NJ

COMAU

NJ 16 - 3.1
NJ 16 - 3.1 Foundry

Rel. 1.0 / Rel. 2.0

Maintenance

Preventive maintenance plan to guarantee the Robot functionality over time
Preventive and special maintenance procedures
Spare parts list

CR00757916-en_01/2018.06

Instructions Handbook

SUMMARY

PREFACE

This chapter contains:

Reference documentation

This document refers to **the Robots with standards dressing listed below:**

– **SMART5 NJ 16 – 3.1 Rel. 1 / Rel. 2**
– **SMART5 NJ 16 – 3.1 Foundry Rel. 1 / Rel. 2**

The structure of the complete set of handbooks describing the Robot and the Control Unit is specified in the following table:

Manufacturer	Robot SMART5	Set of Handbooks
Comau	NJ 16 – 3.1 Rel. 1 / Rel. 2 NJ 16 – 3.1 Foundry Rel. 1 / Rel. 2	– Technical Specifications – Transport and installation – Maintenance – Electrical circuit diagram

These handbooks must be integrated with the following documents:

Manufacturer	Description	Set of Handbooks
Comau	Fork unit	– Instructions Handbook of the Fork Unit
	C5G Control Unit	– Technical Specifications – Transport and installation – Maintenance – Use of the Control Unit – Electrical circuit diagram
	Programming	– PDL2 Programming Language Manual – Motion programming – VP2 Visual PDL2
	Modes and stopping distance of the Robot	– Stopping time

Documentation storage

All documents provided must be set in close proximity to the area in which it is installed the Spot welding system and maintained available to all people that work with it, the documents shall be maintained intact for the entire operational life of Spot welding system.

Limits on the handbook contents

The images included in the instructions handbook have the purpose to represent the product
and can differ from what is actually visible on the Spot welding system.

Symbols used in the handbook

Below are indicated the symbols that represent: **WARNING**, **CAUTION** and **NOTES** and their meaning.

This symbol indicates operating procedures, technical information and precautions that if are not observed and/or correctly performed may cause injuries to the staff.

This symbol indicates operating procedures, technical information and precautions that if are not observed and/or correctly performed may cause equipment damage.

This symbol indicates operating procedures, technical information and precautions that must be underlined.

The symbol draws the attention to materials disposal that is regulated by the WEEE Directive.

The symbol points out to avoid environmental contamination and to properly dismiss the materials in the appropriate collection sites.

1. GENERAL SAFETY REQUIREMENTS

This chapter deals with general specifications that apply to the whole Robot System. Considering its significance, this chapter is referred unreservedly in each system instructions handbook.

This chapter deals with the following topics:

– Responsibilities
– Safety requirements.

1.1 Responsibilities

– The system integrator is responsible for ensuring that the Robotic system (Robot and Control Unit) is installed and handled in accordance with the Safety Standards in force in the country where the installation takes place. The application and use of the necessary protection and safety devices, the issuing of declaration of conformity and any EC marking of the system are the responsibility of the Integrator.
– COMAU refuses any responsibility for accidents caused by incorrect or improper use of the Robotic system (Robot and Control Unit), by tampering with circuits, components, software and with the use of spare parts that are not included in the spare parts list.
– The application of these Safety Requirements is the responsibility of the persons assigned to direct / supervise the activities indicated in the section Applicability, which should make sure that the Authorised Personnel is aware of and scrupulously follow the requirements contained in this document in addition to the general Safety Standards applicable to Robotic system (Robot and Control Unit) in force in the Country where the system is installed.
– The non-observance of the Safety Standards may cause to the operators permanent injuries or death and can damage the Robotic system (Robot and Control Unit).

The installation shall be carried out by qualified Personnel and must conform to all National and Local standards.

1.1.1 Essential safety requirements applied and fulfilled

The Robotic system composed by Control Unit and SMART 5 Robot series considers as applied and respected the following Safety Fundamental Requirements, Annex I of Machinery Directive 2006/42/CE: 1.1.3 – 1.1.5 – 1.2.1 – 1.2.2 – 1.2.3 – 1.2.4.3 – 1.2.5 – 1.2.6 – 1.3.2 – 1.3.4 – 1.3.8.1 – 1.5.1 – 1.5.2 – 1.5.4 – 1.5.6 – 1.5.8 – 1.5.9 – 1.5.10 – 1.5.11 – 1.5.13 – 1.6.3 – 1.6.4 – 1.6.5 – 1.7.1 – 1.7.1.1 – 1.7.2 – 1.7.4.
In case it is provided only the Robot series SMART 5 are to be considered as applied the following requirements: 1.1.3 – 1.1.5 – 1.3.2 – 1.3.4 – 1.3.8.1 – 1.5.1 – 1.5.2 – 1.5.4

– 1.5.6 – 1.5.8 – 1.5.9 – 1.5.10 – 1.5.11 – 1.5.13 – 1.6.4 – 1.6.5 – 1.7.1 – 1.7.1.1 – 1.7.2 – 1.7.4.

1.2 Safety requirements

1.2.1 Purpose

These safety requirements are aimed to define the behaviour and obligations to be observed when performing the activities listed in the Applicabilitysection.

1.2.2 Definitions

Robotic system (Robot and Control Unit)
Robotic system is the workable assembly composed of: Robot, Control Unit, Teach Pendant and other possible options.

Protected Area
The protected area is the zone confined by the protection barriers and intended to be used for the installation and operation of the Robot.

Authorised Personnel
Authorised personnel defines the group of persons who have been appropriately trained and assigned to carry out the activities listed in the section Applicability.

Staff in Charge
The staff in charge defines the personnel who manage or supervise the activities of the employed persons defined in the preceding point.

Installation and Startup
Installation is defined as the mechanical, electrical and software integration of the Robot and Control System in any environment that requires controlled movement of Robot axes, in compliance with the safety requirements of the country where the System is installed.

Functioning in Programming mode
Operating mode under the control of the operator, that excludes automatic operation and allows the following activities: manual movement of Robot axes and programming of work cycles at low speed, programmed cycle testing at low speed and, when allowed, at working speed.

Functioning in Auto / Remote mode
Operating mode in which the Robot autonomously executes the programmed cycle at work speed, with the operators outside the protected area, with the protection barriers closed and included in the safety circuit, with local (located outside the protected area) or remote start/stop.

Maintenance and Repair
Maintenance and repair intervention is defined as the activity that involve periodical checking and/or replacement of Robot and Control System (mechanical, electrical, software) parts or components, and trouble shooting, that ends when the Robot and

Control System has been reset to its original project functional conditions.

Decommissioning and Dismantling

Decommissioning is defined as the activity that involve the mechanical and electrical removal of the Robot and Control System from a production unit or from an environment in which it was under study.
Dismantling consists of the demolition and dismantling of the components that make up the Robot and Control System.

Integrator

The integrator is the professional expert responsible for the Robot and Control System installation and startup.

Misuse

Misuse is defined as the use of the system outside the limits specified in the Technical Documentation.

Action Area

The Robot action area is the enveloping volume of the area occupied by the Robot and its equipment during movement in the area.

1.2.3 Applicability

These requirements must be applied when carrying out the following activities:

- Installation and Startup
- Functioning in Programming mode
- Functioning in Auto / Remote Mode
- Robot axes brake release (where fitted)
- Maintenance and Repair
- Decommissioning and Dismantling.

1.2.4 Operating modes

Installation and Startup

- The startup is only possible when the Robot and Control System has been correctly and completely installed.
- The system installation and startup is exclusively the task of the authorised personnel.
- The system installation and startup is only permitted exclusively inside a protected area of an adequate size to house the Robot and the equipment it is outfitted with, without passing beyond the protection barriers. It is also necessary to check that in normal Robot movement conditions there is no collision with parts inside the protected area (e.g structural columns, power supply lines, etc.) or with the barriers. If necessary, limit the Robot work area using mechanical hard stop (see optional units).
- Any fixed Robot control stations must be located outside the protected area and in a point such as to permit a full view of the Robot movements.
- The Robot installation area must be as free as possible from materials that could impede or limit the visibility.
- During installation the Robot and the Control Unit must be handled as described in the product Technical Documentation; if lifting is necessary, check that the eye-bolts are fixed securely and use only adequate slings and equipment.
- Fix the Robot to mount holder, with all the provided bolts and pins, tightened to the tightening torque indicated in the product Technical Documentation.
- If present, remove the fixing brackets of the axes and verify the proper fixing of the equipment the Robot is outfitted with.
- Check that the Robot guards are correctly fixed and that there are no moving or loose parts. Check that the Control Unit components are intact.
- Install the Control Unit outside the protected area: the Control Unit should not be used as part of the fencing.
- Check that the voltage value of the power mains is consistent with that indicated on the nameplate of the Control Unit.
- Before electrically connect the Control Unit, check that the circuit breaker on the power mains is locked in open position.
- The connection between the Control Unit and the power supply mains of the plant, must be realized via a cable of suitable for the installed on the Control Unit power dimensions (for details refer to the Control Unit “Transport and Installation” handbook).
- Connect the ground cable (PE) then connect the power conductors to the main switch.
- Connect the power supply cable, first connecting the ground cable to the circuit breaker on the power mains line, after checking with a tester that the circuit breaker terminals are not powered. It is recommended to connect the cable armouring to the earth.
- Connect the signals and power cables between the Control Unit and the Robot.

- Connect the Robot to the ground through the Control Unit or specific terminals, according to the prearrangements present on Robot and/or Control Unit.
- Where fitted, check that the Control Unit door/s is/are closed with the appropriate key.
- A wrong connection of the connectors may cause permanent damage to the Control Unit components.
- The Control Unit manages internally the main safety interlocks (gates, enabling push-buttons, etc.). Connect the Control Unit safety interlocks to the line safety circuits, taking care to connect them as required by the Safety Standards. The safety of the interlock signals coming from the transfer line (emergency stop, gates safety devices etc.) i.e. the realisation of correct and safe circuits, is the responsibility of the Robot and Control System integrator.

In the cell/line emergency stop circuit it is necessary to include the contacts of the Control Unit emergency stop push-buttons, available on X30. The push-buttons are not interlocked inside the emergency stop circuit of the Control Unit.

- The safety of the system cannot be guaranteed in case of interlocks erroneous, incomplete or missing execution.
- The safety circuit executes a controlled stop (IEC 60204-1, category 1 stop) for the safety inputs Auto Stop/ General Stop and Emergency Stop. The controlled stop is only active in Automatic mode; in Programming mode the power is disabled immediately.
- When preparing protection barriers, especially light curtains and access doors, take into consideration the Robot stopping times and distances according to the stop category (0 or 1) and the weight of the Robot.

Where foreseen, on the Control Unit, check that the setting of the stop circuit timer is consistent with the type of Robot connected (for details see the Control Unit Transport and Installation handbook).

- Check that the environmental and operating conditions do not exceed the limits specified in the Technical Documentation of the specific product.
- The calibration operations must be carried out with great care, as indicated in the Technical Documentation of the specific product, and should be concluded by checking the correct position of the machine.

– To load or update the system software (for example after boards replacing), use only the original software handed over by COMAU. Scrupulously follow the system software loading procedure described in the Technical Documentation supplied with the specific product. After loading, always make some Robot moving tests at low speed remaining outside the protected area.
– Check that the barriers of the protected area are correctly positioned.

Functioning in Programming mode

– The programming of the Robot is exclusively the task of the authorized personnel.
– Before starting to program, the operator must check the Robotic system (Robot and Control Unit) to make sure that there are no potentially dangerous irregular conditions, and that there is nobody inside the protected area.
– The programming should be controlled from outside the protected area whenever possible.
– Before operating inside the Protected Area, the operator must make sure from outside that all the necessary protections and safety devices are present and in working order, and especially that the Teach Pendant is working properly (low speed, emergency stop device, enabling device, etc.).
– During the programming phases, only the operator with the Teach Pendant is allowed inside the Protected Area.
– If the presence of a second operator in the working area is necessary when checking the program, this person must have an enabling device interlocked with the safety devices.
– Activation of the motors (DRIVE ON) always must be controlled from a position outside the operating range of the Robot, after checking that there is nobody in the area involved. The Drive On operation is considered complete when the relevant machine status indication is shown.
– When programming, the operator must remain at an appropriate distance from the Robot to be able to avoid any irregular machine movements, and in any case in a suitable position to avoid the risk of being trapped between the Robot and structural parts (columns, barriers, etc.), or between movable parts of the Robot.
– When programming, the operator must avoid to remain in a position where parts of the Robot, pulled by gravity, could move downwards, upwards or sideways (when installed on an inclined plane).
– Testing a programmed cycle at working speed with the operator inside the protected area, in some situations where a close visual check is necessary, is only to be carried out after a complete test cycle at low speed has been carried out. The test must be controlled from a safe distance.
– Special attention is to be paid when programming using the Teach Pendant: in this situation, although all the hardware and software safety devices are active, the Robot movement depends on the operator.
– During the first running of a new program, the Robot may move along a path that is not the one expected.
– The modification of program steps (such as moving by a step from one point to another of the flow, wrong recording of a step, modification of the Robot position out of the path that links two steps of the program), could give rise to movements not envisaged by the operator when testing the program.

– In both cases operate cautiously, always remaining out of the Robot range of action and test the cycle at low speed.

Functioning in Auto / Remote Mode

– The activation of the automatic operation (AUTO and REMOTE states) is permitted only with the Robotic system (Robot and Control Unit) integrated inside an area with protection barriers properly interlocked, as required by the Safety Standards currently in force in the Country where the installation takes place.

– Before starting the automatic mode the operator must check the Robot and Control System and the protected area to make sure there are no potentially dangerous irregular conditions.

– The operator can activate automatic operation only after having checked:
  - that the Robot and Control System is not in maintenance or repair status;
  - that the protection barriers are correctly positioned;
  - that there is nobody inside the protected area;
  - that the Control Unit doors are closed and locked with the appropriate key;
  - that the safety devices (emergency stop, protection barrier safety devices) are functioning;

– Special attention is to be paid when selecting the remote mode, in which the line PLC can perform automatic operations of motors power up and program starting.

Robot axes brake release (where fitted)

– In absence of motive power, the Robot axes repositioning is possible by means of optional brake release devices and suitable lifting devices. Such devices only allow the brake deactivation of each axis. In this case, all the system safety devices (including the emergency stop and the enabling push-button) are disabled; also the Robot axes can move upwards or downwards because of the forces generated by the balancing system or by the gravity force.

Before using manual brake releasing devices, it is recommended to sling the Robot, or hook it to an overhead traveling crane.

– The use of brake releasing device may cause the axes falling due to gravity, as well as possible impacts due to an incorrect reset, after applying the brake releasing module. The procedure for the correct usage of the brake releasing device (both for the integrated one and module one) is to be found in the maintenance handbooks.

– When after the interruption of an unfinished MOVE the motion is enabled again, the typical function of trajectory recuperation may generate unpredictable paths that may imply the risk of impact. This same condition arises at the next restart of the automatic cycle. Avoid moving the Robot in positions that are distant from the ones required for the motion restarting; alternatively disable the outstanding MOVE programmes and/or instructions.

Maintenance and Repair

– When assembled in COMAU the Robot is supplied with lubricants that do not contain any harmful to health substances, however, in some cases, repeated and prolonged exposure to the product may cause skin irritation, or if swallowed, sickness.
First Aid Measures. In case of contact with the eyes or skin: rinse the affected areas with copious amounts of water; should irritation persist, seek medical advice. If swallowed, do not induce vomiting or administer anything by mouth; consult a doctor as soon as possible.

– Maintenance, trouble-shooting and repair are only to be carried out by authorised personnel.

– When carrying out maintenance and repair operations, the specific warning sign stating the maintenance status must be placed on the control panel of the Control Unit, until the end of the operation, even if it should be temporarily suspended.

– Maintenance and components or Control Unit replacement operations must be carried out with the main switch in open position and locked with a padlock.

– Even if the Control Unit is not powered (main switch open), there may be interconnected voltages deriving from connection to peripheral units or external power sources (e.g. 24 Vdc input/output). Power off the external sources when operating on involved system parts.

– Removal of panels, protection shields, grids, etc. is only allowed with the main switch open and padlocked.

– Faulty components are to be replaced with others having the same Part No., or equivalent components defined by COMAU.

Where required, the replaced safety components must be configured with the same parameters as those removed.

– Trouble-shooting and maintenance activities must be carried out, whenever possible, outside the protected area.

– Trouble-shooting executed on the control is to be carried out, whenever possible without power supply.

– Should it be necessary, during trouble-shooting, to intervene with the Control Unit powered, all the precautions specified by Safety Standards must be observed when operating in presence of dangerous voltages.

– Trouble-shooting on the Robot must be carried out with the power supply turned off (DRIVE OFF).

– At the end of the maintenance and trouble-shooting operations, all the deactivated safeties must be reset (panels, protection shields, interlocks, etc.).

- Maintenance, repair and trouble-shooting operations must be concluded with the check of the correct functioning of the Robotic system (Robot and Control Unit) and all the safety devices, executed from outside the protected area.
- During the software loading phases (for example after replacement of electronic boards) use only the original software handed over by COMAU. Scrupulously follow the system software loading procedure described in the specific product Technical Documentation; after loading, to be sure, always run a test cycle, remaining outside the protected area
- The disassembly of Robot components (e.g. motors, balancing cylinders, etc.) may cause uncontrolled movements of the axes in different directions: before starting a disassembly procedure, consult the warning plates applied on the Robot and the Technical Documentation supplied.
- Where fitted, always restore the protective casing if previously installed.

Decommissioning and Dismantling

- The decommissioning and removal of the Robot and Control System is exclusively the task of Authorised Personnel.
- Move the Robot in transport position and assemble the axes blocking brackets (when fitted) referring to the plate affixed to the Robot and to its Technical Documentation.
- Before decommissioning the mains voltage of the Control Unit must be powered off (switch off the circuit breaker on the power mains and lock it in open position).
- After using the specific instrument to check there is no voltage on the terminals, disconnect the power supply cable from the circuit breaker on the power mains, first disconnecting the power conductors, then the earth one. Disconnect the power supply cable from the Control Unit and remove it.
- First disconnect the connection cables between the Robot and the Control Unit, then the earth cable.
- If installed, disconnect the pneumatic system from the air supply and blow off the residual air.
- Check that the Robot is properly balanced and if necessary sling it correctly, then remove the screws that fix the Robot to the backing plane.
- Remove the Robot and the Control Unit from the work area, applying the rules indicated in the products Technical Documentation; if lifting is necessary, check the correct fastening of the eye-bolts and use appropriate slings and equipment only.
- Before starting the dismantling operations (disassembly, demolition and disposal) of the Robot and Control System components, contact COMAU or one of its branch offices, that will indicate, according to the type of Robot and Control Unit, the operating methods in accordance with safety and environmental protection principles.

The disposal operations must be carried out in compliance with the legislation in force in the country where the Robotic system is installed; dispose of the batteries, oils and other chemical liquids respecting the environment and in accordance with the environmental laws, transferring them in suitable waste collecting sites.

- Consign the Robot and the Control Unit to a centre responsible for the dismantling and disposal.

2. MAINTENANCE REQUIREMENTS

This chapter deals with the following topics:

- Precautions before starting
- Precautions during the maintenance activities
- Precautions at the end of the maintenance operations
- Personnel in charge of maintenance
- Required equipment
- Assembly notes
- Parts disposal.

The maintenance activities that are not expressly mentioned in this handbook are not authorized. If necessary, require the manufacturer intervention.

2.1 Precautions before starting

- Most maintenance activities on the Robot are to be performed with electrical and pneumatic power supplies turned off. In these cases the maintenance sheet bears the inscription "Power turned off (Electrical and pneumatic power)".
  For the electrical power supplied by the C5G Control Unit disconnection procedure, see Chap.4. - How to disconnect the electrical power supply of C5G Control Unit on page 27.
  For the power sources (electrical and pneumatic) disconnection procedures, refer to the handbook of the cell which integrates the Robot.
- Use only original spare parts. The spare parts are provided by Comau. The spare parts list is given in Chap.12. - Spare Parts List on page 164.

2.2 Precautions during the maintenance activities

If the type of fault allows the Robot repositioning, it is recommended to set it in home position before starting the maintenance operations.

If maintenance and/or troubleshooting activities are carried out on the safety circuits, do not stand near the Robot and move in jog at a suitable distance.

2.3 Precautions at the end of the maintenance operations

After maintenance operations check the Robot proper functioning. Check the correct execution of some Robot working cycles and the correct functioning of safety devices before leaving the station.

At the end of each maintenance operation, the first machine power-up must be considered as a test for the whole system. During this phase the operator must stand outside the Robot action range but in a position that allows to see its motions. Moreover, the Teach Pendant must be placed in close proximity to the operator.

2.4 Personnel in charge of maintenance

The personnel in charge of maintenance activities shall be instructed in order to properly use the lifting means (in case of replacement of the complete Robot).
Moreover, the personnel must be trained in mechanical, fluidic and electrical fields and therefore aware of the dangers associated with the power supplies, and of the precautions to be taken for safe access the Robot installation area.

2.5 Required equipment

The systems fixing the components (screws, nuts) have been standardised, using as few variations as possible.

The minimum required equipment for maintenance intervention of the Robot is divided depending on the type of maintenance operation:

– for **preventive maintenance** see par. 7.2 Required equipment on page 44.

– for **special maintenance** see par. 9.3 Required equipment on page 80.

2.6 Assembly notes

Special maintenance operations must be performed by specialized staff using appropriate tools, applying the standard operating procedures even if not expressly mentioned, including the following:

- Check the O-rings, oil retaining rings and bearings wear condition and replace them if necessary;
- When reassembling, consider the following guidelines:
  - Apply the recommended threadlockers to the screw threads, see Tab. 2.2 - Threadlocker products on page 21.
  - Use recommended products on sealing surfaces and to fix the components, see Tab. 2.3 - Products for sealing and fixing on page 22.
  - While disassembling and reassembling the components, comply with the screw tightening torques. Unless otherwise specified, tighten to the tightening torques required for the type of screws used and tighten the screws and/or nuts to the required tightening torque, see Tab. 2.1 - Tightening torque for Hex head screws and Socket hex head screws (Nm) on page 21.

An excessive tightening may impair the thread and consequently the maintaining in position of the item.
An insufficient tightening can cause the item falling and/or overheating (and consequent breaking) due to an incorrect adherence to the dissipating structure.

  - Apply AREXONS 52A22 to the external diameter of seals for rotary shafts and rubber sealing plugs.
  - Use FUCHS ANTICORIT DFW to protect any exposed machined surfaces.
  - When assembling double-lipped rotary seals or in case of a double seal, fill the gap between the two lips with "NLGI NR.2” grade grease.

Tab. 2.1 - Tightening torque for Hex head screws and Socket hex head screws (Nm)

d x p	Class 8.8*1 screws	Class 10.9*1 screws	Class 12.9*1 screws	Class 12.9 screws (only per NABTESCO gearbox)
3 x 0.5	1.5	1.9	2.3	-
4 x 0.7	3.1	4.3	5.2	-
5 x 0.8	6	8.5	10.1	9.01 ± 0.49
6 x 1	10.4	14.6	17.5	15.6 ± 0.78
8 x 1.25	24.6	34.7	41.6	37.2 ± 1.86
10 x 1.5	50.1	70.5	84.6	73.5 ± 3.43
12 x 1.75	84.8	119	143	129 ± 6.37
14 x 2	135	190	228	205 ± 10.2
16 x 2	205	288	346	319 ± 15.9
18 x 2.5	283	398	478	441 ± 22
20 x 2.5	400	562	674	539 ± 27
24 x 3	691	971	1170	-

*1 Admissible tolerance 0/-10%

A tolerance of ± 10% is allowed on tightening torques of screws and lock nuts for preloading of bearings.

Tab. 2.2 - Threadlocker products

Material	Product *2		
	for screws M5 or M6	for screws M8 and onwards	For plugs and fittings
Aluminium	Loctite 222	Loctite 222	Loctite 572
Steel		Loctite 243	
Cast iron			
Aluminium with Heli-coil			-

For screws up to M4, do not use threadlockers.

*2 As an alternative to the products indicated in the table Tab. 2.2 it is possible to use:

– Arexons 52A22 (alternative for Loctite 222)
– Arexons 52A43 (alternative for Loctite 243)
– Arexons 35A72 (alternative for Loctite 572)

Tab. 2.3 - Products for sealing and fixing

Application	Product*3
Flat sealant	Loctite 518
Polyurethane sealant	BOSTIK MK2639
Bearing fasteners	Loctite 641
High strength fasteners	Loctite 648

*3 As an alternative to the products indicated in the table Tab. 2.3 it's possible to use:

– Arexons 35A72 (alternative for Loctite 518)

– Arexons 35A72 (alternative for Loctite 641)

– Arexons 35A72 (alternative for Loctite 648)

2.7 Parts disposal

The disposal of used oils and greases must be carried out in accordance with the legislation in force in the country where the Robot is installed.

Should it become necessary the Robot partial or total disposal, **it must be carried out** a separate collection of the parts to be disposed (e.g. iron with iron and plastic with plastic).
The disposal of these parts also **must be carried out** in accordance with the legislation in force in the country where the Robot is installed.

3. ASSISTANCE IN PROBLEM SOLVING

This chapter deals with the following topics:

- Precautions before starting
- Methods
- Robot wiring diagram
- Comau Service Center

3.1 Precautions before starting

- Read carefully what described in Chap.2. - Maintenance requirements on page 18.

3.2 Methods

- Problem analysis
- Diagnostic messages
- Traceability for replacement purposes
- Components replacement.

3.2.1 Problem analysis

The C5G Control Unit provides information on the System status using:

- LEDs, positioned on modules and boards
- diagnostic messages, displayed on the Teach Pendant.

For troubleshooting operation it could be useful to use one or both modes (LEDs, messages), depending on the system status:

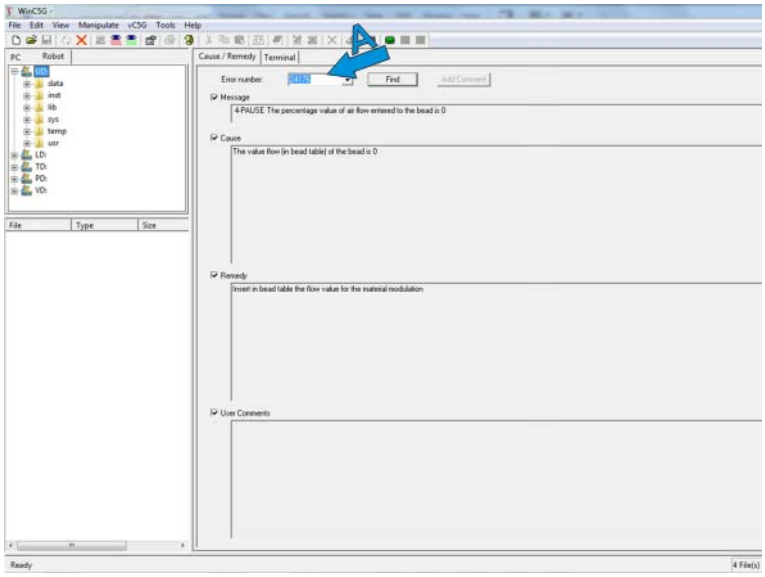
- during the boot phase, the Teach Pendant is not operative and it is necessary to consult the signallings issued by LEDs present on the modules
- when the Teach Pendant is enabled, the Diagnostic messages provided are more efficient
- in each case, especially for auxiliaries circuits power supply, LEDs represent the most immediate diagnostic
- pin outs described in the "Technical specification" handbook of the C5G Control Unit, allow to check the presence of the related foreseen signal
- for connection between the modules and further information on circuits, see the Electrical circuit diagram of the Control Unit.

3.2.2 Diagnostic messages

Diagnostic messages are codified by means of numerical codes with a brief description and can be seen on the Teach Pendant.

In order to better understand the message, detect the cause that generated it and the corresponding solution to solve it, it is possible to use the WinC5Gsoftware .
The main software window (Fig. 3.1) allows to view the above information. To call up the information, indicate the error code in the field **A**.

Fig. 3.1 - WinC5G main window regarding error codes



For further information see the C5G Control Unit instructions handbook.

3.2.3 Traceability for replacement purposes

Each cable / component is codified with a label containing the serial number (S/N) and the purchase Part No., P/N.

Part numbers are so defined:

– S/N followed by 4 digits (production year and month) and two alphabetical letters

– P/N followed by 8 digits (purchase Part No.), one separation point and two digits for review.

3.2.4 Components replacement

To replace the components, it is recommended to detect the damaged component through the identification and codification of connector, cables and modules in order to replace it with an identical one.

The Chap.12. - Spare Parts List on page 164 provides part numbers and descriptions of components available as spare parts.
Spare parts can be acquired directly by Comau at the addressed listed on par. 3.4 Comau Service Center on page 26 where it is also possible to ask for repair of the damaged component.

Do not carry out autonomous or not authorized repairs on the damaged modules. Repairs can be carried out only by Comau.

3.3 Robot wiring diagram

For further details see the Robot electrical diagram and connection details.

3.4 Comau Service Center

In case of need it is possible to contact the Comau Service Centre at the following addresses:

Sector	Address	Service provided
Service	service.robotics@comau.com	Assistance in trouble shooting and software options requirement
	spares.robotics@comau.com	To require spare parts
	repairs.robotics@comau.com	To require repair activities

As an alternative refer to the manufacturer according to what is indicated on par. 2.5 Name and address of the manufacturer on page 18 in the “Technical Specifications” handbook.

4. HOW TO DISCONNECT THE ELECTRICAL POWER SUPPLY OF C5G CONTROL UNIT

This chapter deals with the following topics:

– Precautions and risks associated to the electrical power supply disconnection

– Disconnection of the electrical power supply.

4.1 Precautions and risks associated to the electrical power supply disconnection

– After the Control Unit **shutdown** wait for **at least 30 seconds** before **power it up again**.

– Before removing any connector **wait for at least 30 seconds** and make sure that all the LED are turned off.
The non-compliance with these warnings may result in:
  • jamming one or more modules
  • jeopardizing one or more modules functionality.

– In case of occurring blocking of one or more modules, shut down the system, wait for at least 30 seconds and reconnect the power supply.

– If installed, **X120 connector shall not be used for the power supply powering-off** (C5G-MCK option).

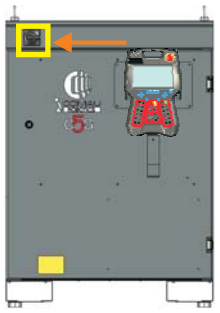
– To **increase the battery life** do not shut down the Control Unit before carrying out the **shutdown software** procedure.

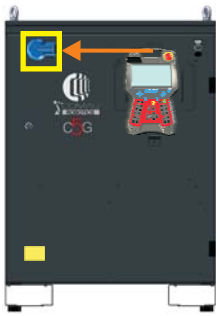
– The **shutdown software** procedure ensures the files and applications closing without requiring the using of the buffer battery.

Shutting down the Control Unit when the Robot is moving, forces the system and consequently the Robot to immediately stop without deceleration ramps, with resulting kinematic chain stress, trajectory direction deviation (unpredictable due to the force of gravity) with consequent risks of impact. The constant repetition of this modality of stopping can damage the Robotic System and/or the equipment connected to the Robot.

Pay attention to the interconnected voltages, usually identified with orange coloured conductors.

4.2 Disconnection of the electrical power supply





Status:	–	Before disconnecting the electrical power supply, it is recommended to deactivate the Robotic system by means of the **shutdown software** procedure.
Material:	–	Padlock (not supplied) **Europe**: min. 4 mm / max 8 mm (*min. 0.15 in / max 0.31 in*), **North America**: external min. 5 mm / max 8 mm (*min. 0.20 in / max 0.31 in*) internal min. 1/4 in / max 0,31 in.
Equipment:	–	Not required

Preliminary procedures / notes

– Most maintenance activities foreseen on the Control Unit are to be carried out with the electrical power supply turned off. In these cases the maintenance sheet bears the inscription “**Main circuit breaker open (OFF)**”.

– Some activities, especially those related to cabinet main power supply disconnecting, must be carried out only after having completely disconnected the power supply of the electric mains. In these cases the maintenance sheet bears the inscription “**Electrical power supply turned off**”.

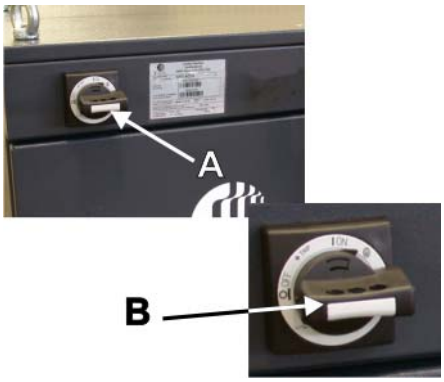
The main circuit breaker located on the Control Unit disconnects the power supply only of the Robot (or Robots) connected to it and occasionally of the application.

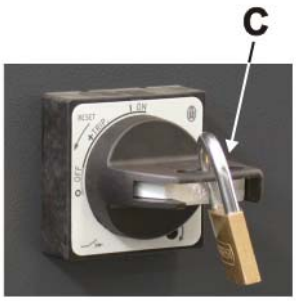
–To verify the area or devices powered by a specific Control Unit it may be necessary to refer also to the Instructions Handbook of the machine which the Robotic System is integrated into.

Operating procedure

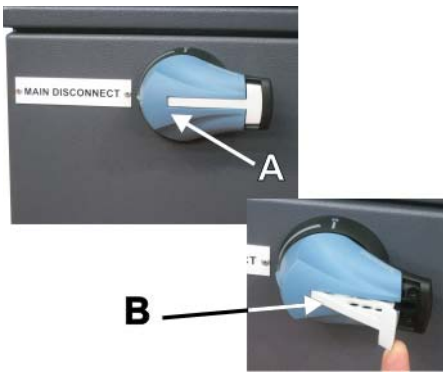
Main circuit breaker open (OFF)

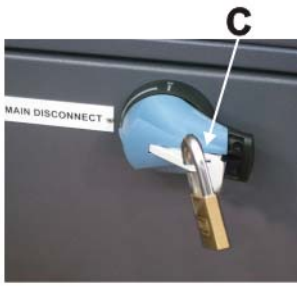
Main circuit breaker on C5G Control Unit (Europe version)



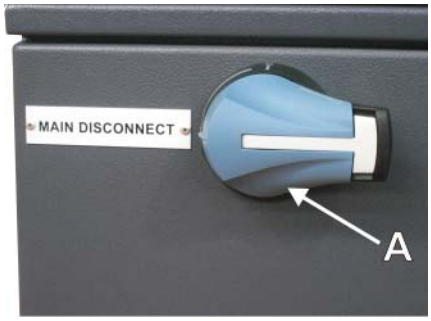


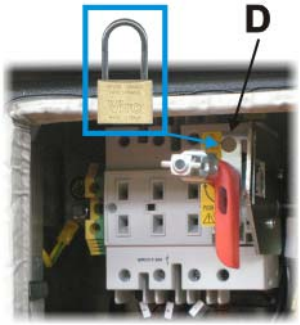
Main circuit breaker on C5G Control Unit (North America version) - in case of power supply disconnection for Robot maintenance purpose





Main circuit breaker on C5G Control Unit (North America version) - in case of power supply disconnection for Control Unit maintenance purpose





a. Carry out the software shutdown. Use the specific command on the Teach Pendant.

b. Wait for the ending of the shutdown procedure.

Operating procedure (Continued)

c. **In case of Robot or Europe Control Unit maintenance**:

c.1 With closed cabinet door, set the Q100 main circuit breaker handle (A) in 0 (OFF) position.

c.2 Move the lever (B) to access the slot.

c.3 Insert the padlock into the slot (C) available on the external handle.

d. **In case of North America Control Unit maintenance**:

d.1 With closed cabinet door, set the Q100 main circuit breaker handle (A) in 0 (OFF) position.

d.2 Open the cabinet door

d.3 Insert the padlock into the slot (D) available on the external handle.

e. **On completion of maintenance**

f. Remove the padlock only at the end of the maintenance activity.

g. The padlock is not supplied together with the electrical cabinet.

With main circuit breaker open, the X120 connector (when present) and the cable upstream the main circuit breaker are live.

Operating procedure (Continued)

Electrical power supply turned off

(if the optional connector X120 is not installed)

a. Perform the power supply off-switching as specified in Main circuit breaker open (OFF).

b. Open and padlock the main circuit breaker upstream the Control Unit. The padlock is not supplied together with the Control Unit.

