

NJ



NJ 40 - 2.5 In-line NJ 40 - 2.5 In-line Foundry NJ 40 - 2.5 Off-set NJ 40 - 2.5 Off-set Foundry

Rel. 1.0 / Rel. 2.0

Technical Specifications

Description, available versions and technical features of the Robot

Robot workspaces and overall dimensions

Features of the Robot wrist

Robot integration principles and description of the available options

CR00757905-en_02/2021.02

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PREFACE

This chapter contains:

- [Reference documentation](#)
- [Documentation storage](#)
- [Limits on the handbook contents](#)
- [Symbols used in the handbook](#)
- [Modification History](#).

Reference documentation

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

- **SMART5 NJ 40 – 2.5 Rel. 1 / Rel. 2**
- **SMART5 NJ 40 – 2.5 Foundry Rel. 1 / Rel. 2**
- **SMART5 NJ 40 – 2.5 Off-set Rel. 1 / Rel. 2**
- **SMART5 NJ 40 – 2.5 Off-set 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 40 – 2.5 In-line Rel. 1 / Rel. 2 NJ 40 – 2.5 In-line Foundry Rel. 1 / Rel. 2 NJ 40 – 2.5 Off-set Rel. 1 / Rel. 2 NJ 40 – 2.5 Off-set 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	– EZ PDL2 Easy programming environment – PDL2 Programming Language Manual – Motion programming – VP2 Visual PDL2
	Modes and stopping distance of the Robot	– Stopping time

Documentation storage

All the provided documents must be placed in close proximity to the area where the Robotic System is installed, maintained available for all people that work on it and preserved intact for the entire operational life of the Robotic 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 personnel.



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



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.

Modification History

The following table shows the history of the Handbook release, with related changes / improvements made.

Date	Edition of the Handbook	Contents
2017-01	01/2017.01	Lubrication and calibration improvements.
2018-06	01/2018.06	Improvement of the handbook contents.
2021-01	02/2021.01	Insertion of additional information on the Foundations preparation (see par. 3.5 on page 21) . Minor corrections to descriptions. Update of data concerning the determination of maximum loads applicable to the wrist flange.

1. GENERAL SAFETY REQUIREMENTS



This chapter deals with general specifications that apply to the whole Robot System. Considering its importance, this chapter is referred to unconditionally in every instruction handbook of the system.

This chapter contains the following topics:

- [Intended use](#)
- [Improper use](#)
- [Essential safety requirements applied and fulfilled](#)
- [Operating modes](#)
- [Aspects of particular attention](#)
- [Responsibilities](#)

1.1 Intended use

The Robot and the Control Unit (when present) represent a robotic system made in compliance with EN ISO 10218-1. Its performance must be exploited in industrial or comparable areas, subject to current regulations, also complementary to the aforementioned standard.

Installation, use, maintenance and disposal of the robotic system must be carried out by authorized and trained personnel.

1.2 Improper use

The robotic system or its parts must not be used in environments that do not comply with the technical specifications indicated in the relative handbooks. The use in non-compliant environments, different from those required, uses beyond the expected performances can create risks both for people and for the Robot system or its parts.

A non-careful integration according to the laws and regulations in force can also incur the integrator to legal and criminal complications.

1.3 Essential safety requirements applied and fulfilled

The robotic system composed of Control Unit and SMART5 Robot series considers as applied and fulfilled the following Safety Fundamental Requirements, Annex I of Machinery Directive 2006/42/EC: 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.

1.4 Operating modes

Installation and Start-up

- 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.
- For Robots with no collaborative functionality:
 - the system installation and startup is only allowed exclusively inside a Protected Zone 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 Zone (e.g structural columns, power supply lines, etc.) or with the barriers. If necessary, limit the Robot workspace by means of mechanical stop buffers (see optional units);
 - any fixed Robot control protections are to be located outside the Protected Zone and in a point where there is a full view of the Robot movements;
 - install the Control Unit outside the Protected Zone: the Control Unit should not be used as part of the fence.
- The Robot installation area is to be as free as possible from materials that could impede or limit visibility.
- During installation, the Robot and the Control Unit must be handled as described in the relative Instruction Handbooks; if lifting is necessary, check that the eyebolts are fixed correctly and use only adequate slings and equipment.
- Fix the Robot to mount holder, with all the provided bolts and pins, tightened to the tightening torques given in the related Instruction Handbooks.
- If present, remove the fastening brackets from the axes and check that the fixing of the Robot fixture is secured correctly.
- Check that the Robot guards are correctly secured and that there are no moving or loose parts. Check that the Control Unit components are intact.
- 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 made through a cable of dimensions suitable for the power installed on the Control Unit (for details refer to chapter “Power supply from the electric network: features and connection” in the Control Unit Instruction Handbooks).
- 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 armor to the ground.
- Connect the signals and power cables between the Control Unit and the Robot.

GENERAL SAFETY REQUIREMENTS

- 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 provided, 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, safety fences etc.), i.e. the making 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 emergency stop push-buttons of the Control Unit available on the appropriate connector (for details, refer to the electrical circuit diagrams and the specific Instruction Handbooks according to the Unit Control model). 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 Robot emergency stop in AUTO/REMOTE mode is set in a controlled way (IEC 60204-1, stop of category 1 or category 2*); it is also possible to set the stop in category 0 by changing the related setting within the control logic of the Control Unit safety aspects.

* the stop in category 2 is only possible for Robots with collaborative functionality



Setting the emergency stop in category 0 can result in mechanical damages to the tools and loss of load if they are not properly designed.

- When preparing protection barriers (when required), especially for light curtains and access doors, take into consideration the Robot stopping times and distances according to the stop category (according to IEC 60204-1) and the weight of the Robot.



The stop circuit timer is normally set to 1.5 seconds. This parameter can be changed if heavy-duty implements (e.g. rotary tables, positioners, etc.) are matched with the Robot. The stop circuit timer can be modified by changing its setting within the control logic of the Control Unit safety aspects. For further details, refer to the paragraph "Safety stop circuit timer" in the Control Unit Instruction Handbooks.

- Check that the environmental and operating conditions do not exceed the limits specified in the specific Instruction Handbooks.
- The calibration operations must be carried out with utmost attention, as indicated in the Instruction Handbooks of the specific product, and must 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 Instruction Handbooks supplied with

the specific product. After loading, always make some Robot motion tests at low speed remaining outside the Robot action radius.

- Check that the barriers of the Protected Zone (when present) are correctly positioned.

Functioning in Programming mode

- The Robot is only to be programmed by the authorised personnel.
- Before proceeding with programming, the operator, remaining at the end of the Protected Zone / Collaborative Zone, must:
 - make sure that all the necessary protective guards and safety devices are present and in working conditions;
 - make sure that the Teach Pendant is functioning correctly (reduced speed, enabling device, emergency stop device, etc.);
 - check the Robotic system (Robot and Control Unit) to make sure that there are no potentially dangerous anomalous conditions and that no person is present in the Protected Zone / Collaborative Zone.
- As far as possible, the programming should be controlled from outside the Protected Zone / Collaborative Zone.
- During the programming phases, only the operator with the Teach Pendant is allowed inside the Protected Zone / Collaborative Zone.
- For Robots without collaborative functionality, if the presence of a second operator is required in the workspace when checking the program, these people must have their enabling device interlocked with the safety devices.
- Activation of the motors (DRIVE ON) must always be controlled from a position outside the Robot area of action, after having verified that there is nobody in the area concerned. The Drive On operation is considered complete when the relevant machine status indication is shown.
- During programming the operator must remain at a distance from the Robot such as to allow him to avoid any anomalous movements of the machine, and in any case in a position to avoid possible risks of restraint between the Robot and parts of the structure (columns, barrier, etc.), or between moving parts of the Robot itself, including parts which, due to gravity, could perform movements downwards, upwards or laterally (in the case of mounting on an inclined plane).
- The test of a programmed cycle at working speed with the operator inside the Protected Zone / Collaborative Zone, in some situations where a close visual check is necessary, must be activated 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 execution of a new program or a varied sequence of instructions, make sure that the movement of the Robot takes place along the intended path.
- Check while remaining out of the Robot action area and test the cycle at low speed.

Functioning in Auto / Remote Mode

- The activation of the automatic operation (AUTO and REMOTE statuses) is only allowed with the Robotic system (Robot and Control Unit) integrated in a special area with sufficient features to meet the needs of Protected Zone / Collaborative

GENERAL SAFETY REQUIREMENTS

Zone (depending on the Robot type) as prescribed by the Safety Regulations in force in the country where the installation is carried out.

- Before activating the automatic operation, the operator must check:
 - the Protected Zone / Collaborative Zone to ensure that there are no potentially dangerous anomalous conditions;
 - that the Robot and Control System is not in a state of maintenance or repair and that there are no potentially dangerous abnormal conditions;
 - that the protection barriers (when present) are correctly positioned;
 - that there is nobody inside the Protected Zone / Collaborative Zone;
 - that the Control Unit doors are closed and locked with the appropriate key;
 - that the safety devices are in working conditions;
- 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.

Functioning in Collaborative Mode

- The Comau collaborative Robots require an appropriate assessment of the risk of the area in which they are integrated, combining the performances already available in the collaborative solutions with additional safety devices.



The integrator is responsible for the correct integration of the collaborative Robot in the complete cell/machine.

- The integrator shall consider at least the following aspects:
 - the tool connected to the Robot, must be equipped with a solution compatible with the collaborative mode of the Robot;
 - the impact force of the Robot against the person, proportional to the movement speed of the Robot itself;
 - the Collaborative Zone, which must be sufficiently large, without edges or structural parts that can block the operator without an escape route, possibly trapped between the skin and a static structural element of the cell / machine;
 - the stopping distance and time of the Robot, which must include a reasonable distance to avoid crushing (see details in “Robot Technical Specifications” handbook, paragraph “Robot stop modes and space” and “Sensorized skin on AURA Collaborative Robot”* handbook, “paragraph Technical features”);

* only available in case of AURA Collaborative Robot

Robot axes brake release (where required)

- The movement of the Robot axes is possible by means of suitable control devices (integrated, where provided, on Robot base, or available as optional devices -brake releasing module-) and adequate lifting means. Such devices only enable 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 gravity.



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

- The brake releasing operation can generate crash risks caused by:

- an incorrect reset after the brake release
 - resumption of movement after an interruption of an incomplete MOVE (whose typical function of trajectory recovery can generate unpredictable paths);
 - subsequent resumption of the automatic cycle (similarly to what has been described above, relating to the resumption of a not completed MOVE).
- 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.
 - The procedure for the correct use of the brake releasing devices (integrated on Robot base and/or optional brake releasing module) is shown in the “Maintenance” section of the Instruction Handbooks of the specific Robot.

Maintenance and Repair

- The Robot (where required) 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 plenty of water; in case irritation persists, seek medical advice. If swallowed, do not induce vomiting or administer anything by mouth; consult a doctor as soon as possible.
- Maintenance, troubleshooting and repair operations 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 replacement operations of the components or Control Unit must be carried out (where provided and necessary) with the main switch in open position and locked with a safety 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 (where provided and necessary).
- 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.

- Troubleshooting and maintenance activities:
 - must be performed, as far as possible, outside the Protected Zone / Collaborative Zone;
 - on Control Units they must as far as possible be performed in the absence of power;
 - on the Robot must be performed with power supply deactivated (DRIVE OFF).

GENERAL SAFETY REQUIREMENTS

- If necessary, during troubleshooting, intervene with the Control Unit powered; all the precautions specified by Safety Standards must be observed when operating in presence of dangerous voltages.
- At the end of the maintenance and troubleshooting operations, all the deactivated safety devices must be reset (panels, protection shields, interlocks, etc.).
- The maintenance, repair and troubleshooting intervention must be completed by verifying the correct operation of the Robotic system (Robot and Control Unit) and all safety devices performed outside the Protected Zone / Collaborative Zone.
- 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 Instruction Handbooks; after loading, always run a test cycle, remaining outside the Protected Zone.
- 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, refer to the warning plates affixed on the Robot and to the supplied Instruction Handbooks.
- On Robots equipped with balancing springs, it is forbidden to remove the protection cover of the springs.
- Where fitted, always restore the protective casing if previously installed.

Decommissioning and Dismantling

- The decommissioning and removal of the Robot and Control System is allowed only to Authorized Personnel.
- Move the Robot in transport position and mount the axes blocking brackets (when required) referring to the plate affixed to the Robot and to the Instruction Handbooks of the Robot itself.
- Before proceeding with decommissioning it is mandatory, depending on the type of Control Unit:
 - on the Control Unit with power cable wired directly to the terminals of the main switch:
 - turn off the mains voltage at the Control Unit input, by disconnecting the circuit breaker on the power mains and locking it in open position;
 - check with a suitable instrument that the terminals are disconnected;
 - disconnect the power supply cable from the circuit breaker on the power mains, first disconnecting the power conductors and then the ground conductor;
 - Disconnect the power supply cable from the Control Unit and remove it.
 - on Control Units equipped with a pre-assembled power cable, with a "socket-plug" system:
 - disconnect the power supply cable.
- 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 supporting surface.

- Remove the Robot and the Control Unit from the workspace, taking all the requirements indicated in the products Instruction Handbooks; if lifting is necessary, check the eyebolts proper fixing and use only suitable slings and equipment.



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 in an environmentally correct way and in accordance with the regulations in force transferring them to specific waste collection centres.

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

1.5 Aspects of particular attention

The documentation of the robotic system required a subdivision of the contents into one or more Instruction Handbooks. For this reason, the understanding of the functionalities and the necessary attention to the requirements may require consultation of the entire applicable documentation, always listed in the first pages of each handbook.

1.6 Responsibilities

The integrator is responsible for the correct integration of the robotic system or its parts in accordance with the applicable legislation.
Comau is not responsible for any improper use of the robotic system or its parts.

2. ROBOT DESCRIPTION

This chapter contains:

- [Robot general description](#)
 - [Description of the mechanics and identification of Robot axes and motors](#)
 - [Declaration of incorporation of partly completed machinery](#)
 - [Name and address of the manufacturer.](#)
-

2.1 Robot general description

The Robot is a machine specifically designed and constructed to be used in industrial environments.

To function properly, the Robot must be matched with the specific C5G Control Unit. The Control Unit features must be consistent with the connected Robot.

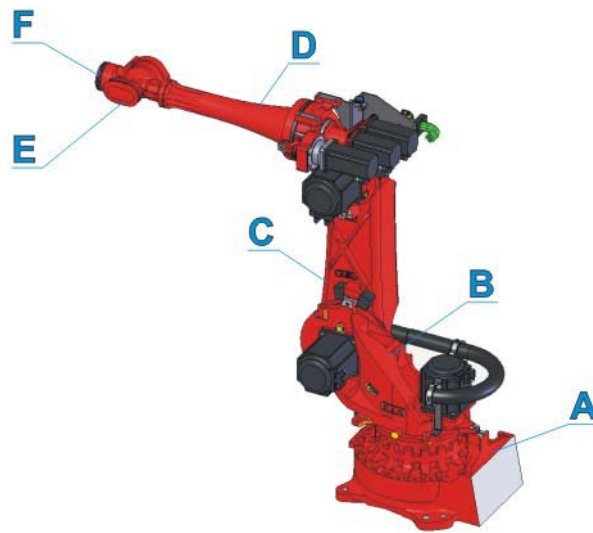
2.2 Description of the mechanics and identification of Robot axes and motors

Degrees of freedom

The Robot is of anthropomorphic type with 6 degrees of freedom.

Robot Configuration

- A - Base
- B - Column
- C - Arm
- D - Forearm
- E - Wrist
- F - Flange



The fixed base of the Robot is anchored to a structure (fixing plate in case of installation on the ground or a supporting structure in case of installation on ceiling).

On the Robot fixed base, a column rotates with vertical rotating axis (axis 1); the column supports the axis 2 motorization composed of the motor fitted directly on the gearbox.

The mechanical connection between the column and the forearm is made by the arm.

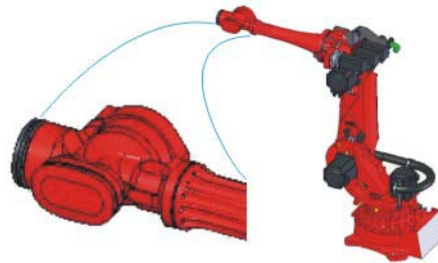
The forearm supports the axis 3 motorization and in the rear part, the motorization of axis 4, 5 and 6 and interfaces with the upper side of the arm.

The wrist is on the front forearm end.

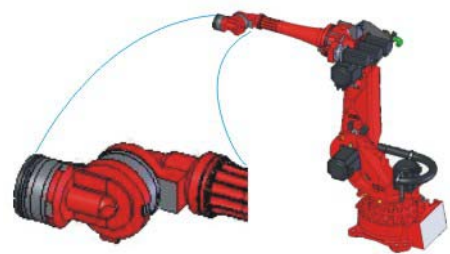
Wrist configuration

The Robot can be set with the following configurations:

In-line



Off-Set

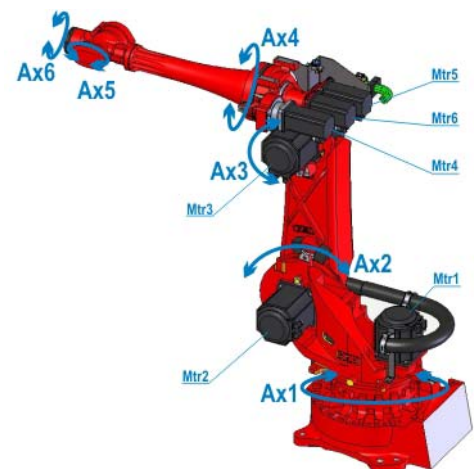


Robot axes motors

The Robot has 6 axes, each one is controlled by a gearmotor (detail in [par. 2.2 Description of the mechanics and identification of Robot axes and motors on pag. 16](#)).

The Robot axes are listed below:

Ax	Robot axis
Mtr	Motor axis



In the picture is represented the Robot with standard wrist (In-line), but is also valid for the Robot with Off-set wrist. For further details see [Chap.6. - Further information on page 31](#).

The motors are of AC brushless type and integrate inside them the brake and the encoder.

The gearboxes are of low backlash type specific for robotic applications.

Robot axes stroke restriction (areas restrictions)

The Robot axes are provided with software stroke-ends (programmable).

In addition, (optional) Robots can be provided with mechanical hard stops and position limit switches.



For all details on options needed for safety areas partialization see the [par. 7.4 Solutions to integrate the Robot in production cells on page 90](#).

2.3 Declaration of incorporation of partly completed machinery

The assembly consisting of the SMART5 series Robot and C5G Control Unit is provided with a **declaration of incorporation of partly completed machine**, as stated in the Annex II b. of the Directive 2006/42/EC.



It is forbidden to start up the assembly consisting of the Robot SMART5 series and C5G Control Unit of the before the machine in which it will be incorporated has been declared compliant with the provisions of the Directive 2006/42/EC.

The **Declaration of incorporation of partly completed machine** is provided in original copy of the assembly consisting of the SMART5 series Robot and C5G Control Unit.

The **identification plate** ([Fig. 2.1](#)) is installed on the Robot body.

Fig. 2.1 - Robot identification plate (example)

		COMAU Robotics Via Rivalta 30 10095 Grugliasco (TO), Italy	
MACHINE TYPE TIPO DI MACCHINA	SMART-5 XXXX		REL. 1.0
PART No. No. PARTE	CRXXXX 		
DATE & SERIAL No DATA E No DI SERIE	MM/AAAA-XXXX 		
		WEIGHT PESO lb / kg	

2.4 Name and address of the manufacturer

As defined by the Machinery Directive, the manufacturer is:

COMAU S.p.A.
 Via Rivalta, 30
 10095 Grugliasco (TO) - ITALY

3. AVAILABLE VERSIONS AND TECHNICAL FEATURES

This chapter contains:

- [Available versions](#)
 - [Technical features](#)
 - [Further information on Rel. 1.0 and Rel. 2.0 and safe Robotic system](#)
-

3.1 Available versions

The versions of the available Robots are listed in the following:

- [Tab. 3.1 - Available versions Robot SMART5 NJ40 - 2.5 In-line on page 24](#)
- [Tab. 3.2 - Available versions Robot SMART5 NJ40 - 2.5 Off-set on page 25.](#)

Tab. 3.1 - Available versions Robot SMART5 NJ40 - 2.5 In-line

Robot type	Wrist load (kg) (lb)	Reach (mm) (ft)	Mounting position	Part No. Robot	Application type	Application Part No.
SMART5 NJ 40 – 2.5 In-line Rel. 1	40 (88.18)	2503 (8.21)	Floor / Ceiling / Inclined plane*	CR82360700	Handling	CR18907680
SMART5 NJ 40 – 2.5 In-line Foundry Rel. 1				CR82365300		
SMART5 NJ 40 – 2.5 In-line Rel. 2	40 (88.18)	2503 (8.21)	Floor / Ceiling / Inclined plane*	CR82381400	Handling	CR18907680
SMART5 NJ 40 – 2.5 In-line Foundry Rel. 2				CR82381600		

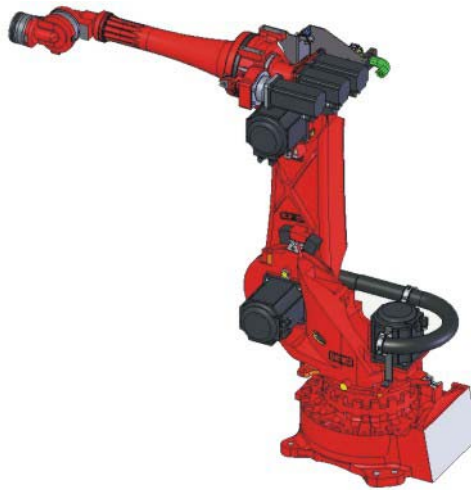


*: max inclination: 45°

*1: To be specified when ordering (see [par. 3.3 In-depth examination for floor and inverted mounting on page 28](#))

Tab. 3.2 - Available versions Robot SMART5 NJ40 - 2.5 Off-set

Robot type	Wrist load (kg) (lb)	Reach (mm) (ft)	Mounting position	Part No. Robot	Application type	Application Part No.
SMART5 NJ 40 – 2.5 Off-set Rel. 1	40 (88.18)	2503 (8.21)	Floor / Ceiling / Inclined plane*	CR82365000	Handling	CR18907680
SMART5 NJ 40 – 2.5 Off-set Foundry Rel. 1				CR82365100		
SMART5 NJ 40 – 2.5 Off-set Rel. 2	40 (88.18)	2503 (8.21)	Floor / Ceiling / Inclined plane*	CR82381500	Handling	CR18907680
SMART5 NJ 40 – 2.5 Off-set Foundry Rel. 2				CR82381700		



*: max inclination: 45°

*1: To be specified when ordering (see [par. 3.3 In-depth examination for floor and inverted mounting on page 28](#))

3.2 Technical features

Tab. 3.3 - Technical features of Robot SMART5 NJ 40 - 2.5 In-line

VERSION		NJ 40 - 2.5 In-line NJ 40 - 2.5 In-line Foundry ^{*3}
Structure / No. of axes		Anthropomorphic / 6 axes
Wrist load		40 kg (88.18 lb) ^{*1}
Axis 4 torque		167 Nm
Axis 5 torque		167 Nm
Axis 6 torque		98 Nm
Stroke /(Speed)	Axis 1	± 180° (170 °/s)
	Axis 2	-60° to +125 °(150 °/s)
	Axis 3	0° to -165° (165 °/s)
	Axis 4	± 2700° (265 °/S)
	Axis 5	± 123° (250 °/S)
	Axis 6	± 2700° (340 °/S)
Max horizontal reach		2503 mm (8.21 ft)
Repeatability		0.06 mm
Robot weight		655 kg (1444 lb)
Robot wrist features tool coupling		ISO 9409 - 1 - A100
Motors		AC Brushless
Position measurement system		Encoder
Protection degree		IP65 ^{*3}
Robot colour (standard)		Grey RAL 9006 ^{*2}
Mounting position		Floor / Ceiling / Sloped ^{*4}
Operating environment temperature		0°C to +45°C
Storage temperature		-25°C to + 55°C
Relative humidity		5% to 95% without condensate
Maximum temperature gradient		1,5 °C/min

Notes:

¹: See the [par. 5.2.3 Determination of max loads to the wrist flange \(Q_F\) on page 41](#) and the [par. 5.2.4 Additional loads \(Q_S\) on page 43](#).

^{*2}: Other colours are available on request. The images included in this instruction handbook are indicative.

^{*3}: The Foundry version is provided with wrist and motors with IP67 protection degree to ensure protection in high temperature environments.

^{*4} Maximum inclination 45°.

Tab. 3.4 - Technical features of Robot SMART5 NJ 40 - 2.5 Off-set

VERSION		NJ 40 - 2.5 Off-set NJ 40 - 2.5 Off-set Foundry *3
Structure / No. of axes		Anthropomorphic / 6 axes
Wrist load		40 kg (88.18 lb) *1
Axis 4 torque		167 Nm
Axis 5 torque		167 Nm
Axis 6 torque		98 Nm
Stroke /(Speed)	Axis 1	± 180° (170 °/s)
	Axis 2	-60° to +125° (150 °/s)
	Axis 3	0° to -165° (165 °/s)
	Axis 4	± 2700° (265 °/S)
	Axis 5	± 2700° (250 °/S)
	Axis 6	± 2700° (340 °/S)
Max horizontal reach		2503 mm (8.21 ft)
Repeatability		0.06 mm
Robot weight		655 kg (1444 lb)
Robot wrist features tool coupling		ISO 9409 - 1 - A100
Motors		AC Brushless
Position measurement system		Encoder
Protection degree		IP65 *3
Robot colour (standard)		Grey RAL 9006 *2
Mounting position		Floor / Ceiling / Sloped *4
Operating environment temperature		0°C to +45°C
Storage temperature		-25°C to + 55°C
Relative humidity		5% to 95% without condensate
Maximum temperature gradient		1,5 °C/min
Notes *1: See the par. 5.2.3 Determination of max loads to the wrist flange (Q_F) on page 41 and the par. 5.2.4 Additional loads (Q_S) on page 43. *2: Other colours are available on request. The images included in this instruction handbook are indicative. *3: The Foundry version is provided with wrist and motors with IP67 protection degree to ensure protection in high temperature environments. *4 Maximum inclination 45°.		

3.3 In-depth examination for floor and inverted mounting

The mounting method must be required when ordering.

Below are some precautions for the correct mounting of the Robots.

Robots designated for floor mounting

- The Robots are equipped with a filling plug with vent plug installed on the motor axis 2.
- The Robots must not be mounted inverted. The inversion of the mounting from floor to ceiling is not allowed (it can generate oil leakage when the vent plug is wrongly located at the lowest point).

Robots designed for inverted mounting

- The fork option is required to allow the Robot to rotate during installation (see [par. 7.1.5 Fork unit \(CR82363100\) on page 83](#)).
- The Robots are equipped with a filling plug with vent valve and a label placed in a bag.
- The inverted mounting requires special attention, as described in the “Transport and Installation” handbook.
- The following label must be affixed near the filling plug with vent valve



3.4 Further information on Rel. 1.0 and Rel. 2.0 and safe Robotic system

Rel. 1.0

Motors installed in the Robot in Rel. 1.0 have available standard encoders.

For this reason, the Robots in Rel. 1.0 can only be matched with standard C5G Control Units and deriving models; it is not possible to match them with Safe Control Units.

Rel. 2.0

Motors installed in the Robot in Rel. 2.0 have available specific encoder.

For this reason, the Robots in Rel. 2.0 can be matched with all the available C5G Control Unit models.

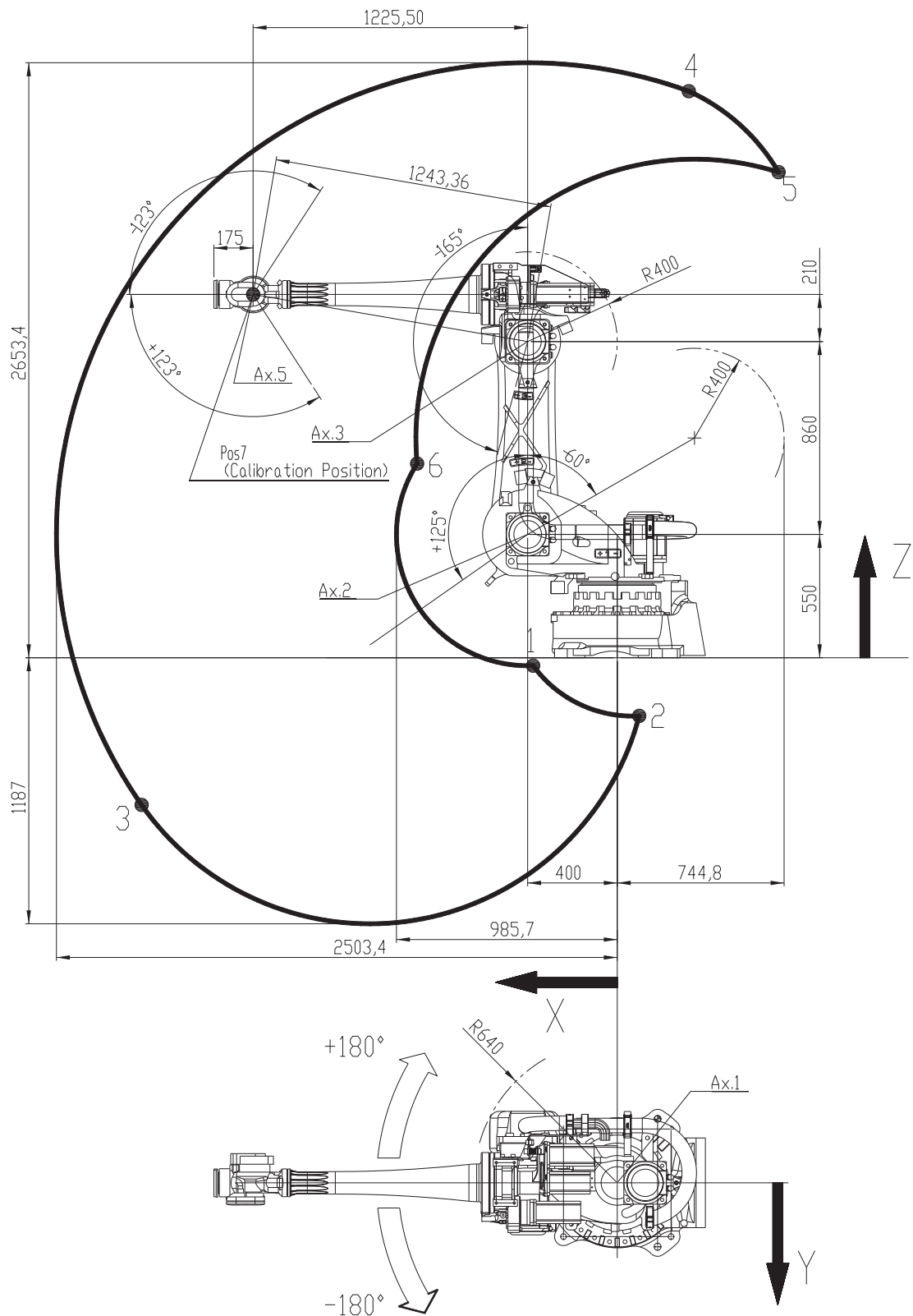
In order to obtain a Safe robotic system from the point of view of the Robot workspace, it is necessary to match the Robot in Rel. 2.0 with the specific C5G Safe Control Unit model.

