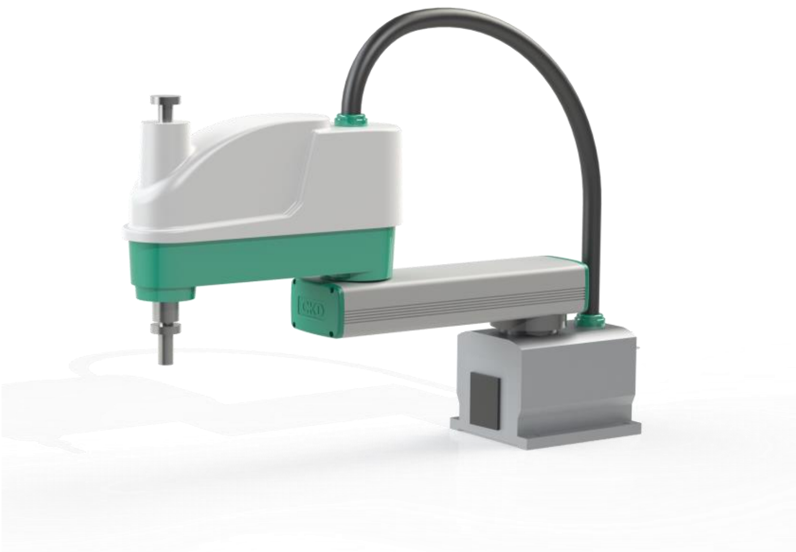
CKD

SCARA Robot

KHL Transportation and Installation Manual

INSTRUCTION MANUAL

SM-A20060-A



- Read this Instruction Manual before using the product.
- Read the safety notes carefully.
- Keep this Instruction Manual in a safe and convenient place for future reference.

CKD Corporation

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 parts:

Section 1-4	Specifications This section describes the basic specifications and names of respective units of the robot and controller.
Section 5-8	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 9-15	Installation This section discusses the equipment installation environment, space requirements, and how to install the equipment.
Section 16-18	System Connections This section describes how to connect the robot, controller and peripheral equipment.
Section 19-25	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

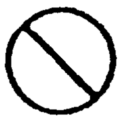
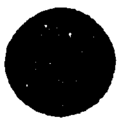
Important information on the robot and controller is noted in the instruction manual to prevent injury to the user and persons nearby, prevent damage to assets and to ensure correct use.
Make sure that the following details (indications and symbols) are well understood before reading this manual.   Always 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. The details 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. Doing so could lead to electric shocks, fires or faults. • 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. • 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 (for KHL500 to KHL700). • Wire the robot after installation. Wiring the robot before installation could lead to electric shocks or injuries. • Always use the power voltage and power capacity designated by CKD. Failure to do so could lead to device faults or fires. • 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. Also, it could cause misoperation by noise.

⚠ CAUTION	
Prohibited	• NEVER lift the robot by the arm 2 cover. Doing so will apply an excessive force on the robot's mechanism section and could lead to faults. • For the controller, secure the ample space for air vent. Heating of controller could lead to malfunction.
Mandatory	• When lifting the robot (for KHL-500 to KHL-700), lift it up slowly. The robot will tilt slightly, so lifting it up suddenly could be hazardous. • 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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Tables and Drawings

1. Specifications (KHL-300 and KHL-400)

1.1 Correspondence between the Robots and the Robot Controllers

Table 1.1 shows the correspondence between the robots and the robot controllers.
The KHL series robots are compatible with the KSL3000 robot controllers.

Table 1.1 Correspondence between the Robots and the Robot Controllers

		Robot	
		KHL-300, KHL-400	KHL-500, KHL-600, KHL-700
Robot controller	KSL3000	○	○

○: Supported

1.2 Robot Configuration Diagram (KSL3000)

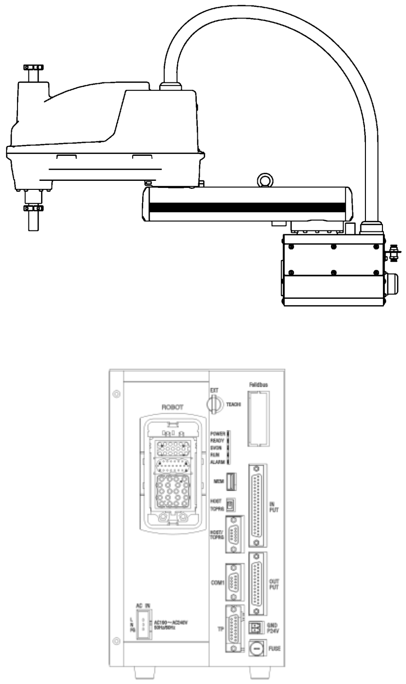


Fig. 1.1 Robot Configuration (KSL3000)

For connection of the 200-volt power source, see "16.1.2 Connecting the Power Cable "ACIN"". For connection of 24-volt power source, see "16.1.7 Connecting the External Input/Output Power Cable "GNDP24V"".

1.3 Name of Each Part

Fig. 1.4 shows the name of each part of the robot (KHL-300 and KHL-400).

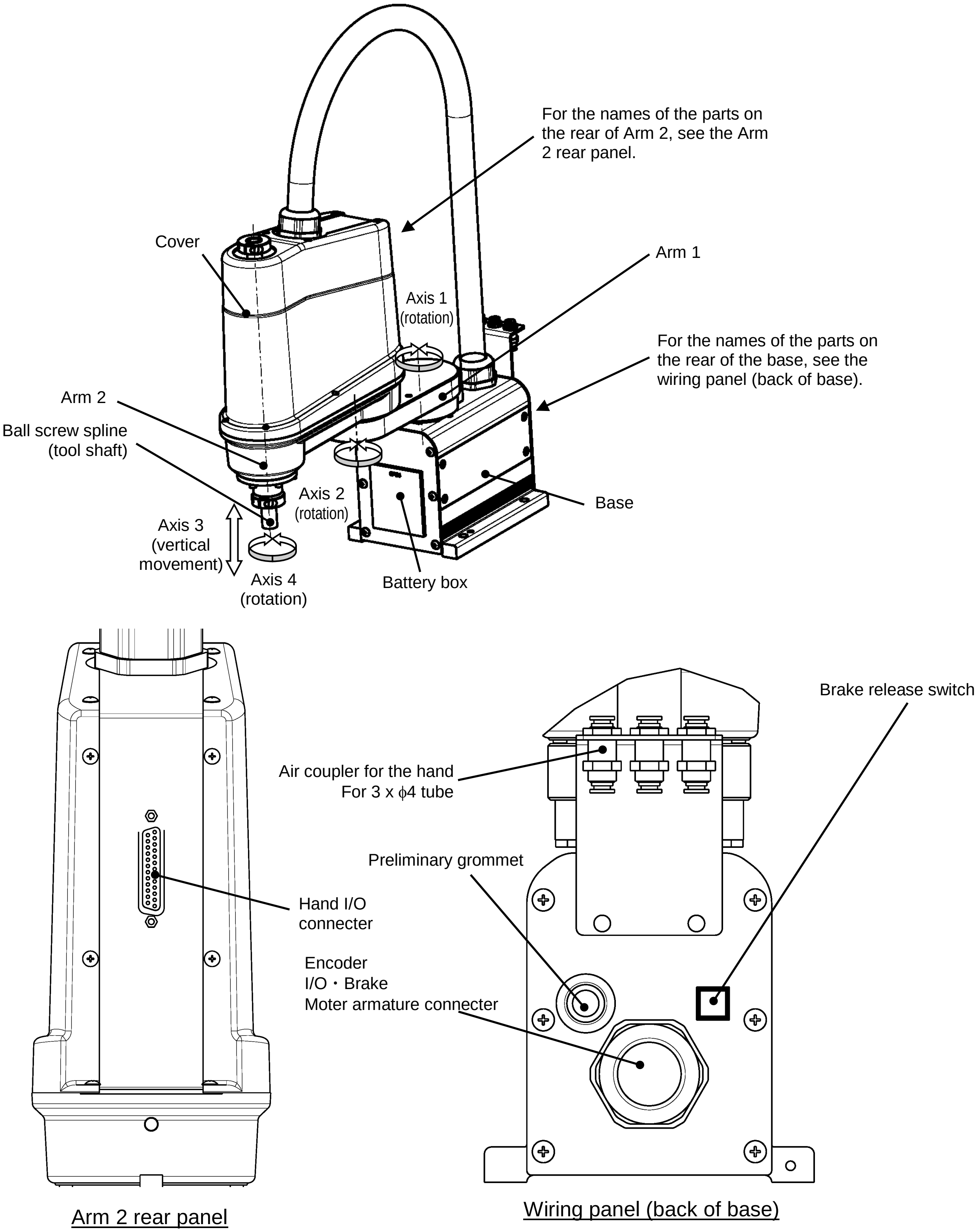
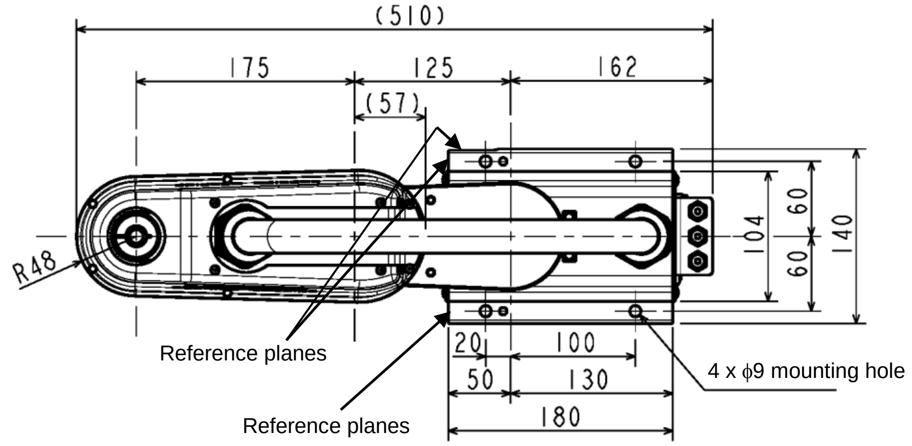


Fig. 1.2 Name of each part (KHL-300 and KHL-400)

1.4 External Dimensions



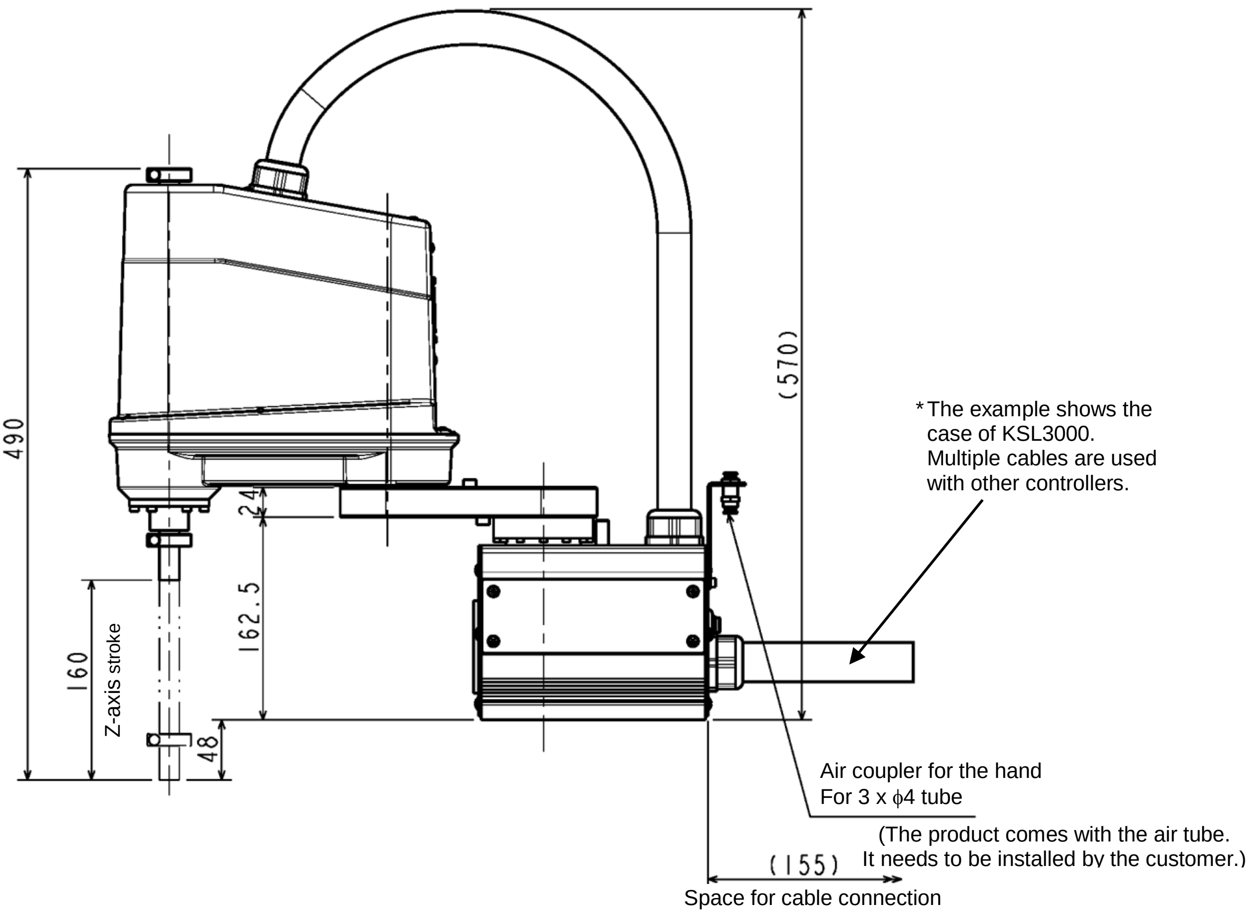
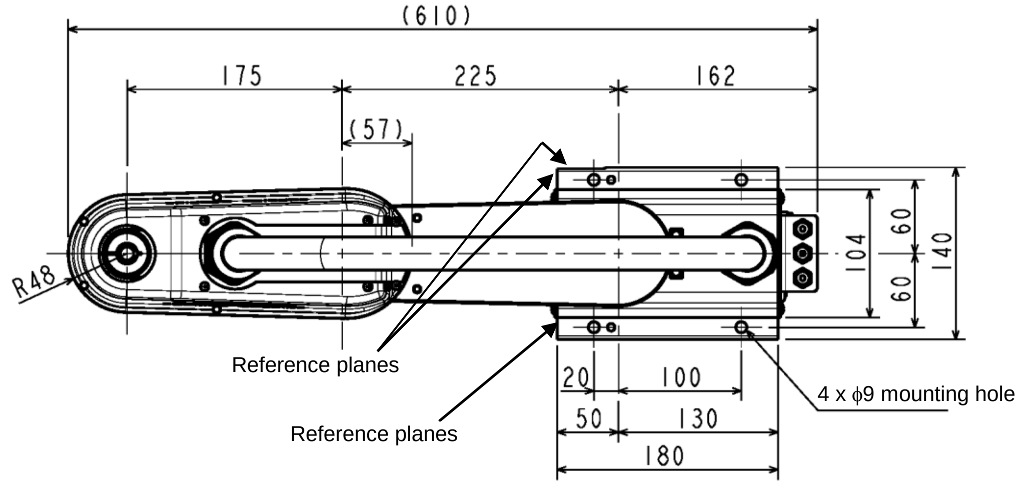


Fig. 1.3 External dimensions of robot (KHL-300)



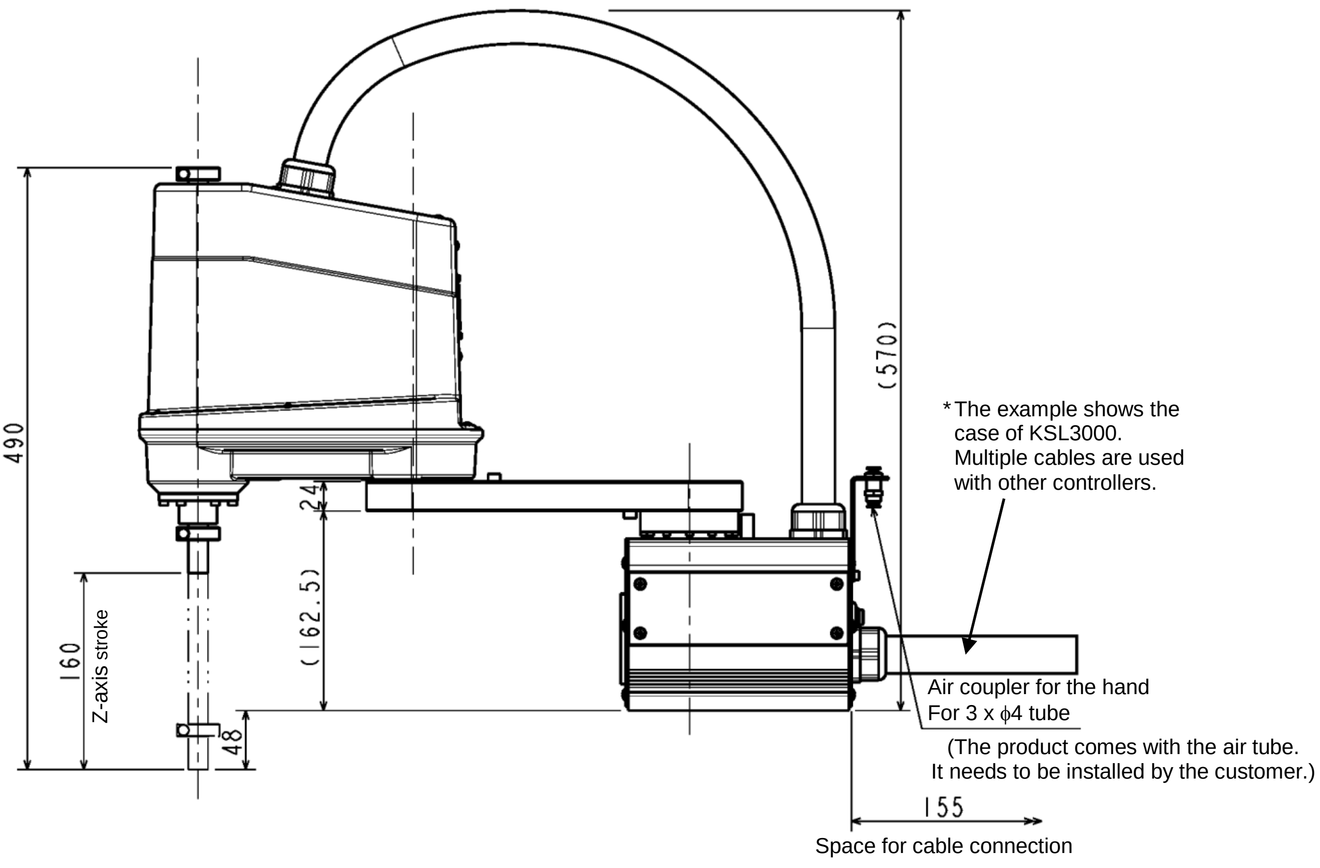


Fig. 1.4 External dimensions of robot (KHL-400)

1.5 Specifications Table

Item		Specifications	
Structure		Horizontal multi-joint type SCARA robot	
Model		KHL-300	KHL-400
Applicable controller		KSL3000	
Mass of robot body		12 kg	13 kg
No. of controlled axes		4	
Arm length		300 mm (125 mm + 175 mm)	400 mm (225 mm + 175 mm)
Motor capacity / Current limit	Axis 1	200 W / 9.84 $A_{0\text{-}P}$	
	Axis 2	100 W / 4.89 $A_{0\text{-}P}$	
	Axis 3	100 W / 4.70 $A_{0\text{-}P}$	
	Axis 4	100 W / 4.89 $A_{0\text{-}P}$	
Operating range	Axis 1	±125 deg	
	Axis 2	±145 deg	
	Axis 3	0 to 160 mm	
	Axis 4	±360 deg	
Maximum speed (*1)	Axis 1	660 deg/s	
	Axis 2	660 deg/s	
	Axis 3	1120 mm/s	
	Axis 4	1500 deg/s	
	Composite speed of axes 1 and 2	5.1 m/s	6.3 m/s
Rated payload mass (*1)		2 kg	
Maximum payload mass (*1)		5 kg	
Permissible load inertia (*1)		0.05 $kg \cdot m^2$	
Repeatability (*2)	X,Y	±0.01 mm	
	Z	±0.015 mm	
	C	±0.007 deg	
Cycle time (*3) (When payload mass is 2 kg)		0.48 s	0.47 s
Drive system		By means of AC servo motors	
Position detection method		Absolute	
Paint color (*4)		Arm 2: Equivalent to human and techno green Body: White alumite processing Arm cover: White	
Power supply capacity		0.7 kVA	

*1: There are restrictions on speed and acceleration speed depending on the operation pattern, load, and offset amount.

*2: This is unidirectional position repeatability when the ambient temperature is constant at 20°C. It is not absolute positioning accuracy. The values of X, Y and C are what Z value is in upper limit. It does not guarantee the trajectory accuracy.

*3: The standard cycle operation pattern cannot achieve continuous operation exceeding the effective load rate. With horizontal direction 300 mm, vertical direction 25 mm round trip, and rough positioning.

*4: The tone may be different among production lots, but it does not affect the product quality.

⚠ CAUTION

- Micro vibration may occur depending on the robot posture. If micro vibration occurs, reduce the acceleration speed to use the robot.
- Put the Z-axis (axis 3) in the raised position as much as possible, when moving Axes 1, 2, and 4.

  Moving Axis 1, 2, or 4 when the Z-axis is in low positions can lead to premature damage to the ball screw spline (Z-axis shaft).

  If Axis 1, 2, or 4 must be moved while the Z-axis is in low positions due to unavoidable circumstances, prevent the ball screw spline vibrations by using the SPEED, ACCEL/DECEL, and PAYLOAD commands to adjust the operation speed and acceleration.
- If Axis 1, 2, or 4 is moved while the Z-axis is in low positions, be extremely careful not to collide with any objects. Even if Axis 1, 2, or 4 is moved at low speed, a collision or other impact with an object can damage the ball screw spline (Z-axis shaft) before alarm occurs.

2. Specifications (KHL-500, KHL-600 and KHL-700)

2.1 Correspondence between robot and controller, and equipment configuration diagram

For the correspondence between robot and controller, and equipment configuration diagram, see the description of 1.1 through 1.4.

2.2 Name of Each Parts

Fig. 2.1 shows the name of each part of the robot (KHL-500, KHL-600 and KHL-700).

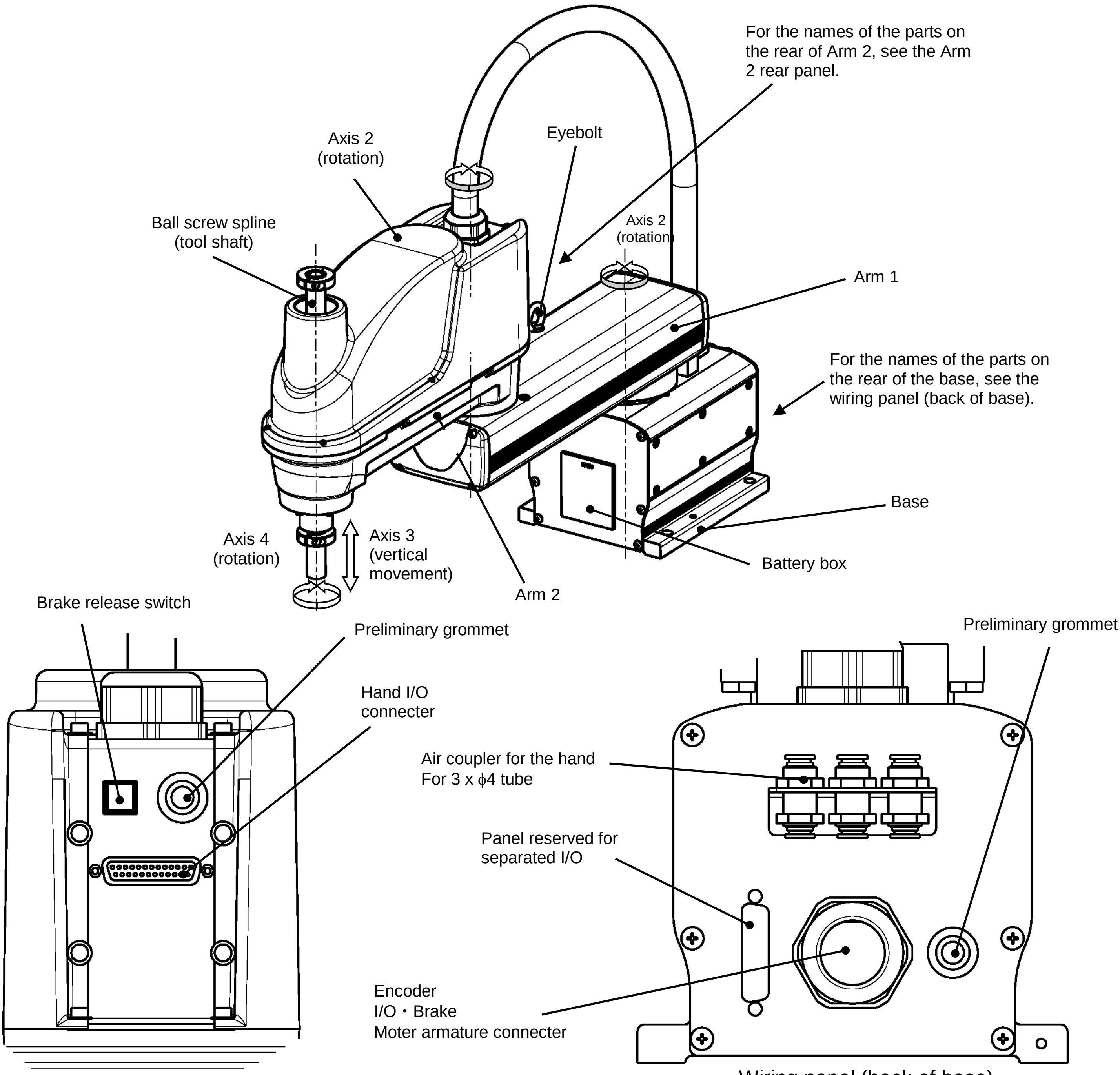


Fig. 2.1 Name of each part (KHL-500, KHL-600 and KHL-700)

2.3 External Dimensions

Figs. 2.2 to 2.4 refer to the external dimensions of the robot (KHL-500, KHL-600 and KHL-700).