Electrical power supply turned off
(if the optional X120 connector is installed)

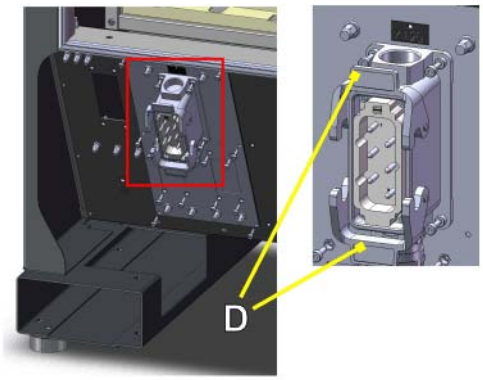
If available, X120 connector shall not be removed with Q100 main circuit breaker closed.

a. Disconnect the electrical power supply as indicated in the previous steps.

b. This activity requires the removal of X120 connector, located in the box lower area.

c. Release the levers (D).

d. Remove the X120 mating connector



Follow-up procedure

– Not necessary on C5G Control Unit (Europe Version)
– On Control Unit C5G (North America Version), when closing the door at the end of the maintenance:
  - do not damage the control and extension shaft
  - carefully close the doors, avoiding excessive pressures.
  - secure the door acting on the lock.

5. HOW TO MOVE THE ROBOT IN CASE OF EMERGENCY

This chapter deals with the following topics:

5.1 Precautions before starting

– Read carefully the instructions described in Chap.2. - Maintenance requirements on page 18
– The “integrated brake releasing module” installed on the Robot may not function in case of damaged Control Unit (see par. 5.2.1 Risks deriving from Robot axes releasing on page 33). Instead the C5G-OBR Brake releasing Module (optional) can be used. The C5G-OBR Brake releasing Module is to be used as alternative solution, when the use of the Teach Pendant is not possible.
– The C5G-OBR Brake releasing Module functioning principle consists in supplying the motors brakes with 24Vdc from external source. The command may therefore generate risks of falling (refer to par. 5.3.1 Risks associated with the Robot motion without the Control Unit being connected on page 36).

5.2 Use of the integrated brake releasing module

5.2.1 Risks deriving from Robot axes releasing

The functionality of the integrated brake releasing module is always available with the Control Unit powered off and motor cables connected.

- The axes brake releasing operation generates the risk of falling of the axes because of the gravity.
- Robot axes subjected to gravity must be held with suitable lifting means (crane, overhead crane).
- Depending on the load applied to the Robot wrist and position, the handling of the axes may not be predictable and could generate a fall profile not perpendicular to the ground.
- During brake releasing operation the operator must avoid standing under the Robot parts that can move upwards or downwards due to forces generated by the balancing system or gravity. No operator can stand in the workspace and in particular under the Robot axes.
- Suitable lifting means may be required to lift the axes and equipment installed onthe Robot wrist, due to their weight (e.g. crane or overhead crane).
- In case a person is entrapped, carry out a brake releasing instruction, only if you are sure that the person does not undergo a higher pressure caused by the weight of the released axes.
- This operation requires at least 2 operators: one to control the crane or overhead crane, the other to control the axes brake releasing operation.
- The dynamic brake release function could be compromised by failures on the C5G drive section having the same name or by the absence of motor electrical connection: in this case the brake release provokes the axis free fall. In case of proper function of the dynamic brake, there exists the fall risk, but with slower fall.

5.2.2 Usage procedure of the integrated brake release device

In the absence of motive power, the Robot axes movement is possible by means of optional release devices and suitable lifting devices. Such devices enable only the brake deactivation of each axis. In that case, all system safety devices (including the emergency stop and enabling push-button) are cut-off.

Status:	–	Power on, C5G on. – X2 motors cable connected to the Robot and control
Material:	–	Integrated brake release device installed on Robot.
Equipment:	–	Suitable lifting means to support the Robot axes subject to gravity

Preliminary procedures / notes

The axes brake releasing operation generates the risk of falling of the axes because of the gravity. Please refer to par. 5.2.1 Risks deriving from Robot axes releasing on page 33.

– In order to be able to operate, the integrated brake releasing module requires:
  - that electric power is delivered to the Control Unit.
  - that the Control Unit is on with 24Vdc section available and working properly.
  - Robot connected to the Control Unit by means of X2 motors cables.
  - Motors off (Drive OFF). With Drive ON motors, the push-button pressure is not influential.
– Motion freedom of axes is conflicted and slowed down by dynamic brake (if it is not damaged).

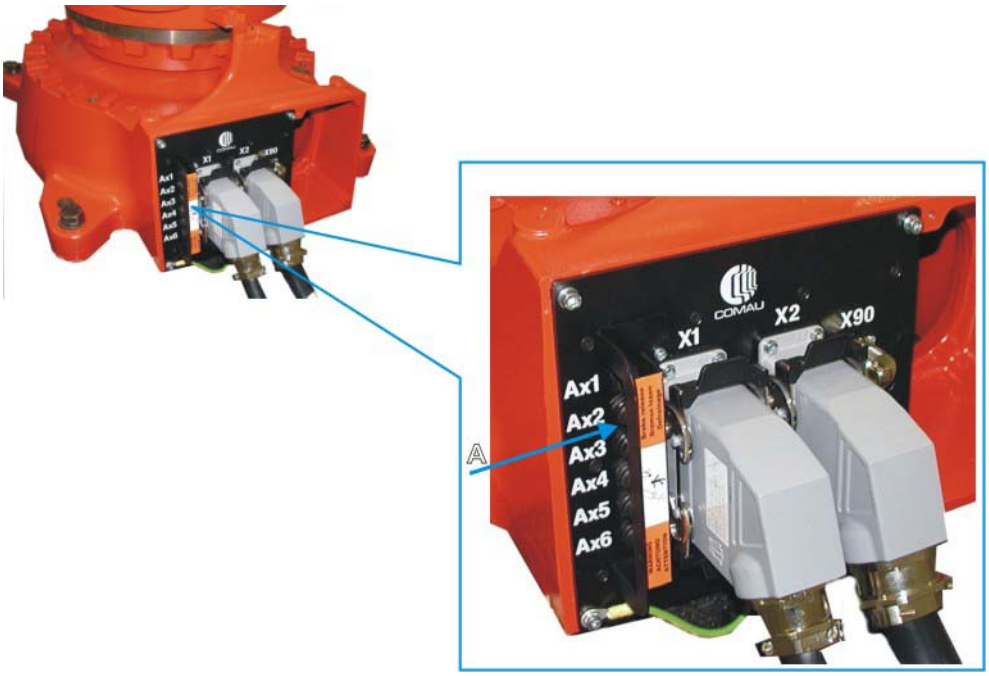
Operating procedure

a. Support the Robot axes subject to gravity with crane or overhead crane. Use ropes or bends. Do not use chains. See the Robot handbook to detect the most suitable points to sling the Robot.

b. To release the Robot axes:
  - Press singularly the push-buttons A.
  - On each push-button there is the wording identifying the related axis.

Pay particular attention, because when pressing more than one push-button, more than one axis simultaneously are released and the Robot reaction is unpredictable.

Operating procedure (Continued)



c. It is recommended to control the brake releasing by pressing the push-button shortly and contemporaneously reducing gradually the pulling tension of the ropes used to support the axes that are subject to gravity.

d. The control is active for the time the action is performed: at the release, the motion stops due to the brakes action.

Follow-up procedure

– Not required.

5.3 Use of the C5G-OBR brake releasing module

5.3.1 Risks associated with the Robot motion without the Control Unit being connected

- The axes brake releasing operation generates the risk of falling of the axes because of the gravity.
- Robot axes subjected to gravity must be held with suitable lifting means (crane, overhead crane).
- Depending on the load applied to the Robot wrist and position, the handling of the axes may not be predictable and could generate a fall profile not perpendicular to the ground.
- During brake releasing operation the operator must avoid standing under the Robot parts that can move upwards or downwards due to forces generated by the balancing system or gravity. No operator can stand in the workspace and in particular under the Robot axes.
- Suitable lifting means may be required to lift the axes and equipment installed onthe Robot wrist, due to their weight (e.g. crane or overhead crane).
- In case a person is entrapped, carry out a brake releasing instruction, only if you are sure that the person does not undergo a higher pressure caused by the weight of the released axes.
- This operation requires at least 2 operators: one to control the crane or overhead crane, the other to control the axes brake releasing operation.
- The C5G-OBR Brake releasing Module excludes all the system safety devices: emergency stop, enabling device push-button, general stop and fence.
- If not differently specified, the contemporaneous use of 2 or more connectors can generate additional risks.
- For information on connector to be used, the selection on selector switch on brake releasing module and consequent released axis, see the following table Tab. 5.1.

The selected axis on the selector switch may not correspond to the number of axis defined in the robotic system. Before issuing the axis release command, check the proper selection on the selector switch and the corresponding matched axis: a neglected matching can cause accidental falling of an axis / arm / satellite due to gravity.

Never use brake releasing push-buttons when operating the C5G-OBR brake releasing module.

Tab. 5.1 - Connector and released axes matching

Part No.	Connector on Robot base	Mating connector to be used on C5G-OBR module	Selected axis on selector switch of the C5G-OBR module					
			1	2	3	4	5	6
			Released axis on the Robot					
NJ	X2	**X2**	1	2	3	4	5	6

5.3.2 Usage procedure of the C5G-OBR brake releasing Module

Status:	–	Power turned off
Material:	–	Power supply cable with plug suitable for the electric energy connection point (not included with the C5G-OBR Brake releasing module)
Equipment:	–	C5G-OBR Brake releasing module
	–	Suitable lifting means to support the Robot axes subject to gravity

Preliminary procedures / notes

The usage procedure of the C5G-OBR brake releasing module option must be carried out when it is not possible to use the Control unit to check the axes motion and / or in case of maintenance operation.

The axes brake releasing operation generates the risk of falling of the axes because of the gravity. Please refer to par. 5.3.1 Risks associated with the Robot motion without the Control Unit being connected on page 36.

– The C5G-OBR Brake releasing Module option includes a mating plug suitable for the panel socket located on the module rear side. Before the first use, connect a power supply cable with suitable plug to the mono-phase power supply system present in the plant.
– Provide power to the module (from 100 to 230 Vac, 1.5 A @ 120 Vac / 0.7 A @ 230 Vac). The cable section shall be at least 0.5 mm² / 20 AWG. Adjust the section according to the cable length and the protection upstream.

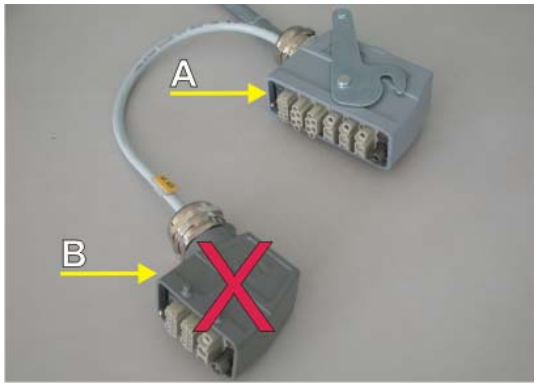
Make sure the power supply voltage is suitable to the model of the brake releasing module used.

Operating procedure

a. Support the Robot axes subject to gravity with crane or overhead crane. Use ropes or bends. Do not use chains.

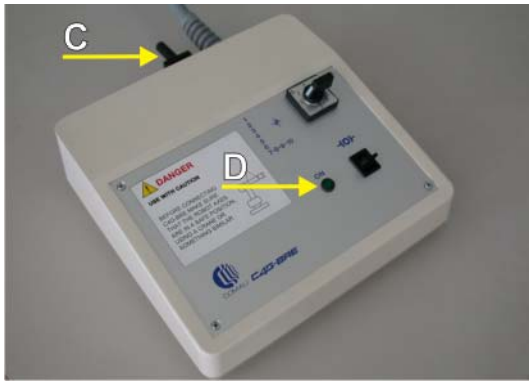
Operating procedure (Continued)

b. To release the 6 Robot axes:
- Disconnect the X2 power connector on Robot base. The connector position differ depending on the type of Robot installation.
- Connect the mating connector (A) to the X2 connector on Robot base. The mating connector (B) should not be used and can be left positioned on the floor.



c. Provide input (C) power supply to the brake releasing module.

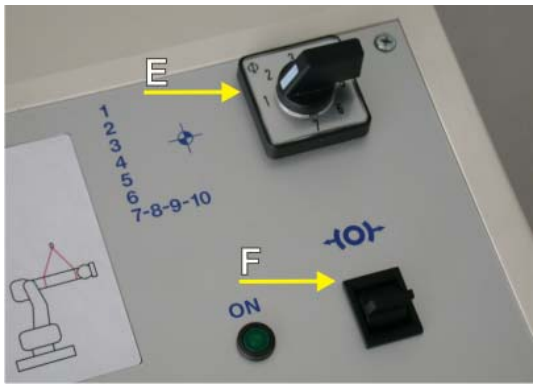
d. The presence of power supply is signalled by the lighting on of the green Led (D).



Representative figure

e. On the selector switch (E) select the axis that you want to release.

f. Se sure to strain the ropes used to support the axes subject to gravity.



g. To release the 6 Robot axes:
- To release axes from 1 to 6 they can be singularly selected with their related position.

h. Use the lever push-button (F) to release the concerned axis. Activate the push-button with short pressure and check the effect of the motion caused by the axis released by the brake. Contemporaneously release gradually the ropes used to support the axes subject to gravity.

i. The push-button release stops the motion thanks to the brake action (maintained operate switch).

Follow-up procedure

– Restore the connections of the power connectors on the Robot and/or the interested axes.

Restore the Robot function after the use of the C5G-OBR brake releasing module

The motion by means of C5G-OBR Brake releasing module leads to axes Turn-set lost; therefore it is very important to restore properly the functioning before the next use:
–Before issuing the Drive On command, do not stand under the Robot and make sure that nothing stands under the axes subject to gravity.
–in Turn-set condition, during Drive on, may occur a falling of the axes subject to gravity, which in case of very big and long Robot arms, can reach several centimetres.

To restore the Turn-set condition proceed as indicated in par. 11.3 Turn-set procedure on page 144.

In case of maintenance with components replacement belonging to the Robot kinematics (motor, gearbox, ...) it is necessary also to carry out the axes calibration operations, as indicated in par. 11.4 System calibration by means of tools on page 145.

6. MAINTENANCE STRUCTURE

This chapter deals with the following topics:

- Overview
- Summary Diagram of the maintenance operations.

6.1 Overview

The Robot maintenance is divided in:

- Summary Diagram of the maintenance operations (see par. 6.2 on page 42)
- Preventive Maintenance
- Special maintenance.

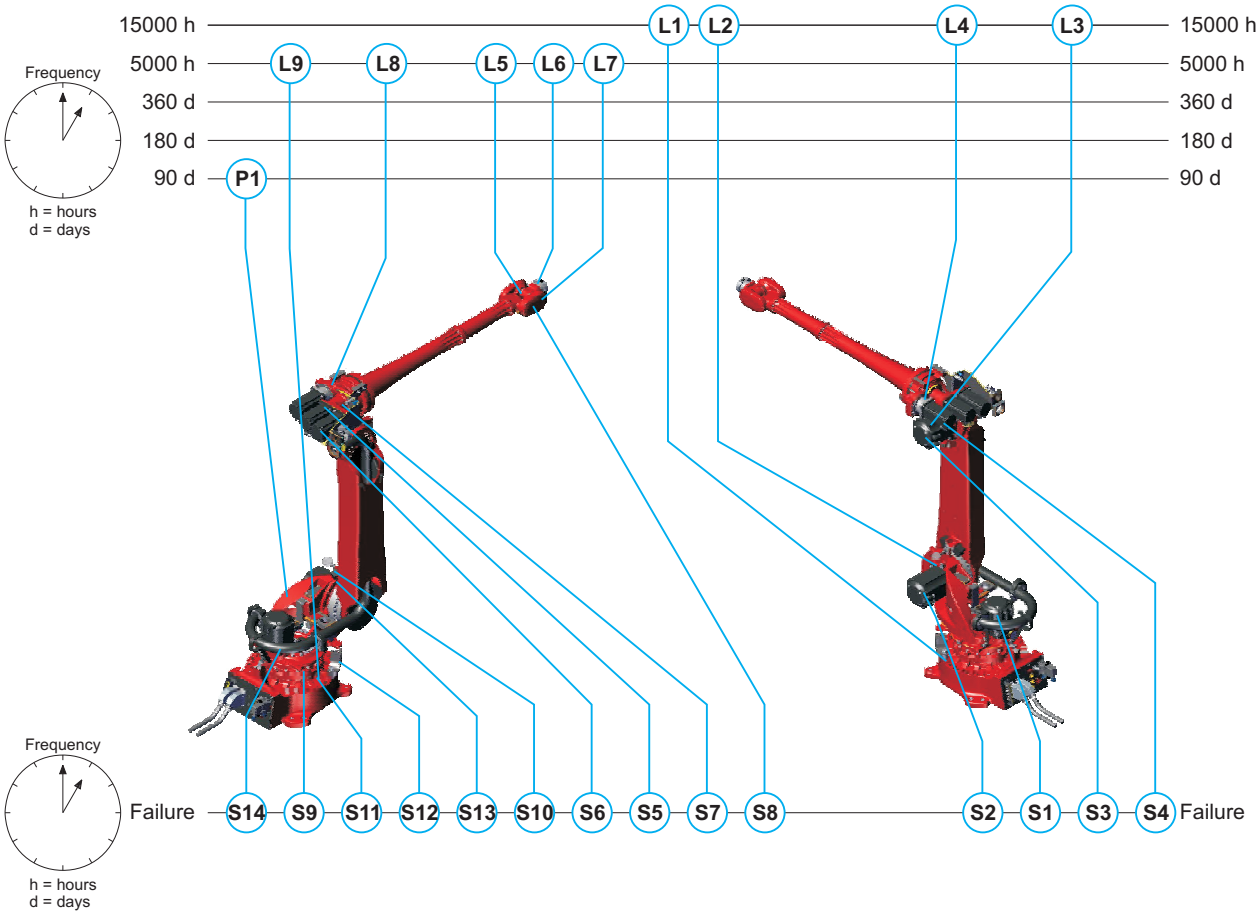
It is recommended to carry out accurate and precise preventive maintenance operations in order to retain over the long term the Robot functional features.
Poor or missing preventive maintenance activities during the warranty period will be regarded as prejudicial to the warranty itself.
The final user must carry out only the maintenance activities listed in this maintenance handbook: for further operations contact the Comau Service Center.

6.2 Summary Diagram of the maintenance operations

The Fig. 6.1 presents the complete maintenance plan diagram in which are identified the positions and frequency of the maintenance interventions to be carried out on Robot.

In the figure are shown the intervention points which can be identified with the references given in the summarising tables of Tab. 7.2 - Preventive maintenance plan on page 45 and Tab. 9.2 - Special maintenance plan on page 81.

Fig. 6.1 - Summary Diagram of the maintenance operations



In the diagram it is represented the Robot installed on the floor.

P_n = Preventive Maintenance
L_n = Lubrication
S_n = Special Maintenance

7. PREVENTIVE MAINTENANCE

This chapter contains:

It is recommended to carry out accurate and precise preventive maintenance operations in order to retain over the long term the Robot functional features.

7.1 Precautions before starting

– Read carefully the instructions described in par. 1. General safety requirements on page 9
– To guarantee the Control Unit proper functioning, it is necessary to carry out periodically preventive maintenance operations, to reduce the amount of faults caused by the ordinary deterioration over time and maintain longer its functional features.

Poor or missing preventive maintenance activities during the warranty period will be regarded as prejudicial to the warranty itself.

7.2 Required equipment

The minimum equipment required for Robot preventive maintenance is:

Tab. 7.1 - Required equipment

–	5, 8 and 10 mm Allen wrench
–	Ratchet torque wrench (or screwdriver) with bits and extension rods
–	Insert for torque wrench 5, 8 and 10 mm
–	Funnel
–	Funnel with flexible extension with cut (for air purge)
–	Drain oil collection container
–	Vacuum generator
–	Fittings for vacuum generator
–	Pipe for oil filling and draining from gearbox
–	Material and detergents for cleaning
–	Tube with fitting 1/2”
–	Tube with fitting 1/8”
–	Manual grease pump
–	Conical grease gun with thread 1/8” GAS
–	Syringe
–	Electronic balancer with 14 gr tolerance (0 ÷ 2 kg)

7.3 Preventive maintenance plan

Find in Tab. 7.2 the preventive maintenance plan based on the periodicity.

Tab. 7.2 - Preventive maintenance plan

Frequency	Intervention / Sheet	Paragraph	Ref. [1]
90 days	Robot cleaning and general inspection	par. 7.4	P1
15000 hours	Oil replacement on axis 1 gearbox (floor installation)	par. 8.3.1	L1
	Oil change on axis 1 gearbox (ceiling installation)	par. 8.3.2	
	Oil replacement on axis 2 gearbox (floor installation)	par. 8.3.3	L2
	Oil change on axis 2 gearbox (ceiling installation)	par. 8.3.5	
	Oil replacement on axis 3 gearbox (floor installation)	par. 8.3.4	L3
	Oil change on axis 3 gearbox (ceiling installation)	par. 8.3.6	
	Oil change on axis 4 gearbox	par. 8.3.7	L4
5000 hours	Grease change on axis 5 gearbox compartment	par. 8.3.9	L5
	Grease change on axis 6 gearbox compartment	par. 8.3.10	L6
	Oil replacement on wrist assembly	par. 8.3.11	L7
	Grease change on axis 4 gear compartment	par. 8.3.8	L8
	Lubrication Axis 1 On-Off mechanical hard stop unit (base RV260C) (CR82362900)	par. 8.3.12	L9

[1] The reference is given in Fig. 6.1 - Summary Diagram of the maintenance operations on page 42.

P_n = Preventive Maintenance
L_n = Lubrication

7.4 Robot cleaning and general inspection

Status:	– Power supplies (electrical and pneumatic) cut off
Material:	– Material and detergents for cleaning If necessary: – Warning plates (see Tab. 7.3)
Equipment:	– Ratchet torque wrench with bits and extension rods – Set of bits and sockets for torque wrench If necessary: – material and equipment for removing and fixing the warning signs
Fixing components:	– ---

Preliminary procedures/ notes

– The frequency of intervention indicated in Tab. 7.2 - Preventive maintenance plan on page 45 can vary depending on the environment and the type of application.
– The procedure is divided into the following steps:
  • Robot cleaning
  • Check of the structure integrity and warning plates
  • Check of Robot fixing

Operating procedure

Robot cleaning

Clean the Robot parts.

Check of the structure integrity and warning plates

a. Check integrity and good conservation state of all the Robot parts.

b. Check the presence and proper fixing of the warning signs. The warning signs position is given in Fig. 7.1.

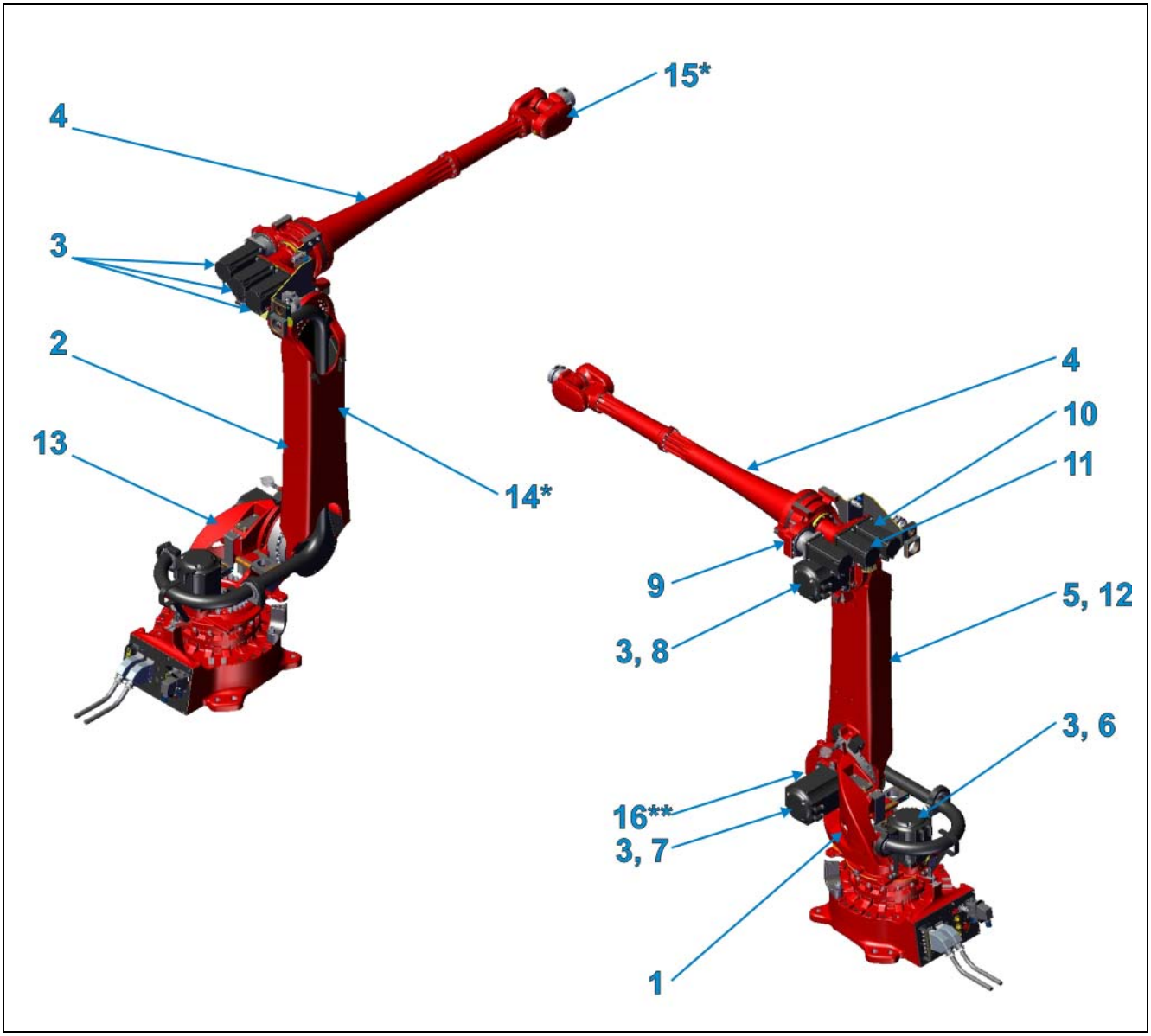
c. Check the integrity and good conservation state of the warning signs.

d. If the warning signs were no longer legible, replace them with signs having the same features. The warning signs part numbers are listed in Tab. 7.3

Operating procedure (Continued)
Check of Robot fixing
e. Check the proper tightening and integrity of connectors.
f. Check the proper tightening and integrity of wiring power supply pipes.
g. Check the proper locking of brackets and wiring supports.
h. Check, by means of appropriate visual reference notches, the proper tightening of the screws that fix the Robot to the floor or to the supporting structure.
i. Check, using suitable visual reference notches, the proper tightening of the screws that fix the equipment on the Robot flange.

Follow-up procedure
– Not necessary

Fig. 7.1 - Warning signs position



Tab. 7.3 - List of warning signs

Ref.	Description	Comau Part No.
1	Lifting and transport warning sign	CR82363501
2	Company logo warning sign diameter 140	82312504
3	Monitory sign (Hot parts)	81784803
4	Comau Robotics plate - 150	CR82281716
5	Lubricants identification plate	82312406
6	MTR 1 - SYN 1 warning sign	81827318
7	MTR 2 - SYN 2 warning sign	81827309
8	MTR 3 - SYN 3 warning sign	81827315
9	MTR 4 - SYN 4 warning sign	81827304
10	MTR 5 - SYN 5 warning sign	81636711
11	MTR 6 - SYN 6 warning sign	81807117
12	Monitory sign (shearing)	82206516
13	Identification plate (Robot NJ 16 In-line)	CR82360801
	Identification plate (Robot NJ 16 In-line Foundry)	CR82365901
14*	Foundry plate	CR82303603
15*	Foundry Wrist plate	CR82325479
16**	Vent plugs plate	CR82393103

*: Only for Robot Foundry
**: Only for ceiling installation

8. LUBRICATION PROCEDURES

This chapter contains:

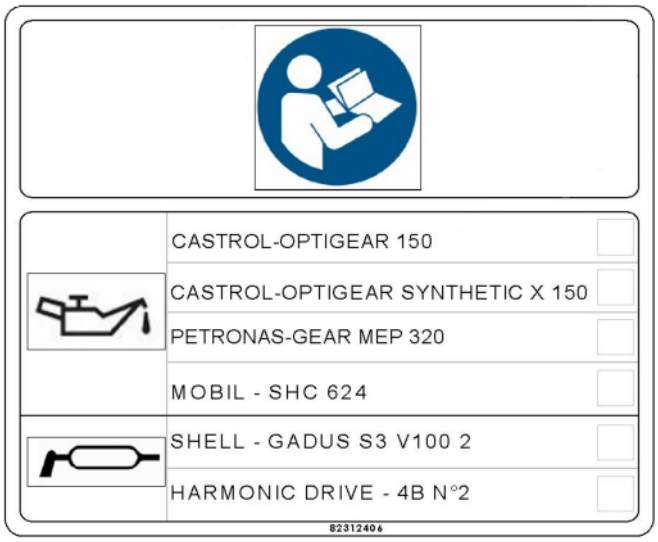
8.1 Precautions regarding the use of lubricants

When assembled in COMAU, the Robot is supplied with lubricants that do not contain any harmful to health substances, however, in some cases, repeated and prolonged exposure to the product may cause skin irritation, or if swallowed, sickness.

In case of contact with eyes or skin: rinse the affected areas with copious amount of water; if irritation persists, consult a doctor.
If swallowed, do not induce vomiting or administer anything by mouth; seek medical advice immediately.

The lubrication operations must be carried out respecting the type of lubricant indicated on the lubricants identification plate installed in a clearly visible position on the Robot body. The indication of the type of lubricant is represented with an “X”.
Do not mix different lubricants.

Fig. 8.1 - Lubricants identification plate



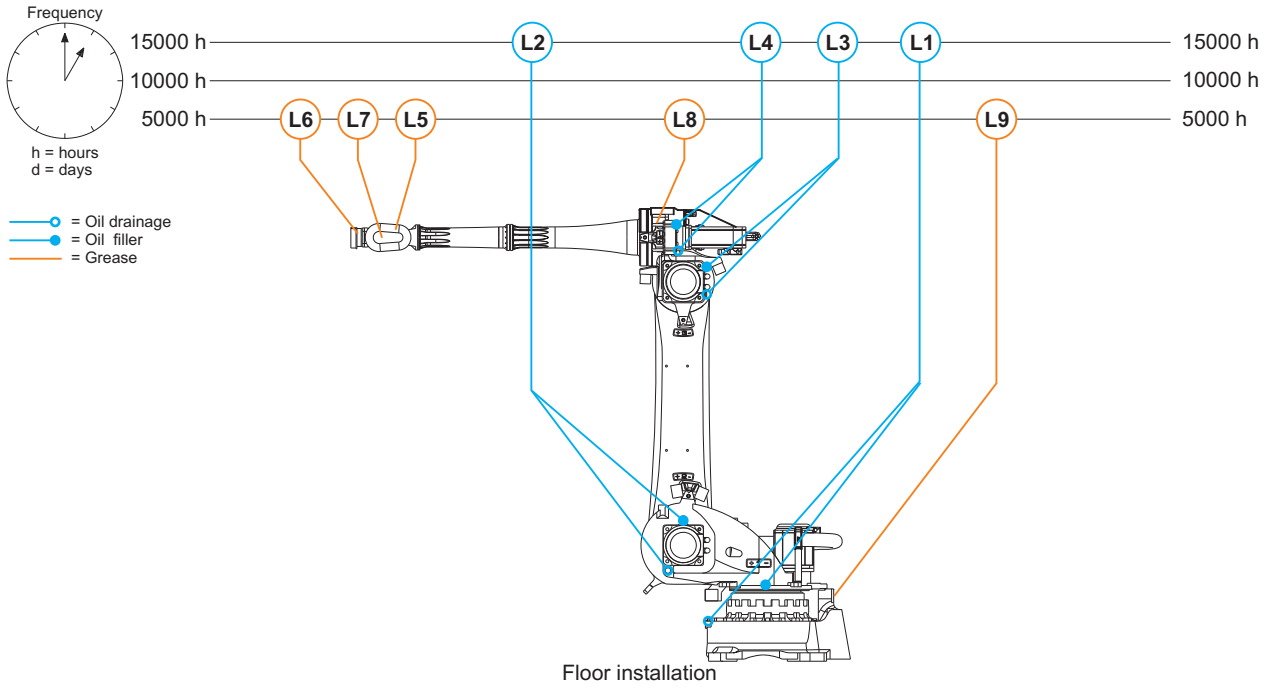
8.2 Remarks on lubrication operations

Before starting the lubrication operations, carry out a general cleaning of the surrounding parts of the lubrication point, in order not to allow the possible insertion of dirt and/or impurities inside the machine body.
After lubrication operations, carry out a general cleaning of the parts surrounding the lubrication point, in order to remove possible lubricant residues.

The quantity of lubricant indicated for the “first intervention” refers to filling after a new unit has been installed.
The quantity indicated for the “following interventions” refers to the replenishment of lubricant drained from the assembly considering an indicative time, required for draining, between 10 and 15 minutes. The time required to drain off the lubricant depends on its viscosity and the temperature of the environment where the operation takes place.

The disposal of used oils and greases must be carried out in accordance with the legislation in force in the country where the Robot is installed.

8.3 Summary of lubrication points



Part to be lubricated	Gearbox						Gears		Axis 1 On-Off mechanical hard stop unit
	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6	Wrist	Axis 4	
Intervention point	L1	L2	L3	L4	L5	L6	L7	L8	L9
Type of lubricant used	OIL - CASTROL OPTIGEAR 150 See Lubricants identification plate			OIL - CASTROL OPTIGEAR SYNTETIC X150 See Lubricants identification plate	GREASE - SHELL GADUS S3 V100 2 See Lubricants identification plate		OIL - MOBIL SHC 624 See Lubricants identification plate	GREASE - SHELL GADUS S3 V100 2 See Lubricants identification plate	
Identification symbol									
Type of intervention	Change				Change		Change	Change	
Frequency of intervention	15000 hours				5000 hours				
Type of allowed lubricant	CASTROL OPTIGEAR 150			CASTROL OPTIGEAR SYNTETIC X150	FUCHS RENOLIT LX EP2 SHELL GADUS S3 V100 2 ESSO UNIREX N2 TEXACO STARPLEX EP2 MOBIL MOBILGREASE XHP222		MOBIL SHC 624	FUCHS RENOLIT LX EP2 SHELL GADUS S3 V100 2 ESSO UNIREX N2 TEXACO STARPLEX EP2 MOBIL MOBILGREASE XHP222	

Part to be lubricated	Gearbox						Gears		Axis 1 On-Off mechanical hard stop unit
	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6	Wrist	Axis 4	
Intervention point	L1	L2	L3	L4	L5	L6	L7	L8	L9
Q.ty for 1st intervention *1	2.70 kg / 3.00 l	1.71 kg / 1.89 l	1.50 kg / 1.60 l	0.06 kg / 0.075 l	0.002 kg	0.001 kg	0.45 kg / 0.53 l	0.1 kg / 0.11 l	10 gr
Quantity for following interventions *2	2.5 kg / 2.77 l	1.51 kg / 1.69 l	1.08 kg / 1.2 l	*3	0.002 kg	0.001 kg	0.40 kg / 0.44 l	0.1 kg / 0.11 l	10 gr
Procedure detail	par. 8.3.1 *4	par. 8.3.3 *4	par. 8.3.4 *4	par. 8.3.7	par. 8.3.9	par. 8.3.10	par. 8.3.11	par. 8.3.8	par. 8.3.12
Procedure detail	par. 8.3.2 *5	par. 8.3.5 *5	par. 8.3.6 *5						

*1 Quantity related to a filling after the assembly of a new unit
*2 Quantity related to refilling of lubricant removed by the unit
*3 About 60% of quantity used during the first filling (indicative quantity for supply)
*4 Installation on the floor
*5 Installation on ceiling

8.3.1 Oil replacement on axis 1 gearbox (floor installation)

Status:	–	Power supplies (electrical and pneumatic) cut off
Material:	–	Lubricant: - Type: OIL - CASTROL OPTIGEAR 150 See Lubricants identification plate - Quantity: 2.5 kg / 2.77 l - Details in par. 8.3
	–	Material and detergents for cleaning
	–	Threadlocker Loctite 572
Equipment:	–	Allen wrench of 10 mm
	–	Torque wrench with 10 mm bit
	–	Funnel
	–	Drain oil collection container
Fixing components:	–	Magnetic hex head plug 1/2” GAS MINTOR (Q.ty: 2)

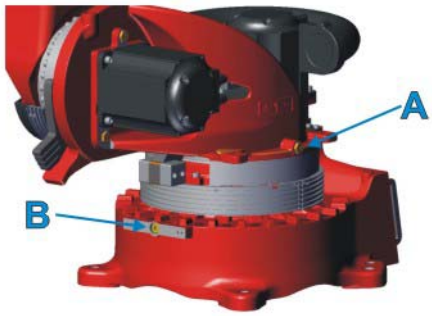
Preliminary procedures/ notes

– Before starting the lubrication operations, carry out a general cleaning of the surrounding parts of the lubrication point, in order not to allow the possible insertion of dirt and/or impurities inside the machine body.

