Comau Robotics
Instruction Handbook

SMART NH4
SMART NH4 SH

Technical Specifications

00757324-en_04/1008

COMAU ROBOTICS

SUMMARY

PREFACE

Symbols used in the manual

The symbols for **WARNING, CAUTION** and **NOTES** are indicated below together with their significance.

This symbol indicates operating procedures, technical information and precautions that if ignored and/or are not performed correctly could cause injuries.

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

This symbol indicates operating procedures, technical information and precautions that it are important to highlight.

Reference documents

This document refers to the **robot SMART** .

The complete set of manuals for the **robot SMART** consists of:

Comau	Robot	– Technical Specifications – Transport and installation – Maintenance – Electrical diagram

These manuals are to be integrated with the following documents:

Comau	C4G Control Unit	– Technical Specifications – Transport and installation – Guide to integration, safeties, I/O and communications – Maintenance – Use of Control Unit – Electrical diagram
	Programming	– EZ PDL2 Programming Environment – PDL2 Programming Language Manual – Motion programming – C4G Control Unit Use – VP2 Visual PDL2

1. GENERAL SAFETY PRECAUTIONS

1.1 Responsibilities

– The system integrator is responsible for ensuring that the Robot and Control System are installed and handled in accordance with the Safety Standards in force in the country where the installation takes place. The application and use of the protection and safety devices necessary, the issuing of declarations of conformity and any CE markings of the system are the responsibility of the Integrator.

– COMAU Robotics & Service shall in no way be held liable for any accidents caused by incorrect or improper use of the Robot and Control System, by tampering with circuits, components or software, or the use of spare parts that are not included in the spare parts list.

– The application of these Safety Precautions is the responsibility of the persons assigned to direct / supervise the activities indicated in the Applicability section,They are to make sure that the Authorised Personnel is aware of and scrupulously follow the precautions contained in this document as well as the Safety Standards in addition to the Safety Standards in force in the country in which it is installed.

– The non-observance of the Safety Standards could cause injuries to the operators and damage the Robot and Control System.

The installation shall be made by qualified installation Personnel and should conform to all national and local codes.

1.2 Safety Precautions

1.2.1 Purpose

These safety precautions are aimed to define the behaviour and rules to be observed when performing the activities listed in the Applicability section.

1.2.2 Definitions

Robot and Control System
The Robot and Control System consists of all the functions that cover: Control Unit, robot, hand held programming unit and any options.

Protected Area
The protected area is the zone confined by the safety barriers and to be used for the installation and operation of the robot

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

Assigned Personnel
The persons assigned to direct or supervise the activities of the workers referred to in the paragraph above.

Installation and Putting into Service
The installation is intended as the mechanical, electrical and software integration of the Robot and Control System in any environment that requires controlled movement of robot axes, in compliance with the safety requirements of the country where the system is installed.

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

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

Maintenance and Repairs
Maintenance and repairs are activities that involve periodical checking and / or replacement (mechanical, electrical, software) of Robot and Control System parts or components, and trouble shooting, that terminates when the Robot and Control System has been reset to its original project functional condition.

Putting Out of Service and Dismantling
Putting out of service defines the activities involved in the mechanical and electrical removal of the Robot and Control System from a production unit or from an environment in which it was under study.
Dismantling consists of the demolition and dismantling of the components that make up the Robot and Control System.

Integrator
The integrator is the professional expert responsible for the installation and putting into service of the Robot and Control System.

Incorrect Use
Incorrect use is when the system is used in a manner other than that specified in the Technical Documentation.

Range of Action
The robot range of action is the enveloping volume of the area occupied by the robot and its fixtures during movement in space.

1.2.3 Applicability

These Specifications are to be applied when executing the following activities:

– Installation and Putting into Service;
– Programming Mode;
– Auto / Remote Automatic Mode;
– Robot axes release;
– Stop distances (threshold values)
– Maintenance and Repairs;
– Putting Out of Service and Dismantling

1.2.4 Operating Modes

Installation and Putting into Service

- Putting into service is only possible when the Robot and Control System has been correctly and completely installed.
- The system installation and putting into service is exclusively the task of the authorised personnel.
- The system installation and putting into service is only permitted inside a protected area of an adequate size to house the robot and the fixtures it is outfitted with, without passing beyond the safety barriers. It is also necessary to check that under normal robot movement conditions there is no collision with parts inside the protected area (structural columns, power supply lines, etc.) or with the barriers. If necessary, limit the robot working areas with mechanical hard stop (see optional assemblies).
- Any fixed robot control protections are to be located outside the protected area and in a point where there is a full view of the robot movements.
- 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 are to be handled as described in the product Technical Documentation; if lifting is necessary, check that the eye-bolts are fixed securely and use only adequate slings and equipment.
- Secure the robot to the support, with all the bolts and pins foreseen, tightened to the torque indicated in the product Technical Documentation.
- 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.
- If applicable, connect the robot pneumatic system to the air distribution line paying attention to set the system to the specified pressure value: a wrong setting of the pressure system influences correct robot movement.
- Install filters on the pneumatic system to collect any condensation.
- Install the Control Unit outside the protected area: the Control Unit is not to be used to form part of the fencing.
- Check that the voltage value of the mains is consistent with that indicated on the plate of the Control Unit.
- Before electrically connecting the Control Unit, check that the circuit breaker on the mains is locked in open position.
- Connection between the Control Unit and the three-phase supply mains at the works, is to be with a four-pole (3 phases + earth) armoured cable dimensioned appropriately for the power installed on the Control Unit. See the product Technical Documentation.
- The power supply cable is to enter the Control Unit through the specific fairlead and be properly clamped.
- Connect the earth conductor (PE) then connect the power conductors to the main switch.

- Connect the power supply cable, first connecting the earth conductor to the circuit breaker on the mains line, after checking with a tester that the circuit breaker terminals are not powered. Connect the cable armouring to the earth.
- Connect the signals and power cables between the Control Unit and the robot.
- Connect the robot to earth or to the Control Unit or to a nearby earth socket.
- Check that the Control Unit door (or doors) is/are locked with the key.
- A wrong connection of the connectors could cause permanent damage to the Control Unit components.
- The C4G Control Unit manages internally the main safety interlocks (gates, enabling pushbuttons, etc.). Connect the C4G 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 (emrgency stop, gates safey devices etc) i.e. the realisation of correct and safe circuits, is the responsibility of the Robot and Control System integrator.

In the cell/line emergency stop circuit the contacts must be included of the control unit emergency stop buttons, which are on X30. The push buttons are not interlocked in the emergency stop circuit of the Control Unit.

- The safety of the system cannot be guaranteed if these interlocks are wrongly executed, incomplete or missing.
- The safety circuit executes a controlled stop (IEC 60204-1 , class 1 stop) for the safety inputs Auto Stop/ General Stop and Emergency Stop. The controlled stop is only active in Automatic states; in Programming the power is cut out (power contactors open) immediately. The procedure for the selection of the controlled stop time (that can be set on ESK board) is contained in the Installation manual .
- When preparing protection barriers, especially light barriers and access doors, bear in mind that the robot stop times and distances are according to the stop category (0 or 1) and the weight of the robot..

Check that the controlled stop time is consistent with the type of Robot connected to the Control Unit. The stop time is selected using selector switches SW1 and SW2 on the ESK board.

- Check that the environment and working conditions are within the range specified in the specific product Technical Documentation.
- The calibration operations are to be carried out with great care, as indicated in the Technical Documentation of the specific product, and are to be concluded checking the correct position of the machine.
- To load or update the system software (for example after replacing boards), use only the original software handed over by COMAU Robotics & Service. Scrupulously follow the system software uploading procedure described in the Technical Documentation supplied with the specific product. After uploading, always make some tests moving the robot at slow speed and remaining outside the protected area.
- Check that the barriers of the protected area are correctly positioned.

Programming Mode

- The robot is only to be programmed by the authorised personnel.
- Before starting to program, the operator must check the Robot and Control System to make sure that there are no potentially hazardous irregular conditions, and that there is nobody inside the protected area.
- When possible the programming should be controlled from outside the protected area.
- Before operating inside the Protected Area, the operator must make sure from outside that all the necessary protections and safety devices are present and in working order, and especially that the hand-held programming unit functions correctly (slow speed, emergency stop, enabling device, etc.).
- During the programming session, only the operator with the hand-held terminal is allowed inside the Protected Area.
- If the presence of a second operator in the working area is necessary when checking the program, this person must have an enabling device interlocked with the safety devices.
- Activation of the motors (Drive On) is always to be controlled from a position outside the range of the robot, after checking that there is nobody in the area involved. The Drive On operation is concluded when the relevant machine status indication is shown.
- When programming, the operator is to keep at a distance from the robot to be able to avoid any irregular machine movements, and in any case in a position to avoid the risk of being trapped between the robot and structural parts (columns, barriers, etc.), or between movable parts of the actual robot.
- When programming, the operator is to avoid remaining in a position where parts of the robot, pulled by gravity, could execute downward movements, or move upwards or sideways (when installed on a sloped plane).
- Testing a programmed cycle at working speed with the operator inside the protected area, in some situations where a close visual check is necessary, is only to be carried out after a complete test cycle at slow speed has been executed. The test is to be controlled from a safe distance.
- Special attention is to be paid when programming using the hand-held terminal: in this situation, although all the hardware and software safety devices are active, the robot movement depends on the operator.
- During the first running of a new program, the robot may move along a path that is not the one expected.
- The modification of program steps (such as moving by a step from one point to another of the flow, wrong recording of a step, modification of the robot position out of the path that links two steps of the program), could give rise to movements not envisaged by the operator when testing the program.
- In both cases operate cautiously, always remaining out of the robot's range of action and test the cycle at slow speed.

Auto / Remote Automatic Mode

– The activation of the automatic operation (AUTO and REMOTE states) is only to be executed with the Robot and Control System integrated inside an area with safety barriers properly interlocked, as specified by Safety Standards currently in force in the Country where the installation takes place.

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

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

– Special attention is to be paid when selecting the automatic-remote mode, where the line PLC can perform automatic operations to switch on motors and start the program.

Robot axes release

– In the absence of motive power, the robot axes movement is possible by means of optional release devices and suitable lifting devices. Such devices only enable the brake deactivation of each axis. In this case, all the system safety devices (including the emergency stop and the enable button) are cut out; also the robot axes can move upwards or downwards because of the force generated by the balancing system, or the force of gravity.

Before using the manual release devices, it is strongly recommended to sling the robot, or hook to an overhead travelling crane.

Stop distances (threshold values)

– As for the stop distance threshold values for each robot type, please turn to the COMAU Robotics & Service Dept.

– Example: Considering the robot in automatic mode, in conditions of maximum extension, maximum load and maximum speed, when the stop pushbutton is pressed (red mushroom head pushbutton on WiTP) an NJ 370-2.7 Robot will stop completely in approx. 85° of motion, equivalent to approx. 3000 mm displacement measured on the TCP flange. Under these conditions indicated, the stoppage time of the NJ 370-2.7 Robot is 1.5 seconds.

– Considering the robot in programming mode (T1), when the stop pushbutton is pressed (red mushroom head pushbutton on WiTP) an NJ 370-2.7 Robot will stop completely in approx. 0.5 seconds.

Maintenance and Repairs

– When assembled in COMAU Robotics & Service, the robot is supplied with lubricant that does not contain substances harmful to health, however, in some cases, repeated and prolonged exposure to the product could cause skin irritation, or if swallowed, indisposition.
First Aid. Contact with the eyes or the skin: wash the contaminated zones with abundant water; if the irritation persists, consult a doctor.

If swallowed, do not provoke vomiting or take anything by mouth, see a doctor as soon as possible.

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

– When carrying out maintenance and repairs, the specific warning sign is to be placed on the control panel of the Control Unit, stating that maintenance is in progress and it is only to be removed after the operation has been completely finished - even if it should be temporarily suspended.

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

– Even if the Control Unit is not powered (main switch open), there may be interconnected voltages coming from connections to peripheral units or external power sources (e.g. 24 Vdc inputs/outputs). Cut out external sources when operating on parts of the system that are involved.

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

– Faulty components are to be replaced with others having the same code, or equivalent components defined by COMAU Robotics & Service.

After replacement of the ESK module, check on the new module that the setting of the stop time on selector switches SW1 and SW2 is consistent with the type of Robot connected to the Control Unit.

– Trouble-shooting and maintenance activities are to be executed, when possible, outside the protected area.

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

– Should it be necessary, during trouble-shooting, to intervene with the Control Unit powered, all the precautions specified by Safety Standards are to be observed when operating with hazardous voltages present.

– Trouble-shooting on the robot is to be carried out with the power supply cut out (Drive off).

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

– Maintenance, repairs and trouble-shooting operations are to be concluded checking the correct operation of the Robot and Control System and all the safety devices, executed from outside the protected area.

– When loading the software (for example after replacing electronic boards) the original software handed over by COMAU Robotics & Service is to be used. Scrupulously follow the system software loading procedure described in the specific product Technical Documentation; after loading always run a test cycle to make sure, remaining outside the protected area

– Disassembly of robot components (motors, balancing cylinders, etc.) may cause uncontrolled movements of the axes in any direction: before starting a disassembly procedure, consult the warning plates applied to the robot and the Technical Documentation supplied.

– It is strictly forbidden to remove the protective covering of the robot springs.

Putting Out of Service and Dismantling

– Putting out of service and dismantling the Robot and Control System is only to be carried out by Authorised Personnel.

– Bring the robot to transport position and fit the axis clamping brackets (where applicable) consulting the plate applied on the robot and the robot Technical Documentation.

– Before stating to put out of service, the mains voltage to the Control Unit must be cut out (switch off the circuit breaker on the mains distribution line and lock it in open position).

– After using the specific instrument to check there is no voltage on the terminals, disconnect the power supply cable from the circuit breaker on the distribution line, first disconnecting the power conductors, then the earth. Disconnect the power supply cable from the Control Unit and remove it.

– First disconnect the connection cables between the robot and the Control Unit, then the earth cable.

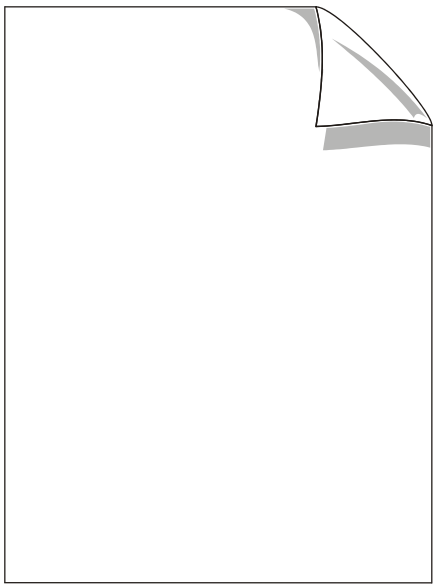
– If present, disconnect the robot pneumatic system from the air distribution line.

– Check that the robot is properly balanced and if necessary sling it correctly, then remove the robot securing bolts from the support.

– Remove the robot and the Control Unit from the work area, applying the rules indicated in the products Technical Documentation; if lifting is necessary, check the correct fastening of the eye-bolts and use appropriate slings and equipment only.

– Before starting dismantling operations (disassembly, demolition and disposal) of the Robot and Control System components, contact COMAU Robotics & Service, or one of its branches, who will indicate, according to the type of robot and Control Unit, the operating methods in accordance with safety principles and safeguarding the environment.

– The waste disposal operations are to be carried out complying with the legislation of the country where the Robot and Control System is installed.



2. GENERAL DESCRIPTION

2.1 Robot SMART NH

SMART NH is the COMAU family of high payload robots, featuring a number of different versions specifically designed to address applications that require “spot by spot” or “trajectory control” programming.

The SMART NH series can be used to carry out a number of applications, enabling the user to choose the most appropriate version for the specific application. While differing in terms of payload, work area and maximum reach, all robots in the SMART NH series share the same basic characteristics thanks to a highly modular design.

The most common applications are:

– handling
– spot welding
– assembly
– adhesive, sealant, protective film application
– chip removal machining (E.g.: trimming, grinding)
– laser welding

The available versions in the SMART NH family are listed in the table below:

Tab. 2.1 - SMART NH robot available versions

Versions	Model	**Payload**	**Reach**
SMART NH1/P Pressbooster (1)	130-2.6 130-3.0	130 kg *(286.60 lb)* 130 kg *(286.60 lb)*	2620 mm *(103.14in)* 3000 mm *(118.11in)*
SMART NH1/P Pressbooster	100-3.2P	100kg *(220.46lb)*	*3280 mm (129,13in)*
SMART NH2 (1)	165-2.6	165 kg *(363.76 lb)*	2650 mm*(104.33 in)*
SMART NH3 (1)	165-3.0 220-2.7	165 kg *(363.76 lb)* 220 kg *(485.01 lb)*	3000 mm *(118.11in)* 2700 mm *(106.30in)*
SMART NH3/SH (1)	210-3.1/SH 160-3,4/SH	210 kg *(462.97lb)* 160kg *(352.74lb)*	3150 mm *(124.01in)* 3443mm *(135.55in)*
SMART NH3/SH/P Pressbooster	100 3.5/SH/P	100kg *(220.46lb)*	3527mm *(138.86 in)*
SMART NH4	165-3.0 200-2.7	165 kg *(363.76 lb)* 200 kg *(440.92 lb)*	3000 mm *(118.11in)* 2700 mm *(106.30in)*
SMART NH4/SH	200-3.1/SH	200 kg *(440.92 lb)*	3150 mm *(124.01in)*

(1) is available Foundry versions with IP67 to guarantee protection in environments with high temperatures ;

Fig. 2.1 - SMART NH1

Fig. 2.2 - SMART NH1/P Pressbooster

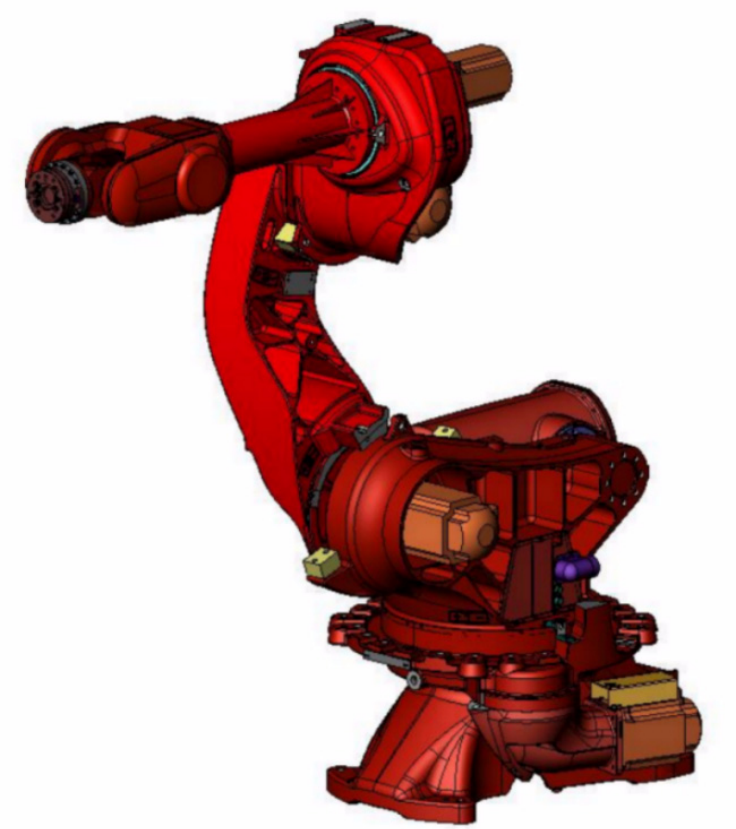


Fig. 2.3 - SMART NH2

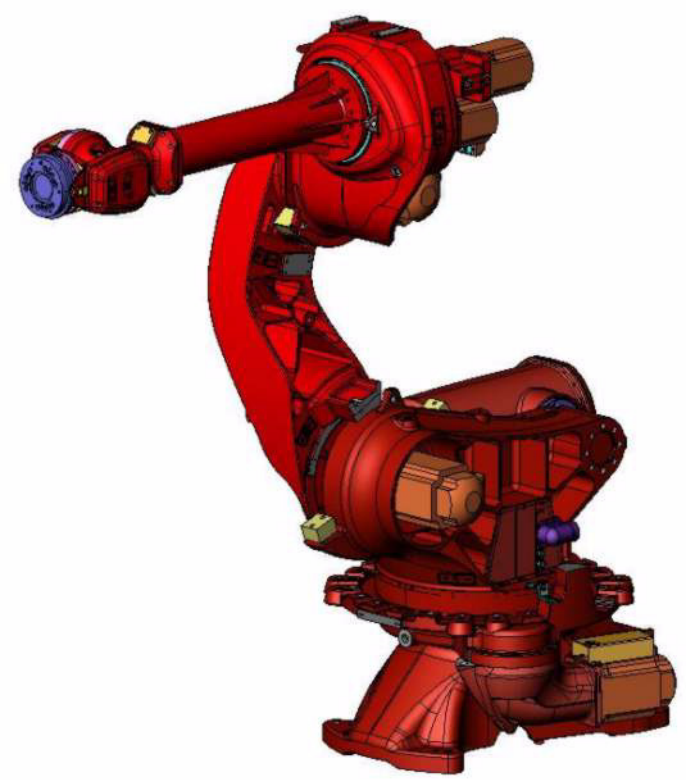


Fig. 2.4 - SMART NH3

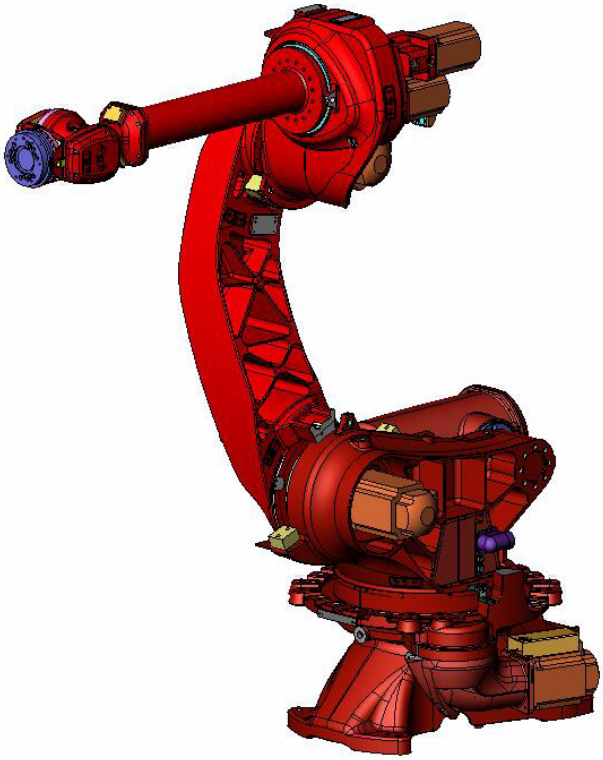


Fig. 2.5 - SMART NH3/SH

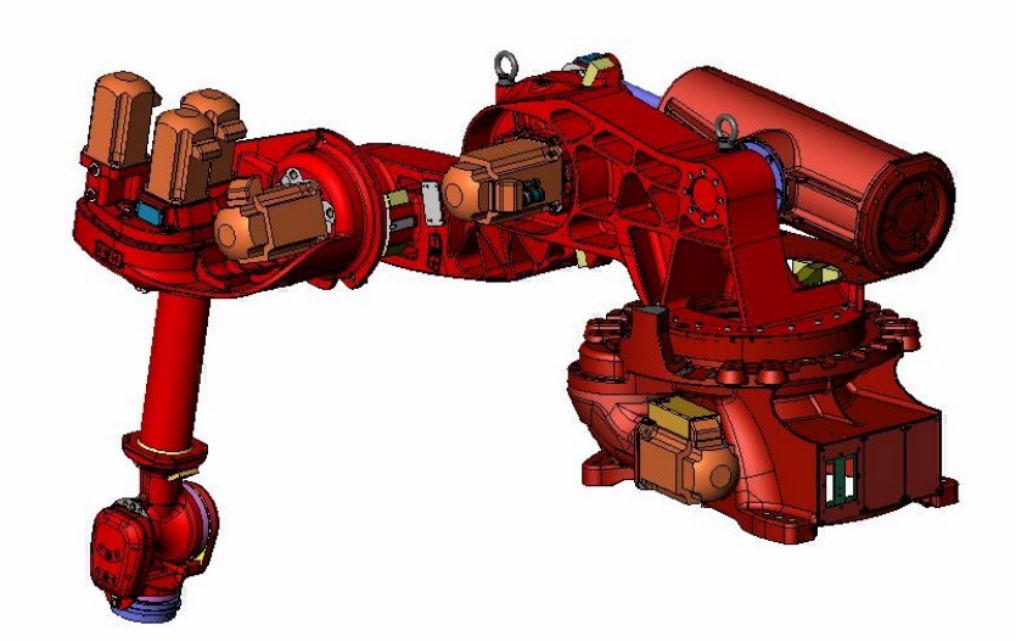


Fig. 2.6 - SMART NH3/SH/P Pressbooster

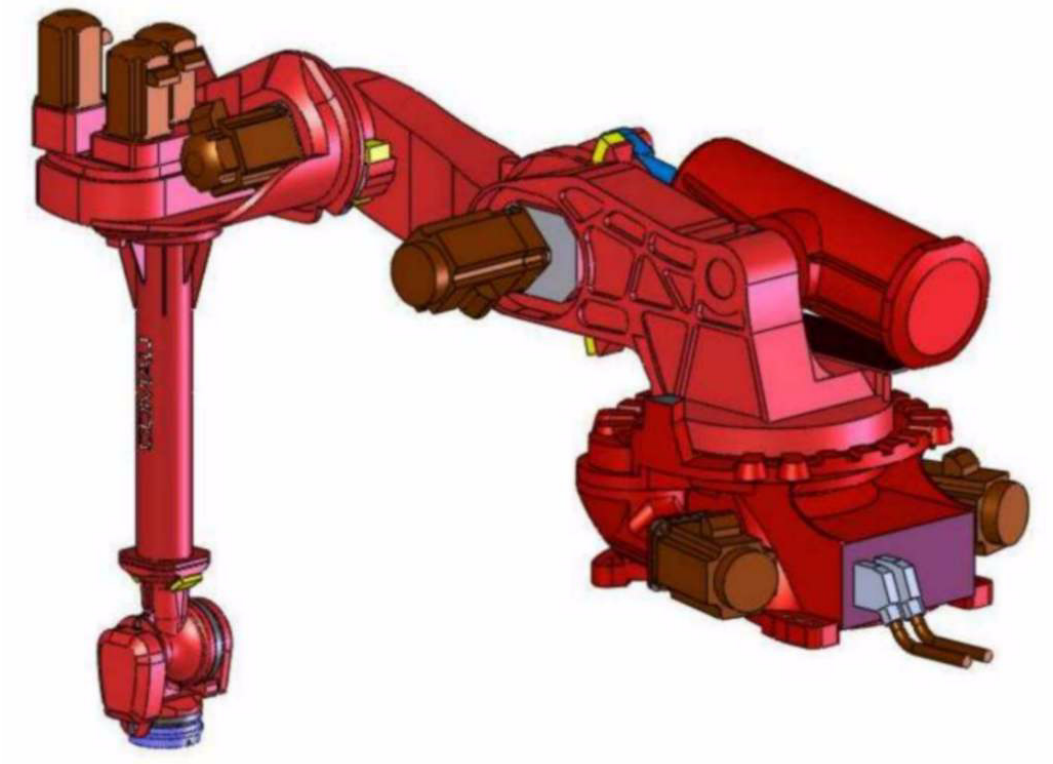


Fig. 2.7 - SMART NH4

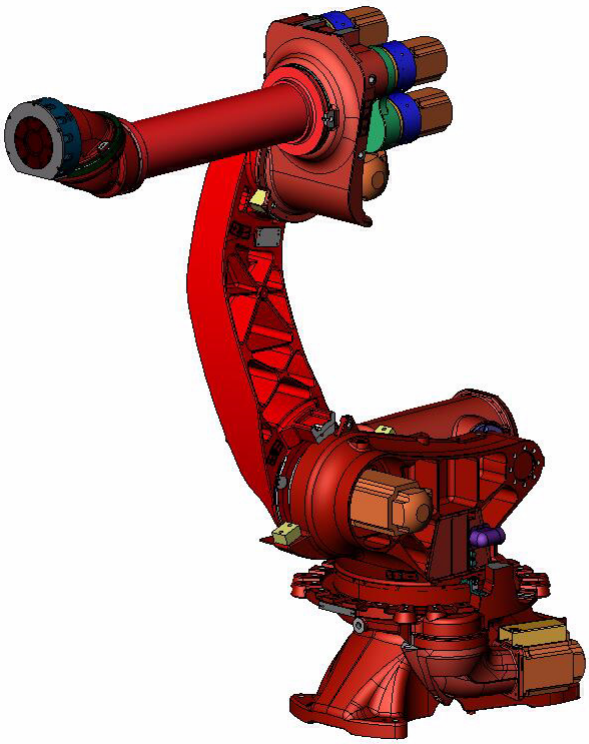
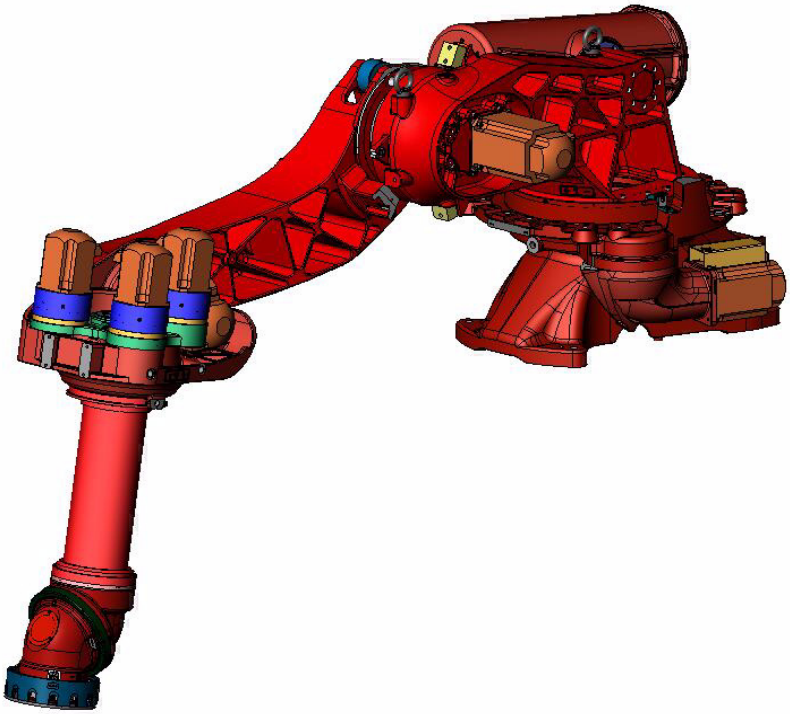


Fig. 2.8 - SMART NH4/SH



The work areas and overall dimensions of each robot are described in the OPERATING AREAS AND ROBOT OVERALL DIMENSIONS chapter.
For all models and versions, the loads indicated (at wrist and additional) can be moved to maximum performance within the entire working range by means of specific software that, by allowing maximum speeds to be reached in applications where the robot strokes are sufficiently wide, permits maximum accelerations according to the load declared and the cycle.
The design has been optimized by using three-dimensional CAD applications, and the structures have been dimensioned by means of finished element analysis (FEA); this has given excellent results in performance and reliability.