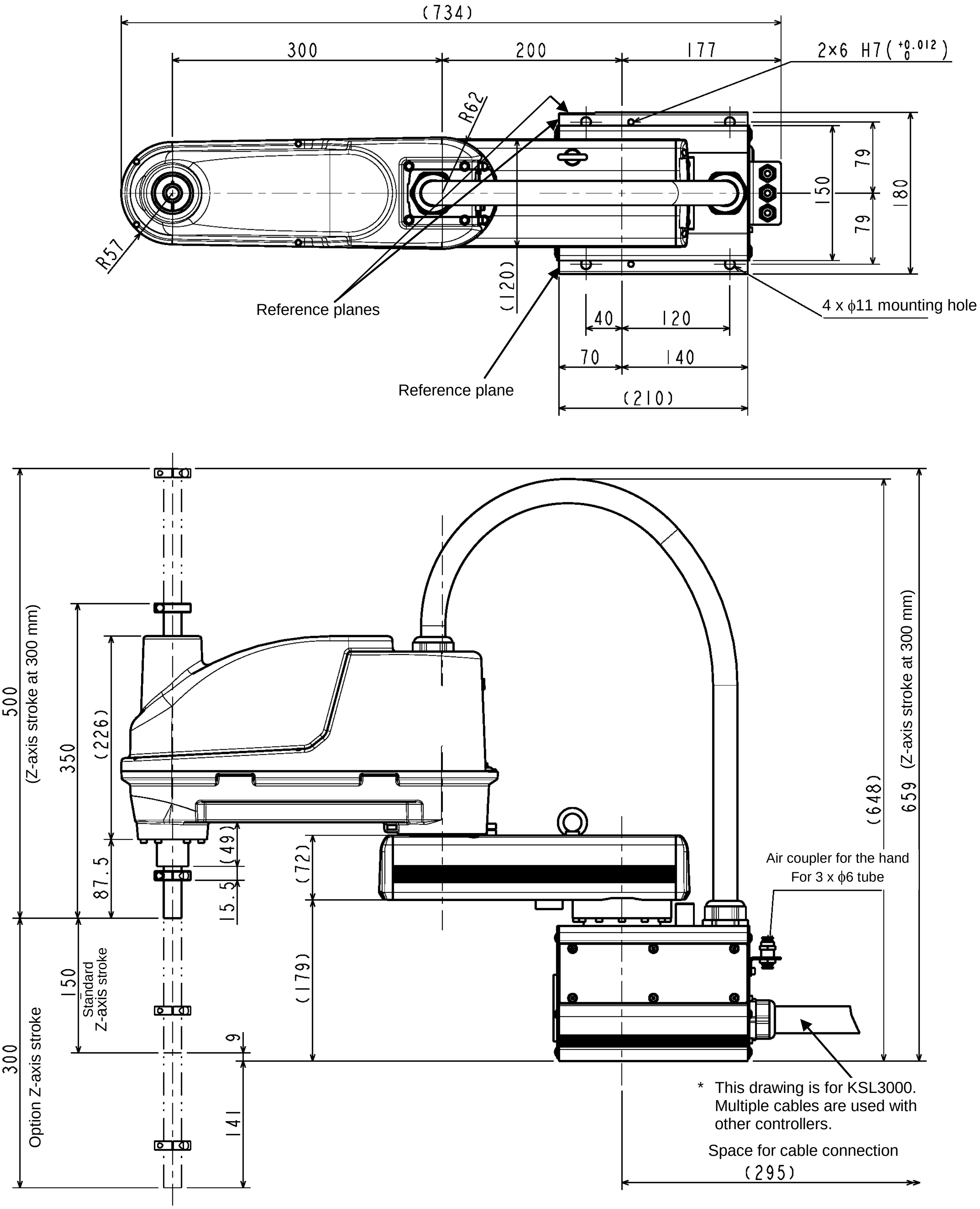
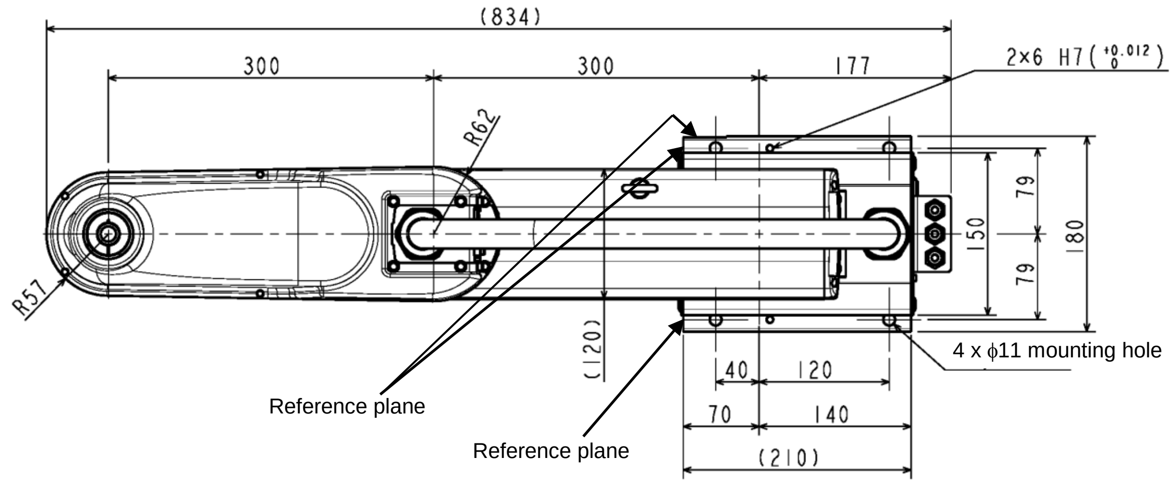


Fig. 2.2 External dimensions of robot (KHL-500)



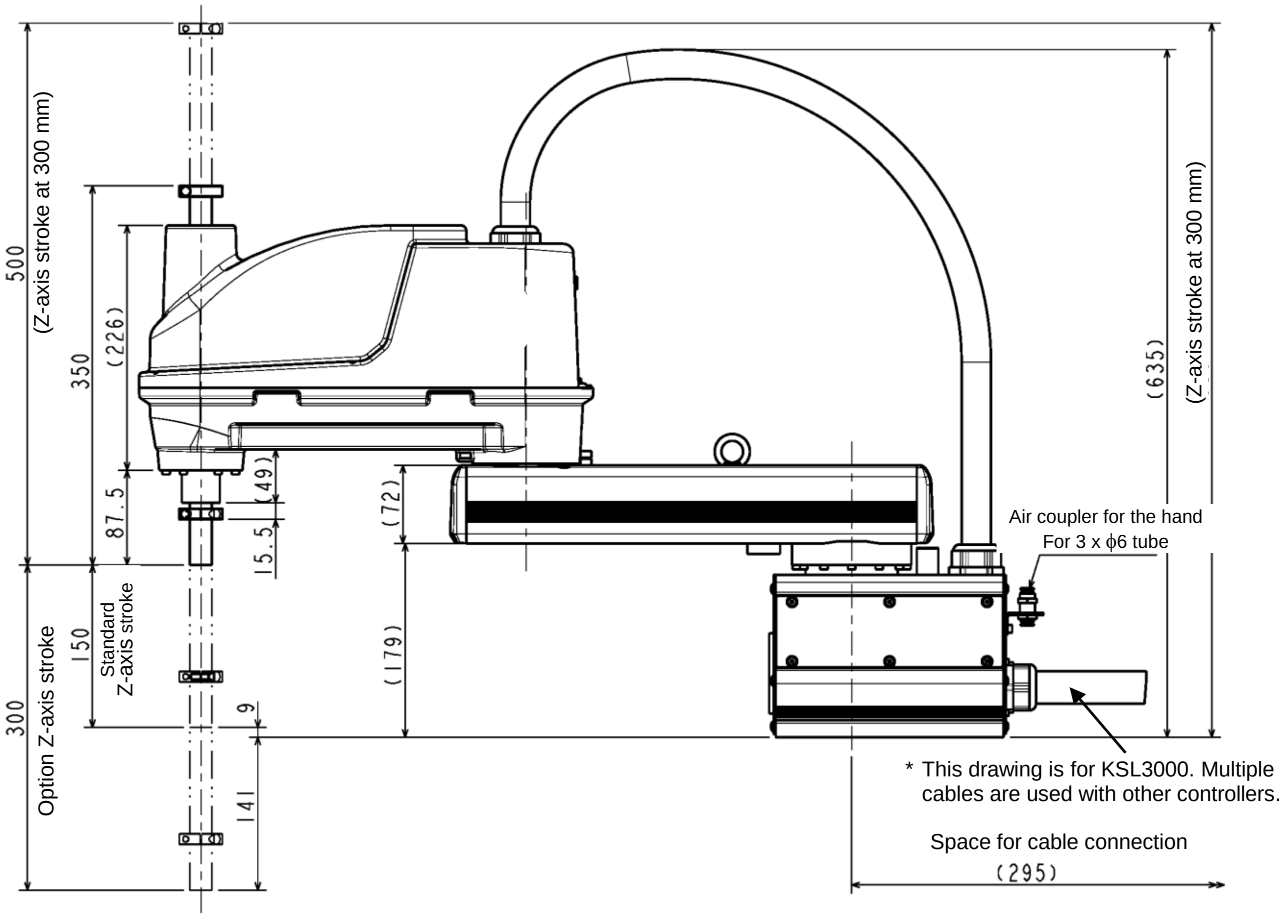


Fig. 2.3 External dimensions of robot (KHL-600)

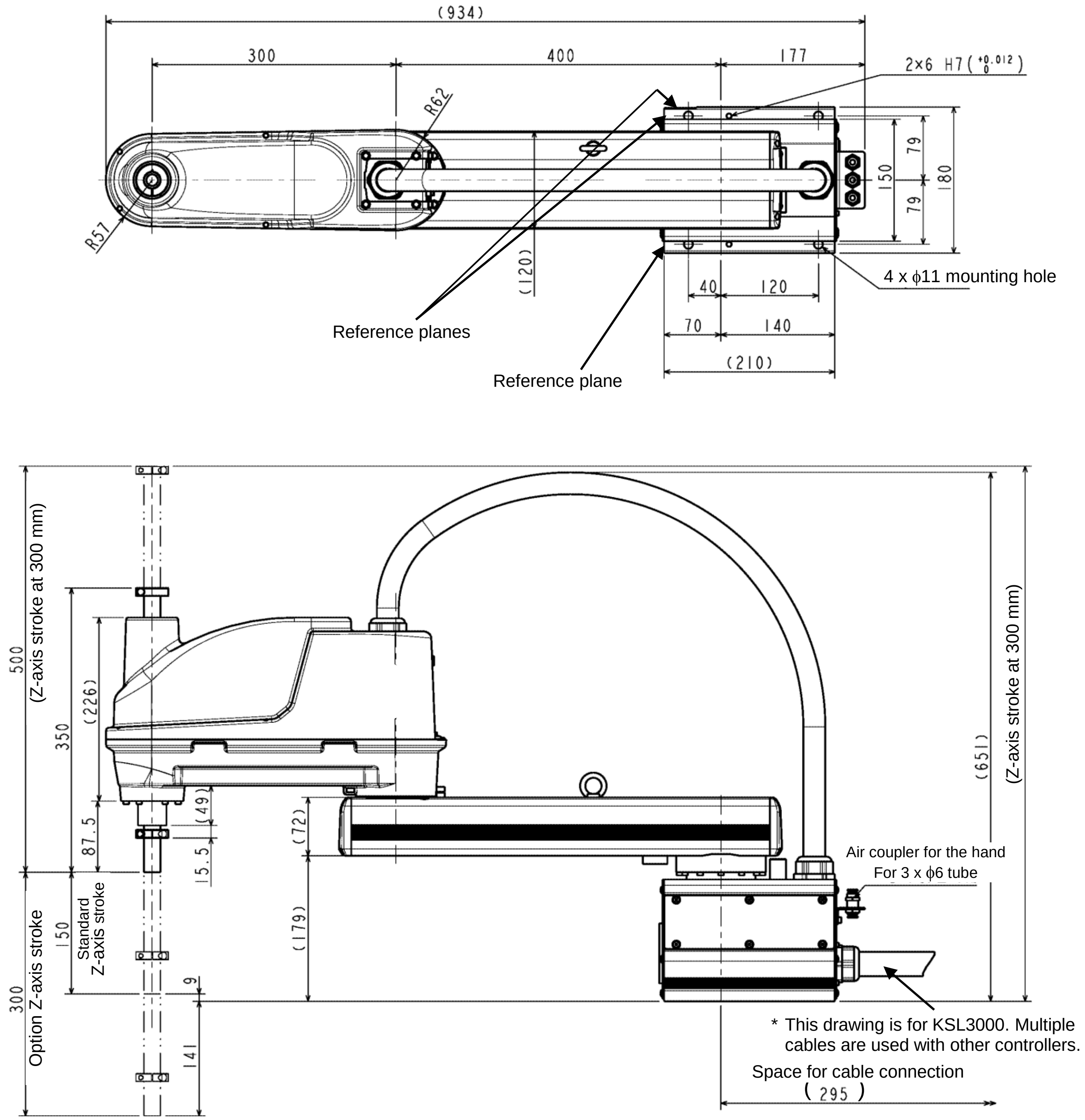


Fig. 2.4 External dimensions of robot (KHL-700)

2.4 Specifications Table

Item		Specifications		
Structure		Horizontal multi-joint type SCARA robot		
Model		KHL-500	KHL-600	KHL-700
Applicable controller		KSL3000		
Mass of robot body		22 kg	23 kg	24 kg
No. of controlled axes		4 axis		
Arm length		500 mm (200 mm + 300 mm)	600 mm (300 mm + 300 mm)	700 mm (400 mm + 300 mm)
Motor capacity / Current limit	Axis 1	400 W / 14.7 $A_{0\text{-}P}$		
	Axis 2	200 W / 9.37 $A_{0\text{-}P}$		
	Axis 3	200 W / 6.90 $A_{0\text{-}P}$		
	Axis 4	200 W / 9.37 $A_{0\text{-}P}$		
Operating range	Axis 1	±125 deg		
	Axis 2	±145 deg		
	Axis 3	0 to 150 mm [option: 0 to 300 mm]		
	Axis 4	±360 deg		
Maximum speed (*1)	Axis 1	450 deg/s		
	Axis 2	450 deg/s		
	Axis 3	2000 mm/s		
	Axis 4	1700 deg/s		
	Composite speed of axes 1 and 2	6.3 m/s	7.1 m/s	7.9 m/s
Rated payload mass (*1)		2 kg		
Maximum payload mass (*1)		10 kg		
Permissible load inertia (*1)		0.2 kg・m^2		
Repeatability (*2)	X,Y	±0.01 mm		
	Z	±0.015 mm		
	C	±0.007 deg		
Cycle time (*3) (When payload mass is 2 kg)		0.45 s		0.50 s
Drive system		By means of AC servo motors		
Position detection method		Absolute		
Paint color (*4)		Arm 2: Equivalent to human and techno green Body: White alumite processing Arm cover: White		
Power supply capacity		1.4 kVA		

*1: There are restrictions on speed and acceleration speed depending on the operation pattern, load, and offset amount.

*2: This is unidirectional position repeatability when the ambient temperature is constant at 20°C. It is not absolute positioning accuracy. The values of X, Y and C are what Z value is in upper limit. It does not guarantee the trajectory accuracy.

*3: The standard cycle operation pattern cannot achieve continuous operation exceeding the effective load rate. With horizontal direction 300 mm, vertical direction 25 mm round trip, and rough positioning.

*4: The tone may be different among production lots, but It does not affect the product quality.

⚠ CAUTION

- Micro vibration may occur depending on the robot posture. If micro vibration occurs, reduce the acceleration speed to use the robot.
- Put the Z-axis (axis 3) in the raised position as much as possible, when moving Axes 1, 2, and 4.

  Moving Axis 1, 2, or 4 when the Z-axis is in low positions can lead to premature damage to the ball screw spline (Z-axis shaft).

  If Axis 1, 2, or 4 must be moved while the Z-axis is in low positions due to unavoidable circumstances, prevent the ball screw spline vibrations by using the SPEED, ACCEL/DECEL, and PAYLOAD commands to adjust the operation speed and acceleration.
- If Axis 1, 2, or 4 is moved while the Z-axis is in low positions, be extremely careful not to collide with any objects. Even if Axis 1, 2, or 4 is moved at low speed, a collision or other impact with an object can damage the ball screw spline (Z-axis shaft) before alarm occurs.

3. Transportation (KHL-300 and KHL-400)

3.1 Unpacking (KSL3000)

The robot and controller are shipped separately in corrugated cardboards. Fig. 3.1 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.

For the controller accessories, see the accessory list packed with the controller.

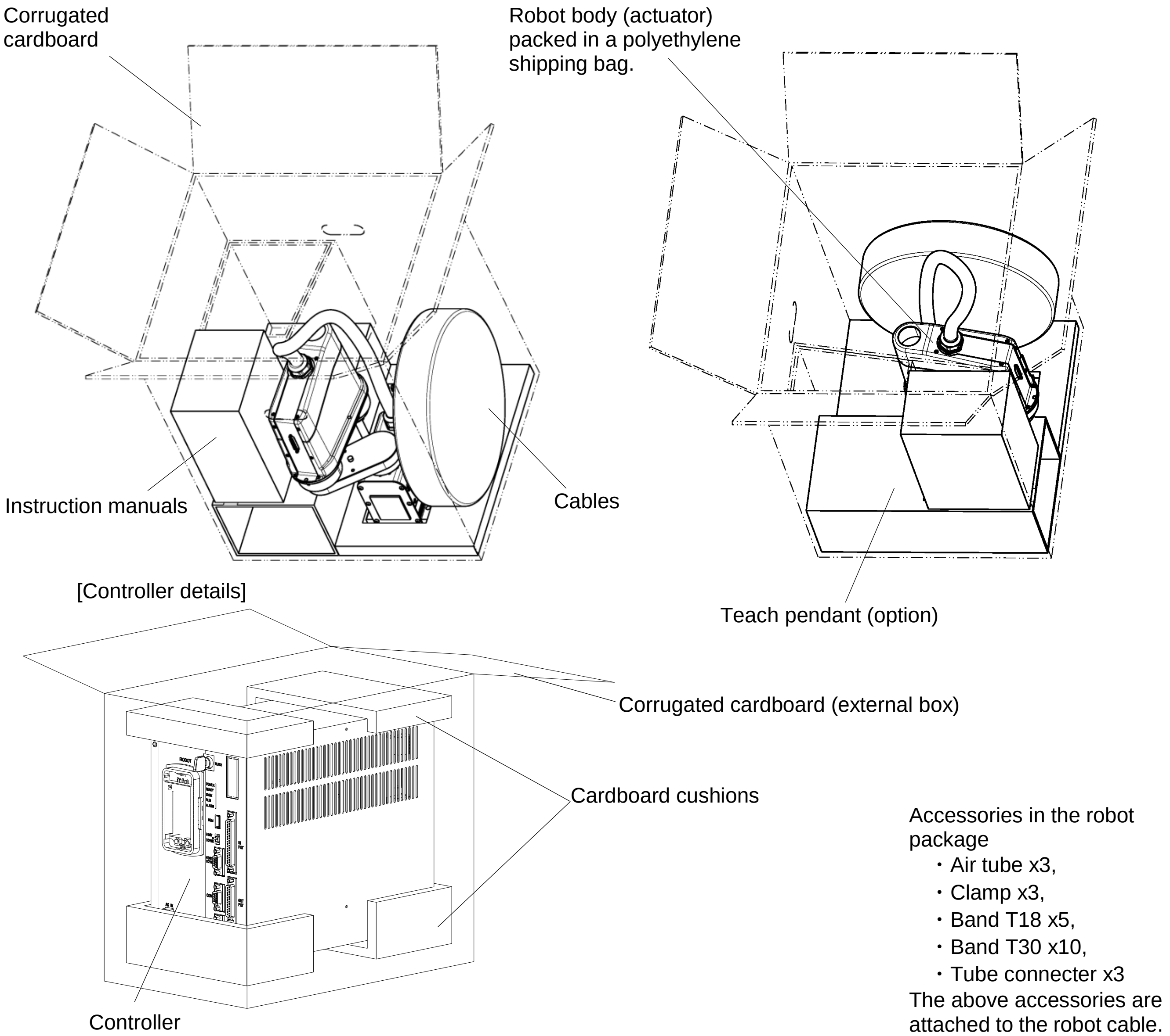


Fig. 3.1 Packaging state (KHL-300/KHL-400 and KSL3000)

⚠ 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 CKD immediately.
- Dispose of the wooden pallet, corrugated cardboards, polyethylene shipping bags and cushion material according to the customer's in-house regulations.

3.2 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.

3.2.1 Mass and Dimensions

The mass and outer dimentions of the robot are shown in Figs. 3.2 to 3.3.
For the controller mass and external dimensions, see "13.1 External Dimensions".

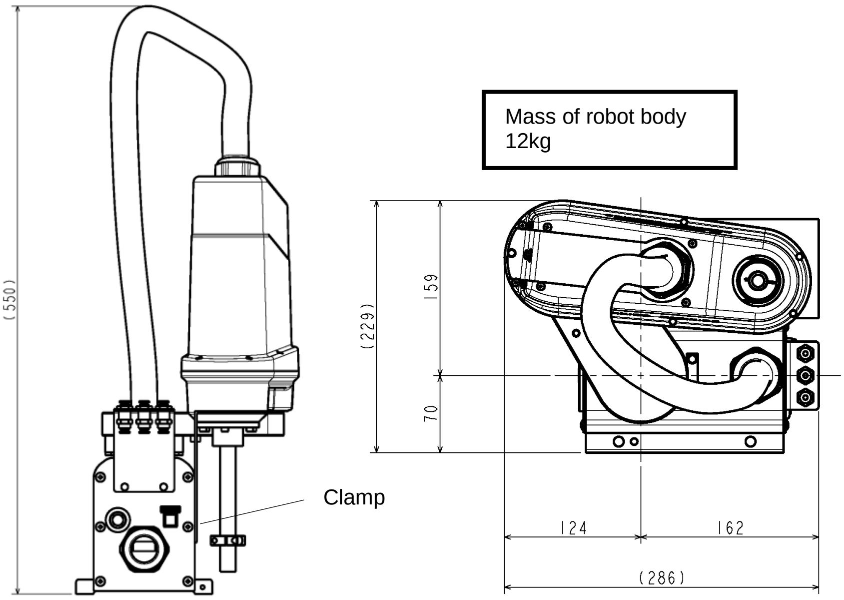


Fig. 3. 2 Packaging state (KHL-300)

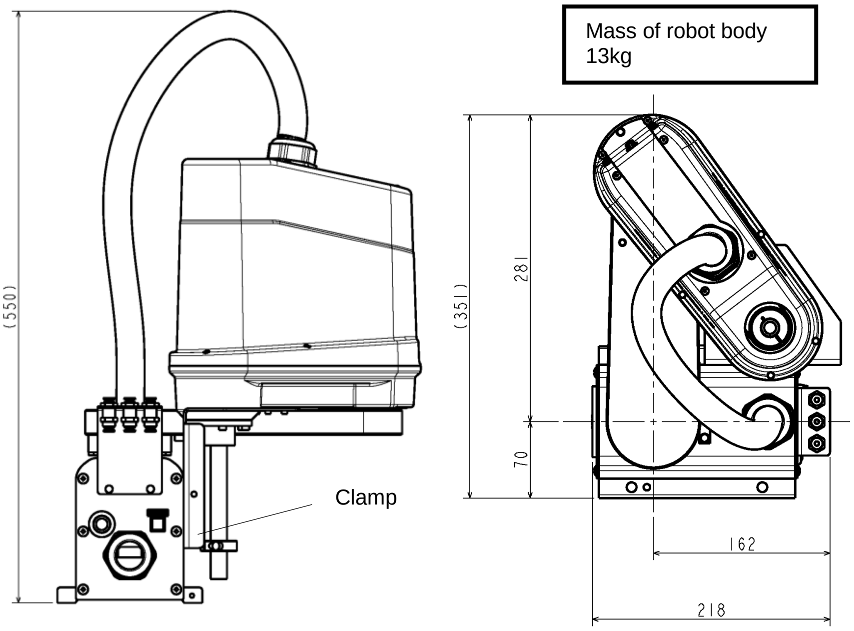


Fig. 3.3　Packaging state (KHL-400)

3.2.2　Transporting the Robot

In principle, the robot should be transported in the state shown in Figs. 3.2 to 3.3 above. Fold back and secure the arm with the attached clamp in Figs. 3.4 above. Then, fix a tip of the ball screw spline in the binding band in Figs. 3.5 above. (The robot is shipped in this posture.　After you have unpacked the shipment, you should move it as it is.)　At this time, take careful precautions not to impose a large force on the tool shaft. Especially, the KHL-300 and KHL-400 are shipped with their ball screw spline shaft drawn out long, so be careful.　Further, the KHL-300 and the KHL-400 cannot be lifted for transportation.