4. ROBOT WORKSPACES AND OVERALL DIMENSIONS

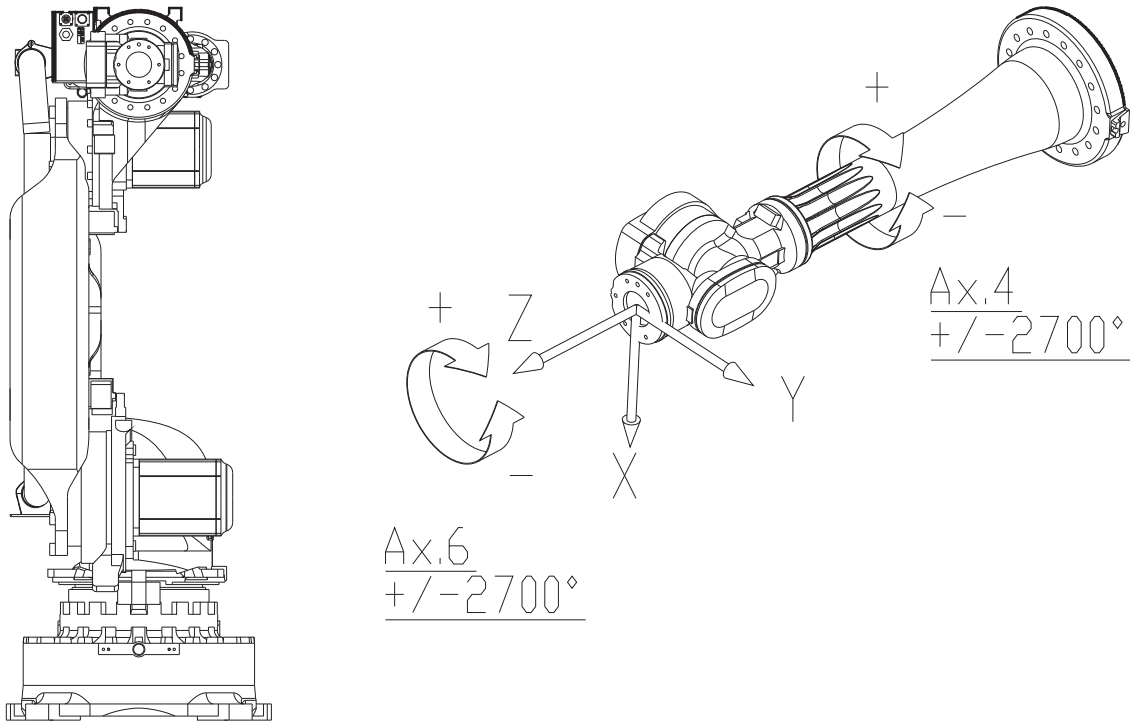
This chapter contains the workspaces drawings of the available Robot versions:

- [SMART5 NJ 40 – 2.5 In-line / SMART5 NJ 40 – 2.5 In-line Foundry.](#)
- [SMART5 NJ 40 – 2.5 Off-set / SMART5 NJ 40 – 2.5 Off-set Foundry.](#)

SMART5 NJ 40 – 2.5 In-line / SMART5 NJ 40 – 2.5 In-line Foundry



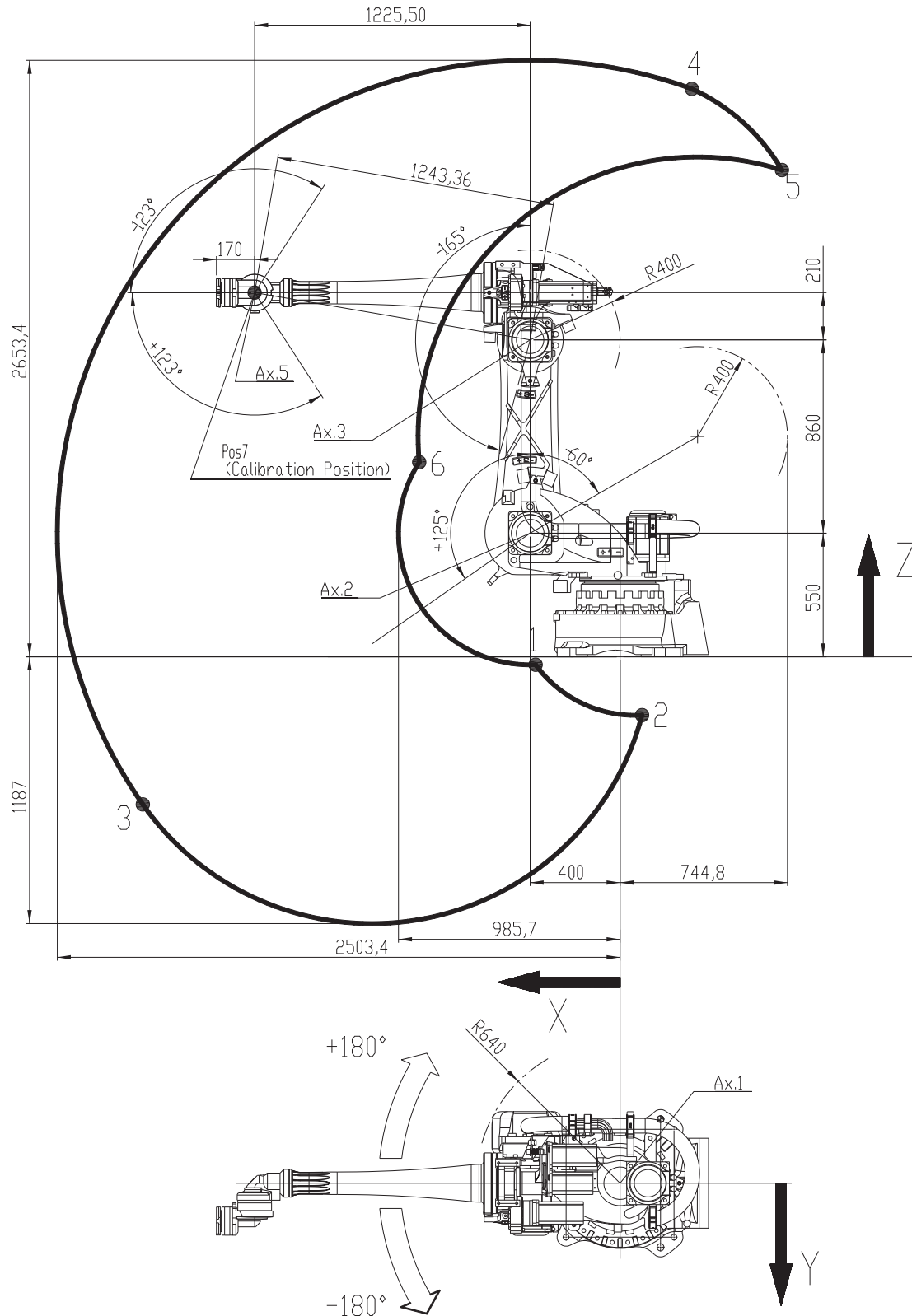
ROBOT WORKSPACES AND OVERALL DIMENSIONS



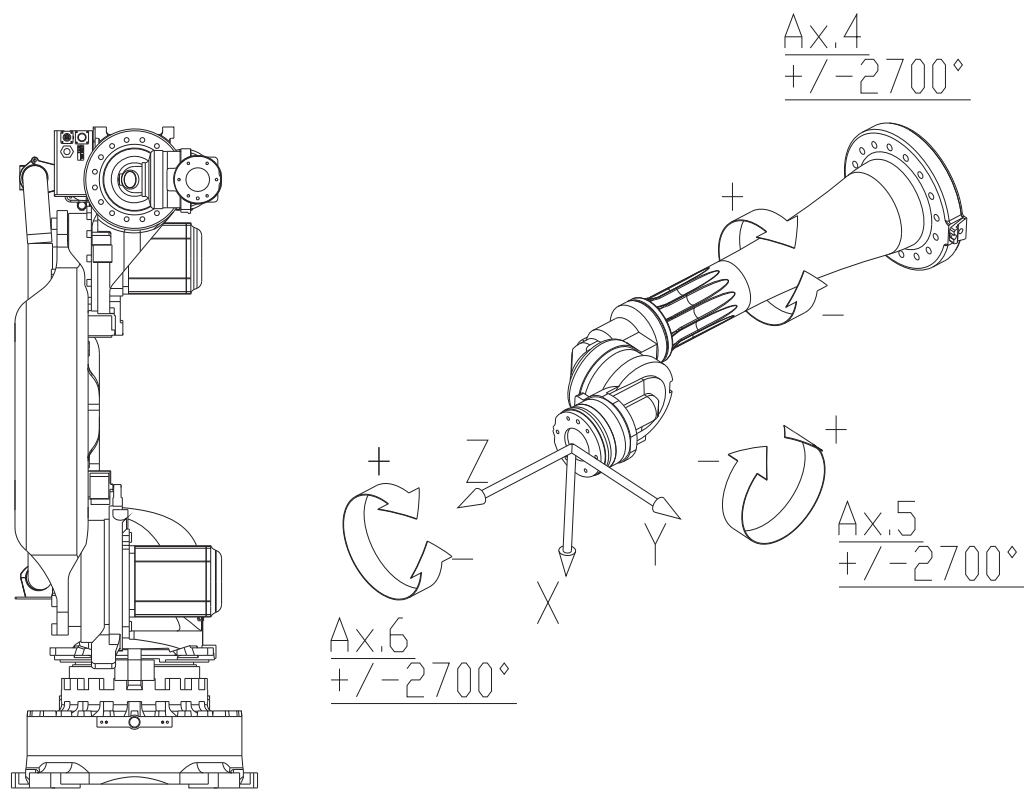
POS.	X	Z	AX.2	AX.3
	[mm]	[mm]	[deg]	[deg]
1	+375,62	-35,15	+65°	-165°
2	-98,06	-259,29	+125°	-140°
3	+2122,97	-656,44	+125°	-9,72°
4	-319,39	+2526,51	-20°	-9,72°
5	-720,19	+2165,33	-60°	-52,15°
6	+893,31	+865,66	-60°	-165°
7	+1625,50	+1620	0°	-90°

Joints in calibration position (pos. 7)					
Ax.1	Ax.2	Ax.3	Ax.4	Ax.5	Ax.6
0°	0°	-90°	0°	0°	0°

SMART5 NJ 40 – 2.5 Off-set / SMART5 NJ 40 – 2.5 Off-set Foundry



ROBOT WORKSPACES AND OVERALL DIMENSIONS



POS.	X	Z	AX.2	AX.3
	[mm]	[mm]	[deg]	[deg]
1	+375,62	-35,15	+65°	-165°
2	-98,06	-259,29	+125°	-140°
3	+2122,97	-656,44	+125°	-9,72°
4	-319,39	+2526,51	-20°	-9,72°
5	-720,19	+2165,33	-60°	-52,15°
6	+893,31	+865,66	-60°	-165°
7	+1625,50	+1620	0°	-90°

Joints in calibration position (pos. 7)					
Ax.1	Ax.2	Ax.3	Ax.4	Ax.5	Ax.6
0°	0°	-90°	0°	0°	0°

5. ROBOT WRIST FEATURES

This chapter contains:

- [Robot wrist flange diagrams](#)
 - [Wrist loads and additional loads](#)
-

5.1 Robot wrist flange diagrams

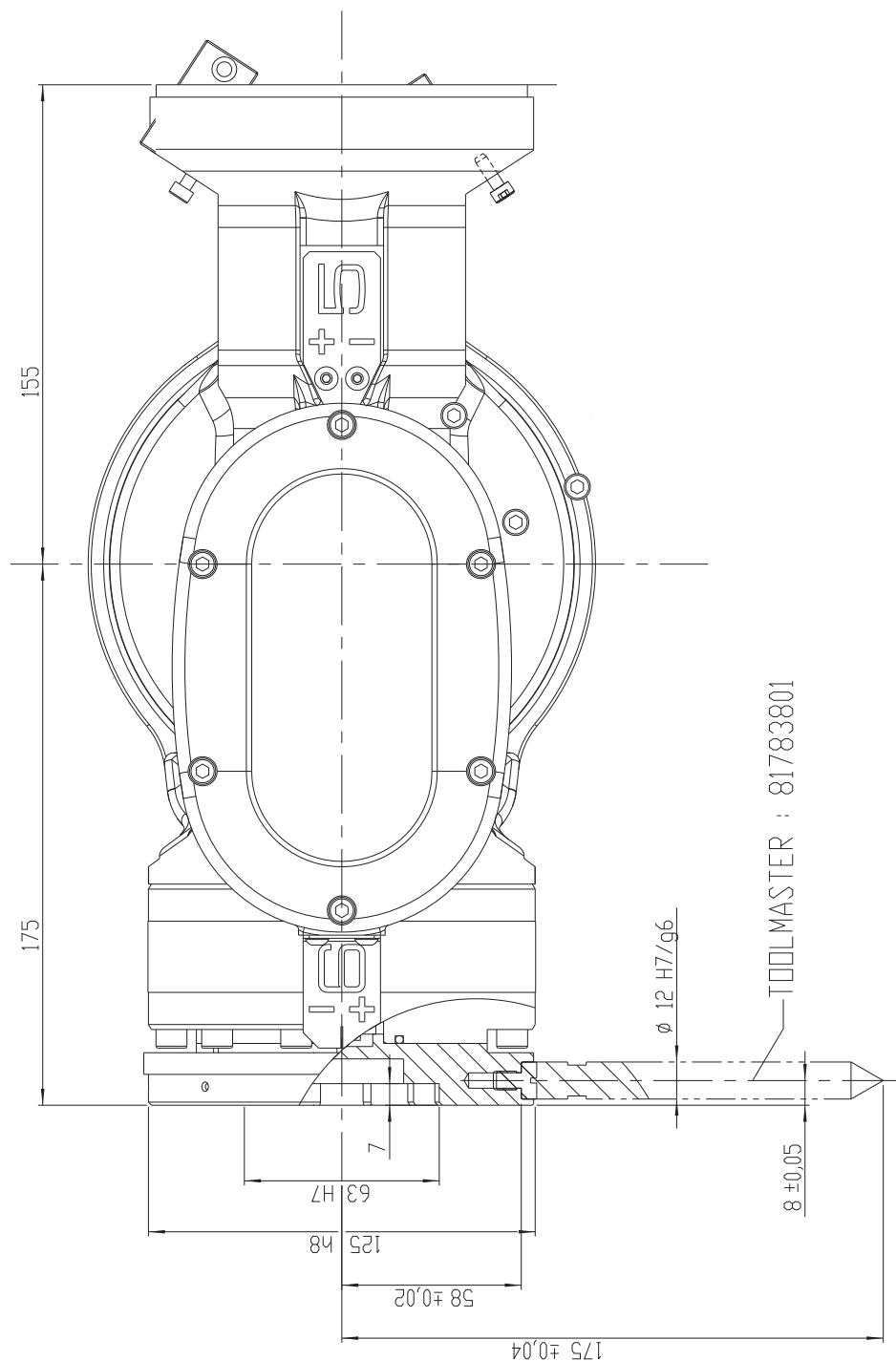
This paragraph contains technical drawings of the Robot wrist flange [SMART5 NJ 40 – 2.5 In-line / SMART5 NJ 40 – 2.5 In-line Foundry](#) and [SMART5 NJ 40 – 2.5 Off-set / SMART5 NJ 40 – 2.5 Off-set Foundry](#) with the dimensions and distance between centers of the holes used to attach the equipment.

In the drawing it is also given the calibrated tool used to calculate with high precision the reference in the middle of the flange in case of equipment installation.

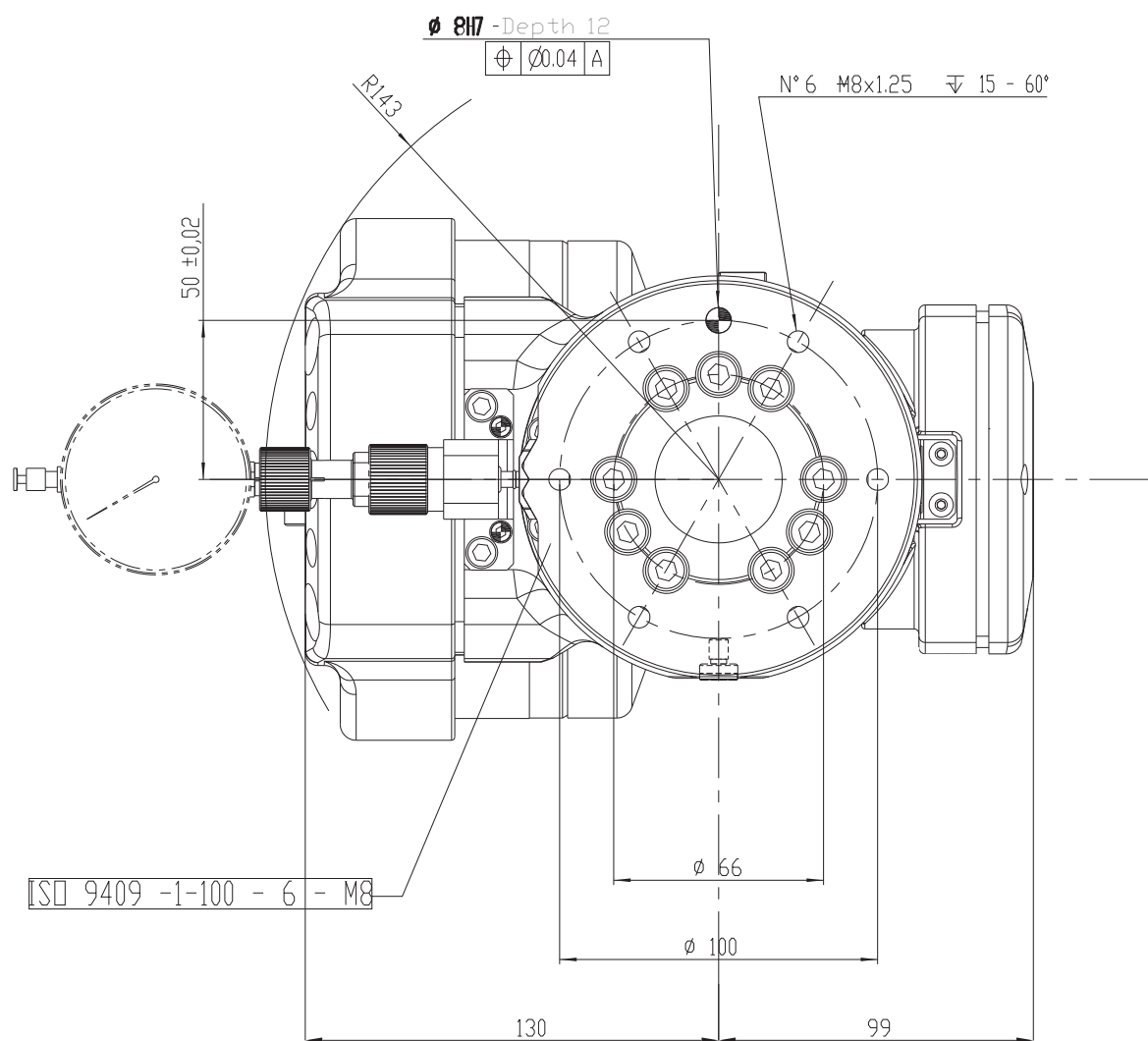
The function of the fittings and connectors installed on the distribution panel is detailed on [par. 6.4 Connections on axis 3 for applications on page 50](#).

5.1.1 SMART5 NJ 40 – 2.5 In-line / SMART5 NJ 40 – 2.5 In-line Foundry

Fig. 5.1 - Tool coupling flange ISO 9409 - 1 - A 100 (Side view)



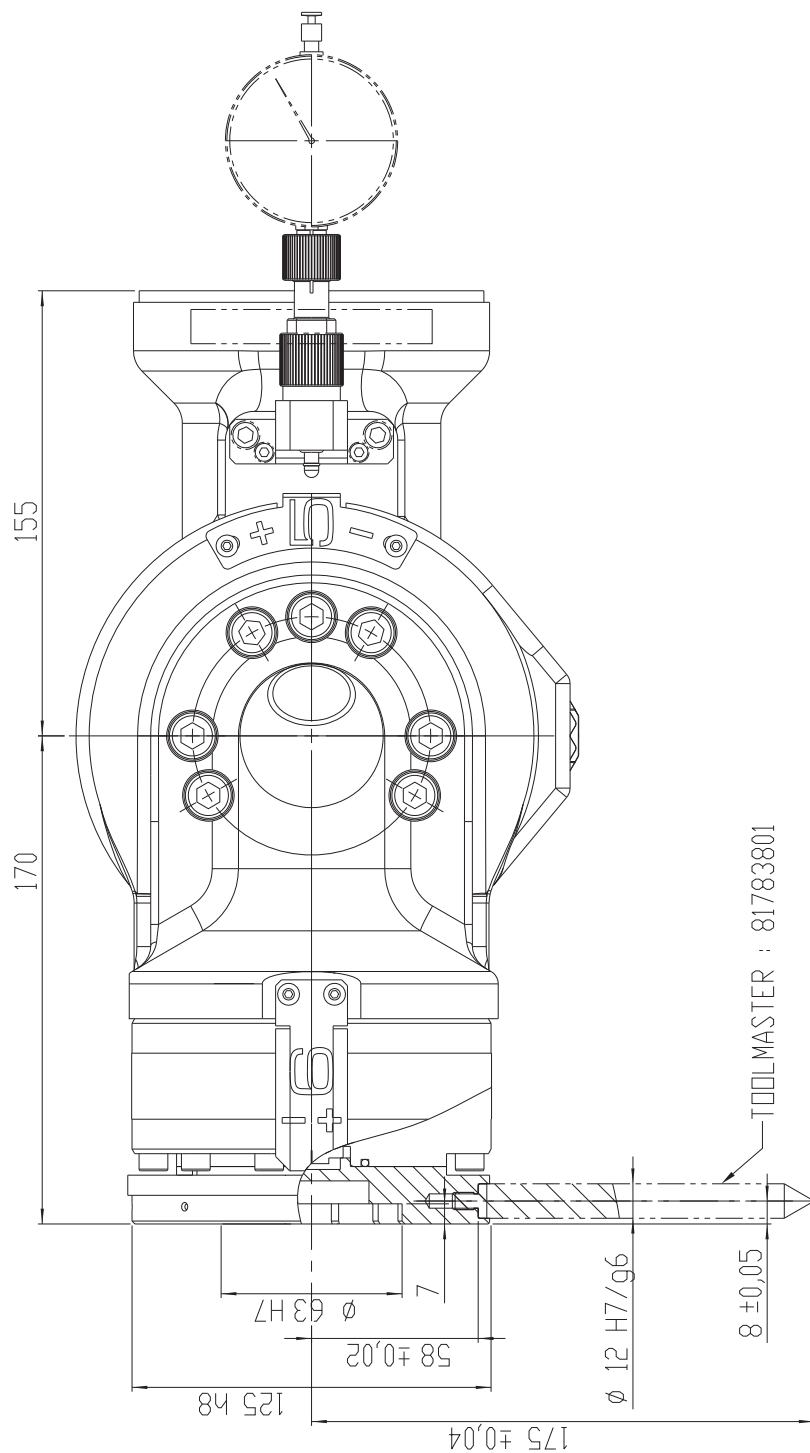
Dimensions in millimetres

Fig. 5.2 - Tool coupling flange ISO 9409 - 1 - A 100 (Front view)

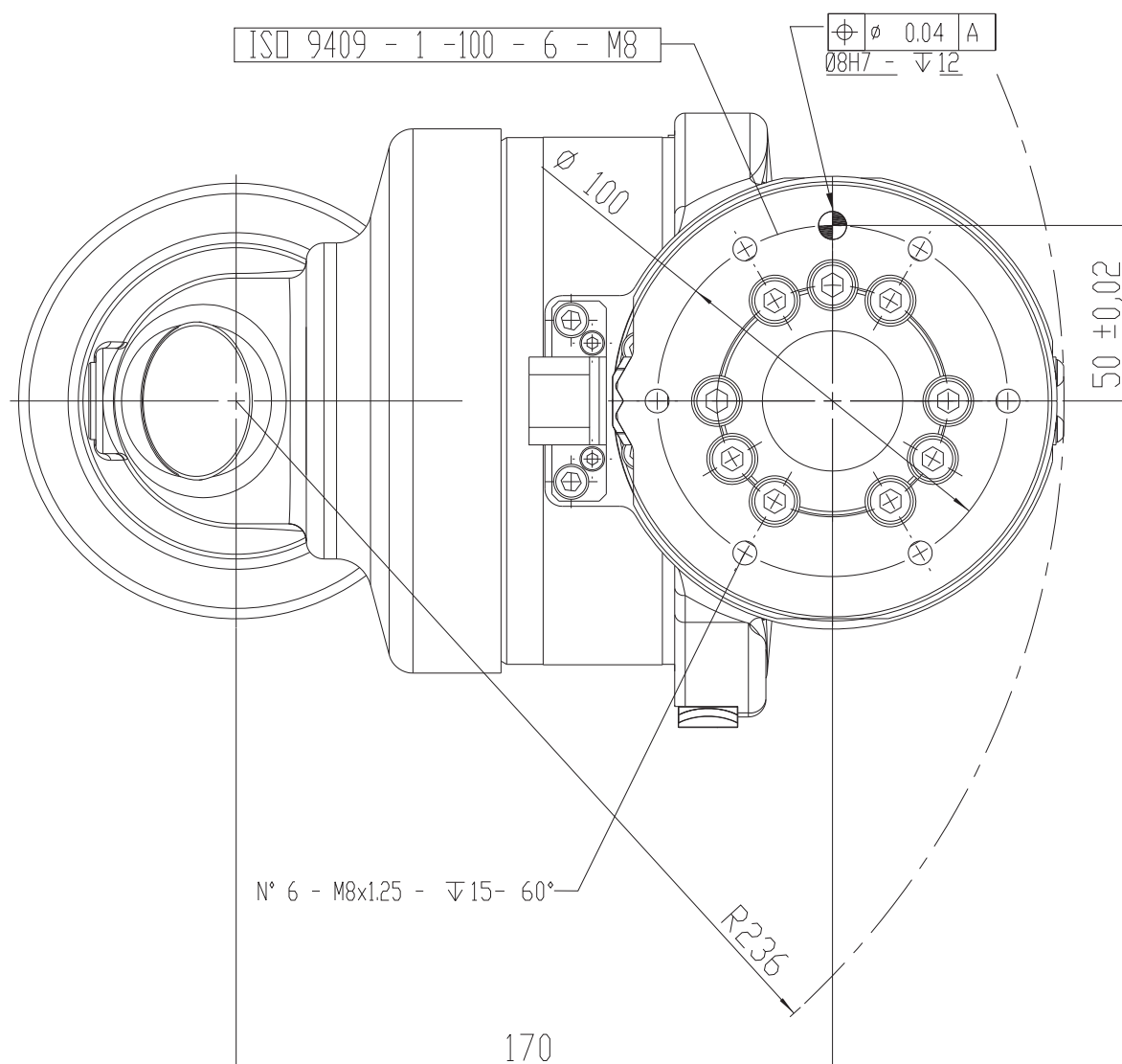
Dimensions in millimetres

5.1.2 SMART5 NJ 40 – 2.5 Off-set / SMART5 NJ 40 – 2.5 Off-set Foundry

Fig. 5.3 - Tool coupling flange ISO ISO 9409 - 1 - A 100 (Side view)



Dimensions in millimetres

Fig. 5.4 - Tool coupling flange ISO 9409 - 1 - A 100 (Front view)

Dimensions in millimetres

5.2 Wrist loads and additional loads

This paragraph describes the procedures to define the maximum load applicable to the Robot flange and the possible additional load applicable on the forearm. In detail:

- [Abbreviations](#)
- [Barycentre and couplings for additional load position](#)
- [Determination of max loads to the wrist flange \(\$Q_F\$ \)](#)
- [Additional loads \(\$Q_S\$ \)](#)

5.2.1 Abbreviations

The following abbreviations have been used throughout the chapter:

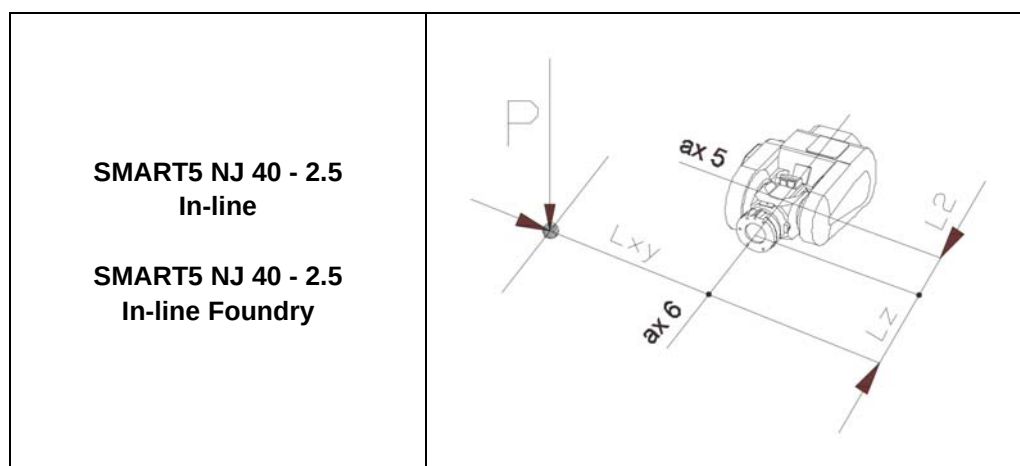
- Q_F = Max load applied to the flange
- Q_S = Additional load applied to the forearm
- Q_T = Max. total load applied on the Robot
- L_Z = Load P barycentre distance from the tool coupling flange plane
- L_{XY} = Load P barycentre distance from axis 6
- M = Mass
- J_0 = Inertia

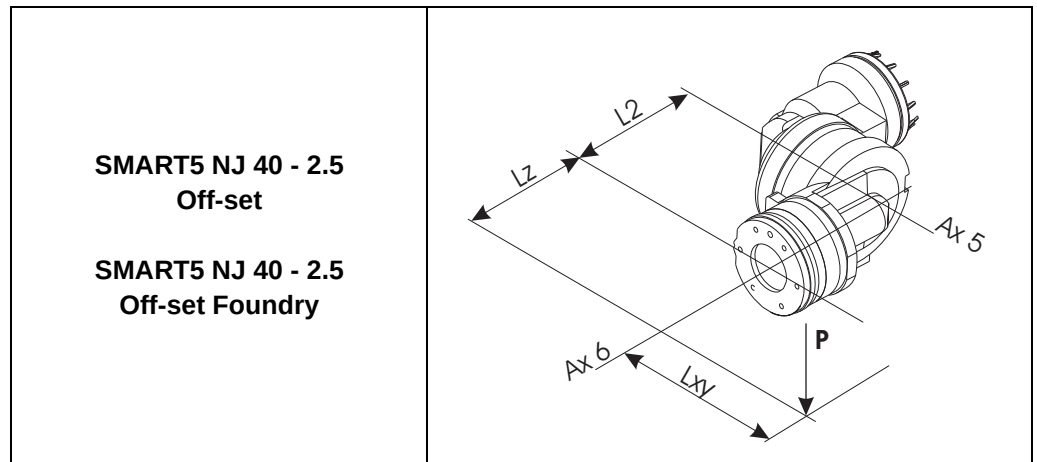
5.2.2 Barycentre and couplings for additional load position

The area in which it is admitted the barycentre position related to the additional load is listed in [Fig. 5.7 - Position of the additional loads barycentre on page 44](#).

Holes centres distances and sizes for coupling additional loads applied on the Robot forearm are listed in the drawings in [Fig. 5.8 - Equipment fixing on page 45](#).

Fig. 5.5 - Coordinates of the load barycentre applied to the flange





5.2.3 Determination of max loads to the wrist flange (Q_F)

The max load applicable to the flange is defined using the graphs of wrist load where the maximum loading curves Q_F are plotted according to the coordinates L_Z and L_Y of the load barycentre.

The area subtended by the load curves defines the barycentre distances admissible for load application specified on the area itself.

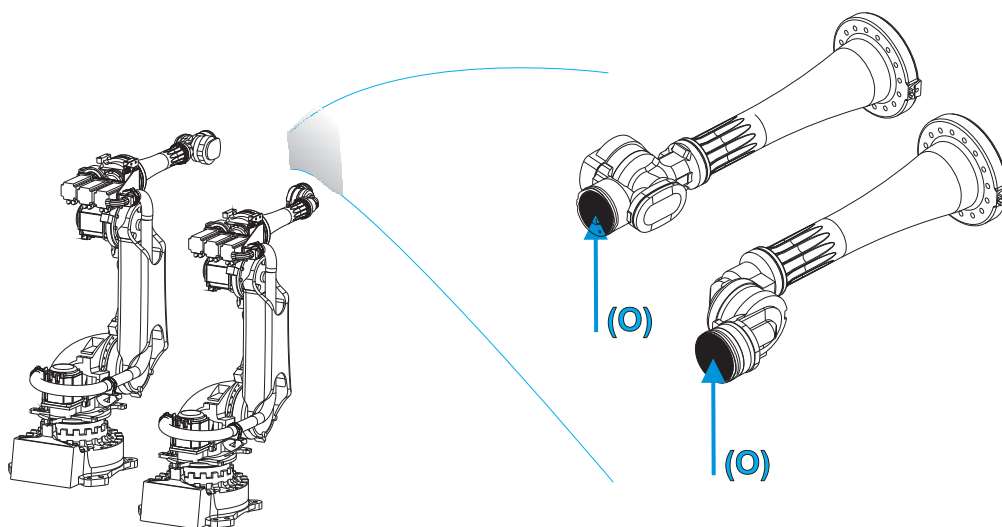
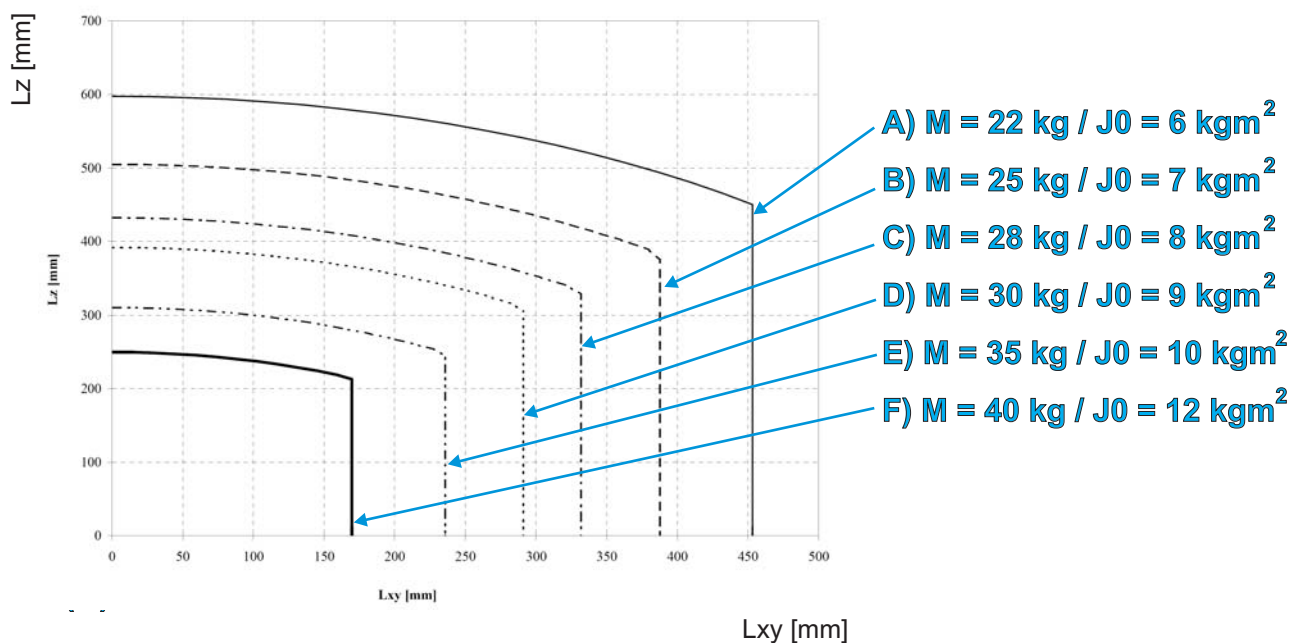
In the following [Fig. 5.6](#) it is shown the diagram of the [Max load capacity to the flange of the Robot SMART NJ 40 - 2.5 In-line / SMART NJ 40 - 2.5 Off-set](#).



The inertia specified in the graph curves refers to the centre of gravity of the load applied on the flange.

When applying loads different from the values specified in the graphs, check the Robot use limitations by means of the SMART Payload software function.

Fig. 5.6 - Max load capacity to the flange of the Robot SMART NJ 40 - 2.5 In-line / SMART NJ 40 - 2.5 Off-set



- M: mass
- J_0 : Inertia



(O) Reference point for wrist load calculation.

