ROBOTICS
MAN AND MACHINE

Arm - TX series 40 family

Instruction manual

D28065504A - 02/2007

STÄUBLI

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CHAPTER 1

INTRODUCTION

1.1. FOREWORD

The information contained in the present document is the property of **STÄUBLI** and it cannot be reproduced, in full or in part, without our prior written approval.

The specifications contained in the present document can be modified without notice. Although all necessary precautions have been taken to ensure that the information contained in this document is correct, **STÄUBLI** cannot be held responsible for any errors or omissions found in the illustrations, drawings and specifications contained in the said document.

If any difficulties are met with during operation or servicing of the robot that are not referred to in this document, or if further information is required, please contact the **STÄUBLI** After Sales Department, "Robot Division".

1.1.1. OBJECTIVE OF THIS MANUAL

The objective of this manual is to provide information concerning the installation, operation and maintenance of **STÄUBLI** robots. It provides help for the persons working on the equipment, for reference purposes only. Indeed, in order to understand the present document and the use of **STÄUBLI** robots, it is necessary for staff to acquire the corresponding knowledge by following a "robots" training course as provided by **STÄUBLI**.

The photos are used to make the document easier to understand, they cannot be construed as being of a contractual nature.

1.1.2. SPECIAL MESSAGES CONCERNING WARNINGS, ALERTS, AND INFORMATION.

In this document, there are two formats for warnings and alerts. The messages contained in the boxes inform staff of the potential risks involved in carrying out an action.

These boxes are as follows (they are shown in decreasing order of importance):

Danger message

DANGER:

Instructions drawing the reader's attention to the risks of accidents that could lead to serious bodily harm if the steps shown are not complied with. In general, this type of indication describes the potential danger, its possible effects and the steps necessary to reduce the danger. It is essential to comply with the instructions to ensure personal safety.

Warning message

CAUTION:

Instructions drawing the reader's attention to the risks of material damage if the steps shown are not complied with. It is essential to comply with these instructions to ensure equipment reliability and performance levels.

Notes
Paragraphs of the "note" type provide very important information to help the reader to understand a description or a procedure.

> **Note:**
> *Supplies further information, or underlines a point or an important procedure. This information must be memorized to make it easier to apply and ensure correct sequencing of the operations described.*

1.2. DEFINITION OF THE ELEMENTS AROUND THE ROBOT CELL

Person: general term identifying all individuals likely to come close to the **STÄUBLI** robot cell.

Staff: identifies the persons specifically employed and trained to install, operate, and service the **STÄUBLI** robot cell.

User: refers to the persons or the company responsible for operating the **STÄUBLI** robot cell.

Operator: refers to the person who starts or stops the robot, or controls its operation.

1.3. SAFETY

1.3.1. REMINDER CONCERNING THE SAFETY STANDARDS

DANGER:

The robot is a fast moving machine. These movements can be dangerous. Always comply with the safety standards recommended for robot use and inform operators about the dangers faced.

The robot is a sub-assembly designed for integration in a robot cell. It has been designed and built to enable the "robot cell" unit to comply with regulatory provisions. Compliance of the robot cell is the responsibility of the prime contractor who very frequently is the owner.

"The user must make sure that the staff programming, operating, maintaining or repairing the robot or the robot cell are correctly trained and show the skills necessary to carry out these tasks in full safety" (extract from standard NF EN 775).

In France, for example, posters isued by the CRAM are available to remind operators of the safety rules applicable in the vicinity of robot stations.

The electrical equipment of the robot and the robot cell must comply with standard EN 60204-1.

The characteristics of the power supply and the grounding terminals must comply with the manufacturers' specifications.

Standards applicable

Installation of the robot must be planned in accordance with the standard instructions.

- ISO 10218, 1992 — International standards
- EEC 98 / 37 "Machine Safety" Directive — European Directive
- Standard EN 775 — Industrial handling robots - Safety
- Standard EN 292 — General principles
- Standard EN 294 — Safety distances
- Standard EN 418 — Emergency stop equipment
- Standard EN 953 — Protective elements
- Standard EN 954-1 — Machine safety
- Standard EN 349 — Minimum clearances
- Standard EN 1050 — Risk assessment
- Standard EN 1088 — Locking devices
- Standard EN 60204-1 — Electrical equipment on machines
- Standard EN 999 — Speed on approach towards the human body
- Standard EN 61 000-6-4 — Electromagnetic compatibility - Emission
- Standard EN 61 000-6-2 — Electromagnetic compatibility - Immunity
- Standard CEI 34-1 — Electrical rotating machines
- Standard UL 1740 — Robots and Robotics Equipment
- Standard RIA15-06 — American National Standard for Industrial Robots and Robot Systems. Safety Requirements.
- Standard CSA Z434-03 — Industrial Robots and Robot Systems. General Safety Requirements.
- Standard NFPA 79 — Electrical standard for industrial machinery
- Standard NFPA 70 — National Electrical Code

1.3.2. SAFETY DIRECTIVES CONCERNING TO THE WORK ENVIRONMENT

Analysis of safety around the robot cell

Safety must be taken into account for the robot cell from the design and development stage on.

Before planning the installation of the robot cell, it is necessary to study the following points:

- Plan the safety strategies that reduce risks to an acceptable level.
- Define the tasks required for the foreseeable applications and assess the access and/or approach requirements.
- Identify the sources of risks including the failures and the failure modes associated with each of the tasks. The risks can involve:
    - the cell itself
    - its association with other items of equipment
    - the interactions between persons and the cell.
- Assess and estimate the risks stemming from cell operation:
    - programming risks
    - operating risks
    - risks during use
    - maintenance risks for the robot cell.
- Select the protective methods:
    - use of protective devices
    - installation of signalling means
    - compliance with safe working procedures.

These points are taken from the standards applicable to robots, and especially European standard EN 775.

Note:
This list is not exhaustive. Above all, it is necessary to comply with the standards in force in your country.

CAUTION:

To ensure reliability and precision in the robot's movements, the robot cell environment must comply with the levels of disturbance set out in the safety standards.

Rules concerning the robot's work area

The controlled area or isolation area in which the robot moves must be determined using protective devices (protective elements).

Note:
Protective elements are devices protecting persons from a dangerous area. See the standards currently in force concerning safety for industrial handling equipment.

DANGER:

At the time of an emergency stop, the final position of the arm can never be determined precisely because of the kinetic energy involved. It is thus necessary to make sure that no persons or obstructions are present in the robot's work area when the arm is powered up.

1.3.3. SAFETY DIRECTIVES CONCERNING TO STAFF PROTECTION

STÄUBLI robots work with computer controlled mechanisms, capable of moving at high speed and exerting considerable force. Like all robots and most industrial equipment, they must be controlled with great care by the user of the robot cell. All staff using STÄUBLI robots must be familiar with the warnings and recommendations given in this manual.

Mechanical and electrical dangers.

> ⚠ **DANGER:**
>
> **Disconnect all the electrical and pneumatic power supplies before carrying out any work on the controller or the arm.**

> ⚠ **DANGER:**
>
> **Each time the arm is powered on, keep one hand close to the "Emergency stop" button in order to be able to press it as quickly as possible in the event of a problem.**

- Do not connect or disconnect components while the unit is under power. The connection between the controller and the robot arm can only be made if the controller has been switched off.
- The arm must not be loaded during maintenance operations.

> ⚠ **DANGER:**
>
> **All persons are prohibited from remaining in the isolation area in which the robot arm operates. Certain robot working modes such as the "brake release" mode can lead to unforeseeable arm movements.**

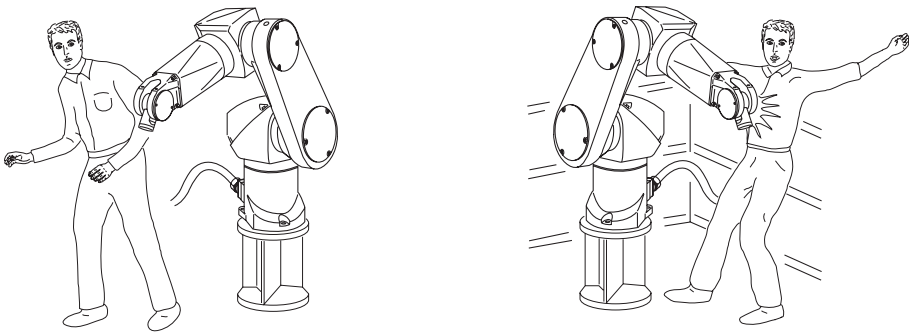


Figure 1.1

Robot cell safety devices

The safety devices must form an integral part of the design and installation of the robot cell. Operator training and compliance with the operating procedures constitute a major element in setting up the safety devices and systems.

STÄUBLI robots are equipped with various communication functions, helping the user to develop safety devices for the robot cell. These functions include emergency stops and digital Input/Output lines.

1.3.4. SAFETY DIRECTIVES CONCERNING TO PROTECTION OF THE EQUIPMENT

1.3.4.1. CONNECTIONS

- Before connecting the controller to the power supply, make sure that its nominal voltage does indeed correspond to the network voltage.
- When connecting the controller, use a cable whose cross-section corresponds to the power rating shown on the manufacturer's plate.
- Before removing or inserting an electronic component, switch off arm power and then switch off controller power and comply with the procedure.
- Take care to avoid blocking the air inlets and outlets for the controller airflow path.
- Never use the emergency stop to power down the arm under normal conditions of use.

1.3.4.2. INFORMATION ON ELECTROSTATIC DISCHARGES

What is an electrostatic discharge?

Everyone has felt the effects of static electricity on their clothes or when they touch a metal object, without being aware of the damage that can be done to electronic components by static electricity.

Our desire to integrate the notions of quality and reliability in our products makes it necessary to prevent electrostatic discharges from causing damage to them. This means that all the staff and login users must be informed.

Storage of a charge
An electric charge is created simply by combining a conductor, a dielectric and the ground (lowest reference potential, usually the ground in the case of an electrostatic charge).
Example: people, printed circuits, integrated circuits, components, conducting mats when separated from the ground by a dielectric.

Electrostatic discharges or ESD
Most people have experienced ESD by receiving an electric shock when walking on a carpet and touching a doorknob or when getting out of a car.
In most case, the following is true:
- To feel an ESD, a charge of at least 3500 V is required.
- To hear one, a charge of at least 5000 V is required.
- To see a spark, a charge of at least 10 000 V is required.

This shows that it is possible to develop charges of over 10 000 V before noticing an electrostatic discharge!

Risks created by an electrostatic discharge

A high ESD voltage (several thousand volts) creates danger for electronic components. A semi-conductor must be handled carefully to prevent destruction by ESD. ESD are truly dangerous. It is estimated that they destroy only 10% of the components that they effect. The other 90% of components fall into the "deteriorated" category. A component may be damaged with simply 25% of the voltage required to destroy it.

These hidden faults can lead to problems that appear several days, weeks or even months after the incident. Components may also undergo a change in their operating characteristics. Initial tests are successfully passed but an intermittent error occurs under vibration or temperature constraints. The same components will pass the "on/off" test successfully, as carried out during repairs, but the problem will reappear again once on site.

Typical ESD voltages

Source	Low relative humidity 10 - 20%	Average relative humidity 40%	High relative humidity 65 - 90%
Walking on carpet	35 kV	15 kV	1,5 kV
Walking on vinyl	12 kV	5 kV	0,3 kV
Working at the workstation	6 kV	2,5 kV	0,1 kV
Plastified instructions	7 kV	2,6 kV	0,6 kV
Polyethylene bags	20 kV	2 kV	1,2 kV
Cellular polyurethane	18 kV	11 kV	1,5 kV

Charge sources	
Work surfaces	Packaging
Floors	Handling
Chairs	Assembly
Carriages	Cleaning
Clothes	Repairing

Parts sensitive to static charges
Electronic cards Power supplies Encoders etc

1.3.4.3. PREVENTION OF DAMAGE DUE TO ELECTROSTATIC DISCHARGES

It is essential to guard against electrostatic discharges during an intervention concerning electronic components, sub-assemblies and complete systems.

Elimination of the danger due to ESD requires a combined team effort. By complying with the following instructions, you can substantially reduce the potential damage caused by ESD and ensure long-term reliability for the robot.

- Inform the staff of the risks stemming from ESD.
- Know the critical zones sensitive to ESD.
- Know the rules and procedures to deal with ESD.
- Always carry components and boards in a tray to protect them from electrostatic charges.
- Always ground yourself before working on a workstation.
- Keep non-conducting equipment (static charge generators) away from components and boards.
- Use tools providing protection from ESD.

STÄUBLI workstation
To handle electronic cards, **STÄUBLI** workstations are given a grounded coating that dissipates static electricity. An anti-static bracelet is required to handle boards or electronic components.

Work zones
Remove objects that generate static electricity charges from the work area, such as:

- plastic cups
- polystyrene
- notebooks
- plastic files and document holders.

Printed circuits, boards and electronic components must be kept in anti-static bags.

Anti-static wrist strap
Use an electrostatic wrist strap connected to the frame of the controller or to the frame of the arm and the ground during all handling of boards or components. The wrist straps are supplied as part of the standard equipment for the robot.

CAUTION:
Use an electrostatic wrist strap and an electrostatic mat connected to the controller during all handling of boards or components.

