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Distributed Control Systems for Industrial Automation

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Product manual

Articulated robot

IRB 2400/L IRB 2400/10 IRB 2400/16 M2000, M2000A, M2004 Note! This PDF includes the two parts; Procedures and Reference information, but is presented as one single file! If delivered as a printed manual, however, the Product manual is divided and published in two separate parts!







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Overview

About this manua	al
	This manual contains instructions for
	• mechanical and electrical installation of the robot
	maintenance of the robot
	• mechanical and electrical repair of the robot.
Usage	
	This manual should be used during
	• installation, from lifting the robot to its work site and securing it to the foundation to
	making it ready for operation
	maintenance work
	• repair work.
Who should read	this manual?
	This manual is intended for:
	• installation personnel
	maintenance personnel
	• repair personnel.
Prerequisites	
	The reader should
	• be a trained maintenance/repair craftsman
	• have the required knowledge of mechanical and electrical installation/repair/
	maintenance work.
Organization of c	hapters

The manual is organized in the following chapters:

Chapter	Contents
Safety, service	Safety information that must be read through before performing any installation or service work on robot. Contains general safety aspects as well as more specific information about how to avoid personal injuries and damage to the product.
Installation and commis- sioning	Required information about lifting and installation of the robot.
Maintenance	Step-by-step procedures that describe how to perform maintenance of the robot. Based on a maintenance schedule that may be used in the work of planning periodical maintenance.
Repair	Step-by-step procedures that describe how to perform repair activities of the robot. Based on available spare parts.
Calibration information	Procedures that does not require specific calibration equipment.
Decommissioning	Environmental information about the robot and its components.

Continues on next page

Overview

Continued

References

Procedures in this product manual contain references to the following manuals:

Document name	Document ID	Note
Product specification - IRB 2400	3HAC9112-1	
Product manual - IRC5	3HAC021313-001	
Product manual - S4Cplus M2000	3HAC021333-001	
Product manual - S4Cplus M2000A	3HAC022419-001	
Operating manual - IRC5 with FlexPendant	3HAC16590-1	
User's guide - S4Cplus	3HAC7793-1	
Operating manual - Service Information System	3HAC025709-001	M2004
Operating manual - Calibration Pendulum	3HAC16578-1	
Operating manual - Levelmeter Calibration	3HAC022907-001	M2000/M2000A
Technical reference manual - System parameters	3HAC17076-1	
Application manual - Additional axes and stand alone controller	3HAC021395-001	M2004
Application manual - External axes	3HAC9299-1	M2000

Additional document references

Document name	Document ID
CalibWare 2.0 Users Guide (M2000)	3HAC16090-1

Revisions

Revision	Description
	 First edition. Replaces previous manuals: Installation and Commssioning Manual Maintenance Manual Repair Manual, part 1 Repair Manual, part 2. Changes made in the material from the previous manuals: Model M2004 implemented.
A	 Chapter" Calibration" replaced with chapter "Calibration information". Safety chapter rewritten. Section Document references is completed with article numbers for calibration manuals.
В	 Sections are restructured into Replacement procedures, instead of removal/refitting procedures. Procedure for refitting the motor of axis 1 is completed. Correction made in <i>Protection classes on page 39</i>. Various corrections due to technical revisions etc.

How to read the product manual

Reading the procedures

The procedures contain references to figures, tools, material etc. The references are read as described below.

References to figures

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

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

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

8. Remove the <i>rear attachment screws, gearbox.</i> Shown in the figure <i>Loca gearbox on page xx.</i>	ation of

References to required equipment

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

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

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

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

Safety information

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

Read more in chapter Safety on page 13.

Product documentation, M2000/M2000A

General	
	The complete product documentation kit for the M2000 robot system, including controller, robot and any hardware option, consists of the manuals listed below:
Product manuals	
	All hardware, robots and controller cabinets, will be delivered with a Product manual which is divided into two parts:
	Product manual, procedures
	Safety information
	• Installation and commissioning (descriptions of mechanical installation, electrical connections and loading system software)
	• Maintenance (descriptions of all required preventive maintenance procedures including intervals)
	• Repair (descriptions of all recommended repair procedures including spare parts)
	Additional procedures, if any (calibration, decommissioning)
	Product manual, reference information
	• Reference information (article numbers for documentation referred to in Product manual, procedures, lists of tools, safety standards)
	• Part list
	Foldouts or exploded views
	Circuit diagrams
	The product manual published as a PDF consists of only one file where the two parts are presented together, as one Product manual.
Software manuals	
	The software documentation consists of a wide range of manuals, ranging from manuals for basic understanding of the operating system to manuals for entering parameters during operation.
	A complete listing of all available software manuals is available from ABB.
Controller hardware	e option manual
	Each hardware option for the controller is supplied with its own documentation. Each document set contains the types of information specified below:

- Installation information
- Repair information
- Maintenance information

In addition, spare part information is supplied for the entire option.

