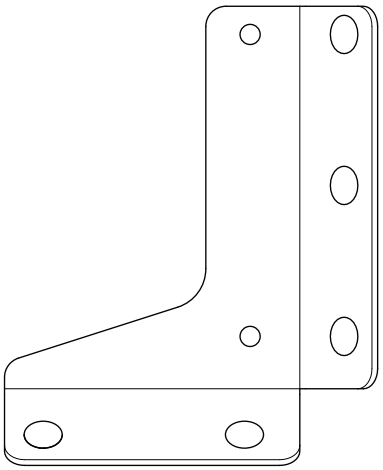
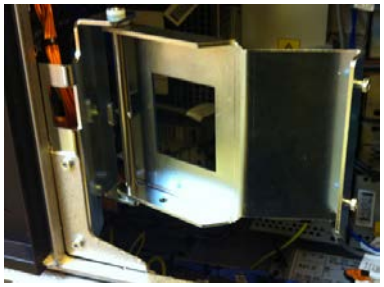
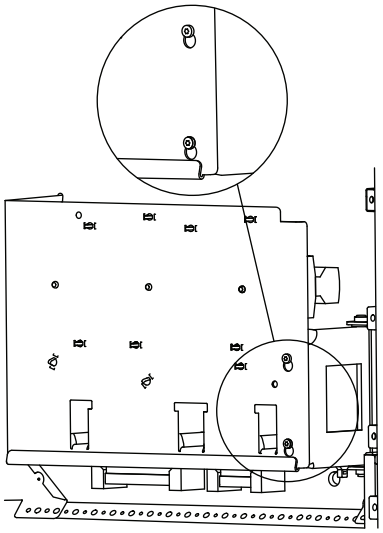
3.6 Retrofit an interface to the IRC5 controller

Continued

	Action	Note
3	Assemble the attachment plate in the cabinet front left corner.	 xx1700001273
4	Attach the hinge to the attachment plate.	 xx1600000460
5	Attach the axis selector to the hinge.	 xx1700001274

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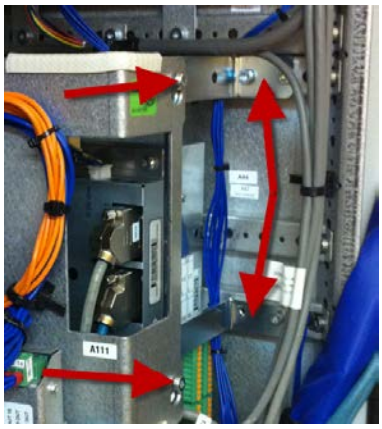
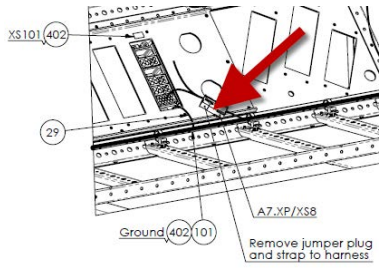
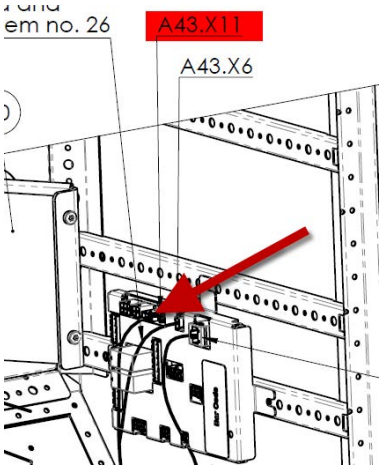
	Action	Note
6	Fit two screws on the lock bracket and attach it to the mounting rails with four screws. **Note** If the standalone controller was ordered without the option *Prepared for MU/GU*, then one mounting rail is missing. One extra rail is delivered with the MU/GU interface and it is necessary to remove the axis computer and the main drive module to attach the rail.	 xx1600000461
7	Locate the connector A7.XS8 in the signal harness from XS102 and connect it to the existing harness in the bottom of the cabinet.	 xx1600000462
8	Locate the connector A43.XS11 in the signal harness from XS102 and connect it to the contactor board at the left side of the cabinet.	 xx1600000463

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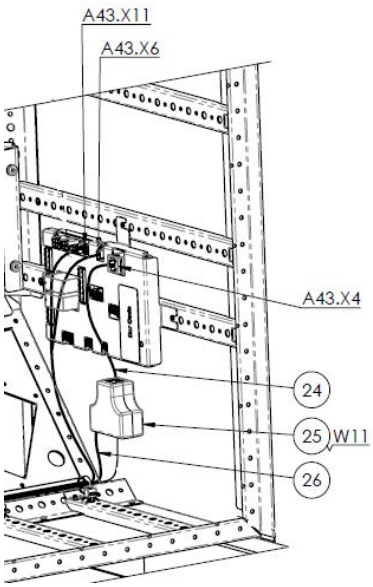
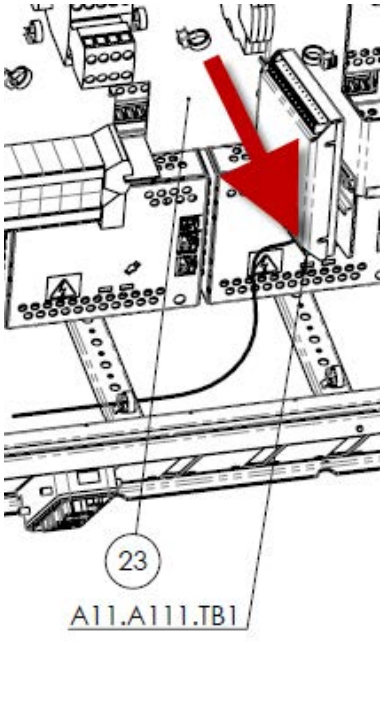
3.6 Retrofit an interface to the IRC5 controller

Continued

	Action	Note
9	Locate the patch cable (item 24), the 3-way connector W11 (item 25), and the I/O cable (item 26). • Remove the existing cable from A43.X4 and connect it to X2 on W11. • Connect the cable item 24 to A43.X4 and W11. • Remove the existing cable from A43.X6 and connect it to A43.X6.1, included in item 26. • Connect A43.X6 on the cable item 26 to the connector board A43.X6. • Connect the W11.X3 connector on cable item 26 to X3 on the W11 connector.	 xx1600000464 • Item 24: *Cable Patch (3HEA802215-001)* • Item 25: *3-way RJ45 8P/8C shielded MPK402 (3HEA802183-001)* • Item 26: *Cable I/O RS485 (3HEA802201-001)*
10	Attach the connectors X1, X2 and A111.TB1 to the axis selector.	
11	Attach the ground cable from the axis selector to the chassis.	 xx1600000465

3.7 Handling of motors

Assembling motor axis and transmission element

Couplings, pulley, and motor pinion (transmission elements) must be assembled using adequate tools. Otherwise the motor shaft can be distorted which damage the resolver. Never use a hammer, as this will damage the equipment.