CHAPTER 2

DESCRIPTION

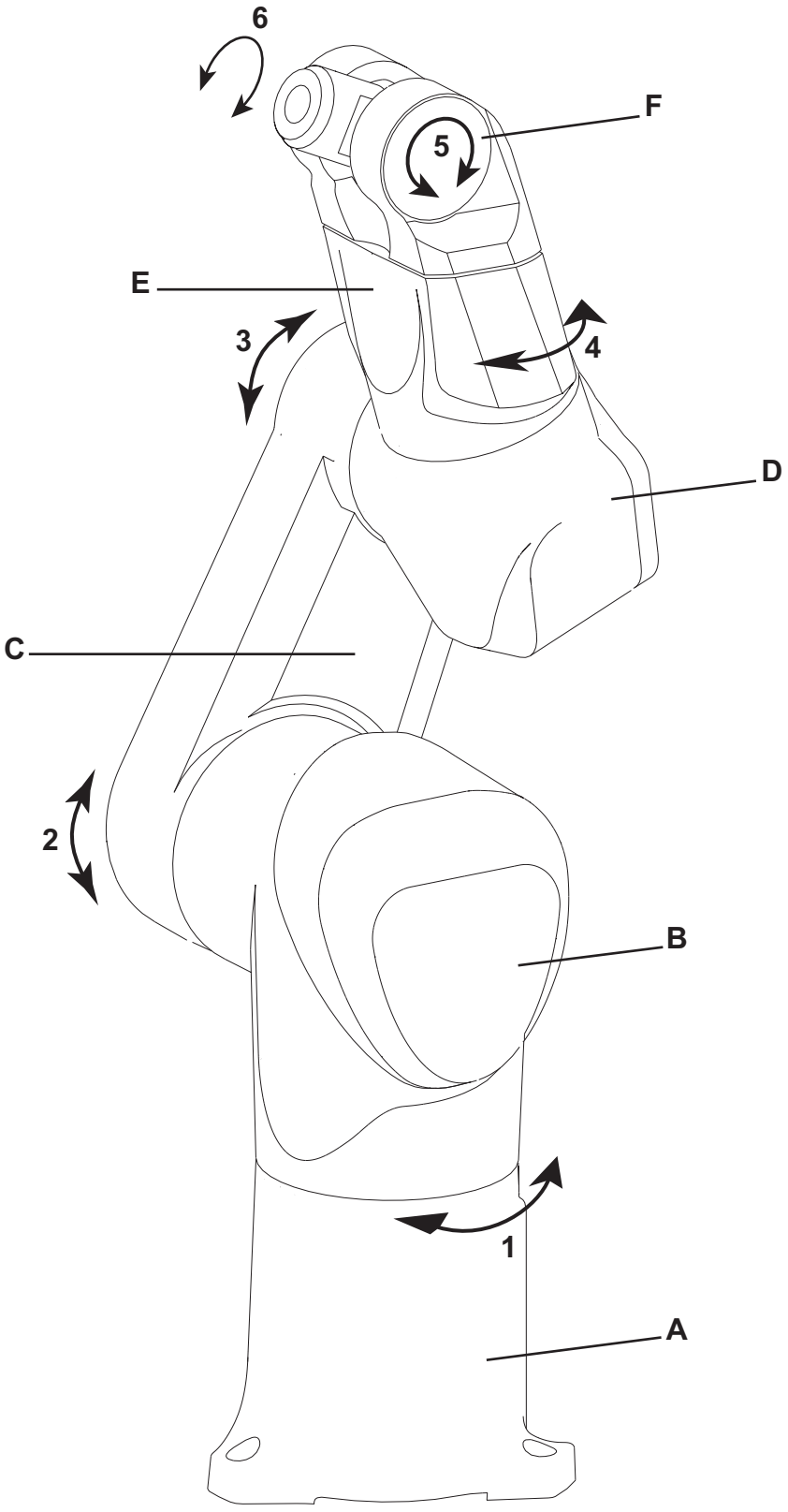
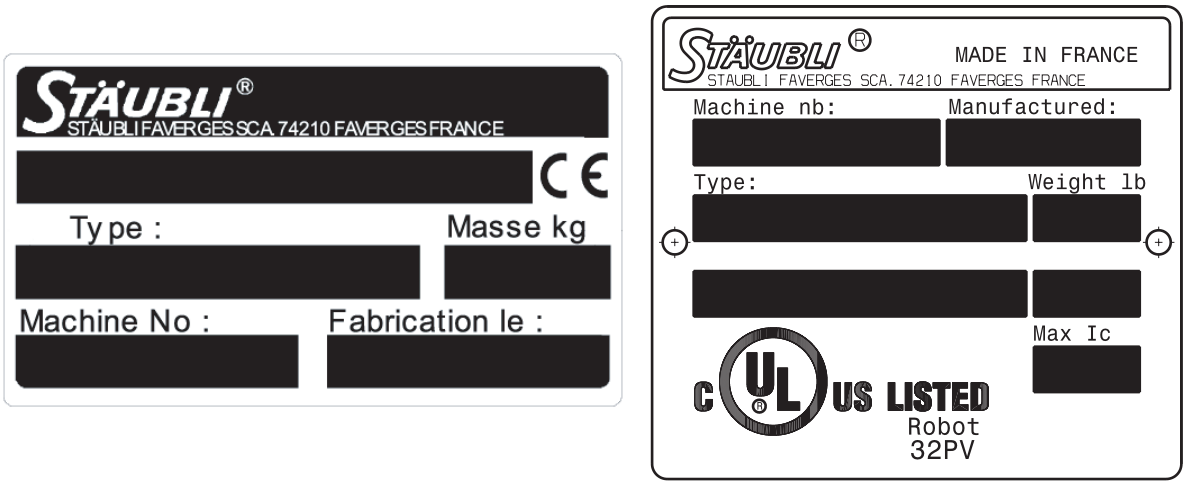


Figure 2.1

2.1. IDENTIFICATION

Manufacturer's plate on each robot.

There is a plate riveted on the controller and arm. (see figure 2.2)



Standard version

UL version

Figure 2.2

For all requests concerning information, replacement part orders, or requests for intervention, please state the type and the serial number of the machine concerned, as set out on the manufacturer's plate.

2.2. GENERAL PRESENTATION

The arm consists of segments or members interconnected by joints **(figure 2.1).**

The arm joint movements are generated by servomotors coupled with encoders. These servomotors are fitted with a parking brake on axis 1, 2, 3 and 5.

This reliable and robust assembly is associated with an innovative counting system allows the absolute position of the robot to be known at all times.

The arm assembly is 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 exhaustive: 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).**

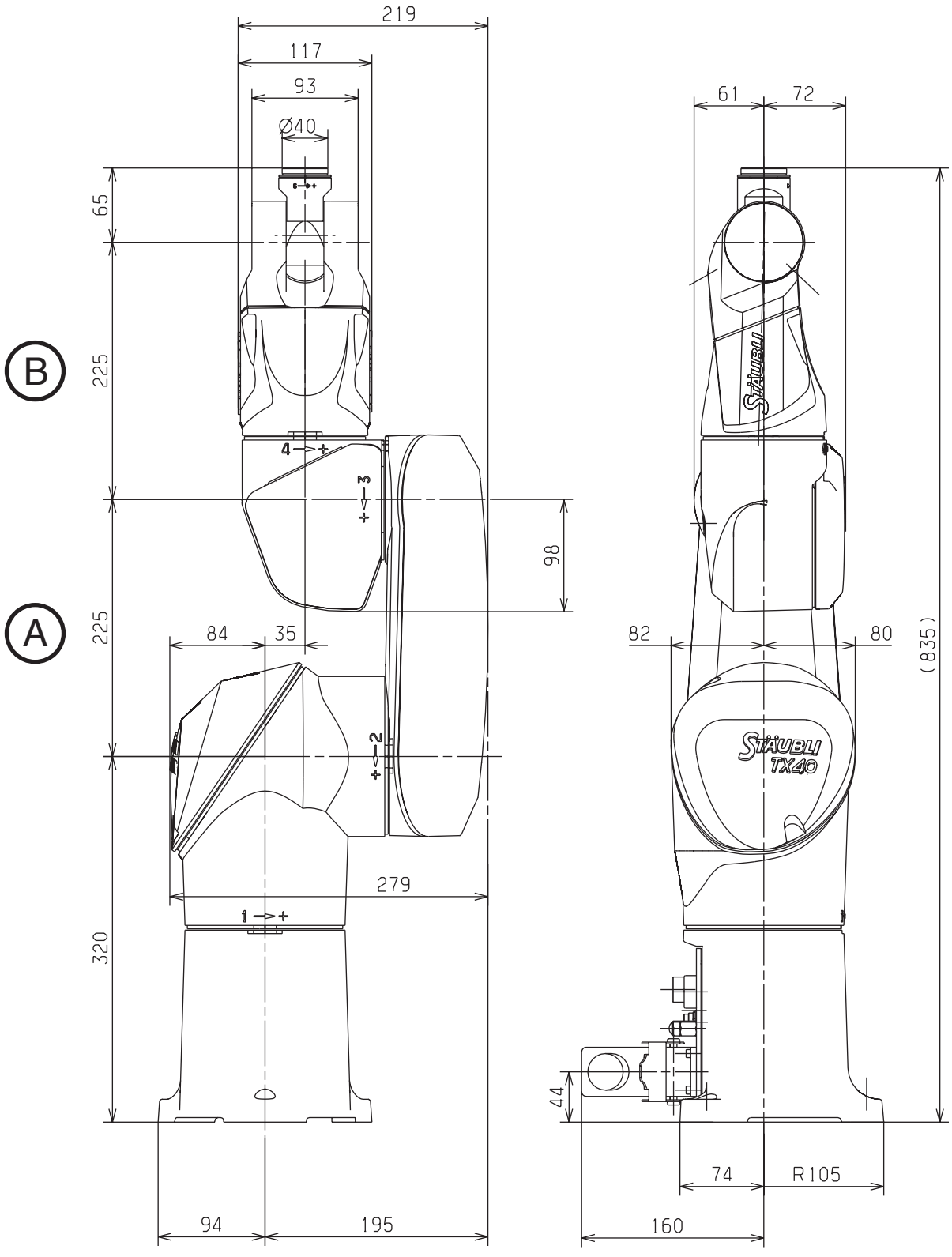


Figure 2.3
Standard arm - Rear cable outlet

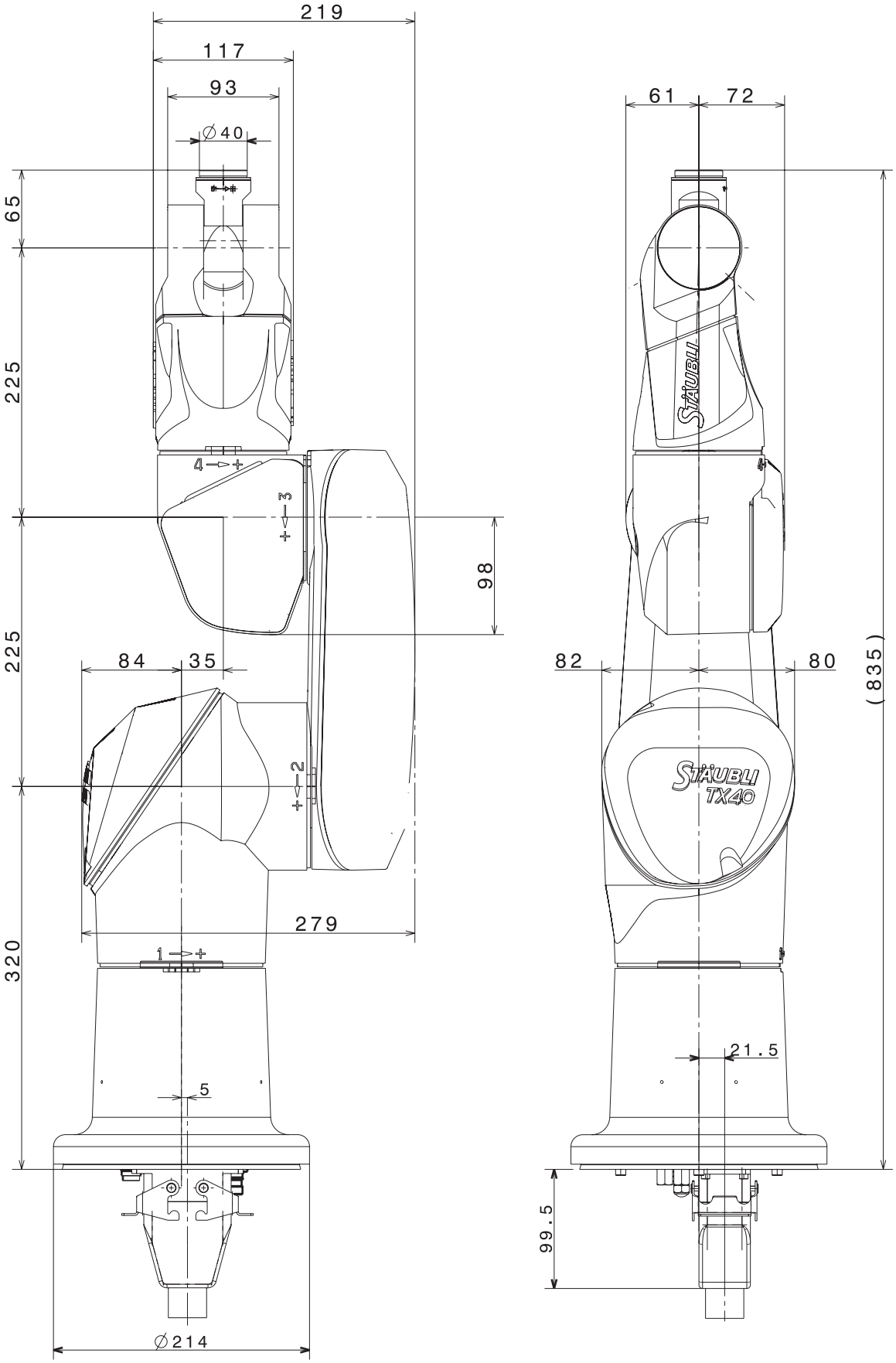


Figure 2.4
Standard arm - Vertical cable outlet

2.3. DESIGNATION OF ROBOTS OF THE TX SERIES 40 FAMILY

TX	4	0		CR
(1)	(2)	(3)		(4)

(1) TX family arm

(2) Maximum working radius between joint 1 and joint 5, expressed in decimeters and rounded off to one significant digit:
dimension (A) + dimension (B).

(3) Number of active joints:
- 0 = 6 active axis.

(4) Upper case letters to indicate an option:
- CR = clean room application
- SCR = ultra-clean room application

In the manual, the following terminology is used:

Standard arm: for arm with standard geometry

- Rear cable outlet **(figure 2.3)**.
- Vertical cable outlet **(figure 2.4)**.

2.4. GENERAL CHARACTERISTICS

2.4.1. DIMENSIONS

See **figure 2.3**.

2.4.2. WORK ENVIRONMENT

- Working temperature: + 5°C to + 40°C (in accordance with standard directive NF EN 60 204-1).

> **CAUTION:**
> **It may be necessary to perform a warm-up cycle before nominal performances are obtained.**

- Humidity: 30% to 95% max. non-condensing (in accordance with standard directive NF EN 60 204-1).
- Altitude: 2000 m max.
- Vibrations: please consult us.

Clean room application:

- CR: cleanness class 4 in accordance with standard 14644-1.
- SCR: cleanness class 3 in accordance with standard 14644-1.

IP65 arm protection and IP67 wrist protection in accordance with standard NF EN 60529 with electric connectors or plugs in place.

> **CAUTION:**
> **If the robot is used in dusty surroundings or in the presence of spattered liquids, we strongly recommend use of the pressurization system as described in chapter 2.9, page 57.**

2.4.3. WEIGHT

Standard arm
27 kg (59.5 lb)

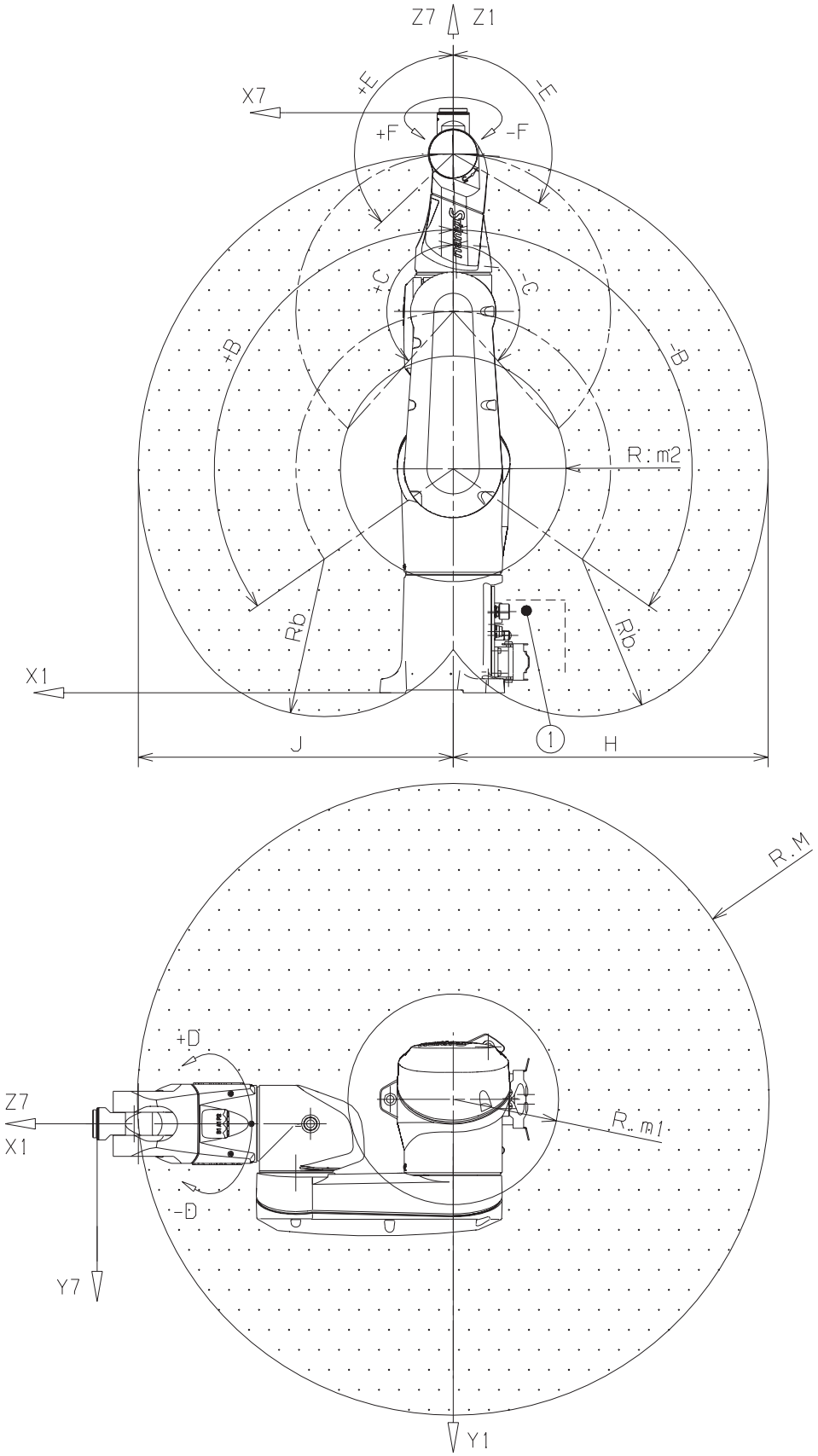


Figure 2.5

2.5. PERFORMANCE

See **figure 2.5** (1) Brake release access area

	Standard arm
Work envelope	
R.M max. reach between axis 1 and 5	450 mm
R.m1 min. reach between axis 1 and 5	151 mm
R.m2 min. reach between axis 2 and 5	162 mm
R.b reach between axis 3 and 5	225 mm
Maximum speed at load center of gravity	8.2 m/s
Repeatability at constant temperature	± 0.02 mm

