# TV800
# TV1000/TS3100
Industrial Robot

# INSTRUCTION MANUAL

## INDUSTRIAL ROBOT

## TRANSPORTATION AND INSTALLATION MANUAL

**Notice**

1. Make sure that this instruction manual is delivered to the final user of Toshiba Machine's industrial robot.
2. Before operating the industrial robot, read through and completely understand this manual.
3. After reading through this manual, keep it nearby for future reference.

December 2008

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# Preface

This manual describes the basic specifications of the industrial robot and controller, and how to unpack and install them. Specifically, it describes how to unpack the shipment containing the equipment, how to install the equipment, how to connect wiring and air piping, and how to attach tools. Be sure to look through this manual before unpacking the shipment.

Before beginning the work according to this manual, read through the Safety Manual so that you can understand the safety measures.

This manual is divided into the following five (5) sections:

Section 1 Specifications
This section describes the basic specifications and names of respective units of the robot and controller.

Section 2 Transportation
This section describes how to remove the robot and controller from their boxes and how to transport them to the installation site. This section also discusses how to temporarily store the equipment after unpacking the shipment.

Section 3 Installation
This section discusses the equipment installation environment, space requirements, and how to install the equipment.

Section 4 System Connections
This section describes how to connect the robot, controller and peripheral equipment.

Section 5 Tool Interface
This section describes how to connect the tool to the robot arm and how to connect pipes and wires to the tool. This section also discusses maximum permissible loads of the tool.

## Precautions on Safety

Important information on the robot and controller is noted in the instruction manual to prevent injury to the user and persons nearby, prevent damage to assets and to ensure correct use.
Make sure that the following details (indications and symbols) are well understood before reading this manual. Always observe the information that is noted.

[Explanation of indications]

| Indication | Meaning of indication |
|---|---|
| ! **DANGER** | This means that "incorrect handling will lead to fatalities or major injuries". |
| ! **WARNING** | This means that "incorrect handling will lead to fatalities or serious injuries." |
| ! **CAUTION** | This means that "incorrect handling may lead to personal injuries *1) or physical damage *2)". |

*1) Injuries refer to injuries, burns and electric shocks, etc., which do not require hospitalization or long term treatment.

*2) Physical damage refers to major fires due to destruction of assets or resources.

[Explanation of symbols]

| Symbol | Meaning of symbol |
|---|---|
| | This means that the action is prohibited (must not be done). The details of the actions actually prohibited are indicated with pictures or words in or near the symbol. |
| | This means that the action is mandatory (must be done). The details of the actions that must be done are indicated with pictures or words in or near the symbol. |
| | This means danger and caution.<br>The details of the actual caution are indicated with pictures or words in or near the symbol. |

**CAUTION**

- Always read through the Safety Manual provided separately before starting actual work to ensure safety work covering from the robot installation to operation.

[Installation and transportation]

Always observe the following items to safely use the robot.

| **DANGER** | |
|---|---|
| Prohibited | • DO NOT install or operate if any parts are damaged or missing.<br>Doing so could lead to electric shocks, fires or faults.<br>• DO NOT install the robot where it may be subject to fluids such as water. Doing so could lead to electric shocks, fires or faults.<br>• Do not place the robot near combustible matters. Doing so could lead to fires if the matter ignites due to a fault, etc. |
| Mandatory | • Always secure the robot with the attached clamps before transporting it. Failure to do so could lead to injuries if the arm moves when the robot is suspended.<br>• Wire the robot after installation.<br>Wiring the robot before installation could lead to electric shocks or injuries.<br>• Always use the power voltage and power capacity designated by Toshiba Machine. Failure to do so could lead to device faults or fires.<br>• Always use the designated power cable. Using a cable other than that designated could lead to fires or faults. |
| Always ground | • Completely connect the grounding cable. Failure to do so could lead to electric shocks or fires if a fault or fault current occurs. Noise could lead to malfunction.<br>Also, it could cause mis-operation by noise. |

| **CAUTION** | |
|---|---|
| Prohibited | • NEVER lift the robot by the arm 1 cover or arm 2. Doing so will apply an excessive force on the robot's mechanism section and could lead to faults.<br>• For the controller, secure the ample space for air vent. Heating of controller could lead to malfunction. |
| Mandatory | • When lifting the robot, lift it up slowly. The robot will tilt slightly, so lifting it up suddenly could be hazardous.<br>• When storing the robot, secure it to the base. The robot will be unstable if just set down, and it could tilt over. |

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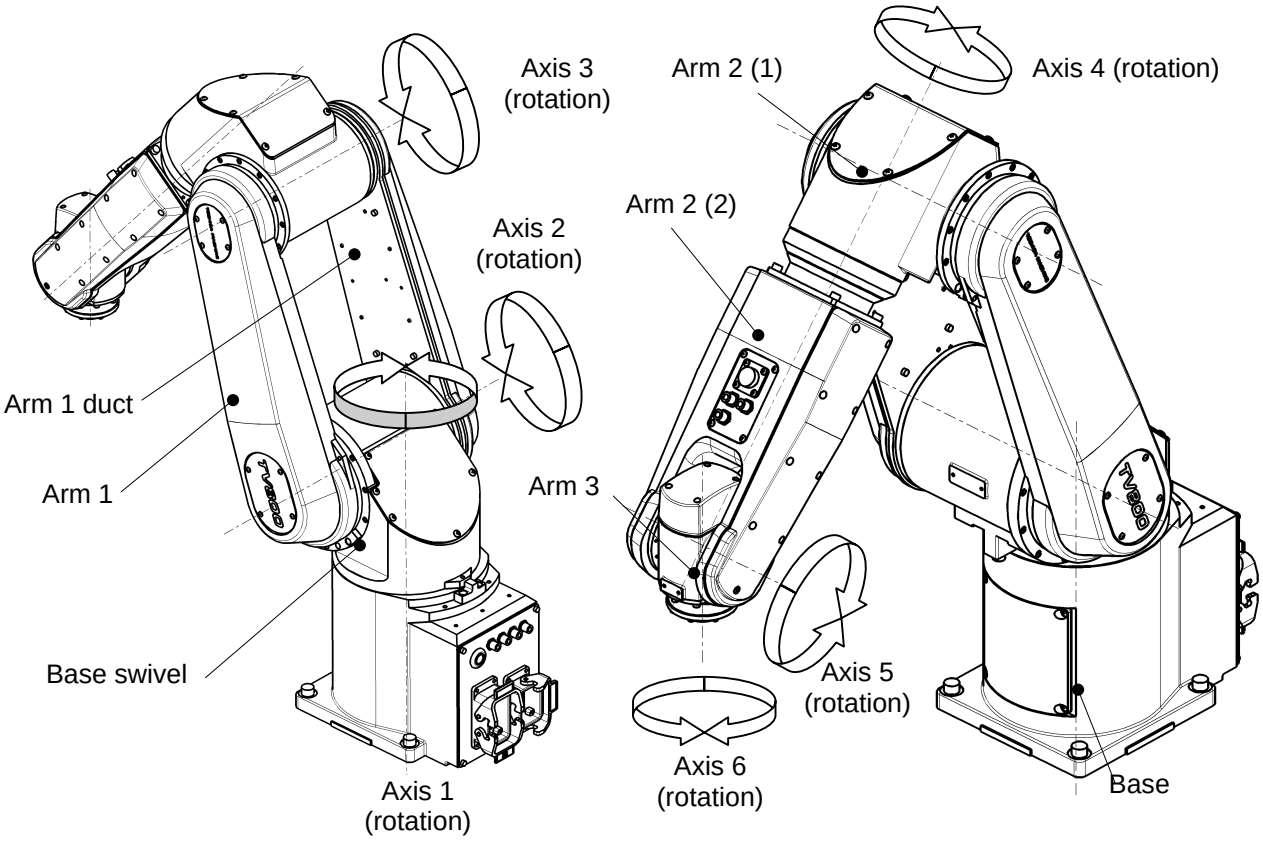
# 1. Specifications

## 1.1 Name of Each Part

Fig. 1.1 shows the name of each part of the robot.



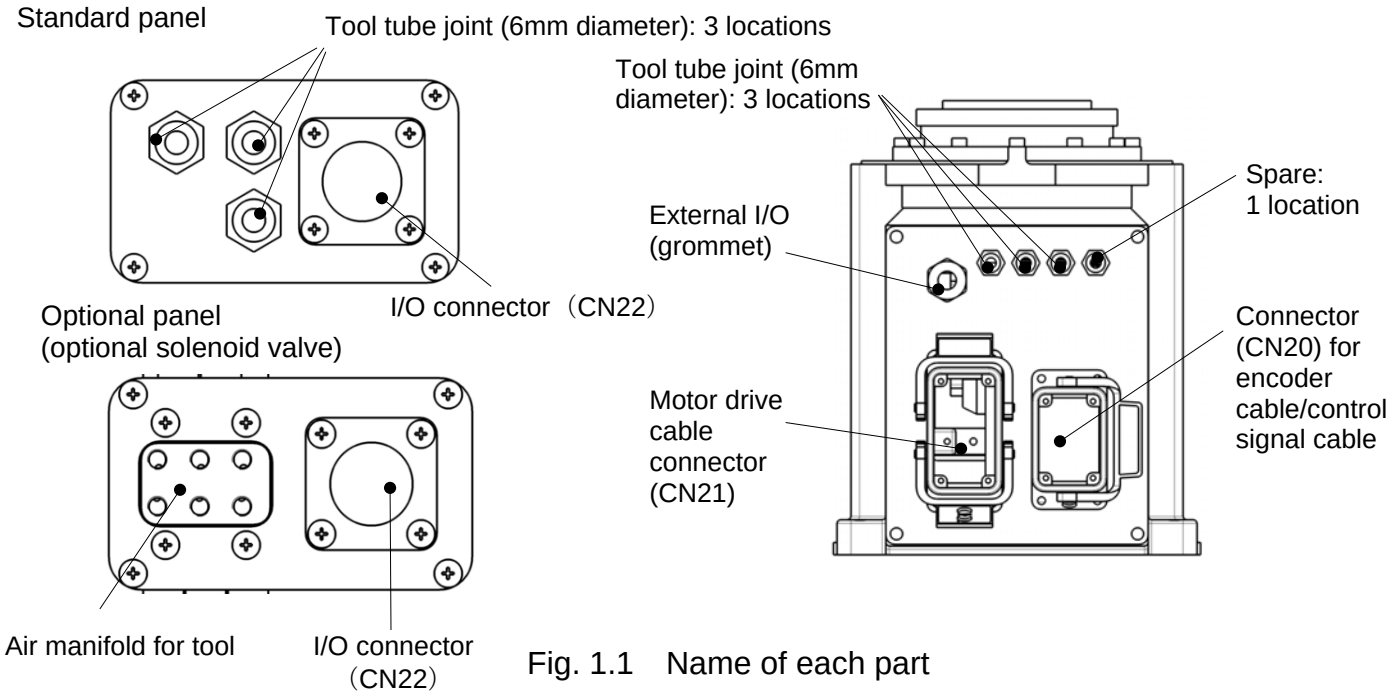




Fig. 1.1 Name of each part

## 1.2 External Dimensions

Fig. 1.2 and Fig. 1.3 refers to the external dimensions of the robot.

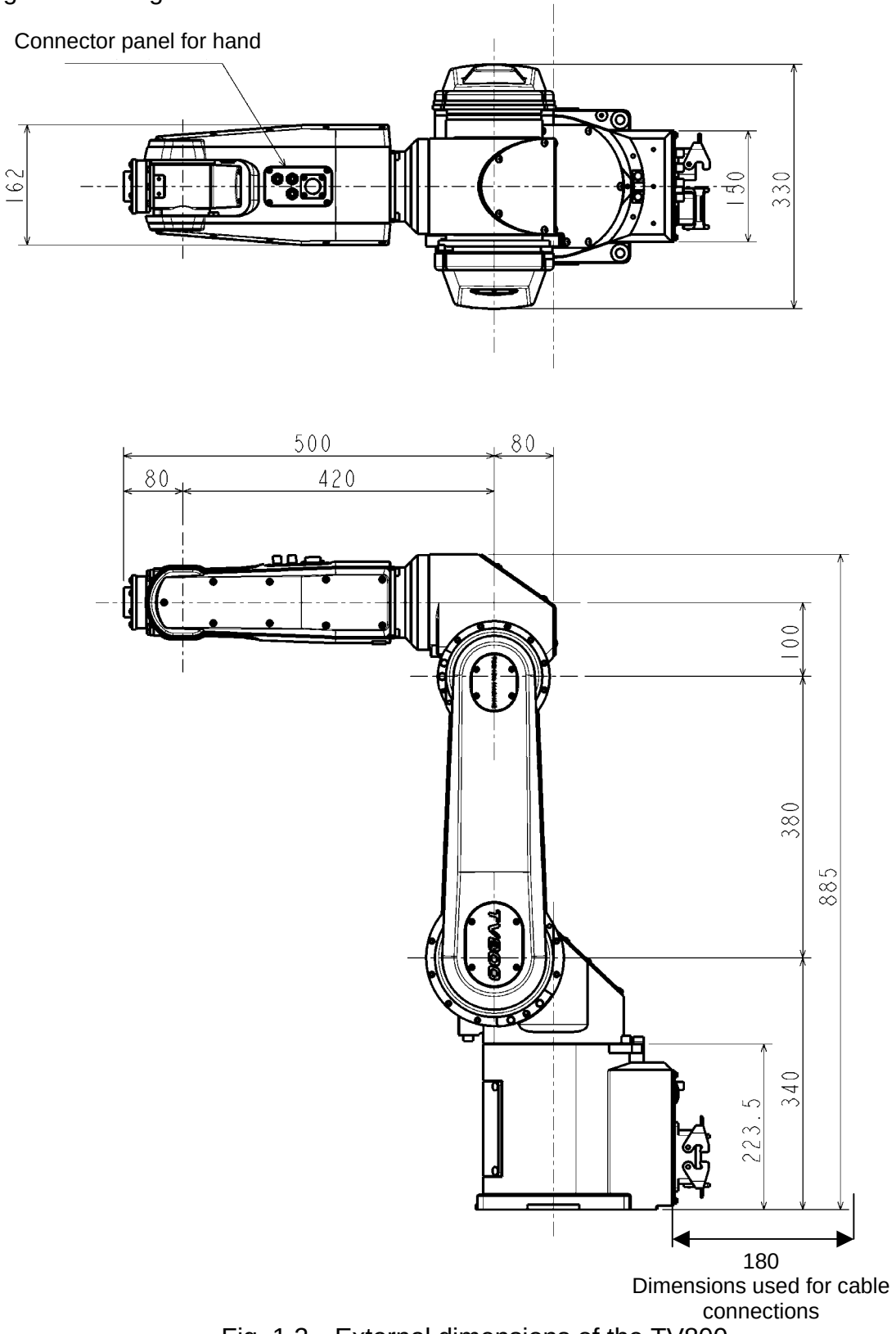



Fig. 1.2 External dimensions of the TV800

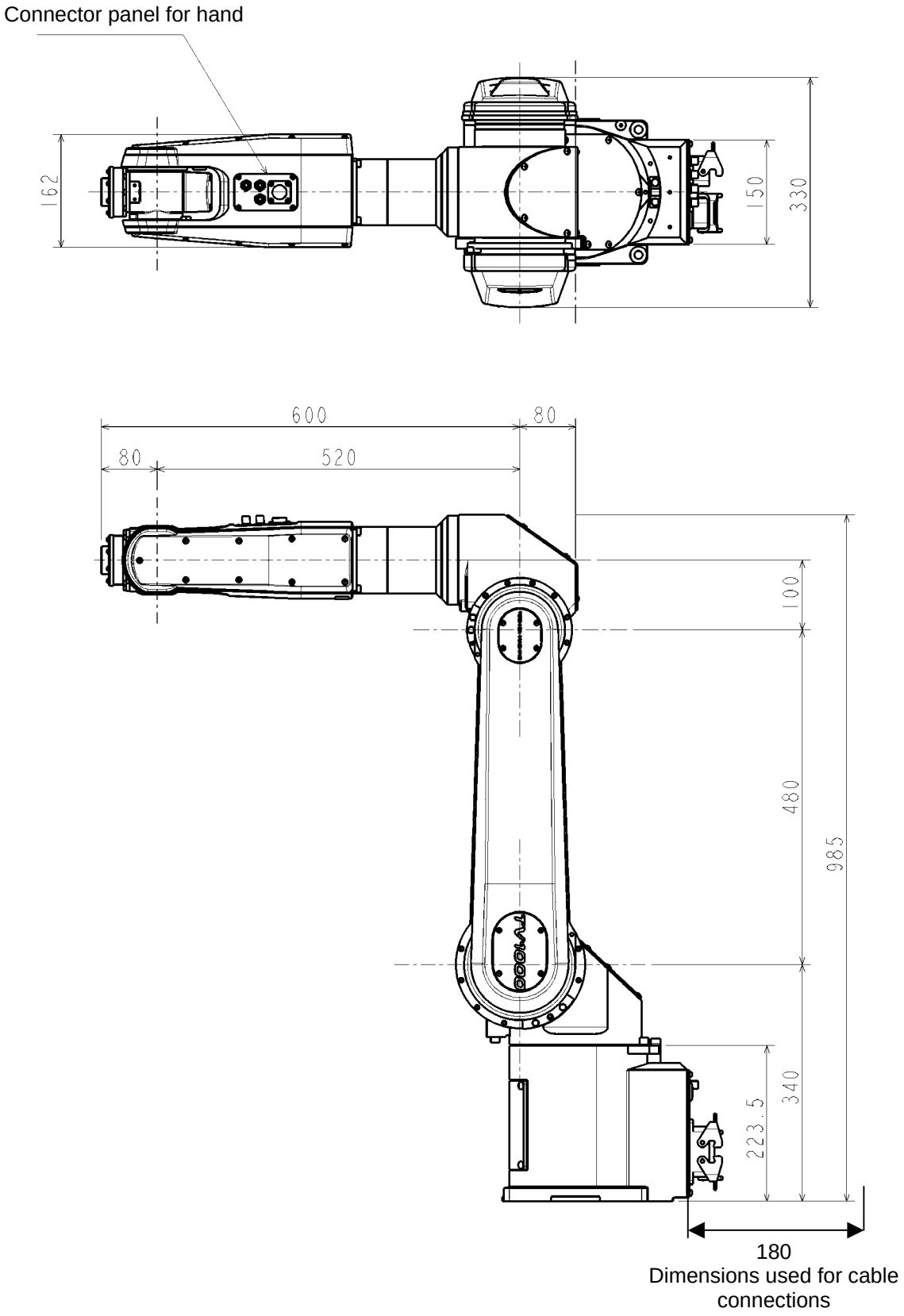



Fig. 1.3 External dimensions of the TV1000

## 1.3 Specifications Table

| Item | | Specifications | | | |
|---|---|---|---|---|---|
| Structure | | Vertical multi-joint 6-axis robot | | | |
| Model | | TV800 | TV800-BL | TV1000 | TV1000-BL |
| Applicable controller | | TS3100 | | | |
| Mass of actuator | | 45.5kg | | 47kg | |
| No. of controlled axes | | 6 | | | |
| Arm length | | 800mm (380mm + 420mm)<br>Reach: 892mm | | 1000mm (480mm + 520mm)<br>Reach: 1090mm | |
| Operating range | Axis 1 | ±170 (deg) | | | |
| | Axis 2 | +150 to -100 (deg) | | | |
| | Axis 3 | +167 to -127 (deg) | | | |
| | Axis 4 | ±190 (deg) | | | |
| | Axis 5 | ±120 (deg) | | | |
| | Axis 6 | ±360 (deg) | | | |
| Maximum speed *2 | Axis 1 | 237 (deg/s) | | | |
| | Axis 2 | 240 (deg/s) | | | |
| | Axis 3 | 288 (deg/s) | | | |
| | Axis 4 | 350.5 (deg/s) | | | |
| | Axis 5 | 484 (deg/s) | | | |
| | Axis 6 | 576 (deg/s) | | | |
| | Maximum composite speed | 8058 (mm/s) | | 9610 (mm/s) | |
| Rated payload mass | | 2 (kg) | | | |
| Maximum payload mass | | 5 (kg) | | | |
| Maximum allowable inertia moment around axes 4 and 5 | | 0.3 (kg•$m^2$) *1 | | | |
| Maximum allowable inertia moment around axis 6 | | 0.05 (kg•$m^2$) *1 | | | |
| Repeatability | X, Y, Z | ±0.02 (mm) *2 | | ±0.03 (mm) *2 | |
| Cycle time *3 | | 0.4 (sec) unit | | 0.6(sec) unit | |
| Drive system | | AC servomotor<br>All axes with a motor brake | AC servomotor<br>Axes 1, 4, and 6 with no motor brake *4 | AC servomotor<br>All axes with a motor brake | AC servomotor<br>Axes 1, 4, and 6 with no motor brake *4 |
| Position detection method | | Absolute | | | |

*1: The speed and acceleration are limited in accordance with the operation pattern, the load mass, and the offset value.
*2: In environment in which the ambient temperature is constant
*3: Continuous operation cannot be performed if the effective load factor of the standard cycle operation pattern is exceeded.
Shuttle time for rough positioning in horizontal direction of 300 mm and vertical direction of 25 mm
*4: The axes 2, 3, and 5 are equipped with a motor brake.

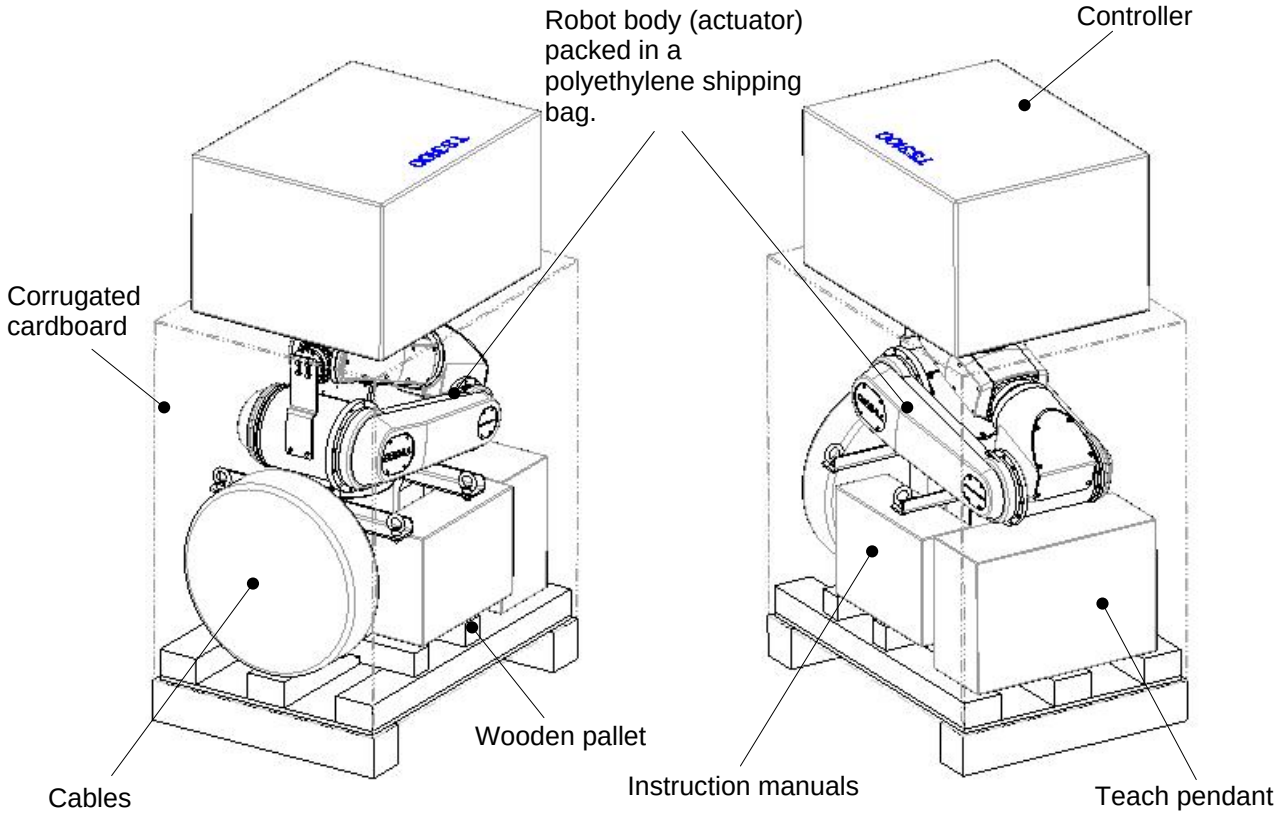
## 2. Transportation

### 2.1 Unpacking

The robot and controller are shipped separately in corrugated cardboards. Fig. 2.1 shows each packaging state.