Numerical constants to be applied to the formulas given in **Determination of max loads to the wrist flange (Q_F)**: $a=9.583$; $b=0.281$; $c=0.079$; $d=4.691$; $e=0.207$; $f=0.043$; $H=17000$; $N=10000m$

5.2.4 Additional loads (Q_S)

Besides the load on the flange Q_F , on the Robot forearm can be applied an additional load Q_S .

The maximum loads applicable are those listed in [Tab. 5.1 - Maximum applicable loads on page 43](#).

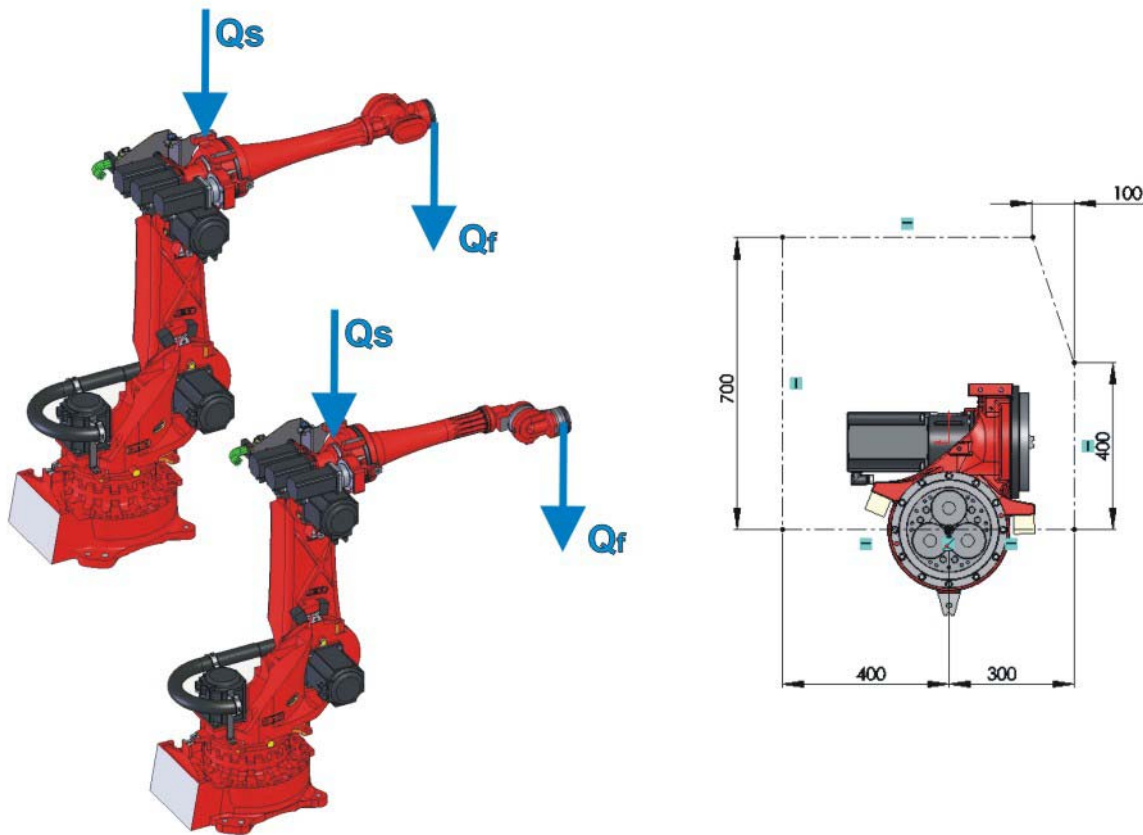
In each application the following conditions must be met:

- The barycentre of the load applied on the flange Q_F must be within the area defined by the curves of the graphics specific for each Robot, as described in paragraph [Determination of max loads to the wrist flange \(\$Q_F\$ \) \(see par. 5.2.3 on page 41\)](#)
- The barycentre of the additional load Q_S must be included in the area of the diagram specific for each Robot (see [Fig. 5.7 - Position of the additional loads barycentre on page 44](#))

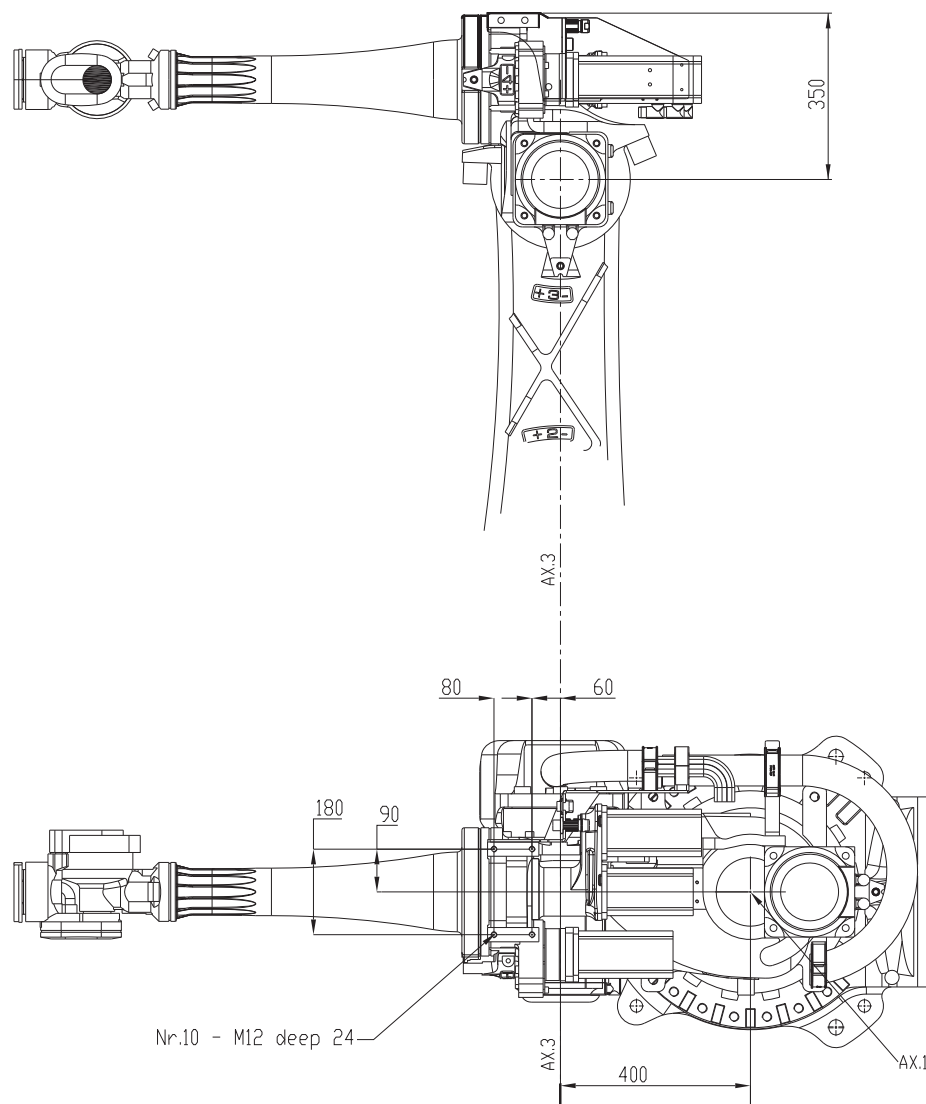
To install special equipment on the Robot it is possible to use the holes present on the Robot forearm and listed in the specific drawings for Robot version (see [Fig. 5.8 - Equipment fixing on page 45](#)).

Tab. 5.1 - Maximum applicable loads

Robot type SMART5	Q_F Max load applicable on the flange	Q_S Max additional load applicable on the forearm	Q_T Max total load applicable on the Robot
NJ 40 - 2.5 In-line	40 kg (88.18 lb)	35 kg (77.16 lb)	75 kg (165.34 lb)
NJ 40 - 2.5 In-line Foundry			
NJ 40 - 2.5 Off-set	40 kg (88.18 lb)	35 kg (77.16 lb)	75 kg (165.34 lb)
NJ 40 - 2.5 Off-set Foundry			

Fig. 5.7 - Position of the additional loads barycentre

The diagram shown in the figure is also applicable to inverted mounting.
Dimensions in millimetres

Fig. 5.8 - Equipment fixing

Dimensions in millimetres

The diagram shown in the figure is also applicable to inverted mounting.

6. MATCHING WITH C5G CONTROL UNIT AND USER CUSTOMIZATIONS

This chapter contains:

- [Management and control through Control Unit C5G](#)
- [Connections overview](#)
- [Connections on Robot base \(distribution panel\)](#)
- [Connections on axis 3 for applications.](#)

6.1 Management and control through Control Unit C5G

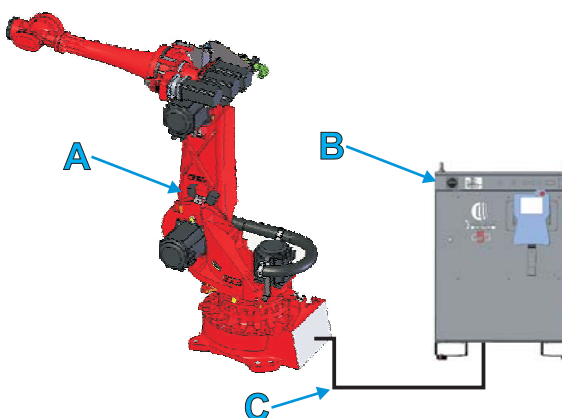
The Robot is managed and controlled by the COMAU C5G Control Unit and is not allowed another matching.

The Robot is matched with a specific size of the C5G Control Unit (see purchase Part No. on the Control Unit "Technical Specifications" handbook C5G).

The electrical connection between the Robot and the Control Unit is possible using specific kits of connection cables.

In addition suitable options on C5G Control Unit can solve integration requirements.

- A** Robot
- B** C5G Control Unit
- C** Connection cables kit



The Control Unit (B) and the connection cables (C) are described in the C5G Technical Specifications instructions handbook.

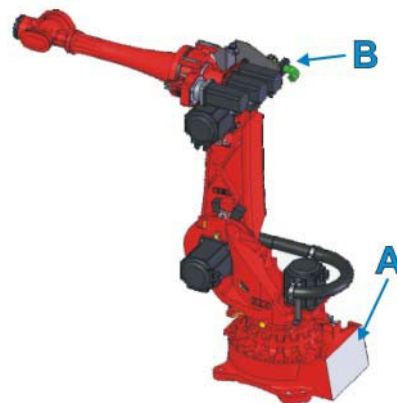
6.2 Connections overview

The integrator must connect the Robot to the Control Unit through specific cables (see [par. 6.1](#)).

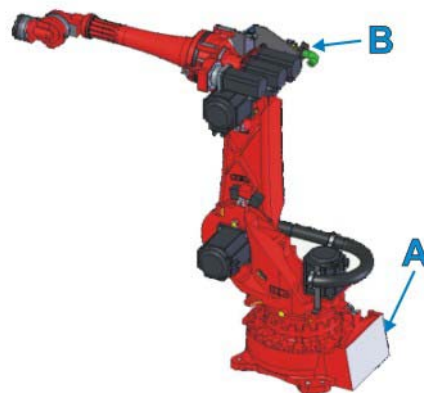
Moreover he arranges on the Robot the settings to optimize the Robot integration in the production process (air connection, electrical connection).

In-line version

- A Connections on Robot base (distribution panel)
- B Connections on axis 3 for applications

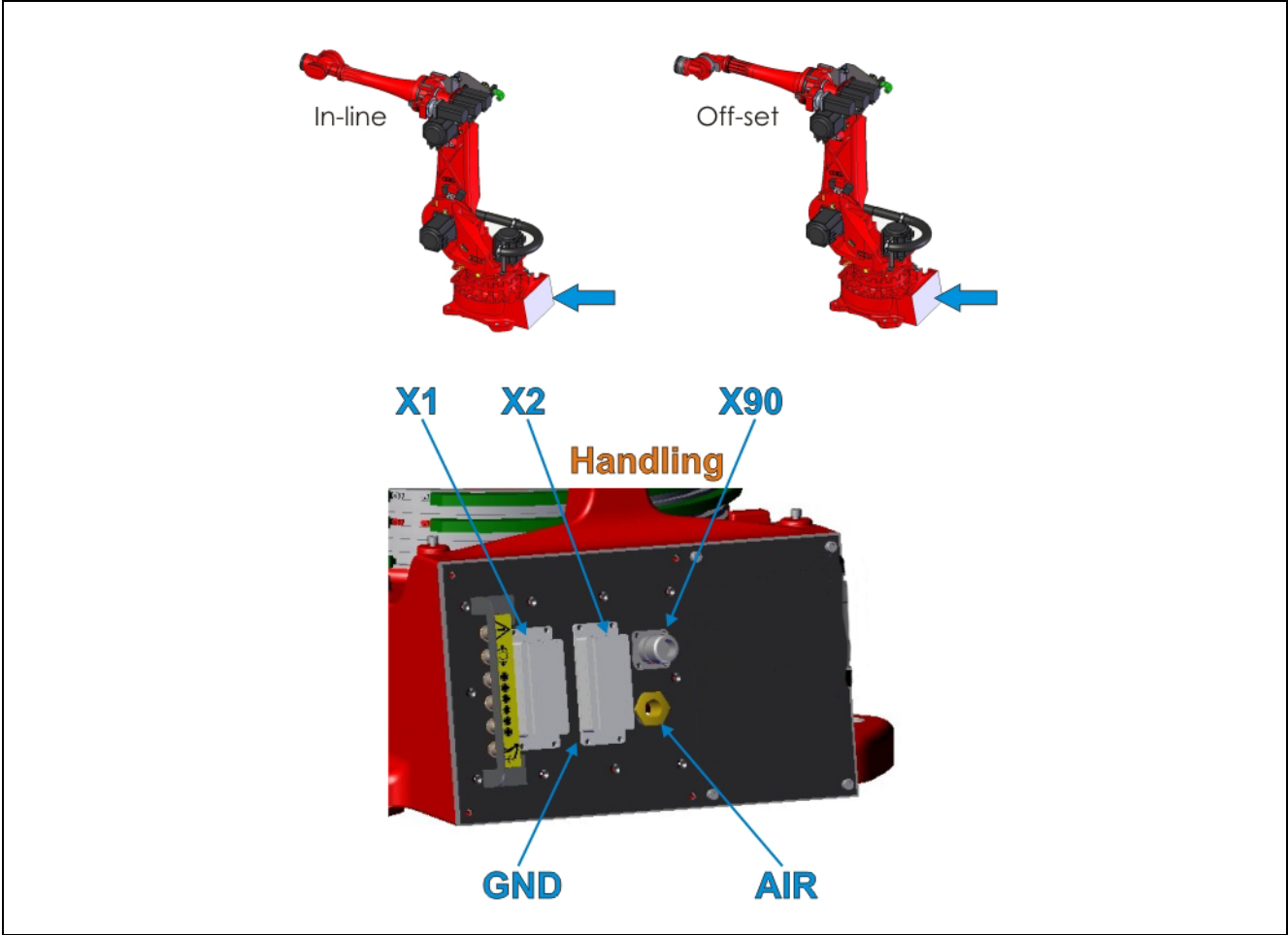


Off-set version



6.3 Connections on Robot base (distribution panel)

In the following figure are shown all connections available on Robot base plate (distribution panel).



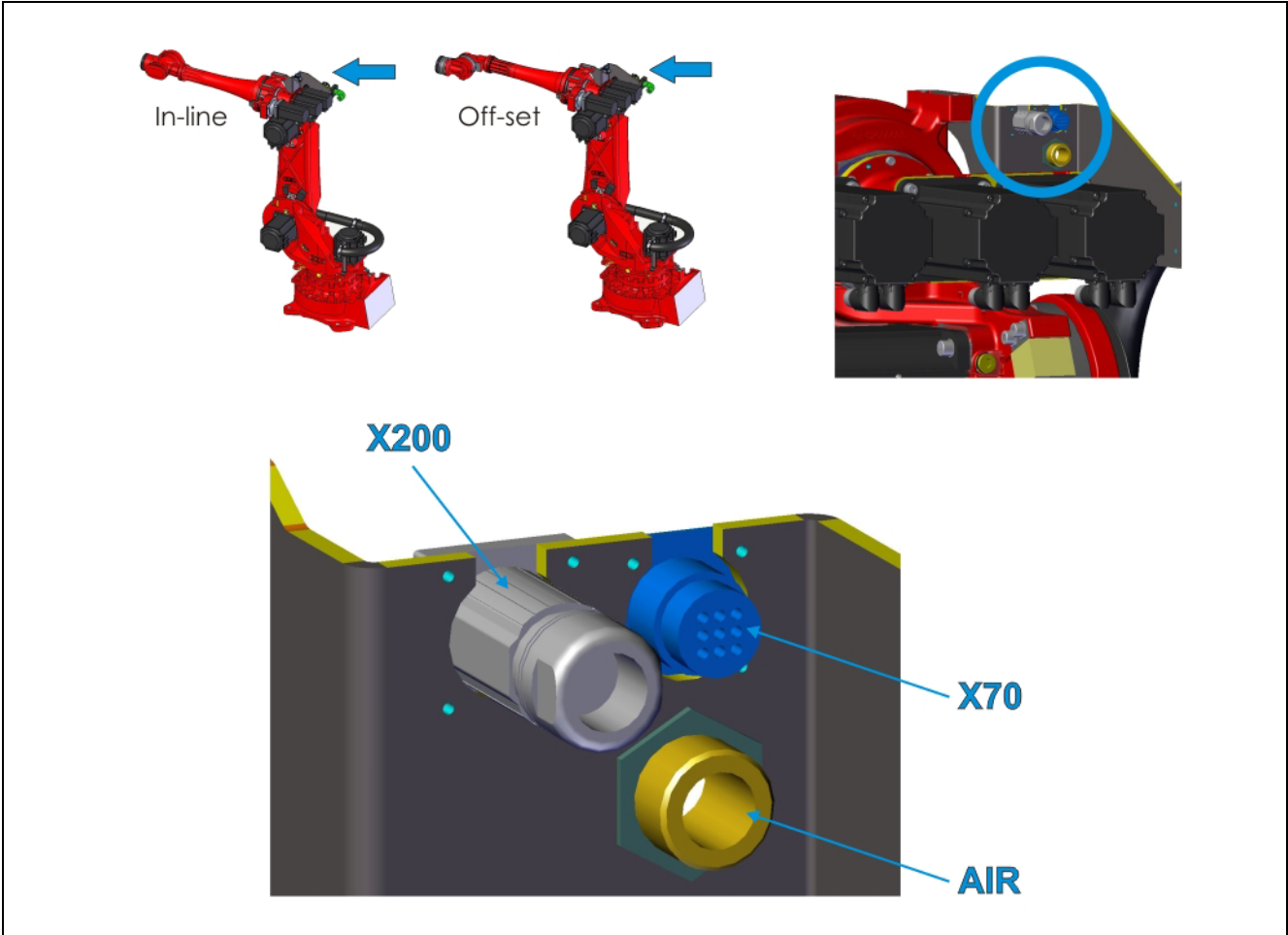
Ref.	Function	Description
X1	Encoder signals / Signals connector	X1 Encoder/Signals signals connector is connected to the X10 connector on Control Unit C5G through specific cable. For further information on Encoder / Signals: – Control Unit C5G: see the Control Unit C5G “Technical Specifications” handbook.
X2	Motor and Brake signals connector	The X2 motors signals connector is connected to the X60 connector on the C5G Control Unit through specific cable. For further information on motor/brakes signals: – Control Unit C5G: see the Control Unit C5G “Technical Specifications” handbook.

Ref.	Function	Description
GND	Conductor connection of the equalizer circuit	Connection screw GND through connection screw GND on C5G Control Unit with conductor. For further information on the connection to the equipotential circuit: – Control Unit C5G: see the Control Unit C5G “Technical Specifications” handbook.
X90	Connector for Fieldbus signals	The connector X90 is connected to the X93 connector on the C5G Control Unit through specific cable. As an alternative to the cable it is possible to order the 17 pins male crimp mating connector ASTA 215 MR25 59 0038 000 INTERCONTEC. Depending on the use, see: – Handling: see the par. 6.5 Solutions for automations on Robot SMART5 Series NJ on page 52
AIR	AIR fitting for air input	Female thread fitting 1/2". The inner tube ends on the robot wrist without interruption. Depending on the use, see: – Handling: see the par. 6.5 Solutions for automations on Robot SMART5 Series NJ on page 52



In addition see the Instructions handbook of the application installed on the Robot (Handling).

6.4 Connections on axis 3 for applications



Ref.	Function	Description
X70	Connector for input / output signals	The connector X70 is connected to connector X1 on robot base through specific cable. The mating connector to be matched is: – male 19 pins mating connector UT0616-19PH BURNDY – Casing with cable gland GVUTO16NI13R106 VALINOTTO – male contact 20 AWG print SM20 ML-1S6 BURNDY Depending on the use, see: – Handling: see the par. 6.5 Solutions for automations on Robot SMART5 Series NJ on page 52

Ref.	Function	Description
X200	Connector for Fieldbus signals	The X200 connector is connected to X90 connector on Robot base through specific cable. The mating connector to be matched is: – INTERCONTEC ASDA 215 MR25 59 0038 000 Depending on the use, see: – Handling: see the par. 6.5 Solutions for automations on Robot SMART5 Series NJ on page 52
AIR	Bulkhead for air passage	Female thread bulkhead 1/2" The pipe starts from the Robot base and reaches without interruptions to the plate of axis 3. Depending on the use, see: – Handling: see the par. 6.5 Solutions for automations on Robot SMART5 Series NJ on page 52



See C5G Control Unit Instructions Handbook

In addition see the Instructions handbook of the application installed on the Robot (Handling).

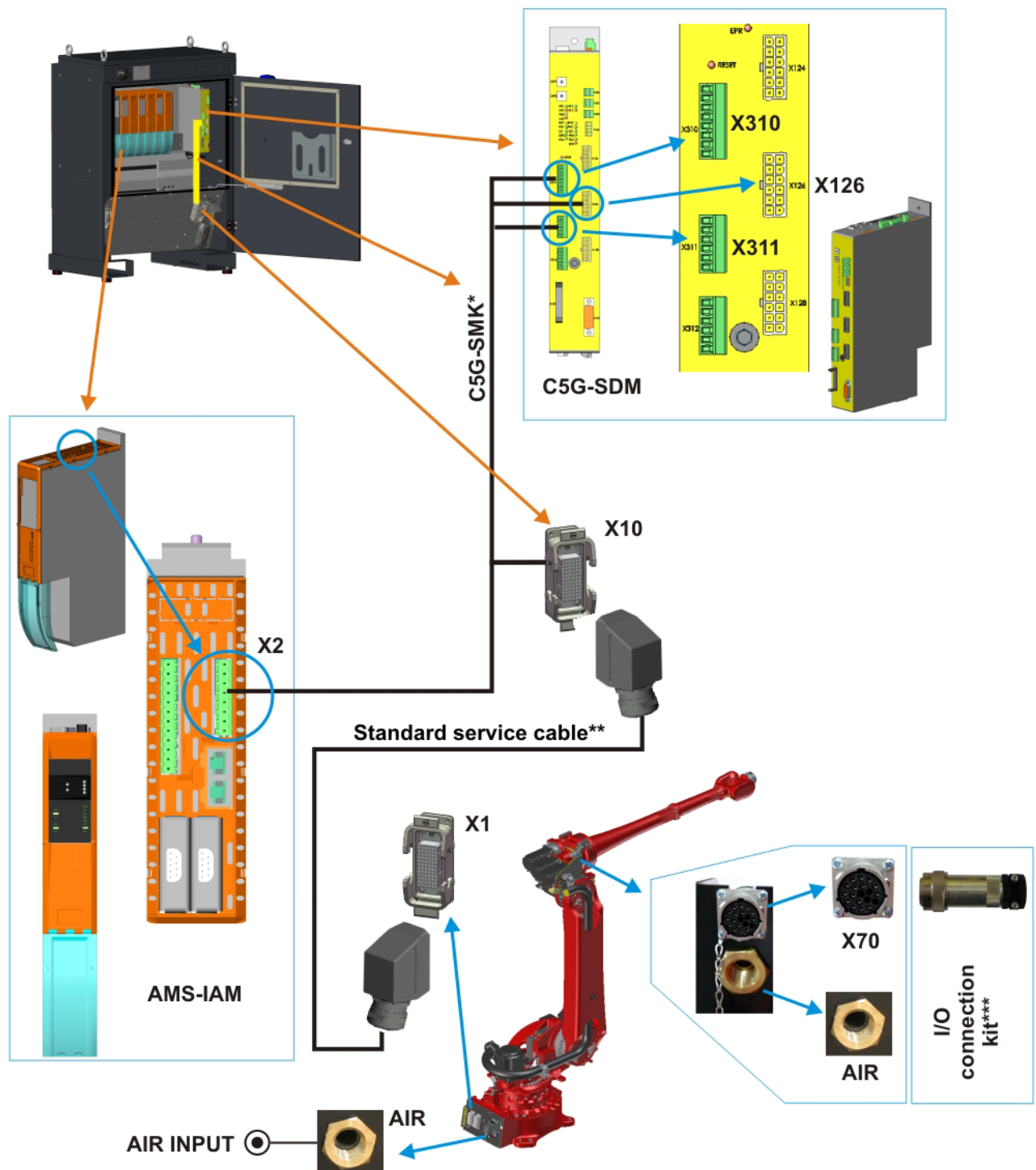
6.5 Solutions for automations on Robot SMART5 Series NJ

In this chapter are described the following topics:

- [Solution with Digital Inputs / Outputs Deriving from SDM Module](#)
 - [I/O principle diagram on SDM](#)
 - [Composition of I/O Solution on SDM](#)
 - [X70 connector pinout on Robot NJ axis 3](#)
 - [AIR fitting features on axis 3 Robot NJ](#)
 - [X70 mating connector kit for NJ Robot I/O \(optional\) \(16657880\)](#)
 - [I/O principle electrical circuit diagram on SDM](#)
 - [Robot NJ connection principle pneumatic diagram](#)
- [Solutions with Inputs / Outputs through Fieldbus on X20 interface modules](#)
 - [Profibus-DP principle diagram](#)
 - [Structure of the Solution with I/O signals through Profibus-DP Fieldbus](#)
 - [DeviceNet principle diagram](#)
 - [Structure of the Solution with I/O signals through DeviceNet Fieldbus](#)
 - [ProfiNet principle diagram](#)
 - [Structure of the Solution with I/O signals through ProfiNet Fieldbus](#)
 - [Bus connector pinout](#)
 - [AIR fitting features on axis 3 Robot NJ](#)
 - [Mating connectors Kit X200 and AIR for Fieldbus solution Robot NJ \(optional\) \(16689780\)](#)
 - [Multibus cable](#)
 - [Multibus cable for Control Unit in B.R.I.C. configuration](#)

6.5.1 Solution with Digital Inputs / Outputs Deriving from SDM Module

Fig. 6.1 - I/O principle diagram on SDM



*Optional component of the Control Unit

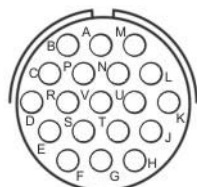
**Connection signal cable between Control Unit and Robot

*** Connection Kit optional I/O

Tab. 6.1 - Composition of I/O Solution on SDM

Item Fig. 6.1	Description	For details see
Optional components required		
C5G-SMK	Signal Machine Kit	par. 10
I/O Connection Kit	I/O Connection Kit	par. 6.5.1.3
Standard components		
AMS-IAM	Axes control module	par. 10
C5G-SDM	Safety Distribution Module (SDM)	par. 10
Standard service cable	Connection cable between C5G Control Unit and Robot	par. 10
X1	Robot position control signals connector on the Robot base	par. 10
X10	Robot position control signals connector on the Cabinet base	par. 10
X70	I/O signals connector installed on a distribution panel	par. 6.5.1.1
AIR	Compressed air outlet installed on distribution panel	par. 6.5.1.2

6.5.1.1 X70 connector pinout on Robot NJ axis 3



- Connector for:
 - I/O signals
 - 24 Vdc
- female** 19 crimping pin (on distribution panel axis 3)



Mating connectors in [par. 6.5.1.3 X70 mating connector kit for NJ Robot I/O \(optional\) \(16657880\)](#) on page 56.

Front view - Female connector

Pin	Description	Pin	Description
A	+24V ROBOT	L	Output 2
B	0V (24Vdc)	M	Output 3
C	Shield	N	Output 4
D	Robot alarm	P	Input 1
E	HSI+ 3	R	Input 2
F	HSI- 3	S	Input 3
G	Input 4	T	Not Used
H	Air input	U	Not Used
J	Not Used	V	Not Used
K	Output 1		

6.5.1.2 AIR fitting features on axis 3 Robot NJ



- Fitting to provide air to the devices installed on machine
- female threaded 1/2" GAS M22x1.5
- DN12 pipe
- maximum pressure supported by the pipe - 2 MPa (20 Bar)



Mating connectors in [par. 6.5.1.3 X70 mating connector kit for NJ Robot I/O \(optional\) \(16657880\)](#) on page 56.

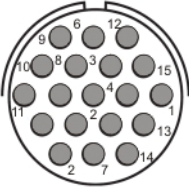
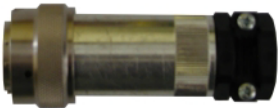
6.5.1.3 X70 mating connector kit for NJ Robot I/O (optional) (16657880)

The option consists of one multipolar connector to wire the related X70 (I/O) connector located on Robot axis 3.

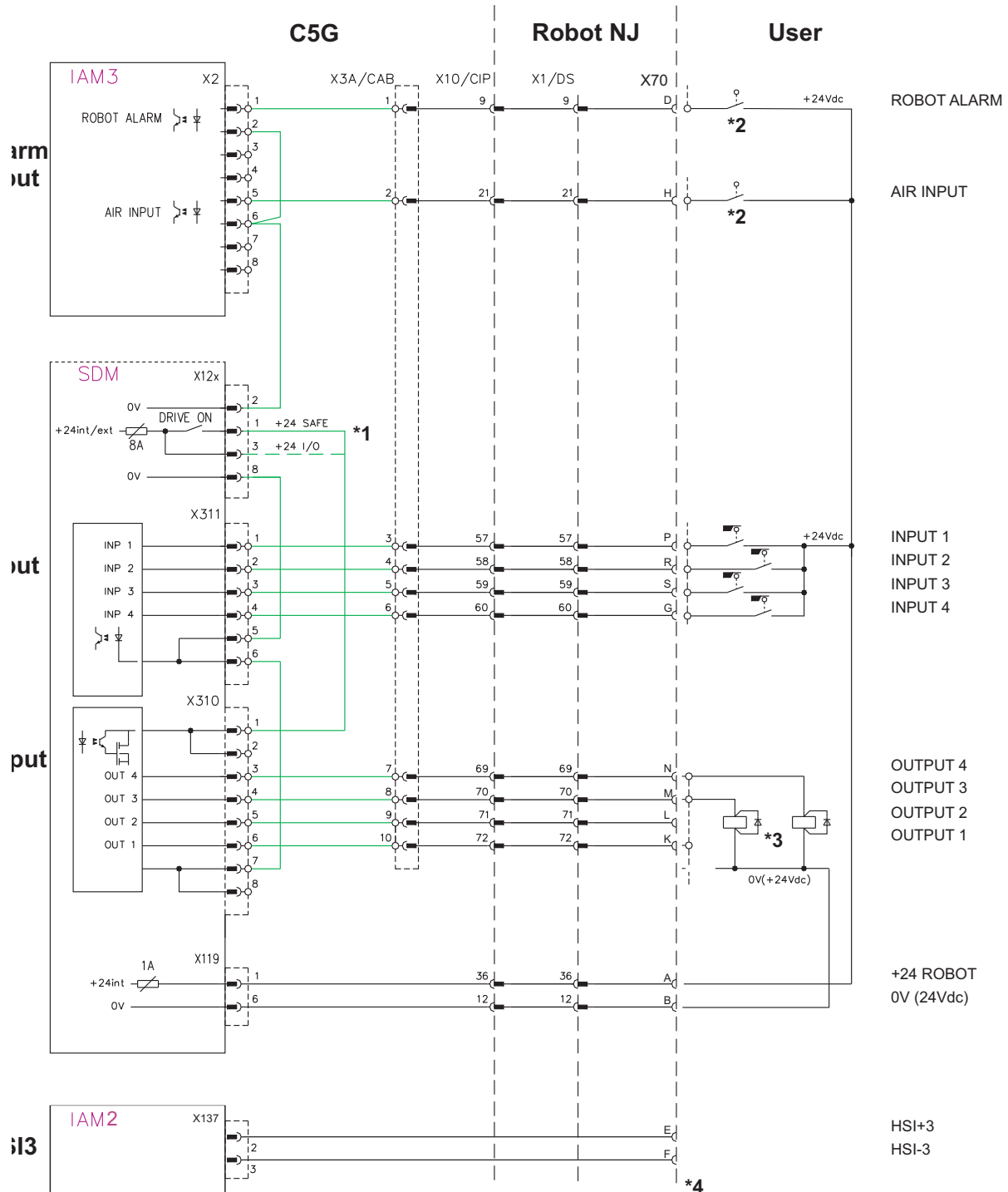
The AIR fitting installed on the distribution panel, can be used with hose pipe fitting available in the option described in [par. 6.5.2.6 Mating connectors Kit X200 and AIR for Fieldbus solution Robot NJ \(optional\) \(16689780\)](#) on page 68.



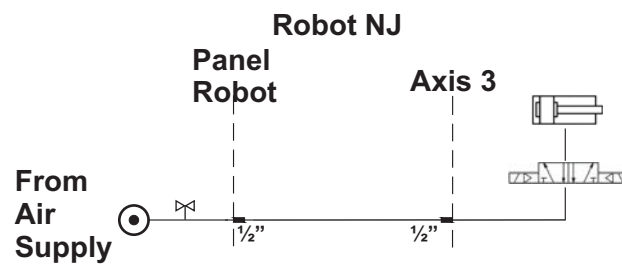
The connectors pinout corresponds to panel connectors installed on Robot axis 3 distribution panel.