2.5.1. AMPLITUDE, SPEED AND RESOLUTION

Axis	1	2	3	4	5	6
Amplitude (°)	360	250	276	540	253.5	540 (1)
Working range distribution (°)	A ± 180	B ± 125	C ± 138	D ± 270	E + 133.5 - 120	F ± 270
Nominal speed (°/s)	287	287	430	410	320	700
Maximum speed (°/s) (2)	370	370	550	900	900	1000
Angular resolution ($°.10^{-3}$)	0.057	0.057	0.122	0.114	0.122	0.172

(1) Can be configured by software up to ± 18000°. See the "Software configuration" chapter in the "Controller" documentation

(2) Maximum speed for reduced conditions of load and inertia.

CAUTION:

In some arm configurations, the maximum joint speeds can be reached only if payloads and inertias are reduced.

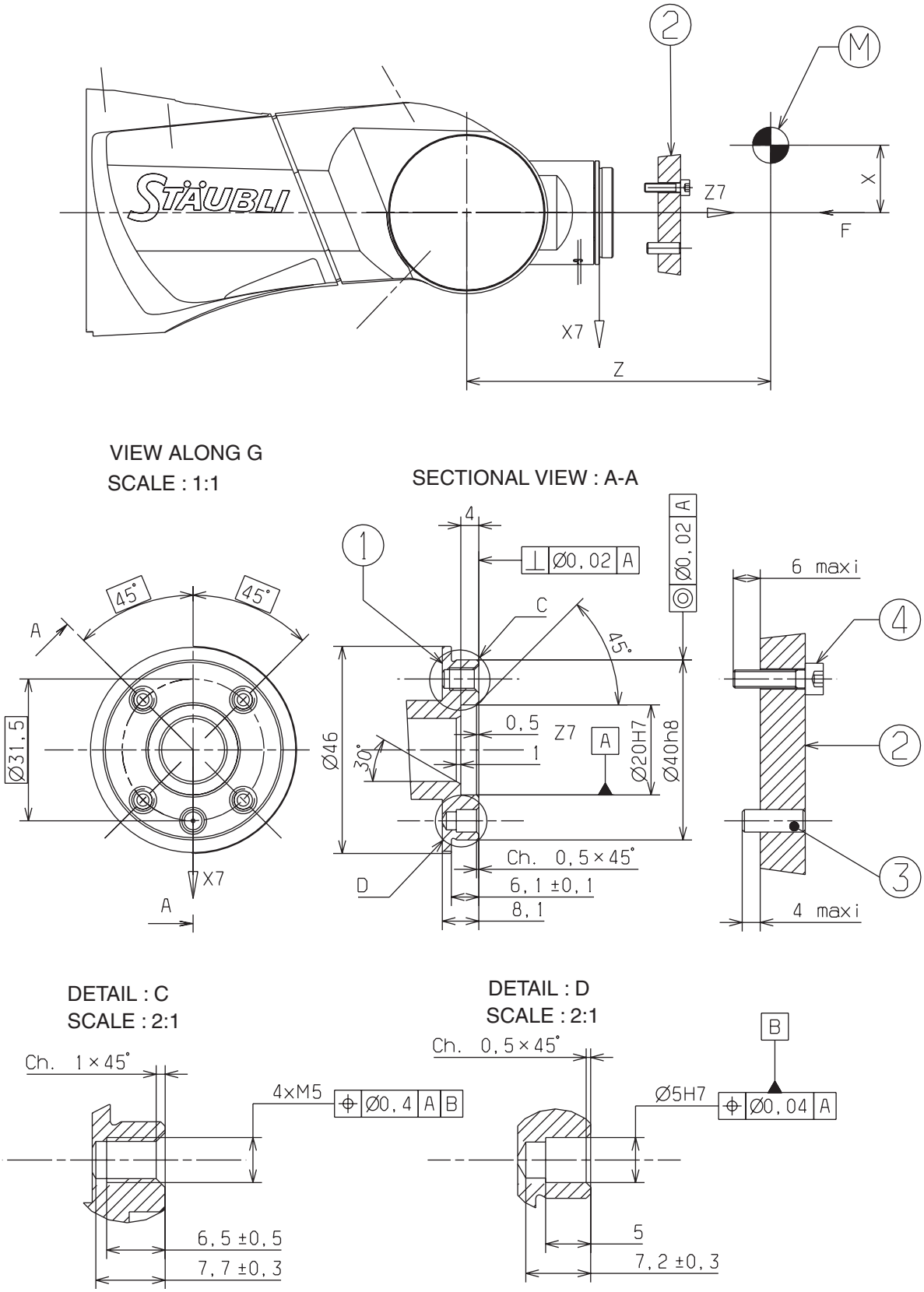

2
M
STÄUBLI
Z7
X
F
X7
Z
VIEW ALONG G
SCALE : 1:1
SECTIONAL VIEW : A-A
45°
45°
A
Ø31,5
X7
A
1
4
⊥ Ø0,02 A
Ø0,02 A
C
45°
Ø46
30°
0,5
1
Z7
A
Ø20H7
Ø40h8
D
Ch. 0,5×45°
6,1 ±0,1
8,1
6 maxi
4
2
3
4 maxi
DETAIL : C
SCALE : 2:1
Ch. 1×45°
4×M5
⌖ Ø0,4 A B
6,5 ±0,5
7,7 ±0,3
DETAIL : D
SCALE : 2:1
Ch. 0,5×45°
B
Ø5H7
⌖ Ø0,04 A
5
7,2 ±0,3

Figure 2.6

2.6. LOAD CAPACITY – MECHANICAL INTERFACE

See **figure 2.6**.

Terminal **(2)** is not supplied with the 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.

Terminal **(2)** is mounted on the wrist's mechanical interface **(1)** (dimensions given in Figure **2.6**).

Secured by 4 class 12-9 screws M5 **(4)**, tightening torque 9.5 Nm ± 0.7 Nm.

Indexing pin, 5-mm diameter pin **(3)**.

Mechanical interface designation:
ISO 9409 - 1 - A31.5 as per Standard ISO 9409 - 1 : 1996 (F)
(except the localization of the 4 M5 threaded holes)

CAUTION:

Length of end-effector attaching screws is limited to avoid all interference with the wrist (figure 2.6).

2.6.1. LOAD CAPACITY **(figure 2.6,2.7)**

Load characteristics:

Load center of gravity position : z = 135 mm with respect to joint 5 and x = 30 mm with respect to joint 6.

Load capacity	**Standard arm**	
	kg	lb
At nominal speed	1.7	3.75
At reduced speed (1)	2	4.41
Maximum load capacity at low speed (see figure 2.7)(2)	2.3	5.1

(1) In all configurations and taking maximum inertias into account. See table below.
(2) Maximum load for which the maximum arm extension cannot exceed that shown in figure 2.7.

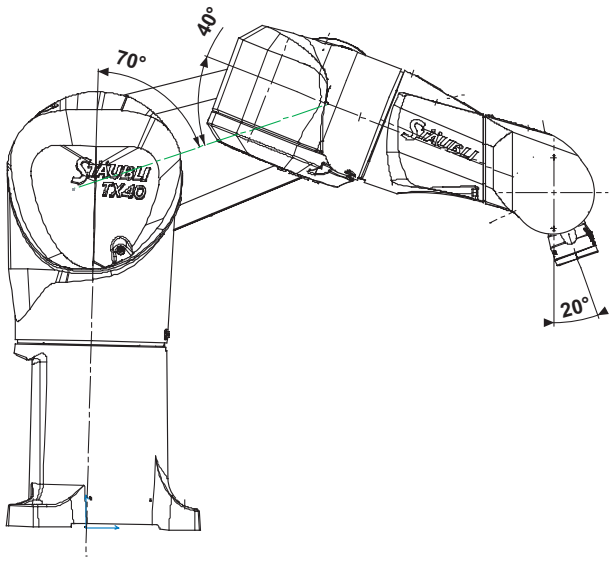


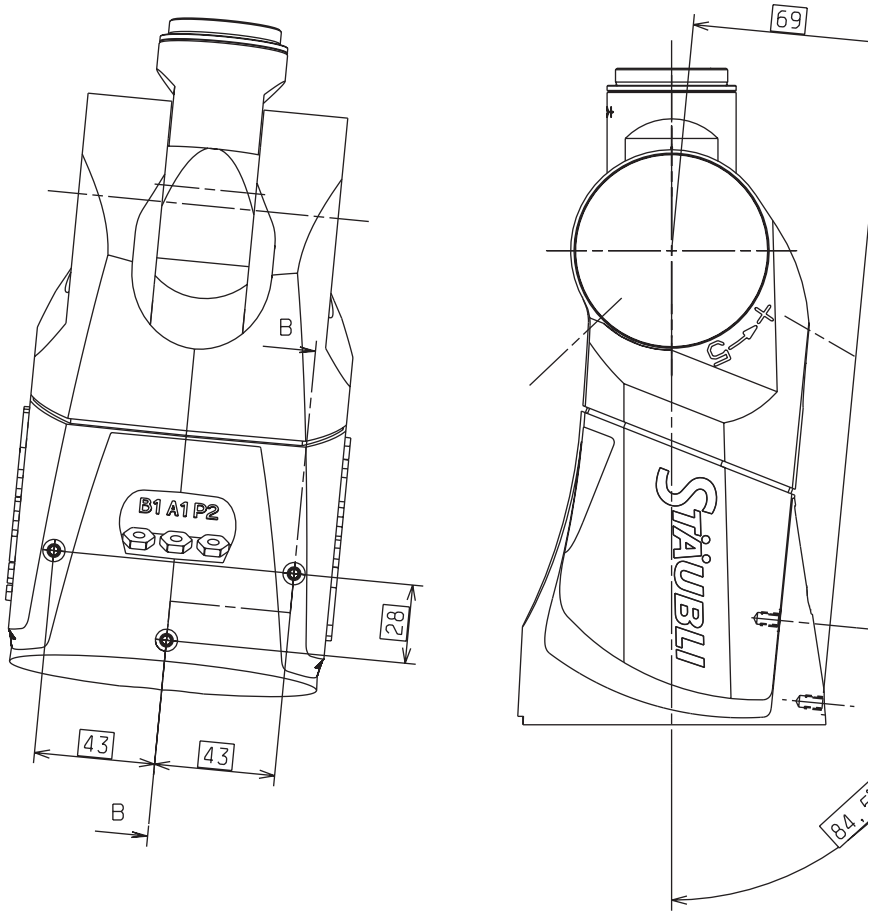
Figure 2.7

	Nominal inertias (kg.m²)	**Maximal inertias (kg.m²) (2)**
	Standard arm	**Standard arm**
For joint 5	0.033	0.1
For joint 6	0.002	0.03

(2) Under reduced speed and acceleration conditions:
Generally, VEL = 60%, ACC = 60%, DEC = 60% (consult us)

CAUTION:
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.

VIEW ALONG : G



SECTIONAL VIEW : B-B

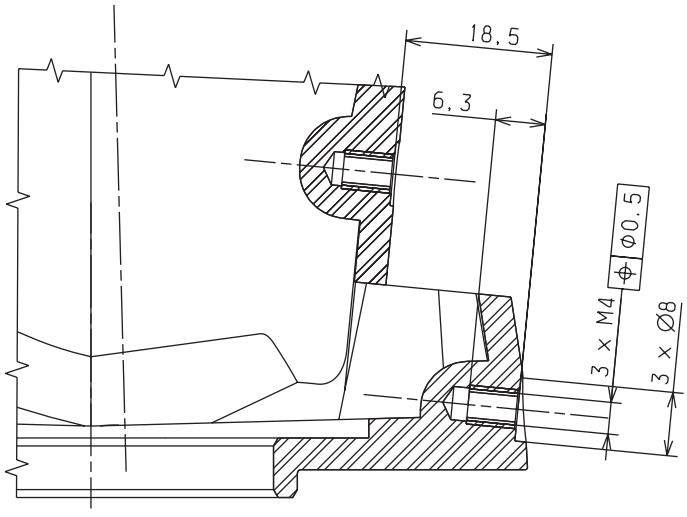


Figure 2.8

2.6.2. TORQUE LIMITS

	Reference axis							
	Axis 1 (floor mounting)	**Axis 1 (wall mounting)**	**Axis 2**	**Axis 3**	**Axis 4**	**Axis 5**		**Axis 6**
Static torque (Nm)	40	11	11	8	4	4 (1)	2.6 (2)	1.4

(1) If axis 6 torque = 0

(2) For maximum torque on axis 6

Note:
These pairs are available for a load carried equal to 0 Kg.

2.6.3. ATTACHMENT OF ADDITIONAL LOAD ON FOREARM

See **figure 2.8**.

An additional load can be attached to the forearm using 3 M4 screws; maximum torque is 3 Nm.

Position of 3 M4 tapped holes: See **figure 2.8**.

CAUTION:
The additional load depends on nominal load. In all cases, do not exceed load characteristics.