The attention to detail has resulted in a machine that is user-friendly in daily use, reducing the number of parts and facilitating access for servicing.

Robots require little maintenance, which is intuitive and does not require the use of any special equipment.

Interchangeability between robots of the same version is ensured: a robot can be replaced quickly without any complex corrective operations on the program.

Each robot is equipped with a Control System that conforms to European Union safety standards and all the other most important standards.

Connection cables between the control and the robot have "plug-in" connectors.

Safety is guaranteed by the availability of a series of optional equipment in compliance with the most severe European and international standards.

The SMART NH1 - NH2 - NH3 versions are pre-engineered to incorporate a spot welding dressing (optional) to beyond Ax3, thus eliminating the need to incorporate other bulky and unreliable devices.

The SMART NH4 version has a special spot welding and/or handling dressing that runs entirely inside the robot, from the base to the tool coupling flange.

This solution, made possible thanks to the use of a hollow wrist so that the bundle of hoses and cables can be housed in the forearm, enhances the reliability of the dressing and offers the following practical advantages:

– defined overall dimensions of robot and dressing, for more simple and reliable off-line programming.
– simple installation and programming due to the elimination of the restrictions deriving from the overall dimensions of the application assemblies
– smaller external overall dimensions with increased penetration
– high “real” payload for greater ease of use
– greater reliability and longer life, less maintenance because the bundle of cables and hoses are protected by the forearm

The SH (shelf) versions are intended for installation on platform in those applications where the working area has to be placed under the installation platform.

The P (press) versions are particularly suitable for handling of parts in press lines.

2.2 Robot mechanical features

Each robot consists of an anthropomorphic structure with 6 degrees of freedom.

The fixed base is secured to the floor by six M24 screws and precisely located in relation to the mounting plate by means of two special Ø 30 mm pins.

On the fixed base a column with the axis 2 gear reducer and balancing assembly rotates around the vertical rotation axis (axis 1).

In all the versions, axis 2 is balanced by compression springs in a suitable housing; this solution does not require maintenance.

An arm connects axis 2 to the forearm that includes the gearmotors of axes 3-4-5-6.

The wrist is located at the end of the forearm: in the SMART NH4 it is of the “hollow” type, capable of housing the complete dressings. The SMART NH1, NH2, NH3 versions feature a spherical wrist.

The robot axes are equipped with software limit stop (programmable) and /or mechanical shock absorber stops supplied as standard or on request; the strokes of the main axes (axes 1-2-3) can be limited by means of additional mechanical shock absorber stops, according to specific application requirements.

A mobile mechanical shock absorber stop is available upon request for axis 1 only.

Tab. 2.2 - Limit stops available

Robot Model	Standard		Optionals	
	Software limit stop	Mechanical hard stop	Adjustable mechanical limit stop	
SMART NH1	Ax 1-2-3-4-5-6	Ax 1-2-3-4-5	Ax 1-2-3	Ax 1 on-off
SMART NH2	Ax 1-2-3-4-5-6	Ax 1-2-3-5		
SMART NH3	Ax 1-2-3-4-5-6	Ax 1-2-3-5		
SMART NH4	Ax 1-2-3-4-5-6	Ax 1-2-3 (1)		

– (1) On axes 4-5-6 of the NH4 only, there are limit switches that have the sole function of enabling a correct calibration of the axes while protecting the cables inside the forearm.

The reducers are of the type with zero clearance, specifically designed for robot applications.

All reducers are all oil lubricated to ensure maximum efficiency; a complete oil change is only required after 15,000 hours of operation, which is equivalent to about 3 years working through three shifts.

The motors are of the AC brushless type and incorporate the brake and encoder.

2.3 Interchangeability

The interchangeability of robots of the same version is a fundamental characteristic in order to enable rapid substitution, or to transfer the same program to another robotic station.
This characteristic is guaranteed by:

– adequate construction tolerances of all the parts that make up the structure

– precise robot location on the mounting plate by means of two pins (supplied with the robot)

– possibility of bringing the axes to a known position (Calibration) using a specific tool (the same for all axes and all models)

– optional possibility of using TV cameras to identify the actual geometry of the robot and of using specific offset software.

These features make it possible to transfer programs between robots of the same version.
The above-mentioned characteristics are indispensable for effective “off-line programming” executed in virtual environment.

2.4 Calibration

Calibration is the operation that makes it possible to bring the robot axes to a known position to ensure the correct repetition of programmed cycles and interchangeability between machines of the same version.

There are two calibration methods:

– precise calibration: executed using a special tool that is the same for all axes and all models. This operation must be executed after special maintenance operations involving the separation of the kinematic chain between the motor and the robot axis, or when particularly demanding cycles regarding precision have to be executed.

– calibration using location notches enables rapid but improper calibration with less precision, and it may not restore robot movements with the precision that is required by the specific application. Calibration by notches consists of bringing the robot axes onto the calibration notches, aligning them with precision by sight, without using specific tools, executing the calibration commands axis by axis.

3. TECHNICAL CHARACTERISTICS

3.1 Overview

This chapter contains views and characteristics of the available SMART NH4 robots.

The working volume and the overall dimensions of all the robots available are contained in Chap.4. - Operating Areas and Robot Overall Dimensions

Fig. 3.1 - SMART NH4-165-3.0 overall view

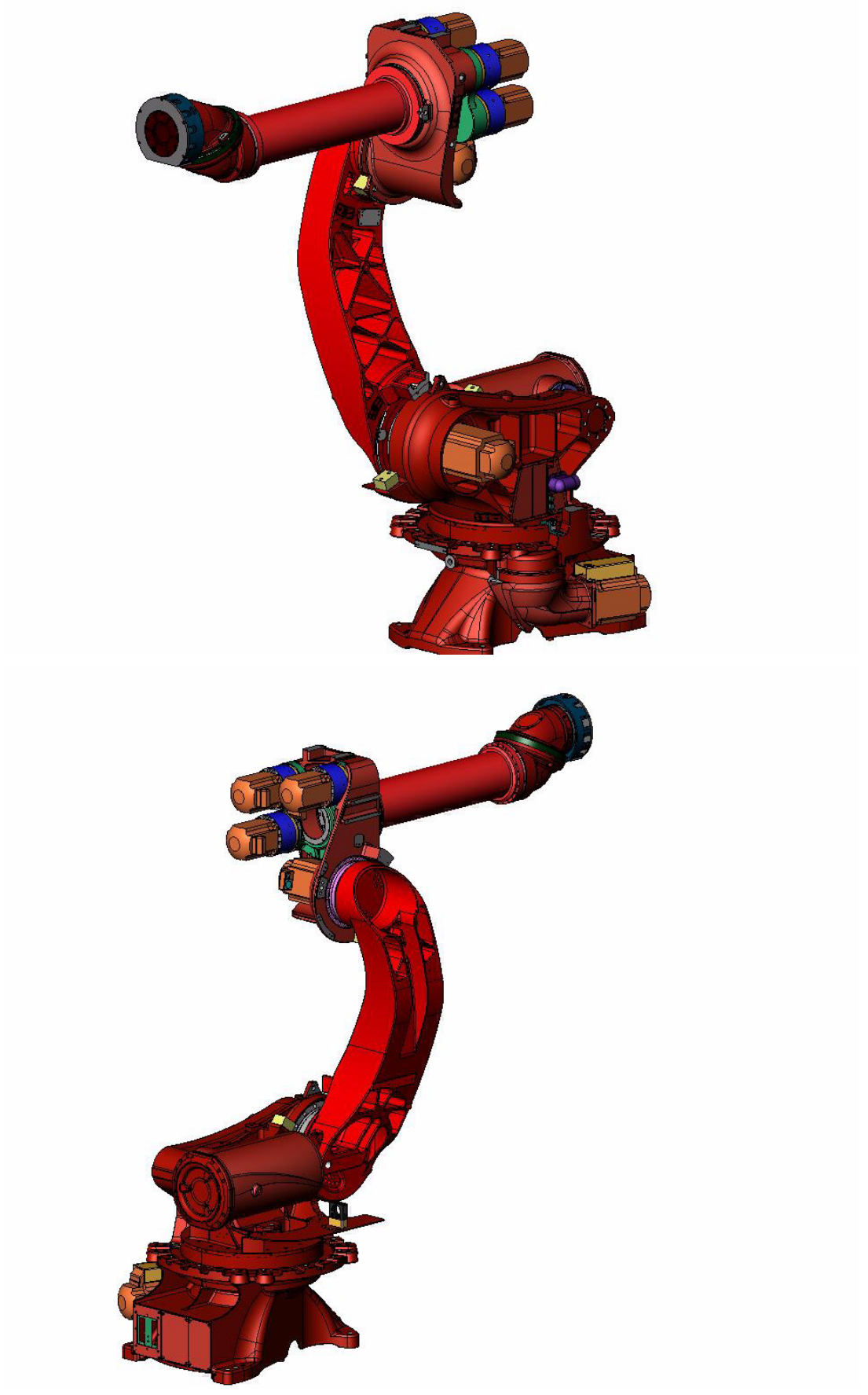


Fig. 3.2 - SMART NH4-200-2.7 overall view

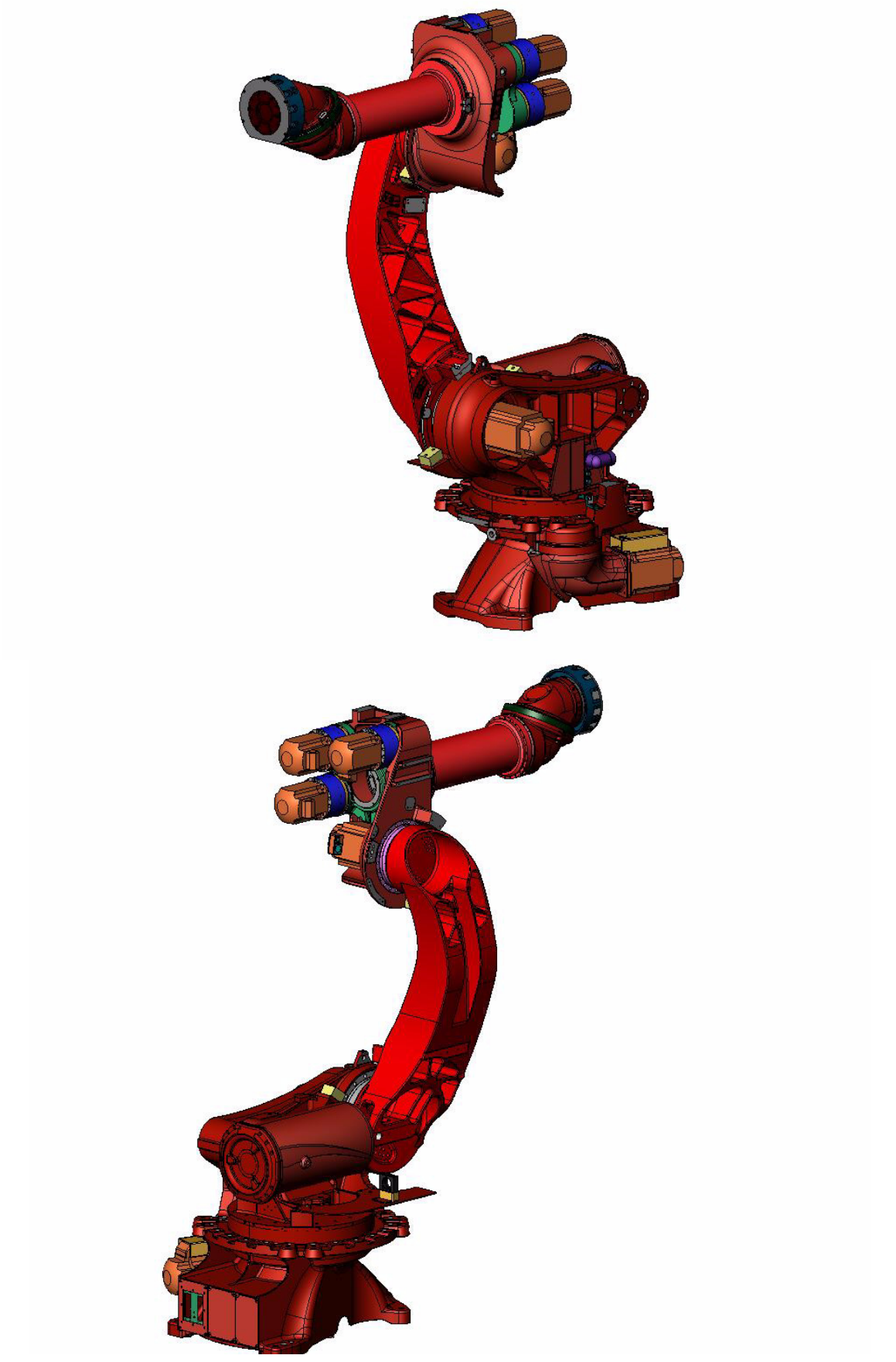
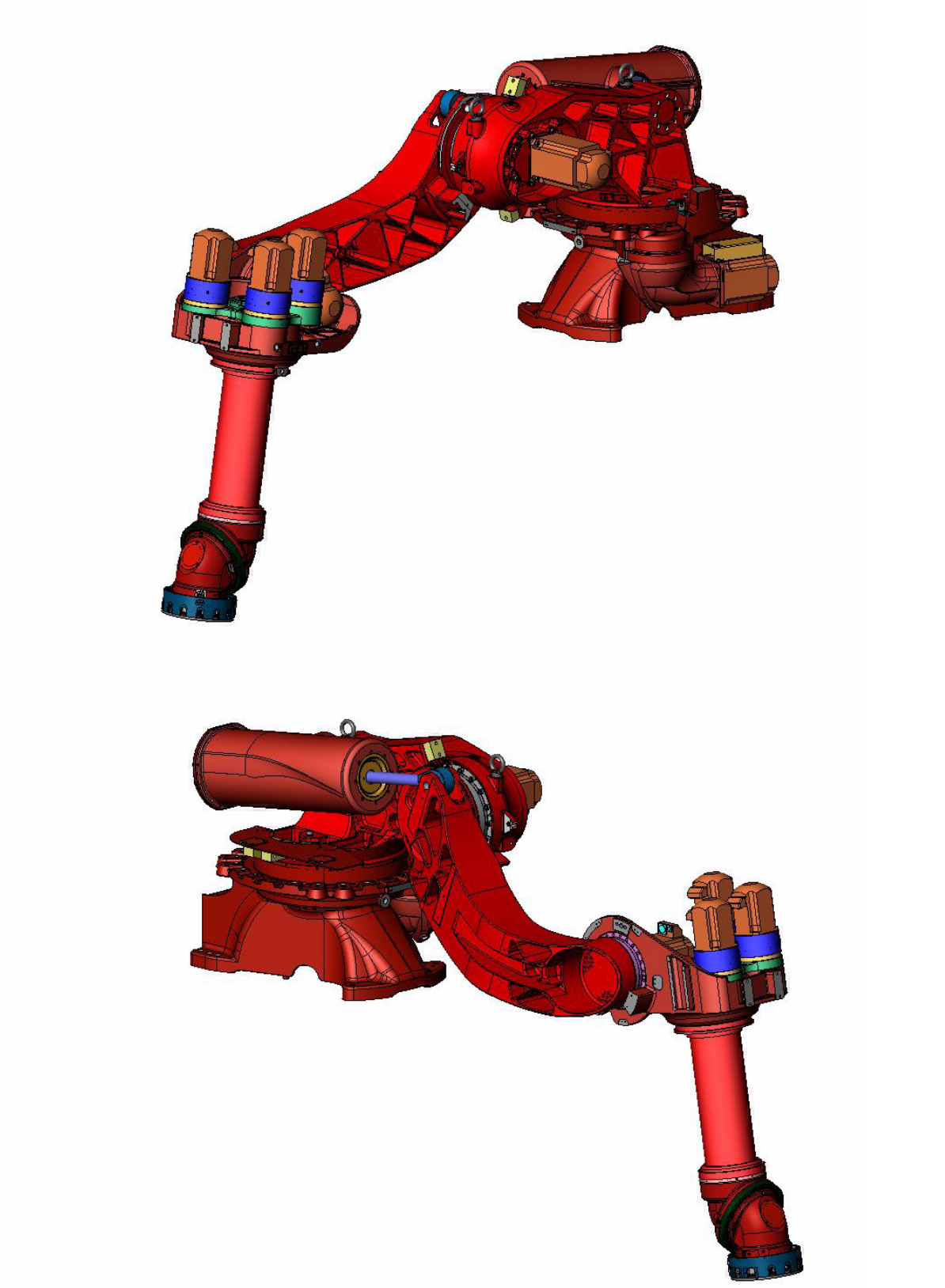


Fig. 3.3 - SMART NH4 SH-200-3.1 overall view

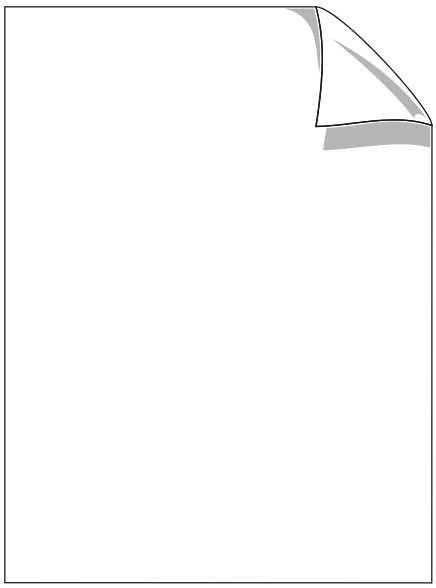


Tab. 3.1 - Characteristics and performance

VERSION		NH4-165-3.0	NH4-200-2.7	NH4 SH-200-3.1
Structure / n° axes		Anthropomorphous 6 axes	Anthropomorphous 6 axes	Anthropomorphous 6 axes
Load at wrist [kg]		165 kg *(363.76 lb)*(1)	200 kg *(485.01lb)* (1)	200 kg *(485.01lb)* (1)
Additional load on forearm [kg]		50 kg *(110.23 lb)* (2)	50 kg *(110.23 lb)* (2)	50 kg *(110.23 lb)* (2)
Torque axis 4		981 Nm	981 Nm	981 Nm
Torque axis 5		981 Nm	981 Nm	981 Nm
Torque axis 6		687 Nm	687 Nm	687 Nm
Stroke / (Speed)	Axis 1	+/- 180°(85°/s)	+/- 180°(85°/s)	+/- 180°(85°/s)
	Axis 2	+75°/-60°(90°/s)	+75°/-60°(90°/s)	+160°/-30°(78°/s)
	Axis 3	+110°/-170°(90°/s)	+110°/-170°(90°/s)	+110°/-170°(90°/s)
	Axis 4	+/- 200°(°143°/s)	+/- 200°(143°/s)	+/- 200°(143°/s)
	Axis 5	+/- 200°(143°/s)	+/- 200°(143°/s)	+/- 200°(143°/s)
	Axis 6	+/- 200(205°/s)	+/- 200(205°/s)	+/- 200(205°/s)
Repeatability [mm]		+/-0.15 mm *+/-0.0059 in*	+/- 0.10 mm *+/-0.0039 in*	+/- 0.15 mm *+/-0.0059 in*
Robot weight		2100 kg *(4629.70lb)*	2100 kg *(4629.70lb)*	2350 kg *(5180.85lb)*
Tool coupling flange		ISO 9409-1-A160 ISO 9409-1-A125	ISO 9409-1-A160 ISO 9409-1-A125	ISO 9409-1-A160 ISO 9409-1-A125
Motors		AC brushless	AC brushless	AC brushless
Position measurement system		with encoder	with encoder	with encoder
Balancing	Axis 2:	spring	spring	spring
Total power installed		12 kVA / 18.5 A	12 kVA / 18.5 A	12 kVA / 18.5 A
Protection class		IP65	IP65	IP65
Working temperature		0 [°C] to+ 45[°C] *+32[°F]÷+113 [°F]*	0[°C] to + 45[°C] *+32[°F]÷+113 [°F]*	0[°C] to + 45[°C] *+32[°F]÷+113 [°F]*
Storage temperature		- 40[°C] to +60[°C] *-40[°F]÷ +140 [°F]*	- 40 [°C] to +60[°C] *-40[°F]÷ +140 [°F]*	- 40 [°C] to+60[°C] *-40[°F]÷ +140 [°F]*
Colour of robot (standard)		Red RAL 3020	Red RAL 3020	Red RAL 3020
Assembly position		Floor	Floor	Shelf

(1) See:Chap.5. - Loads at Wrist and Additional Loads par. 5.2 Determination of max loads at wrist flange (QF) on page 5-2

(2) See: Chap.5. - Loads at Wrist and Additional Loads par. 5.3 Additional loads (QS) on page 5-5



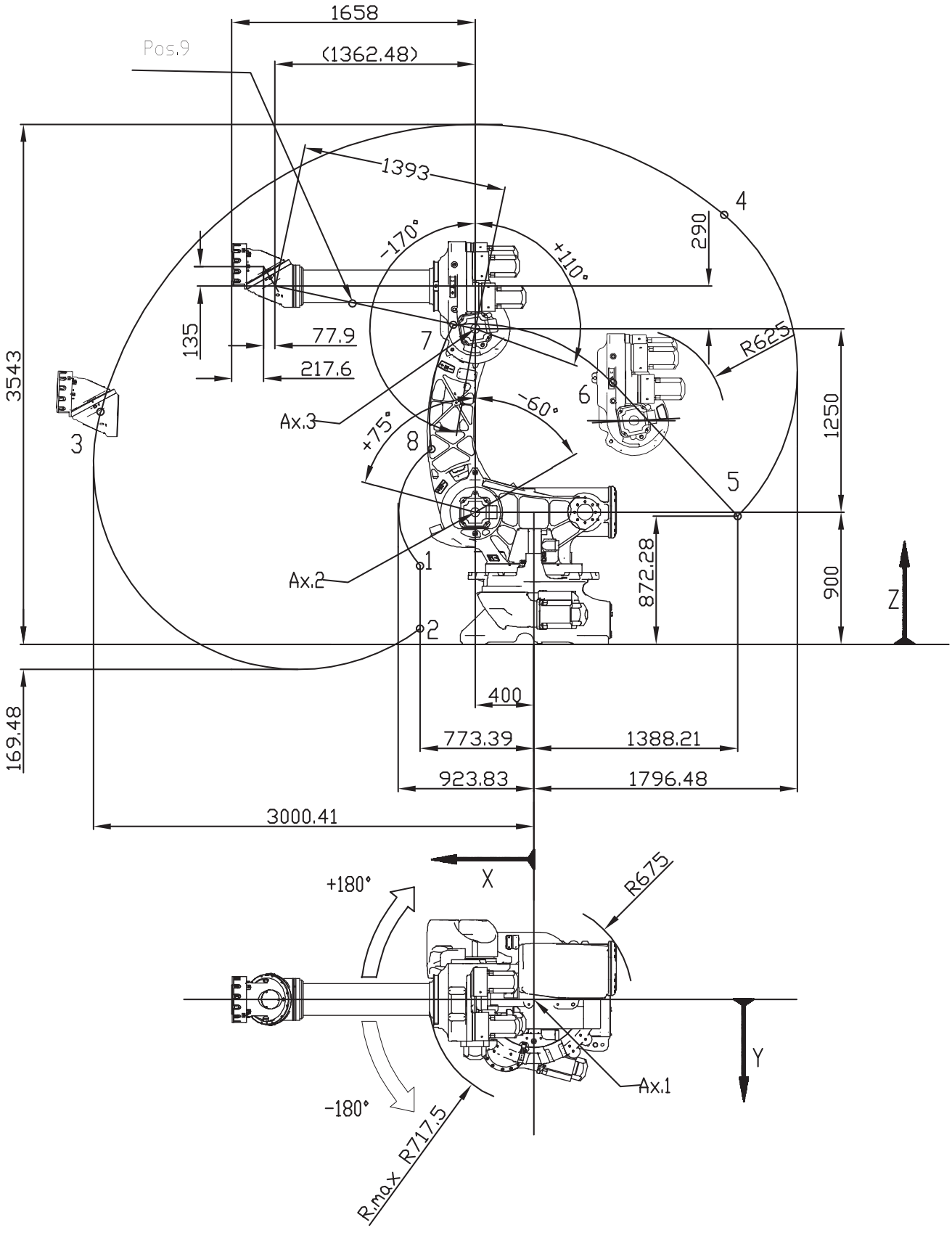
4. OPERATING AREAS AND ROBOT OVERALL DIMENSIONS

This chapter contains the drawings of the work volumes for the SMART NH4 robots listed below:

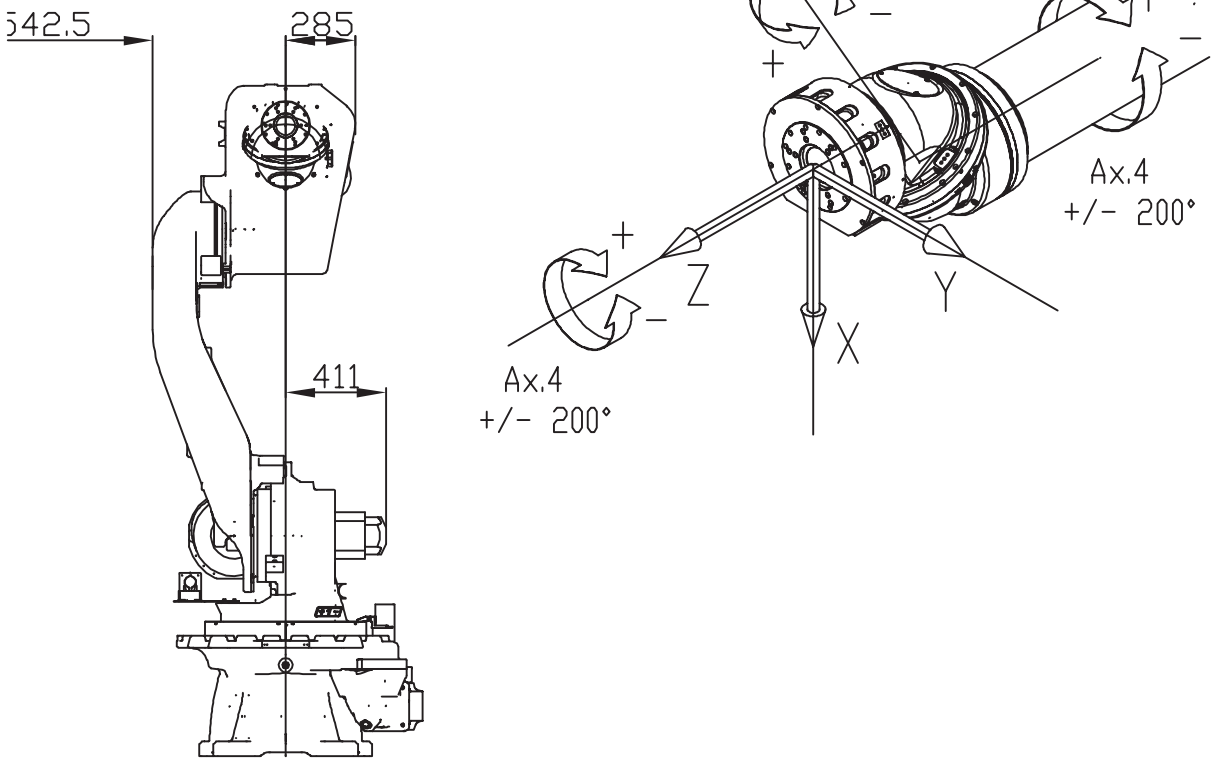
- SMART NH4 -165-3.0 Operating area
- SMART NH4 - 200-2.7 Operating area
- SMART NH4 200-3.1/SH Operating area
- SMART NH4 - 200-2.7- Operating area limits

The operating areas are shown at wrist centre.