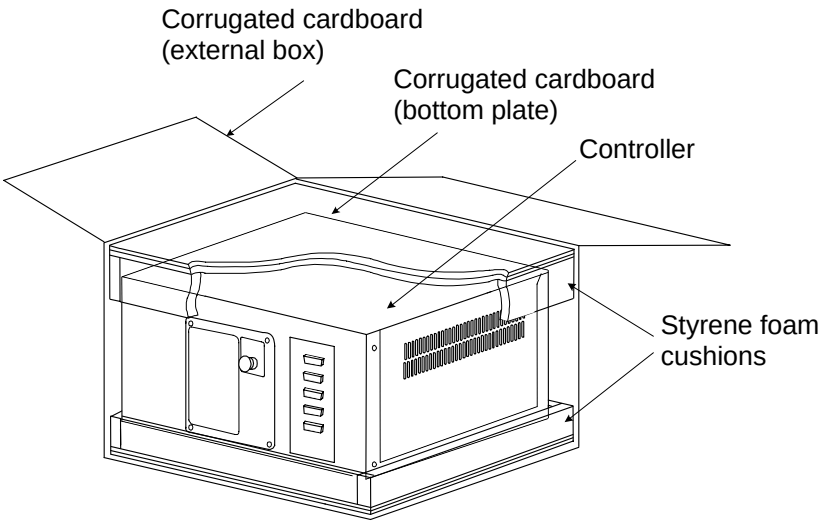
Open the packages in a location easily accessible, where the equipment is to be installed. Take careful precautions not to damage the robot and controller.

After opening the packages, make sure that all the accessories are present and that nothing has been damaged during transport.




Accessories included in the instruction manuals

| | |
|---|---|
| System floppy disk: | 3 pcs. |
| CD-ROM for TCPRGOS (option): | 1 pc. |
| CD-ROM for TSPC6axis (option): | 1 pc. |




Accessories included in the controller package
EMS dummy connector: 1 pc.
SYSTEM dummy connector: 1 pc.
TP dummy connector: 1 pc.

Fig. 2.1 Packaging state

**DANGER**

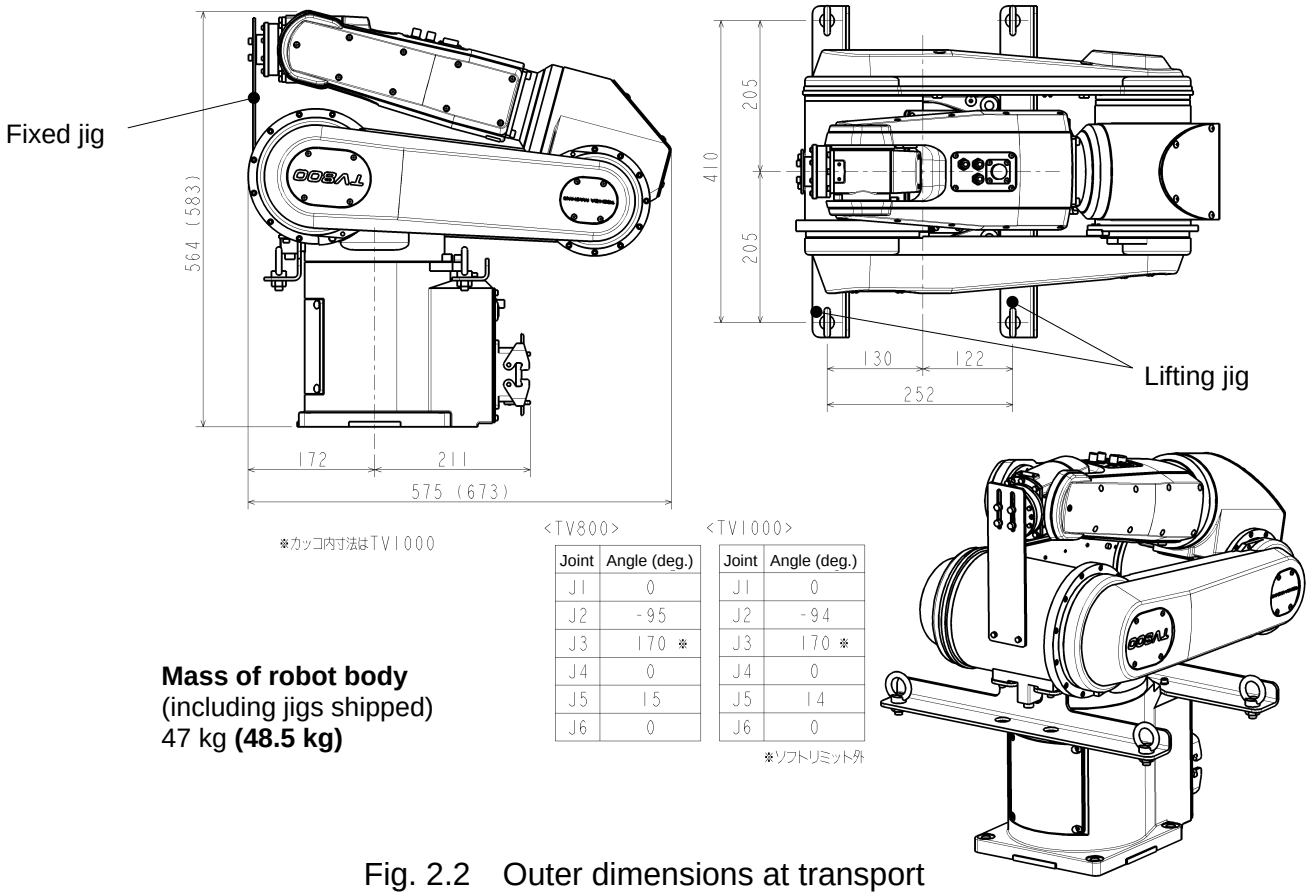
- If any parts of the equipment are found damaged or any accessories are missing after the shipment containing the robot and controller have reached your office, DO NOT install and operate them. Otherwise, the equipment will malfunction. Contact Toshiba Machine immediately.
- Dispose of the wooden pallet, corrugated cardboards, polyethylene shipping bags and cushion material according to the customer's in-house regulations.

## 2.2 Transportation

Move the robot and controller very carefully. Make sure that no excessive impact or vibration is exerted on the equipment. If the equipment is to be subject to vibration over a long period, be sure to tighten all the clamp and base set bolts completely.
If the equipment is to be moved to a location some distance from where it was unpacked, reposition the cushions as they were and put the equipment back into the corrugated cardboards.

### 2.2.1 Mass and Dimensions

The mass and outer dimensions of the robot are shown in Fig. 2.2.
For the mass and outer dimensions of the controller, see Fig. 3.18 of Para. 3.4.1.




<TV800>

| Joint | Angle (deg.) |
|---|---|
| J1 | 0 |
| J2 | -95 |
| J3 | 170 ※ |
| J4 | 0 |
| J5 | 15 |
| J6 | 0 |

<TV1000>

| Joint | Angle (deg.) |
|---|---|
| J1 | 0 |
| J2 | -94 |
| J3 | 170 ※ |
| J4 | 0 |
| J5 | 14 |
| J6 | 0 |

※ソフトリミット外

**Mass of robot body**
(including jigs shipped)
47 kg **(48.5 kg)**

Fig. 2.2 Outer dimensions at transport

### 2.2.2 Transporting the Robot

In principle, the robot should be transported in the state shown in Fig. 2.2 above. Fold back and secure the arm with the attached clamp. (The robot is shipped in this posture. After you have unpacked the shipment, you should move it as it is.)

**! DANGER**

- Be sure to secure the arm with the attached clamp before transporting the robot. Failure to do so could cause a hazardous situation as the arm will move when the robot is lifted.

It is possible to lift up and transport the robot. Pass the wire through the attached eyebolt, then lift up the robot carefully, as shown in Fig. 2.3.

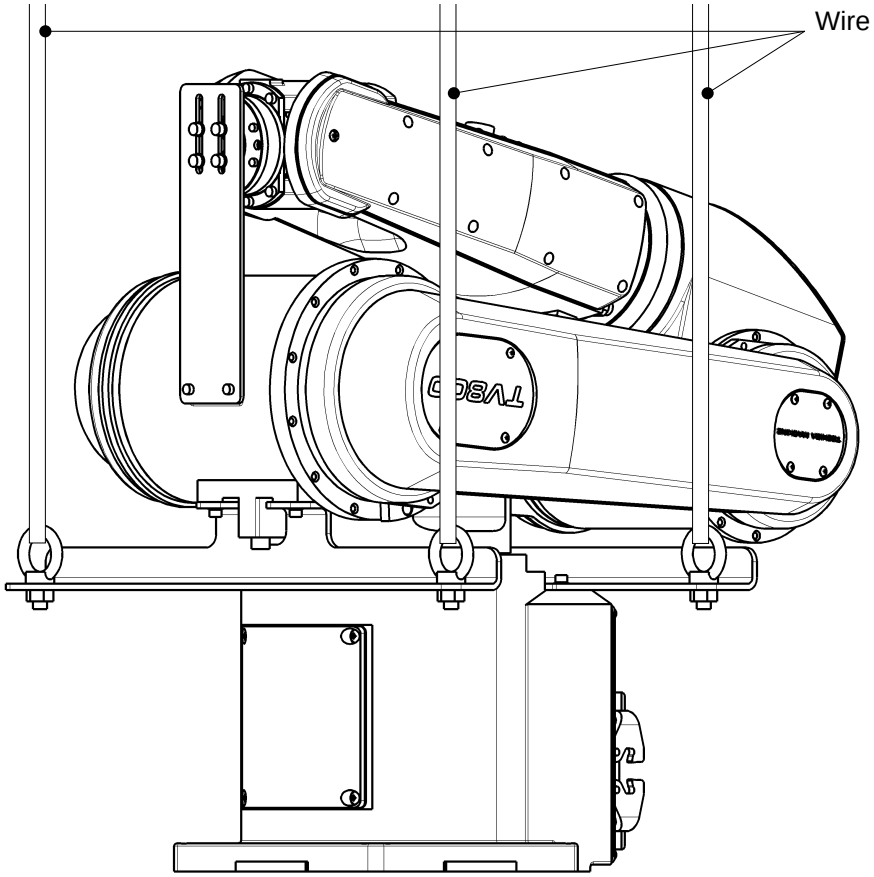



Fig. 2.3 Lifting up the robot

**! CAUTION**

- The wire to be used should be such that can well withstand the mass of the robot.
- When lifting up the robot, it may tilt a little. Lift it up slowly.
- Lifting up and down should be performed carefully so that any impact cannot be exerted on the robot.
- When carrying the robot by workers, take careful precautions to prevent their hand or leg from being caught in the robot.

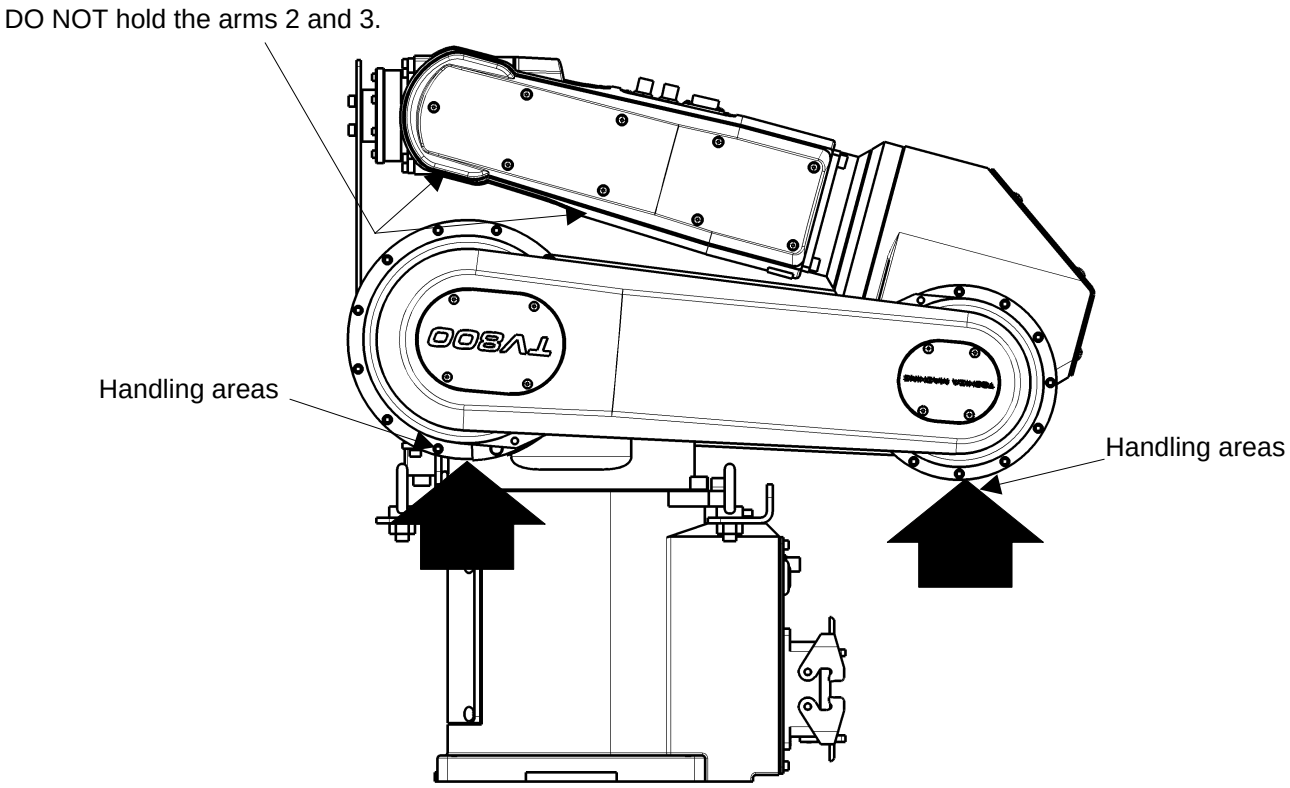



Fig. 2.4 Robot handling areas

After the installation, remove the clamp and eyebolt used for transport.

**! CAUTION**

- Do not remove the fixing brackets when transporting the TV800-BL/TV1000-BL. Doing so can cause the rotation of the axes with no motor brake.
- When lifting up the robot by workers, hold the locations (arrowed parts) by hands as shown in Fig. 2.4. If the arm 2 and arm 3 are held by hands, an unusually large force is exerted, resulting in a malfunction.
- When carrying the robot by workers, take careful precautions to prevent their hand or leg from being caught in the robot.
- Do not hold the arm-1 duct cover when handling the robot. Otherwise, it will be deformed.
- The work should be performed by three or more workers.

### 2.2.3 Transporting the Controller

Disconnect all cables and teach pendant before transporting the controller.

**! DANGER**

- When placing the controller on the floor, etc., make sure not to have your hands or feet caught.

## 2.3 Storage

Avoid storing the robot and controller for long periods of time after unpacking them. If this is unavoidable, however, strictly observe the following precautions for storage.

### 2.3.1 Storage Precautions for the Robot

**! CAUTION**

- Secure the base completely to prevent the robot from falling over. When placed directly on the floor, the robot is unstable and will fall over.
- Keep the robot out of direct sunlight. The timing belts and resin covers may deteriorate.
- Seal the robot in a vinyl bag to prevent rust development and contaminant. Put a desiccant in the bag to absorb moisture.
- Before starting an operation, perform running completely.
- During storage, the life of the backup batteries will shorten. It is recommended to replace the batteries at the time of operation.

### 2.3.2 Storage Precautions for the Controller

**! CAUTION**

- Keep the controller out of direct sunlight. Otherwise, the controller interior will be excessively heated up, causing a trouble.
- Seal the controller in a vinyl bag to prevent rust development and contaminant. Put a desiccant in the bag to absorb moisture.

# 3. Installation

## 3.1 Installation Environment

Table 3.1 shows the environmental conditions for the location in which the robot and controller are to be installed.

Table 3.1 Environmental conditions for robot and controller

| Item | Specifications |
|---|---|
| Temperature | In operation : 0 to 35°C *1<br>In storage : –10 to 50°C |
| Humidity | 20 to 90 % (Non-condensing)<br>DO NOT install the robot where it may be subject to fluids such as water. |
| Altitude | 1000 m or less |
| Vibration | In operation : 0.98m/s$^2$ or less |
| Dust | No inductive dust should exist.<br>Consult with Toshiba Machine first if you wish to use the robot and controller in a dusty environment. |
| Gas | No corrosive or combustible gas should exist. |
| Sunlight | The robot and controller should not be exposed to direct sunlight. |
| Power noise | A heavy noise source should not exist nearby. |
| Magnetic field | A heavy magnetic field source should not exist nearby. |

*1: If the robot is used in a place where the temperature rises to 35°C or more, pay special attention to the ambient temperature when the robot is operating. Consider the cooling of the robot body as needed. Please ask us for the cooling of the robot.

**! DANGER**

- Do not place the robot or controller near combustible. Doing so could lead to fires if it ignites due to a fault, etc.

## 3.2 Robot Installation

Before the robot can be installed, the installation layout must be studied in consideration of the presence/absence of motor brakes, the working envelope, the coordinate system, and the maintenance clearance.
Particularly, the installation layout of the TV800-BL/TV1000-BL (without axis-1, axis-4, and axis-6 motor brakes) must be well studied so that the force of gravity will not act in the rotation directions of any axes not having a motor brake.

### 3.2.1 External Dimensions

External view drawing of the robot is shown in Fig. 3.1 and in Fig. 3.2.

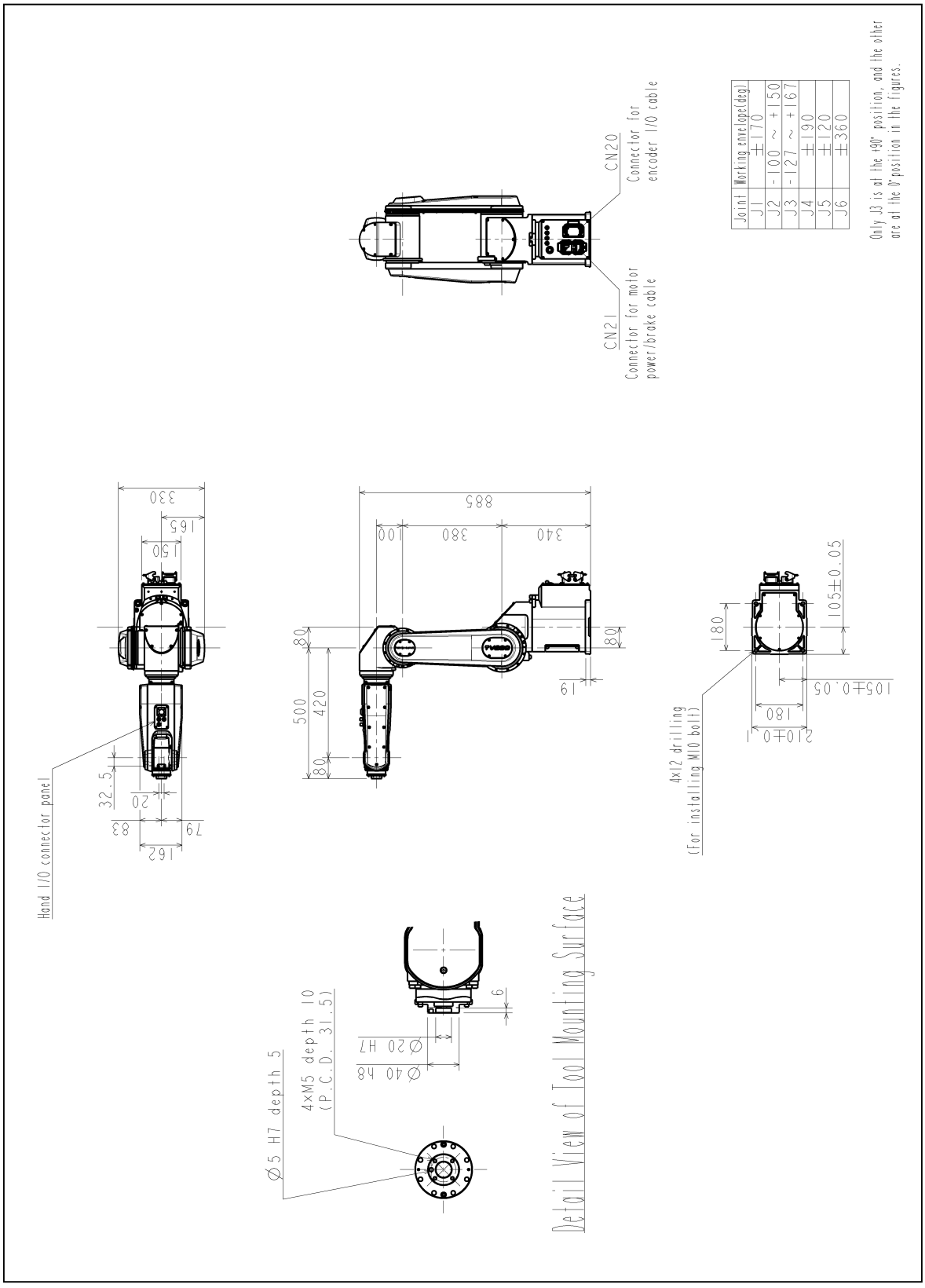



Fig. 3.1 External view TV800

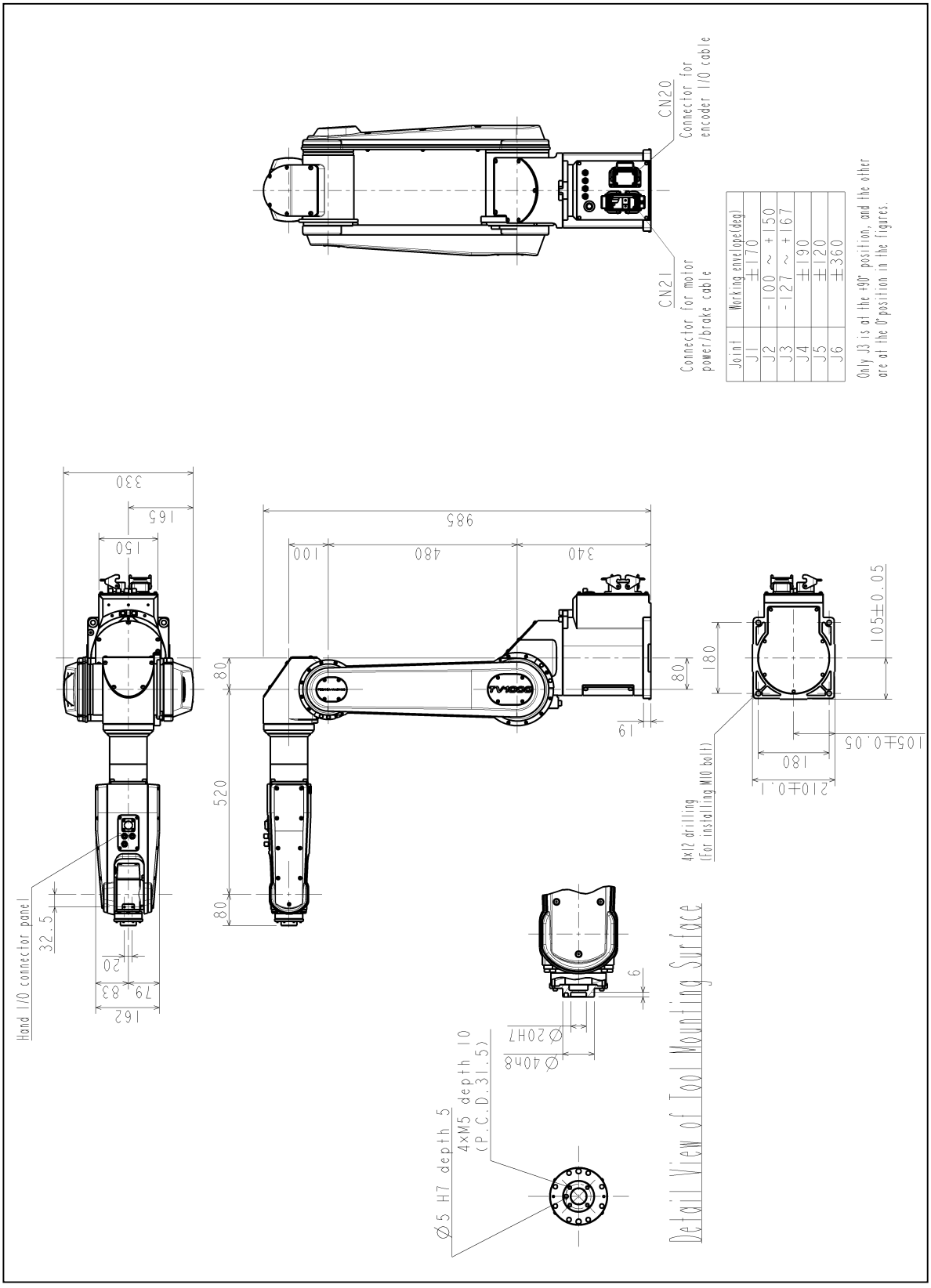



Fig. 3.2 External view TV1000

### 3.2.2 Working Envelope

Fig. 3.3 and Fig. 3.4 shows the working envelope of the robot.
Each axis can operate within the working envelope. To prevent the robot from moving out of the working envelope by mis-operation, the robot is equipped with mechanical stoppers (mechanical ends) outside the working envelope. Additionally, soft limits which can be set by the user are provided. For further information, see the user parameter instruction manual provided separately.