Product documentation, M2004

General	
	The robot documentation may be divided into a number of categories. This listing is based on the type of information contained within the documents, regardless of whether the products are standard or optional. This means that any given delivery of robot products <i>will not contain</i> <i>all</i> documents listed, only the ones pertaining to the equipment delivered.
	However, all documents listed may be ordered from ABB. The documents listed are valid for M2004 robot systems.
Product manuals	
	All hardware, robots and controller cabinets, will be delivered with a Product manual which is divided into two parts:
	Product manual, procedures
	Safety information
	Installation and commissioning (descriptions of mechanical installation, electrical connections and loading system software)
	• Maintenance (descriptions of all required preventive maintenance procedures including intervals)
	• Repair (descriptions of all recommended repair procedures including spare parts)
	• Additional procedures, if any (calibration, decommissioning)
	Product manual, reference information
	Reference information (article numbers for documentation referred to in Product manual, procedures, lists of tools, safety standards)
	• Part list
	Foldouts or exploded views
	Circuit diagrams
	The product manual published as a PDF consists of only one file where the two parts are presented together, as one Product manual.
RobotWare manuals	3
	The following manuals describe the robot software in general and contain relevant reference information:

- **RAPID Overview**: An overview of the RAPID programming language.
- **RAPID reference manual** : Description of all RAPID instructions.
- **Technical reference manual System parameters**: Description of system parameters and configuration workflows.

Continued

Application manual	S			
	Specific applications (e.g. software or hardware options) are described in Application manuals . An application manual can describe one or several applications.			
	An application manual generally contains information about:			
	• The purpose of the application (what it does and when it is useful)			
	What is included (e.g. cables, I/O boards, RAPID instructions, system parameters)How to use the application			
	• Examples of how to use the application			
Operating manuals				
	This group of manuals is aimed at those having first hand operational contact with the robot,			
	i.e. production cell operators, programmers and trouble shooters. The group of manuals			
	includes:			
	Getting started - IRC5 and RobotStudio Online			
	Operating manual - IRC5 with FlexPendant			

- Operating manual RobotStudio Online
- Trouble shooting manual for the controller and robot

1 Safety

1.1. Introduction

Overview

The safety information in this manual is divided in two categories:

- general safety aspects, important to attend to before performing any service work on the robot. These are applicable for all service work and are found in section *General safety information on page 14*.
- specific safety information, pointed out in the procedure at the moment of the danger. How to avoid and eliminate the danger is either detailed directly in the procedure, or further detailed in separate instructions, found in section *Safety related instructions on page 30*.

1.2.1. Safety in the robot system

1.2 General safety information

1.2.1. Safety in the robot system

Validity and responsibility

The information does not cover how to design, install and operate a complete system, nor does it cover all peripheral equipment, which can influence the safety of the total system. To protect personnel, the complete system must be designed and installed in accordance with the safety requirements set forth in the standards and regulations of the country where the robot is installed.

The users of ABB industrial robots are responsible for ensuring that the applicable safety laws and regulations in the country concerned are observed and that the safety devices necessary to protect people working with the robot system are designed and installed correctly. Personnel working with robots must be familiar with the operation and handling of the industrial robot, described in the applicable documents, e.g. *User's guide - S4Cplus (M2000) / Operating manual - IRC5 with FlexPendant (M2004)* and *Product manual.*

Connection of external safety devices

Apart from the built-in safety functions, the robot is also supplied with an interface for the connection of external safety devices. Via this interface, an external safety function can interact with other machines and peripheral equipment. This means that control signals can act on safety signals received from the peripheral equipment as well as from the robot.

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.

Related information

Type of information	Detailed in document	Section
Installation of safety devices	Product manual for the robot	Installation and com- missioning
Changing operating modes	User's guide - S4Cplus (RobotWare 4.0) Operating manual - IRC5 with FlexPendant (RobotWare 5.0)	Start-up Operating modes
Restricting the working space	Product manual for the robot	Installation and com- missioning

1.2.2. Safety risks

1.2.2.1. Safety risks during installation and service work on robot

Overview		
	This section includes information of general safety risks to be considered when performing	
installation and service work on the robot.		
General risks during	installation and service	
	• The instructions in the Product Manual - Installation and Commissioning must always be followed.	
	• Emergency stop buttons must be positioned in easily accessible places so that the robot can be stopped quickly.	
	• Those in charge of operations must make sure that safety instructions are available for the installation in question.	
	• Those who install the robot must have the appropriate training for the robot system in question and in any safety matters associated with it.	
Nation/region specif	ic regulations	
	To prevent injuries and damage during the installation of the robot system, the regulations applicable in the country concerned and the instructions of ABB Robotics must be complied with.	
Non-voltage related	risks	
	• Safety zones, which have to be crossed before admittance, must be set up in front of the robot's working space. Light beams or sensitive mats are suitable devices.	
	• Turntables or the like should be used to keep the operator out of the robot's working space.	
	• The area are offected by the former of analytic when the healing are released. In addition	

- The axes are affected by the force of gravity when the brakes are released. In addition to the risk of being hit by moving robot parts, you run the risk of being crushed by the parallel arm.
- Energy, stored in the robot for the purpose of counterbalancing certain axes, may be released if the robot, or parts thereof, are dismantled.
- When dismantling/assembling mechanical units, watch out for falling objects.
- Be aware of stored heat energy in the controller.
- Never use the robot as a ladder, i.e. do not climb on the robot motors or other part during service work. There is a serious risk of slipping because of the high temperature of the motors or oil spills that can occur on the robot.

