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STÄUBLI®

RX90 FAMILY

ROBOT

CS7 M

INSTRUCTION MANUAL

D.280.037.14.B - Rev. B 07/97

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FOREWORD

This manual is intended to be used, for reference only, by persons who have successfully completed the "Robotics" training course given by STÄUBLI.

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If difficulties arise during the operation or the maintenance of the robot which are not dealt with in this document or if additional information is required, please contact the STÄUBLI "Robot Division" After-Sales Service.



The robot, which is a subassembly intended to be integrated into installations, has been designed and built so that these "installation-robot" assemblies can meet regulatory provisions. The responsibiliity for the "installation-robot" assembly falls to the project leader who very often is the user (NF EN 775: 1993).

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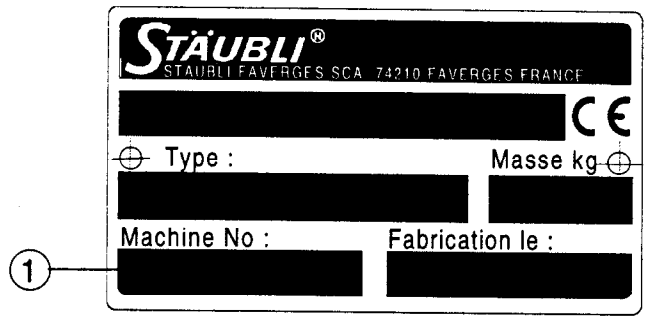
PLAQUE D'IDENTIFICATION DE CHAQUE ROBOT
rivetée sur la baie de commande et sur le bras

ROBOTER-TYPENSCHILD
auf den Steuerschrank und genietet

PIASTRA DI IDENTIFICAZIONE DI OGNI ROBOT
rivettata sull'armadio di comando e sul braccio

IDENTIFICATION PLATE OF EACH ROBOT
riveted to the controller and to the arm

PLACA DE IDENTIFICACION DE CADA ROBOT
fijada en el armario de mando y en el brazo



Pour chaque contact avec nos Services, nous conseillons à nos clients de nous communiquer le numéro de machine (1) du robot qui est gravé sur la plaque d'identification.
La qualité du service ne pourra qu'en être améliorée.

Bitte geben Sie bei Rücksprache mit unserem Kundendienst die auf dem Typenschild eingravierte Seriennummer (1) des Roboters an.
So kônnen wir Ihnen bessere und schnellere Unterstützung bieten.

Per qualsiasi contatto con i ns. Servizi, consigliamo ai ns. clienti di comunicare il numero della macchina (1) del robot che è inciso sulla piastra sovra esposta.
La qualita del servizio non potrà che beneficiarne.

Each time that you contact our Service Dept., we recommend that you give them the robot machine number (1) which is engraved on the identification plate.
This will help us to improve the quality of our service.

Para cada contacto con nuestros Servicios, aconsejamos a nuestros clientes nos comuniquen el número de máquina (1) del robot que está grabado en la placa de identificación.
La calidad del servicio no podrá ser más que mejorada.

I. GENERAL

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CHAPTER 1 - SAFETY

CHAPTER 1 - SAFETY CAUTION 

The robot, which is a subassembly intended to be integrated into a robotic cell, has been designed and built so that the "robotic cell" assembly can meet regulatory provisions.
The responsibility for the robotic cell falls to the project leader who very often is the user.

REFERENCE DOCUMENTS:
- International Standard: ISO 10128. 1992
- European Directive: CEE 89-392
- French Standard: NF EN 775. 1993

"The user has to ensure that the person who programs, operates, maintains or repairs the robot or the robotic cells, is correctly trained and has the ability to carry out these tasks in all safety". Extract of the NF EN 775 standard.

This manual is intended to be used for reference only by personnel who have successfully completed the "robotics" training course given by Stäubli (personnel: persons specially employed and trained in the use and maintenance of robotics cells).

1.1. CAUTIONS

Note : **This list is not exhaustive, you must first of all comply with the standards in force in the country concerned.**

The controlled space or isolated area in which the robot moves must be determined by protective devices (protectors, devices protecting persons from a dangerous area, refer to standards in force concerning safety of industrial manipulators).

Special attention must be paid as the final position of the robot after emergency shutdown can not be precisely defined because of the cinetic energy involved.

Due to its design, joint 5 can not be moved by hand. In emergency situation, joint 5 can be released by moving other joints, as an example by combining movement of joints 2 and 3.

The controller must be switched off before it is connected to the robot arm.

Do not connect or disconnect items supplied with power.

All obstructions must be removed from the robot work envelope before switching on the arm.

Each time that arm is switched on, keep one hand near to the "Emergency stop" pushbutton.
Do not use the emergency stop or the dead man to switch off the arm under normal utilization conditions.

Be careful not to block the air inlets and outlets of the controller ventilation circuit.

Before connecting the controller, check that its voltage rating corresponds to that of the power network.

Connect the controller using a cable suitable for the power mentioned on the identification plate.

It is prohibited to perform operations inside the controller or on the arm if the electrical or pneumatic power supplies inside or outside the controller are switched on.

Remember that in "brake release" mode, the servomotors are switched off and their brakes are released so that the joint is free from all stresses.

During the maintenance operations, the arm must be freed from all loads.

Before extracting or inserting an Adept controller board, switch off the arm then the controller following the procedure described in section III, chap. 2.2, **AND** place the switch located on the front face of the Adept controller in "OFF" position (section III - figure 3.2.9 - item 13).

The arm is fitted with balancing springs.
Releasing the brakes may cause movement in the system.

1.2. WARNINGS (Caution, Note)

There are two types of warnings in this manual. In decreasing order of importance:

> ⚠ Risk of physical injury or serious damage to equipment if the measures described are not observed. Such an indication generally describes the potential danger, its possible effects and the measures to be taken to reduce the danger.

> **NOTE**
>
> Provides additional information, underscores a point or a procedure, or gives a recommendation to facilitate operation.

1.2.1. INSTRUCTION AND TRAINING OF ROBOTIC CELL USERS

Stäubli robots include mechanisms controlled by a computer, and are capable of moving at high speed and exerting a considerable force. Like all robots and most industrial equipment, they must be treated with the utmost care by the user of the robotic cells.

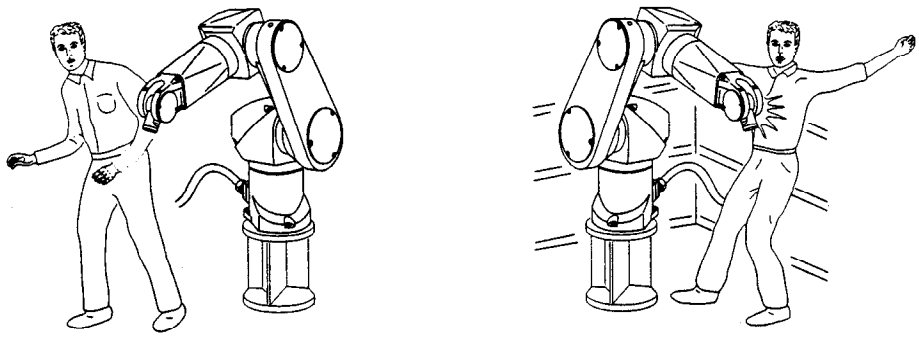


Figure 1.1.1 - Shocks and traps

> **NOTE**
>
> In this manual, the term "user" designates the person or company responsible and "operator" the person who starts, stops or controls the robot's operation.

All persons using Stäubli robots must be acquainted with the recommendations in this manual.

1.2.2. ROBOTIC CELL SAFETY DEVICES

Safety devices must be an integral part of the design and the installation of the robotic cell, the training of the operators and the operating procedures. Stäubli robots possess various communication functions helping the user to develop safety devices for the robotic cells. They include emergency stop circuits and digital I/O lines.

Computer-controlled robots

As Stäubli robots can be controlled automatically, the program controlling the robot can cause the robot to move at a time and along a trajectory not anticipated by the personnel. This is why the personnel must not enter the cell when the green ARM POWER ON or ARM POWER indicator light or the orange PROG RUN indicator light on the controller's (local or remote) front panel are on (figure 1.1.2).

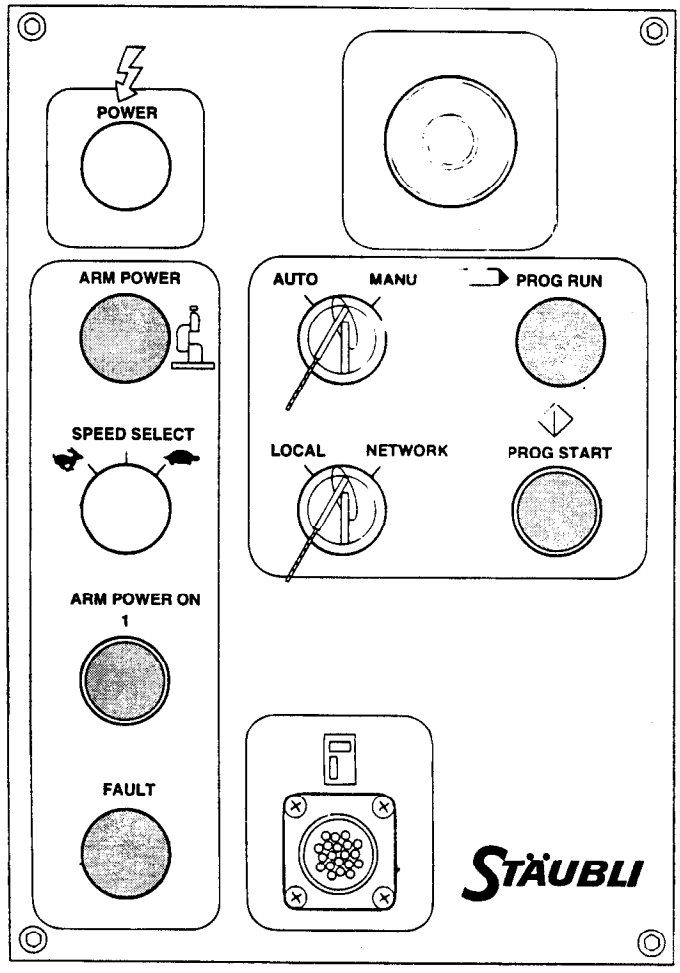


Figure 1.1.2 - Arm power on / Arm power and Program running indicator lights

Manually controlled robots

Stäubli robots can also be controlled manually when the green ARM POWER ON / ARM POWER indicator lights of the controller's front panel are on. At this time, the robot's motion can be controlled from the terminal or the teach pendant. If you enter into the robot's work envelope when this light is on, you must take the teach pendant and press the MAN/HALT key. This disables all unexpected robot motion commands given by a third party from the terminal keyboard.

Also, a pendant reduced speed option (turtle position) voluntarily limits the speed of the robot by supplying it with reduced voltage in order to give the persons sufficient time to stop the robot or move away (figure 1.1.2).

Other computer-controlled equipment

In addition, these systems can be programmed to control equipment and devices other than the robot. As with the robot, the program which controls this equipment may move it at a time not anticipated by the personnel. It is essential that the safety devices prevent the personnel from entering into the work envelope when the orange PROG RUN indicator light on the controller's front panel is on.

> ⚠ Entering the robotic cell when the green ARM POWER ON / ARM POWER indicator lights or the orange PROG RUN indicator light are on may lead to serious physical injury.

Stäubli recommends the use of additional safety devices such as optical curtains, safety doors or tactile mats to prevent entry into the cell when the ARM POWER indicator light is on. These devices can be connected using the emergency stop circuit external to the controller.

CHAPTER 2 - ROBOT START-UP

CHAPTER 2 - ROBOT START-UP

⚠ Do not switch on the controller until all safeties are installed and operate correctly. Check that there are no obstructions or persons in the cell.

⚠ Do not connect the cable or modify the electrical configuration when the controller is switched on.

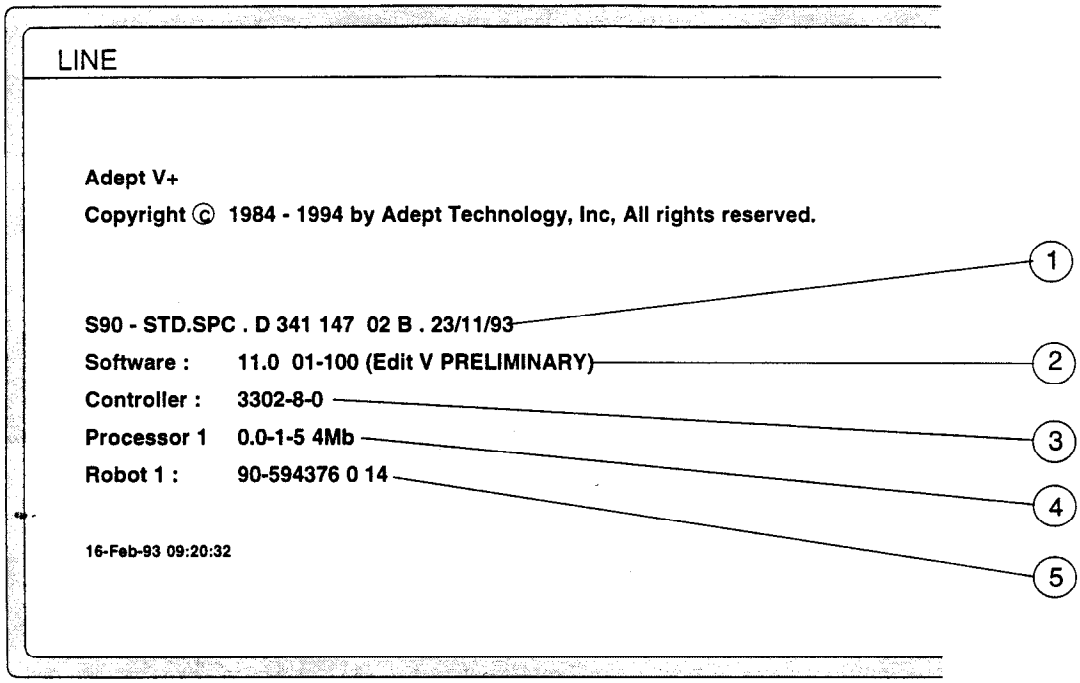


Figure 1.2.1

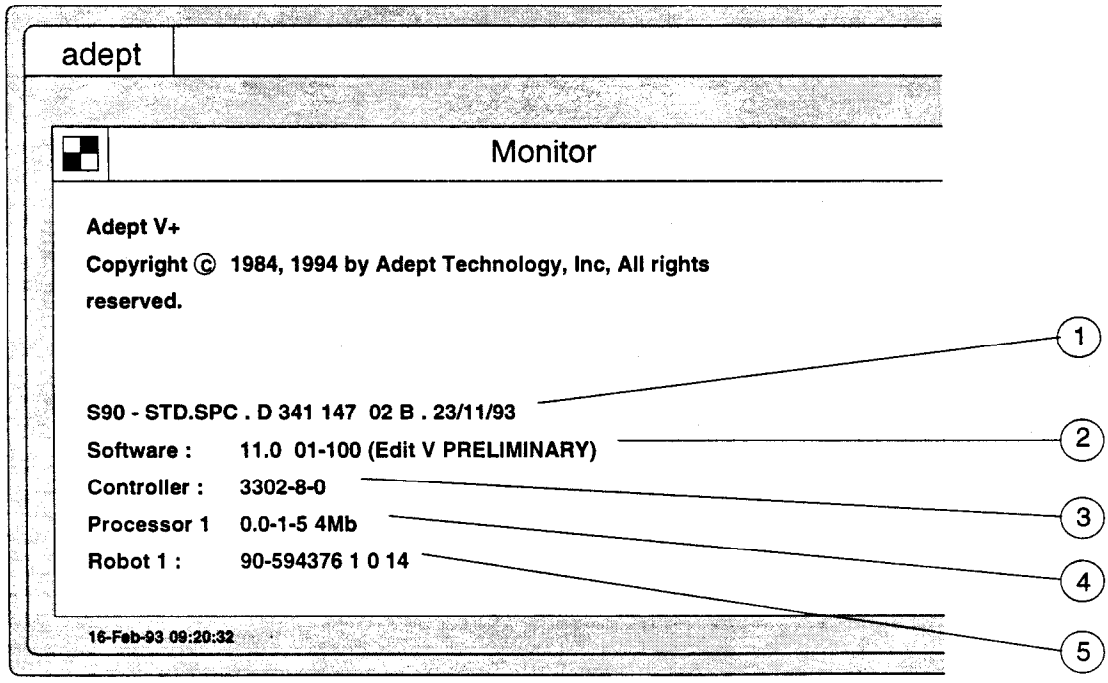


Figure 1.2.2

2.1. CONTROLLER POWER-UP

Place the general switch located on the rear of the controller in position 1 and check that the "POWER" indicator light is on.

With a graphics configuration, switch on the monitor.

With a standard configuration which uses the WYSE terminal, switch on the terminal.

Make sure that switch 0/1 on the Adept controller is in position 1. The Adept controller then runs a sequence of automatic tests on its various peripherals and loads the operating system. The controller will try to load the operating system in the drive by default. If the operating system is not in the drive, you will be asked to specify the drive containing the copy of the operating system.

The start-up sequence lasts approximately one minute.
When the start-up process is completed, a screen similar to the one shown on figure 1.2.1 (for a standard terminal) or on figure 1.2.2 (for a monitor) will be displayed. The exact text will depend on the software version, the robot and the options installed on your system. On completion of the procedure, the cursor is positioned beside a "." on the left of the screen indicating that you are in control mode.

Meaning of the most important parameters:

line (1) : gives the name (S90 for an RX90) and the number (D 341 147 02 B) of the specifications file used for the robot. A second line of this type will appear if the "External Axes" option is used.

line (2) : gives information on controller V+ software. The information supplied is of type software = version - revision option 1 - option 2. For example, version 11, revision 0.

line (3) : gives information on type of Adept controller (3302) and controller's serial number. For example, 3302-8 for controller No.8.

line (4) : gives type of processor board with its memory capacity (4 Mb).

line (5) : gives type of robot (90 = RX90) and its serial number (594376). The serial number corresponds to the robot's order number.

For further details concerning the meaning of these parameters, refer to the "V+ Language Reference Guide", part relative to "ID" instruction.

Note: The example above is given for an RX90 robot. For other robots, some of the numbers will be different.

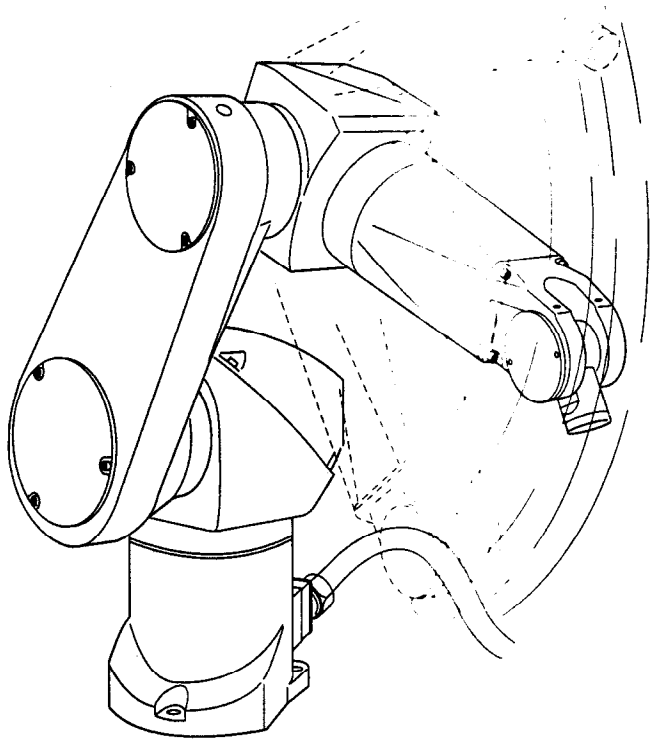


Figure 1.2.3

2.2. ARM POWER-UP

Each time the controller is switched on, an arm automatic calibration procedure is performed. When the controller is switched on, power is not present on the arm.

When you are ready, apply power to the arm by entering the following command via the keyboard:

. enable power (return)

or press the COMP/POWER button on the teach pendant.

> ⚠ When power is active, the robot may move. Before entering this command, make sure that there are no obstacles in the cell and that all persons are outside the robot's work envelope.

The green "ARM POWER ON" illuminated pushbutton is flashing for a time t (t = 10 seconds per default. This time can be modified by changing the "power time out" value in program "CONFIG_C").
You can then power on the robot by pressing the "ARM POWER ON" pushbutton. The green "ARM POWER" indicator light then changes to condition 1. If time t is over, you must type the following command on the keyboard: enable power (return).

The system is now ready to accept your motion commands (figure 1.2.3).

Each time the controller is switched on, check that the automatic calibration procedure is correctly performed. The LEDs located on the front face of the ACB (see Section IV - chapter 2.2) must all be off. Check that the angular position of each robot joint is coherent with its real position by entering the following command via the keyboard:

. where (return)

which displays the angular position of each robot joint.

It is possible to more accurately check the position of the robot by the alignment of the marks located on each joint (see Section II - chapter 3).

Mark alignment procedure:
. load mark (return)
. speed 5 (return)
. do move # mark (return)

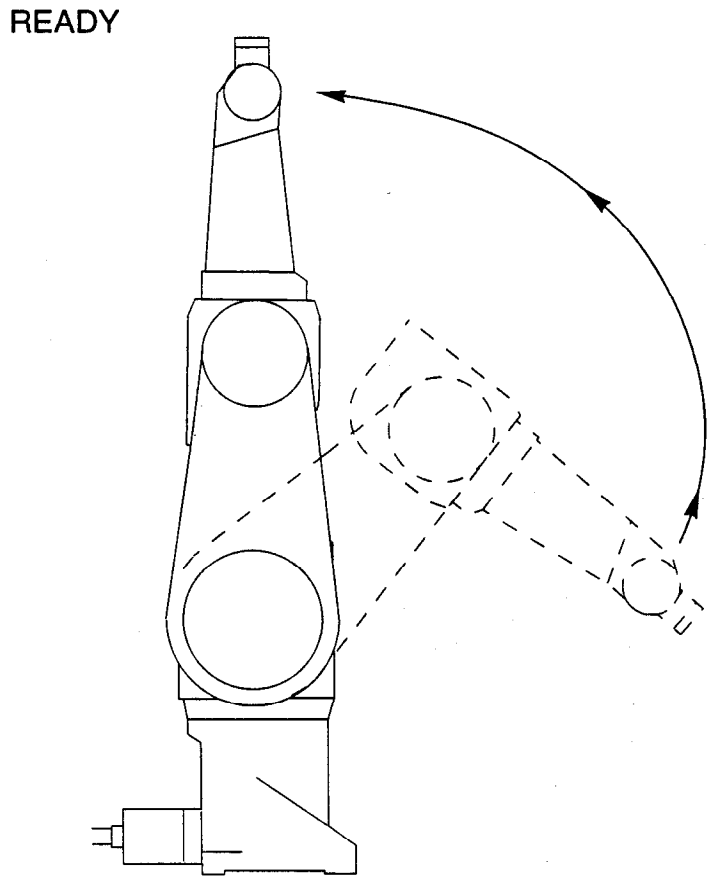


Figure 1.2.4

At end of movement, the robot will be in the position shown on figure 1.2.4 with the various marks aligned.

> ⚠ Make sure that no obstacles are located in the arm's trajectory towards the "aligned marks" position.

> If marks are incorrectly aligned, please contact the Staubli "Robot Division" After-Sales Service.

Before switching off the installation, it is recommended to set the robot to "READY".

To do this, enter the following command:

. speed 5 (return)
. do ready (return)

The angular position of each joint must then be:

. where (return)

JT1	JT2	JT3	JT4	JT5	JT6
0°	-90°	90°	0°	0°	0°

2.5. HOW TO SWITCH OFF THE CONTROLLER

- Cut off the power to the arm (paragraph 2.3).
- Cut off the display console power supply.
- Cut off the general power supply (general switch behind the controller).

> ⚠ Before extracting or inserting an Adept controller board, switch off the power to the arm then to the controller following the procedure described above AND place the switch located on the front face of the Adept controller in "OFF" position.

2.6. PROGRAMMING

The various possibilities of the V+ language are described in the "V+1 Instruction Manual".

> ⚠ These manuals are intended to be used by persons who have successfully completed the "V+ level 1" training course given by Stäubli.

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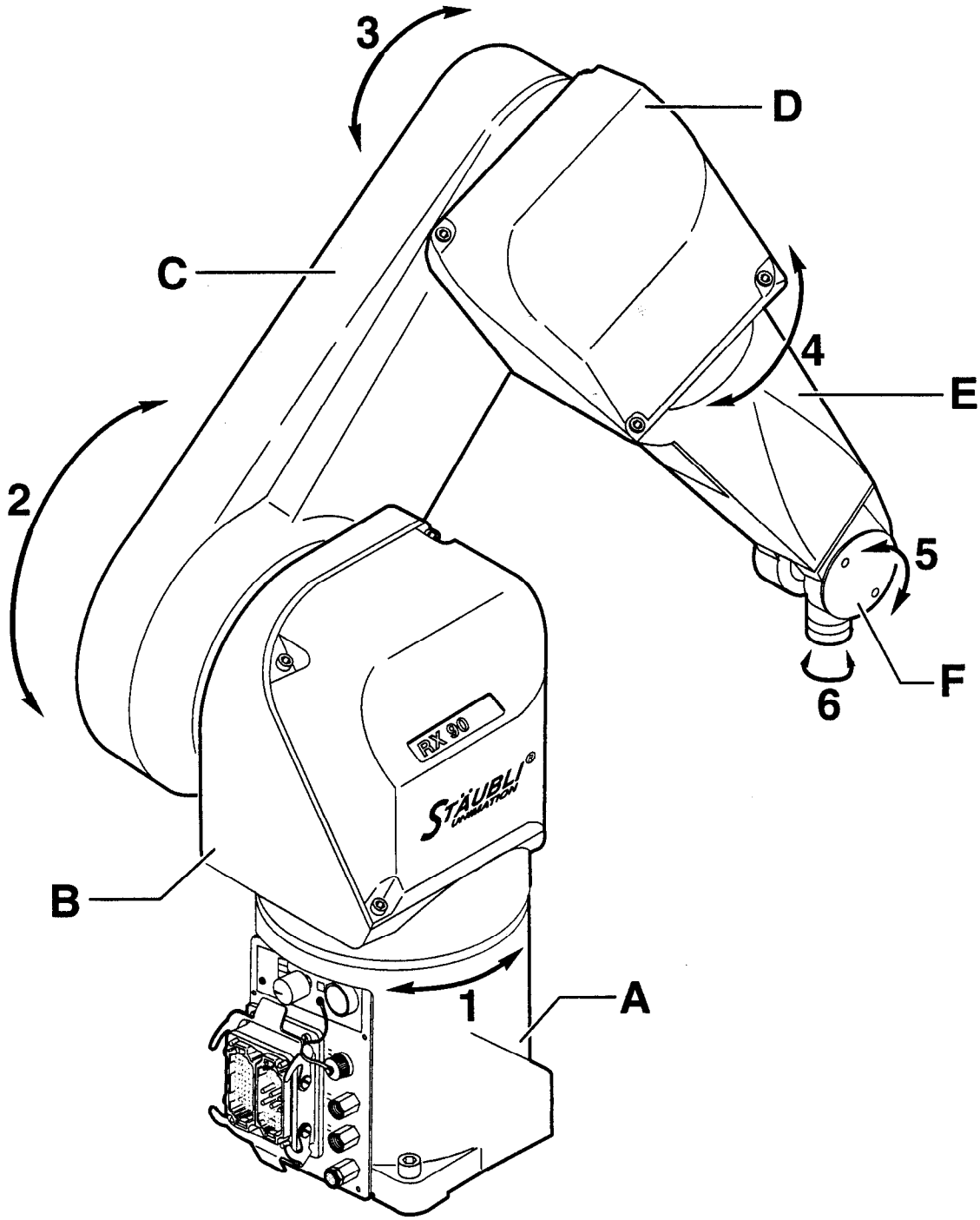


Figure 1.3.1

CHAPTER 3 - GLOSSARY

The robot consists of an ARM (mechanical part) and a CONTROLLER (intelligent part), both being connected by a interconnexion cable.