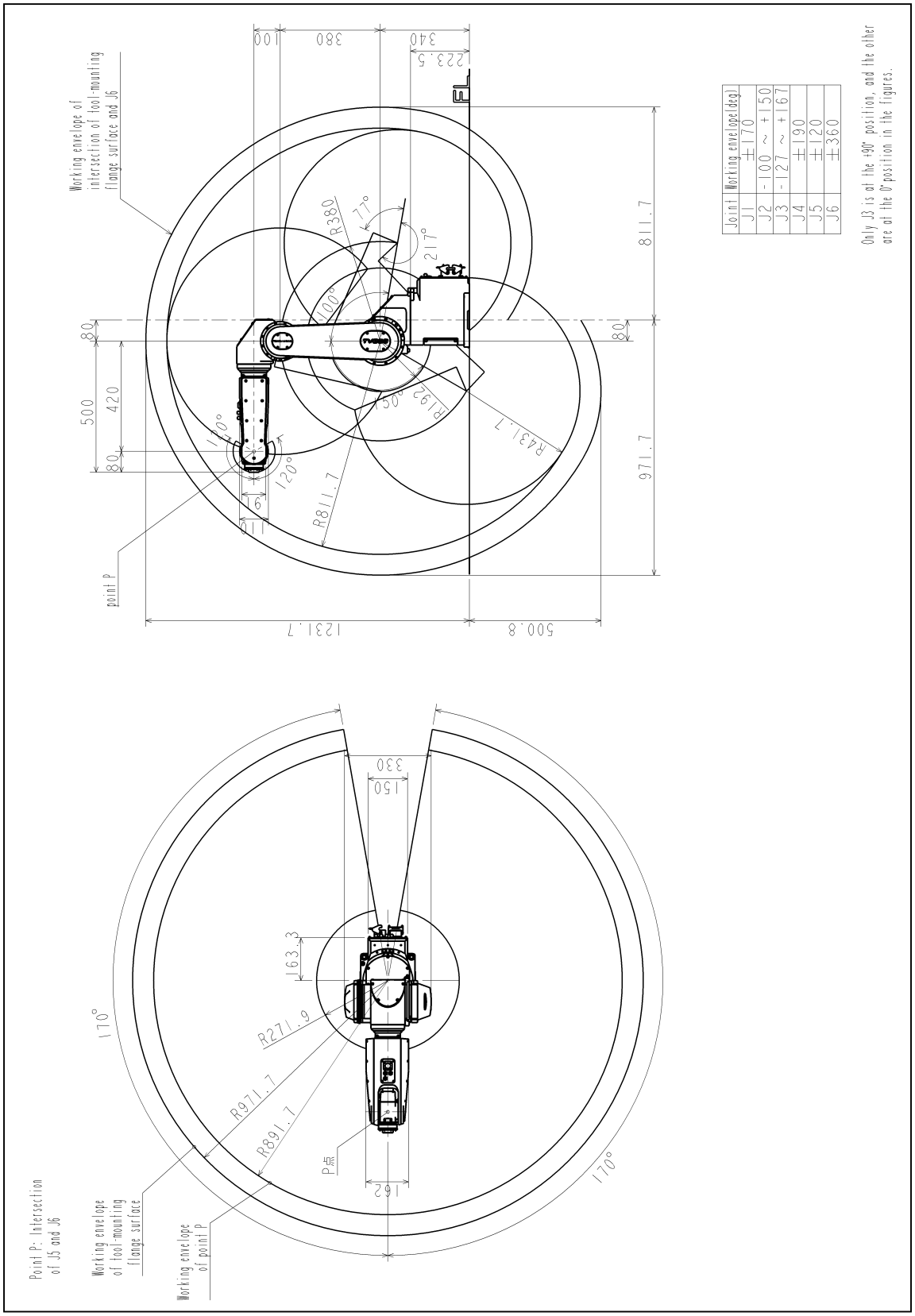



Fig. 3.3 Working envelope TV800

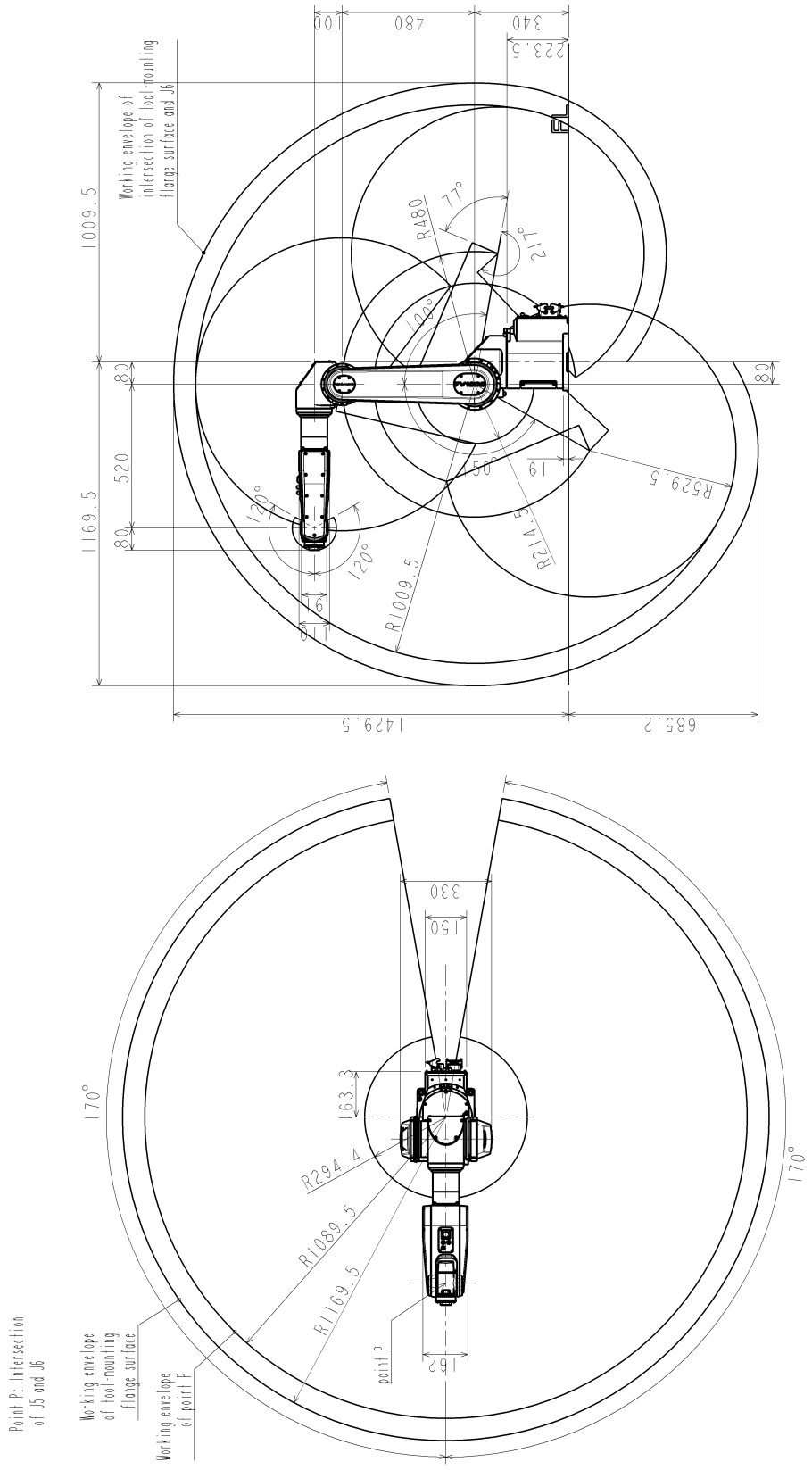
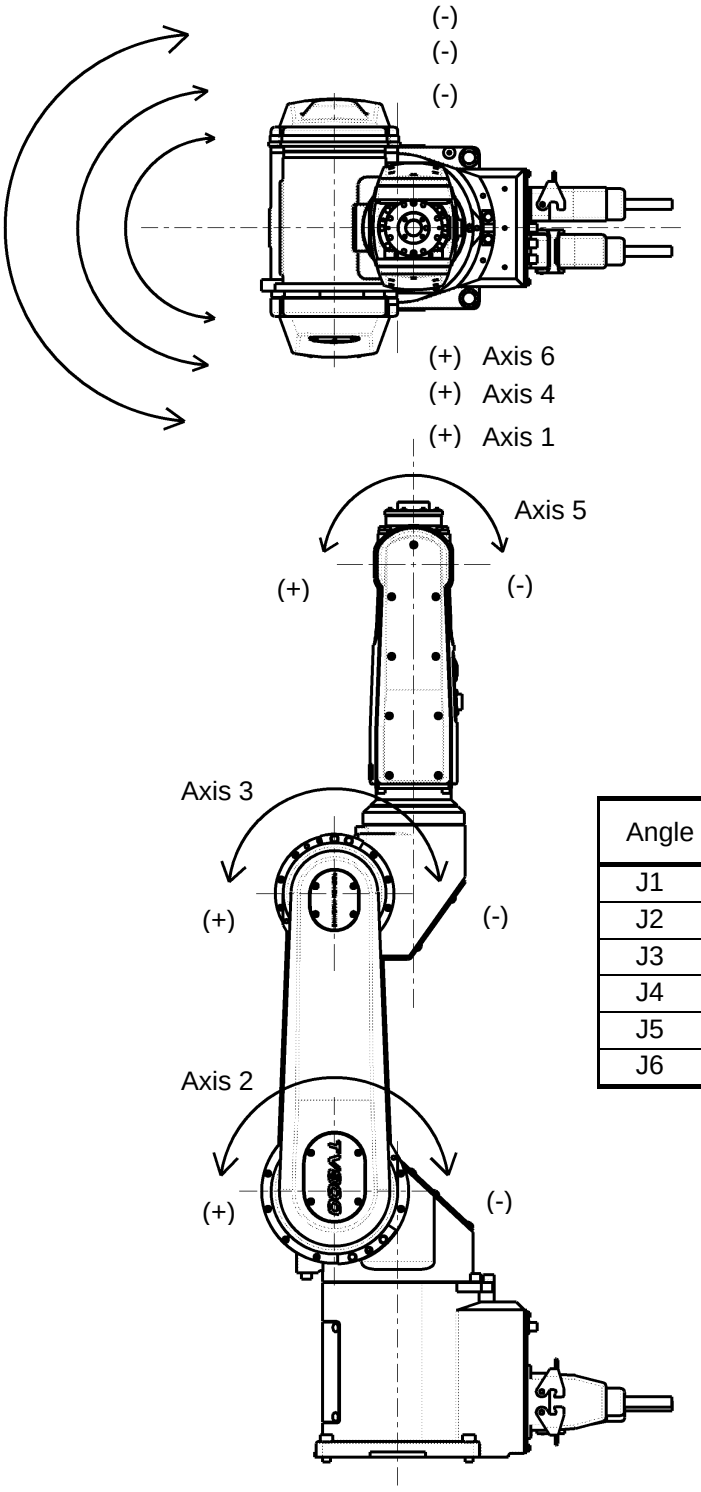



Fig. 3.4 Working envelope TV1000

### 3.2.3 Coordinate System

The robot's joint angle origin (0° position) is factory-calibrated according to the base reference planes. Fig. 3.5 shows the base coordinate system and origin of each axis joint angle.




| Angle of axis | | Base coordinate system | |
|---|---|---|---|
| J1 | 0° | X | -20 |
| J2 | 0° | Y | 0 |
| J3 | 0° | Z | 1220 |
| J4 | 0° | A | 0 |
| J5 | 0° | B | 0 |
| J6 | 0° | C | 0 |

Fig. 3.5 Base coordinate system and joint angle origin

### 3.2.4 Installing the Robot

The robot is secured, using the set holes on the base (four (4) places). Use M10 hexagon socket head cap screws.

The robot installation method is shown in Fig. 3.6. Reference planes are provided on the base unit.

To align the robot position in the base coordinate system, or to replace the robot, provide adequate reference planes. Then, contact such reference planes to the base reference planes and secure the robot.

**! CAUTION**

- The robot will suddenly accelerate and decelerate during operation. When installing it on a frame, make sure that the frame has sufficient strength and rigidity.

  If the robot is installed on a frame that does not have sufficient rigidity, vibration will occur while the robot is operating, and could lead to faults.

  When installing the robot on the floor, secure the robot with anchor bolts, etc.
- Install the robot on a level place. Failure to do so could lead to a drop in performance or faults.

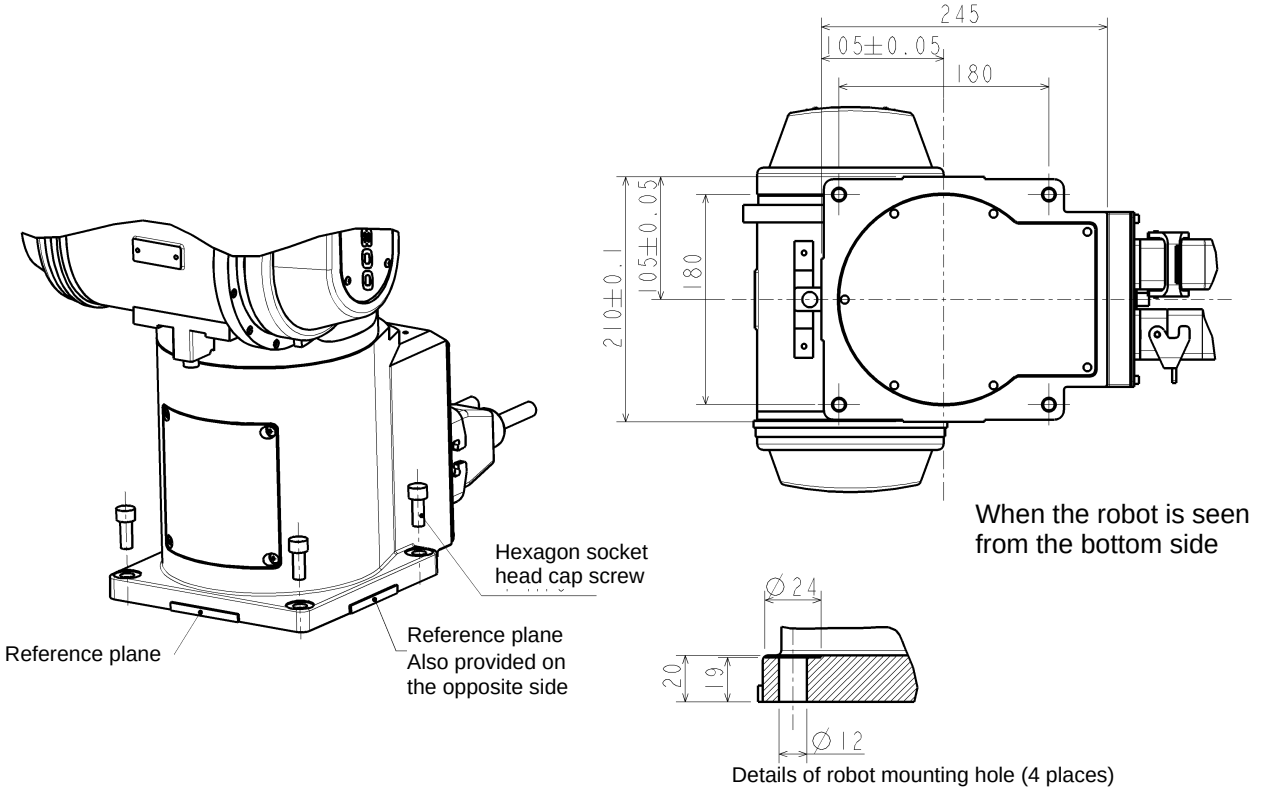



Fig. 3.6 Setting method

## 3.3 Mechanical End Change

This section explains the change of mechanical ends for the axes 1 to 3 of the TV800/TV1000.

**! CAUTION**

- If mechanical ends are to be changed, design and manufacture mechanical stoppers in accordance with your operating conditions, referring to this manual.
- If mechanical ends are changed after the mechanical stoppers, be sure to change the soft limits in order to prevent the robot from coming into contact with the mechanical stoppers during operation.
- The mechanical stoppers are not to strictly limit the movable range of the robot. Do not go into the robot's working envelope when you turn on the robot.
- If the robot collides with a mechanical stopper, the robot will stop recognizing the collision, but the mechanical stopper may be damaged. Do not use the mechanical stopper any more.
- The mechanical stopper reference drawings in this manual do not satisfy your operating conditions. Design, manufacture, and mount mechanical stoppers in accordance with your operating conditions such as the working envelope.
- A robot failure arising from mechanical stoppers is excluded from the warranty.

### 3.3.1 Change of Axis-1 Mechanical Ends

<1> Change of axis-1 mechanical ends

The change of axis-1 mechanical ends by adding or changing a mechanical stopper is called mechanical end change.

The TV800/TV1000 is shipped while the soft limits and mechanical ends are factory-set for axis 1 to travel between ±171°.

Fig. 3.7 shows the factory-set mechanical ends.

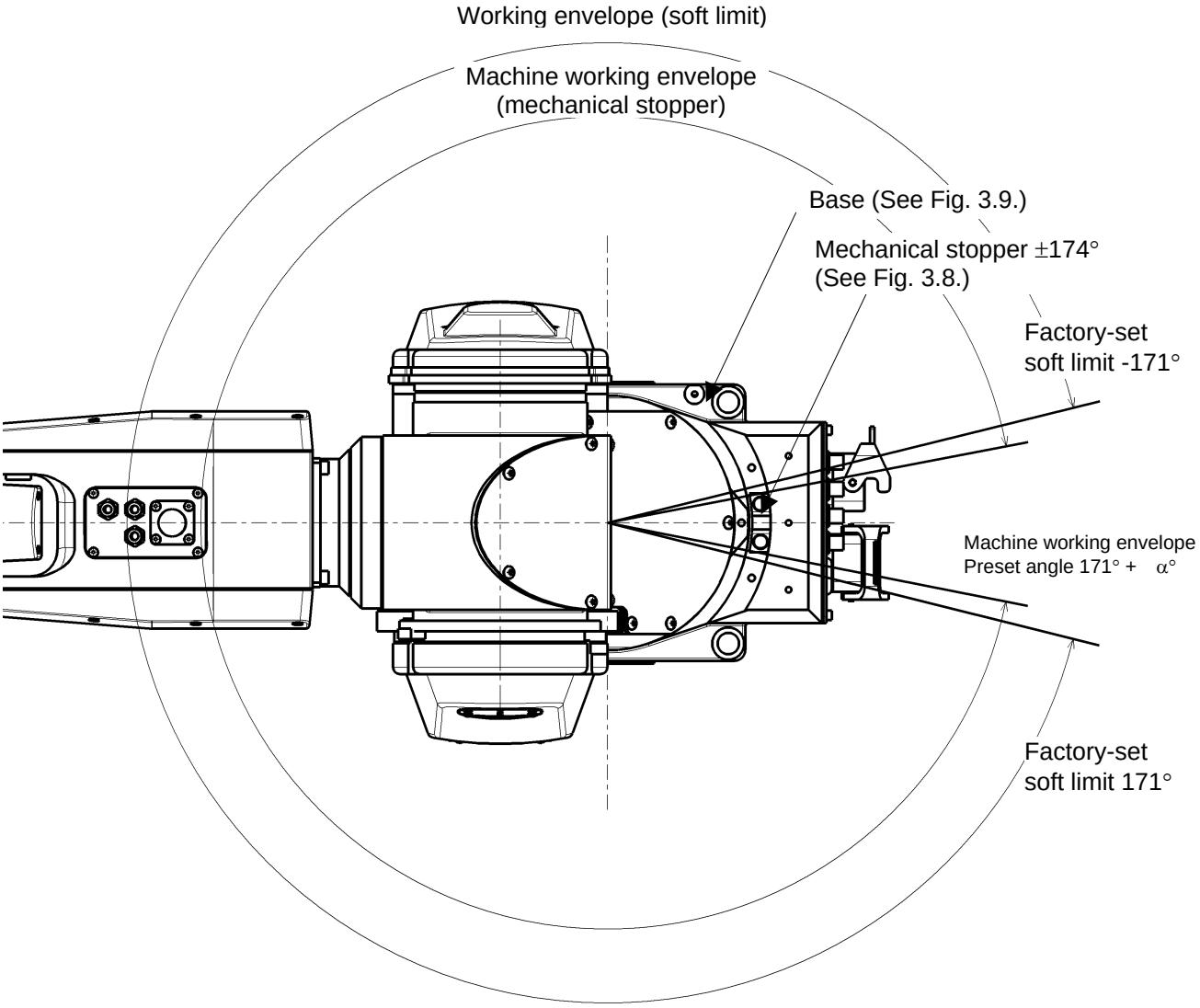



Fig. 3.7 Axis-1 mechanical end setting

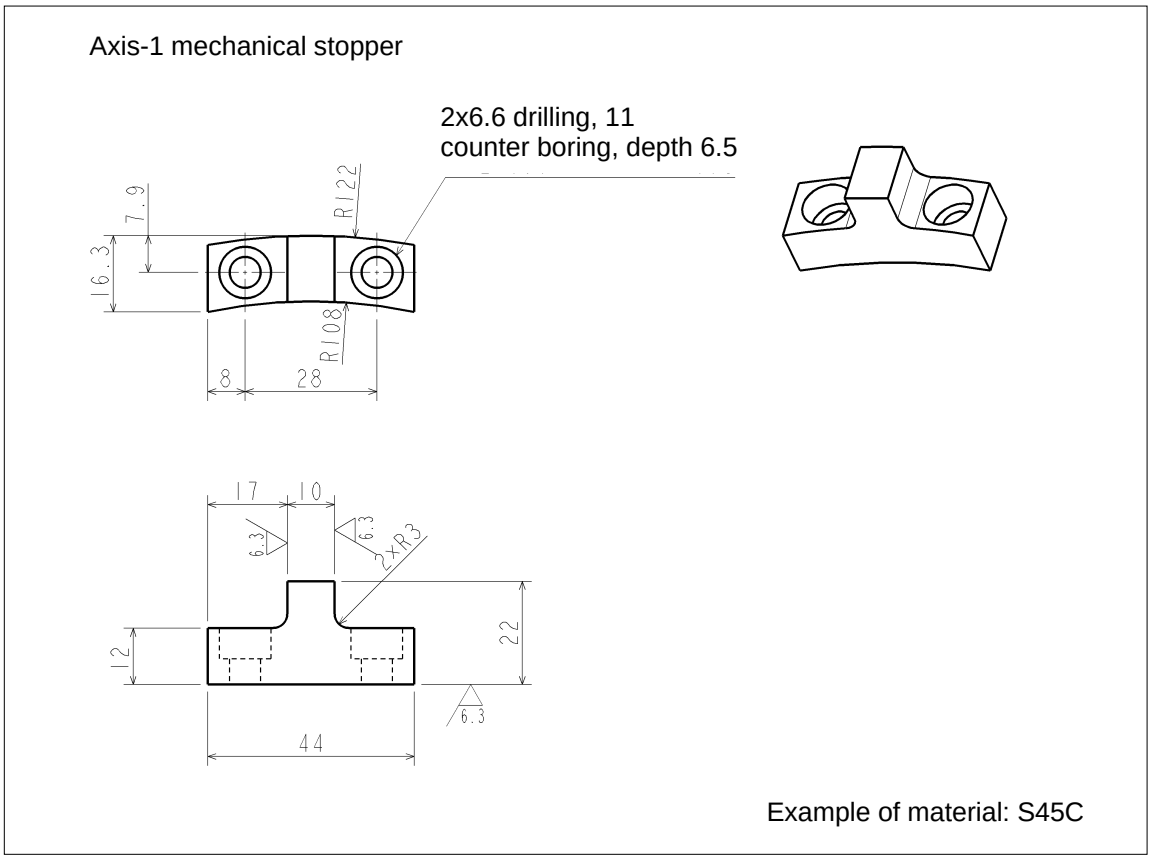



Fig. 3.8 Factory-set mechanical stopper

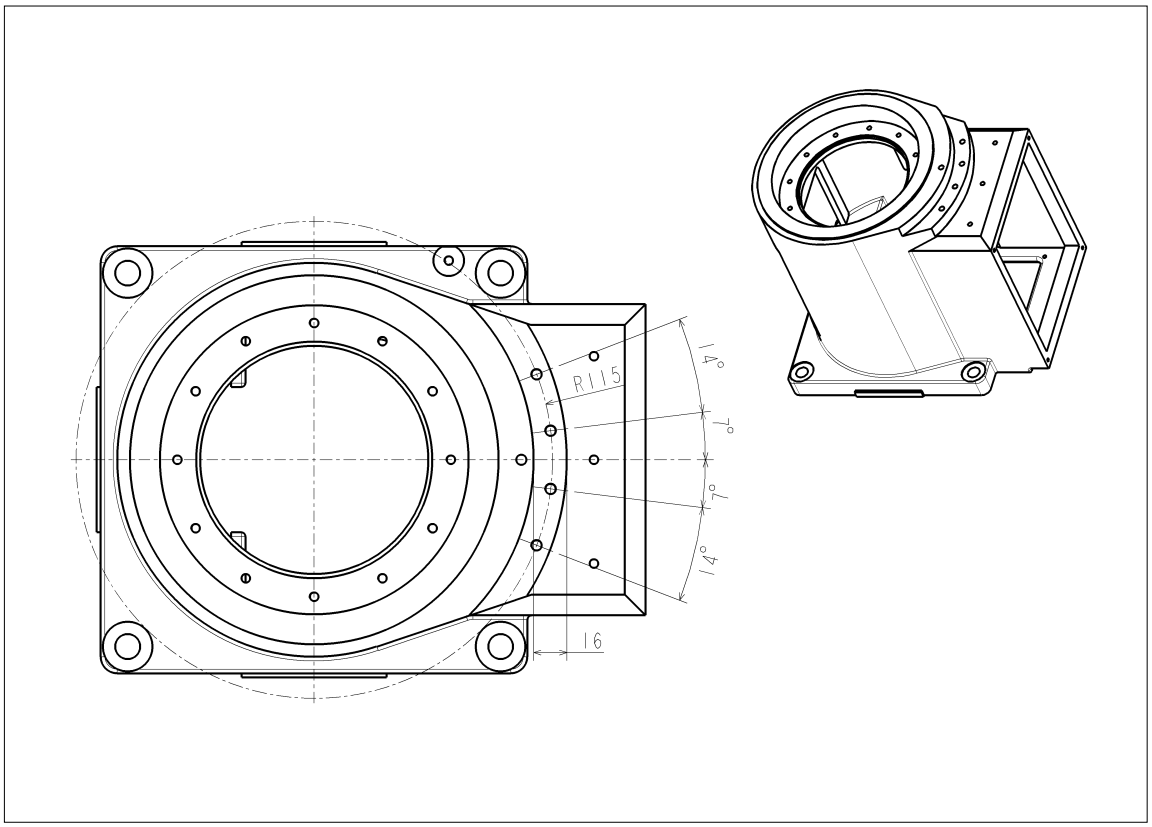



Fig. 3.9 Mechanical stopper location (at the base)

<2> Example of changing axis-1 mechanical ends and the change method

If a mechanical end position is changed, the soft limit must be changed. There are soft limits that can be changed by the user. For details, see the user parameter instruction manual provided separately.