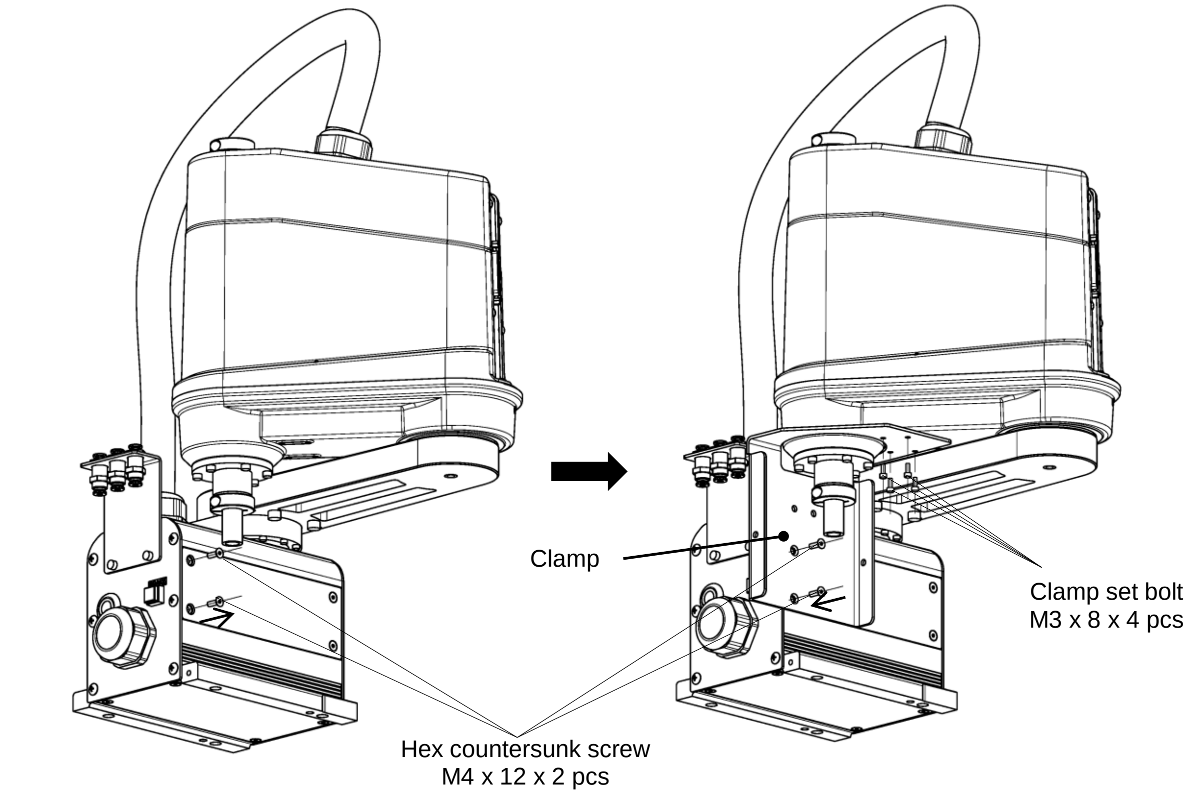


Fig. 3.4 Attaching the clamp (KHL-300/KHL-400)

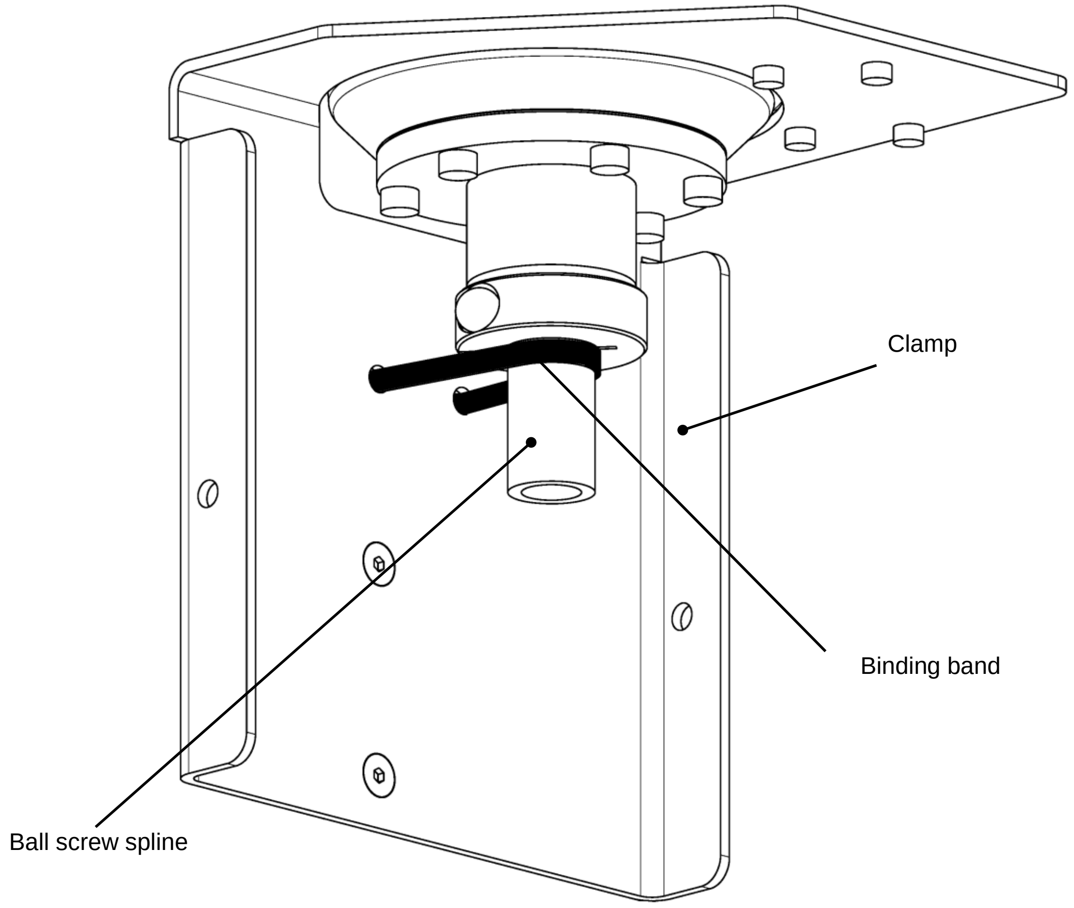


Fig. 3.5 Fixing the ball screw spline (KHL-300/KHL-400)

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.

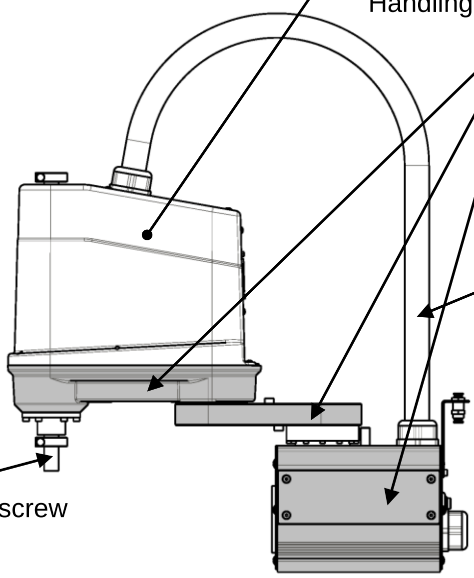


Fig. 3.6 Robot Handling Locations (KHL-300 and KHL-400)

After the installation, remove the clamp used for transport.

CAUTION

- When lifting up the robot by workers, hold the locations (shaded areas) by hands as shown in Fig. 3.6. Holding the arm 2 cover, the cable and the ball screw spline shaft will apply excess force, possibly causing failure.
- When carrying the robot by workers, take careful precautions to prevent their hand or leg from being caught in the robot.
- The work should be performed by two (2) or more workers.
- Never touch the ball screw spline shaft with a bare hand. If you touch it with a bare hand, earlier rust formation may result. Be sure to use gloves.

3.2.3 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.

3.3 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.

3.3.1 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.
> - Avoid direct sunshine and high temperature/humidity when the robot is stored. 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. As the tool shaft is susceptible to rust development, coat it with rust-preventive agent or grease the entire tool shaft beforehand.
>   For the grease application procedure, see the maintenance manual "Greasing Ball Screw Spline Unit and Applying Anticorrosive".
> - Before the use, apply the grease to the tool shaft.
> - Before starting an operation, perform running completely.

3.3.2 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.

4. Transportation (KHL-500, KHL-600 and KHL-700)

4.1 Unpacking (KSL3000)

The robot and controller are shipped separately in corrugated cardboards. Fig. 4.1 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.
For the controller accessories, see the accessory list packed with the controller.

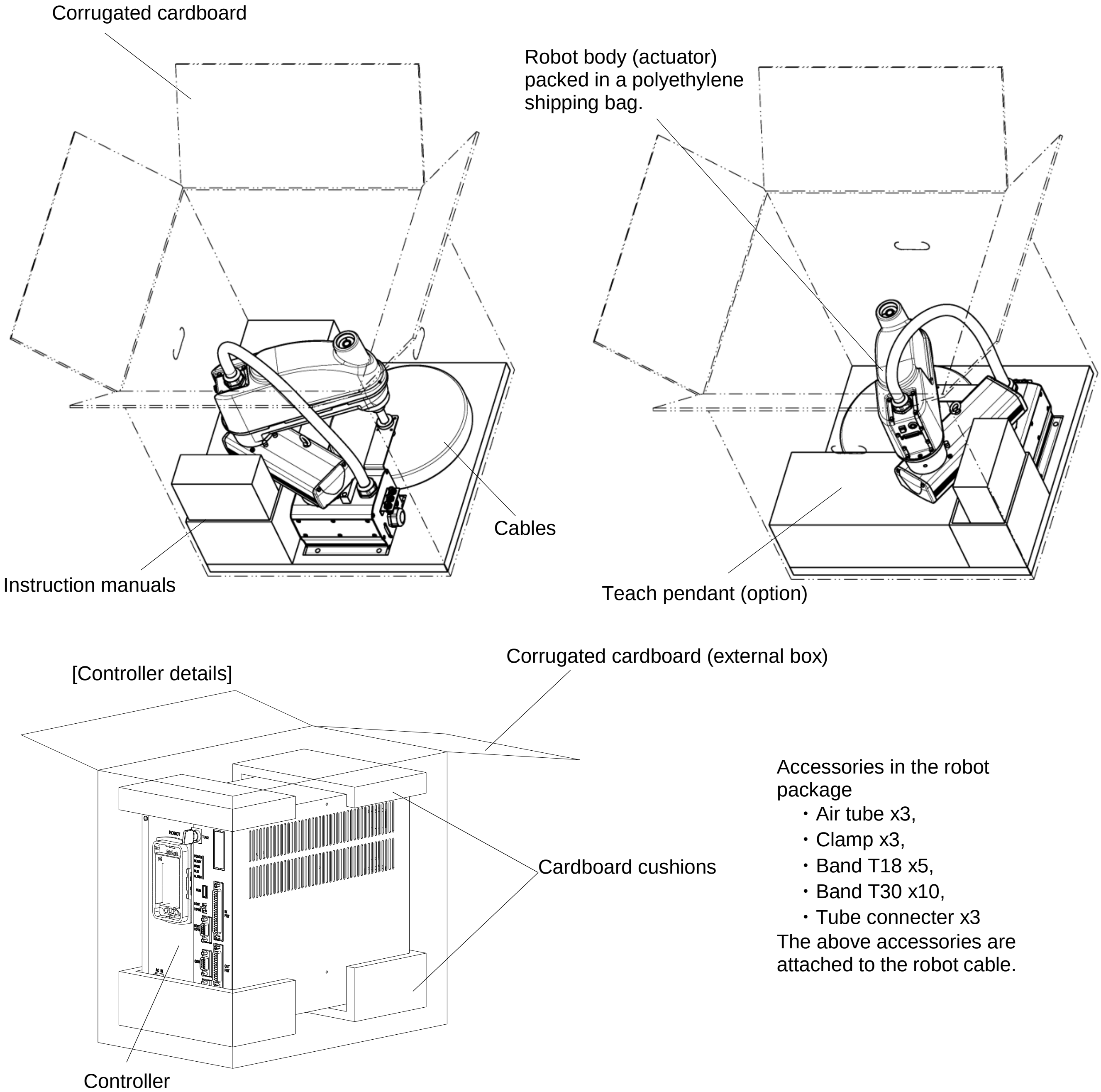


Fig. 4.1 Packaging state (KHL-500/KHL-600/KHL-700 and KSL3000)

⚠ 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 CKD immediately.
- Dispose of the wooden pallet, corrugated cardboards, polyethylene shipping bags and cushion material according to the customer’s in-house regulations.

4.2 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.

4.2.1 Mass and Dimensions

The mass and outer dimensions of the robot are shown in Figs. 4.2 to 4.4.
For the controller mass and external dimensions, see "13.1 External Dimensions".

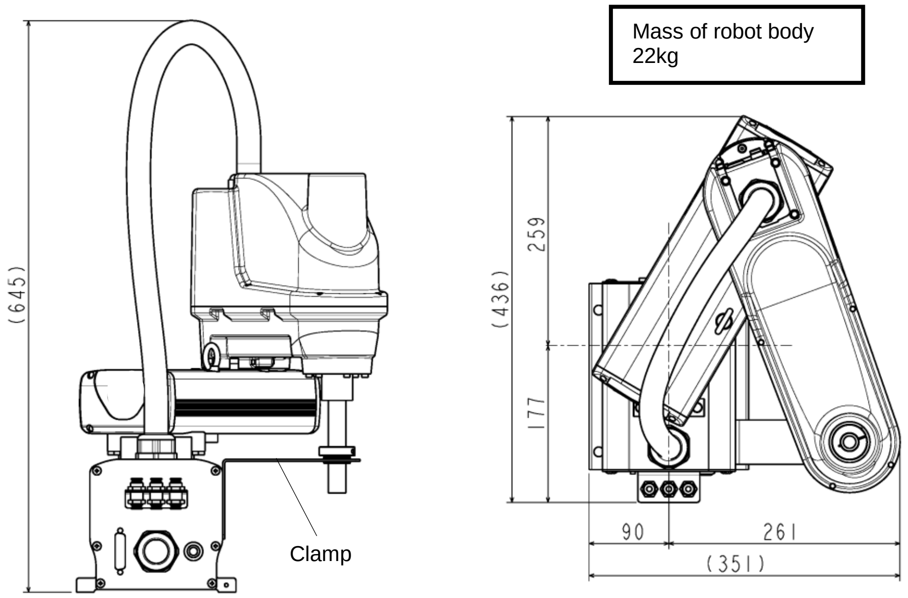


Fig. 4.2 Packaging state (KHL-500)

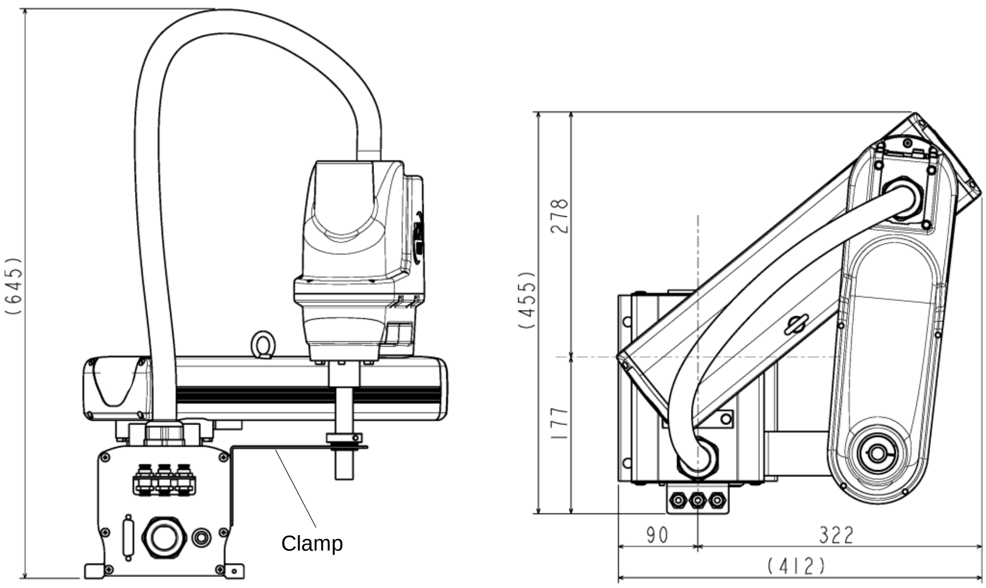


Fig. 4.3　Packaging state (KHL-600)

Mass of robot body
24kg

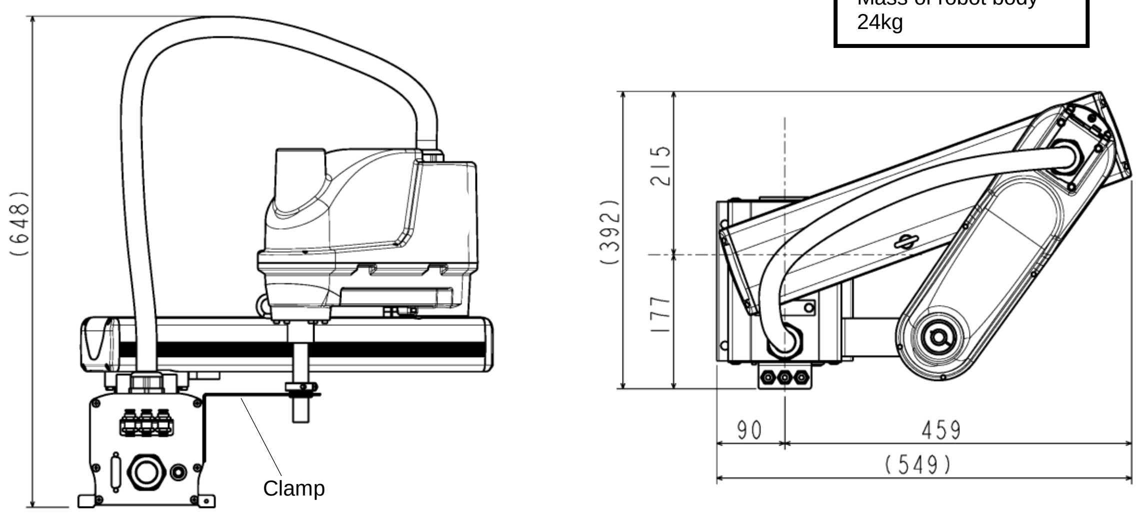


Fig. 4.4　Packaging state (KHL-700)

4.2.2 Transporting the Robot

In principle, the robot should be transported in the state shown in Figs. 4.2 to 4.4 above. Fold back and secure the arm with the attached clamp in Figs. 4.5 above. (The robot is shipped in this posture. After you have unpacked the shipment, you should move it as it is.) At this time, take careful precautions not to impose a large force on the tool shaft.

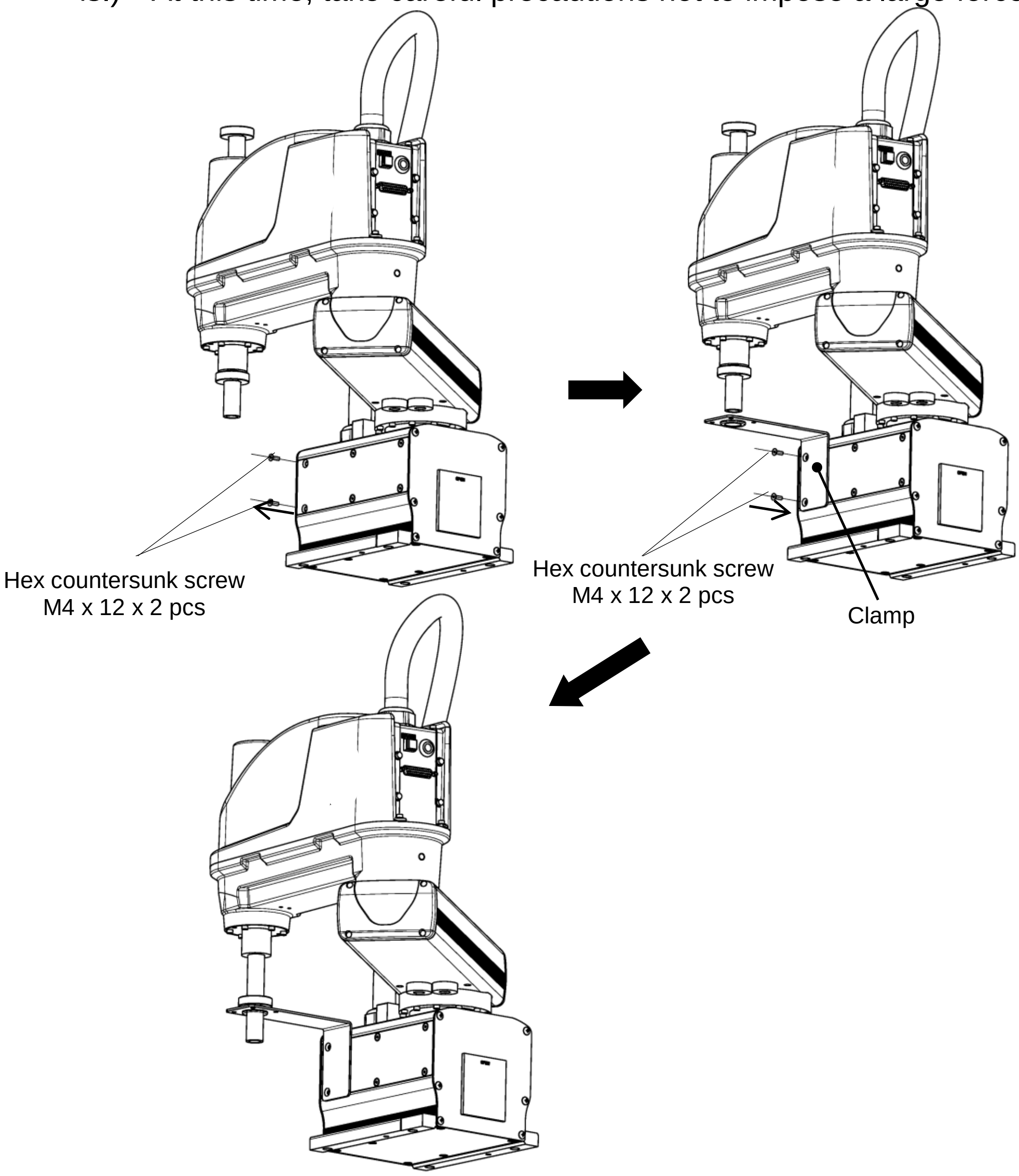


Fig. 4.5 Attaching the clamp (KHL-500/KHL-600/KHL-700)

⚠ 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 KHL-500, KHL-600 and KHL-700. Pass the wire through the attached eyebolt, then lift up the robot carefully, as shown in Fig. 4.6.

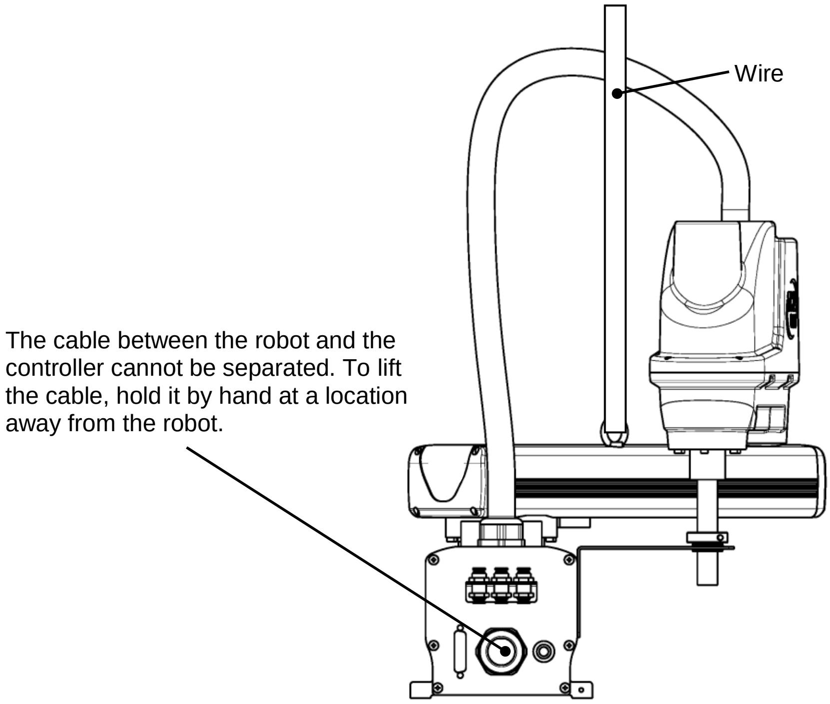


Fig. 4.6 Lifting up the robot

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.

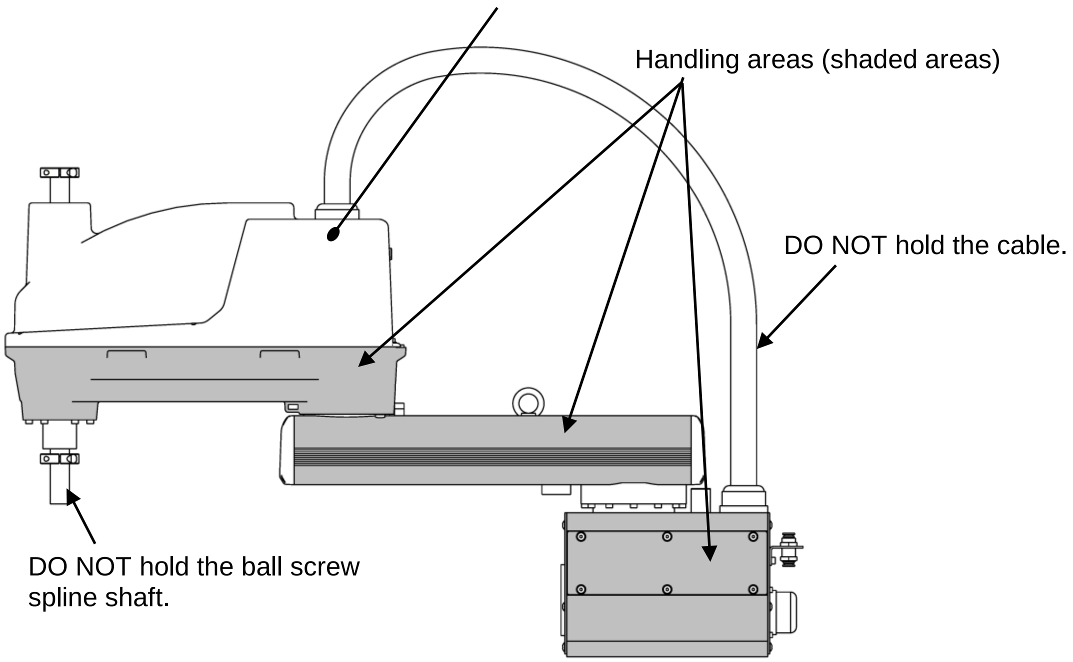


Fig. 4.7 Robot Handling Locations (KHL-500, KHL-600 and KHL-700)

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

CAUTION

- When lifting up the robot by workers, hold the locations (shaded areas) by hands as shown in Fig. 4.7. Holding the arm 2 cover, the cable and the ball screw spline shaft will apply excess force, possibly causing failure.
- When carrying the robot by workers, take careful precautions to prevent their hand or leg from being caught in the robot.
- Never touch the ball screw spline shaft with a bare hand. If you touch it with a bare hand, earlier rust formation may result. Be sure to use gloves.
- The work should be performed by two (2) or more workers.
- Plug up the threaded bore which took off an eyebolt by a bolt attached to the robot.

4.2.3 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.

4.3 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.

4.3.1 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.
- Avoid direct sunshine and high temperature/humidity when the robot is stored. 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. As the tool shaft is susceptible to rust development, coat it with rust-preventive agent or grease the entire tool shaft beforehand.
  For the grease application procedure, see the maintenance manual "Greasing Ball Screw Spline Unit and Applying Anticorrosive".
- Before the use, apply the grease to the tool shaft.
- 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.

4.3.2 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.

Table of Contents

Tables and Drawings

5. Robot Installation (KHL-300 and KHL-400)

5.1 Installation Environment

Table 5.1 shows the environmental conditions for the location in which the robot and controller are to be installed.