– See Precautions regarding the use of lubricants (see par. 8.1 on page 50) and the Remarks on lubrication operations (see par. 8.2 on page 51).

Gearbox oil change procedure

a. Place a collection container under the oil drain plug **B**; if the container shape does not allow to place it under the drain plug, apply a plastic protection on the Robot base, to channel the oil in the underlying container.



b. Unscrew the filling plug with hex slot 1/2” GAS **A** to vent the compressed air possibly present in the gearbox and prevent the oil from coming out with high pressure when removing the drain plug.

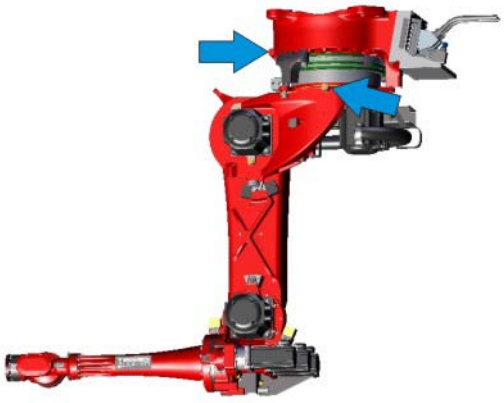
c. Unscrew the drain plug with hex slot 1/2” GAS **B** and drain the oil.

d. To speed up the oil draining, it is possible to blow inside the gearbox compressed air at low pressure (0.5 MPa max).

Gearbox oil change procedure (Continued)
e. After the oil draining, check the sealing gasket and screw the drain plug with hex slot 1/2” GAS **B**, applying the sealant Loctite 572 on the thread.
f. Place a funnel in the filling hole **A** (Plug with hex slot 1/2” GAS) and insert the required lubricating oil.
g. Check the sealing gasket and screw the plug with hex slot 1/2” GAS **A** of the oil filling hole, applying the sealant Loctite 572 on the thread. Tighten up to 30 Nm.

Follow-up procedure
– After lubrication operations, carry out a general cleaning of the parts surrounding the lubrication point, in order to remove possible lubricant residues.
Dispose the waste oil in compliance with the norms in force in the user country.

8.3.2 Oil change on axis 1 gearbox (ceiling installation)



Status:	–	Power supplies (electrical and pneumatic) cut off
Material:	–	Lubricant: - Type: OIL - CASTROL OPTIGEAR 150 See Lubricants identification plate - Quantity: 2.5 kg / 2.77 l - Details in par. 8.3
	–	Material and detergents for cleaning
	–	Threadlocker Loctite 572
Equipment:	–	Vacuum generator
	–	Fittings for vacuum generator
	–	Pipe for oil filling and draining from gearbox
	–	Allen wrench of 8 mm
	–	Allen wrench of 5 mm
	–	Torque wrench with 5 and 10 mm bit
	–	Funnel
	–	Drain oil collection container
	–	Pipe with 1/2" and 1/8" fitting
Fixing components:	–	Magnetic hex head plug 1/2” GAS MINTOR (Q.ty: 2)
	–	Grub screw GAS DN 1/8”

Preliminary procedures/ notes

– Before starting the lubrication operations, carry out a general cleaning of the surrounding parts of the lubrication point, in order not to allow the possible insertion of dirt and/or impurities inside the machine body.

– See Precautions regarding the use of lubricants (see par. 8.1 on page 50) and the Remarks on lubrication operations (see par. 8.2 on page 51).

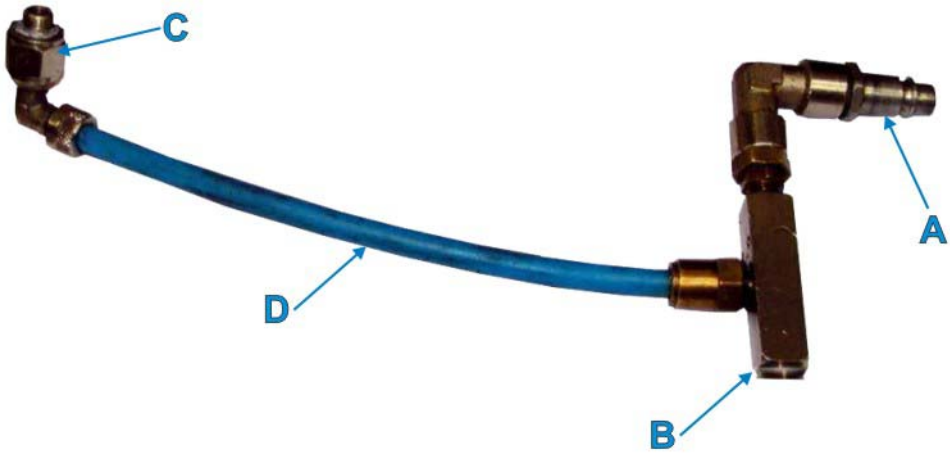
Picture of the equipment to be used

– For oil change in the axis 1 gearbox with Robot installed on ceiling, it is necessary to use a vacuum generator connected with suitable fittings to the compressed air and to the air vent hole set on the Robot base. The vacuum generator works exploiting the Venturi effect. With reference to the following figure, when the vacuum generator is supplied with compressed air, from the fitting **A** to the fitting **C** a depression is generated while the air supplied, together with the sucked one, is discharged from the fitting **B**. When the air supply is interrupted in **A**, the vacuum effect ends in **C**.

(See the following pictures)

Picture of the equipment to be used (Continued)

Vacuum generator and pneumatic connections



A: Pneumatic joint (6 bar)
B: Vacuum generator (6 bar)
C: Fitting 1/8 " gas
D: Air suction pipe

Pipe for oil filling and draining from gearbox

E: Male fitting 1/2 " gas
F: Pipe for oil suction and drain (L max = 1m)

Gearbox oil change procedure

a. Place a collection container under the drain plug with hex slot 1/2" GAS A.

b. Loosen the oil filling plug with hex slot 1/2" GAS **B** to vent the compressed air possibly present in the gearbox and prevent the oil from coming out with high pressure when removing the drain plug.

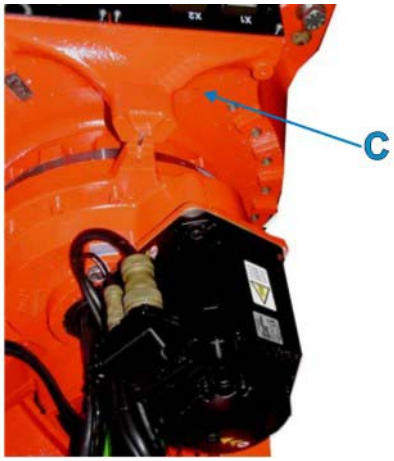
Gearbox oil change procedure (Continued)

c. Unscrew the oil drain plug with hex slot 1/2" GAS **A** and drain the oil.

d. Wait for the oil drain.

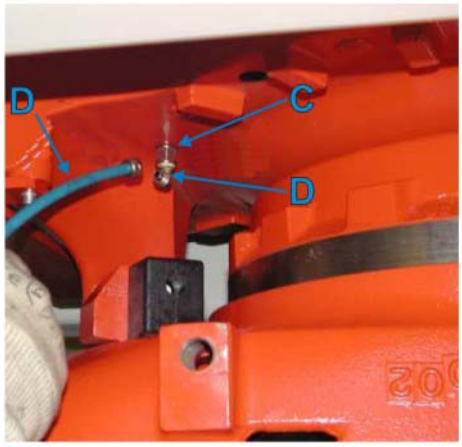
e. Screw in the drainage oil hole A a tube with fitting 1/2".

f. Remove the oil vent plug **C** (grub screw GAS DN 1/8") located on the Robot base.



g. Screw in the air vent hole **C** an elbow fitting **D** of 1/8" GAS.

h. Connect to the fitting D the suction pipe E of the venturi meter F.



Gearbox oil change procedure (Continued)

i. Connect the venturi meter to the pipe for compressed air supply of the plant pneumatic system.

j. Fill a vessel with the foreseen oil and immerse in it the pipe screwed to the hole for oil drain.

k. Feed the venturi meter with compressed air.
The air pressure passing in the venturi meter F creates a depression inside the gearbox box which sucks upward the oil from the tank beneath inserting it in the gearbox.

l. Once the oil filling has been completed check the sealing gasket, apply the sealant Loctite 572 on the thread an screw the cone plug without forcing.

m. With the venturi meter, check the sealing gasket and screw the drain plug **A** (Hex head 1/2" GAS), applying the sealant Loctite 572 on the thread. Tighten to the tightening torque of 30 Nm.

n. Remove the venturi meter.

Follow-up procedure

– After lubrication operations, carry out a general cleaning of the parts surrounding the lubrication point, in order to remove possible lubricant residues.

Dispose the waste oil in compliance with the norms in force in the user country.

8.3.3 Oil replacement on axis 2 gearbox (floor installation)

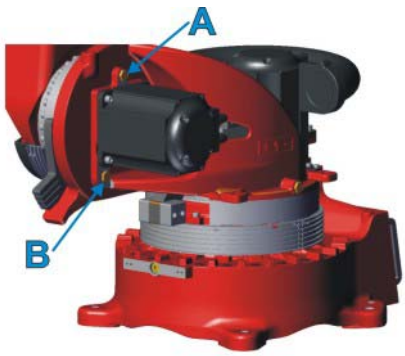
Status:	–	Power supplies (electrical and pneumatic) cut off
Material:	–	Lubricant: - Type: OIL - CASTROL OPTIGEAR 150 See Lubricants identification plate - Quantity: 1.51 kg / 1.69 l - Details in par. 8.3
	–	Material and detergents for cleaning
	–	Adhesive tape
	–	Threadlocker Loctite 572
Equipment:	–	Allen wrench of 10 mm
	–	Torque wrench with insert for 10 mm Allen wrench
	–	Torque wrench with insert for 30 mm open-end wrench
	–	Funnel with flexible extension with cut (for air vent)
	–	Drain oil collection container
Fixing components:	–	Magnetic hex head plug 1/2” GAS MINTOR (Q.ty: 1)
	–	Vent plug 1/2”CR82398900(Q.ty: 1)

Preliminary procedures/ notes

– Before starting the lubrication operations, carry out a general cleaning of the surrounding parts of the lubrication point, in order not to allow the possible insertion of dirt and/or impurities inside the machine body.
– See Precautions regarding the use of lubricants (see par. 8.1 on page 50) and the Remarks on lubrication operations (see par. 8.2 on page 51).
– Pay attention to reposition the vent filling plugs and drain plugs in the correct assembly position.

Gearbox oil change procedure

a. Use adhesive tape to retain the motor cables on one side, to avoid smearing them with oil during the draining.



Gearbox oil change procedure (Continued)

b. Place a container under the drain plug with hex slot 1/2” GAS B.

c. Unscrew from the gearbox the drain plug with hex slot 1/2” GAS **B**.

d. Unscrew and remove the oil vent filling plug 1/2” A.

e. Completed the oil draining, thoroughly clean the drain hole and plug **B** from any ferrous residues.

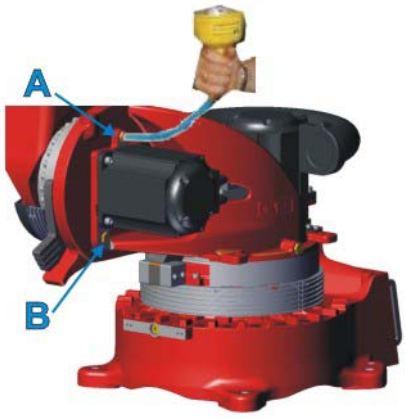
f. Install a new gasket on the drain plug B (with hex slot 1/2” GAS) and tighten it applying the sealant Loctite 572 on the thread. Tighten up to 60 Nm.

g. Place a funnel with flexible extension with cut (for air vent) in the filling hole **A**.

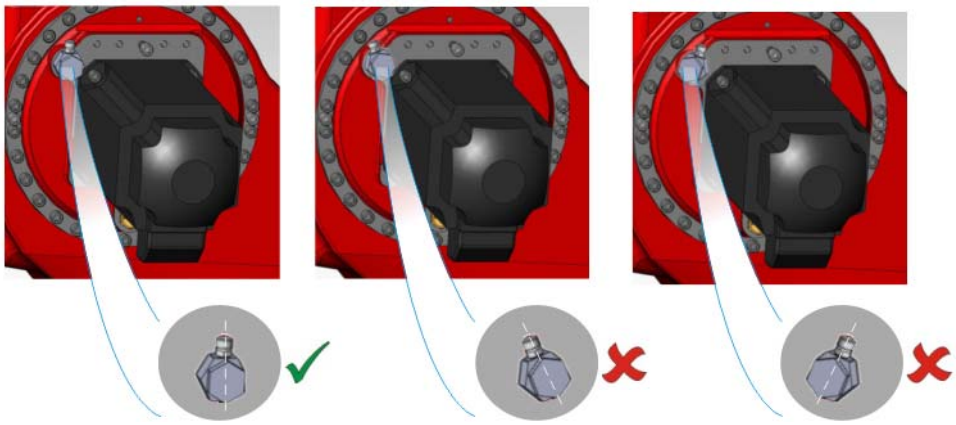
h. Insert the required lubricating oil.

i. Install a new gasket on the filling plug A (1/2”) and loosely tighten it applying the sealant Loctite 572 on the thread.

j. Install a new gasket on the vent of the filling plug **B** and tighten it with an open-end wrench of 14 mm applying the sealant Loctite 572 on the thread.



k. Maintaining the orientation of the vent valve in vertical position as shown in the figure, tighten the filling plug up to 60 Nm and the vent plug up to 10 Nm.



Follow-up procedure

– After lubrication operations, carry out a general cleaning of the parts surrounding the lubrication point, in order to remove possible lubricant residues.

Dispose the waste oil in compliance with the norms in force in the user country.

8.3.4 Oil replacement on axis 3 gearbox (floor installation)

Status:	–	Power turned off (electrical and pneumatic power), except when expressly indicated
Material:	–	Lubricant: - Type: OIL - CASTROL OPTIGEAR 150 See Lubricants identification plate - Quantity: 1.08 kg / 1.2 l - Details in par. 8.3
	–	Material and detergents for cleaning
	–	Adhesive tape
	–	Threadlocker Loctite 572
Equipment:	–	Allen wrench of 10 mm
	–	Torque wrench with 10 mm bit
	–	Funnel
	–	Piping for oil filling
	–	Drain oil collection container
Fixing components:	–	Magnetic hex head plug 1/2” GAS MINTOR (Q.ty: 2)

Preliminary procedures/ notes

– Before starting the lubrication operations, carry out a general cleaning of the surrounding parts of the lubrication point, in order not to allow the possible insertion of dirt and/or impurities inside the machine body.

– See Precautions regarding the use of lubricants (see par. 8.1 on page 50) and the Remarks on lubrication operations (see par. 8.2 on page 51).

Gearbox oil change procedure

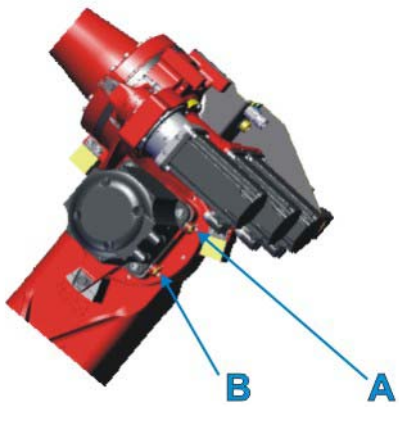
a. Move the Robot setting the filling plug A (Hex head 1/2” GAS) and the drain plug B (Hex head 1/2” GAS) in low position (see approximate position in the figure).

b. Disconnect the energies.

c. Use adhesive tape to retain the motor cables on one side, to avoid smearing them with oil during the draining.

d. Loosen the oil filling plug with hex slot 1/2” GAS **A** to vent the compressed air possibly present in the gearbox and prevent the oil from coming out with high pressure when removing the drain plug with hex slot 1/2” GAS **B**.

e. Place a container under the drain plug with hex slot 1/2” GAS B.



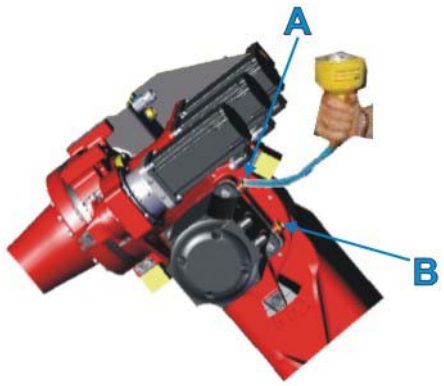
Gearbox oil change procedure (Continued)

f. Unscrew from the gearbox the drain plug **B** (Hex head 1/2” GAS).

g. Wait for the complete oil draining.

h. Power on the energies

i. Move the Robot setting the filling plug A (Hex head 1/2” GAS) and the drain plug B (Hex head 1/2” GAS) in high position (see approximate position in the figure).



j. Disconnect the energies.

k. Unscrew the oil filling plug with hex slot 1/2” GAS A.

l. Place a funnel in the filling hole **A** (Plug with hex slot 1/2” GAS) and insert the required lubricating oil.

m. Check the sealing gasket and screw the plug with hex slot 1/2” GAS **A** of the oil filling hole, applying the sealant Loctite 572 on the thread. Tighten up to 30 Nm.

n. Check the sealing gasket and screw the drain plug **B** (Hex head 1/2” GAS), applying the sealant Loctite 572 on the thread. Tighten to the tightening torque of 30 Nm.

Follow-up procedure

– After lubrication operations, carry out a general cleaning of the parts surrounding the lubrication point, in order to remove possible lubricant residues.

Dispose the waste oil in compliance with the norms in force in the user country.

8.3.5 Oil change on axis 2 gearbox (ceiling installation)

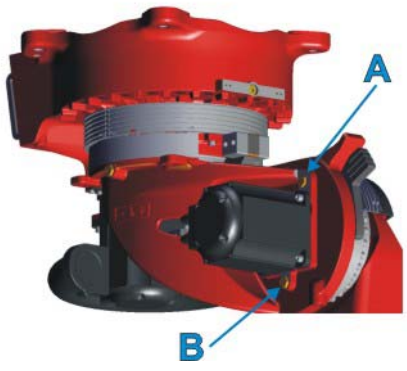
Status:	–	Power supplies (electrical and pneumatic) cut off
Material:	–	Lubricant: - Type: OIL - CASTROL OPTIGEAR 150 See Lubricants identification plate - Quantity: 1.51 kg / 1.69 l - Details in par. 8.3
	–	Material and detergents for cleaning
	–	Adhesive tape
	–	Threadlocker Loctite 572
Equipment:	–	Allen wrench of 10 mm
	–	Torque wrench with insert for 10 mm Allen wrench
	–	Torque wrench with insert for 30 mm open-end wrench
	–	Funnel with flexible extension with cut (for air vent)
	–	Drain oil collection container
Fixing components:	–	Magnetic hex head plug 1/2” GAS MINTOR (Q.ty: 1)
	–	Vent plug TSF3 1/2”(Q.ty: 1)

Preliminary procedures/ notes

– Before starting the lubrication operations, carry out a general cleaning of the surrounding parts of the lubrication point, in order not to allow the possible insertion of dirt and/or impurities inside the machine body.
– See Precautions regarding the use of lubricants (see par. 8.1 on page 50) and the Remarks on lubrication operations (see par. 8.2 on page 51).
– Pay attention to reposition the vent filling plugs and drain plugs in the correct assembly position.

Gearbox oil change procedure

a. Use adhesive tape to retain the motor cables on one side, to avoid smearing them with oil during the draining.



Gearbox oil change procedure (Continued)

b. Place a container under the drain plug with hex slot 1/2” GAS B.

c. Unscrew and remove from the gearbox the drain plug **B** (Hex head 1/2” GAS).

d. Unscrew and remove the oil vent filling plug 1/2” A.

e. Completed the oil draining, thoroughly clean the drain hole and plug **B** from any ferrous residues.

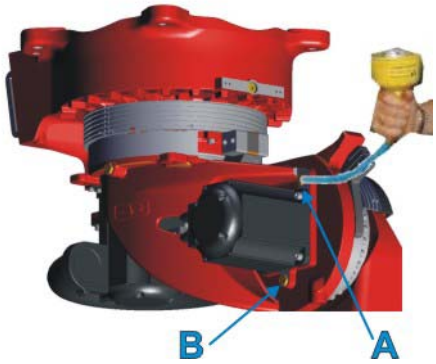
f. Install a new gasket on the drain plug B (with hex slot 1/2” GAS) and tighten it applying the sealant Loctite 572 on the thread. Tighten up to 60 Nm.

g. Place a funnel with flexible extension with cut (for air vent) in the filling hole **A**.

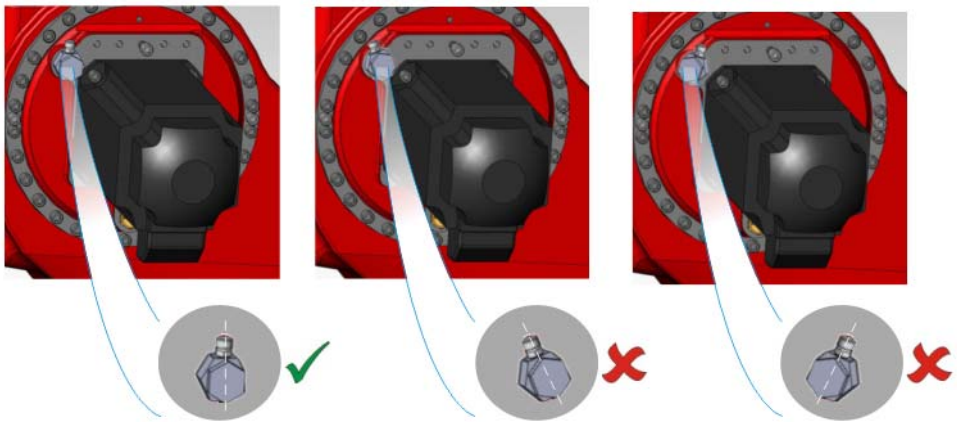
h. Insert the required lubricating oil.

i. Install a new gasket on the filling plug A (1/2”) and loosely tighten it applying the sealant Loctite 572 on the thread.

j. Install a new gasket on the vent of the filling plug **B** and tighten it with an open-end wrench of 14 mm applying the sealant Loctite 572 on the thread.



k. Maintaining the orientation of the vent valve in vertical position as shown in the figure, tighten the filling plug up to 60 Nm and the vent plug up to 10 Nm.



Follow-up procedure

– After lubrication operations, carry out a general cleaning of the parts surrounding the lubrication point, in order to remove possible lubricant residues.

Dispose the waste oil in compliance with the norms in force in the user country.

8.3.6 Oil change on axis 3 gearbox (ceiling installation)

Status:	–	Power turned off (electrical and pneumatic power), except when expressly indicated
Material:	–	Lubricant: - Type: OIL - CASTROL OPTIGEAR 150 See Lubricants identification plate - Quantity: 1.08 kg / 1.2 l - Details in par. 8.3
	–	Material and detergents for cleaning
	–	Adhesive tape
	–	Threadlocker Loctite 572
Equipment:	–	Allen wrench of 10 mm
	–	Torque wrench with 10 mm bit
	–	Funnel
	–	Piping for oil filling
	–	Drain oil collection container
Fixing components:	–	Magnetic hex head plug 1/2” GAS MINTOR (Q.ty: 2)

Preliminary procedures/ notes

– Before starting the lubrication operations, carry out a general cleaning of the surrounding parts of the lubrication point, in order not to allow the possible insertion of dirt and/or impurities inside the machine body.

– See Precautions regarding the use of lubricants (see par. 8.1 on page 50) and the Remarks on lubrication operations (see par. 8.2 on page 51).

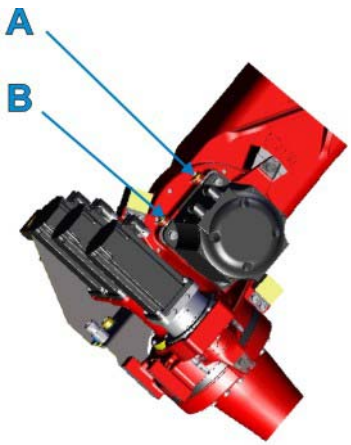
Gearbox oil replacement

a. Move the Robot setting the filling plug A (Hex head 1/2” GAS) and the drain plug B (Hex head 1/2” GAS) in low position (see approximate position in the figure).

b. Disconnect the energies.

c. Use adhesive tape to retain the motor cables on one side, to avoid smearing them with oil during the draining.

d. Loosen the oil filling plug **A** (Hex head 1/2” GAS) to blowdown the compressed air possibly present in the gearbox and to prevent the oil overflowing when the drain plug **B** (Hex head 1/2” GAS) is removed.



Gearbox oil replacement (Continued)

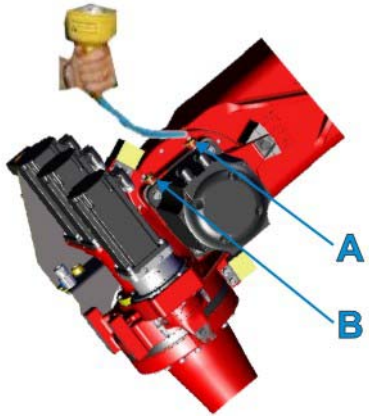
e. Place a container under the drain plug with hex slot 1/2” GAS B.

f. Unscrew from the gearbox the drain plug with hex slot 1/2” GAS **B**.

g. Wait for the complete oil draining.

h. Power on the energies.

i. Move the Robot setting the filling plug A (Hex head 1/2” GAS) and the drain plug B (Hex head 1/2” GAS) in high position (see approximate position in the figure).



j. Disconnect the energies.

k. Unscrew and remove the plug **A** (Hex head 1/2" GAS) from he filling hole with appropriate wrench.

l. Place a funnel in the filling hole **A** (Plug with hex slot 1/2” GAS) and insert the required lubricating oil.

m. Check the sealing gasket and screw the plug with hex slot 1/2” GAS **A** of the oil filling hole, applying the sealant Loctite 572 on the thread. Tighten up to 30 Nm.

n. Check the sealing gasket and screw the drain plug **B** (Hex head 1/2” GAS), applying the sealant Loctite 572 on the thread. Tighten to the tightening torque of 30 Nm.

Follow-up procedure

– After lubrication operations, carry out a general cleaning of the parts surrounding the lubrication point, in order to remove possible lubricant residues.

Dispose the waste oil in compliance with the norms in force in the user country.

8.3.7 Oil change on axis 4 gearbox

Status:	–	Power turned off (electrical and pneumatic power), except when expressly indicated
Material:	–	Lubricant: - Type: OIL - CASTROL OPTIGEAR SYNTETIC - Lubricant quantity: use the same quantity of the drained oil - Details in par. 8.3
	–	Material and detergents for cleaning
	–	Threadlocker Loctite 572
Equipment:	–	Allen wrench of 5 mm
	–	Funnel
	–	Piping for oil filling
	–	Drain oil collection container
	–	Electronic balancer with 14 gr tolerance (0 ÷ 2 kg)
	–	Syringe
Fixing components:	–	Plug M10x1 DIN 908 MAGNETIC (Q.ty: 2)

Preliminary procedures/ notes

– Before starting the lubrication operations, carry out a general cleaning of the surrounding parts of the lubrication point, in order not to allow the possible insertion of dirt and/or impurities inside the machine body.

– See Precautions regarding the use of lubricants (see par. 8.1 on page 50) and the Remarks on lubrication operations (see par. 8.2 on page 51).

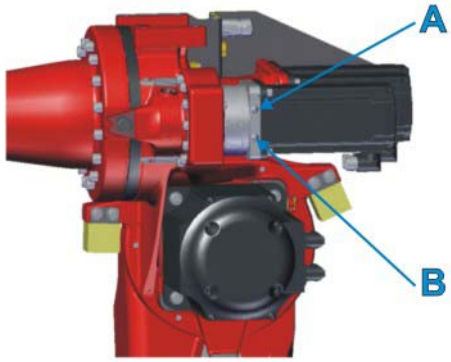
Gearbox oil change procedure

a. Move the Robot setting the filling plug **A** (M10x1) and the drain plug **B** (M10x1) in low position (see approximate position in the figure).

b. Disconnect the energies.

c. Place a container under the drain plug **B** (M10x1).

d. Loosen the filling plug **A** (M10x1) and the drain plug **B** (M10x1).



Gearbox oil change procedure (Continued)
e. Wait for the complete oil draining.
f. Weight the oil quantity removed from the motor gear using a precision electronic balance.
g. Refill the gearbox with prescribed oil using a syringe; insert the same lubricant quantity previously extracted in the hole of plug **A**.
h. Check the sealing gasket and screw the two drain plugs **A** and **B** (M10x1), applying the sealant Loctite 572 on the thread.

Follow-up procedure
– After lubrication operations, carry out a general cleaning of the parts surrounding the lubrication point, in order to remove possible lubricant residues.
Dispose the waste oil in compliance with the norms in force in the user country.

8.3.8 Grease change on axis 4 gear compartment

Status:	–	Power supplies (electrical and pneumatic) cut off
Material:	–	Lubricant - Type: GREASE - SHELL GADUS S3 V100 2 See Lubricants identification plate - Quantity: 0.1 kg / 0.11 l - Details in par. 8.3
	–	Material and detergents for cleaning
	–	Threadlocker Loctite 572
Equipment:	–	Allen wrench of 5 mm
	–	Manual grease pump
Fixing components:	–	Conical plug DN 1/8” GAS
	–	Conical grease gun with thread 1/8” GAS

Preliminary procedures/ notes

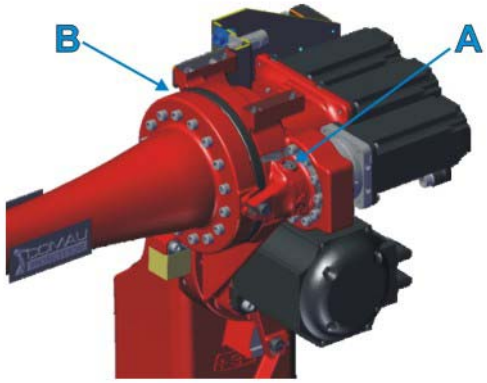
– To speed up the greasing procedure, replace the grease nipples with appropriate conical plugs of 1/8” gas.
– Before starting the lubrication operations, carry out a general cleaning of the surrounding parts of the lubrication point, in order not to allow the possible insertion of dirt and/or impurities inside the machine body.
– See Precautions regarding the use of lubricants (see par. 8.1 on page 50) and the Remarks on lubrication operations (see par. 8.2 on page 51).

Gears compartment grease change procedure

a. Unscrew the filling plug **A** (DN 1/8” GAS) of the lubricant.

b. Install a grease nipple 1/8” GAS.

c. Unscrew the vent plug **B**.



Gears compartment grease change procedure (Continued)
d. Using a manual grease pump, insert slowly the new grease, without applying an exceeding force, **until some clean oil comes out from the vent hole B.**
e. Remove the grease nipple from the hole A.
f. **Do not reassemble the filling plug A and the vent plug B and m**ove the Robot axis for at least 20 minutes, in order to spread equally the lubricant inside the unit, allow the exceeding grease to flow and the grease residual pressure relief. Position suitable grease collection tanks under the drain and vent holes to avoid to get the floor dirt. If it is not possible to carry out a complete axis stroke, increase the Robot motion time.
g. Screw the filling plug **A** (DN 1/8" GAS) **and the vent hole B, applying the sealant** Loctite 572 **on the thread**.

Follow-up procedure
– After 50/100 hours from the lubrication operations, carry out a general cleaning of the parts surrounding the lubrication point, in order to remove any residual lubricant.

8.3.9 Grease change on axis 5 gearbox compartment

Status:	–	Power supplies (electrical and pneumatic) cut off
Material:	–	Lubricant - Type: GREASE - SHELL GADUS S3 V100 2 See Lubricants identification plate - Quantity: 0.002 kg - Details in par. 8.3
	–	Material and detergents for cleaning
	–	Threadlocker Loctite 572
Equipment:	–	Allen wrench of 5 mm
	–	Manual grease pump
Fixing components:	–	Conical plug DN 1/8” GAS
	–	Conical grease gun with thread 1/8” GAS

Preliminary procedures/ notes

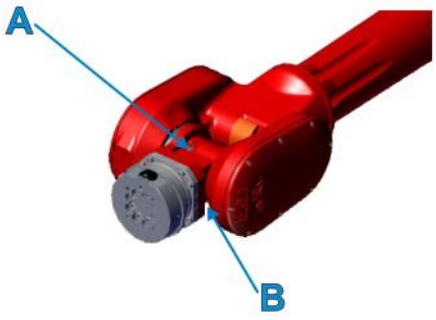
– To speed up the greasing procedure, replace the grease nipples with appropriate conical plugs of 1/8” gas.
– Before starting the lubrication operations, carry out a general cleaning of the surrounding parts of the lubrication point, in order not to allow the possible insertion of dirt and/or impurities inside the machine body.
– See Precautions regarding the use of lubricants (see par. 8.1 on page 50) and the Remarks on lubrication operations (see par. 8.2 on page 51).

Gears compartment grease change procedure

a. Unscrew the filling plug **A** (DN 1/8” GAS) of the lubricant.

b. Install a grease nipple 1/8” GAS.

c. Unscrew the vent plug **B** (DN 1/8” GAS).



Gears compartment grease change procedure (Continued)
d. Using a manual grease pump, insert slowly the new grease, without applying an exceeding force, **until some clean oil comes out from the vent hole B.**
e. Remove the grease nipple from the hole A.
f. **Do not reassemble the filling plug A and the plug B and m**ove the Robot axis for at least 20 minutes, in order to spread equally the lubricant inside the unit, allow the exceeding grease to flow and the grease residual pressure relief. Position suitable grease collection tanks under the drain and vent holes to avoid to get the floor dirt. If it is not possible to carry out a complete axis stroke, increase the Robot motion time.
g. Screw the two plugs **A** and **B** (DN 1/8” GAS)**, apply the sealant** Loctite 572 **on the thread**.

Follow-up procedure
– After 50/100 hours from the lubrication operations, carry out a general cleaning of the parts surrounding the lubrication point, in order to remove any residual lubricant.

8.3.10 Grease change on axis 6 gearbox compartment

Status:	–	Power supplies (electrical and pneumatic) cut off
Material:	–	Lubricant - Type: GREASE - SHELL GADUS S3 V100 2 See Lubricants identification plate - Quantity: 0.001 kg - Details in par. 8.3
	–	Material and detergents for cleaning
	–	Threadlocker Loctite 572
Equipment:	–	Allen wrench of 5 mm
	–	Manual grease pump
Fixing components:	–	Conical plug DN 1/8” GAS
	–	Conical grease gun with thread 1/8” GAS

Preliminary procedures/ notes

– To speed up the greasing procedure, replace the grease nipples with appropriate conical plugs of 1/8” gas.
– Before starting the lubrication operations, carry out a general cleaning of the surrounding parts of the lubrication point, in order not to allow the possible insertion of dirt and/or impurities inside the machine body.
– See Precautions regarding the use of lubricants (see par. 8.1 on page 50) and the Remarks on lubrication operations (see par. 8.2 on page 51).

Gears compartment grease change procedure

a. Unscrew the two plugs **A** (DN 1/8” GAS).

b. Install the grease nipple 1/8" GAS in one of the two holes.

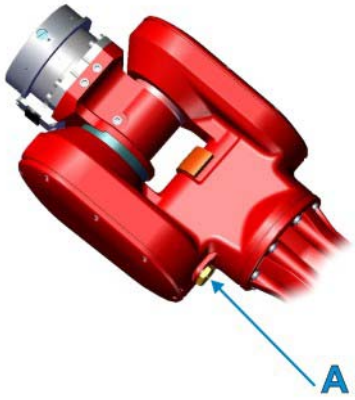
Gears compartment grease change procedure (Continued)
c. Using a pump manual lubricator, insert slowly the new grease, without applying an exceeding force, **until some clean grease comes out from the hole without the grease nipple.**
d. Remove the grease nipple from the hole.
e. **Do not reassemble the two plugs A and m**ove the robot axis at least 20 minutes, in order to spread equally the lubricant inside the unit; drain the exceeding grease in order to allow the grease residual pressure discharge. Position suitable grease collection tanks under the drain and vent holes to avoid to get the floor dirt. If it is not possible to carry out a complete axis stroke, increase the Robot motion time.
f. Screw the two plugs **A** (DN 1/8” GAS)**, applying the sealant** Loctite 572 **on the thread**.

Follow-up procedure
– After 50/100 hours from the lubrication operations, carry out a general cleaning of the parts surrounding the lubrication point, in order to remove any residual lubricant.