To be observed by the supplier of the complete system

- The supplier of the complete system must ensure that all circuits used in the safety function are interlocked in accordance with the applicable standards for that function.
- The supplier of the complete system must ensure that all circuits used in the emergency stop function are interlocked in a safe manner, in accordance with the applicable standards for the emergency stop function.

Continues on next page

1 Safety

1.2.2.1. Safety risks during installation and service work on robot

Continued

Complete robot

Safety risk	Description	
Hot components!		
	Caution!	
	Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!	
Removed parts may result in collapse of robot!	Warning!	
	Take any necessary measures to ensure that the robot does not collapse as parts are removed, e.g. secure the lower arm with fixtures if removing motor, axis 2.	

Cabling

Sa	ıfety risk	Description
Ca	ble packs are sensitive to echanical damage!	Caution! The cable packs are sensitive to mechanical damage! They must be handled with care, especially the connectors, in order to avoid damaging them!

Gearboxes and motors

Safety risk	Description
Gears may be damaged if excessive force is used!	!
	Caution! Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!

1.2.2.2. Safety risks related to tools/workpieces

1.2.2.2. Safety risks related to tools/workpieces

Safe handling	
	It must be possible to safely turn off tools, such as milling cutters, etc. Make sure that guards remain closed until the cutters stop rotating.
	It should be possible to release parts by manual operation (valves).
Safe design	
	Grippers/end effectors must be designed so that they retain workpieces in the event of a power failure or a disturbance of the controller.
	CAUTION!
	Ensure that a gripper is prevented from dropping a workpiece, if such is used.

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1.2.2.3. Safety risks related to pneumatic/hydraulic systems

1.2.2.3. Safety risks related to pneumatic/hydraulic systems

General	
	Special safety regulations apply to pneumatic and hydraulic systems.
Residual energy	
	• Residual energy may be present in these systems. After shutdown, particular care must be taken.
	• The pressure in pneumatic and hydraulic systems must be released before starting to repair them.
Safe design	
	• Gravity may cause any parts or objects held by these systems to drop.
	• Dump valves should be used in case of emergency.
	• Shot bolts should be used to prevent tools, etc., from falling due to gravity.

General	
	• The industrial robot is a flexible tool which can be used in many different industrial applications.
	• All work must be carried out professionally and in accordance with the applicable safety regulations.
	• Care must be taken at all times.
Qualified personnel	
	• Corrective maintenance must only be carried out by qualified personnel who are familiar with the entire installation as well as the special risks associated with its different parts.
Extraordinary risks	
	If the working process is interrupted, extra care must be taken due to risks other than those associated with regular operation. Such an interruption may have to be rectified manually.

1.2.2.4. Safety risks during operational disturbances

1.2.2.5. Risks associated with live electric parts

1.2.2.5. Risks associated with live electric parts

Voltage related risks, general

- Although troubleshooting may, on occasion, have to be carried out while the power supply is turned on, the robot must be turned off (by setting the mains switch to OFF) when repairing faults, disconnecting electric leads and disconnecting or connecting units.
- The mains supply to the robot must be connected in such a way that it can be turned off outside the robot's working space.

Voltage related risks, controller S4Cplus

A danger of high voltage is associated with the following parts:

- Be aware of stored electrical energy (DC link) in the controller.
- Units inside the controller, e.g. I/O modules, can be supplied with power from an external source.
- The mains supply/mains switch
- The power unit
- The power supply unit for the computer system (230 VAC)
- The rectifier unit (400-480 VAC and 700 VDC. Note: Capacitors!)
- The drive unit (700 VDC)
- The service outlets (115/230 VAC)
- The power supply unit for tools, or special power supply units for the machining process.
- The external voltage connected to the control cabinet remains live even when the robot is disconnected from the mains.
- Additional connections

1.2.2.5. Risks associated with live electric parts

Continued

Voltage related risks, controller IRC5

A danger of high voltage is associated with the following parts:

- Be aware of stored electrical energy (DC link, Ultra Cap unit) in the controller.
- Units inside the controller, e.g. I/O modules, can be supplied with power from an external source.
- The mains supply/mains switch
- The transformers
- The power unit
- The control power supply (230 VAC)
- The rectifier unit (400-480 VAC and 700 VDC. Note: Capacitors!)
- The drive unit (700 VDC)
- The drive system power supply (230 VAC)
- The service outlets (115/230 VAC)
- The customer power supply (230 VAC)
- The power supply unit for tools, or special power supply units for the machining process.
- The external voltage connected to the control cabinet remains live even when the robot is disconnected from the mains.
- Additional connections.