Table 5.1 Environmental conditions for robot and controller

Item	Specifications
Temperature	In operation: 0 to 40°C In storage: –10 to 50°C
Humidity	20 to 80% (Non-condensing) DO NOT install the robot where it may be subject to fluids such as water.
Altitude	1000 m or less
Vibration	In operation: 0.98 m/s^2 or less
Dust	No inductive dust should exist. Consult with CKD first if you wish to use the robot and controller in a dusty environment.
Gas	No corrosive or combustible gas should exist.
Degrees of protection	IEC60529 IP10(robot only) IP20(controller only)
Overvoltage category	IEC60664-1 ClassⅢ(controller only)
Protection against electric shock	IEC61140 Class Ⅰ (controller only)
Pollution Degree	IEC60664-1 Pollution Degree 3(controller only)
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.
Other ambient environment	Must be free from iron powder, oil, salt, and organic solvents. Must not be exposed to water.

⚠ DANGER

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

⚠ CAUTION

- In the case where batteries for detecting the motor position are of alkaline type (standard type), the batteries can overheat, leak battery fluid, or rupture when used under high temperatures. Also, high temperatures can reduce the performance and lifespan of the battery. If using the robot under high temperatures, please consult with the CKD sales office.
- When starting fast-movement operation in low-temperature environment, errors may occur because of the increased torque. In operating the robot in low-temperature environment, start by making low-speed continuous operation for a several minutes to soften the grease before starting high-speed operations.

5.2 Installation

Before installing the robot, you should plan a layout, fully considering the working envelope (or operating range), coordinate system and space for maintenance.

5.2.1 External Dimensions and Working Envelope

Figs. 5.1 and 5.2 show the external view drawing and 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 misoperation, the robot is equipped with mechanical stoppers outside the working envelope. Additionally, soft limits that can be set by the user are provided. For further information, see the “Instruction Manual: User Parameters” provided separately.

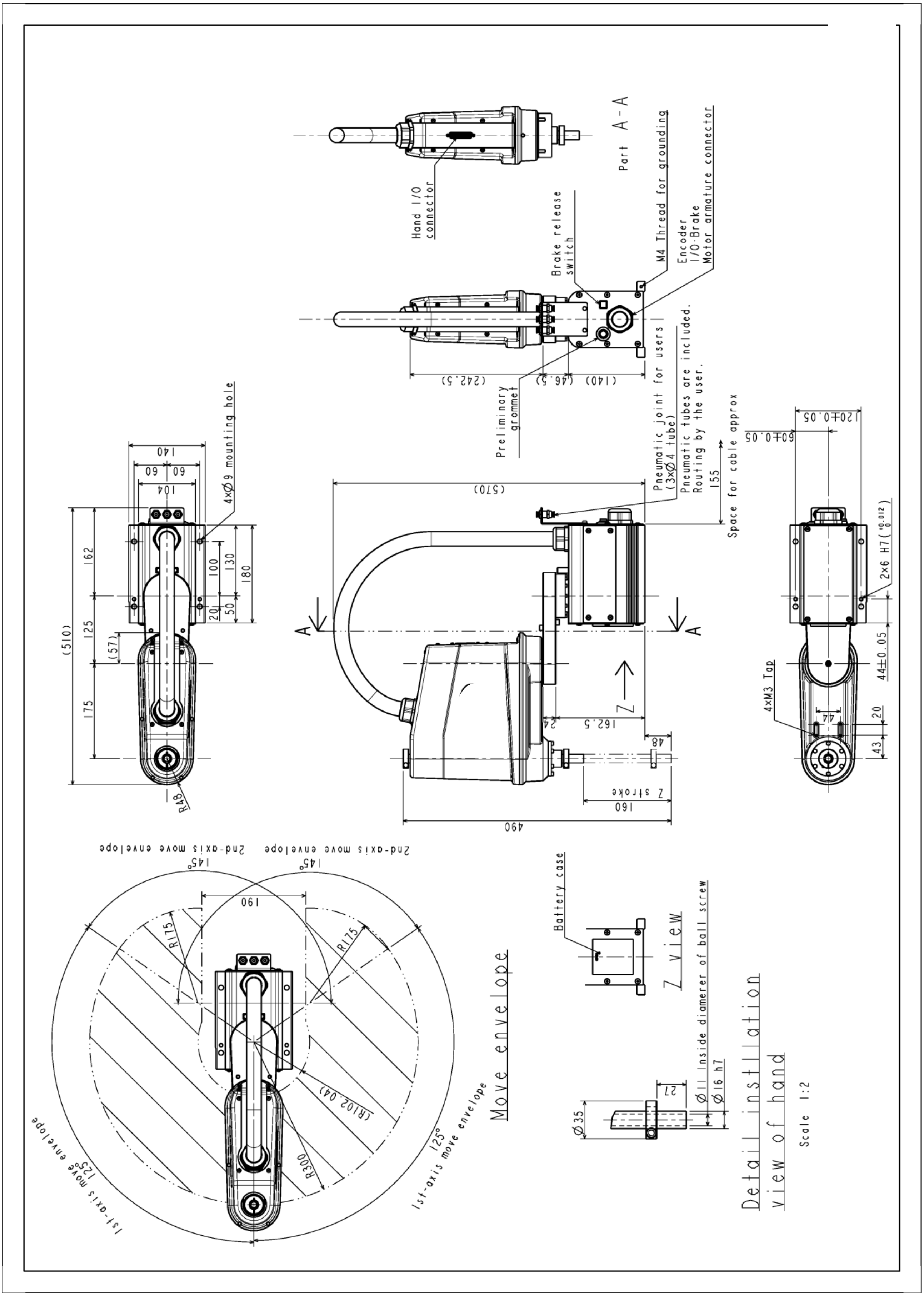


Fig. 5.1 External view and working envelope (KHL-300)

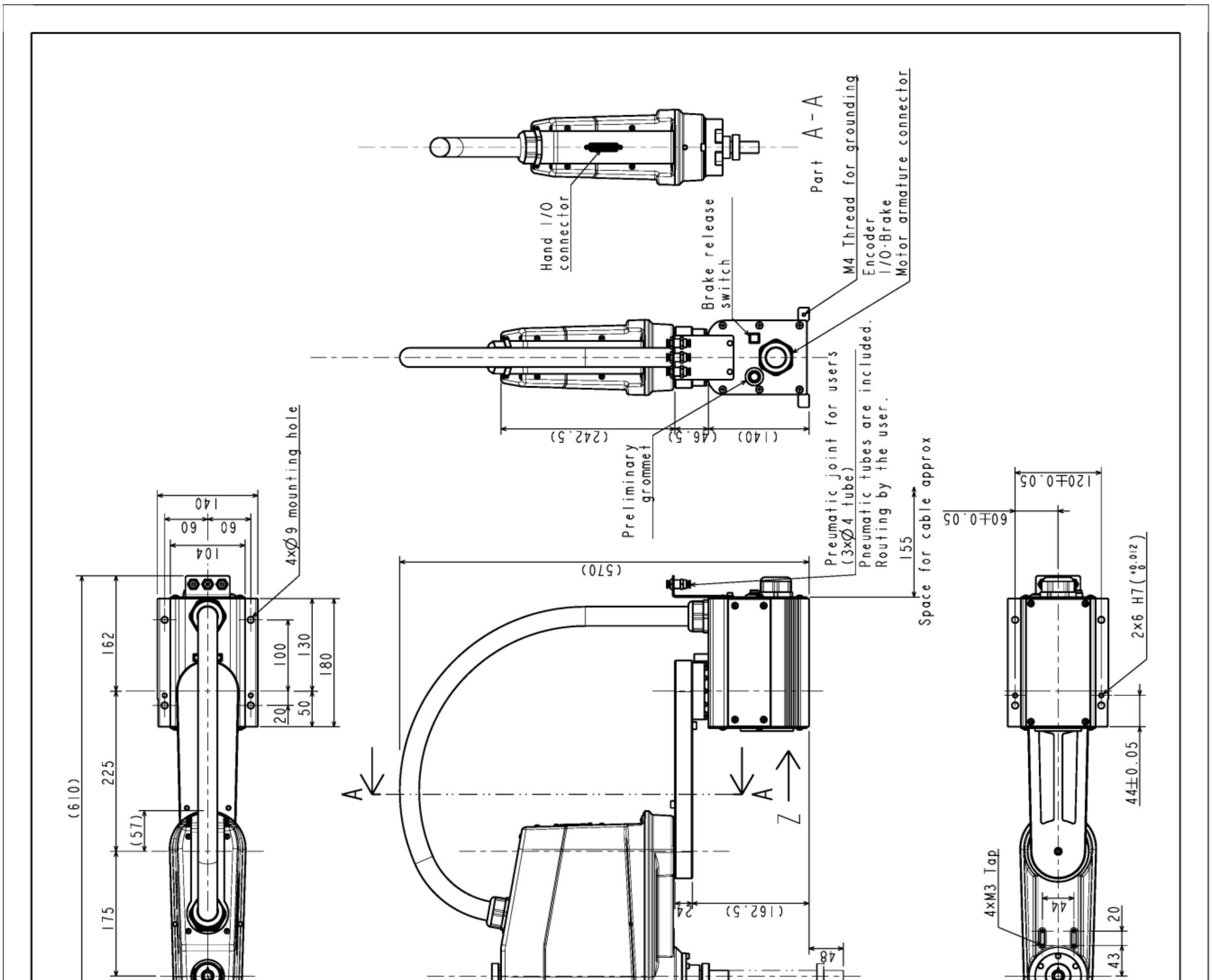


Fig. 5.2　External view and working envelope (KHL-400)

5.2.2 Changing the Operation Ranges of Axes 1 and 2

Mechanical stoppers are installed to each robot to mechanically control the operation range of each axis. Changing the mechanical operation range of a robot by modifying these mechanical stoppers is referred to as "change in operating range."
Here, how to change the operating ranges of Axes 1 and 2 of a robot is explained.

Regarding how to change the operating range of Axis 3, see Para. 5.2.3.
Note that Axis 4 is different from other operating axes; it restricts the operating range with software limits only, not with mechanical stoppers. Therefore, regarding how to change the operating range of Axis 4, see Para. 5.2.4.

⚠ CAUTION

- To change operating ranges, design and produce mechanical stoppers by referring to this document according to your usage.
- When mechanical stoppers have been changed and then operating ranges have been changed, be sure to also change software limits to prevent contact with the mechanical stoppers while operating a robot.
- Mechanical stoppers do not securely restrict the movable ranges of robots.

  When the power of a robot is turned on, never enter the operating range of the robot.
- If a robot collides with a mechanical stopper, the robot detects the collision and stops, but the mechanical stopper may be damaged. Avoid reusing the mechanical stopper.
- The mechanical stopper reference drawings shown in this document do not fully satisfy the customer's usage.

  Design, produce and install mechanical stoppers according to your usage, such as the operating range.
- The failures of a robot caused by mechanical stoppers will be excluded from the warranty coverage.

As shown in Fig. 5.3, the operation range can be altered by changing the position of the mechanical stopper.

Table 5.2 Operation ranges before and after change (KHL-300 and KHL-400)

		Before change	After change
Axis 1 operation range	+ direction	125°	105°
	- direction	125°	105°
Axis 2 operation range	+ direction	145°	120°
	- direction	145°	120°

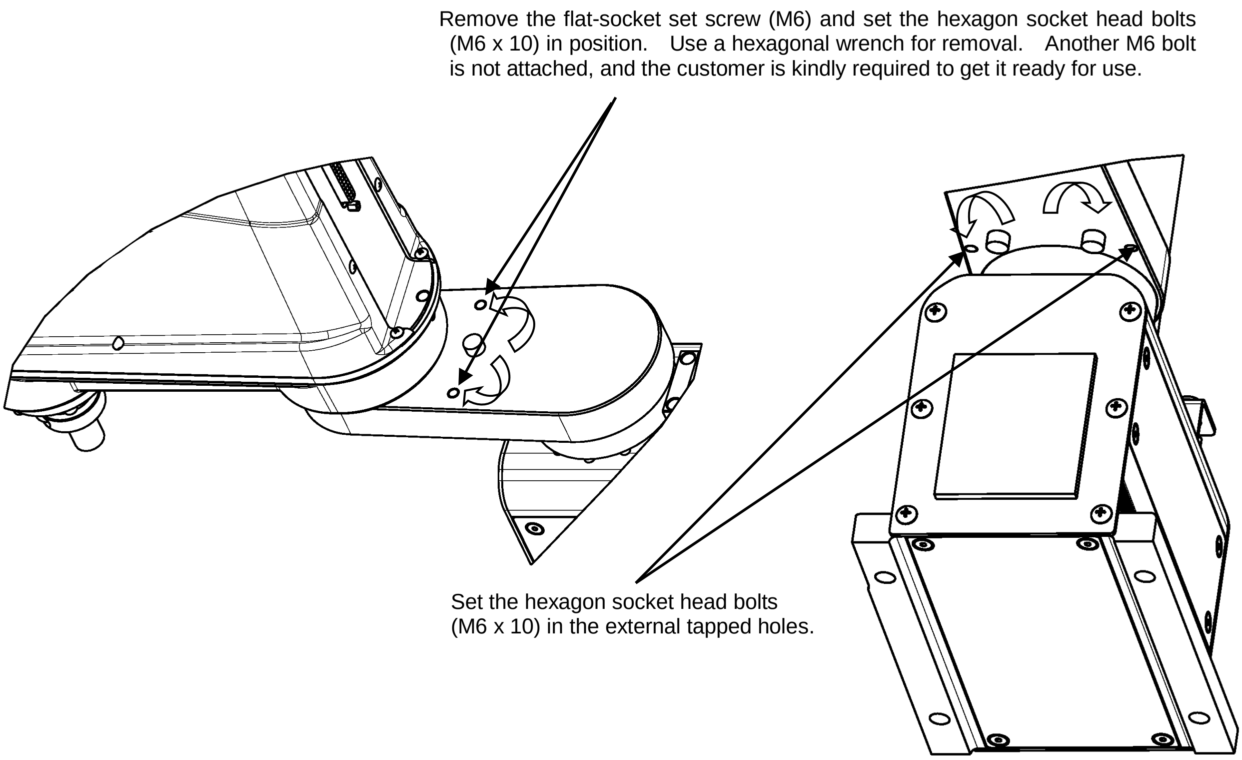


Fig. 5.3 Changing the Operating Ranges of Axes 1 and 2 (KHL-300 and KHL-400)

If the operation range is changed, it is necessary to change the user parameter. Regarding how to change software limits, see Para. 5.2.4.

5.2.3 Changing the Operating Range of Axis 3

At the factory shipment of a robot, software limits and mechanical stoppers are preset so that the Z stroke of Axis 3 is between 0 and 160 mm.　Fig. 5.4 shows the settings of operating range at the factory shipment.

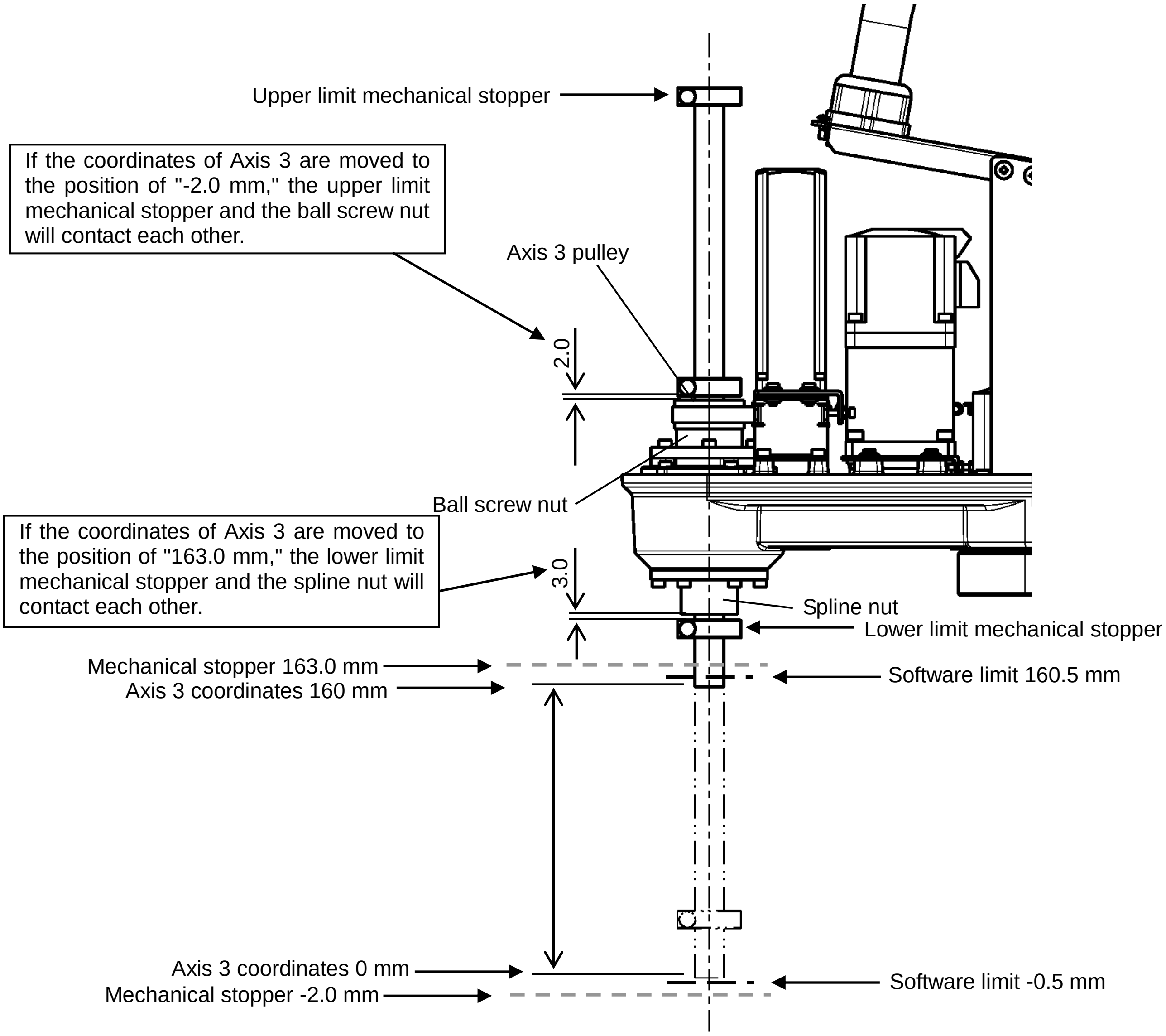


Fig. 5.4　Changing the Operating Range of Axis 3 (KHL-300 and KHL-400)

1) Remove the Arm 2 cover. The cover is fastened to Arm 2 and the harness guide with four (4) hexagon socket head bolts (M3 x 16) and ten (10) cross recessed truss head screw (M3 x 10 x 2 pcs. and M3 x 6 x 8 pcs.). It is recommended to lower Axis 3 in advance until the upper limit stopper of the ball screw enters the cover.

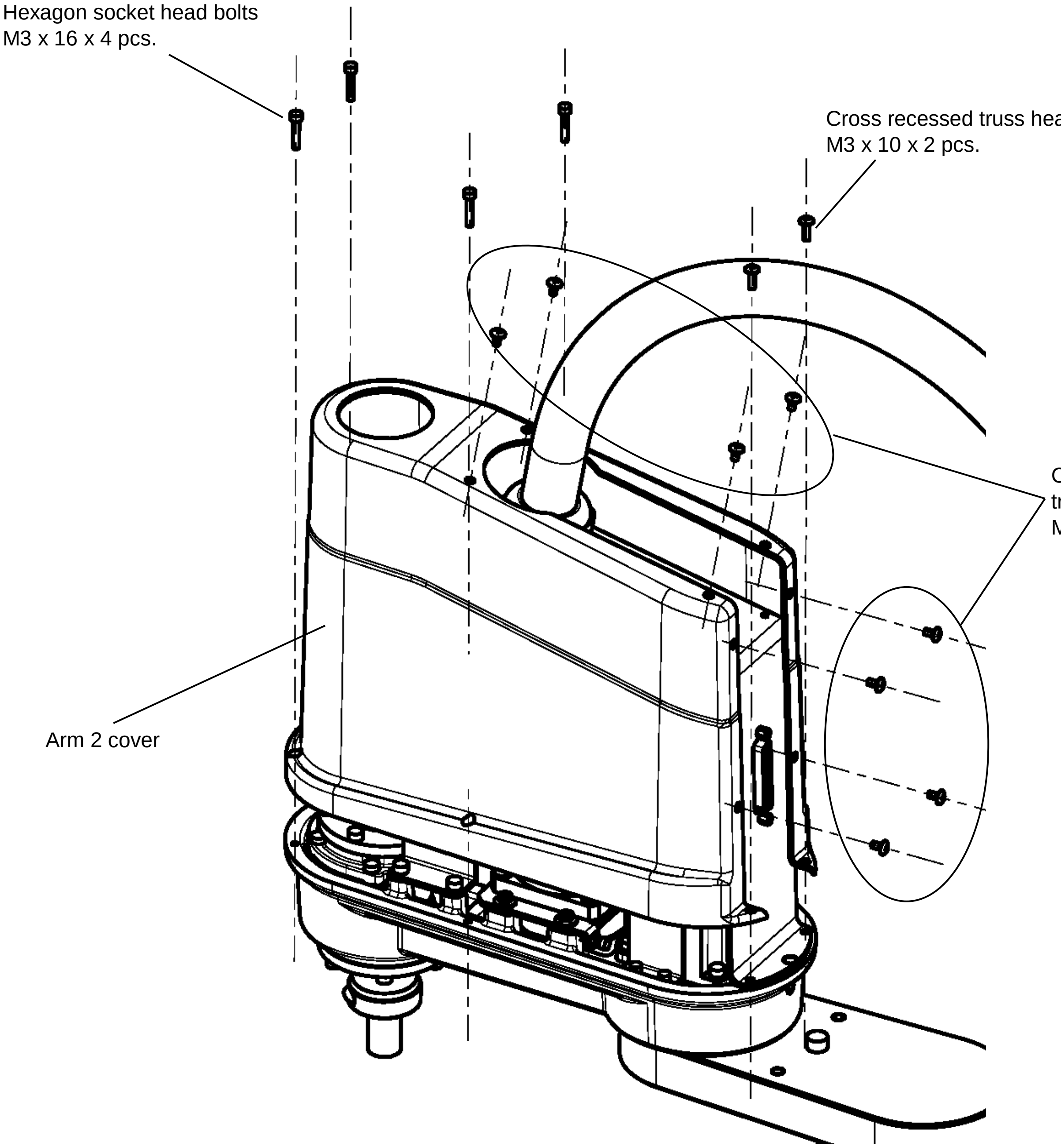
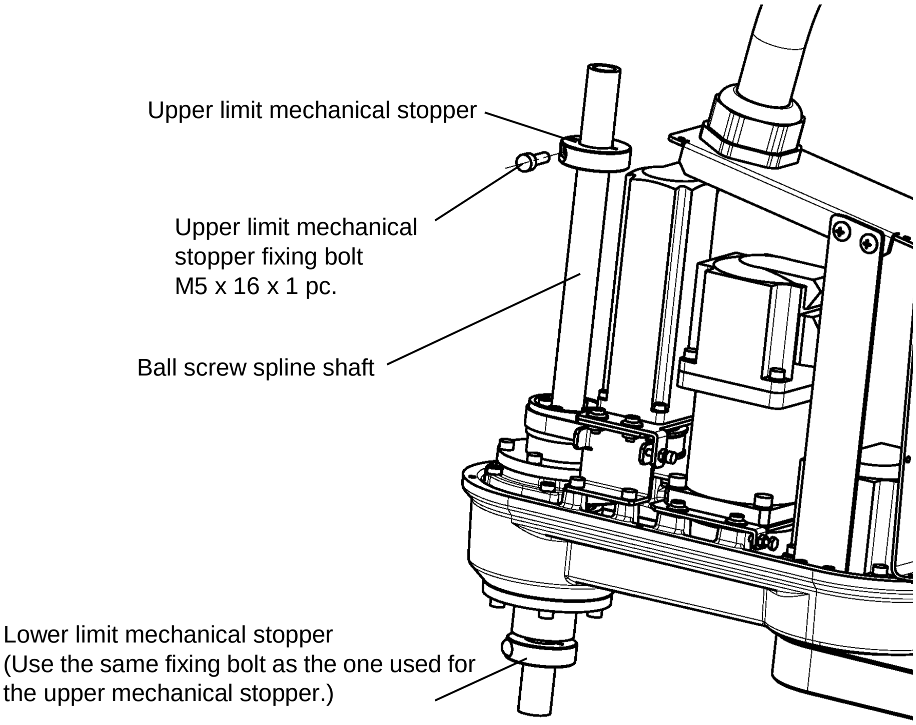


Fig. 5.5 Removing the Arm 2 Cover (KHL-300 and KHL-400)

2) Loosen the fixing bolts of the mechanical stoppers, move the mechanical stoppers to a desired position, and fix them again. When fixing the mechanical stoppers, be sure to apply Loctite to the fixing bolts.



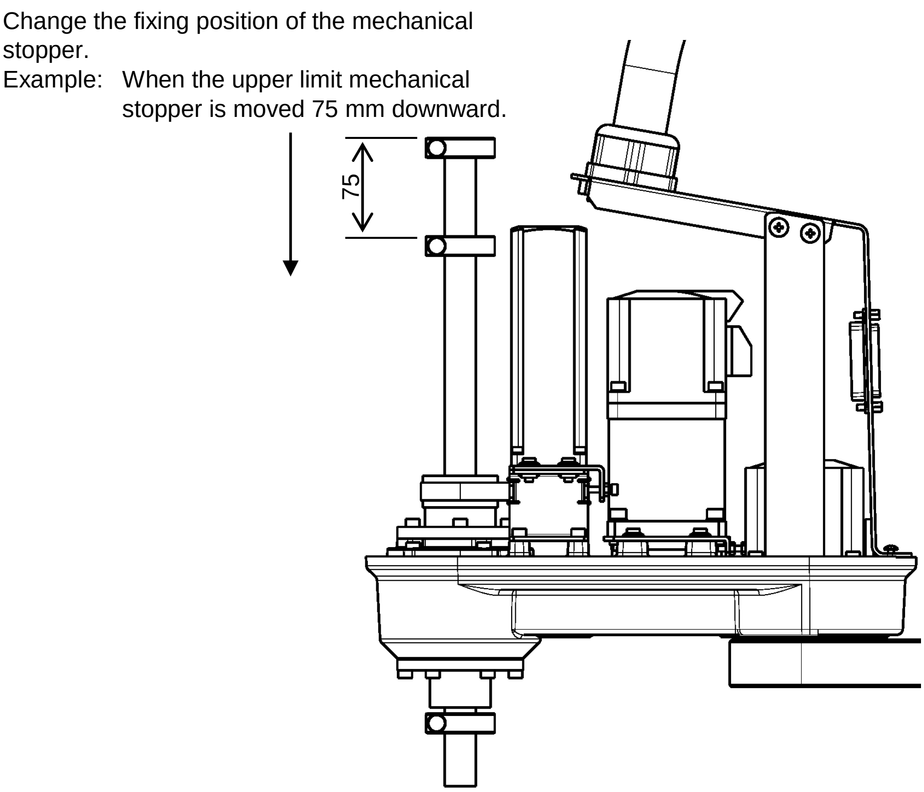


Fig. 5.6 Changing the Operating Range (KHL-300 and KHL-400)

3) When the mechanical stoppers are changed, be sure to also change the software limits. Regarding how to change software limits, see Para. 5.2.4 and Fig. 5.8. After changing the software limit, while pressing the axis 3 brake release switch, move Axis 3 manually, and make sure that the software limit is correctly set.