3.1. ARM

BASE	Fixed part (A)
SHOULDER	Movable part (B), rotation around axis 1 also called joint 1
ARM	Movable part (C), rotation around axis 2 also called joint 2
ELBOW	Movable part (D), rotation around axis 3 also called joint 3
FOREARM	Movable part (E), rotation around axis 4 also called joint 4
WRIST	Movable part (F), rotation around axes 5 and 6 also called joints 5 and 6. The wrist is conceived from a compact transmission module with reduced backlash realized by two worm gear systems. This module runs in oil-bath.
JCS	Stäubli combined joint, compact transmission module without backlash integrating two functions: joint and reduction. The central passage is freed for the energy transfer (electric and pneumatic). The JCS runs in oil-bath.
JOINT 1 (Jt1)	Rotation axis Nr 1
JOINT 2 (Jt2)	Rotation axis Nr 2, perpendicular to rotation axis nr 1
JOINT 3 (Jt3)	Rotation axis Nr 3, parallel to rotation axis nr 2
JOINT 4 (Jt4)	Rotation axis Nr 4, perpendicular to rotation axis nr 3
JOINT 5 (Jt5)	Rotation axis Nr 5, perpendicular to rotation axis nr 4
JOINT 6 (Jt6)	Rotation axis Nr 6, perpendicular to rotation axis nr 5

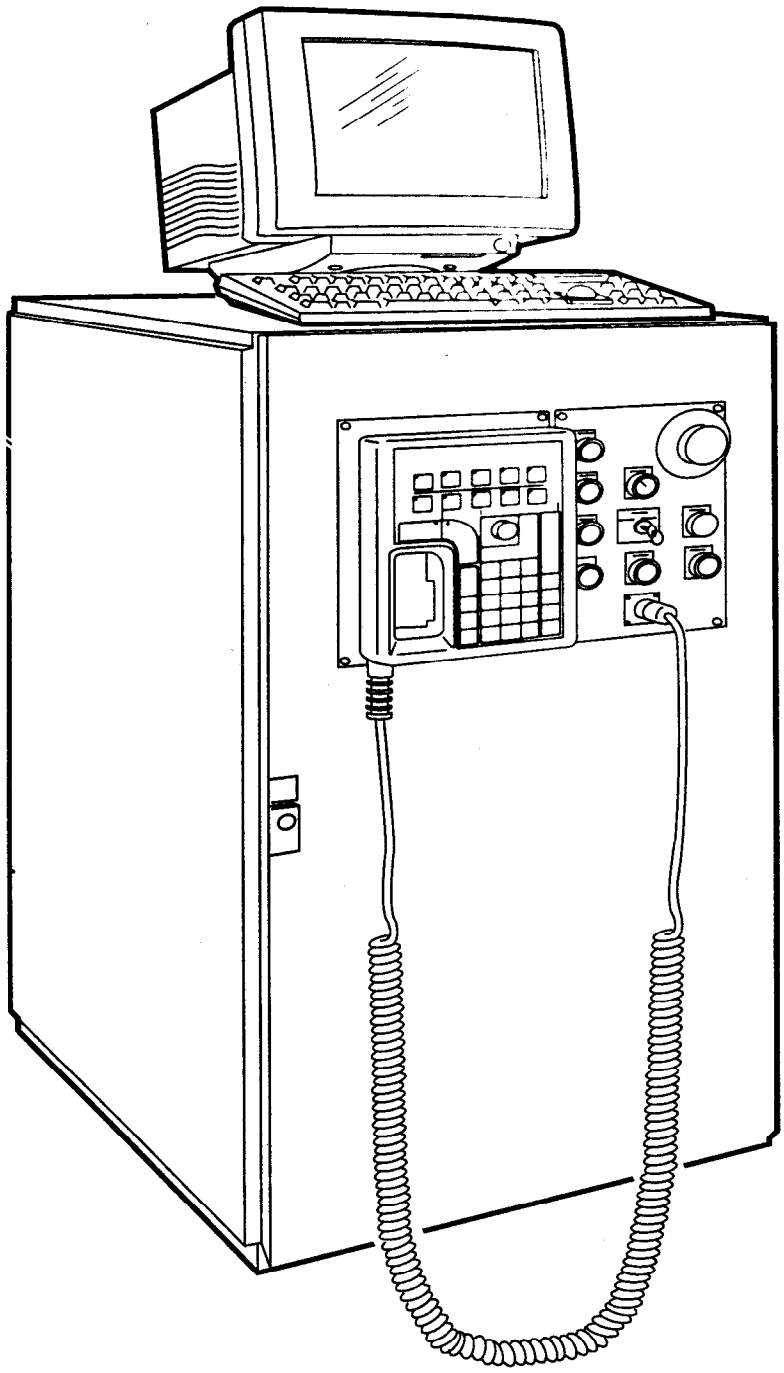


Figure 1.3.2

3.2. CONTROLLER

FP	Front Panel
MCP	Teach pendant
VME	Versa Module Eurocard
VMI	VME Motion Interface Board
MI6	VME Motion Interface Board
030	VME 68030 system processor board
040	VME 68040 system processor board
SIO	System I/O module
DIO	Digital Input/Output board
AIO	Analog Input/Output board
VGB	VME Graphic Board
VIS	VME vision interface
VFI	VME force interface
IMAS	Inductive Modular Absolute System
AU	Emergency stop
ACB	Absolute Calibration Board
V+	Language/Adept operating system
	Safety board
Turtle	Operation at reduced pendant speed
Rabbit	Operation at normal speed
Dummy plug	MCP plug short circuiting the dead man and emergency stop of the manual control pendant
VTB	Auxiliary backplane

II. ARM

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CHAPTER 1 - DESCRIPTION

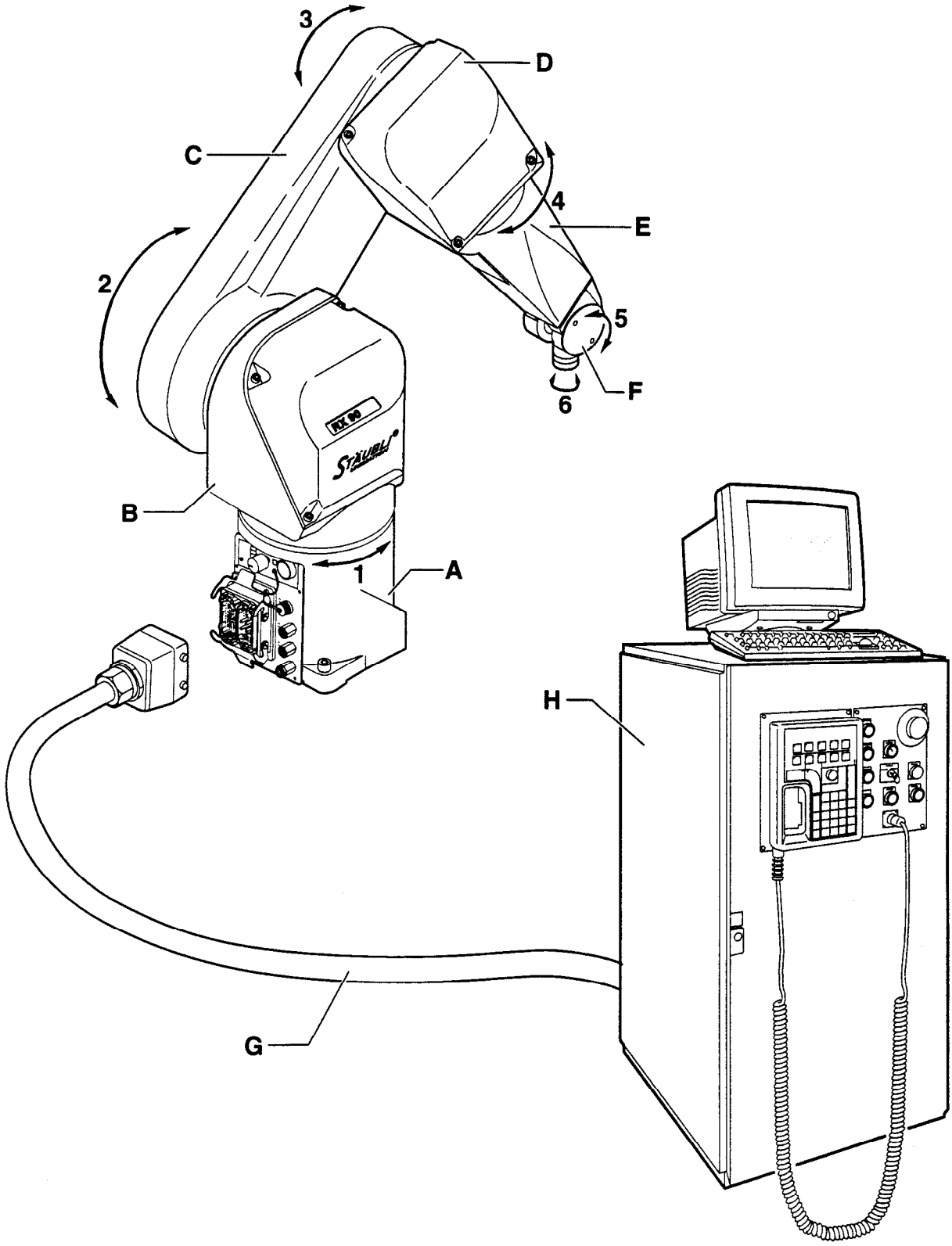


Figure 2.1.1

CHAPTER 1 - DESCRIPTION

1.1. GENERAL PRESENTATION (See glossary - General Section - Chapter 3)

The robots of the RX series 90 family are of the multiple-joint type with 6 (or 5) degrees of freedom. They consist of a mechanical arm assembly (A to F) and a controller (H), connected via a connecting cable (G) (figure 2.1.1).

The arm consists of segments or members interconnected by joints.
Each joint comprises an axis around which two members pivot.
The movements of the robot's joints are generated by brushless motors coupled to resolvers.
This reliable and robust assembly associated with an innovative counting system allows the absolute position of the robot to be known at all times.

The arm assembly is sufficiently flexible and is able to perform a great variety of applications.
Example: Handling of loads, assembly, process, application of adhesive beads, control/check and clean room applications. This list is not restrictive: for further information, please consult us.

The various elements of the robot's arm are: the base (A), the shoulder (B), the arm (C), the elbow (D), the forearm (E) and the wrist (F) (figure 2.1.1).
The robot arm assembly thus contains the motorization, brakes, motion transmission mechanisms, cable bundles, pneumatic and electric circuits for the user and the counterbalance system.

The robots of the RX series 90 family can accelerate very quickly and move at high speeds.
Of simple construction, the RX90 arm assembly consists of a rigid and encased structure (protection IP65 to standard NF EN 60529) to protect it against external aggressions. Its design is based on transmission modules: JCS (Stäubli Combined Joint) used on joints 1, 2, 3 and 4 (see figure 2.1.1).
The wrist consists of joints 5 and 6 (figure 2.1.1).

The arm has a built-in spring counterbalance system giving an attractive low weight system.

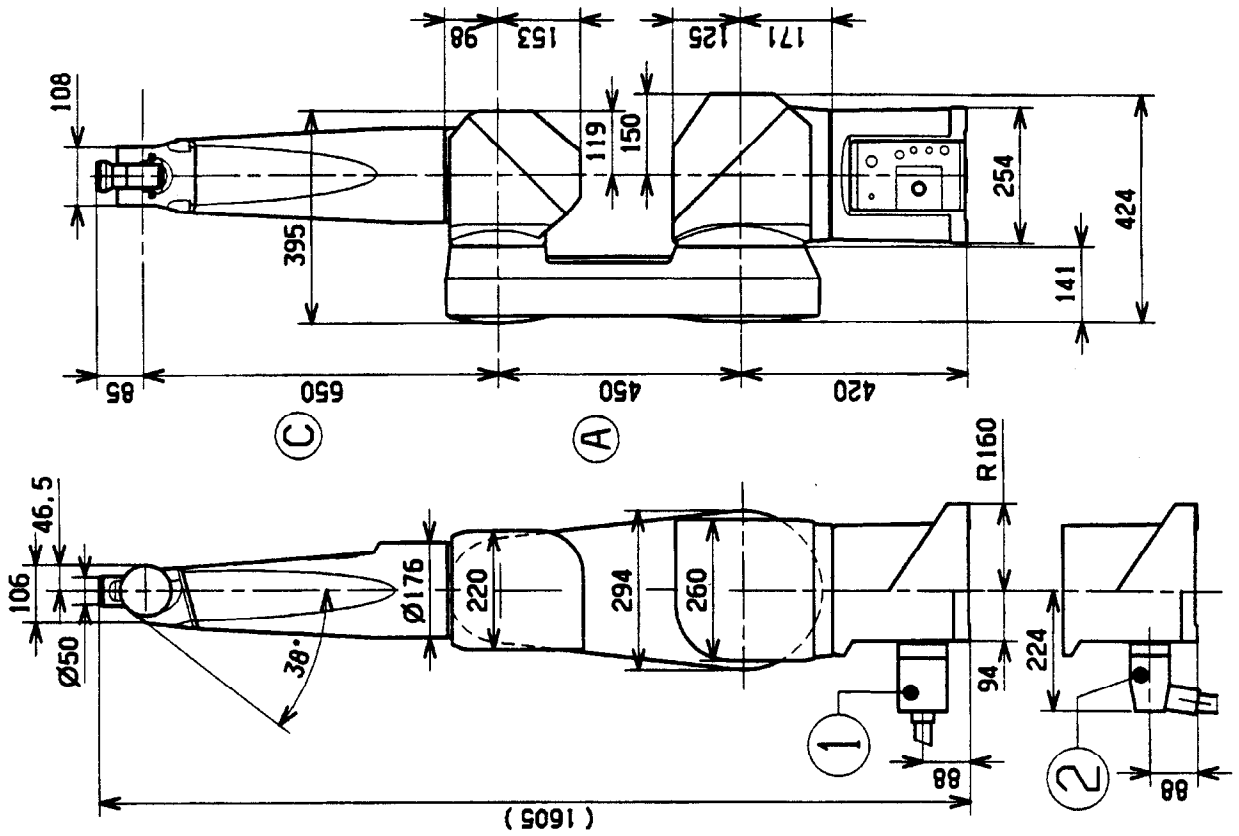


Figure 2.1.2

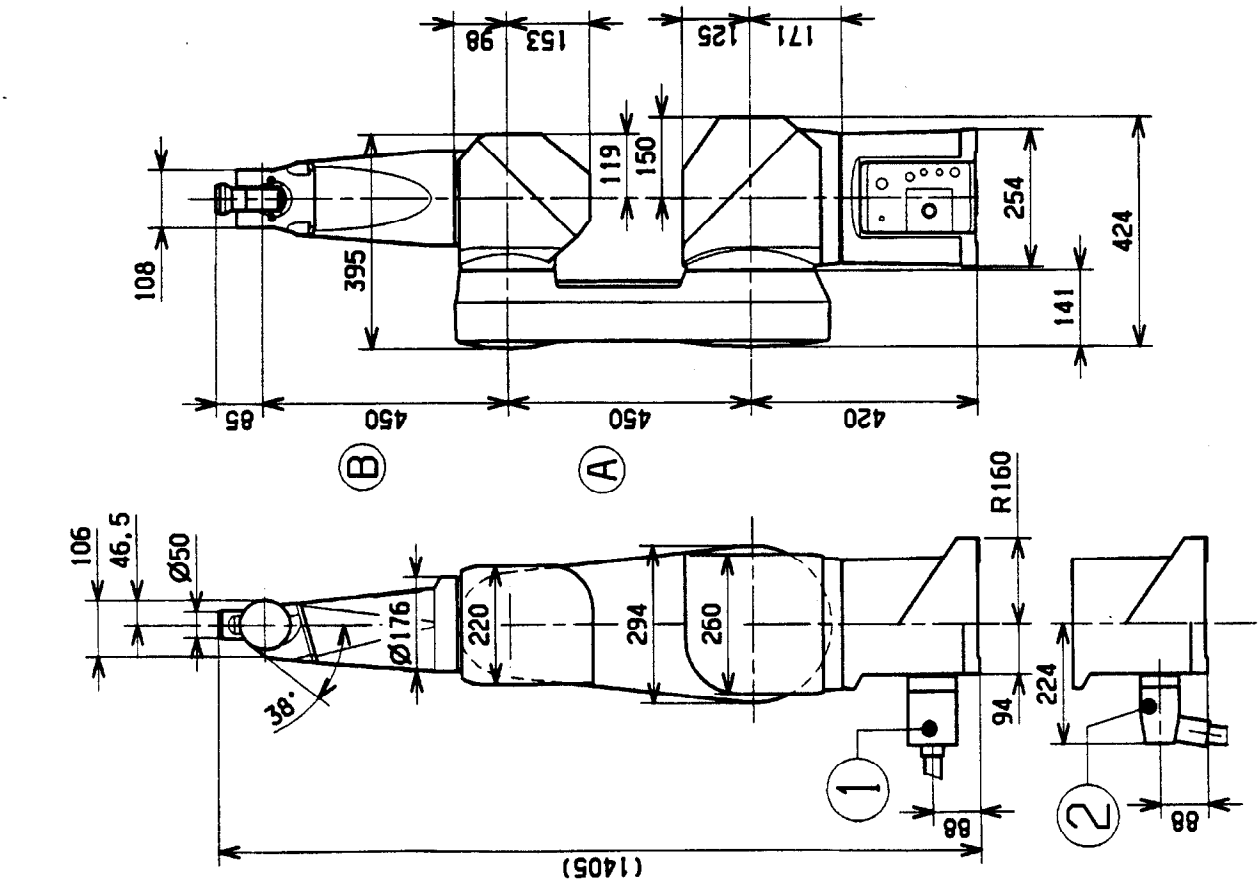


Figure 2.1.3

1.2. DESIGNATION OF ROBOTS OF THE RX SERIES 90 FAMILY

RX	9	0		CR
(1)	(2)	(3)		(4)

(1) RX family arm

(2) Maximum reach between joints 2 and 5 expressed in decimeters: dimension Ⓐ + dimension Ⓑ

(3) Number of active joints: 0 = 6 active joints.
5 = 5 active joints, geometry being conserved.

(4) Upper case letters to indicate an option.
Examples: L = extended forearm dimension Ⓒ (figure 2.1.2.).
CR = clean room application.
EX = explosive atmosphere application.
HP = high load capacity
These letters can be combined.
Example: LCR = extended forearm clean room application.

In the manual, the following terminology is used:
Standard arm: for arm with standard geometry (figure 2.1.3).
Long arm: for arm with different geometry where forearm is extended (figure 2.1.2).
5-joint arm: for arm with 5 active joints.
High load arm: for arm with a high load capacity.

1.3. GENERAL CHARACTERISTICS

1.3.1. OVERALL DIMENSIONS (figures 2.1.2. and 2.1.3.)

① Straight connector
② Elbow connector

1.3.2. WORK ENVIRONMENT

Working temperature: + 5°C to + 40°C (as per standard NF EN 60 204-1)
Humidity : 30% to 95% max. non-condensing (as per standard NF EN 60 204-1)
Altitude : 2000 m max
Vibrations : please consult us

Clean room application: Cleanliness class 10 (as per Federal Standard 209E and JIS B9920)

1.3.3. WEIGHT

Standard arm	Long arm	5-joint arm	Long 5-joint arm
112 kg	113 kg	107 kg	108 kg

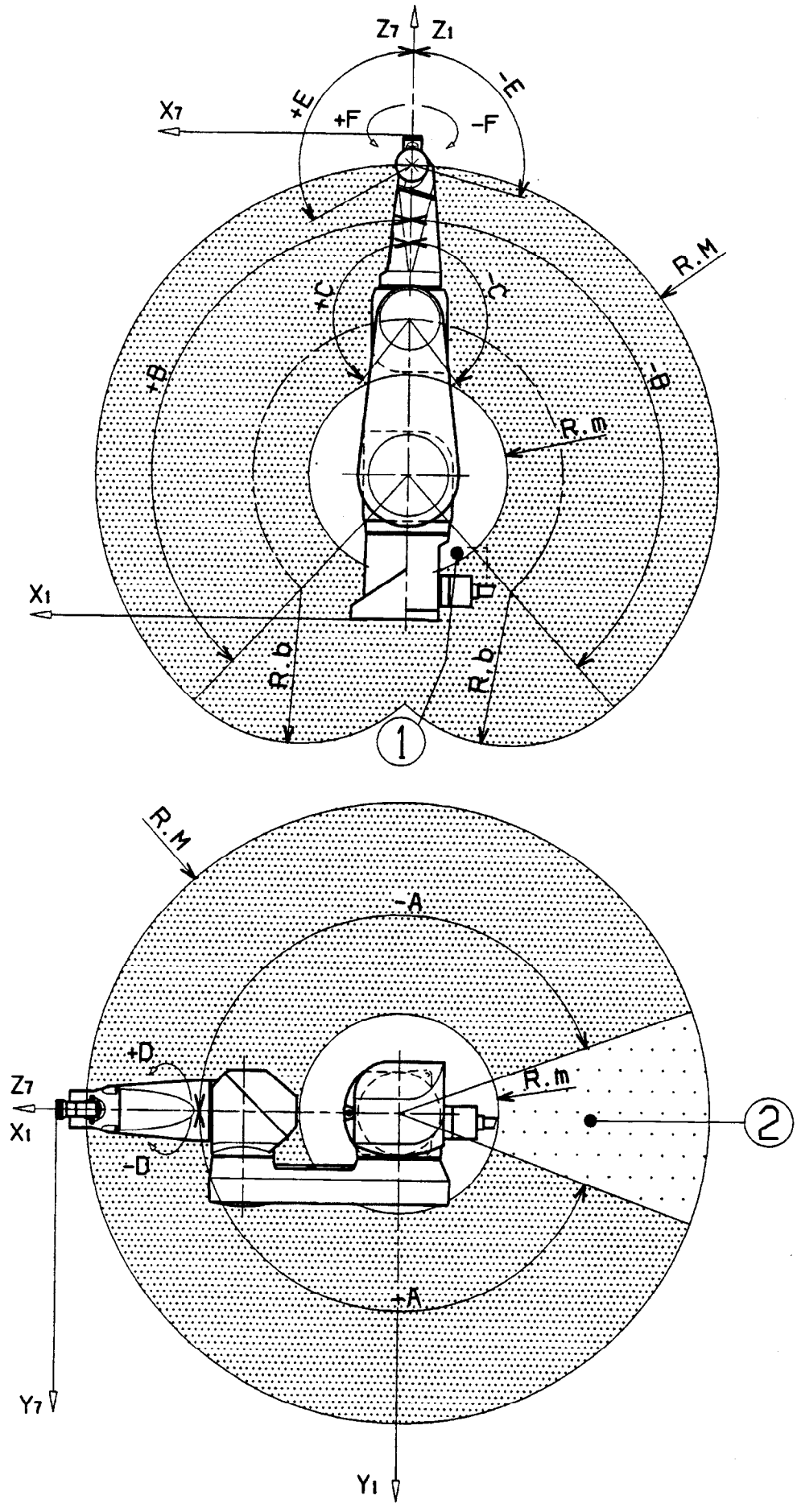


Figure 2.1.4

1.4. PERFORMANCE

On figure 2.1.4. ① Brake release access area

② Area accessible in righty configuration

	Standard arm	Long arm
Work envelope		
RM max. reach between joints 2 and 5	900 mm	1100 mm
Rm min. reach between joints 2 and 5	289 mm	401 mm
Rb reach between joints 3 and 5	450 mm	650 mm
Maximum speed at load center of gravity		
standard arm	11 m/s	12.6 m/s
high load arm	10.6 m/s	12.2 m/s
Repeatability at constant temperature	+/- 0.02 mm	+/- 0.025 mm

1.4.1. TORQUE LIMITS

	Reference joint		
Reference joint	Joint 5 (Z_6)		Joint 6 (Z_7)
Static torque (N.m)			
standard arm	16(1)	6(2)	10
high load arm	26(1)	16(2)	10
Peak torque (N.m)	100(1)	57(2)	43

(1) if joint 6 torque = 0
(2) for maximum torque on joint 6

1.4.2. AMPLITUDE, SPEED AND RESOLUTION

Joint	1	2	3	4(1)	5	6
Amplitude (°)	320	275	285	540	225	540(2)
Working range distribution (°)	A +/-160	B +/-137.5	C +/-142.5	D +/-270	E +120 -105	F +/-270
Nominal speed (°/s)	236 177(3)	200 150(3)	286 143(3)	401 201(3)	320 160(3)	580 390(3)
Maximum speed (°/s)	356	356	296	409	480 288(3)	1125(4)
Angular resolution (°.10-3)	0.87	0.87	0.72	1	1.17 0.7(3)	2.75

(1) For 5-joint arms, joint 4 is fixed. Joint 5 corresponds to joint 4 and joint 6 to joint 5 of the software.
(2) Multiturn version available as an option.
(3) high load arm.
(4) without axis 5 interaction.

Low speed for manual control pendant: Cartesian mode 250 mm/s
revolute mode: 10% of nominal speeds

Maximum Cartesian speed: 1.5 m/s

1.4.3. MODIFICATION OF AMPLITUDES

The arm is installed to obtain maximum angular amplitudes.
The amplitude of the joints can be voluntarily limited by the "software" (see chapter on programming). Also, the position of the mechanical travel limiters on joints 1, 2 and 3 and of the electrical travel limiters on joints 1 and 2 can be modified in a certain number of positions (for modification, please consult Stäubli).

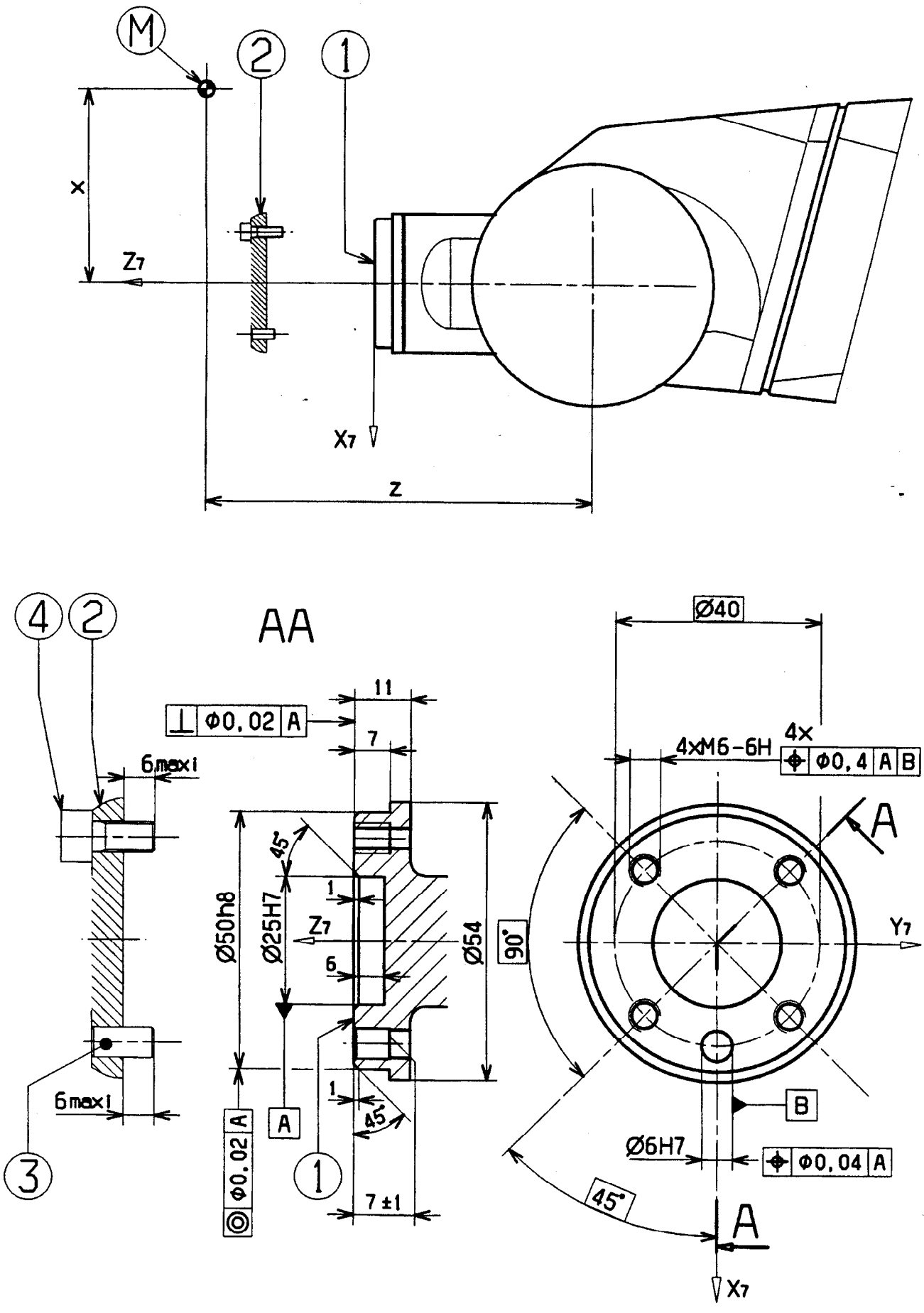

M
2
1
X
Z7
X7
Z
4
2
AA
11
⊥ Φ0,02 A
7
6maxi
45°
Ø50h8
Ø25H7
Z7
Ø54
1
6
6maxi
1
45°
◎ Φ0,02 A
A
3
1
7 ±1
Ø40
4xM6-6H
4x
⌖ Φ0,4 A B
A
90°
Y7
B
Ø6H7
⌖ Φ0,04 A
45°
A
X7

Figure 2.1.5

1.5. LOAD CAPACITY - MECHANICAL INTERFACE

① Mechanical interface
② End-effector

The end-effector is not supplied with the robot arm assembly ; its design depends on the robot's specific applications. All studies can be undertaken in cooperation with STÄUBLI to obtain optimum performance without exceeding the robot arm assembly load limits.
The end-effector is installed on the mechanical interface of the wrist dimensions of which are given on figure 2.1.5.
Attachment by 4 M6 screws item ④, Class 12-9, torque 16.7 N.m +/-1.2 N.m.
Indexing by pin item ③, diameter 6.