Mechanical end change enables the user to set a desired working envelope by changing the mechanical stopper shape. Reference drawings for mechanical stoppers are shown in the manual, so set a desired movable range, and design and manufacture a mechanical stopper as needed.

Fig. 3.10 shows an example of changing mechanical ends when the setting range is +90° to -120°.

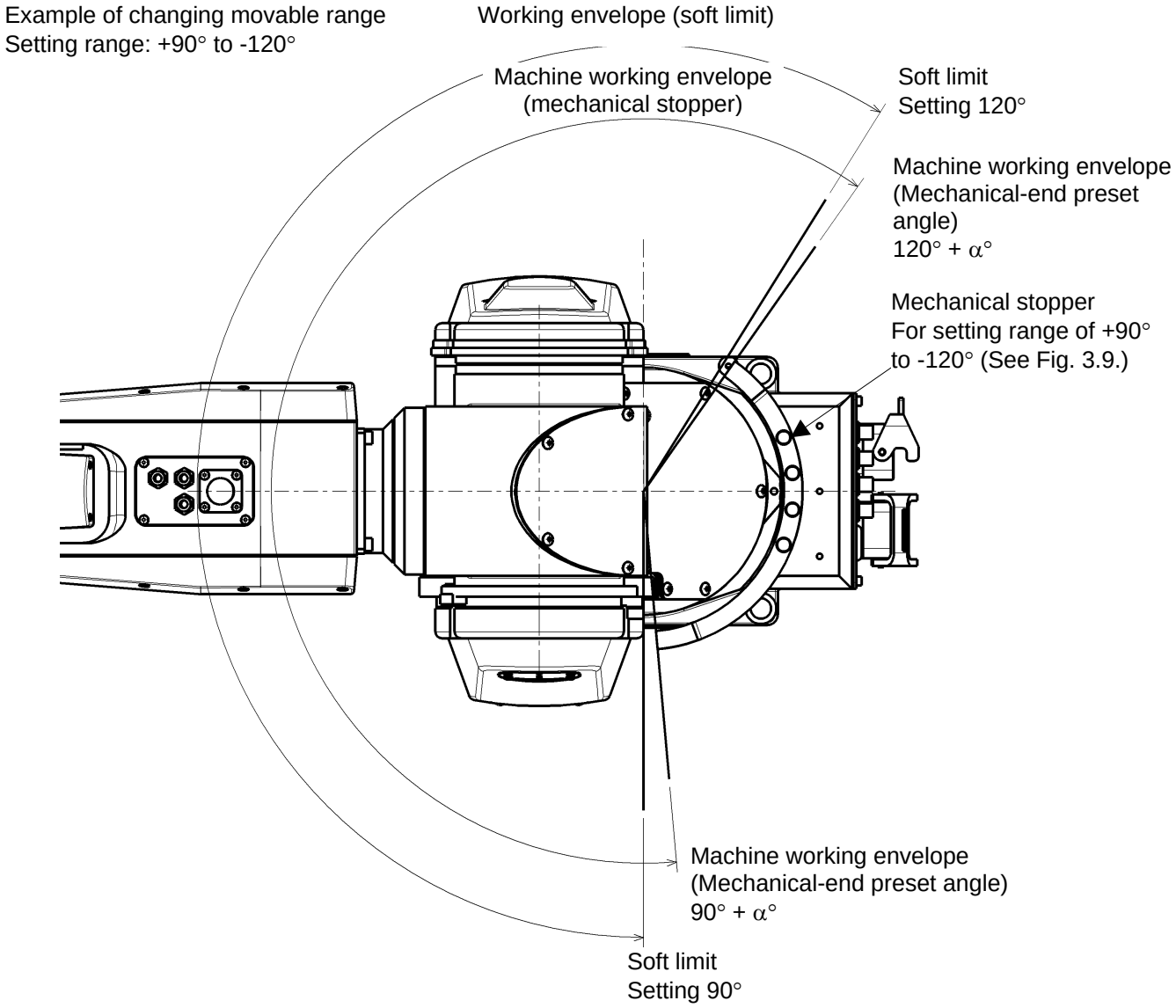



Fig. 3.10 Example of changing axis-1 mechanical ends

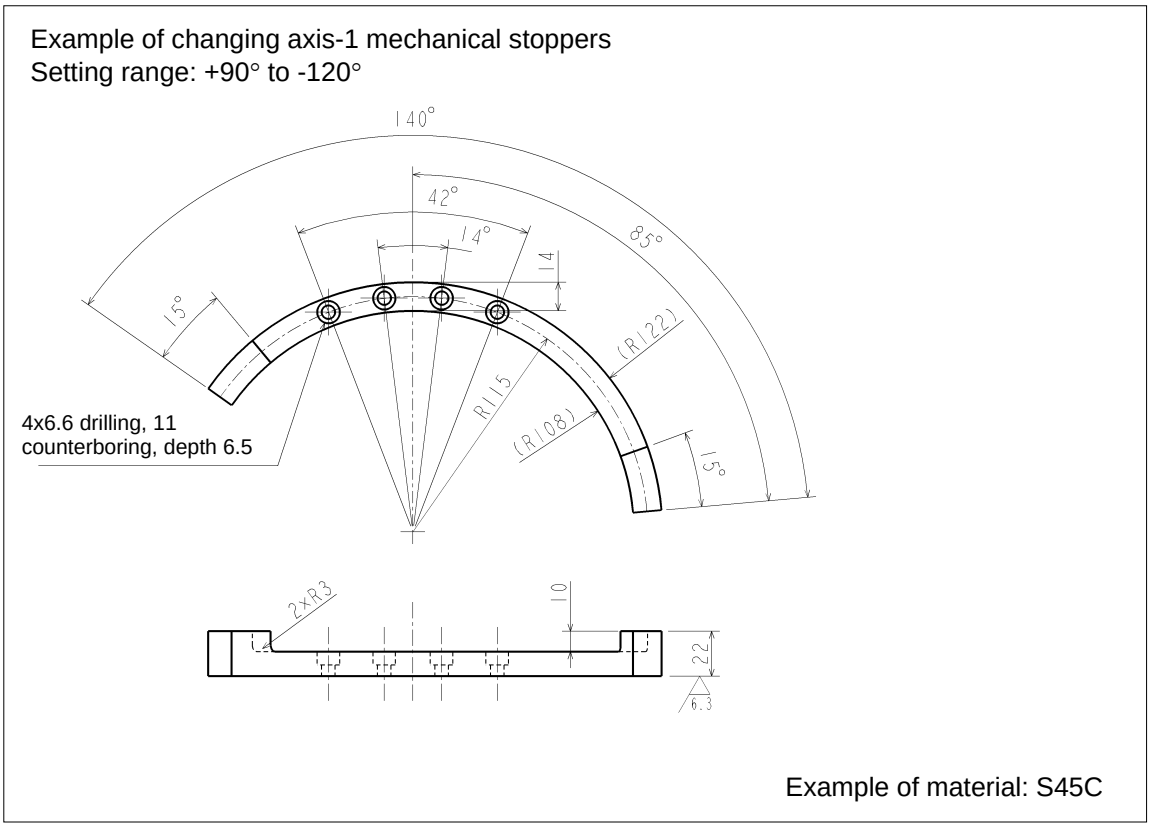



Fig. 3.11 Example of changing mechanical stoppers (reference)

### 3.3.2 Change of Axis-2 and Axis-3 Mechanical Ends

<1> Change of axis-2 and axis-3 mechanical ends

The TV800/TV1000 is shipped while the mechanical ends are factory-set with the angles in Table 3.2.

Working angles are determined by soft limits which are set for the insides of the mechanical ends.

Table 3.2 Factory-set working angles

| Working direction | Axis-2 working envelope | Axis-3 working envelope |
|---|---|---|
| + | +151 | +168 |
| - | -101 | -128 |

For the axis-2 or axis-3 mechanical ends to be changed, the user is responsible for preparing new mechanical stoppers.

If a mechanical end position is changed, the soft limit must be changed.

There are soft limits that can be changed by the user. For details, see the user parameter instruction manual provided separately.

<2> Examples of changing axis-2 and axis-3 mechanical ends and the change method

The following are mechanical stopper reference drawings for axis-2 and axis-3 mechanical ends.

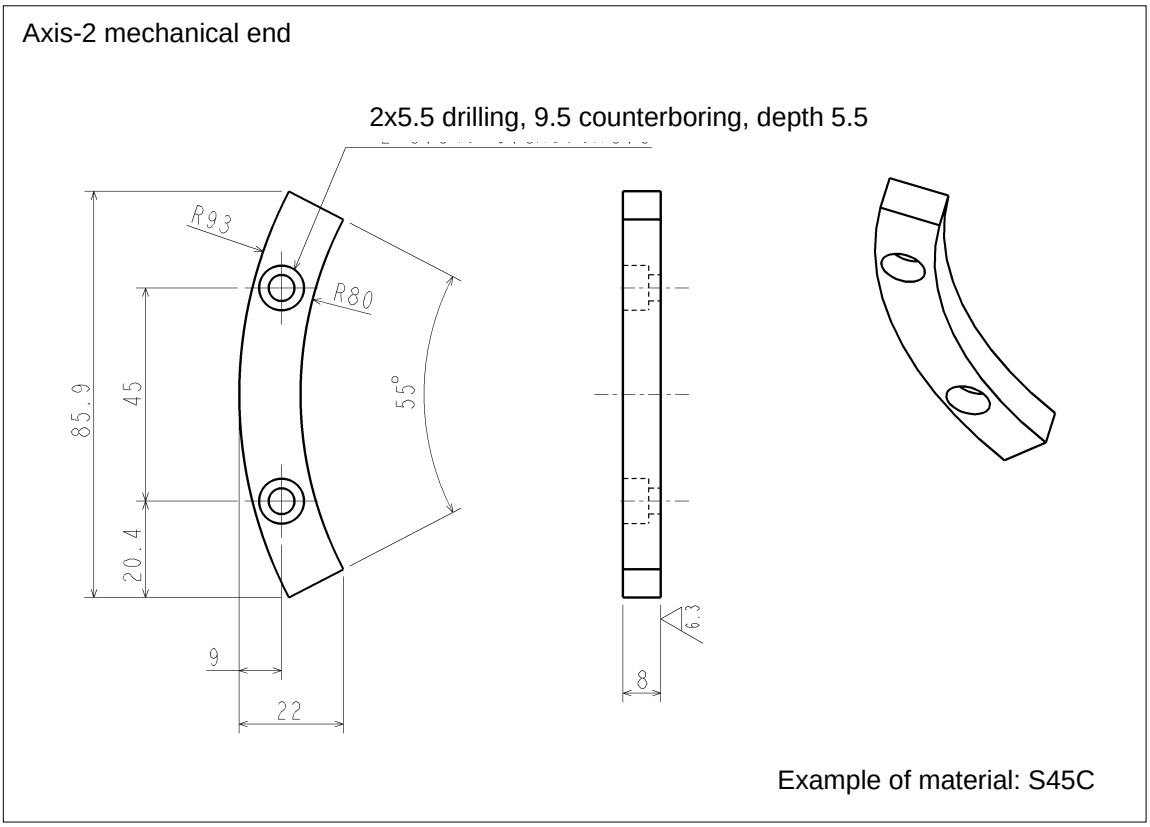



Fig. 3.12 Axis-2 mechanical stopper reference drawing

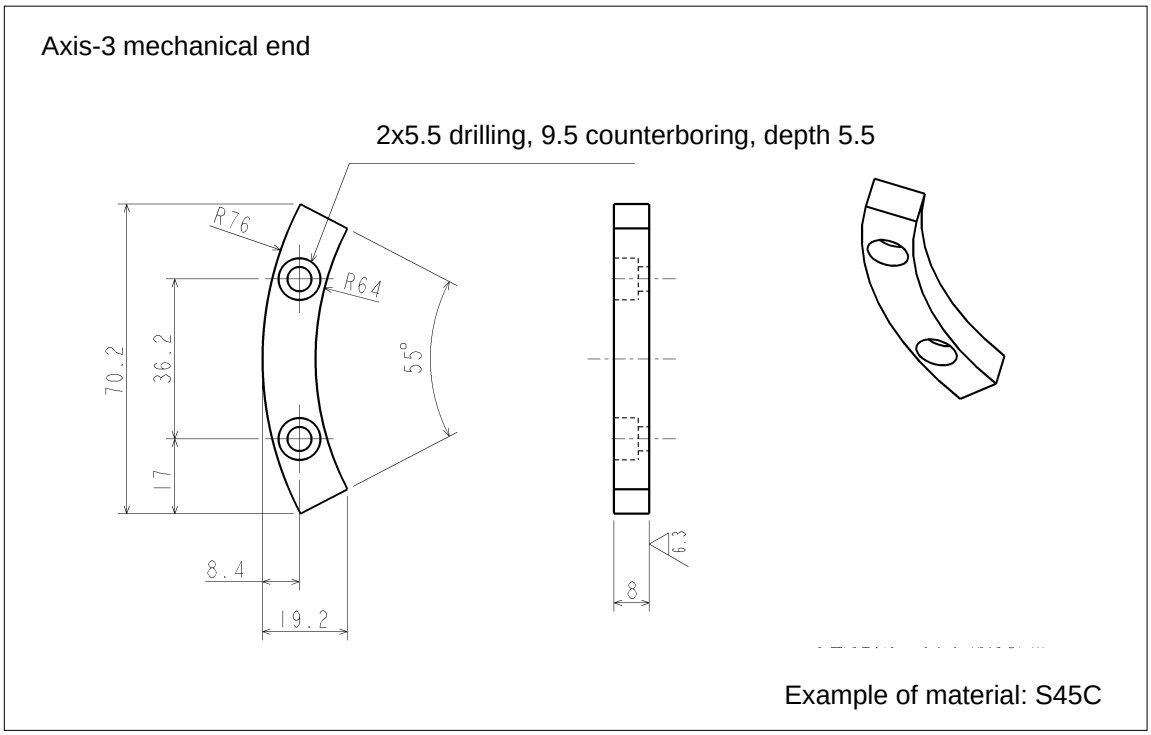



Fig. 3.13 Axis-3 mechanical stopper reference drawing

① Example of changing axis-2 mechanical ends (1)

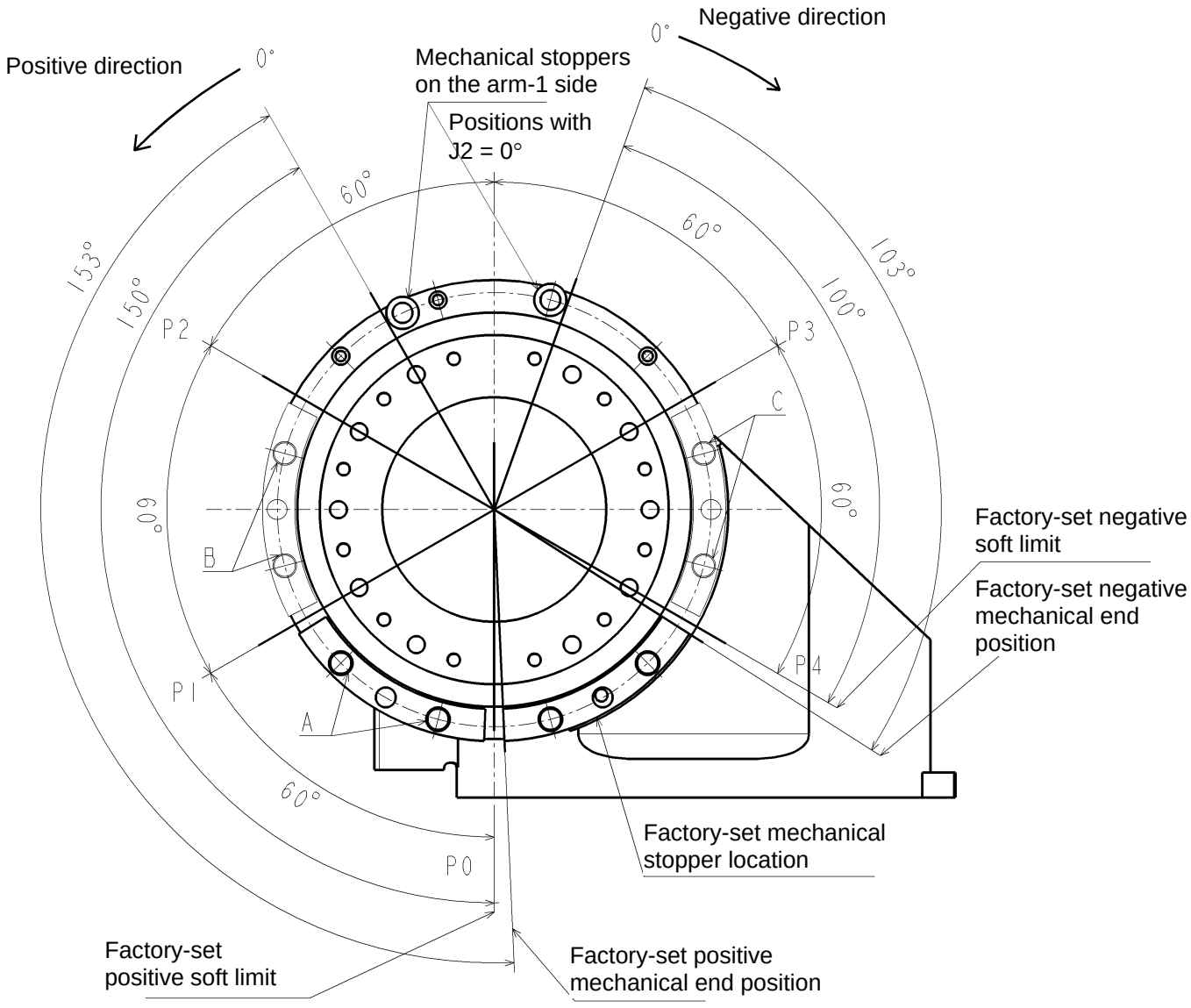



Fig. 3.14 Example of changing axis-2 mechanical ends (1)

| Additional mechanical stopper position | Movable range in positive direction | Movable range in negative direction |
|---|---|---|
| No addition (when shipped) | P0<br>Mechanical-end preset angle: +153°<br>Soft limit: +150° | P4<br>Mechanical-end preset angle: -103°<br>Soft limit: -100° |
| Example 1<br>Mechanical stoppers shown in Fig. 3.12 are mounted at positions A. | P1<br>Mechanical-end preset angle: +93°<br>Soft limit: +90° | - |
| Example 2<br>Mechanical stoppers shown in Fig. 3.12 are mounted at positions B. | P2<br>Mechanical-end preset angle: +33°<br>Soft limit: +30° | - |
| Example 3<br>Mechanical stoppers shown in Fig. 3.12 are mounted at positions C. | - | P3<br>Mechanical-end preset angle: -43°<br>Soft limit: -40° |

② Example of changing axis-2 mechanical ends (2)

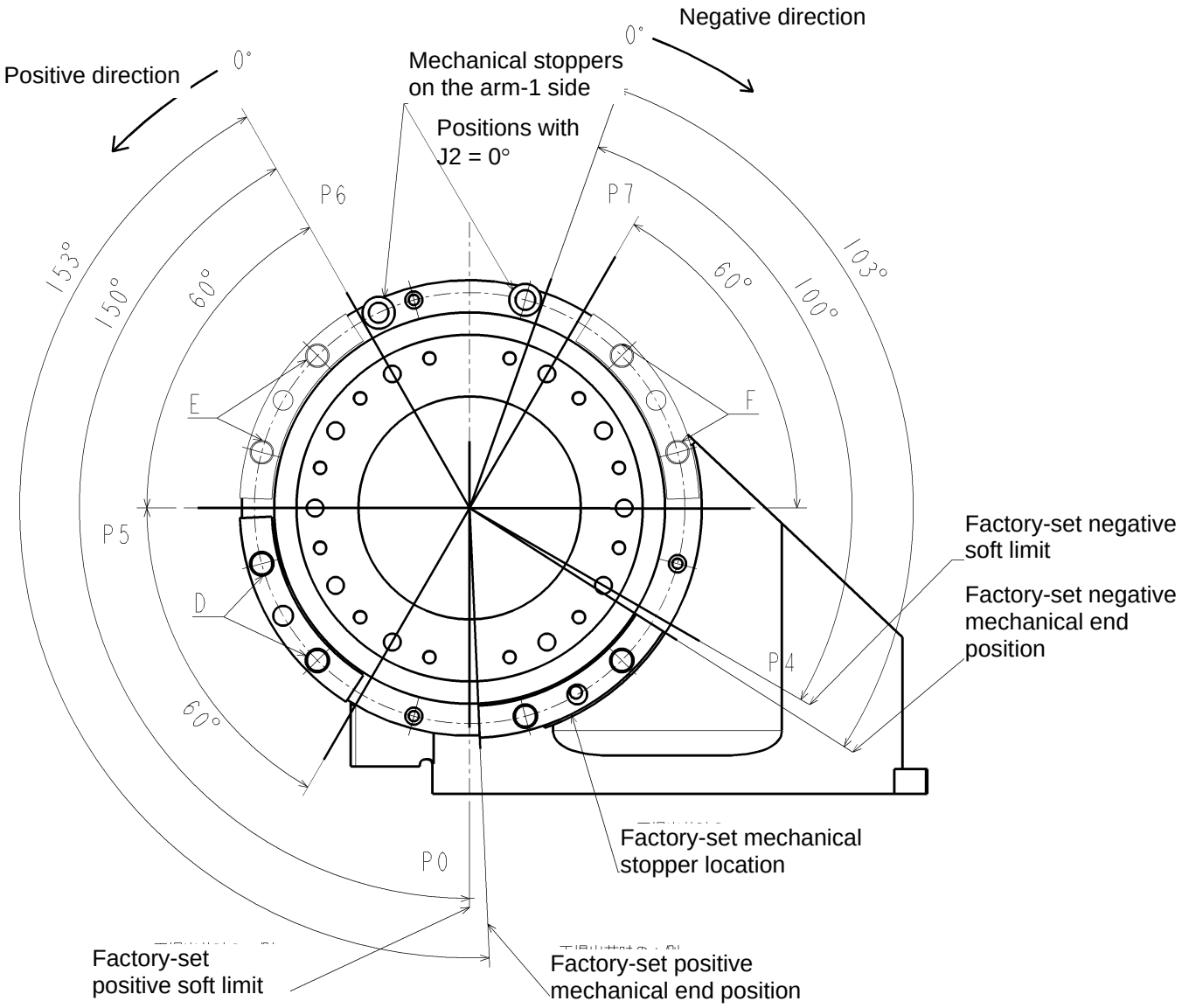



Fig. 3.15 Example of changing axis-2 mechanical ends (2)

| Additional mechanical stopper position | Movable range in positive direction | Movable range in negative direction |
|---|---|---|
| No addition (when shipped) | P0<br>Mechanical-end preset angle: +153°<br>Soft limit: +150° | P4<br>Mechanical-end preset angle: -103°<br>Soft limit: -100° |
| Example 4<br>Mechanical stoppers shown in Fig. 3.12 are mounted at positions D. | P5<br>Mechanical-end preset angle: +63°<br>Soft limit: +60° | - |
| Example 5<br>Mechanical stoppers shown in Fig. 3.12 are mounted at positions E. | P6<br>Mechanical-end preset angle: +3°<br>Soft limit: +0° | - |
| Example 6<br>Mechanical stoppers shown in Fig. 3.12 are mounted at positions F. | - | P7<br>Mechanical-end preset angle: -13°<br>Soft limit: -10° |