CAUTION

When fitting the transmission element, make sure not to use high force or other methods that can damage the transmission element, shaft, resolver, or connection box.

The motor axis should be fitted using a press tool or a method with a dolly. Use heating if required.

The maximum allowed press force depends on the assembly method. See the following figures and tables.

Note

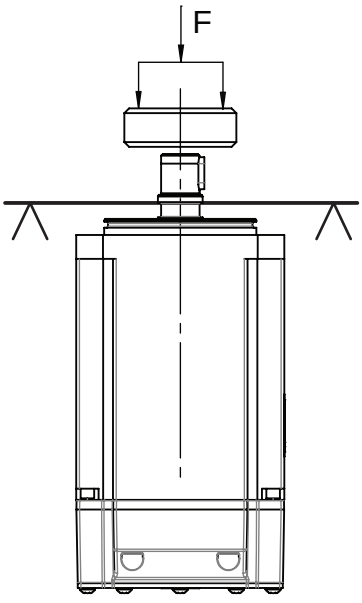
Grease the shaft after assembly to avoid oxidation.

Assembly with press tool

Assembly using a press tool with dolly is the best method. The tool can be fitted on the motor shaft as shown in the following figure.

Note

This method is not applicable for MU 100 since it does not have a flange on the motor shaft.



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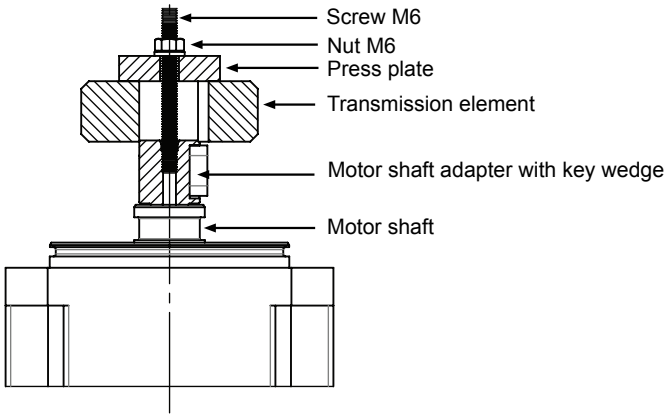
3.7 Handling of motors
Continued

	Maximum allowed axial force (F)
MU 80	15 kN
MU 100	-
MU 200	40 kN
MU 250	40 kN
MU 300	40 kN
MU 400	60 kN

Assembly with nut and bolt

The motor and the transmission element can be assembled with a nut and bolt as shown in the following figure. The transmission element is driven onto the motor shaft by turning the nut. If needed, the transmission element can also be heated.



xx1300000314

Assembly by pressing on the pinion

The motor and the transmission element can be assembled by pressing, with or without heat.

Use the motor flange as a dolly, as shown in the following figure.

CAUTION

Make sure that the contact surfaces between the motor and the dolly distribute the press force evenly.

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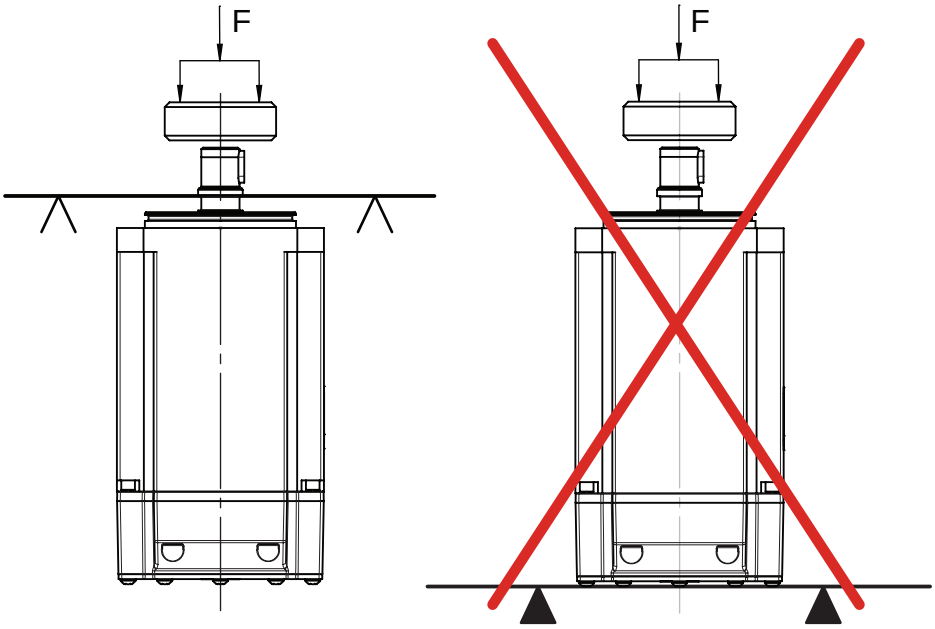

xx1300000315

	Maximum allowed axial force (F)
MU 80	650 N
MU 100	125 N
MU 200	1,963 N
MU 250	1,963 N
MU 300	1,963 N
MU 400	2,825 N

Assembly with open back cover

If no press tool with dolly is available, the back cover of the motor can be opened so that some other flat and stable object can be used as dolly directly on the motor shaft. Make sure not to press on the resolver.

Note

This method is not applicable for MU 80 since it does not have a connection box and the back cover of the motor is not allowed to be opened.

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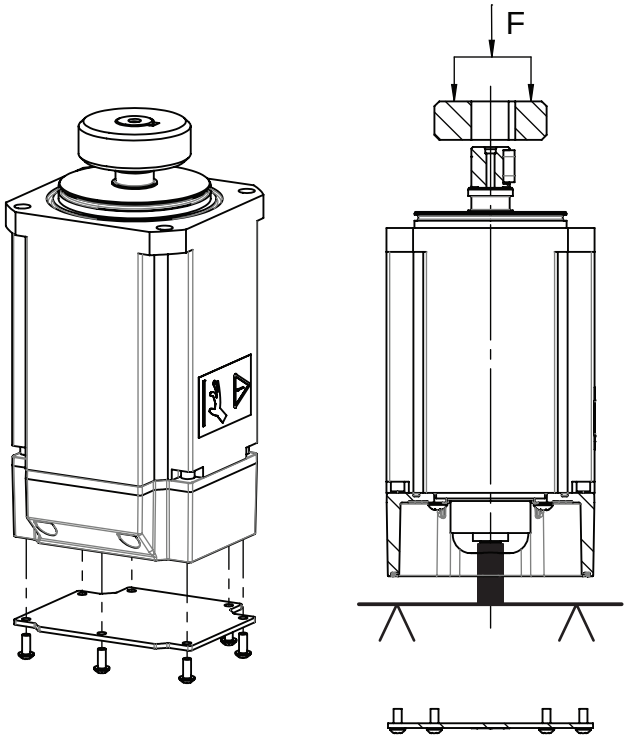
3.7 Handling of motors
Continued