X70 Connector	
 Front view - Male connector	– Connector for: • I/O signals • 24 Vdc – male 19 pins crimp mating UT0616-19PH BURNDY Casing with cable gland GVUTO16NI13R106 VALINOTTO male contact 20 AWG print SM20 ML-1S6 BURNDY

6.5.1.4 I/O principle electrical circuit diagram on SDM



6.5.1.5 Robot NJ connection principle pneumatic diagram



6.5.2 Solutions with Inputs / Outputs through Fieldbus on X20 interface modules

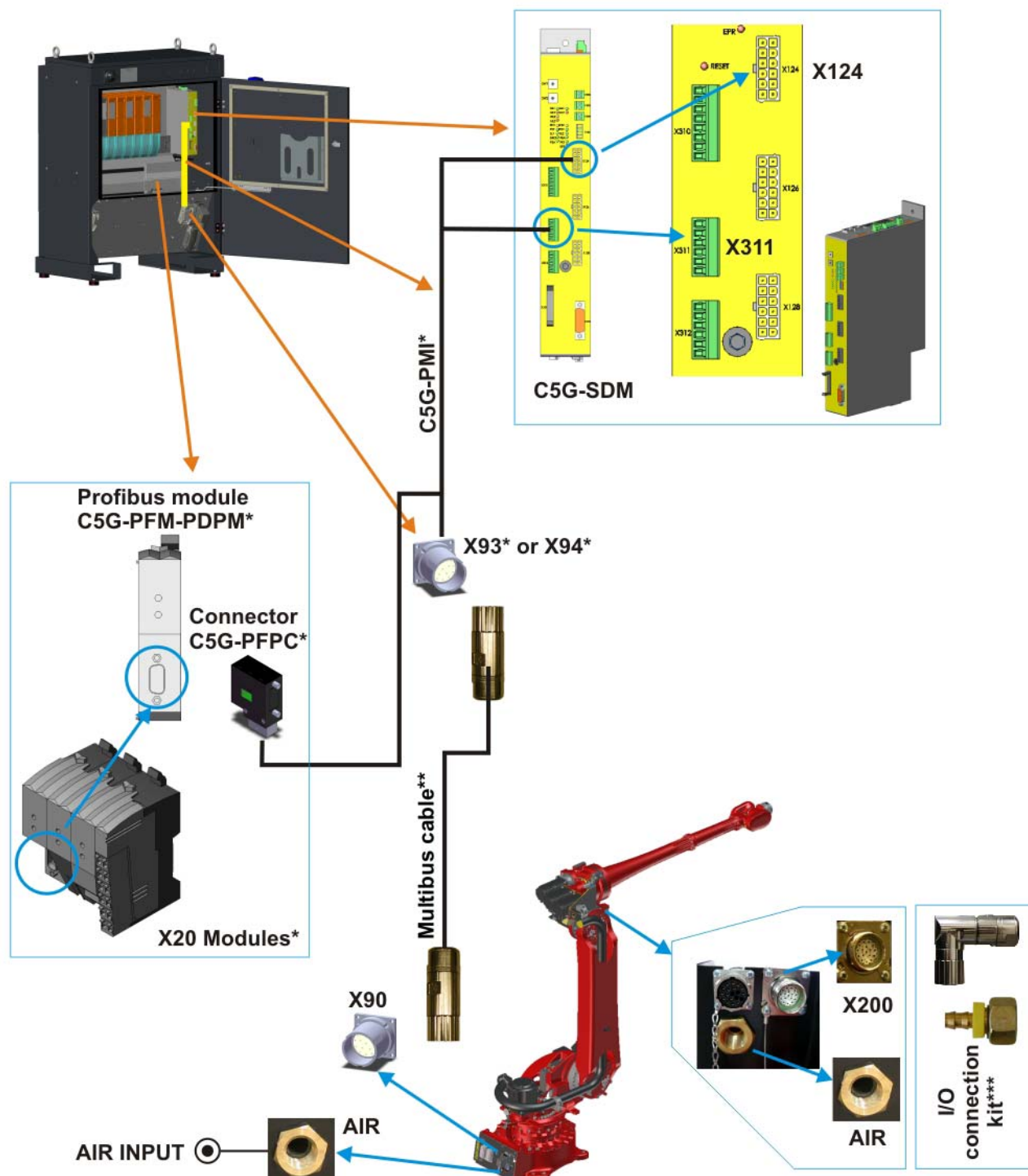
The I/O signals can be transmitted from the Control Unit to Robot through one of the following solutions:

- [Solutions with Profibus-DP Fieldbus](#)
- [Solutions with DeviceNet Fieldbus](#)
- [Solutions with ProfiNet Fieldbus](#)

The following paragraphs represent the connection principle diagrams between the Robot and Control Unit in case of Fieldbus I/O signals.

6.5.2.1 Solutions with Profibus-DP Fieldbus

Fig. 6.2 - Profibus-DP principle diagram



*Optional components of the Control Unit

**Optional Multibus cable

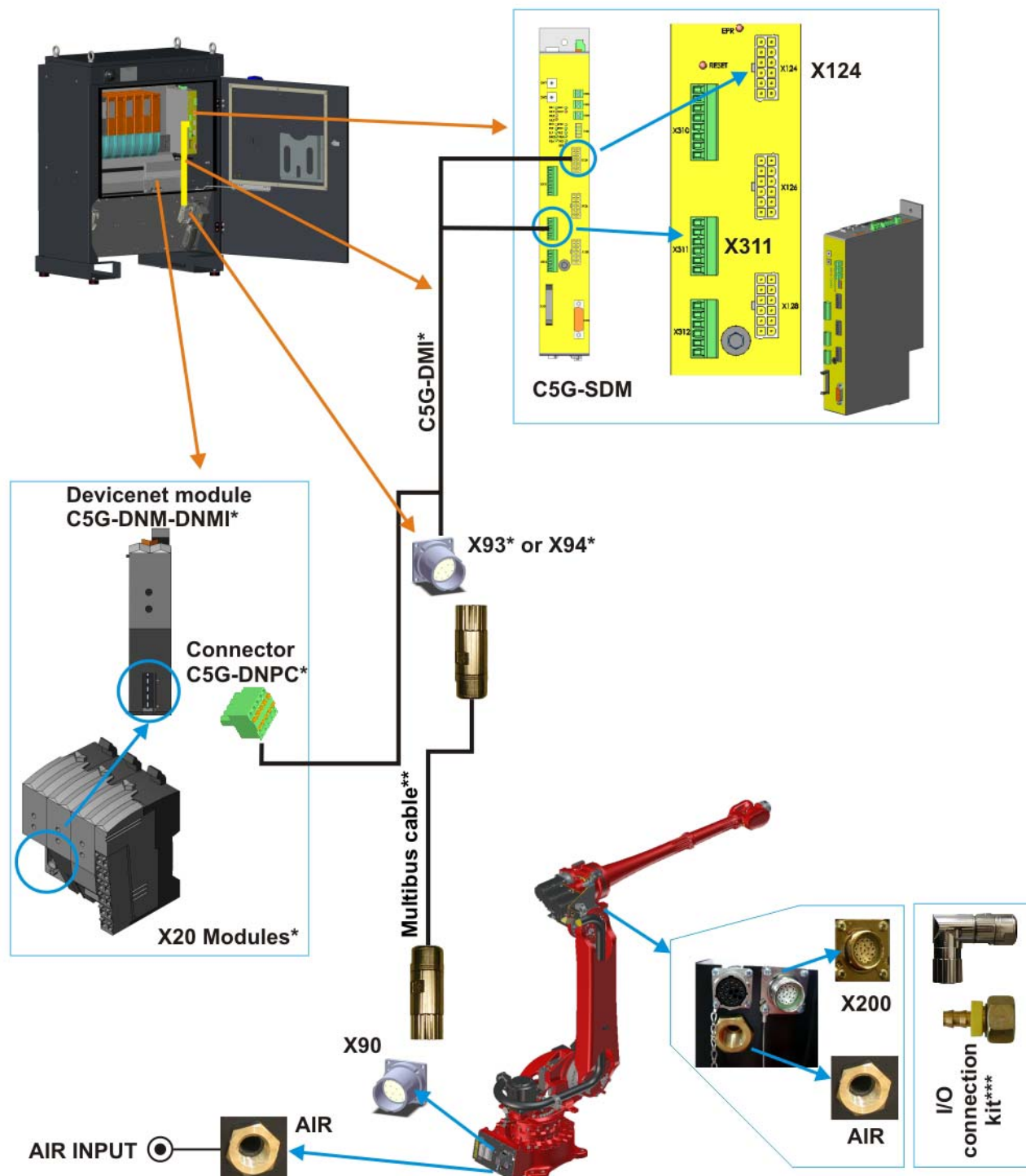
*** connector Kit and optional fittings

Tab. 6.2 - Structure of the Solution with I/O signals through Profibus-DP Fieldbus

Item Fig. 6.2	Description	For details see
Optional components required		
C5G-PMI	Interface cable for Profibus-DP module	Chap.10. on page 133
C5G-PFM-PDPM	Profibus-DP Master Interface module	"Technical Specifications C5G Control Unit" handbook
C5G-PFPC	Connector for Profibus-DP Master modules	"Technical Specifications C5G Control Unit" handbook
I/O Connection Kit	I/O Connection Kit	par. 6.5.2.6
Multibus cable	Connection cable between C5G Control Unit and Robot	par. 6.5.2.7 par. 6.5.2.8
X20 Module	Interface module	Chap.10. on page 133
X93 or X94	Multibus connector on cabinet base available after installing the C5G-PMI	Chap.10. on page 133
Standard components		
X90	Multibus connector on the Robot base	Chap.10. on page 133
X200	Multibus connector installed on a distribution panel	par. 6.5.2.4

6.5.2.2 Solutions with DeviceNet Fieldbus

Fig. 6.3 - DeviceNet principle diagram



*Optional components of the Control Unit

**Optional Multibus cable

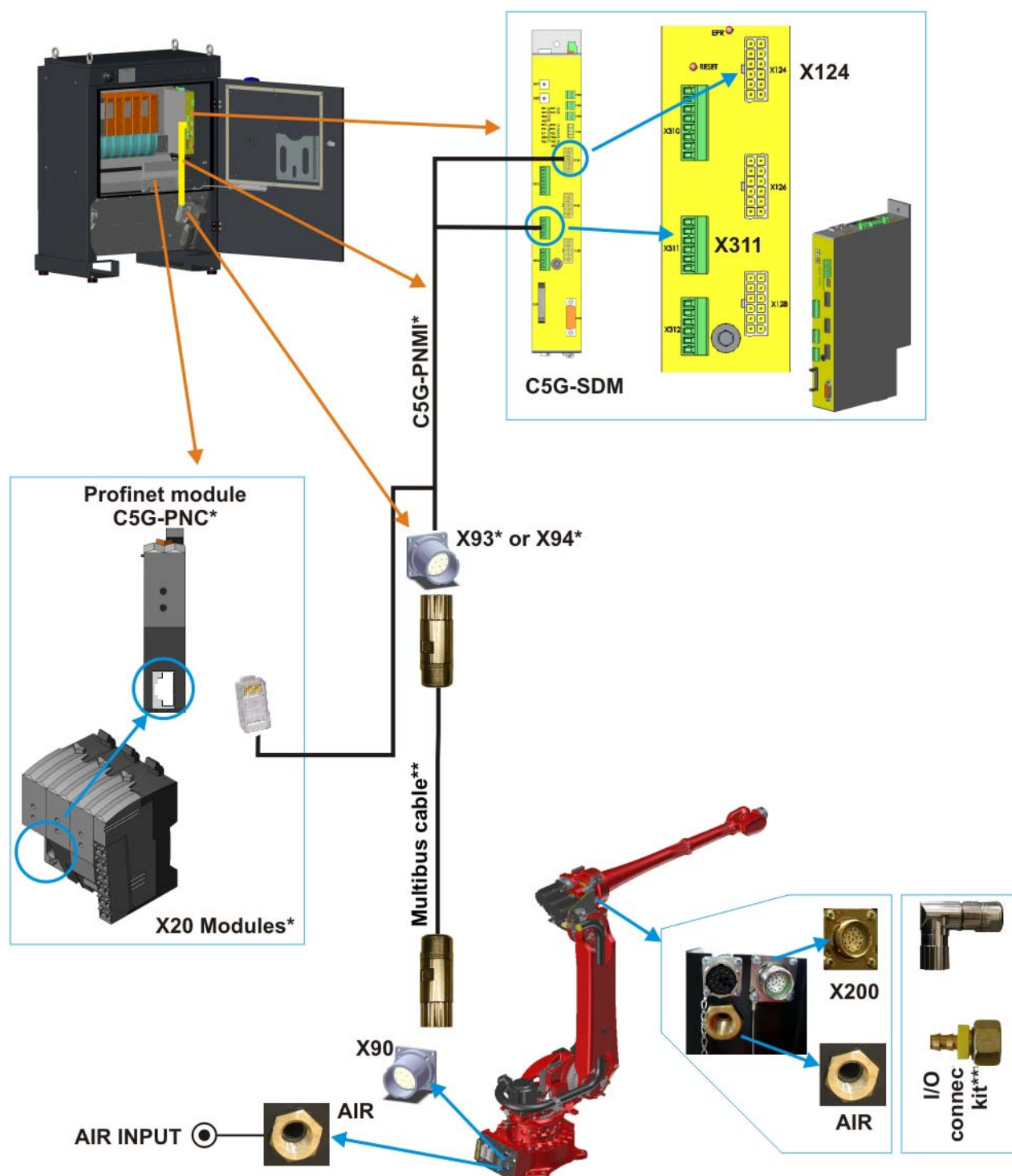
*** connector Kit and optional fittings

Tab. 6.3 - Structure of the Solution with I/O signals through DeviceNet Fieldbus

Item Fig. 6.3	Description	For details see
Optional components required		
C5G-DNM-DNMI	DeviceNet Master Interface module	"Technical Specifications C5G Control Unit" handbook
C5G-DNPC	Connector for DeviceNet Master modules	"Technical Specifications C5G Control Unit" handbook
C5G-DMI	Interface cable for DeviceNet modules	Chap.10. on page 133
I/O Connection Kit	I/O Connection Kit	par. 6.5.2.6
Multibus cable	Connection cable between C5G Control Unit and Robot	par. 6.5.2.7 par. 6.5.2.8
X20 Module	Fieldbus module on X20 interface	Chap.10. on page 133
X93 or X94	Multibus connector on cabinet base available after installing the C5G-DMI	Chap.10. on page 133
Standard components		
X90	Multibus connector on the Robot base	Chap.10. on page 133
X200	Multibus connector installed on a distribution panel	par. 6.5.2.4

6.5.2.3 Solutions with ProfiNet Fieldbus

Fig. 6.4 - ProfiNet principle diagram



*Optional components of the Control Unit

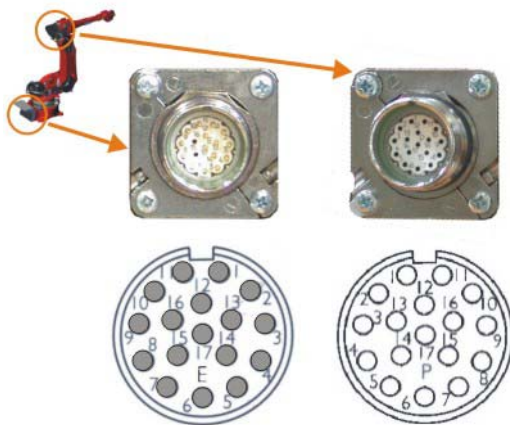
**Optional Multibus cable

*** connector Kit and optional fittings

Tab. 6.4 - Structure of the Solution with I/O signals through ProfiNet Fieldbus

Item Fig. 6.4	Description	For details see
Optional components required		
C5G-PNMI	Interface cable for Profinet modules	"Technical Specifications C5G Control Unit" handbook
C5G-PNC	Profinet interface module	"Technical Specifications C5G Control Unit" handbook
I/O Connection Kit	I/O Connection Kit	par. 6.5.2.6
Multibus cable	Connection cable between C5G Control Unit and Robot	par. 6.5.2.7 par. 6.5.2.8
X20 Module	Interface module	Chap.10. on page 133
X93 or X94	Multibus connector on cabinet base available after installing the C5G-PNMI	Chap.10. on page 133
Standard components		
X90	Multibus connector on the Robot base	Chap.10. on page 133
X200	Multibus connector installed on a distribution panel	par. 6.5.2.4

6.5.2.4 Bus connector pinout



- Connector for:
 - Fieldbus signals
 - 24 Vdc
 - KSR/HS3 *1
- female 17 crimping pin (on distribution panel axis 3)
- male 17 crimping Pins (on the Robot base)



Mating connectors in [par. 6.5.2.6 Mating connectors Kit X200 and AIR for Fieldbus solution Robot NJ \(optional\) \(16689780\) on page 68.](#)

Front view - Male connector

Front view - Female connector

Connector	PROFIBUS	DEVICENET	PROFINET
Pin out	Description	Description	Description
1	0 Vdc US1	0 Vdc US1	0 Vdc
2	0 Vdc US2	0 Vdc US2	0 Vdc
3	24 Vdc US2	24 Vdc US2	24 Vdc Safe
4	24 Vdc US1	24 Vdc US1	24 Vdc I/O
5	Ground	Ground	Ground
6	PROFIBUS B	Not used	Not used
7	Thermal probe input / Not Used *3	Thermal probe input / Not Used *3	TX-
8	Not Used	Not used	TX+
9	+ Vsec*2	+ Vsec*2	RX-
10	- Vsec*2	- Vsec*2	RX+
11	PROFIBUS A	Not used	Not used
12	KSR / HS3 + *1	KSR / HS3 + *1	KSR / HS3 + *1
13	Not Used	CAN_H	+ Vsec*2
14	Not Used	CAN_L	- Vsec*2
15	Reserved	Reserved	Not used
16	Reserved	Reserved	Not used
17	KSR / HS3 - *1	KSR / HS3 - *1	KSR / HS3 - *1

*1 The conductor assumes the definition of HS3 in case of HANDLING applications, and KSR in case of SPOT WELDING application.

*2 Signal is present only in case of SPOT WELDING applications of medium frequency with adaptive control of quality.

*3 The conductor assumes the definition "Thermal probe input" in case of SPOT WELDING application, and it is not used in other cases.

6.5.2.5 AIR fitting features on axis 3 Robot NJ



- Fitting to provide air to the devices installed on machine
- female threaded 1/2" GAS M22x1.5
- DN12 pipe
- maximum pressure supported by the pipe - 2 MPa (20 Bar)



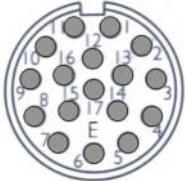
Mating connectors in [par. 6.5.1.3 X70 mating connector kit for NJ Robot I/O \(optional\) \(16657880\)](#) on page 56.

6.5.2.6 Mating connectors Kit X200 and AIR for Fieldbus solution Robot NJ (optional) (16689780)

The option consists of one multi-pin connectors and hose pipe fitting to wire the related connectors X200 (multibus) and AIR (compressed air) installed on Robot axis 3.



The connectors pinout corresponds to panel connectors installed on Robot axis 3 distribution panel.

X200 connector	
 Front view - Male connector	– Connector for: • I/O signals • 24 Vdc – male 17 pins crimp mating ASDA 034 MR04 59 0038 000 INTERCONTEC
AIR hose pipe fitting	
	– Hose pipe fitting to supply air to the devices installed on machine 07-001-13-8B AEROQUIP

6.5.2.7 Multibus cable

Purpose

The multibus cable is usually connected the C5G Control Unit and the Robot, transferring the Fieldbus signals, 24 Vdc power supply and other process signals.

Technical features and composition

The cable on the C5G side is provided with multi-pin connector with 17 pins to be connected to the CIP panel, to the X93 or X94 connector; the other outer end is for the Robot and it is provided with multi-pin X90 connector with 17 pins.

Tab. 6.5 - Multibus cable

Description	Comau Part No.
Multibus cable length 5 m (16.40 ft)	18567660
Multibus cable length 10 m (32.81 ft)	18567661
Multibus cable length 15 m (49.21 ft)	18567662
Multibus cable length 20 m (65.62 ft)	18567663
Multibus cable length 25 m (82.02 ft)	18567664
Multibus cable length 30 m (98.42 ft)	18567665
Multibus cable length 40 m (131.23 ft)	CR18567666

6.5.2.8 Multibus cable for Control Unit in B.R.I.C. configuration

Purpose

The multibus cable is usually connected the C5G Control Unit and the Robot, transferring the Fieldbus signals, 24 Vdc power supply and other process signals. In case of Control Unit in B.R.I.C. configuration, the multibus cable to be used has different features compared to standard multibus cable.

Technical features and composition

The cable on the side of C5G is equipped with cable gland and plates, and passes through the CIP panel without interruption. It finishes directly on the Fieldbus Modules installed inside the Control Unit, according to the signal or connector. The cable plate should be mounted on a drilled plate (e.g. C5G-APK2) to connect X42 connector; the other cable end designed on the Robot base is equipped with 17 multi-pin (X90) connector. In the following [Tab. 6.6](#) there are given the ordering codes of cables, depending on the length and the type of protocol supported.

Tab. 6.6 - Multibus cable for Control Unit in B.R.I.C. configuration

Description	Comau Part No.
C5G-PBC02 - Profibus-DP multibus cable 2 m length (6.56 ft), for B.R.I.C. Control Unit	CR17243467
C5G-PBC05 - Profibus-DP multibus cable 5 m length (16.40 ft), for B.R.I.C. Control Unit	CR17243468
C5G-MD2C5 - DeviceNet multibus cable 2,5 m length (8.20 ft), for B.R.I.C. Control Unit	CR17244561
C5G-MDC05 - DeviceNet multibus cable 5 m length (16.40 ft), for B.R.I.C. Control Unit	CR17244562
C5G-MDC10 - DeviceNet multibus cable 10 m length (32.81 ft), for B.R.I.C. Control Unit	CR17244563
C5G-MDC15 - DeviceNet multibus cable 15 m length (49.21 ft), for B.R.I.C. Control Unit	CR17244564
C5G-MDC25 - DeviceNet multibus cable 25 m length (82.02 ft), for B.R.I.C. Control Unit	CR17244565
C5G-MB2C5 - Profinet multibus cable 2,5 m length (8.20 ft), for B.R.I.C. Control Unit	CR17243460
C5G-MB2C05 - Profinet multibus cable 5 m length (16.40 ft), for B.R.I.C. Control Unit	CR17243461
C5G-MB2C10 - Profinet multibus cable 10 m length (32.81 ft), for B.R.I.C. Control Unit	CR17243462
C5G-MB2C15 - Profinet multibus cable 15 m length (49.21 ft), for B.R.I.C. Control Unit	CR17243463
C5G-MB2C20 - Profinet multibus cable 20 m length (65.62 ft), for B.R.I.C. Control Unit	CR17243464

7. ROBOT INTEGRATION PRINCIPLES

This chapter contains:

- Available solutions for installation
- Stresses on the supporting structure
- Determination of the axis 1 admissible stroke in case of angle mounting
- Solutions to integrate the Robot in production cells
- Modes and stopping distance of the Robot.

7.1 Available solutions for installation



Because of the considerable stresses discharged on the ground by the Robot and the need to have appropriate supporting surfaces, direct fixing to the floor/ceiling is not foreseen.

The Robot fixing surface must be horizontal.

Depending on the application and operating requirements, the Robot can be mounted on **floor** or on **ceiling** (inverted).

In both possible solutions, the Robot must always be mounted on a **supporting structure** interposed between the Robot base and the mounting surface.

Robot SMART5 version	Mounting Type	Available OPTIONS for installation	
		Optional solutions (available alternatives)	Matched Robot fixing components
NJ 40 - 2.5 In-line NJ 40 - 2.5 In-line Foundry NJ 40 - 2.5 off-set NJ 40 - 2.5 off-set Foundry	Floor *2	Levelling plate unit for Robot fixing (CR82362700) *1	Screws and pins kit for robot fastening (CR82362500)
		Non-levelling plate unit for Robot fixing (CR82362800) *1	
		Plate / Support provided by the integrator	
	Ceiling	Supporting structure with Robot mounting from below	Screws and pins kit for robot fastening (CR82362500)
		B.R.I.C. supporting structure with Robot mounting from above	NJ fixing on ceiling and fall-prevention unit - B.R.I.C. (CR82363000)
		Supporting structure provided by the integrator with Robot mounting from above	

*1 The units cannot be used simultaneously.

*2 The Robot can be installed on a maximum 45° inclined plane.

In addition a set of optional equipment is available:

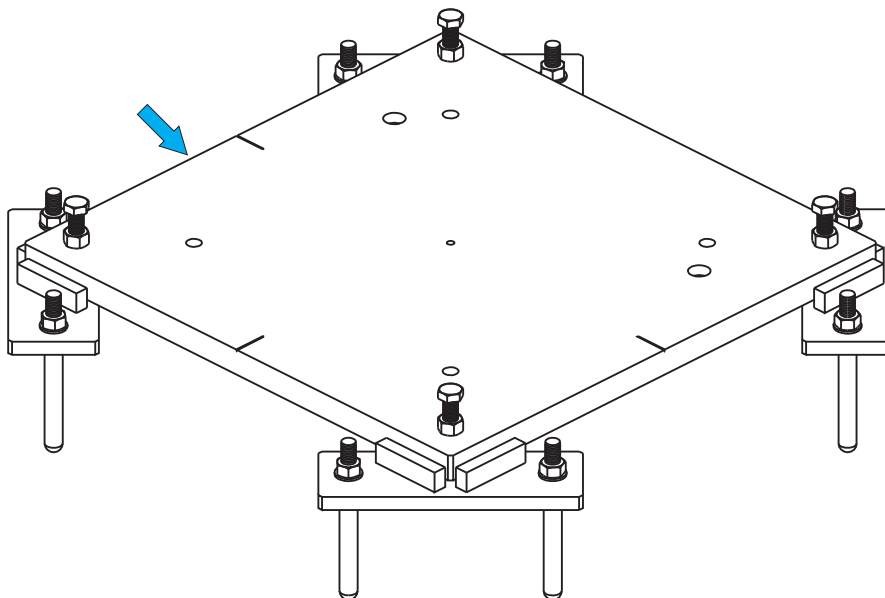
Robot SMART5 version	Mounting Type	Available OPTIONAL EQUIPMENT	
		Optional equipment	Notes
NJ 40 - 2.5 In-line	Floor *4	Protection unit distribution panel connections (CR82352200)*2	---
NJ 40 - 2.5 In-line Foundry		Fork unit (CR82363100)*3	---
NJ 40 - 2.5 off-set	Ceiling	Fork unit (CR82363100)*3	Compulsory
NJ 40 - 2.5 off-set Foundry			

*2 In case it is necessary to protect the connections on the Robot base.

*3 In case it is necessary to lift the Robot by means of lift truck

*2 The Robot can be installed on a maximum 45° inclined plane (do not use the fork unit).

7.1.1 Levelling plate unit for Robot fixing (CR82362700)



Purpose

The levelling plate option for Robot fixing allows to fix properly the Robot on the floor.

The unit allows to meet the following requirements:

- ensure a good flatness of the supporting surface in order to avoid abnormal stresses on the Robot base structure.
- possibility to get the Robot plumb and level to simplify the “off-line programming” applications.

Technical features and composition

The unit consists of:

- four steel plates to be fixed on the floor by means of chemical sleeve anchors (for a total of 8 sleeve anchors, which are not supplied).
- a levelling plate to be welded on the plates specified above after having reached the optimal Robot levelling condition, operating on the specific levelling screws.



The Fig. 7.1 shows the optional fixing plate which can be provided by Comau. Other solutions can be carried out by the installer as long as the stresses produced by the Robot and the resistance conditions of the fixing surface are verified (see [par. 7.2 Stresses on the supporting structure on page 86](#)).

To fix the Robot on the plate, the [Screws and pins kit for robot fastening \(CR82362500\)](#) option is available.

Limitations

- Use 1 plate to fix one Robot.
- To be used as an alternative to the [Non-levelling plate unit for Robot fixing \(CR82362800\)](#) or the supporting plate / structure provided by the integrator.

Fixing components

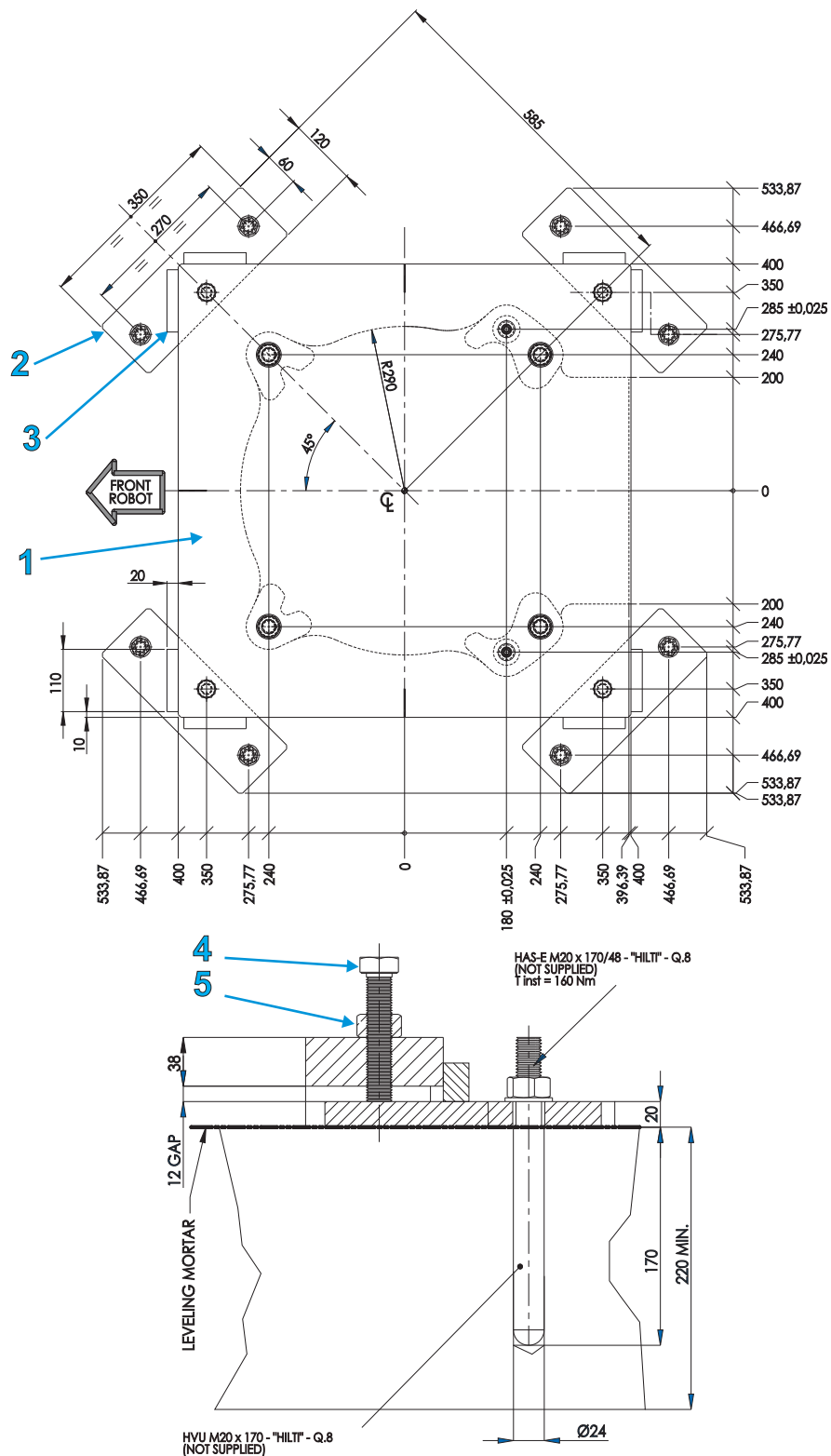
- Fully threaded hex head screw M20x100 (8.8)
- Hex nut M20-8 Fe/Zn 12-III - ISO 4032
- Chemical sleeve anchors (not supplied)

Installation components

- Self-levelling mortar

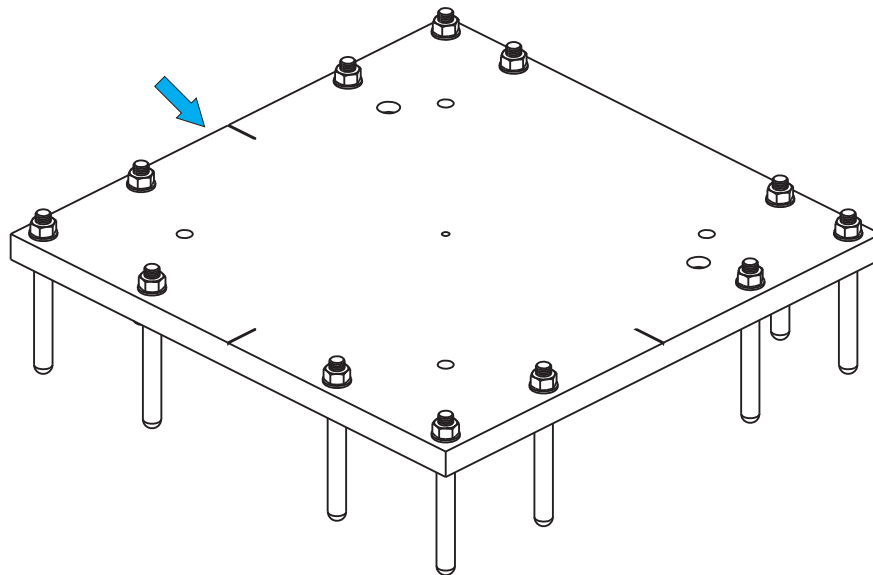
Weight

- About 220 kg (*440.92 lb*)



1. Levelling plate (q.ty = 1)
2. Plate (q.ty = 4)
3. Straight edge (q.ty = 8)
4. Hex head screw M20x100 (8.8) (q.ty = 4)
5. Hex nut M20-8 M20-8 Fe/Zn 12-III - ISO 4032 (q.ty = 4)

7.1.2 Non-levelling plate unit for Robot fixing (CR82362800)



Purpose

The non-levelling plate option for Robot fixing allows to fix properly the Robot to the ground.

Technical features and composition

The unit consists of a steel plate with holes for chemical sleeve anchors specific for fixing on the floor (for a total of 12 sleeve anchors not included in the supply).