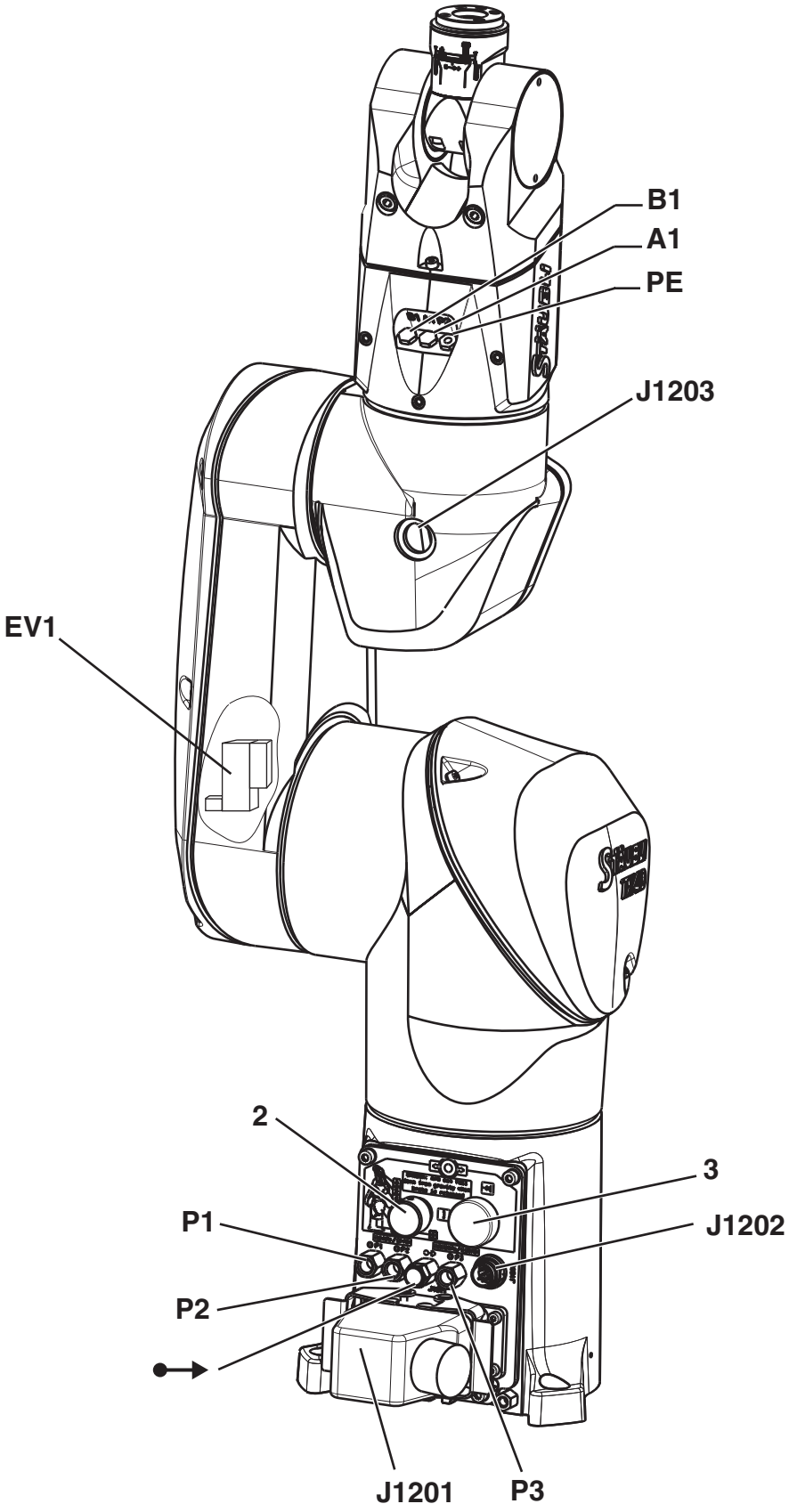


Figure 2.9
Arm - Rear cable outlet

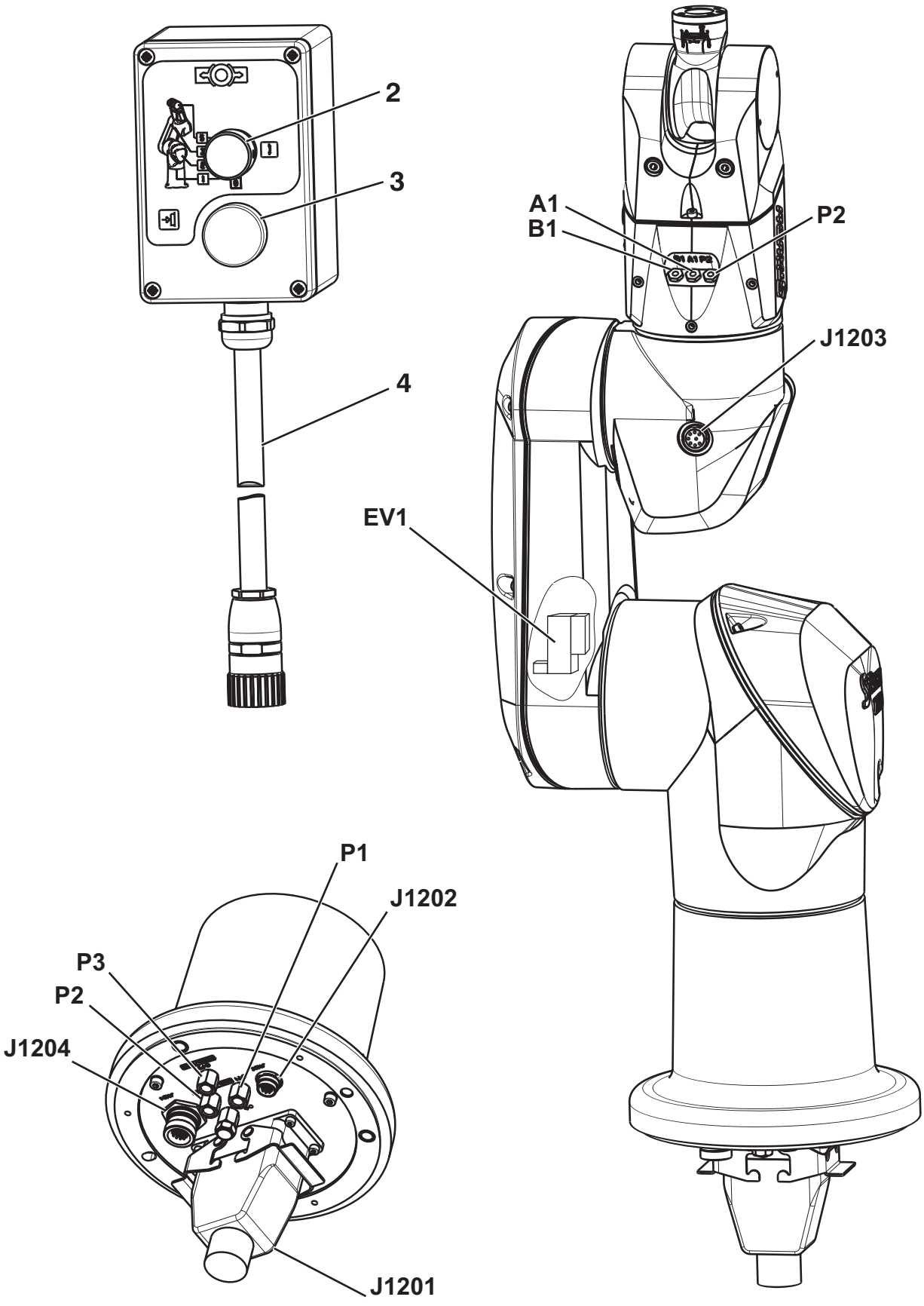


Figure 2.10
Arm - Vertical cable outlet

2.7. USER CIRCUIT

See **figure 2.9**.: Arm - Rear cable outlet
See **figure 2.10**.: Arm - Vertical cable outlet

The arm cabling system is made up of a harness containing several electrical cables used to power the servomotors (power, brakes, coders), the distributors, and the login user socket. These components are connected by means of removable connectors.

It also integrates the pneumatic pipes that provide 2 pressure supplies **(A1)** and **(P2)** near the tool clamp.

As an option, the arm incorporates the pneumatic pipes supplying the **(EV1)** electric distributor and those used for the **(EV1)** electric distributor outlets on the forearm at **(A1)** and **(B1)**. The robot also has a pressure source **(P2)** close to the tool clamp.

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

Arm - Rear cable outlet (figure **2.9**)

- Arm ground connection **(1)**.
- Arm/controller connector **(J1201)**.
- connector intended for the user for possible electrical connection of grip (**J1202**).
- Brake release selector **(2)**.
- Brake release pushbutton **(3)**.
- Pneumatic connections to the **(P1)** and **(P2)** compressed air networks.
- Connection for creating overpressure in the **(P3)** arm.

Arm - Vertical cable outlet (figure **2.10**)

- Arm/**(J1201)** controller interconnection socket.
- connector intended for the user for possible electrical connection of grip **(J1202)**.
- Socket for connection of the remote brake release box **(J1204)**.
- Pneumatic connections to the **(P1)** and **(P2)** compressed air networks.
- Connection for creating overpressure in the **(P3)** arm.
- Remote brake release box (**4**).
- Brake release selector **(2)**.
- Brake release pushbutton **(3)**.

CAUTION:
The overpressure must never exceed 20 mbar (0.28 psi).

- Pneumatic exhaust muffler .

CAUTION:
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.

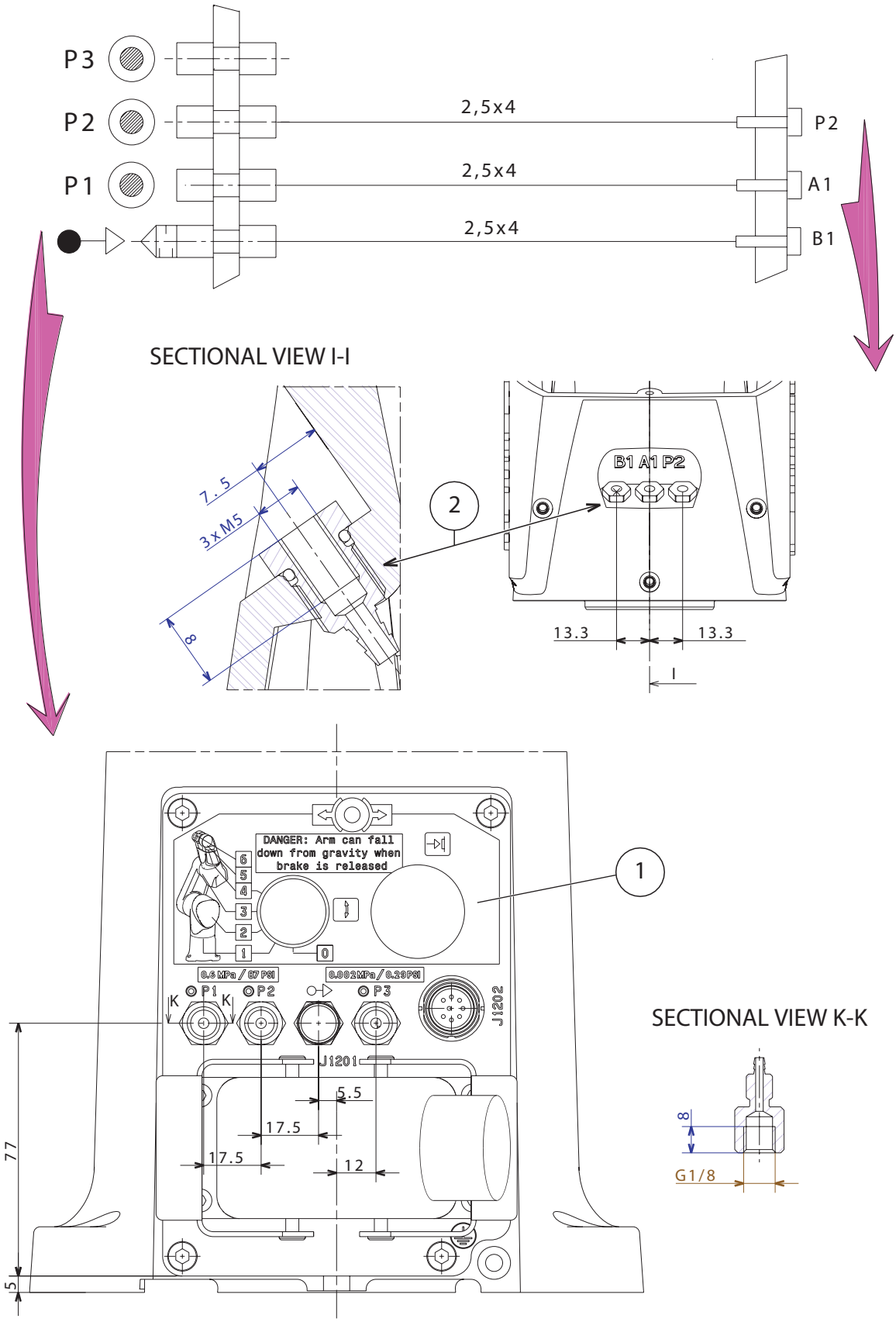


Figure 2.11
Arm - Rear cable outlet

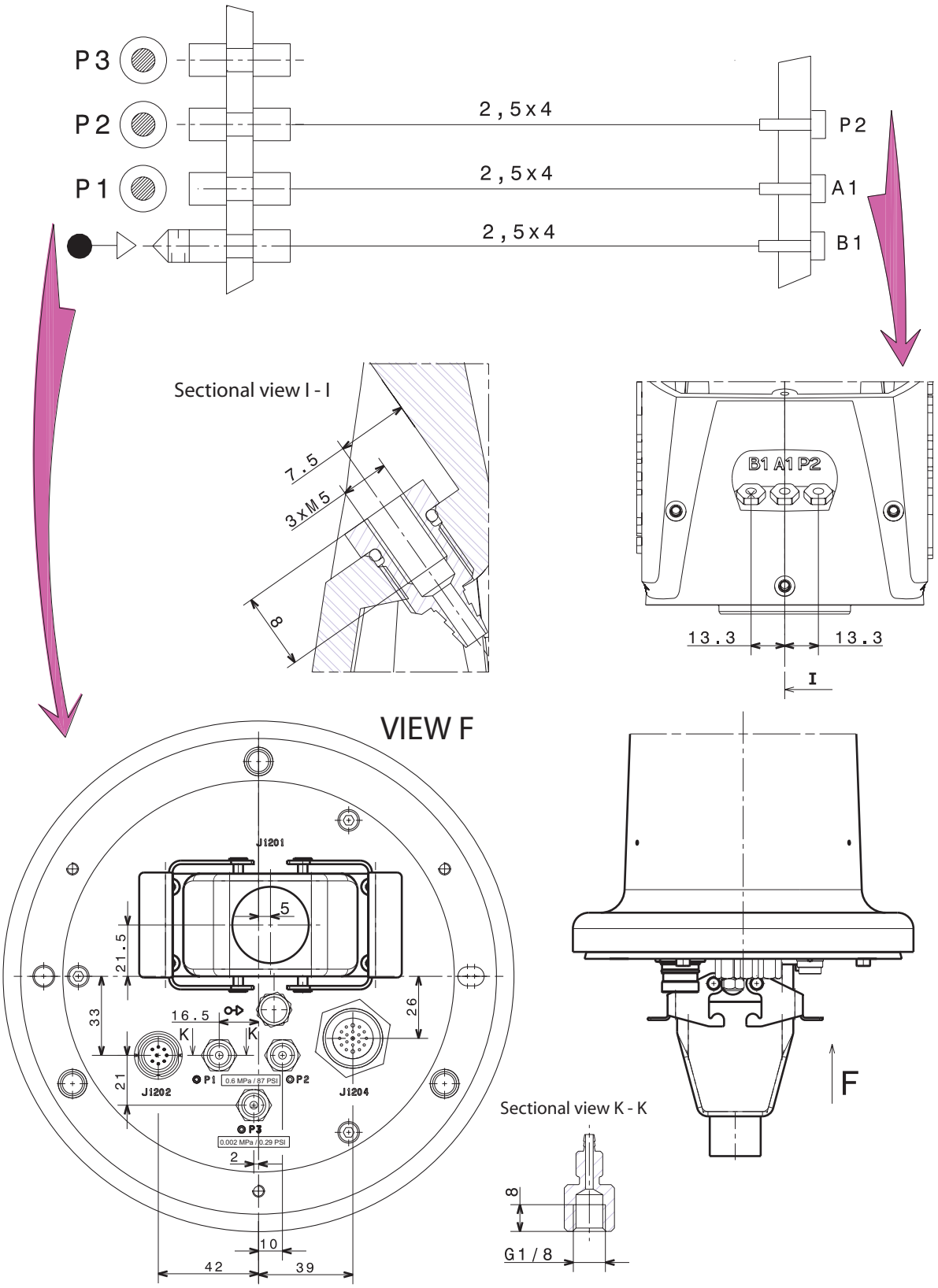


Figure 2.12
Arm - Vertical cable outlet

2.8. PNEUMATIC AND ELECTRIC SYSTEMS

2.8.1. STANDARD PNEUMATIC SYSTEM (STANDARD ROBOT EQUIPMENT)

(1) Plate attached to base

(2) Forearm

Description (figure 2.11): Arm - Rear cable outlet
Description (figure 2.12): Arm - Vertical cable outlet

- The arm is connected to the compressed air network (6 bar (87 psi) maximum, with or without lubrication) through its base (**P1** and **P2**). There are two direct lines between the base and the forearm.
- The centralized exhaust **(B1)** is directed towards the base and its outlet is through a muffler •⟶ .
- An orifice **(P3)** is provided to connect the pressurization system, if used, to the base of the robot.