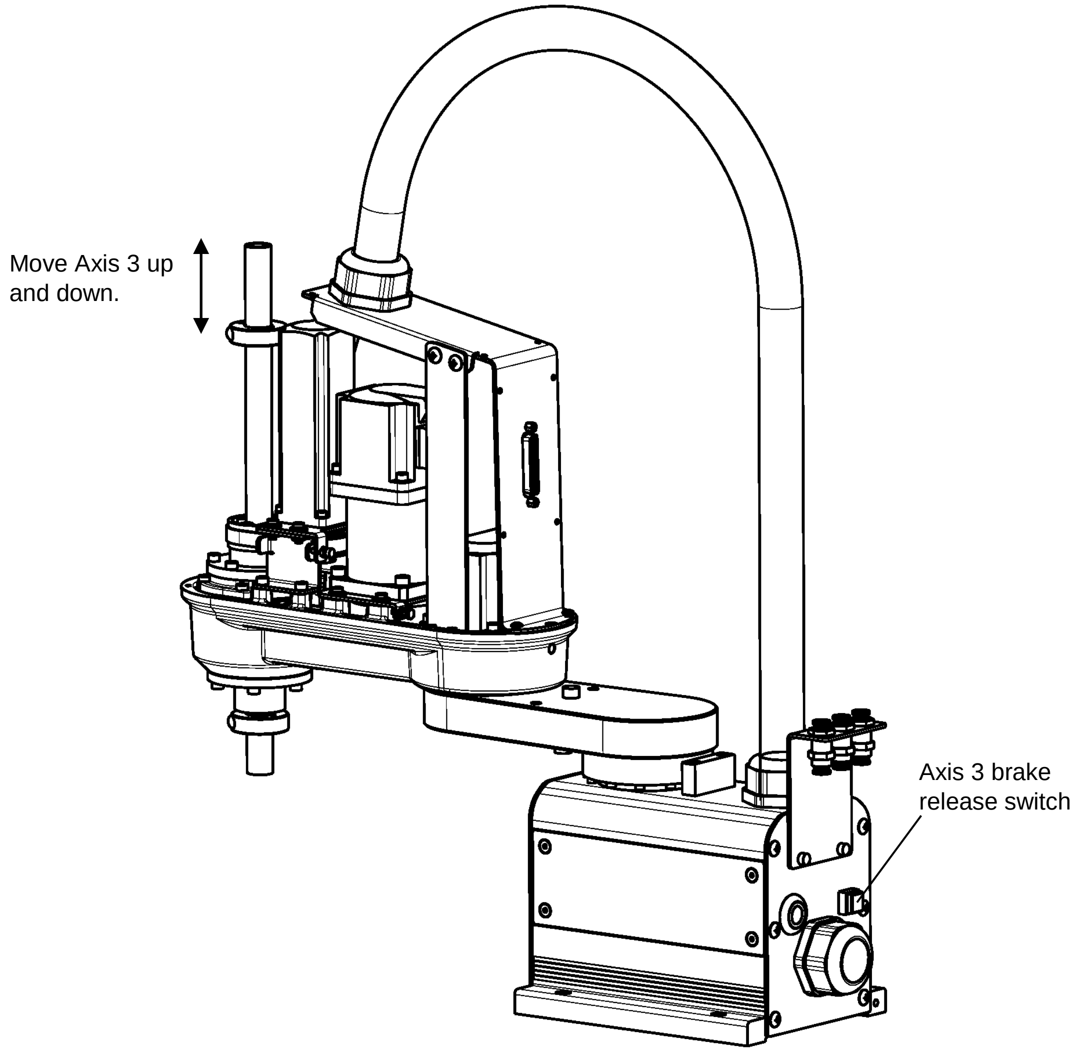


Fig. 5.7 Checking Software Limit Change (KHL-300 and KHL-400)

Fig. 5.8 shows the settings of the operating range when the upper limit mechanical stopper is moved 75 mm downward.

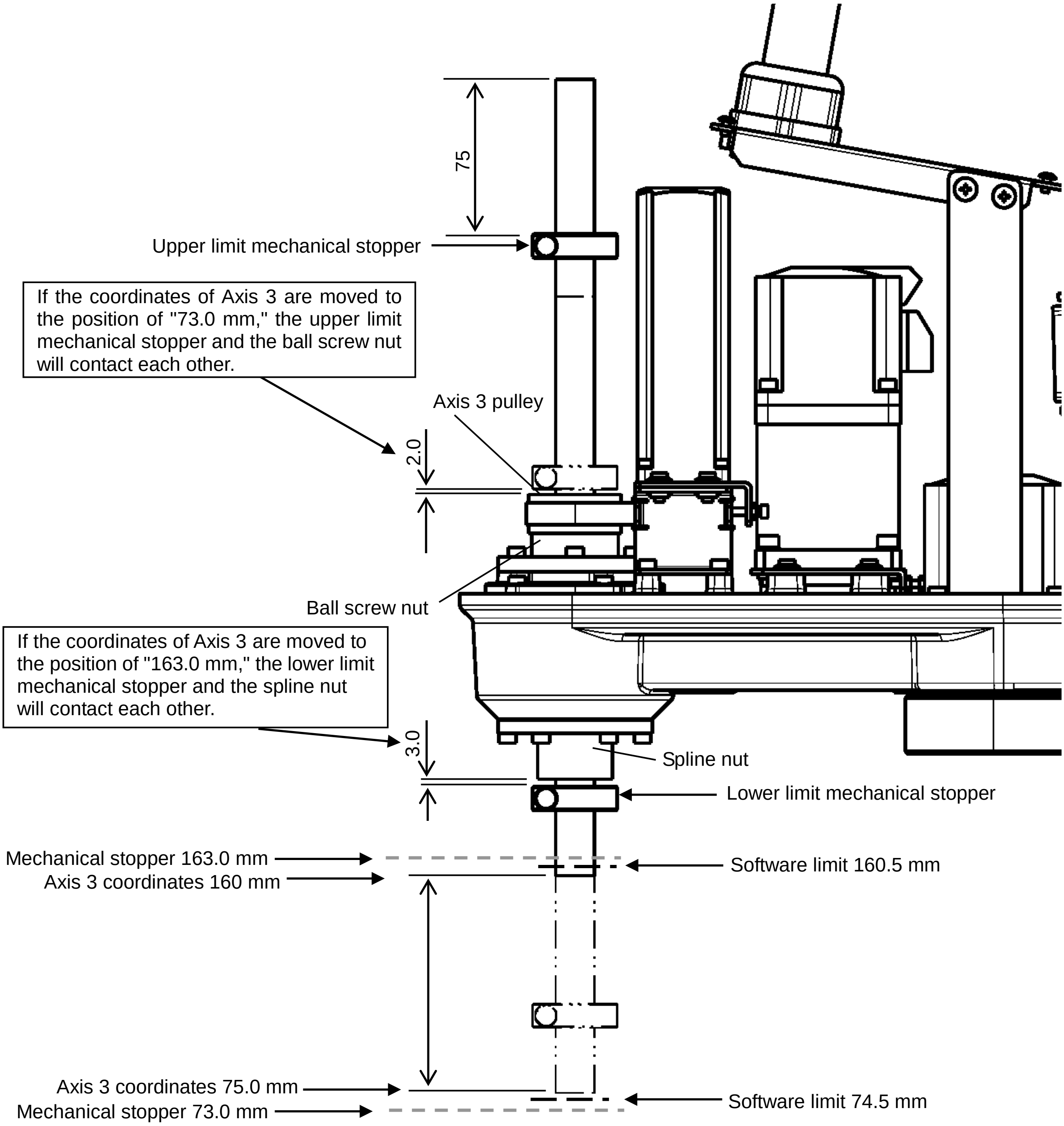


Fig. 5.8 Changing the Operating Range of Axis 3 (KHL-300 and KHL-400)

4) Remove the Arm 2 cover. The cover is fastened to Arm 2 and the harness guide with four (4) hexagon socket head bolts (M3 x 16) and ten (10) cross recessed truss head screw (M3 x 10 x 2 pcs. and M3 x 6 x 8 pcs.). It is recommended to lower Axis 3 in advance until the upper limit stopper of the ball screw enters the cover.

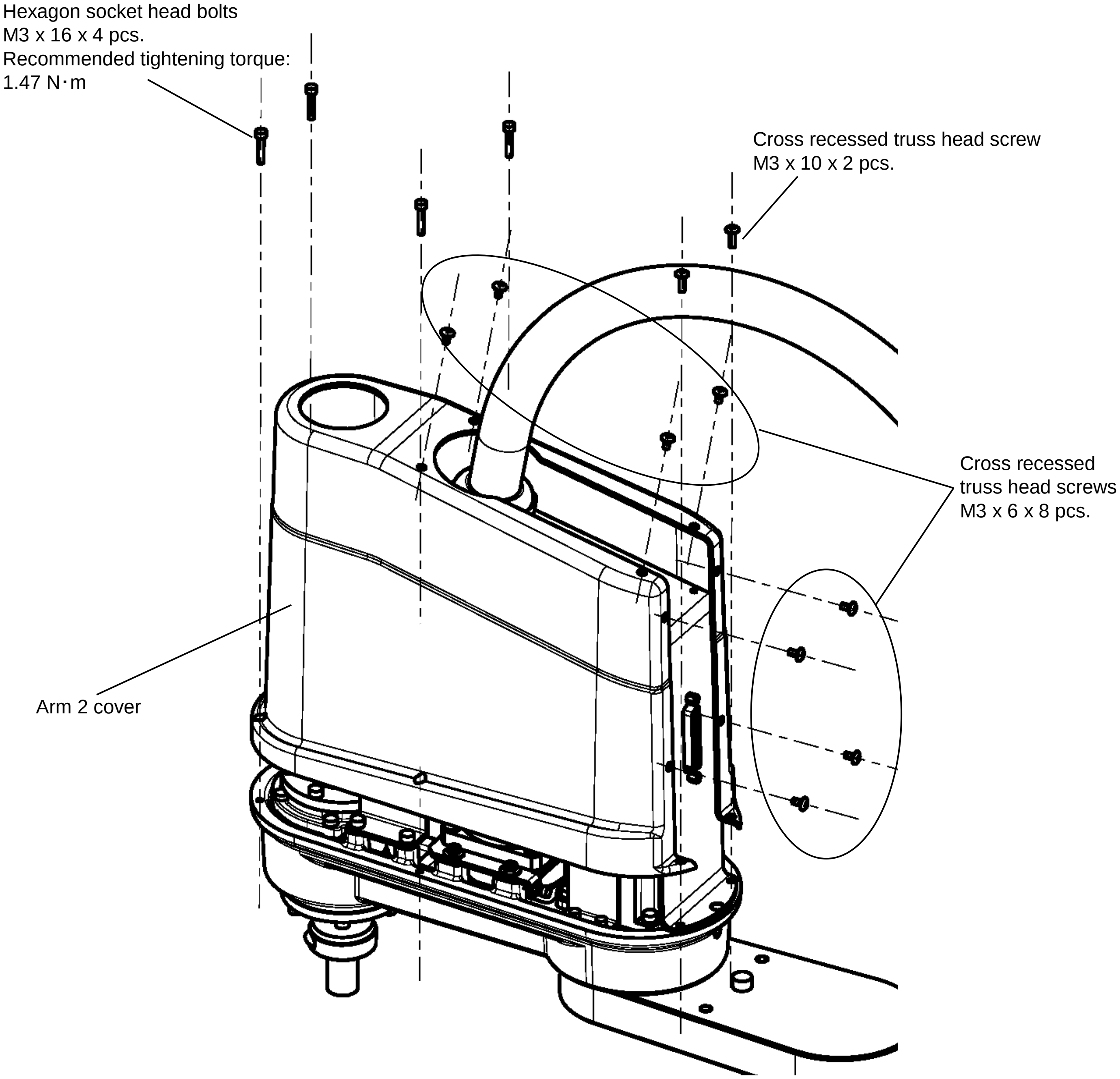


Fig. 5.9 Removing the Arm 2 Cover (KHL-300 and KHL-400)

5.2.4 Changing Software Limits

When the mechanical stoppers are changed, be sure to also change the software limits. There are the following two types of methods to change software limits.

[1] Change the setting values of the "User Parameter File (file name: USER.PAR)." There are software limits that can be set by the customer. For more details, refer to the item of [U14] SOFTWARE LIMIT in the "Instruction Manual: User Parameters" separately available.

[2] By manipulating the teaching pendant, change software limits in the utility mode "J-LIM."
For more details, refer to "10.8 Joint Limit Setting [J-LIM]" in Chapter 10, "Utilities" in the "Instruction Manual: Operations" separately available.

Note that if software limits are changed using the above two types of methods, the factory preset values of the software limits set up in the "User Parameter File (file name: USER.PAR)" will be overwritten and saved.

Thus, **be sure to create a backup of the "User Parameter File" before changing software limits** so as to get a grasp of the factory preset values of the software limits in the "User Parameter File."

Also, when software limits were changed, be sure to turn OFF and then ON the power.
If the power is not turned OFF and then ON again, changes to the user parameters will not take effect.

5.2.5 Coordinate System

The robot's joint angle origin (0° or 0 mm position) is factory-calibrated according to the base reference planes. Fig. 5.10 shows the base coordinate system and origin of each axis joint angle. The coordinate system is common between the KHL-300 and KHL-400. Figure shows the KHL-300.

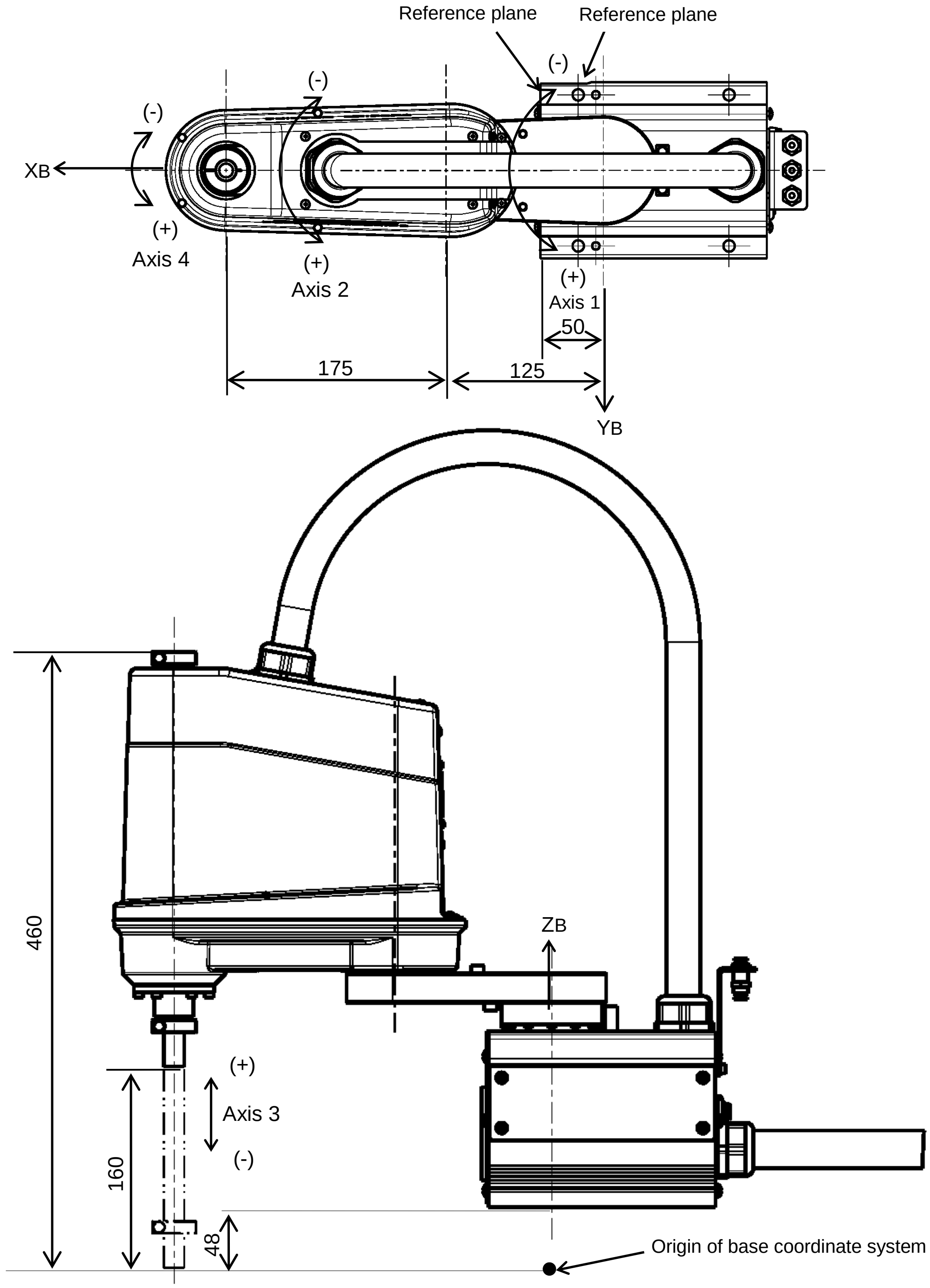


Fig. 5.10 Base coordinate system and joint angle origin (KHL-300)

5.2.6 Installing the Robot

The robot is secured, using the mounting holes on the base (four places). Use M8 hexagon socket head cap screws.
Table 5.3 lists the loads applied to the frame during horizontal operation, and Fig. 5.11 shows how to install the robot. 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. Further, a pin hole is provided. This hole can be used for positioning.

⚠ 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.

Table 5.3 Load applied to the frame during horizontal operation (KHL-300 and KHL-400)

Model	Loads applied to the frame during horizontal operation [Nm]	Robot main body mass [kg]
KHL-300	110	12
KHL-400	110	13

* These values are reference values. When designing a frame, take the safety factor into consideration.

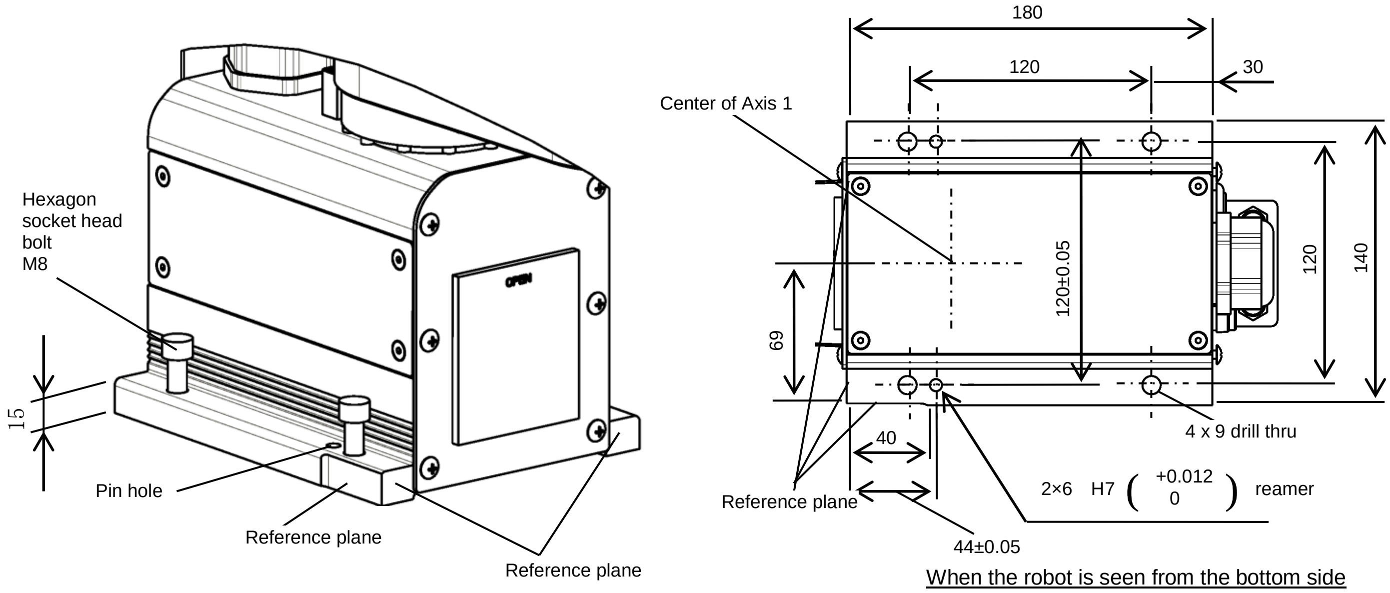


Fig. 5.11 Installation method (KHL-300 and KHL-400)

5.3 Precautions for Handling the Teach Pendant

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

CAUTION

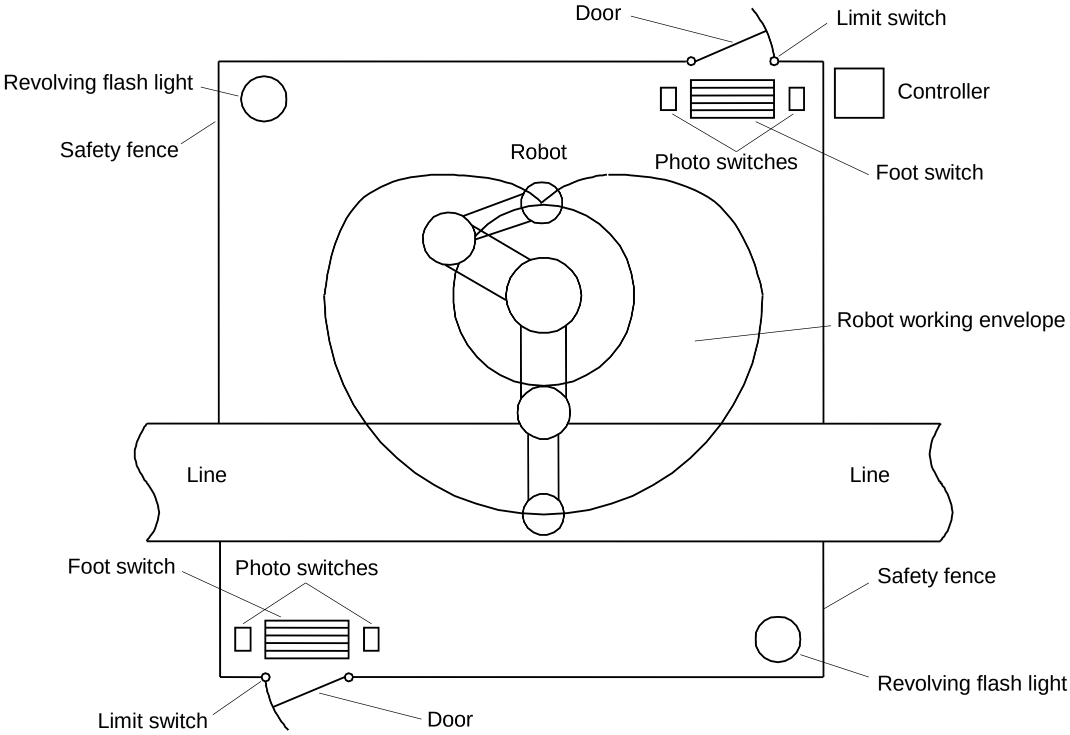
- DO NOT drop the teach pendant or hit it against anything.
- DO NOT pull the cable running from the teach pendant.
- DO NOT press the switches on the teach pendant with anything sharp (like the tip of a knife, pencil, ball-point pen, etc.).
- DO NOT place or use the teach pendant near open flames.
-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

5.4 Safety Measures

a) When installing the robot, provide sufficient space to carry out the work safely.

b) Clarify the hazard zone, and provide a safety fence so that other persons cannot enter the zone easily.　The hazard zone is the zone near the robot's working space where a hazardous state could occur if a person enters.

c) Provide limit switches, photo switches, foot switch, etc., at the entrance of the safety fence to provide an emergency stop function that will stop the robot if a person enters the hazard zone.　The emergency stop function should be an electrically independent normal close contact b (closed in normal operation) with compulsive opening function and must not be automatically recovered.



d) The controller should be installed at a place outside the hazard zone where the operator can view the robot movement.

6. Robot Installation (KHL-500, KHL-600 and KHL-700)

6.1 Installation Environment

For mounting environment, see "5.1 Installation Environment".

6.2 Installation

Before installing the robot, you should plan a layout, fully considering the working envelope (or operating range), coordinate system and space for maintenance.

6.2.1 External Dimensions and Working Envelope

Figs. 6.1 to 6.3 show the external view drawing and 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 misoperation, the robot is equipped with mechanical stoppers outside the working envelope. Additionally, soft limits that can be set by the user are provided. For further information, see the “Instruction Manual: User Parameters” provided separately.