Voltage related risks, robot

A danger of high voltage is associated with the robot in:

- The power supply for the motors (up to 800 VDC).
- The user connections for tools or other parts of the installation (max. 230 VAC, see chapter Installation and commissioning in the Product manual).

Voltage related risks, tools, material handling devices, etc

Tools, material handling devices, etc., may be live even if the robot system is in the OFF position. Power supply cables which are in motion during the working process may be damaged.

1 Safety

1.2.3.1. Safety fence dimensions

1.2.3. Safety actions

1.2.3.1. Safety fence dimensions

General

Install a safety cell around the robot to ensure safe robot installation and operation.

Dimensioning

Dimension the fence or enclosure to enable it to withstand the force created if the load being handled by the robot is dropped or released at maximum speed. Determine the maximum speed from the maximum velocities of the robot axes and from the position at which the robot is working in the work cell (see Product Specification - Description, Robot Motion). Also consider the maximum possible impact caused by a breaking or malfunctioning rotating tool or other device fitted to the manipulator.

1.2.3.2. Fire extinguishing

1.2.3.2. Fire extinguishing



NOTE!

Use a CARBON DIOXIDE (CO_2) extinguisher in the event of a fire in the robot (manipulator or controller)!



1.2.3.3. Emergency release of the robot's arm

1.2.3.3. Emergency release of the robot's arm

Description	
	In an emergency situation, any of the robot's axes may be released manually by pushing the
	brake release buttons on the robot.
	How to release the brakes is detailed in section:
	• Manually releasing the brakes on page 43.
	The robot arm may be moved manually on smaller robot models, but larger models may require using an overhead crane or similar.
Increased injury	
	Before releasing the brakes, make sure that the weight of the arms does not increase the pressure on the trapped person, further increasing any injury!

1.2.3.4. Brake testing

1.2.3.4. Brake testing

When to test	
	During operation the holding brake of each axis motor wear normally. A test may 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 checked as detailed below:
	1. Run each manipulator axis to a position where the combined weight of the manipulator arm and any load is maximized (max. static load).
	2. Switch the motor to the MOTORS OFF position with the Operating mode selector on the controller.
	3. Check 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.

1.2.3.5. Risk of disabling function "Reduced speed 250 mm/s"

1.2.3.5. Risk of disabling function "Reduced speed 250 mm/s"



NOTE!

Do not change "Transm gear ratio" or other kinematic parameters from the Teach Pendant Unit or a PC. This will affect the safety function Reduced speed 250 mm/s.



1.2.3.6. Safe use of the Teach Pendant Unit



NOTE!

The enabling device is a push button located on the side of the Teach Pendant Unit (TPU) which, when pressed halfway in, takes the system to MOTORS ON. When the enabling device is released or pushed all the way in, the robot is taken to the MOTORS OFF state.

To ensure safe use of the Teach Pendant Unit, the following must be implemented:

- The enabling device must never be rendered inoperative in any way.
- During programming and testing, the enabling device must be released as soon as there is no need for the robot to move.
- The programmer must always bring the Teach Pendant Unit with him/her, when entering the robot's working space. This is to prevent anyone else taking control of the robot without the programmer knowing.



1.2.3.7. Work inside the manipulator's working range

1.2.3.7. Work inside the manipulator's working range



WARNING!

If work must be carried out within the robot's work envelope, the following points must be observed:

- The operating mode selector on the controller must be in the manual mode position to render the enabling device operative and to block operation from a computer link or remote control panel.
- The robot's speed is limited to max. 250 mm/s when the operating mode selector is in position "manual mode with reduced speed". This should be the normal position when entering the working space. The position "manual mode with full speed (100%)" may only be used by trained personnel who are aware of the risks that this entails.
- Pay attention to the rotating axes of the manipulator! Keep a distance to the axes in order not to get entangled with hair or clothing. Also be aware of any danger that may be caused by rotating tools or other devices mounted on the manipulator or inside the cell.
- Test the motor brake on each axis, according to section *Brake testing on page 25*.

1.2.3.8. Translate the information on safety and information labels

Labels on the product

Both the robot and the controller are marked with several safety and information labels, containing important information about the product. The information is useful for all personnel handling the robot system, eg. during installation, service or operation.

Translation possibilities

The labels fitted to the product contain space for adding a fourth language underneath the three standard languages (English, German and French).

Add a local language to the label by:

• using a transparent sticker over the standard label with text added in a fourth language. Drawings detailing the design (text, figure, dimensions) of the standard labels can be ordered from ABB. Notice that each label is identified according to the article number located in the lower corner of the label.