③ Example of changing axis-3 mechanical ends (1)

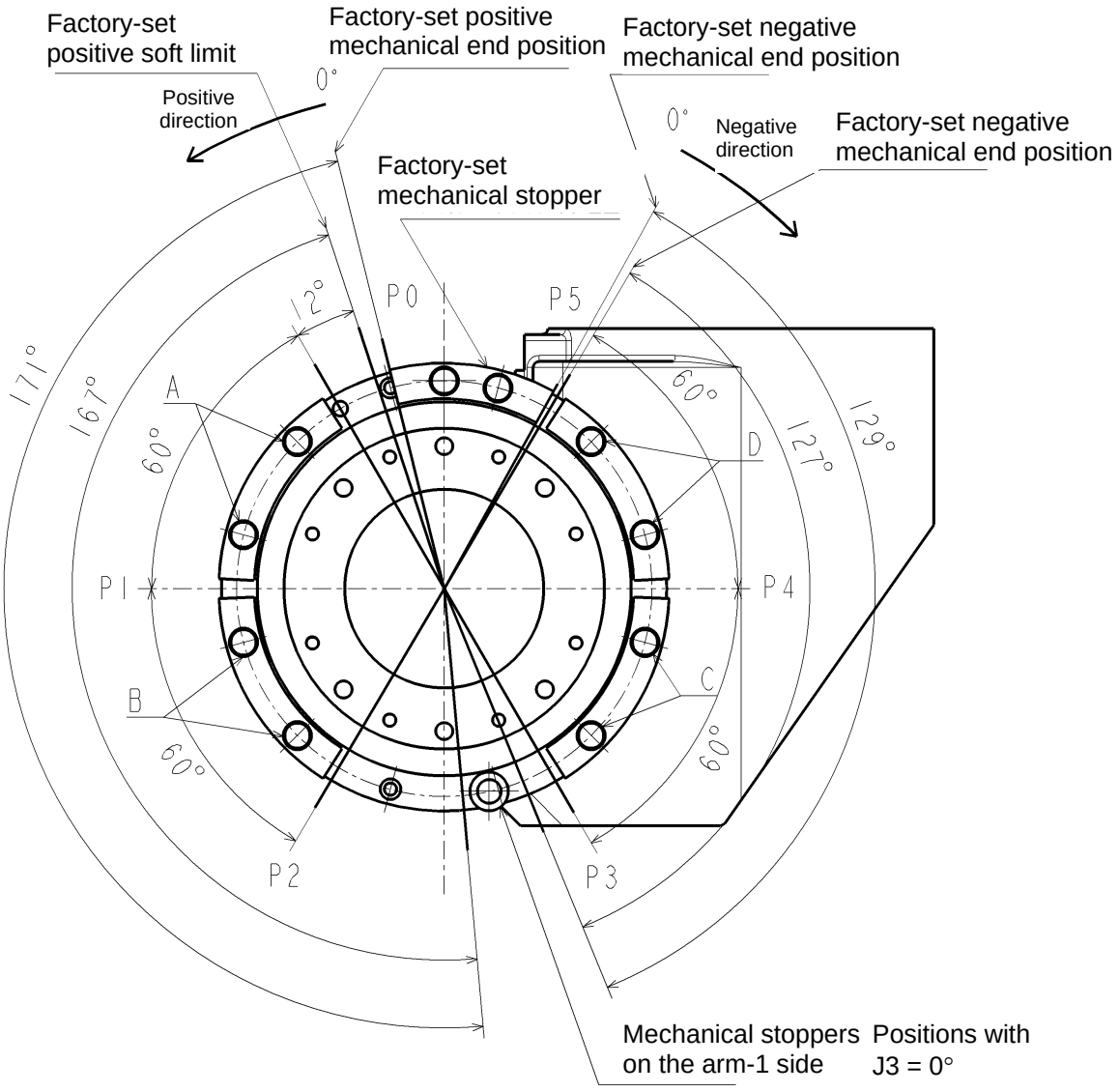



Fig. 3.16 Example of changing axis-3 mechanical ends (1)

| Additional mechanical stopper position | Movable range in positive direction | Movable range in negative direction |
|---|---|---|
| No addition (when shipped) | P0<br>Mechanical-end preset angle: +171°<br>Soft limit: +167° | P4<br>Mechanical-end preset angle: -129°<br>Soft limit: -127° |
| Example 1<br>Mechanical stoppers shown in Fig. 3.13 are mounted at positions A. | P1<br>Mechanical-end preset angle: +99°<br>Soft limit: +95° | - |
| Example 2<br>Mechanical stoppers shown in Fig. 3.13 are mounted at positions B. | P2<br>Mechanical-end preset angle: +39°<br>Soft limit: +35° | - |
| Example 3<br>Mechanical stoppers shown in Fig. 3.13 are mounted at positions C. | - | P4<br>Mechanical-end preset angle: -9°<br>Soft limit: -7° |
| Example 4<br>Mechanical stoppers shown in Fig. 3.13 are mounted at positions D. | - | P5<br>Mechanical-end preset angle: -69°<br>Soft limit: -67° |

④ Example of changing axis-3 mechanical ends (2)

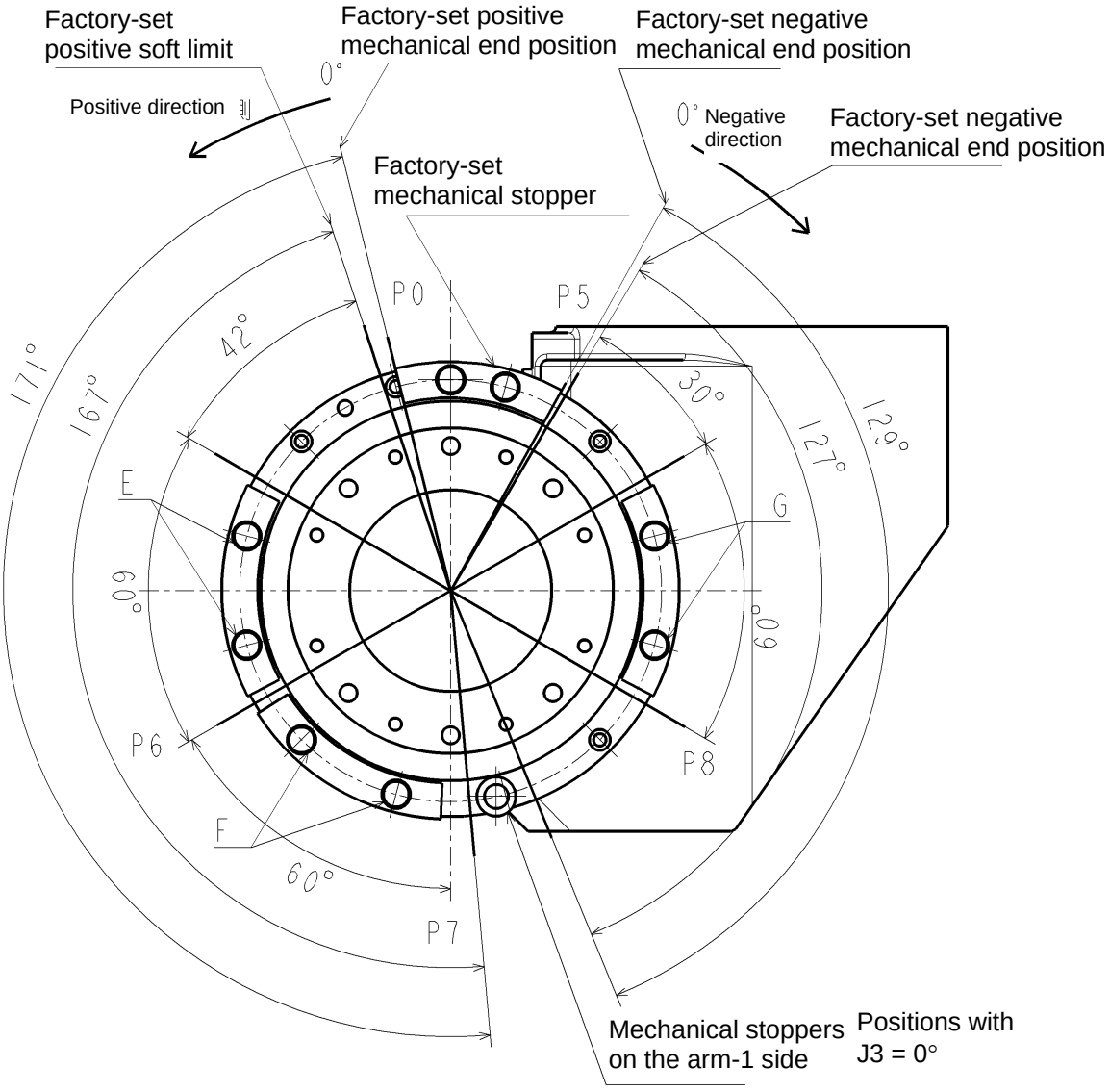


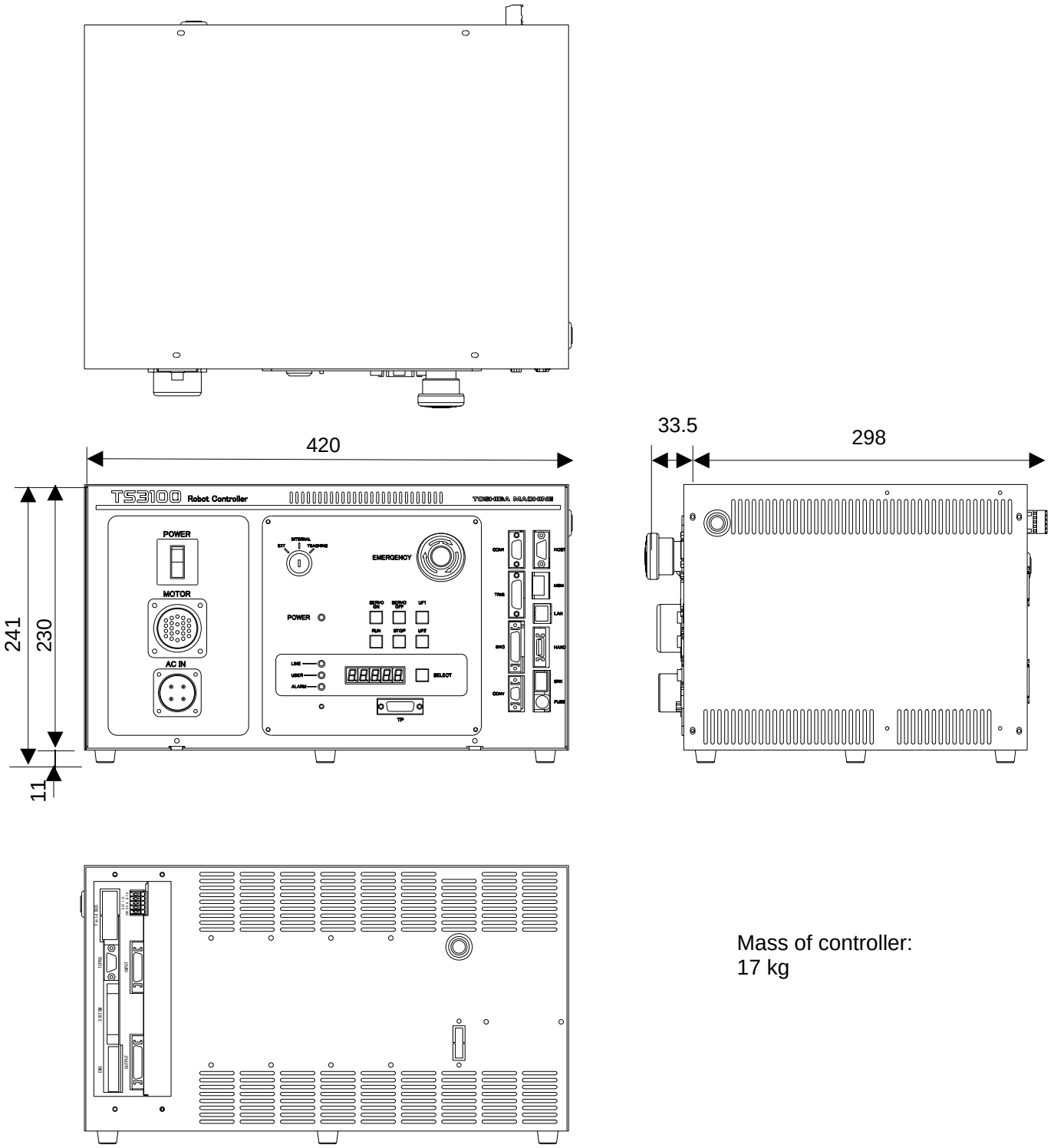

Fig. 3.17 Example of changing axis-3 mechanical ends (2)

| Additional mechanical stopper position | Movable range in positive direction | Movable range in negative direction |
|---|---|---|
| No addition (when shipped) | P0<br>Mechanical-end preset angle: +171°<br>Soft limit: +167° | P4<br>Mechanical-end preset angle: -129°<br>Soft limit: -127° |
| Example 5<br>Mechanical stoppers shown in Fig. 3.13 are mounted at positions E. | P6<br>Mechanical-end preset angle: +69°<br>Soft limit: +65° | - |
| Example 6<br>Mechanical stoppers shown in Fig. 3.13 are mounted at positions F. | P2<br>Mechanical-end preset angle: +9°<br>Soft limit: +5° | - |
| Example 7<br>Mechanical stoppers shown in Fig. 3.13 are mounted at positions G. | - | P8<br>Mechanical-end preset angle: -39°<br>Soft limit: -37° |

## 3.4 Installing the Controller

### 3.4.1 External Dimensions

External view of the controller is shown in Fig. 3.18.




Mass of controller:
17 kg

Fig. 3.18 External view of controller

### 3.4.2 Precautions for Direct Installation

It is necessary to provide a clearance of 50 mm or more in the horizontal direction and a clearance of 100 mm or more in the upward direction near the controller.

**! CAUTION**

- Provide a ventilation space at the side of the controller so that the air vent holes are not blocked. The space equal to the length of the legs should be kept below the lower surface.

  Failure to do so could cause the cooling performance to drop or to faults.
- DO NOT stack the controllers.
- DO NOT place any object on top of the controller.

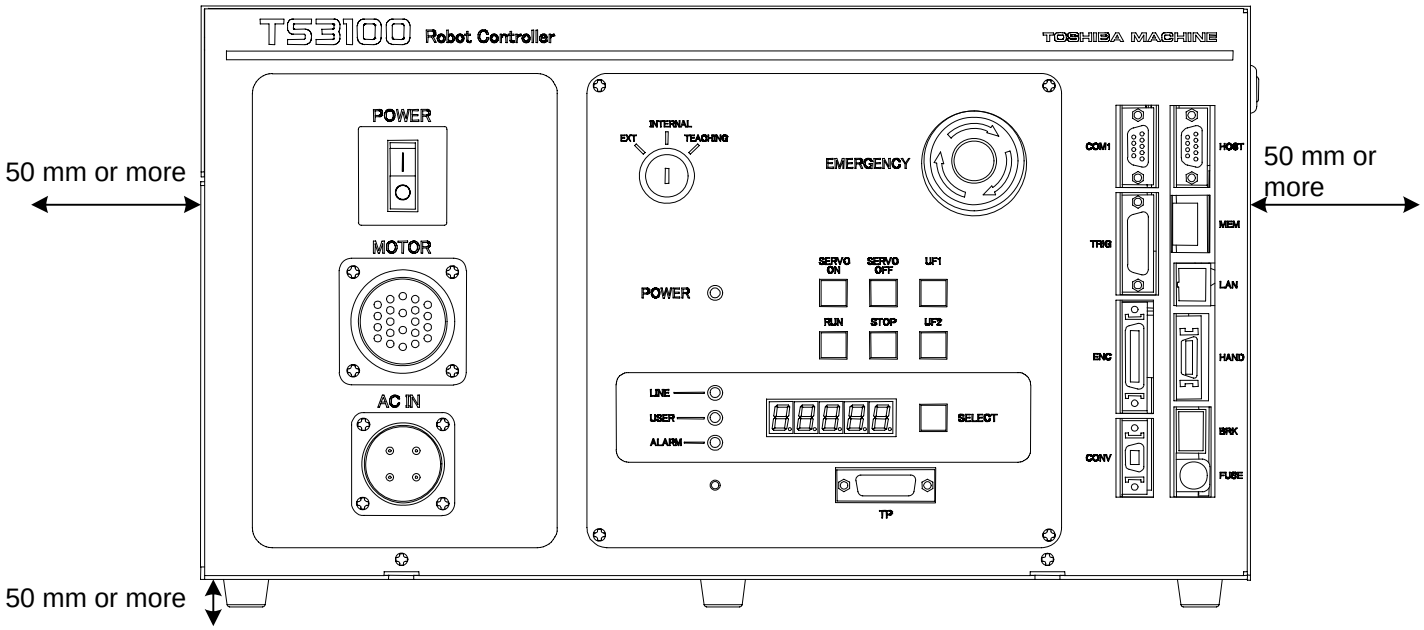



Fig. 3.19 Controller ventilation space

### 3.4.3 Rack Mounting Dimensions

When mounting the robot controller in a rack, set the side brackets using the screw holes provided on both ends of the front panel, and secure the controller to the rack. The side brackets ① in Fig. 3.18 are optional.

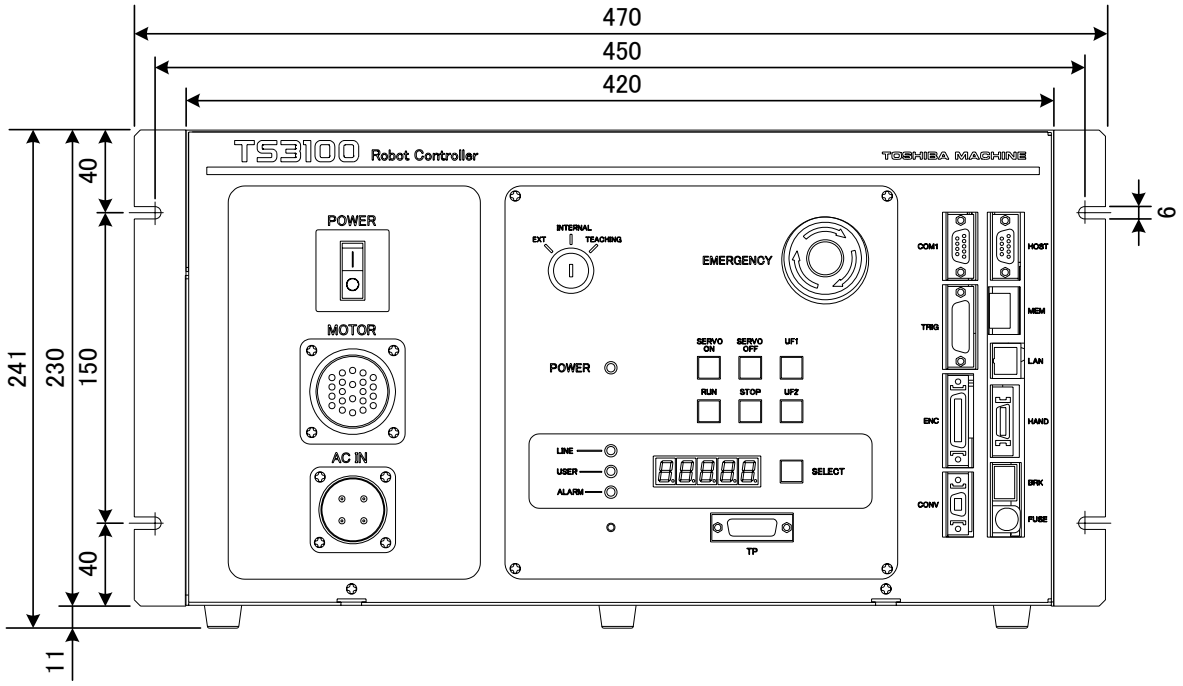



Fig. 3.20 Screw hole dimensions for securing controller

### 3.4.4 Precautions for Rack Mounting

Pay attention to the following matters when rack-mounting the robot controller.

a) When mounting the robot controller in a rack, use the screw holes provided on both ends of the front panel, and secure the controller. (Optional side brackets are required.)

**! CAUTION**

- If the rack is completely sealed, provide holes to allow the air to be let out, force-ventilate the rack with a fan, or cool it indirectly so that the heat will not be trapped in the rack.

  If the heat is trapped in the rack or controller, faults could occur.

b) As the cable connectors are connected to the rear side of the controller, provide a space of 110 mm on the rear side.
For maintenance, the upper cover should be removed. (See Fig. 3.8.)

Keep this in mind when installing the controller. At maintenance, the controller should be removed from the rack. Specifically, be careful of the following points.

1) Arrange the cables around the rear side of the controller (so that the controller can be removed).
2) Arrange the cables between the controller and control panel when the control panel is separated.
3) Connect all cables in such a manner that the robot can be operated even if the controller is removed from the rack.

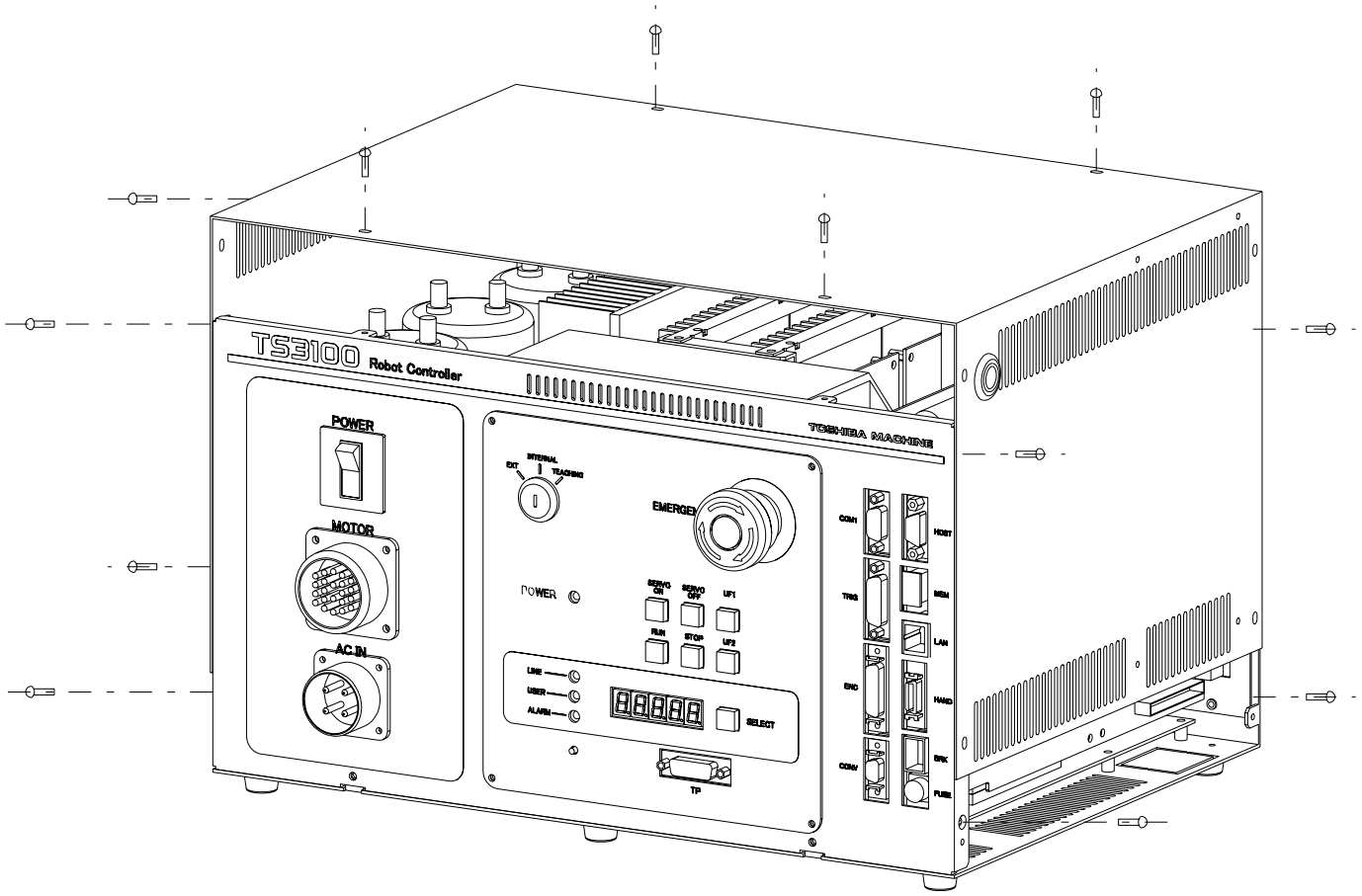



Fig. 3.21 Removing upper cover

c) When the controller is mounted on the rack, the weight of the controller should be supported with the legs of the controller. Screw holes for rack-mounting the controller are used for securing the controller panel, and the weight of the controller cannot be supported only with these screws.

d) On the front of the controller, a clearance of approx. 90 mm should be provided for connecting the connector of the teach pendant. Even if the teach pendant is not used, a clearance of approx. 60 mm is required for connecting a dummy plug.