8.3.11 Oil replacement on wrist assembly

Status:	–	Power supplies (electrical and pneumatic) cut off
Material:	–	Lubricant: - Type: OIL - MOBIL SHC 624 See Lubricants identification plate - Quantity: 0.40 kg / 0.44 l - Details in par. 8.3
	–	Material and detergents for cleaning
	–	Adhesive tape
	–	Threadlocker Loctite 572
Equipment:	–	Allen wrench of 10 mm
	–	Torque wrench with 10 mm bit
	–	Funnel with flexible extension with cut (for air vent)
	–	Piping for oil filling
	–	Drain oil collection container
Fixing components:	–	Magnetic plug with hex slot 1/2” GAS MINTRON (Q.ty: 1)

Preliminary procedures/ notes
– Before starting the lubrication operations, carry out a general cleaning of the surrounding parts of the lubrication point, in order not to allow the possible insertion of dirt and/or impurities inside the machine body. – See Precautions regarding the use of lubricants (see par. 8.1 on page 50) and the Remarks on lubrication operations (see par. 8.2 on page 51).

Gearbox oil change procedure
a. Loosen the plug with hex slot 1/2” GAS **A** so as to release the residual pressure.
b. Move the Robot wrist setting the plug **A** (Hex head 1/2” GAS) in low position (see approximate position in the following figure). 
c. Disconnect the energies.

Gearbox oil change procedure (Continued)

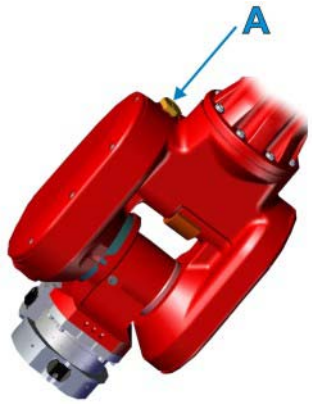
d. Place a container under the plug with hex slot 1/2” GAS **A**.

e. Unscrew the plug with hex slot 1/2” GAS A.

f. Carry out the complete oil drainage.

g. Power on the energies.

h. Move the Robot setting the filling plug A (Hex head 1/2” GAS) in high position (see approximative position in the figure).



i. Disconnect the energies.

j. Place a funnel with flexible extension with cut (for air vent) and insert the required lubricating oil.

k. After proper filling, check the sealing gasket and screw the plug with hex slot 1/2” GAS **A** of the oil filling hole, applying the sealant Loctite 572 on the thread. Tighten up to 30 Nm.

Follow-up procedure

– After lubrication operations, carry out a general cleaning of the parts surrounding the lubrication point, in order to remove possible lubricant residues.

Dispose the waste oil in compliance with the norms in force in the user country.

8.3.12 Lubrication Axis 1 On-Off mechanical hard stop unit (base RV260C) (CR82362900)

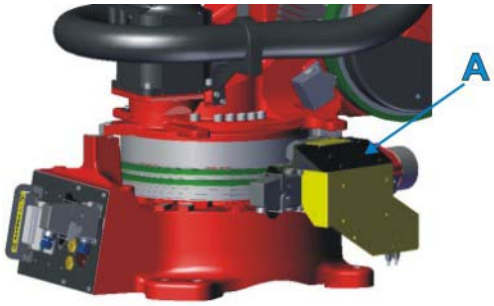
Status:	–	Power supplies (electrical and pneumatic) cut off
Material:	–	Lubricant: - Type: GREASE - SHELL GADUS S3 V100 2 See Lubricants identification plate - Quantity: 10 gr - Details in par. 8.3
	–	Material and detergents for cleaning
Equipment:	–	Manual grease pump
Fixing components:	–	---

Preliminary procedures/ notes
– None

Lubrication procedure

a. Insert the prescribed grease through the two grease nipples **A** present on the unit **until the clean grease comes out from the guides of the grease nipple central body.**

b. Activate the central body several times to distribute the grease.



Follow-up procedure
– After 50/100 hours from the lubrication operations, carry out a general cleaning of the parts surrounding the lubrication point, in order to remove any residual lubricant.

9. SPECIAL MAINTENANCE

This chapter contains:

It is recommended to carry out accurate and precise preventive maintenance operations in order to retain over the long term the Robot functional features.

9.1 Overview

The replacement procedures for the main Robots spare parts is to be carried out after mechanical accidents or in case the wear limit has been reached are described in the maintenance sheets below.

Read carefully what described in par. 1. General safety requirements on page 9.
Maintenance operations must be carried out with system powered off: powers must be disconnected.

It is recommended to carry out accurate and precise preventive maintenance operations, in order to maintain for long the Robot functional features.

9.2 Precautions before starting

Read carefully the instructions described in par. 1. General safety requirements on page 9

The maintenance activities that are not described in the following sheets shall be performed by Comau qualified staff.

9.3 Required equipment

The minimum equipment for **special maintenance** on the Robot is:

Tab. 9.1 - Required equipment

– Allen wrench of 3, 4, 5, 6, 8, 10, 14, 17 mm
– Ratchet torque wrench (or screwdriver) with bits and extension rods
– Insert for torque wrench of 3, 4, 5, 6, 8, 10, 14, 17 mm
– Insert for torque wrench 13, 27 mm
– Lever approx. length 400 mm
– Lifting mean
– Lifting ropes
– Pin removal tool
– 2 male eyebolts M10
– 2 male eyebolts M6
– Cross-head screwdrivers set
– Flat-tip screwdrivers set
– A pair of scissors

9.4 Special maintenance plan

Find in Tab. 9.2 the special maintenance plan.

Tab. 9.2 - Special maintenance plan

Frequency	Intervention / Sheet	Paragraph	Ref. [1]
Broken-down	AXIS 1 MOTOR: complete replacement (installation on the floor)	par. 9.5	S1
	MOTOR AXIS 1: complete replacement (ceiling installation)	par. 9.6	
	AXIS 2 MOTOR: complete replacement (floor and ceiling installation)	par. 9.7	S2
	AXIS 3 MOTOR: complete replacement (floor and ceiling installation)	par. 9.8	S3
	AXIS 4 MOTOR: complete replacement (ceiling and floor installation)	par. 9.9	S4
	AXIS 5 MOTOR: complete replacement (floor and ceiling installation)	par. 9.10	S5
	AXIS 6 MOTOR: complete replacement (floor and ceiling installation)	par. 9.11	S6
	AXIS 5 BELT: replacement	par. 9.12	S7
	WRIST UNIT: complete replacement	par. 9.13	S8
	AXIS 1 WORK AREA PARTIALIZATION UNIT: multiple position switch replacement	par. 9.14	S9
	AXIS 2 WORK AREA PARTIALIZATION UNIT: multiple position switch replacement	par. 9.15	S10
	AXIS 1 ON-OFF MECHANICAL HARD STOP UNIT: complete replacement / replacement only of the position limit switch	par. 9.16	S11
	AXIS 1 ADJUSTABLE MECHANICAL HARD STOP UNIT: replacement	par. 9.17	S12
	AXIS 2 ADJUSTABLE MECHANICAL HARD STOP UNIT: replacement	par. 9.18	S13
	Handling application complete wiring: complete replacement	par. 9.19	S14

[1] The reference is given in Fig. 6.1 - Summary Diagram of the maintenance operations on page 42.

9.5 AXIS 1 MOTOR: complete replacement (installation on the floor)

Status:	–	The procedure must be carried out with the system powered off: the main switch of the Control Unit MUST be in OFF position (closed).
Material:	–	Axis 1 motor [See Chap.12. - Spare Parts List on page 164]
	–	Threadlocker Loctite 243
	–	Flat sealant Loctite 518
Equipment:	–	Allen wrench of 8 and 10 mm
	–	Torque wrench with bits of 8 and 10 mm
	–	Lever approx. length 400 mm
	–	Lifting mean
	–	Lifting ropes
Fixing components:	–	Motor fixing socket hex head screws M12x30 (8.8)
	–	Pinion fixing socket hex head screws M10x25(12.9)

Preliminary procedures/ notes

HIGH TEMPERATURES DANGER
Danger because of possible high temperature of the motor.
Before working on the motor check the motor temperature. Wait till the temperature is not dangerous and, if necessary, use appropriate gloves for high temperatures.

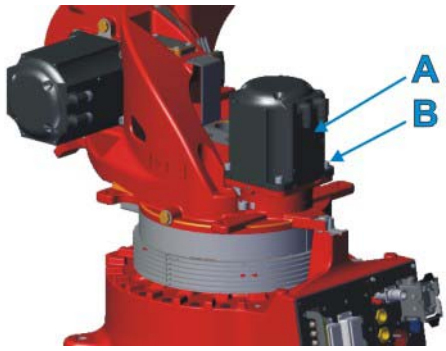
The motor must be slung and supported considering that its weight is 21.5 kg / *47.39 lb*.

Some components inside the motor could be damaged if subject to violent impacts: do not use a hammer or beat against the motor during disassembly and reassembly.
Improper use of hammers or other tools on the motor will undermine the validity of the warranty.

– If the Robot functions allow it, position the axis 1 of the Robot with the accessible motor.

Disassembly procedure

a. If necessary, release the brake of the motor to be replaced using the brake releasing device integrated on Robot base (details in par. 5.2).



The axes brake releasing operation generates the risk of falling of the axes because of the gravity. Please refer to par. 5.2.1.

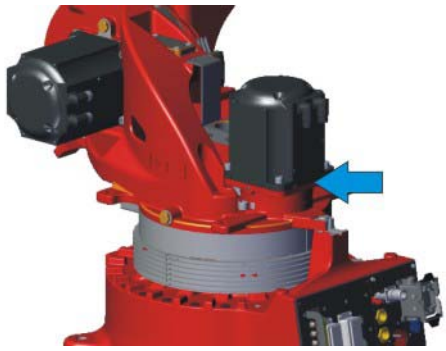
b. Disconnect the electrical connectors from the motor **A**.

c. Unscrew the 4 screws **B** (socket hex head screws M12x30) that fasten the motor to the robot base.

d. Sling and support suitably the motor **A** with a rope and appropriate lifting means/equipment, to support it during the moving operations and prevent falls.

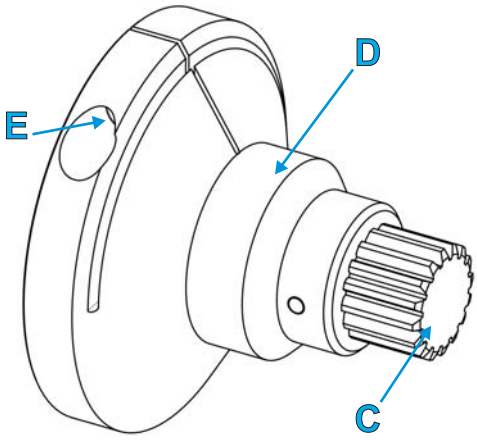
Make sure that the rope is positioned so as to hold the motor firmly and balanced, with no possibility that it could slip off and fall.

e. Detach the motor from the gearbox flange.



If the motor remains attached to the gearbox flange because of the sealant used during the installation, insert a lever into the notch on the gear housing and apply a force on the lever to detach it from the gearbox flange.

f. Bring the motor on the workbench and remove the gear assembly C and terminal D unscrewing the screw **E** (socket hex head screw M10x25).



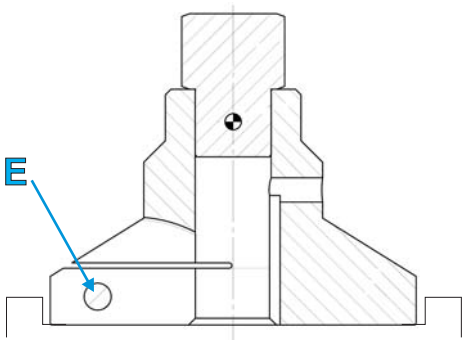
Reassembly procedure

When reassembling, apply to the screws the threadlocker Loctite 243.

a. Clean and lubricate the driving shaft.

b. Subsequently fit the pinion on the driving shaft up to the stop of the driving shaft.

c. Screw the fixing socket hex head screws M10x25 **E** of the pinion on the driving shaft to the tightening torque of 70 Nm.



d. Clean the motor coupling flange and apply the flat sealant Loctite 518.

e. Sling and support suitably the motor **A** with a rope and appropriate lifting means/equipment, to support it during the moving operations and prevent falls.

f. Position manually the motor on the assembling seat with the connectors properly positioned; give a small rotation to the motor to adjust the position of the fixing holes.

g. Screw the 4 screws **B** (socket hex head M10x30) for fixing the motor to the Robot base to the 84.8 Nm. tightening torque.

h. When the assembling has been completed:
   - properly screw the connectors

Follow-up procedures

Procedure for Robot matched with Standard Control Unit

– When restarting, the following message is displayed on the Teach Pendant: *"64054-11 Axis <<axis number>> New element drive-motor-transducer"* The signalling must be silenced with the function key "Confirmation" [F1] from the screen page "Alarm".
– Carry out the calibration procedure, as described in par. 11.4.4.1 Axis 1 calibration on page 148
– Check the correct functioning of the Robot running a slow speed work program.

Procedure for Robot matched with Safe Control Unit

– The Safe Control Unit does not allow the restart if before there was not performed a confirmation of a Safe (motor) component replacement and the calibration with updating of the dimensions in Safe field.
– Carry out the reset procedure as described in the "Use of RoboSAFE functionality" handbook in the paragraph "Reset after a motor replacement".
– Subsequently, check the correct functioning of the Robot running a slow speed work program.

9.6 MOTOR AXIS 1: complete replacement (ceiling installation)

Status:	–	The procedure must be carried out with the system powered off: the main switch of the cell controller MUST be in OFF position (turned off).
	–	Position the Robot axis 1 with the accessible motor
Material:	–	Axis 1 motor [See Chap.12. - Spare Parts List on page 164]
	–	Threadlocker 52A43
	–	Flat sealant 35A73
	–	2 threaded bars M12, length 500 mm
	–	2 hex nuts M12
	–	1 blade thickness 5 mm with two holes diameter 13 mm spacing 215 mm
Equipment:	–	Allen wrench of 8 and 10 mm
	–	Torque wrench with bits of 8 and 10 mm
	–	Lever approx. length 400 mm
	–	Lifting mean
	–	Lifting ropes
Fixing components:	–	Motor fixing socket hex head screws M12x30 (8.8)
	–	Pinion fixing socket hex head screws M10x25(12.9)

Preliminary procedures/ notes

HIGH TEMPERATURES DANGER
Danger because of possible high temperature of the motor.
Before working on the motor check the motor temperature. Wait till the temperature is not dangerous and, if necessary, use appropriate gloves for high temperatures.

The motor must be slung and supported considering that its weight is 21.5 kg / *47.39 lb*.
Considering the motor weight to be held and the assembling position, it is advisable that the maintenance operations are carried out:
–by two maintenance operators
–with the help of a supporting structure (see diagram)

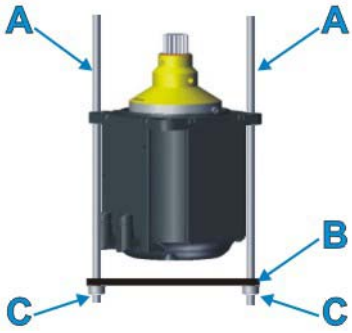
Preliminary procedures/ notes (Continued)

Some components inside the motor could be damaged if subject to violent impacts: do not use a hammer or strike the motor during disassembly and reassembly.
Improper use of hammers or other tools on the motor will undermine the validity of the warranty.

– If the Robot functions allow it, move Axis 2 of the Robot in calibration position.

Structure diagram to be used for the gearmotor reassembling

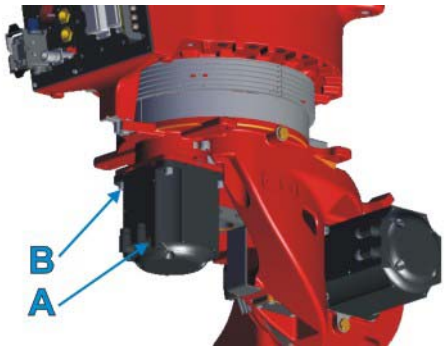
– **A**: Threaded bar M12, length 500 mm (Q.ty = 2)
– **B**: Hex nut M12 (Q.ty = 2)
– **C**: Blade thickness 5 mm with two holes diameter 13 mm spacing 215 mm (Q.ty = 1)



Disassembly procedure

a. If it is necessary, carry out the brake release of the motor to be replaced using the brake releasing device from the Robot base (details on par. 5.2).

The axes brake releasing operation generates the risk of falling of the axes because of the gravity. Please refer to par. 5.2.1.



b. Drain the oil from the gearbox A (see **par. 8.3.2 Oil change on axis 1 gearbox (ceiling installation) on page 56**)

Disassembly procedure (Continued)

c. Remove the electrical connectors from the motor.

d. Sling and support suitably the motor **A** with a rope and appropriate lifting means/equipment, to support it during the moving operations and prevent falls.

Make sure that the rope is positioned so as to hold firmly and balanced the motor, with no possibility that it could slip off and fall.

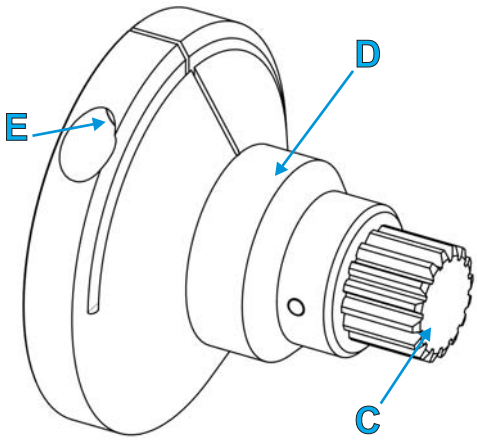
e. Loosen **one screw B** (socket hex head M12x30) without removing it, **so that it can support safely the motor when the other three screws will be removed.**

f. Unscrew and remove the other 3 screws **B** (socket hex head screws M12x30) that fasten the motor to the robot base and remove the motor from the coupling flange.

If the motor remains attached to the gearbox flange because of the sealant used during the installation, insert a lever into the notch on the gear housing and apply a force on the lever to detach it from the gearbox flange.

g. Once the motor has been removed from the gearbox flange, remove the screw **B** (socket hex head screws M12x30) foreseen to support it and bring the motor on the workbench.

h. Bring the motor on the workbench and remove the assembly together with the gear C and terminal block D unscrewing the screw **E** (socket hex head screw M10x25).



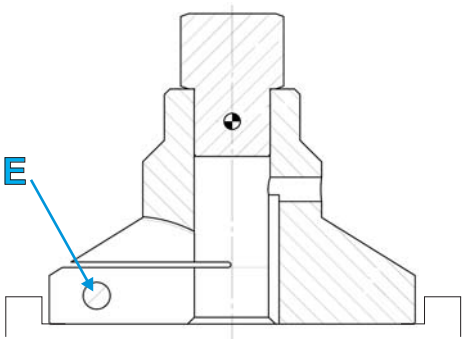
Reassembly procedure

When reassembling, apply to the screws the threadlocker Loctite 243.

a. Clean and lubricate the driving shaft.

b. Subsequently fit the pinion on the driving shaft up to the stop of the driving shaft.

c. Screw the fixing socket hex head screws M10x25 **E** of the pinion on the driving shaft to the tightening torque of 70 Nm.



Reassembly procedure (Continued)

d. Screw the two threaded bars of the supporting structure in the motor fixing screws seats, insert on the two diametrically opposite bores.

e. Clean the motor coupling flange and apply the flat sealant Loctite 572.

f. Sling and support suitably the motor **A** with a rope and appropriate lifting means/equipment, to support it during the moving operations and prevent falls.

Make sure that the rope is positioned so as to hold the motor firmly and balanced, with no possibility that it could slip off and fall.

g. Insert manually the motor from the bottom, by inserting the flange holes used for fastening inside the threaded bars.

h. Operating in two maintenance operators, hold the motor and position the blade inside the threaded holes and then screw the two hex nuts on the threaded bars.

i. Lift manually the motor in order to set it on the assembling bench, paying attention to fasten properly the driving shaft gear.

j. Position manually the motor on the assembling seat with the connectors positioned properly.

k. Screw the 4 screws **B** (socket hex head M12x30) that fix the motor to the Robot base to the 84.8 Nm. tightening torque.

l. Unscrew the two hex nuts from the threaded bars and remove the blade.

m. Unscrew and remove the two threaded bars.

n. Screw the other two screws **B** (socket hex head M12x30) that fix the motor to the Robot base to the 84.8 Nm. tightening torque.

o. Fill the gearbox with the required lubricating oil adopting the specific procedure for ceiling installation (see par. 8.3 Summary of lubrication points on page 52 and par. 8.3.2 Oil change on axis 1 gearbox (ceiling installation) on page 56).

p. When the assembling has been completed:
   - properly screw the connectors

Follow-up procedures

Procedure for Robot matched with Standard Control Unit

– When restarting, the following message is displayed on the Teach Pendant: *“64054-11 Axis <<axis number>> New element drive-motor-transducer"*
The signalling must be silenced with the function key “Confirmation” [F1] from the screen page “Alarm”.
– Carry out the calibration procedure, as described in par. 11.4.4.1 Axis 1 calibration on page 148
– Check the correct functioning of the Robot running a slow speed work program.

Follow-up procedures (Continued)
Procedure for Robot matched with Safe Control Unit – The Safe Control Unit does not allow the restart if before there was not performed a confirmation of a Safe (motor) component replacement and the calibration with updating of the dimensions in Safe field. – Carry out the reset procedure as described in the “Use of RoboSAFE functionality” handbook in the paragraph "Reset after a motor replacement". – Subsequently, check the correct functioning of the Robot running a slow speed work program.

9.7 AXIS 2 MOTOR: complete replacement (floor and ceiling installation)

The figure shows the Robot installed on the floor

Status:	–	The procedure must be carried out with the system powered off: the main switch of the Control Unit MUST be in OFF position (closed).
Material:	–	Axis 2 motor [See Chap.12. - Spare Parts List on page 164]
	–	Threadlocker Loctite 243
	–	Flat sealant Loctite 518
Equipment:	–	Allen wrench of 6 and 10 mm
	–	Torque wrench with bits of 6 and 10 mm
	–	Lifting mean
	–	Ropes for lifting
Fixing components:	–	Motor fixing socket hex head screws M12x30 (8.8)
	–	Pinion fixing socket hex head screw M8x130 (8.8)

Preliminary procedures / Notes

HIGH TEMPERATURES DANGER
Danger because of possible high temperature of the motor.
Before working on the motor check the motor temperature. Wait till the temperature is not dangerous and, if necessary, use appropriate gloves for high temperatures.

The motor must be slung and supported considering that its weight is 27.5 kg / *60.62 lb*.

Preliminary procedures / Notes (Continued)

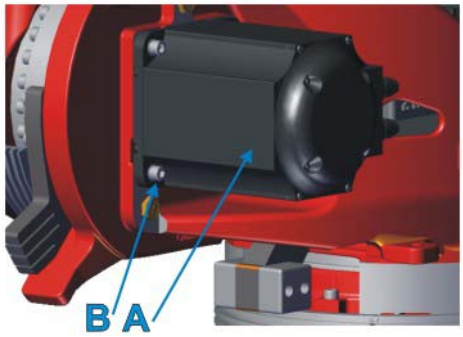
The removal of the motor involves the axis 2 brake release. Before starting the motor removal, sling with ropes and suitably support so as to make sure that the axis is blocked in a position that prevents possible uncontrolled movements of the masses applied on the Robot.

Some components inside the motor could be damaged if subject to violent impacts: do not use a hammer or strike the motor during disassembly and reassembly.
Improper use of hammers or other tools on the motor will undermine the validity of the warranty.

– If the Robot functionality permits, move axes 2 and 3 to bring the Robot in a position that allows to eliminate or reduce the motion possibility of the parts subjected to gravity.
– **If it is not possible to move the Robot axes, block the forearm to prevent uncontrolled movements during the motor removal.**

Disassembly procedure

a. If it is necessary, carry out the brake release of the motor to be replaced using the brake releasing device from the Robot base (details on the par. 5.2).



The axes brake releasing operation generates the risk of falling of the axes because of the gravity. Please refer to par. 5.2.1.

b. Disconnect the electrical connectors from the motor A.

c. Drain the oil from the gearbox (seepar. 8.3.3 Oil replacement on axis 2 gearbox (floor installation) on page 60 orpar. 8.3.5 Oil change on axis 2 gearbox (ceiling installation) on page 64).

d. Sling and support suitably the motor **A** with a rope and appropriate lifting means/equipment, to support it during the moving operations and prevent falls.

Make sure that the rope is positioned so as to hold the motor firmly and balanced, with no possibility that it could slip off and fall.

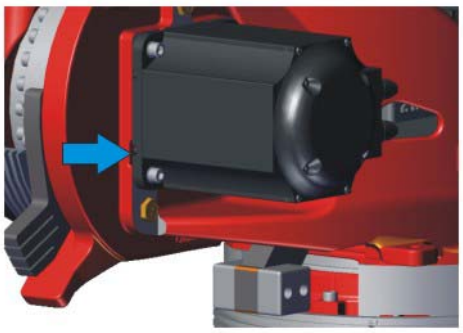
e. Loosen **one screw B** (socket hex head M12x30) without removing it, **so that it can support safely the motor when the other three screws will be removed.**

f. Unscrew and remove the other 3 screws **B** (socket hex head M12x30) that fix the motor to the gearbox and remove the motor from the coupling flange.

Disassembly procedure

g. Detach the motor from the gearbox flange.

If the motor remains attached to the gearbox flange because of the sealant used during the installation, insert a lever into the notch on the gear housing and apply a force on the lever to detach it from the gearbox flange.



The figure shows the Robot installed on the floor

h. Once the motor has been removed from the gearbox flange, remove the screw **B** foreseen to support it.

i. Bring the motor on the workbench.

j. Unscrew the fixing socket hex head screw M8x130 and remove the pinion from the driving shaft.

Reassembly procedure

When reassembling, apply to the screws the threadlocker Loctite 243.

a. Clean and lubricate the coupling surfaces of the pinion on the driving shaft.

b. Fit the pinion without knocking on the driving shaft.

c. Screw the fixing socket hex head screw M8x130 that fasten the pinion on the driving shaft tightening up to 24.6 Nm.

d. Clean the motor coupling flange and apply the flat sealant Loctite 518.

e. Sling and support suitably the motor **A** with a rope and appropriate lifting means/equipment, to support it during the moving operations and prevent falls.

Make sure that the rope is positioned so as to hold the motor firmly and balanced, with no possibility that it could slip off and fall.

f. Position manually the motor on the assembling seat with the connectors properly positioned; give a small rotation to the motor to adjust the position of the fixing holes.

g. Screw the 4 screws **B** (socket hex head M12x30) that fix the motor to the Robot base, tightening them to the 84.8 Nm. tightening torque.

h. Fill the gearbox with the required lubricating oil adopting the specific procedure (see par. 8.3 Summary of lubrication points on page 52 and par. 8.3.3 Oil replacement on axis 2 gearbox (floor installation) on page 60 / par. 8.3.5 Oil change on axis 2 gearbox (ceiling installation) on page 64).

i. When the assembling has been completed:

- properly screw the connectors

Follow-up procedures
Procedure for Robot matched with Standard Control Unit – When restarting, the following message is displayed on the Teach Pendant: *“64054-11 Axis <<axis number>> New element drive-motor-transducer"* The signalling must be silenced with the function key “Confirmation” [F1] from the screen page “Alarm”. – Carry out the calibration procedure, as described in par. 11.4.4.2 Axis 2 calibration on page 151 – Check the correct functioning of the Robot running a slow speed work program.
Procedure for Robot matched with Safe Control Unit – The Safe Control Unit does not allow the restart if before there was not performed a confirmation of a Safe (motor) component replacement and the calibration with updating of the dimensions in Safe field. – Carry out the reset procedure as described in the “Use of RoboSAFE functionality” handbook in the paragraph "Reset after a motor replacement". – Subsequently, check the correct functioning of the Robot running a slow speed work program.

9.8 AXIS 3 MOTOR: complete replacement (floor and ceiling installation)

The figure shows the Robot installed on the floor

Status:	–	The procedure must be carried out with the system powered off: the main switch of the Control Unit MUST be in OFF position (closed).
Material:	–	Axis 3 motor [See Chap.12. - Spare Parts List on page 164]
	–	Threadlocker Loctite 243
	–	Flat sealant Loctite 518
Equipment:	–	6 and 10 mm Allen wrenches
	–	Torque wrench with bits of 6 and 10 mm
	–	Lifting mean
	–	Ropes for lifting
Fixing components:	–	Motor fixing socket hex head screws M12x30 (8.8)
	–	Pinion fixing socket hex head screw M8x110 (8.8)

Preliminary procedures/ notes

HIGH TEMPERATURES DANGER
Danger because of possible high temperature of the motor.
Before working on the motor check the motor temperature. Wait till the temperature is not dangerous and, if necessary, use appropriate gloves for high temperatures.

The motor must be slung and supported considering that its weight is 21.5 kg / *47.39 lb*.

Preliminary procedures/ notes (Continued)

The removal of the motor involves the axis 3 brake release. Before starting the motor removal, sling with ropes and suitably support so as to make sure that the axis is blocked in a position that prevents possible uncontrolled movements of the masses applied on the Robot.

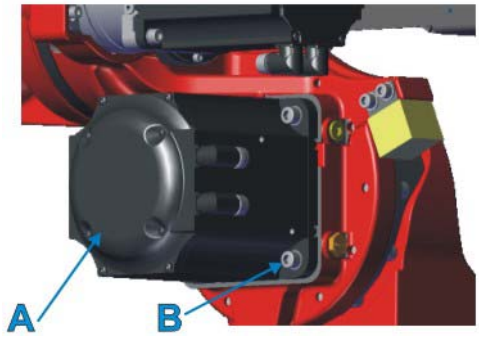
Some components inside the motor could be damaged if subject to violent impacts: do not use a hammer or strike the motor during disassembly and reassembly.
Improper use of hammers or other tools on the motor will undermine the validity of the warranty.

– If the Robot functionality permits, move axes 2 and 3 to bring the Robot in a position that allows to eliminate or reduce the motion possibility of the parts subjected to gravity.
– If the Robot functionality permits, move axes 2 and 3 to bring the Robot in a position that allows to eliminate or reduce the motion possibility of the parts subjected to gravity.
– **If it is not possible to move the Robot axes, block the forearm to prevent uncontrolled movements during the motor removal.**

Disassembly procedure

a. If it is necessary, carry out the brake release of the motor to be replaced using the brake releasing device from the Robot base (details on par. 5.2).

The axes brake releasing operation generates the risk of falling of the axes because of the gravity. Please refer to par. 5.2.1.



The figure shows the Robot installed on the floor

b. Disconnect the electrical connectors from the motor **A**.

c. Drain the oil from the gearbox (seepar. 8.3.3 Oil replacement on axis 2 gearbox (floor installation) on page 60 orpar. 8.3.5 Oil change on axis 2 gearbox (ceiling installation) on page 64).

d. Sling and support suitably the motor **A** with a rope and appropriate lifting means/equipment, to support it during the moving operations and prevent falls.

Make sure that the rope is positioned so as to hold the motor firmly and balanced, with no possibility that it could slip off and fall.

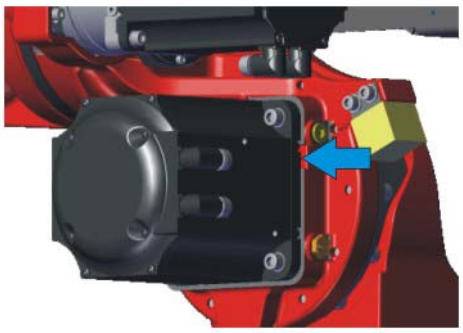
e. Loosen **one screw B** (socket hex head M12x30) without removing it, **so that it can support safely the motor when the other three screws will be removed.**

f. Unscrew and remove the other 3 screws **B** (socket hex head M12x30) that fix the motor to the gearbox and remove the motor from the coupling flange.

Disassembly procedure (Continued)

g. Detach the motor from the gearbox flange.

If the motor remains attached to the gearbox flange because of the sealant used during the installation, insert a lever into the notch on the gear housing and apply a force on the lever to detach it from the gearbox flange.



The figure shows the Robot installed on the floor

h. Once the motor has been removed from the gearbox flange, remove the screw **B** foreseen to support it and bring the motor on the workbench.

i. Unscrew the fastening socket hex head screw M8x110 and remove the pinion from the driving shaft.

j. Bring the motor on the workbench.

Reassembly procedure

When reassembling, apply to the screws the threadlocker Loctite 243.

a. Clean and lubricate the coupling surfaces of the pinion on the driving shaft.

b. Fit the pinion without knocking on the driving shaft.

c. Screw the fixing socket hex head screw M8x110 that fasten the pinion on the driving shaft tightening up to 24.6 Nm.

d. Clean the motor coupling flange and apply the flat sealant Loctite 518.

e. Sling and support suitably the motor **A** with a rope and appropriate lifting means/equipment, to support it during the moving operations and prevent falls.

Make sure that the rope is positioned so as to hold the motor firmly and balanced, with no possibility that it could slip off and fall.

f. Position manually the motor on the assembling seat with the connectors properly positioned; give a small rotation to the motor to adjust the position of the fixing holes.

g. Screw the 4 screws **B** (socket hex head M10x30) for fixing the motor to the Robot base to the 84.8 Nm. tightening torque.

h. Fill the gearbox with the required lubricating oil adopting the specific procedure for ceiling installation (see par. 8.3 Summary of lubrication points on page 52 and par. 8.3.4 Oil replacement on axis 3 gearbox (floor installation) on page 62 / par. 8.3.6 Oil change on axis 3 gearbox (ceiling installation) on page 66).

i. When the assembling has been completed:
- properly screw the connectors

Follow-up procedures
Procedure for Robot matched with Standard Control Unit – When restarting, the following message is displayed on the Teach Pendant: *“64054-11 Axis <<axis number>> New element drive-motor-transducer"* The signalling must be silenced with the function key “Confirmation” [F1] from the screen page “Alarm”. – Carry out the calibration procedure, as described in par. 11.4.4.3 Axis 3 calibration on page 154 – Check the correct functioning of the Robot running a slow speed work program.
Procedure for Robot matched with Safe Control Unit – The Safe Control Unit does not allow the restart if before there was not performed a confirmation of a Safe (motor) component replacement and the calibration with updating of the dimensions in Safe field. – Carry out the reset procedure as described in the “Use of RoboSAFE functionality” handbook in the paragraph "Reset after a motor replacement". – Subsequently, check the correct functioning of the Robot running a slow speed work program.

9.9 AXIS 4 MOTOR: complete replacement (ceiling and floor installation)

The figure shows the Robot installed on the floor

Status:	–	The procedure must be carried out with the system powered off: the main switch of the Control Unit MUST be in OFF position (closed).
Material:	–	Axis 4 motor [See Chap.12. - Spare Parts List on page 164]
	–	Threadlocker Loctite 243
Equipment:	–	Allen wrench of 8 mm
	–	Torque wrench with 8 mm bits
Fixing components:	–	Motor fixing socket hex head screws M10x30 (8.8)

Preliminary procedures / notes

HIGH TEMPERATURES DANGER
Danger because of possible high temperature of the motor.
Before working on the motor check the motor temperature. Wait till the temperature is not dangerous and, if necessary, use appropriate gloves for high temperatures.

The removal of the motor involves the axis 4 brake release. Before starting the motor removal, sling with ropes and suitably support so as to make sure that the axis is blocked in a position that prevents possible uncontrolled movements of the masses applied on the Robot.

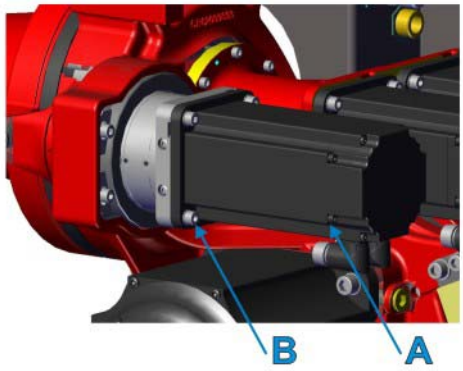
Some components inside the motor could be damaged if subject to violent impacts: do not use a hammer or beat against the motor during disassembly and reassembly.
Improper use of hammers or other tools on the motor will undermine the validity of the warranty.

– Clamp the forearm to prevent uncontrolled movement of the masses applied to the Robot when the motor is removed
– If Robot functioning allows, position the motor axis vertically upward as shown in the figure.
– **If it is not possible to move the Robot axes, block the forearm to prevent uncontrolled movements during the motor removal.**

Disassembly procedure

a. If necessary, release the brake of the motor to be replaced using the brake releasing device integrated on Robot base (details in par. 5.2).

The axes brake releasing operation generates the risk of falling of the axes because of the gravity. Please refer to par. 5.2.1.