The [Fig. 7.2](#) shows the optional fixing plate which can be provided by Comau. Other solutions can be carried out by the installer as long as the stresses produced by the Robot and the resistance conditions of the fixing surface are verified (see [par. 7.2 Stresses on the supporting structure on page 86](#)).

To fix the Robot on the plate, the [Screws and pins kit for robot fastening \(CR82362500\)](#) option is available.

Limitations

- Use 1 plate to fix one Robot.
- To be used as an alternative to the [Levelling plate unit for Robot fixing \(CR82362700\)](#) or the supporting plate / structure provided by the integrator.

Fixing components

- Chemical sleeve anchors (not supplied)

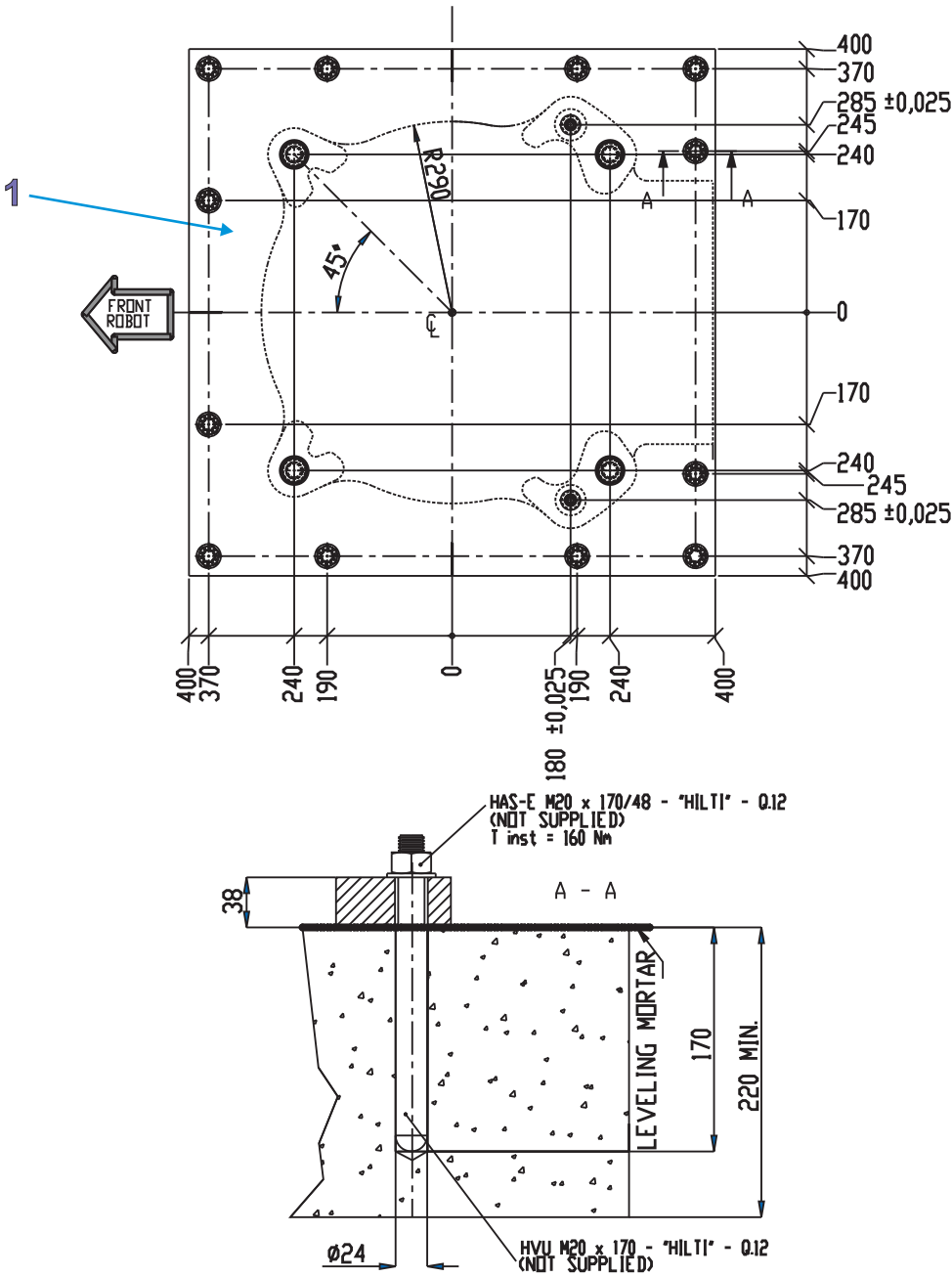
Installation components

- Self-levelling mortar

Weight

- About 220 kg (485 lb)

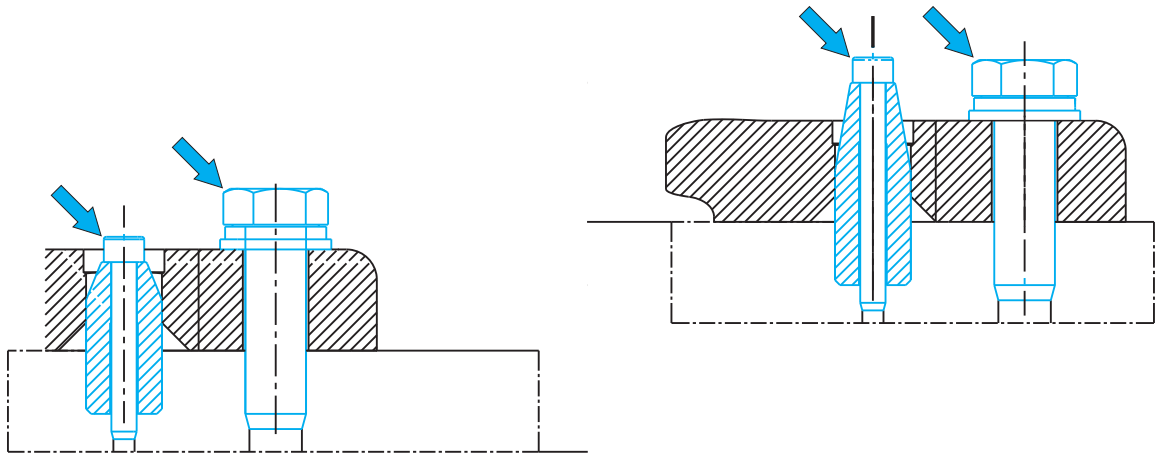
Fig. 7.2 - Option method of use diagram



Dimensions in millimetres

- 1. Plate (q.ty = 1)

7.1.3 Screws and pins kit for robot fastening (CR82362500)



Purpose

The screws and pins option for fixing the Robot allows the Robot proper fixing to the plate.

Technical features and composition

The unit consists of the screws and pins needed to secure the Robot to a steel plate provided with appropriate holes (see [par. 7.1.1](#) and [par. 7.1.3](#)).

The steel plate and its arrangement for fixing the Robot must be provided by the installer.

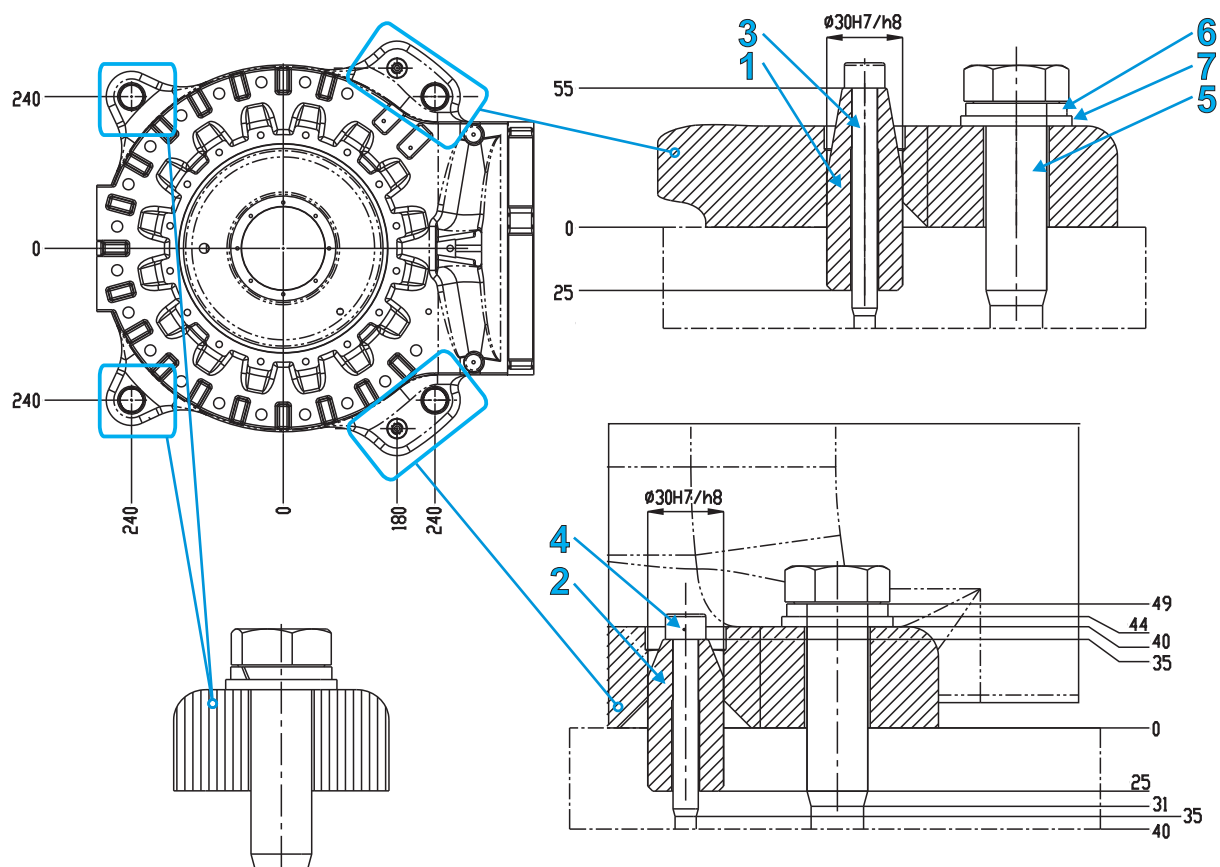
Limitations

- Use 1 unit to fix 1 Robot.

Fixing components

- Socket hex head screw M10x90 mm (8.8)
- Socket hex head screw M10x70 mm (8.8)
- Partially threaded hex head screw M24x80 mm (8.8)
- Split spring washer $\varnothing=24\text{mm}$
- Flat washer $\varnothing=24\text{ mm}$

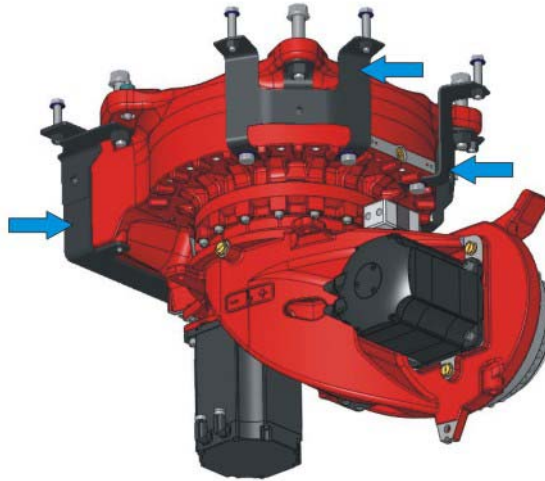
Fig. 7.3 - Option method of use diagram



Dimensions in millimetres

1. Centring pin $\varnothing=30$ mm L= 80 mm (q.ty = 1)
2. Centring pin $\varnothing=30$ mm L = 60 mm (q.ty = 1)
3. Socket hex head screw M10x90 (8.8) (q.ty = 1)
4. Socket hex head screw M10x70 (8.8) (q.ty = 1)
5. Partially threaded hex head screw M24x80 (8.8) (q.ty = 4)
6. Split spring washer $\varnothing = 24$ mm (q.ty = 4)
7. Flat washer $\varnothing = 24$ mm (q.ty = 4)

7.1.4 NJ fixing on ceiling and fall-prevention unit - B.R.I.C. (CR82363000)



Purpose

The fixing to ceiling and fall prevention option can be used in case of Robot inverted mounting to improve the supporting feature in case of accidental untightening of the standard fixing screws.

Technical features and composition

The units consists of robust steel brackets that are fastened to the front and back side of the base.

The supporting plate, which holds the Robot, shall be provided with drillings suitable for the screws described in the "Transport and installation" instructions handbook.



The Robot inverted mounting procedure with the indications of the screws tightening torque can be found in the Transport and Installation handbook of this Robot.

Limitations

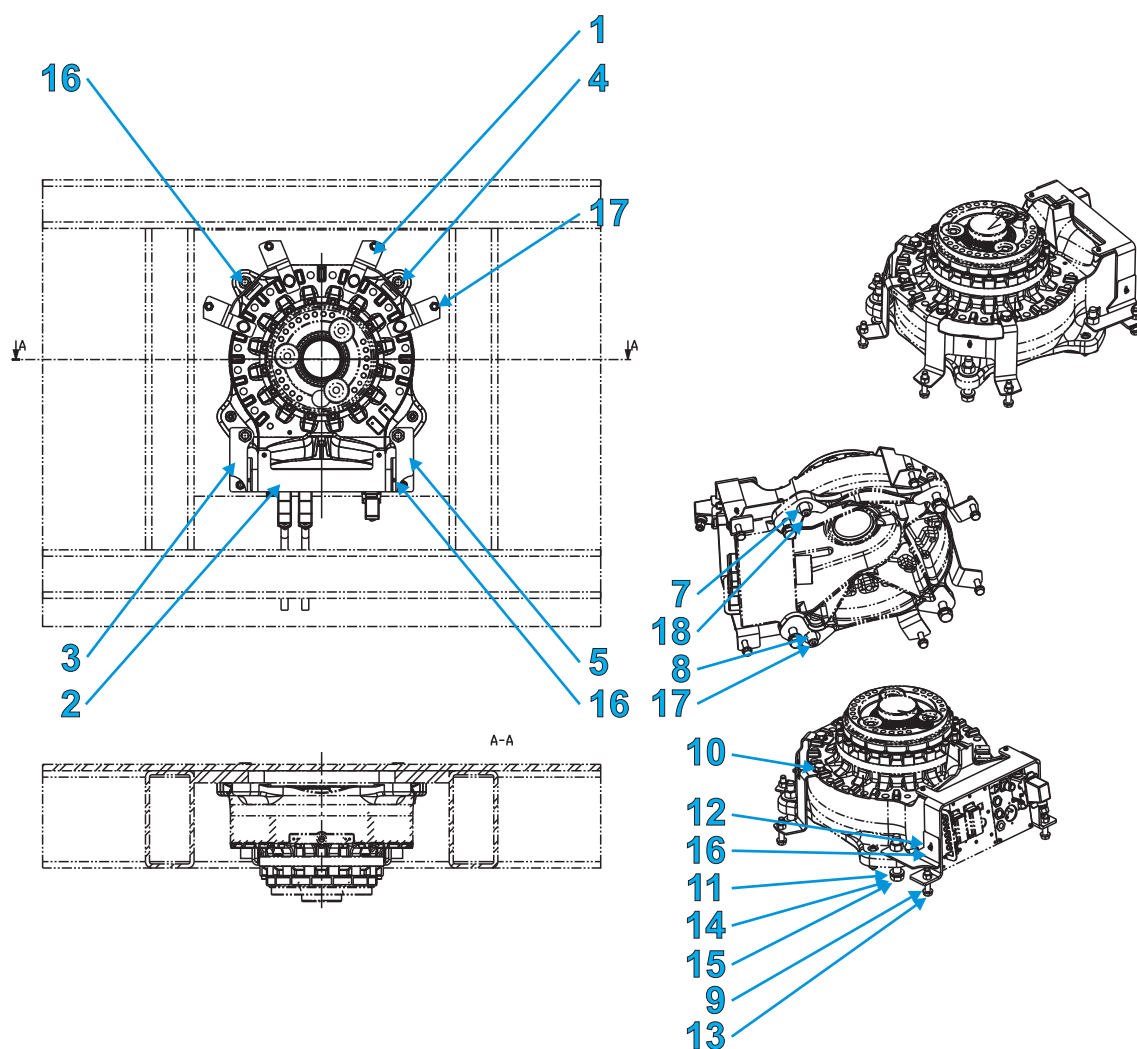
- Use no. 1 unit to fasten one Robot.

Fixing components

- Hex head screw M16x80 mm (8.8)
- Hex head screw M20x40 mm (8.8)
- Hex head screw M24x140 mm (8.8)
- Flat washer for M6 screw
- Flat washer for M16 screw
- Flat washer for M24 screw

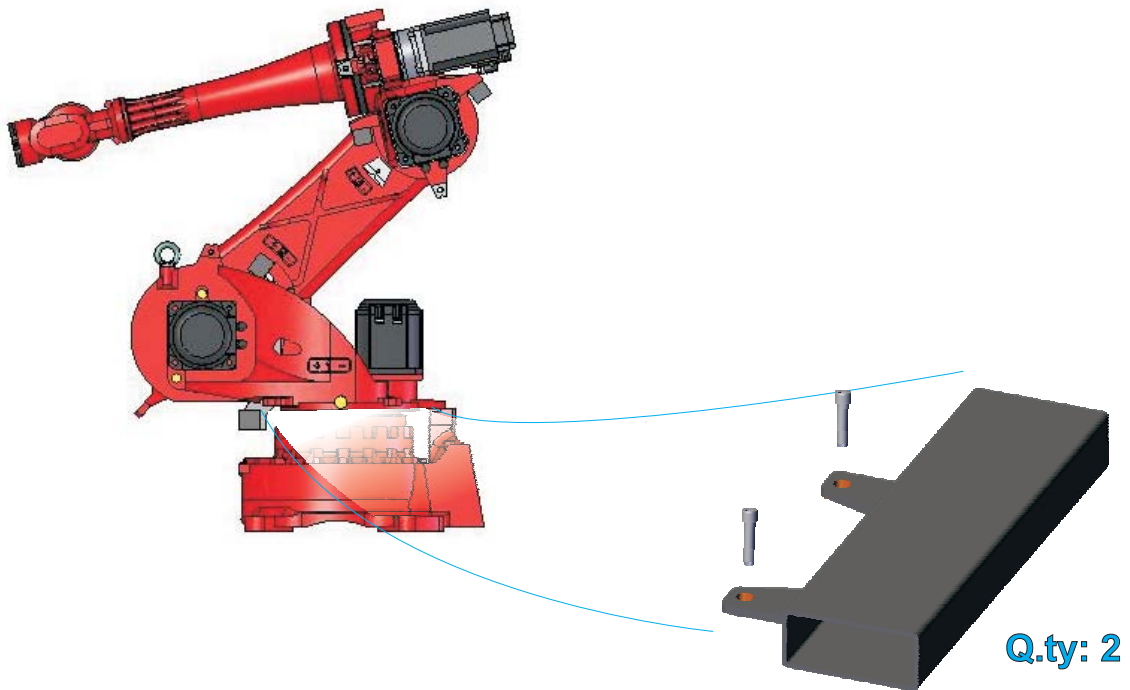
- Spring washer for M24 screw
- Socket hex head screw M6x16 mm (8.8)
- Socket hex head screw M10x70 mm (8.8)
- Socket hex head screw M10x90 mm (8.8)

Fig. 7.4 - Option method of use diagram



1. Bracket (q.ty = 2)
2. Bracket (q.ty = 1)
3. Bracket (q.ty = 1)
4. Bracket (q.ty = 2)
5. Bracket (q.ty = 1)
6. ---
7. Centring (q.ty = 1)
8. Centring (q.ty = 1)
9. Hex head screw M16x80 mm (q.ty = 6)
10. Hex head screw M20x40 mm (q.ty = 4)
11. Hex head screw M24x140 mm (q.ty = 4)
12. Flat washer for M6 screw (q.ty = 6)
13. Flat washer for M16 screw (q.ty = 6)
14. Flat washer for M24 screw (q.ty = 10)
15. Spring washer for M24 screw (q.ty = 4)
16. Socket hex head screw M6x16 mm
17. Socket hex head screw M10x70 mm
18. Socket hex head screw M10x90 mm

7.1.5 Fork unit (CR82363100)



To carry out the lifting using the fork unit, the Robot must be in transport position.

Purpose

The fork option is an option for Robot lifting by means of a lift truck.

This option is essential for Robot inverted mounting, as it allows to position the Robot properly using a lift truck with tilting forks.

Technical features and composition

The unit consists of:

- two rectangular electro-welded steel sections, that are fixed to the Robot column sides
- four fixing screws.

Inside the section bars are inserted the lift truck forks.



The fork unit is supplied with own EC marking and shall be subject to specific provisions for use and maintenance.

Before using the fork unit, read the usage instructions in the pertaining instruction handbook supplied with the unit.

Limitations

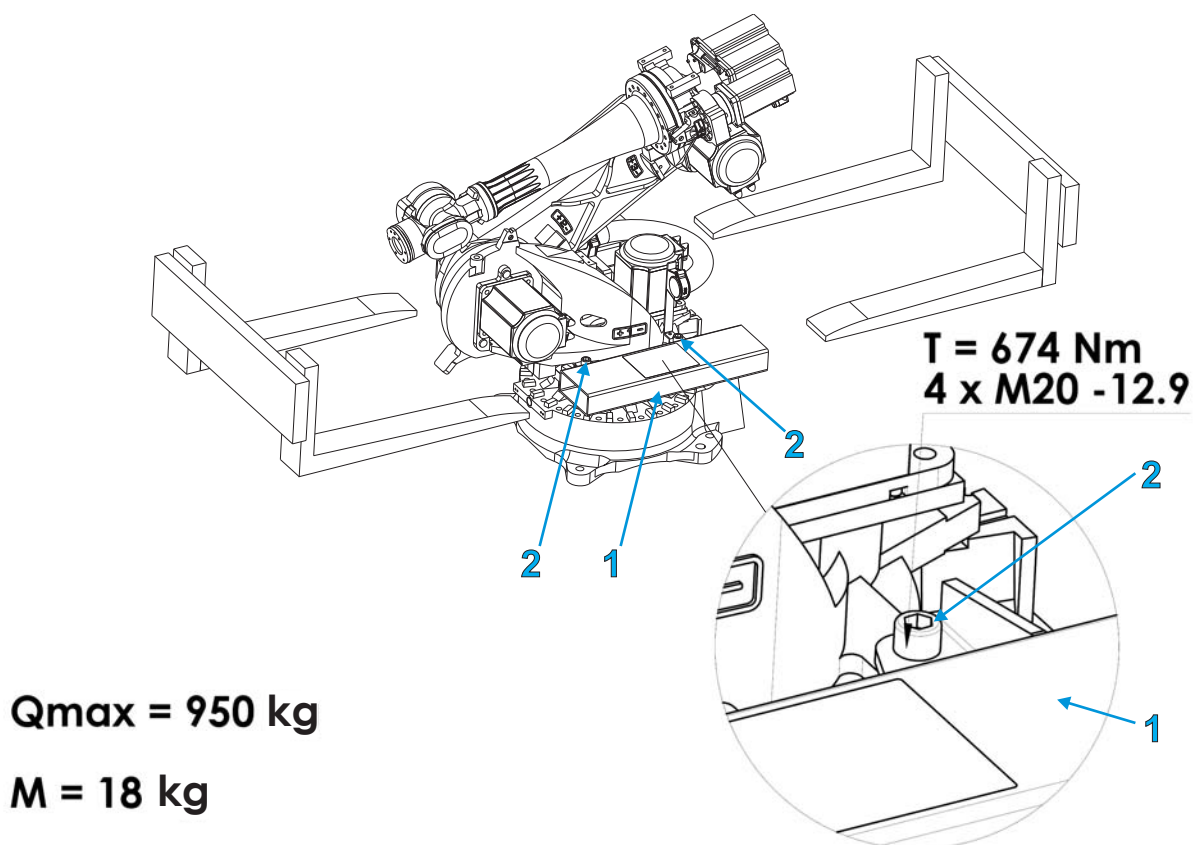
- Use 1 unit to lift 1 Robot.
- At the end of the lifting procedure, dismount the steel sections from the Robot body.

Fixing components

- Socket hex head screw M20x40 (12.9)

Weight

- 18 kg (39.68 lb)

Fig. 7.5 - Option method of use diagram

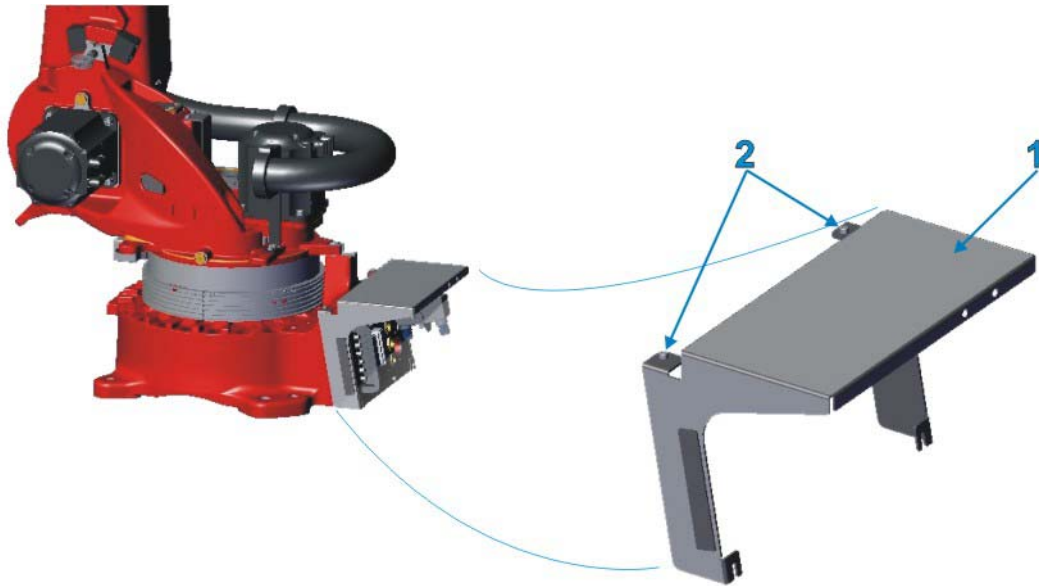
1. Steel section (q.ty = 2)
2. Socket hex head screw M20x40 (12.9) (q.ty = 4)

M = Option weight

T = Tightening torque of the fixing screws

Qmax = Max. capacity of the fork unit

7.1.6 Protection unit distribution panel connections (CR82352200)



1. Sheet guard (q.ty = 1)
2. Socket hex head screw M6x12 (8.8) (q.ty = 2)

Purpose

The option is used to protect all connectors of the Robot distribution panel.

Technical features and composition

The unit consists of:

- a robust sheet guard
- two fixing screws.

The sheet guard is fixed to the Robot base.

Limitations

- Use 1 unit for each Robot.

Fixing components

- Socket hex head screw M6x12 (8.8)

Weight

- About 3,6 kg (8 lb)

7.2 Stresses on the supporting structure



The possible vibrations transmitted by machines nearby the Robot installation area can reduce the precision and repeatability of the Robot motions.

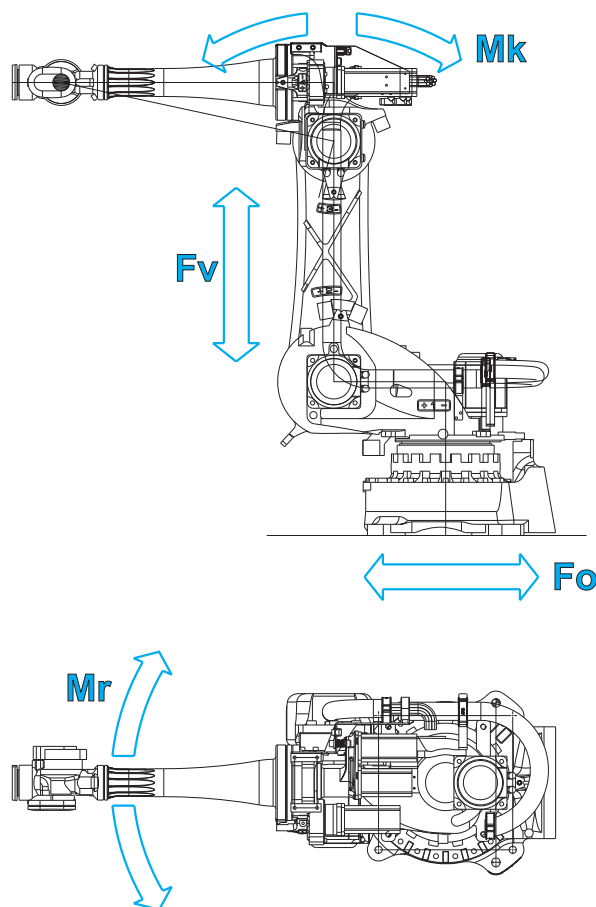
It is recommended to prepare a suitable foundation in order to reduce at minimum level the transmitted vibrations.

Because of the considerable stresses discharged to the ground by the Robot and the need to have appropriate supporting surfaces, direct fixing to the floor is not foreseen. The Robot fastening surface can be sloped maximum of 45°.

The values of the stresses generated by the Robot on the supporting structure on which it is mounted differ according to whether it is mounted on floor or inverted, as shown in the figure.

- [Fig. 7.6 - Stresses on the supporting structure with Robot mounted on floor on page 86](#)
- [Fig. 7.7 - Stresses on the supporting structure with Robot mounted inverted on page 87.](#)

Fig. 7.6 - Stresses on the supporting structure with Robot mounted on floor

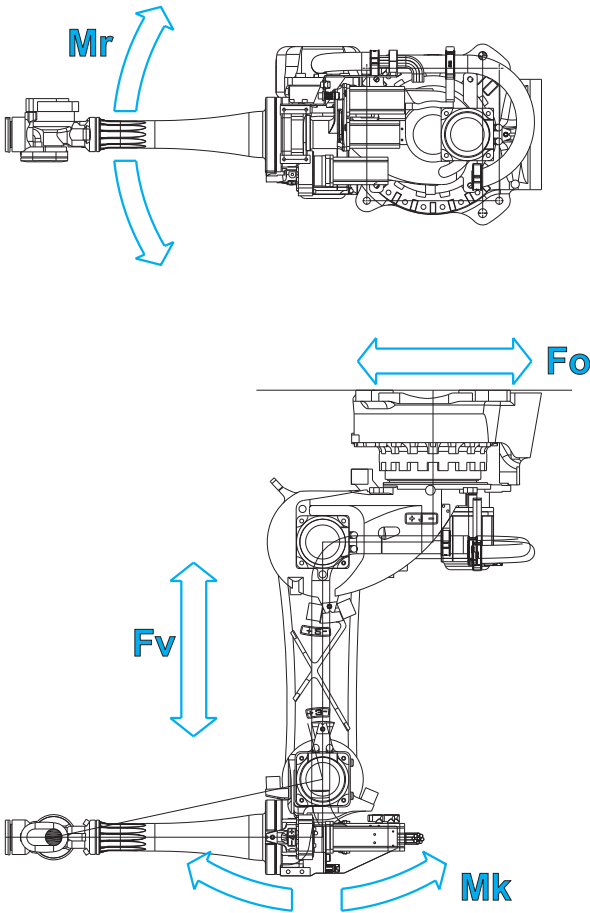




The picture represents the Robot with the In-line wrist version, but it is also valid with Off-set wrists version.

Robot SMART 5	Motion Type	Fv (N)	Fo (N)	Mr (Nm)	Mk (Nm)
NJ 40 - 2.5 In-line NJ 40 - 2.5 In-line Foundry	Accelerating	9000	4000	4000	12000
	Emergency braking	12000	8000	7000	22000
NJ 40 - 2.5 Off-set NJ 40 - 2.5 Off-set Foundry	Accelerating	9000	4000	4000	12000
	Emergency braking	12000	8000	7000	22000

Fig. 7.7 - Stresses on the supporting structure with Robot mounted inverted



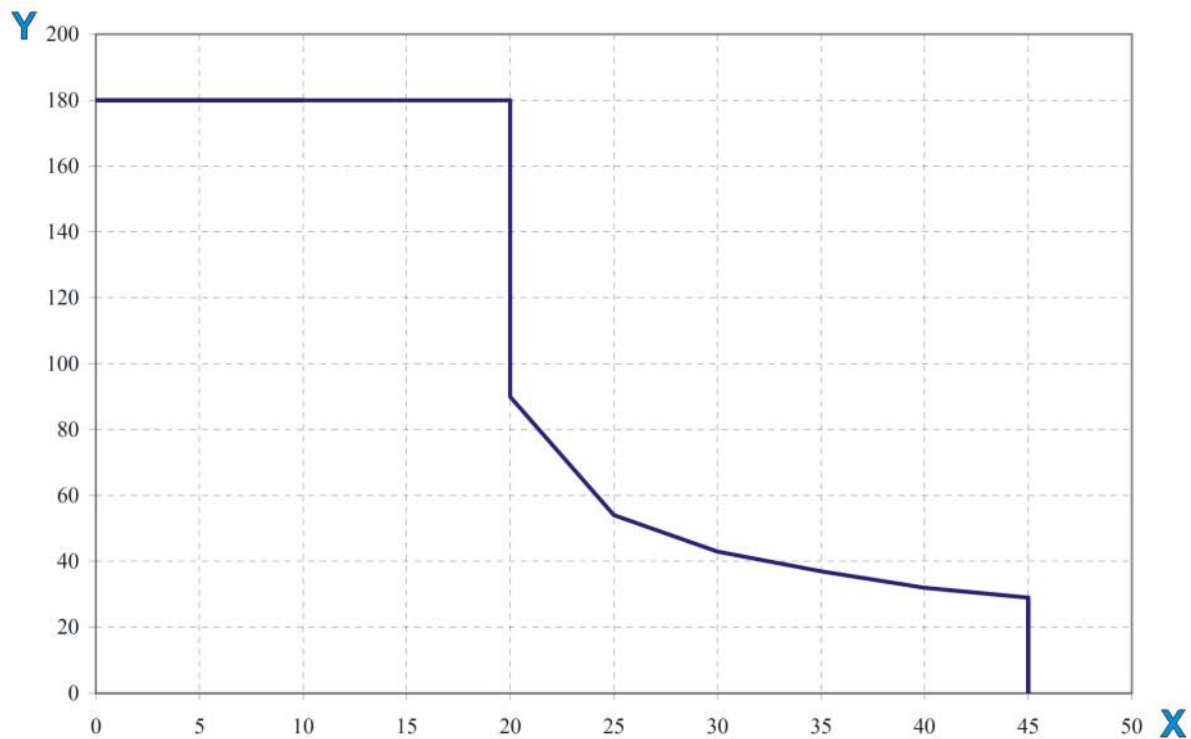
The picture represents the Robot with the In-line wrist version, but it is also valid with Off-set wrists version.