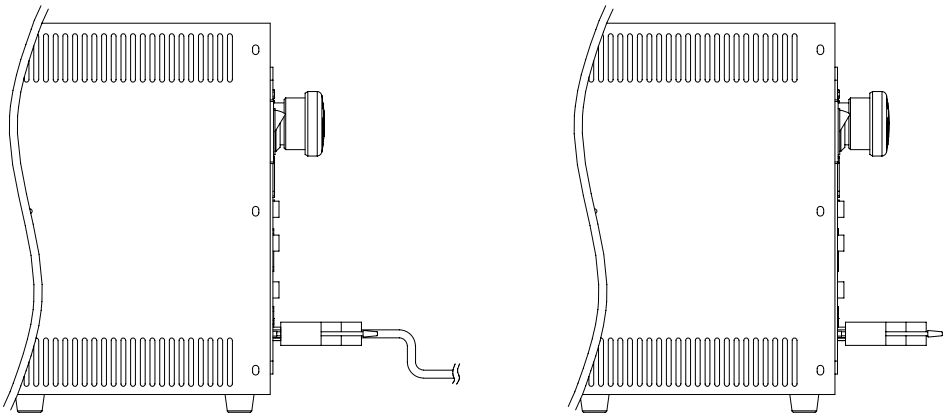


Fig. 3.22 Clearance of controller front side

## 3.5 Precautions for Handling the Teach Pendant

Be careful of the following matters when handling the teach pendant.

**! CAUTION**

- DO NOT drop the teach pendant or hit it against anything.
- DO NOT pull the cable running from the teach pendant.
- DO NOT press the switches on the teach pendant with anything sharp (like the tip of a knife, pencil, ball-point pen, etc.).
- DO NOT place or use the teach pendant near open flames.
- DO NOT leave the teach pendant in direct sunlight for a long period of time.

## 3.6 Safety Measures

To correctly handle the robot, carefully read the instruction manual "Safety" as a separate volume and take necessary safety measures.

# 4. System Connections

## 4.1 Cable Wiring

This section describes the various types of cables and connectors and explains how these are to be connected.

### 4.1.1 Connector Arrangement on the Controller

The cables connected to the robot controller are shown in Fig. 4.1.

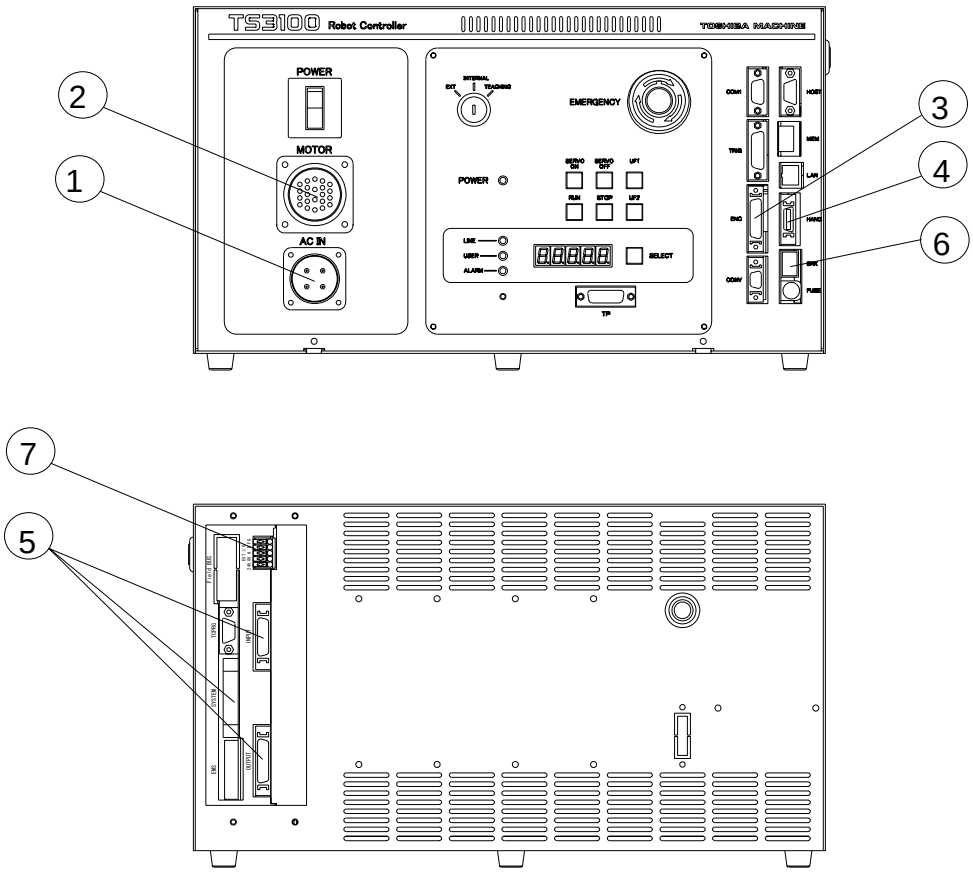



Fig. 4.1 Robot controller connector arrangement

① Power cable (ACIN)
② Motor cable (MOTOR)
③ Encoder cable (ENC)
④ Robot control signal cable (HAND)
⑤ External operation input signal cables (SYSTEM, INPUT, OUTPUT)
⑥ Brake signal cable (BRK)
⑦ Distribution I/O cable (EXT-I/O)

In the subsequent paragraphs, we explain how to connect cables ① to ④ inclusive.
For information on how to connect cables ⑤, ⑥ and ⑦, refer to the Interface Manual.

### 4.1.2 Connecting the Power Cable "ACIN" (① of Fig. 4.1; plug connector attached)

The power cable is used to supply the main AC power to the controller.

Table 4.1 Power supply specifications

| | |
|---|---|
| Power supply | Single-phase, AC 200 ~ 240 V, 50/60 Hz ±1 Hz |
| Power capacity | 4.4 kVA |
| Instantaneous power failure | Within 40 msec |
| Grounding | Class D grounding |

The connector is CN1 ([1] of Fig. 4.1).

| | | |
|---|---|---|
| ACIN1 plug connector | Type: JL04V–6A22-22SE-EB-R | Maker: Japan Aviation Electronics Industry |
| CN1 cable clamp | Type: JL04–2022CK(14)-R | Maker: Japan Aviation Electronics Industry |
| Wire | 3.5 $mm^2$ ~ 5.5 $mm^2$ | |

As the cable is not an accessory, use the attached plug connector connected to ACIN on the controller side to manufacture a cable.
Wires are to be soldered to the connector.

**! DANGER**

- Be sure to use the designated wire. Failure to do so could lead to fires or faults.
- When connecting the connector and wires, make sure not to mistake the terminal arrangement.
- After making the connection, use a tester, etc., to confirm the connection.

For the terminal arrangement, see Para. 4.1.7.

**! CAUTION**

- Unless the main power is normally supplied to the controller due to phase defect or voltage drop, an error of “8–027 Slow Charge error” occurs. When this happens, make sure that the maser power voltage at the controller power connector satisfies the specified input power of the controller, and that the same voltage is stabilized.
- For details of the 8–027 error, see Para. 13.7 of the Operator’s Manual.

### 4.1.3 Connecting the Motor Cable “CN21” (② of Fig. 4.1) (Cable attached)

The motor cable connects the controller and robot, and supplies the power required to rotate the motor from the controller servo driver to each axis feed motor of the robot. The motor cable is connected to the connector "MOTOR" (② in Fig. 4.1). The motor cable on the robot side is connected to the connector "CN21" (① in Fig. 4.2).

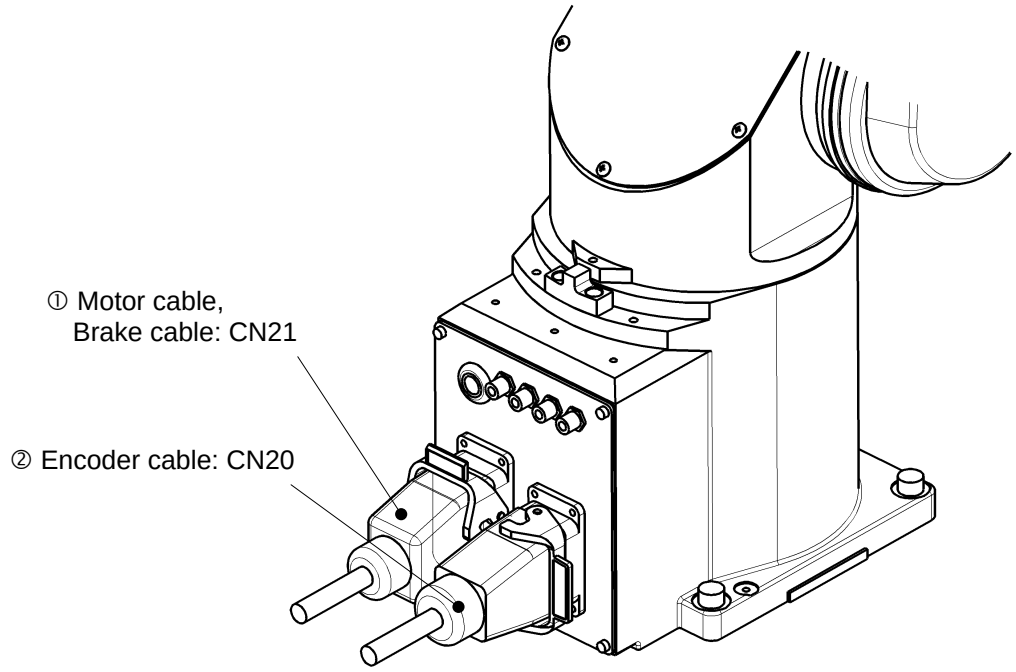



Fig. 4.2 Robot side connector arrangement

### 4.1.4 Connecting the Encoder Cable "CN20" (③ of Fig. 4.1) (Cable attached)

The encoder cable is a signal line used to transmit a signal from the rotation angle detecting encoder of each robot axis to the controller.
The connector for connecting the encoder cable is ENC (③ of Fig. 4.1). Location of the encoder cable on the robot side is ② "CN20" in Fig. 4.2.

### 4.1.5 Connecting the Robot Control Signal Cable "CN20" (④. ⑥ of Fig. 4.1) (Cable: option)

The robot control signal cable is used for motor brake ON and OFF, and input and output of robot control signals such as hand operation signal.
The robot control signal cable is connected to the connector "HAND" (④ of Fig. 4.1), and the motor shaft brake signal cable is connected to the connector "BRK" (⑥ of Fig. 4.1).

The robot control signal cable on the robot side is connected to the connector "CN20" (② of Fig. 4.2).

### 4.1.6 Connecting and Disconnecting Cables

**! CAUTION**

- Before connecting or disconnecting any controller cable, be sure to turn off the main power ("POWER") switch.
- When disconnecting a cable, be sure to pull the plug and not the cord. Otherwise, you may damage the cable.

a) Circular connectors: ACIN, MOTOR
Firstly align the key position, and completely insert the connector on the cable side into the controller connector. Then turn the cable side lock screw to the right to clamp the cable. A loose screw can cause a contact failure or other accident. To avoid this, make sure that the screw is clamped completely.
To disconnect the connectors, turn the lock screw to the left and pull out the cable side connector.

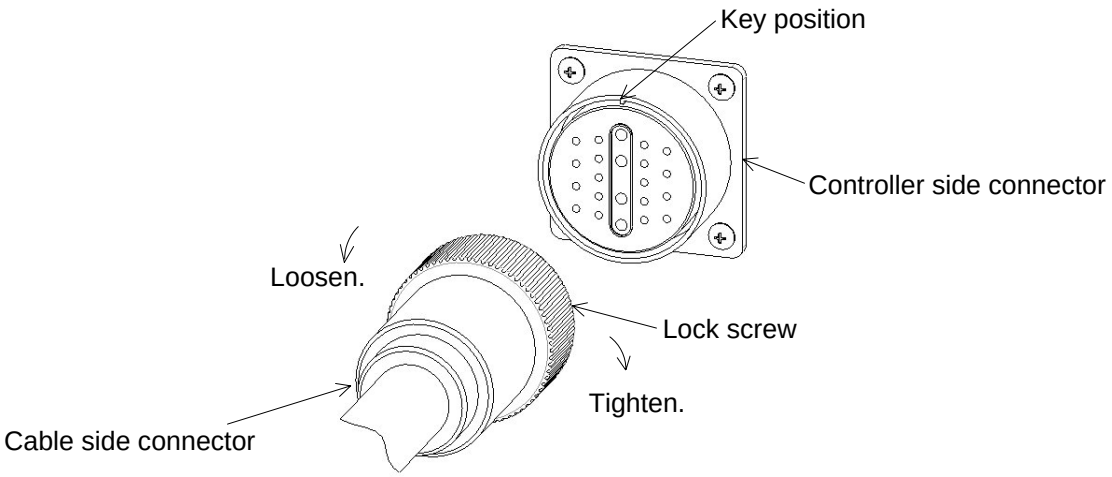



Fig. 4.3 Connecting and disconnecting a circular connector

b) Square connectors: ENC, HAND, SYSTEM, INPUT, OUTPUT, TRIG, CONV
Firstly, completely insert the cable side connector into the controller connector. Then tighten the lock screws on both ends of the cable side connector with a screwdriver. A loose screw can cause a contact failure or other accident. To avoid this, make sure that the screws are clamped completely
To disconnect the connectors, first loosen the lock screws, then pull out the cable side connector. INPUT and OUTPUT are quick-operated lock type connectors, however.

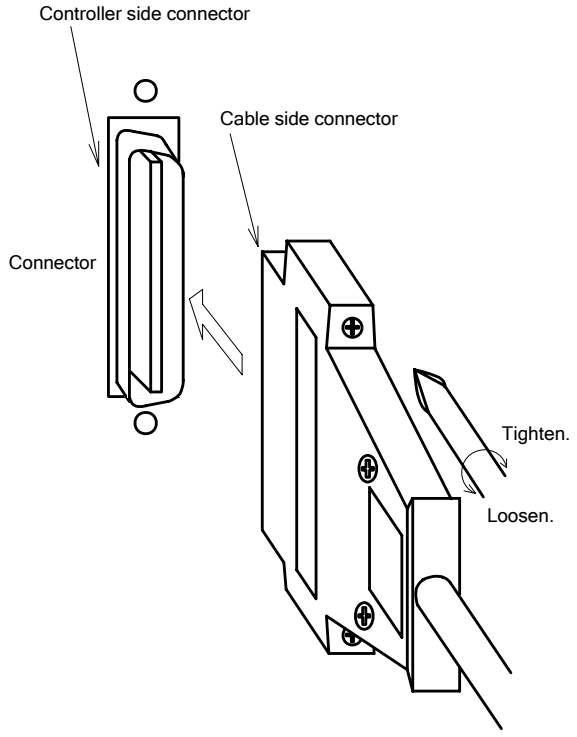
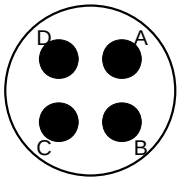



Fig. 4.4 Connecting and disconnecting a square connector

4.1.7 Examples of Connector Terminal Arrangement

a) Power cable connector ACIN




Connects to controller.

Type: JL04HV-2E22-22PE-B

Manufacturer:
Japan Aviation
Electronics Industry

A
B
C
D

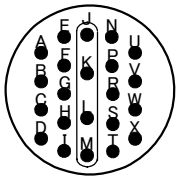
Single-phase, AC 200~240 V, 50/60 Hz

Grounding (Class D or higher level)

**! DANGER**

- Completely connect the grounding cable. Otherwise, an electric shock or fire may be caused if a fault or electric leak occurred. Or mis-operation may be caused by noise.

b) Motor cable connector MOTOR

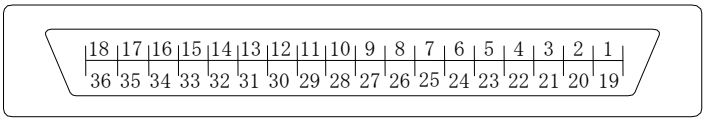



Connects to controller.

Type: JL04V–2A28–11SE

Manufacturer: Japan Aviation Electronics Industry

c) Encoder cable connector ENC

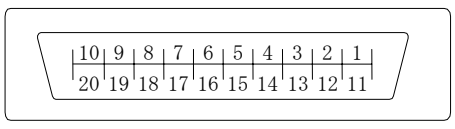



Connects to controller.

Type: 52986-3659

Manufacturer: Molex

d) Robot control signal cable connector HAND

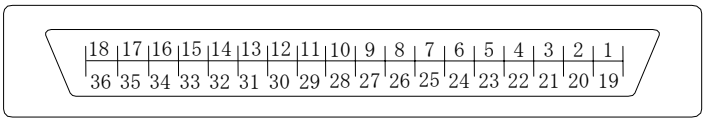



Connects to controller.

Type: 52986-2079

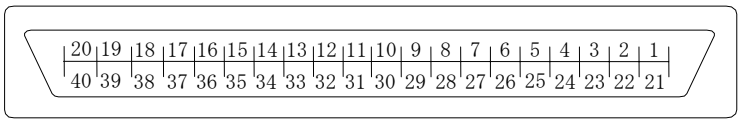
Manufacturer: Molex

e) General purpose input signal cable connector INPUT



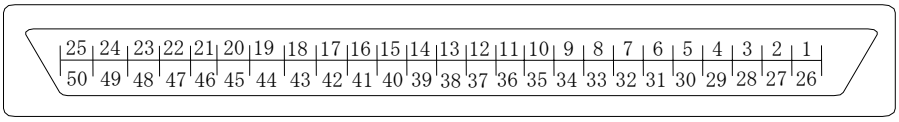

Connects to controller.
Type: DHA-RC36-R132N-FA
Manufacturer: DDK Ltd.

f) General purpose output signal cable connector OUTPUT



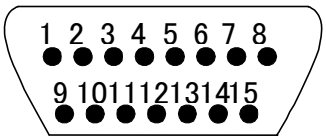

Connects to controller.
Type: DHA-RC40-R132N-FA
Manufacturer: DDK Ltd.

g) System input/output signal cable connector SYSTEM



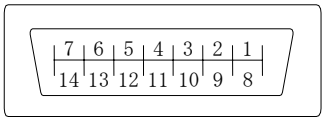

Connects to controller.
Type: 52986-5079
Manufacturer: Molex

h) Trigger input connector TRIG



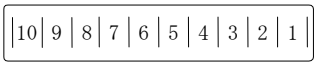

Connects to controller.
Type: XM2C-1542-112L
Manufacturer: Omron

i) Encoder cable connector CONV




Connects to controller.
Type: 52986-1479
Manufacturer: Molex

j) Emergency stop, safety input, and external 24 V power connector EMS

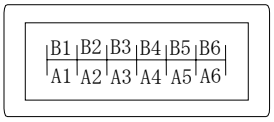



Connects to controller.

Type: ML-4000CWJH-10PGY

Manufacturer: Sato Parts

k) Brake connector BRK




Connects to controller.

Type: 1-1827876-6

Manufacturer: Tyco Electronics

## 4.2 Controller Connector Signals

### 4.2.1 Connector Signal Connection Diagrams

Diagrams showing which signals correspond to which terminals are shown in Section 2 of the Interface Manual.

### 4.2.2 Jumpers for Safety Related Signals

The following system input signals are provided to serve for the safety purpose.

| | | |
|---|---|---|
| System input signals | SYSTEM-12 | (STOP) |
| | SYSTEM-16 | (SVOFF) |
| | SYSTEM-14 | (BREAK) |
| | EMS-7, 8 | (EMS2B ~ EMS2C) |
| | EMS-9, 10 | (EMS1B ~ EMS1C) |
| | EMS-3, 4 | (ENA2B ~ ENA2C) |
| | EMS-5, 6 | (ENA1B ~ ENA1C) |

These signals are already jumpered for the connectors provided for the TS3100 robot controller. If you wish to use or change them, therefore, you should remove the jumpers and rewire as appropriate. If you plan to use the robot without using system input signals, be sure to connect the attached connectors to the controller side SYSTEM, EMS connectors.
Unless the following signals are used as the system signals, jumper them also.

SYSTEM-15 (LOW_SPD)
SYSTEM-13 (CYCLE)

Connector jumpers

| SYSTEM | | EMS | |
|---|---|---|---|
| 12-17 (18) | 14-17 (18) | 3-4 | 5-6 |
| 16-17 (18) | (13-17 (18)) | 7-8 | 9-10 |
| (15-17 (18)) | - | | |

**! CAUTION**

- Unless the signals of SVOFF and emergency stop contacts 1, 2 are jumpered, the controller servo power cannot be turned on.
- Unless the CYCLE signal is jumpered, the controller enters the cycle operation mode.
- Unless the LOW_SPD signal is jumpered, the robot is operated at low speed during automatic operation.
- Unless the STOP signal is jumpered, automatic operation of the robot is not possible.
- Unless the BREAK signal is jumpered, automatic operation of the robot is not possible.

## 4.3 Separating Control Panel from Controller

### 4.3.1 Removing Control Panel

Remove the control panel in the following manner.

a) Loosen the four (4) screws at the four (4) corners, which secure the control panel.

b) Remove these screws, then carefully draw out the control panel toward your side.

Caution: Be careful of the cable connected on the rear side.

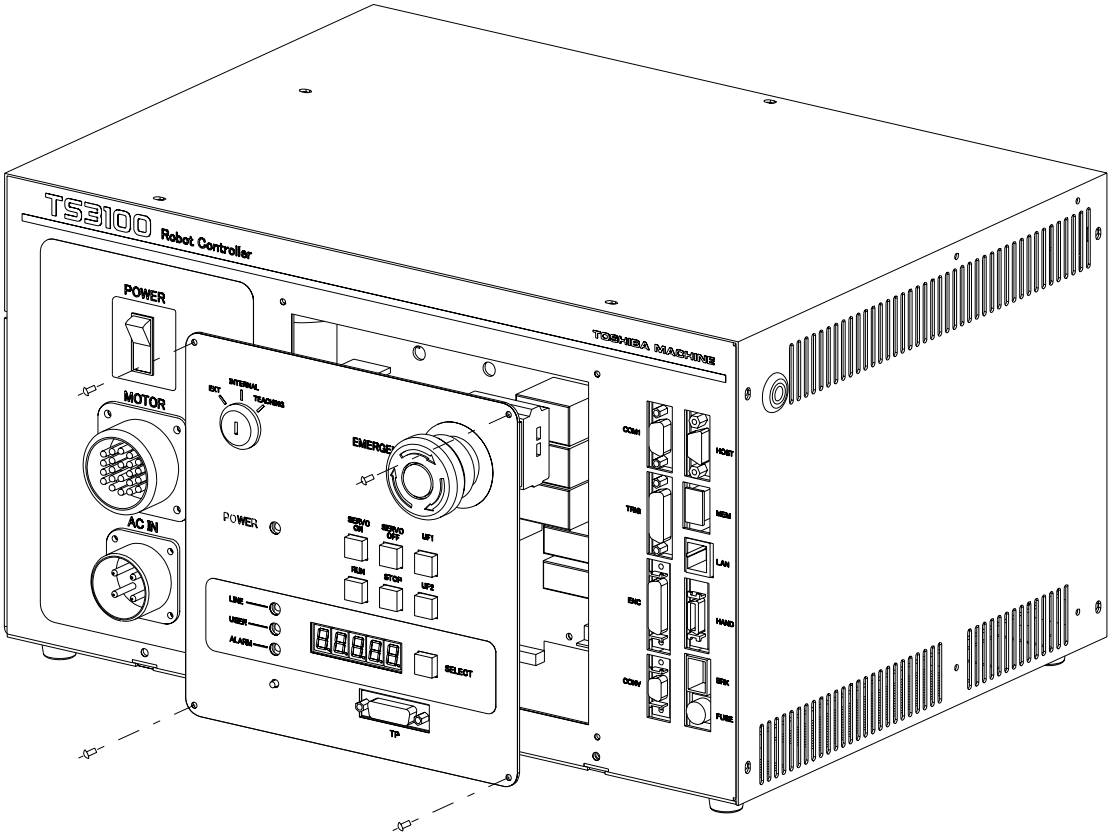



Fig. 4.5 Removing control panel

### 4.3.2 Cable between Controller and Control Panel

The cable required to connect the control panel and controller when they are installed separately can be provided optionally.

### 4.3.3 Control Panel Mounting Dimensions

The dimensions of mounting the control panel are shown in Fig. 4.6.
Cross truss head screws (ø3 x 6, ZN3–B) are used.