CAUTION:
Do not use this orifice for other purposes.

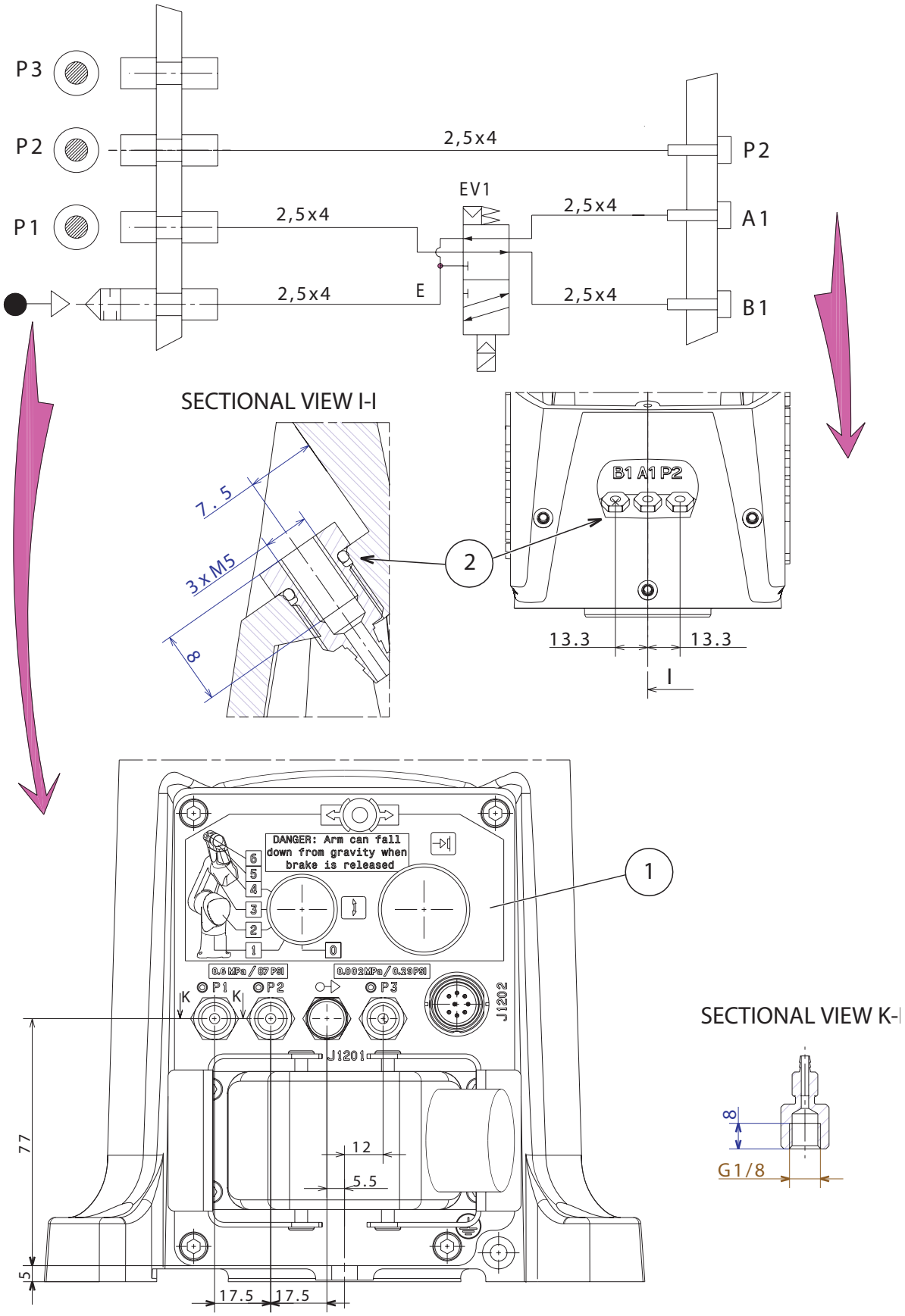


Figure 2.13
Arm - Rear cable outlet

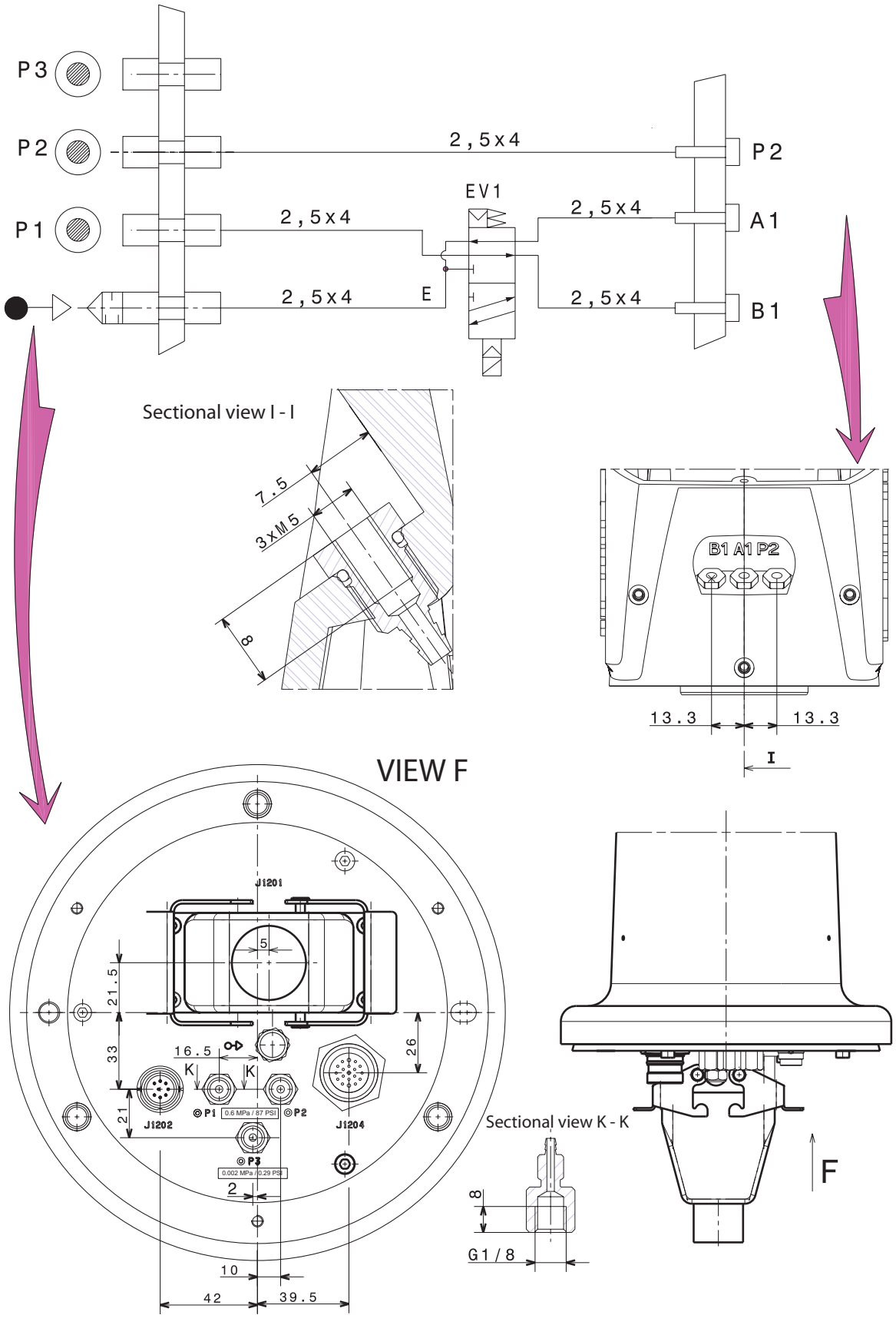


Figure 2.14
Arm - Vertical cable outlet

2.8.2. PNEUMATIC SYSTEM WITH ELECTRIC DISTRIBUTOR FOR USE WITH COMPRESSED AIR (OPTION)

(1) Plate attached to base

(2) Forearm

Description (figure 2.13): Arm - Rear cable outlet
Description (figure 2.14): Arm - Vertical cable outlet

Electric distributor (EV1).

- 5/2-way monostable.
- Electrically controlled (24 VDC).
- Working pressure: 1.5 to 7 bar (21.75 to 100 psi.).
- Output coefficient: Kv = 2.86 S = 3.6 mm^2.
- Clip-on connector.
- Overvoltage protective circuit and indicator diode.

Description (figure 2.13):

- The arm is connected to the compressed air network (6 bar (87 psi)s max., lubricated or not) via the base **P1**.

> **CAUTION:**
> **The air must be filtered by a 10 µm filter.**

- There is a direct line between the base and the forearm **(P2)**.
- The exhaust from the electric distributor is directed to the base and through a muffler ⟶.
- An orifice **(P3)** is provided to connect the pressurization system, if used, to the base of the robot.

> **CAUTION:**
> **Do not use this orifice for other purposes.**

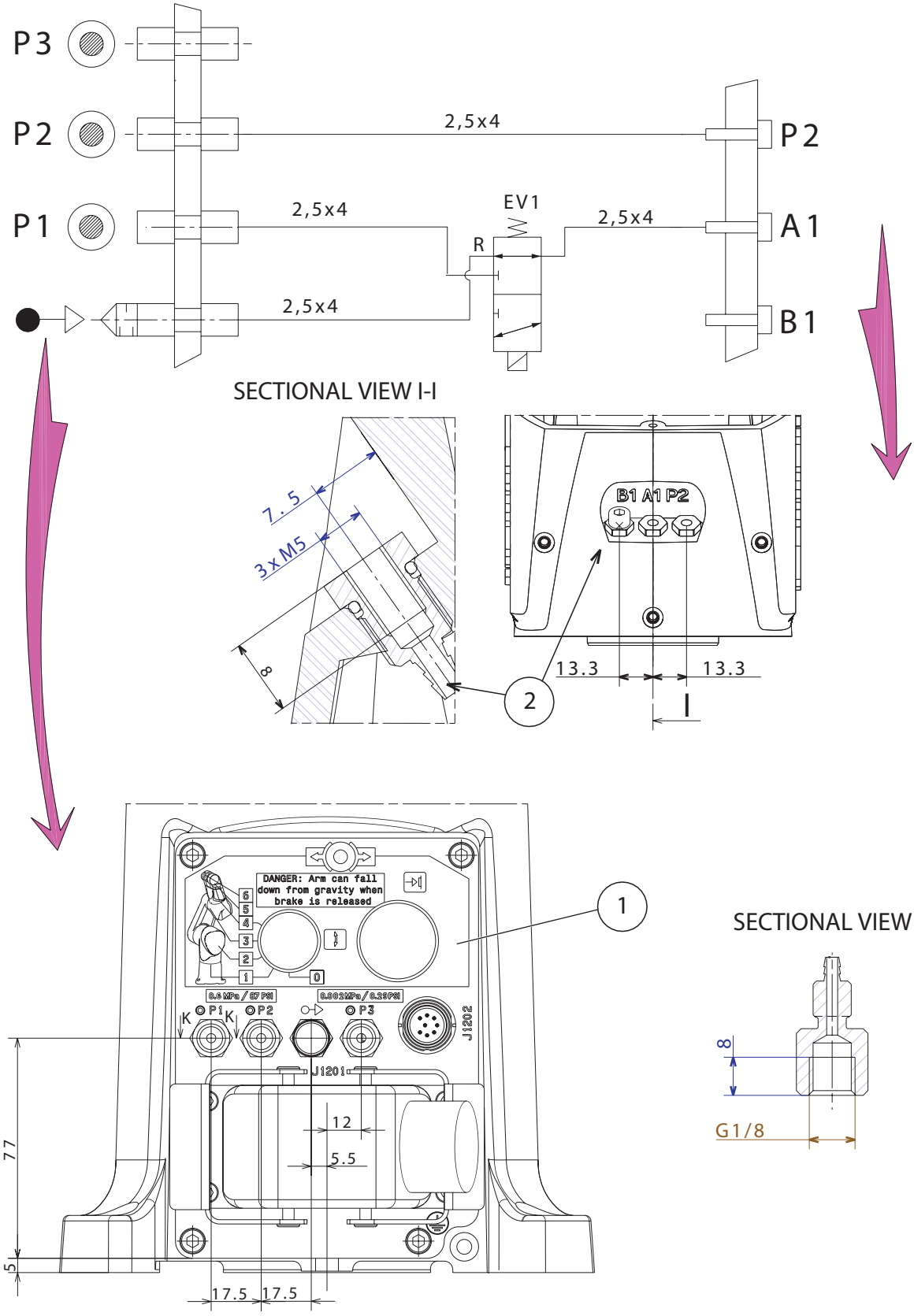


Figure 2.15
Arm - Rear cable outlet

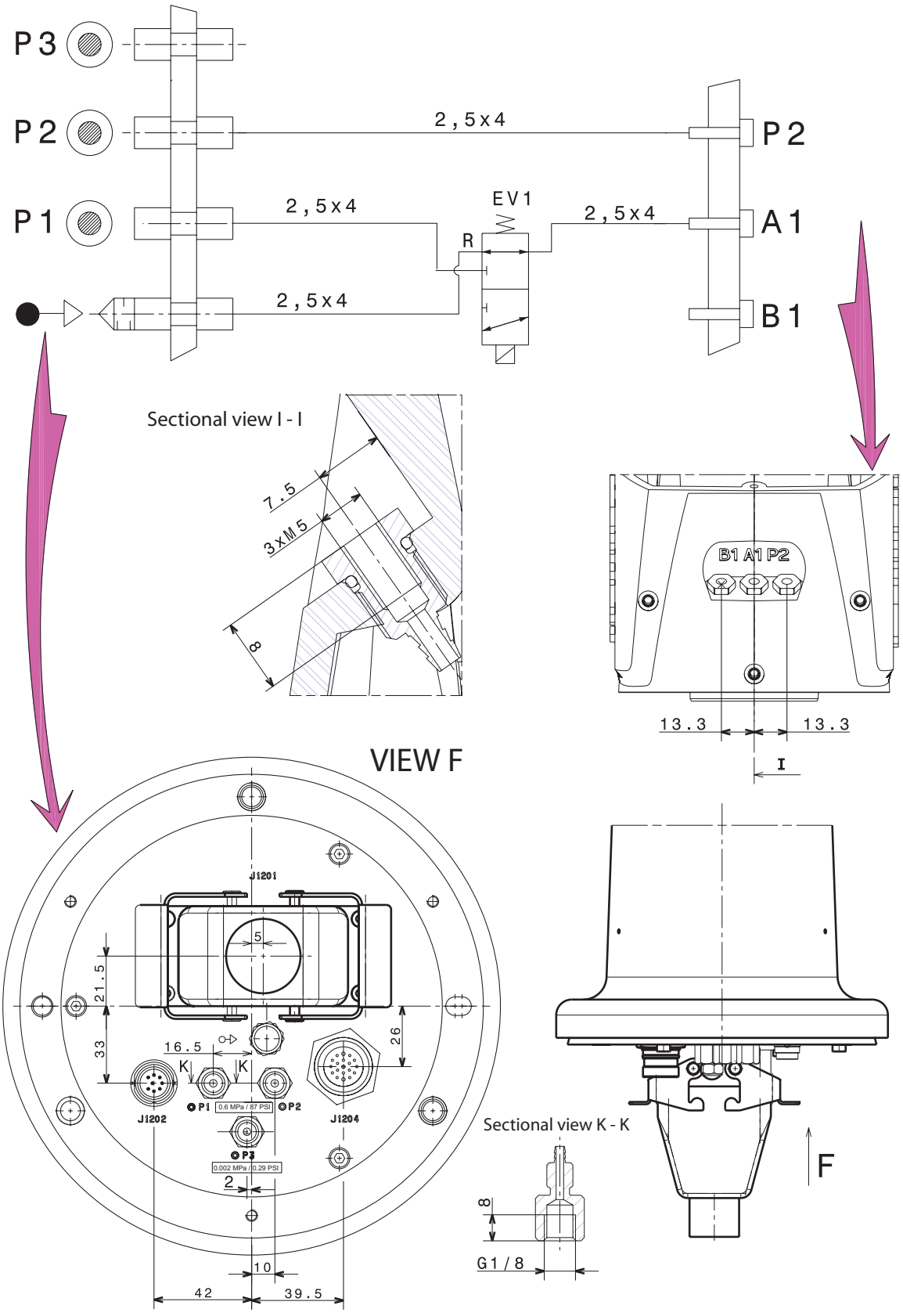


Figure 2.16
Arm - Vertical cable outlet

2.8.3. PNEUMATIC SYSTEM WITH ELECTRIC DISTRIBUTOR FOR USE WITH VACUUM (OPTION)

(1) Plate attached to base

(2) Forearm

Description (figure 2.15): Arm - Rear cable outlet
Description (figure 2.16): Arm - Vertical cable outlet

Electric distributor (EV1).