Mechanical interface designation : ISO 9409 - 1 - A40
as per Standard ISO 9409 - 1 : 1996 (F) (except the localization of the 4 M6 threated holes)

> ⚠ **CAUTION**
>
> Length of end-effector attaching screws is limited to avoid all interference with the wrist (figure 2.1.5).

1.5.1. LOAD CAPACITY (figure 2.1.5)

1.5.1.1. STANDARD ARM

Load characteristics:

Load center of gravity position Ⓜ: z = 150 mm from centerline of joint 5 and x = 75 mm from centerline of joint 6 (figure 2.1.5)

Load capacity	**Standard arm**	**Long arm**
At nominal speed*	6 kg	3.5 kg
At reduced speed*	9 kg	6 kg
Please consult us if:	Load > 9 kg	Load > 6 kg

(*) in all configurations and taking maximum inertias into account. See table below.

	Nominal inertias (kg.m²)		Maximum inertias (kg.m²)*	
	Standard arm	**Long arm**	**Standard arm**	**Long arm**
For joint 5	0.135	0.079		
without rotation			0.675	0.395
with rotation			0.405	0.237
For joint 6	0.034	0.020	0.102	0.06

* under reduced speed and acceleration conditions: SP 60 max. and ACC (8) 50,50.

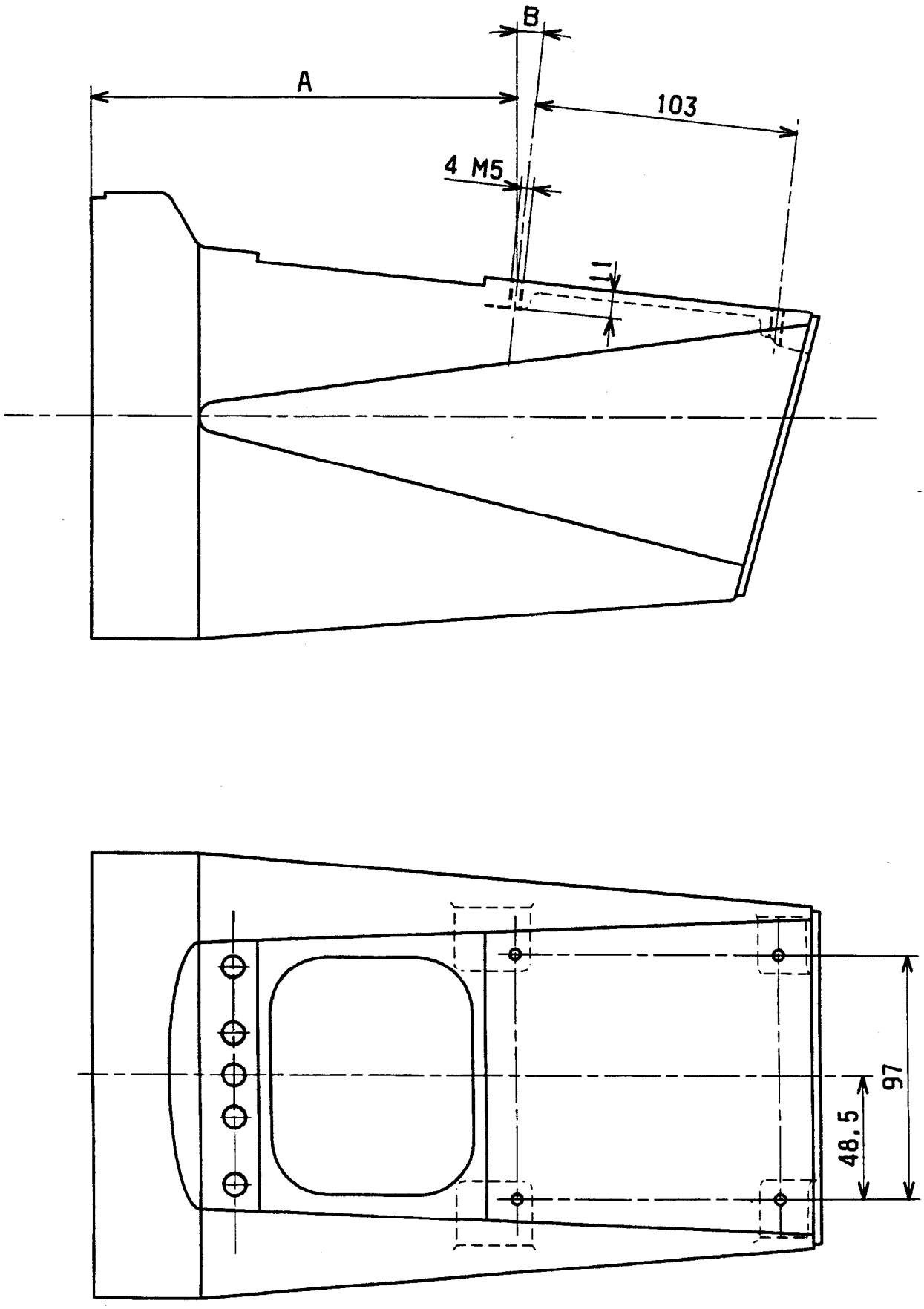


Figure 2.1.6

⚠ The nominal values can be exceeded to a certain extent but imply **a limitation to the speed and the acceleration of the arm.** If these limits are to be exceeded, please consult STÄUBLI.

1.5.1.2. HIGH LOAD ARM (figure 2.1.5)

Load characteristics:

Load center of gravity position Ⓜ : Z = 150 mm from centerline of joint 5 and Y = 50 mm from centerline of joint 6.

Load capacity	**Standard arm**	**Long arm**
At nominal speed*	12 kg	8 kg
Please consult us if:	Load > 12 kg	Load > 8 kg

(*) in all configurations and taking maximum inertias into account. See table below.

	maximum inertias (kg.m²) **Standard arm**
For joint 5	0.86
For joint 6	0.24

1.5.2. ATTACHMENT OF ADDITIONAL LOAD ON FOREARM

Holes to be drilled after removing wrist (See figure 2.1.6).

Dimensions	Standard arm	Long arm
A	167.5 +/-1mm	272 +/-1mm
B	6°	4.5°

Caution: This additional load depends on nominal load (see next page) ; in all cases, do not exceed load characteristics.

No chips are allowed in the forearm during drilling.
Ensure sealing if liquid is splashed on forearm.

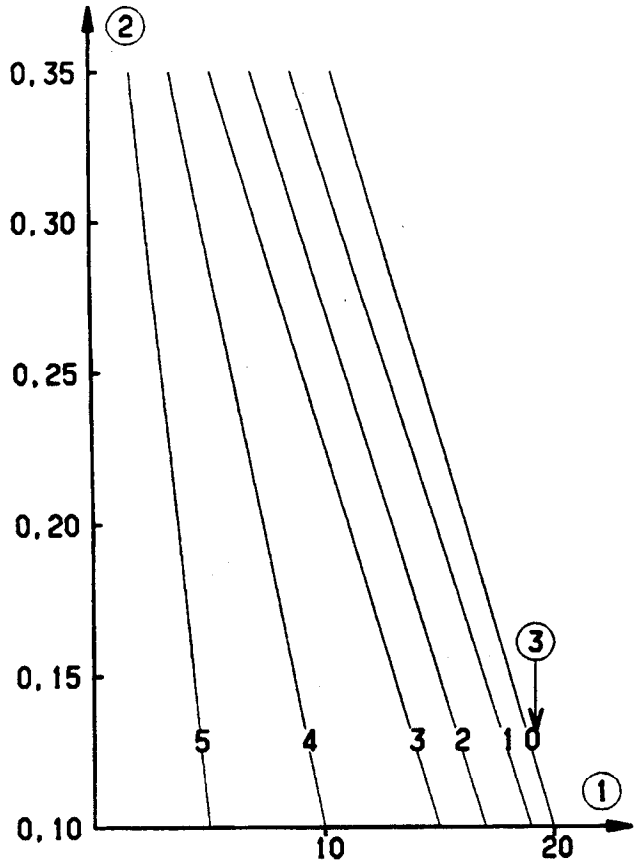


Figure 2.1.7.1

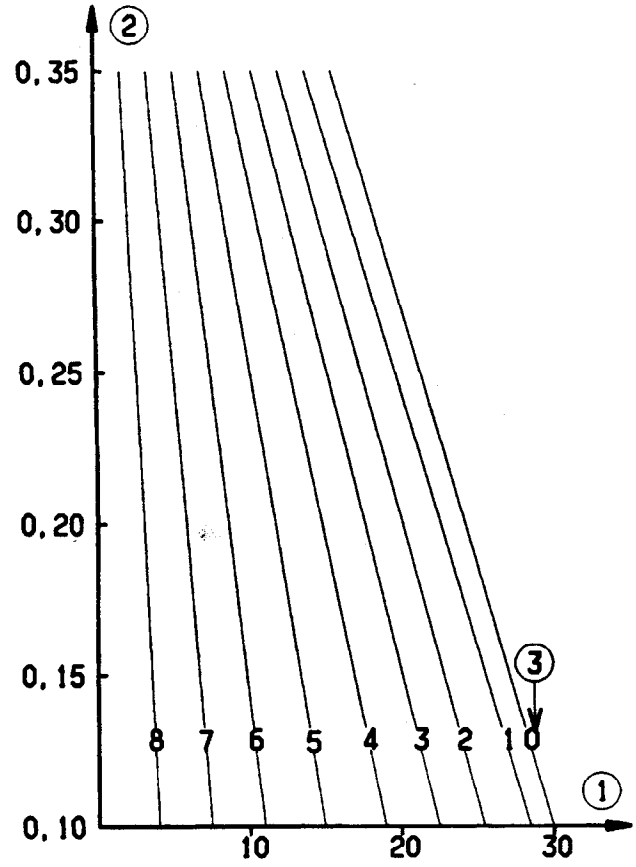


Figure 2.1.7.2

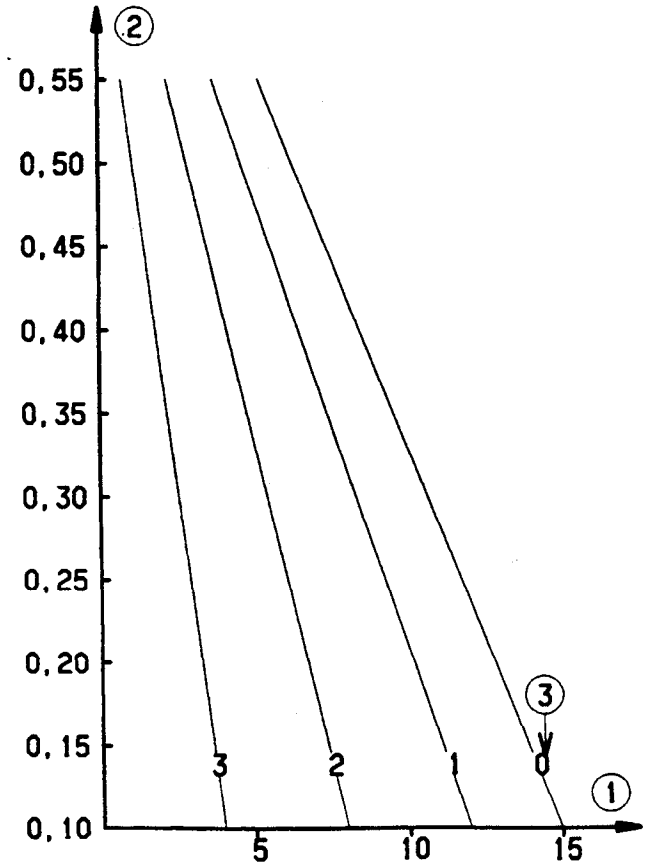


Figure 2.1.7.3

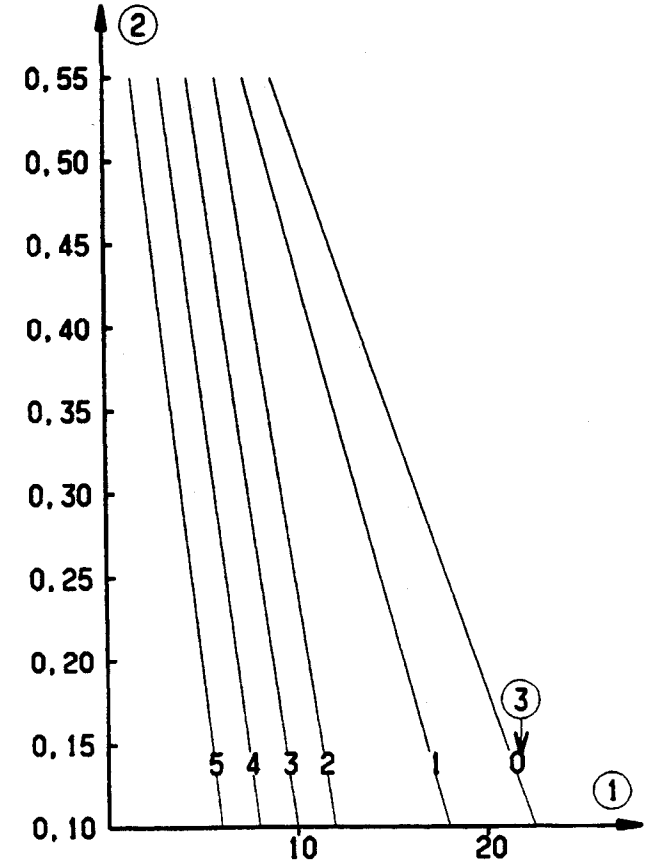


Figure 2.1.7.4

1.5.3. ADDITIONAL LOAD DIAGRAMS

These diagrams can be used to determine the additional load which can be attached to the forearm depending on its center of gravity position from joint 3 and the load attached to the mechanical interface of the wrist.

(1) Additional load (kg)

(2) Additional load center of gravity position (m) from centerline of joint 3.
The additional load center of gravity position is at 0.25 m max. from the centerline of joint 4.

(3) Load attached to the mechanical interface of the wrist.
150 mm from the centerline of joint 5 and 75 mm from the centerline of joint 6.

Figure 2.1.7.1: for standard RX90
Figure 2.1.7.2: for standard RX90 with reduced speeds* or high load arm
Figure 2.1.7.3: for RX90 long arm
Figure 2.1.7.4: for RX90 long arm with reduced speeds* or high load arm

* Reduced speeds SP 60 max.
ACC(8) 50,50

Figure 2.1.8'

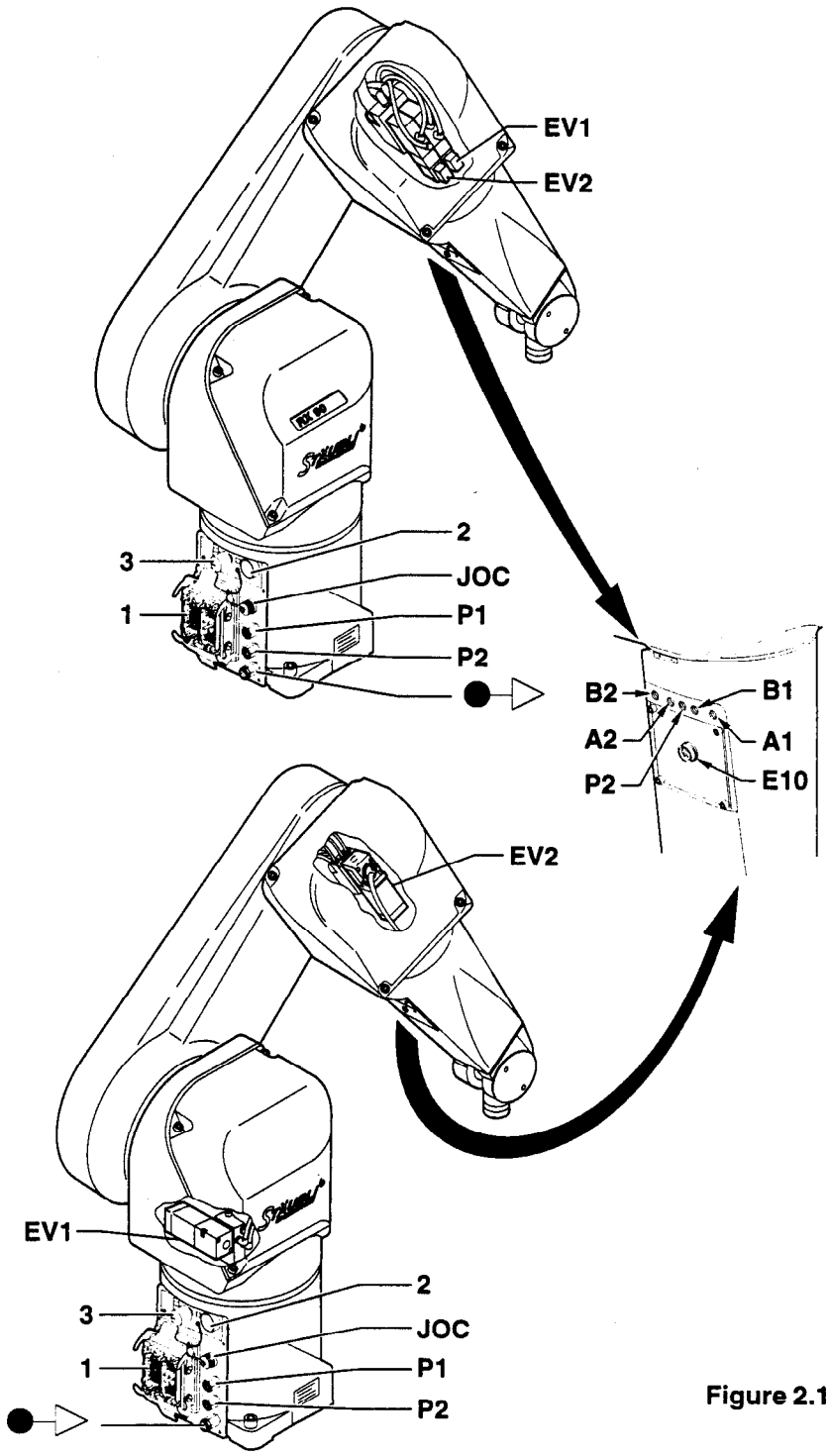


Figure 2.1.8

1.6. USER CIRCUIT

1.6.1. DESCRIPTION

The electric wiring of the arm is assembled into a harness including several cables supplying the motors (power, brakes, resolvers), the solenoid valves, the limit switches and user connector. These components are connected by means of removable connectors.

The harness also includes pneumatic hoses which supply air to the solenoid valves (EV1 and EV2).
The robot also has a pressure source (P2) close to the tool clamp.
The outlets of the solenoid valves EV1 and EV2 are on the forearm:

A1 and B1 for solenoid valve EV1
A2 and B2 for solenoid valve EV2.

Figure 2.1.8 is for all robots except the clean room application.
Figure 2.1.8' is for clean room application robots.

The wiring is inside the structure and routed through the center of the joints. It is connected to the arm base on a plate which includes several electrical and pneumatic components such as:

Figures 2.1.8' and 2.1.8:

Harting arm/controller connector (1).
Binder connector intended for the user for possible electrical connection of grip (JOC).
Brake release selector (3).
Brake release pushbutton (2).
Compressed air network pneumatic (or vacuum) connections P1 and P2.
Pneumatic (or vacuum) exhaust muffler 

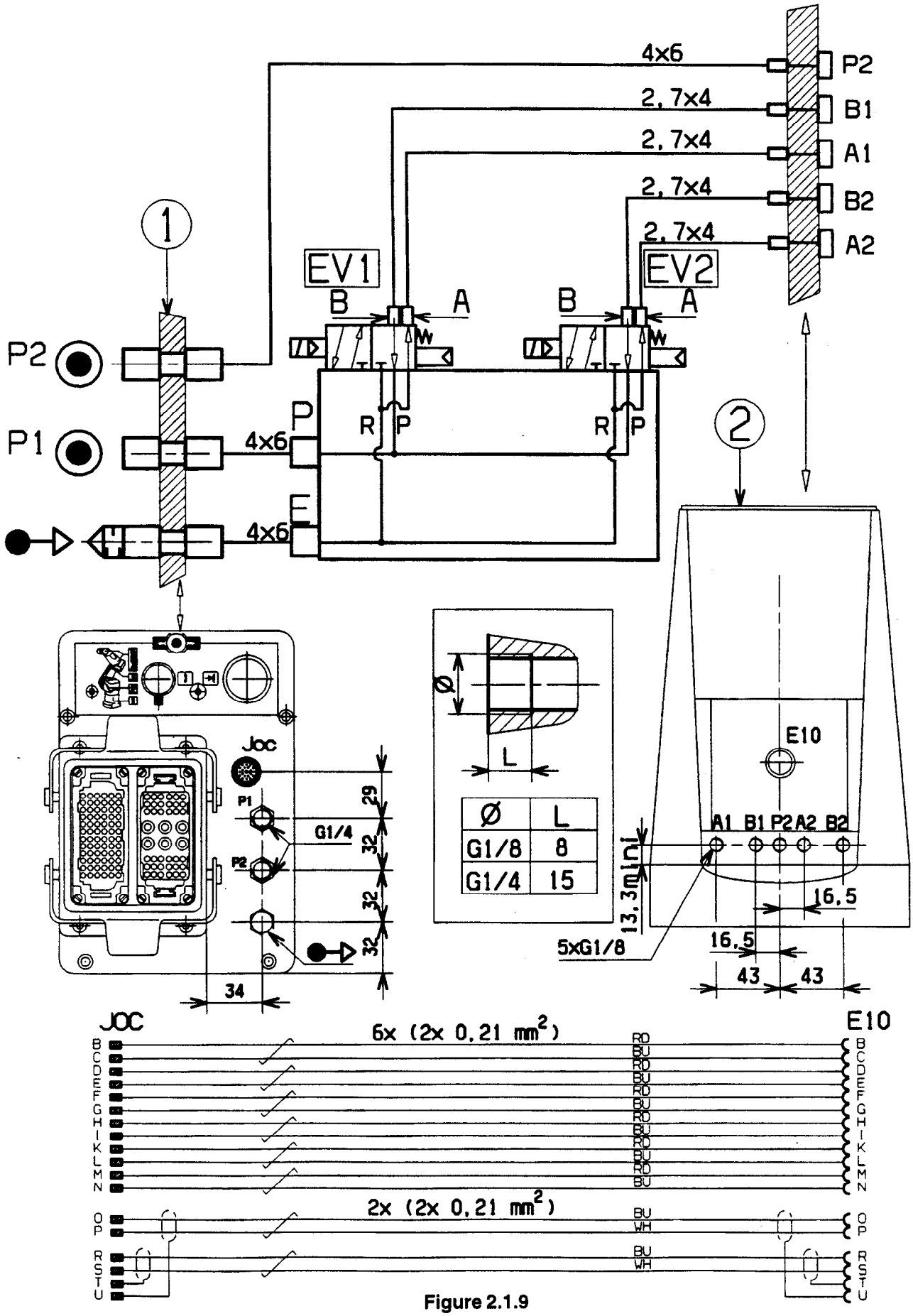
> ⚠ Do not add wires or cables to arm wiring as this may cause premature wear of the arm electrical wiring and lead to loss of the warranty.

1.7. RELEASING JOINT BRAKE

The controller must be switched on.
Place the brake release selector in position corresponding to the joint to be released.

> ⚠ Make sure that the arm and load relevant to this joint are suitably supported.

Press the brake release pushbutton, the selected joint is totally free.
When the pushbutton is released, the brakes will then be engaged and the corresponding joint locked.


4x6
2,7x4
2,7x4
2,7x4
2,7x4
P2
B1
A1
B2
A2
1
EV1
EV2
B
A
B
A
P2
P1
P
4x6
R
P
R
P
E
4x6
2
Joc
P1
P2
G1/4
29
32
32
32
34
Ø
L
Ø
L
G1/8
8
G1/4
15
E10
A1 B1 P2 A2 B2
13,3 min
5xG1/8
16,5
16,5
43
43

JOC
E10
6x (2x 0,21 mm²)
2x (2x 0,21 mm²)
B C D E F G H I K L M N
O P
R S T U
RD BU RD BU RD BU RD BU RD BU RD BU
BU WH
BU WH

Figure 2.1.9

1.8. PNEUMATIC AND ELECTRIC CIRCUITS (EXCEPT FOR CLEAN ROOM APPLICATION)

1.8.1. PNEUMATIC CIRCUIT

① Plate attached to base
② Forearm

Solenoid valves (EV1 and EV2) :

5/2-way monostable
Electrically controlled (24 VDC)
Working pressure: 1.5 to 7 bars.
Flow coefficient KV 8.6.
Clip-on connector.
Overvoltage protective circuit and indicator diode.

Description (figure 2.1.9):

The arm is connected to the compressed air network (7 bars max., lubricated or not) via the base: P1.

There is a direct line between the base and the forearm (P2).

The centralized solenoid valve exhaust is directed to the base and through a muffler.

1.8.2. ELECTRIC CIRCUIT (figure 2.1.9)

12 0.21 mm² conductors (1A max.) plus 2 0.21 mm² twisted shielded pairs (1A max.).
Connection to forearm (E10) by BINDER elbow male cylindrical connector.
Connection to base (JOC) by BINDER straight female cylindrical connector.

⚠ This electric circuit is deleted for **explosive atmosphere** application robots.