4.1 SMART NH4 -165-3.0 Operating area



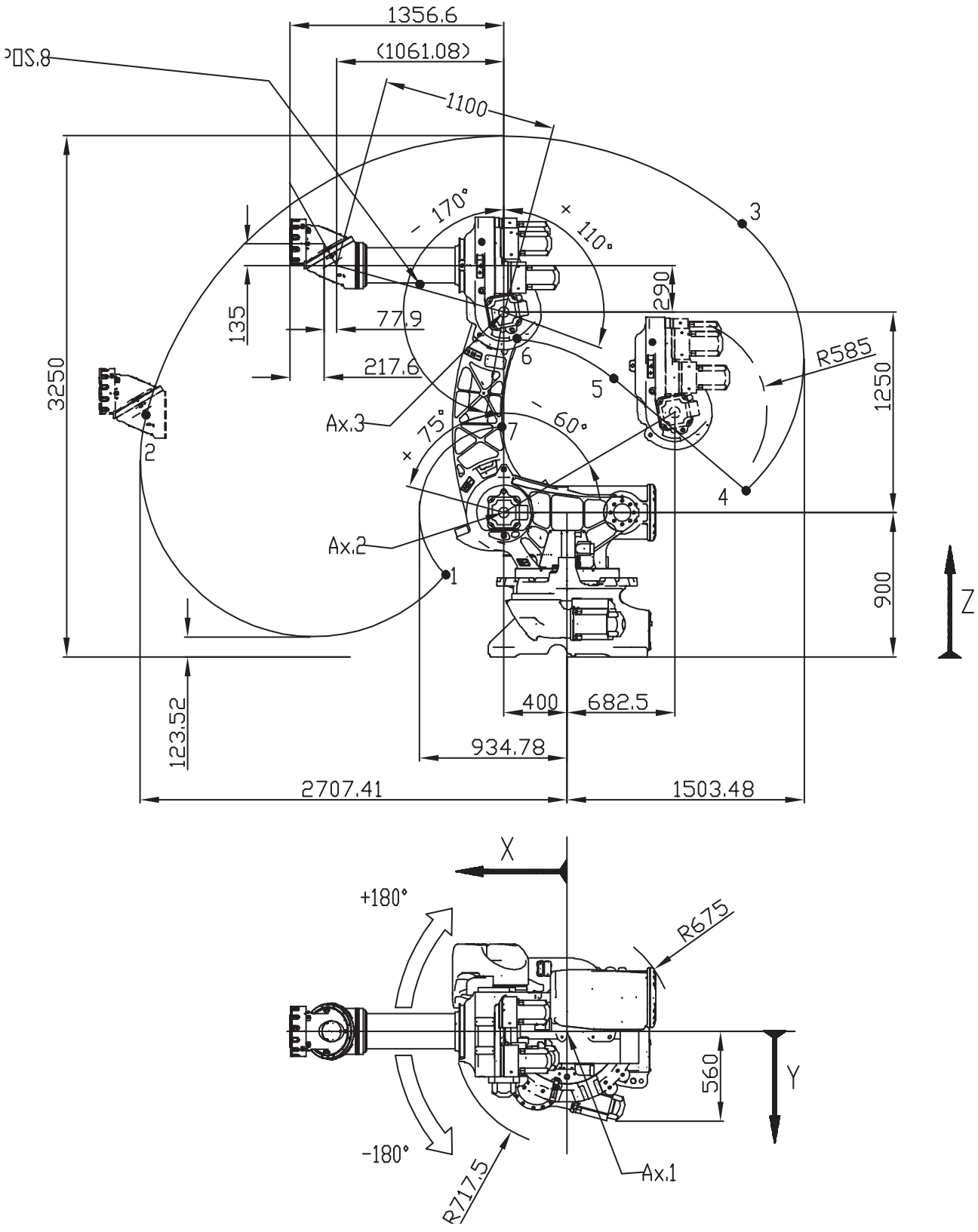
4.2 SMART NH4-165-3.0 Operating area



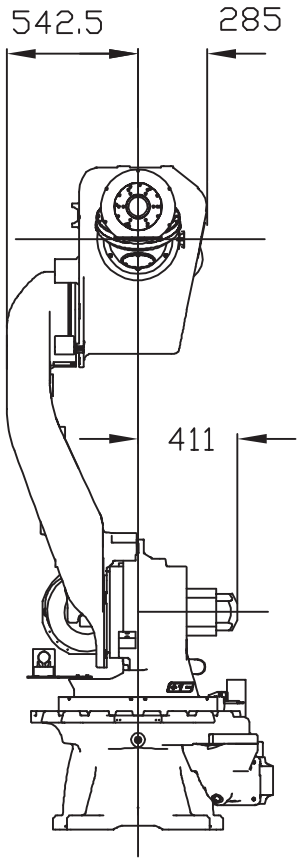
Pos.	X[mm]	Z[mm]	Ax.2[deg]	Ax.3[deg]
1	773.39	532.61	+40°	-170°
2	773.39	107.79	+75°	-153.79°
3	2952.94	1584.06	+75°	-12.02°
4	-1298.94	2924.66	-40°	-12.02°
5	-1388.21	872.28	-40°	+83°
6	-540.08	1779.17	+19.67°	+110°
7	547.60	2178.63	-60°	-134.03°
			+73.17°	+110°
8	696.97	1331.89	-60°	-170°
9	1234.21	2322.88	-25°	-115°

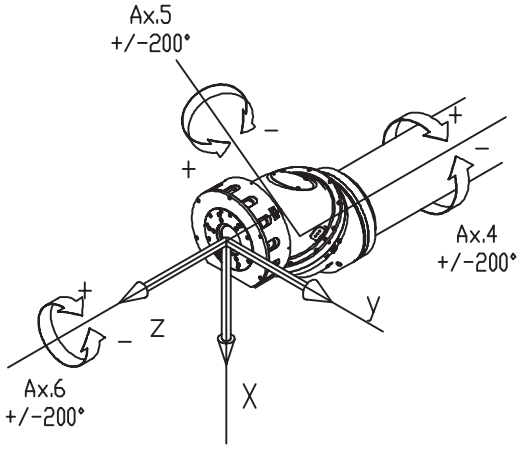
Joints in calibration position (pos.9)					
Ax 1	Ax 2	Ax 3	Ax 4	Ax 5	Ax 6
0°	-25°	-115°	0°	0°	0°

4.3 SMART NH4 - 200-2.7 Operating area



4.4 SMART NH4 - 200-2.7 Operating area

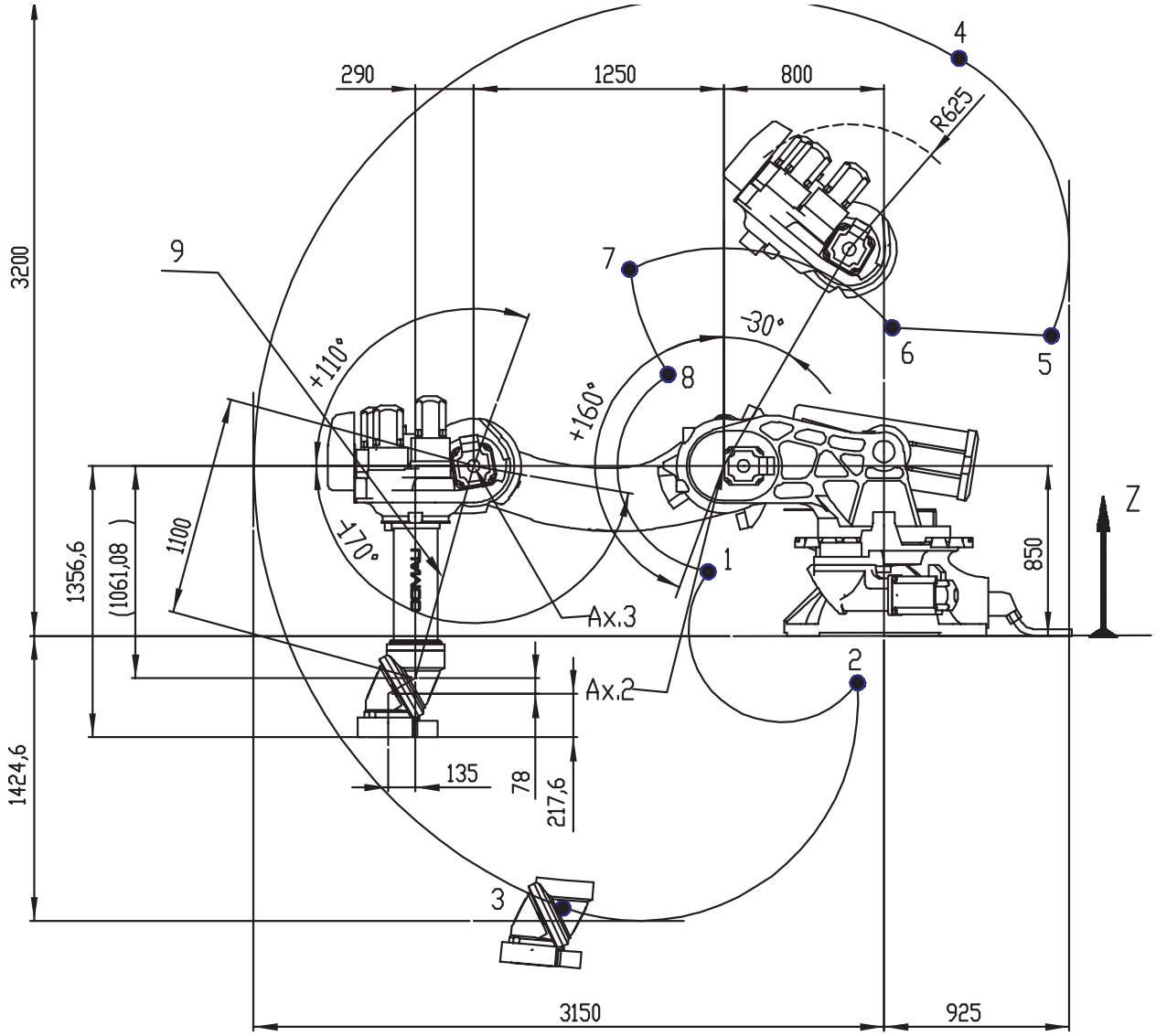


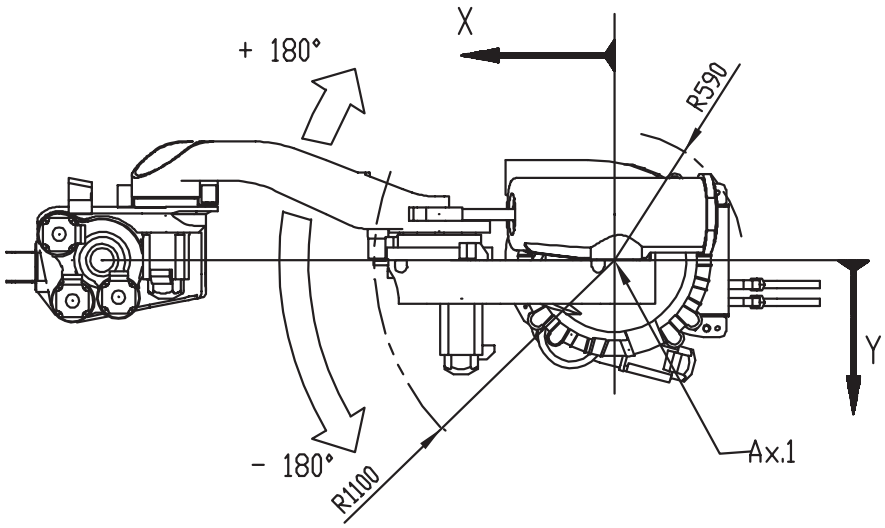


Pos.	X[mm]	Z[mm]	Ax.2(°)	Ax.3(°)
1	512.26	768.30	+75°	-170°
2	2669.93	1508.22	+75°	-15.29°
3	-1110.55	2700.20	-40°	-15.29°
4	-1135.44	1036.43	-40°	+83°
5	-296.82	1735.69	+15.79°	+110°
6	316.71	1984.90	-60°	-140.57°
			+51.22°	+110°
7	413.75	1434.60	-60°	-170°
8	932.81	2333.88	-25°	-115°

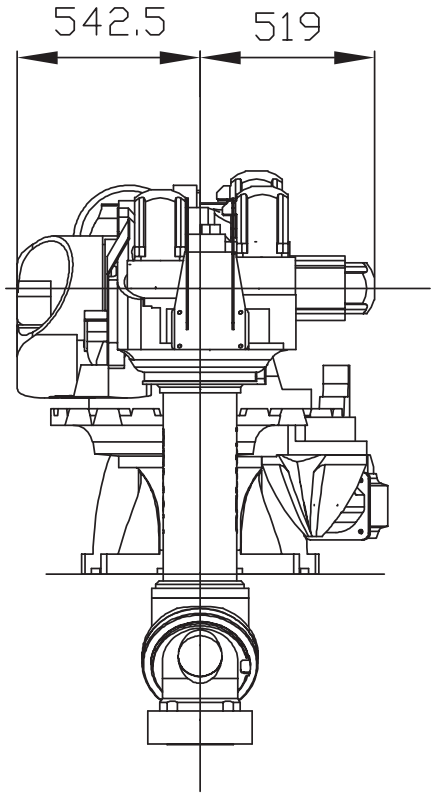
Joints in calibration position (pos.8)					
Ax 1	Ax 2	Ax 3	Ax 4	Ax 5	Ax 6
0°	-25°	-115°	0°	0°	0°

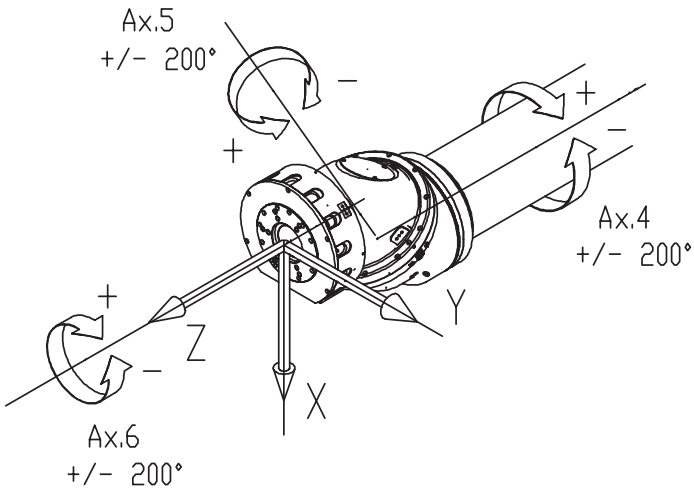
4.5 SMART NH4 200-3.1/SH Operating area





4.6 SMART NH4 200-3.1/SH Operating area

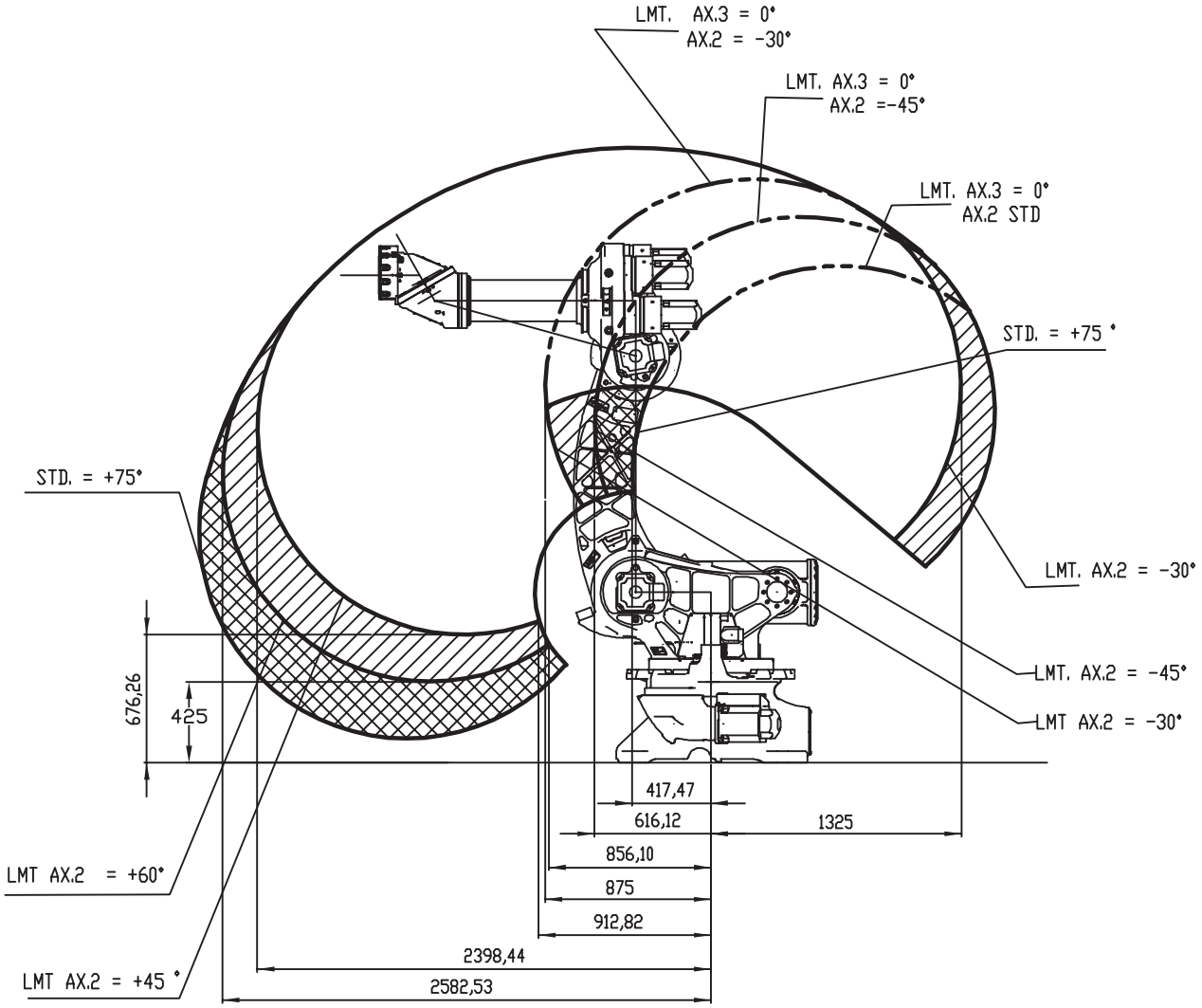




Pos	X[mm]	Z[mm]	Ax.2(°)	Ax.3(°)
1	879.30	321.13	+110°	-170°
2	131.25	-234.22	+160°	-130°
3	1603.74	-1358.27	+160°	-15.29°
4	-375.00	2885.15	-30°	-15.29°
5	-722.90	1297.11	-30°	+80°
6	-40.92	1540.50	+5°	+110°
7	1270.31	1831.19	-30°	-140.57°
			+81.22°	+110°
8	1079.20	1306.11	-30°	-170°
9	2222.88	317.20	+65°	-115°

Joints in calibration position (pos.9)					
Ax 1	Ax 2	Ax 3	Ax 4	Ax 5	Ax 6
0°	-65°	-115°	0°	0°	0°

4.7 SMART NH4 - 200-2.7- Operating area limits



LMT = Operation are with axes limits
STD = Standard operating area

5. LOADS AT WRIST AND ADDITIONAL LOADS

5.1 Overview

This chapter describes the procedures to determine the maximum load that can be applied to the robot flange and any additional load applied on the forearm. It also contains the graphs needed to define:

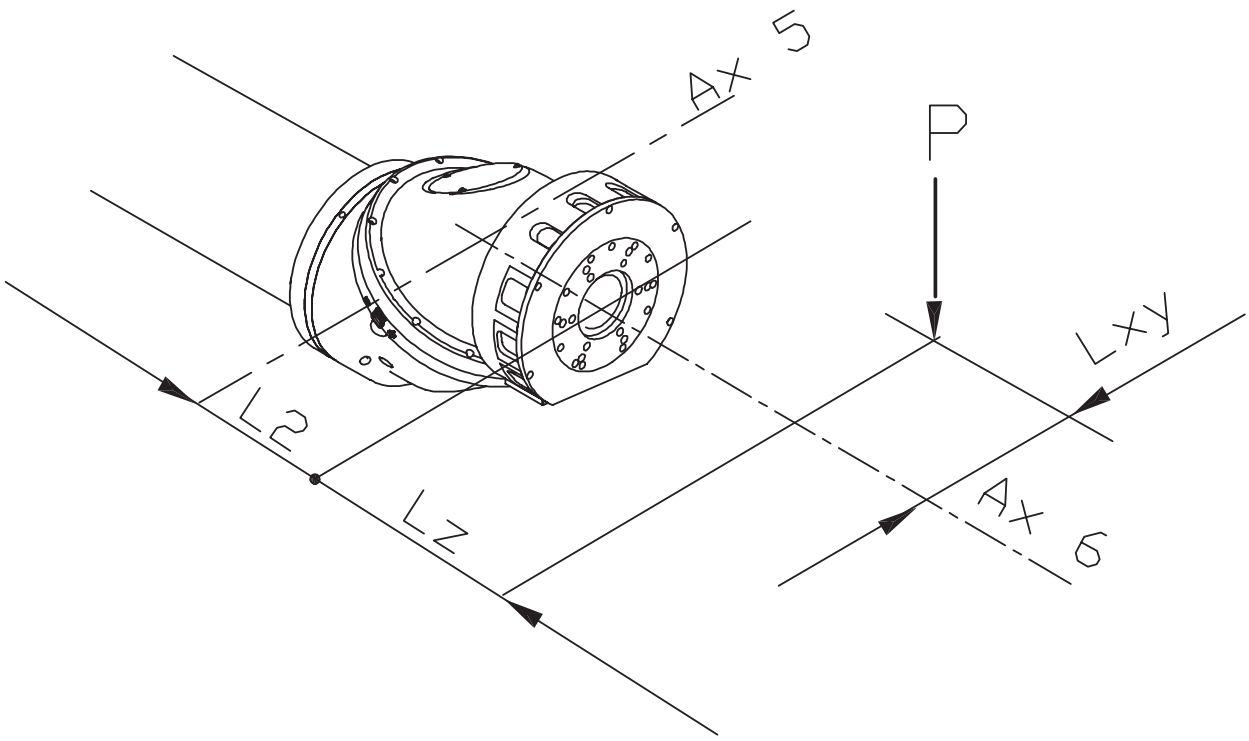
– load capacity on the flange according to the distance from the centre of gravity;
  • Fig. 5.2 - SMART NH4-165 - 3.0 Maximum load capacity at the flange
  • Fig. 5.3 - SMART NH4 200 - 2.7- SMARTNH4 200-3.1/SH Maximum load capacity at the flange

– areas where the centre of gravity is allowed in relation to the additional load
  • Fig. 5.4 - Centre of gravity position of additional loads

– centre distances and dimensions of holes to fasten any fixtures applied on the robot forearm (see Fig. 5.5 - Drilling for fixture assembly)

Abbreviations
In this chapter the following abbreviations have been used:
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;
Lz = distance of load P centre of gravity from the flange axis;
Lxy = distance of load P centre of gravity from axis 6.

Fig. 5.1 - Centre of gravity co-ordinates of the applied load

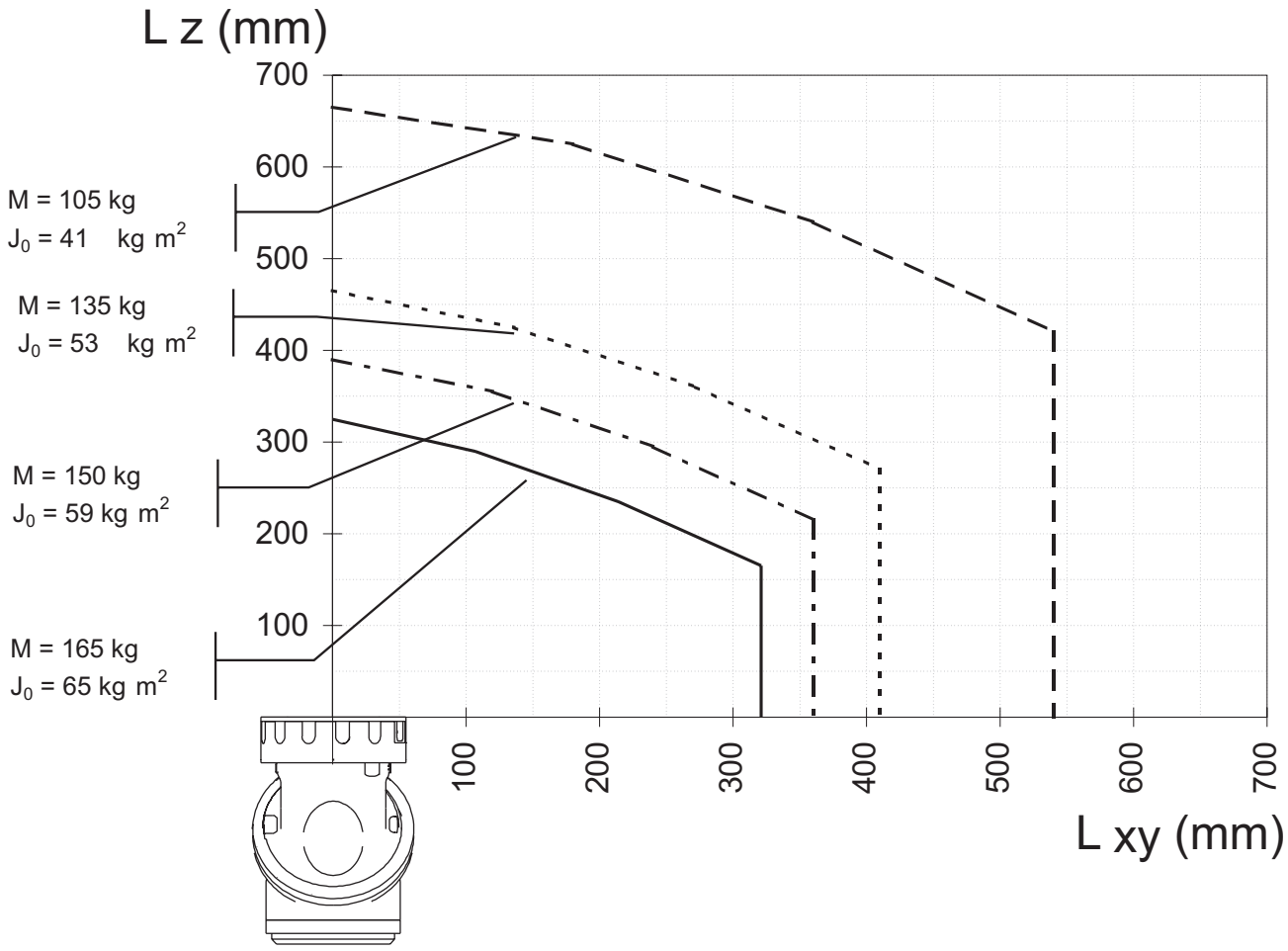


5.2 Determination of max loads at wrist flange (Q_F)

The maximum load that can be applied to the flange is defined using the wrist load graphs, where the curves of maximum load Q_F are plotted according to co-ordinates Lxy and Lz of the load centre of gravity. Each curve is plotted for specific load values and inertia torques

The area below the load curve defines the Lz and Lxy centre of gravity distances allowed for the application of the load indicated on it.