Robot SMART 5	Motion Type	Fv (N)	Fo (N)	Mr (Nm)	Mk (Nm)
NJ 40 - 2.5 In-line NJ 40 - 2.5 In-line Foundry	Accelerating	9000	4000	4000	12000
	Emergency braking	12000	8000	7000	22000

Robot SMART 5	Motion Type	Fv (N)	Fo (N)	Mr (Nm)	Mk (Nm)
NJ 40 - 2.5 Off-set NJ 40 - 2.5 Off-set Foundry	Accelerating	9000	4000	4000	12000
	Emergency braking	12000	8000	7000	22000

7.3 Determination of the axis 1 admissible stroke in case of angle mounting

In case of angle mounting of the Robot (max. admissible inclination 45°) it is necessary to determine axis 1 stroke according to the following diagram.



Y = Axis 1 semi-stroke (degrees)

X = Slope angle of the fixing surface of the Robot base (Degrees)

7.4 Solutions to integrate the Robot in production cells

To guarantee the minimum safety requirements of the Robot integrated in production cells, it is possible to limit the axes stroke, depending on the cell configuration and specific production needs.

The axis stroke limitation allows to avoid interferences with other machine parts and assure a safe area, usually the one where the operator works, during the motion trajectories of the Robot working cycle.

It is possible to install on the Robot a series of options to partialize its axes in safety areas, as shown in the following table.

Choose the most suitable solution considering the [Modes and stopping distance of the Robot](#) (see par. 7.5 on page 115).

Available solutions for areas limitation	Supply	Application	Type of intervention
Software stroke-end	Standard	Axis 1 Axis 2 Axis 3 Axis 4 Axis 5 Axis 6	Software *3

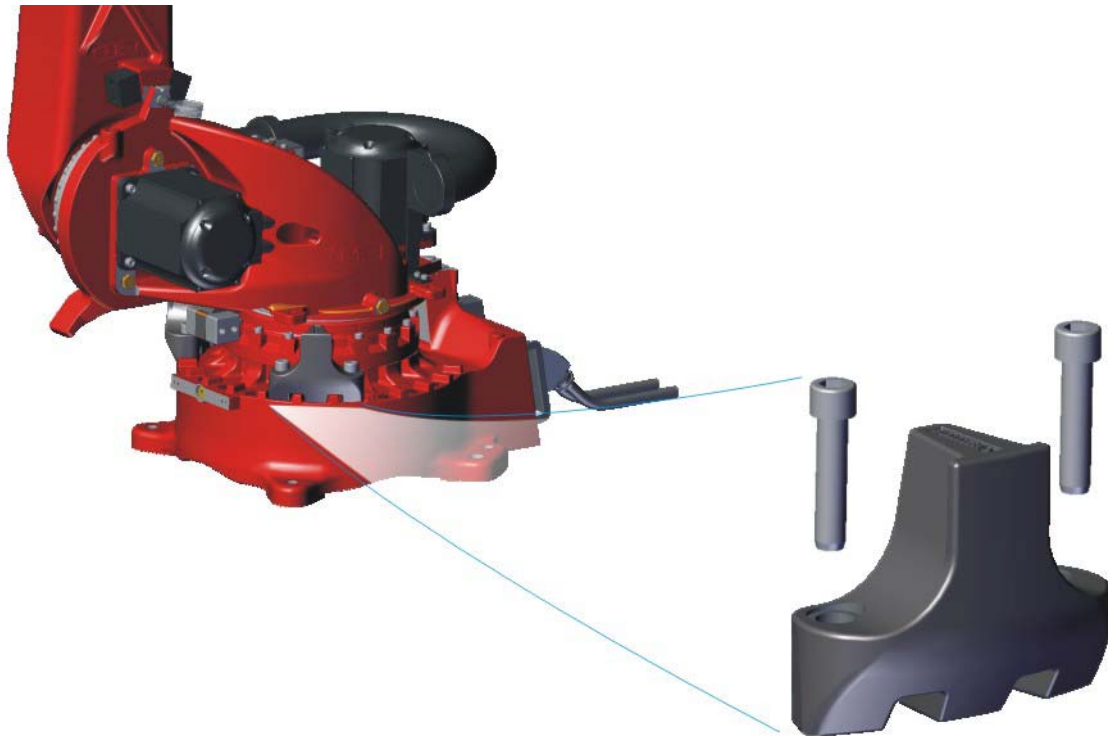
Available solutions for safety areas partialization	Supply	Application	Type of intervention
Axis 1 adjustable mechanical hard stop unit (CR82362100)	Optional	Axis 1	Mechanical *1
Axis 2 adjustable mechanical hard stop unit (CR82362200)		Axis 2	
Axis 1 On-Off mechanical hard stop unit (base RV260C) (CR82362900)		Axis 1	
Axis 1 workspace partialization unit - 3 areas (RV260C) (CR82362300)		Axis 1 (3 areas)	Electrical *2
Axis 2 workspace partialization unit - 2 areas (CR82362400)		Axis 2 (2 areas)	

Mechanical *1: Mechanical stop by means of stop buffer

Electrical *2: Detection of workspaces

Software *3: Detection of workspaces

7.4.1 Axis 1 adjustable mechanical hard stop unit (CR82362100)



Purpose

The adjustable mechanical hard stop of axis 1 limits the stroke of axis 1 in both work directions in steps of 15°.

Technical features and composition

The unit consists of two stop buffers to be fixed using the screws supplied, in the specific seats on the Robot base to limit the axis 1 stroke in both directions; in case it is necessary to limit the stroke in just one direction, only one of the two stops will be used. The axis 1 adjustable mechanical hard stop unit meets "man safety" requirements since it is able to absorb all the axis kinetic energy.



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

- stop buffer and fixing screws;
- rubber buffers on knocker and fixing screws.

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

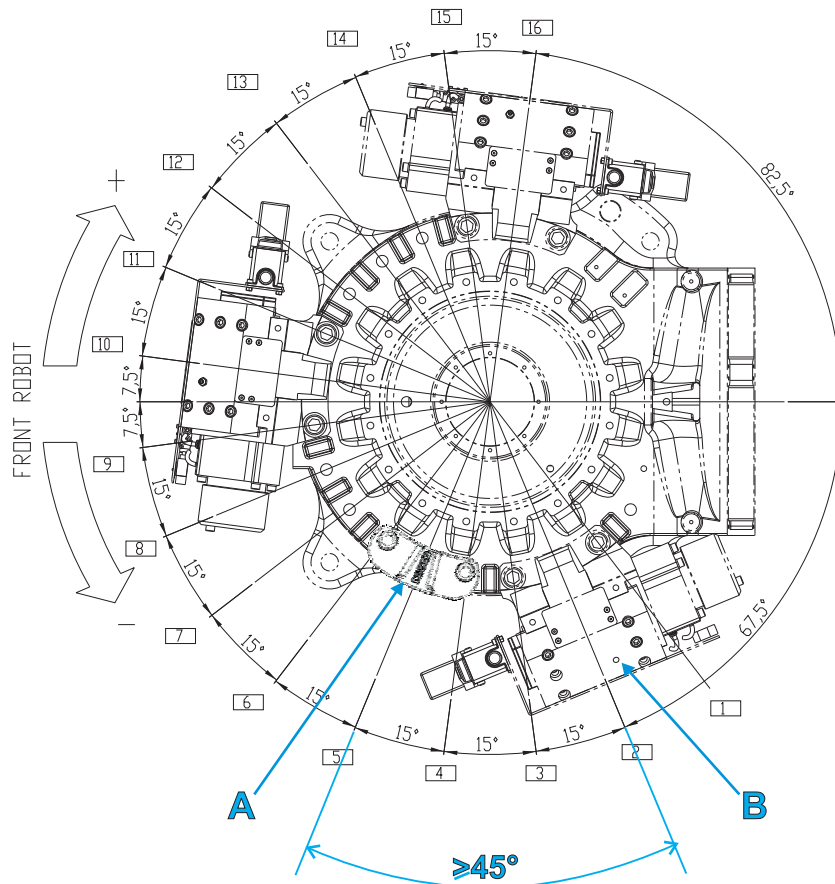
- the base in the area of unit fixing;
- the column in the area of knocker fixing;
- the equipment moved by Robot.

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

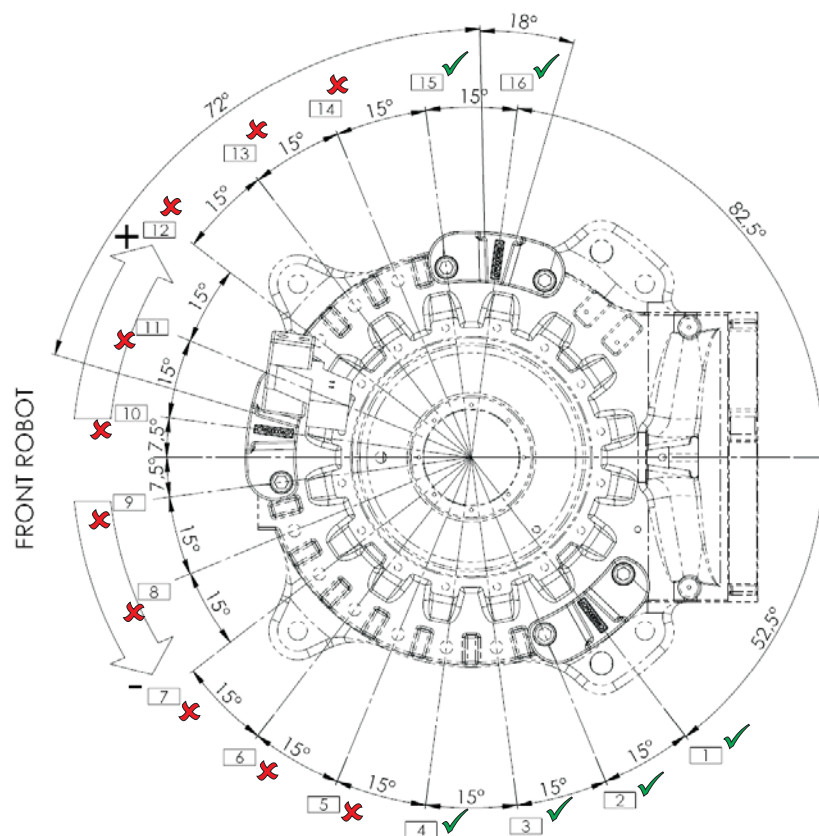
Limitations

- Use maximum 2 stop buffers for each Robot base.

- It can be used in combination to the option **Axis 1 On-Off mechanical hard stop unit (base RV260C) (CR82362900)**
- In case of use of the fixed stop buffers **A** together with the option **Axis 1 On-Off mechanical hard stop unit (base RV260C) (CR82362900) B**, consider that between the units it is necessary to maintain a minimum distance of 45°



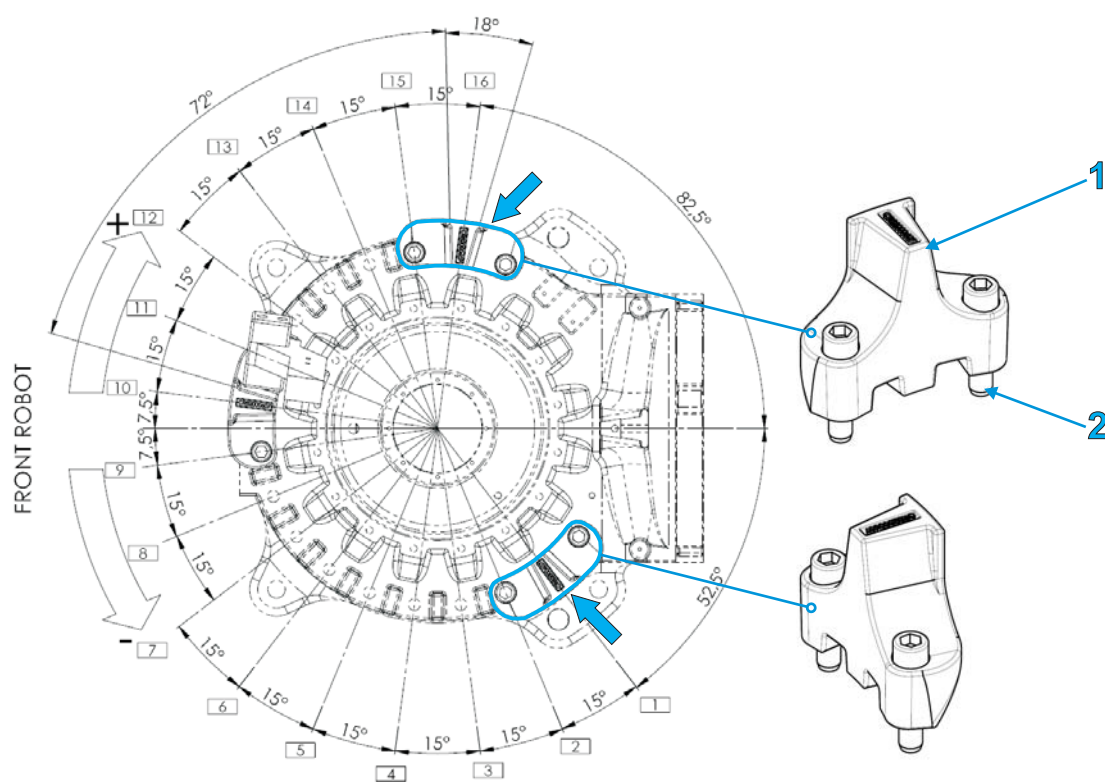
- In case of use of the fixed stop buffers **A** together with the option **NJ fixing on ceiling and fall-prevention unit - B.R.I.C. (CR82363000)**, consider to set the buffers in the positions **1, 2, 3, 4, 15, 16**.



Fixing components

- Socket hex head screw M20 x 90 (12.9).

Fig. 7.8 - Option method of use diagram



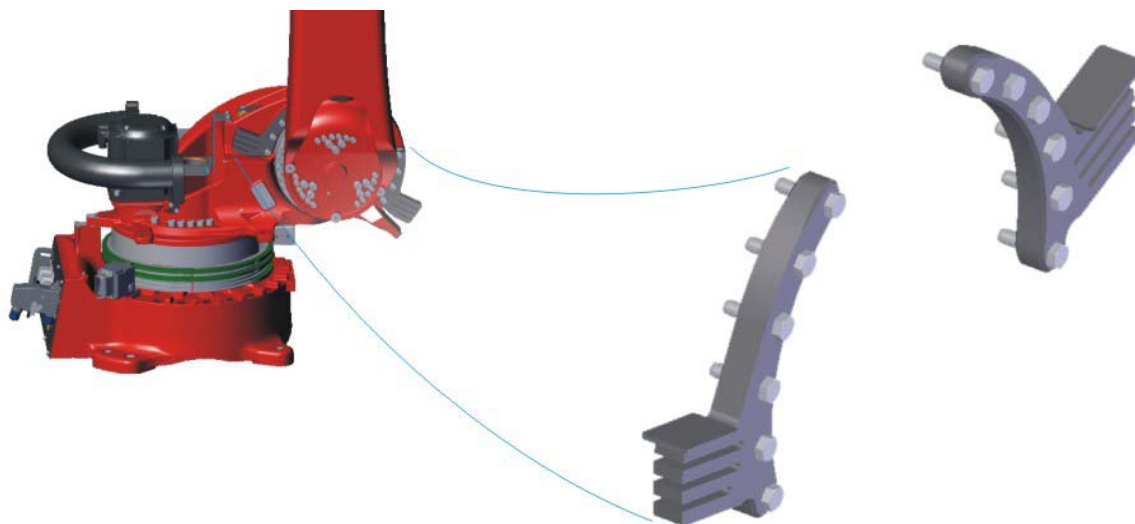
Dimensions in millimetres

1. Stop buffer Ax.1 (q.ty: 2)
2. Socket hex head screw M20 x 90-12.9 (q.ty: 4)

Tab. 7.1 - Stroke limitations that can be obtained

Axis 1 adjustable mechanical limitations				
Pos.	Ax.1 negative stroke		Ax.1 positive stroke	
	from [°]	to [°]	from [°]	to [°]
1	-125	-180	-130	+180
2	-110	-180	-115	+180
3	-95	-180	-100	+180
4	-80	-180	-85	+180
5	-65	-180	-70	+180
6	-50	-180	-55	+180
7	-35	-180	-40	+180
8	-20	-180	-25	+180
9	-5	-180	-10	+180
10	+10	-180	+5	+180
11	+25	-180	+20	+180
12	+40	-180	+35	+180
13	+55	-180	+50	+180
14	+70	-180	+65	+180
15	+85	-180	+80	+180
16	+100	-180	+95	+180

7.4.2 Axis 2 adjustable mechanical hard stop unit (CR82362200)



Purpose

The adjustable mechanical hard stop of axis 2 limits the stroke of axis 2 in both work directions in steps of 15° (25° for the rear hard stop position).

Technical features and composition

The unit consists of one set of 2 stop buffers to be interposed between the column structure and the rubber buffer already installed on the Robot.

The axis 2 adjustable mechanical hard stop unit fulfils “man safety” requirements as it is able to absorb all the kinetic energy of the axis.



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

- **stop buffers on column and rubber buffers on the arm**
- **fixing screws and buffers 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**
- **the equipment moved by Robot.**

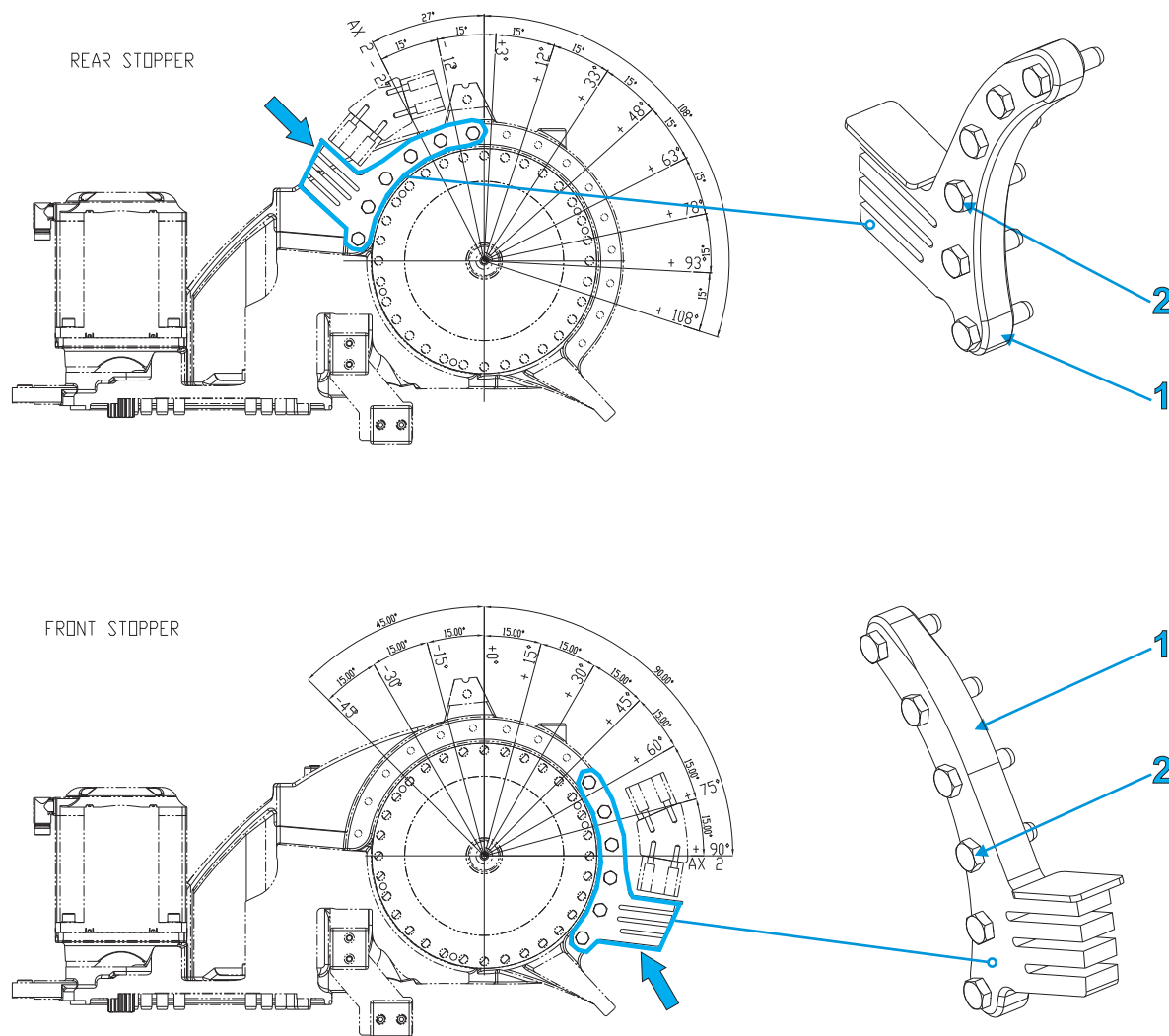
The failed replacement in case of impact will undermine the correct functioning (and therefore the Robot stopping) in case of later interventions.

Limitations

- Use maximum 2 stop buffers for each Robot.

Fixing components

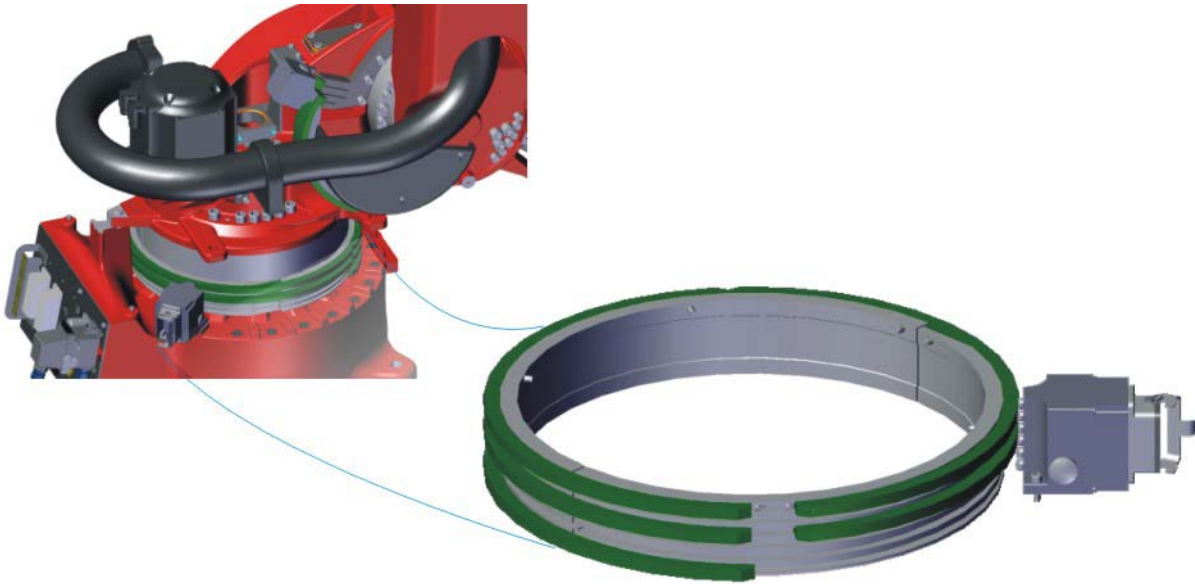
- Socket hex head screw M12 x 45 (12.9)

Fig. 7.9 - Option method of use diagram

Dimensions in millimetres

1. Stopper ax.2 (Q.ty 2)
2. Hex head screw M12 x 45 -12.9 (Q.ty 12)

7.4.3 Axis 1 workspace partialization unit - 3 areas (RV260C) (CR82362300)



Purpose

The axis 1 workspace partialization option allows to detect one or more workspaces of axis 1 through safe electrical signals, using a six push-button multiple electrical position switch with in order to monitor up to 3 workspaces.

Technical features and composition

The unit consists of:

- one multiple mechanical hard stop with push-buttons with Harting connector
- a support for cam holder
- a cam holder
- one set of plastic cams
- one mating connector.

Cams must be cut according to the length required for the application. Therefore, they are to be inserted, positioned and locked on two cam holders fastened to the Robot column instead of the protection guard.

The mating connector, present on the position switch, allows to connect the contacts directly on the safety circuits of the entire cell (integrator task).



Connect the limit hard stops so that the given command, after leaving the monitored area, result in emergency stop.

On this purpose use the safety signals in input to the C5G control unit.

In addition consider also [Modes and stopping distance of the Robot](#).

The versatility of the tracks and contacts number allows to implement the solution that the integrator considers suitable on behalf of the safety category required.

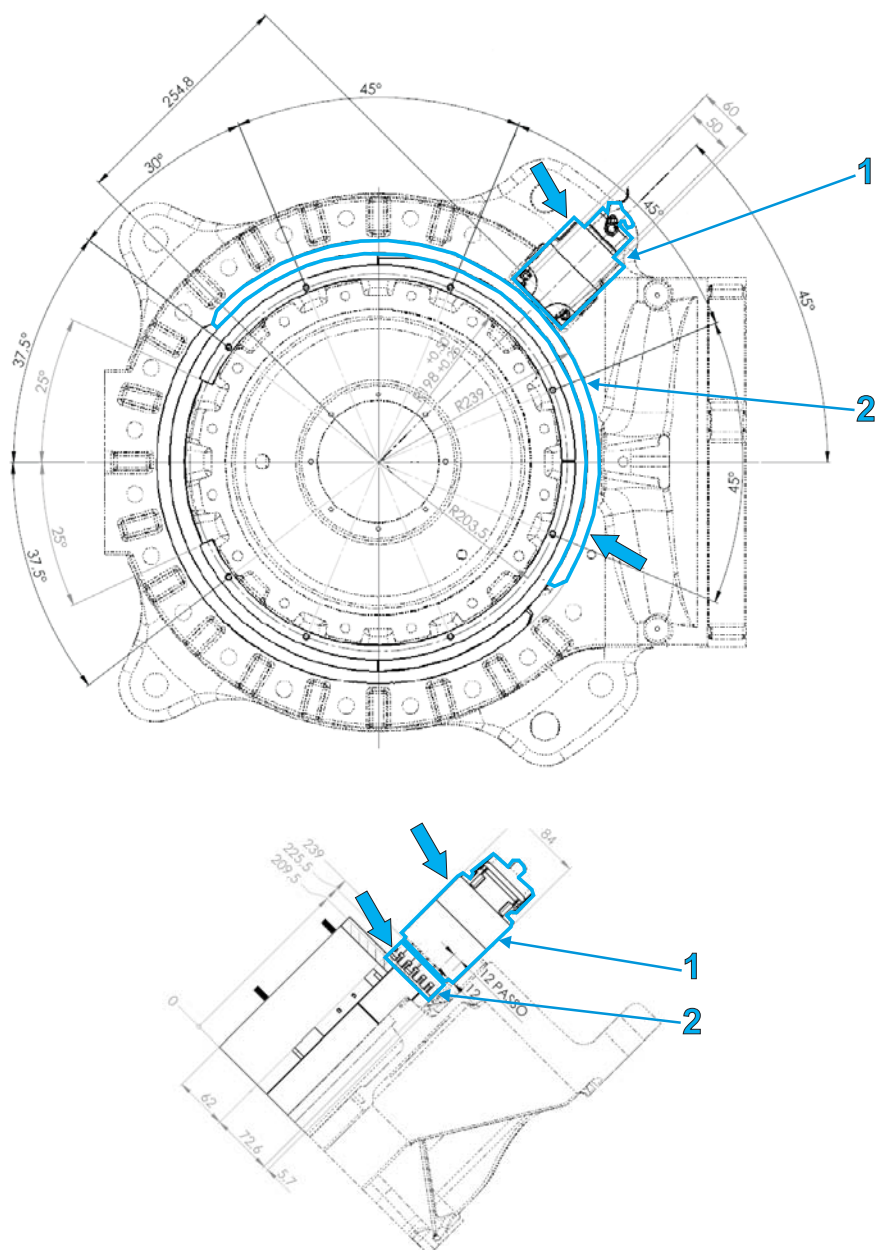
Limitations

- Use maximum 1 unit for each Robot.

Fixing components

- Headless screw M6x12 mm (8.8)
- Socket hex head screw M6x20 mm (8.8)
- Hex socket stub screw M6x10 - 8.8 ISO 7984
- Socket hex head screw M6x70 - 8.8 ISO 8734
- Dowel pin diam. 4x20
- Nut M6 - CH9

Fig. 7.10 - Option method of use diagram

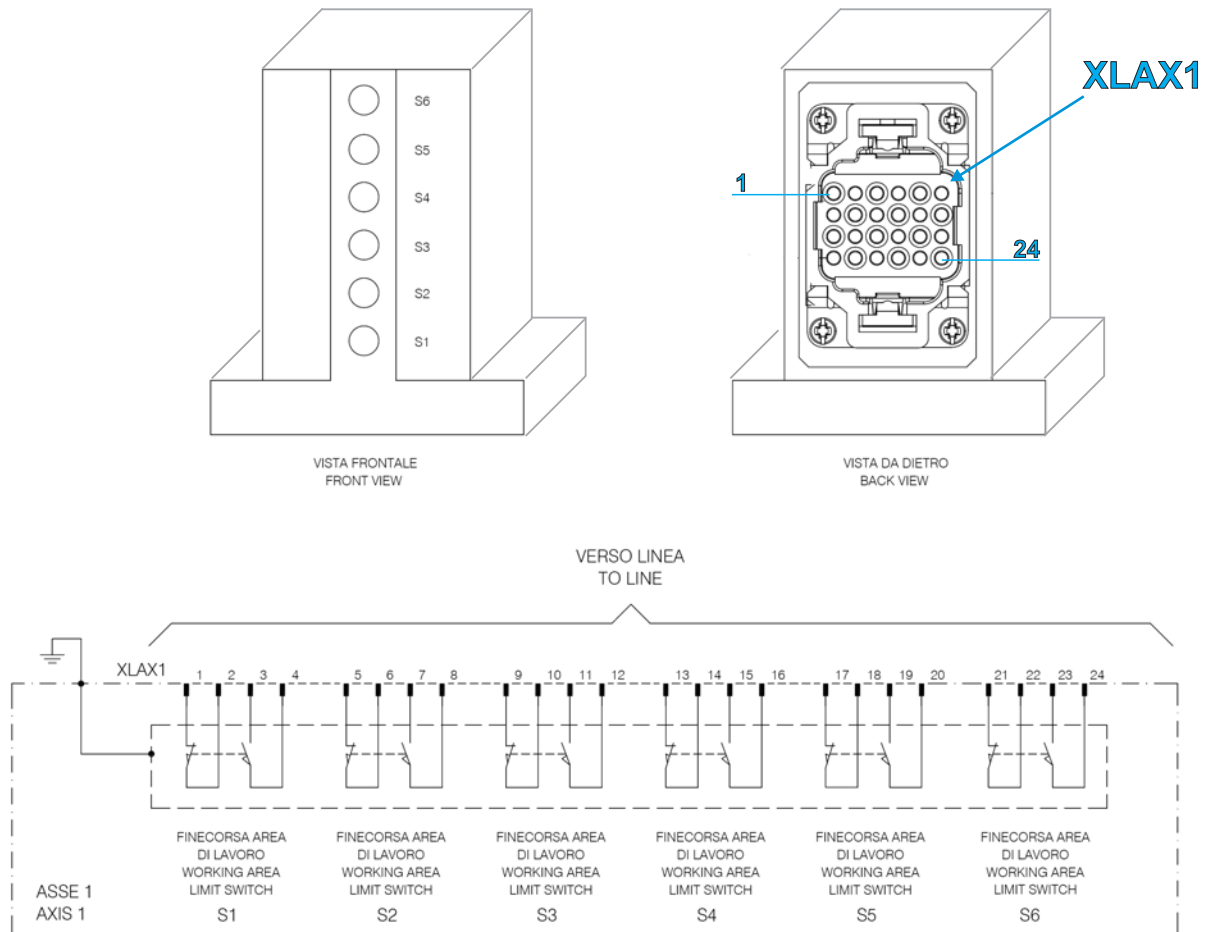


Dimensions in millimetres

1. Multiple electrical position switch with push-buttons
2. Cam

Connection diagram

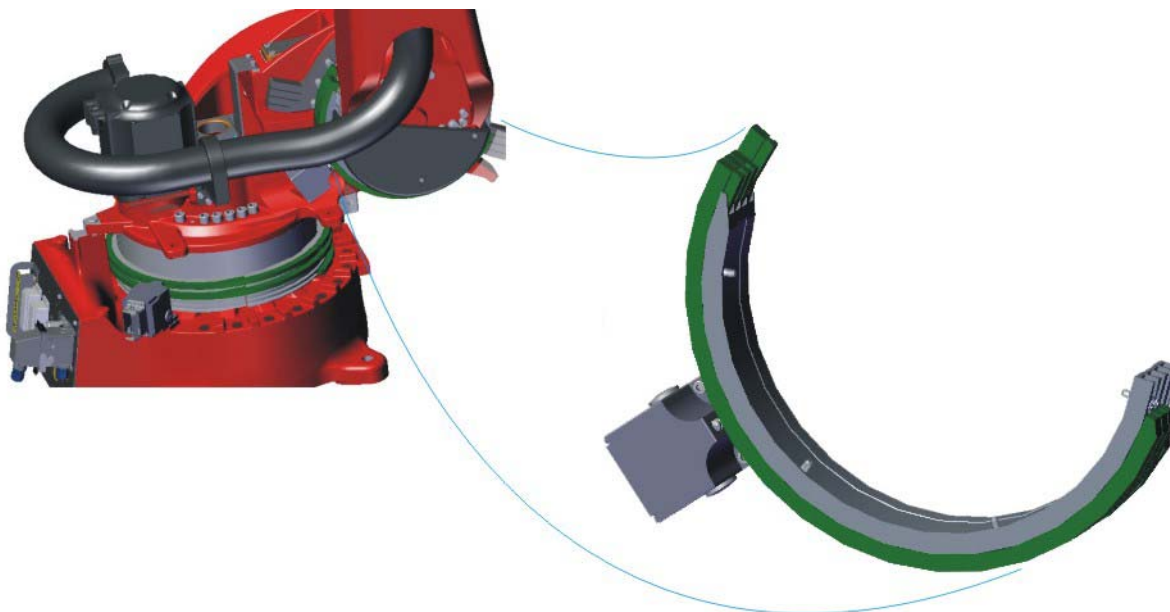
The electric connection of the electrical position limit switch is performed using a 24-pins HARTING connector.