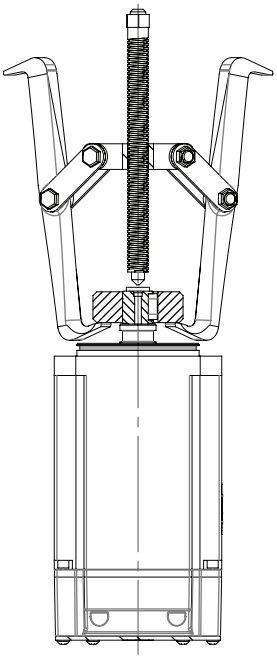
xx1300000316

	Maximum allowed axial force (F)
MU 100	10 kN
MU 200	20 kN
MU 250	20 kN
MU 300	20 kN
MU 400	30 kN

Continues on next page

Disassembling the transmission element from the motor

Use a puller tool to disassemble the the transmission element from the motor axis.



xx1300000318

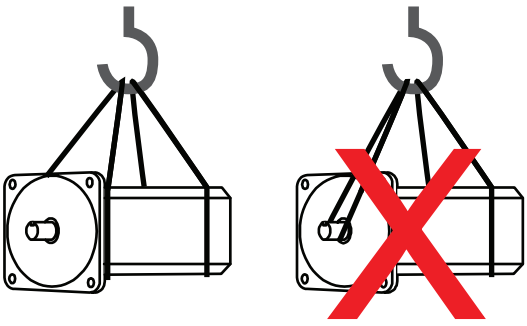
Note

Place a shim or washer on the shaft end for protection, so that the puller tool does not press directly on the shaft.

Lifting motors

Use lifting accessories that are accordingly sized for the motor.

When lifting the motor with roundslings, never place the sling around the motor shaft.



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3.8 Testing the brake release buttons

Introduction to testing brake release buttons

The brake release buttons should be tested before mounting loads or external equipment.

Prerequisites

The motor unit or gear unit must be installed.

The brake release button must be installed correctly by referring to *Circuit diagram - Motor Units and Gear Units*.

There must be power available to the controller.

Testing the brake release buttons

Use this procedure to test the brake release buttons.

	Action	Information
1	Turn on the power to the controller.	
2	**WARNING** When releasing the holding brakes, the axes can move very quickly and sometimes in unexpected ways! Make sure no personnel is near or beneath an axis!	
3	Press the brake release button.	When the brake is released, the axis should be possible to move.
4	Verify that the correct motor brake was released.	

3.9 Insulation in arc welding stations

Galvanic insulation from the weld circuit

If using the motor unit or gear unit in an arc welding cell, the return currents must be properly taken care of. The SMB box must always be insulated from the weld circuit.

Gear units

The rotary units (MTD) and the station interchange units (MID) have the motor galvanically insulated from the weld circuit, that is, there is no connection between the weld circuit and protective earth.

SMB box

The SMB box is connected to protective earth and must always be mounted galvanically insulated from the weld circuit.

Motor units

The motor units are connected to protective earth. When using the motor units in work piece positioners or other equipment connected to the weld circuit there will be a connection between the weld circuit and protective earth.

To avoid malfunction:

- Verify that good contact is established between the welding power source and work piece positioner.
- Never disconnect the weld return cable.
- Verify that the current collector, if used, is working properly and has a low voltage drop.

Hazardous scenario

The following graphic shows a hazardous scenario with two faults causing the weld current to flow in protective earth.

- The weld return cable is disconnected from the work piece positioner.
- The weld return cable has contact with protective earth, in this case a cable channel made of metal.

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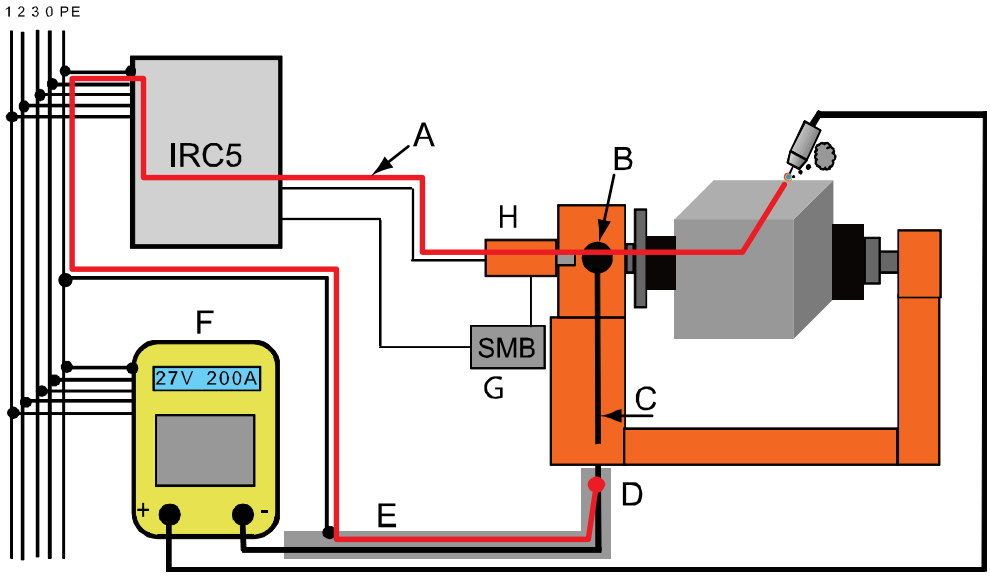
3.9 Insulation in arc welding stations

Continued



xx1100000103

A	Weld return current in protective earth
B	Current collector
C	The weld return cable is disconnected from the work piece positioner
D	The weld return cable has contact with protective earth
E	Cable channel made of metal
F	Power source
G	SMB box galvanically insulated from the weld circuit
H	Motor unit’s protective earth connected to the weld circuit

3.10 Installing non ABB brake release buttons

Brake release buttons

The motor units are prepared for installing other brake release buttons than those supplied in the SMB box.

Installing non ABB brake release buttons

Use connection BRAKE PB. See the connections in the circuit diagram, *Circuit diagram - Motor Units and Gear Units*.

3.11 Changing the cable harness in the controller

Cable harness

The cable harness for the seventh axis must be replaced if a motor unit is added to a controller that is delivered without any of the motor unit options.

Note

The procedure depends on the motor variant, if an axis selector is used etc. Use the action scenarios in the circuit diagram as reference during the installation of the cable harness.

Changing the cable harness

Use this procedure to change the cable harness in the controller.

	Action	Note
1	**DANGER** Before commencing any work inside the cabinet, please observe the safety information in section *Make sure that the main power has been switched off! on page ?*.	
2	Remove the cable harness for the XS.7 contact.	
3	Refit the new cable harness.	*Circuit diagram - Motor Units and Gear Units*

4 Configuration

4.1 Loading configuration files

Introduction to configuration files

Template configuration files are included in the delivery with the motor units and gear units. The configurations for motor units and gear units can be tuned before running in production to optimize performance.