- 3/2-way monostable.
- Electrically controlled (24 VDC).
- Working pressure: vacuum only ~ -1 bar (-14.5 psi).
- Output coefficient: Kv = 2.86 S = 3.6 mm^2.
- Clip-on connector.

Description (figure 2.15):

- The arm is connected to the vacuum network via the base **P1**.

> **CAUTION:**
> **Cleanliness of sucked in air must be equivalent to 10µm filtered air.**

- There is a direct line between the base and the forearm **(P2)**.
- The exhaust from the electric distributor is directed to the base and through a muffler ⟶.
- An orifice **(P3)** is provided to connect the pressurization system, if used, to the base of the robot.

> **CAUTION:**
> **Do not use this orifice for other purposes.**

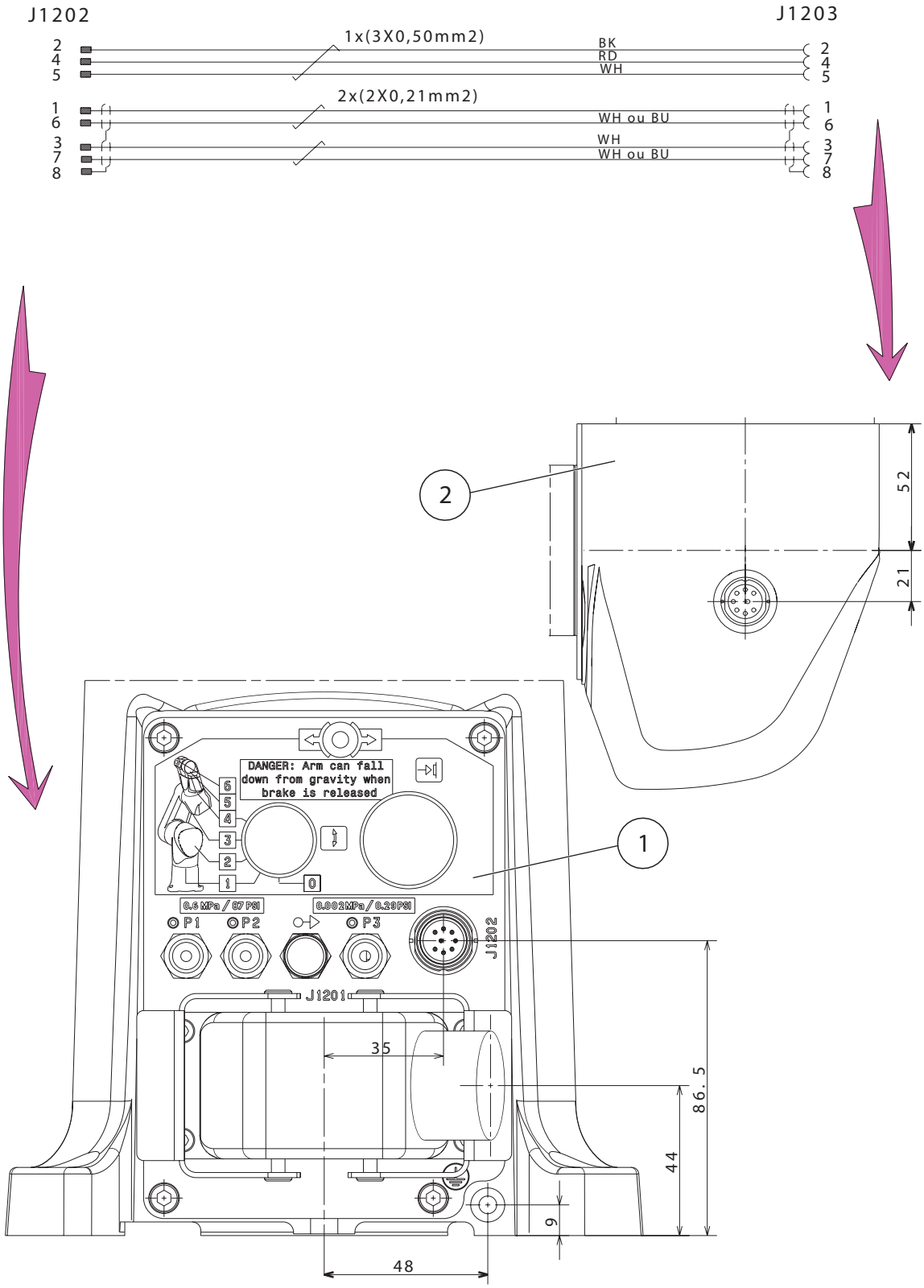


Figure 2.17
Arm - Rear cable outlet

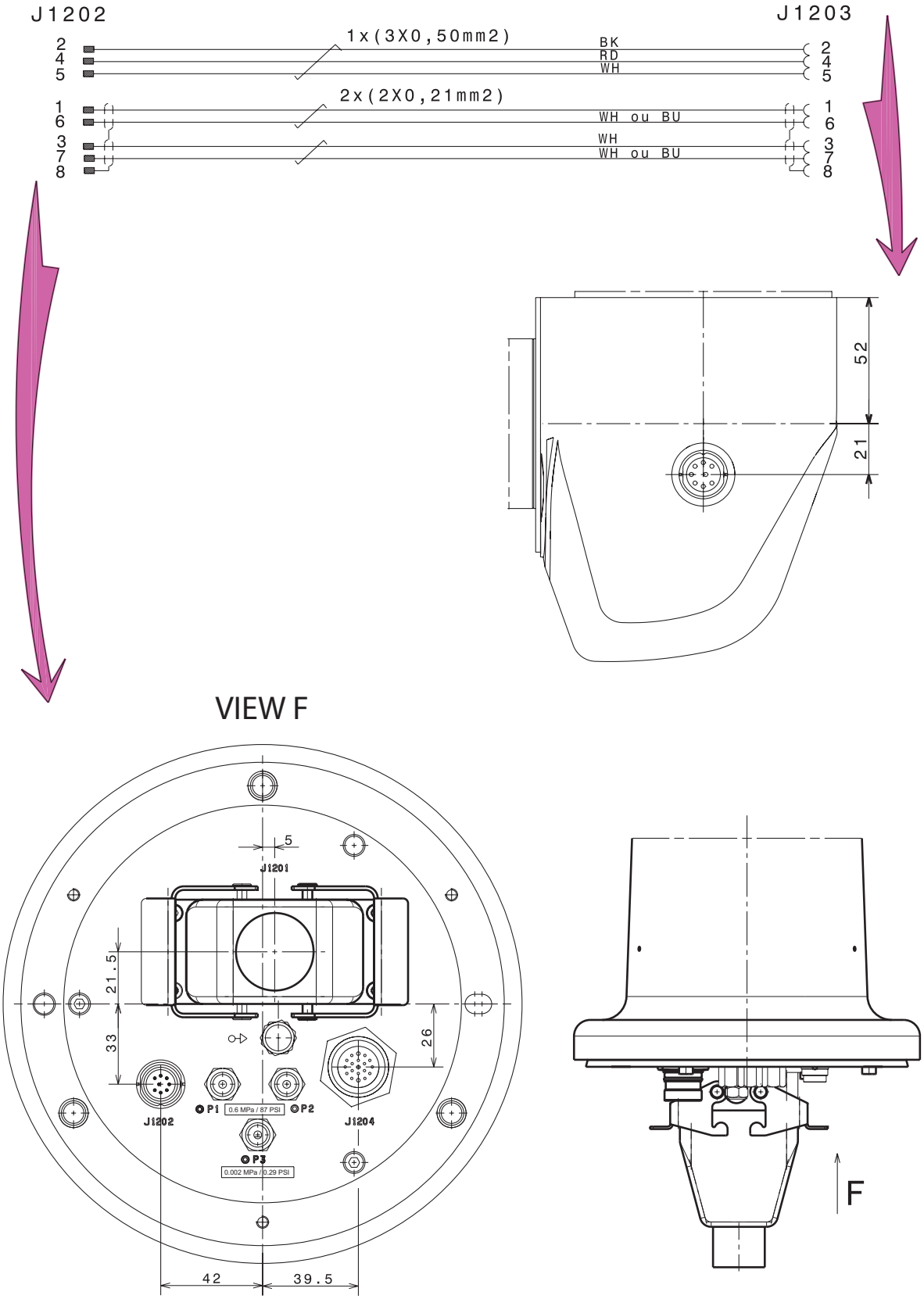


Figure 2.18
Arm - Vertical cable outlet

2.8.4. ELECTRIC CIRCUIT

(1) Plate attached to base

(2) Elbow

Description (figure 2.17): Arm - Rear cable outlet
Description (figure 2.18): Arm - Vertical cable outlet

The electrical circuit consists of:
- A male 8-contact socket at the bottom of the arm.
- A female 8-contact socket on the forearm.

These 8 contacts include 3 power contacts and 5 signal contacts.

The 3 power contacts in each socket are connected by a 3-wire conductor with cross-section AWG20 (contacts 2-4-5).
The 5 signal contacts in each socket are connected in the following way:
- 2 shielded twisted pairs, cross-section AWG20 connecting contacts 1-6-8 and 3-7-8 in each socket.

Supply voltage: 60 VDC - 25 VAC.

Permissible current:
- 3-wire conductor AWG20: 4 A per contact.
- AWG24 screened pairs: 2 A per contact.

CAUTION:
Do not use the shields as a conductive cable.

- Connection to elbow (**J1203**) by elbow male cylindrical connector.
- Connection to base (**J1202**) by straight female cylindrical connector.

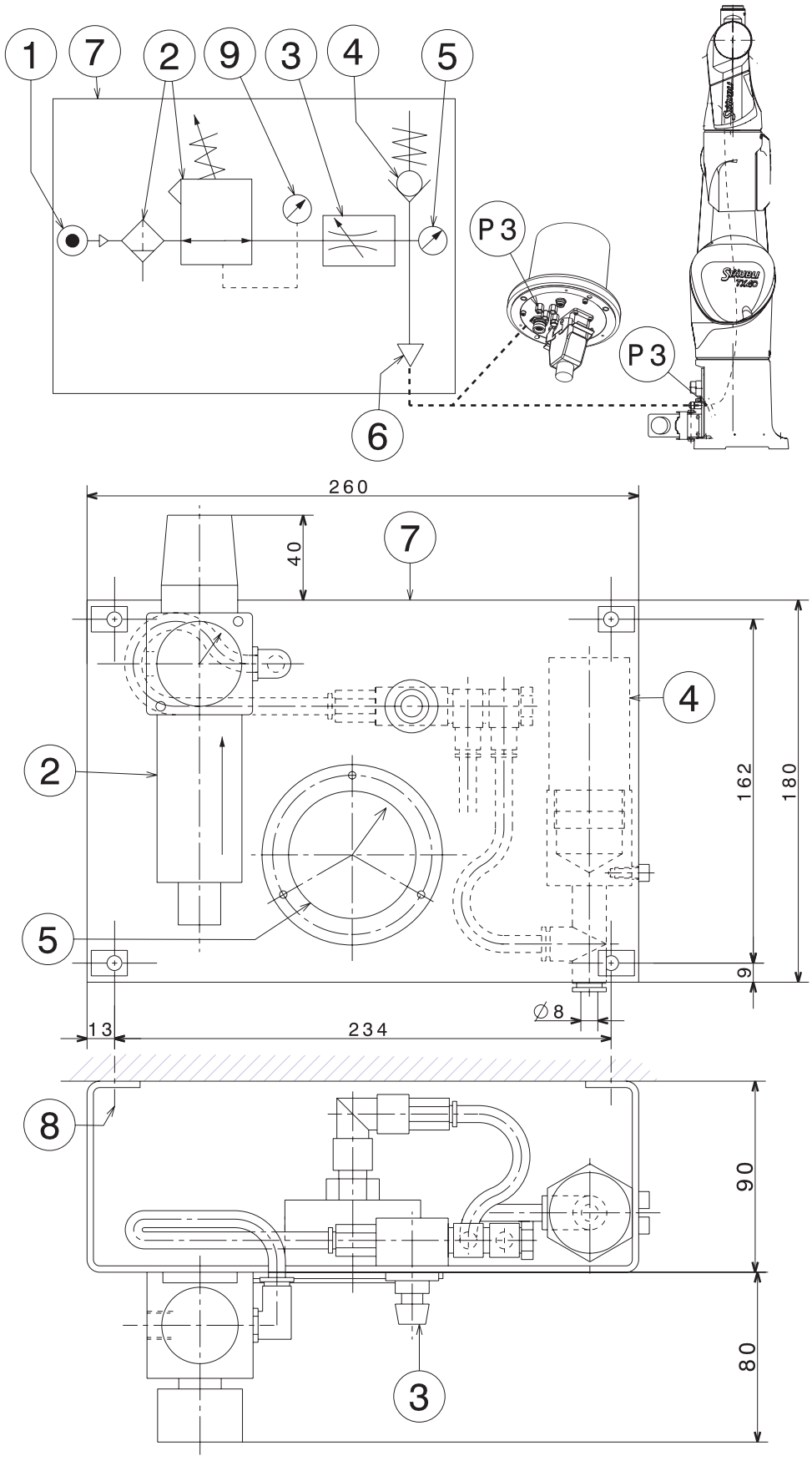


Figure 2.19

2.9. PRESSURIZATION SYSTEM FOR DUSTY SURROUNDINGS OR SPATTERING WITH LIQUIDS

2.9.1. PURPOSE

For very severe applications in dusty surroundings or with spattered liquids, the objective is to keep the pressure inside the arm above atmospheric pressure in order to avoid migration of dust and liquids.

CAUTION:
The overpressure must never exceed 20 mbar (0.28 psi).