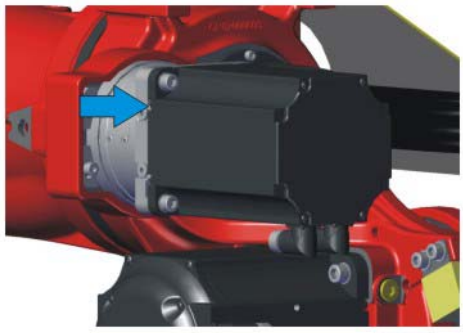
The figure shows the Robot installed on the floor

b. Disconnect the electrical connectors from the motor **B**

c. Loosen **one screw A** (socket hex head M10x30) without removing it, **so that it can support safely the motor when the other three screws will be removed.**

d. Unscrew and remove the other 3 screws **A** (socket hex head M10x30) that fix the motor to the gearbox and remove the motor from the coupling flange.

e. Support with one hand the motor **B** and release the motor from the flange of the gearbox unit.



The figure shows the Robot installed on the floor

f. Once the motor has been removed from the gearbox flange, remove the screw **B** (socket hex head screw M10x30) foreseen to support it.

g. Remove and bring the motor on the workbench.

Reassembly procedures

When reassembling, apply to the screws the threadlocker Loctite 243.

a. Reassemble the motor on the gearbox following the removal procedure in reverse order.

b. Clean the motor coupling flange.

c. Position manually the motor on the assembling seat with the connectors properly positioned; give a small rotation to the motor to adjust the position of the fixing holes.

d. Screw the 4 screws **B** (socket hex head screws M10x30) for fixing the motor to the robot base at a tightening torque of 50.1 Nm.

e. When the assembling has been completed:
   - properly screw the connectors

Follow-up procedures

Procedure for Robot matched with Standard Control Unit

– When restarting, the following message is displayed on the Teach Pendant: *“64054-11 Axis <<axis number>> New element drive-motor-transducer"* The signalling must be silenced with the function key “Confirmation” [F1] from the screen page “Alarm”.
– Carry out the calibration procedure, as described in par. 11.4.4.4 Axis 4 calibration on page 157
– Check the correct functioning of the Robot running a slow speed work program.

Procedure for Robot matched with Safe Control Unit

– The Safe Control Unit does not allow the restart if before there was not performed a confirmation of a Safe (motor) component replacement and the calibration with updating of the dimensions in Safe field.
– Carry out the reset procedure as described in the “Use of RoboSAFE functionality” handbook in the paragraph "Reset after a motor replacement".
– Subsequently, check the correct functioning of the Robot running a slow speed work program.

9.10 AXIS 5 MOTOR: complete replacement (floor and ceiling installation)

The figure shows the Robot installed on the floor

Status:	–	The procedure must be carried out with the system powered off: the main switch of the Control Unit MUST be in OFF position (closed).
Material:	–	Axis 5 motor [See Chap.12. - Spare Parts List on page 164]
	–	Driving belt (if worn) [See Chap.12. - Spare Parts List on page 164]
	–	Threadlocker Loctite 243
Equipment:	–	Allen wrench of 4 and 6 mm
	–	Torque wrench with bits of 4 and 6 mm
	–	Lifting mean
	–	Lifting ropes
Fixing components:	–	Motor fixing socket hex head screws M8x25 (8.8)
	–	Pulley fixing socket hex head screws M5x16 (8.8)

Preliminary procedures / notes

HIGH TEMPERATURES DANGER
Danger because of possible high temperature of the motor.
Before working on the motor check the motor temperature. Wait till the temperature is not dangerous and, if necessary, use appropriate gloves for high temperatures.

The removal of the motor involves the axis 5 brake release. Before starting the motor removal, sling with ropes and suitably support so as to make sure that the axis is blocked in a position that prevents possible uncontrolled movements of the masses applied on the Robot.

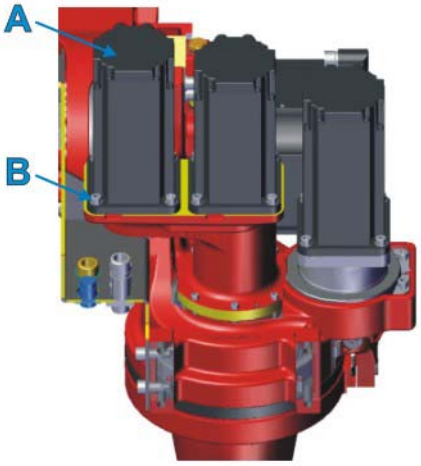
Some components inside the motor could be damaged if subject to violent impacts: do not use a hammer or strike the motor during disassembly and reassembly.
Improper use of hammers or other tools on the motor will undermine the validity of the warranty.

– If the Robot functioning allows it, position the forearm in vertical position, with motors positioned upwards. Move axis 2 in horizontal position and Axis 3 in vertical position in order to set the motor in vertical position.
– Clamp the wrist to prevent uncontrolled movement of the masses applied to the Robot flange when the motor is removed.

Disassembly procedure

a. If necessary, release the brake of the motor to be replaced using the brake releasing device integrated on Robot base (details in par. 5.2).

The axes brake releasing operation generates the risk of falling of the axes because of the gravity. Please refer to par. 5.2.1.



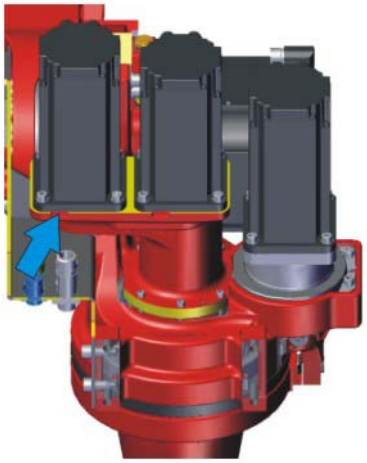
b. Disconnect the electrical connectors from the motor **A**.

c. Unscrew and remove the 4 screws B (socket hex head screws M8x25) that fasten the motor on the clamping flange.

d. Release the motor A from the unit flange.

e. Remove the driving belt from the pulley.

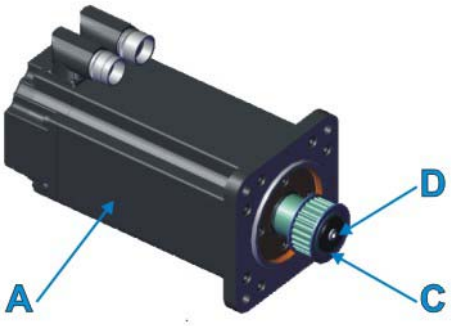
f. Remove the motor and take it to the bench.



g. Unscrew the fixing screw **D** (socket hex head screw M5x16).

h. Remove the toothed pulley **C** from the driving shaft.

i. Check the wear status of the driving belt and replace it if necessary.



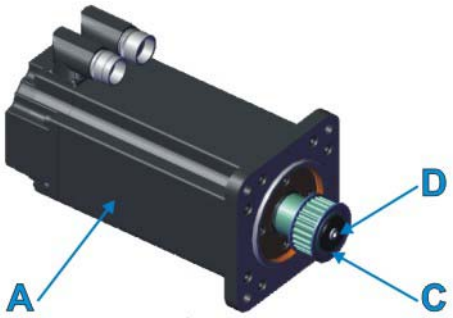
Reassembly procedures

When reassembling, apply to the screws the threadlocker Loctite 243.

a. Clean the driving shaft in the coupling area with toothed pulley **C**.

b. Fit the pulley on the driving without striking

c. Screw the two fixing screws **D** (socket hex head screws M5x16) tightening them at a torque of 6 Nm



d. Clean the motor coupling flange.

e. Fit the timing belt on the motor pulleys.

f. Position and centre manually the motor on the assembling seat with the connectors positioned properly.

g. Screw the 4 screws **B** (socket hex head screws M8x25) that fasten the motor to the robot base at the tightening torque 24.6 Nm.

h. When the assembling has been completed:
   - properly screw the connectors

Follow-up procedures

Procedure for Robot matched with Standard Control Unit

– When restarting, the following message is displayed on the Teach Pendant: *“64054-11 Axis <<axis number>> New element drive-motor-transducer"* The signalling must be silenced with the function key “Confirmation” [F1] from the screen page “Alarm”.
– Carry out the calibration procedure, as described in par. 11.4.4.5 Axis 5 calibration on page 159
– Check the correct functioning of the Robot running a slow speed work program.

Procedure for Robot matched with Safe Control Unit

– The Safe Control Unit does not allow the restart if before there was not performed a confirmation of a Safe (motor) component replacement and the calibration with updating of the dimensions in Safe field.
– Carry out the reset procedure as described in the “Use of RoboSAFE functionality” handbook in the paragraph "Reset after a motor replacement".
– Subsequently, check the correct functioning of the Robot running a slow speed work program.

9.11 AXIS 6 MOTOR: complete replacement (floor and ceiling installation)

The figure shows the Robot installed on the floor

Status:	–	The procedure must be carried out with the system powered off: the main switch of the Control Unit MUST be in OFF position (closed).
Material:	–	Axis 6 motor [See Chap.12. - Spare Parts List on page 164]
	–	Threadlocker Loctite 243
Equipment:	–	Allen wrench of 5 and 6 mm
	–	Torque wrench with bits of 5 and 6 mm
	–	Lifting mean
	–	Lifting ropes
Fixing components:	–	Motor fixing socket hex head screws M8x25 (8.8)
	–	Countershaft fixing socket hex head screw M6x16 (8.8)

Preliminary procedures / notes

HIGH TEMPERATURES DANGER
Danger because of possible high temperature of the motor.
Before working on the motor check the motor temperature. Wait till the temperature is not dangerous and, if necessary, use appropriate gloves for high temperatures.

The removal of the motor involves the axis 6 brake release. Before starting the motor removal, sling with ropes and suitably support so as to make sure that the axis is blocked in a position that prevents possible uncontrolled movements of the masses applied on the Robot.

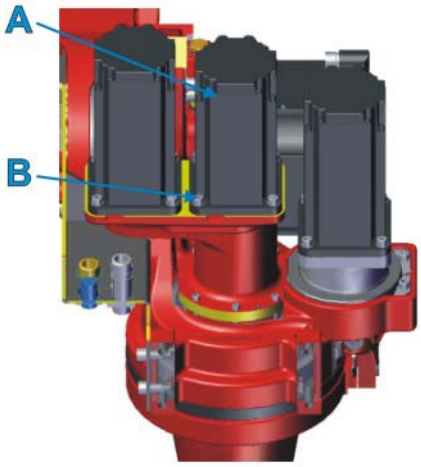
Some components inside the motor could be damaged if subject to violent impacts: do not use a hammer or strike the motor during disassembly and reassembly.
Improper use of hammers or other tools on the motor will undermine the validity of the warranty.

– If the Robot functioning allows it, position the forearm in vertical position, with motors positioned upwards. Move axis 2 in horizontal position and Axis 3 in vertical position in order to set the motor in vertical position.
– Lock the equipment installed on the flange in order to prevent uncontrolled motions during the motor removal.

Disassembly procedure

a. If necessary, release the brake of the motor to be replaced using the brake releasing device integrated on Robot base (details in par. 5.2).

The axes brake releasing operation generates the risk of falling of the axes because of the gravity. Please refer to par. 5.2.1.



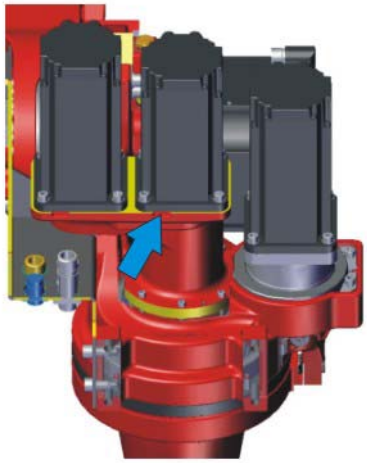
b. Disconnect the electrical connectors from the motor **A**.

c. Unscrew and remove the 4 screws B (socket hex head screws M8x25) that fasten the motor on the coupling flange.

d. Release the motor A from the unit flange.

e. Lift the motor from the coupling flange.

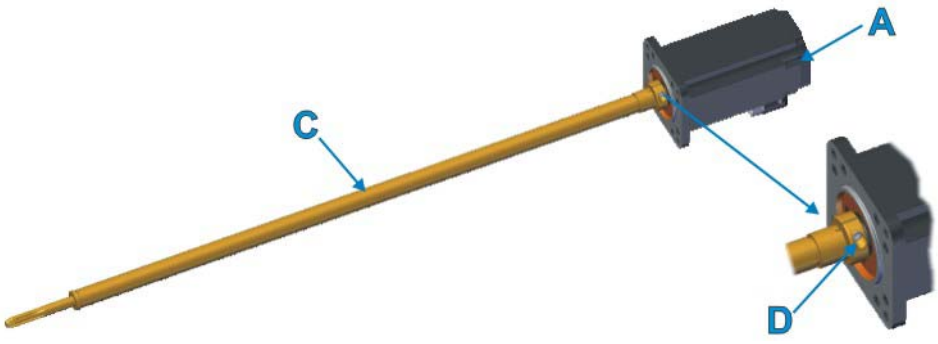
The countershaft fitted on the Axis 6 driving shaft has a length approximately equal to that of the forearm. Before removing the motor, evaluate the space required to carry out easily the operations.



f. Remove and bring the motor on the workbench.

g. Unscrew the fixing screw **D** (socket hex head screw M6x16).

h. Remove the countershaft **C** from the driving shaft.



Reassembly procedure

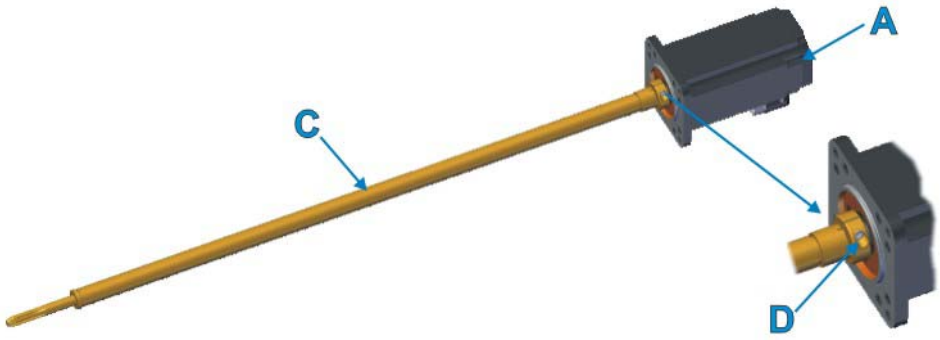
When reassembling, apply to the screws the threadlocker Loctite 243.

a. Clean the coupling surfaces of the driving shaft and the countershaft end part **C**.

b. Position the countershaft **C** on the driving shaft, until the motor reaches the stop.

c. Screw the two fixing screws **D** (socket hex head screws M6x16) tightening them at a torque of 10.4 Nm

d. Clean the motor coupling flange.



e. Position the countershaft **C** in the assembling seat and centre manually the motor in order to insert the ends of the countershaft inside the gearbox on the Robot wrist.

f. Position manually the motor **A** on the assembling seat with the connectors properly positioned.

g. Screw the 4 screws **B** (socket hex head screws M8x25) that fasten the motor to the robot base at the tightening torque 24.6 Nm.

h. When the assembling has been completed:
   - properly screw the connectors

Follow-up procedures

Procedure for Robot matched with Standard Control Unit

– When restarting, the following message is displayed on the Teach Pendant: *"64054-11 Axis <<axis number>> New element drive-motor-transducer"* The signalling must be silenced with the function key "Confirmation" [F1] from the screen page "Alarm".
– Carry out the calibration procedure, as described in par. 11.4.4.6 Axis 6 calibration on page 161
– Check the correct functioning of the Robot running a slow speed work program.

Follow-up procedures (Continued)
Procedure for Robot matched with Safe Control Unit – The Safe Control Unit does not allow the restart if before there was not performed a confirmation of a Safe (motor) component replacement and the calibration with updating of the dimensions in Safe field. – Carry out the reset procedure as described in the “Use of RoboSAFE functionality” handbook in the paragraph "Reset after a motor replacement". – Subsequently, check the correct functioning of the Robot running a slow speed work program.

9.12 AXIS 5 BELT: replacement

Status:	–	The procedure must be carried out with the system powered off: the main switch of the Control Unit MUST be in OFF position (closed).
Material:	–	Driving belt [See Chap.12. - Spare Parts List on page 164[]
	–	Threadlocker Loctite 243
	–	Flat sealant in polyurethane S006 [for Robot Foundry]
Equipment:	–	Allen wrench of 4 mm
	–	Torque wrench with 4 mm bits
	–	Lifting mean
	–	Lifting ropes
Fixing components:	–	Safety guard fixing hex head screws M5x10 (8.8)

Preliminary procedures / notes

To replace the driving belt it is necessary to disassemble the Axis 5 motor (details in par. 9.10 AXIS 5 MOTOR: complete replacement (floor and ceiling installation) on page 101) and Axis 6 motor (details on par. 9.11 AXIS 6 MOTOR: complete replacement (floor and ceiling installation) on page 104).

When the two motors are removed axis 5 and axis 6 are released. Before starting to remove the motor sling with ropes and should suitably in order to be sure that the axes are locked in a position that prevents possible uncontrolled movements of the weights applied on the robot.

– If the Robot functioning allows it, position the forearm in vertical position, with motors positioned upwards.
– Lock the equipment installed on the flange in order to prevent uncontrolled motions during the motor removal.

Disassembly procedure

a. Release the motors brakes of the Axis 5 **A** and Axis 6 **B** using the integrated brake releasing device on Robot base (details in par. 5.2).

The axes brake releasing operation generates the risk of falling of the axes because of the gravity. Please refer to par. 5.2.1.

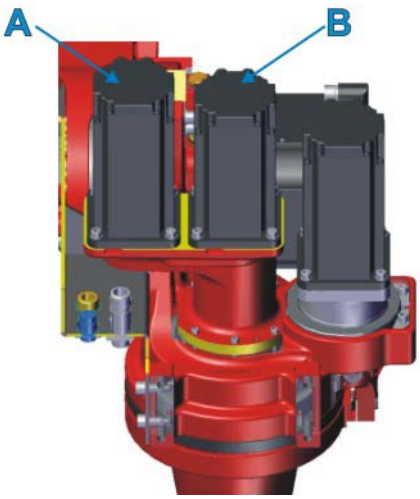
b. Disassemble Axis 5 motor **A** (details in par. 9.10).

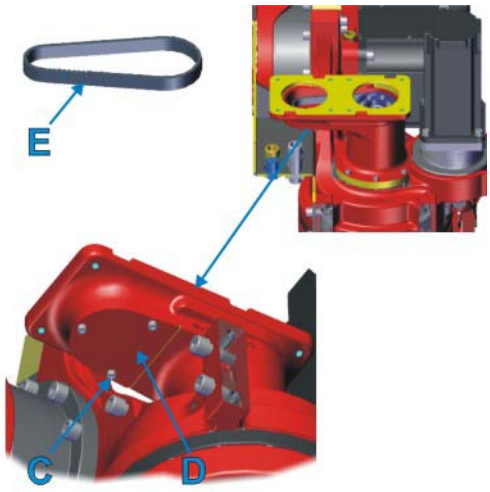
c. Disassemble Axis 6 motor **B** (details in par. 9.12).

d. Unscrew and remove the three fixing screws C (socket hex head screws M5x10).

e. Remove the safety guard D

f. Pull out the driving toothed belt E.





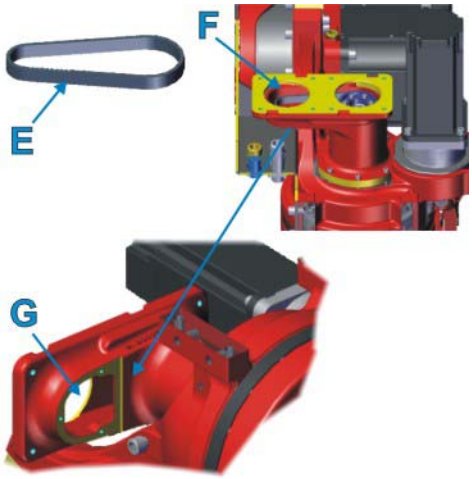
Reassembly procedure

When reassembling, apply to the screws the threadlocker Loctite 243.

a. Insert a new driving toothed belt E from the upper hole F.

b. Assemble the Axis 6 motor (details in par. 9.12) making sure that the driving belt E is properly fitted on the pulley.

c. Insert the Axis 5 motor making sure that the driving belt E is properly fitted on the pulley intervening also from the lower hole G.



d. Set the Axis 5 motor in assembling position and install the Axis 5 motor (details in par. 9.10).

For Robots in Foundry version apply the flat sealant in Polyurethane S006 on the belt cover.

e. Position the cover **D** and screw the three fixing screws C (socket hex head screws M16x16) tightening them at the tightening torque 6 Nm.

Follow-up procedures

Procedure for Robot matched with Standard Control Unit

– When restarting, the following message is displayed on the Teach Pendant: *“64054-11 Axis <<axis number>> New element drive-motor-transducer"* The signalling must be silenced with the function key “Confirmation” [F1] from the screen page “Alarm”.
– Carry out the axes 5-6 calibration procedure, as described in par. 11.4.4.5 Axis 5 calibration on page 159 and par. 11.4.4.6 Axis 6 calibration on page 161
– Check the correct functioning of the Robot running a slow speed work program.

Procedure for Robot matched with Safe Control Unit

– The Safe Control Unit does not allow the restart if before there was not performed a confirmation of a Safe (motor) component replacement and the calibration with updating of the dimensions in Safe field.
– Carry out the reset procedure as described in the “Use of RoboSAFE functionality” handbook in the paragraph "Reset after a motor replacement".
– Subsequently, check the correct functioning of the Robot running a slow speed work program.

9.13 WRIST UNIT: complete replacement

Status:	–	The procedure must be carried out with the system powered off: the main switch of the Control Unit MUST be in OFF position (closed).
Material:	–	Wrist unit [See Chap.12. - Spare Parts List on page 164]
	–	Threadlocker Loctite 222 / Loctite 243
Equipment:	–	Allen wrench of 5 mm
	–	Torque wrench with 5 mm bit
	–	Ø6 mm pin extraction tool
	–	Lifting mean
	–	Ropes for lifting
	–	A pair of scissors
Fixing components:	–	Wrist fixing socket hex head screws M6x16 (8.8)
	–	Dowel pin Ø 6x16 mm

Preliminary procedures / notes

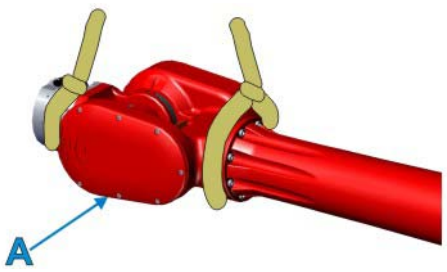
In order to guarantee the safety conditions, prepare an appropriate equipment to support the complete wrist taking into consideration that its weight is about 22 kg / 48.50 lb.

– Set axes 4-5 and 6 in calibration position.
– Remove the tooling installed on the wrist.

– The procedure is divided in:
  - Wrist disassembly procedure
  - Wrist reassembly procedure
  - Procedure conseguenti

Wrist disassembly procedure

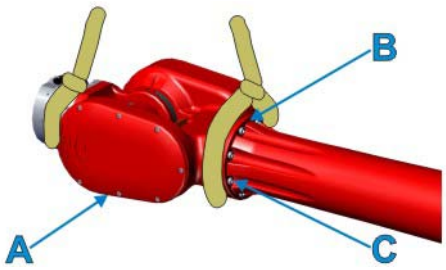
a. Support the wrist A by means of ropes as described in the figure.



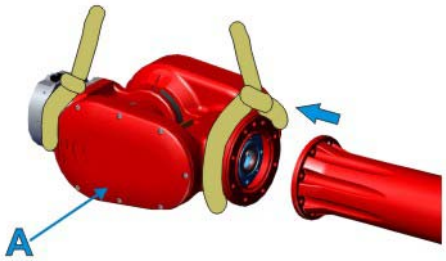
Wrist disassembly procedure

b. Unscrew the 8 screws **C** (socket hex head screws M6x16) that fasten the wrist **A**.

c. Remove the dowel pin **B** (Ø 6x16 mm) using an extraction tool.



d. Extract the wrist **A** from its seat.

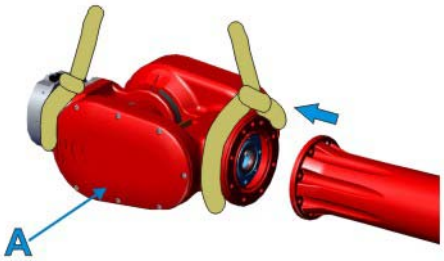


Wrist reassembly procedure

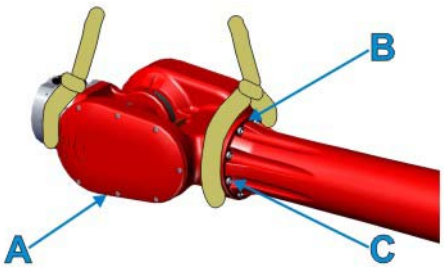
When reassembling apply the prescribed Loctite 222 / Loctite 243 threads sealant to the screws as described in Tab. 2.3.

a. Insert the dowel pin **B** (Ø 6x16 mm).

b. Position the wrist **A** on its seat, paying attention to fit properly the spline shaft inside the wrist.



c. Screw the 8 screws **C** (socket hex head screws M6x16) that fasten the wrist **A** tightening them to a torque of 10.4 Nm.



d. When the assembling has been completed:
- Calibrate the axis 4 (see par. 11.4.4.4 Axis 4 calibration on page 157)
- Calibrate the axis 5 (see par. 11.4.4.5 Axis 5 calibration on page 159)
- Calibrate the axis 6 (see par. 11.4.4.6 Axis 6 calibration on page 161)
- test the Robot operating program.

Follow-up procedures
Procedure for Robot matched with Standard Control Unit – When restarting, the following message is displayed on the Teach Pendant: *“64054-11 Axis <<axis number>> New element drive-motor-transducer"* The signalling must be silenced with the function key “Confirmation” [F1] from the screen page “Alarm”. – Perform the calibration procedure as described in par. 11.4.4.4 Axis 4 calibration on page 157, par. 11.4.4.5 Axis 5 calibration on page 159 and par. 11.4.4.6 Axis 6 calibration on page 161 – Check the correct functioning of the Robot running a slow speed work program.
Procedure for Robot matched with Safe Control Unit – The Safe Control Unit does not allow the restart if before there was not performed a confirmation of a Safe (motor) component replacement and the calibration with updating of the dimensions in Safe field. – Carry out the reset procedure as described in the “Use of RoboSAFE functionality” handbook in the paragraph "Reset after a motor replacement". – Subsequently, check the correct functioning of the Robot running a slow speed work program.

9.14 AXIS 1 WORK AREA PARTIALIZATION UNIT: multiple position switch replacement

Status:	–	Power turned off
Material:	–	Multiple position switch Axis 1 operating area restriction assembly - 3 areas (RV260C) (CR82362300) [See Chap.12. - Spare Parts List on page 164]
	–	Threadlocker Loctite 222
Equipment:	–	Allen wrench of 5 mm
	–	Torque wrench with 5 mm bit
	–	Pin removal tool
Fixing components:	–	Socket hex head screw M6x20 mm (8.8)
	–	Dowel pin Ø4x20

Preliminary procedures / notes

After maintenance interventions it is necessary to check the proper functioning of the unit and the lock of the fixing screws.

When reassembling, reposition the multiple position switch in the same position of the replaced one, in order to guarantee the safety aspects required in the cell.

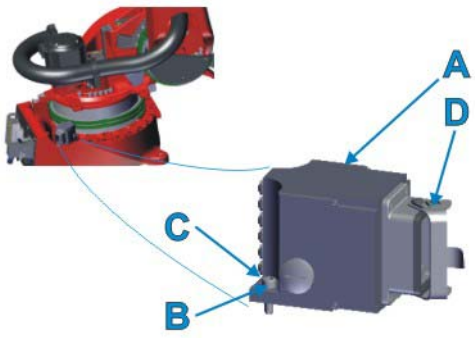
Disassembly procedure

a. Remove the mating connector from the connector **D**.

b. Remove the two dowel pins C (Ø4x20) using the extraction tool.

c. Unscrew the 2 fixing screws **B** (socket hex head M6x20).

d. Remove the multiple position switch **A** from the Robot base.



Reassembly procedure

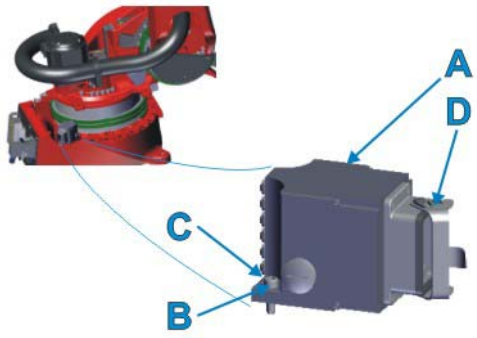
When reassembling, apply to the screws the threadlocker Loctite 222.

a. Clean the Robot base surface on which the multiple position switch **A** is to be installed.

b. Position the multiple position switch **A** on the Robot base, in the same position of the previously replaced one.

c. Insert the two dowel pins **C** (Ø4x20).

d. Screw the 2 fixing screws B (socket hex head M6x20) tightening them to a torque of 10.4 Nm.



e. Connect the mating connector to connector **D**.

For further information on installation, refer to the "Transport and Installation" handbook par. 7.4 Installation Axis 1 operating area restriction assembly - 3 areas (RV260C) (CR82362300) on page 103.

Follow-up procedures

– Check proper function of the unit, being sure of the intervention of the limit switch on the Robot stopping command.

9.15 AXIS 2 WORK AREA PARTIALIZATION UNIT: multiple position switch replacement

Status:	–	Power turned off
Material:	–	Multiple position switch Axis 2 operating area restriction assembly - 2 areas (CR82362400) [See Chap.12. - Spare Parts List on page 164]
	–	Threadlocker Loctite 222
Equipment:	–	Allen wrench of 5 mm
	–	Torque wrench with 5 mm bit
	–	Pin removal tool
	–	Cross-head screwdriver for terminal block
Fixing components:	–	Socket hex head screw M6x20 mm (8.8)
	–	Dowel pin Ø4x24

Preliminary procedures / notes

After maintenance interventions it is necessary to check the proper functioning of the unit and the lock of the fixing screws.

When reassembling, reposition the multiple position switch in the same position of the replaced one, in order to guarantee the safety aspects required in the cell.

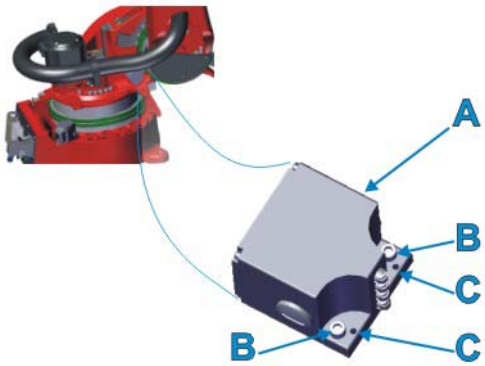
Disassembly procedure

a. Remove the cable disconnecting the wires directly on the multiple position limit switch **A**.

b. Remove the two dowel pins **C** (Ø4x24) using the extraction tool.

c. Unscrew the 2 fixing screws **B** (socket hex head M6x20).

d. Remove the multiple limit position switch **A** from the Robot.



Reassembly procedure

When reassembling, apply to the screws the threadlocker Loctite 222.

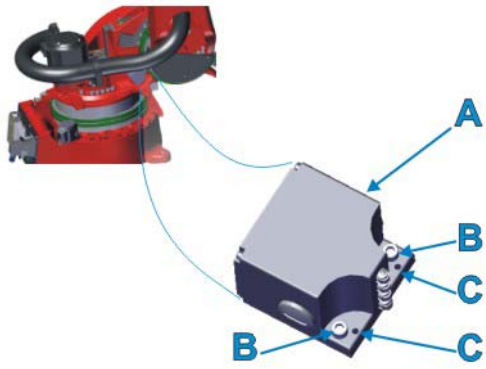
a. Clean the Robot surface on which the multiple position limit switch **A** is to be installed.

b. Position the multiple position limit switch **A** on the Robot body.

c. Insert the two dowel pins **C** (Ø4x24).

d. Connect the conductors directly on the multiple position limit switch **A**.

e. Screw the 2 fixing screws B (socket hex head M6x20) tightening them to a torque of 10.4 Nm.



For further information on details, please see the "Transport and installation" handbook on par. 7.5 Installation Axis 2 operating area restriction assembly - 2 areas (CR82362400) on page 108.

Follow-up procedures

– Check proper function of the unit, being sure of the intervention of the limit switch on the Robot stopping command.

9.16 AXIS 1 ON-OFF MECHANICAL HARD STOP UNIT: complete replacement / replacement only of the position limit switch

Status:	–	Power turned off (electrical and pneumatic)
Material:	–	Axis 1 On-Off mechanical hard stop unit (base RV260C) (CR82362900) [See Chap.12. - Spare Parts List on page 164]
	–	Threadlocker Loctite 222 and Loctite 243
Equipment:	–	Allen wrench of 3, 5, 17 mm
	–	Torque wrench with bits of 3, 5 and 17 mm
	–	Pin removal tool
	–	Lifting mean
	–	Lifting ropes
	–	2 male eyebolts M10
Fixing components:	–	Socket hex head screw M4x10 (8.8)
	–	Socket hex head screw M6x16 (8.8)
	–	Socket hex head screw M20x90 (8.8)
	–	Blank washer 20x37x3

Preliminary procedures/ notes

After maintenance interventions it is necessary to check the proper functioning of the unit and the lock of the fixing screws.

When reassembling, position the limit switch in the same position of the replaced one, in order to guarantee the safety aspects foreseen in the cell.

In order to guarantee the safety conditions, sling and support the unit taking into consideration that its weight is 36 kg / *79.36 lb*.

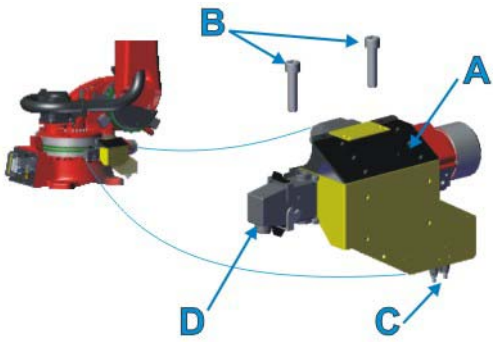
If it is enough to replace only the position switch, carry out the Position switch disassembly procedure.

Complete unit disassembly procedure

a. Remove the Harting electrical connector **D** from the lock pin unit **A**.

b. Remove the pneumatic power supply pipes of the fitting unit **C**.

c. Screw two male eyebolts M10 in the holes on the lock pin unit body **A**.



Complete unit disassembly procedure (Continued)

d. Unscrew the 2 fixing screws **B** (socket hex head screws M20x90).

e. Sling suitably the unit **A** with a rope and suitable lifting means.

f. Lift and remove the lock pin unit **A** from the robot base.

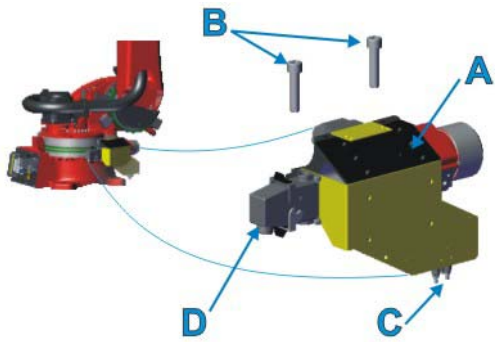
Complete unit reassembly procedure

When reassembling apply the threadlocker Loctite 222 / Loctite 243 to the screws as indicated in Tab. 2.2.

a. Clean the surface on the Robot base on which the lock pin unit is to be installed.

b. Screw two male eyebolts M10 in the holes on the lock pin unit body.

c. Hook a rope to the two eyebolts and move the unit using the lifter.



d. Position the unit A on the Robot base.

e. Screw the 2 screws **B** (socket hex head screws M20x90)with the related split washer tightening them at a torque of 400 Nm.

f. Connect a tube with inner Ø 4mm and outer Ø 6mm to fitting **C** for the unit pneumatic supply.
Warning: **The lockout pin motion can cause danger of crushing between lockout pin and Robot base seat, therefore, pay attention during lockout pin motion phases.**

g. Connect the Harting electrical connector **D** on the lock pin unit.

For further information on assembling, see the par. 7.6 Installation Axis 1 On-Off mechanical hard stop unit (base RV260C) (CR82362900) on page 112.

Follow-up procedures

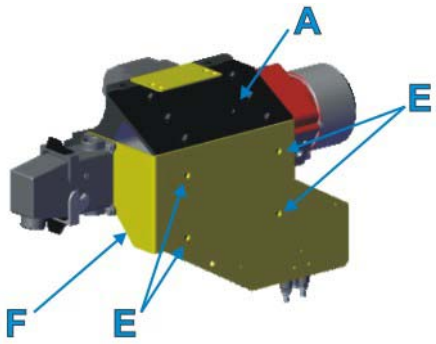
– Check proper function of the unit.
– Carry out the lubrication operations of the unit as shown in par. 8. Lubrication procedures on page 50
– Remove the two male eyebolt M10

Position switch disassembly procedure

If it is necessary to replace only the the position limit switch present on the unit A, set the disassembled unit on the Robot workbench and follow the instructions below:

Position switch disassembly procedure (Continued)

a. Unscrew the 4 screws **E** (Socket hex head M4x10) and remove the safety guard **F**.