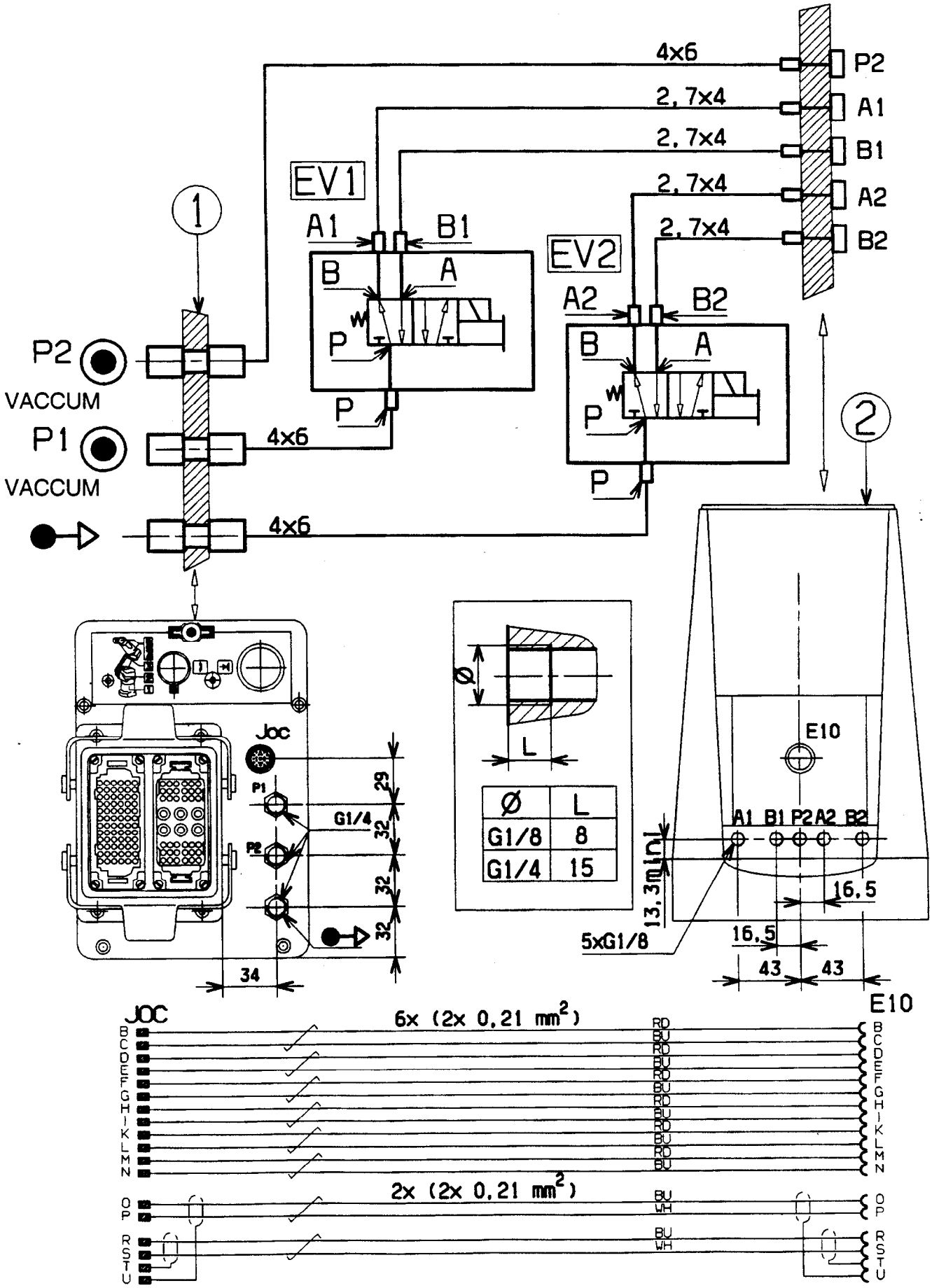

4x6
P2
2,7x4
A1
2,7x4
B1
2,7x4
A2
2,7x4
B2
EV1
A1
B1
B
A
P
EV2
A2
B2
1
2
P2
VACCUM
P1
VACCUM
4x6
4x6
Joc
P1
P2
G1/4
29
32
32
32
34
Ø
L
Ø L
G1/8 8
G1/4 15
E10
A1 B1 P2 A2 B2
13,3mm
16,5
16,5
5xG1/8
43
43
E10
JOC
6x (2x 0,21 mm²)
2x (2x 0,21 mm²)

Figure 2.1.10

1.9. PNEUMATIC AND ELECTRIC CIRCUITS CLEAN ROOM APPLICATION

1.9.1. PNEUMATIC CIRCUIT

① Plate attached to base
② Forearm

Solenoid valves (EV1 and EV2):

5/2-way monostable
Electrically controlled (24 VDC)
Max. working pressure: vacuum only.
Flow coefficient KV 5.72.
Clip-on connector

Description (figure 2.1.10):

The arm is connected to the vacuum network via the base (P1 and●—▷).
There is a direct line between the base and the forearm (P2).
There is no exhaust to the outside of the arm for the solenoid valves controlling the vacuum circuit.

1.9.2. ELECTRIC CIRCUIT (figure 2.1.10)

12 0.21 mm² conductors (1A max.) plus 2 0.21 mm² twisted shielded pairs (1A max.).
Connection to forearm (E10) by BINDER elbow male cylindrical connector.
Connection to base (JOC) by BINDER straight female cylindrical connector.

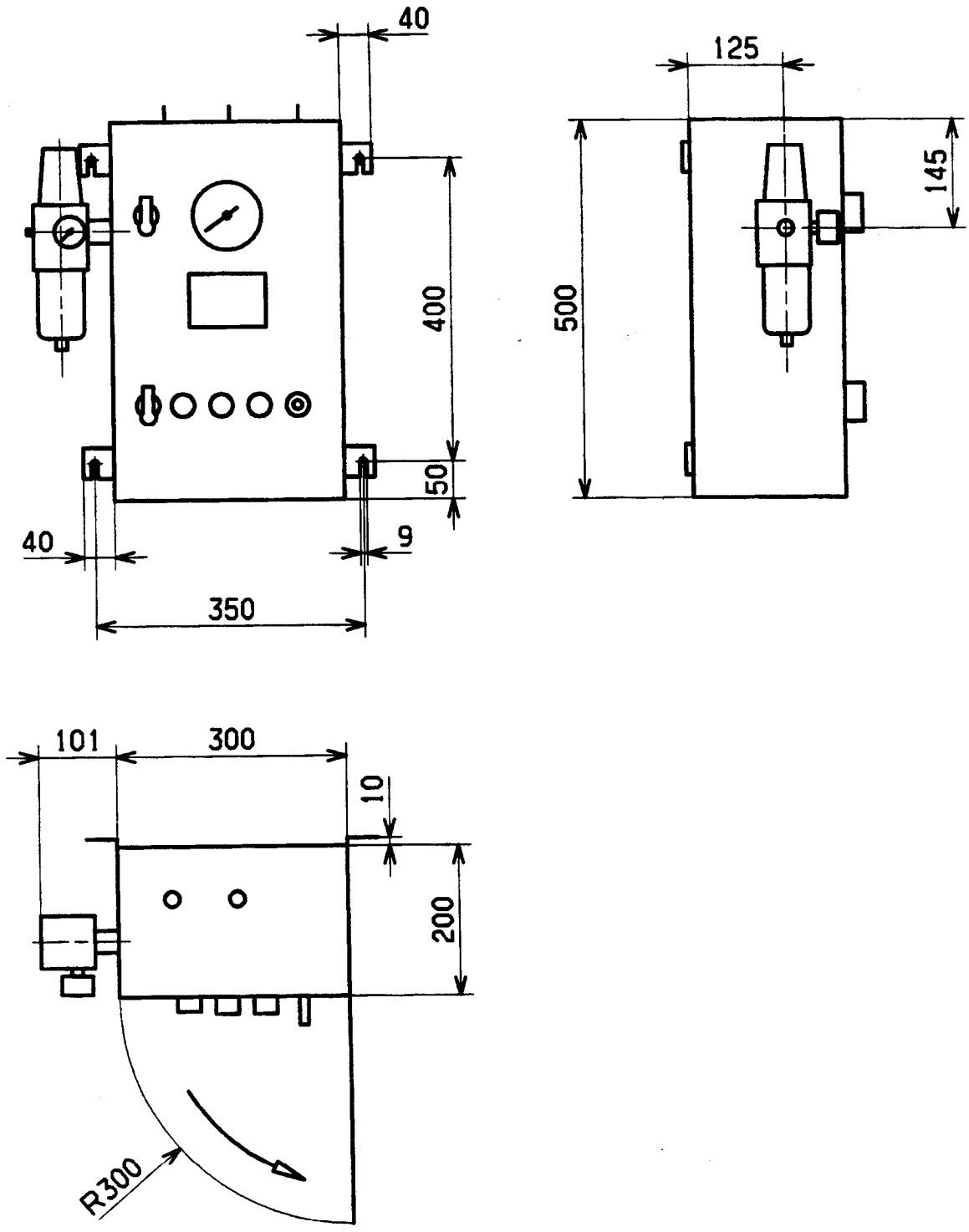


Figure 2.1.11

1.10. EX UNIT SPECIFICATIONS FOR EXPLOSIVE ATMOSPHERE APPLICATION ROBOT

1.10.1. PROTECTION METHOD

Internal overpressure "p", group II and temperature class T3 according to recommendations of standard NF C 23-516 which is the French version of European standard EN 50 016 - first edition - March 1977.

1.10.1.1. INTERNAL OVERPRESSURE "p"

The minimum air pressure inside the arm is 5 mbars.
Robot stops when pressure drops to 3 mbars.
Sweep is performed for 5 minutes on each arm power-up.

1.10.1.2. GROUP II

All application sites other than gaseous mines.

1.10.1.3. TEMPERATURE T3

The arm must never be used in an atmosphere liable to ignite at a temperature LOWER than or EQUAL to 200 degrees.

1.10.2. PRESSURIZATION UNIT (figure 2.1.11)

A pressurization unit includes all components required for internal overpressure and arm sweep.
It operates in explosive atmospheres.
It is connected to the arm via a pneumatic pipe bundle with an unmodifiable length of 5 meters.
It is also connected to the controller via a 20-meter long electric cable.

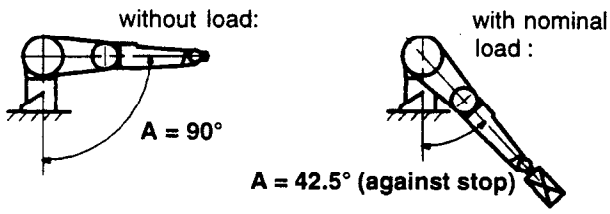
1.10.3. CERTIFICATION

The arm and unit are certified by the L.C.I.E. (*) under following numbers:
- Arm: L.C.I.E. - 95.D6060X, type EEx p II T3
- Unit: L.C.I.E. - 88.B0003U, type EEx p II

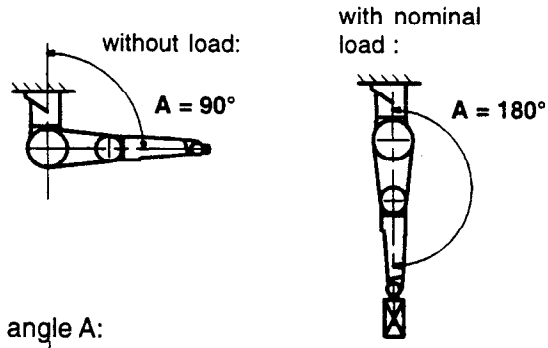
(*) L.C.I.E.: Laboratoire des Industries Electriques
33, avenue du Général Leclerc
F 92260 FONTENAY-AUX-ROSES

FLOOR CONFIGURATION:

1) Balanced position (joint 2 brake released) is as follows:



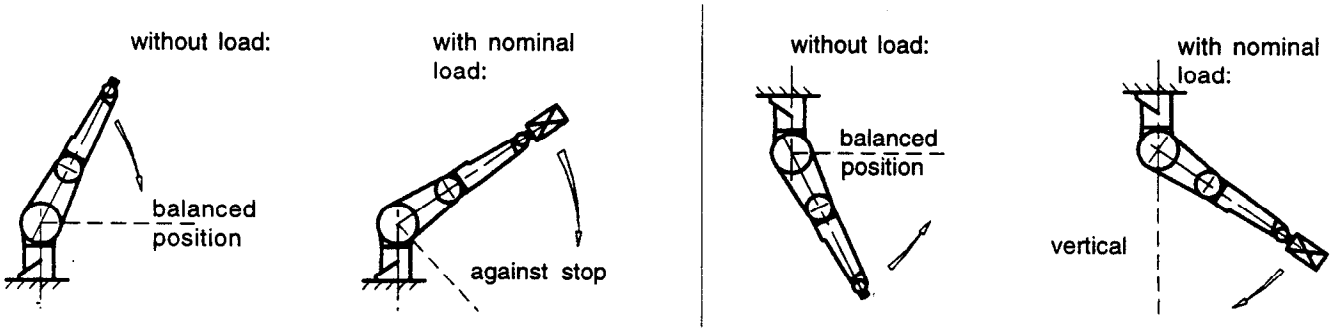
CEILING CONFIGURATION:



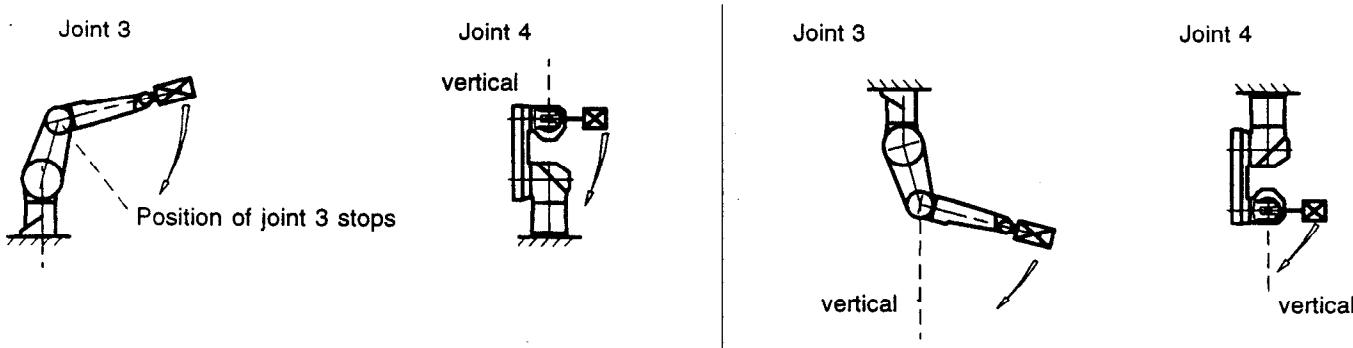
Rotating joint 3 modifies angle A:



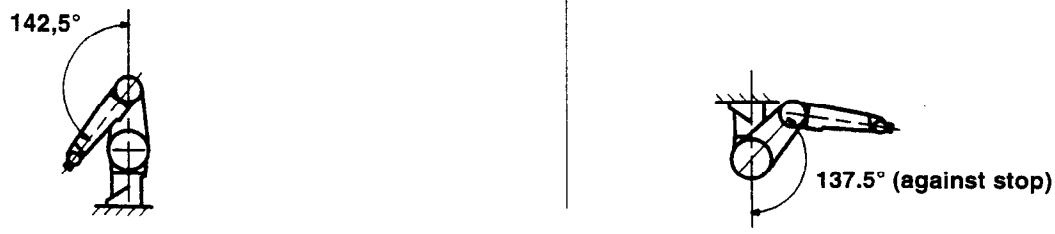
2) When arm is in a position other than balanced position, releasing joint 2 brake causes arm to return to balanced position.



3) Releasing brakes of joints 3 and 4 causes arm to move down whether loaded or not.
⚠ No brake on joint 5 (irreversible) and joint 6 (reversible).



4) Before all operations on arm (especially for removal), springs must be released and arm placed in following position:



1.11. SAFETY

The robot arm's energy is that accumulated by the springs.

Indeed, joint 2 is equipped with a spring balance system. Releasing joint 2 discharges the accumulated energy. This energy label is attached on the arm and must remain in place.

The brake release movements are described on the opposite page according to arm configuration (floor or ceiling).

CHAPTER 2 - ON-SITE PREPARATION

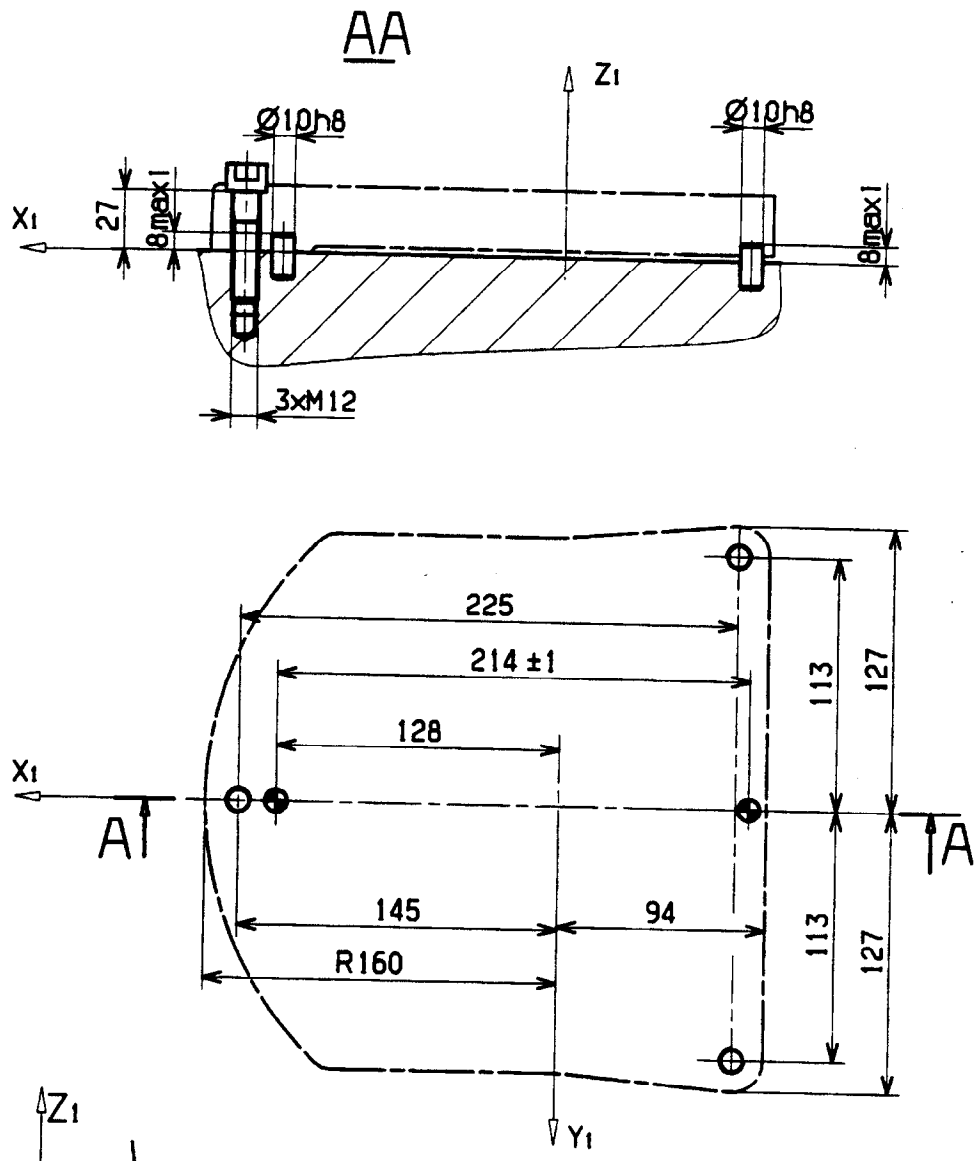


Figure 2.2.1

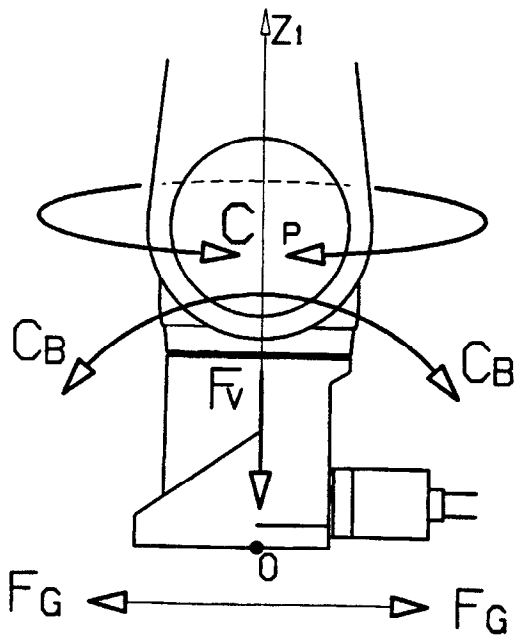


Figure 2.2.2

CHAPTER 2 - ON-SITE PREPARATION

2.1. WORKING SPACE

The user is responsible for performing all preparatory work required to complete the on-site installation of the robot. Working space must be sufficient, installation surface appropriate; power sources shall be available (for electrical power, consult controller characteristics).

⚠ The arm's working area must be surrounded by a closed safety enclosure in compliance with the country's safety legislation preventing personnel accessing the dangerous area.

International standard : ISO 10128 (1992)
French standard : NF EN 775 (1993)
European Directive : machine directive CEE 89-392

⚠ There must be no obstacles within the robot work envelope.

2.2. ATTACHMENT (figure 2.2.1)

The robot arm can be installed vertically, base downwards (floor-mounted version) or base upwards (ceiling-mounted version). In all cases, it must be securely attached by **3 class 12.9 M12 hex. socket head screws.**
Attachment surface shall be flat and metallic. A deformable support will greatly reduce robot's performance in speed and accuracy.

To dimension the support, take into account the maximum loads generated by the arm in motion at point 0 (figure 2.2.2) which are:

FV = 1900 N
FG = 1600 N
CB = 1300 N.m
CP = 800 N.m

under following load conditions:

		Load position (mm)	
	Load (kg)	Joint 5	Joint 6
Standard arm	6	150	75
Long arm	3.5		

The user can accurately position the robot by means of two 10h8 diameter centering pins.

CHAPTER 3 - INSTALLATION

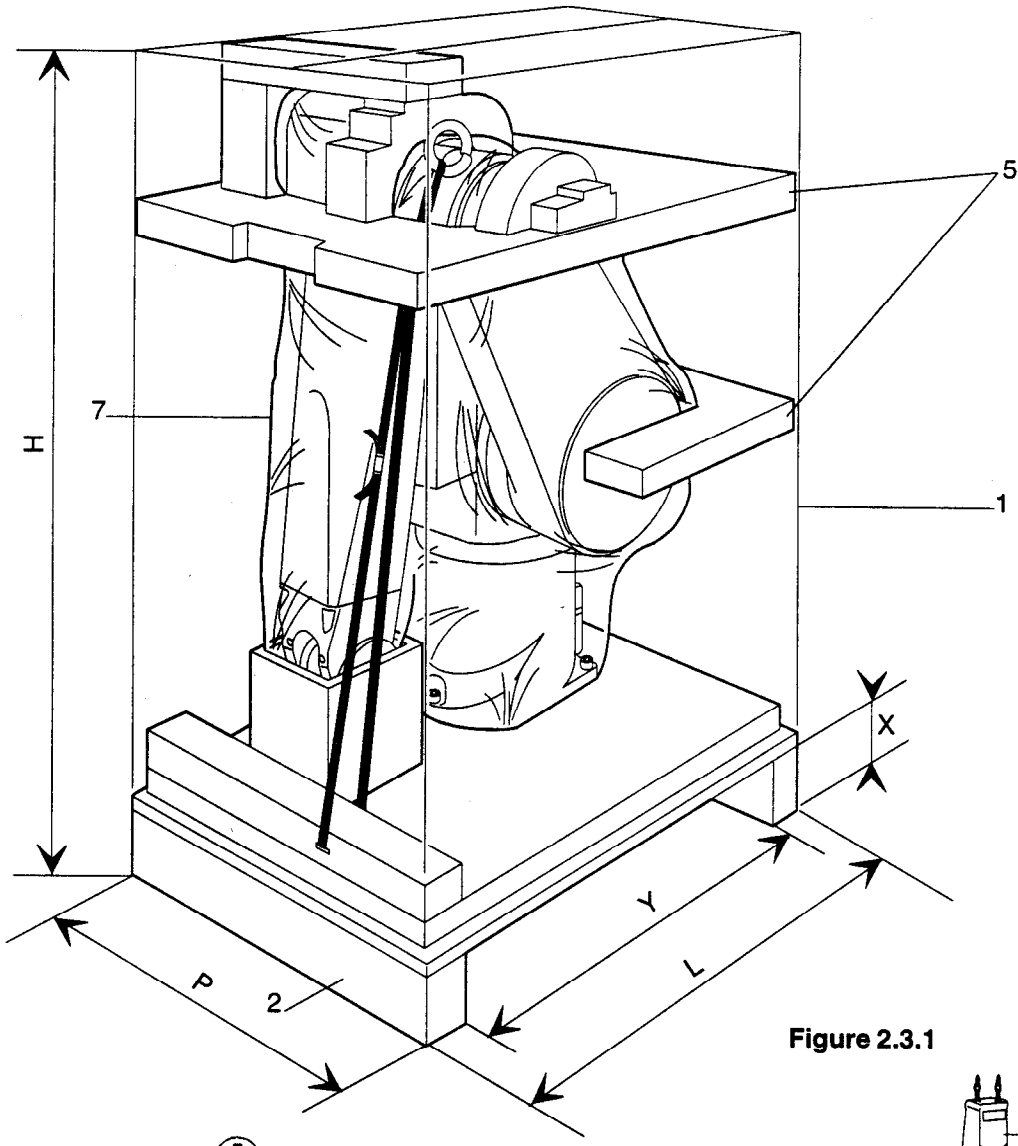


Figure 2.3.1

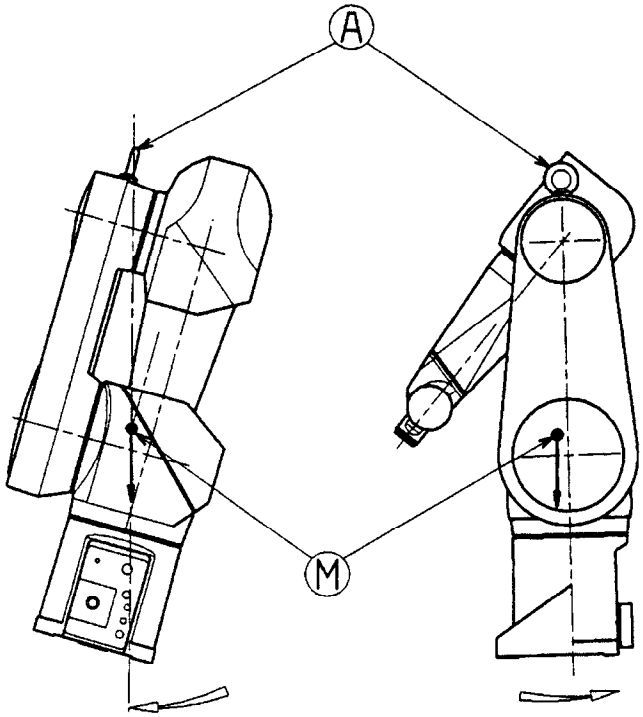


Figure 2.3.2

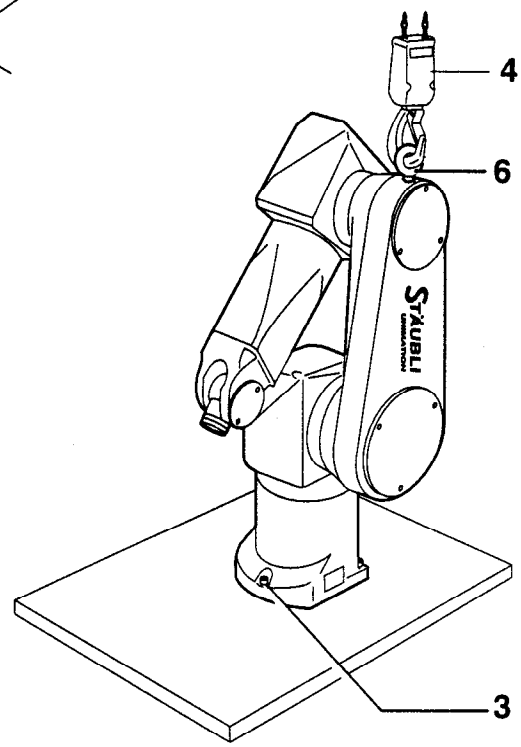


Figure 2.3.3

CHAPTER 3 - INSTALLATION

3.1. ARM PACKAGING (figure 2.3.1.)

Case (1) : L x H x D 850 x 1210 x 640 mm
Gross weight : Standard arm : 140 kg
Long arm : 141 kg
The arm is packed in the vertical position. It is attached to the pallet (2) by 3 M12 bolts (3).