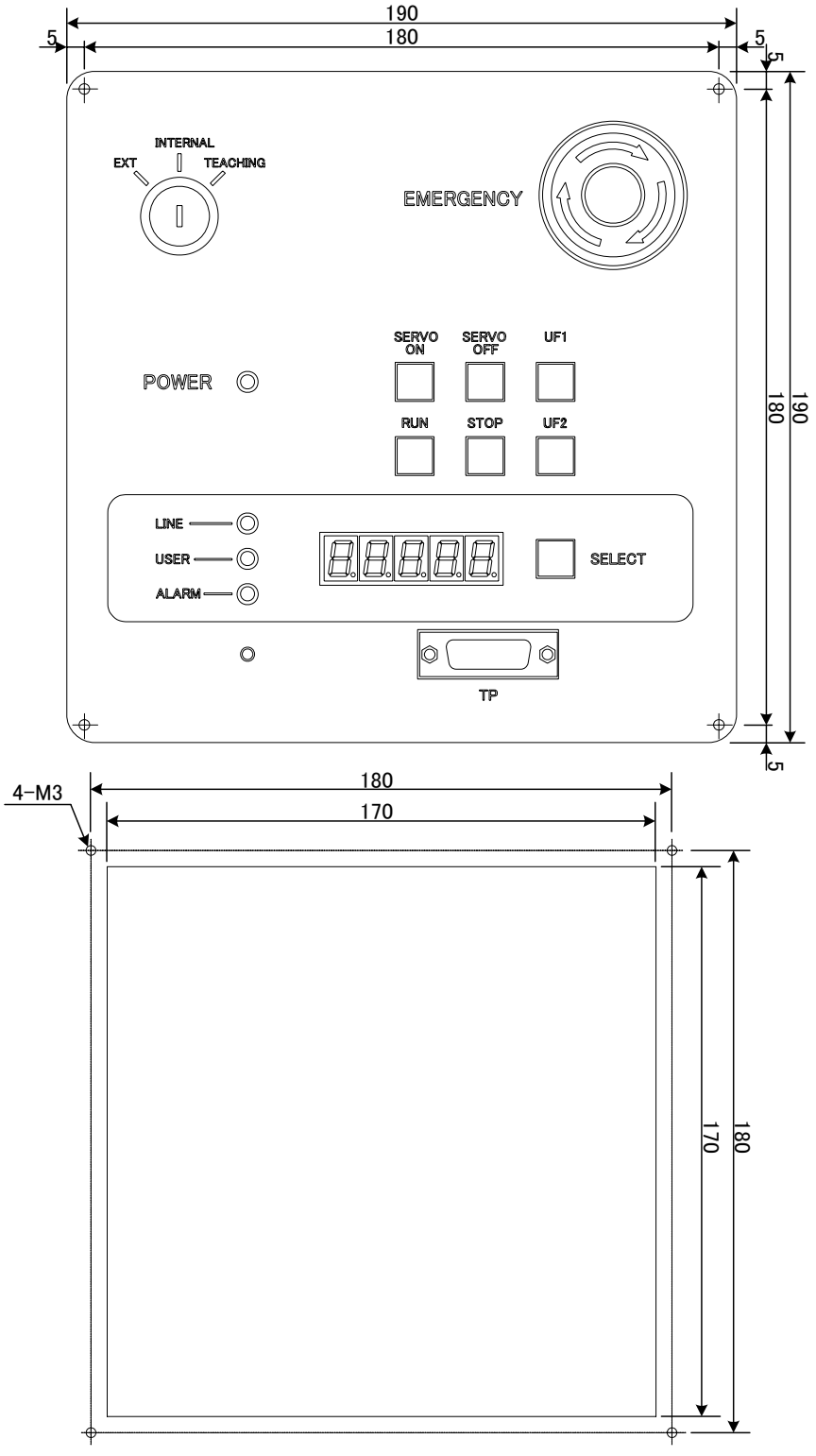



Fig. 4.6 Control panel mounting dimensions

### 4.3.4 Mounting Dummy Panel on Controller

When the control panel has been disengaged from the controller, mount a dummy panel on the place where the control panel was set before, as shown in Fig. 4.7. The dummy panel, set parts, etc. are provided optionally.

a) Connect the cable connector which was disconnected when separating the controller from the control panel, to the rear side of the dummy panel, then screw both ends of the connector. When mounting the connector, use the cross truss screws (ø3 x 6, ZN3–B).

b) Screw the dummy panel into the controller.

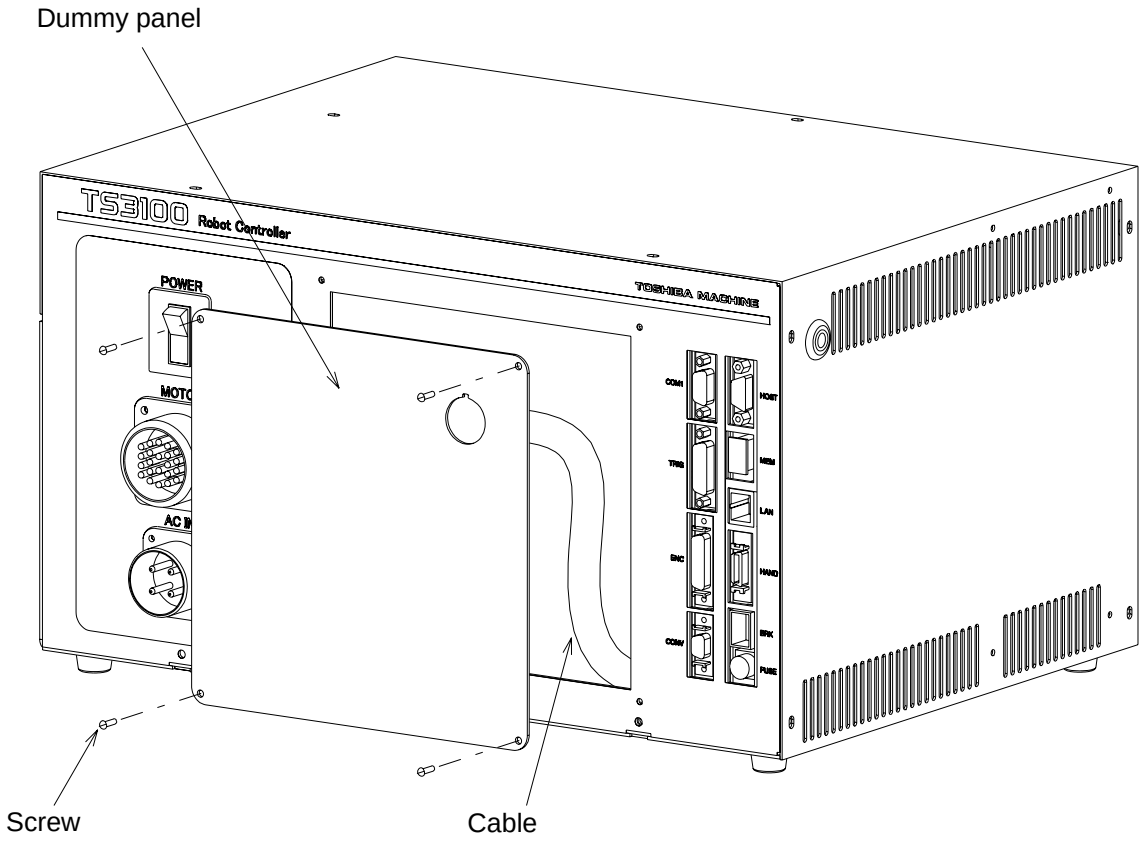



Fig. 4.7 Mounting dummy panel

### 4.3.5 Dimensions when Separating Control Panel

Fig. 4.8 shows the connections of the control panel and dummy panel. Provide a clearance of 50 mm or more (with cover, 60 mm or more) on the rear side of the separated control panel.

When the cable is connected to the dummy panel of the controller, provide a clearance of 80 mm or so in front of the controller as the cable connector sticks out of the panel surface.

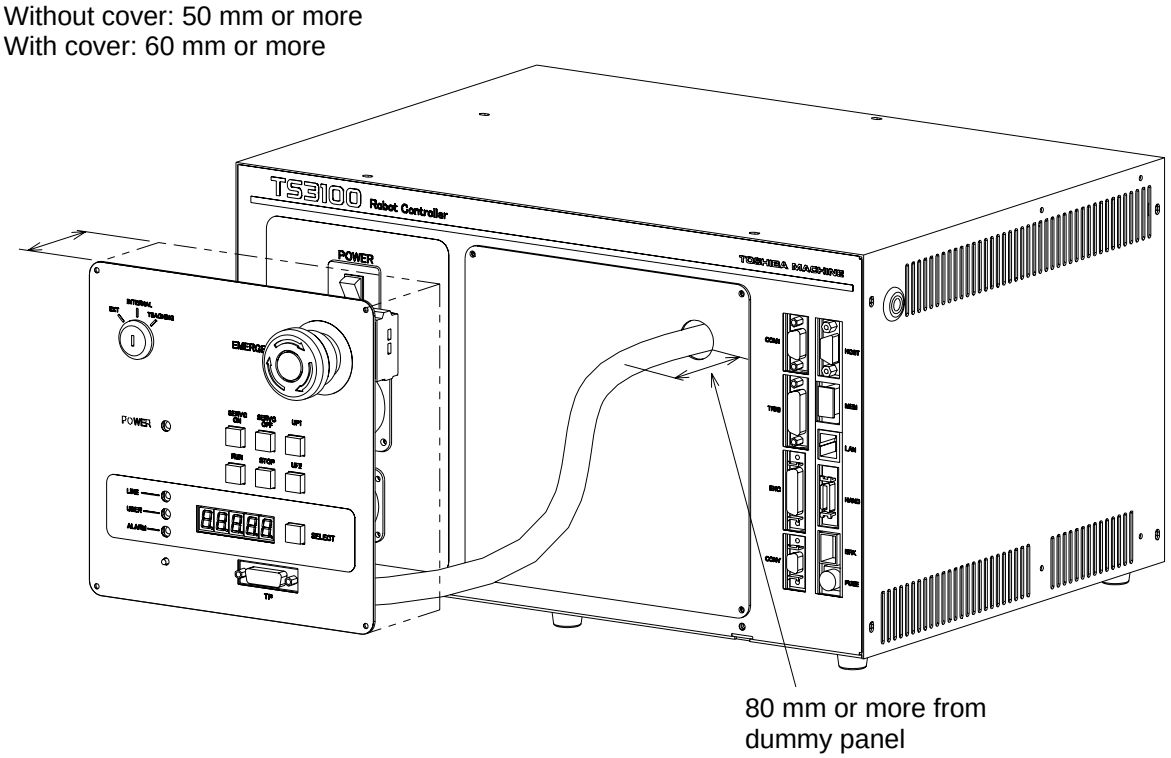



Fig. 4.8 Cable connections of dummy panel and control panel

## 5. Tool Interface

### 5.1 Mounting Tool

The tool is to be mounted on the tool mounting flange at the end of arm 3. Fig. 5.1 shows the dimensions of the tool mounting flange.
As shown in Fig. 5.1, the tool is centered with the ø20H7 mating section. The tool direction is adjusted by means of the ø5 knock pin and secured with four (4) M5 bolts.

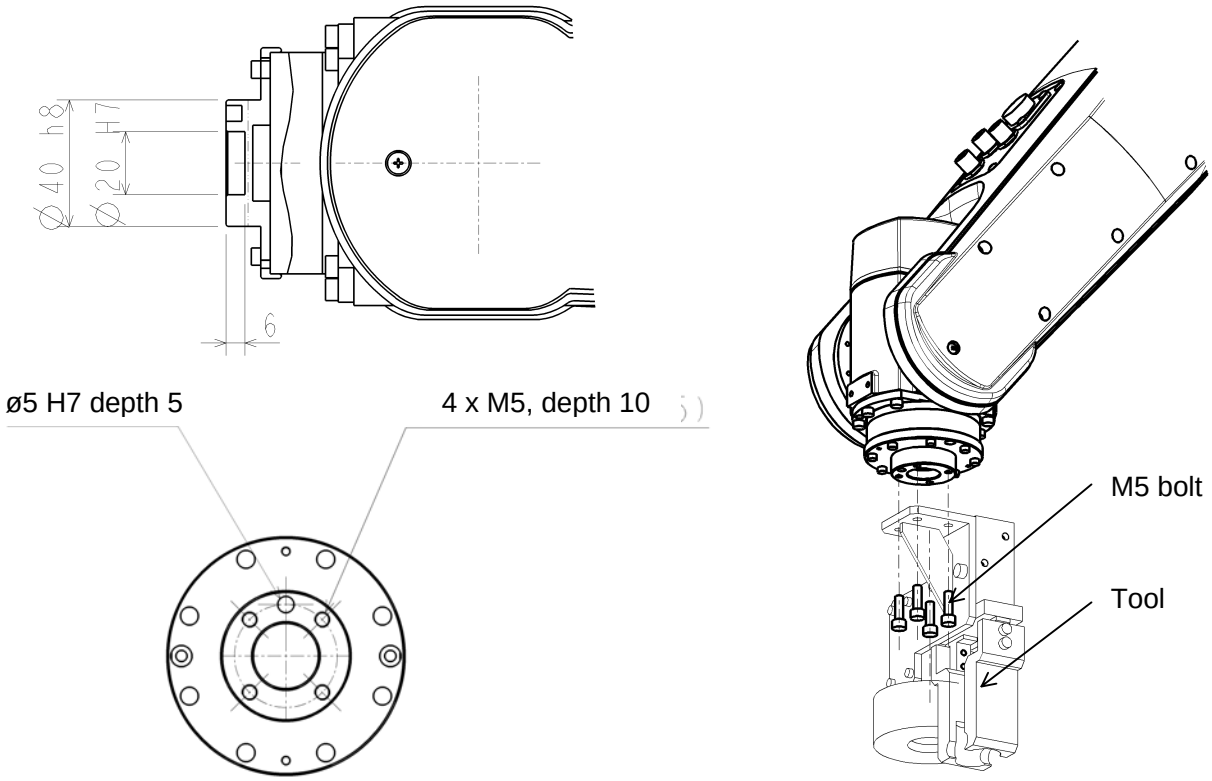



Fig. 5.1 Tool mounting dimensions

## 5.2 Tool Wiring and Piping

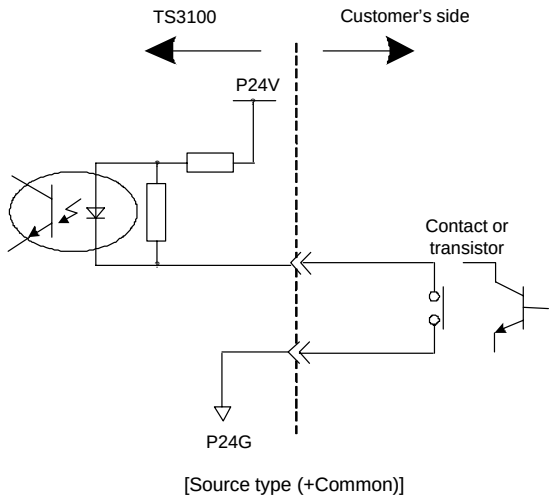
The robot is provided with wiring and air piping for the tool. These wiring and piping extend to the arm 2 and are used as follows:

Connection to external equipment from the robot controller can also be made without using the tool wiring in the robot arm.

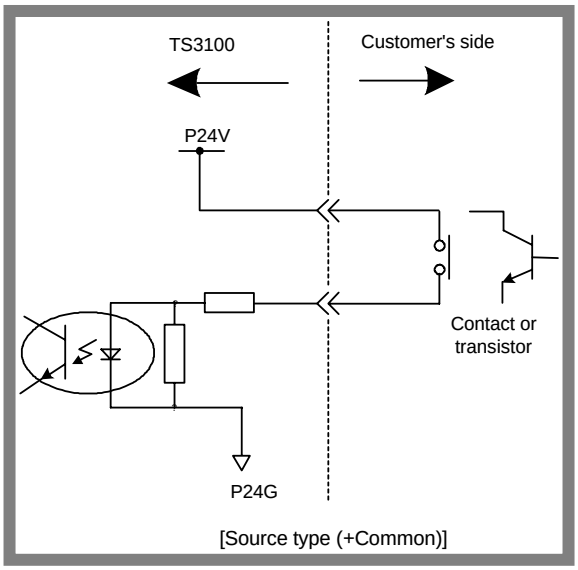
### 5.2.1 Tool Signals (Controller Side)

Eight input signals for components such as sensors, eight control signals for components such as solenoid valves, 24 VDC, and 24 VDC GND are provided as tool signals for the controller, thus enabling the wiring from the controller to external equipment. (Cables between the controller and external equipment are optional.) The signals are explained below.

a-1) Input signal connector HAND (Type-N)

| Pin | Signal name | | Signal No. | Input circuit and example of connections |
|---|---|---|---|---|
| 1 | D-IN 1 | Input signal 1 | 201 |  [Source type (+Common)] |
| 2 | D-IN 2 | Input signal 2 | 202 | |
| 3 | D-IN 3 | Input signal 3 | 203 | |
| 4 | D-IN 4 | Input signal 4 | 204 | |
| 5 | D-IN 5 | Input signal 5 | 205 | |
| 6 | D-IN 6 | Input signal 6 | 206 | |
| 7 | D-IN 7 | Input signal 7 | 207 | |
| 8 | D-IN 8 | Input signal 8 | 208 | |
| 19 | PG | 0V | | |
| 20 | | | | |

a-2) Input signal connector HAND (Type-P)

| Pin | Signal name | | Signal No. | Input circuit and example of connections |
|---|---|---|---|---|
| 1 | D-IN 1 | Input signal 1 | 201 |  |
| 2 | D-IN 2 | Input signal 2 | 202 | |
| 3 | D-IN 3 | Input signal 3 | 203 | |
| 4 | D-IN 4 | Input signal 4 | 204 | |
| 5 | D-IN 5 | Input signal 5 | 205 | |
| 6 | D-IN 6 | Input signal 6 | 206 | |
| 7 | D-IN 7 | Input signal 7 | 207 | |
| 8 | D-IN 8 | Input signal 8 | 208 | |
| 19 | P24V | | DC24V power | |
| 20 | | | | |



As input signals, no-voltage contacts or transistor open collector inputs are used.

No-voltage contact specifications:

Contact rating: DC24 V, 10 mA or over (circuit current: approx. 7 mA)

Minimum contact current: DC24 V, 1 mA

Contact impedance: 100 Ω or less

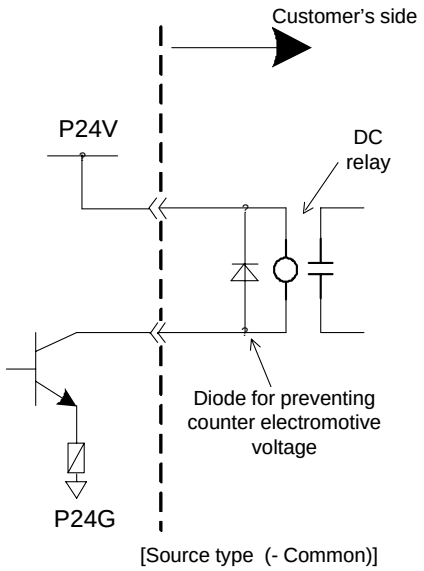
Transistor specifications:

Withhold voltage between collector and emitter: 30 V or over

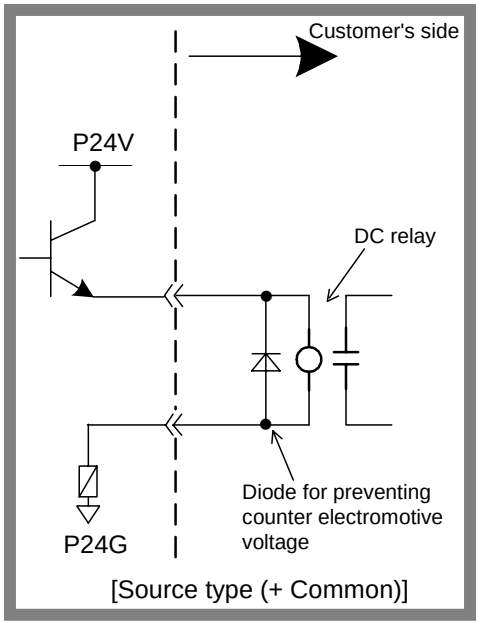
Current between collector and emitter: 10 mA or over (circuit current: approx. 7 mA)

Leak current between collector and emitter: 100 μA or less

b-1) Output signal connector HAND (Type-N)

| Pin | Signal name | | Signal No. | Input circuit and example of connections |
|---|---|---|---|---|
| 9 | D-OUT 1 | Output signal 1 | 201 |  |
| 10 | D-OUT 2 | Output signal 2 | 202 | |
| 11 | D-OUT 3 | Output signal 3 | 203 | |
| 12 | D-OUT 4 | Output signal 4 | 204 | |
| 13 | D-OUT 5 | Output signal 5 | 205 | |
| 14 | D-OUT 6 | Output signal 6 | 206 | |
| 15 | D-OUT 7 | Output signal 7 | 207 | |
| 16 | D-OUT 8 | Output signal 8 | 208 | |
| 17 | P24V | | DC24V power | |
| 18 | | | | |

b-2) Output signal connector HAND (Type-P)

| Pin | Signal name | | Signal No. | Input circuit and example of connections |
|---|---|---|---|---|
| 9 | D-OUT 1 | Output signal 1 | 201 |  |
| 10 | D-OUT 2 | Output signal 2 | 202 | |
| 11 | D-OUT 3 | Output signal 3 | 203 | |
| 12 | D-OUT 4 | Output signal 4 | 204 | |
| 13 | D-OUT 5 | Output signal 5 | 205 | |
| 14 | D-OUT 6 | Output signal 6 | 206 | |
| 15 | D-OUT 7 | Output signal 7 | 207 | |
| 16 | D-OUT 8 | Output signal 8 | 208 | |
| 17 | P24V | | DC24V power | |
| 18 | | | | |



By using the DC24 V power of the controller, a relay, solenoid valve, etc., can be driven. When the external power is used, GND of the external power should be common to GND (PG) of the robot controller. NEVER connect +24 V with P24 V. Otherwise, the power supply may be damaged.

Output specifications:

Rated voltage : DC24 V
Rated current : 100 mA

- When a relay or solenoid valve, etc., is connected, it is necessary to use a surge killer or diode to absorb the surge voltage.
- When a double solenoid is used, HO_1 and HO_2, and HO_3 and HO_4 are used as pairs.

The right figure shows the DC relay circuit when the external power is used.

### 5.2.2 Tool Wiring

Eight input signals are provided for sensors, etc. and eight control signals for solenoid valves, etc. A supply power signal of DC24 V is also provided. They are connected to the controller. The wiring arrangement for these cables is shown in Fig. 5.2. The wires are connected to the connectors on the upper side of the arm 2. The user should provide the following connectors to connect the cables.

Cannon connector (standard) Type: Straight plug JN2DW15SL1
Angle plug JN2FW15SL1
(Maker: Japan Aviation Electronics Industry)
Type of contact:JN1-22-26S-PKG100 Adaptive cable:AWG26～AWG28
JN1-22-26S-PKG100 AWG21～AWG25
JN1-22-20S-PKG100 AWG20
Triple manifold (option) Type: SYJ3233-5MR (Maker: SMC)
Obtaining is difficult: It Shown in Table 5.1 of P73.

**! DANGER**

- Be sure to use the designated wire. Otherwise, fires or faults may be caused.
- When connecting the connector and wires, make sure not to mistake the terminal arrangement.
- After making the connection, use a tester, etc., to confirm the connection.

When controlling the robot from the sequencer (i.e., programmable ladder controller: PLC), etc. installed separately, remove the motor cover from the base section, remove connectors JOES and SOLS on the rear side, then connect the cables running from the PLC, etc. through the cable inlets provided on the motor cover. (See Fig. 5.2.)
For ahead of the JOES and SOLS connectors, the user should prepare the following plug connectors and connect the cables. The current is 1 A or less per cable.

Type of connector: JOES J11DF-20V-KX (Maker: J.S.T. Mfg.)
SOLS J11DF-08V-KX (Maker: J.S.T. Mfg.)
Type of contact:SF1F-002T-P0.6 Adaptive cable:AWG24～AWG28
SF1F-21T-M0.6A AWG18～AWG22

Opposite connector type

Type of connector: JOEP J11DFM-20V-KX (Maker: J.S.T. Mfg.)
SOLP J11DFM-08V-KX (Maker: J.S.T. Mfg.)
Type of contact: SF1M-21T-M0.6A(Maker: J.S.T. Mfg.)