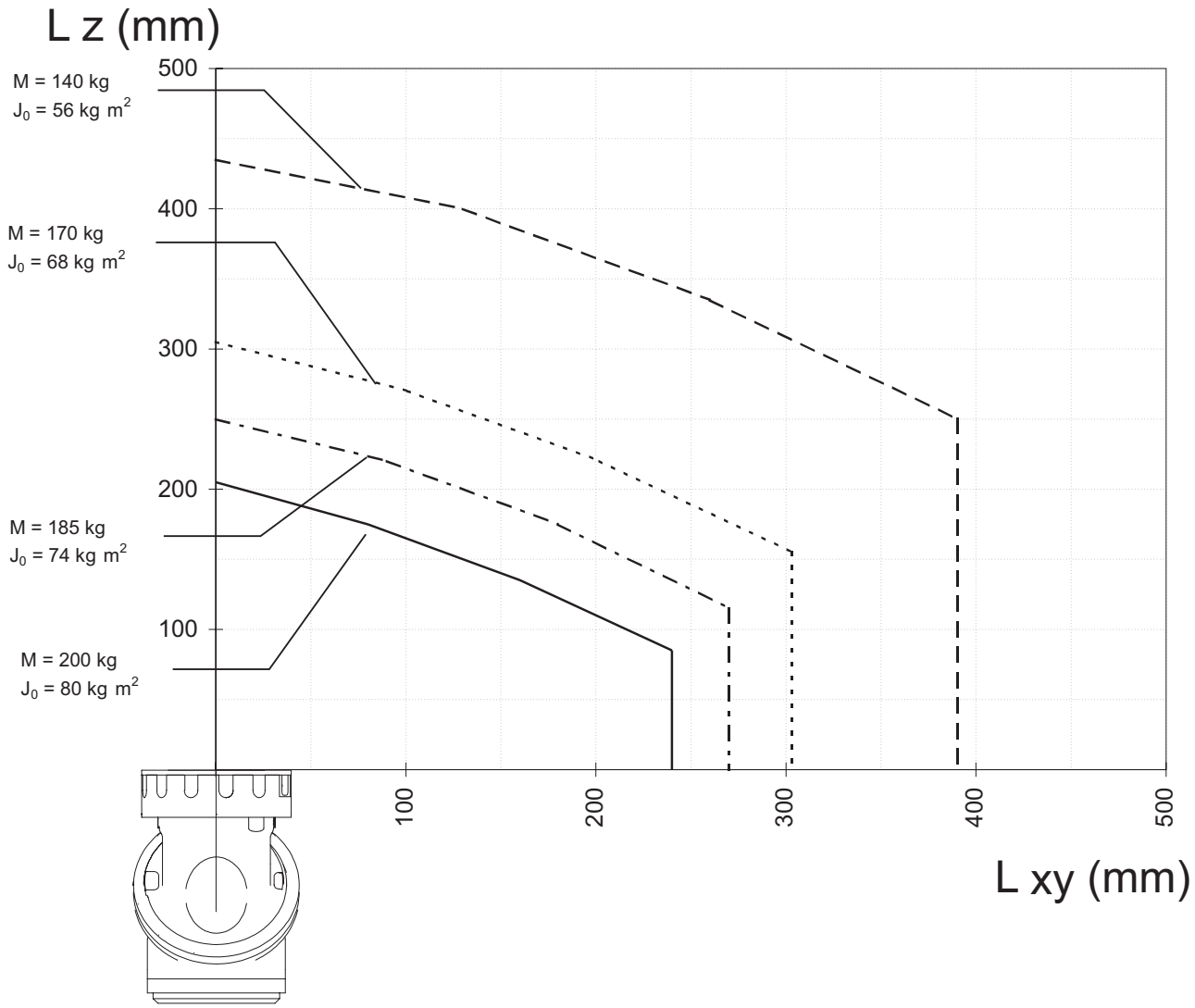
Fig. 5.2 - SMART NH4-165 - 3.0 Maximum load capacity at the flange



Maximum static torques: axis 5 = 981 Nm - axis 6 = 687 Nm

Inertia J_0 specified in the graph curves refers to the centre of gravity of the load applied on the flange.

Fig. 5.3 - SMART NH4 200 - 2.7-
SMARTNH4 200-3.1/SH
Maximum load capacity at the flange



Maximum static torques: axis 5 = 981 Nm - axis 6 = 687 Nm

Inertia J_0 specified in the graph curves refers to the centre of gravity of the load applied on the flange.

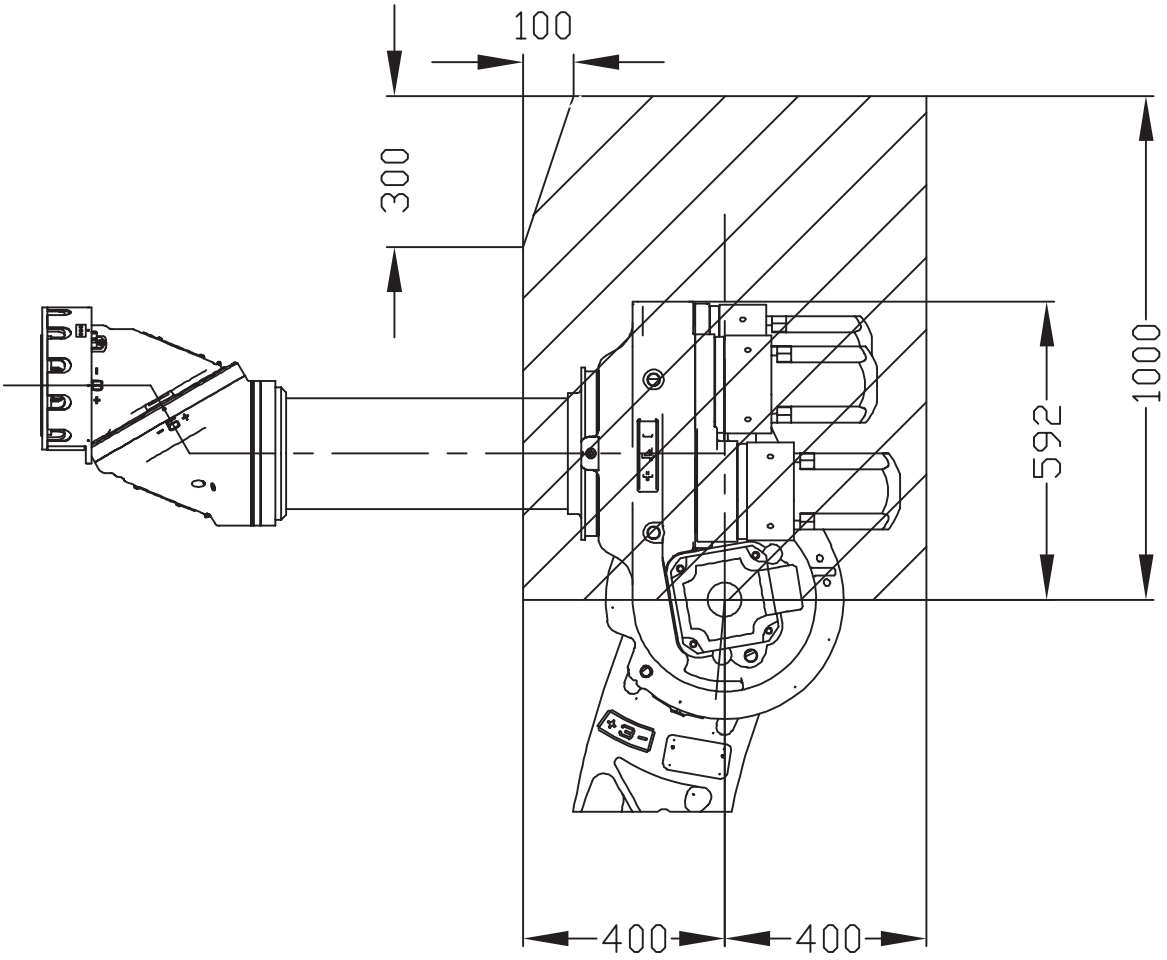
5.3 Additional loads (Q_S)

It is possible to apply an additional load Q_S on the forearm, besides the load on the flange Q_F, for all the robots, except the SH versions. The values of these loads are indicated in Tab. 5.1 - Maximum applicable loads.

In each application, the load centre of gravity applied on flange Q_F is to be within the area subtended by the curves of the graphs of the section "Determination of max loads at wrist flange (QF)" furthermore the centre of gravity of the additional load Q_S is to be within the graph area (Fig. 5.4 - Centre of gravity position of additional loads).

To install special fixtures on the robot, the holes on the robot forearm are to be used and coupled in Fig. 5.5 - Drilling for fixture assembly

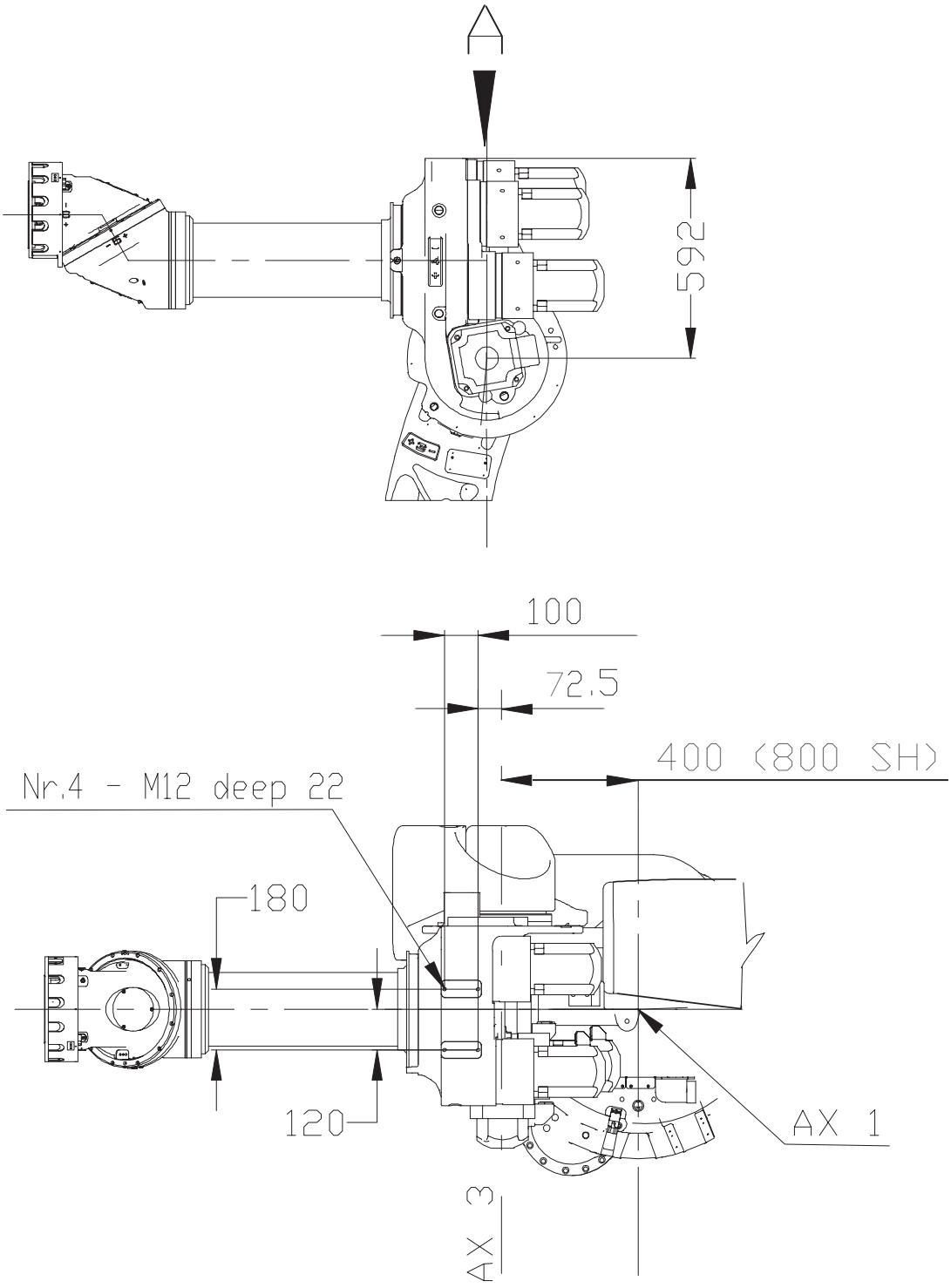
Fig. 5.4 - Centre of gravity position of additional loads

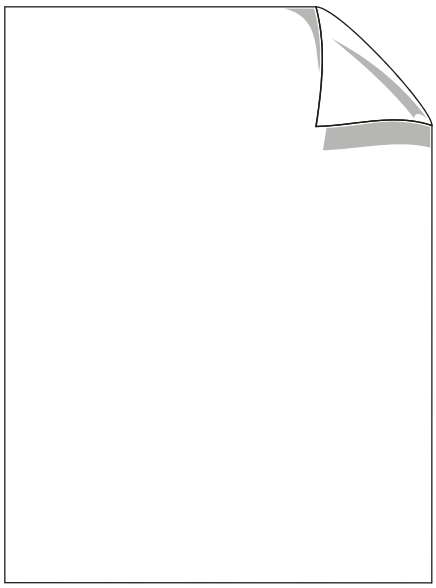


Tab. 5.1 - Maximum applicable loads

Max. total load	SMART NH4 165-3.0	SMART NH4 200-2.7
On flange Q_F	165 kg *(363.76lb)*	200 kg *(440.92lb)*
Additional on forearm Q_S	50 kg *(110.23 lb)*	50 kg *(110.23 lb)*

Fig. 5.5 - Drilling for fixture assembly





6. ROBOT FLANGE

This chapter contains the drawings of the tool coupling flange and the distributor assemblies for interconnection of external outfittings for welding with electric guns and handling and welding with pneumatic guns and handling.

6.1 Tool coupling flange

The drawings of the tool coupling flange show the centre distances of the holes to secure tools and the dimensions of the calibrated fixture used to make the precise calculation of the flange centre location when specific fixtures are installed.

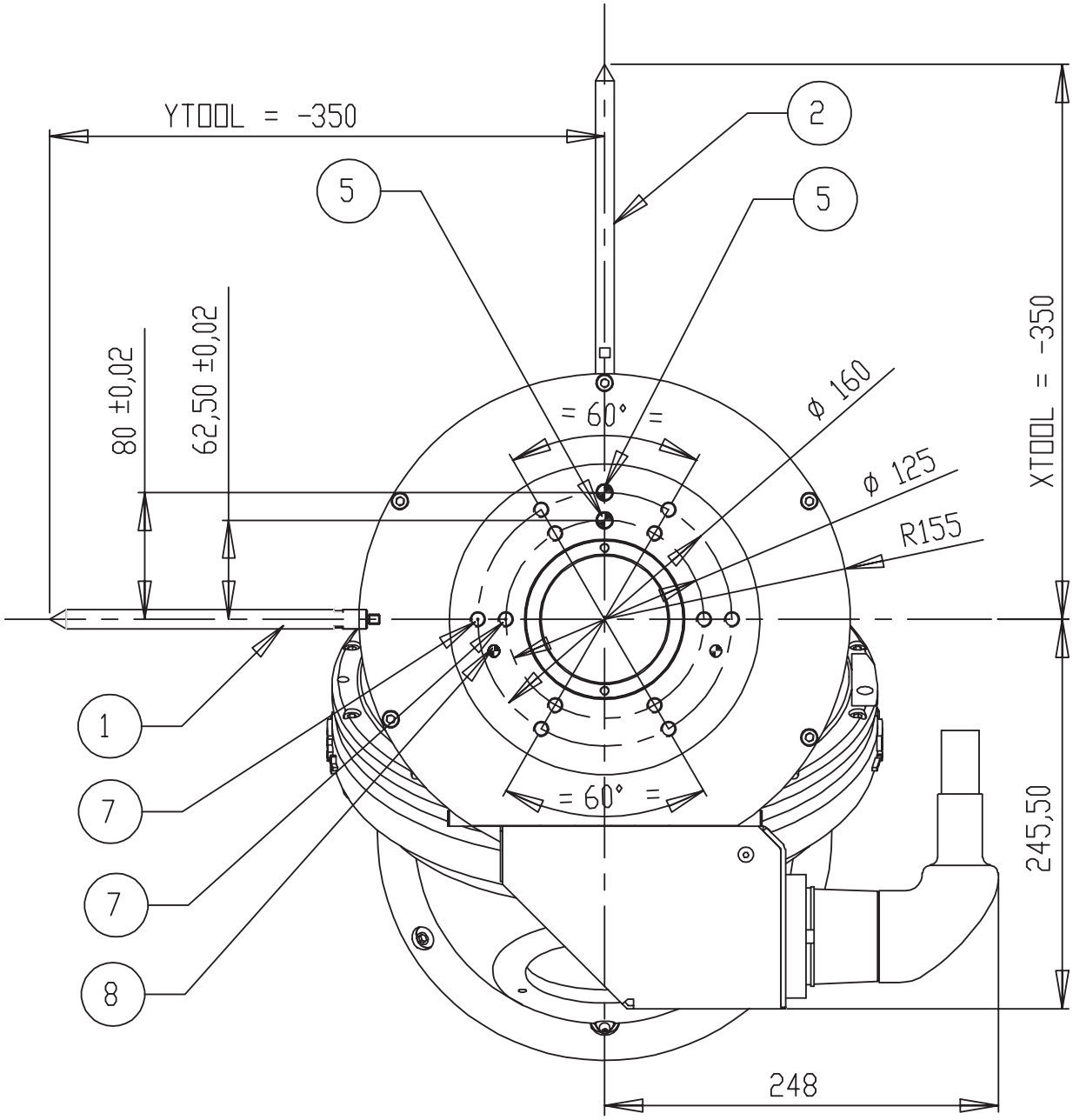
– Fig. 6.1 - SMART NH4 tool coupling flange - front view
– Fig. 6.2 - SMART NH4 Tool coupling flange - side view

6.2 Distributor assemblies flange

The drawings of the distributor assemblies indicate the positions and the names of the pneumatic and electrical connectors used for interfacing outside the welding outfitting.

– Fig. 6.3 - Distributor assembly for outfitting with electric gun welding and handling
– Fig. 6.4 - Distributor assembly for welding with pneumatic gun and handling

Fig. 6.1 - SMART NH4 tool coupling flange - front view

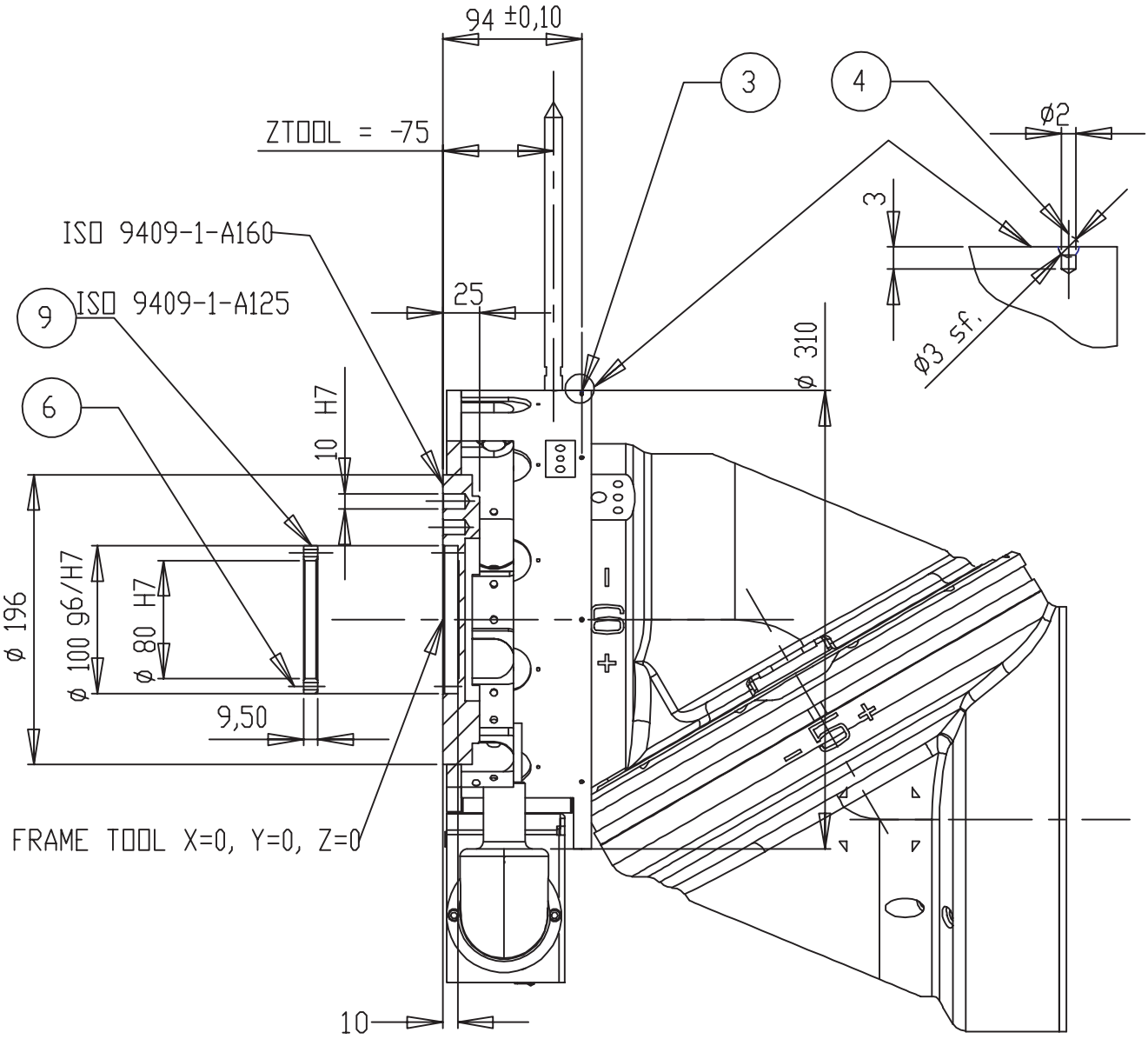


POS. 1 XTOOL= 0, YTOOL= -350, ZTOOL= -75

POS. 2 XTOOL= -350, YTOOL= 0, ZTOOL= -75

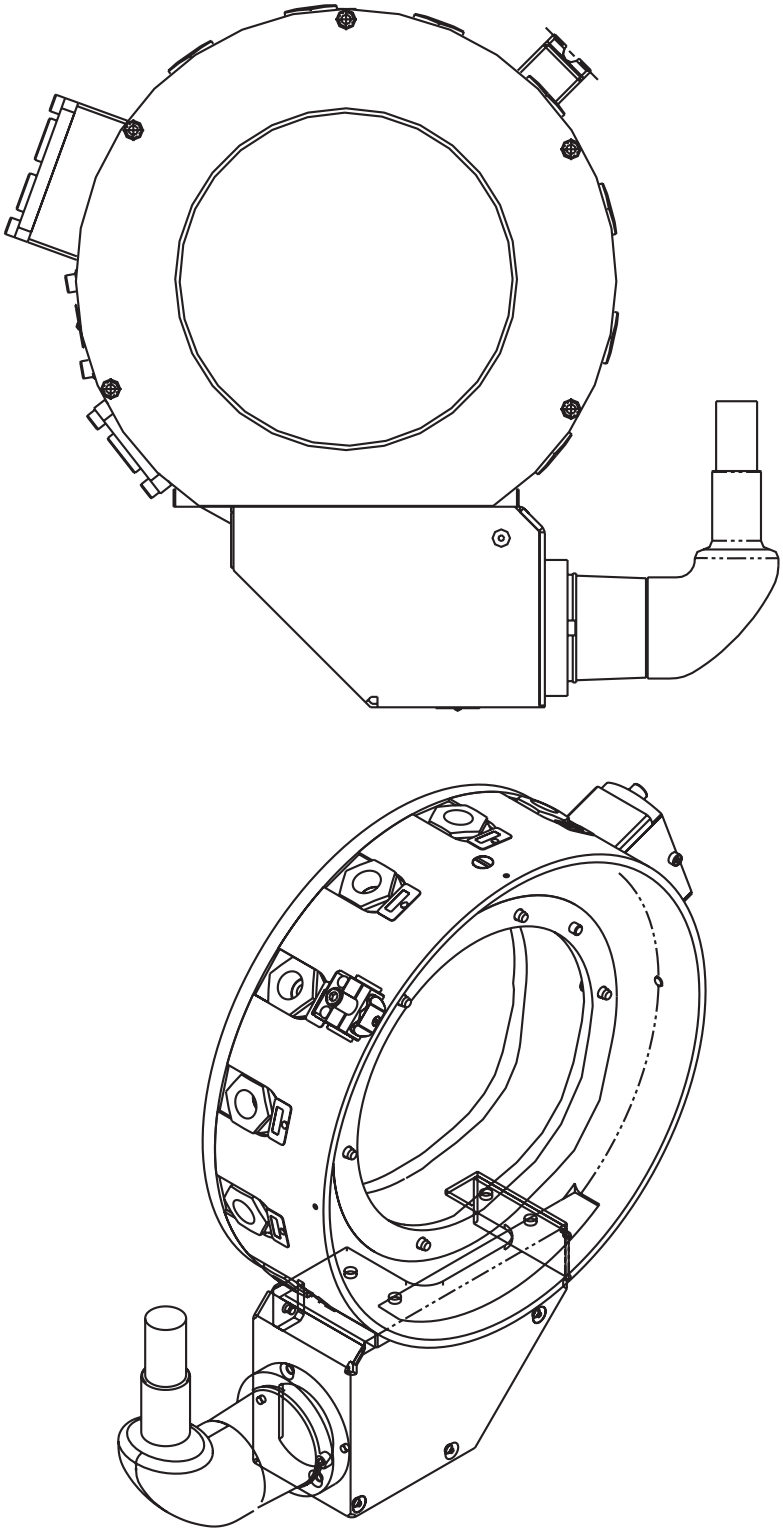
1. Calibrated fixture (L = 200mm) in assembly position 1
2. Calibrated fixture (L = 200mm) in assembly position 2
3. Spherical seat position at 0°
4. Ø3 spherical - n. 8 seats for robot position location- spherical seat depth is the same for the 8 positions
5. N. 1 + 1 hole Ø10H7 depth 15 for fixture locating pin
6. N° 2 holes M6 for extraction
7. N° 6 + 6holes M10 depth 18x60°
8. N. 2 holes Ø8H7 depth 15 mm for calibration level resting pins
9. Centring ring to convert flange in ISO 9409-1-A125