Transport condition: Minimum temperature -20°C
Maximum temperature +60°C

3.2. HANDLING OF PACKING (figure 2.3.1.)

By pallet truck under base (2).

X = 100 mm
Y = 700 mm

3.3. UNPACKING AND INSTALLATION OF ARM

> ⚠ According to European Directive CEE 89-392, the hoisting ring's (6) threaded hole (M20) used for the robot hoisting is defined according to the ISO 262 standard.

- Move the packing case as near as possible to the installation site.
- Remove the cardboard packaging (1), remove the packing material (5) and the plastic cover (7) (figure 2.3.1).
- Pass the hook (4) of the hoist through the hoisting ring (6) and hold slightly tensioned to stop the arm from tipping
  (figure 2.3.3).
- Remove the bolts (3) from the arm.
- Slowly raise the arm using the hoist.

> ⚠ Caution: the robot will swing when raised and moved (figure 2.3.2).

Ⓐ Attachment point
Ⓜ Center of gravity

> ⚠ For ceiling-mounted version robots (balance springs of joint 2 released), **do not rotate joint 2.**

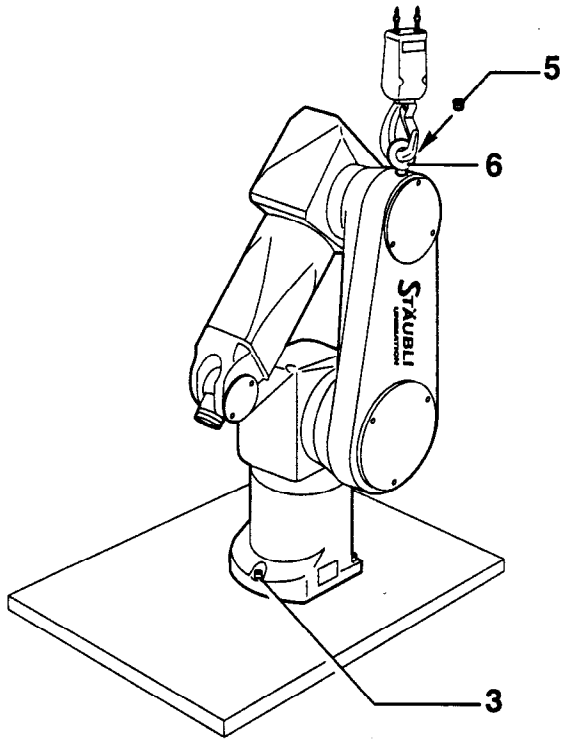


Figure 2.3.4

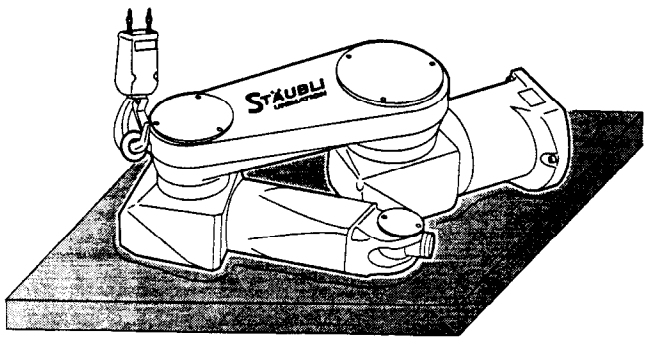


Figure 2.3.5

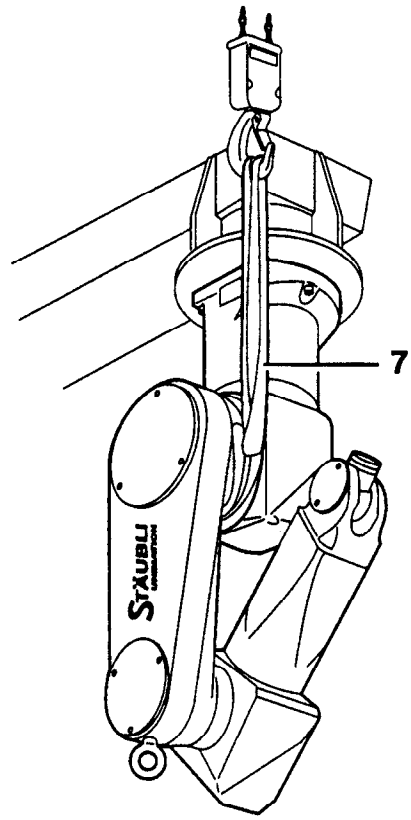


Figure 2.3.6

3.4. INSTALLATION OF ARM

> ⚠ **CAUTION**
>
> The arm can be attached with the base downwards (floor-mounted version) or with base upwards (ceiling-mounted version). Caution: the balance system is installed in the factory for one OR the other of these versions. Conversion from a floor-mounted version to a ceiling-mounted version requires a mechanical operation on the balance system.

3.4.1. INSTALLATION OF ARM ON FLOOR (figure 2.3.4):

- Position the arm on the support at its final attachment points.
- Attach the arm with 3 class 12.9 M12 hex. socket head screws (3), tightened to 132 Nm +/- 9 Nm.
- Unscrew the hoisting ring (6) and install the plug (5)

> ⚠ For safety reasons, hold the sling slightly tensioned until arm is securely attached to the floor.

3.4.2. INSTALLATION OF ARM ON CEILING

> ⚠ Do not rotate joint 2.

- Carefully lay down the arm on a flexible support as shown on figure 2.3.5.
- Place the fabric sling (7) around joint 2 as shown on figure 2.3.6.

> ⚠ 500 kg fabric sling.

- Position the arm on the support at its final attachment points.
- Attach the arm with 3 class 12.9 M12 hex. socket head screws, tightened to 132 Nm +/- 9 Nm.
- Tension the springs for robots delivered in ceiling-mounted version using the tool supplied with the robot (see chapter 3.5.).

> ⚠ For safety reasons, hold the sling slightly tensioned until arm is securely attached to the ceiling.

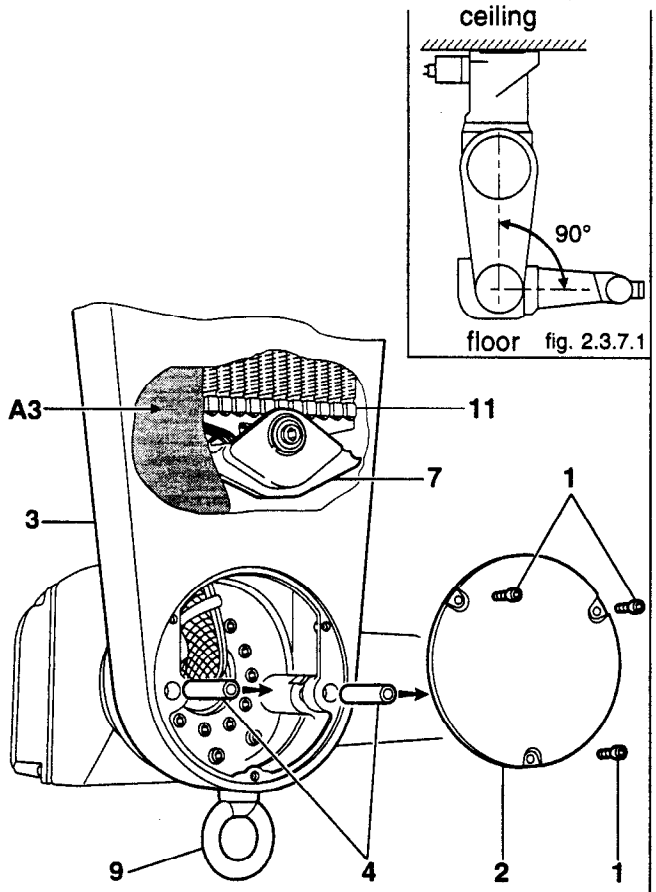


Figure 2.3.7

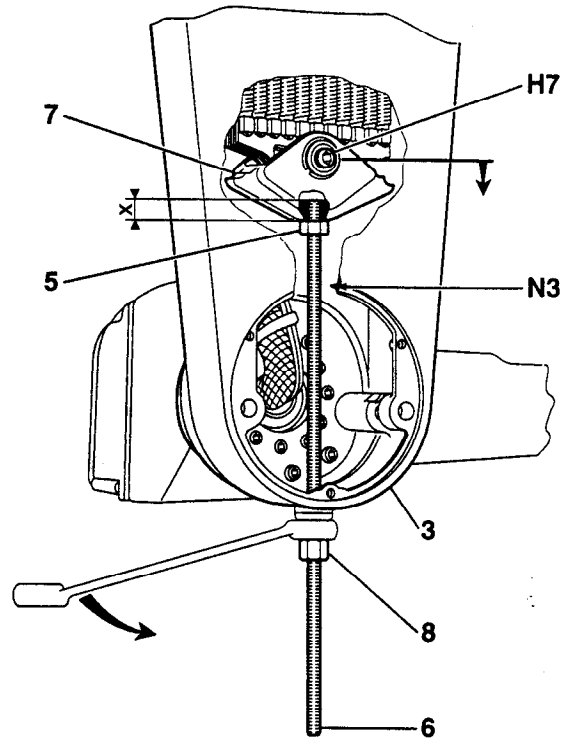


Figure 2.3.8

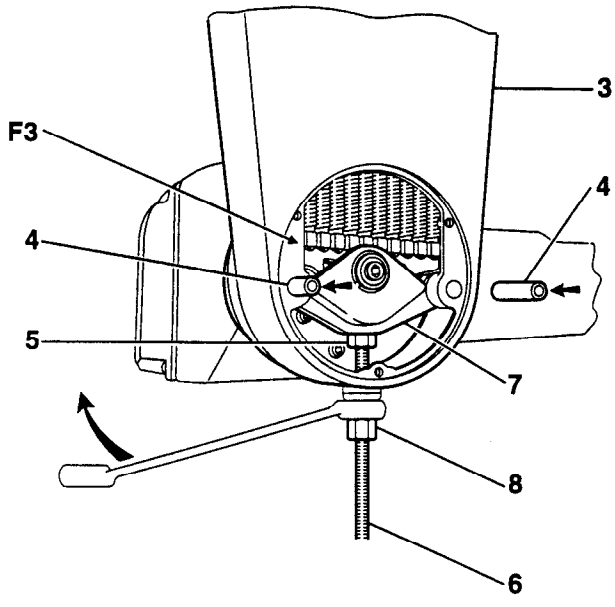


Figure 2.3.9

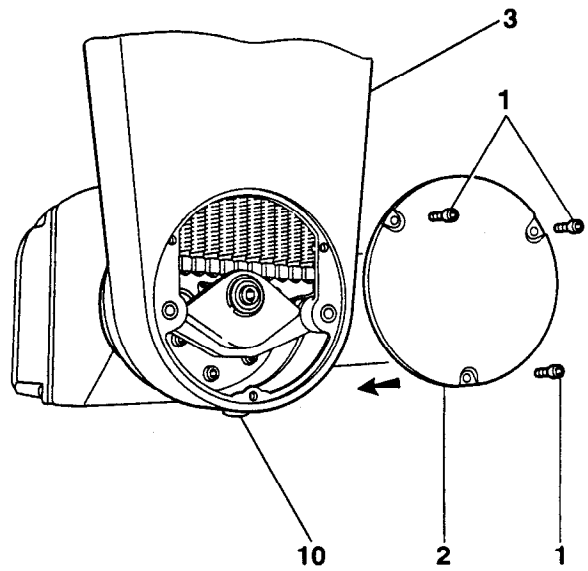


Figure 2.3.10

3.5. SPRING TENSION

> ⚠ The robot must be attached to the ceiling.
> Do not rotate joint 2.

Figure 2.3.7:

- Remove hoisting ring (9) from the arm.
- Unscrew the 3 M5 screws (1) from cover (2).
- Remove cover (2) from arm (3).
- Remove the 2 pins (4) from arm (3).
- Remove foam (A3) wedging beam (7) against arm (3).
- Check that beam (7) and its springs (11) are not jammed in arm (3).
- Place the robot in position (figure 2.3.7.1).

Figure 2.3.8:

- Unscrew the M12 nut (5) from the M12 threaded rod (6).
- Insert threaded rod (6) into arm (3) (polyamide washer in contact with arm).
- Screw nut (5) onto threaded rod (6).
- Screw the end of threaded rod (6) into beam (7).
  Grip length X = 15 mm +/- 1 mm
- Tighten nut (5) against beam (7).
- Using an 18 mm ring spanner (not supplied), tighten nut (8) until the pin holes of beam (7) coincide and pass beyond (+/- 1 mm) those on the arm.

Figure 2.3.9:

- When beam (7) is in position, insert pins (4) in arm (3) (pin threads on outside). The pins must be inside face (F3) of arm (3).
- Unscrew nut (8) so that beam (7) bears on pins (4).
- Unlock nut (5).
- Unscrew threaded rod (6).
- Unscrew nut (5) from threaded rod (6).
- Remove threaded rod (6) from the arm.

Figure 2.3.10:

- Install cover (2) on arm (3).
- Tighten the 3 screws (1).
- Install plug (10) in arm (3).

CHAPTER 4 - MARK POSITION ALIGNMENT

CHAPTER 4 - MARK POSITION ALIGNMENT

Due to the technical definition and the factory arm resetting procedure, the «Ready» position does not correspond to mark position alignment.

For: - checking position
- repair
- maintenance

the marks must be aligned.

Each robot, adjusted in factory, has a mark alignment point called : «#mark». This is saved under file name «order number.mrk» on the hard disk and on the 3 1/2" operating system diskette.

Mark alignment procedure:
- LOAD order number.mrk (return)
- SP 5 (return)
- DO MOVE #mark (return)

⚠ Check that there are no obstacles on arm trajectory towards «marks alignment» position.

IMPORTANT

In case of:
- replacement of transmission components
- mechanical slip
- replacement of calibration components

the robot MUST be reset.

REMARK

The «mark» program with its #mark point is stored in memory.

CHAPTER 5 - INTERNAL VARIATIONS BETWEEN VARIOUS TYPES OF ARMS

CHAPTER 5 - INTERNAL VARIATIONS BETWEEN VARIOUS TYPES OF ARMS

5.1. PURPOSE OF THIS CHAPTER

This chapter shows the internal design variations between different types of arms.

These variations are detailed on the following pages.

Only the views of the standard version are shown in the following paragraphs.

5.1.1. CLEAN ROOM ARM

These variations concern the type of solenoid valves and their locations.

Two solenoid valves are placed at joints 3 and 4 in the standard arms.

For space reasons, one solenoid valve is attached to joints 3 and 4 and the other to joint 1 on the clean room arms.

5.1.2. HIGH LOAD ARM

Motors are modified, no IMAS.

- Joints 1 and 2 shorter motors (shape not modified)
- Joints, 3, 4, 5 and 6 shape modified.

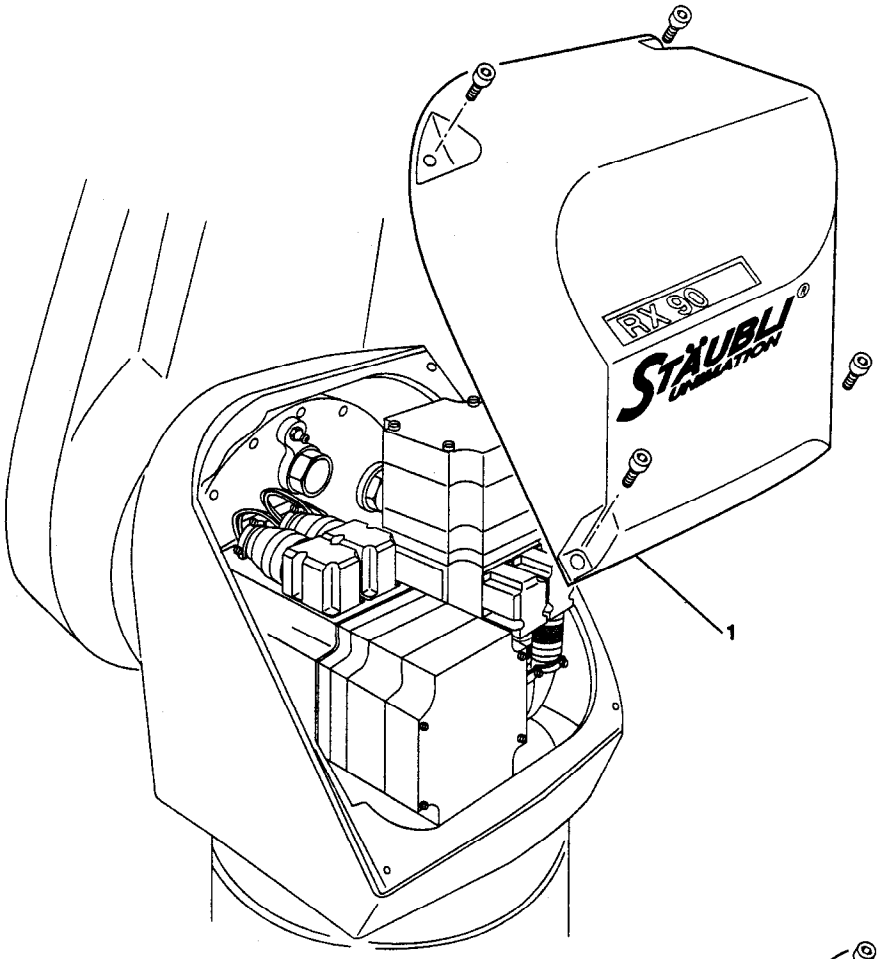


Figure 2.5.1.

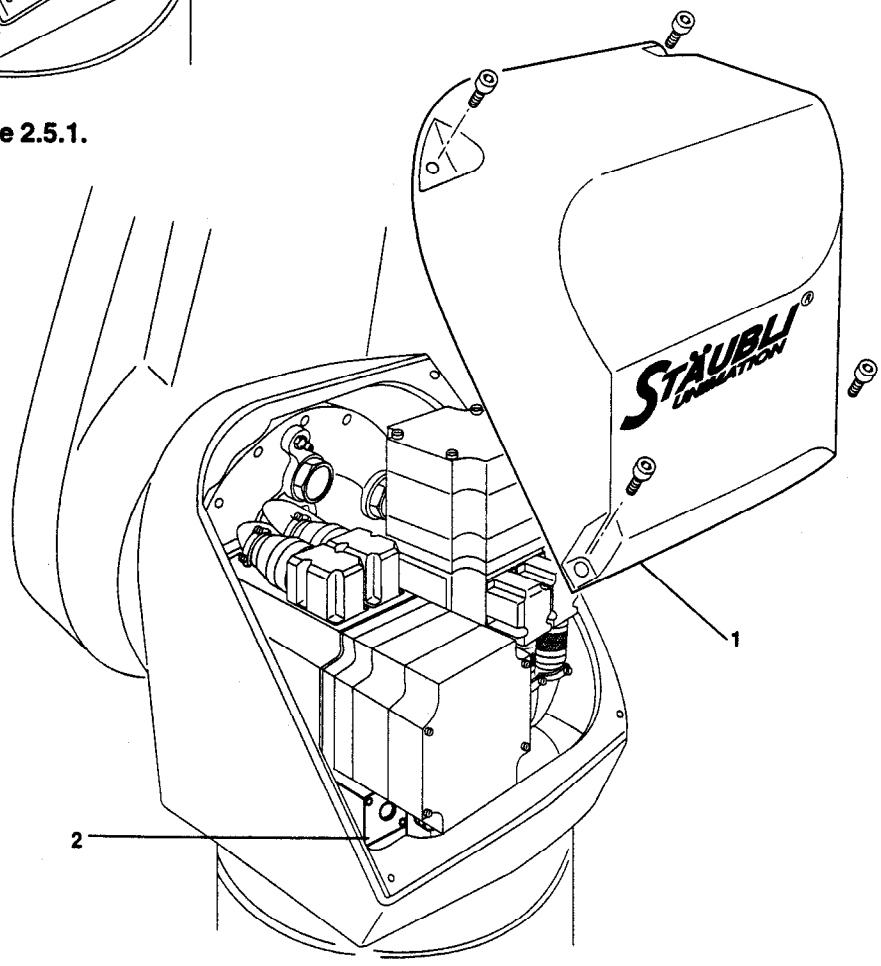


Figure 2.5.2.

5.2. JOINTS 1 AND 2, CLEAN ROOM ARM

On the clean room arm, solenoid valve (2) is visible (bottom left) when cover (1) is removed.

Figure 2.5.1.: Joints 1 and 2 standard arm
Figure 2.5.2.: Joints 1 and 2 clean room arm

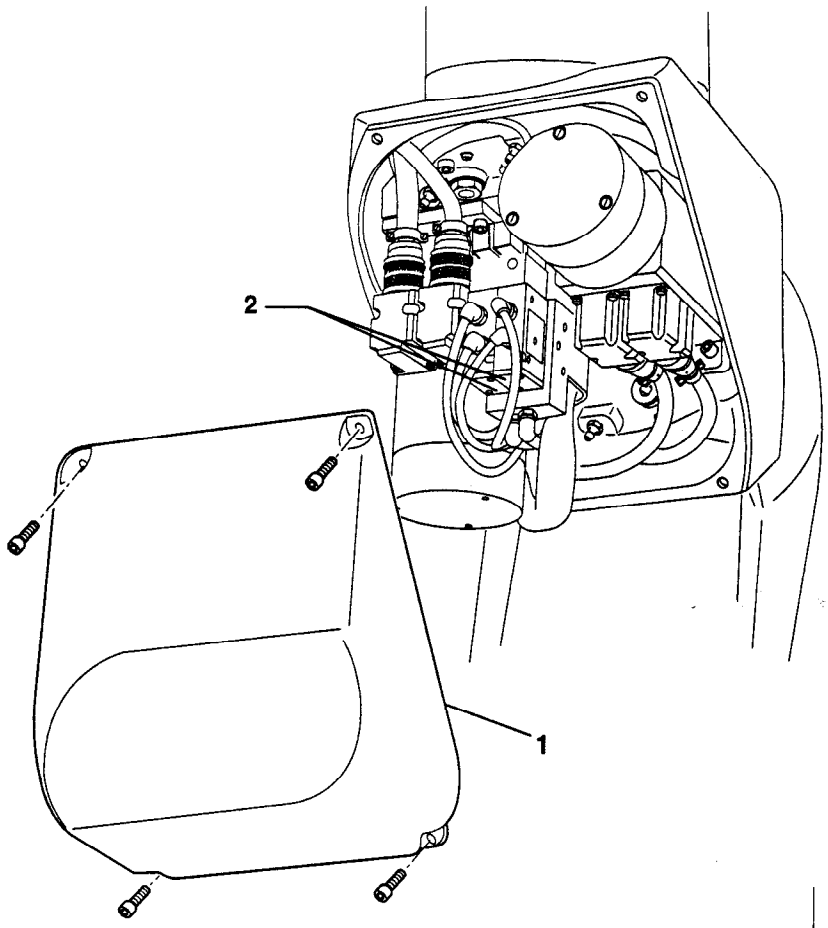


Figure 2.5.3

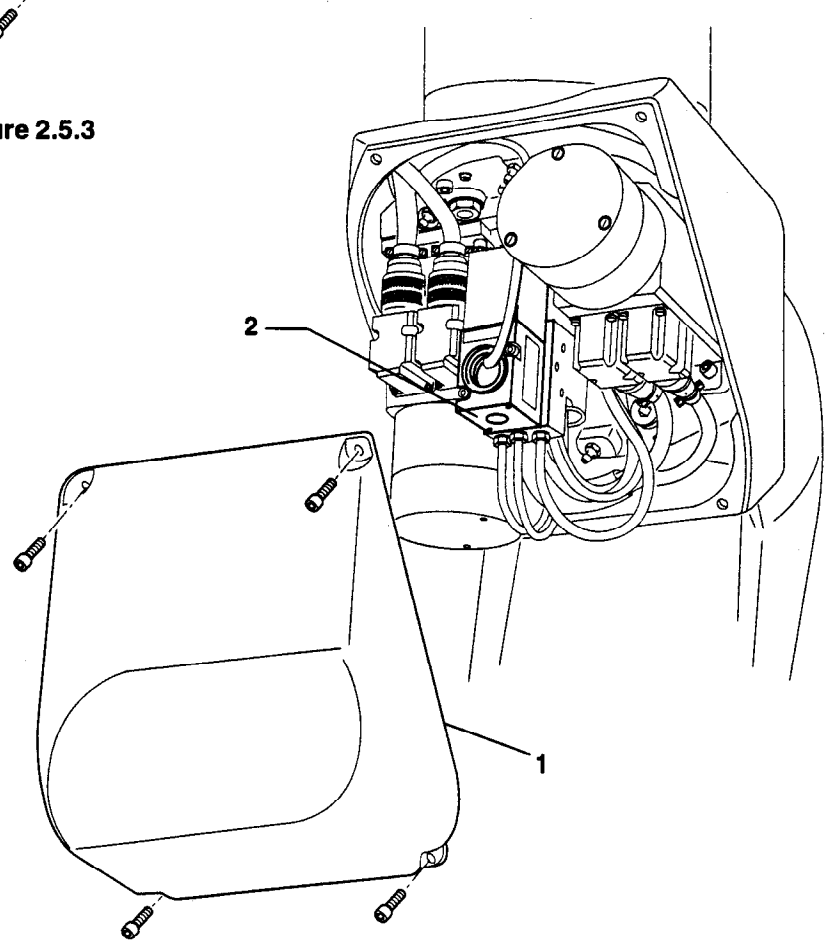


Figure 2.5.4.

5.3. JOINTS 3 AND 4

5.3.1. CLEAN ROOM ARM

After removing cover (1), the two solenoid valves (2) of the standard arm are replaced by a single solenoid valve (2) on the clean room arm.

Figure 2.5.3.: Joints 3 and 4 standard arm
Figure 2.5.4.: Joints 3 and 4 clean room arm.

5.3.2. HIGH LOAD ARM

No IMAS (views not shown).

CHAPTER 6 - TRANSMISSION CASING OIL CHANGE

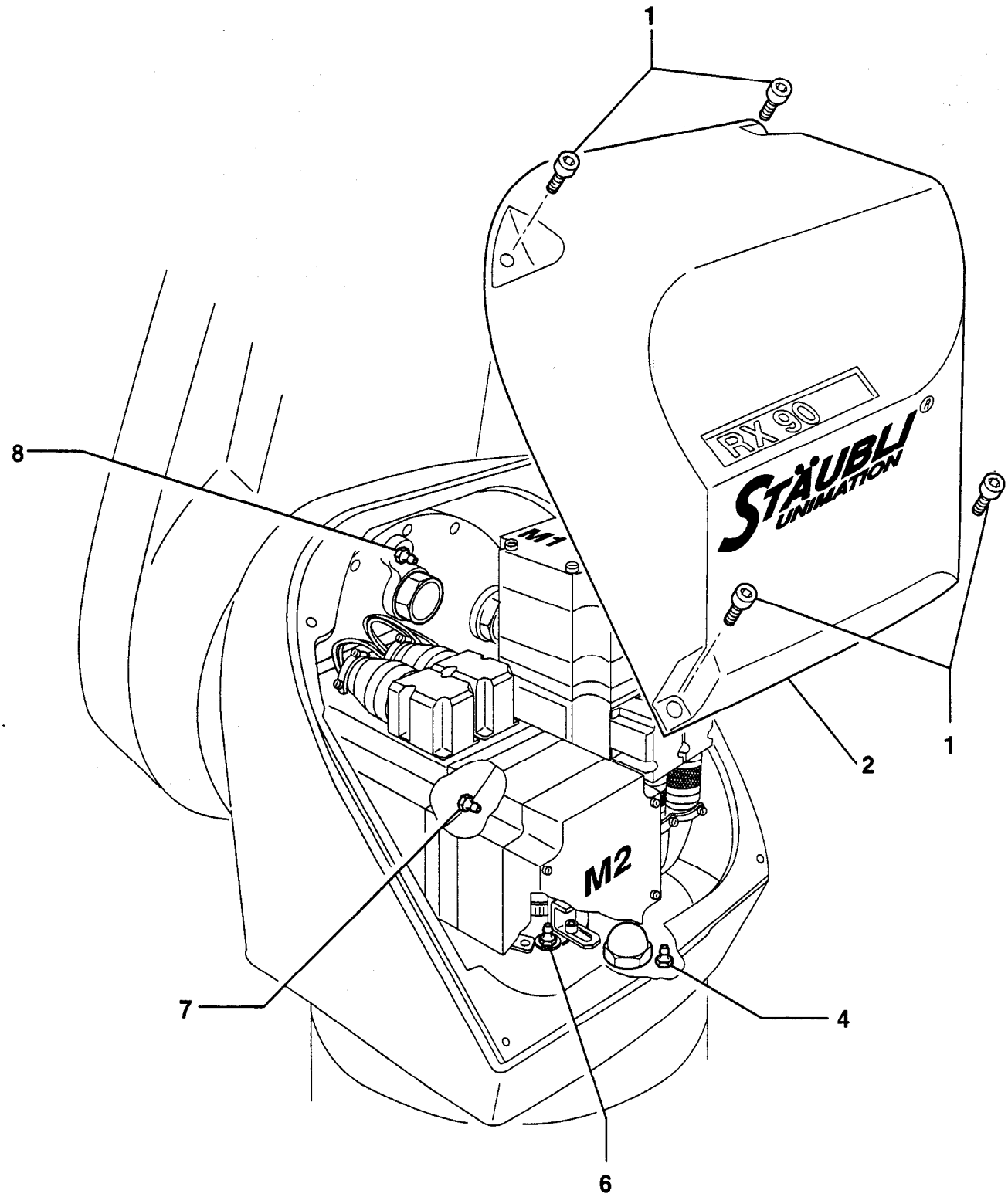


Figure 2.6.1

⚠ The figures in this chapter show the standard arm (see chapter 5 for variations)

CHAPTER 6 - TRANSMISSION CASING OIL CHANGE

6.1. JOINT 1 TRANSMISSION CASING (Figure 2.6.1)

⚠ Comply with safety instructions in Section I.