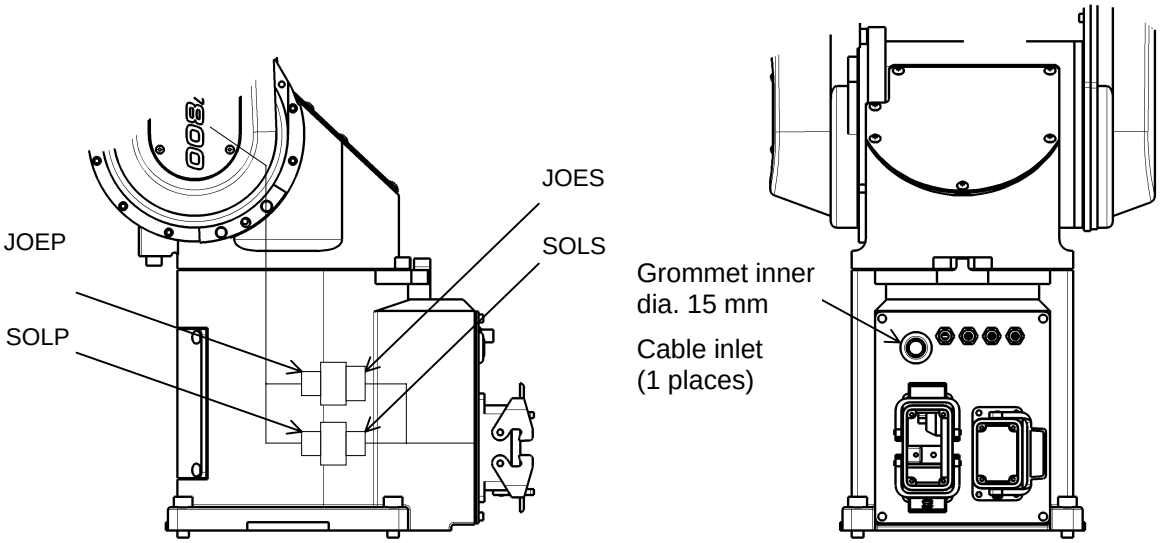
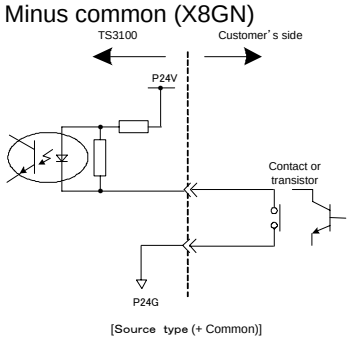
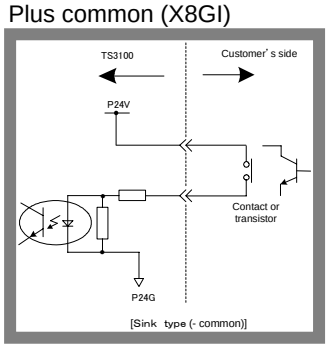
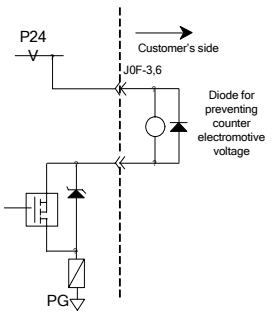
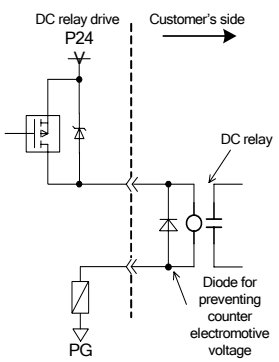



Fig. 5.2 Wiring to PLC, etc.

Input/output signal connector CN22

| Pin (Cannon) | Signal name | | Signal No. | Input/output circuit and example of connections | |
|---|---|---|---|---|---|
| 1 | H_IN0 | Input signal 0 | 201 | Minus common (X8GN)   | Plus common (X8GI)   |
| 2 | H_IN1 | Input signal 1 | 202 | | |
| 3 | H_IN2 | Input signal 2 | 203 | | |
| 4 | H_IN3 | Input signal 3 | 204 | | |
| 5 | H_IN4 | Input signal 4 | 205 | | |
| 6 | H_IN5 | Input signal 5 | 206 | | |
| 7 | H_IN6 | Input signal 6 | 207 | | |
| 8 | H_IN7 | Input signal 7 | 208 | | |
| 9 | H_OUT0 | Output signal 0 | 201 |   |   |
| 10 | H_OUT1 | Output signal 1 | 202 | | |
| 11 | P24 | DC24V power supply | | | |
| 12 | PGND | 0V | | | |
| 13 | PGND | 0V | | | |
| 14 | NC | Not used | | | |
| 15 | FG | Frame ground | | | |
| | | | | | |
| | | | | | |

Input/output signal connector SOLP
(This connector is located in arm 2, and connected to the solenoid valve when the manifold is optional.)

| Pin (Connector) | Signal name | | Signal No. |
|---|---|---|---|
| A1 | H_OUT2 | Output signal 2 | 203 |
| B1 | H_OUT3 | Output signal 3 | 204 |
| A2 | H_OUT4 | Output signal 4 | 205 |
| B2 | H_OUT5 | Output signal 5 | 206 |
| A3 | H_OUT6 | Output signal 6 | 207 |
| B3 | H_OUT7 | Output signal 7 | 208 |
| A4 | NC | Not used | |
| B4 | P24 | DC24V power supply | |

As input signals, no-voltage contacts or transistor open collector inputs are used.

No-voltage contact specifications:

Contact rating: DC24 V, 10 mA or over (circuit current: approx. 7 mA)
Minimum contact current: DC24 V, 1 mA
Contact impedance: 100 Ω or less

Transistor specifications:

Withhold voltage between collector and emitter: 30 V or over
Current between collector and emitter: 10 mA or over (circuit current: approx. 7 mA)
Leak current between collector and emitter: 100 μA or less

By using the DC24 V power of the controller, a relay, solenoid valve, etc., can be driven. When the external power is used, GND of the external power should be common to GND (PG) of the robot controller.

Output specifications:

Rated voltage : DC24 V
Rated current : 100 mA

- If the DC24 V power supplied from the robot controller is used, the total current should be 2 A or less.
- When the external power is used, the total current should also be 2 A or less.
- When a relay or solenoid valve, etc., is connected, it is necessary to use a surge killer or diode to absorb the surge voltage.

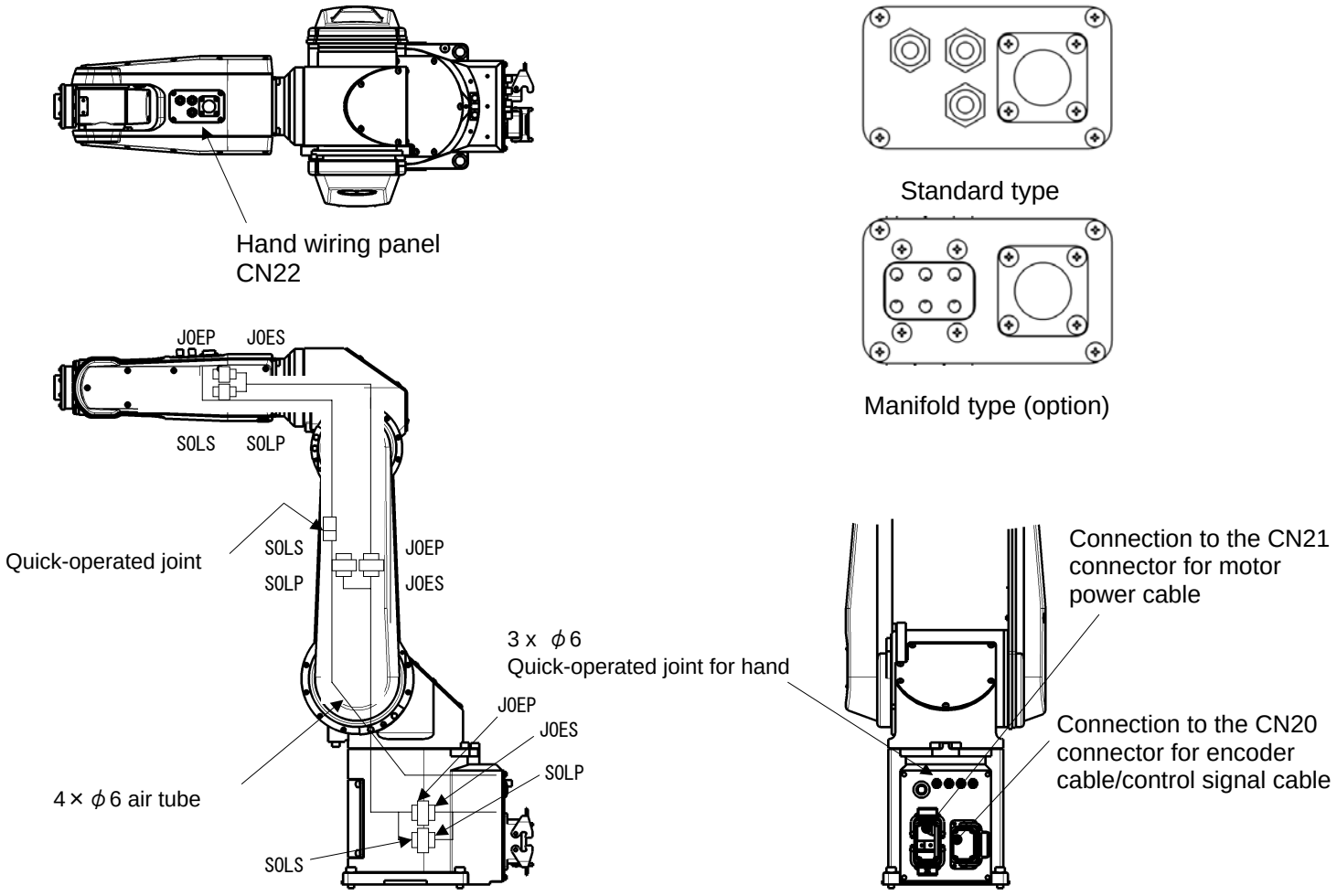



Fig. 5.3 Tool wiring

Table 5.1 CN22 Cable (option) list

| | Part name | Toshiba Dwg. No. | Unit code | Maker | Plug type | Length |
|---|---|---|---|---|---|---|
| 1 | I/O cable | 338N9101 | Y610A38W0 | Toshiba Machine | Straight plug | 1m |
| 2 | | 338N9102 | Y610A38X0 | | | 2m |
| 3 | | 339N2601 | Y610A3FP0 | | Angle plug | 1m |
| 4 | | 339N2602 | Y610A3FR0 | | | 2m |

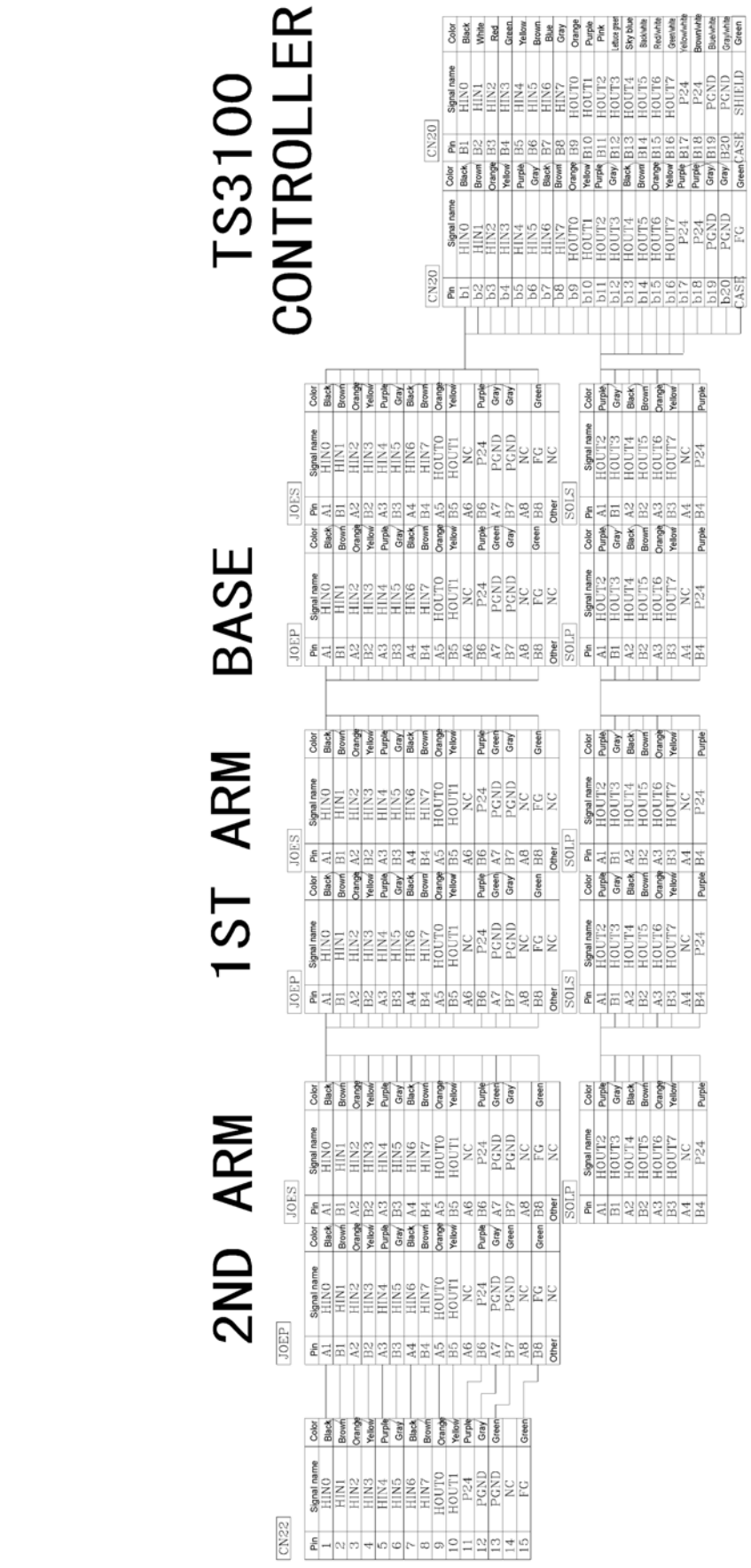
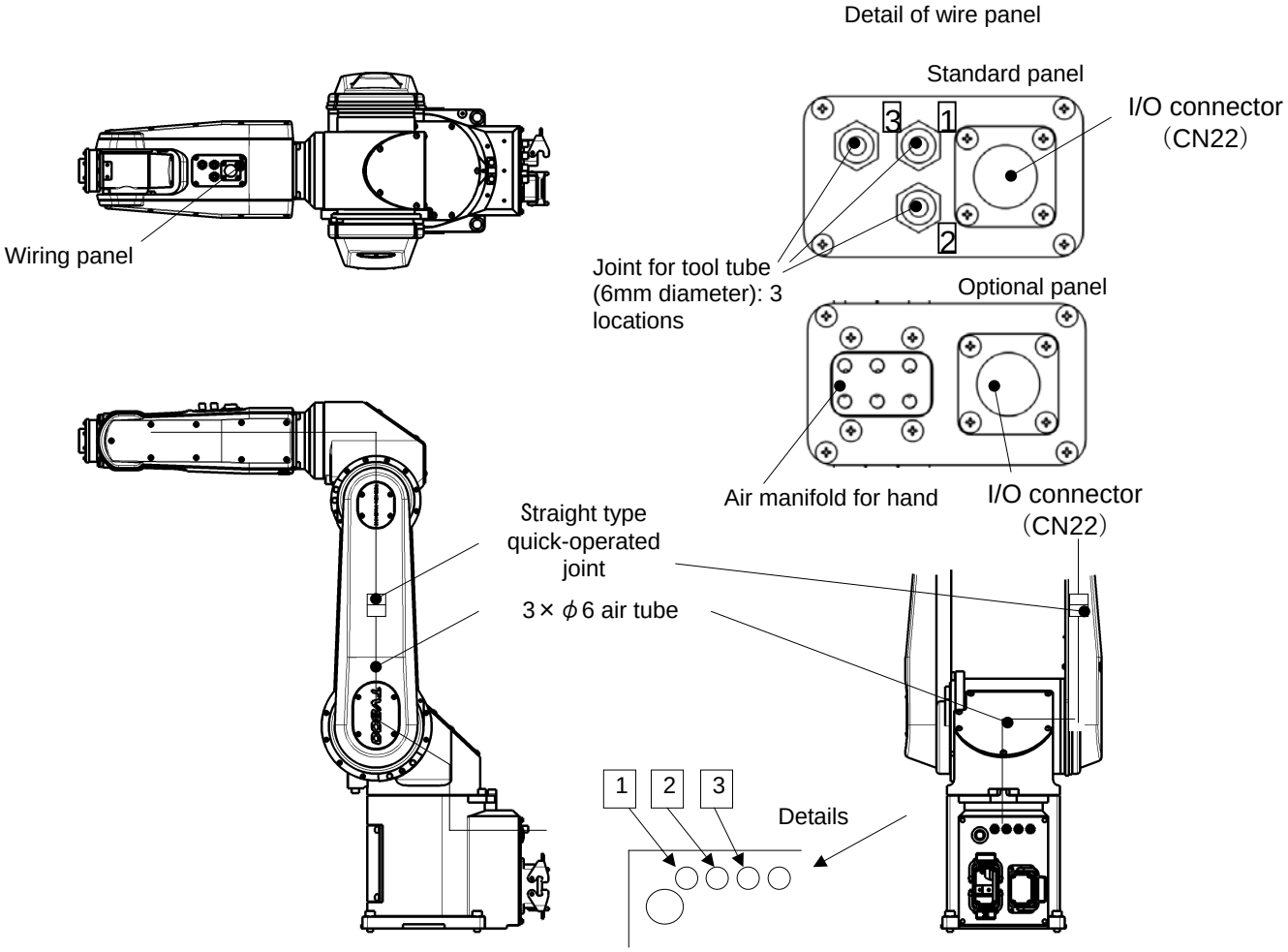



Fig. 5.4 Internal connection diagram

### 5.2.3 Tool Air Piping

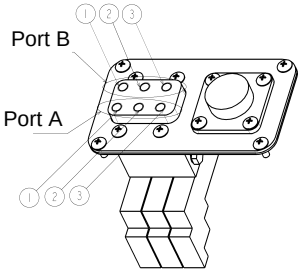
The robot is provided with four (4) air lines for the tool.
The outer diameter of the air pipelines is 6 mm. Fig. 5.6 shows the tool air piping.
The air control unit (oiler, regulator with gage and filter) for the solenoid valves should be provided by the customer.




The air tube is identified by the number and color. At piping, make sure that each tube is connected properly, referring to the below-mentioned.

1 : Red 2 : White 3 : Blue

The following is signal allocation of the manifold.




| Port | Signal name |
|---|---|
| A1 | H_OUT2(1A) |
| B1 | H_OUT3(1B) |
| A2 | H_OUT4(2A) |
| B2 | H_OUT5(2B) |
| A3 | H_OUT6(3A) |
| B3 | H_OUT7(3B) |

Fig. 5.6 Tool air piping

## 5.3 Permissible Load Conditions and Program Setting

This paragraph describes the permissible load conditions of the robot and how to set up the program according to the load.

### 5.3.1 Permissible Load Conditions

The robot load conditions are defined by the tool mass, moment of inertia and offset value of tool gravity center from the center of the tool shaft, as shown in Fig. 5.7.
The permissible load conditions are shown in Table 5.2.

Table 5.2 Permissible load conditions

| Conditions | Permissible values |
|---|---|
| Mass | Max. 5 kg |
| Load inertia | Max. 0.05 kg·m$^2$ |
| Offset value of load gravity center | Max. 100 mm |

**! CAUTION**

- NEVER operate the robot under the load conditions exceeding the permissible values. Otherwise, the robot life and safety cannot be guaranteed.

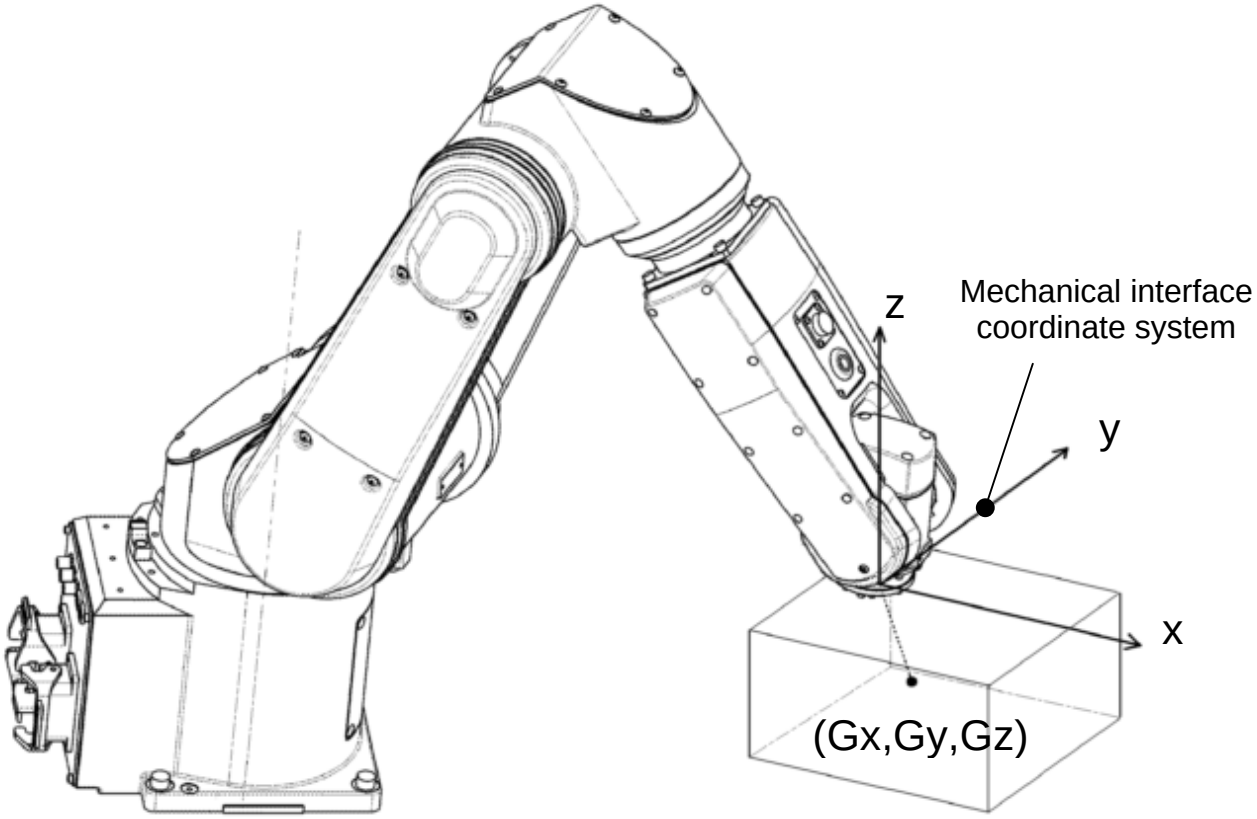



Fig. 5.7 Robot tool

### 5.3.2 Load Conditions and Program Setting

This robot can automatically change the maximum speed, acceleration/deceleration and servo gain by using the PAYLOAD command in the program according to the load conditions.

**Be sure to use the PAYLOAD command.**

The specific method for using this function is explained below.

a) PAYLOAD command format

The PAYLOAD command format is written as shown below if the tool mass is M kg and the gravity center offset is G mm.

PAYLOAD = {M, Gx,Gy,Gz}

M : Load mass (unit: kg)

Gx: Center-of-gravity offset in the X direction (Units in mm: Absolute value)

Gy: Center-of-gravity offset in the Y direction (Units in mm: Absolute value)

Gz: Center-of-gravity offset in the Z direction (Units in mm: Absolute value)

The PAYLOAD command has the following functions.

- The maximum speed and acceleration/deceleration of each robot axis are automatically changed according to the set load conditions.
- The servo gain of each robot axis is automatically changed according to the set load conditions.

b) Program examples

Basic program examples using the PAYLOAD command are shown below. For further information, see the Robot Language Manual.

(Program example 1)

The robot is moved under the load conditions of 5 kg mass and (50mm,50mm,50mm) gravity center offset.

```
PROGRAM SAMPLE
  SPEED=100
  PAYLOAD={5,50,50,50}
  MOVE P1
  MOVE P2
  STOP
END
```

(Program example 2)

When the hand mass is 3 kg and the gravity center offset is (0mm,0mm,30 mm) and the mass is 5 kg and gravity center offset is (30mm,0mm,50 mm) when the workpiece is grasped.

Pick-and-place operation is executed under the above conditions.

```
PROGRAM SAMPLE
  PAYLOAD={3,0,0,20}
  ACCUR=COARSE
  ENABLE NOWAIT
  RESET DOUT
  MOVE P0
  DOUT(1)
  WAIT DIN(1)
LOOP:
  MOVE P1+POINT(0,0,100)
  IF DIN(-1)THEN GOTO FIN
  MOVE P1
  WAIT MOTION>=100
  DOUT(213)
  DELAY 1
```

```
   PAYLOAD={5,30,0,50}
   MOVE P1+POINT(0,0,100)
   MOVE P2+POINT(0,0,100)
   MOVE P2
   WAIT MOTION>=100
   DOUT(-213)
   DELAY 1
   PAYLOAD={3,0,0,20}
   MOVE P2+POINT(0,0,100)
   GOTO LOOP
FIN:
   MOVE P0
   DOUT(1)
   STOP
END
```

**! CAUTION**

- When guiding manually, the robot may vibrate if the load mass or gravity center offset is large. This is because the servo gain is not appropriate. When this happens, perform the following operation while setting the load conditions in the test run mode.

  DO PAYLOAD = {M, L}  M: Mass [kg]  L: Offset [mm]
  EXE

  The servo gain is changed then to the value which meets the load conditions.

APPROVED BY: Y. Yamaguchi

CHECKED BY: K. Okabe

PREPARED BY: T. Uematsu