The template files are located in the following directory in the RobotWare installation:

- `...\RobotPackages\RobotWare_RPK_<version>\utility\MotorUnits\`
- `...\RobotPackages\RobotWare_RPK_<version>\utility\GearUnits\`

Note

Navigate to the RobotWare installation folder from the RobotStudio **Add-Ins** tab, by right-clicking on the installed RobotWare version in the **Add-Ins** browser and selecting **Open Package Folder**.

Tip

In RobotWare 6.05 (and later) the Add-In for motor units and gear units can be selected directly in **Installation Manager**. See *Installing a system with MU/GU on page 73*. For all RobotWare versions, the tuning is done after installation.

Limitations

The values for acceleration and deceleration used in the template files might need to be verified. For gear units see *Dimensioning gear units on page 79*. For motor units, see *Application manual - Additional axes and stand alone controller*.

For MID gear units, the working range must be carefully tested and if needed redefined. If the defined value is wrong, there is a risk that the MID crashes into the end stop.

Acceleration torque limit for motor units

The acceleration torque limit for the motor units is by default reduced to protect connected equipment. The acceleration torque limit can be increased, see *Product specification - Motor Units and Gear Units*.

Redefine the system parameter *Torque Absolute Max* in the type *Stress Duty Cycle* (topic *Motion*) to increase the acceleration torque limit.

File name convention

The configuration files use a naming convention, based on the following data:

- Configuration topic
- Type of unit
- Drive unit and drive module (system parameters *Drive Unit* and *Drive Module*)

Continues on next page

- Measurement link, board position, and measurement node (system parameters *Measurement Link*, *Board Position*, and *Measurement Node*)

For example, `MOC_MU100_M7DM1_L1B1N7.cfg`, defines:

- Topic *Motion*
- Motor unit MU 100
- Drive unit 7 and drive module 1
- Measurement link 1, board position 1, and measurement node 7

Loading configuration files

Use this procedure to load configuration files.

	Action	Information
1	In RobotStudio, load the configuration files for the motor units and the gear units. Open the file `readme.txt` to verify which files to use.	All files are included in the folder `...\utility\...` in the RobotWare installation.
2	If using an axis selector, load the configuration files for the axis selector after the files for the motor units and gear units are loaded. Use the add and replace duplicates option to overwrite existing parameters.	
3	Tune the motor.	See *Tuning on page 80*.

Configuration files and standard system parameters are described in *Technical reference manual - System parameters*.

4.2 Installing a system with MU/GU

Introduction

Robotware 6 provides an add-in with all mandatory configuration files needed to install motor units and gear units. This add-in is installed with RobotWare and can be added in the product selection of **Installation Manager** when the system is built.

The following illustration show the *MotorAndGearUnits* add-in in **Installation Manager**.

xx2200001228

General information about the *MotorAndGearUnits* add-in

The *MotorAndGearUnits* add-in provides configuration files to use the gear units with drive system 1. The first gear unit could either be used with the robot's SMB (node 7) which is linked to measurement system 1, or can be used with an SMB box on node 1-3 linked to measurement system 2.

In addition, the add-in provides configuration files to use motor units with drive system 1 and drive system 2. The first motor unit could either be used with the robot's SMB (node 7) which is linked to measurement system 1, or can be used with an SMB box on node 1-3 linked to measurement system 2 for drive module 1.

The configuration files for the motor units connected to drive system 2 are only valid for a single system where more than 3 motor or gear units are connected (no common drive solution) as all configuration files are linked to measurement system 1. The motor units can be used with node 1-6.

Limitations

The add-in can only be used with the standard offer and does therefore not support the following scenarios:

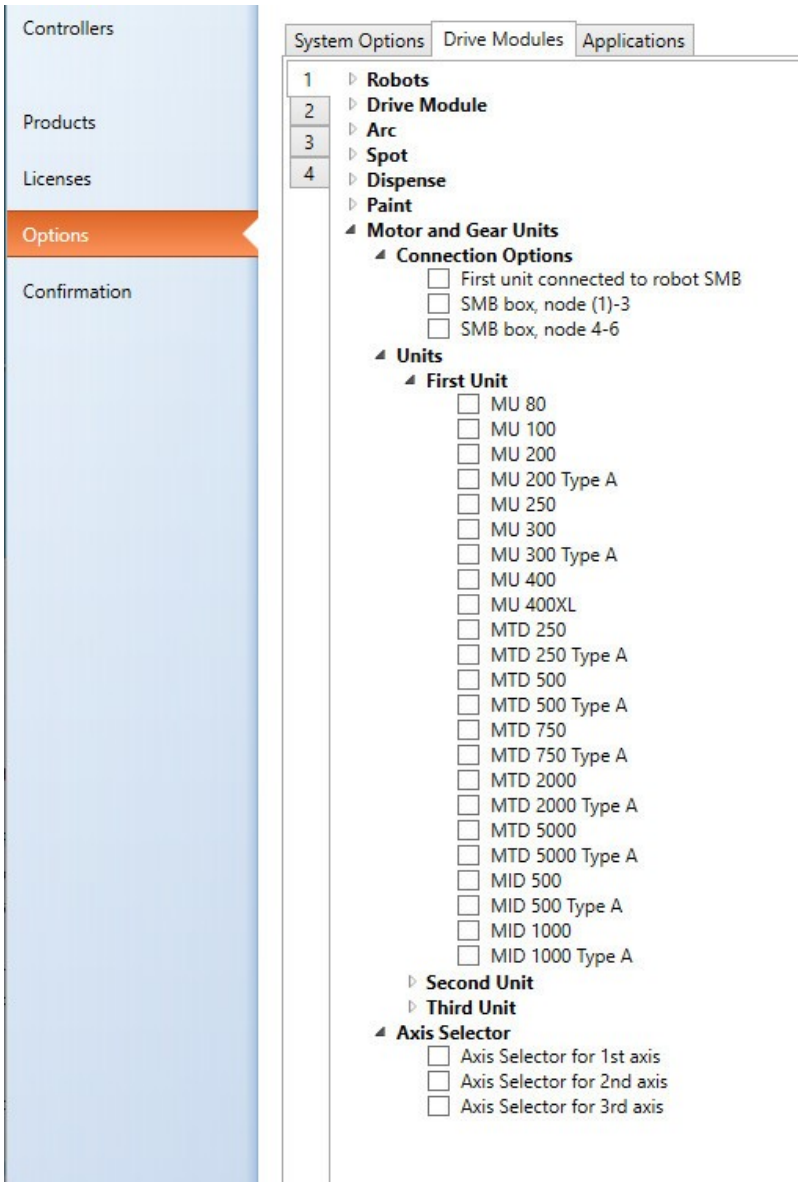
- MU & GU combined with track motions (IRBT, RTT) and/or positioners (IRBP)
- MU & GU used with in MultiMove systems (GU only in DM1)
- Kinematic models are not included.

Continues on next page

Motor and gear unit selection in Installation Manager

The motor and gear unit can be selected in the **Drive Modules** tab for the selected robot. Up to 3 devices (motor and/or gear units) can be connected to the SMB box.