Example of transparent sticker

The figure below shows the location of the free space on one of the labels on the robot, where the fourth language can be added. The figure also shows a transparent sticker, containing the text in Swedish.



1.3.1. Safety signals, general

1.3 Safety related instructions

1.3.1. Safety signals, general

General

This section specifies all dangers that may arise from performing the work detailed in the manual. Each danger is detailed in its own section consisting of:

- A caption specifying the danger level (DANGER, WARNING or CAUTION) and the type of danger.
- A brief description of what will happen if the operator/service personnel **do not** eliminate the danger.
- An instruction of how to eliminate the danger to facilitate performing the activity at hand.

Danger levels

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

	Symbol	Designation	Signification
	danger	DANGER	Warns that an accident <i>will</i> occur if the instructions are not followed, resulting in a serious or fatal injury and/or severe 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.
	Warning	WARNING	Warns that an accident <i>may</i> 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.
	Electrical shock	ELECTRICAL SHOCK	The electrocution or electrical shock symbol indicates electrical hazards which could result in severe personal injury or death.
	caution	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.

1 Safety

1.3.1. Safety signals, general

Continued

Symbol	Designation	Signification
Electrostatic discharge (ESD)	ELECTROSTATIC DISCHARGE (ESD)	The electrostatic discharge (ESD) symbol indicates electrostatic hazards which could result in severe damage to the product.
Note	NOTE	Note symbols alert you to important facts and conditions.
Tip	TIP	Tip symbols direct you to specific instructions, where to find additional information or how to perform a certain operation in an easier way.

1.3.2. DANGER - Moving manipulators are potentially lethal!

1.3.2. DANGER - Moving manipulators are potentially lethal!

Description

Any moving manipulator is a potentially lethal machine.

When running the manipulator, it may perform unexpected and sometimes irrational movements. However, all movements are performed with great force and may seriously injure any personnel and/or damage any piece of equipment located within the manipulator working range.

Elimination

	Action	Note/Illustration
1.	Before attempting to run the manipulator, make sure all <i>emergency stop equipment</i> is correctly installed and connected.	Emergency stop equipment such as gates, tread mats, light curtains, etc.
2.	If possible, use the hold-to-run button whenever possible. The hold-to-run button is used in manual mode, not in automatic mode.	How to use the hold-to-run control in RobotWare 5.0 is detailed in section <i>How</i> <i>to use the hold-to-run function</i> in the <i>Operating manual - IRC5 with FlexPen-</i> <i>dant.</i> How to use the hold-to-run control in RobotWare 4.0 is detailed in section <i>The</i> <i>Teach Pendant unit</i> in the <i>User's Guide.</i>
3.	Make sure no personnel are present within the manipulator working range before pressing the start button.	

1.3.3. DANGER - First test run may cause injury or damage!

Description	
	Since performing a service activity often requires disassembly of the robot there are several
	safety risks to take into consideration before the first test run.
Elimination	
	Follow the procedure below when performing the first test run after a service activity (repair,
	installation or maintenance):
	Action
	1. Remove all service tools and foreign objects from the robot and its working area!
	2. Install all safety equipment properly!
	3. Make sure all personnel are standing at a safe distance from the robot, i.e. out of its reach behind safety fences, etc!
	4. Pay special attention to the function of the part previously serviced!

1.3.4. WARNING - The unit is sensitive to ESD!

1.3.4. WARNING - The unit is sensitive to ESD!

Description

ESD (electro static 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.

Elimination

	Action	Note
1.	Use a wrist strap	Wrist straps must be tested frequently to ensure that they are not damaged and are operating correctly.
2.	Use an ESD protective floor mat.	The mat must be grounded through a current- limiting resistor.
3.	Use a dissipative table mat.	The mat should provide a controlled discharge of static voltages and must be grounded.

1.3.5. WARNING - Safety risks during work with gearbox oil

Description

When handling the gearbox oil, there are several dangers to both personal injuries and product damages! Following safety information must be regarded before performing any work with the oil in the gearboxes!

Warnings and elimination

Warning	Description	Elimination / Action
Hot oil!	Changing and draining gearbox oil may require handling hot oil of up to 90 °C!	Make sure that protective gear like goggles and gloves are always worn during this activity.
Possible pressure build up in gearbox!	When opening the oil plug, there may be pressure present in the gearbox, causing oil to spray from the opening!	Open oil plug carefully and keep away from the opening. Do not overfill the gearbox when filling.
Do not overfill!	Overfilling of gearbox oil 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 manipulator from moving freely.	Make sure not to overfill the gearbox when filling with oil! After filling, check the correct oil level.
Do not mix types of oil!	Mixing types of oil may cause severe damage to the gearbox!	When filling gearbox oil, do not mix different types of oil unless specified in the instruction. Always use the type of oil specified by the manufacturer!