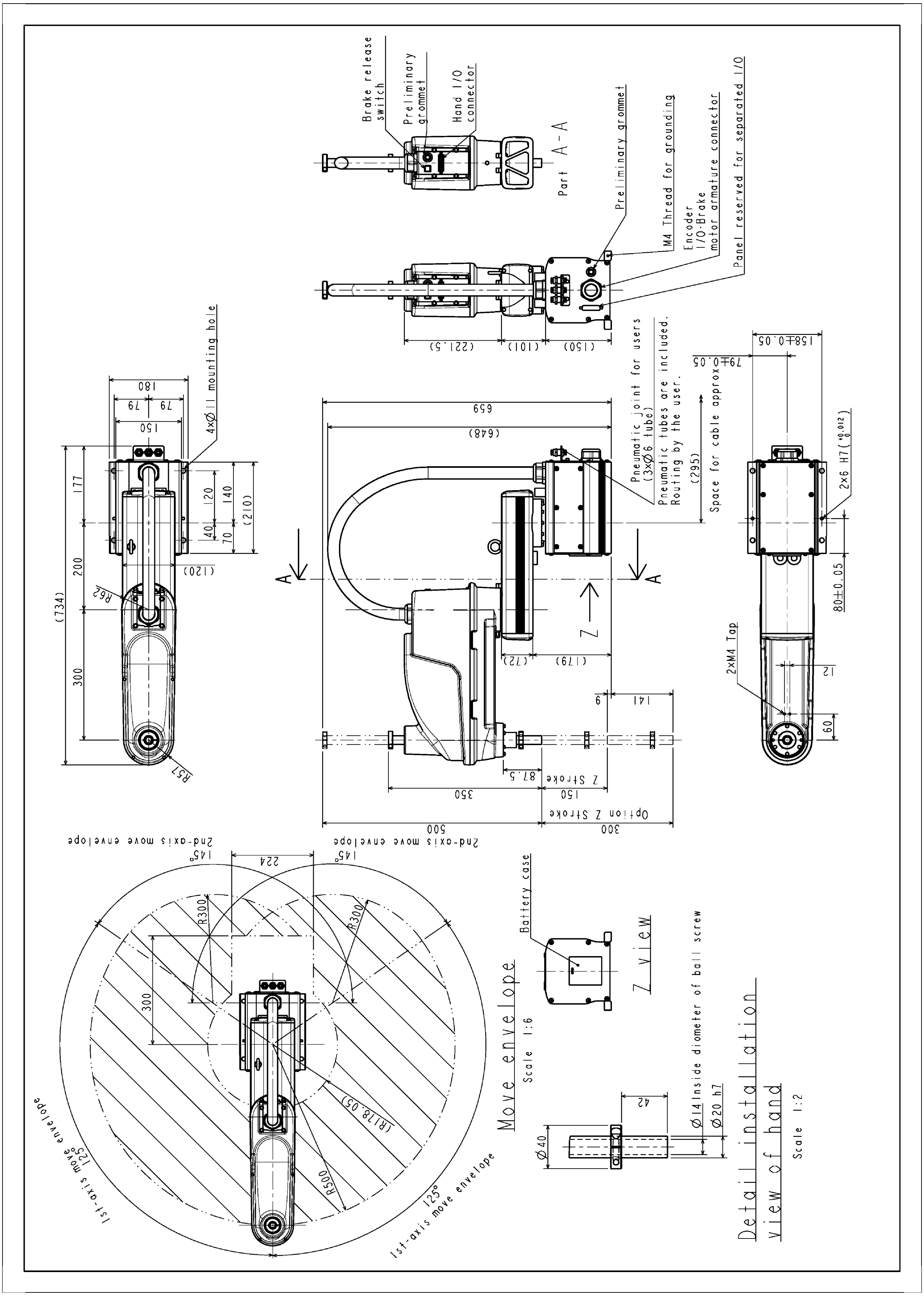


Fig. 6.1 External view and working envelope (KHL-500)

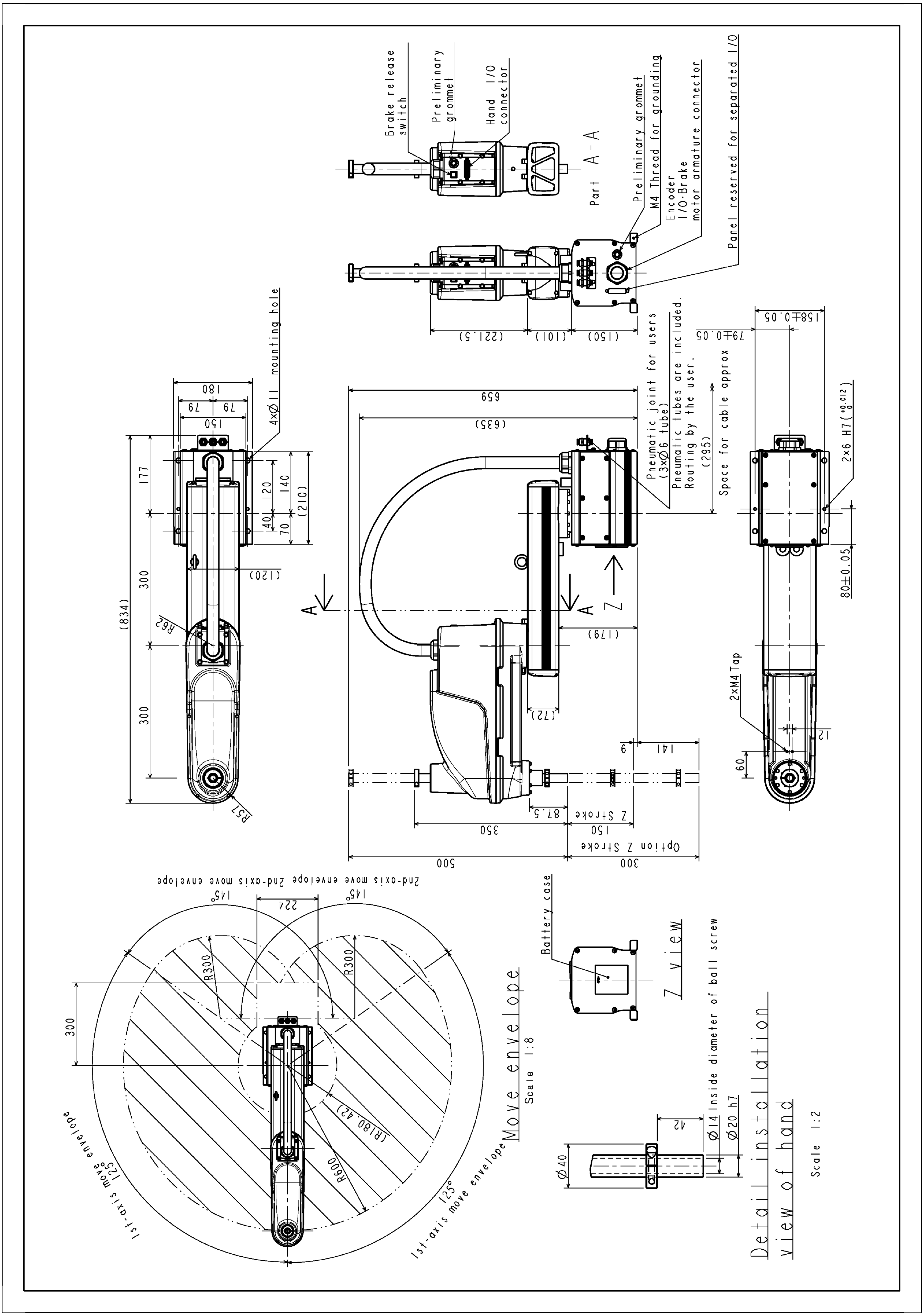


Fig. 6.2 External view and working envelope (KHL-600)

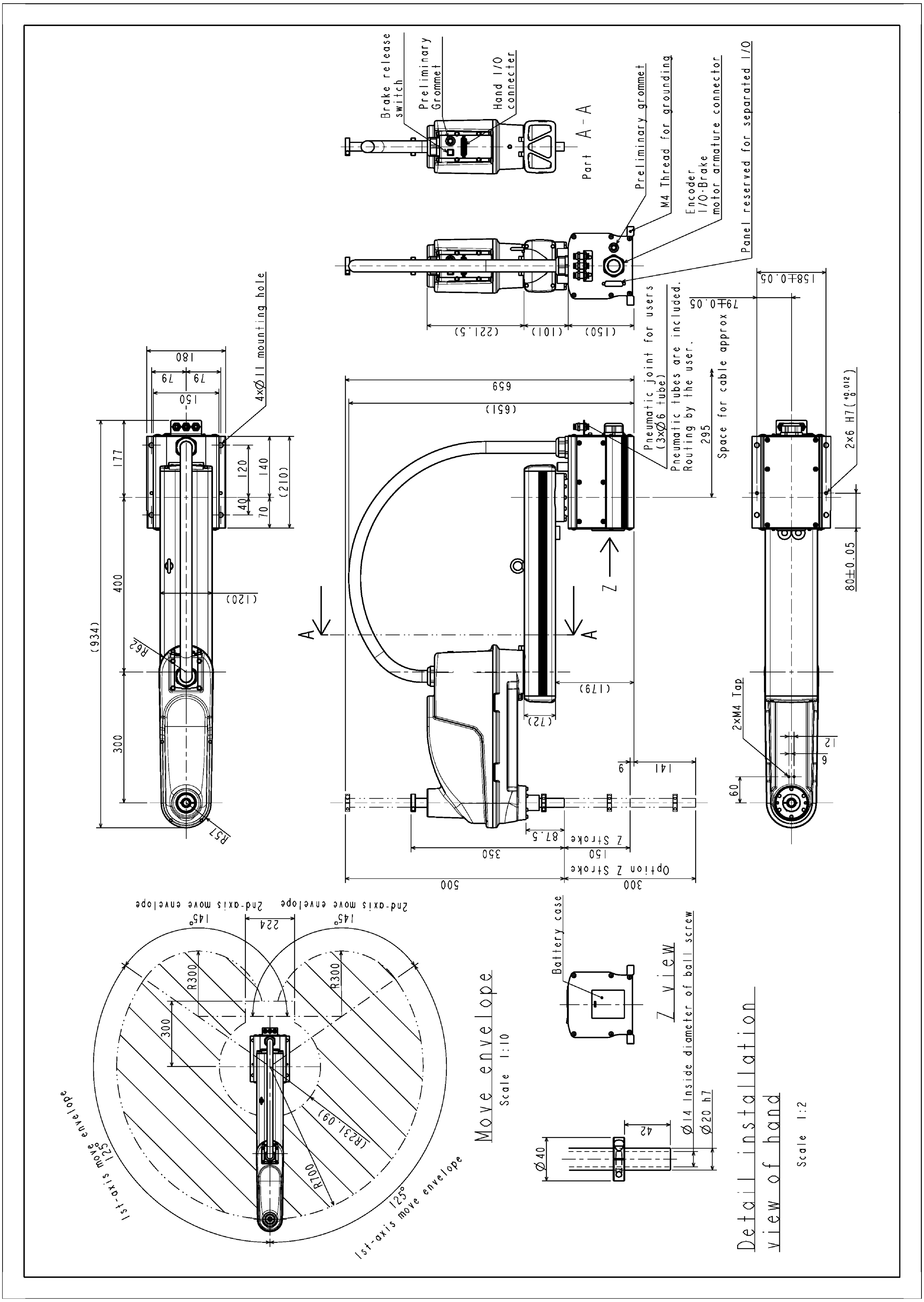


Fig. 6.3 External view and working envelope (KHL-700)

6.2.2 Changing the Operating Ranges of Axes 1 and 2

Mechanical stoppers are installed to each robot to mechanically control the operation range of each axis. Changing the mechanical operation range of a robot by modifying these mechanical stoppers is referred to as "change in operating range."
Here, how to change the operating ranges of Axes 1 and 2 of a robot is explained.

Regarding how to change the operating range of Axis 3, Para. 6.2.3.
Note that Axis 4 is different from other operating axes; it restricts the operating range with software limits only, not with mechanical stoppers. Therefore, regarding how to change the operating range of Axis 4, see Para. 5.2.4.

⚠ CAUTION

- To change operating ranges, design and produce mechanical stoppers by referring to this document according to your usage.
- When mechanical stoppers have been changed and then operating ranges have been changed, be sure to also change software limits to prevent contact with the mechanical stoppers while operating a robot.
- Mechanical stoppers do not securely restrict the movable ranges of robots.

  When the power of a robot is turned on, never enter the operating range of the robot.
- If a robot collides with a mechanical stopper, the robot detects the collision and stops, but the mechanical stopper may be damaged. Avoid reusing the mechanical stopper.
- The mechanical stopper reference drawings shown in this document do not fully satisfy the customer's usage.

  Design, produce and install mechanical stoppers according to your usage, such as the operating range.
- The failures of a robot caused by mechanical stoppers will be excluded from the warranty coverage.

As shown in Fig. 6.4, the operation range can be altered by changing the position of the mechanical stopper.

Table 6.1 Operation ranges before and after change (KHL-500, KHL-600 and KHL-700)

		Before change	After change
Axis 1 operation range	+ direction	125°	105°
	- direction	125°	105°
Axis 2 operation range	+ direction	145°	110°
	- direction	145°	110°

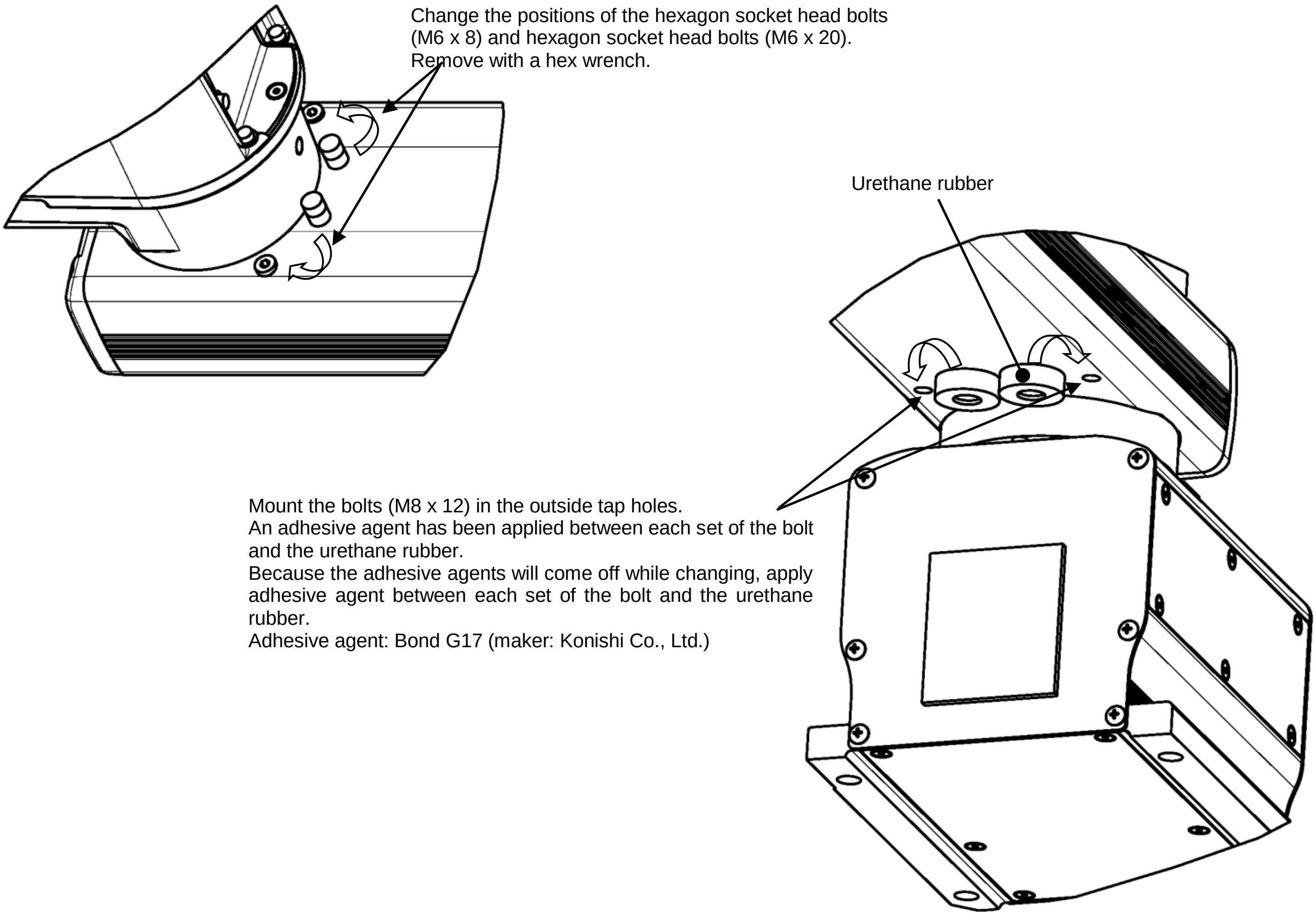


Fig. 6.4 Changing the Operating Ranges of Axes 1 and 2 (KHL-500, KHL-600 and KHL-700)

If the operation range is changed, it is necessary to change the user parameter.
For the software limit change procedure, see "5.2.4 Changing Software Limits".

6.2.3 Changing the Operating Range of Axis 3

At the factory shipment of a robot, software limits and mechanical stoppers are preset so that the Z stroke of Axis 3 is between 0 and 150 mm (0 through 300 mm for Z-long specifications). Fig. 10.5 shows the settings of operating range at the factory shipment.

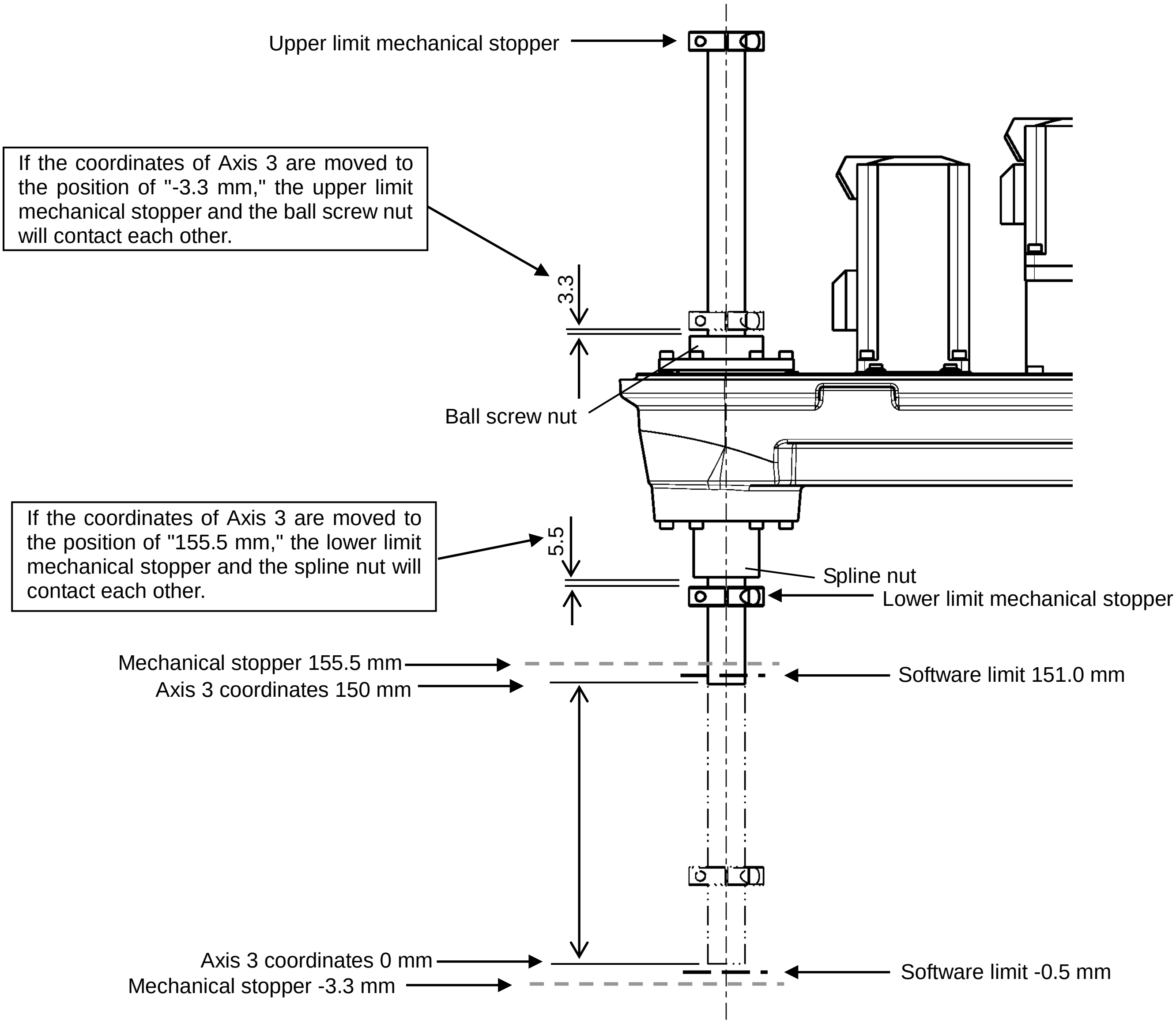


Fig. 6.5 Changing the Operating Range of Axis 3 (KHL-500, KHL-600 and KHL-700)

1) Remove the Arm 2 cover. The cover is fastened to Arm 2 and the harness guide with 14 hexagon socket head bolts (M3 x 16 x 4 pcs., M4 x 6 x 8 pcs. and M4 x 10 x 2 pcs.)

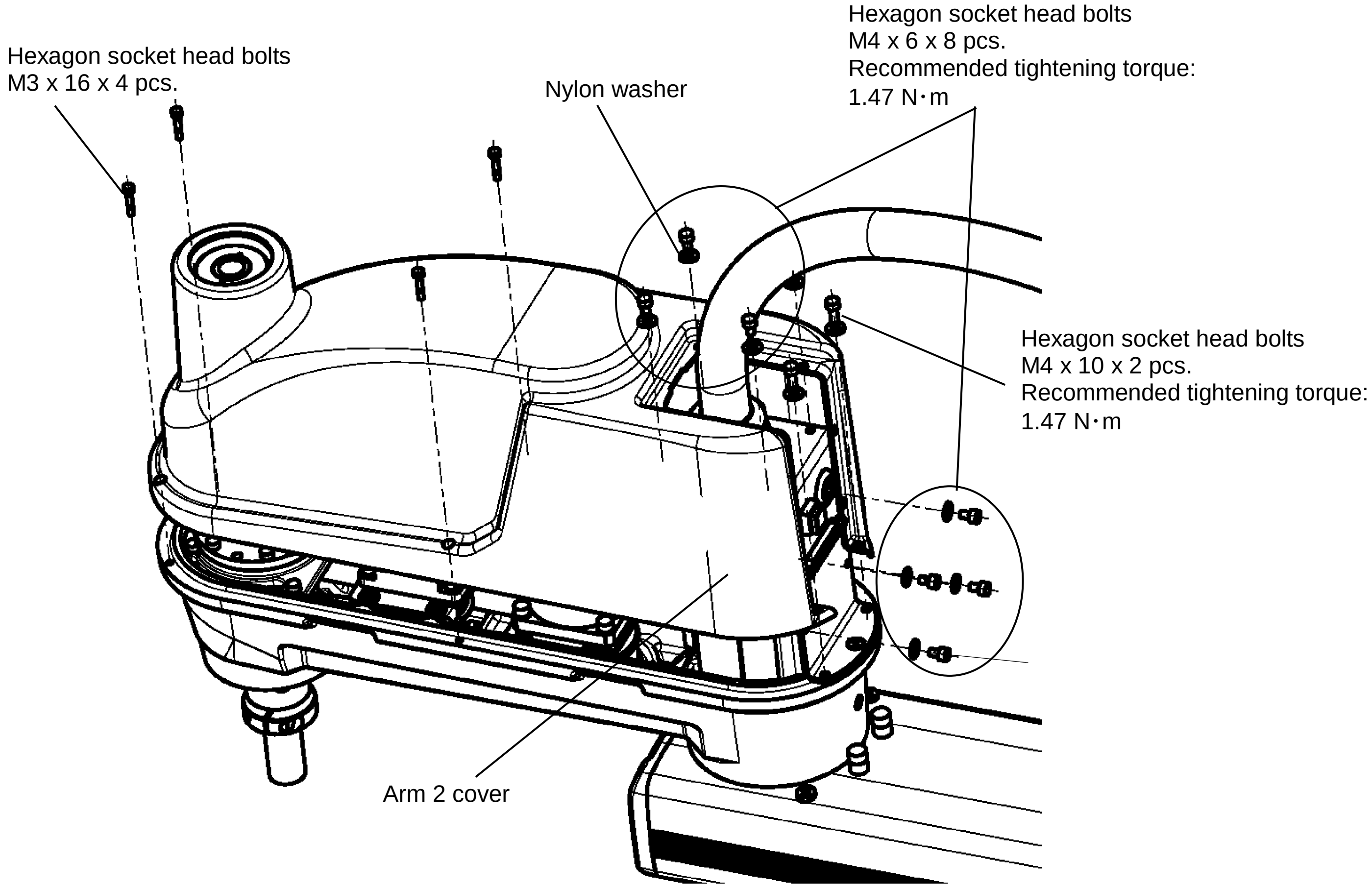


Fig. 6.6 Removing the Arm 2 Cover (KHL-500, KHL-600 and KHL-700)

2) Loosen the fixing bolts of the mechanical stoppers, move the mechanical stoppers to a desired position, and fix them again. When fixing the mechanical stoppers, be sure to apply Loctite to the fixing bolts.

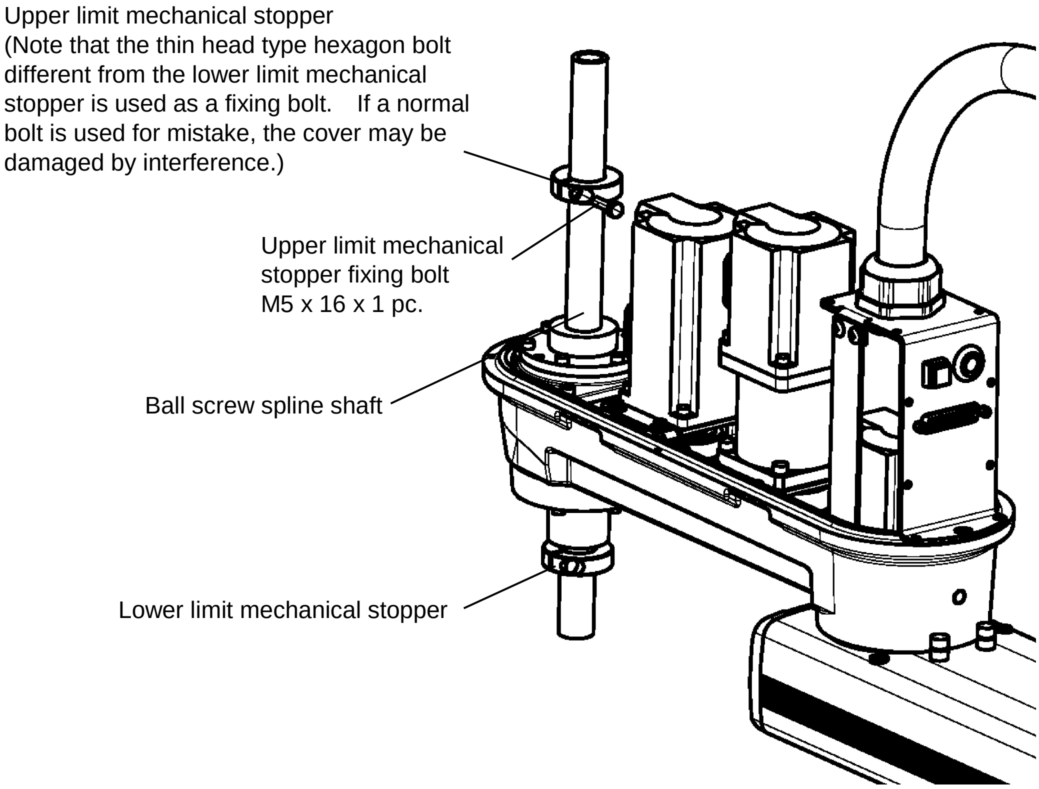


Fig. 6.7 Checking Software Limit Change (KHL-500, KHL-600 and KHL-700)

3) When the mechanical stoppers are changed, be sure to also change the software limits. Regarding how to change software limits, see Para. 5.2.4 and Fig. 6.10. After changing the software limit, while pressing the axis 3 brake release switch, move Axis 3 manually, and make sure that the software limit is correctly set.