Tab. 7.2 - Characteristics of the position switch contacts

ELECTRICAL DATA	
Switch type	BSE 85 for DIN EN 60204-1
Type of contacts	with positive opening
Insulation	C unit (VDE 0110)
Maximum voltage	50 Vac
Maximum power supply	2 A
Minimum load	≥ 20 mA
Contact resistance	< 40 m Ω
Power supply interruption	2 A, $\cos \varphi = 0,8$

7.4.4 Axis 2 workspace partialization unit - 2 areas (CR82362400)



Purpose

The axis 2 workspace partialization option allows to detect one or two workspaces of the axis 2 through safe safety signals, using an electrical position switch, in compliance with the most restrictive safety standards.

Technical features and composition

The unit consists of:

- a multiple 4-button electrical position switch with output on cable gland,
- a support for cam holder
- a cam holder
- a set of plastic cams to be cut to the length required for the specific application.
- one mating connector.

The cams must be inserted and blocked on the cam holders fastened to the Robot by means of the specific supports.

The mating connector allows the connection between the electrical position switch and the safety circuits of the complete cell (by the integrator), directly on the X42/DS connector on the Robot base.



Connect the position switch so that the given command, after leaving the monitored area, result in emergency stop.

On this purpose use the safety signals in input to the C5G control unit.

In addition consider also [Modes and stopping distance of the Robot](#).

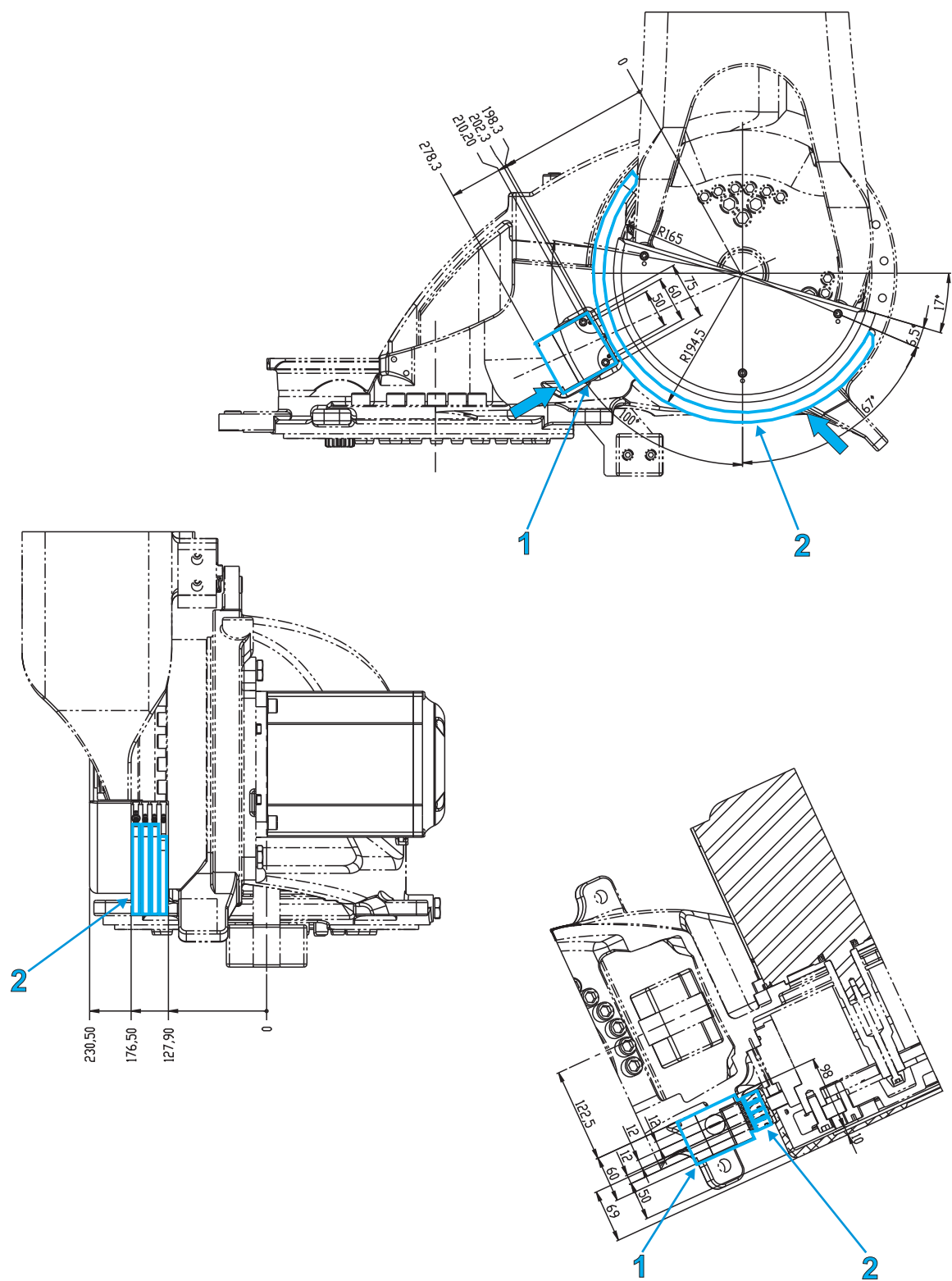
Limitations

- Use maximum 1 unit for each Robot.

Fixing components

- Headless screw M6x12 mm (8.8)
- Socket hex head screw M6x20 mm (8.8)
- Hex socket stub screw M6x10 - 8.8 ISO 7984
- Socket hex head screw M6x12 - 8.8 - ISO 4762
- Cylindrical slotted pan head screw M3x10 - 8.8 - DIN 84
- Dowel pin diam. 4x24

Fig. 7.11 - Option method of use diagram



Dimensions in millimetres

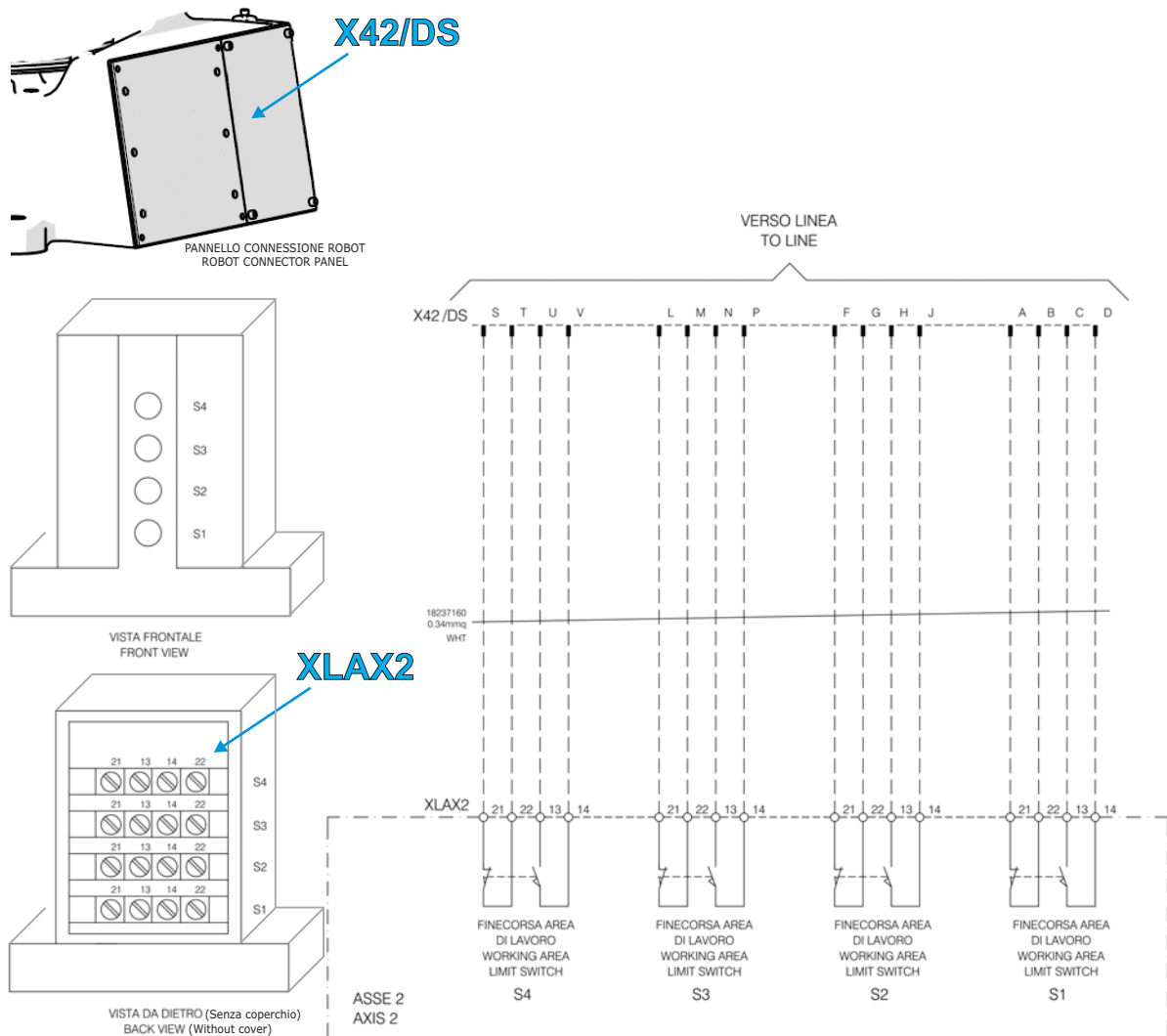
- 1. Multiple position switch with push-buttons
- 2. Cam

Connection diagram

The kit includes:

- 1 connector (supplied by FCI) 19 pins, type UTG1619SN;
- No. 19 crimping female contacts, SC20ML-1S6 type for wires from AWG 20;
- No. 1 cable clamp with PG16 (for cables from $\varnothing 8 \text{ mm}^2$ a $\varnothing 16 \text{ mm}^2$).

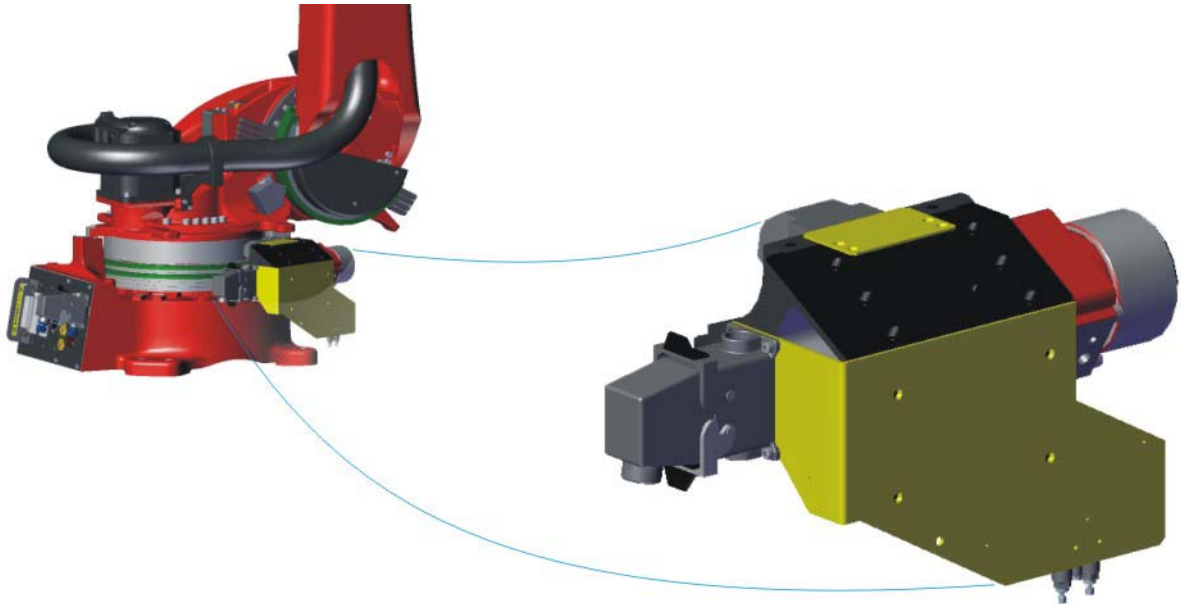
To crimp the female pins onto the wires from AWG 20 it is recommended to use the FCI “crimping tool” of Y14MTV or Y16SCM2 type.



Tab. 7.3 - Characteristics of the position limit switches contacts

ELECTRICAL DATA	
Switch type	BSE 85 for DIN EN 60204-1
Type of contacts	with positive opening
Insulation	C unit (VDE 0110)
Maximum voltage	50 Vac
Maximum power supply	2 A
Minimum load	≥ 20 mA
Contact resistance	< 40 m Ω
Power supply interruption	2 A, $\cos \varphi = 0,8$

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



Purpose

Axis 1 on-off mechanical hard stop option can be used to enable the temporary partialization of the Robot workspace and can be positioned on the entire stroke of the axis 1 with steps of 15°, as shown in the diagram [Fig. 7.12](#).

The partialization is obtained by means of a movable mechanical pin that operates on the stroke of Robot axis 1 as mechanical stop buffers (see [par. 7.4.1](#)).

Technical features and composition

The unit consists of a mechanical lockout pin and a stop block to be fixed in the provided coupling surfaces of the Robot base. The plug allows to fix the lockout pin also in the base sector where the hard stop included in the area partialization unit is fixed, maintaining the step constant.

The lockout pin is triggered by a pneumatic rotary actuator and is equipped with safety limit switch and electrically-controlled solenoid valves.

Fitted in the context of appropriate cell safety devices (safety PLC, optional safety barriers, etc.) the on-off mechanical hard stop unit allows reaching a complete "man safety" condition; the lockout pin must be necessarily controlled by a safety system controlling the Robot position.



Safety contacts present in the option must be integrated (by the integrator) in the safety circuit that manages the access authorizations in the restricted area.

The integration of information on safety and physic Robot position may be necessary using the option [Axis 1 workspace partialization unit - 3 areas \(RV260C\) \(CR82362300\)](#).

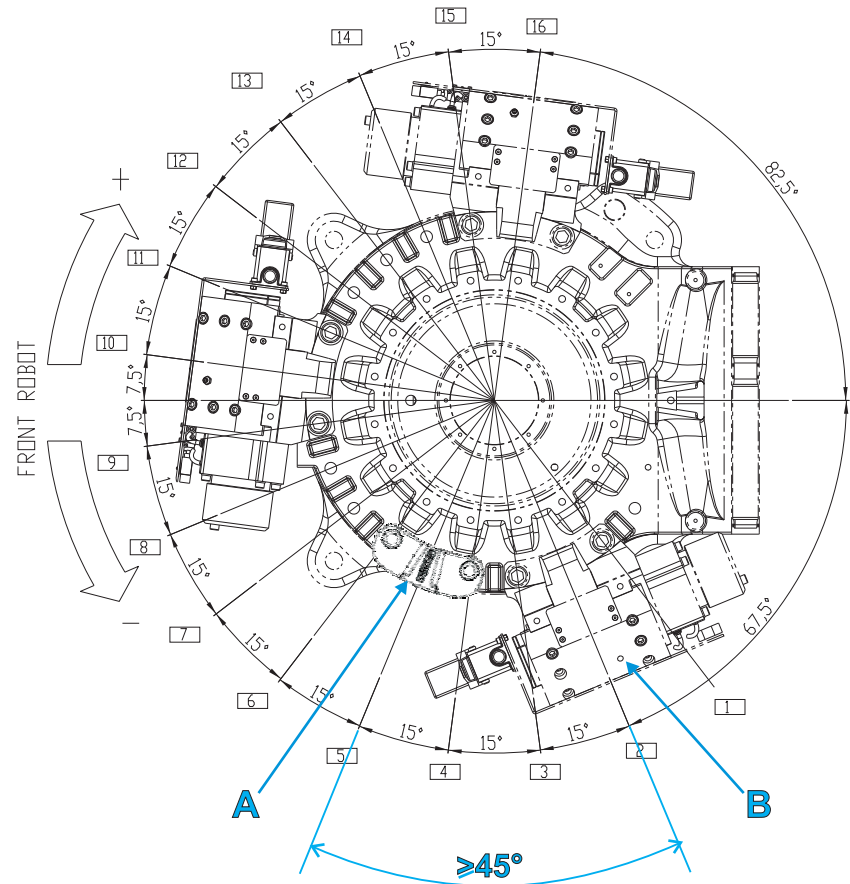
After maintenance interventions or mechanical impacts it is necessary to check the proper functioning of the unit and the lock of the fixing screws.

Avoid the overhaul and/or replacement of some unit items; it is recommended to replace always the entire unit.

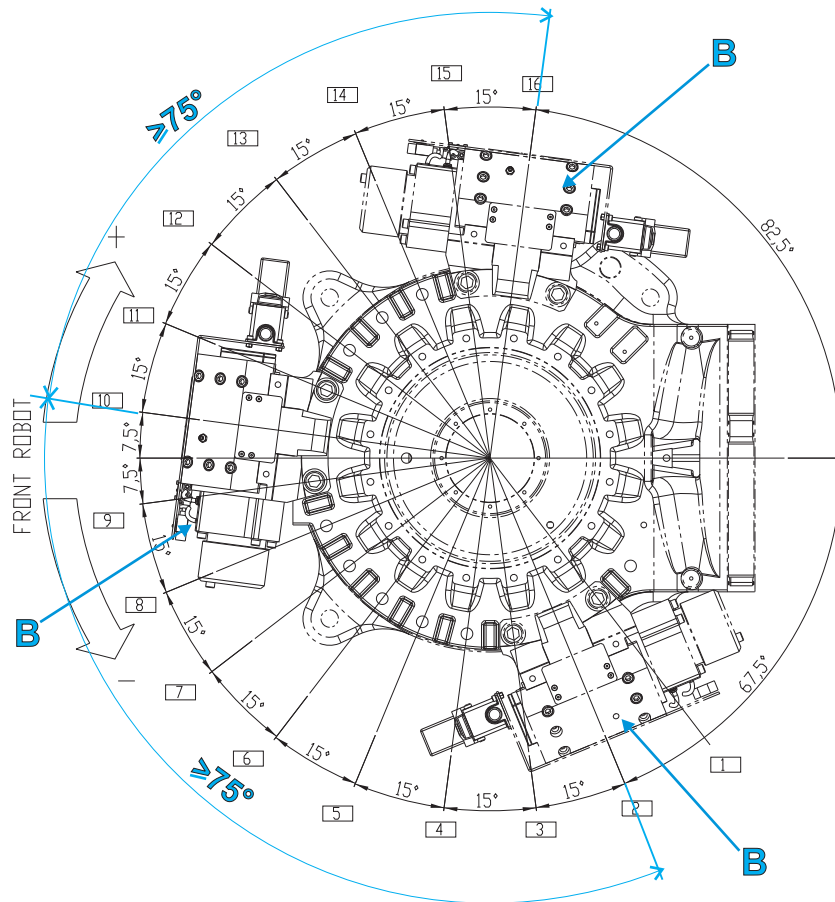
Limitations

- It can not be used in case of Robot inverted mounting and use of the unit [NJ fixing on ceiling and fall-prevention unit - B.R.I.C. \(CR82363000\)](#)
- It can be necessary to carry out the electrical partialization
- It can be used in combination to the option [Axis 1 adjustable mechanical hard stop unit \(CR82362100\)](#)

- In case of use of the lock pin unit **B** together with the option **Axis 1 adjustable mechanical hard stop unit (CR82362100) A**, consider that among the units it is necessary to maintain a minimum distance of 45°



- In case more than one lockout pin units **B** are used, consider that between the units it is necessary to maintain a minimum distance of 75° (overall mechanical limit for being able to position them properly)

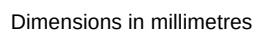


Fixing components

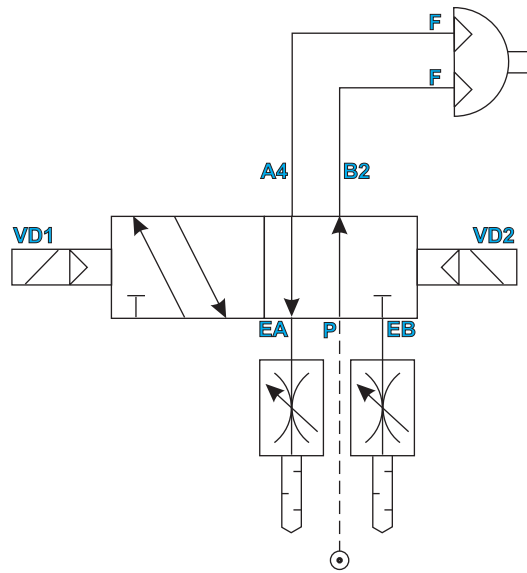
- Socket hex head screw M20x90 mm (8.8)
- Blank washer 20x37x3

Weight

- About 36 kg (79.36 lb)



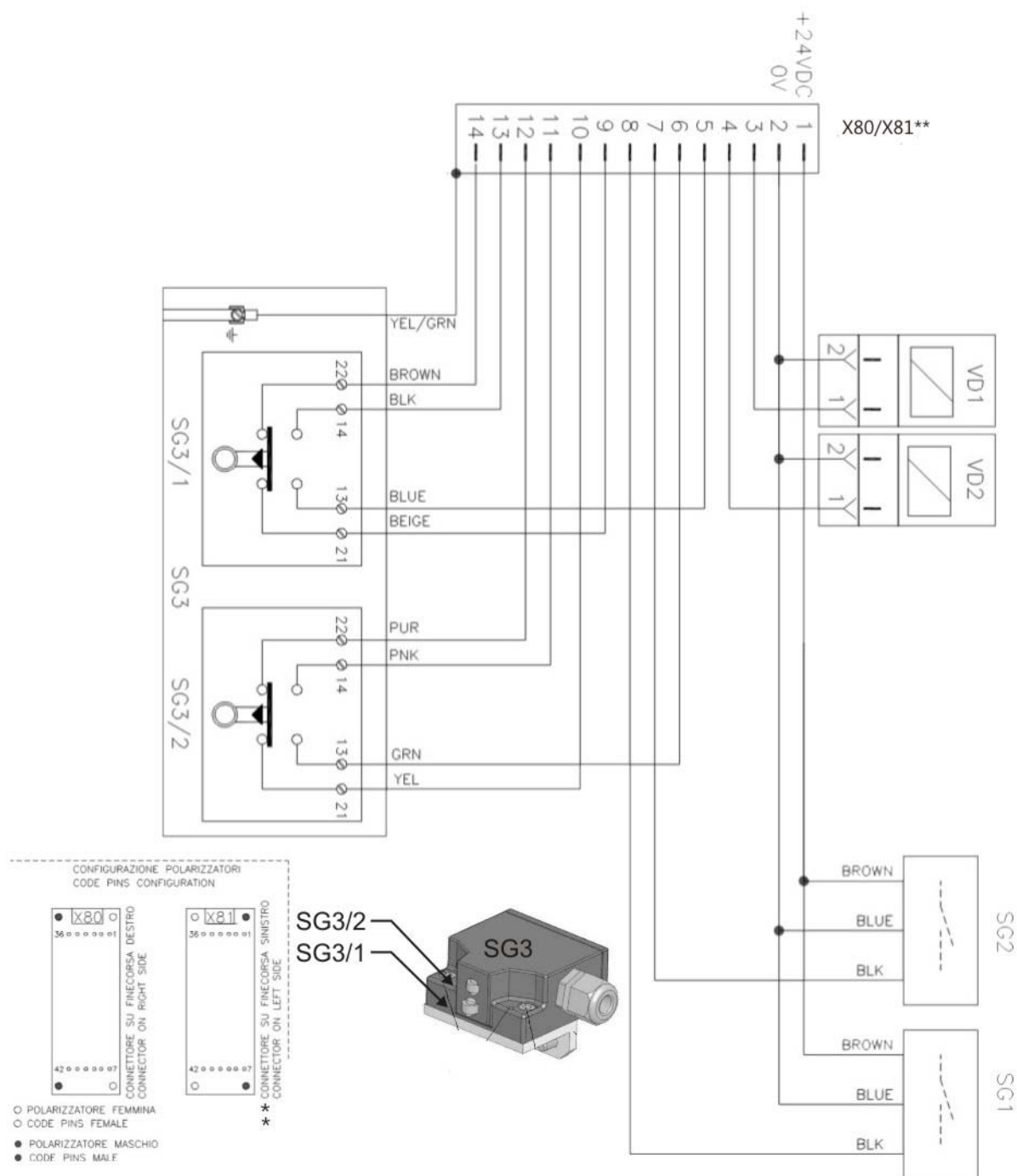
1. Axis 1 On-Off mechanical hard stop unit (with q.ty 2 socket hex head fixing screws 20x90 (8.8))

Pneumatic connection diagram of the option

VD1: Control solenoid valve for disconnected lockout pin

VD2: Control solenoid valve for connected lockout pin

Electrical connection diagram of the option



VD1: Control solenoid valve for disconnected lockout pin

VD2: Control solenoid valve for connected lockout pin

SG1: Inductive proximity switch for disconnected lockout pin position

SG2: Inductive proximity switch for connected lockout pin position

SG3 (SG3\1): Safety limit switch for disconnected lockout pin position

SG3 (SG3\2): Safety limit switch for connected lockout pin position

X80/X81: Option interface connector

** Customization applied according to the quantity installed and physical location

7.5 Modes and stopping distance of the Robot



For details related to stopping distances and times, consult the [Reference documentation](#) (Stopping time).

8. DEVICES FOR CALIBRATION AND MAINTENANCE

This chapter contains:

- [Devices for calibration.](#)
- [Maintenance devices](#)

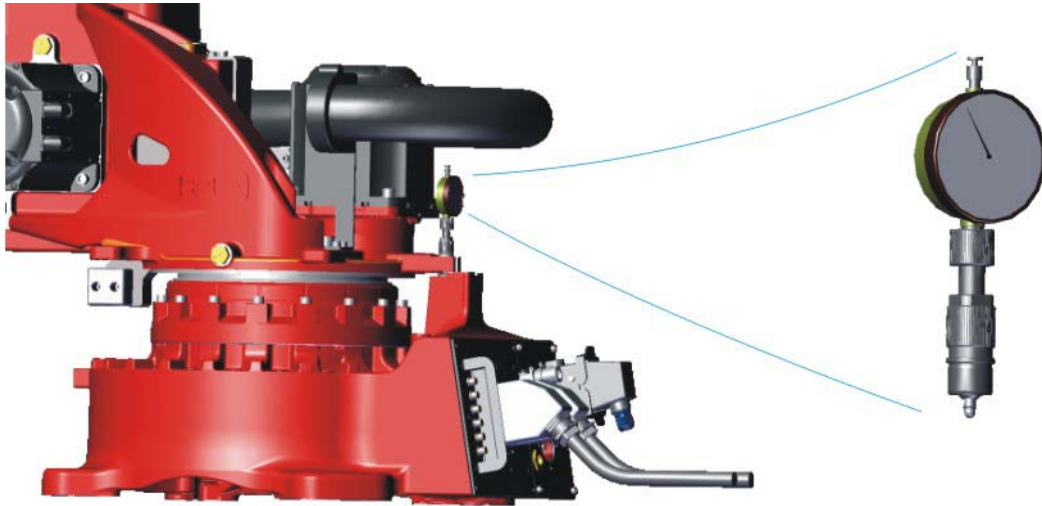
8.1 Devices for calibration

The Robot is provided with a series of necessary devices to carry out the calibration operations of the Robot axes, as described in the following table.

Tab. 8.1 - Available devices

Robot SMART5 version	Description	Ref.
NJ 40 - 2.5 In-line NJ 40 - 2.5 In-line Foundry NJ 40 - 2.5 Off-set NJ 40 - 2.5 Off-set Foundry	Calibration tool (82314100)	par. 8.1.1
	Kit for Axis 5 and Axis 6 calibration (82212400)	par. 8.1.2
	Calibrated Tool Unit - Tool Master L=117 mm (81783801)	par. 8.1.3

8.1.1 Calibration tool (82314100)



Purpose

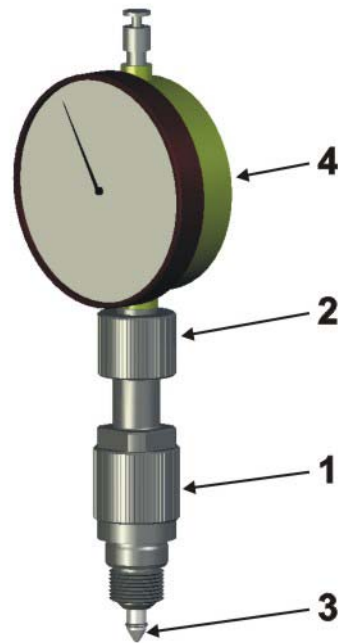
The calibration tool unit with dial gauge allows to carry out a correct manual calibration of each Robot axis.

Technical features and composition

The kit consists of a dial gauge holder that is screwed into the specific seats on each of the Robot axes and a centesimal dial gauge to find the correct calibration position. When the dial gauge is not used it must be removed from the Robot and preserved for further use.

Limitations

- None

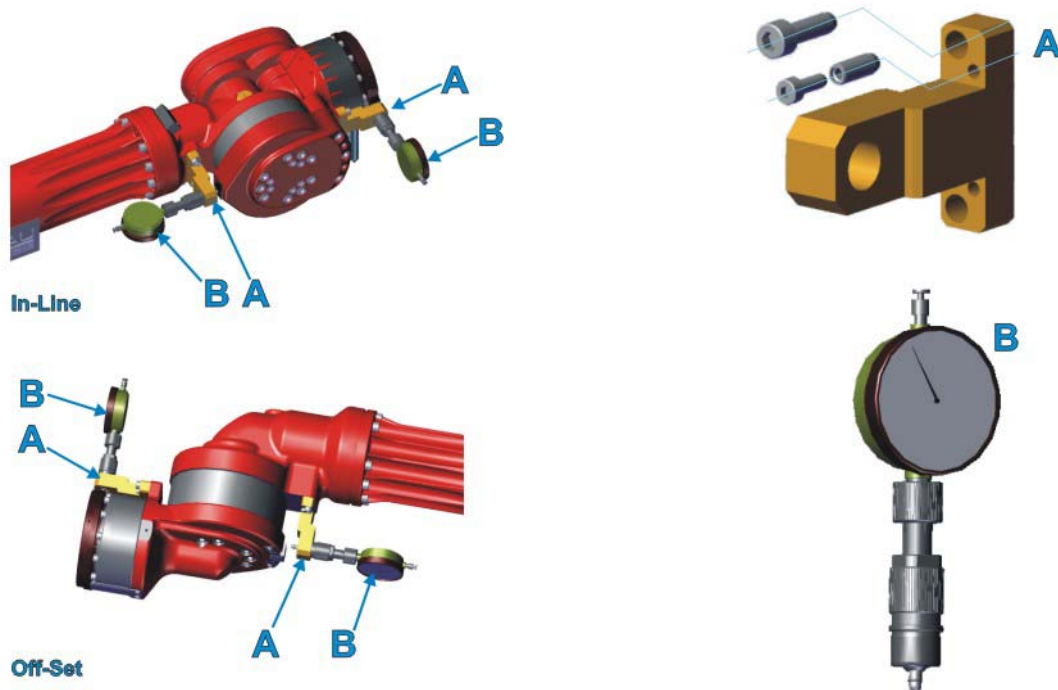
Fig. 8.1 - Assembly Diagram

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



For details on calibration procedures, see the Robot Maintenance handbook.

8.1.2 Kit for Axis 5 and Axis 6 calibration (82212400)



Purpose

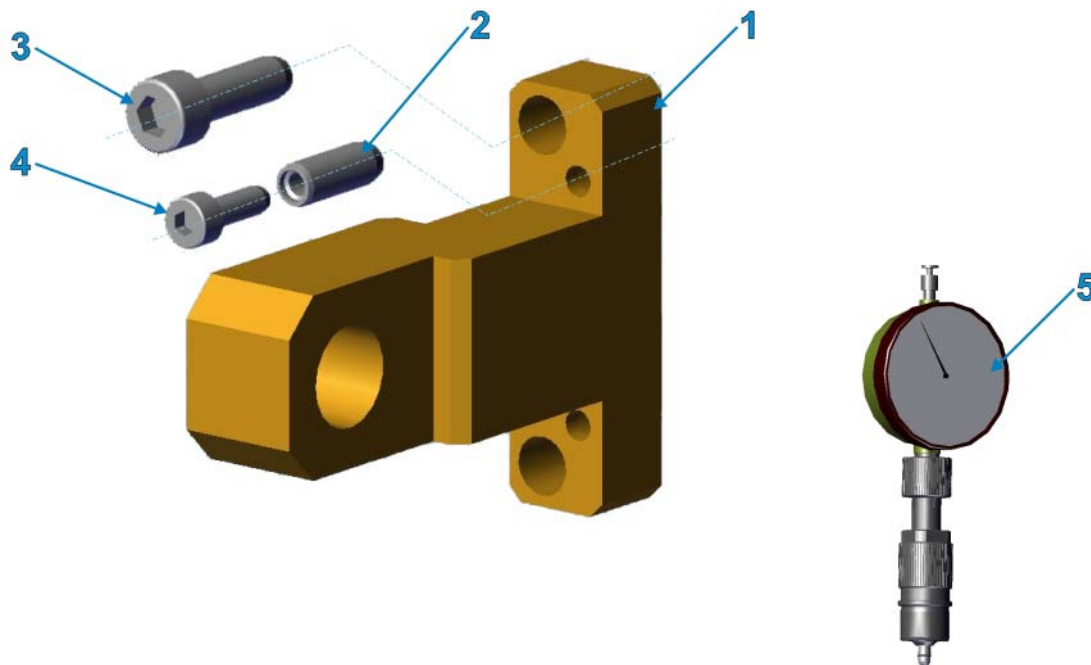
This unit permits to use the [Calibration tool \(82314100\)](#) assembly to carry out the proper calibration of axes 5 and 6 in manual mode.