2.9.2. INSTALLATION **(figure 2.19)**

- Use orifice **(P3)** to connect the pressurization system to the base of the robot.
- Attach the unit with 4 screws (Ø 6 max.) at item **(8)** (screws not supplied) to a rigid vertical wall in direction shown by arrow; the air inlet **(1)** being to the left of the regulator **(2)**.
- Provide for air inlet at **(1)**, this is a G1/4 tapped hole; the air pressure is 10 bar maximum. Before the pressure arrives at **(1)**, make sure that the regulator **(2)** is completely screwed out and that the valve **(3)** is completely screwed in. Before pressurizing the arm, also make sure that the arm is correctly connected and fully sealed (covers closed, plugs in the tapped holes in the arm, hose connected at **(6)** and **(P3)**, etc.).
- Install a pipe with an outside Ø 8 between the unit (output **6**) and the arm (input **P3**). At **(P3)**, the hole is a G1/8 tapped hole.
- Pressurize the arm:

  1) Slowly screw in the regulator. First adjust the pressure to 1 bar max. (pressure shown on pressure gage **9**).

     Note:
     *At this stage, the low pressure gage **(5)** must remain at 0 mbar.*

  2) Very slowly screw out the valve **(3)**; the value on the pressure gage **(5)** must increase progressively. When this value reaches 5 to 10 mbar and remains stable, adjustment is considered as correct.

CAUTION:
An excessive value (above 40 mbar (0.57 psi)) will make the pressure gage (5) unusable.

- If however the valve **(3)** is completely screwed out and it is impossible to reach 5 mbar, check that:

  a) The circuit is tight (unit, arm, pipe, etc.).

  b) The pressure gage **(5)** is not unserviceable (damaged by a pressure greater than 40 mbar).

If the 2 points a and b are correct, the pressure can be increased by means of the **(2)** regulator without however exceeding 2 bar.

Note:
For safety reasons (valve 4 opens between 15 and 25 mbar) and to reduce consumption levels, it is preferable to work at low pressure.

2.10. RELEASING JOINT BRAKE

CAUTION:
Make sure that the arm and load relevant to this joint are suitably supported.

The controller must be connected to the power supply.

Place the brake release selector in position corresponding to the joint to be released.

When the pushbutton is pressed to free the brakes, the brake on the joint under consideration is freed and the motor is put into short-circuit on the amplifier to reduce the arm drop speed.

DANGER:
Arm can fall because of gravity when brake is released.

2.11. SAFETY

DANGER:
None of the joints are equipped with a counter balancing system. Short-circuiting of the motors is the only system used to limit the drop speed.

2.11.1. POTENTIAL RISKS

For the UL version, a yellow indicator light **(1)** is fitted on the robot arm to show that drive power is available, motion is possible and that it represents a possible cause of risks for the operator (figure **2.20**).

When the indicator light **(1)** is on, take all necessary precautions to reduce risks.

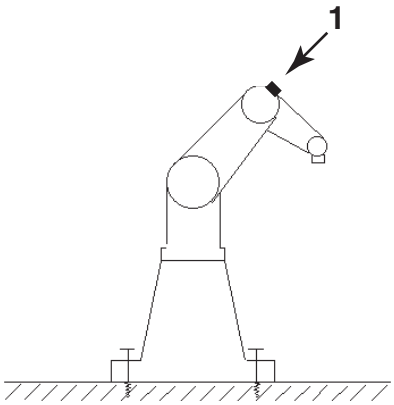


Figure 2.20

2.11.2. STOPPING ANGLES IN THE CASE OF AN EMERGENCY STOP

	Axis 1	Axis 2	Axis 3
TX40	42.5°	41.3°	47.3°

2.11.3. MAXIMUM ENERGY GENERATED BY THE ROBOT IN THE EVENT OF AN IMPACT

This energy is calculated with the arm fully extended, with the nominal load and at the nominal speed.

	Maximum energy
TX40	65 J

2.11.4. NOISE LEVEL IN ACCORDANCE WITH THE STANDARD

	Noise level
TX40	

2.11.5. OUTSIDE TEMPERATURE OF THE ARM

DANGER:

The temperature at the surface of the arm can reach 80°C (176°F) under severe operating conditions.

2.11.6. ACCELERATIONS, DECELERATIONS

The robot is capable of strong accelerations and decelerations. Check in the application that:

- The robot hand and the tool are correctly sized and firmly fixed in place.
- The robot hand is designed to hold the load in the event of a failure in its electrical or pneumatic power supply.
- The arm is correctly fastened to the floor.

2.12. JOINT DISPLACEMENT LIMITERS

The mechanical joint displacement limiters are never reached during normal use of the robot (software joint displacement limiters and electric limiters).

Nonetheless, if the equipment comes up against mechanical limiters, the fixed and moving parts must be replaced (consult the Staubli services).

CHAPTER 3

ON-SITE PREPARATION

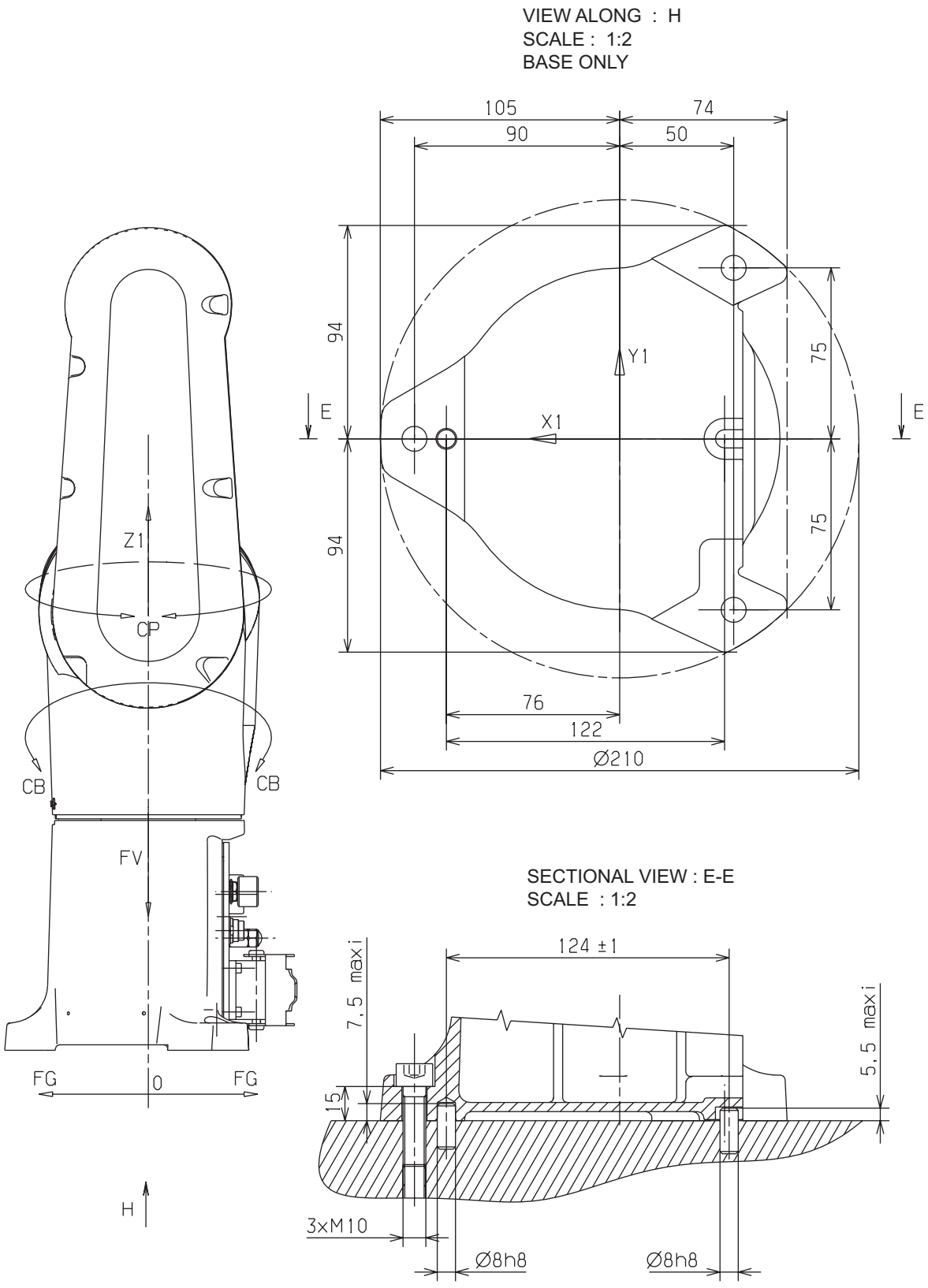
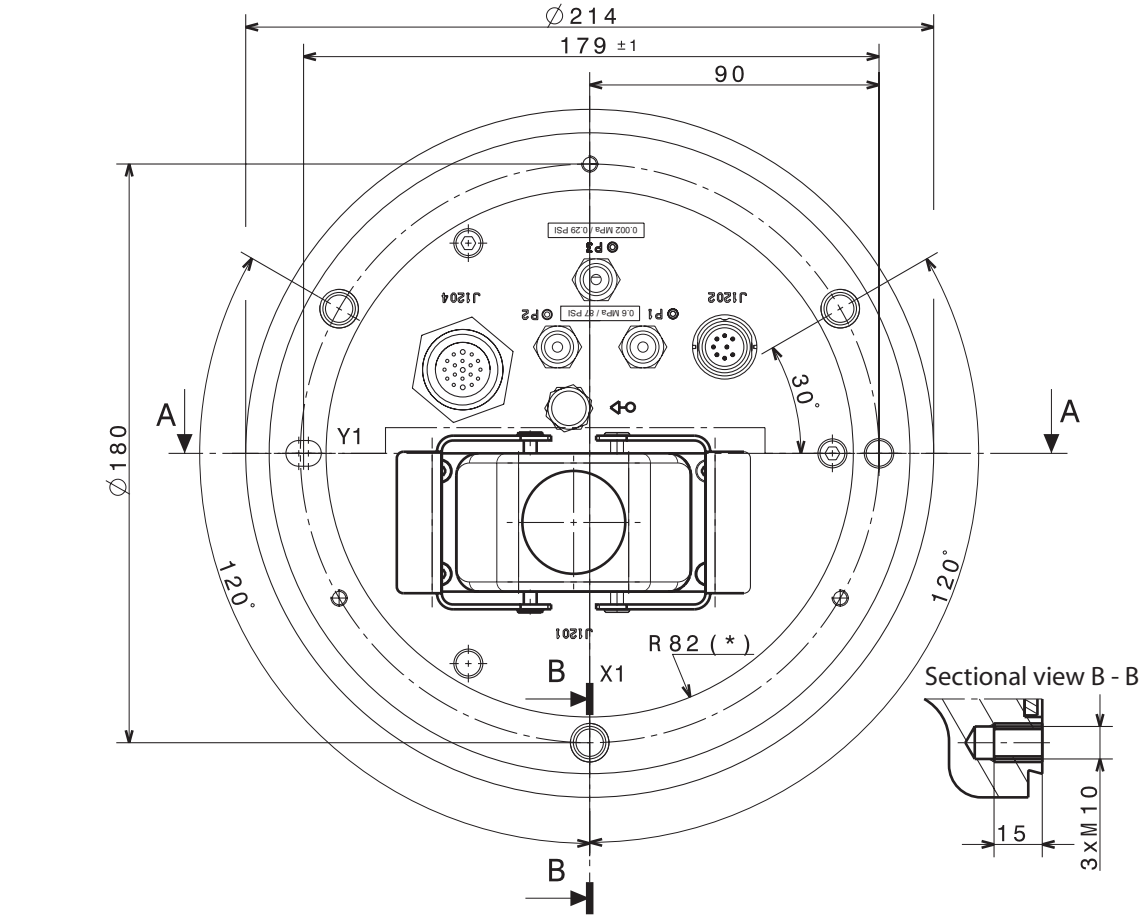


Figure 3.1
Arm - Rear cable outlet



(*) opening to put connections and screws through

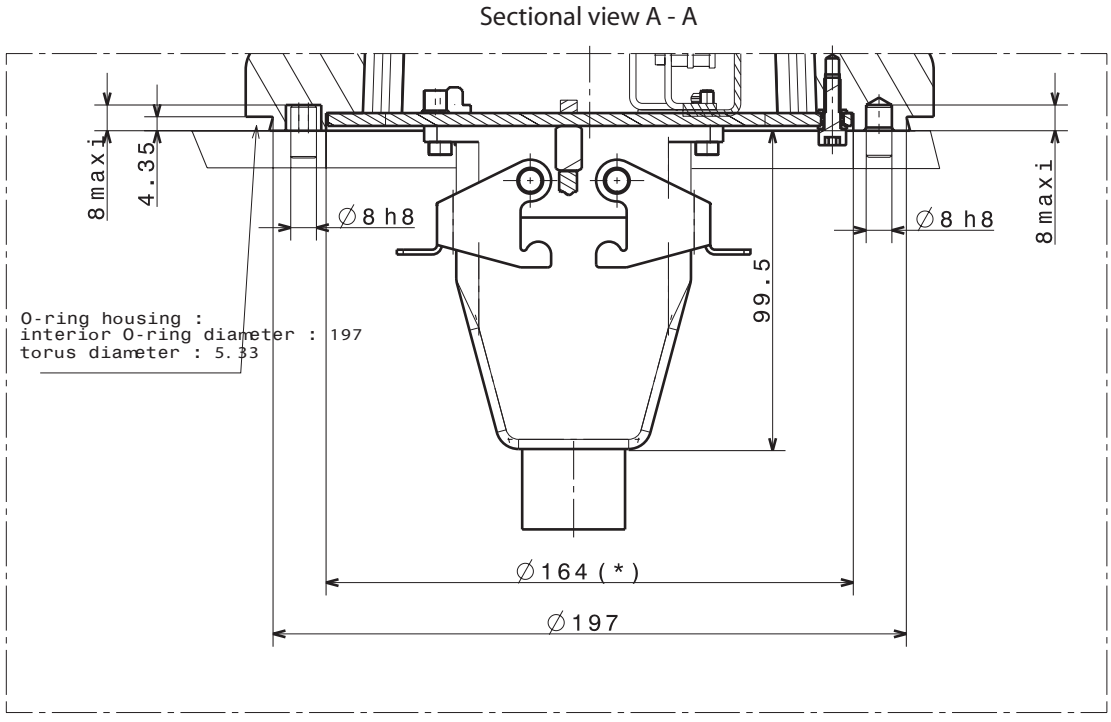


Figure 3.2
Arm - Vertical cable outlet

3.1. 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; the power supplies must be available (for the electric power supplies, see the characteristics of the controller).

CAUTION:

To enable all maintenance operations to be carried out, it is essential to provide easy access to the robot (e.g. removable safety barriers, etc.) and anchoring points for easy handling of the arms, especially those whose weight exceeds 70 kg / 154 lb.

DANGER:

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 10218 (1992).

French standard: NF EN 775 (1993).

European Directive: machine directive CEE 89-392.

CAUTION:

There must be no obstacles within the robot work envelope.

3.2. ATTACHMENT

See **figure 3.1**: Rear cable outlet
See **figure 3.2**: Vertical cable outlet with minimum opening size to be made or left in the attachment surface to put the cable through and access the connections

The arm can be installed in any position without mechanical modifications. In all cases, it must be securely attached by 3 class 12.9 M10 hex. socket head screws.

CAUTION:

It is necessary to configure the controller to suit the robot installation. To do so, see the "Software configuration" chapter in the controller manual.

Attachment surface shall be flat and metallic. A deformable support will greatly reduce robot's performance in speed and accuracy.

When calculating the size of the support, it is necessary to take into account the maximum forces transmitted by the arm in movement at point 0, which are as follows for the standard arm:

Floor or ceiling mounted arm

- F_V = 696 N
- F_G = 700 N
- C_B = 470 Nm
- C_P = 115 Nm

Under following load conditions:

	Load (kg)		Load position (mm)			
			Axis 5		Axis 6	
	kg	lb	mm	inch	mm	inch
Standard arm	1.7	3.75	135	5.31	30	1.18

The user can accurately position the robot by means of two 8h8 diameter centering pins (not supplied).