- Unscrew the 4 M5 screws (1) of cover (2).
- Remove shoulder cover (2).
- Install a 6/8 pneumatic hose on drain screw (6) (drain screw (4) for ceiling-mounted version).
- Unscrew drain screws (4) (6) by approximately 2 turns.
- Using a pumping device, remove oil from casing via the hose.
- Top up with oil* via the hose.
- Tighten drain screws (4) and (6) to 20 Nm +/- 1.4 Nm.
- Disconnect the hose.
- Install shoulder cover (2).
- Tighten the 4 M5 screws (1) attaching the cover (2) to 5.7 Nm +/- 0.4 Nm.

6.2. JOINT 2 TRANSMISSION CASING - (Figure 2.6.1)

⚠ Comply with safety instructions in Section I.

- Unscrew the 4 M5 screws (1) of cover (2).
- Remove shoulder cover (2).
- Install a 6/8 pneumatic hose on drain screw (7) (drain screw (8) for ceiling-mounted version).
- Unscrew drain screws (7) (8) by approximately 2 turns.
- Using a pumping device, remove oil from casing via the hose.
- Top up with oil* via the hose.
- Tighten drain screws (7) and (8) to 20 Nm +/- 1.4 Nm.
- Disconnect the hose.
- Install shoulder cover (2).
- Tighten the 4 M5 screws (1) attaching the cover (2) to 5.7 Nm +/- 0.4 Nm.

(*) Recommended oil : see spare parts,
oil level: see chapter 8.2.1.

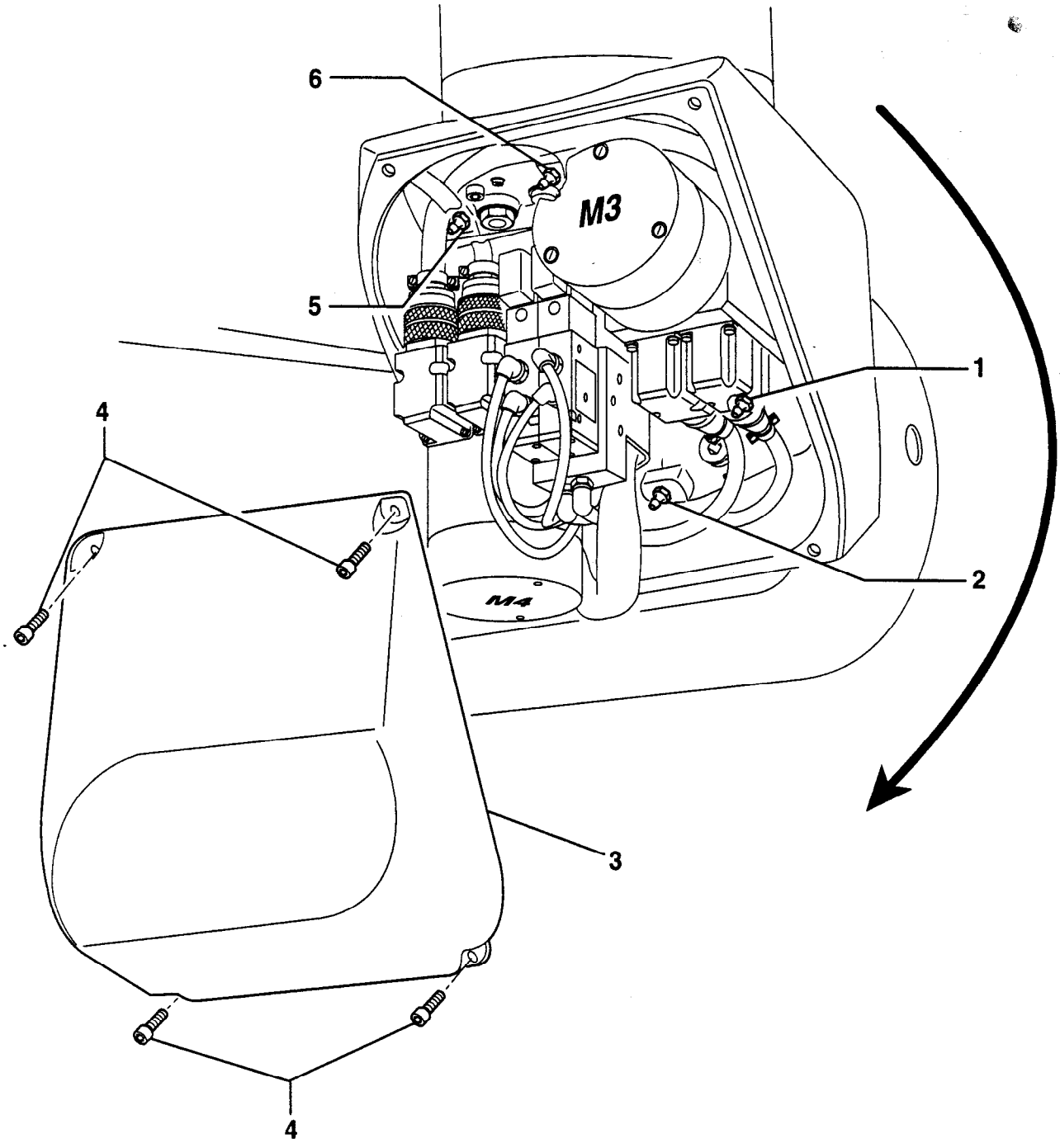


Figure 2.6.2

6.3. JOINT 3 TRANSMISSION CASING - (Figure 2.6.2)

> ⚠ Comply with safety instructions in Section I.

- Place the arm in horizontal position and the forearm perpendicular to the arm, upwards.
- Unscrew the 4 M5 screws (4) of cover (3).
- Remove elbow cover (3).
- Install a 6/8 pneumatic hose on drain screw (2).
- Unscrew drain screws (2) then (1) by approximately 2 turns.
- Using a pumping device, remove the oil from the casing via the hose.
- Top up with oil* via the hose.
- Tighten drain screws (1) and (2) to 15 Nm +/-1 Nm.
- Disconnect the hose.
- Install elbow cover (3).
- Tighten the 4 M5 screws (4) to 5.7 Nm +/- 0.4 Nm.

6.4. JOINT 4 TRANSMISSION CASING - (Figure 2.6.2)

> ⚠ Comply with safety instructions in Section I.

- Place the arm in horizontal position and the forearm perpendicular to the arm, upwards.
- Unscrew the 4 M5 screws (4) of cover (3).
- Remove elbow cover (3).
- Install a 6/8 pneumatic hose on drain screw (6).
- Unscrew drain screws (6) then (5) by approximately 2 turns.
- Using a pumping device, remove the oil from the casing via the hose.
- Turn the forearm through 180° in direction shown by arrow, downwards.
- Top up with oil* via the hose.
- Tighten drain screws (5) and (6) to 15 Nm +/-1 Nm.
- Disconnect the hose.
- Install elbow cover (3).
- Tighten the 4 M5 screws (4) to 5.7 Nm +/- 0.4 Nm.

(*) Recommended oil: see spare parts,
oil levels: see chapter 8.2.1.

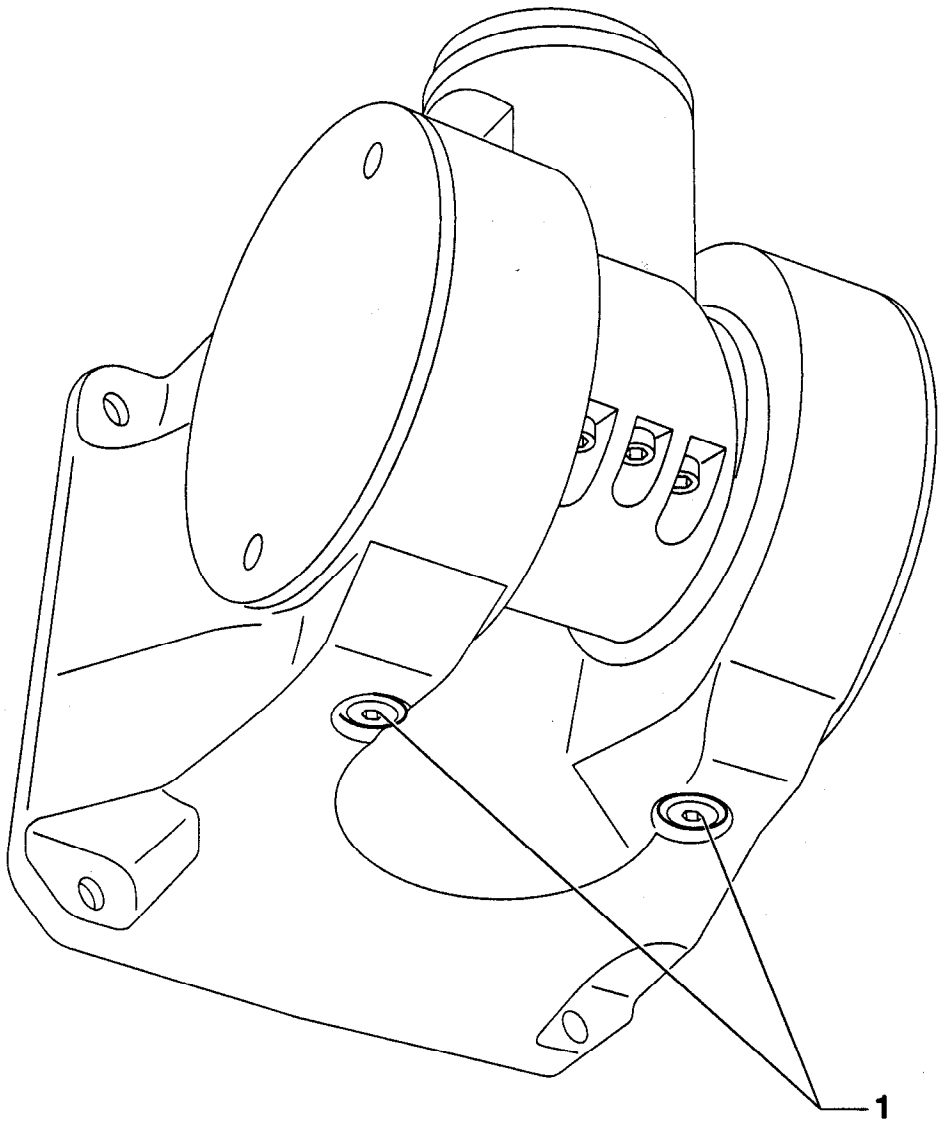


Figure 2.6.3

6.5. TRANSMISSION CASING OF JOINTS 5 AND 6 - (Figure 2.6.3)

> ⚠ Comply with safety instructions in Section I.

- Turn the joints so that forearm is horizontal, plugs (1) facing downwards, joint 6 vertical, upwards.
- Unscrew plugs (1).
- Wait approximately 10 minutes for oil to flow out.
- Turn the joints so that plugs (1) are facing upwards.

> ⚠ As joint 4 has no mechanical stop, check, when turning plugs (1) upwards that joint 4 remains within its envelope.

- Top up with oil* via holes of plugs (1).
- Tighten plugs (1) to 4 Nm +/- 0.3 Nm.

(*) Recommended oil: see spare parts,
oil levels: see paragraph 8.2.1.

CHAPTER 7 - OPERATIONS ON MOTORS

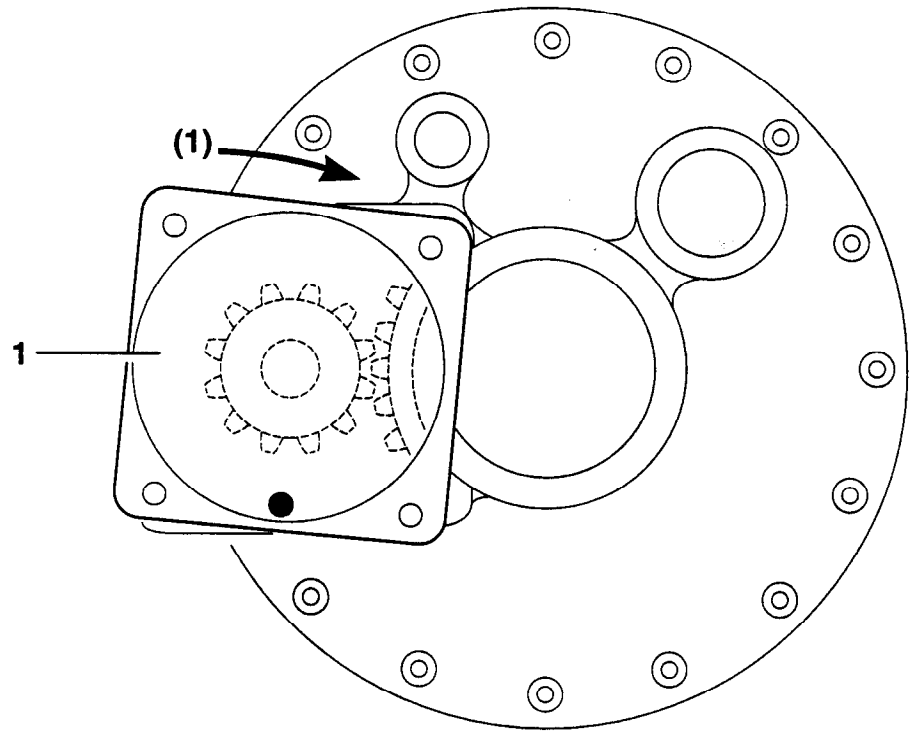


Figure 2.7.1

CHAPTER 7 - OPERATIONS ON MOTORS

⚠ Comply with safety instructions in Section I.

7.1. MOTOR PLAY ADJUSTMENT PROCEDURE

7.1.1. ACCESS TO MOTORS

The operations to be performed to access the motors are described in paragraph 7.2 «Replacement of a motor».

Operations specific to play adjustment are marked with sign ◆.

7.1.2. JOINTS 1, 2, 3 AND 4

Motor play is adjusted by moving the motor gear wheel towards the toothed wheel of the JCS transmission module:

- Unscrew the 4 screws of the motor of the joint concerned by 1/4 to 1/2 of a turn.
- Push motor (1) clockwise (figure 2.7.1) to reduce play.
- Progressively tighten the 4 motor screws, working diagonally.

⚠ Do not hold the motor pressed against the toothed wheel when tightening its 4 attachment screws.

- Check adjustment by conducting the following «motor play check» procedure:

To check for play in a joint:
- Release the brake of the joint concerned.
- Move the joint to both sides in movement direction.
- If there is play in the joint, a characteristic noise will be heard when direction of movement is reversed.

For the robot to work under the best conditions, transmission play must tend towards zero without this jamming the gearing or creating a friction point in the transmission or significant operating noise.

7.1.3. JOINTS 5 AND 6

Play of joints 5 and 6 must be adjusted in the factory or by a qualified technician.

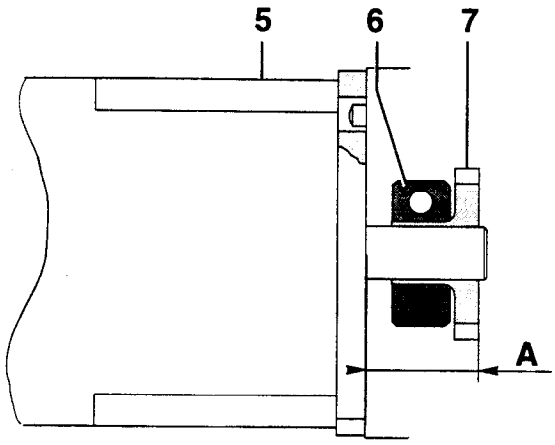


Figure 2.7.2'

Figure 2.7.2

7.2. REPLACEMENT OF A MOTOR

> ⚠ Comply with safety instructions in Section I.
>
> If an item is replaced or joint transmission uncoupled, an arm resetting procedure must be performed.
>
> The figures in this chapter show the standard arm (see chapter 5 for variations)

7.2.1. JOINT 1 (Figure 2.7.2)

- Align the joint position marks.
- Unscrew the 4 M5 screws (1) of cover (2).
- Remove shoulder cover (2).
  - For ceiling-mounted version, drain the joint casing (see § 6.1).
  - Disconnect connectors (3) from motor M1.
  - Unscrew the 4 M6 screws (4) attaching motor M1.
  - Remove motor M1.

> ⚠ Hold the joint in position.
> Check for good condition and positioning of the O-ring under the motor.
> Make sure that no impurities enter the joint JCS casing.

Figure (2.7.2')
- Untighten the M6 screw of bushing (6).
- Remove gear wheel (7) from motor (5).

On the new motor:
- Install the gear wheel (7) and bushing (6) assembly on motor (5).
  Dimension (A) is 25 mm +/- 0.1 mm.
- Tighten the M6 screw of bushing (6) to 16.7 Nm +/- 1.2 Nm.
- Install motor M1 on joint 1 casing.

> ⚠ - Do not damage the O-ring under the motor.
> - Correctly position motor M1 on the locating stud.
> - Keep the joint marks aligned to within 1/2 of a tooth.

- Install the 4 M6 screws (4) attaching motor M1, do not tighten down.
- Connect connectors (3) on motor M1.
- Perform the motor play adjustment procedure.
- Tighten the 4 M6 screws (3) attaching motor M1 to 16.7 Nm +/- 1.2 Nm.
- Install shoulder cover (2).
- Tighten the 4 M5 screws (1) attaching cover (2) to 5.7 Nm +/- 0.4 Nm.

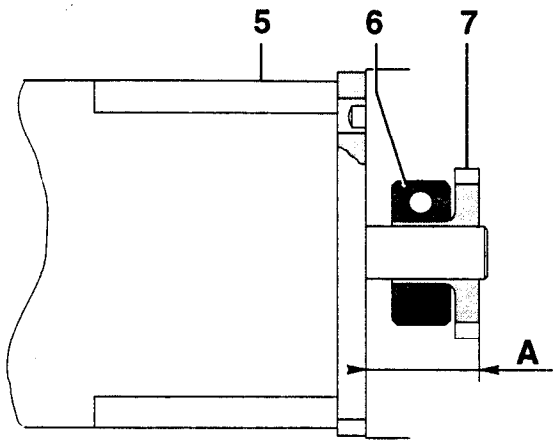


Figure 2.7.3'

Figure 2.7.3

7.2.2. JOINT 2 - (Figure 2.7.3)

> ⚠ Comply with safety instructions in Section I.

- Align the joint position marks.
- Unscrew the 4 M5 screws (1) of cover (2).
- Remove shoulder cover (2).
- Disconnect connectors (4) from motor M2.
- Unscrew the 4 M6 screws (3) attaching motor M2.
- Remove motor M2.

> ⚠ - Hold the joint in position.
> - Check for good condition and positioning of the O-ring under the motor.
> - Make sure that no impurities enter the joint JCS casing.

Figure (2.7.3')
- Untighten the M6 screw of bushing (6).
- Remove gear wheel (7) from motor (5).

On the new motor:
- Install the gear wheel (7) and bushing (6) assembly on motor (5).
- Dimension (A) is 25 mm +/- 0.1 mm.
- Tighten the M6 screw of bushing (5) to 16.7 Nm +/- 1.2 Nm.

- Install motor M2 on joint 2 casing.

> ⚠ - Do not damage the O-ring under the motor.
> - Correctly position motor M2 on the locating stud.
> - Keep the joint marks aligned to within 1/2 of a tooth.

- Install the 4 M6 screws (3) attaching the motor M2, do not tighten down.
- Connect connectors (4) on motor M2.
- Perform the motor play adjustment procedure.
- Tighten the 4 M6 screws (3) attaching motor M2 to 16.7 Nm +/- 1.2 Nm.
- Install shoulder cover (2).
- Tighten the 4 M5 screws (1) attaching cover (2) to 5.7 Nm +/- 0.4 Nm.

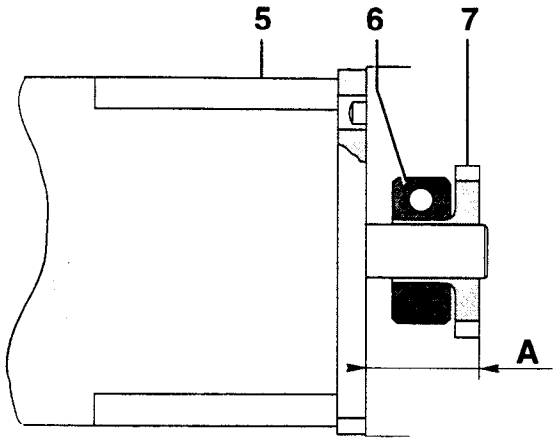


Figure 2.7.4'

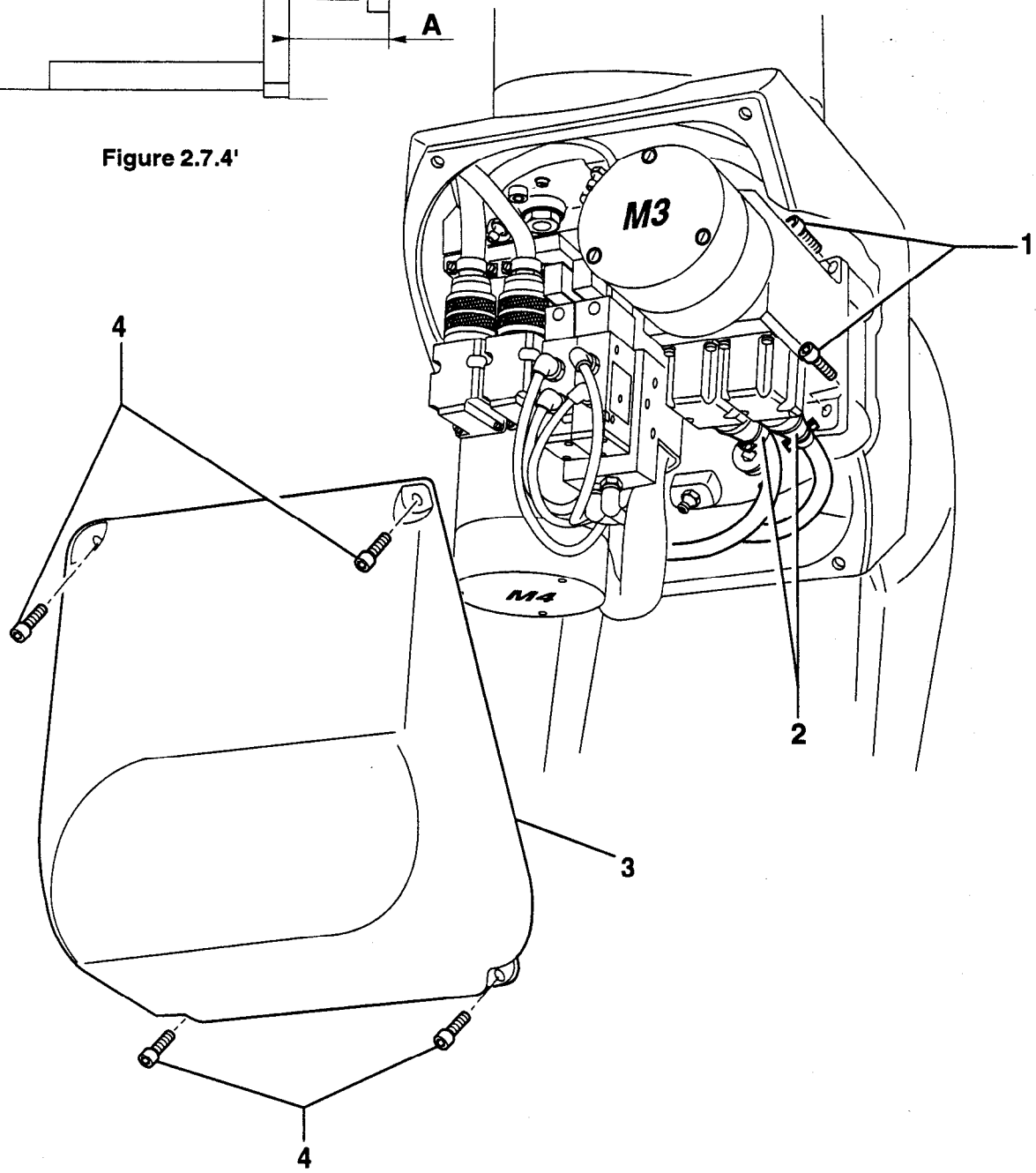


Figure 2.7.4

7.2.3. JOINT 3 - (Figure 2.7.4)

> ⚠ Comply wtih safety instructions in Section I.

- Align the joint position marks.
- Unscrew the 4 M5 screws (4) of cover (3).
- Remove elbow cover (3).
  - Disconnect connectors (2) from motor M3.
  - Unscrew the 4 M5 screws (1) attaching motor M3.
  - Remove motor M3.

> ⚠
> - Hold the joint in position.
> - Check for good condition and positioning of the O-ring under the motor.
> - Make sure that no impurities enter the joint JCS casing.

Figure (2.7.4')

- Untighten the M6 screw of bushing (6).
- Remove gear wheel (7) from motor (5).

On the new motor:

- Install the gear wheel (7) and bushing (6) assembly on motor (5).
- Dimension (A) is 23 mm, +/- 0.1 mm.
- Tighten the M6 screw of bushing (6) to 16.7 Nm +/- 1.2 Nm.

- Install motor M3 on joint 3 casing.

> ⚠
> - Do not damage the O-ring under the motor.
> - Correctly position motor M3 on the locating stud.
> - Keep the joint marks aligned to within 1/2 of a tooth.

- Install 4 M5 screws (1) attaching motor M3, do not tighten down.
- Connect connectors (2) to motor M3.

- Perform the motor play adjustment procedure.
- Tighten the 4 M5 screws (1) attaching motor M3 to 9.5 Nm +/- 0.7 Nm
- Install elbow cover (3).
- Tighten the 4 M5 screws (4) attaching cover (3) to 5.7 Nm +/- 0.4 Nm.