Fig. 6.2 - SMART NH4 Tool coupling flange - side view



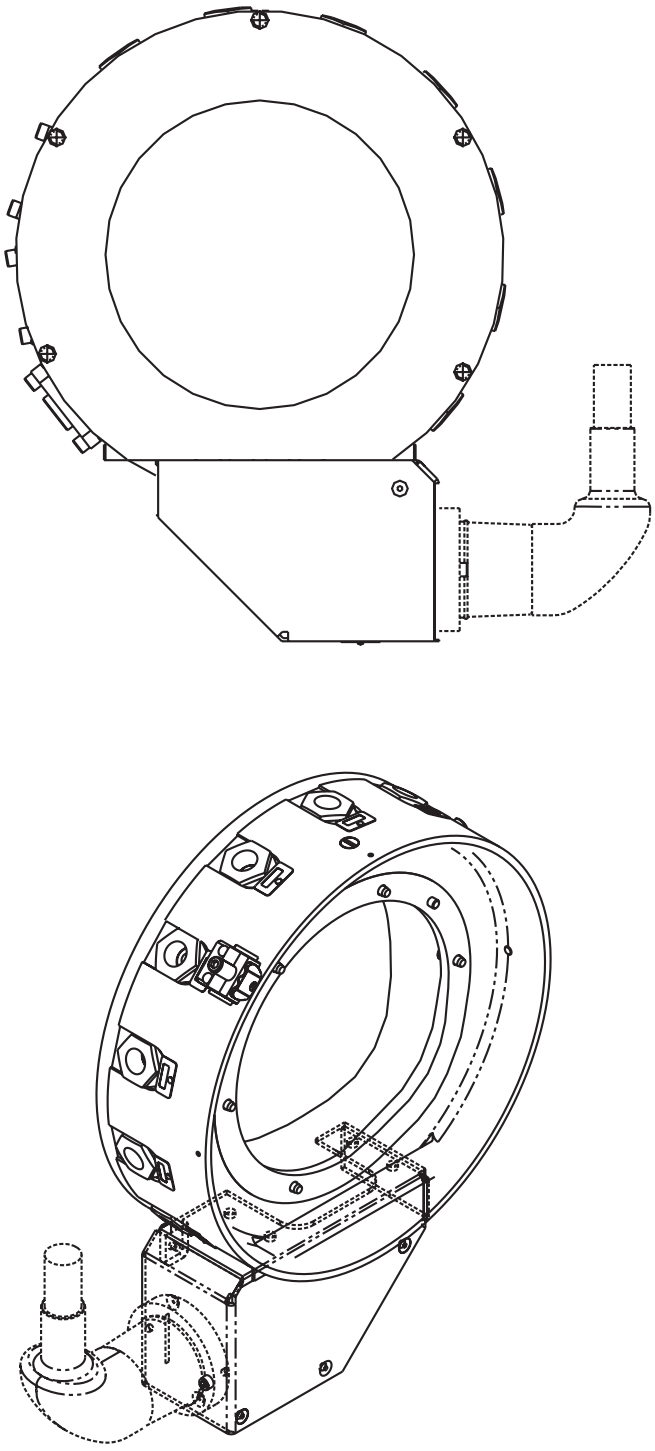
1. Calibrated fixture (L = 200mm)in assembly position 1
2. Calibrated fixture (L = 200mm) in assembly position 2
3. Spherical seat position at 0°
4. Ø3 spherical - n. 8 seats for robot position location- spherical seat depth is the same for the 8 positions
5. N. 1 + 1 hole Ø10H7 depth 15 for fixture locating pin
6. N° 2 holes M6 for extraction
7. N° 6 + 6 holes M10 depth 18x60°
8. N. 2 holes Ø8H7 depth 15 mm for calibration level resting pins
9. Locating ring to convert flange in ISO 9409-1-A125

Fig. 6.3 - Distributor assembly for outfitting with electric gun welding and handling

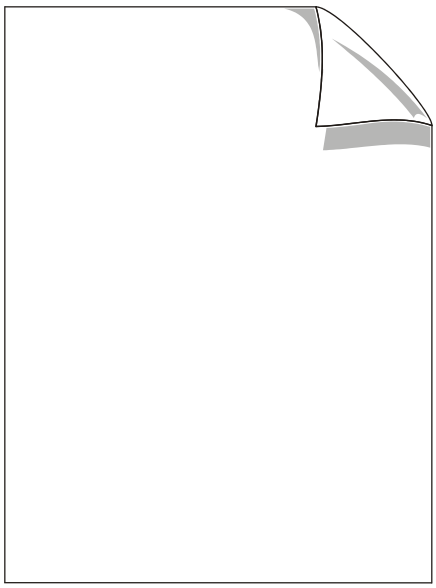


1. Female chock fitting Ø G 3/8” (qty 7)
2. Calibration block for axis 6

Fig. 6.4 - Distributor assembly for welding with pneumatic gun and handling



1. Female chock fitting Ø G 3/8” (qty 7)
2. Calibration block for axis 6



7. PREPARATION FOR ROBOT INSTALLATION

Before carrying out any type of installation operation carefully read Chap.1. - General Safety Precautions

7.1 Environment conditions

The environment for robot use is the usual workshop environment.

Avoid areas with corrosive vapours and excessive heat sources.

7.1.1 Environment data

- Operating environment temperature: 0 [°C] to+ 45[°C] (*+32[°F]÷+113 [°F]*)
- Relative humidity: 5% to 95% without condensation.
- Storage environment temperature: - 40[°C] to +60[°C] (*-40[°F]÷ +140 [°F]*)
- Maximum temperature gradient: 1.5 °C/min.

7.1.2 Operating space

The maximum overall dimensions of the robot operating area is indicated in the chapter OPERATING AREA AND ROBOT OVERALL DIMENSIONS from the centre of the wrist.

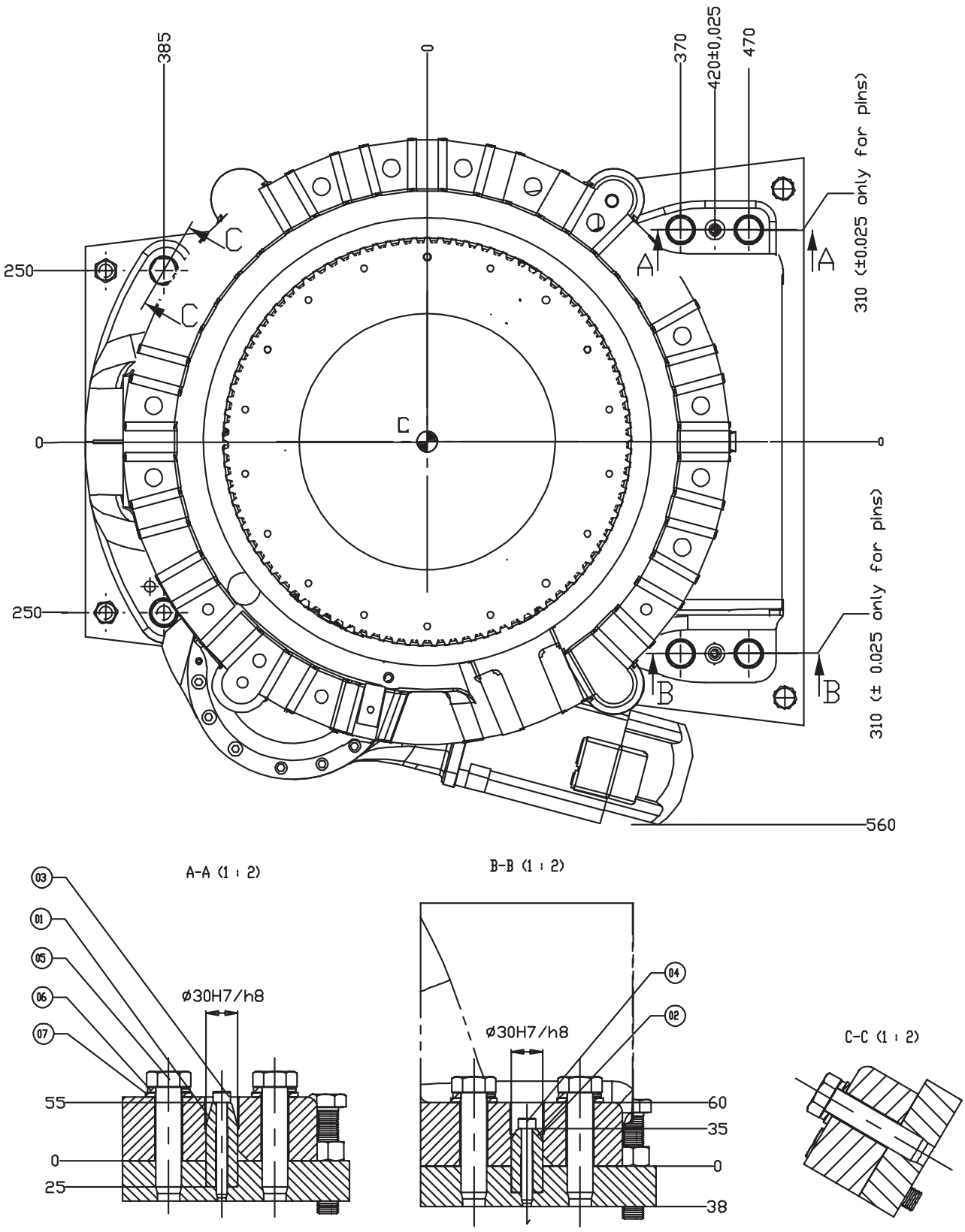
7.1.3 Attachment to a steel plate

The robot can be attached to a steel plate already drilled for the screws and pins (see Fig. 7.1 - Robot-base attachment screws and pins; the screws and pins needed to secure the robot are supplied as an optional.

7.1.4 Attachment to a plate with adjustable level (optional)

The robot can be assembled using an optional assembly consisting of 4 floor attachment plates and a steel plate fastened to the robot that can be adjusted in level through the specific screws (see Leveling plate assembly in Chap. OPTIONAL EQUIPMENT - TECHNICAL SPECIFICATION manual)

Fig. 7.1 - Robot-base attachment screws and pins



Key:Fig. 7.1 - Robot-base attachment screws and pins

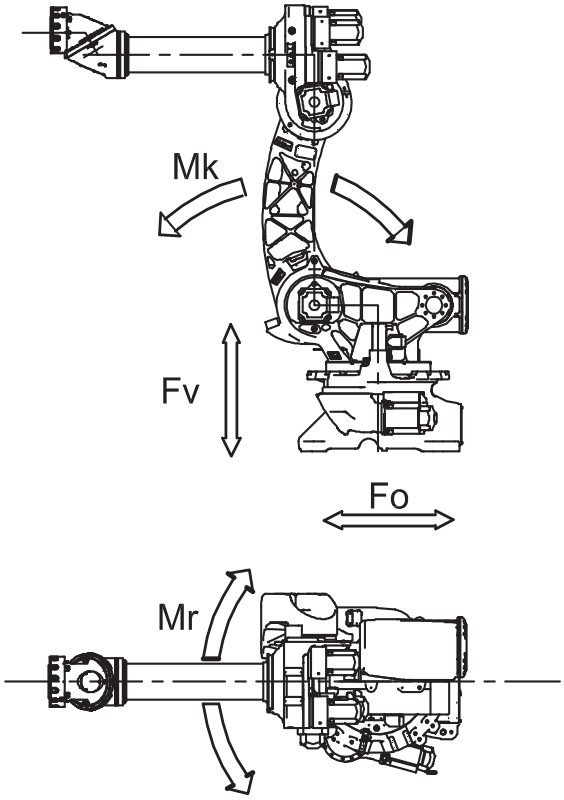
1. Centring Ø = 30 mm L = 80 mm (q.ty = 1)
2. Centring Ø = 30 mm L = 60 mm (q.ty = 1)
3. Socket head cap screw M 10 x 90 (8.8) (q.ty = 1)
4. Socket head cap screw M 10 x 70 (8.8) (q.ty= 1)
5. Partially threaded hex head screw M 24 x 100 (8.8.) (q.ty = 6)
6. Split washer Ø = 24mm (q.ty = 6)
7. Flat washer Ø = 24 mm (q.ty = 6)

7.2 Supporting structure stress

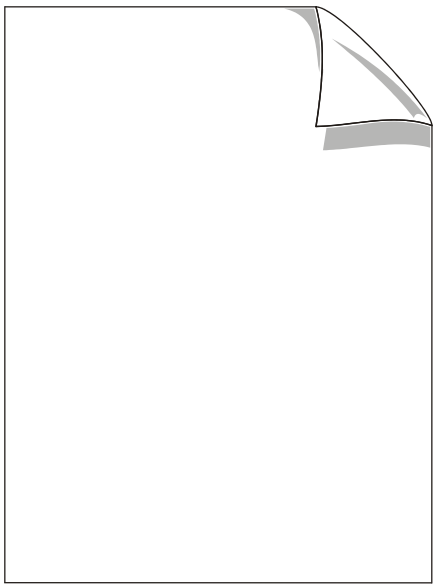
The foundations where the robot is installed are not to suffer vibrations coming from other machines (such as sledge hammers, presses, etc.).

Because of the considerable stress discharged to the ground by the robot, and the need to have an appropriate supporting surface, direct fixing to the floor is not foreseen.
The robot mounting surface must be horizontal

Fig. 7.2 - Supporting structure stress



Robot	Robot movement	Supporting structure stress			
		Fv (N)	Fo (N)	Mr (Nm)	Mk (Nm)
SMART NH4	In acceleration	26500	8300	9000	36000
	In emergency braking	30500	16500	18000	54000
SMART NH4SH	In acceleration	26000	7000	8500	37000
	In emergency braking	31000	15000	17000	54000



8. OPTIONAL EQUIPMENT

8.1 Overview

Before starting any installation operation, read Chap.1. - General Safety Precautions with care.
The robot has to be connected to the C4G Control Unit . No other use is allowed.
Any exemptions are to be specifically authorised by COMAU Robotics & Service.

Tab. 8.1 - Applicability of options

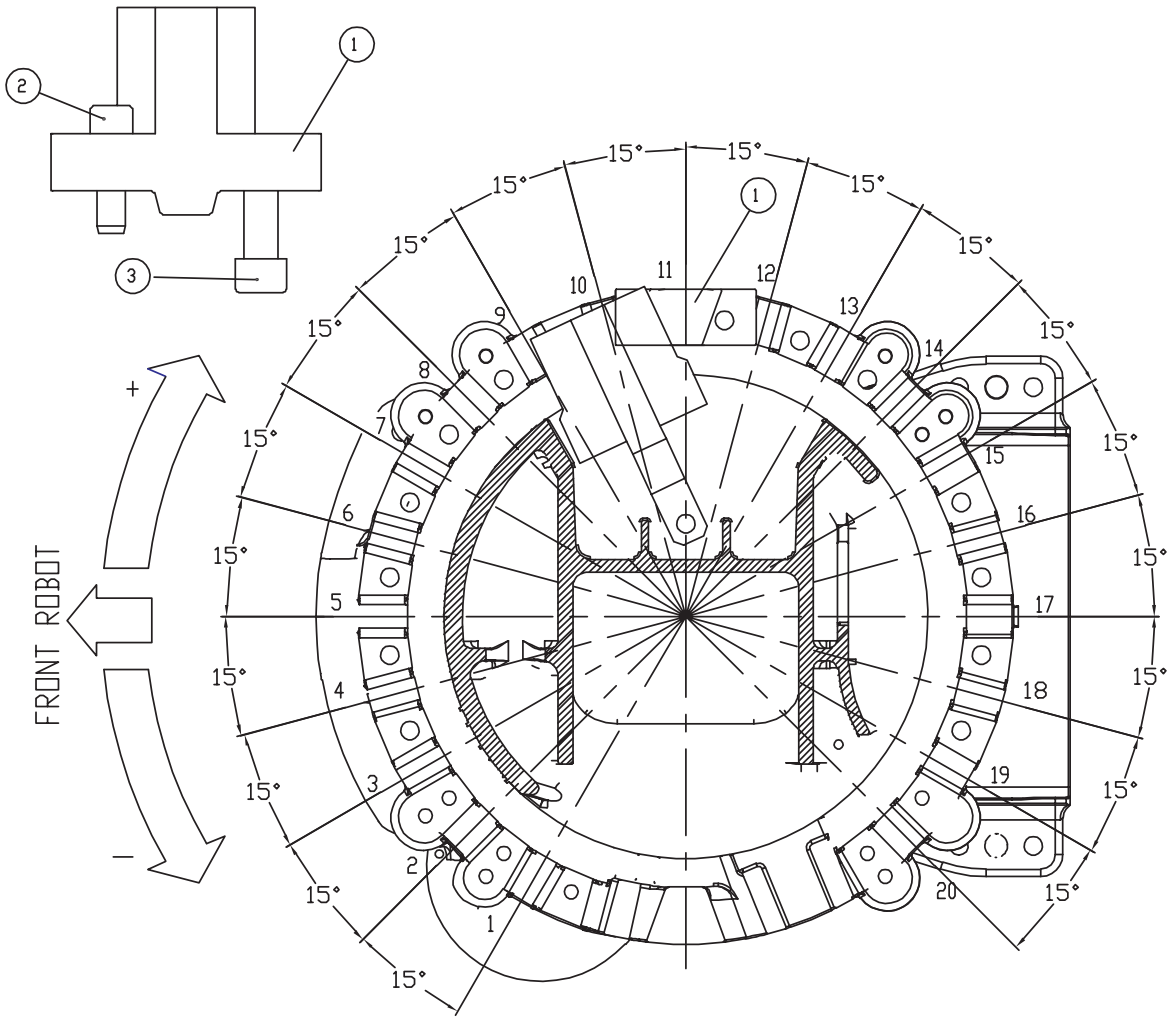
Code	Description	Applicability				
		NH1	NH1 100-3.2P	NH2	NH3	NH4
82313300	Axis 1 adjustable mechanical hard stop assembly (code 82313300)	1		1	1	1
82313400	Axis 2 adjustable mechanical hard stop assembly (code 82313400 excluded SH versions)	1		1	1	1
82317200	Axis 2 adjustable mechanical hard stop assembly (code 82317200 SH versions)	-		-	1	1
82313500	Axis 3 adjustable mechanical hard stop assembly (NH3-NH4 code 82313500)	-	1	-	1	1 NH4 SH excluded
82318700	Axis 3 adjustable mechanical hard stop assembly (NH1-NH2 code 82318700)	1	-	1	-	-
82315800	Axis 1 mechanical hard stop on-off assembly (lock pin - code 82315800)	2max	2max	2max	2max	2max
CR82325600	Axis 1 work area partialization assembly - 3 areas (code CR82325600)	1	1	1	1	1
CR82325700	Axis 1 work area partialization assembly - 2 areas (code CR82325700)	1	1	1	1	1
CR82325800	Axis 1 work area partialization assembly - 1 area (code CR82325800)	1	1	1	1	1
CR82325900	Axis 2 work area partialization assembly (code CR82325900)	1	1	1	1	1
CR82326000	Axis 3 work area partialization assembly (code CR82326000)	1	1	1	1	1
82314100	Calibration tool (code 82314100)	1	1	1	1	1
81783801	Calibrated fixture unit L =117 mm (code 81783801)	1	1	1	1	-
82109501	Calibrated fixture unit L = 200 mm (code 82109501)	-	-	-	-	1

Tab. 8.1 - Applicability of options

Code	Description	Applicability				
		NH1	NH1 100-3.2P	NH2	NH3	NH4
82312900	Axis 5 - 6 calibration tool assembly (SMART NH1 - code 82312900)	1	1	-	-	-
82314000	Fork liftable fitting (code: 82314000) (excluded SH versions)	1	1	1	1	1
82314700	Set of screws and pins to secure robot (code 82314700)	1	1	1	1	1
82314800	Leveling plate assembly (code 82314800)	1	1	1	1	1
82322600	Distribution connection guard assembly (floor panel - code 82322600)	1	1	1	1	1
82107937	Centring (code 82107937)	-	-	-	-	1
82309240	Axis 1 standard motor guard (code 82309240)	1	1	1	1	1
82309259	Axis 1 ventilated motor guard (code 82309259)	-	-	-	1 (1)	-
CR82309259	Axis 2 ventilated motor guard (Foundry)	1	1	-	1	-
		Foundry version only				
refer to par. 8.21	Robot NH SH Supports	-	-	-	1 NH3 SH	1 NH4 SH
CR18968580	Brake release module	1	1	1	1 (2)	1

(1) The guard for the axis 1 ventilated motor (code 82309258) is specifically for robot NH3 SH -100-3.5P
(2) The Brake Release Module cannot be used on SMART NH3/SH/P Pressbooster

8.2 Axis 1 adjustable mechanical hard stop assembly (code 82313300)



1. Mechanical hard stop (q.ty 2)
2. M20 x 70 socket head cap screw (8.8) (q.ty 4)
3. M24 x 80 socket head cap screw (8.8) (q.ty 4)

Tab. 8.2 - Permissible stroking limits, axis 1

Pos.	Corsa asse 1 / *Axis 1stroke*				Pos.	Corsa asse 1 / *Axis 1stroke*			
	Corsa in senso negativo *Negative stroke*		Corsa in senso positivo *Positive stroke*			Corsa in senso negativo *Negative stroke*		Corsa in senso positivo *Positive stroke*	
	da/*from* [°]	a/*to* [°]	da/*from* [°]	a/*to* [°]		da/*from* [°]	a/*to* [°]	da/*from* [°]	a/*to* [°]
1	-	-	-150	+180	11	0	-180	0	+180
2	-135	-180	-135	+180	12	+15	-180	+15	+180
3	-120	-180	-120	+180	13	+30	-180	+30	+180
4	-105	-180	-105	+180	14	+45	-180	+45	+180
5	-90	-180	-90	+180	15	+60	-180	+60	+180
6	-75	-180	-75	+180	16	+75	-180	+75	+180
7	-60	-180	-60	+180	17	+90	-180	+90	+180
8	-45	-180	-45	+180	18	+105	-180	+105	+180
9	-30	-180	-30	+180	19	+120	-180	+120	+180
10	-15	-180	-15	+180	20	+135	-180	+135	+180

Pos: Posizione montaggio arresto meccanico / *Installation position of mechanical stop assembly*

8.2.1 Description

The axis 1 adjustable mechanical hard stop assembly can be used to limit the stroke of axis 1 in both directions of work with steps of 15°. The assembly consists of two stop pads that are fastened, by means of the screws supplied with the robot, in the seats on the robot base to limit the stroke of axis 1 in both directions; it is possible to use just one of the two stop pads to limit the stroke in one direction only.
The axis 1 adjustable mechanical hard stop assembly satisfies “operator safety” requirements as it can absorb all of the kinetic energy of the axis.

Warning

Once the stop has been used (impact), the following parts must be replaced:

– mechanical hard stop and fastening screws;

– rubber stop blocks and fastening screws.

Deve inoltre essere verificata l’integrità delle parti del robot interessate, ad esempio:

– the part of the base housing the assembly;
– the part of the column housing the stop;
– the equipment being used by the robot.

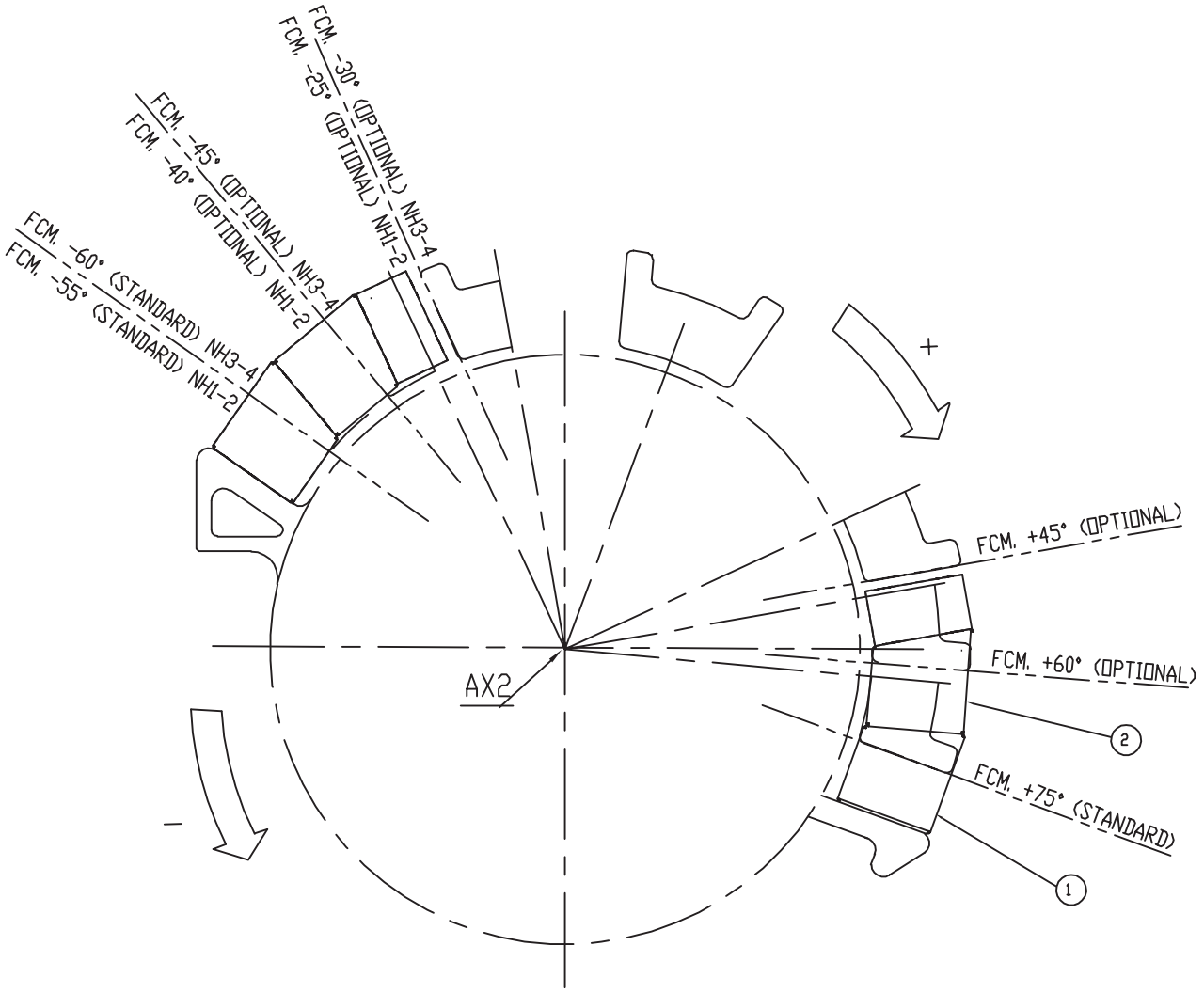
Failure to replace any damaged parts will undermine correct operation (and thus stopping) in future.

After an impact, check the clearance on axis 1 and correct any slackening of the axis.

The following figure shows the example of the axis 1 stroke limited by -15° - +15° with mechanical hard stops installed in positions 10 and 12.