The following illustration show all options that can be selected with the *MotorAndGearUnits* add-in in **Installation Manager**.



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Installation Manager: Connection Options

In the list **Connection Options**, select if the first unit is connected to the robot SMB board (this is typically the case for for example, a track motion, a servo gun, or servo gripper) or if an SMB box is connected to the system. For the SMB box you need to select what node (1-3 or 4-6) is used. The connection options can be selected for drive module 1 and drive module 2.

Continues on next page

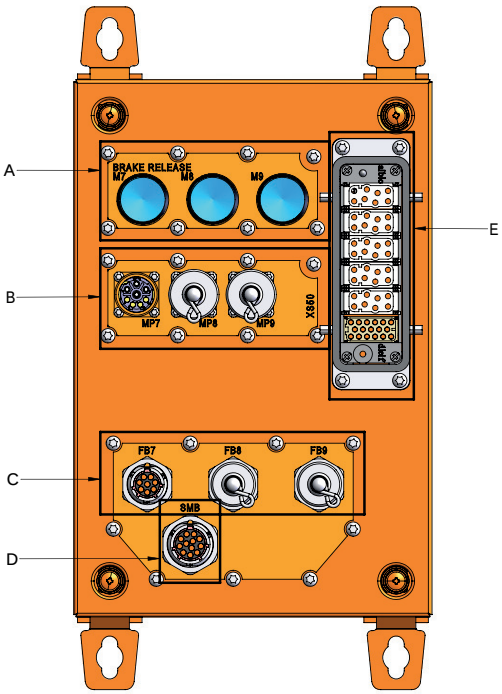
More information on possible connection scenarios can be found in the product specification, section *Scenarios*. See *References on page 7*.

Note

The standard configuration in the SMB box will always use nodes 1-3.

The resolver cables connected to "C" in the illustration below are linked to the following nodes:

- FB7 is linked to node 1
- FB8 is linked to node 2
- FB9 is linked to node 3



xx1000001204

A	Brake release buttons (option)
B	Motor cables to motor units and/or gear units
C	Resolver cables to motor units and/or gear units
D	SMB cable from robot controller
E	Motor cable from robot controller

Motor units connected to Drive Module 2

The *MotorAndGearUnits* add-in also provides configuration files for motor units connected to drive module 2. This can be the case if more than 3 units are connected to a single system. The configuration files are prepared to be used with note 1-3 or note 4-6 and are linked to the first measurement system. The standard configuration in the SMB box will always use node 1-3.

Continues on next page

Gear units are not supported on drive module 2 when using the *MotorAndGearUnits* add-in.

Note

An Ethernet switch is mandatory for MultiMove, also when running MultiMove with only one axis computer in the system. For example, when running MultiMove on one robot together with a positioner or additional axes. In addition, the software option *MultiMove Coordinated* or *MultiMove Independent* is needed.

Note

To change the nodes in the SMB box, remove R1.SMB1-4 and re-connect it to R1.SMB3-6. See the circuit diagram listed in *References on page 7*.

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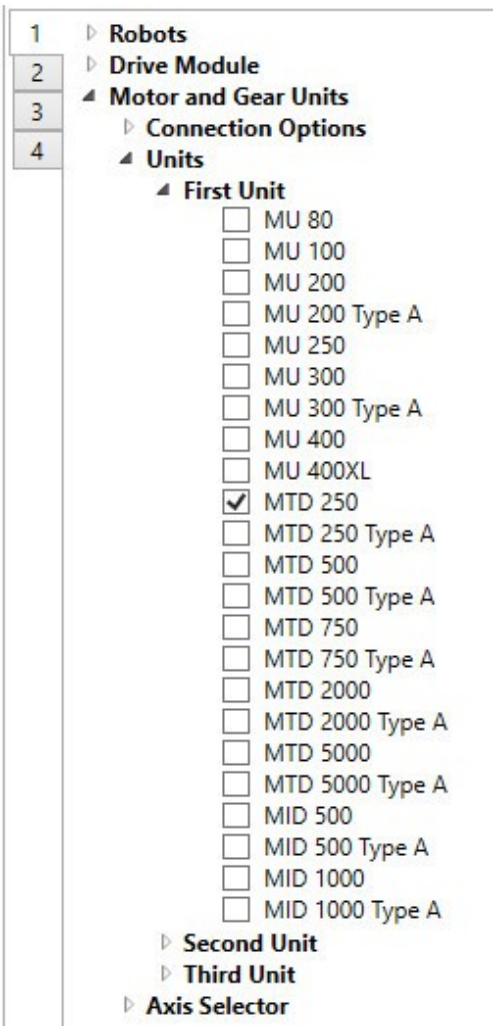
Installation Manager: Units

In the list **Units**, select the used motor or gear unit that is connected as first, second, and third unit depending on the number of motor units and/or gear units. If there are missing options or dependencies, then **Installation Manager** will show a dialog.

The following illustration shows the selected first unit.



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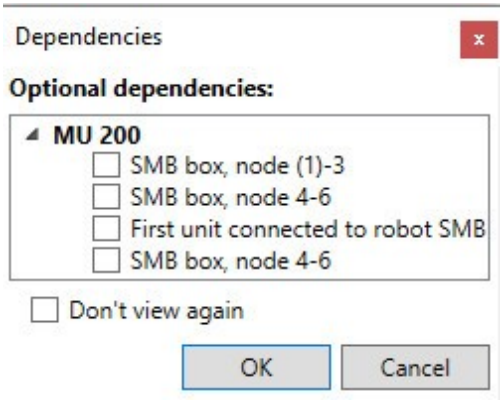
The following illustration shows the dependencies for the first unit that will appear if not previously selected. One of the option dependencies must be selected.



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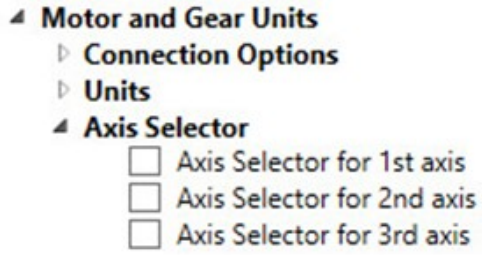
Change to tab 2 to select motor units that are connected to drive module 2.

Installation Manager: Axis Selector

The axis selector (option) is mounted inside the robot controller and makes it possible to cut the power for selected connected external units. The *MotorAndGearUnits* add-in provides configuration files for the axis selector option mounted in drive module 1.

Select the axis selector option for each unit connected to the system.



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The related configuration files, including EIO configuration (such as activation signals) and motion files (including the activation relay and brake relay), are installed upon selection.