1.3.5. WARNING - Safety risks during work with gearbox oil

Continued

Warning	Description	Elimination / Action
Heat up the oil!	Warm oil drains quicker than cold oil.	When changing gearbox oil, first run the robot for a time to heat up the oil.
Specified amount depends on drained volume!	The specified amount of oil is based on the total volume of the gearbox. When changing the oil, the amount of refilled oil may differ from the specified amount, depending on how much oil has previously been drained from the gearbox.	After refilling, check the oil level.

DCS Centel

2.1. Introduction

2 Installation and commissioning

2.1. Introduction

General

This chapter contains information for installing the robot to the working site.

More detailed technical data, such as load diagram, permitted extra loads (equipment) and location of extra loads (equipment), may be found in the Product Specification for the robot.



2.2.1. Pre-installation procedure

2.2 Unpacking

2.2.1. Pre-installation procedure

General				
	These instructions are to be used	when unpacking and install	ing the robot for the first time.	
	They also contain information useful later during re-installation of the robot.			
Checking the pre-ree	quisites for installation			
	The check-list below details what must be observed before proceeding with the actual installation of the robot:			
	1. Make sure only qualified installation personnel conforming to all national and local codes are allowed to perform the installation.			
	2. Make sure the robot is not dan	naged, by visually inspectir	ng it.	
	3. Make sure the lifting device to in <i>Weight, robot on page 38.</i>	be used is fit to handle the	weight of the robot as specified	
	4. If the robot is not to be installe in <i>Storage conditions on page</i>	d directly, it must be stored <i>39</i> .	according to the specifications	
	5. Make sure the appointed opera specifications outlined in <i>Operation</i>	ating environment of the ro	bot conforms to the 9.	
	6. Before taking the robot to the installation site, make sure the site conforms to <i>Loads on</i> foundation on page 38, Requirements, foundation on page 39 and Protection classes on page 39.			
	 When these prerequisites are met, the robot may be taken to its installation site as described in <i>Lifting robot with lifting slings on page 42</i>. 			
Weight, robot				
	Robot model	Weight		
	IRB 2400	380 kg		
Loads on foundation	า			
	The table below shows the differe kinds of operation.	nt forces and torques work	ing on the robot during various	
	Note! These forces and torques ar operation. The values also never s	re extreme values that are ra simultaneously reach their r	arely encountered during naximum!	
IRB 2400 -10, -16				
	Forces and torques	Endurance load (operation)	Max. load (emergency stop)	
	Force xy (upright/suspended)	± 2000 N	± 2600 N	
	Force z (upright)	4100 ± 1400 N	4100 ± 1900 N	
	Forze z (suspended)	- 4100 ± 1400 N	- 4100 ± 1900 N	
	Torque Mxy	± 3400 Nm	± 4000 Nm	
	Torque Mz	± 550 Nm	± 900 Nm	

2.2.1. Pre-installation procedure

Continued

IRB 2400 - L

Forces and torques	Endurance load (operation)	Max. load (emergency stop)
Force xy	± 1700 N	± 2100 N
Force z, upright	4100 ± 1100 N	4100 ± 1400 N
Force z, suspended	- 4100 ± 1100 N	- 4100 ± 1400 N
Torque Mxy	± 3000 Nm	± 3400 Nm
Torque Mz	± 450 Nm	± 900 Nm

Requirements, foundation

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

Requirement	Value
Min. levelity	0.5 mm
Max. tilt	5°
Min. resonance frequency	30 Hz

Storage conditions

The table below shows the allowed storage conditions for the robot:		
Parameter	Value	
Min. ambient temperature, storage	-25° C	
Max. ambient temperature, storage	+55° C	
Max. ambient temperature, storage (less than 24 hrs)	+70° C	
Max. ambient humidity, storage	Max. 95% at constant temperature	

Operating conditions

The table below shows the allowed operating conditions for the robot and controller:

Parameter	Value
Min. ambient temperature	+5° C
Max. ambient temperature	+45° C
Max. ambient humidity	Max. 95% at constant temperature

Protection classes

The table below shows the protection class of the main parts of the robot system:

Equipment	Protection class
Robot IRB 2400 (Foundry, Wash)	IP 67
Robot IRB 2400 (Standard, CleanRoom)	IP 54

2.2.2. Working range

2.2.2. Working range

Working range

This section specifies the working areas of the robot models.

IRB 2400/L

The working area is the same for both floor and inverted (suspended). Positions are located at wrist center.



Pos.	х	Z	Angle axis 2	Angle axis 3
0	970	1620	0	0
1	404	2298	0	-60
2	602	745	0	65
3	1577	-246	110	-60
4	400	-403	110	24.5
5	-1611	623	-100	-60
6	-115	1088	-100	65

2.2.2. Working range

Continued



IRB 2400/10, /16

Positions in the working range

The table below specifies the positions inside the working range, shown in the figure above.