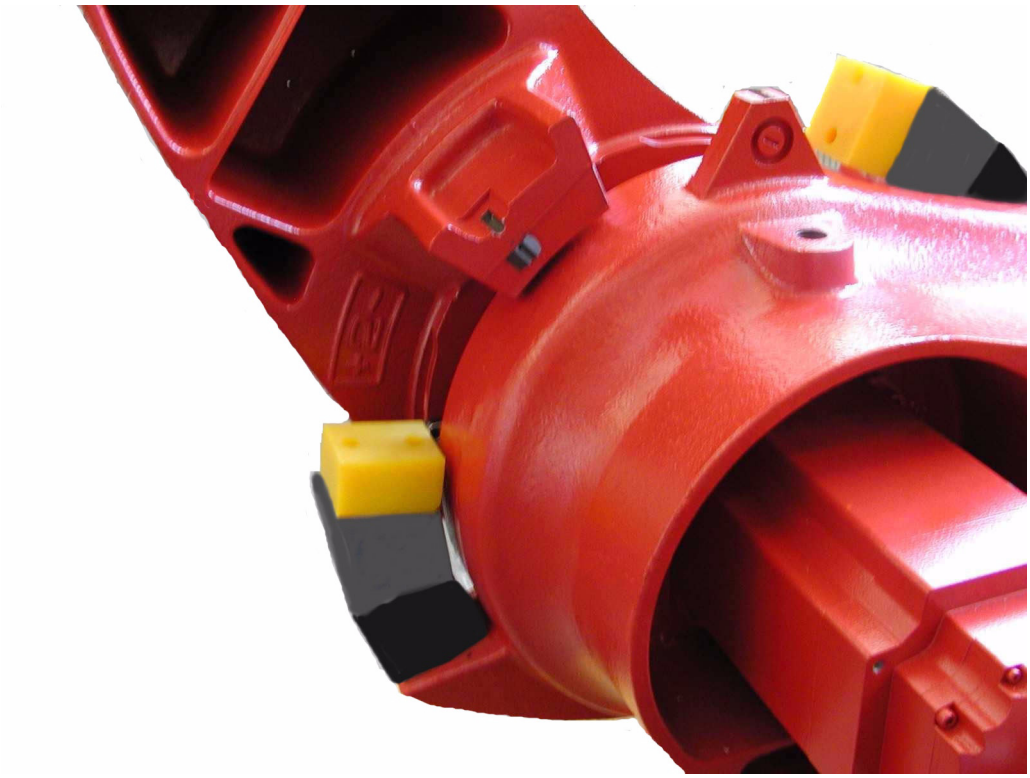
8.3 Axis 2 adjustable mechanical hard stop assembly (code 82313400 excluded SH versions)

Axis 2 adjustable mechanical hard stop assembly (code 82317200 SH versions)



1. Stop block (q.ty 2)
2. Stop block (q.ty 2)

8.3.1 Description



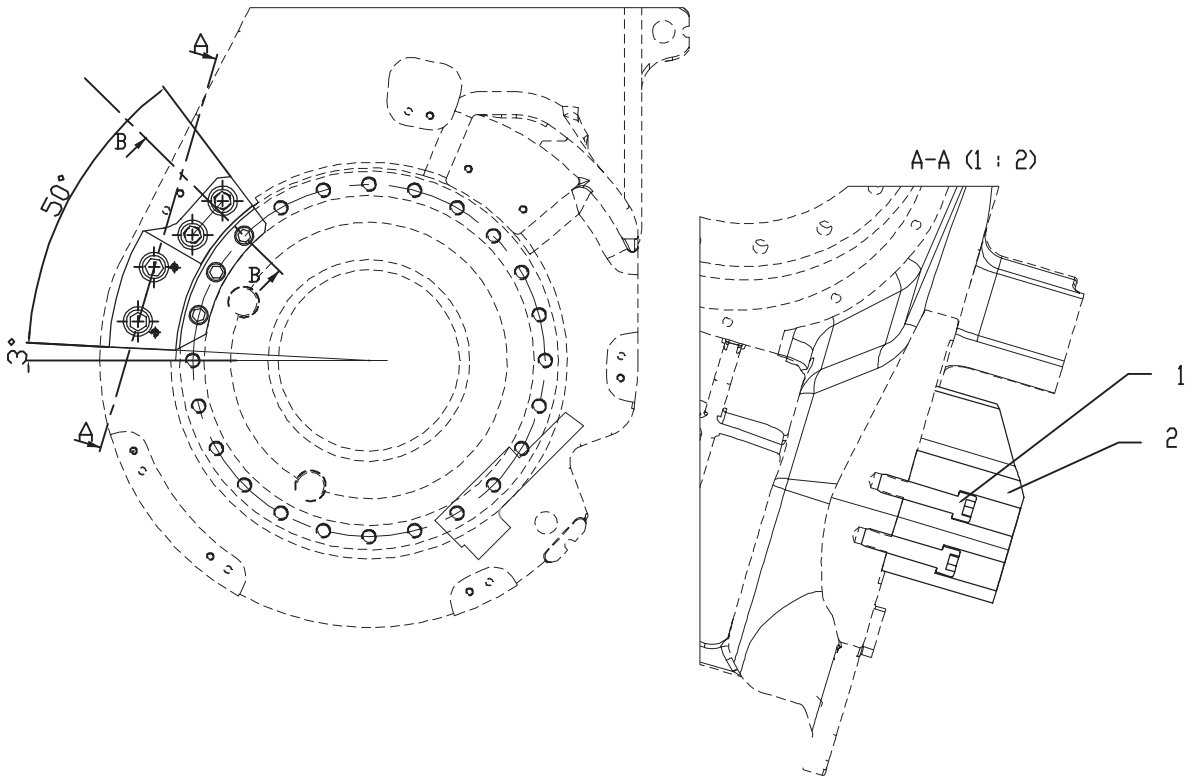
The axis 2 adjustable mechanical hard stop assembly can be used to limit the stroke of axis 2 in both directions of work with steps of 15°.
The unit consists of two sets of blocks to insert between the column structure and the stop pad already installed on the robot. The stroke can be limited:

- in the positive direction at +60° or at +45° (instead of the standard stroke of +75°,
- in the negative direction:
  - with NH1 and NH2 robot: at -40° or at -25° (instead of the standard stroke of +55°).
  - with NH3 and NH4 robot: at -45° to -30° (instead of the standard stroke at -60°).

The axis 2 adjustable mechanical hard stop assembly satisfies “operator safety” requirements as it can absorb all of the kinetic energy of the axis.

8.4 Axis 3 adjustable mechanical hard stop assembly (NH1-NH2 code 82318700)

Axis 3 adjustable mechanical hard stop assembly (NH3-NH4 code 82313500)



1. Socket head cap screw M16x60 cl 8.8
2. Block (q.ty 1)

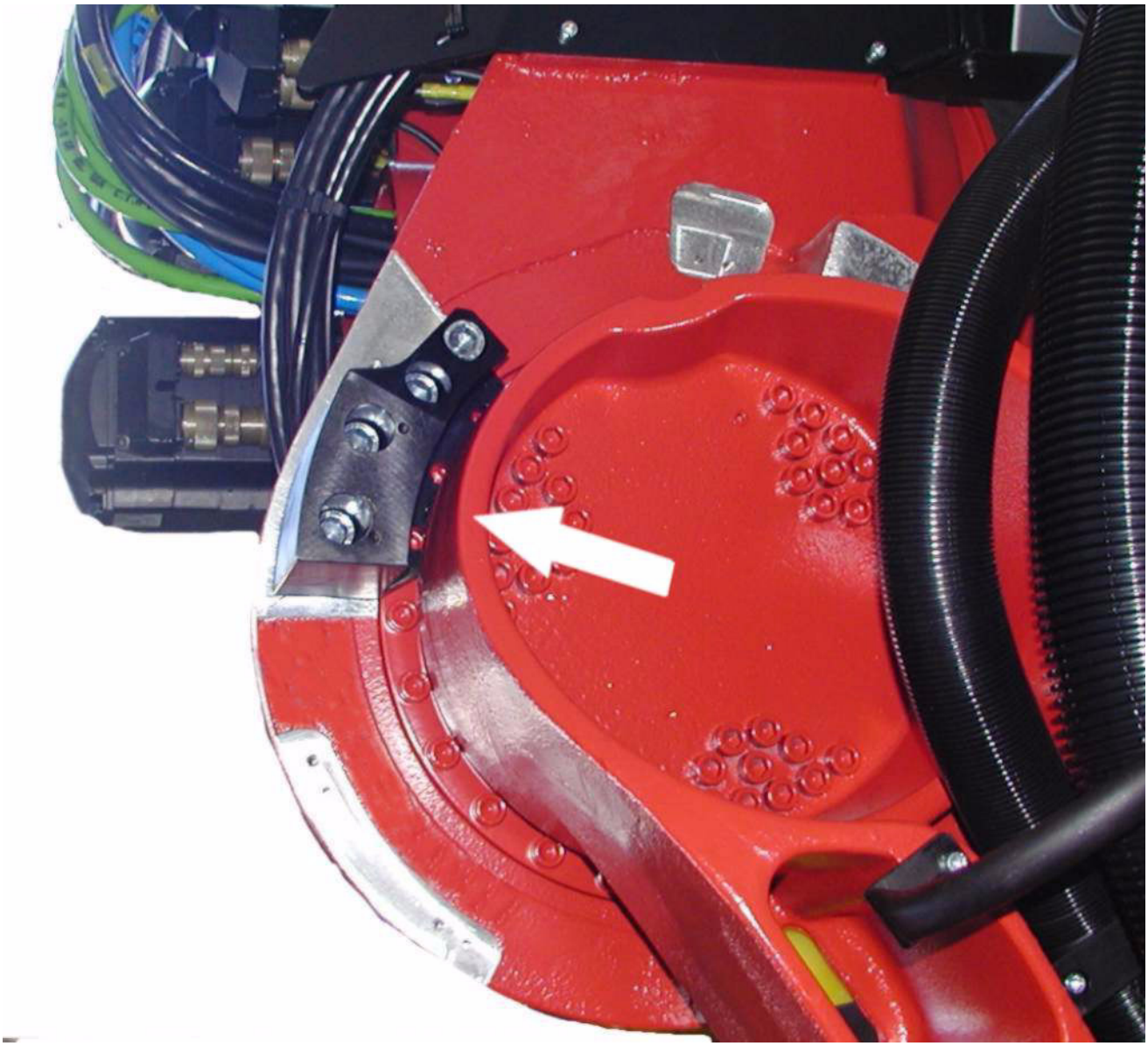
8.4.1 Description

The purpose of the axis 3 adjustable mechanical hard stop assembly is to prevent the forearm from overturning by preventing this from entering the work area behind the robot.

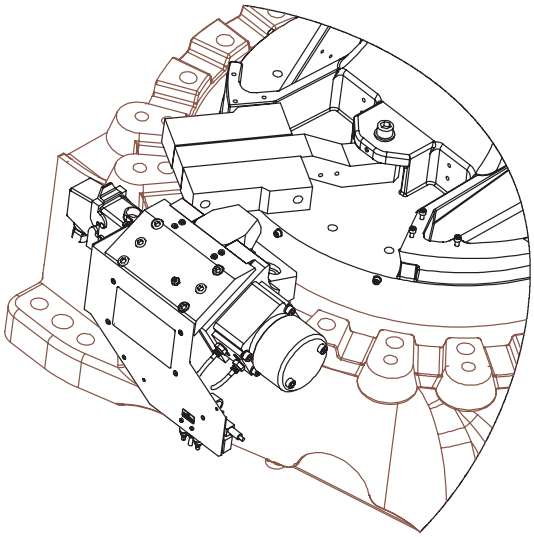
The assembly consists of a block that is fastened to the side of the body of the forearm using the screws and pin supplied with the robot: in case of an impact the stop block comes into contact with the fixed block that is always present on board the robot arm.

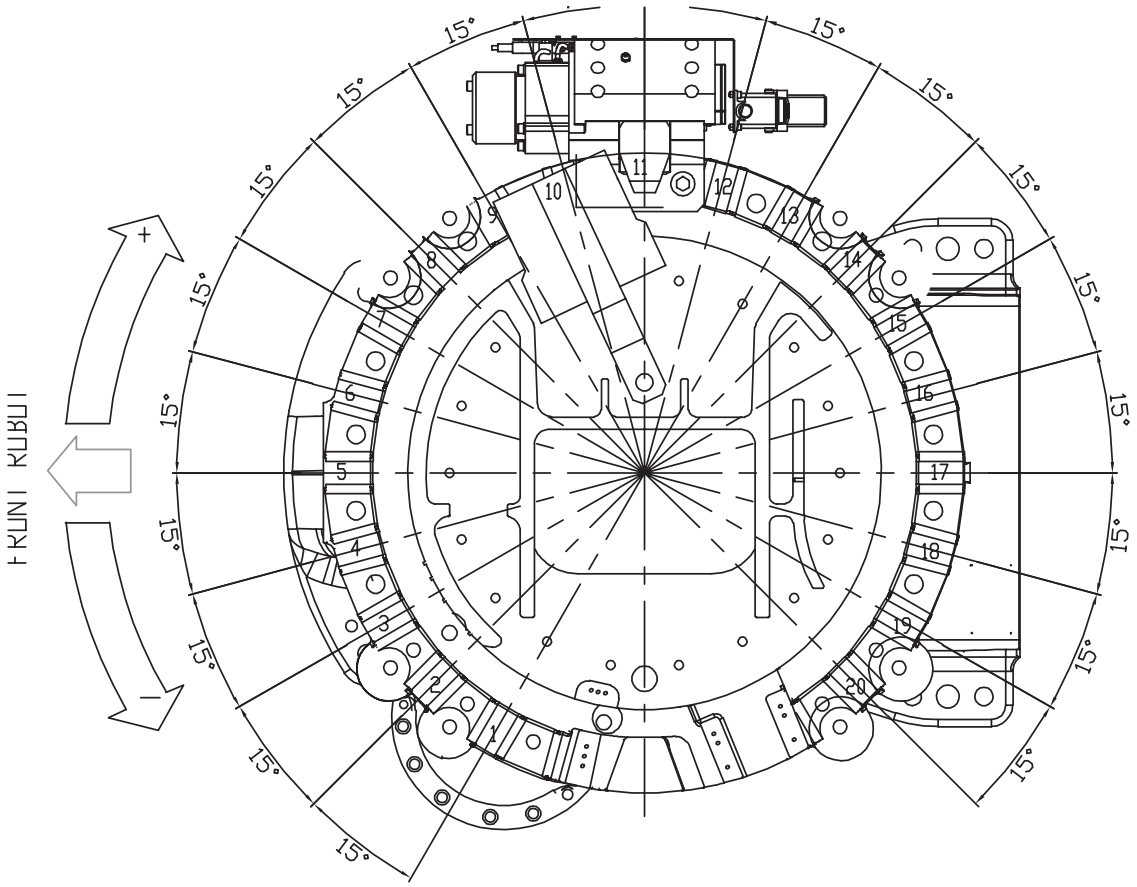
Axis 3 has a working stroke of between 0° and -170° while the blocked stroke is from 0° to +110°

The axis 3 adjustable mechanical hard stopechanical hard stop assembly satisfies “operator safety” requirements as it can absorb all of the kinetic energy of the axis.



8.5 Axis 1 mechanical hard stop on-off assembly (lock pin - code 82315800)





Tab. 8.3 - Possible axis 1 stroke limitations

Pos.	Corsa asse 1 / *Axis 1stroke*			
	Corsa in senso negativo *Negative stroke*		Corsa in senso positivo *Positive stroke*	
	da/*from* [°]	a/*to* [°]	da/*from* [°]	a/*to* [°]
1	-	-	-150	+180
2	-135	-180	-135	+180
3	-120	-180	-120	+180
4	-105	-180	-105	+180
5	-90	-180	-90	+180
6	-75	-180	-75	+180
7	-60	-180	-60	+180
8	-45	-180	-45	+180
9	-30	-180	-30	+180
10	-15	-180	-15	+180
11	0	-180	0	+180
12	+15	-180	+15	+180
13	+30	-180	+30	+180
14	+45	-180	+45	+180
15	+60	-180	+60	+180
16	+75	-180	+75	+180
17	+90	-180	+90	+180
18	+105	-180	+105	+180
19	+120	-180	+120	+180
20	+135	-180	+135	+180
Pos: Posizione montaggio arresto meccanico/ Installation position of mechanical stop assembly				

8.5.1 Description

The axis 1 mechanical hard stopmechanical hard stop on-off assembly can be used to enable the temporary sectoring of the robot work area and can be positioned on the whole of the axis 1 stroke with steps of 15°.

The assembly consists of a mechanical lock pin that is operated by a rotating pneumatic actuator and is complete with safety micro-switches and electrically-controlled solenoid valves.

When used with the 8.6 Axis 1 work area partialization assembly and/or the 8.4 Axis 3 adjustable mechanical hard stop assembly (NH1-NH2 code 82318700), and incorporated with the appropriate cell safety devices (safety PLC, additional safety barriers, etc....) the mechanical hard stop on-off assembly ensures complete "operator safety"; the lock pin must always be managed by a safety system that controls the robot position (e.g. work area partialization assemblies supplied by COMAU Robotics & Final Assembly);

The axis 1 mechanical hard stop on-off assembly can be used on all robots in the SMART NH family; up to a maximum of 2 partialization assemblies and 3 work areas can be used on each robot.

Movement of the plug could cause a crushing hazard between the plug and the robot base housing, therefore it is important to pay attention when handling the plug.

8.5.1.1 Command and control circuit safety specifications:

– Standard ISO 13849-1 (EN 954-1) category 3

8.5.1.2 Electrical characteristics

– See Tab. 8.4 - Electrical characteristics of axis 1 mechanical limit switch assembly

8.5.1.3 Pneumatic supply

– Circuit supply pressure: 5 bars
– Lubricated air

Tab. 8.4 - Electrical characteristics of axis 1 mechanical limit switch assembly

ELECTRICAL DATA SG1-SG2	
Description	Solid state switch
Type of connection	With 3 WIRES
Output	PNP
Applicable load	IC circuits, RELAY, PLC
Power supply voltage	from 4.5 Vdc to 28 Vdc
Current draw	≤ 10 mA
Load voltage	≤ 10 Vdc
Load current	≤ 80 mA

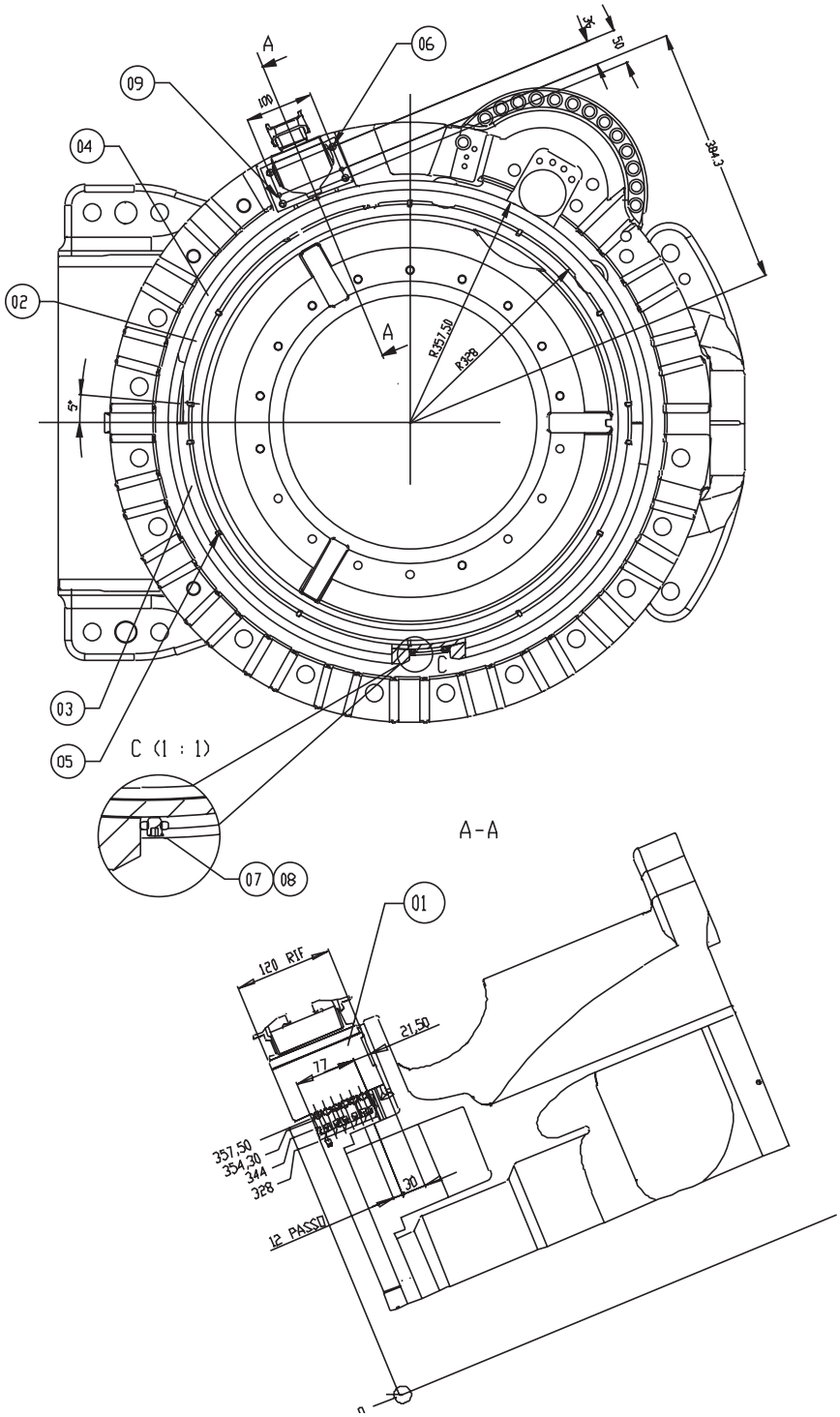
ELECTRICAL DATA SG3	
Description	Microswitch with forced opening contacts
Position of contacts	1 n.c. / 1 n.o.
Insulation	Group C (VDE 0110)
Maximum nominal voltage	250 Vac
Maximum direct current	6 A
Minimum load at 24 Vdc	≥ 20 mA
Contact resistance	< 40 mΩ
Interruption power	2 A

ELECTRICAL DATA VD1-VD2	
Description	Solenoid for solenoid valve
Power supply voltage	24 Vdc
Maximum voltage fluctuation	± 10% of power supply voltage
Maximum power	0,5-0,55 W

ELECTRICAL DATA X80-X81	
Description	Loose female connector (HARTING 09330102701)
Type of connection	Screwed (2,5 mm^2/AWG 14 maximum)
Cable inlet	Cable clamp PG21, Ø outside cable from 13 mm^2 to 18 mm^2

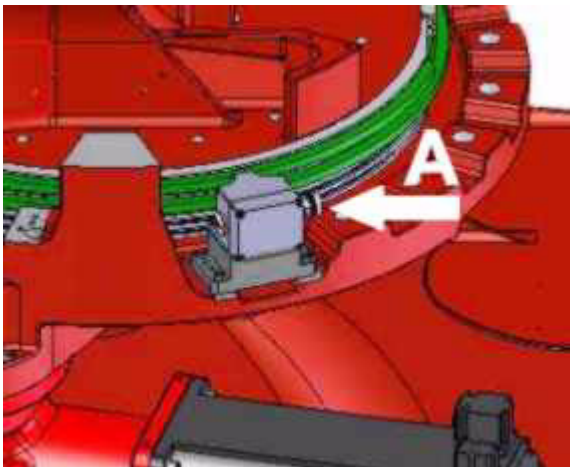
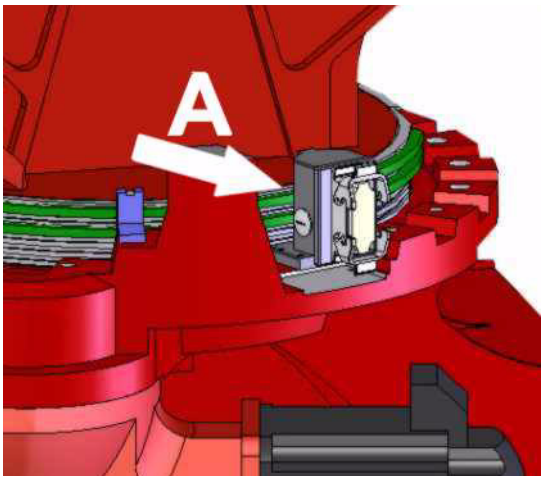
8.6 Axis 1 work area partialization assembly

(1 area code CR 82325800 - 2 areas code CR82325700 - 3 areas code CR82325600)



1. Micro limit switch (with 6 pushbuttons for 3 areas - 4 pushbuttons for two areas - 2 pushbuttons for one single area)
2. RH cam holder
3. LH cam holder
4. Cam
5. Stubbed socket head cap screw M6x10
6. Socket head cap screw M6x25
7. Socket grub screw to secure cams
8. Low hex nut
9. Internal thread parallel pin with 6x20 type B

8.6.1 Description

Axis 1 work area partialization assembly 1-2 areas	Axis 1 work area partialization assembly 3 areas
	

The axis 1 work area shut-off assembly makes it possible to electrically sector the robot work area using pushbutton micro switches of different types according to the number of areas to be sectored, in detail :

– for up to 3 work areas a six-pushbutton micro is used

– for up to 2 work areas a 4-pushbutton micro is used

– for a single work area a two-pushbutton micro switch is used

The work areas are each controlled by two safety micro switches in conformity with the most severe safety standards

The assembly consists of:

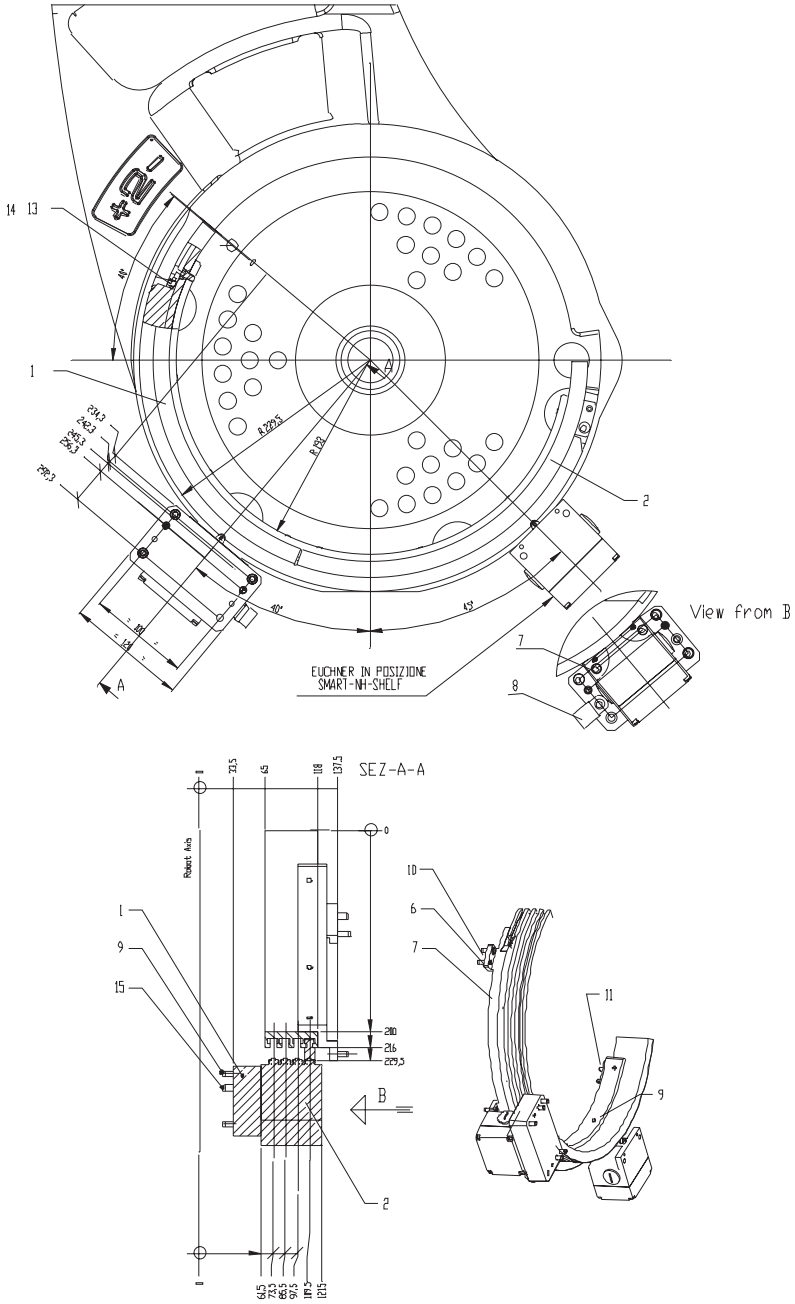
- a multiple micro switch with Harting connector
- a set of plastic cams to be cut to the length required by the application and installed on cam holder

The cams are to be inserted, positioned and clamped on the cam holders attached to the robot column to substitute the protection guard.

For the micro electrical connection, the following is foreseen:
in the case of a current slicer for three areas, a 32-pin HARTING connector, for current slicing of one to two areas, a 90° 19-pin female connector.

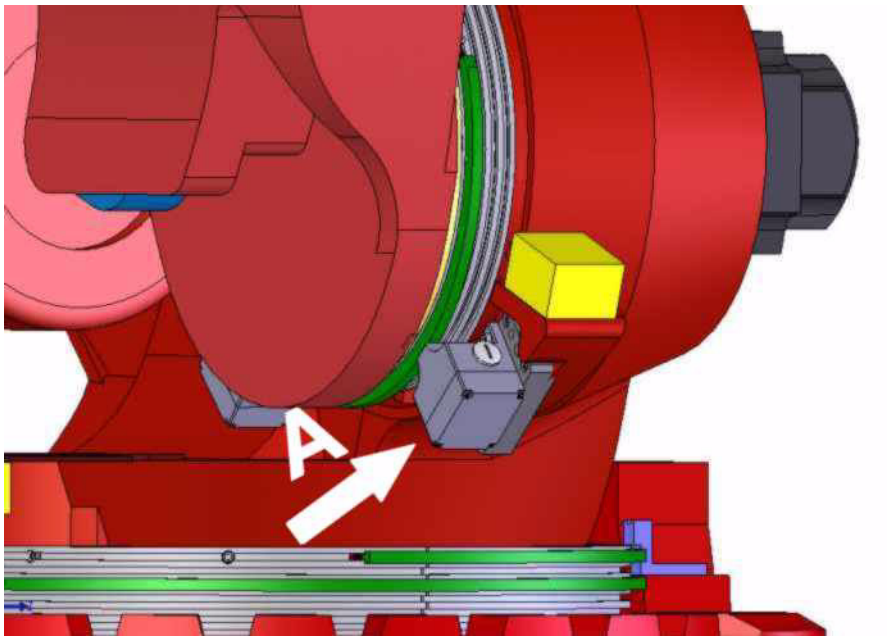
For the microswitch assembly internal electrical layout. see the robot Circuit Diagram.