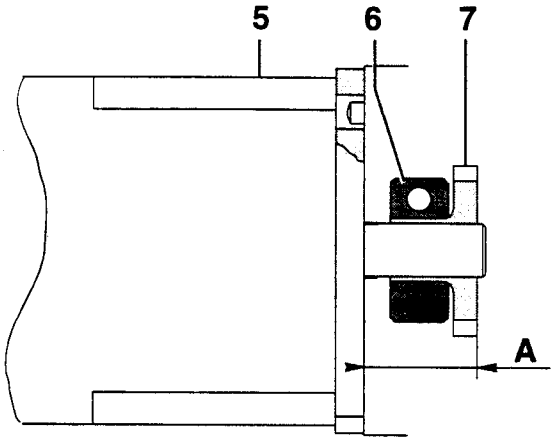


Figure 2.7.5'

Figure 2.7.5

7.2.4. JOINT 4 - Figure (2.7.5)

> ⚠ Comply with safety instructions in Section I.

- Configure the robot arm:
  - . Arm horizontal (joint 2),
  - . Forearm vertical, wrist downwards,
  - . Joint 4 marks aligned.
- Unscrew the 4 M5 screws (1) of cover (2).
- Remove elbow cover (2).
  - Disconnect connectors (3) from motor M4.
  - Unscrew the 4 M5 screws (4) attaching motor M4.
  - Remove motor M4.

> ⚠
> - Hold the joint in position.
> - Check for good condition and positioning of the O-ring under the motor.
> - Make sure that no impurities enter the joint JCS casing.

Figure (2.7.5')

- Untighten the M6 screw of bushing (6).
- Remove gear wheel (7) from motor (5).

On the new motor :

- Install the gear wheel (7) and bushing (6) assembly on motor (5).
- Dimension (A) is 23 mm +/- 0.1 mm.
- Tighten the M6 screw of bushing (6) to 16.7 Nm +/- 1.2 Nm.

- Install the motor M4 on joint 4 casing.

> ⚠
> - Do not damage the O-ring under the motor.
> - Correctly position motor M4 on the locating stud.
> - Keep the joint marks aligned to within 1/2 of a tooth.

- Install the 4 M5 screws (4) attaching motor M4, do not tighten down.
- Connect connectors (3) to motor M4.

- Perform the motor play adjustment procedure.
- Tighten the 4 M5 screws (4) attaching motor M4 to 9.5 Nm +/- 0.7 Nm.
- Install elbow cover (2).
- Tighten the 4 M5 screws (1) attaching cover (2) to 5.7 Nm +/- 0.4 Nm.

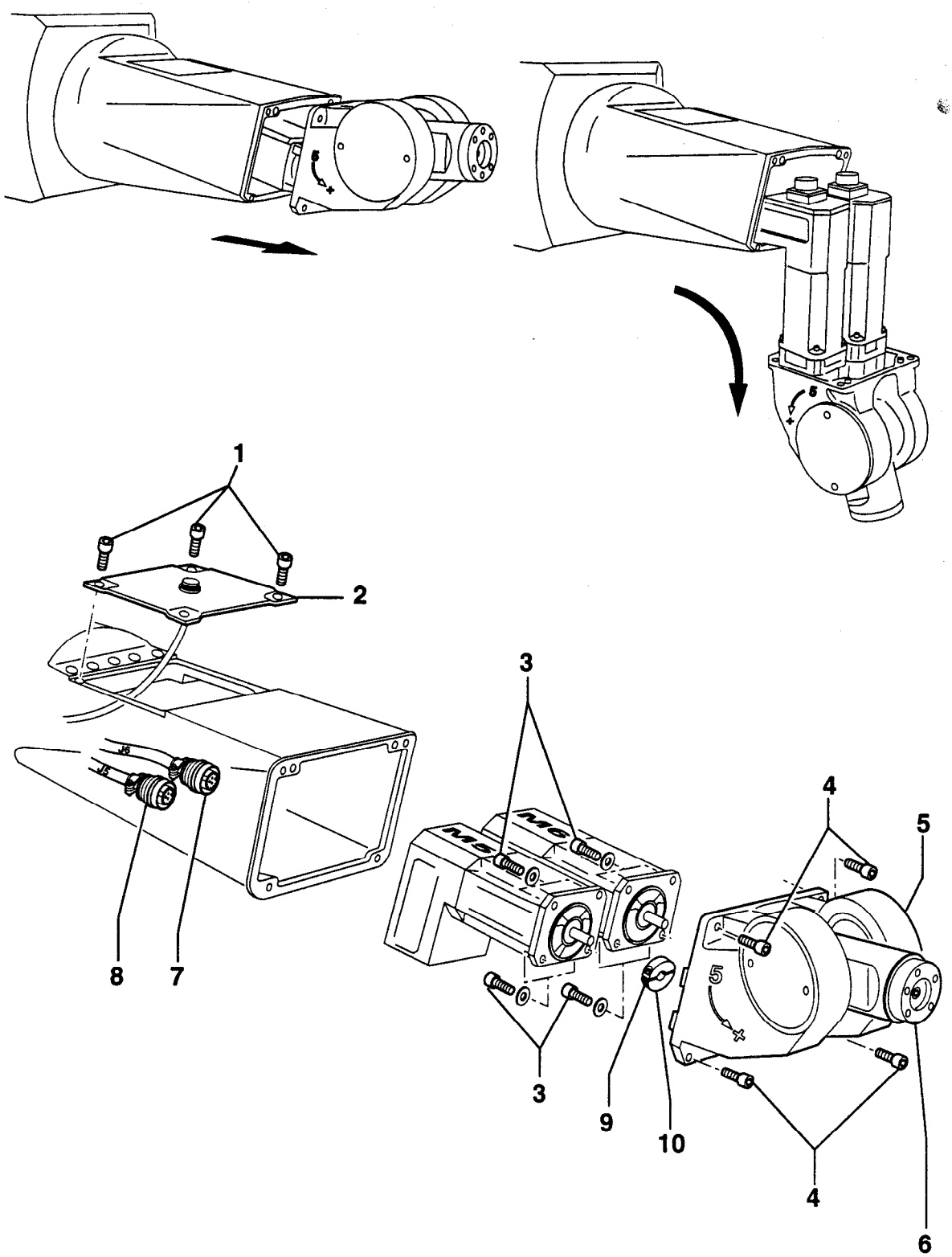


Figure 2.7.6

7.2.5. JOINTS 5 AND 6 - (Figure 2.7.6)

> ⚠ Comply with safety instructions in Section I.

- Remove the end-effector installed on mechanical interface (6) of wrist (5).
- Unscrew the 4 M5 screws (1) attaching cover (2).
- Disconnect connectors (7) and (8) from motors M6/M5.
- Unscrew the 4 M5 screws (4) attaching wrist (5).
- Remove the wrist/motor assembly according to procedure shown on figure 2.7.6.

Motor replacement

- Unscrew the 4 M4 screws (3) attaching the motor.
- Untighten the M5 screw (9) of bushing (10).
- Install the new motor.
- Tighten the 4 M4 screws (3) attaching the motor to 4.8 Nm +/- 0.30 Nm.
- Tighten the M5 screw (9) of bushing (10) to 9.5 Nm +/- 0.7 Nm.

- Reinstall the wrist/motor assembly working back through procedure shown on figure (2.7.6).
- Tighten the 4 M5 screws (4) attaching the wrist to 5.7 Nm +/- 0.4 Nm.
- Install connectors (7) and (8) on motors M6 and M5.

> ⚠ Check that connector marks correspond to motors.

- Install cover (2).
- Tighten the 4 M5 screws (1) to 5.7 Nm +/- 0.4 Nm.

7.3. REPLACEMENT OF AN IMAS

> ⚠ Comply with safety instructions in Section I.
> If a motor or an Imas is replaced, arm resetting procedure must be performed (chapter 7.4).

- The robot is in ready position.
- Remove the upper cover from the motor concerned.
- Disconnect the 2 connectors of the Imas in place.
- Mark the position of the Imas in the motor.
- Remove the defective Imas and return it to Stäubli After-Sales Service.
- Install the new Imas in the same position.

> ⚠ Take care not to inverse the IN connector (connection of master resolver) and the OUT connector (output to motor connector : larger section wire).
>
> Respect wire passages to avoid pinching between printed circuit, frame and motor upper cover.

- Install motor upper cover.
- Reset the arm as described in procedure of chapter 7.4.

7.4. RESETTING AN RX ROBOT

7.4.1. WITH IMAS

7.4.1.1. PRINCIPLE

Absolute calibration is performed on controller power-up or after a .CAL (calibrate) command. It consists in reading, on each motor, the values of the three resolvers (fine, coarse 1, coarse 2) then in calculating the angular position of the joint by comparing the values just read with those recorded in the system when the arm was in «Ready» position.

Absolute calibration requires the use of the following items:

- **The SPEC_CAL utility program** to record the reference values of the resolvers (arm in «Ready» position).

- **The ACB.CAL program**, run automatically on power-up, following a .CAL command or in the SPEC_CAL utility program.

  Note: Before the V+ 11.2P version, the ACB.CAL program was invisible for the end user.

- **The ACB board**. This board is only used during calibration to acquire the resolver values by means of the multiresolver boards via an «SSI» serial link. It serves no purpose during the normal running of the robot.

- **The multiresolver board** (one per joint) which, by using different offset values, allows the positions of the fine resolver and of the two coarse resolvers to be addressed and read.

- **The three-resolver system** (per joint): includes a fine resolver installed directly on the motor joint and two coarse resolvers (IMAS). These resolvers are mechanically coupled by a reduction gear, the reduction ratio between two successive resolvers is 16. This means that the system is absolute over 256 motor revolutions. Apart from during the calibration operations, the coarse resolvers are not used; only the fine resolver is permanently read.

The process by which the resolvers are read and analyzed is only used during the system initialization sequences (controller power-up, .CAL command or in the SPEC_CAL utility program). The absolute position is calculated from the combination of readings made on the three resolvers (of a given joint) in order to obtain a single absolute value per joint. This value will be recorded in the system so that the movement of the robot can be followed. As resolver reading will remain unchanged for a given arm position, and once the relation between the resolvers and the actual angular position of the joint have been established, the calibration procedure becomes automatic.

In general, the operation can be compared with that of a watch: on power-up, the exact time is calculated from the position of the three hands in relation to the position of these hands recorded by the system during the resetting procedure (described below) when robot was in its mechanical «Ready» position; then, only the movements of the second hand (fine resolver) are counted and then added to or substracted from the start time.

7.4.1.2. RESETTING PROCEDURE

- Following replacement of a motor or resolver, a robot mechanical zero pendant procedure must be performed.

- Set the Robot to Ready and check its position via the following command
  .where (return)
  (the angular coordinates of joints 1 to 6 must be mandatorily: 0, -90, 90, 0, 0, 0°).
  If you have performed an operation on a joint, it must be brought as accurately as possible to ready, that is alignment of the marks of the joint concerned.

- Switch off the arm:
  .dis power (return)

> ⚠ The arm must be switched off in «Ready» position to record the resolver values.

- Load and run the absolute calibration recording software located in the UTIL_ZZ directory (where ZZ is the revision of V+) on the hard disk or on the «Adept Utility disk».
  . load C:\UTIL_ZZ\SPEC.V2 (return) (with password SPEC_CAL)
  . ex 1 a.spec (return).

After release of V+11.2P, you must use the SPEC.V2 program then enter password SPEC_CAL to access the SPEC_CAL.V2 utility menus
  «Enter password to increase access».
Enter password: SPEC_CAL (return).

- On the menu which is displayed, select the following commands

  «Edit robot specifications» (return), then
  «Edit motor calibration parameters» (return), then
  «Record resolver offset at nest location for all motors» (return).

> ⚠ When you execute this command, the system searches for the ACB.CAL program in the CALIB directory of the disk drive used for the controller boot sequence.

With the arm switched off, it is then possible to display the «Fine, coarse 1, coarse 2 resolver offset» values of the 6 robot joints in order to check for correct readout of the offsets which must be different from each other for a given joint. For this, select :
  «change motor number» (return)
then specify joint required (return).

- Return to the main menu by selecting
  «Exit» (return), then
  «Exit to main menu» (return)

- Store the information on the hard disk by :
  «Save all specifications to system disk» (return)
  «Do you want to write the data to the boot disk (Y/N) ?» Y (return)
  «Which disk drive contains the boot disk (A/C) ?» C (return)
  «OK to write to boot disk in drive C (Y/N) ?» Y (return)
  Writing to boot disk ... completed
  All done press ENTER to continue
  Press the return key.

- Save the robot's overlay file (calibration specifications) as a hard disk file by:
  «Save robot specification to a disk file» as an **ASCII** file then enter file name:
  C:\SVYXXXZ.SPC
  where V=N for an RX robot and V= R for a linear joint
  YXXX = the last four digits of the serial number
  Z = serial number index.
  This number is marked on the identification plate of the mechanism,
  then select:
  «Exit to system monitor» (return)

7.4.1.3. CHECK OF RECORDED READY

- Switch off the controller (switch (6) on front panel). Absolute calibration is only taken into account during the Adept controller start-up sequence.
- Check that there is no system diskette in drive A in order to reboot on hard disk C then switch on the controller.
- On completion of the boot sequence, switch on the arm
  . en power (return) then press ARM POWER ON pushbutton
  . sp 5 (return)
  . do ready (return)
  . Load the application program or simply a precise point in order to check for correct setting of the robot.
  . Move the robot to the point (using the manual control pendant or with the V+ instruction «do move»
  . Enter
  . where (return) (**first where**)

a. The robot perfectly positioned on the point, all that remains to be done is to update the system diskette following the procedure described below.

b. The robot is slightly offset:

b1. With the manual control pendant, bring the robot exactly to the required position moving only the joint with which you are concerned and enter:
where (return) (**second where**)

Note the difference in degrees with regard to the first recorded where, by:
DIFFERENCE = value of the second where - value of the first where
. Bring the robot to ready
. Enter:
. do drive joint, difference, 10 (return)
careful with +/- sign for difference and joint number.
. Switch off the power to the arm
«. dis power» (return) and repeat the previously described absolute calibration recording procedure (§ 8.4.2).

b2. or perform the V_REG procedure on the joint concerned then repeat the absolute calibration recording procedure (§ 8.4.2).

Figure 2.8.6 shows the RX robot resetting principle.

RX ROBOT RESETTING PRINCIPLE

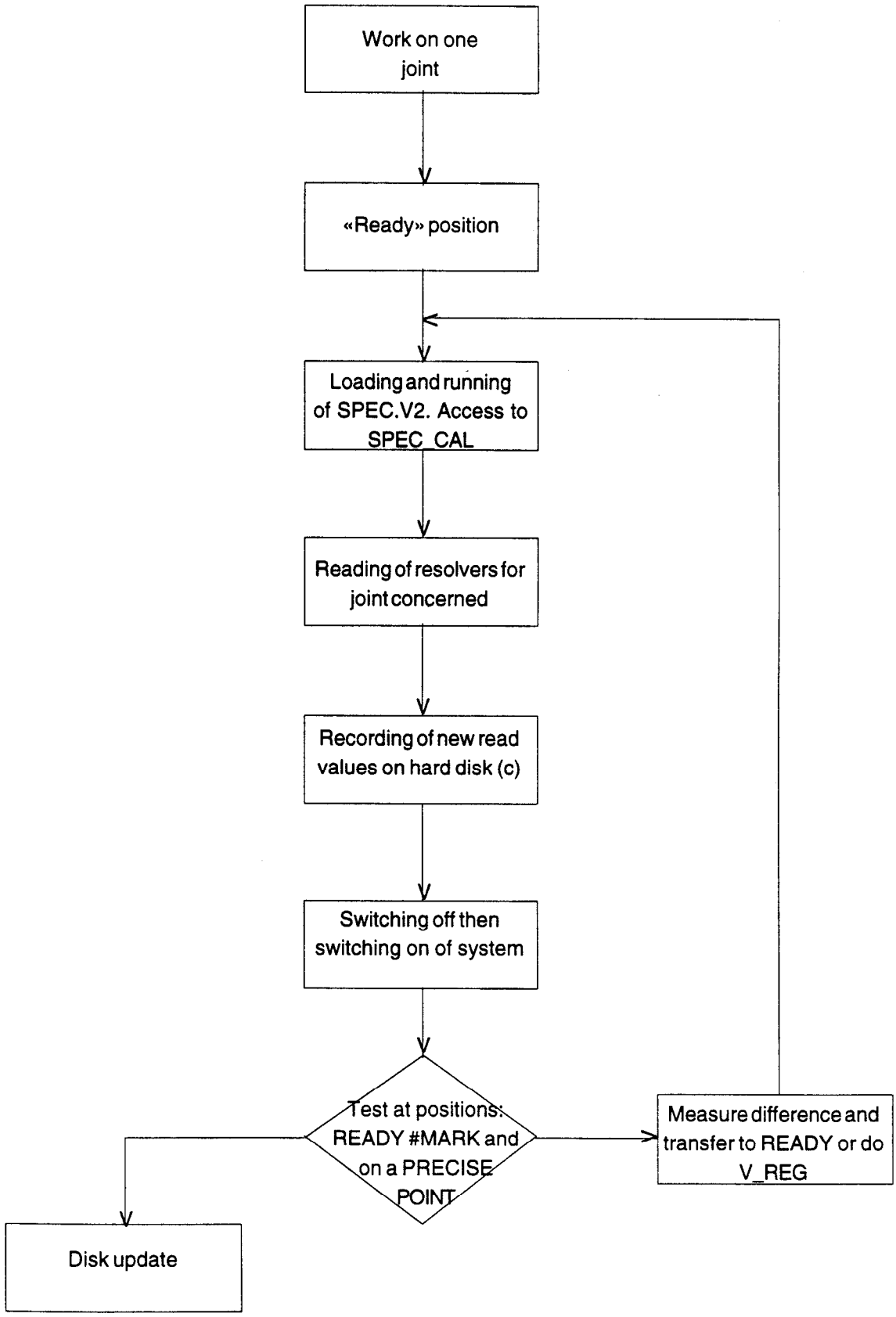


Figure 2.7.7

7.4.1.4. UPDATING SYSTEM DISK

- Load and run the absolute calibration recording software
    . load c:\UTIL_ZZ\SPEC.V2 (return)
    . ex 1 a.spec (return)

After release of V+11.2P, you must use the SPEC.V2 program then enter password SPEC_CAL to access the menus of the SPEC_CAL.V2 utility.
    «Enter password to increase access» (return)
Enter password: SPEC_CAL (return)

- Insert the system disk in drive A then select following command.
    «Save all specifications to system disk» (return)
    «Do you want to write the data to the boot disk (Y/N) ?» Y (return)
    «Which disk drive contains the boot disk (A/C) ?» A (return)
    «Make sure the disk is not write protected»
    «OK to write to boot disk in drive A (Y/N) ?» Y (return)
Writing to boot disk ....completed.
All done press ENTER to continue.
    Press the return key

Save the robot's overlay file (calibration specifications) as a file on disk.

    «Save robot specification to a disk file» as an **ASCII** file then enter file name:
        A:\SVYXXXZ.SPEC
    where V=N for an RX robot and V=R for a linear joint
        YXXX = last four digits of serial number
        Z = serial number index
    then select
        «Exit to system monitor».

The hard disk and the system disk are now updated.

7.4.2. WITH RPT SYSTEM

When installing a new arm or after replacement of a motor.
These RX robots will only operate with a V+ version greater than or equal to 11.4C to obtain full integration.

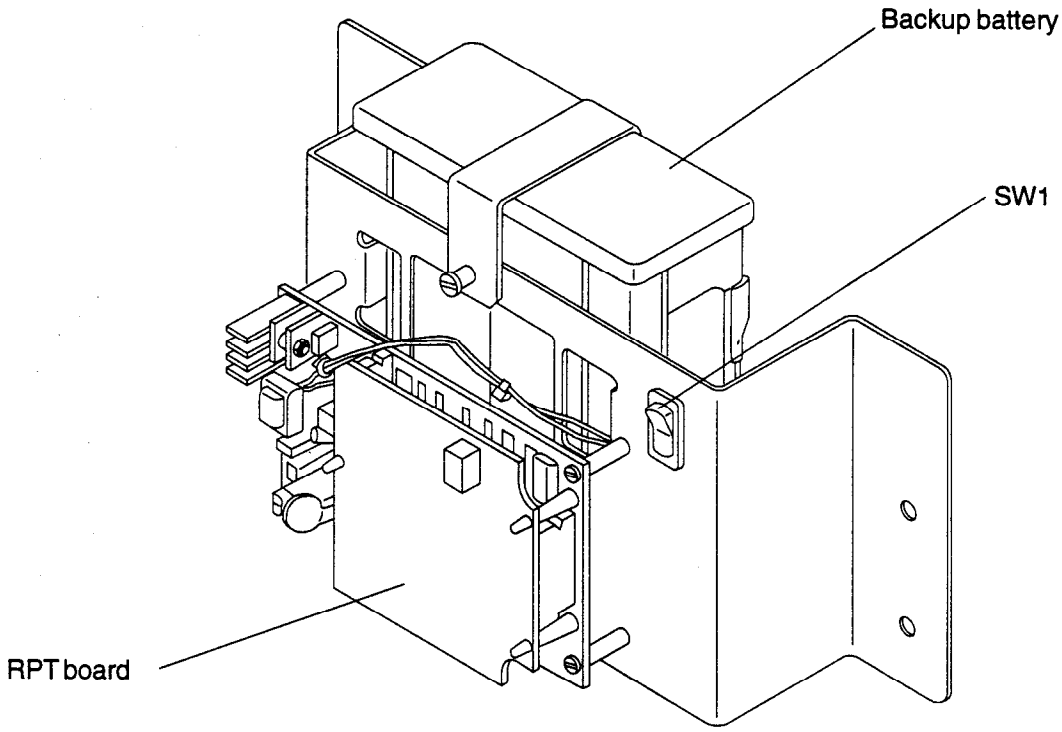


Figure 2.7.8

7.4.2.1. ABSOLUTE CALIBRATION PRINCIPLE WITH RPT (Resolver Position Tracking) BOARD

The system consists of an electronic board (RPT board - fig 2.7.8) counting the motor revolutions backed up by battery. This battery can be disconnected (for long duration storage or for transport) via the switch SW1. The RPT board directly uses the sine and cosine signals delivered by the resolvers. In fact, it is connected in parallel with the sine and cosine lines connecting the amplifiers and the resolvers.

In normal operation (power on), the reference received by the RPT board is directly transferred to the resolvers. This reference signal is generated by the axis 3 amplifier. This amplifier therefore operates in «master» mode and the other five (axes 1, 2, 4, 5 and 6) operate in «slave» mode.
When supply voltage is absent, the board samples the position of each of the resolvers by sending a pulsed reference signal (instead of the sine-wave signal sent normally by the amplifiers). The microcontroller of the RPT board then detects passage from quadrant 1 to quadrant 4 (a motor revolution is divided into 4 equal quadrants) and counts one revolution more (or less). This sampling principle greatly reduces the electrical consumption of the assembly (and increases the autonomy of the backup battery).

When the electrical power supply returns, the controller will read the number of revolutions counted on each of the axes by the RPT board. By combining this value with the current position of the resolver (position in a revolution), we obtain the absolute position of the axis. The dialog between the RPT board and the controller is achieved via an RS422 serial link.

> ⚠ **Important**: before starting up the installation and after having connected the cable between the arm and the controller, you must close switch SW1 between the backup battery and the RPT board (in position I). Also, before disconnecting the arm from the controller, it is recommended to switch off the battery (switch in position 0).

The calibration system of the V+11.4C version does not take external axes into account. This will be achieved in a later version.

The calibration of the RX robot also requires the use of the following items:

- **The ACB board**. This board is only used during calibration to acquire the resolver values by means of the multiresolver boards via an «SSI» serial link. It serves no purpose during the normal running of the robot.

- **The multiresolver board** (one per axis) used to address and read the position of the fine resolver. Board of axis 3 operates in master mode (generation of the reference signal when the amplifiers are supplied) and the boards of axes 1, 2, 4, 5 and 6 operate in slave mode.

- **The SPEC.V2 software (with password SPEC_CAL).** Certain options allow the user to control and manage robot calibration. In particular:
- Initialization of the RPT board
- Recording of the reference position (Ready)
- Recovery of the V_REG position if the RPT board has lost the content of the revolution counters.
- Modification of standard Ready.

- **The RPT.CAL program.** Called automatically during a CALIBRATE command or when certain menus of the SPEC.V2 utility softare are executed. Must be present in the system disk CALIB directory which was used to boot the controller.

7.4.2.2. WHICH SPEC.V2 SOFTWARE OPTION SHOULD BE USED AND IN WHICH CASE?

The table below gives the option of the "Edit motor calibration parameters" menu in SPEC.V2 (password SPEC_CAL) to be selected in various situations:

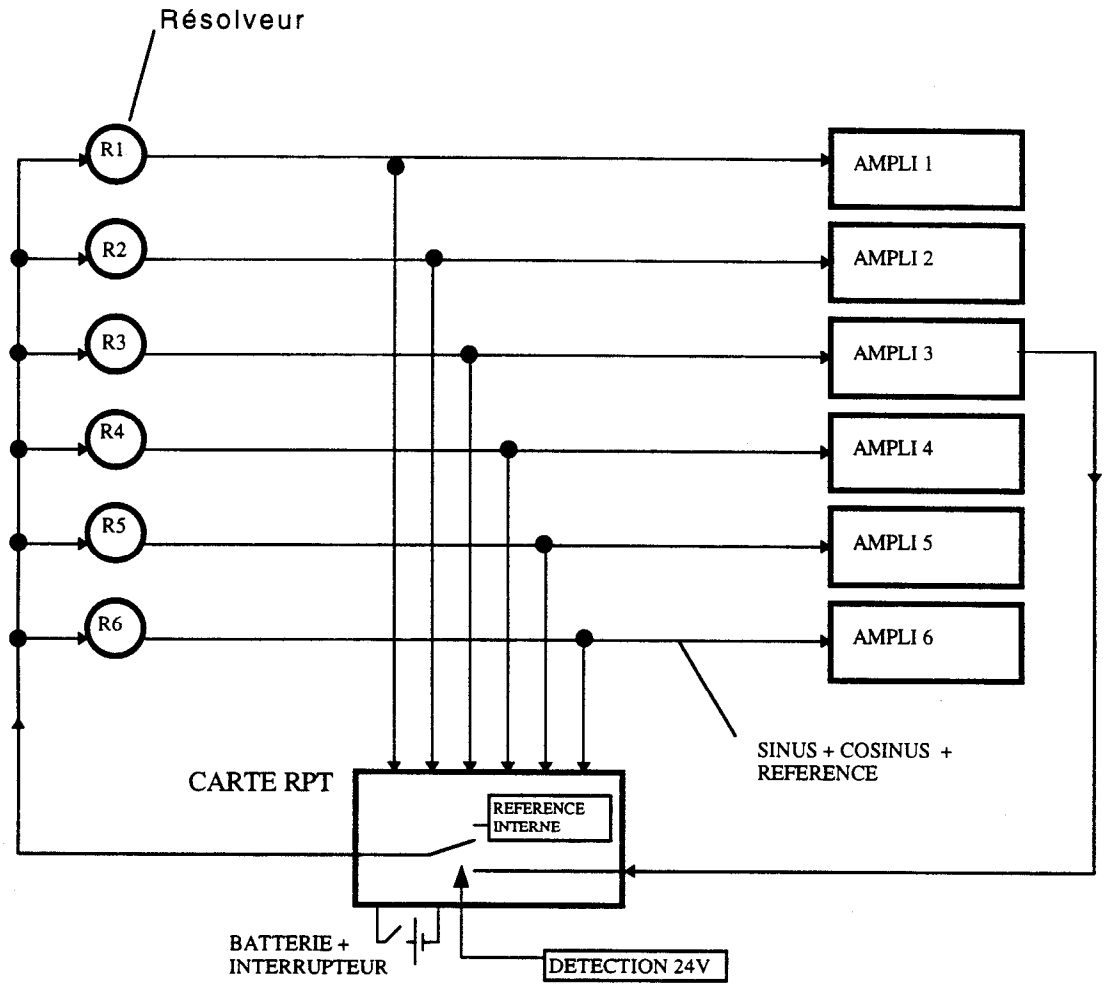
USE	OPTION IN SPEC_CAL
*Arm installation in factory**	*V_REG + A or B*
*Change of motor**	*V_REG + B*
*Change of resolver**	*V_REG + B*
Replacement of battery with controller switched on	no procedure required
Change of battery with controller switched off or loss of RPT information	C
Change of interconnecting cable	C
Replacement of RPT board	C
First installation of arm at customer's	C
Recording of a new Ready	A or B
Interconnecting cable disconnected	C
Normal startup of installation after controller is switched off (without loss of RPT information)	RPT.CAL via CALIBRATE (automatic calibration)

* Note: Staübli After-Sales Service must be called on for operations shown in italics.

where: A = Setup RPT board, record resolver pos. @ nest (all motors)
B = Setup RPT board, record resolver pos. @ nest (this motor)
C = V_REG position recovery

(options A, B and C then require a calibration operation (CALIBRATE command) - See paragraph 9.3.4.)