Position in figure	Position (mm)	Angles (º)		
	Х	Z	Axis 2	Axis 3
1	870	1139	0	0
2	510	1246	-28	-17
3	446	722	-28	31
4	515	218	60	119
5	607	-73	85	119
6	1506	210	85	26
7	1313	1148	42	-17

2.3.1. Lifting robot with lifting slings

2.3 On-site installation

2.3.1. Lifting robot with lifting slings

General

This section details how to lift the robot using lifting slings.

Required equipment

Equipment	Note
Sling line Type: KDBK 7-8.	Length: 2 m. Load at 90°: 380 kg.

Illustration, attachment of lifting slings

The figure below shows how to attach the lifting slings to the robot.



Lifting of robot

	Action	Note
1.	Move the robot to the lifting position shown in the figure above.	If necessary, release the brakes as detailed in section <i>Manually</i> releasing the brakes on page 43.
2.	Attach the straps to the special eye bolts on the gearboxes for axes 2 and 3.	
3.	Lift the robot carefully.	

2.3.2. Manually releasing the brakes

2.3.2. Manually releasing the brakes

General

The holding brakes of each axis' motor are of an electromechanical type and are released when voltage is applied. This section details how to release the brakes, using the internal brake release unit, in order to enable the axes to move manually.

The brake of each motor can also be released by connecting an external voltage supply directly on the motor connector, see the circuit diagram or the repair procedures for each motor (section *Motors on page 118*).

Releasing the brakes using the brake release unit

The procedure below details how to release the holding brakes using the internal brake release unit.



2.3.2. Manually releasing the brakes

Continued

Supplying power to connector R1.MP

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



2.3.3. Orienting and securing the robot

2.3.3. Orienting and securing the robot

General

This section details how to orient and secure the robot to the foundation in order to safely run the robot. The requirements for the foundations are shown in the tables and figures below.

Bolting requirements

When bolting a base plate or the base to a concrete floor, follow the general instructions for expansion-shell bolts. The screw joint must be able to withstand the stress loads defined in section *Loads on foundation on page 38*.

NOTE!

When the robot is to be mounted in a tilted or a suspended position, the guide sleeves must be used to secure the bolted joint.

Attachment screws

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

M16 x 50
Quality 8.8
Thickness: 3 mm
Outer diameter: 30 mm
Inner diameter: 17 mm
190 Nm

Hole configuration

The figure below shows the hole configuration of the robot base, used when securing the robot. Cross section is shown in the following figure.



2.3.3. Orienting and securing the robot

Continued

Cross section, guide sleeve hole

The figure below shows the cross section of the guide sleeve holes (from previous figure):



Guide sleeves

Two guide sleeves can be fitted to the two rear bolt holes to allow the same robot to be remounted without re-adjusting the program.

Equipment	Art. no.		
Guide sleeves	2151 0024-169		

2.3.4. Suspended mounting

2.3.4. Suspended mounting

General

The robot can be mounted in a suspended position. This section details how to turn the robot.

Turning the robot

1. Use the special tool for inverted mounting, see following figure.



2. Seal the eight holes in the bottom plate with plastic plugs, see following figure.



2.3.5. Loads

2.3.5. Loads

General	
	Any loads mounted on the robot must be defined correctly and carefully (with regard to the position of center of gravity and inertia factor) in order to avoid jolting movements and overloading the motors.
	CAUTION!
	Incorrect defined loads may result in operational stops or major damage in bearings.
References	
	Load diagrams, permitted extra loads (equipment) and their positions are specified in the

Product Specification. The loads must also be defined in the software as detailed in *User's Guide* (RobotWare 4.0), or *Operating manual* (RobotWare 5.0).

Stop time and braking distances

Robot motor brake performance depends on any loads attached. For further information about brake performance, please contact ABB.

2.4.1. Introduction

2.4 Restricting the working range

2.4.1. Introduction

General

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

The working range of the following axes may be restricted:

- Axis 1, hardware (mechanical stop and position switch)
- Axis 2, hardware (mechanical stop).
- Axis 3, hardware (limit switch)

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

Notice that adjustments must also be made in the software. References to software manuals are given in the following installation procedures.

2.4.2. Mechanically restricting the working range of axis 1

2.4.2. Mechanically restricting the working range of axis 1

Restrictions in the working range

The working range of axis 1 can be restricted within the area from 50° to 140° as shown in the figure below. The restrictions are made by fitting two extra stops to the robot base.



Location of the mechanical stop, axis 1

The extra mechanical stop is fitted to the robot base as shown in the figure below.

Note! The stop must only be mounted in the direction shown below!



2.4.2. Mechanically restricting the working range of axis 1

Continued

Required equipment

Equipment	Art. no.	Note
Stop, axis 1	3HAB 7298-1	Includes: • removable stop (2 pcs) • plain washers (4 pcs) • hex socket head cap screw (4 pcs, M12x30) • drill template (1 pc)
User's guide - S4Cplus (RobotWare 4.0) Technical reference manual - System parameters (RobotWare 5.0)		Art. no. is specified in section <i>References on page 8</i> .