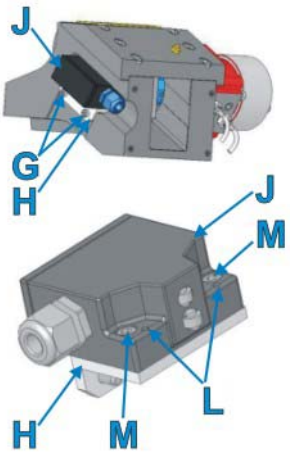


b. Unscrew the two screws **G** (socket hex head M6x16) and remove from the unit the bracket **H** including the position switch **J**.

c. Remove the electrical connections on the position limit switch.

d. Remove the two dowel pins **L** (Ø4x14) using a puller.

e. Unscrew the two screws **G** (socket hex head M6x16) and remove the limit switch from the fastening bracket.



f. Position the new limit switch on the supporting bracket **H**.

g. Align carefully the front profile of the limit switch with the bracket, and insert the two dowel pins **L** (Ø4x12).

h. Tighten the screws **M** (socket hex head M6x16) that fix the position switch.

i. Restore the electrical connections on the position switch.

Follow-up procedures

– Check proper function of the unit.

9.17 AXIS 1 ADJUSTABLE MECHANICAL HARD STOP UNIT: replacement

Status:	–	Power turned off
Material:	–	Mechanical hard stop Axis 1 adjustable mechanical hard stop assembly (CR82362100) [See Chap.12. - Spare Parts List on page 164]
	–	Complete knocker [See Chap.12. - Spare Parts List on page 164]
	–	Threadlocker Loctite 243
Equipment:	–	8, 14, 17 mm Allen wrench
	–	Torque wrench with 8, 14 and 17 mm insert
Fixing components:	–	Socket hex head screw M10x25 (8.8)
	–	Socket hex head screw M16x40 (8.8)
	–	Socket hex head screw M20x90 (12.9)

Preliminary procedures/ notes

After the hard stop intervention (impact), the following parts must be replaced:

–Stop buffer and fixing screws

–Footing support of the knocker (present only in case of installation of the buffer in position 4 or 16; see Fig. 8.8 - Option method of use diagram on page 97 of the manual Technical Specifications)

–knocker and knocker support with rubber blocks and fixing screws

Verify the integrity of the Robot parts involved in the impact, for example:

- **base in the area of unit fixing;**
- **column in the area of knocker fixing;**
- **equipment moved by Robot.**

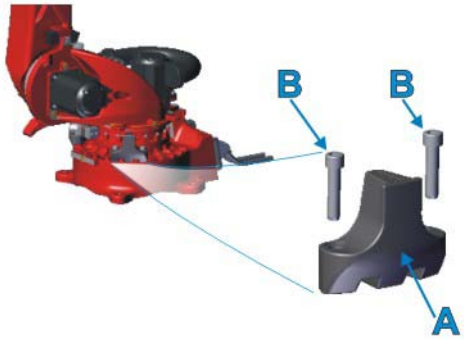
Failure to replace the damaged parts will undermine the correct functioning (and therefore the Robot stopping) in case of later interventions.

Before performing the intervention, position the Robot axis so as to be able to carry out disassembly operations of the hard stop unit.

Disassembly procedure

a. Unscrew and remove the 2 fixing screws **B** (socket hex head M20x90).

b. Remove the stopping buffer **A** from the Robot base seat.

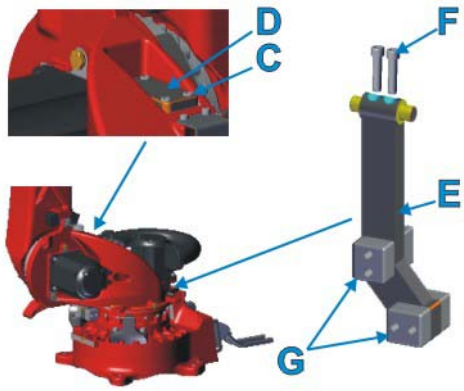


c. Unscrew and remove the four fixing screws **C** (socket hex head M10x25) of the upper plate **D**.

d. Remove the upper plate **D**.

e. Unscrew and remove the two fixing screws **F** (socket hex head M16x40).

f. Remove and replace the knocker **E** with the rubber blocks **G**.

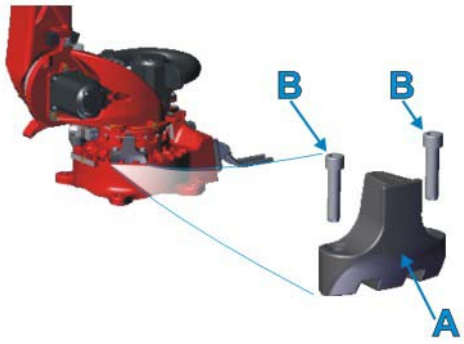


Reassembly procedure

When reassembling, apply to the screws the threadlocker Loctite 243.

a. Place the buffer **A** in desired position in the seats on Robot base, in relation to the stroke limitations to be obtained.

b. Screw the two fixing screws B (socket hex head M20x90) tightening them at a torque of 674 Nm.

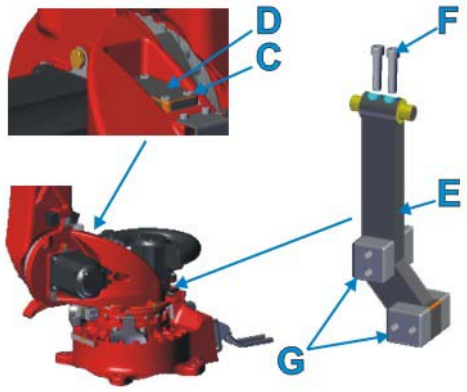


c. Position the new knocker **E** equipped with rubber blocks **G**.

d. Screw the two fixing screws **F** (socket hex head M16x40) tightening them at a torque of 205 Nm.

e. Position the upper plate **D**.

f. Screw the four fixing screws **C** (socket hex head M10x25) of the upper plate **D** tightening them at a torque of 50.1 Nm.



For further information on assembling, see the par. 7.2 Installation Axis 1 adjustable mechanical hard stop assembly (CR82362100) on page 99.

Follow-up procedures

It is prohibited to modify or alter the positions of the mechanical stops because they generate risks due to the alteration of the Robot allowed movement area, with consequent serious damages to people and objects.

– Check proper functioning of the Robot.

9.18 AXIS 2 ADJUSTABLE MECHANICAL HARD STOP UNIT: replacement

Status:	–	Power turned off
Material:	–	Hard stop Axis 2 adjustable mechanical hard stop assembly (CR82362200) [See Chap.12. - Spare Parts List on page 164]
	–	Threadlocker Loctite 243
Equipment:	–	18 mm open-end wrench
	–	Torque wrench with 18 mm socket
Fixing components:	–	Hex head screw M12x45 (12.9)

Preliminary procedures / notes

After the hard stop intervention (impact), the following parts must be replaced:
–stop buffers on column and rubber blocks on the arm
–screws and fixing pins.

Verify the integrity of the Robot parts involved in the impact, for example:
– the column in the area of stop buffers fixing
– the arm in the area of rubber buffers fixing
– equipment moved by Robot

Failure to replace the damaged parts will undermine the correct functioning (and therefore the Robot stopping) in case of later interventions.

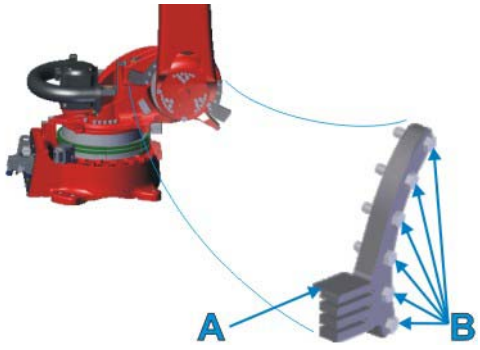
Before performing the intervention, position the Robot axis so as to be able to carry out disassembly operations of the hard stop unit.

Disassembly procedure

a. Unscrew and remove the 6 fixing screws **B** (hex head M12x45).

b. Remove the stopping buffer **A** from the axis 2 Robot seat.

c. Replace the rubber buffers installed on the column.

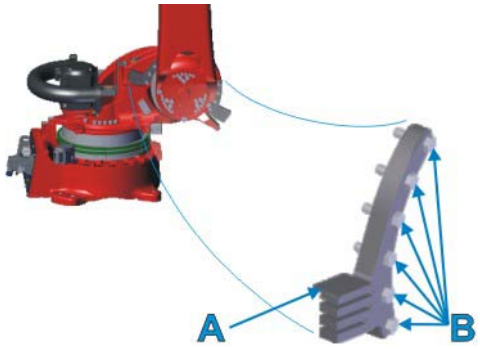


Reassembly

When reassembling, apply to the screws the threadlocker Loctite 243.

a. Position the buffer **A** in the desired position on Robot Axis 2.

b. Screw the six fixing screws **B** (hex head M12x45) tightening them to a torque of 143 Nm.



For further information on assembling, see the par. 7.3 Installation Axis 2 adjustable mechanical hard stop assembly (CR82362200) on page 101.

Follow-up procedures

It is prohibited to modify or alter the positions of the mechanical stops because they generate risks due to the alteration of the Robot allowed movement area, with consequent serious damages to people and objects.

– Check proper functioning of the Robot.

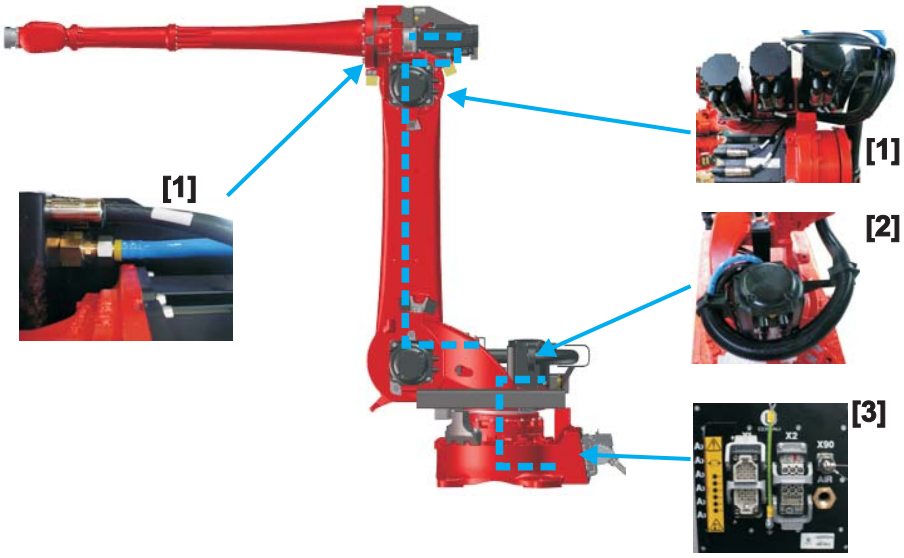
9.19 Handling application complete wiring: complete replacement

Status:	–	The procedure must be carried out with the system powered off: the main circuit breaker of the cell controller MUST be in OFF position (closed).
Spare part:	–	NJ 16 3.1 Handling dressing CR18909980
Equipment:	–	Allen wrench of 5, 6 mm; – Open-end wrench of 13, 27 mm; – Torque wrench with bits of 5, 6 mm; – A pair of scissors
Fixing components:	–	Supplied with the assembling kit.

Preliminary procedures/ notes
– The procedure is divided in: • Complete wiring disassembly procedure • Complete wiring assembling procedure

Complete wiring disassembly procedure

If the Robot functioning permits, bring the axes to calibration position to replace the complete wiring.

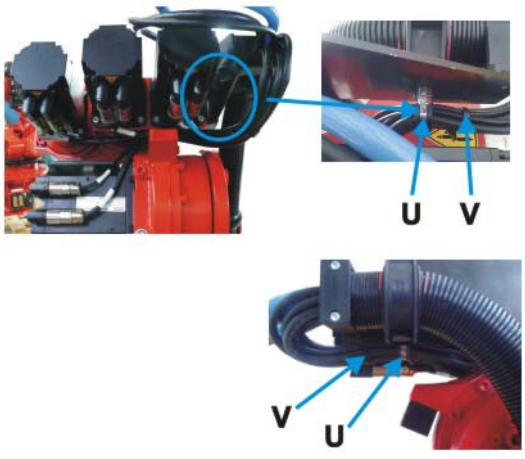


[1] Axis 3 dressing disassembly
[2] Dressing disassembly from axis 3 to axis 2
[3] Dressing disassembly from axis 2 to axis 1

[1] Axis 3 dressing disassembly

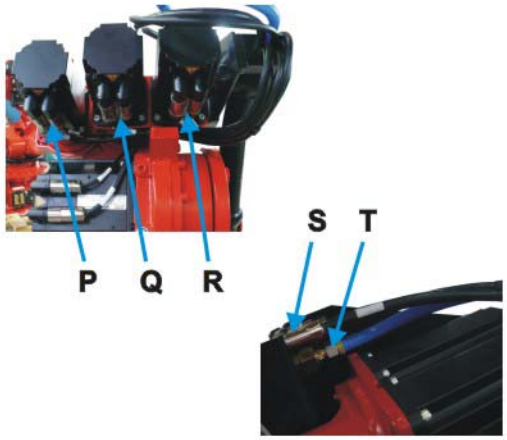
a. Remove the cables unscrewing the lock nut M8 present on the fixing device U.

b. Untie the cables cutting the cable ties V.



Complete wiring disassembly procedure (Continued)

c. Disconnect the signal connectors (bus X200 and services**X70**) **S** from axis 3 services bracket.



d. Disconnect the compressed air tube T from axis 3 services bracket.

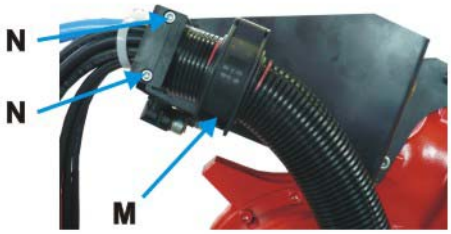
e. Disconnect the connectors **P** (XMTR4 - XSYN4) from axis 4 motor.

f. Disconnect the connectors Q (XMTR5 - XSYN5) from axis 5 motor.

g. Disconnect the connectors **R** (XMTR6 - XSYN6) from axis 6 motor.

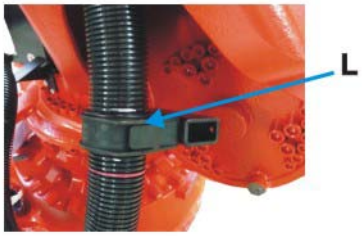
[2] Dressing disassembly from axis 3 to axis 2

h. Release the polyurethane jacket unscrewing the screws N (socket hex head M6x90.



i. Remove the dressing from the locking device M present in the axis 3 services bracket.

j. Remove the dressing from the clamp L present on the Robot lever by unscrewing the two socket hex head screws M8x16



k. Remove the dressing from the locking device K.

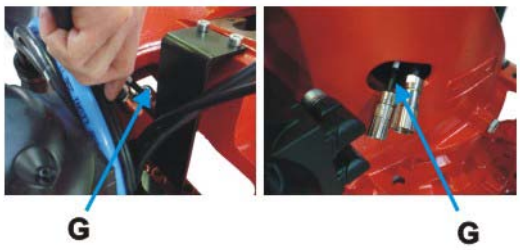
Complete wiring disassembly procedure (Continued)

[3] Dressing disassembly from axis 2 to axis 1

l. Untie the cables cutting the cable tie J.

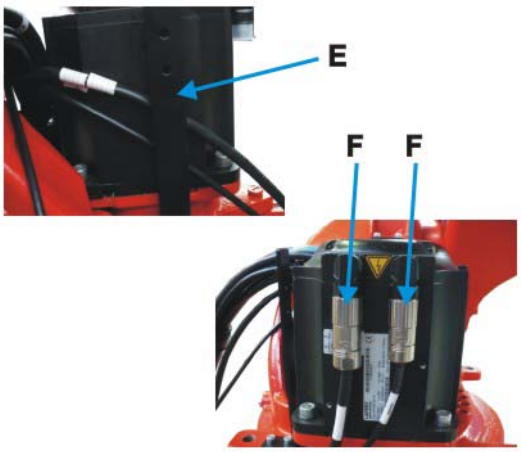
m. Disconnect the connectors **H** (XMTR2 - XSYN2) from axis 2 motor.

n. Extract the cables motor axis 2 passing them trough the gates G.

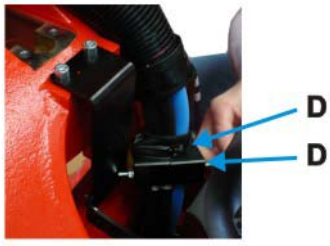


o. Extract the motor cables axis 1 from behind the bracket E.

p. Disconnect the connectors **F** (XMTR1 - XSYN1) from axis 1 motor.



q. Remove the dressing from the bracket unscrewing the screws D (socket hex head screws M6x90) of the locking device.

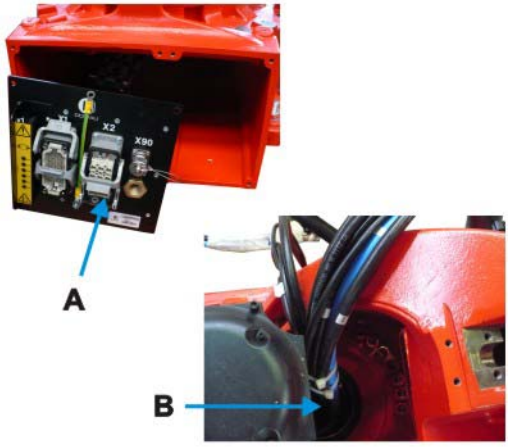


Complete wiring disassembly procedure (Continued)

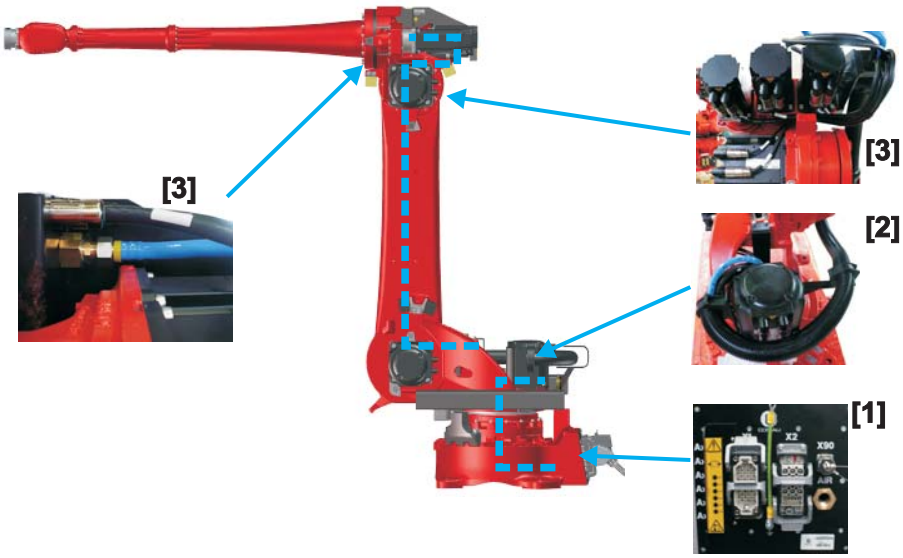
r. Disconnect the yellow conductor from the bottom left screw.

s. Unscrew the screws C (socket hex head screws M6x16) that fasten the dressing panel.

t. Extract the dressing in the Robot base **A** and draw it out from the axis 1 hole **B**.



Complete wiring assembling procedure



[1] Dressing passage and assembly from axis 1 to axis 2
[2] Dressing passage and assembly from axis 2 to axis 3
[3] Axis 3 dressing passage and assembly

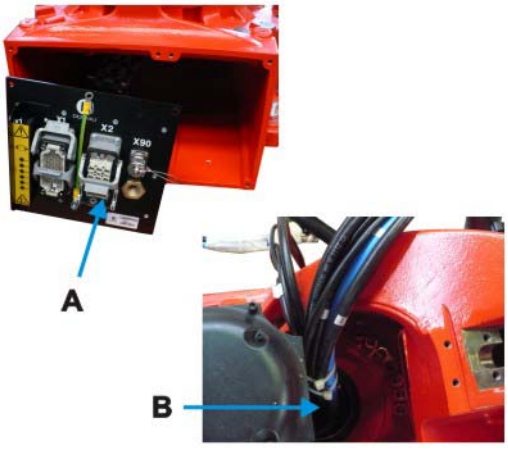
During the activity check that the pipes are not constricted and cables are adequately curved.

[1] Dressing passage and assembly from axis 1 to axis 2

a. Lay the dressing on the ground and cut the locking plastic cable ties.

b. Insert the dressing in the Robot base **A** and draw it out from the axis 1 hole **B**.

c. Cut the lower cable tie.



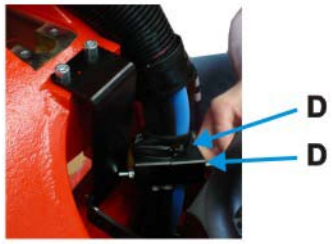
Complete wiring assembling procedure (Continued)

d. Screw the screws C (socket hex head screws M6x16) that fasten the dressing panel.

e. Connect the yellow conductor from the bottom left screw.

f. Fasten the dressing to the bracket by beans of the locking device using the screws S (socket hex had screw M6x90).

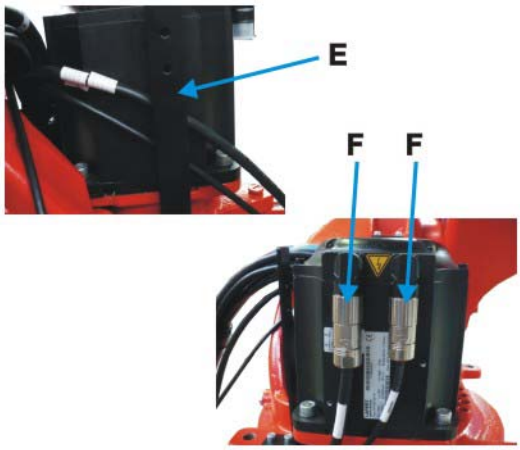
g. Check that when closing the locking device the dressing is not pinched.



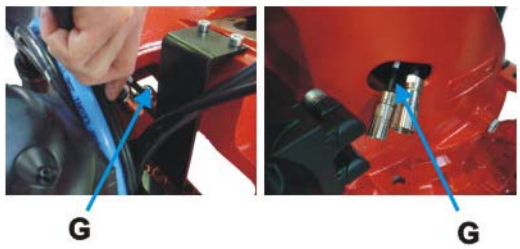
h. Cut the cable tie.

i. Let the motor cables pass behind the bracket E as described in the figure on the side.

j. Connect the connectors **F** (XMTR1 - XSYN1) to the axis 1 motor.



k. Let the axis 2 motor cables pass trough the gates G.



Complete wiring assembling procedure (Continued)

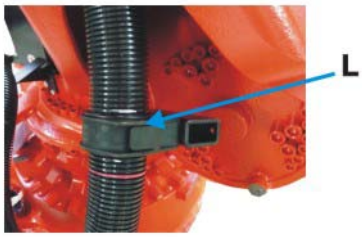
l. Connect the connectors **H** (XMTR2 - XSYN2) to the axis 2 motor.

m. Fix the cables with the cable tie J.

[2] Dressing passage and assembly from axis 2 to axis 3

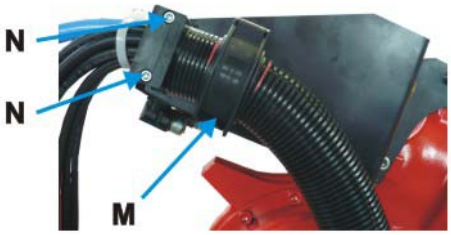
n. Fasten the dressing inside the locking **K**.
To position properly the jacket refer to the coloured notches present on the corrugated pipe.

o. Fasten the dressing from the locking device L present on the Robot lever.
To position properly the jacket refer to the coloured notches present on the corrugated pipe.



p. Fasten the dressing from the locking device M present in the axis 3 services bracket.
To position properly the jacket refer to the coloured notches present on the corrugated pipe.

q. Fasten the corrugated locking device of the corrugated tube to the services bracket using the screw N (socket hex head screw M6x90).



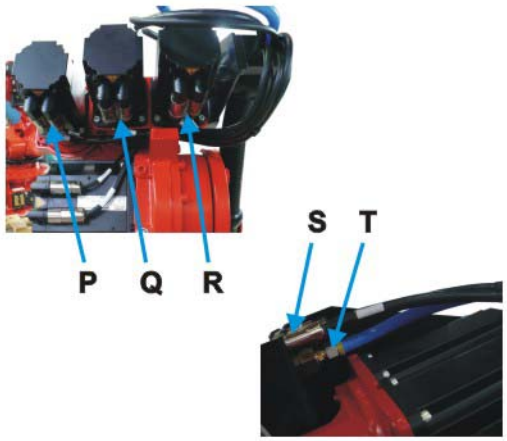
Complete wiring assembling procedure (Continued)

[3] Axis 3 dressing passage and assembly

r. Connect the connectors **P** (XMTR4 - XSYN4) to the axis 4 motor.

s. Connect the connectors Q (XMTR5 - XSYN5) to the axis 5 motor

t. Connect the connectors **R** (XMTR6 - XSYN6) to the axis 6 motor.

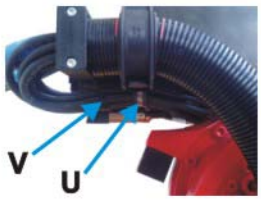


u. Connect the signal connectors (bus X200 and services**X70**) **S** to axis 3 services bracket.

v. Connect the compressed air tube T from axis 3 services bracket.

w. Lock the cables through the fixing collar U using a locking nut M8.

x. Clamp the cables using the cable strap **V** as described in the figure.



At the end of the activity, check that the pipes and cables are not constricted or inadequately curved.
Before starting the production cycle move the Robot with low speed, in order to check the proper positioning of the dressing.

10. TURN-SET AND CALIBRATION - BASIC CONCEPTS

10.1 Introduction

The purpose of this chapter is to provide basic concepts and terms related to the position information management of Robot axes. For the description of the operating procedures, see chapter TURN-SET AND CALIBRATION - OPERATING PROCEDURES, specific **for the Robot** used.

In this chapter is provided basic information on the following topics:

– used Terminology
– Turn-set
– Calibration.

10.2 Terminology

- *TRANSDUCER*: Two types of position transducer are supported: encoder and resolver.
- *NUMBER OF TRANSDUCER ROTATIONS:* during the Robot axis motion, the transducer can perform more rotations; the rotation number is initialized by the calibration or turn-set operation.
- *AXIS DIMENSIONS:* the dimensions of an axis contains all the information required to define the proper position of an axis in the space;
- *DIMENSION RECONSTRUCTION:* when the Control Unit is turned on, the system software, among the other initialization processes, reconstructs the Robot axes dimension.
  The system software checks this dimensions; it checks if the difference between the restored position and the position before the shutdown is below a threshold. If the threshold is exceeded, the Control Unit displays the error **59411 - 08 Ax <axis_numb> Arm <arm_numb> motion after shutdown** and leaves to the operator the responsibility to check that the Robot physical position corresponds to the new dimension.
- *CALIBRATION POSITION:* it is a pre-set position that can be checked by means of suitable tools (dial gauges, supports, calibration tools). The calibration position is a reference position in the Robot workspace that is used to univocally initialize the dimension of each single axis and to calculate and assign the corresponding Cartesian position of the Robot.
- *CALIBRATION CONSTANTS:* the calibration constant is the difference between the datum read by the transducer and the theoretical position that the transducer should assume in that particular position of the Robot axis. In fact, since the transducer positioning in relation to the Robot joint is random (as it depends on how the transducer has been assembled), it is necessary to correct the real position of the transducer depending on the theoretical position required by the Robot axis.
  The calibration constant is expressed within a transducer rotation and is stored in the $ARM_DATA[].CAL_DATA variable. It is represented in motor rotations and it is a value included between -0.5 (excluded) and +0.5 (included). The calibration constant described in the $ARM_DATA[].CAL_DATA variable can be read from the Teach Pendant, page **SETUP**, sub-page **Calib**.
- *ASCII CALIBRATION FILE*: the calibration file UD:\SYS\<$SYS_ID>_CAL<arm_numb>.PDL (where $SYS_ID indicates the system identification label, as for example NJ4_001) is an ASCII file with syntax of a PDL2 file in which are stored the calibration constants ($ARM_DATA[arm_numb].CAL_DATA[n]) and other Robot typical data.
- *RETENTIVE MEMORY:* is a memory used to save featuring information of the Robot matched with the Control Unit, the calibration constants and the axes length. It can be found in the Controller CPU board.

10.3 Turn-set

The purpose of the turn-set operation is to update only the number of rotations of the transducer in case the Control Unit has lost that value when restarting.

The operation consists of setting the interested axis in calibration position, by means of the reference notches, and give the proper command. It does not require any specific equipment because, **the only one initialized value** is the number of transducer rotations.

The **turn-set** operation is required when

– axes motion occur when the controller is powered off (e.g. when the error **59411 - 08 Ax <axis_numb> Arm <arm_numb> motion after shutdown** is signaled)

– occur some events that lead to the loss of the number of rotations, and therefore the calibration procedure is not required. On the Teach Pendant status windows or the PC screen it is shown the message **Ar:TURN**.

If the turn set is carried out with the Robot in system calibration position or user calibration position, you will have:

– Turn-set on system calibration position

– Turn-set on user calibration position

– Turn-set for Robot axes with multi-turn stroke

10.3.1 Turn-set on system calibration position

It allows to initialize the number of transducer rotations of each Robot axes in **the system calibration position** (calibration position pre-defined by COMAU).

For further information see par. 10.4.1 System calibration on page 140 ($ARM_DATA[].CAL_SYS).

10.3.2 Turn-set on user calibration position

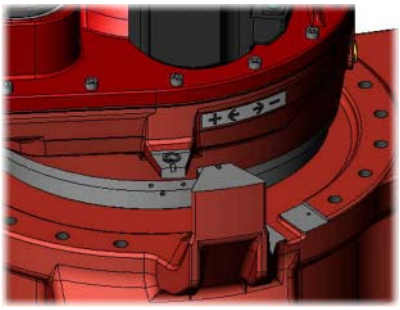
It allows to initialize the number of transducer rotations of each Robot axes in **the user calibration position** (“out of work area” calibration position defined by the user).

For further information see par. 10.4.2 User calibration on page 140 ($ARM_DATA[].CAL_USER).

10.3.3 Turn-set for Robot axes with multi-turn stroke

In the Robot axes having the possibility to accomplish the multi-turn stroke, it may occur that during the Turn-set procedure, the mechanical calibration notches are out of alignment (such condition can occur when the Robot axis, having completed one or more complete rotations, is positioned in a different mechanical rotation than that of the original calibration).

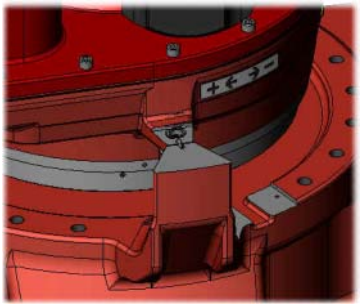
Fig. 10.1 - Wrong Axis Position in TURN SET



Representative figure

In the condition specified above, when moving the axis to align the notches, on the Teach Pendant is displayed the following position error message:

5409 - 02 Ax <axis_numb> Arm <arm_numb> joints position not sufficiently accurate



Representative figure

In case the conditions specified above occur, do not send the Turn-set command (the axis would be calibrated in an incorrect position), but restore the correct position by carrying out, alternatively, one of the following procedures:

1. Rotate the axis and find the position where the initial starting calibration has occurred with some trials of axis rotation. Restart the notches alignment and give the TURN-SET command. Once the proper position has been restored, on the Teach Pendant it **Completed Command**.

Or as an alternative

2. Carry out full axis calibration (see chapter - **Turn-Set and Calibration - Operating Procedures**)

10.4 Calibration

The purpose of the calibration is to define the axes position of a Robot, referring it to an ideal Robot. That allows to initialize the Robot axes dimensions and to make universal the position variables used in the Robot programs.

During the calibration procedure, when the required axis is in the calibration position, the deviation is stored (within a transducer rotation) between the value in the real position and that in the theoretical position of the axis.

The notches available on each axis will allow to carry out future turn-set operations of a Robot already installed.

Remember that carrying out the calibration operation (from Teach Pendant, page SETUP, sub-page Calib, command Calibra) by simply positioning the Robot axes on the reference notches, without using suitable tools, is an operation that does not guarantee the required precision when positioning the Robot.

Recovering the calibration (made by COMAU), if necessary, must be carried out at the time of the first commissioning of the Robot.

Then, the calibration will not have to be carried out, unless a mechanical failure occurs, that implies the replacement of a component of the kinematic chain, or unless crashes damaging the Robot structure.

Find below the basic concepts on:

– System calibration

– User calibration

10.4.1 System calibration

It allows to initialize the Robot axes dimensions in the **system** calibration position (calibration position pre-defined by COMAU - $ARM_DATA[].CAL_SYS).

To define the correct calibration position, special tools have to be used (dial gauges, supports, etc.) able to determine with the required precision the position of each single axis.

10.4.2 User calibration

The user calibration allows to define a new **calibration position different from the one of the system**.

This type of calibration (usually defined as **out of work area calibration**) can be used if the system position is hardly reachable once the Robot is included in the final application, and therefore it is necessary to define a different calibration position, defined as user calibration position ($ARM_DATA[].CAL_USER).

It will be the task of the user to find suitable tools to check the proper Robot positioning in possible user recalibration, in particular as far as the reference notches position are regarded.

11. TURN-SET AND CALIBRATION - OPERATING PROCEDURES

The purpose of this chapter is to provide the turn-set and calibration operating procedures, in particular the following topics are explained:

- General requirements
- Identification of Robot calibration position
- Turn-set procedure
- System calibration by means of tools
- User calibration

11.1 General requirements

WARNING:
Intrusion risk of not foreseen areas: a faulty or performed with poor accuracy calibration alters the originally programmed operational area of the Robot, with the consequent risk (even severe) to the operator.

The System calibration by means of tools must be performed following mechanical disassembly operations that alter the geometry of the Robot.

The accuracy level achieved during the calibration affects the positioning: if a new calibration is performed with poor accuracy, the Tool Center Point and the equipment installed may reach technological points of the working cycle in a different position with respect to that obtained with the previous calibration.

It is necessary to remember that:

- **it is recommended to perform the calibration in axes progressive sequence, starting from the axis on which the calibration is required and continuing with the subsequent axes;**
- **the calibration of a single wrist axis (axes 4, 5 and 6) requires the positioning on the calibration notches of the other wrist axes not involved in the calibration, and their sequential calibration.**

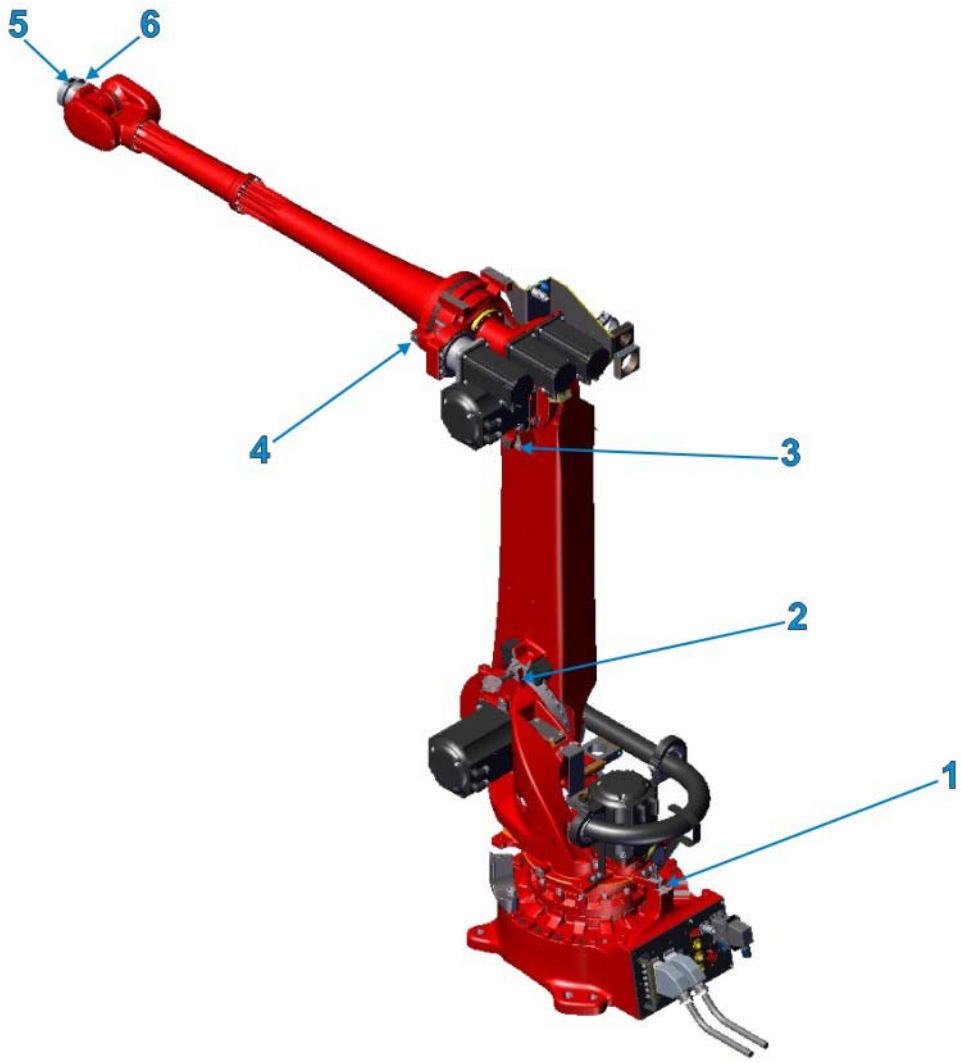
The theoretical aspects and functional description of the calibration and turn-set can be found in Chap.10. - Turn-set and Calibration - Basic Concepts on page 135.