SYNOPTIQUE



BLOCK DIAGRAM

Resolver

RPT BOARD

SINE + COSINE + REFERENCE

INTERNAL REFERENCE

BATTERY + SWITCH

24V DETECTION

7.4.2.3. RESETTING PROCEDURE

Requires use of the SPEC.V2 program (password SPEC_CAL).

The «Edit motor calibration parameters» menu allows you, on the one hand, to initialize the RPT board and record the reference position of the arm (Ready) and, on the other hand, to refind this reference position if problems occur. It is delivered on the Adept Utility Disk and is installed on the hard disk in the utilities directory.

The following conditions must be met for the options to operate correctly:
- V+ system version 11.4C minimum,
- task execution other than 0 (task 1 for instance),
- controller equipped with hardware for RPT absolute calibration.

To load and run the program, enter:

```
.load a:spec.v2
.ex  1 a.spec
```

To gain access to the options of the "Edit motor calibration parameters" menu, you must first enter the SPEC_CAL password. To do this:
- choose the "Enter password to increase access" option in the main menu
- enter the password: "SPEC_CAL"

Then, select the "Edit robot specifications" then "Edit motor calibration parameters" options. You will then have access to the calibration menu.

Presentation of resetting menu

*** ROBOT 1 / MOTOR 1 CALIBRATION ***

CURRENT HOMING CONFIGURATION
Absolute Calibration with ACB/RPT Board

RESOLVER DATA

Position:	1250	status lines
Phase Number:	4	
Number of Revolutions:	23	

0 => Exit	options
1 => Change motor number	
2 => ACB servo board number	
3 => ACB channel number	
4 => Motor position at nest location (res. cts)	
5 => Setup RPT board, record resolver pos. @ nest (all motors)	
6 => Setup RPT board, record resolver pos. @ nest (this motor)	
7 => Record resolver position (all motors)	
8 => Record resolver position (this motor)	
9 => V_REG position recovery	
10 => Calibrate motor	
11 => Calibrate robot	

Enter selection:

This menu is split into two parts:

Status lines

Position	Resolver value corresponding to Ready position. This value is between 0 and 4095.
Phase Number	Number of quadrant in which resolver is located at Ready position.
Number of revolutions	Number of motor revolutions made from Ready position. This number is zero in Ready position. This value can be positive or negative depending on direction of rotation. Value between -4095 and +4095.

Remark: These three parameters are associated with the motor selected (motor 1 by default). It is possible to refresh the display of the resolver and quadrant values (Position and Phase number) for current position by selecting the "Record resolver position (all motors)" or "Record resolver position (this motor)" options. But, the system must be rebooted after selecting these options in order to work with the original values.

Options

Exit	To exit the calibration menu.
Change motor number	To change selected motor number and display associated parameters at status line level (resolver value, quadrant and number of revolutions).
ACB servo board number	Function same as IMAS calibration. Do not modify this parameter.
ACB channel number	Function same as IMAS calibration. Do not modify this parameter.

Motor position at nest location (res. cts)

Value of Encoder Register at Ready position (in counts). Must only be modified when recording a Ready position different from standard position defined in factory.

Setup RPT board, record resolver pos @ nest (all motors)

This option performs the following operations:
- initializes RPT board (the various board channels can then follow the movement of the robot's motors),
- resets motor revolution counters,
- saves the value of all resolvers in controller RAM and records current position as being the Ready position, the status lines are refreshed.

This operation is performed for all arm motors (independent of selected motor number).

The "All done - Press ENTER" message is displayed when the various operations have been correctly executed. Press ENTER to return to resetting menu. If a problem occurs, an error message is displayed.

Caution: On quitting this option, the robot is not calibrated.

⚠ The new reference position is not automatically saved on the hard disk (and V+ system disk). Use the SPEC program ("Save ALL specifications to system disk" option) to perform this save operation.

⚠ Also, do not forget to save this new reference position as a calibration file (on hard disk and on backup system disk). Use the SPEC.V2 program with password SPEC_CAL («Save robot specifications to a disk file» option). Save the file in ASCII format with a name of form SNxxxxz.SPC (xxxx being the last four digits of the serial number and z the serial number index).

Setup RPT board, record resolver pos @ nest (this motor)

This option performs the following operations:
- initializes the channel of the RPT board corresponding to the selected motor,
- resets the motor revolution counter,
- saves the value of the selected motor resolver in the controller RAM and records the current position as being the reference position (Ready).

The "All done - Press ENTER" message is displayed when the various operations have been correctly executed. Press ENTER to return to resetting menu. If a problem occurs, an error message is displayed.
Caution: On quitting this option, the robot is not calibrated.

⚠ The new reference position is not automatically saved on the hard disk (and V+ system disk). Use the SPEC program ("Save ALL specifications to system disk" option) to perform this operation.

⚠ Also, do not forget to save this new reference position as a calibration file (on hard disk and on backup system disk). Use the SPEC.V2 program with password SPEC_CAL («Save robot specifications to a disk file» option). Save the file in ASCII format with a name of form SNxxxxz.SPC (xxxx being the last four digits of the serial number and z the serial number index).

The two following options are available only to perform debug operations and must never be used during resetting operations.

Record resolver position (all motors)

To read the current value of all resolvers and update certain status lines. These new values are not recorded in the RAM.

YOU MUST THEREFORE REBOOT THE CONTROLLER TO FIND CORRECT READY POSITION (SAVED ON HARD DISK OR V+ DISK).

Record resolver position (this motor)

To read current value of selected motor resolver and update certain status lines. This new value is recorded in the RAM.

YOU MUST THEREFORE REBOOT THE CONTROLLER TO FIND CORRECT READY POSITION (SAVED ON HARD DISK OR V+ DISK).

V_REG position recovery

To find the "mechanical zero" of the arm defined at the factory with the V_REG program. This procedure is required when the RPT board data has been lost.
For example:
- stop of controller when backup battery is defective or unconnected,
- disconnection of connecting cable between controller and arm,
- replacement of RPT board,
- first commissioning at customer's.

> ⚠ This program automatically moves the six arm axes to "customer" Ready from the marks. You must therefore comply with normal safety conditions. Also, no obstacles must hinder the robot's movement. If the Ready position cannot be reached, the procedure must be conducted axis by axis previously checking that the Ready position of the axis concerned can be reached.

Description of the "V_REG position recovery" option menu:

After selecting the "V_REG position recovery" option in the calibration menu, you can access the special menu of the reference position recovery procedure:

```
*** V_REG POSITION RECOVERY ***
AXIS RECOVERY STATUS
(0 : need to be recovered / 1 : recovered)

Axis 1 : 0          Axis 4 : 0
Axis 2 : 0          Axis 5 : 0      status lines
Axis 3 : 0          Axis 6 : 0
   => ROBOT NOT CALIBRATED <=
(Note : all axes have to be recovered to calibrate the robot)
```

```
0 => Exit
1 => Recovery for axis 1
2 => Recovery for axis 2
3 => Recovery for axis 3
4 => Recovery for axes 4, 5 and 6 (simultaneously)
5 => Recovery for all axes
```

options

Enter selection:

Status lines

The status lines indicate if the channel of the RPT board associated with a motor is correctly initialized (value of 1) or if Ready position is lost (value 0). The "=> ROBOT NOT CALIBRATED <=" message is displayed when an axis is not initialized.
To calibrate the arm, all axes must be correctly initialized.

Options
Option 0 (Exit) exits the recovery procedure and returns you to the previous menu.

If "mark" position or Ready position cannot be reached, you can recover (from V+ 11.4C version) the V_REG position axis by axis (except for axes 4, 5 and 6 which must be dealt with simultaneously). For this, select options 1 to 4 according to the axes to be processed and position the various axes so that selected axis can move between its "mark" position and its Ready position. To recover the position of all axes simultaneously, selection option 5 (Recovery for all axes).

Once the axis or axes to be processed have been selected, the "Enter the name of the scribe marks file (unit:\dir\name.ext default '.ext' is '.MRK') :" message is displayed. Enter the mark file name (with access path if applicable) in "serial_number.MRK" form (example: 5962051.MRK). This serial number is given on the robot's identification plate and the file is stored on the hard disk root and at the V+ system disk backup root.

If the marks file (".MRK" extension) does not exist, the following error message will be displayed: "*file not found*". The option is cancelled. The "mechanical zero" position defined by the V_REG program is lost. Contact Stäubli After-Sales Service.

If the file exists, then:
- use the teach pendant or press the brake release button to place the arm axis or axes opposite the marks on the casting. Press the "MAN" button on the teach pendant and select the axes to be processed one by one (JOINT mode). Positioning on marks must be sufficiently accurate to find correct motor revolution.

Tolerance for each joint of an RX60 robot is as follows:

JOINT	1	2	3	4	5	6
1 motor revolution	+/-1.48 jt°	+/-1.48 jt°	+/-1.65 jt°	+/-2.4 jt°	+/-1.8 jt°	+/-5.6 jt°

where jt° = joint degrees

On completion of the operation, press ENTER. Remember to return to automatic mode by pressing the COMP/PWR button on the teach pendant.
- Check that arm can move from current position. After the «Continue (Y/N) ?» message, type «N» to cancel this option or type «Y» to continue.
- The program will automatically move the arm to the Ready position defined at the factory after V_REG procedure.
- The position found is saved in the RAM of the controller and taken as reference position (Ready). The RPT board is initialized.
- The arm is switched off.
- If the procedure was correctly carried out, the following message is displayed: "The V_REG position is now recovered and the robot is ready for calibration. Type 0 in the V_REG Position Recovery menu to exit and then execute the 'Calibrate Robot' option in the Calibration Parameter menu.". The status lines corresponding to the axes processed are set to 1. If an error occurs, a message will be displayed indicating type of error.

Caution: Even if all status lines are set to 1, the arm is not automatically calibrated. To do this, you must quit the "V_REG position recovery" meny by typing 0 (Exit) then select the "Calibrate robot" option in the previous SPEC.V2 menu. The robot is now ready to operate.

Remark: If the V_REG position recovery procedure is conducted during the CALIBRATE command (and not from the SPEC.V2 program), the arm will be automatically calibrated once all status lines are set to 1 (see paragraph 9.3.4).

7.4.2.4. CALIBRATION SEQUENCE FOR AN RX ROBOT

The robot calibration program (RPT.CAL) is run automatically during controller startup. However, it can be run at all times using the following commands:

```
. DISABLE POWER
. PAR NOT.CAL=1
. CALIBRATE
        Are you sure (Y/N) ? : Y
```

When the program is triggered, the version number is displayed on the screen in the following form:
"RPT.CAL RELEASE NUMBER D ... ..."

The RPT.CAL program is necessarily located in the CALIB subdirectory on the hard disk or on the V+ system disk used to start the controller.

Problem during calibration

If the calibration program detects a problem at RPT board revolution counter level (reference position lost), the Ready position recovery procedure can be directly performed.
For this, reply "Y" to the question "Do you want to recover the V_REG position now (Y/N) ? ".

The recovery procedure menu is then displayed as in the SPEC.V2 program (see 9.3.3. - V_REG position recovery). Sequence of this procedure is the same as the one followed in SPEC.V2.

The only difference concerns the end of the procedure. Indeed, at the end of the procedure, the robot is automatically calibrated (unlike operation under SPEC). The following message is displayed: "The V_REG position is now recovered and the robot is calibrated. Type 0 in the V_REG Position Recovery menu to exit." Now, simply select option 0 (Exit) in the Ready recovery menu to exit the calibration program. The arm is now ready to operate.

Problems and error messages for SPEC.V2 and RPT.CAL

Backup battery

The RPT board is an electronic board using a microcontroller to count the number of motor revolutions. To conserve this information when the controller is switched off, the board is equipped with a sealed lead backup battery (requiring no maintenance). This battery is recharged by the RPT board itself when the controller is switched on. A switch SW1 allows you to disconnect this battery during transport and storage. For the CS7 controller, it is located on the inside (on the right looking from the rear) and for the CS7M controller on the connector plate (at the rear) (figure 2.9.6).

> ⚠ Check before first use of robot that this switch is closed (battery in service - Position I).

If a battery problem occurs during arm calibration (CALIBRATE command), the following message is displayed:

```
*WARNING - Battery voltage low*
Risk of bad calibration
Check:
- the position of the switch between the backup battery and the RPT board,
- the cables between the backup battery and the RPT board,
- the backup battery state of charge.
```

In this case, check the position of the battery switch, the cables between the battery and the RPT board and the battery state of charge (date when placed in service). If this message is displayed after prolonged shutdown of the controller (more than 40 days), this means that life of battery has been exceeded. However, if it is displayed after a short period of time (several days), this may mean that the battery is in poor condition and must be replaced.

Remark: This message is also displayed during first calibration following battery connection. In this case, do not take it into acount.

List of error messages

"*Axis Reset error*"
Communication error between the controller and the RPT board. Restart the SPEC program.

"*Error detected while reading Encoder Scale Factor*"
Encoder Scale Factor register not correctly read.

"*Error detected while reading Encoder Register*"
Encoder Register not correctly read.

"*Error detected while reading Motor Sign*"
Motor sign not correctly read.

"*Error detected while reading ACB channel number*"
ACB board cannot be read.

"*Error detected during Axis Preset*"
Error detected during RPT board revolution counter configuration. Restart the SPEC program.

"*File not found*"
Mark file ".MRK" cannot be found. Check for presence on hard disk or on backup diskette.

"*Invalid function code*"
Function code incorrect in SPEC.V2 calibration menu.

"*Illegal quadrant on RPT channel X*"
The RPT board has detected a succession of motor quadrants not coherent on axis X. Reference position is lost. Run the SPEC.V2 program (V_REG position recovery option). If the problem persists, check the connection of the resolver signals. This message may be caused by excessive rotational speed of the motor of the axis in question.

"*Number of joints must be 4, 5 or 6*"
The RPT system is limited to robots equipped with 4, 5 or 6 joints only.

"*Preset error on axis X*"
The RPT board has detected an error during the channel X initialization. Rerun the SPEC.V2 program.

"*RPT system is limited to only one robot*"
Only one robot can be declared for this version of the calibration program.

"*RPT Hardware error*"
The RPT calibration board is defective and must be replaced. Robot calibration is impossible.

"*Resolver primary shorted*"
The reference signal delivered by axis 3 amplifier and supplying the six resolvers of the arm and the other five amplifiers is short circuited. Check wiring between controller and arm or inside arm. The program is stopped.

"*Resolver open or shorted on RPT channel X*"
Axis X resolver signals are incorrect. Check wiring between controller and arm and arm internal wiring.

"*Serial line time out error*"
Reception error on RS422 serial link. Check connection of serial cable between RPT board and the RS422 port of the controller's CPU board. Also check that the RPT board is correctly supplied (on RPT board, a red LED must be on).

"*V+ release not compatible*"
The V+ version of the controller is not compatible with the calibration program. It must be at least equal to V+ 11.4C.

"*180 degree preset error on RPT channel X*"
The RPT board has not been correctly configured. Restart the SPEC.V2 program. If the problem persists, check connection of resolver signals.

7.4.2.5. TECHNICAL CHARACTERISTICS

RPT board operating temperature	-10 / +60°C
RPT board storage temperature	-10 / +70°C
RPT board supply voltage	17 VDC / 36 VDC
Battery	
Voltage	6 V
Capacity	8 Ah
Charge time	20 hours
End of charge voltage	6.70 V
Max. charge current	700 mA
Battery low voltage	5.8 V
Battery discharge voltage	5.4 V
Backup time	1000 hours
Resolver acceleration by default	800 quadrants/sec²
Rapid sampling	1.042 ms
Resolver maximum rotational speed	7200 rev/min
Reference signal	14 Vpp - 5 KHz
Serial porf	RS422
Dimensions (without battery)	180 x 80 x70 mm

STÄUBLI

RELEASE NOTE D280293 - 1

Product Family: CS7 / CS7 M

January 15, 1998

Subject: **RPT BOARD BATTERY**

DESCRIPTION

When a battery of an RPT board is defective (completely dead or short-circuited), the RPT board does not operate and all of the amplifiers are in error (the red indicator light on the front of the amplifier is ON).

To use the machine in this case, a ***temporary solution*** is to disconnect the battery until you change it. In this case, the robot can operate on condition that you load the «V_REG Recovery» procedure **at each power on sequence**.

CHAPTER 8 - ROUTINE MAINTENANCE

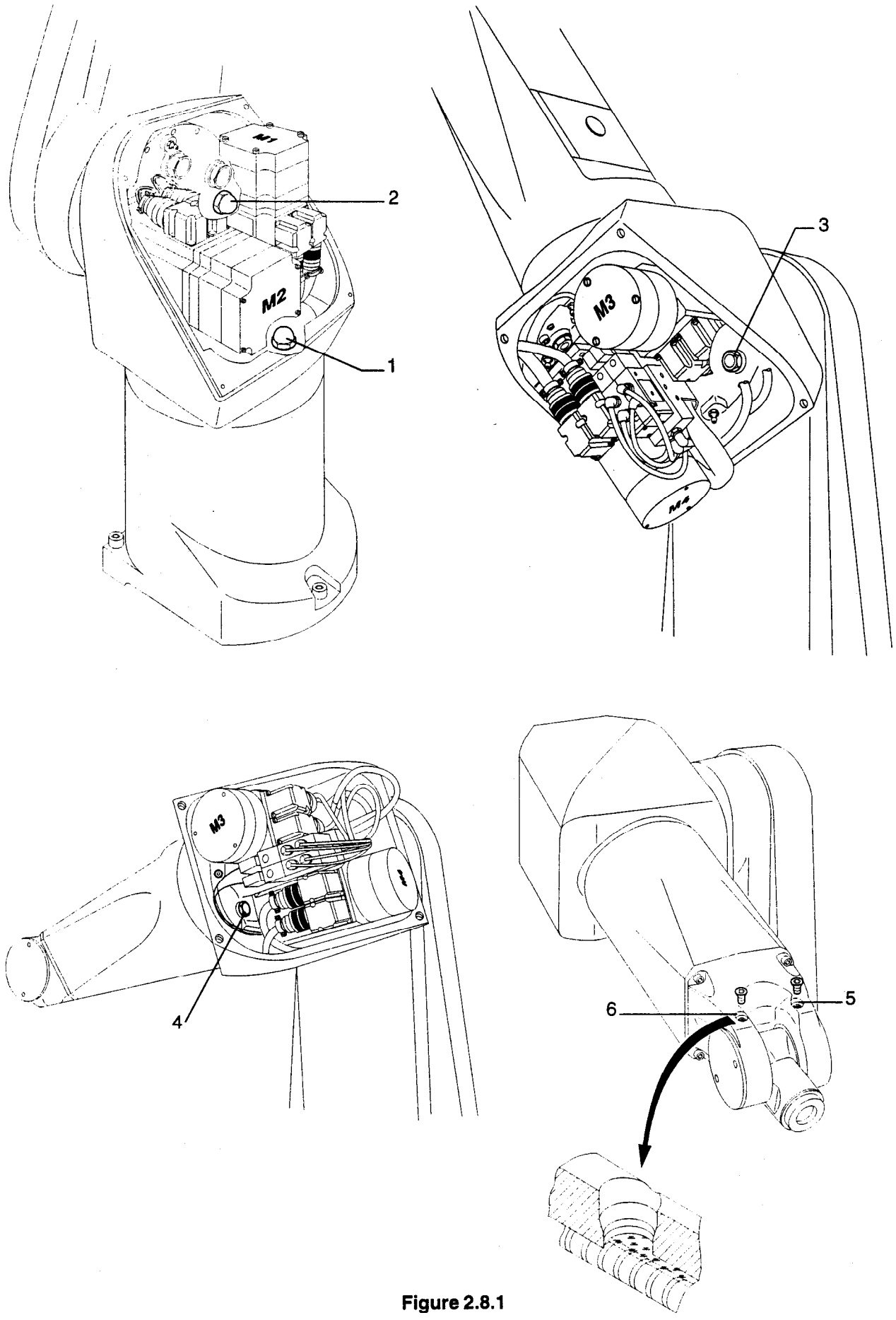


Figure 2.8.1

CHAPTER 8 - ROUTINE MAINTENANCE

To keep the performance of the arm at an optimal level the arm requires routine maintenance.

The maintenance operations must be carried out by persons who have followed the appropriate course given by Stäubli.

8.1. MAINTENANCE FREQUENCY

Every year:
- Check the arm pneumatic and electric harness (check all visible parts and replace damaged harness).
- Check oil levels for joints 1 to 4 (see paragraph 8.2.).
- Check motor play and oil level for joints 5 and 6.

Every 5 years or 20,000 hours:
- Change the oil* in the casings of joints 1, 2, 3, 4, 5 and 6 (see chapter 6).

* Recommended oil: see spare parts

8.2. CHECKING OIL LEVELS

8.2.1. ARM IN FLOOR-MOUNTED POSITION (figure 2.8.1)

8.2.1.1. SOFTWARE ANGULAR POSITION OF JOINTS FOR CHECKING LEVELS

	POSITION				
CHECK	Joint 1	Joint 2	Joint 3	Joint 4	Joints 5 & 6
Joint 1	0°	-90°	90°	0°	0°
Joint 2					
Joint 3			58°		
Joint 4			-17.5° *		
Joints 5 & 6			195°		

* For a more reliable oil level reading, turn joint from -50° to -17.5°

8.2.1.2. LEVELS TO BE OBSERVED

With the robot in position specified above, the oil levels to be observed are as follows:
- Joint 1: Oil level flush with lower edge of toothed wheel visible via indicator (1).
- Joint 2: Oil level in center of indicator (2) + 3 mm +/- 1 mm.
- Joints 3 and 4: Oil level at center of indicators (3) and (4) +/- 1 mm.
- Joints 5 and 6: Level flush with worm screws (plugs removed) (5) and (6).

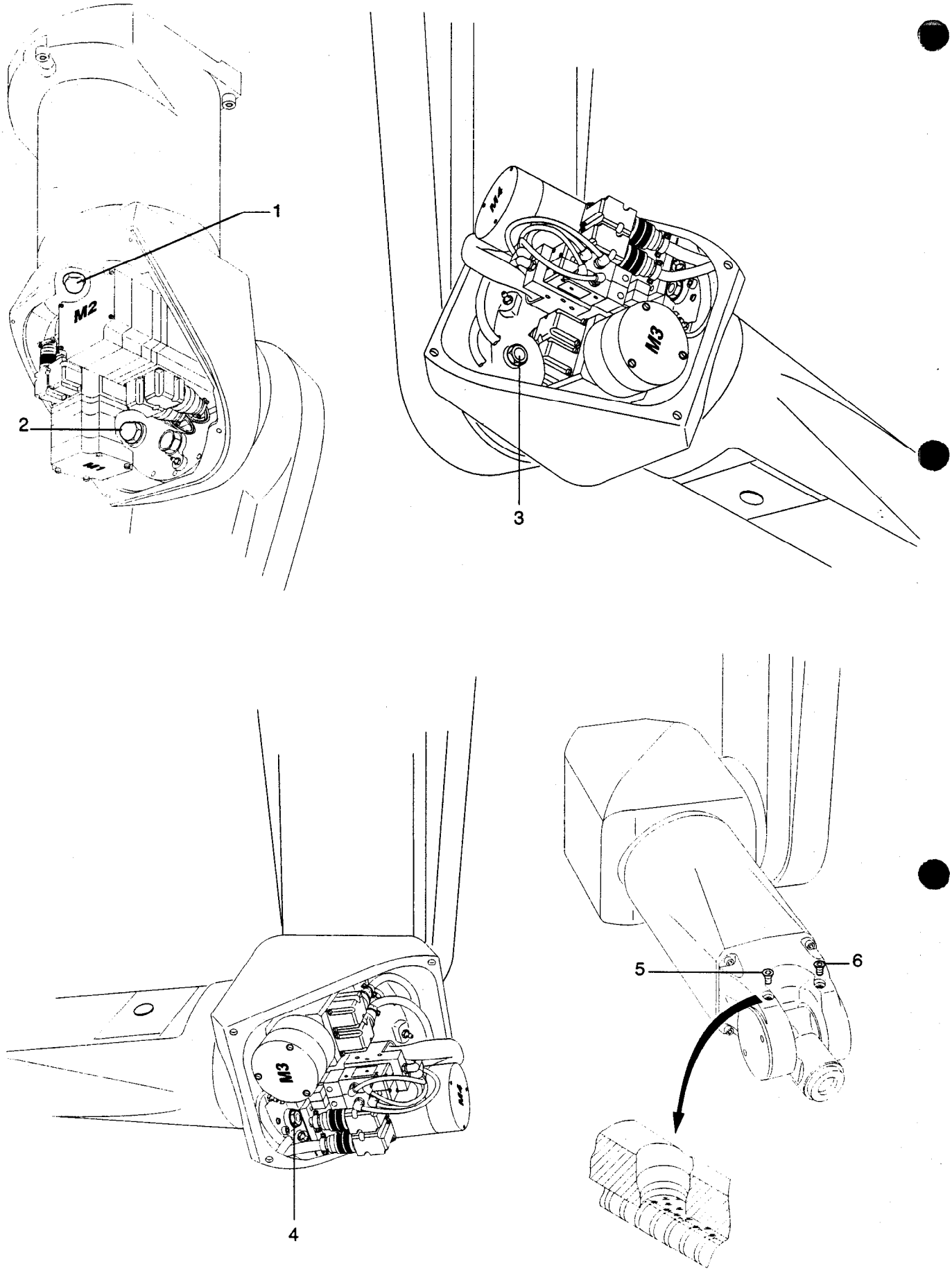


Figure 2.8.2

8.2.2. ARM IN CEILING-MOUNTED POSITION (figure 2.8.2)

8.2.2.1. SOFTWARE ANGULAR POSITION OF JOINTS FOR CHECKING LEVELS

	POSITION				
CHECK	Joint 1	Joint 2	Joint 3	Joint 4	Joints 5 & 6
Joint 1	0°	-90°	90°	0°	0°
Joint 2					
Joint 3			21°		
Joint 4			168°		
Joints 5 & 6			15°		

8.2.2.2. LEVELS TO BE OBSERVED

With the robot in position specified above, the oil levels to be observed are as follows:

- Joint 1: The indicator is filled with oil (1).
- Joint 2: Oil level in center of indicator (2) + 3 mm +/- 1 mm.
- Joints 3 and 4: Oil level at center of indicators (3) and (4) +/- 1 mm.
- Joints 5 and 6: Level flush with worm screws (plugs removed) (5) and (6).

CHAPTER 9 - RECOMMENDED SPARE PARTS

CHAPTER 9 - RECOMMENDED SPARE PARTS

NOTE

Level 0 : Maintenance
Level 1 : Recommended spare.
Client with a robot vital for production or 10 robots in a team.
Level 2 : Spare for 99% of problems.
Client with more than 10 robots.

Level 0 maintenance parts :
- Mobil SHC 629 oil* (for wrist)
- Mobil SHC 626 oil*

Level 1 spare parts :
- Solenoid valve
- IMAS encoder joints 5 and 6
- IMAS 70 encoder joints 1, 2, 3 and 4
- 1/2 NPT pressure reducer filter + 0 to 10 bar pressure gage — for EX robot

Level 2 spare parts :
- Pneumatic harness
- Motor joints 1, 2, 3, 4, 5 and 6
- O-ring for motors joints 1, 2, 3 and 4
- Electrical harness
- Brake + safety board
- 0 to 16 mbar pressure gage
- Key switch No. 520
- Solenoid valve

— for EX robot

* Maximum oil quantity (cm^3) :
- SHC 629: wrist 170 and 220 for HP robot
- SHC 626: joint 1 —> 300
joint 2 —> 170
joint 3 —> 100
joint 4 —> 100
total 670

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