Fitting, mechanical stop axis 1

The procedure below details how to fit a mechanical stop to the robot base.

	Action	Note
1.	Decide where to fit the extra mechanical stops, according to the figure <i>Location of where to drill holes for extra stops on page 52</i> .	
2.	Make a copy of the drill template, enclosed with the mechanical stop.	The template is also shown in the figure <i>Drill template on page 54</i> in scale 1:1.
3.	Use the template to mark the center of the two holes on each stop.	Place the template edge edge with the robot base, as shown in the figure <i>Location of where to drill holes for extra stops on page 52</i> .
4.	Drill the holes through, Ø 10.2. Cut threads, M12.	
5.	Fit the stops to the robot base, but without tightening the screws.	Note! The stops must be mounted in correct direction, as shown in the figure <i>Location of where to drill holes for extra stops on page 52.</i>
6.	Turn axis 1 manually and check the working range between the stops.	If necessary; correct the angle of impact.
7.	Tighten the screws.	
8.	The software working range limitations must be re-defined to correspond to the changes in the mechanical limitations of the working range.	How to define the range of movement in RobotWare 4.0 is detailed in <i>User's</i> <i>guide - S4Cplus, chapter System</i> <i>Parameters - topic Manipulator.</i> The system parameters that must be changed in RobotWare 5.0 (Upper joint bound and Lower joint bound) are further detailed in <i>Technical reference</i> <i>manual - System parameters.</i>
9.	WARNING! If the mechanical stop is deformed after a hard collision, it must be replaced!	

Continues on next page

2.4.2. Mechanically restricting the working range of axis 1

Continued

Location of where to drill holes for extra stops

The figure below shows the drill pattern used when drilling for mechanical stops on axis 1.



Maximum working range, axis 1
Minimum working range, axis 1
Drilling pattern enclosed with the mechanical stop.
This mounting direction only
The minimum and maximum measurement between the mechanical stops. The difference between the measurement and the minimum and maximum working range is $2 \times 4^{\circ}$, which corresponds to the width of the stop pin (at the frame).

2.4.2. Mechanically restricting the working range of axis 1

Continued



Continues on next page

2.4.2. Mechanically restricting the working range of axis 1

Continued

Drill template



2.4.3. Mechanically restricting the working range of axis 2

2.4.3. Mechanically restricting the working range of axis 2

General

The range of rotation for axis 2 can be limited mechanically by fitting extra stops on the lower arm.

Restrictions in working range

The figure below shows the mechanical stops available. The number of items that are needed for different working ranges are specified in the following table.



+110° / -100° +110° / -70° 1 2 2 2	Working range	Qty. item 1	Qty. item 2	Qty. item 3
+110° / -70° 1 2 2 +110° / -40° 2 2 4 +80° / -100° 1 2 2 2 +80° / -70° 2 2 4 +80° / -40° 3 2 6	+110° / -100°	-	-	-
+110°/-40° 2 2 4 +80°/-100° 1 2 2 +80°/-70° 2 2 4 +80°/-40° 3 2 6	+110° / -70°	1	2	2
+80° / -100°122+80° / -70°224+80° / -40°326	+110° / -40°	2	2	4
+80°/-70° 2 2 2 4 +80°/-40° 3 2 6	+80° / -100°	1	2	2
+80°/-40° 3 2 6	+80° / -70°	2	2	4
	+80° / -40°	3	2	6
+50°/-100° 2 2 4	+50° / -100°	2	2	4
+50°/-70° 3 2 6	+50° / -70°	3	2	6
+50°/-40° 4 2 8	+50° / -40°	4	2	8
+20°/-100° 3 2 6	+20° / -100°	3	2	6
+20°/-70° 4 2 8	+20° / -70°	4	2	8
+20°/-40° 5 2 10	+20° / -40°	5	2	10

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Required equipment

Equipment	Art. no.	Note
Stop, axis 2	3HAC 2624-1	

2.4.3. Mechanically restricting the working range of axis 2

Continued

Equipment	Art. no.	Note
User's guide - S4Cplus (RobotWare 4.0) Technical reference manual - System parameters (RobotWare 5.0)	-	Art. no. is specified in section <i>References on page 8</i> .
Standard toolkit	-	The contents are defined in section <i>Standard toolkit on page 176</i> , in part 2 of the Product manual.



2.4.4. Installation of limit switch, axis 3

2.4.4. Installation of limit switch, axis 3

General

The working range of axis 3 can be limited by fitting an electrical switch on the gearbox axis 3, which senses the position via a cam.

Mounting of eletrical stop

Following illustration shows howe to fit the electrical stop.



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2.5.1. Connectors on robot

2.5 Electrical connections

2.5.1. Connectors on robot

Connectors on the robot

The figure below shows all connections of the robot cabling, including the customer connections.