The calibration position of the Robot, defined by the alignment of all reference notches of the axes, is illustrated in Fig. 11.1 - Robot calibration position on page 143.

11.2 Identification of Robot calibration position

The Robot calibration positions are listed in Tab. 11.1, but may differ if a different calibration position has been differently defined by the integrator (see par. 8.4.2 Calibrazione utente on page 139)

Fig. 11.1 - Robot calibration position



1. Axis 1 calibration reference notch
2. Axis 2 calibration reference notch
3. Axis 3 calibration reference notch
4. Axis 4 calibration reference notch
5. Axis 5 calibration reference notch
6. Axis 6 calibration reference notch

Tab. 11.1 - Joints position in calibration ($ARM_DATA[].CAL_SYS)

Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6
0°	0°	-90°	0°	0°	0°

11.3 Turn-set procedure

This procedure is performed upon the system software request, if the Control Unit knows the calibration constants, but have lost the information regarding the number of revolutions of the transducer, for example due to an electrical disconnection of the motors.

Position the Robot axes on the reference notches in a position visually as accurate as possible: the system signals to the operator the error **59409 SAX: *joints position not accurate enough*** and subsequently displaying the error **59421 SAX: *a positive adjustment is required*** and/or displaying the error **59422 SAX: *a negative adjustment is required*** to reach the correct position.

Perform the Turn-set operations according to one of the indicated methods, depending on the available software version:

1. **through CAT system command (Configure Arm Turn_set)**
   - If the arm number is not specified, the default arm is used, while the axis number shall always be specified. To show all the arm axes, specify an asterisk (*).
   - Set the command **CAT** (**Configure Arm Turn-set**) with the Robot properly positioned as specified in the Fig. 11.1 - Robot calibration position on page 143

The Turn-set command implies the option: ***/User*** that allows to recalculate the transducer revolutions number referring to the user calibration ($ARM_DATA[].$CAL_USER).

2. **through specific video pages of the Teach Pendant**
   - If the arm number is not specified, the default arm is used, while the axis number shall always be specified. The current arm can be changed in the "Motion" page, "General" sub-page.
   - Select in the following order the "Setup", "Motion", "Calib" pages
   - Carry out the "Turn Set" command:
     - short press for Turn set on standard calibration position;
     - press and hold for Turn set on user calibration position previously acquired, then press "User".

Afterwards, the system recalculates the correct number of revolutions of the transducer depending on the calibration position ($ARM_DATA[].CAL_SYS). The operation shall be performed only on the axis on which the count has been lost; if more than one axes are in the situation described above it is advisable to carry out the turn-set of each axis separately.

11.4 System calibration by means of tools

This paragraph describes the system calibration using tools considering the position of the Robot corresponding to the $ARM_DATA[].$CAL_SYS function and is divided in the following points:

- Requirements for axes positioning control
- Required equipment
- Preliminary operations and ordinary operations
- Axes calibration procedure

11.4.1 Requirements for axes positioning control

Release of the enabling button on the Teach Pendant (DRIVE OFF) may cause slight movements of the axes generated by the gravity of the masses applied, and made more evident if the drives activation functions are carried out in quick succession.

- During the calibration it is necessary to limit to a minimum the number of activations/deactivations of the drives to avoid possible slight movements of the axes. The system recovers automatically the motions bringing the axes in the proper calibration position under the condition that they have been previously calibrated.
- The axes repositioning can be checked on the teach pendant by registering the joints position values through the commands **Display - Arm - Joint (F2; F1; F4)**.

After every system drives activation command, check on the Teach Pendant that the axes return to the correct calibration position.
If the axes do not return in the proper position, it is necessary to start again from the beginning the calibration procedure.

11.4.2 Required equipment

The following is the minimum necessary equipment and the fixing components for calibration operations:

Tab. 11.2 - Required equipment

– Calibration tool (see Fig. 11.2)
– Cross-head screwdrivers set
– Flat-tip screwdrivers set
– Screws for holes protection for dial gauge (to be stored)

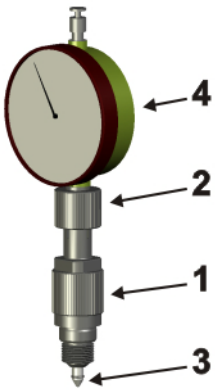
11.4.3 Preliminary operations and ordinary operations

Calibration shall be carried out with Robot without loads applied to the axes (tool, grippers, etc.) excluded axis 1.
Remove the Tool from the wrist before starting the calibration operations.

a. Activate on the Control Unit the programming functioning mode **(PROG)**.

b. When required in the calibration procedure of the single axis, follow the steps below for the correct calibration tool assembly.
   – Use the appropriate tool (see Fig. 11.2).
   – The threaded seat and the reference notch are protected by specific guards. Remove the guards and store them for the subsequent reassembly.
   – Screw in the seat provided in each axis of the Robot the dial gauge holder.
   – Screw the dial gauge in the dial gauge holder: the dial gauge is used to detect the minimum point with respect to the underlying fixed "V" notch. The position of the Robot in the minimum point is the calibration position.

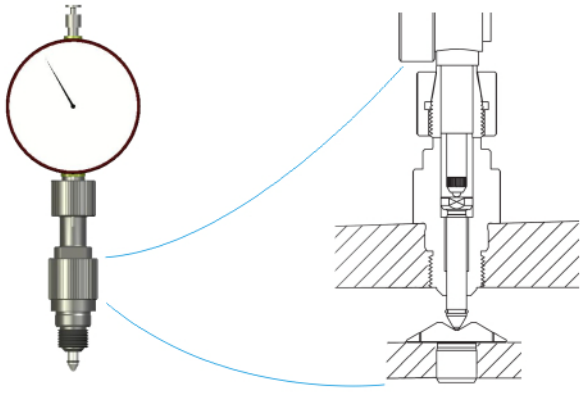
Fig. 11.2 - Calibration tool (optional)



1. Dial gauge holder
2. Conical ring nut
3. Probe
4. Dial gauge

When assembling the calibration tool, stick to the diagram below

Fig. 11.3 - Calibration tool assembly diagram



11.4.4 Axes calibration procedure

The operational procedures for the Robot single axes calibration are described below:

- Axis 1 calibration
- Axis 2 calibration
- Axis 3 calibration
- Axis 4 calibration
- Axis 5 calibration
- Axis 6 calibration.

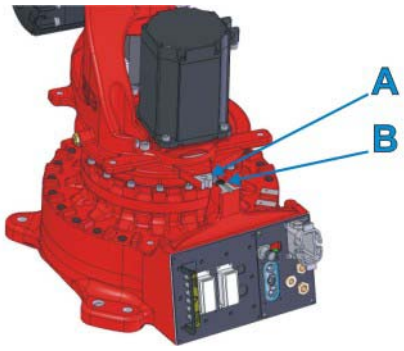
11.4.4.1 Axis 1 calibration

Status:	–	Control Unit switched on and operating
Material:	–	---
Equipment:	–	Calibration tool (82314100)
	–	Cross-head screwdriver for M3 screw
	–	Flat-tip screwdriver for M14 screw
Fixing components:	–	Teflon slotted head screw M14 for dial gauge hole protection for calibration
	–	Stainless cross-slotted screw M3x16 for reference notch protection fixing

Preliminary procedures/ notes
– ---

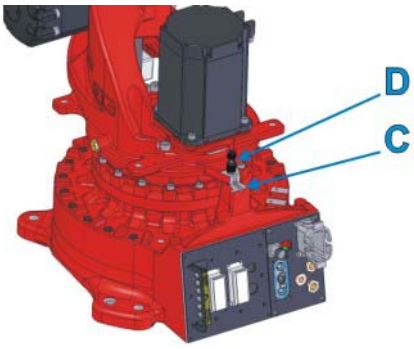
Calibration procedure

a. Remove the guards from the reference notch **A** and from the seat **B** for fixing the dial gauge holder equipment.



Calibration procedure (Continued)

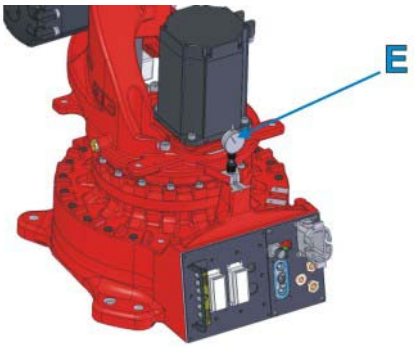
b. Via the Teach Pendant, move the Robot axes in the calibration position, up to bring the movable reference notch **C** to coincide with the fixed reference notch.



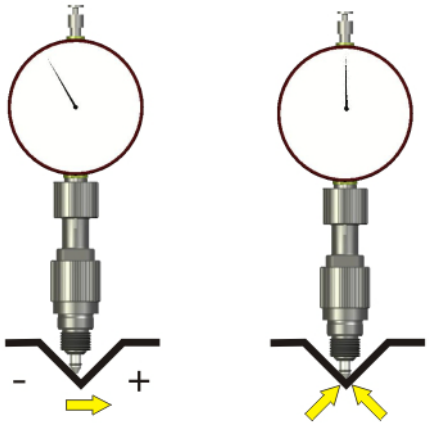
c. Screw the dial gauge holder equipment **D** in the seat, and screw the dial gauge in the holder up to preload the rod of the dial gauge of a few millimetres (about 2.5 mm).

For further information on calibration tool assembly, see par. 11.4.3 from step b.

d. Move at low speed (recommended at 1% and, in any case, not exceeding 5% - GEN-OVR < 5%) the axis to be calibrated, **moving from negative to positive direction** until registering on the dial gauge **E** the minimum point.



If the minimum point has been passed, return to the start position and repeat the measurement, always moving the Robot axis from negative to positive direction so as to compensate possible mechanical clearance of the axis.



e. On the Teach Pendant keyboard select **CAC** (Configure Arm Calibrate) command.

f. Select the arm to be calibrated and confirm with ENTER.

g. Select the axis to be calibrated and confirm with ENTER.

Follow-up procedures
– Remove the dial gauge and reassemble the guards in the seats for fixing the dial gauge holder equipment and in the reference notches for calibration.

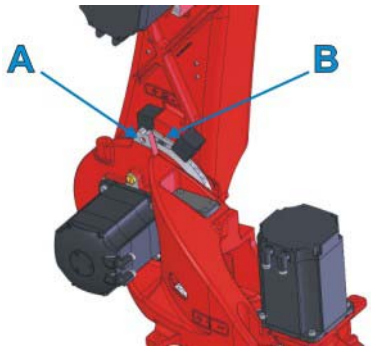
11.4.4.2 Axis 2 calibration

Status:	–	Control Unit switched on and operating
Material:	–	---
Equipment:	–	Calibration tool (82314100)
	–	Cross-head screwdriver for M3 screw
	–	Flat-tip screwdriver for M14 screw
Fixing components:	–	Teflon slotted head screw M14 for dial gauge hole protection for calibration
	–	Stainless cross-slotted screw M3x16 for reference notch protection fixing

Preliminary procedures/ notes
– ---

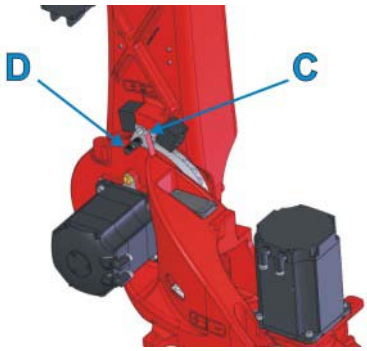
Calibration procedure

a. Remove the guards from the reference notch **A** and from the seat **B** for fixing the dial gauge holder equipment.



Calibration procedure (Continued)

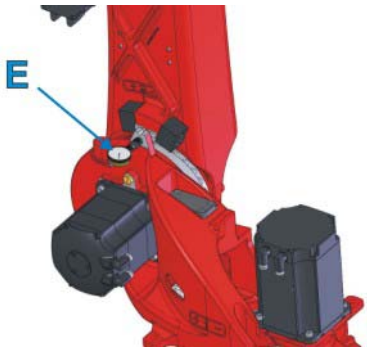
b. Via the Teach Pendant, move the Robot axes in the calibration position, up to bring the movable reference notch **C** to coincide with the fixed reference notch.



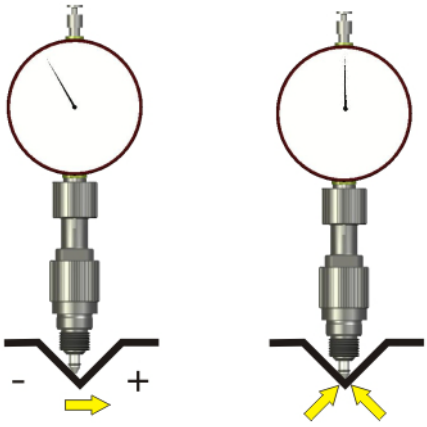
c. Screw the dial gauge holder equipment **D** in the seat, and screw the dial gauge in the holder up to preload the rod of the dial gauge of a few millimetres (about 2.5 mm).

For further information on calibration tool assembly, see par. 11.4.3 from step b.

d. Move at low speed (recommended at 1% and, in any case, not exceeding 5% - GEN-OVR < 5%) the axis to be calibrated, **moving from negative to positive direction** until registering on the dial gauge **E** the minimum point.



If the minimum point has been passed, return to the start position and repeat the measurement, always moving the Robot axis from negative to positive direction so as to compensate possible mechanical clearance of the axis.



e. On the Teach Pendant keyboard select **CAC** (Configure Arm Calibrate) command.

f. Select the arm to be calibrated and confirm with ENTER.

g. Select the axis to be calibrated and confirm with ENTER.

Follow-up procedures
– Remove the dial gauge and reassemble the guards in the seats for fixing the dial gauge holder equipment and in the reference notches for calibration.

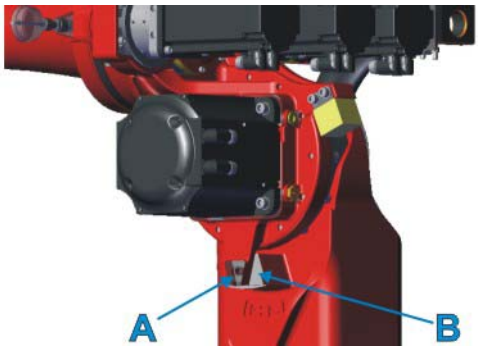
11.4.4.3 Axis 3 calibration

Status:	–	Control Unit switched on and operating
Material:	–	---
Equipment:	–	Calibration tool (82314100)
	–	Cross-head screwdriver for M3 screw
	–	Flat-tip screwdriver for M14 screw
Fixing components:	–	Teflon slotted head screw M14 for dial gauge hole protection for calibration
	–	Stainless cross-slotted screw M3x16 for reference notch protection fixing

Preliminary procedures/ notes
– ---

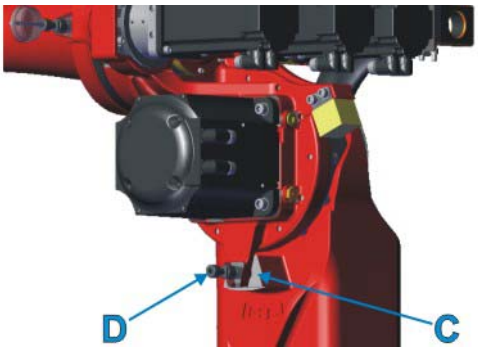
Calibration procedure

a. Remove the guards from the reference notch **A** and from the seat **B** for fixing the dial gauge holder equipment.



Calibration procedure (Continued)

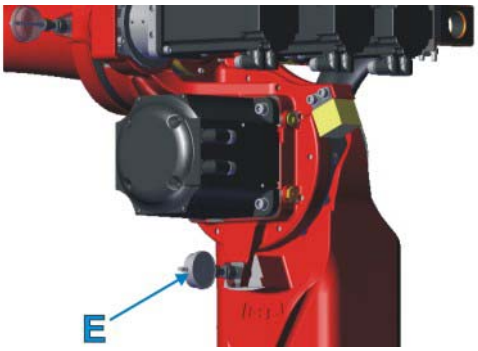
b. Via the Teach Pendant, move the Robot axes in the calibration position, up to bring the movable reference notch **C** to coincide with the fixed reference notch.



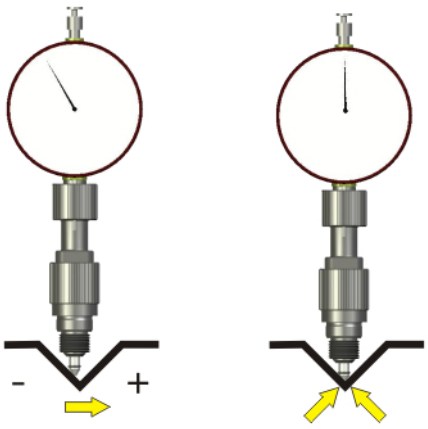
c. Screw the dial gauge holder equipment **D** in the seat, and screw the dial gauge in the holder up to preload the rod of the dial gauge of a few millimetres (about 2.5 mm).

For further information on calibration tool assembly, see par. 11.4.3 from step b.

d. Move at low speed (recommended at 1% and, in any case, not exceeding 5% - GEN-OVR < 5%) the axis to be calibrated, **moving from negative to positive direction** until registering on the dial gauge **E** the minimum point.



If the minimum point has been passed, return to the start position and repeat the measurement, always moving the Robot axis from negative to positive direction so as to compensate possible mechanical clearance of the axis.



e. On the Teach Pendant keyboard select **CAC** (Configure Arm Calibrate) command.

f. Select the arm to be calibrated and confirm with ENTER.

g. Select the axis to be calibrated and confirm with ENTER.

Follow-up procedures
– Remove the dial gauge and reassemble the guards in the seats for fixing the dial gauge holder equipment and in the reference notches for calibration.

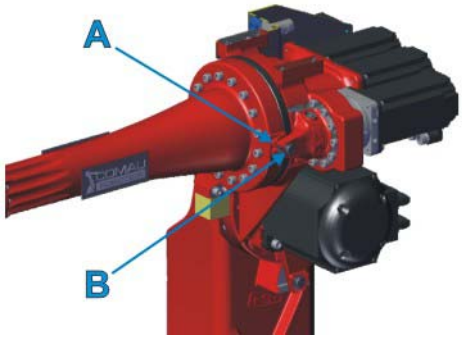
11.4.4.4 Axis 4 calibration

Status:	–	Control Unit switched on and operating
Material:	–	---
Equipment:	–	Calibration tool (82314100)
	–	Cross-head screwdriver for M3 screw
	–	Flat-tip screwdriver for M14 screw
Fixing components:	–	Teflon slotted head screw M14 for dial gauge hole protection for calibration
	–	Stainless cross-slotted screw M3x16 for reference notch protection fixing

Preliminary procedures / notes
– ---

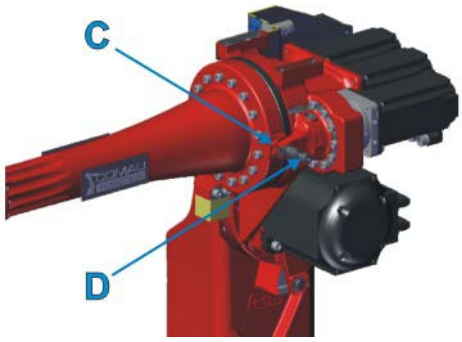
Calibration procedure

a. Remove the guards from the reference notch **A** and from the seat **B** for fixing the dial gauge holder equipment.



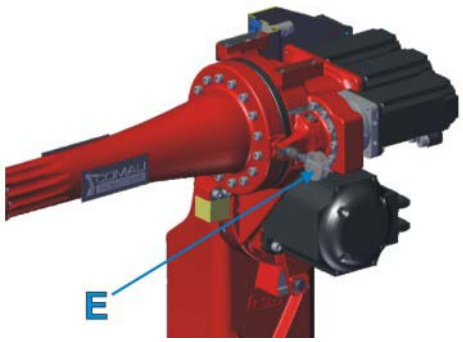
b. Via the Teach Pendant, move the Robot axes in the calibration position, up to bring the movable reference notch **C** to coincide with the fixed reference notch.

c. Screw the dial gauge holder equipment **D** in the seat, and screw the dial gauge in the holder up to preload the rod of the dial gauge of a few millimetres (about 2.5 mm).

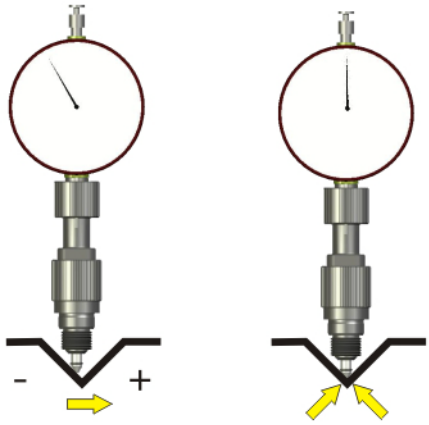


Calibration procedure (Continued)

d. Move, at low speed the axis to be calibrated, **from negative to positive direction,** up to register on the dial gauge E the minimum point.



If the minimum point has been passed, return to the start position and repeat the measurement, always moving the Robot axis from negative to positive direction so as to compensate possible mechanical clearance of the axis.



Follow-up procedures

– Remove the dial gauge and reassemble the guards in the seats for fixing the dial gauge holder equipment and in the reference notches for calibration.

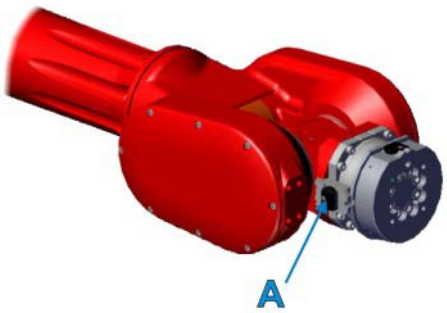
11.4.4.5 Axis 5 calibration

Status:	–	Control Unit switched on and operating
Material:	–	---
Equipment:	–	Calibration tool (82314100)
	–	Kit for Axis 5 and Axis 6 calibration (82282100) - Axis 5 dial gauge holding support equipment (82312911)
	–	Cross-head screwdriver for M3 screw
	–	5 mm Allen wrench
Fixing components:	–	Stainless cross-slotted screw M3x16 for reference notch protection fixing
	–	Socket hex head screws M6x12 to fasten the supporting equipment

Preliminary procedures/ notes
– ---

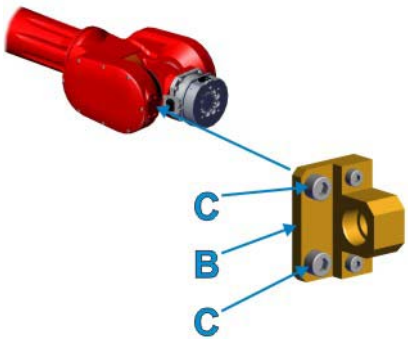
Calibration procedure

a. Remove the protection from the reference notch **A**.



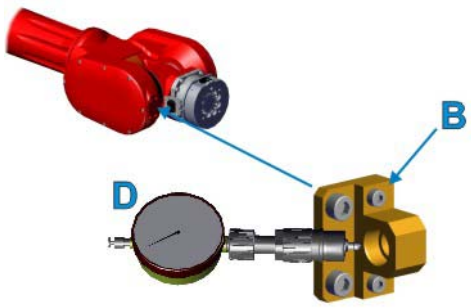
b. Position the dial gauge supporting equipment **B** (82312911) on the Robot wrist.

c. Screw the 2 fixing screws **C** (socket hex head screws M6x12).



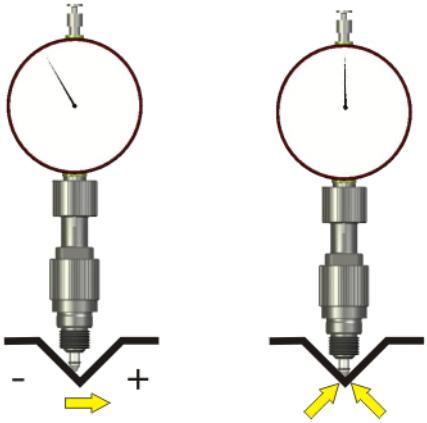
Calibration procedure (Continued)

d. Screw the dial gauge **D** on the holder **B** up to pre-load the dial gauge rod of some millimeters (about 2.5 mm).



e. Move at low speed (recommended at 1% and, in any case, not exceeding 5% - GEN-OVR < 5%) the axis to be calibrated, **moving from negative to positive direction** until detecting on the dial gauge the minimum point.

If the minimum point has been passed, return to the start position and repeat the measurement, always moving the Robot axis from negative to positive direction so as to compensate possible mechanical clearance of the axis.



f. On the Teach Pendant keyboard select **CAC** (Configure Arm Calibrate) command.

g. Select the arm to be calibrated and confirm with ENTER.

h. Select the axis to be calibrated and confirm with ENTER.

Follow-up procedures

– Remove the dial gauge and the dial gauge holder equipment.
– Unscrew the two fixing screws **D** (socket hex head screws M6x12).
– Remove the supporting equipment **B**.
– Reassemble the protection on the reference notch for calibration.

11.4.4.6 Axis 6 calibration

Status:	–	Control Unit switched on and operating
Material:	–	---
Equipment:	–	Calibration tool (82314100)
	–	Kit for Axis 5 and Axis 6 calibration (82282100) - Axis 6 dial gauge holding support equipment (82282111)
	–	Cross-head screwdriver for M3 screw
	–	5 mm Allen wrench
Fixing components:	–	Stainless cross-slotted screw M3x16 for reference notch protection fixing
	–	Fixing Socket hex head screws M6x25

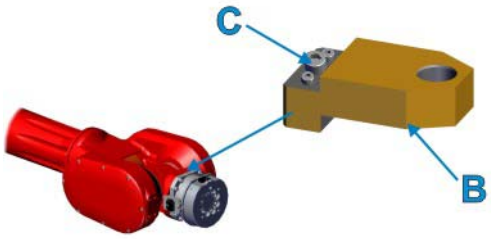
Preliminary procedures/ notes
– ---

Calibration procedure

a. Remove the protection from the reference notch **A**.

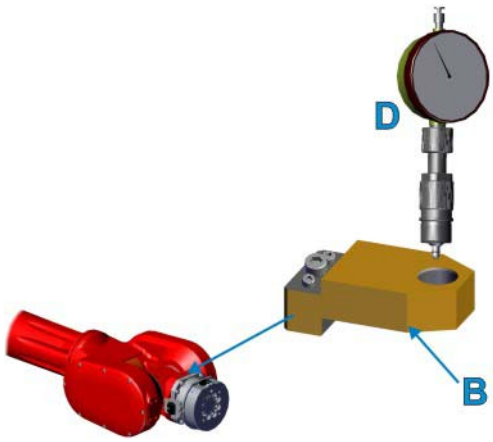
b. Position the dial gauge supporting equipment **B** (82282111) on the Robot wrist.

c. Unscrew the fixing screw **C** (socket hex head screw M6x25).



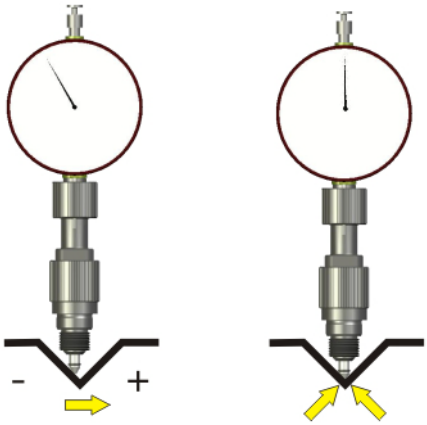
Calibration procedure (Continued)

d. Screw the dial gauge **D** on the holder **B** up to pre-load the dial gauge rod of some millimeters (about 2.5 mm).



e. Move at low speed (recommended at 1% and, in any case, not exceeding 5% - GEN-OVR < 5%) the axis to be calibrated, **moving from negative to positive direction** until detecting on the dial gauge the minimum point.

If the minimum point has been passed, return to the start position and repeat the measurement, always moving the Robot axis from negative to positive direction so as to compensate possible mechanical clearance of the axis.



f. On the Teach Pendant keyboard select **CAC** (Configure Arm Calibrate) command.

g. Select the arm to be calibrated and confirm with ENTER.

h. Select the axis to be calibrated and confirm with ENTER.

Follow-up procedures

– Remove the dial gauge and the dial gauge holder equipment.
– Unscrew the fixing screw **D** (socket hex head screw M6x25).
– Remove the supporting equipment **B**.
– Reassemble the protection on the reference notch for calibration.

11.5 User calibration

The calibration command allows specific options (which can be activated by pressing contemporaneously the keys **SHIFT** and **9**,**/** on the Teach Pendant) that allow to define a Robot calibration position different from the system one (out-of-area calibration) illustrated in Fig. 11.1 - Robot calibration position on page 143.
In particular can be used the following functions:

– **/Learn**
used to move the Robot in the desired position and set the command **CAC/L**. So the Robot position is stored in the system variable $ARM_DATA[num_arm].CAL_USER.
To be able to carry out this operation, it is necessary that a system calibration (Configure Arm Calibrate without options) must first be performed.

– **/User**
can be used to carry out the calibration on the position stored in the system variable $ARM_DATA[arm_num].CAL_USER as described in the previous point. After this operation, the calibration constant is stored in the same system variable dedicated to the system calibration constant ($ARM_DATA[].CAL_DATA).

12. SPARE PARTS LIST

This chapter deals with the following topics:

12.1 Precautions regarding spare parts usage

This chapter contains the lists of the spare parts foreseen for the Robots.

For Robot maintenance use only original spare parts.
Do not carry out uncontrolled or unauthorized repair activities of single spare parts.
Do not use spare parts for different purposes than those indicated.

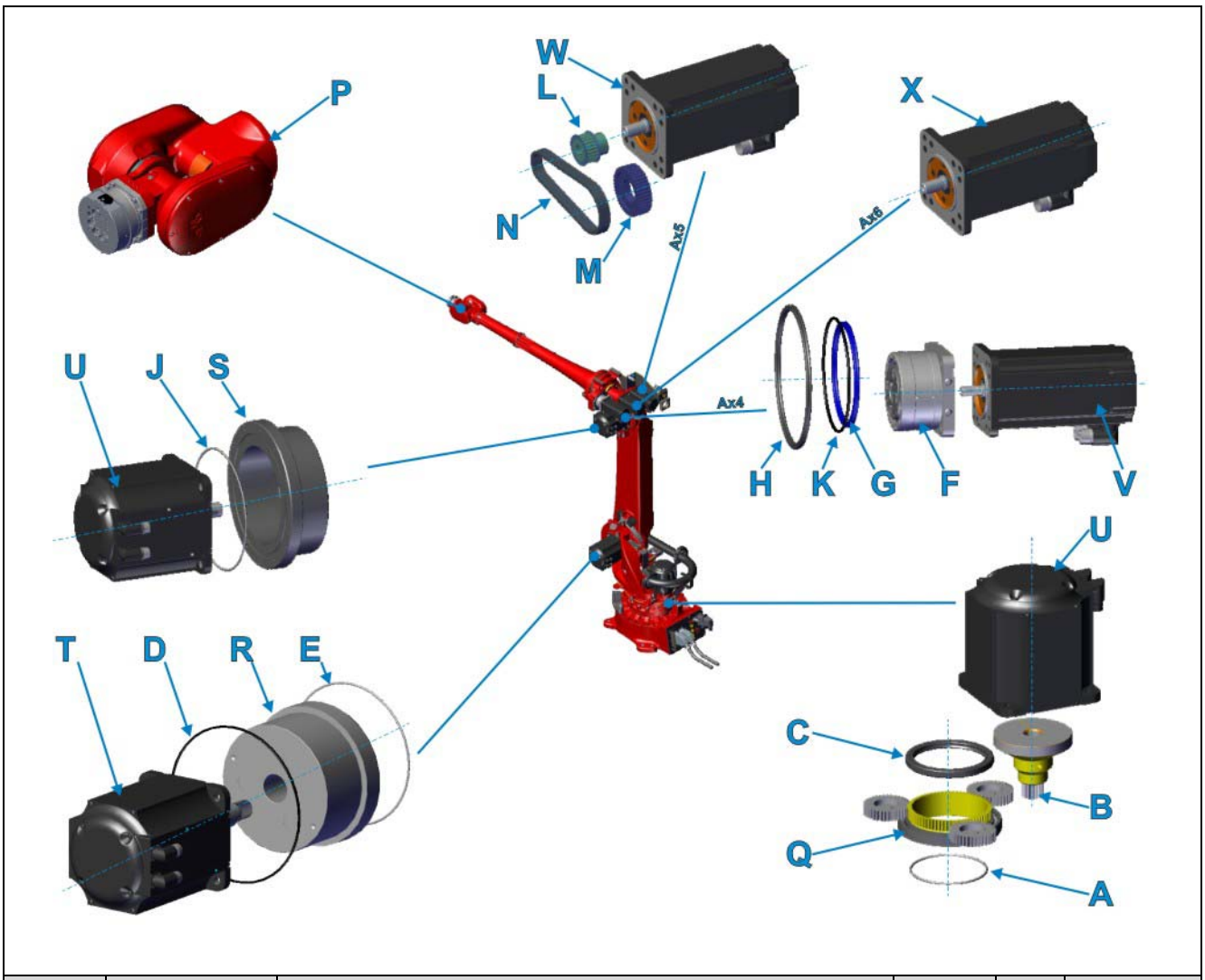
12.2 Where to find the spare parts

The original spare parts can be required to the Comau Service Center.