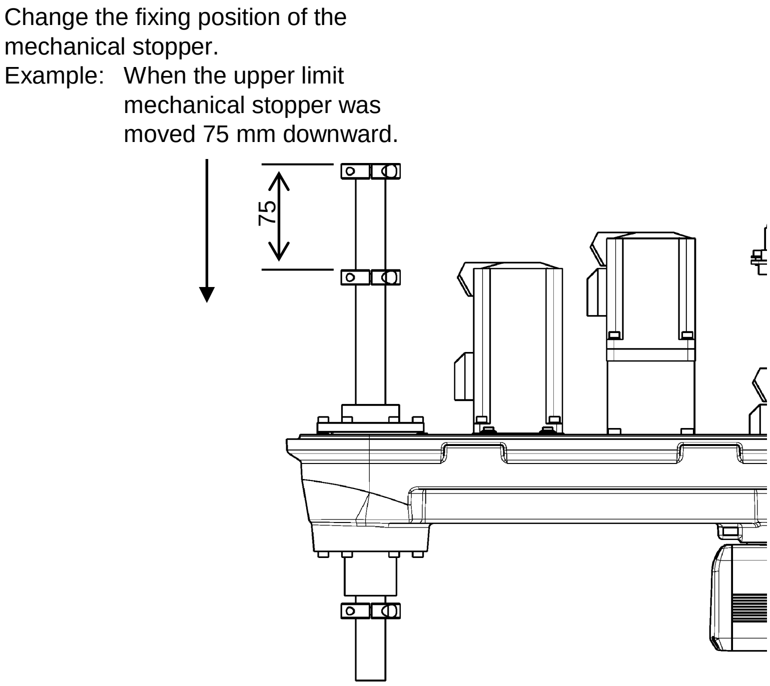


Fig. 6.8 Changing the Operating Range (KHL-500, KHL-600 and KHL-700)

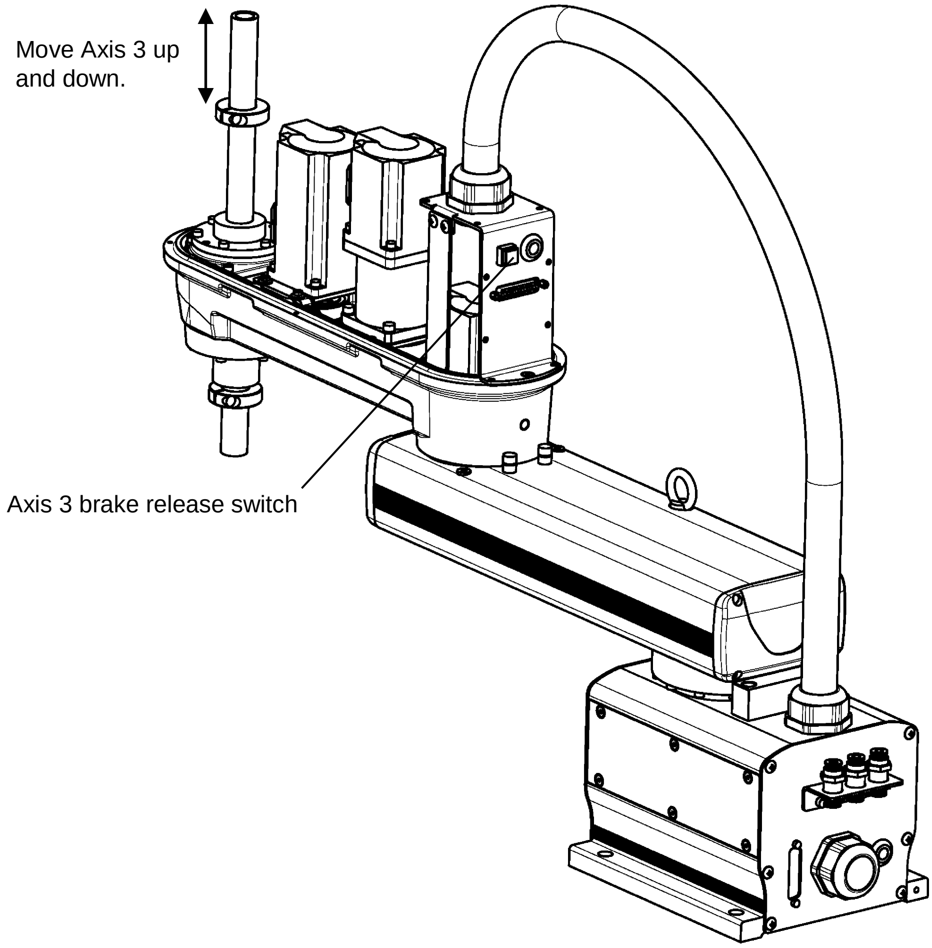


Fig. 6.9 Checking Software Limit Change (KHL-500, KHL-600 and KHL-700)

Fig. 6.10 shows the settings of the operating range when the upper limit mechanical stopper was moved 75 mm downward.

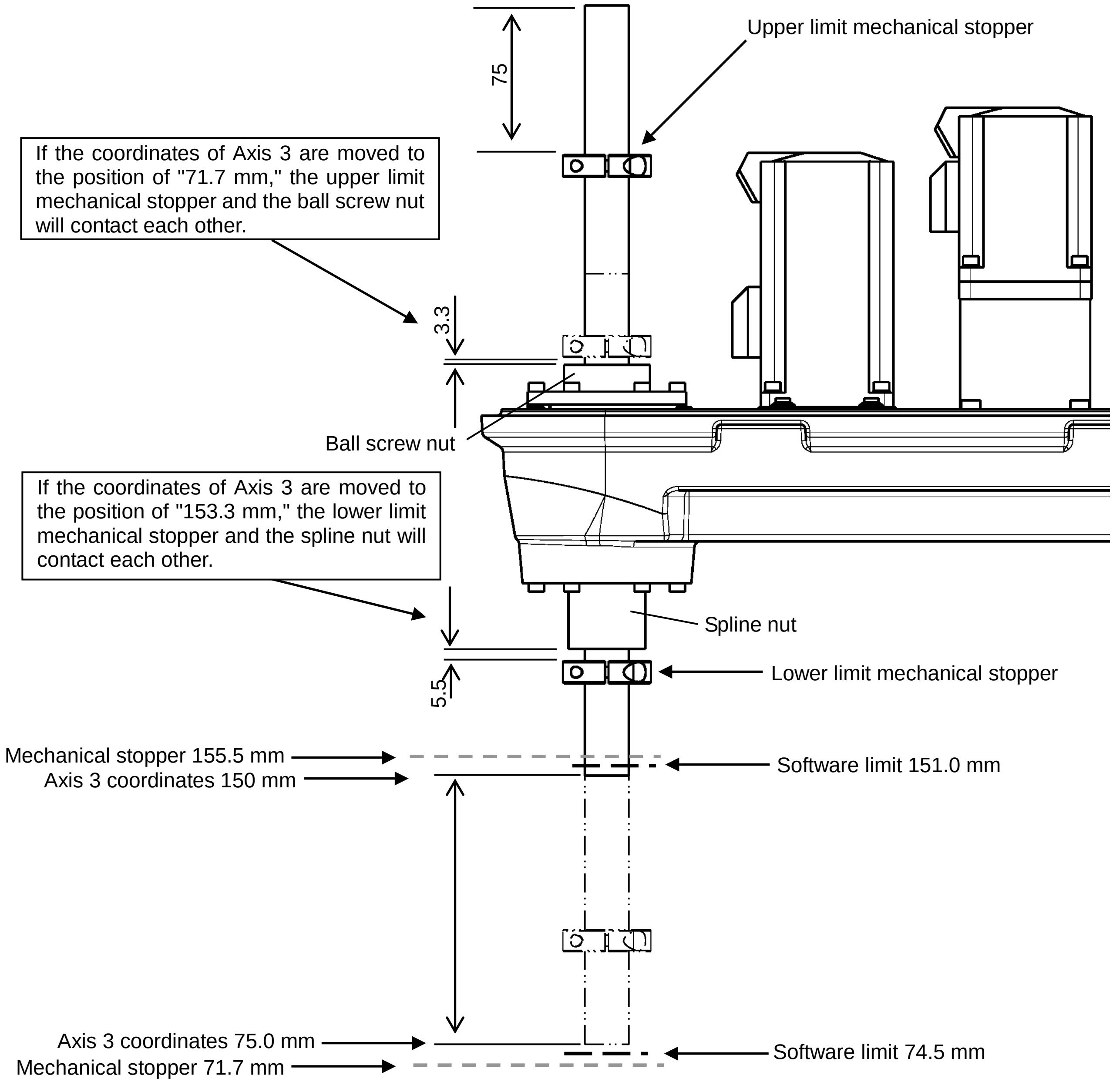


Fig. 6.10 Changing the Operating Range of Axis 3 (KHL-500, KHL-600 and KHL-700)

4) Fasten the Arm 2 cover to Arm 2 and the harness guide with 14 hexagon socket head bolts (M3 x 16 x 4 pcs., M4 x 6 x 8 pcs. and M4 x 10 x 2 pcs.) and nylon washers. (Application of Loctite during installation is not necessary.)

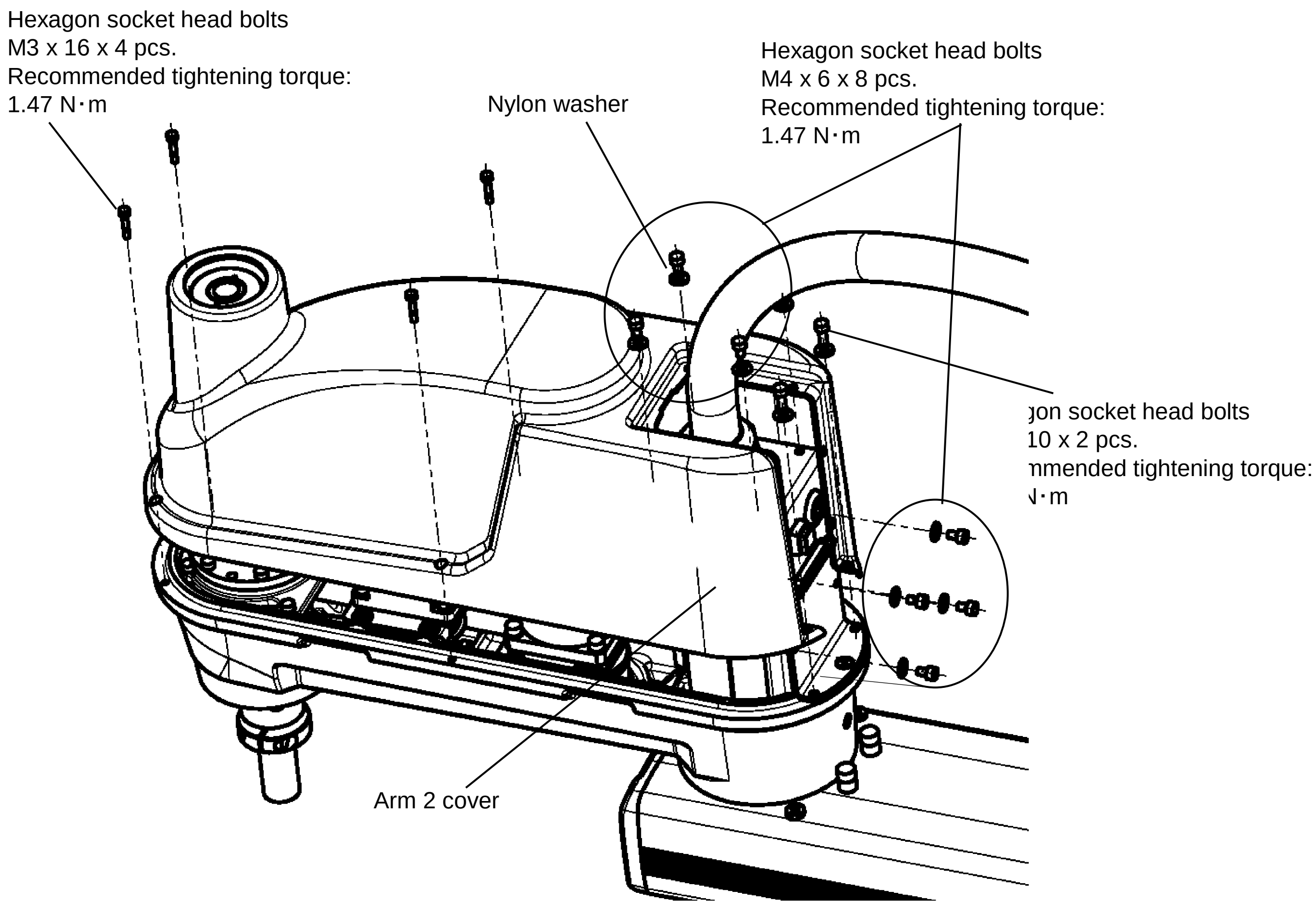


Fig. 6.11 Removing the Arm 2 Cover (KHL-500, KHL-600 and KHL-700)

After installation, manually move the ball screw spline shaft up and down while holding down the brake release switch, and check that the holes for the ball screws of the Arm 2 cover and the mechanical stoppers are not interfering with each other.

6.2.4 Changing Software Limits

For the software limit change procedure, see "5.2.4 Changing Software Limits".

6.2.5 Coordinate System

The robot's joint angle origin (0° or 0 mm position) is factory-calibrated according to the base reference planes. Fig. 6.12 shows the base coordinate system and origin of each axis joint angle. The coordinate system is common among the KHL-500, KHL-600, and KHL700. Figure shows the KHL600.

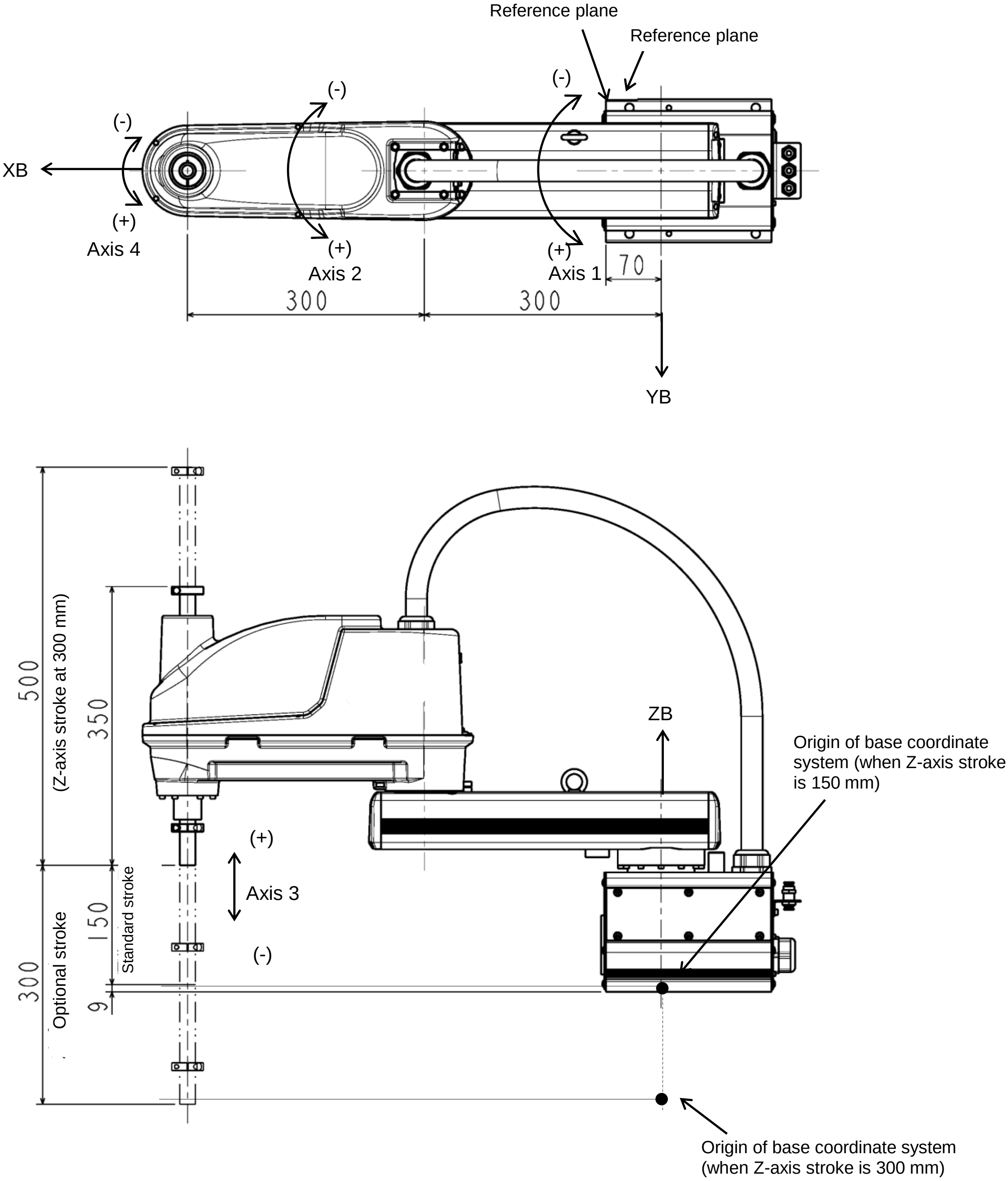


Fig. 6.12 Base coordinate system and joint angle origin (KHL-600)

6.2.6 Installing the Robot

The robot is secured, using the mounting holes on the base (four places). Use M10 hexagon socket head cap screws.
Table 6.2 lists the loads applied to the frame during horizontal operation, and Fig. 6.13 shows how to install the robot. 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. Further, a pin hole is provided. This hole can be used for positioning.

⚠ 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.

Table 6.2 Load applied to the frame during horizontal operation (KHL-500, KHL-600 and KHL-700)

Model	Loads applied to the frame during horizontal operation [Nm]	Robot main body mass [kg]
KHL-500	350	22
KHL-600	350	23
KHL-700	350	24

* These values are reference values. When designing a frame, take the safety factor into consideration.

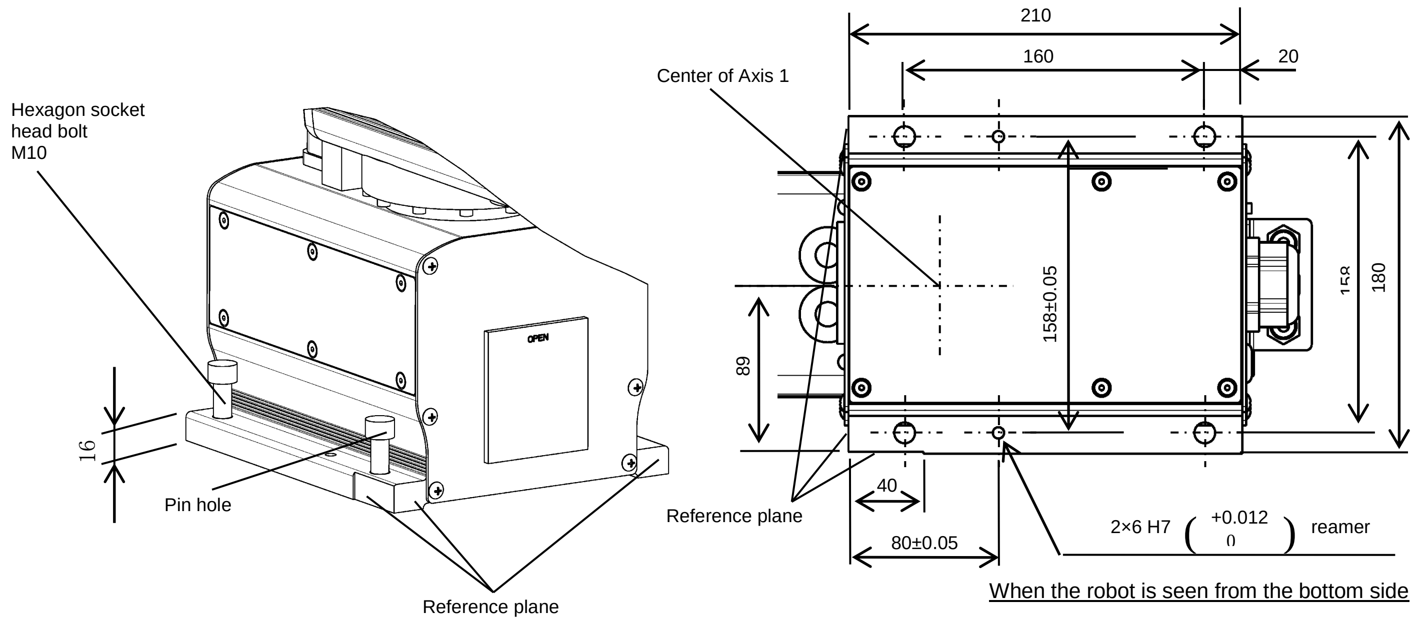


Fig. 6.13 Installation method (KHL-500, KHL-600 and KHL-700)

6.3 Precautions for Handling the Teach Pendant

For the teach pendant handing procedure, see "5.3 Precautions for Handling the Teach Pendant".

6.4 Safety Measures

For safety measures, see "5.4 Safety Measures".

7. Installing the Controller (KSL3000)

7.1 External Dimensions

External view of the controller KSL3000 is shown in Fig. 7.1.

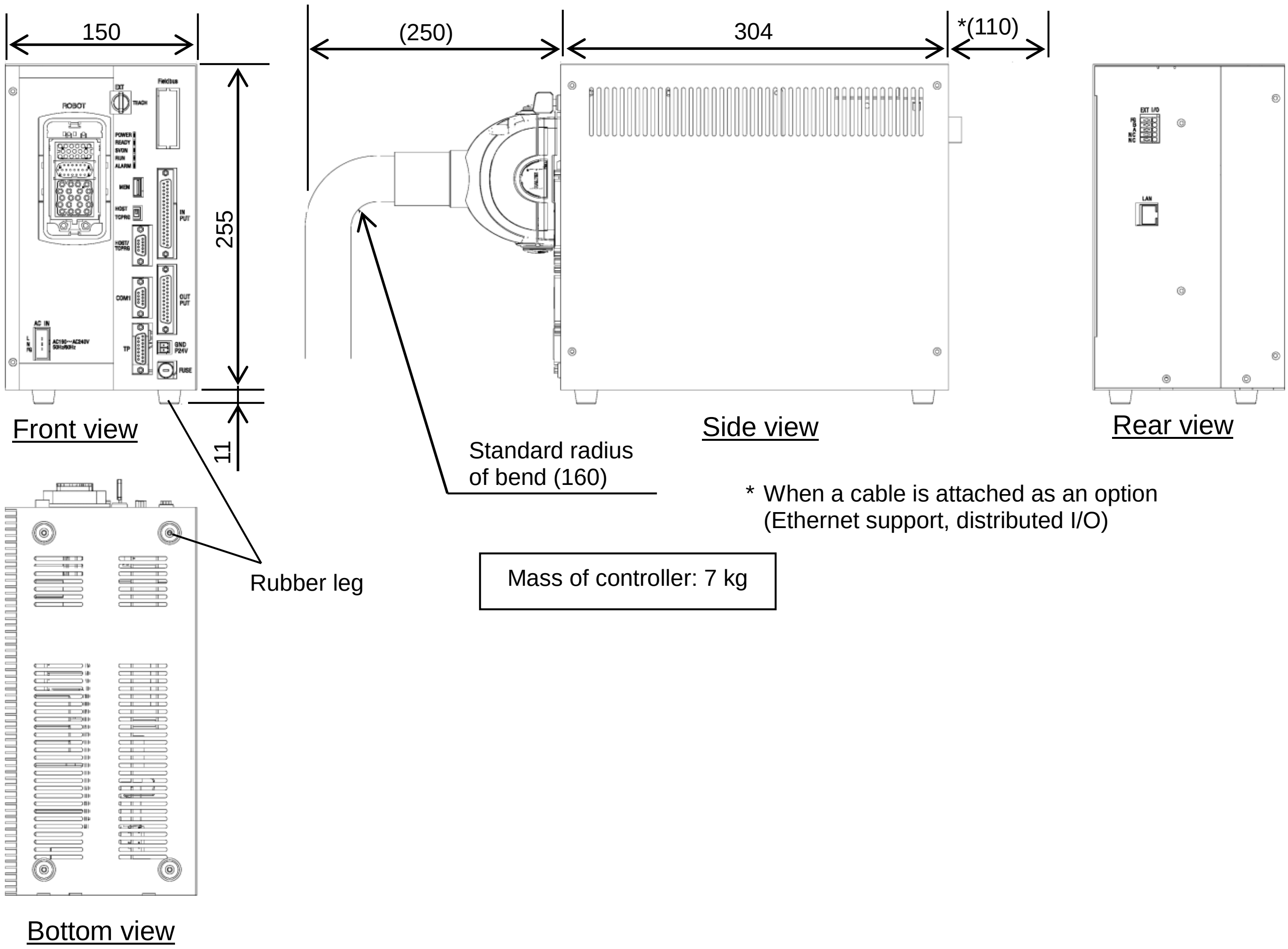


Fig. 7.1 External view of controller (KSL3000)

7.2 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 rubber legs should be kept below the lower surface. Otherwise, the cooling capacity will drop, causing controller failure.
- DO NOT stack the controllers.
- DO NOT place any object on top of the controller.