CHAPTER 4

STORAGE, TRANSPORT AND INSTALLATION

4.1. ARM PACKAGING

Packaging position of the arm:

	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6
Angular position	0°	+93°	+87°	0°	0°	0°

Standard packaging:

	Standard arm
Case L x H x D	900 x 640 x 570 mm (35.4 x 25.2 x 22.4 in)
Gross weight	40 kg (88.2 lb)

International packaging:

	Standard arm
Case L x H x D	960 x 755 x 610 mm (37.8 x 29.7 x 24 in)
Gross weight	54 kg (119.1 lb)

4.1.1. CONDITIONS OF STORAGE AND TRANSPORT

- Temperature for storage and transport : -20°C to +60°C

4.2. HANDLING OF PACKING

Handling of the packaging by pallet truck.

4.3. UNPACKING AND INSTALLATION OF ARM

- Move the packing case as near as possible to the installation site.
- Open the case.
- Take out the packing wedges.
- Take out the arm+support assembly and put it on the floor.
- Remove the arm's 3 M10 bolts while holding the arm in position, and remove the support and protection cover.

4.4. INSTALLATION OF ARM

CAUTION:

The arm can be fixed with its base facing downwards (floor-mounted version), upwards (ceiling-mounted version), or against a wall, without requiring any mechanical modifications. However, it is necessary to configure the controller accordingly. To do so, see the "Software configuration" chapter in the controller manual.

CAUTION:

Throughout all handling and installation operations concerning the arm, it is essential to keep the protection on the main connector at the foot of the robot in place at all times to avoid damaging and soiling the electrical and optical contacts.

4.4.1. INSTALLATION OF ARM

- Position the arm on the support at its final attachment points.
- Attach the arm with 3 class 12.9 M10 hex. socket head screws, tightened to 77 Nm ± 5 Nm.

4.4.2. MOUNTING FLOOR QUALITY

The user has to make sure that the mechanical caracteristics of the floor and the means of fixture allow to hold up the maximum forces caused by the moving arm *(see chapter **3**).*

CAUTION:

The height of the robot support can strongly influence the forces on the floor.

4.4.3. 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).

Note:
The angle values given on the figures are software values that it is therefore possible to reach.
Joints 1 to 5 are fitted with mechanical displacement limiters.

CAUTION:

The mechanical joint displacement limiters cannot be modified.

CHAPTER 5

PREVENTIVE MAINTENANCE

5.1. DEFINING THE LEVELS OF INTERVENTION

Level 1: Operations that can be carried out by a maintenance technician without specific STÄUBLI training.

- Replacement of the cover seals (see chapter 5.2)
- Checking oil levels (see chapter 5.4)
- Replacement of an electric distributor

Level 2: Operations that can be carried out by a maintenance technician who has undergone specific STÄUBLI training. The documentation corresponding to these operations will be provided during the training.

- Replacement of the accessible seals
- Wheel replacement (wheel and worm screw reducers)
- Backlash adjustment
- Replacement of a motor on axis 3, 4, 5, 6
- Replacement of the joint cartridge 4
- Replacement of the joint belt 4
- Replacement of DSI boards

Level 3: Operations that must be carried out by the STÄUBLI After-Sales Service.

- Replacement of JCM stators, rotors and drive units
- Replacement of lip seals
- Replacement of harnesses
- Replacement of encoder brake modules
- Replacement of encoders

DANGER:

Failure to comply with the levels of intervention can lead to incorrect operation of the robot and entail risks for the user and the machine environment.

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

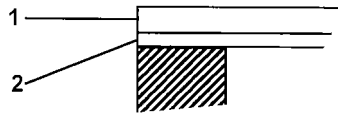
The maintenance operations must be carried out by persons who have followed the appropriate course given by STÄUBLI.

CAUTION:
To ensure a correct seal, it is essential to replace the seal each time a cover is removed.

5.2. PROCEDURE FOR REPLACING THE FLAT SEAL

The flat seal is made up of 2 sections:

- A section made of foam **(1)**,
- An adhesive section **(2)**.



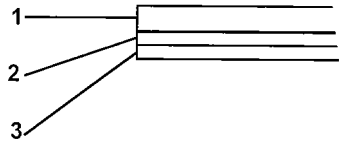
5.2.1. REMOVING THE SEAL

- To remove the flat seal, peel off a corner of the seal and pull it towards you.
  If the adhesive section **(2)** remains stuck to the cover, use "C" fluid (ethyl acetate) to remove it.
- Clean the surface, remove all paint and all other particles present on the surface, without scratching it.
- Clean the whole surface using "C" fluid (ethyl acetate).

5.2.2. FITTING A NEW SEAL

The new seal is made up of 3 sections:

- A section made of foam **(1)**,
- An adhesive section **(2)**,
- A protective paper covering the adhesive **(3)**.



- Remove the cut-out sections such as screw holes.
- Present the seal. Line the contour of the seal up with that of the surface.
- Apply the new seal to the surface. Remove a corner of the protective paper covering, apply that part to the surface, and then continue to remove the paper and put the seal into contact with the surface.

5.3. MAINTENANCE FREQUENCY

Every year:

- Check the general condition of the arm.
- Check the oil level for each seal.
- Check the condition of the harness (visible parts).

After 20 000 h:

- Consult STÄUBLI to define a preventive maintenance programme adapted to the use you make of the arm.

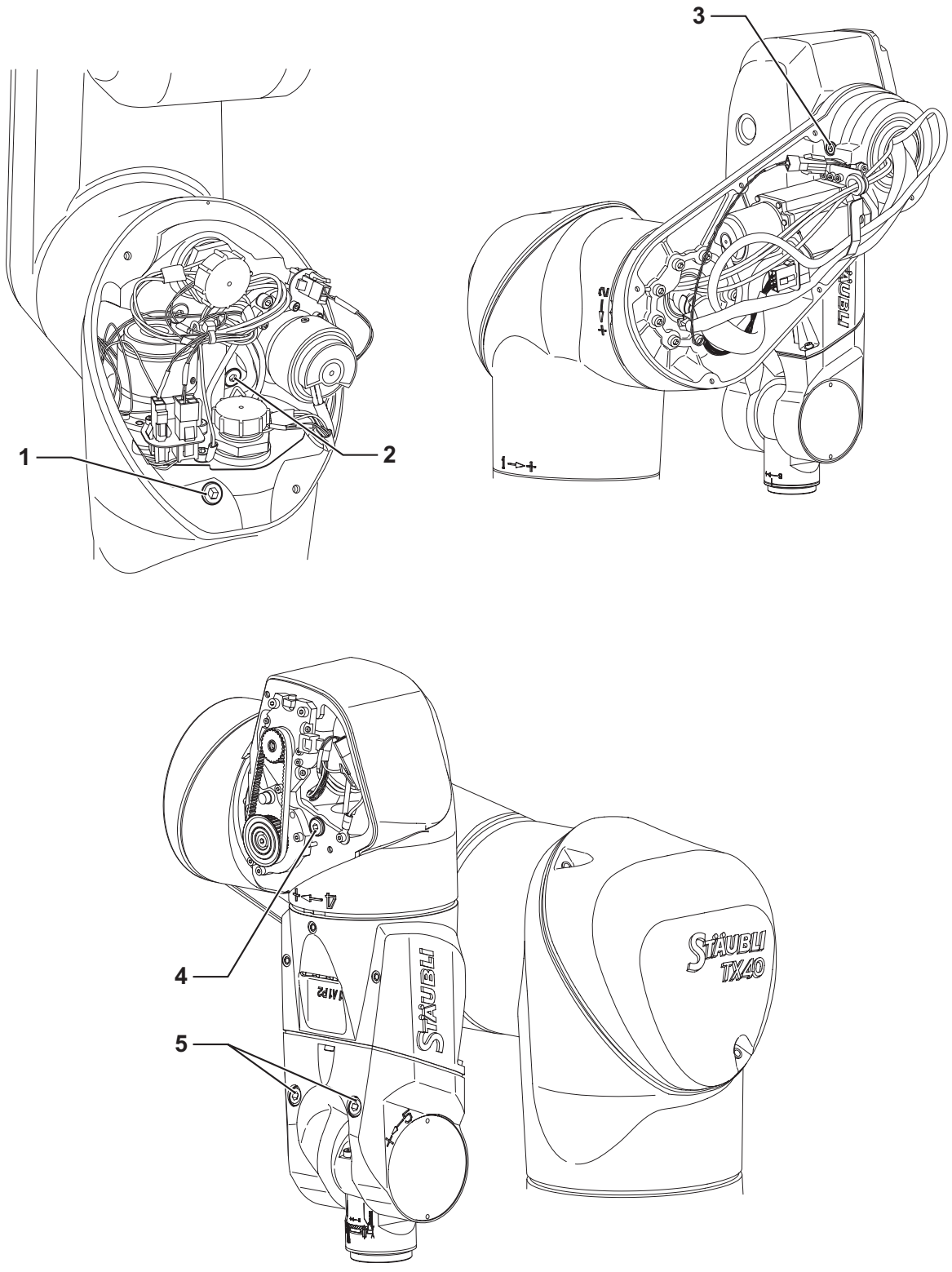


Figure 5.1

5.4. CHECKING OIL LEVELS

5.4.1. ARM IN FLOOR-MOUNTED POSITION **(figure 5.1)**

5.4.1.1. SOFTWARE ANGULAR POSITION OF JOINTS FOR CHECKING LEVELS

		Position				
		Joint 1	**Joint 2**	**Joint 3**	**Joint 4**	**Joint 5**
Check	Joint 1	0°	0°	0°	0°	0°
	Joint 2	0°	0°	0°	0°	0°
	Joint 3	0°	-75°	-90°	180°	0°
	Joint 4	0°	-75°	-90°	180°	0°
	Joints 5 and 6	0°	-75°	-120°	180°	-60°

5.4.1.2. LEVELS TO BE OBSERVED

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

- Joint 1: The oil level coincides with the base of hole after removing cap **(1)**.
- Joint 2: The oil level coincides with the base of hole after removing cap **(2)**.
- Joint 3: The oil level coincides with the base of hole after removing cap **(3)**.
- Joint 4: The oil level coincides with the base of hole after removing cap **(4)**.
- Joints 5 and 6: The oil should be flush with the bottom of the holes after the plugs **(5)** have been removed.

CAUTION:
Too much or too little oil can prevent the robot from operating correctly.

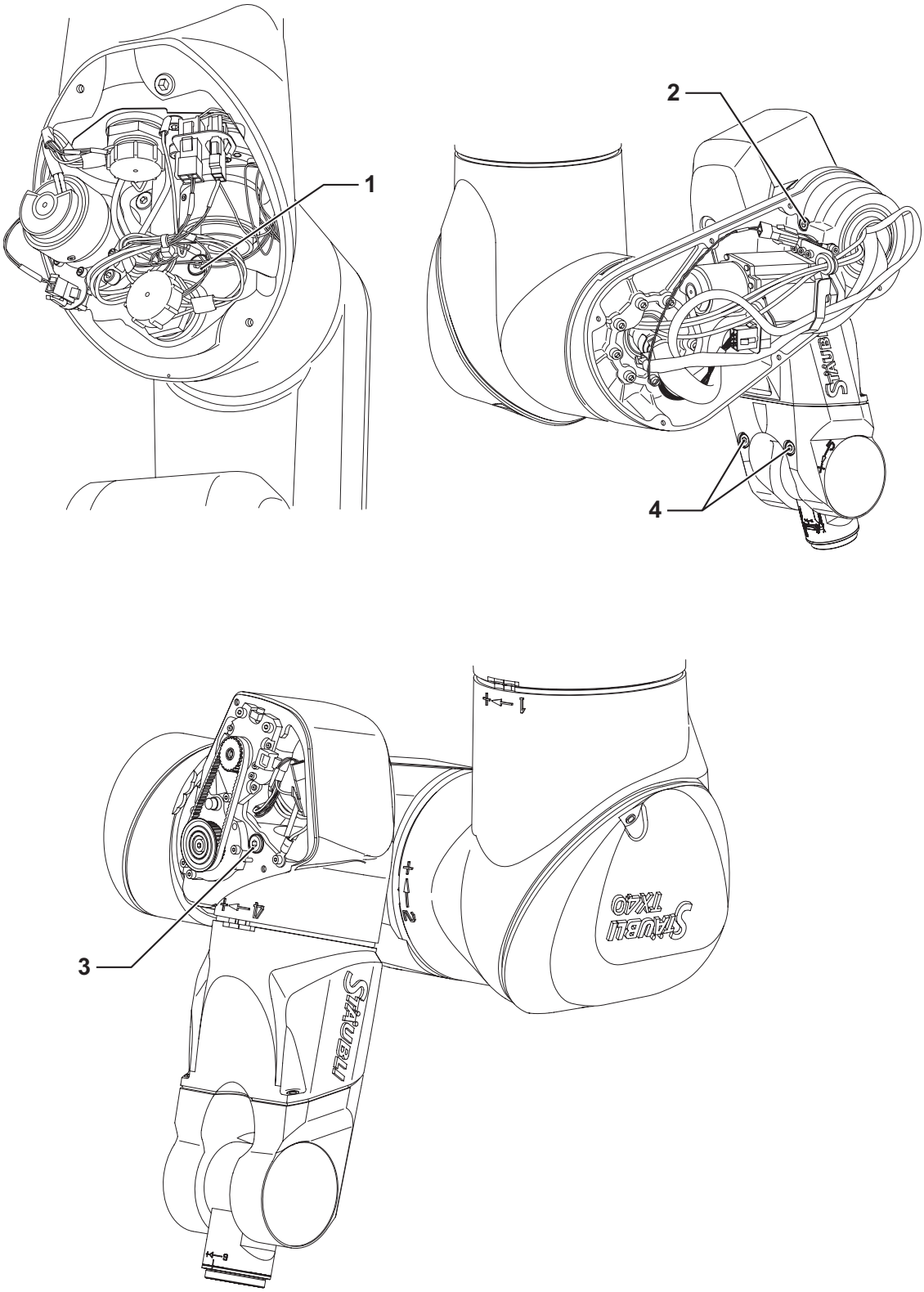


Figure 5.2

5.4.2. ARM IN CEILING-MOUNTED POSITION **(figure 5.2)**

5.4.2.1. SOFTWARE ANGULAR POSITION OF JOINTS FOR CHECKING LEVELS.

		Position				
		Joint 1	**Joint 2**	**Joint 3**	**Joint 4**	**Joint 5**
Check	Joint 1	0°	0°	0°	0°	0°
	Joint 2	0°	0°	0°	0°	0°
	Joint 3	0°	105°	-90°	0°	0°
	Joint 4	0°	105°	-90°	0°	0°
	Joints 5 and 6	0°	105°	-90°	0°	0°

5.4.2.2. LEVELS TO BE OBSERVED

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

- Joint 1:
    - Remove the arm from its support by proceeding in the reverse order to installation.
    - Place the arm in position on the floor.
    - Follow the arm on floor procedure.
- Joint 2: The oil level coincides with the base of hole after removing cap **(1)**.
- Joint 3: The oil level coincides with the base of hole after removing cap **(2)**.
- Joint 4: The oil level coincides with the base of hole after removing cap **(3)**.
- Joints 5 and 6: The oil should be flush with the bottom of the holes after the plugs **(4)** have been removed.

CAUTION:
Too much or too little oil can prevent the robot from operating correctly.

CHAPTER 6

RECOMMENDED SPARE PARTS

- Solenoid valve.
- MOBIL SHC 626 oil*.
- MOBIL SHC 639 oil*.
- Cover seal kit.

***Maximum oil quantity:**

• Axis 1:	SHC 626	300 cm^3
• Axis 2:	SHC 626	90 cm^3
• Axis 3:	SHC 639	80 cm^3
• Axis 4:	SHC 639	38 cm^3
• Wrist (5 and 6):	SHC 639	75 cm^3

CAUTION:
To ensure correct operation of the robot, it is essential to use original STÄUBLI parts when making repairs.