8.7 Axis 2 work area partialization assembly (code CR82325900)



1. Support
2. Micro Switch
3. LH cam holder
4. RH cam holder
5. Stubbed socket head cap screw M6x10
6. Cam holder support
7. Cams
8. Parallel pin 4x20
9. Socket head cap screw M6x30
10. Socket head cap screw M6x12
11. Internal thread parallel pin 6x20
12. Socket head cap screw M6x25
13. Socket grub screw M6x8
14. Low hex nut M6
15. Internal thread parallel pin 6x30
16. Bracket with cables attachment sheath

8.7.1 Description



The axis 2 work area partialization assembly enables electrical partialization of up to 2 work areas, each of which is controlled by two safety micro-switches built to the strictest safety standards.

The assembly consists of

- a multiple 4-pushbutton micro switch with output on cable clamp
- a set of plastic cams to be cut to the length required by the application

The cams are to be inserted and clamped on the cam holder secured to the robot by specific supports

The free connector is supplied for the external connection.

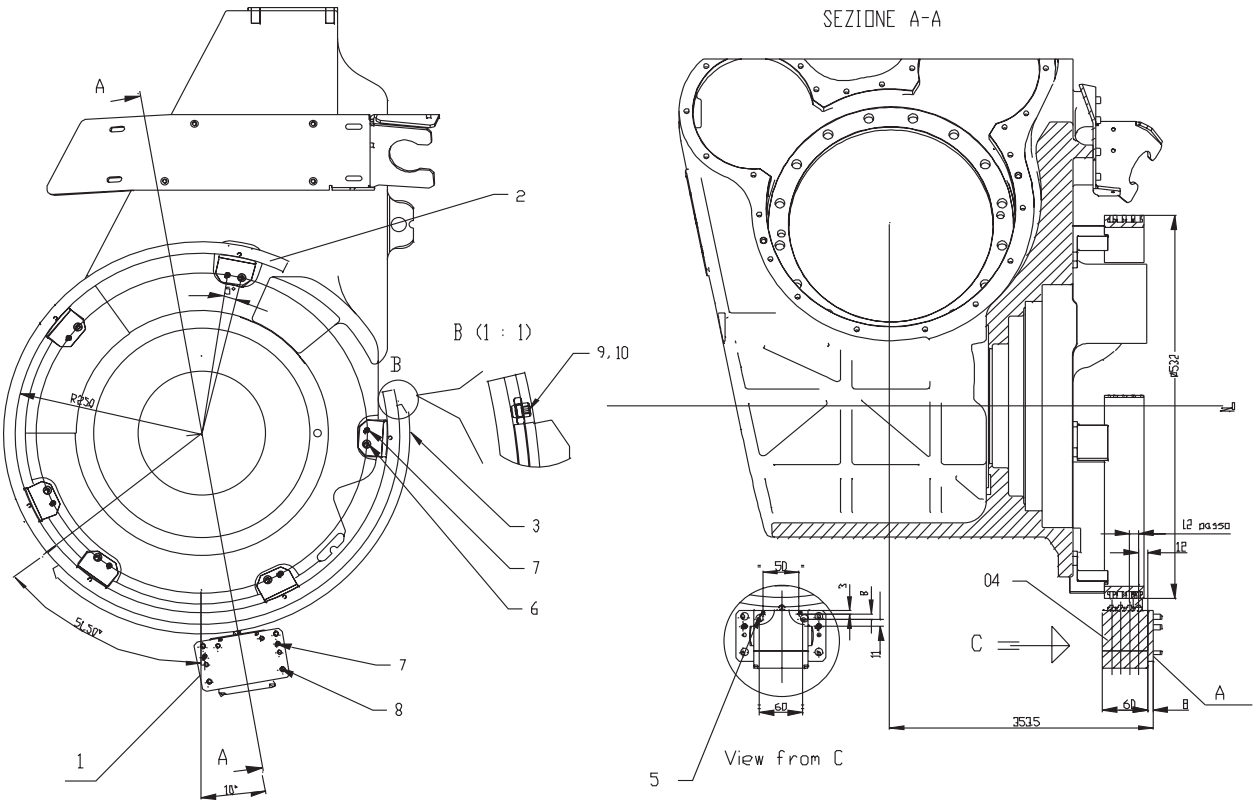
The kit includes:

- Nr. 1 connector (supplied by FCI) 19 pins, type UTG1619SN;
- Nr. 19 female contacts to be crimped, type SC20ML-1S6 for wires from AWG 20;
- Nr. 1 cable clamp with PG16 (for cables from Ø 8 mm^2 to Ø 16 mm^2).

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

For the microswitch assembly internal electrical layout. see the robot Circuit Diagram.

8.8 Axis 3 work area partialization assembly (code CR82326000)



A : Flange mounting edge

1. Limit switch plate
2. Cam holder
3. Cam
4. Micro Switch
5. Parallel pin 4x20
6. Socket head cap screw M6x12
7. Internal thread parallel pin 6x20
8. Socket head cap screw M6x20
9. Socket grub screw m6x8
10. Low hex nut M6

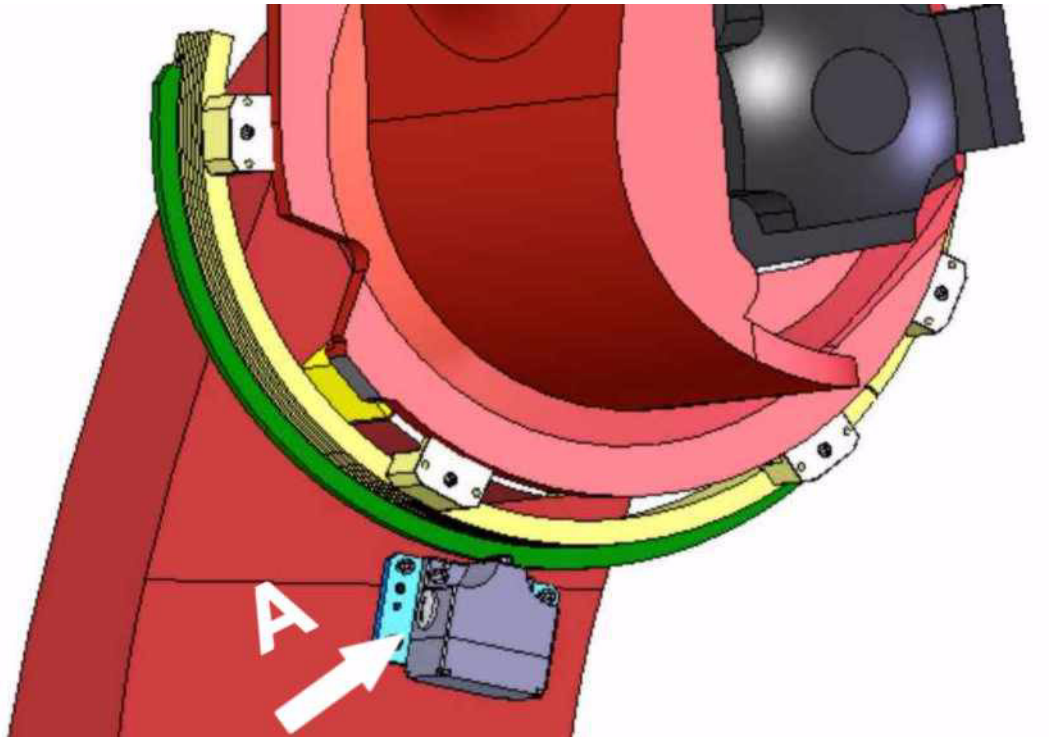
8.8.1 Description

The axis 3 work area shut-off assembly makes it possible to safely electrically sector up to 2 work areas, each controlled by two safety micro switches , in conformity with the most severe safety standards

The assembly consists of

- a multiple 4-pushbutton micro switch with output on cable clamp
- a set of plastic cams to be cut to the length required by the application

The cams are to be inserted adn clamped on the cam holders attached to the robot by specific supports



The free connector is supplied for the external connection.
The kit includes:

- Nr. 1 connector (supplied by FCI), 19 pins, type UTG1619SN;
- Nr. 19 female contacts to be crimped, type SC20ML-1S6 for wires from AWG 20;
- Nr. 1 cable clamp with PG16 (for cables from Ø 8 mm^2 to Ø 16 mm^2).

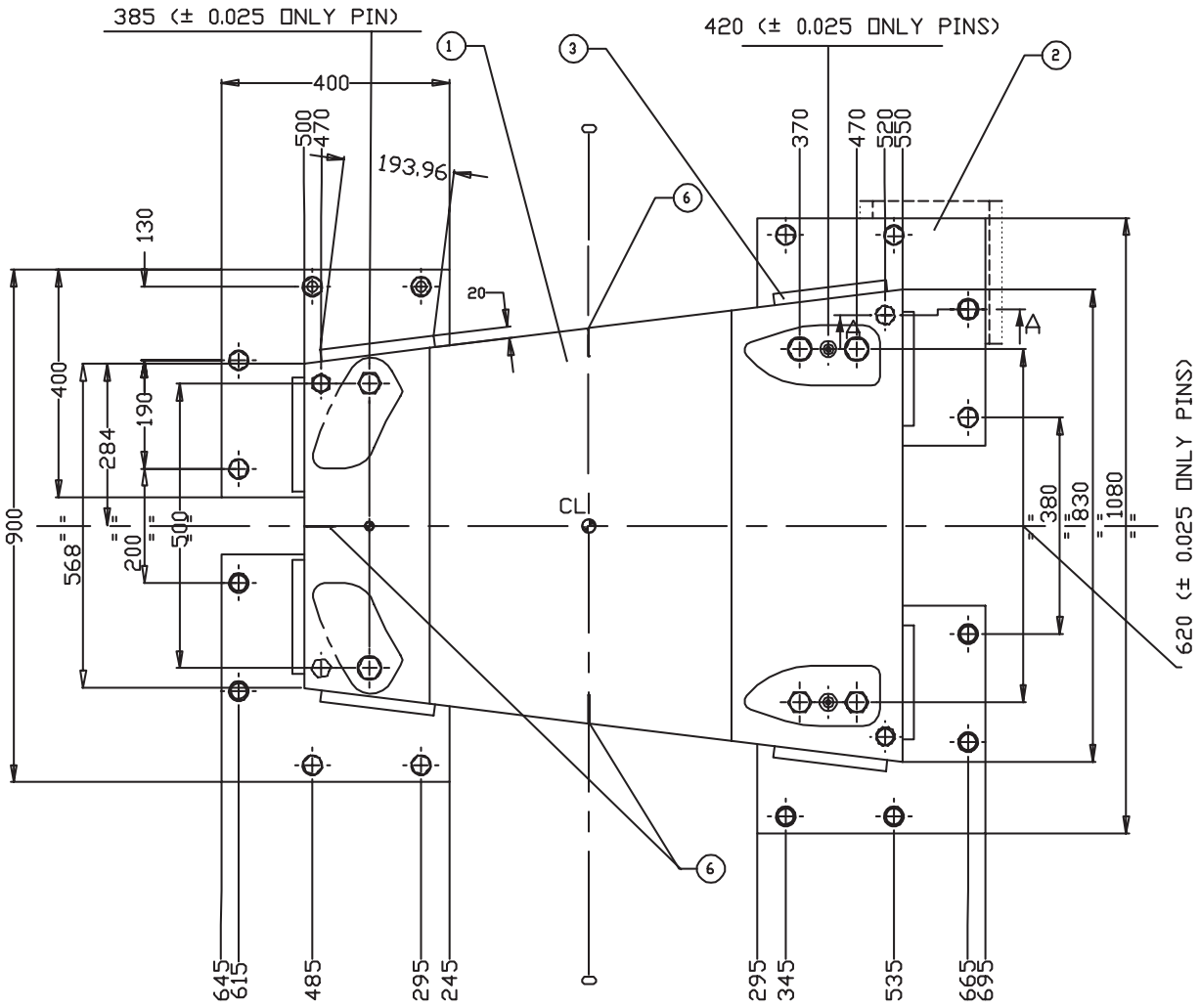
To crimp the female pins onto the wires from AWG 20 it is recommended to use the FCI "crimping tool" type Y14MTV or Y16SCM2.

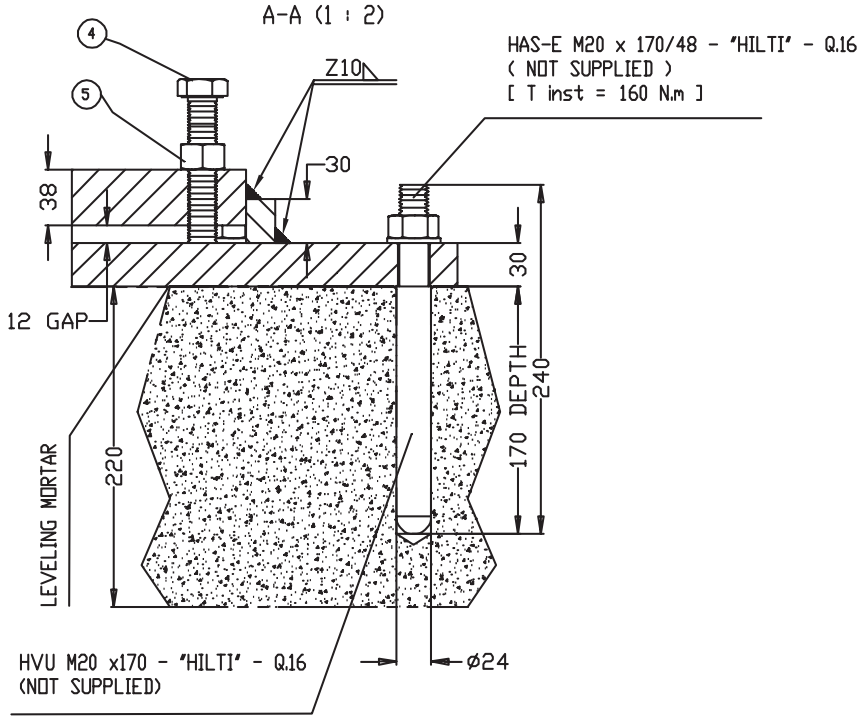
For the microswitch assembly internal electrical layout. see the robot Circuit Diagram.

Tab. 8.5 - Electrical characteristics of axis 1, axis 2 and axis 3 mechanical limit switch assembly

DATI ELETTRICI	
Type of switch	BSE 85 for DIN EN 60204-1
Insulation	Group C (VDE 0110)
Maximum voltage	50 Vac
Maximum current	2 A
Minimum load	≥ 20 mA
Contact resistance	< 40 mΩ
Interruption current	2 A, cos φ=0,8

8.9 Leveling plate assembly (code 82314800)





Key Leveling plate assembly (code 82314800)

1. Leveling plate (q.ty =1)
2. Plate (q.ty 4)
3. Straight edge (q.ty 8)
4. M20 x 100 FULLY THREADED hex head cap screw – 8.8 (q.ty 4)
5. M20 -8 FE/ZN 12 hex nut (q.ty = 4)

8.9.1 Description

The robot leveling plate assembly is used to ensure that the robot is anchored correctly to the floor (see instructions for installation in the INSTALLATION section).
This assembly satisfies the following requirements:

– it ensures good mounting plate levelness, to avoid any incorrect stresses on the structure of the robot base.

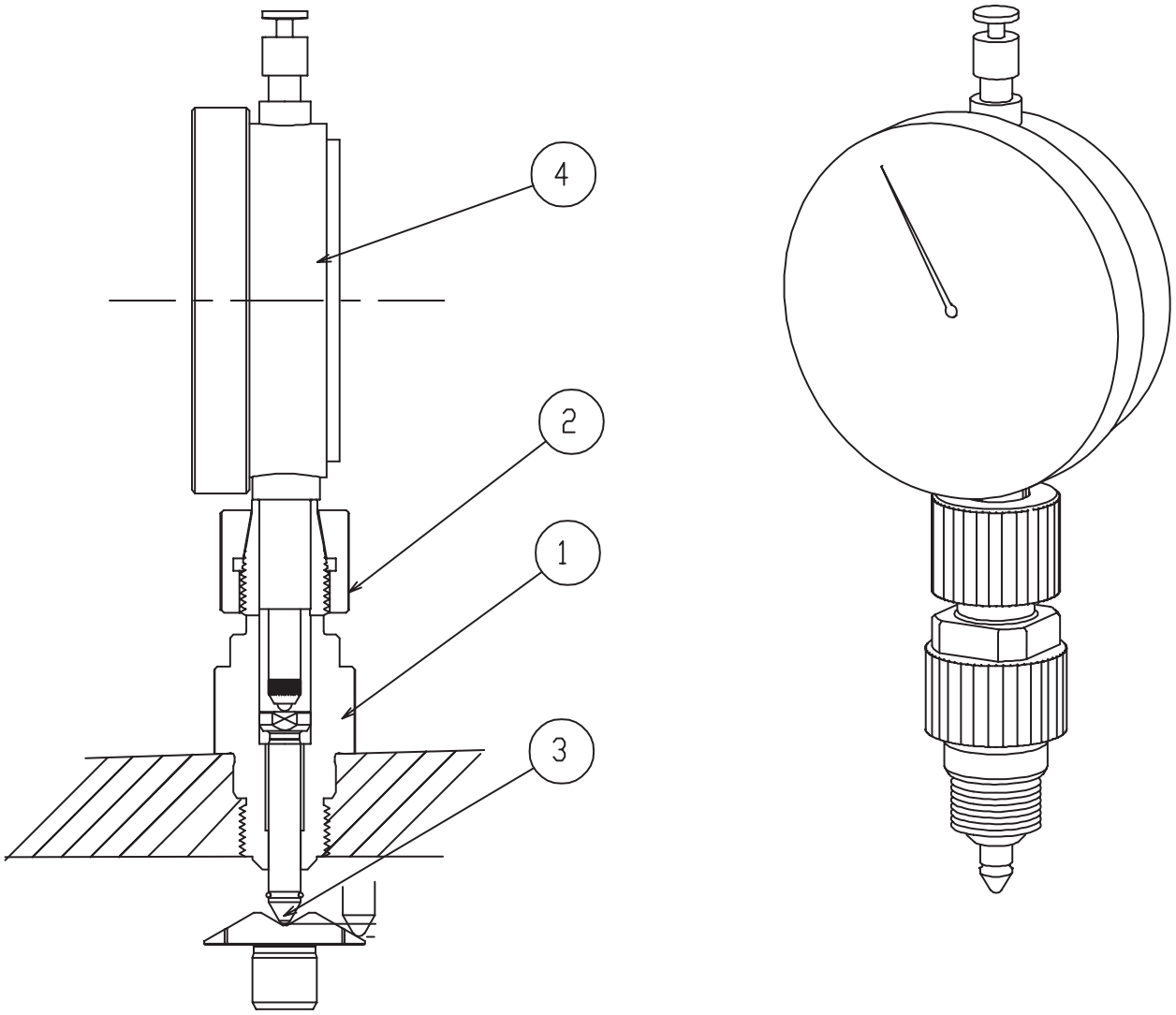
– a perfectly aligned robot assembly that facilitate "off-line programming" applications.

The assembly consists of:

– four steel plates that are anchored to the floor by means of chemical bolts (for a total of 16 anchor bolts, which are not supplied).

– a leveling plate that is welded to the plates described above after using the specific adjustment screws to obtain optimal robot leveling.

8.10 Calibration tool (code 82314100)

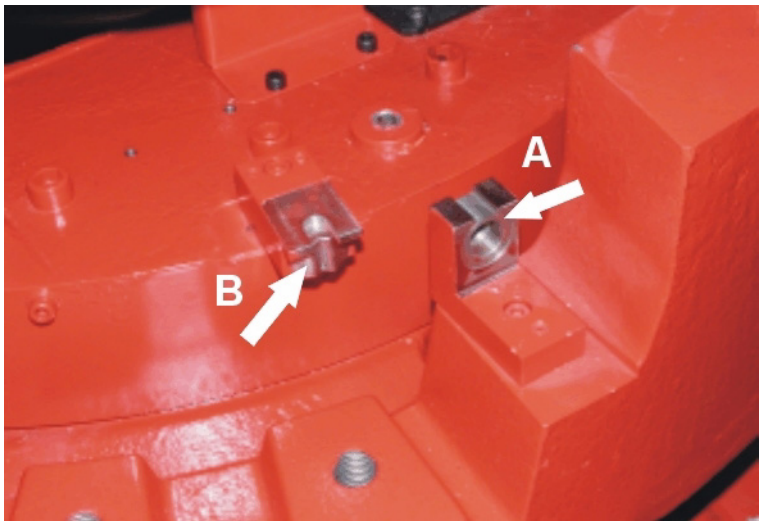
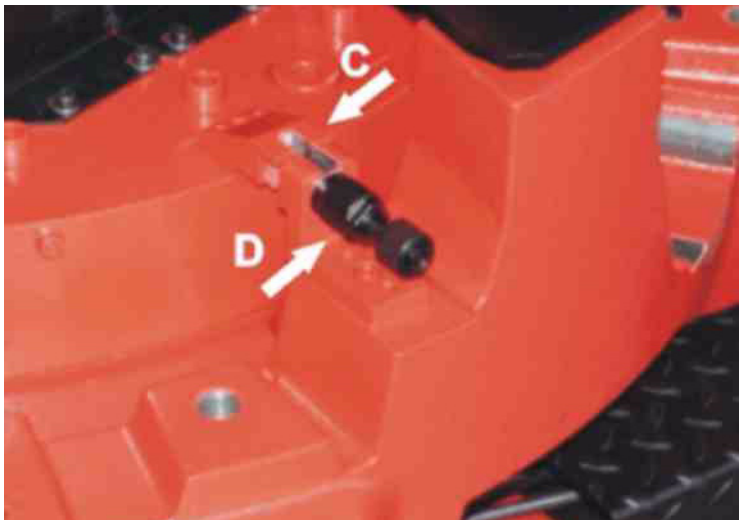


1. Dial gauge holder
2. Tapered ring nut
3. Probe
4. Dial gauge

8.10.1 Description

The calibration tool assembly with dial gauge is used to make the correct calibration of each robot axis in manual mode
The assembly consists of a dial gauge holder fixture to be screwed into the seats provided on each robot axis and by a centesimal dial gauge to measure the correct calibration position.

Tab. 8.6 - Example of use of the calibration kit

Remove guards from calibration reference surfaces	
Align calibration reference surfaces by sight	
Assemble dial gauge support and find axis calibration point	

8.11 Axis 5 - 6 calibration tool assembly (SMART NH1 - code 82312900)

Axis 5	Axis 6
	

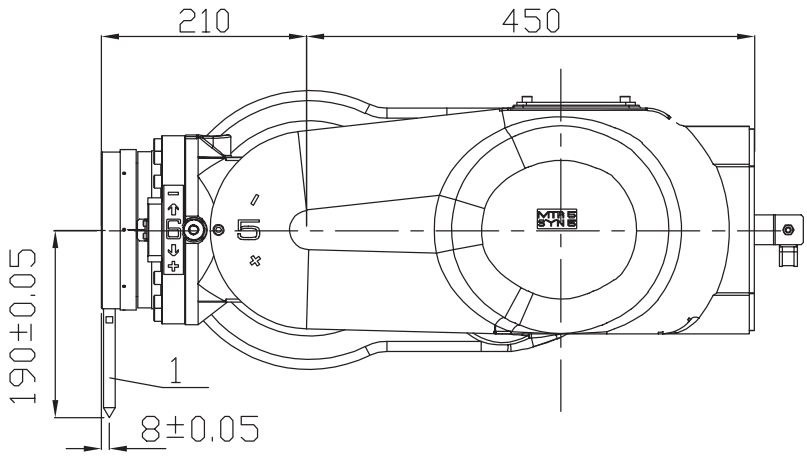
8.11.1 Description

The axis 5-6 calibration tool assembly is essential in order to calibrate the wrist axes of the NH1 robot.

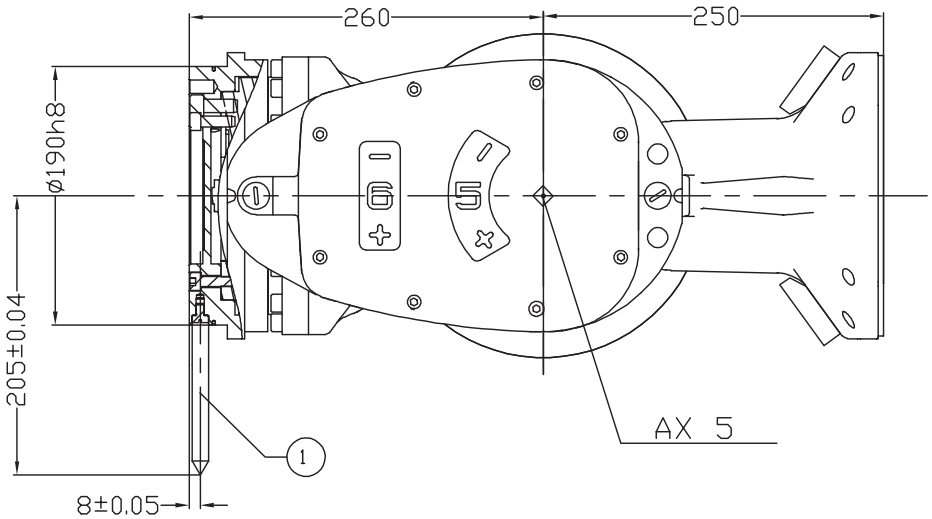
The assembly consists of two supports that are perfectly located with screws and pins, installed respectively on the body of the wrist to calibrate axis 5 and on the oscillating body to calibrate axis 6. The standard dial gauge support that is used to calibrate the other robot axes is screwed onto the supports.