12.3 Spare parts list

In the following Tables are indicated:

Tab. 12.1 - Motors and gears spare parts Robot SMART NJ 16 - 3.1 Rel. 1.0

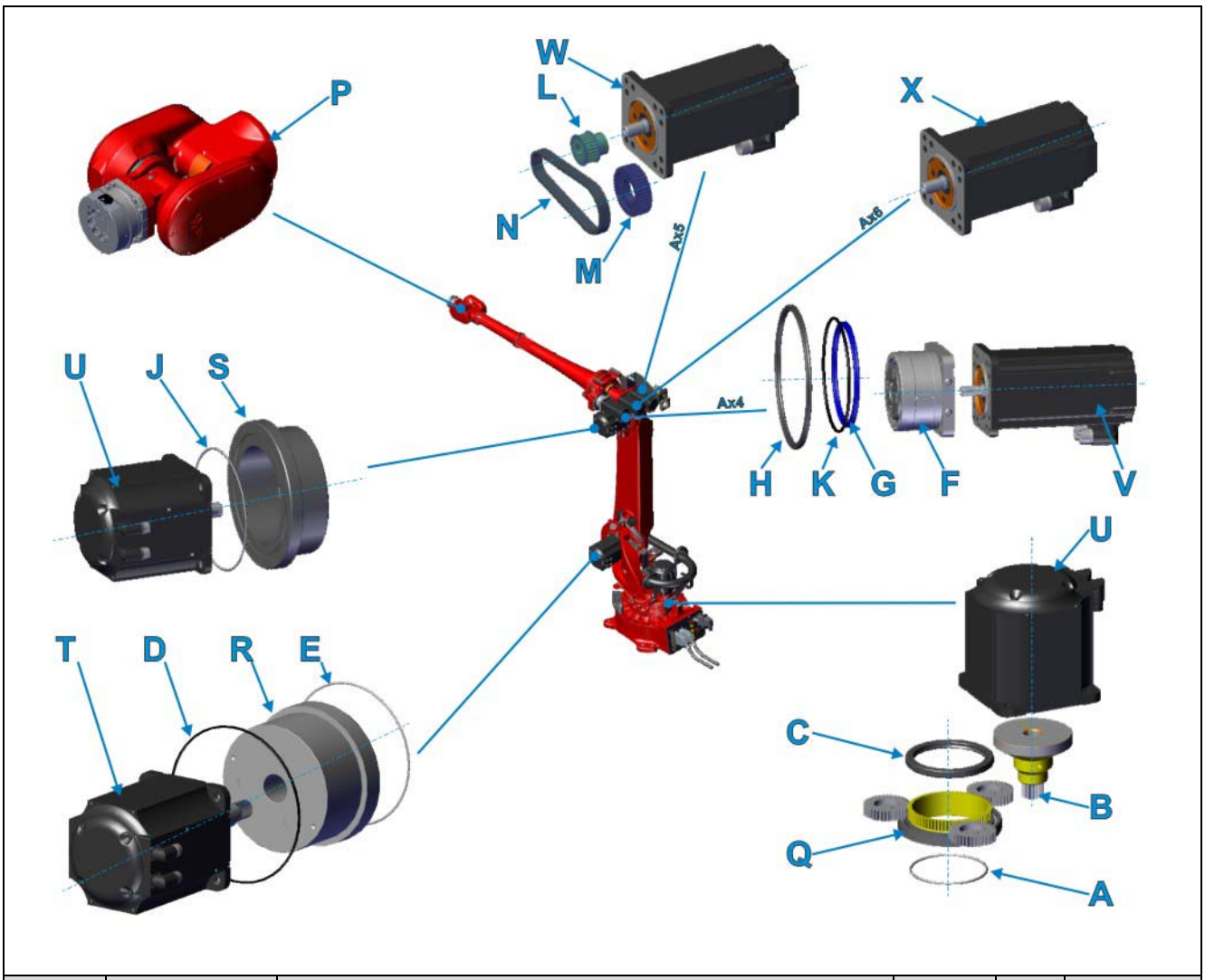


Pos.	COMAU Part No.	Description	Robot axis	Q.ty	Weight
A	00301241	Toroidal seal No. 159 (2.62x126.67)	Ax 1	1	---
B	CR82361102	Gear-terminal assembly unit	Ax 1	1	---
C	CR82221034	Radial shaft seal 125x150x12 Type 4	Ax 1	1	---
D	00300683	Toroidal seal No. 275 (3.53x266.3)	Ax 2	1	---
E	00300708	Gasket OR No. 178 (2.62x247.3)	Ax 2	1	---
F	CR82343805	Gearbox assembly	Ax 4	1	3.5 kg *(7.71 lb)*
G	00300165	Gasket Q RING No. 57 6 99x129 54x143	Ax 4	1	---
H	00300180	Gasket Q RING No. 69 6 99x183 52x197	Ax 4	1	---
J	00300681	Toroidal seal No. 270 (228.19x3.53)	Ax 3	1	---
K	00300638	Toroidal seal No. 258 (152x3.53)	Ax 4	1	---
L	82200703	Toothed pulley Power-Grip GT 5M Z=26	Ax5	1	---

Tab. 12.1 - Motors and gears spare parts Robot SMART NJ 16 - 3.1 Rel. 1.0 (Continued)

Pos.	COMAU Part No.	Description	Robot axis	Q.ty	Weight
M	82200704	Toothed pulley Power-Grip GT 5M Z=44	Ax5	1	---
N	82200705	Toothed belt Power-Grip 5M-425-15	Ax5	1	---
P	CR82284000	Wrist assembly (HD25 + HD25)	Ax 5-6	1	22 kg *(24.25 lb)*
Q	CR82309128	Gearbox assembly	Ax 1	1	68.6 kg *(146.82 lb)*
R	CR82309148	Gearbox assembly	Ax 2	1	58 kg *(127.86 lb)*
S	CR82309124	Gearbox assembly	Ax 3	1	27.4 kg *(60.40 lb)*
T	CR82350091	Motor 33 NM - C5G - IP65-COMPACT	Ax 2	1	27.5 kg *(60.62 lb)*
U	CR82350071	Motor 18 NM - C5G - IP65-COMPACT	Ax 1-3	2	21.5 kg *(47.39 lb)*
V	CR82350041	Motor 5 NM - C5G - IP65 - Spline Shaft	Ax 4	1	6.3 kg *(13.88 lb)*
W	CR82350040	Motor 5 NM - C5G - IP65	Ax 5	1	6.3 kg *(13.88 lb)*
X	CR82350030	Motor 3.5 NM - C5G - IP65	Ax 6	1	5.5 kg *(12.12 lb)*

Tab. 12.2 - Motors and gears spare parts Robot SMART NJ 16 - 3.1 Rel.2.0

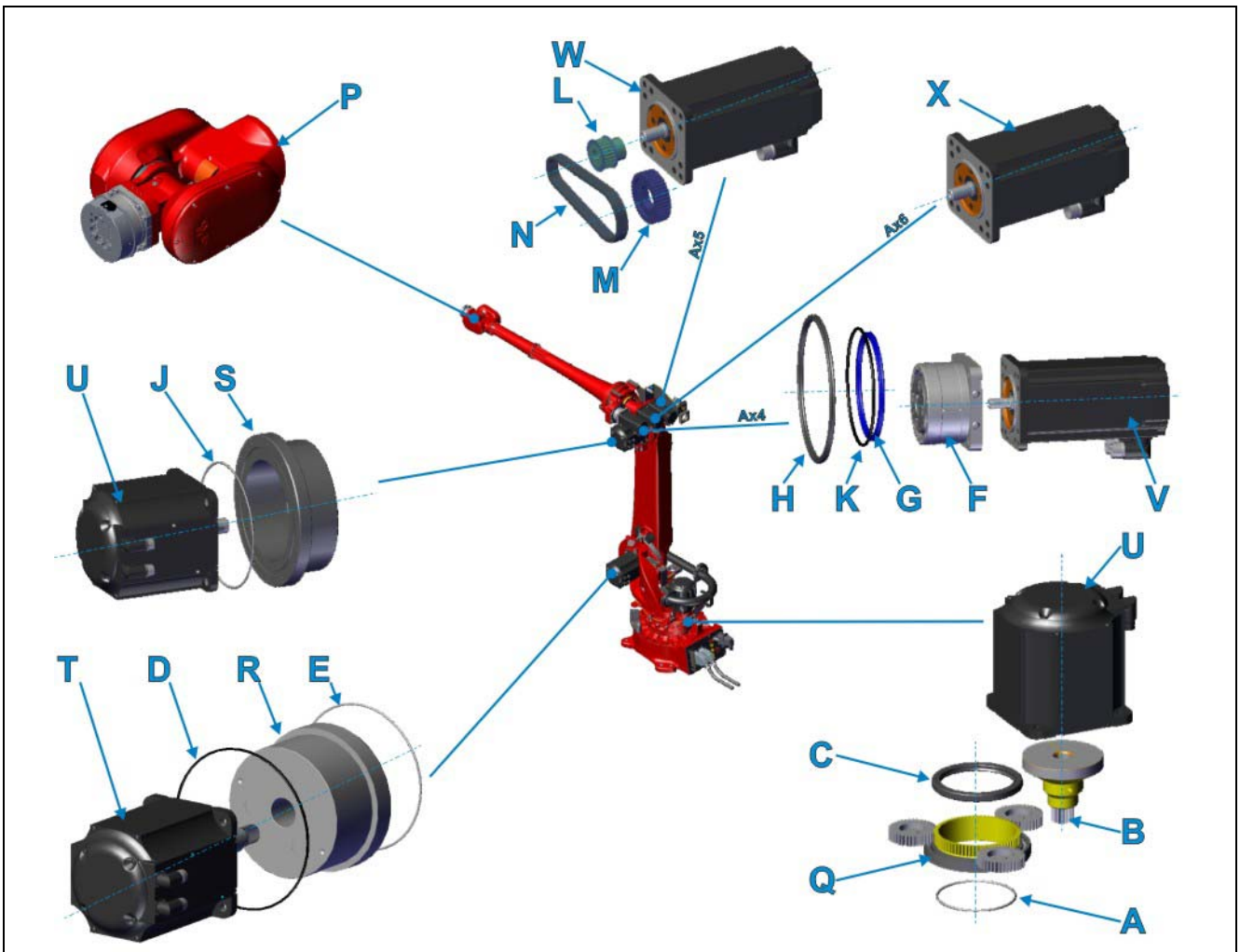


Pos.	COMAU Part No.	Description	Robot axis	Q.ty	Weight
A	00301241	Toroidal seal No. 159 (2.62x126.67)	Ax 1	1	---
B	CR82361102	Gear-terminal assembly unit	Ax 1	1	---
C	CR82221034	Radial shaft seal 125x150x12 Type 4	Ax 1	1	---
D	00300683	Toroidal seal No. 275 (3.53x266.3)	Ax 2	1	---
E	00300708	Gasket OR No. 178 (2.62x247.3)	Ax 2	1	---
F	CR82343805	Gearbox assembly	Ax 4	1	3.5 kg *(7.71 lb)*
G	00300165	Gasket Q RING No. 57 6 99x129 54x143	Ax 4	1	---
H	00300180	Gasket Q RING No. 69 6 99x183 52x197	Ax 4	1	---
J	00300681	Toroidal seal No. 270 (228.19x3.53)	Ax 3	1	---
K	00300638	Toroidal seal No. 258 (152x3.53)	Ax 4	1	---
L	82200703	Toothed pulley Power-Grip GT 5M Z=26	Ax5	1	---

Tab. 12.2 - Motors and gears spare parts Robot SMART NJ 16 - 3.1 Rel.2.0 (Continued)

Pos.	COMAU Part No.	Description	Robot axis	Q.ty	Weight
M	82200704	Toothed pulley Power-Grip GT 5M Z=44	Ax5	1	---
N	82200705	Toothed belt Power-Grip 5M-425-15	Ax5	1	---
P	CR82284000	Wrist assembly (HD25 + HD25)	Ax 5-6	1	22 kg *(24.25 lb)*
Q	CR82309128	Gearbox assembly	Ax 1	1	68.6 kg *(146.82 lb)*
R	CR82309148	Gearbox assembly	Ax 2	1	58 kg *(127.86 lb)*
S	CR82309124	Gearbox assembly	Ax 3	1	27.4 kg *(60.40 lb)*
T	CR82370094	Motor 33 NM - C5G - IP67-COMPACT	Ax 2	1	27.5 kg *(60.62 lb)*
U	CR82370074	Motor 18 NM - C5G - IP67-COMPACT	Ax 1-3	2	21.5 kg *(47.39 lb)*
V	CR82370044	Motor 5 NM - C5G - IP67 - Spline Shaft	Ax 4	1	6.3 kg *(13.88 lb)*
W	CR82370042	Motor 5 NM - C5G - IP67	Ax 5	1	6.3 kg *(13.88 lb)*
X	CR82370032	Motor 3.5 NM - C5G - IP67	Ax 6	1	5.5 kg *(12.12 lb)*

Tab. 12.3 - Motors and gears spare parts Robot SMART NJ 16 - 3.1 Foundry Rel. 1.0

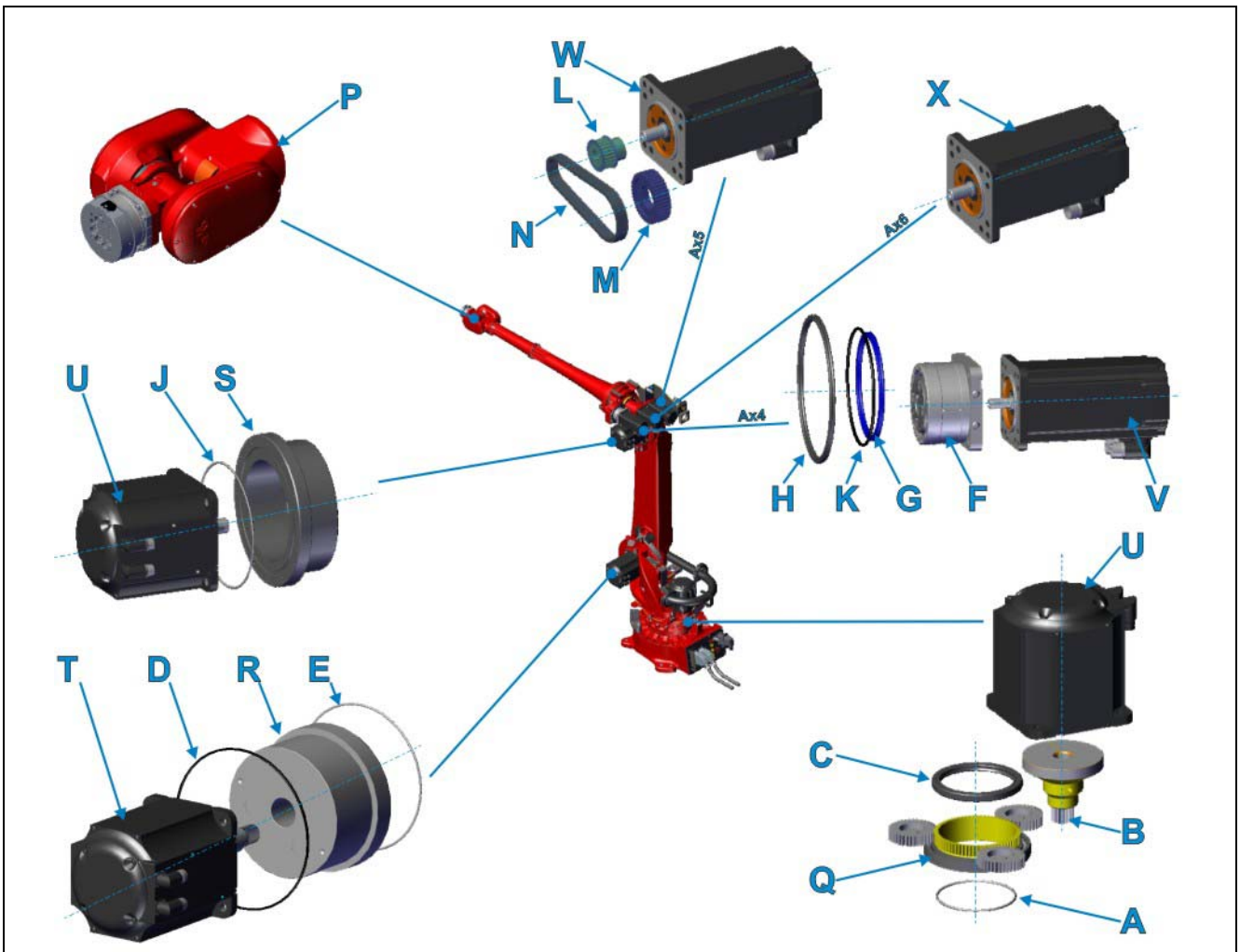


Pos.	COMAU Part No.	Description	Robot axis	Q.ty	Weight
A	00301241	Toroidal seal No. 159 (2.62x126.67)	Ax 1	1	---
B	CR82361102	Gear-terminal assembly unit	Ax 1	1	---
C	CR82221034	Radial shaft seal 125x150x12 Type 4	Ax 1	1	---
D	00300683	Toroidal seal No. 275 (3.53x266.3)	Ax 2	1	---
E	00300708	Gasket OR No. 178 (2.62x247.3)	Ax 2	1	---
F	CR82343805	Gearbox assembly	Ax 4	1	3.5 kg *(7.71 lb)*
G	00300165	Gasket Q RING No. 57 6 99x129 54x143	Ax 4	1	---
H	00300180	Gasket Q RING No. 69 6 99x183 52x197	Ax 4	1	---
J	00300681	Toroidal seal No. 270 (228.19x3.53)	Ax 3	1	---
K	00300638	Toroidal seal No. 258 (152x3.53)	Ax 4	1	---
L	82200703	Toothed pulley Power-Grip GT 5M Z=26	Ax5	1	---
M	82200704	Toothed pulley Power-Grip GT 5M Z=44	Ax5	1	---

Tab. 12.3 - Motors and gears spare parts Robot SMART NJ 16 - 3.1 Foundry Rel. 1.0 (Continued)

Pos.	COMAU Part No.	Description	Robot axis	Q.ty	Weight
N	82200705	Toothed belt Power-Grip 5M-425-15	Ax5	1	---
P	82211500	In-Line wrist unit	Ax 5-6	1	22 kg *(24.25 lb)*
Q	CR82309128	Gearbox assembly	Ax 1	1	68.6 kg *(146.82 lb)*
R	CR82309148	Gearbox assembly	Ax 2	1	58 kg *(127.86 lb)*
S	CR82309124	Gearbox assembly	Ax 3	1	27.4 kg *(60.40 lb)*
T	CR82350094	Motor 33 NM - C5G - IP67 - COMPACT	Ax 2	1	27.5 kg *(60.62 lb)*
U	CR82350074	Motor 18 NM - C5G - IP67 - COMPACT	Ax 1-3	2	21.5 kg *(47.39 lb)*
V	CR82350044	Motor 5 NM - C5G - IP67 - Spline Shaft	Ax 4	1	6.3 kg *(13.88 lb)*
W	CR82350042	Motor 5 NM - C5G - IP67	Ax 5	1	6.3 kg *(13.88 lb)*
X	CR82350032	Motor 3.5 NM - C5G - IP67	Ax 6	1	5.5 kg *(12.12 lb)*

Tab. 12.4 - Motors and gears spare parts Robot SMART NJ 16 - 3.1 Foundry Rel. 2.0

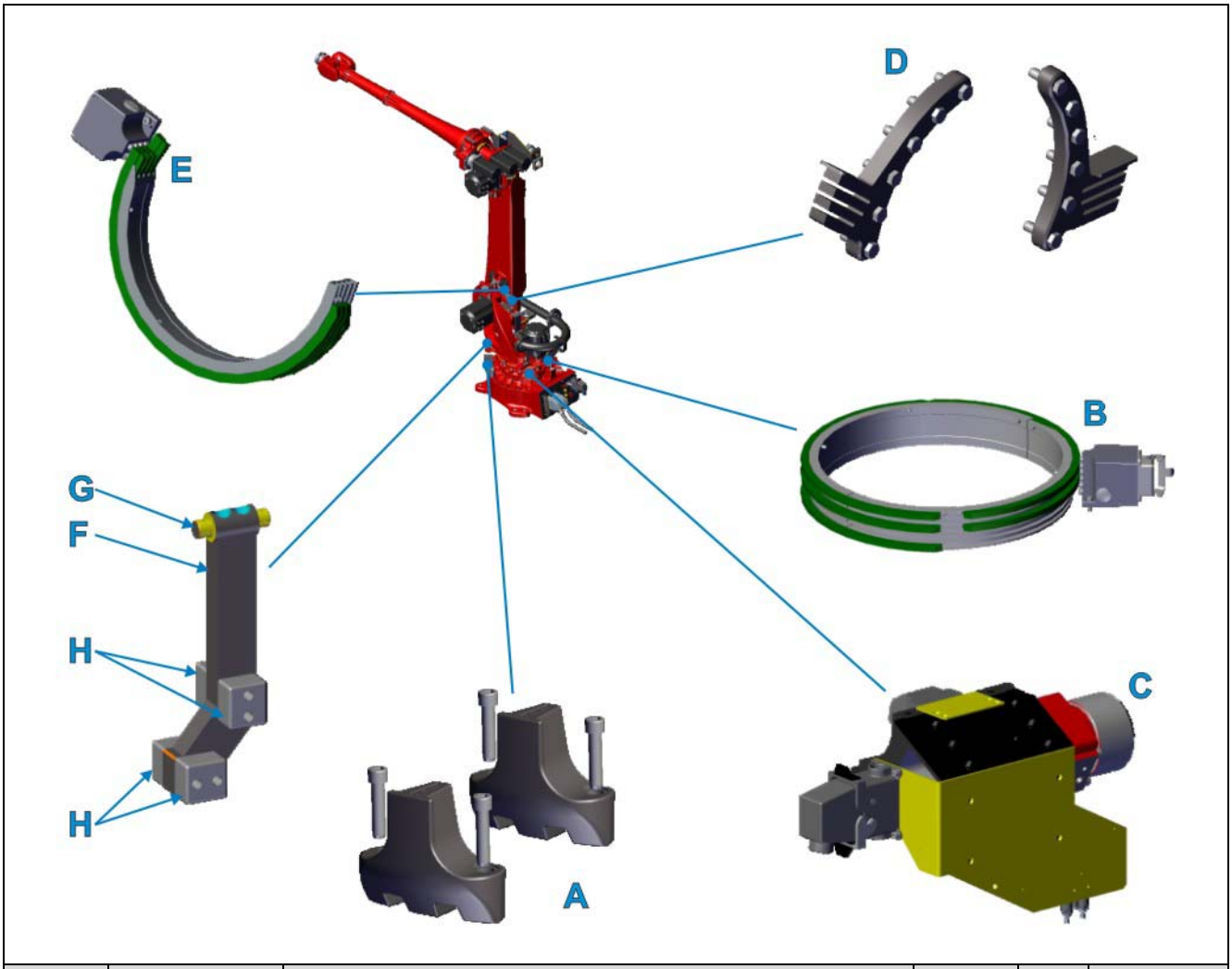


Pos.	COMAU Part No.	Description	Robot axis	Q.ty	Weight
A	00301241	Toroidal seal No. 159 (2.62x126.67)	Ax 1	1	---
B	CR82361102	Gear-terminal assembly unit	Ax 1	1	---
C	CR82221034	Radial shaft seal 125x150x12 Type 4	Ax 1	1	---
D	00300683	Toroidal seal No. 275 (3.53x266.3)	Ax 2	1	---
E	00300708	Gasket OR No. 178 (2.62x247.3)	Ax 2	1	---
F	CR82343805	Gearbox assembly	Ax 4	1	3.5 kg *(7.71 lb)*
G	00300165	Gasket Q RING No. 57 6 99x129 54x143	Ax 4	1	---
H	00300180	Gasket Q RING No. 69 6 99x183 52x197	Ax 4	1	---
J	00300681	Toroidal seal No. 270 (228.19x3.53)	Ax 3	1	---
K	00300638	Toroidal seal No. 258 (152x3.53)	Ax 4	1	---
L	82200703	Toothed pulley Power-Grip GT 5M Z=26	Ax5	1	---
M	82200704	Toothed pulley Power-Grip GT 5M Z=44	Ax5	1	---

Tab. 12.4 - Motors and gears spare parts Robot SMART NJ 16 - 3.1 Foundry Rel. 2.0 (Continued)

Pos.	COMAU Part No.	Description	Robot axis	Q.ty	Weight
N	82200705	Toothed belt Power-Grip 5M-425-15	Ax5	1	---
P	CR82284000	Wrist unit	Ax 5-6	1	22 kg *(24.25 lb)*
Q	CR82309128	Gearbox assembly	Ax 1	1	68.6 kg *(146.82 lb)*
R	CR82309148	Gearbox assembly	Ax 2	1	58 kg *(127.86 lb)*
S	CR82309124	Gearbox assembly	Ax 3	1	27.4 kg *(60.40 lb)*
T	CR82370094	Motor 33 NM - C5G - IP67 - COMPACT	Ax 2	1	27.5 kg *(60.62 lb)*
U	CR82370074	Motor 18 NM - C5G - IP67 - COMPACT	Ax 1-3	2	21.5 kg *(47.39 lb)*
V	CR82370044	Motor 5 NM - C5G - IP67 - Spline Shaft	Ax 4	1	6.3 kg *(13.88 lb)*
W	CR82370042	Motor 5 NM - C5G - IP67	Ax 5	1	6.3 kg *(13.88 lb)*
X	CR82370032	Motor 3.5 NM - C5G - IP67	Ax 6	1	5.5 kg *(12.12 lb)*

Tab. 12.5 - Mechanical stops and partialization spare parts Robot SMART NJ 16 - 3.1 / NJ 16 - 3.1 Foundry Rel. 1.0

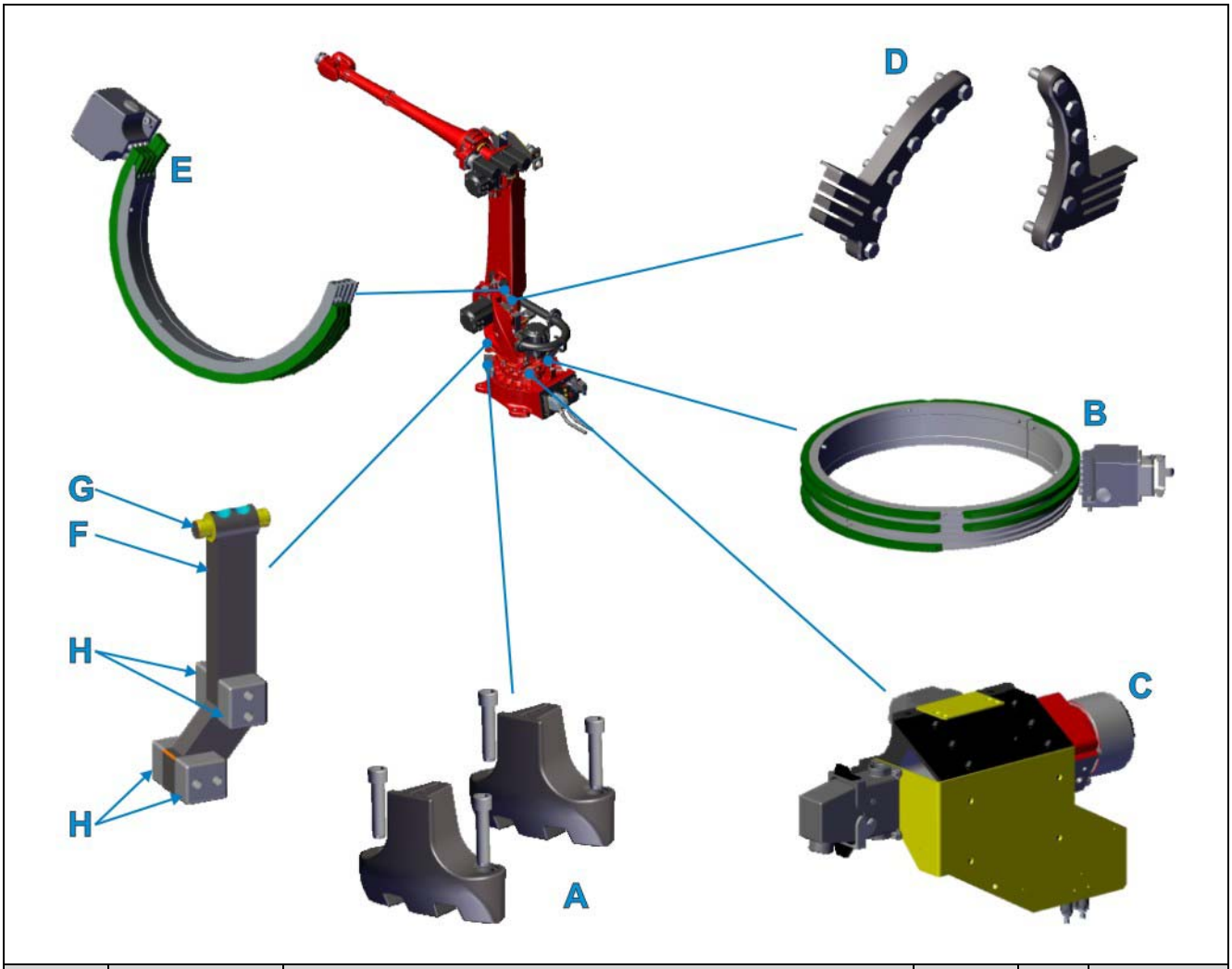


Pos.	COMAU Part No.	Description	Robot axis	Q.ty	Weight
A	CR82362100	Axis 1 adjustable mechanical hard stop unit	Ax 1	1	---
B	CR82362300	Axis 1 work area partialization unit - 3 areas (RV260C)	Ax 1	1	---
	CR82342204	*6 push-button multiple position switch*	Ax 1	1	---
C	CR82362900	Axis 1 On-Off mechanical hard stop unit (RV260C)	Ax 1	1	36 kg *(79.36 lb)*
	82315806	*SMC rotating pneumatic actuator*	Ax 1	1	---
	82315807	*Wheel with threaded pin SKF type KRV22PP*	Ax 1	1	---
	82315809	*2 push-button multiple position switch*	Ax 1	1	---
	82315813	*Solenoid valve 5/2 - 1/8" - 24VCC - SMC*	Ax 1	1	---
D	CR82362200	Axis 2 adjustable mechanical hard stop unit	Ax 2	1	---
E	CR82362400	Axis 2 work area partialization unit - 2 areas	Ax 2	1	---
	CR82325902	4 push-button multiple position switch	Ax 2	1	---

Tab. 12.5 - Mechanical stops and partialization spare parts Robot SMART NJ 16 - 3.1 / NJ 16 - 3.1 Foundry Rel. 1.0 (Continued)

Pos.	COMAU Part No.	Description	Robot axis	Q.ty	Weight
F	CR82361107	Knocker	Ax 1	1	5.7 Kg *(12.56 lb)*
G	CR82361108	Knocker support	Ax 1	1	---
H	CR82341207	Stop buffer	Ax 1	4	---

Tab. 12.6 - Mechanical stops and partialization spare parts Robot SMART NJ 16 - 3.1 / NJ 16 - 3.1 Foundry Rel. 2.0

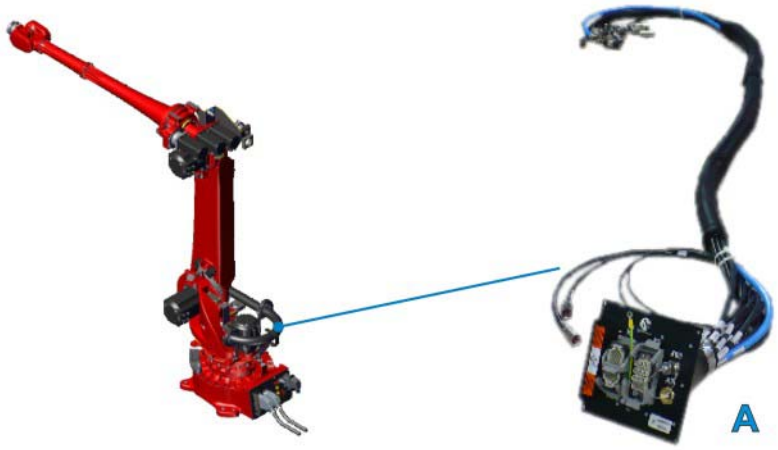


Pos.	COMAU Part No.	Description	Robot axis	Q.ty	Weight
A	CR82362100	Axis 1 adjustable mechanical hard stop unit	Ax 1	1	---
B	CR82362300	Axis 1 work area partialization unit - 3 areas (RV260C)	Ax 1	1	---
	CR82342204	*6 push-button multiple position switch*	Ax 1	1	---
C	CR82362900	Axis 1 On-Off mechanical hard stop unit (RV260C)	Ax 1	1	36 kg *(79.36 lb)*
	82315806	*SMC rotating pneumatic actuator*	Ax 1	1	---
	82315807	*Wheel with threaded pin SKF type KRV22PP*	Ax 1	1	---
	82315809	*2 push-button multiple position switch*	Ax 1	1	---
	82315813	*Solenoid valve 5/2 - 1/8" - 24VCC - SMC*	Ax 1	1	---
D	CR82362200	Axis 2 adjustable mechanical hard stop unit	Ax 2	1	---
E	CR82362400	Axis 2 work area partialization unit - 2 areas	Ax 2	1	---
	CR82325902	4 push-button multiple position switch	Ax 2	1	---

Tab. 12.6 - Mechanical stops and partialization spare parts Robot SMART NJ 16 - 3.1 / NJ 16 - 3.1 Foundry Rel. 2.0 (Continued)

Pos.	COMAU Part No.	Description	Robot axis	Q.ty	Weight
F	CR82361107	Knocker	Ax 1	1	5.7 Kg *(12.56 lb)*
G	CR82361108	Knocker support	Ax 1	1	---
H	CR82341207	Stop buffer	Ax 1	4	---

Tab. 12.7 - Complete wiring spare part Robot SMART NJ16 3.1 / NJ16 3.1 Foundry Rel. 1.0 - Rel.2.0



Pos.	COMAU Part No.	Description	Robot axis	Q.ty	Weight
A	CR18909980	Motors wiring	-	1	15 kg *(33.06 lb)*

13. DECOMMISSIONING AND DISPOSAL

This chapter deals with the following topics:

13.1 Precautions before starting

The robotic system (consisting of Robot and Control Unit) must be disposed of in an environmentally correct way and according to the specific methodologies of the nation where installed.
Prepare different containers to collect the different materials separately.

13.2 Personnel in charge of decommissioning and dismantling

Personnel in charge of dismantling should be trained to operate correctly with lifting means.
Furthermore, the personnel must be *trained* (in electrical and mechanical fields) and therefore aware of the dangers deriving from the electrical power supply and of the precautions to be taken when working on electrical connections.

13.3 Required equipment

– Standard mechanical and electrical equipment.

– Various containers.

13.4 Decommissioning and dismantling procedure

In this section are described the main steps to perform the robot system dismantling at the end of its operating life.
The activities below are to be carried out by the Personnel in charge of decommissioning and dismantling only:

a. create around the Robotic system enough space to perform all the motions without risks for the personnel;

b. move the Robot in transport position and assemble the axes locking brackets (when required) referring to the instructions on the plate affixed on the Robot and to Technical Documentation of the Robot itself;

c. open the Control Unit main switch and lock it in open position;

d. disconnect the electrical power at the power distribution point and lock the switch in open position;

e. disconnect the multipolar connectors on the Robot side;

f. if present, disconnect the pneumatic system from the distribution network and remove the residual air;

g. remove the present oil and grease:
   - carefully empty the oil from the gearboxes following the specific lubrication procedures given in the handbook;
   - it is possible that some compartments may not completely empty, in this case manually aspirate the remaining lubricant;
   - the grease must be removed by removal or washing with specific detergents;
   - carry out a general cleaning of the parts surrounding the lubrication point, in order to remove possible lubricant residues;

h. read carefully and follow the instructions given in the chemicals safety sheets in order to not endanger the operator and avoid environmental contamination;

i. remove the Robot from the work area following all the precautions indicated in the products Technical Documentation; if lifting is necessary, check the eyebolts proper fixing and use only apposite slings and equipment;

j. bring the Robot to the area intended for the dismantling and disposal procedures;

k. if the procedure is to be carried out independently, disassemble the components from top to bottom and paying particular attention to machine units/parts that may fall due to gravity:

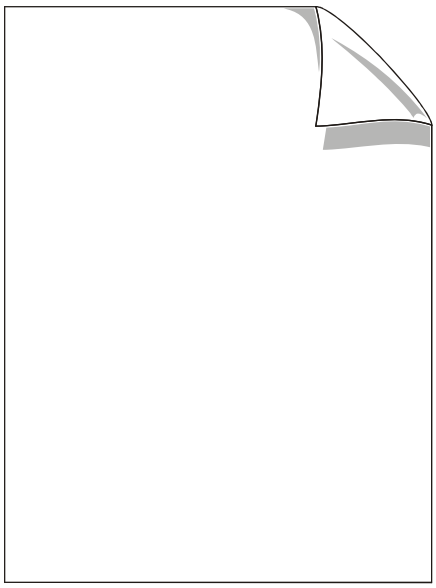
Act carefully, to avoid possible parts or components falling during the removal phase, as this could severely endanger the operators.

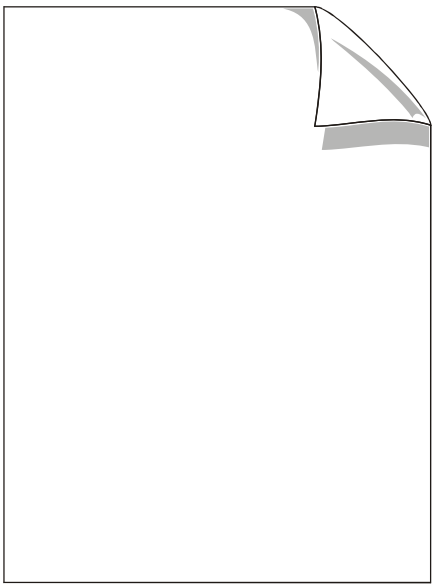
l. remove the parts and separate as much as possible the different components based on the materials (plastic, metal, etc.) that shall be disposed of applying the waste separation principle.

13.5 Parts disposal

The disposal operations must be carried out in compliance with the law in force in the country where the machine is installed: ferrous / plastic materials, the oil and grease must be disposed of in accordance with the regulations in force transferring them to the appropriate waste collection centres.
Assign the disposal of the materials resulting from the dismantling to the responsible companies.

In case of problems while carrying out the components disassembling, dismantling and disposing procedures, consult the manufacturer design technical department, which will specify the operating modalities in compliance with the safety and environmental protection principles.





robotics.comau.com

Original instructions

Made in Comau