Technical features and composition

The kit consists of a dial gauge holder that is screwed into the specific seats on robot axis 5 and axis 6 and a centesimal dial gauge to find the correct calibration position. When the equipment is not used it must be removed from the Robot and preserved for further use.

Limitations

- None

Fig. 8.2 - Assembly Diagram

1. Equipment to support the dial gauge (82212410)
2. Q.ty 2 parallel pins (Ø6x16)
3. Q.ty 2 fixing screws (socket hex head screws M6x20).
4. Q.ty 2 extraction pin screws (socket hex head screws M4x12)
5. [Calibration tool \(82314100\)](#)

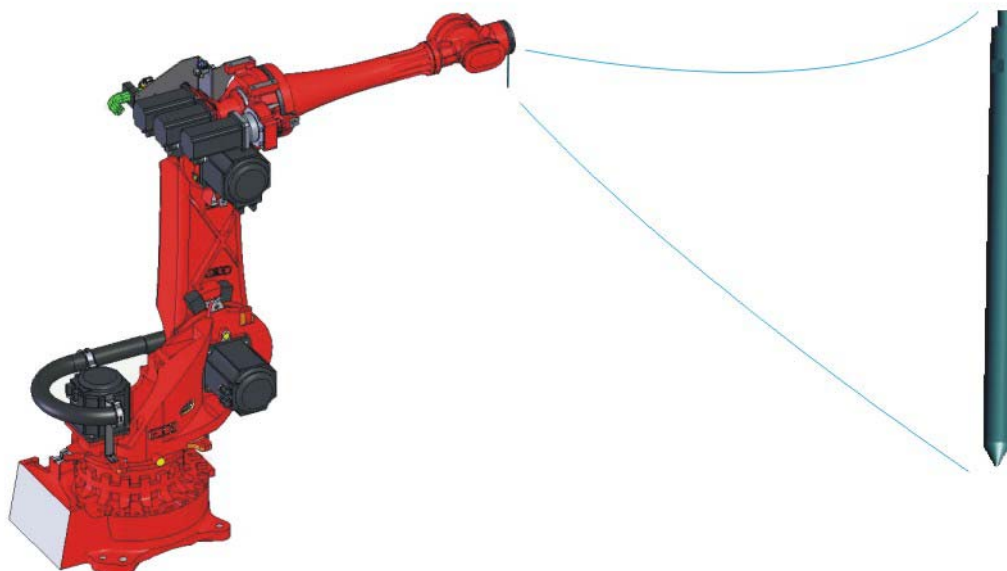


For details on calibration procedures, see the Robot Maintenance handbook.

8.1.3 Calibrated Tool Unit - Tool Master L=117 mm (81783801)

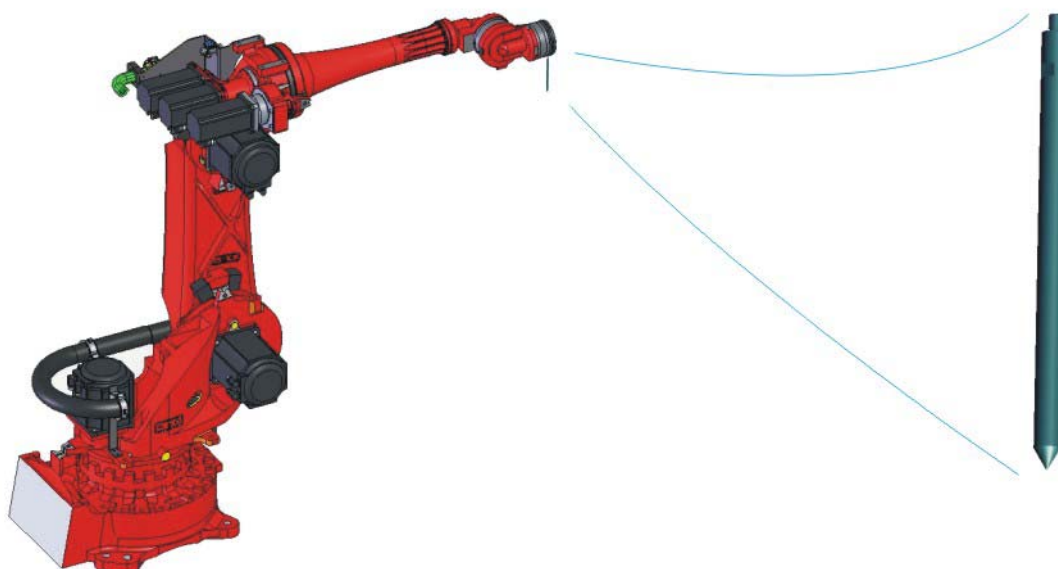
Robot SMART5 NJ 40 - 2.5 In-line

Robot SMART5 NJ 40 - 2.5 In-line Foundry



Robot SMART5 NJ 40 - 2.5 Off-set

Robot SMART5 NJ 40 - 2.5 Off-set Foundry



Purpose

The calibrated tool unit is used to calculate the **TCP** (Tool Centre Point) related to the Robot flange.

Technical features and composition

This unit consists of a cylindrical push rod whose length is defined such as that the end is positioned in a given point in relation to the wrist centre.

The push rod is screwed directly on axis 6 outlet flange in radial position to it and does not require the disassembly of the equipment possibly mounted on the flange itself. When it is not used to calculate the TCP, the calibrated tool must be removed from the Robot wrist.

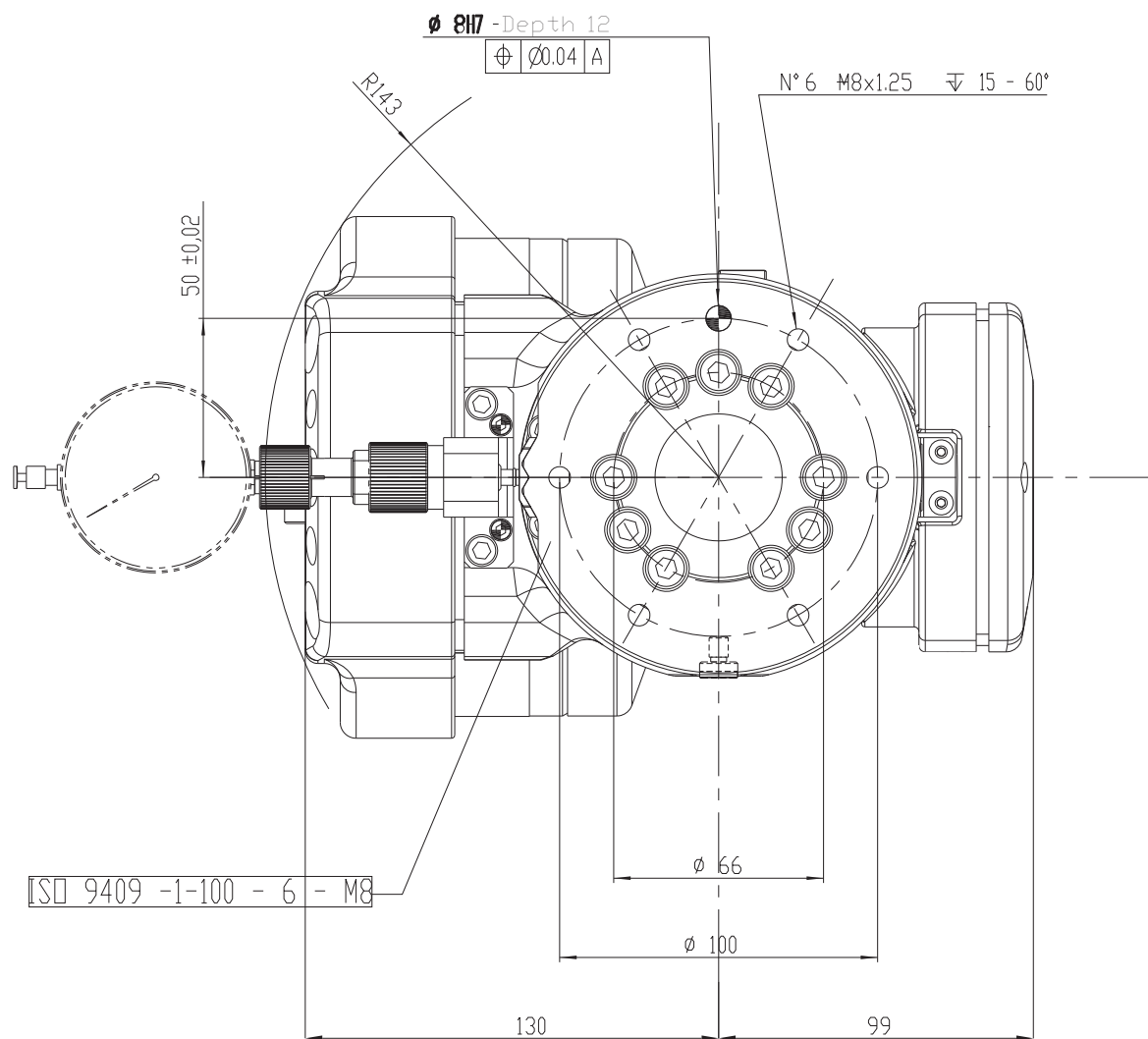
The following figures show the tip measures are referred to the Robot flange centre.

- [Fig. 8.3 - SMART5 NJ 40 - 2.5 In-line / SMART5 NJ 40 - 2.5 In-line Foundry on page 123](#)
- [Fig. 8.4 - SMART5 NJ 40 - 2.5 Off-set / SMART5 NJ 40 - 2.5 Off-set Foundry on page 125](#)

Limitations

- None

Fig. 8.3 - SMART5 NJ 40 - 2.5 In-line / SMART5 NJ 40 - 2.5 In-line Foundry



DEVICES FOR CALIBRATION AND MAINTENANCE

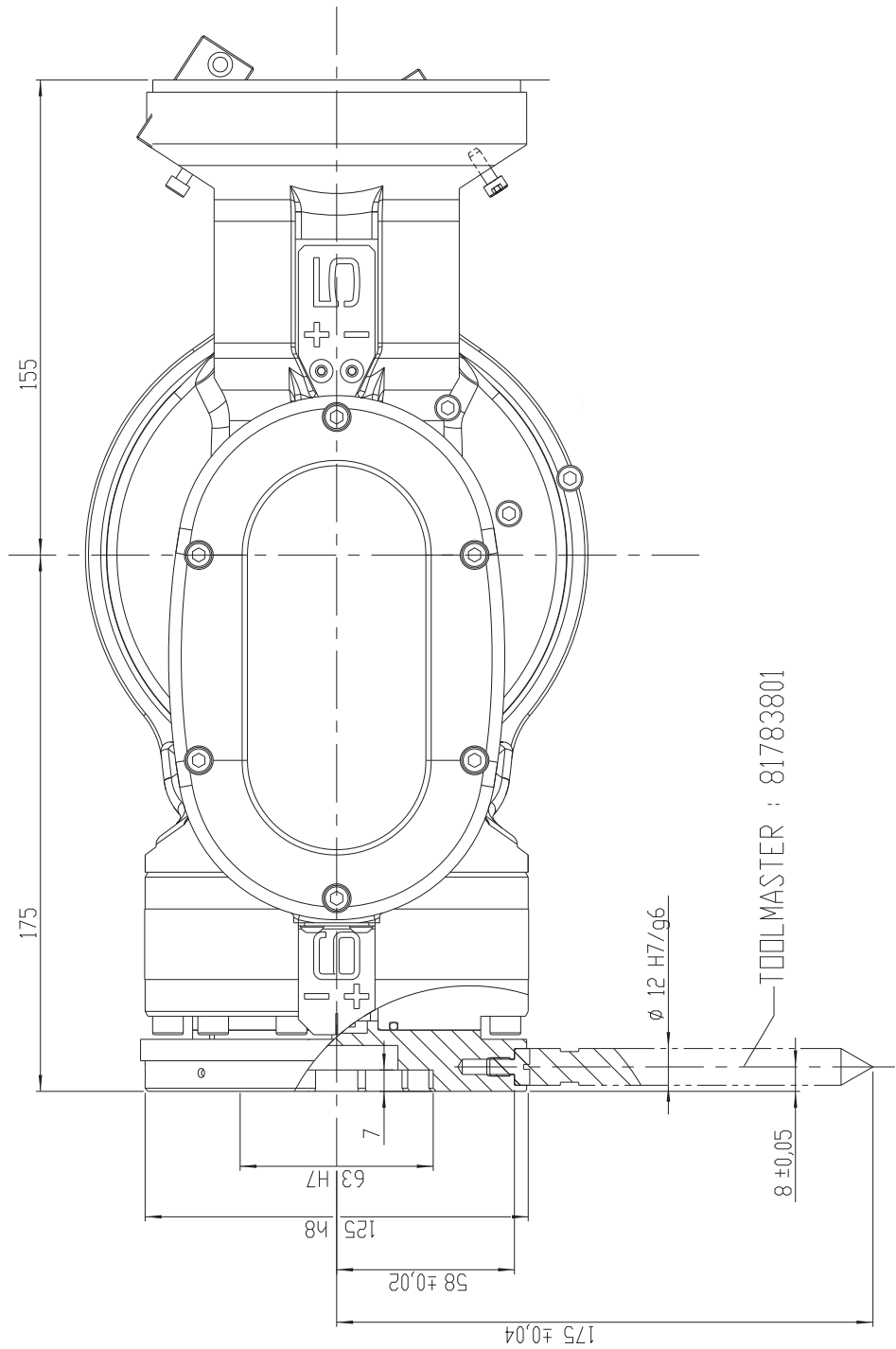
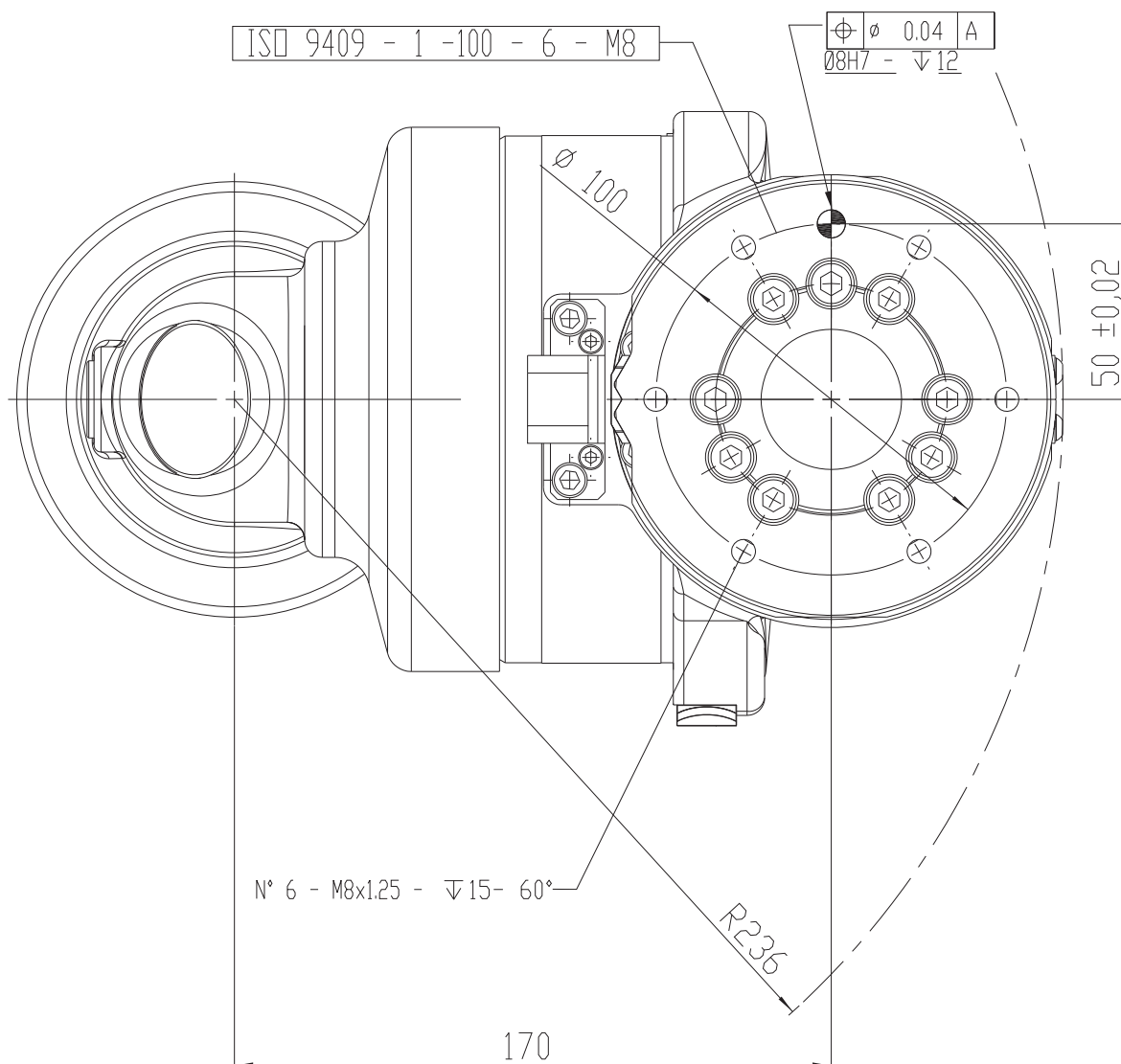
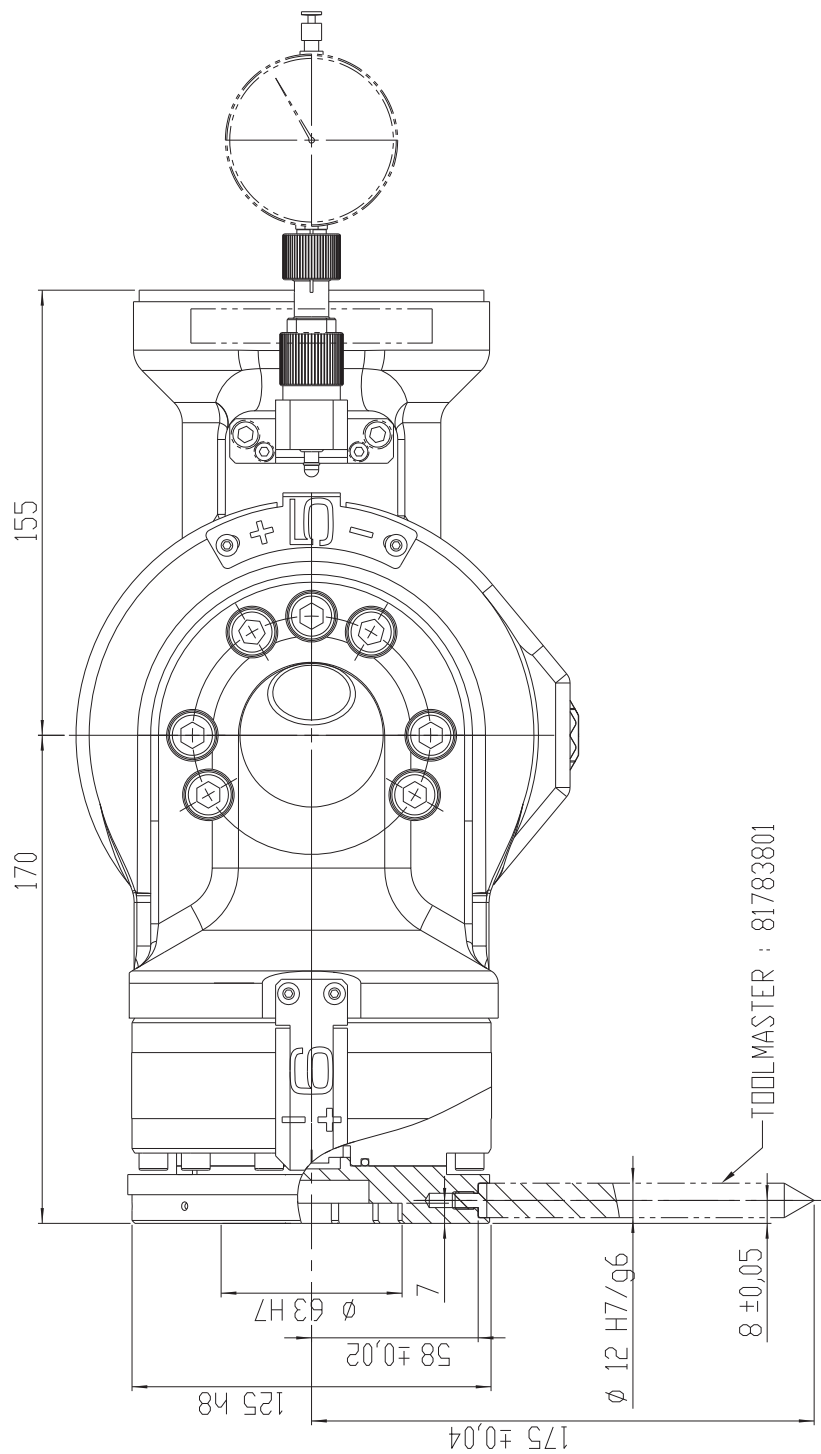


Fig. 8.4 - SMART5 NJ 40 - 2.5 Off-set / SMART5 NJ 40 - 2.5 Off-set Foundry



DEVICES FOR CALIBRATION AND MAINTENANCE



Dimensions in millimetres

8.2 Maintenance devices

The Robot is provided with a series of necessary devices to carry out the maintenance operations, as described in the following table.

Tab. 8.2 - Available devices

Robot SMART5 version	Description	Ref.
NJ 40 - 2.5 In-line NJ 40 - 2.5 In-line Foundry	C5G-OBR: axis brake releasing module (CR17133880)	par. 8.2.1
NJ 40 - 2.5 Off-set NJ 40 - 2.5 Off-set Foundry	Robot axes integrated brake releasing module	par. 8.2.2

8.2.1 C5G-OBR: axis brake releasing module (CR17133880)



Typical Robot Representative Image

Purpose

The C5G-OBR (**O**uter **B**rake **R**elease) option makes available a transportable module which allows to release each Robot axes, positioners and tables, to be used in case of damaged Control Unit.

Technical features and composition

The brake releasing module requires power supply from the network (single-phase, from 100 to 230 Vac, 1.5 A @ 120 Vac / 0.7 A @ 230 Vac, self-adapting) and maintains, in this way, independence from the Control Unit. Power supply shall be connected by means of mating plug IEC type C13 model, provided with the option.

The three pole cable (2 poles and the ground, minimum section 0.5 mm² / 20 AWG) and the suitable plug to the user Country shall be provided and connected by the user, in compliance with the electrical power supply of the country where the brake releasing module is used.

To adapt the different configurations of the Robot units, the brake releasing module is provided with 3 movable connectors, which can be used in this way:

- for Robots / positioners / Robot Tracks Motion, X2 connector to be connected directly on the connector placed on the related base
- for MP positioners and Robot Track Motions, AUX connector to be connected directly on the connector placed on the corresponding base
- for tables, MTR7 connector to be connected directly on the motor brake connector and for Robots provided with second motor on axis 1 (SMART5 Press).

The connectors shall be used one at a time, according to the Robot configuration to be released (with the only exception of Robot SMART 5 Press). The connectors are connected to the brake releasing module by means of a cable of 5 m, to allow the control operations only with adequate distance from the Robot on which it is necessary to operate.

It is possible to release only one axis at a time. The control procedure foresees the selection of the desired axis by means of a rotating selector, and so the releasing control with lever push-button, (maintained action control):

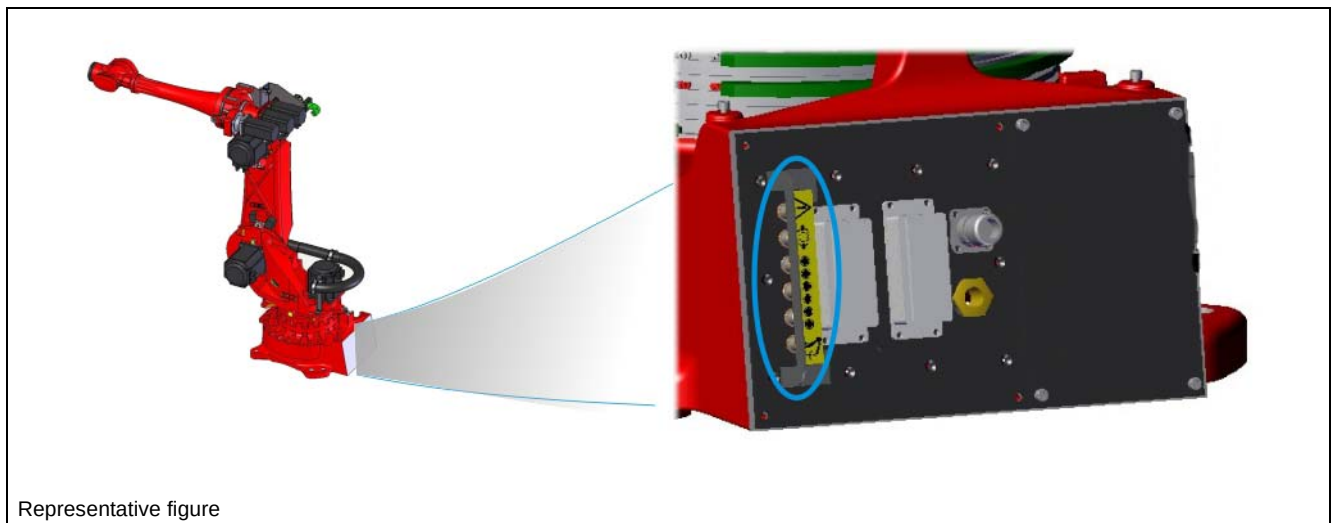
Limitations

- It is possible to use maximum 1 option for each Robot Control Unit.



Refer also to the Control Unit “Technical Specifications” handbook.

8.2.2 Robot axes integrated brake releasing module



Representative figure

Purpose

In the absence of motive power, the Robot axes movement is possible by means of devices for the brake release and appropriate lifting means.

The integrated brake releasing module allows the brake deactivation of each axis by pressing the appropriate push-buttons (provided with identification logo as shown in the figure) provided on the base plate of the Robot.

During the axes brake releasing activity, all the system safety devices (including the emergency stop and the enabling push-button) are disabled.

Technical features and composition

The integrated brake releasing module is constituted from push-buttons to individually release the axes brake (identified by the labels visible in the figure).

In order to be able to operate the integrated brake releasing module requires:

- Robot connected to the Control Unit
- Motors off (Drive OFF). With Drive ON motors, the push-button pressing has no effect.

Limitations

- Motion freedom of axes is obstructed and slowed down by dynamic braking.



Refer also to the Control Unit “Technical Specifications” handbook.
For details on the brake releasing device use, see the Maintenance handbook of the Robot.

9. OPTIONS

This chapter contains:

- [Information on installation of options](#)
- [Electrical circuit diagram of the options](#)
- [Available options for the Robot](#)

9.1 Information on installation of options

The options provided together with the Robot are quite always supplied already installed.

The options installation instructions are fully described on the Transport and Installation handbook.



The options listed below can be installed and used only on the Robot SMART5.

9.2 Electrical circuit diagram of the options

The electrical circuit diagrams of the options (foreseen only where electrical connections are present) are available in the complete electrical circuit diagram of the Robot.

Because of the complexity of some options, it is possible that some electrical diagrams are provided in a separated document.



All electrical diagrams are available in the Complete CD-ROM provided together with the Robot.

In addition see [par. Reference documentation on page 6](#).

9.3 Available options for the Robot

The Robot can be integrated with additional options to better adapt to the installation requirements. These options, if not differently specified, can be chosen matching them with the available ones. Any limitation to the mutual incompatibility or the maximum amount that can be installed is clearly indicated.



For convenience of research, the options are listed below organised according to the topic and field of application, while the details are directly described in the chapter to which they belong.

Available options for installation	
	– Screws and pins kit for robot fastening (CR82362500) – Levelling plate unit for Robot fixing (CR82362700) – Non-levelling plate unit for Robot fixing (CR82362800) – NJ fixing on ceiling and fall-prevention unit - B.R.I.C. (CR82363000) – Fork unit (CR82363100)
Available options for integration in production cells	
	– Axis 1 adjustable mechanical hard stop unit (CR82362100) – Axis 2 adjustable mechanical hard stop unit (CR82362200) – Axis 1 workspace partialization unit - 3 areas (RV260C) (CR82362300) – Axis 2 workspace partialization unit - 2 areas (CR82362400) – Axis 1 On-Off mechanical hard stop unit (base RV260C) (CR82362900)
Available options for calibration	
	– Calibration tool (82314100) – Kit for Axis 5 and Axis 6 calibration (82212400) – Calibrated Tool Unit - Tool Master L=117 mm (81783801)
Available options for maintenance	
	– C5G-OBR: axis brake releasing module (CR17133880)
Accessories	
	– Protection unit distribution panel connections (CR82352200) – Cover assembly (CR82341604) <i>To close the dressing compartment on Robot base</i> – Flange assembly ISO 9409-1-A100 INOX (CR82212825)

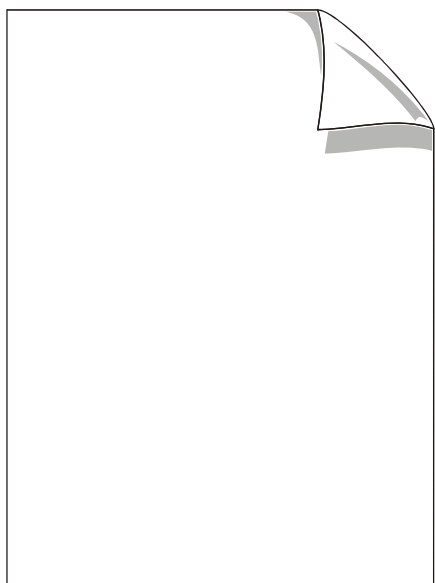
10. FURTHER DETAILS ON COMPONENTS

Tab. 10.1 - Generalities about the components

Component	Description	Reference manual
Components available only on C5Compact and C5G Control Unit		
AMS-IAM	AMS-IAM modules are axes control boards dedicated to the axes management. Modules set to manage 1 axis or 2 axes are available; depending on the power class, the modules take up from 1 to 2 slots.	C5G / C5Compact Control Unit Technical Specifications
C5G-SDM	The SDM module is mechanically fastened on the Control Unit rack and occupies therefore the space of a slot. The 24 Vdc power supply of the module and all the signals are connected by means of connectors; the bus on the rack is not displayed. The module has an internal logic with double processor to manage the safety signals and the communication via CAN Bus with APC module.	C5G / C5Compact Control Unit Technical Specifications
Modulo X20	The Fieldbus module is available in the master and slave versions, that can be chosen among Profibus-DP, Profinet and DeviceNet protocols. The Fieldbus modules can be installed only on the slots 1 and 2 of the Bus Coupler PFG-BCO module on X20 interface. It is possible to install contemporaneously Fieldbus modules and I/O modules.	C5G / C5Compact Control Unit Technical Specifications
Components available only on C5G Control Unit		
C5G-DMI	The C5G-DMI (Devicenet Multibus Interface cable) option makes available a connector on cabinet base that includes 24 Vdc, Devicenet Master network and several I/O digital signals, suitable for connecting slave external devices (e.g. Robot) by means of Multibus Cable.	C5G Control Unit Technical Specifications
C5G-PMI	The C5G-PMI (Profibus-DP Multibus Interface cable) option provides available a connector on the cabinet basis that includes 24 Vdc, Profibus-DP Master network and some I/O digital signals; able to connect slave external devices (e.g. Robot) by means of Multibus Cable.	C5G Control Unit Technical Specifications
C5G-PNC	The C5G-PNC (ProfiNet I/O Controller) option makes available a Profinet Master interface module inside the Control Unit, with Profinet RT Controller (Master) function. The module must be installed on PFG-BCO Bus Coupler module on X20 interface. It is supplied with an integrated Ethernet switch to allow an efficient connection of two RJ45 connectors.	C5G Control Unit Technical Specifications
C5G-PNMI	The C5G-PNMI (ProfiNet Multibus Interface cable) option makes available a connector on cabinet base that includes 24 Vdc, Profinet I/O Controller (Master) network and several I/O digital signals, suitable for connecting slave external devices (e.g. Robot) by means of Multibus Cable.	C5G Control Unit Technical Specifications

Tab. 10.1 - Generalities about the components (Continued)

Component	Description	Reference manual
X10	The X10 connector is a multi-pin connector that collects all the position management signals of the Robot (Encoders with EnDat 2.2 interface), up to the configuration of 6 axis in total. The X10 connector is installed on Connector Interface Panel (CIP) and, it is connected to X1 connector on the Robot base, by means of Connection cables between C5G and Robot.	C5G Control Unit Technical Specifications
X60	The X60 connector is a multi-pin connector that collects all the Robot axis power signals (motors) and brakes, up to the configuration of 6 axis in total. The X60 connector is installed on Connector Interface Panel (CIP) and, it is connected to X2 connector on the Robot base, by means of Connection cables between C5G and Robot.	C5G Control Unit Technical Specifications
C5G-SMK	The C5G-SMK option (Signal Machine Kit) makes available two 24 Vdc alarm inputs, 4 24Vdc inputs and 4 24Vdc outputs on Robot, to be used for small applications by the user. The option uses some inputs and outputs already existing as standards on Safety Distribution Module (SDM).	C5G Control Unit Technical Specifications
X93	The (X93 / X94) connectors for the Master Fieldbus allows the connection of the Fieldbus between Control Unit master module and the slave modules on tooling and / or on Robot.	C5G Control Unit Technical Specifications
X94	The connector is installed on the Control Unit base on the Connector Interface Panel (CIP). The X93 connector is combined with the first Fieldbus Master module available on ARM1, while the X94 connector, if existing, with the second master module available on ARM2.	





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