8.12 Calibrated fixture unit L =117 mm (code 81783801)

– SMART NH1

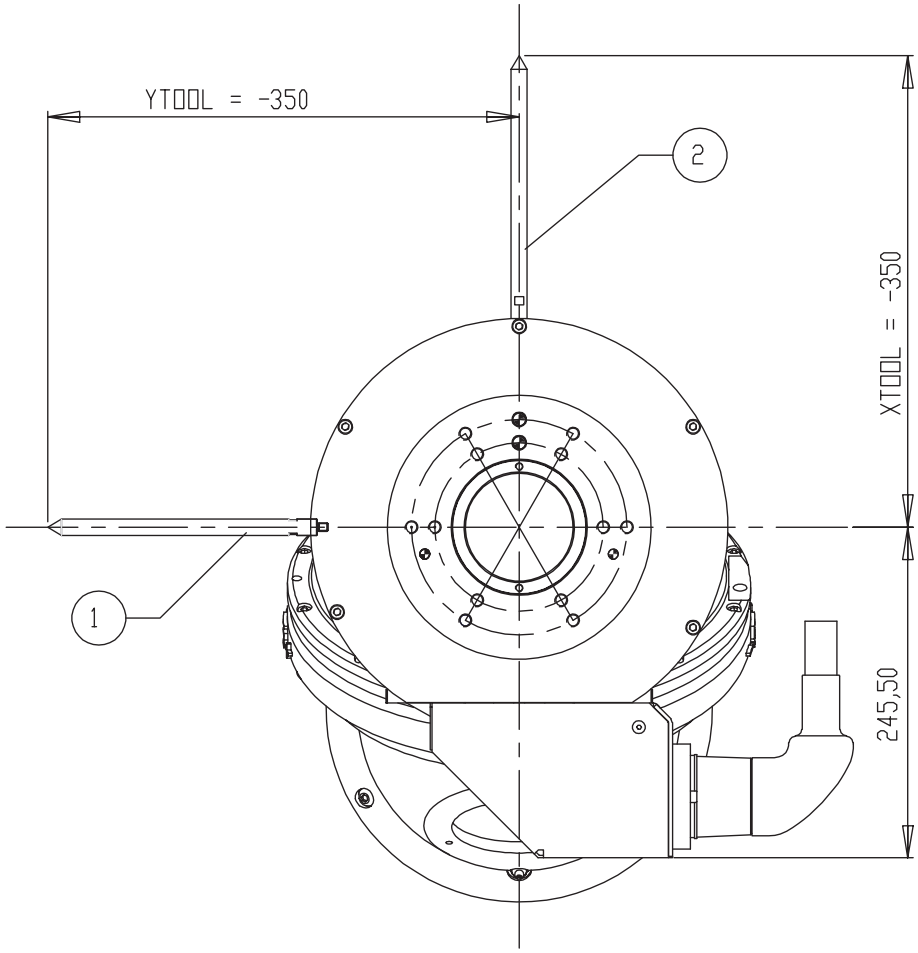


– SMART NH2 - SMART NH3



8.13 Calibrated fixture unit L = 200 mm (code 82109501)

– SMART NH4



POS. 1 XTOOL= 0, YTOOL= -350, ZTOOL= -75

POS. 2 XTOOL= -350, YTOOL= 0, ZTOOL= -75

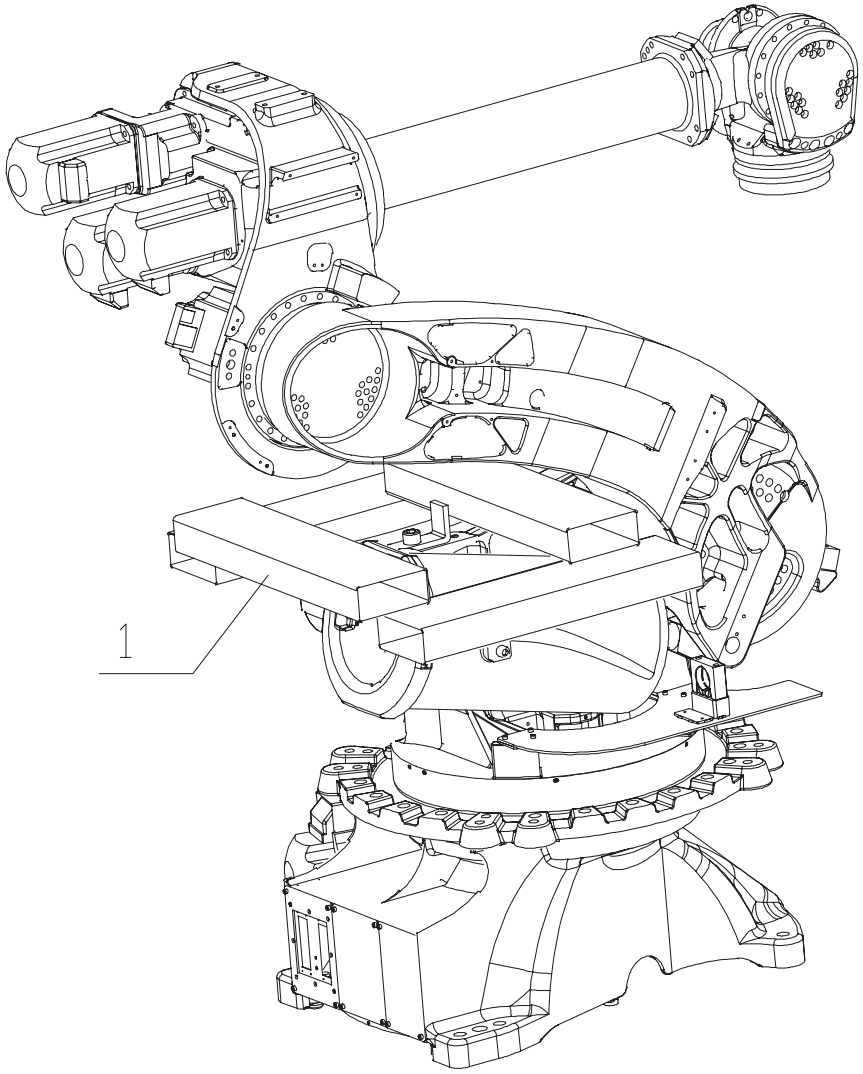
1. Calibrated fixture (L = 117mm for SMART NH1-NH2-NH3; L = 200mm for SMART NH4)
2. Calibrated fixture (L = 200mm for SMART NH4)

8.13.1 Description

The gauged tool assembly is used to calculate the **TCP** (Tool Center Point) in relation to the robot flange.
The assembly consists of a cylindrical test rod of a length that is defined so that the end is at an exact position in relation to the center of the wrist.
The prod is screwed directly onto the axis 6 output flange in a radial position in relation to the latter and there is no need to disassemble any tools that are installed on the flange.
Two tools of different lengths L are available depending on the type of robot that is used

- L = 117 mm for SMART NH1-NH2-NH3 robot;
- L = 200 mm for SMART NH4 robot.

8.14 Fork liftable fitting (code: 82314000)



1. Fork liftable option

The robot shown in the figure is approximate

8.14.1 Description

The fork liftable fitting is essential in order to transport the robot using a fork lift truck. The fitting can be mounted so that the forks enter from the rear or the side of the robot. The fitting consists of a rectangular electrowelded structure (200 x 100 mm) made of structural steel that is fastened to the robot.

8.15 Set of screws and pins to secure robot (code 82314700)

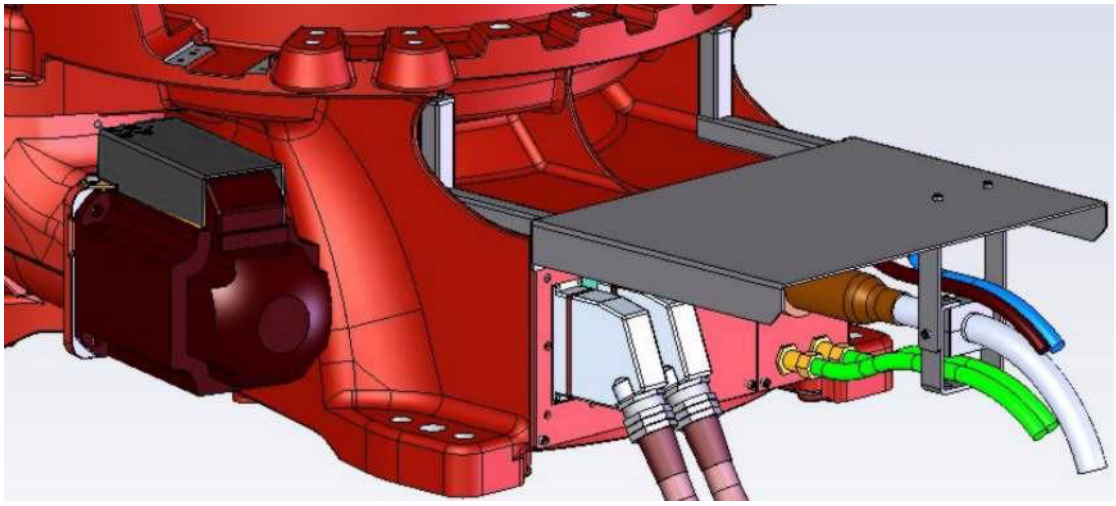
8.15.1 Description

The set includes the screws and pins needed to secure the robot to the steel robot base plate. For further information see the chapter Preparation for Robot Installation.

Legend: Fig. 8.1 - Set of screws and pins for robot-to-base fastening (code 82314700)

1. Centring Ø = 30 mm L = 80 mm (qty = 1)
2. Centring Ø = 30 mm L = 60 mm (qty = 1)
3. Socket head cap screw M 10 x 90 (8.8) (qty = 1)
4. Socket head cap screw M 10 x 70 (8.8) (qty = 1)
5. Partially threaded hex head screw M 24 x 100 (8.8.) (qty = 6)
6. Split washer Ø = 24mm (qty = 6)
7. Flat washer Ø = 24 mm (qty = 6)

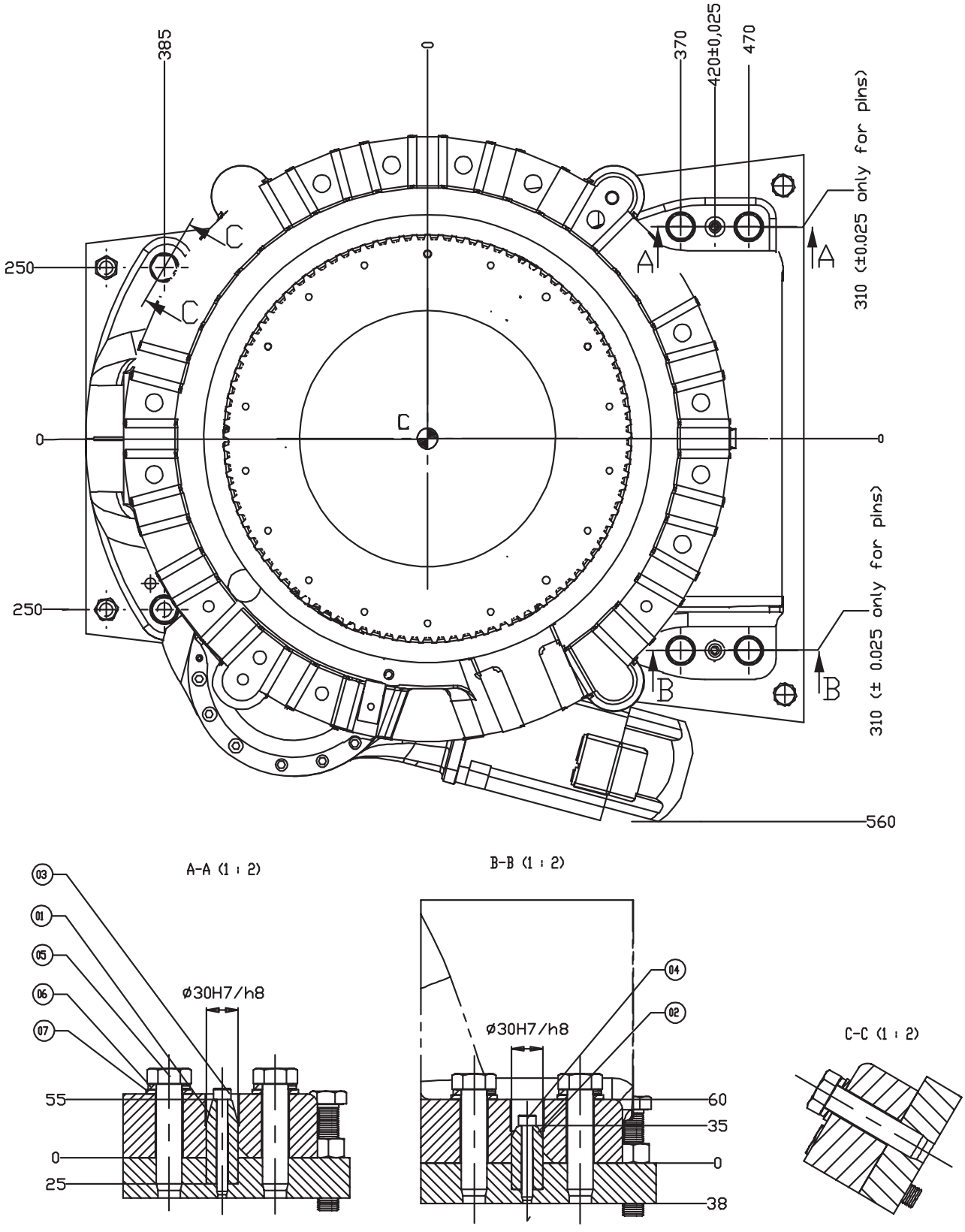
8.16 Distribution connection guard assembly (floor panel - code 82322600)



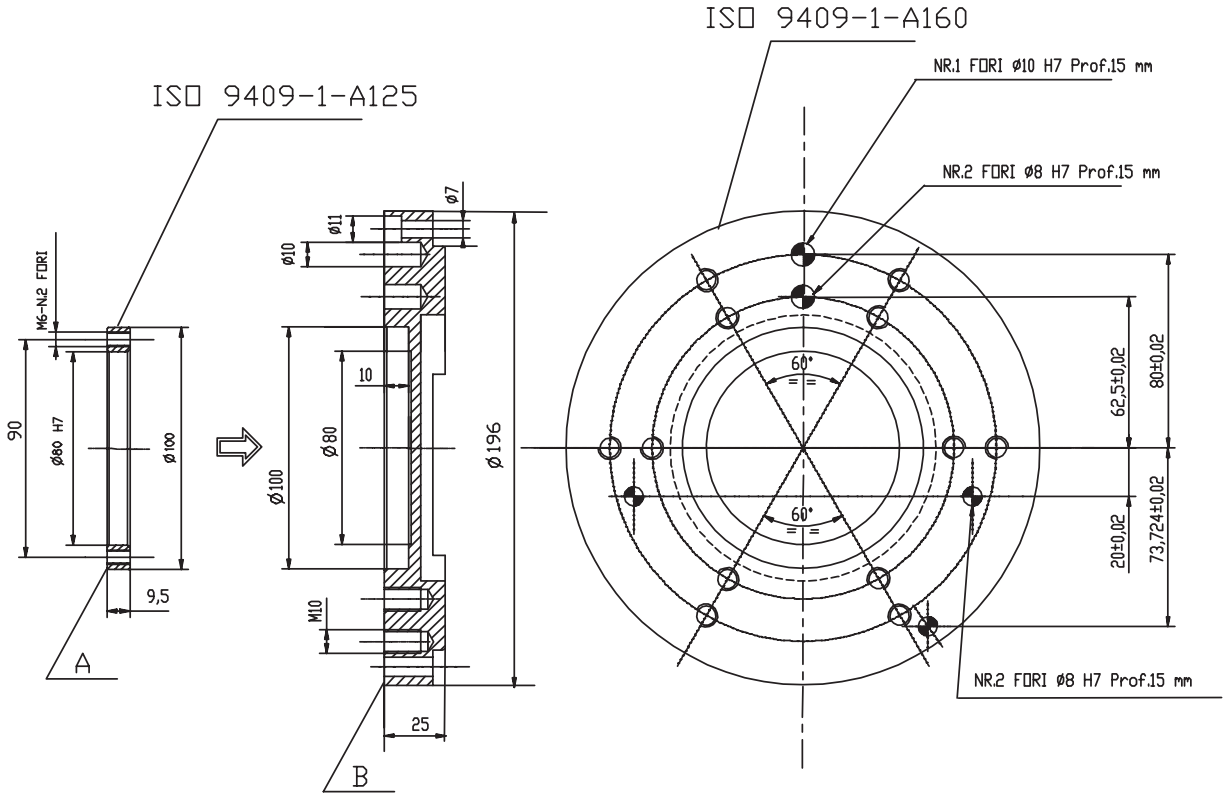
8.16.1 Description

The assembly consists of a robust guard made out of sheet metal that is fastened to the base of the robot to protect all the connectors connected to the robot distribution unit.

Fig. 8.1 - Set of screws and pins for robot-to-base fastening (code 82314700)



8.17 Centring (code 82107937)

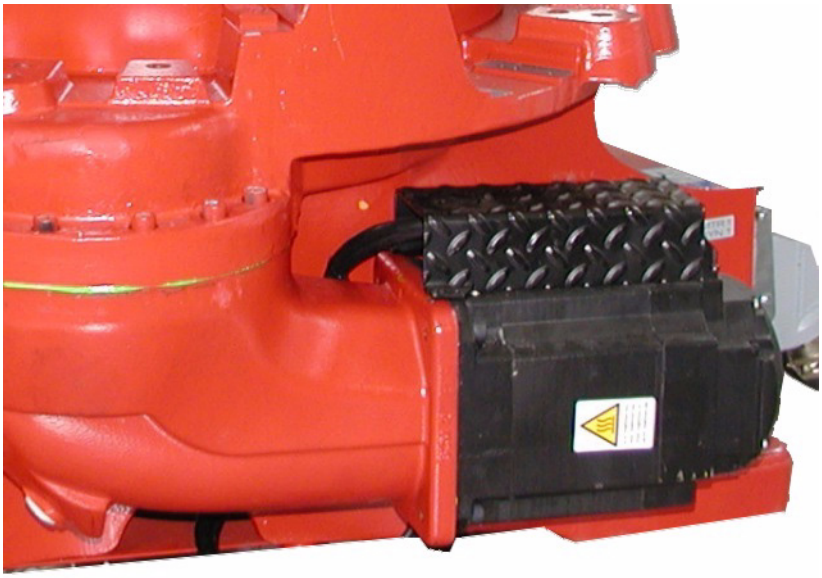


8.17.1 Description

The option consists of a simple ring (A) that is keyed into the centring hole of a robot flange ISO 9409-1-A160 (B) to adjust it to flange ISO 9409-1-A125 reducing the axial centring diameter to Ø 80 mm.

8.18 Axis 1 standard motor guard (code 82309240)

8.19 Axis 1 ventilated motor guard (code 82309259)

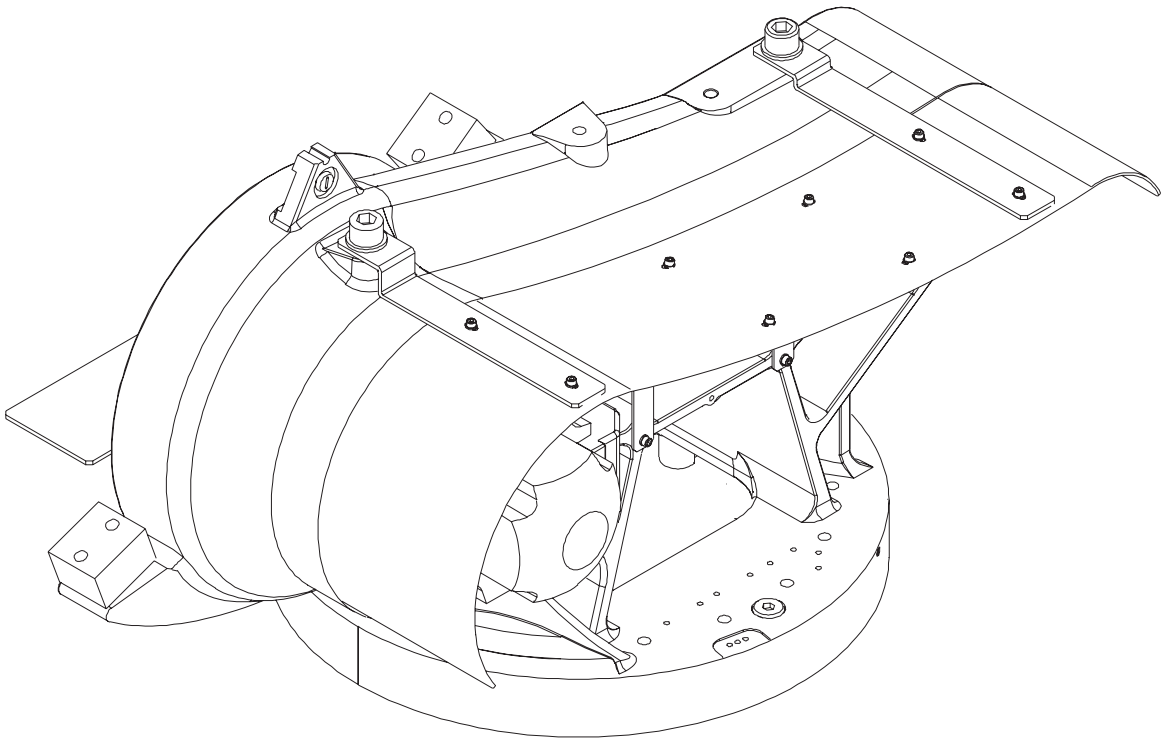


8.19.1 Description

The assembly consists of a strong sheet metal guard that is secured to the robot axis 1 reduction unit to protect the electric connectors of axis 1 motor.

The axis 1 ventilated motor guard (code 82309259) is specific for robot NH3 SH -100-3.5P

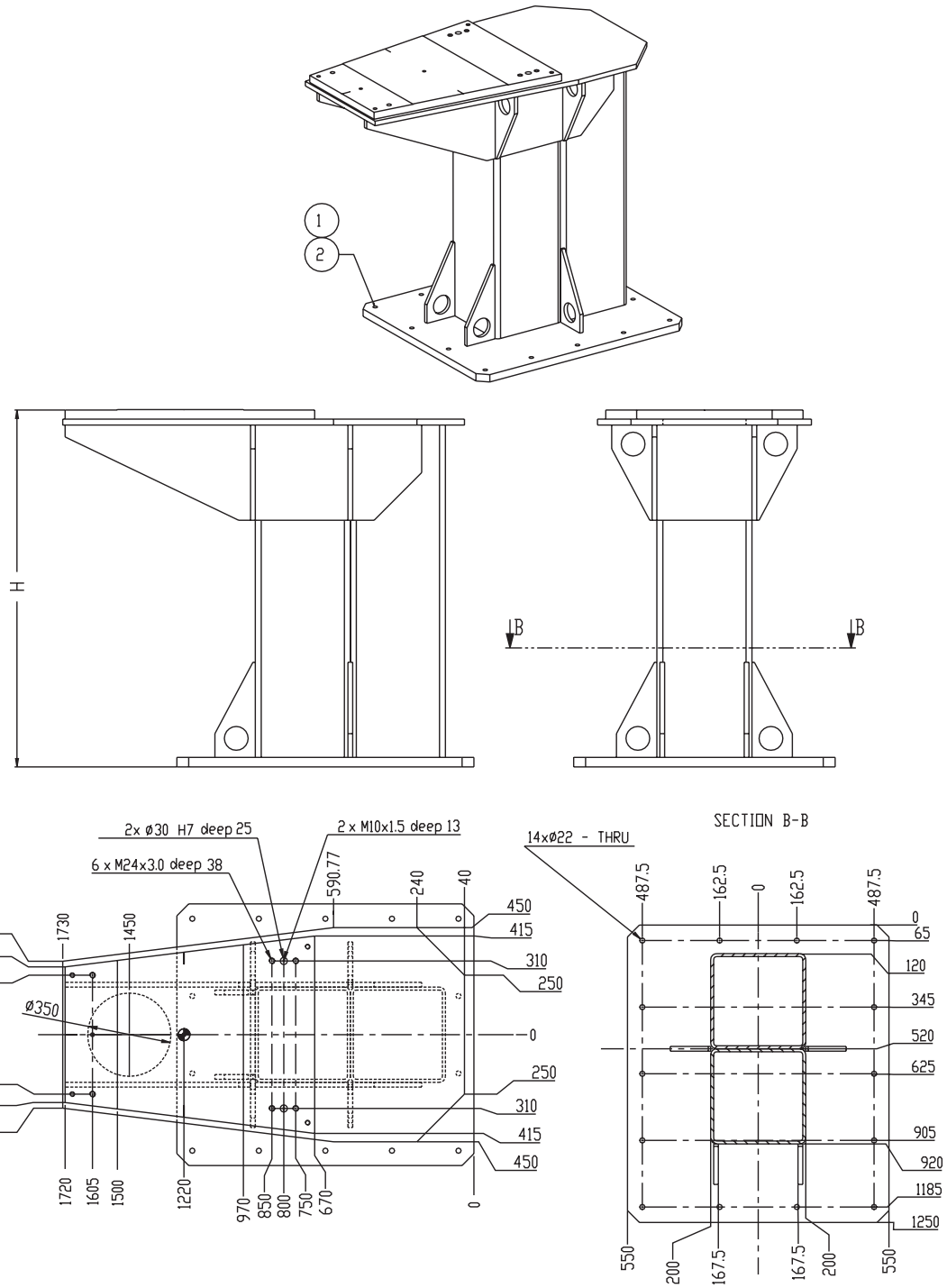
8.20 Axis 2 ventilated motor guard (Foundry)



8.20.1 Description

For the foundry robot versions, a sheet metal guard is available that is secured to the left side of the robot column to protect axis 2 motor and wiring against dust and splatter that could occur in applications used in the foundry

8.21 Robot NH SH Supports



1. Screw HH ISO 4014 - M20x70 - 8.8 - q.ty 14
2. Washer ISO 7089 - 20 - 200 HV - q.ty 14

Support height:

- H = 1500 mm *(59.05 in)* cod. CR 82328115
- H = 1600 mm *(62,99 in)* cod. CR 82328116
- H = 1700 mm *(66,92 in)* cod. CR 82328117
- H = 1800 mm *(70,86 in)* cod. CR 82328118

– H = 1900 mm *(74,80 in)* cod. CR 82328119
– H = 2000 mm *(78,73 in)* cod. CR 82328120

8.22 Brake release module

The integrated brake release device is an optional accessory that permits the release of a single robot axis for robot maintenance operations with a seriously damaged Control Unit.
This option is installed permanently and the brake release function can be used without the need for disconnections or temporary installation of additional control systems. The mobile pushbutton panel is connected by means of a cable with connector, directly to connector X2 at the Robot base.
The module is powered directly by the Control Unit, that has to remain powered during the use of the integrated brake release device. Brake release is made more efficient by the dynamic braking active on the Control Unit.

The brake release module option consists of:

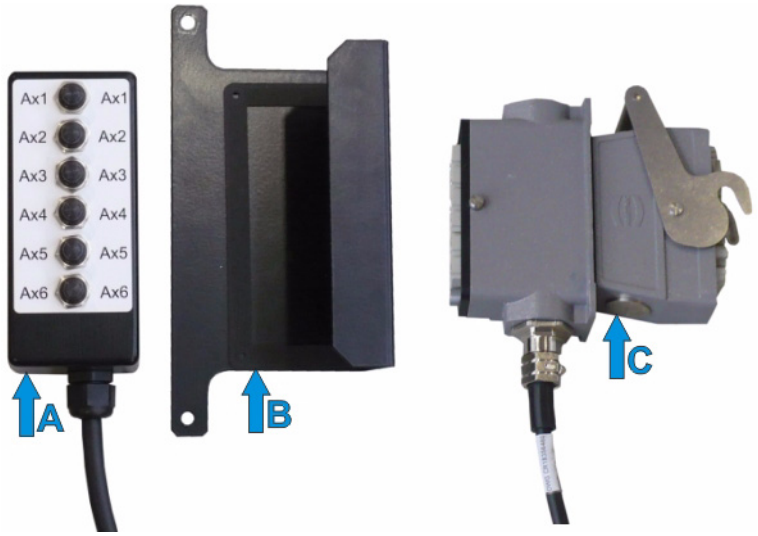
– kit inside C4G-SIBR4 cabinet (provides +24Vdc on X60)

– kit on board robot (control pushbutton panel; adapter cable with connector).

The pushbutton panel can be installed on the left or on the right of the robot.
The individual axis is released by means of the pushbuttons on the robot. The pushbuttons are only active with the Control Unit powered and in Drive Off status; they are automatically excluded in Drive On.

The brake release module is to be used by skilled, authorised operators, together with lifting systems.
The mode of use is explained in the robot maintenance manual.

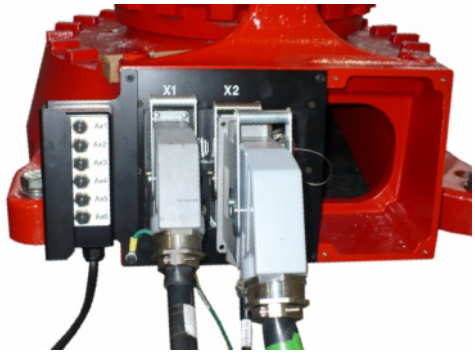
Fig. 8.2 - Brake release module



A - Pushbutton panel

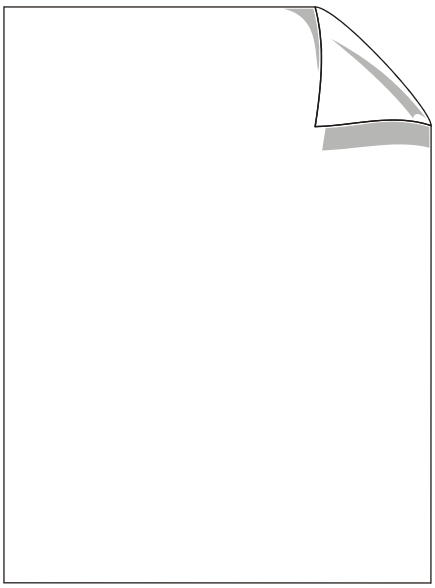
B - Pushbutton panel support bracket

C - Pushbutton panel connector

Left side installation	Right side installation
	

Tab. 8.7 - Brake release module

COMAU code	Type des.	Description
CR18968580	---	Complete brake release module option



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