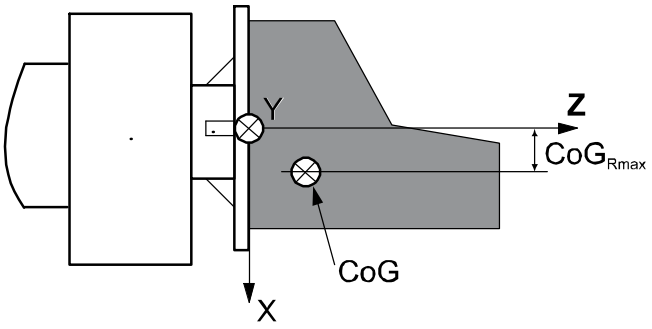
4.3 Dimensioning gear units

Acceleration and deceleration values

To secure that gear units will not run too hard and damage the gear box, the acceleration and deceleration of the axis on the arm side must be calculated.

This calculation will give a maximum value for the system parameters *Nominal Acceleration* and *Nominal Deceleration*. The value can be lowered if the acceleration is too fast, see *Application manual - Additional axes and stand alone controller*. Do not use values higher than the recommended maximum acceleration, see *Maximum gearbox torques on page 79*.

$$(T_{maxgear} - m * g * CoG_{Rmax}) / (m * CoG_{Rmax}^2 + J_{0z})$$



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J_{0z} is the moment of inertia around the Z axis at the center of gravity (CoG).

CoG_{Rmax} is the radial distance in X and Y directions between the Z axis and the center of gravity (CoG).

Define the system parameters *Nominal Acceleration* and *Nominal Deceleration* in the type *Acceleration Data* in the topic *Motion*, based on the calculations.

Maximum gearbox torques

Use the $T_{maxgear}$ values from the table for the calculation.

Gear unit	$T_{maxgear}$ (max torque on arm side) (Nm)	Recommended maximum acceleration and deceleration (rad/s^2)
MTD 250	480	4
MTD 500	1,100	3
MTD 750	1,950	3
MTD 2000	5,000	0.8
MTD 5000	11,400	0.5
MID 500	1,950	2.4
MID 1000	5,000	1.1

Related information

Dimensioning of motors is described in *Application manual - Additional axes and stand alone controller*.

4.4 Tuning

Introduction to tuning

The template configuration files can be tuned to optimize the performance. The configuration data is preferably tuned using *TuneMaster*, or as described for additional axes, see *Application manual - Additional axes and stand alone controller*.

TuneMaster

TuneMaster is an easy to use PC tool to optimize the motion performance. TuneMaster is included in the RobotWare distribution, in the folder *Tools*. How to use TuneMaster is described in the help file included in the installation.

Basic approach for tuning

How to tune depends on the tools used. However, the following steps apply:

1. Testrun without loads to verify if tuning is needed.
2. Testrun with loads.
3. If needed, tune the configuration data and repeat steps 1-2.

5 Calibration

When to calibrate

Mechanical units must be calibrated after installation, if parts of the transmission are replaced, or if the resolver memory is lost.

Fine calibration defines the calibration zero position and updates the revolution counters.

Robot calibration is described in *Operating manual - IRC5 with FlexPendant*, and in the product manual for the robot.

Commutation of motors is described in *Application manual - Additional axes and stand alone controller*.

Coordinated positioners and user frames are described in *Application manual - Additional axes and stand alone controller*.

Calibration position

Any position can be defined as the calibration zero position but it must be possible to move the axis to this position with good precision repeatedly. For example, this can be a mechanical stop or another indicator that clearly shows the position.

Fine calibrating mechanical units

Use this procedure to fine calibrate the mechanical units.

	Action	Note
1	Move the mechanical unit to a suitable zero position for calibration.	Mark the zero position for future reference.
2	On the FlexPendant **ABB** menu, tap **Calibration**.	
3	Tap to select the mechanical unit.	
4	Tap **Fine Calibration**.	
5	Tap to select the axis and then tap **Calibrate**.	

Updating revolution counters

Use this procedure to update revolution counters.

	Action	Note
1	Move the mechanical unit to the zero position for calibration.	
2	On the FlexPendant **ABB** menu, tap **Calibration**.	
3	Tap **Rev. Counters** and then tap **Update Revolution Counters**.	
4	Tap to select the axis and then tap **Update**.	

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6 Tuning the thermal supervision

Thermal supervision

The motor units (except MU 80 and MU 100) and the gear units are protected from overload by a thermal supervision. If the motor temperature is close to the defined maximum temperature then the system shows a warning. If the maximum temperature is exceeded then the unit will stop.

For optimal efficiency, the thermal supervision should be tuned for the environment in which the system is installed.

System parameters

The maximum temperature for the robot and the thermal supervision sensitivity ratio are defined by the system parameters. The values can be changed using the *Control Panel* on the FlexPendant.

System parameter	Allowed values	Default value	Note
Maximum temperature (*Max Temperature Robot*)	+5°C to +52°C	+45°C	The value should be set to the maximum expected ambient temperature for the MU, MTD, MID, and manipulator. Topic *Motion*, type *Motion System*.
Thermal supervision (*Thermal Supervision Sensitivity Ratio*)	0.5 to 2	1.0	Topic *Motion*, type *Supervision*.

Note

The system must be restarted after modifying the system parameters for the changes to take effect.

CAUTION

Never let the motor body temperature exceed 105°C. It may cause motor damages.

Tuning the thermal supervision

Use this procedure to tune the thermal supervision.

	Action	Information
1	Start the motor and run the toughest expected cycle.	
2	Monitor the motor body temperature and the thermal model temperature rise (test signal number 190), in TuneMaster.	T_{stator_rise}= Measured motor body temperature + 35 – actual ambient temperature 35 is the approximate difference between the motor body temperature and the stator temperature.

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	Action	Information
3	If T_{stator_rise} is larger than the thermal model temperature rise, then increase the thermal supervision sensitivity ratio. If T_{stator_rise} is smaller than the thermal model temperature rise, then decrease the thermal supervision sensitivity ratio.	**Tip** You can use the ratio between T_{stator_rise} and the thermal model temperature rise, when estimating how much the Thermal supervision sensitivity ratio should be changed.
4	If T_{stator_rise} + *Max temperature robot* > 130 °C (max allowed is 140 °C, hot motor warnings will appear at 130 °C) consider actions to reduce the temperature, for example improving the cooling, reducing the average torque, or choosing a larger motor unit or gear unit.	

Related information

Technical reference manual - System parameters

Application manual - TuneMaster

7 Maintenance

7.1 Introduction

Structure of this chapter

This chapter describes all the maintenance activities recommended for the motor units and gear units.

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

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

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

Safety information

Observe all safety information before conducting any service work.

There are general safety aspects that must be read through, as well as more specific safety information that describes the danger and safety risks when performing the procedures. Read the chapter *Safety on page 11* before performing any service work.

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

Note

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

For more information see:

- *Product manual - IRC5*
- *Fastening cables on page 47*.

7.2 Maintenance schedule

Introduction

The equipment 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 equipment. Any damage must be attended to immediately.

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

Activities and intervals

The table below specifies the required maintenance activities and intervals:

Maintenance activity	Equipment	Interval	Detailed in section
Cleaning	Motor units and gear units	-	*Cleaning the motor units and gear units on page 92*
Inspection	Cables	Running	*Inspecting cables on page 87*
Inspection	MU250 drain holes  **Note** Only MU250 has drain holes.	Running	*Inspecting MU250 drain holes on page 88*
Lubrication	Current collector	400 hours	*Lubricating the current collector on page 93*
Replacement	Battery pack, measurement system of type RMU101 or RMU102 (3-pole battery contact)	36 months or battery low alert [i]	*Replacing SMB battery on page 89*
Replacement	Battery pack, measurement system with 2-pole battery contact, e.g. DSQC633A	Battery low alert [ii]	*Replacing SMB battery on page 89*

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

See the replacement instruction for more details.

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

7.3 Inspecting cables

Inspecting cables

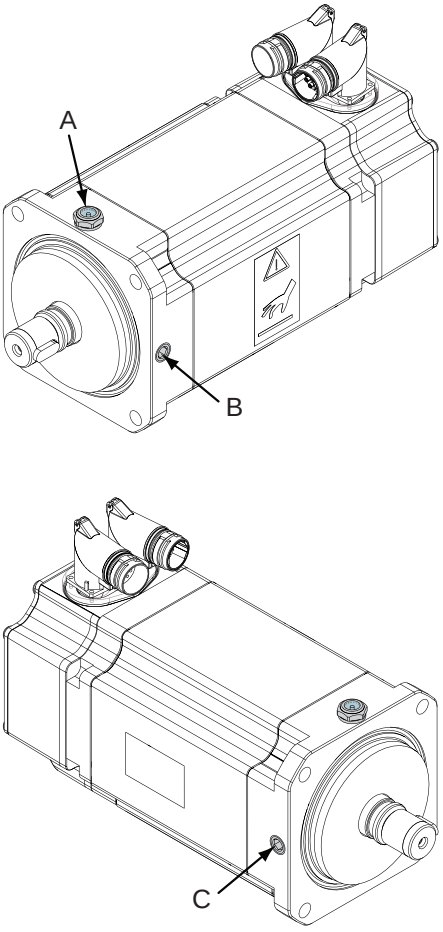
Use this procedure to inspect cables.

	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	Make an overall visual inspection of the cables to detect wear or damage.	
3	Check the connectors.	
4	Check that all brackets and straps are properly attached.	
5	Replace the cables if wear, cracks, or damage is detected.	

7.4 Inspecting MU250 drain holes

Inspecting MU250 drain holes

Use this procedure to inspect MU250 drain holes.

	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	Inspect the drain hole from the glass cover in the middle.	 xx1700000553 Parts: • A: Drain hole with glass cover • B: Drain hole with stop screw • C: Drain hole with stop screw
3	Replace the MU250 if oil leakage is detected in the middle drain hole.	
4	Check that the stop screws for the other two drain holes are properly attached.	
5	Secure or reassemble the stop screws if any loose or missing.	

7.5 Replacing SMB battery

Note

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

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

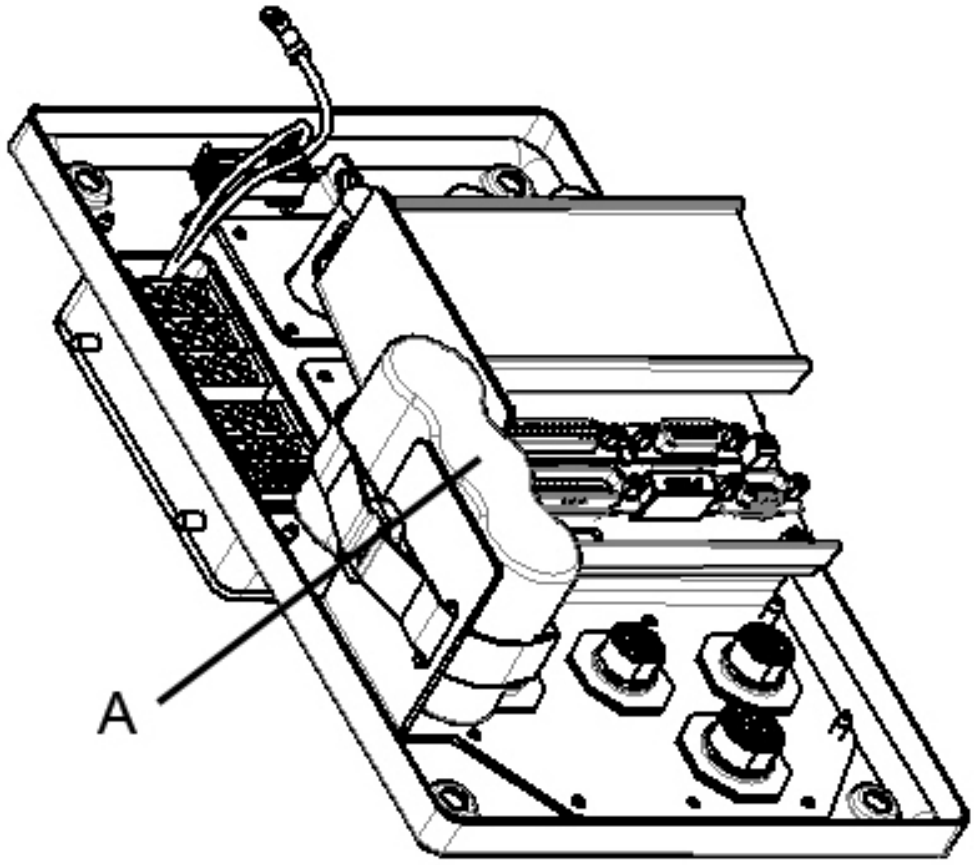
For an SMB board with 2-pole battery contact, the typical lifetime of a new battery is 36 months if the robot is powered off 2 days/week or 18 months if the robot is powered off 16 h/day. The lifetime can be extended for longer production breaks with a battery shutdown service routine. See *Operating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

WARNING

See *Hazards related to batteries on page 26*.

Continues on next page

Location of SMB battery



xx1000001415

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!

Continues on next page

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.	
2	 **ELECTROSTATIC DISCHARGE (ESD)** Before handling the unit, see *The unit is sensitive to ESD on page 39*.	
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 81*.
8	Dispose of the old battery.	See *Environmental information on page 100*.

7.6 Cleaning the motor units and gear units

DANGER

Turn off all:

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

to the robot, before entering the safeguarded space.

General

To secure high uptime it is important that the motor units and gear units is cleaned regularly. The frequency of cleaning depends on the environment in which the product works.

Special cleaning considerations

This section specifies some special considerations when cleaning the robot.

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

Cleaning methods

The following table defines what cleaning methods are allowed.

Cleaning method	Note
Vacuum cleaner	Yes
Wipe with cloth	Yes. With light cleaning detergent.
Rinse with water	Yes. It is highly recommended that water contains a rust prevention solution and that the robot is dried afterwards.
High pressure water or steam	No

Cables

Movable cables need to be able to move freely:

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

7.7 Lubricating the current collector

DANGER

Turn off all electrical power, hydraulic and pneumatic pressure supplies before entering the workspace of the manipulator.

See also the information in section *Safety on page 11*.

Current collector

The function of the current collector is to transfer the weld current through the rotary unit. This takes place through a spring-loaded contact bar against the shaft. The contact bar needs to be lubricated approximately after 400 hours of operation. This should be done using a special grease, P34 from Nies, article number: 0501869-001.

Required equipment

Equipment	Note
Grease	Grease type: P34 from Nies. Article number: 0501869-001.
Standard tools	
Grease gun	

Lubricating the current collector

	Action	Information
1	Lubricate the current collector using a grease gun.	**Note** Amount of grease: 12 ml.

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8 Repair

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

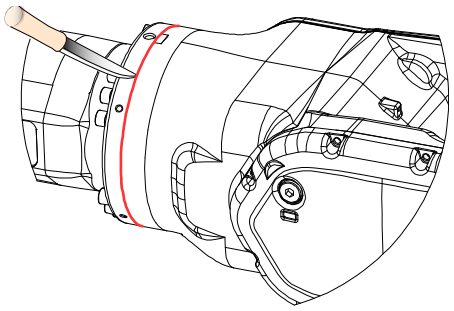
General

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

Required equipment

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

Removing

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

8.2 Replacing SMB board

WARNING

See *Hazards related to batteries on page 26*.

Required equipment

Note

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

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

Equipment	Note
SMB board	See *Spare parts and exploded views on page 106*.

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 safeguarded space.	
2	**ELECTROSTATIC DISCHARGE (ESD)** Before handling the unit, see *The unit is sensitive to ESD on page 39*.	
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.	Keep the toothed washers.
6	Pull out the plate.	
7	Loosen the four nuts holding the SMB board.	The nuts do not have to be removed, only loosened.

Continues on next page

	Action	Information
8	Pull out the SMB board.	
9	Dispose of the old SMB board.	See *Environmental information on page 100*.

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	Check that the toothed washer is in place and fasten the nuts 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 81*.

8.3 Repair in the motor connection box

Motor connection box

The motor connection box can be opened to replace equipment.

Note

MU 80 does not have a connection box.

Note

When assembling the connection box to the motor or the top cover to the connection box, make sure that the o-ring is in the groove.

9 Decommissioning

9.1 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 100*.

Transportation

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

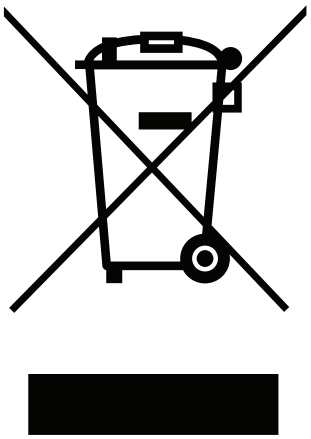
9.2 Environmental information

Introduction

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

Symbol

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



xx1800000058

Materials used in the product

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

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

Material	Example application
Aluminium	Motor housings
Batteries, Lithium	Serial measurement board
Cast iron/nodular iron	Gear housings
Copper	Cables, motors
Neodymium	Brakes, motors
Oil, grease	Gearboxes
Plastic/rubber	Cables, connectors, and so on.
Steel	Gears, screws, shafts, brackets, 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.

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10 Reference information

10.1 Applicable standards

Note

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

General

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

Normative standards as referred to from ISO 10218-1

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

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

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

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

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10.1 Applicable standards

Continued

Standard	Description
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.

10.2 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	

10.3 Spare parts and exploded views

Introduction

Spare parts and exploded views are not included in the manual but delivered as a separate document on the documentation DVD. Article number for *Product manual, spare parts - Motor Units and Gear Units* is 3HAC040278-001.

10.4 Circuit diagrams

Overview

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

See the article numbers in the tables below.

Controllers

Product	Article numbers for circuit diagrams
Circuit diagram - IRC5	*3HAC024480-011*
Circuit diagram - Euromap 67, design 14	*3HAC024120-005*
Circuit diagram - Spot welding cabinet	*3HAC057185-001*

Manipulators

Product	Article numbers for circuit diagrams
Circuit diagram - IRB 120	*3HAC031408-003*
Circuit diagram - IRB 140 type C	*3HAC6816-3*
Circuit diagram - IRB 260	*3HAC025611-001*
Circuit diagram - IRB 360	*3HAC028647-009*
Circuit diagram - IRB 390	*3HAC060545-009*
Circuit diagram - IRB 460	*3HAC036446-005*
Circuit diagram - IRB 660	*3HAC025691-001*
Circuit diagram - IRB 760	*3HAC025691-001*
Circuit diagram - IRB 1200	*3HAC046307-003*
Circuit diagram - IRB 1410	*3HAC2800-3*
Circuit diagram - IRB 1600/1660	*3HAC021351-003*
Circuit diagram - IRB 1520	*3HAC039498-007*
Circuit diagram - IRB 2400	*3HAC6670-3*
Circuit diagram - IRB 2600	*3HAC029570-007*
Circuit diagram - IRB 4400/4450S	*3HAC9821-1*
Circuit diagram - IRB 4600	*3HAC029038-003*
Circuit diagram - IRB 6620	*3HAC025090-001*
Circuit diagram - IRB 6620 / IRB 6620LX	*3HAC025090-001*
Circuit diagram - IRB 6640	*3HAC025744-001*
Circuit diagram - IRB 6650S	*3HAC13347-1* *3HAC025744-001*
Circuit diagram - IRB 6660	*3HAC025744-001* *3HAC029940-001*
Circuit diagram - IRB 6700 / IRB 6790	*3HAC043446-005*

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10.4 Circuit diagrams
Continued

Product	Article numbers for circuit diagrams
Circuit diagram - IRB 7600	*3HAC13347-1* *3HAC025744-001*
Circuit diagram - IRB 14000	*3HAC050778-003*
Circuit diagram - IRB 910SC	*3HAC056159-002*

Other hardware

Product	Article numbers for circuit diagrams
Circuit diagram - Motor Units and Gear Units	*3HAC039887-001*

10.5 Standard toolkit

General

All service (repairs, maintenance and installation) procedures contain 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 table below.

This way, the tools required are the sum of the Standard toolkit and any tools listed in the instructions.

Contents, standard toolkit

Qty	Tool	Note
1	Ring-open-end spanner 8-19 mm	
1	Socket head cap 5-17 mm	
1	Torx socket no: 20-60	
1	Box spanner set	
1	Torque wrench 75-400 Nm	
1	Torque wrench 500-1500 Nm	
1	Ratchet head for torque wrench 1/2	
2	Hexagon-headed screw M10x100	
1	Socket head cap no: 14, socket 40 mm bit L 100 mm	
1	Socket head cap no: 14, socket 40 mm bit L 20 mm	To be shortened to 12 mm
1	Socket head cap no: 6, socket 40 mm bit L 145 mm	
1	Socket head cap no: 6, socket 40 mm bit L 220 mm	

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