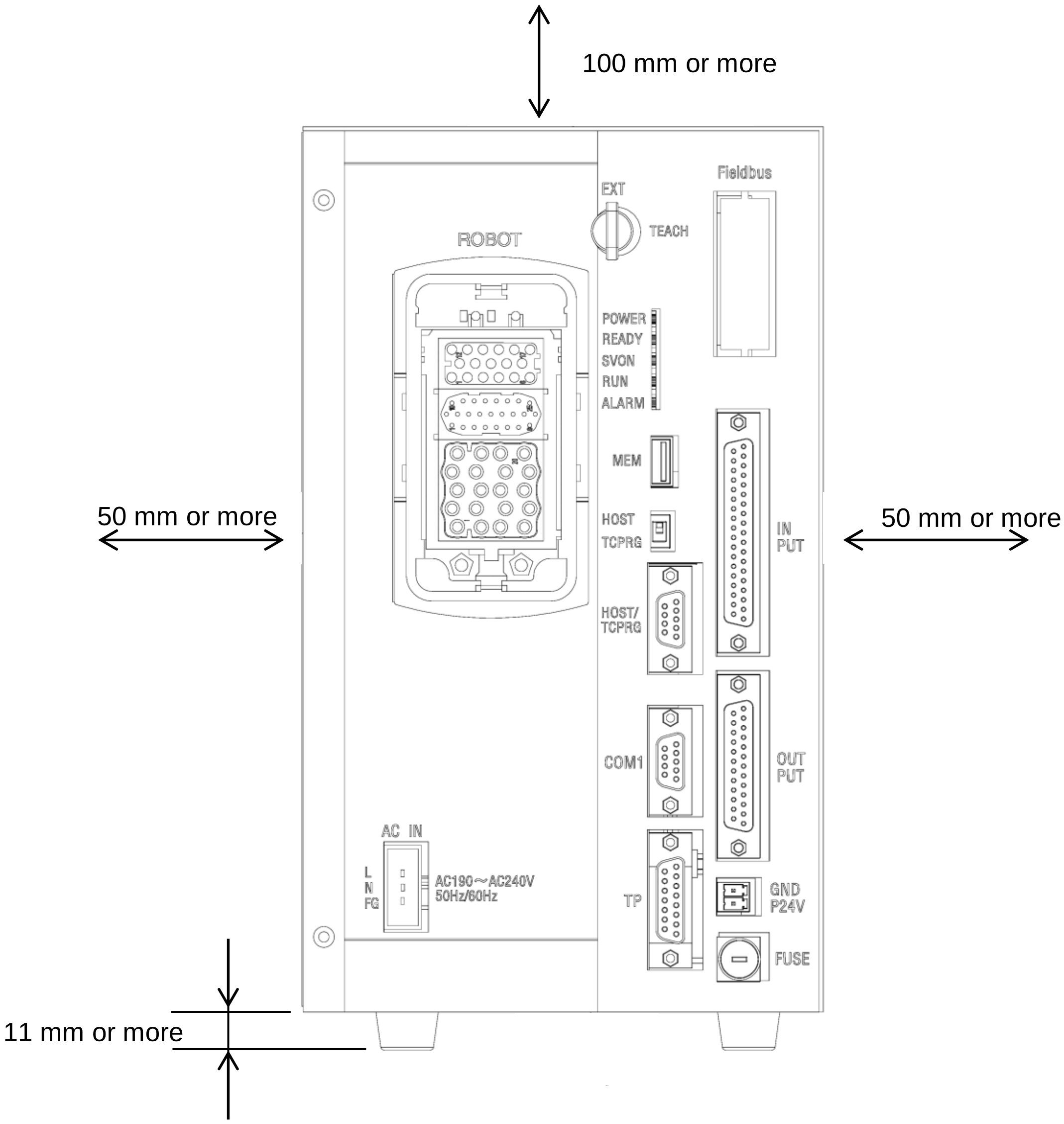


Fig. 7.2 Controller ventilation space (KSL3000)

7.3 Rack Mounting Dimensions

When installing the robot controller KSL3000 to the control panel, attach the mounting fixtures using the screw holes for mounting the rubber legs on the bottom surface, and then fasten the controller to the control panel.
Note) The mounting fixtures (2 piece set) are optional. The customer is requested to do assembly.

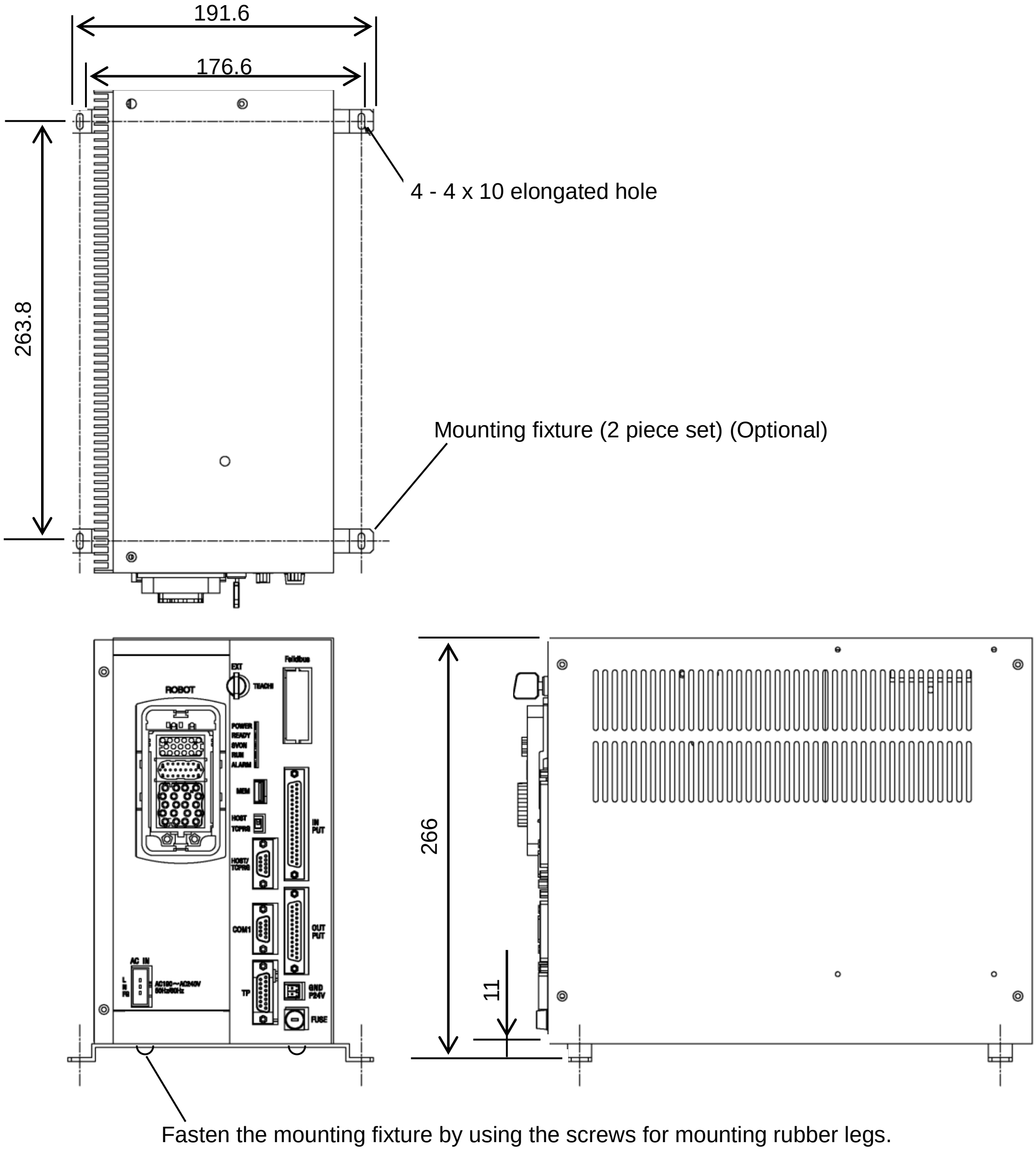


Fig. 7.3 Screw hole dimensions for securing controller (KSL3000)

7.4 Precautions for Assembling the Control Panel

When installing the robot controller KSL3000 to the control panel, be careful with the following items.

a) When installing the robot controller to the control panel, remove the rubber legs on the bottom surface and use the holes for installing the rubber legs to fix the controller in position.

b) If there are options such as Ethernet support and distributed I/O, it is necessary to connect a cable to the rear of the controller, and a space of at least 110 mm is necessary in the rear direction when doing so.

c) To do maintenance of the controller, do it with the upper cover removed. (See Fig. 13.4.)

d) When installing the controller, make sure that the maintenance of the controller can be done without any problem. Especially when storing the controller in the control panel, it will be necessary to take out the controller from the control panel for maintenance.

   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) Connect all cables in such a manner that the robot can be operated even if the controller is removed from the rack.

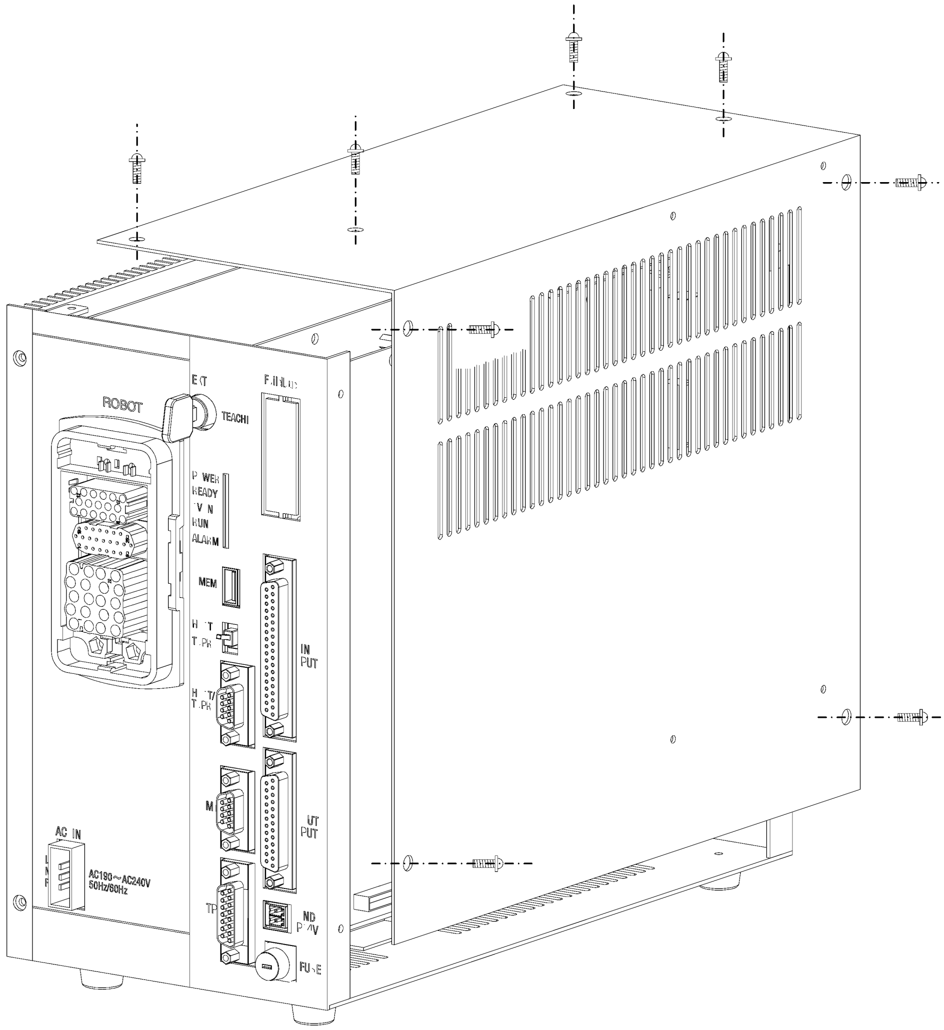


Fig. 7.4　Removing upper cover (KSL3000)

e) Allocate a clearance of about 250 mm in front of the controller for connecting the robot cable connector.

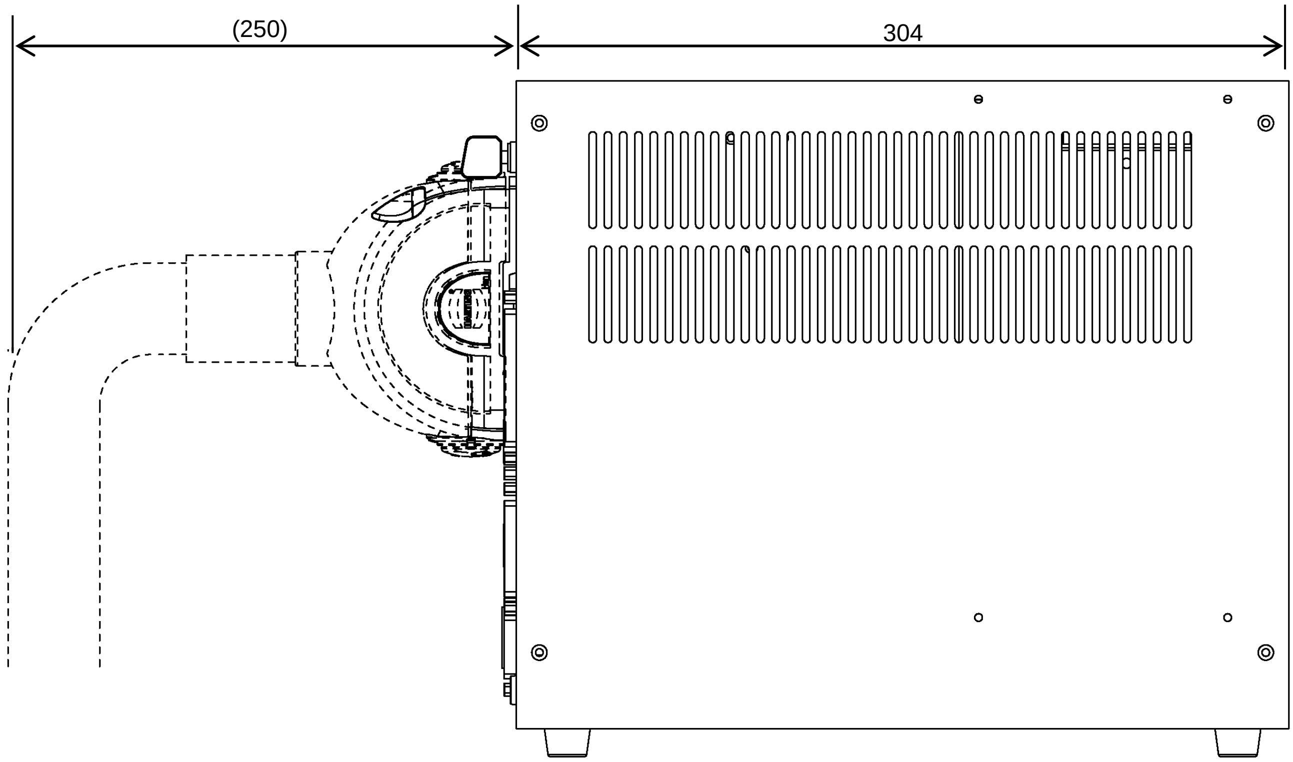


Fig. 7.5 Clearance of controller front side (KSL3000)

CAUTION

- If the control panel is completely sealed up, open air release holes, ventilate the air forcibly with a fan, or conduct indirect cooling to release heat from the control panel. Otherwise, heat will be confined in the control panel and the controller, causing failure.

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8. System Connections (KSL3000)

8.1 Cable Wiring

8.1.1 Connector Arrangement on the Controller

The cables connected to the robot controller are shown in Fig. 8.1.

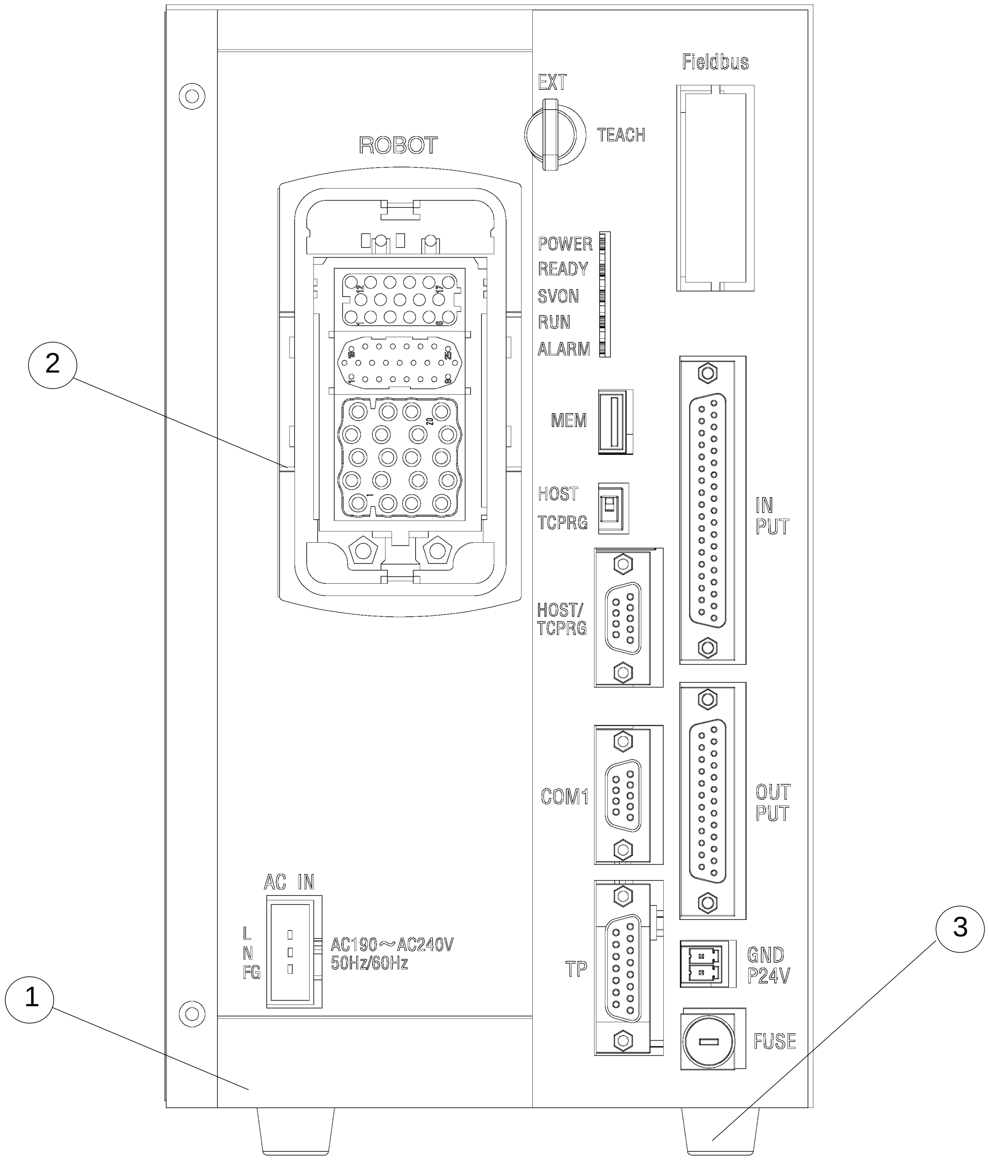


Fig. 8.1 Robot controller connector arrangement (KSL3000)

① Power cable (ACIN)
② Motor cable, encoder cable, robot control signal cable, brake signal cable (ROBOT)
③ External input/output power cable (GNDP24V)

In the subsequent paragraphs, we explain how to connect cables ①, ② and ③. For information on how to connect other cables, refer to the KSL3000 Interface Manual STE85364.

8.1.2 Connecting the Power Cable "ACIN" (① of Fig. 8.1) (Plug connector attached)

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

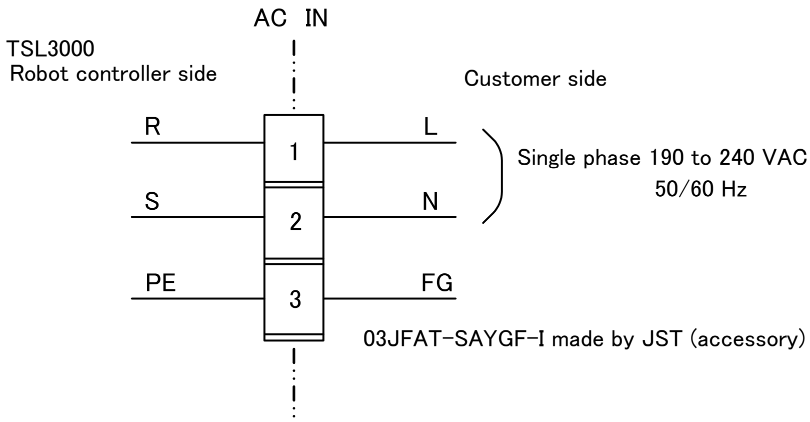


Table 8.1 Power supply specifications (KSL3000)

Power supply	Single phase, 190 - 240 V AC, 50/60 Hz ±1 Hz
Instantaneous power failure	Within 40 msec
Grounding	JIS class D

The connector is ACIN (① of Fig. 16.1).

ACIN plug connector: Type: 03JFAT-SAYGF-I Maker: J.S.T. Mfg. Co., Ltd.
Wire: 0.8 mm^2 to 2.0 mm^2 (AWG#18 to AWG#14)

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

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. 8.1.9.

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 "Instruction Manual: Operations".

8.1.3 Connecting the Motor Cable "ROBOT" (② of Fig. 8.1) (KHL-300 to KHL-700)

The motor cable is integrated with the encoder cable, robot control signal cable, and brake signal cable. This integrated cable is further integrated with the robot. 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.

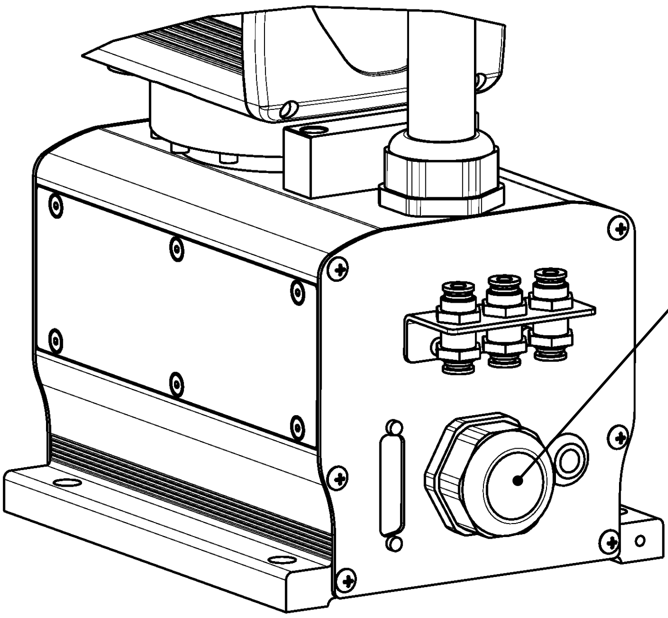


Fig. 8.2　Robot side connector arrangement (KSL3000)

8.1.4　Connecting the Encoder Cable "ROBOT" (② of Fig. 8.1)

The encoder cable is integrated with the motor cable, robot control signal cable, and brake signal cable.　This integrated cable is further integrated with the robot.　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.

8.1.5　Connecting the Robot Control Signal Cable "ROBOT" (② of Fig. 8.1)

The robot control signal cable is integrated with the motor cable, encoder cable, and brake signal cable.　This integrated cable is further integrated with the robot.　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.

8.1.6　Connecting the Brake Signal Cable "ROBOT" (② of Fig. 8.1)

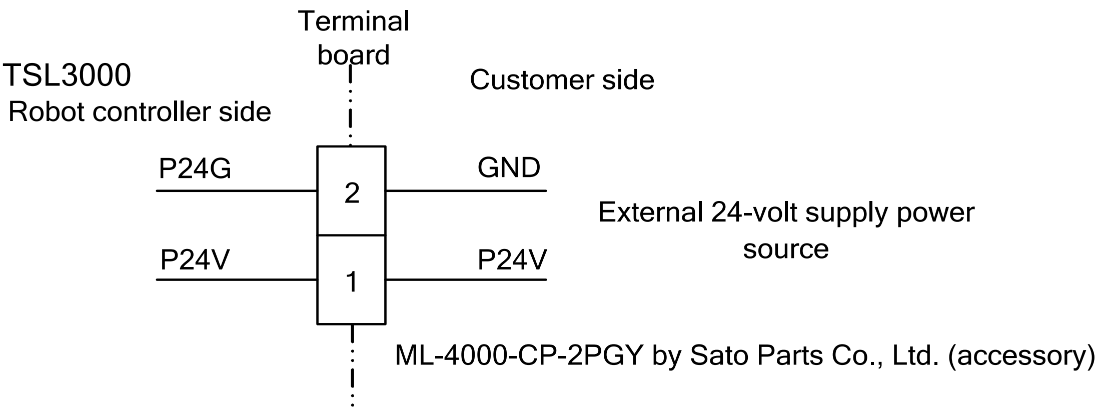
The brake signal cable is integrated with the motor cable, encoder cable, and robot control signal cable.　This integrated cable is further integrated with the robot.　The brake signal cable is used to turn ON and OFF the brake for fixing the motor axis.

8.1.7 Connecting the External Input/Output Power Cable "GNDP24V" (③ of Fig. 8.1)

An attached connector (ML-4000-CP-2PGY) is used to connect the external input/output power cable. The P24V power is supplied from the front of the controller.

The following shows the I/O using the external supply power (24 VDC). Be sure to supply power (24 VDC) from the outside.

- External input/output
- Externally operated input/output
- Extended input/output
- Manual input/output



The connector compatible cables are "AWG24 through 16"
Select the optimum external power source in conformity to the customer's system specifications (power capacity).
To connect and disconnect the external input/output power cable, see the description of "Interface Part".

⚠ CAUTION

Be sure to supply external power (24 VDC). If not, safety signals are not enabled and the controller servo power cannot be turned on.

8.1.8 Connecting and Disconnecting Cables

CAUTION

- Before connecting or disconnecting any controller cable, be sure to turn off the main power.
- When disconnecting a cable, be sure to pull the connector and not the cord. Otherwise, you may damage the cable.
- When disconnecting a cable, pull out the plug while holding down the controller. If failed to hold down the controller, the controller may fall down when pulling out the connector.

a) ROBOT connector: ROBOT
When connecting the connector, completely insert it into the connector on the controller body side while holding down the buttons located at the top and bottom of the connector on the cable side. If connection is loose, it may cause accidents due to connector contact failure, so be sure to check that the connector is completely inserted.
To remove the connector, reverse the process: Pull out the connector on the cable side while holding down the buttons located at the top and bottom of the connector.

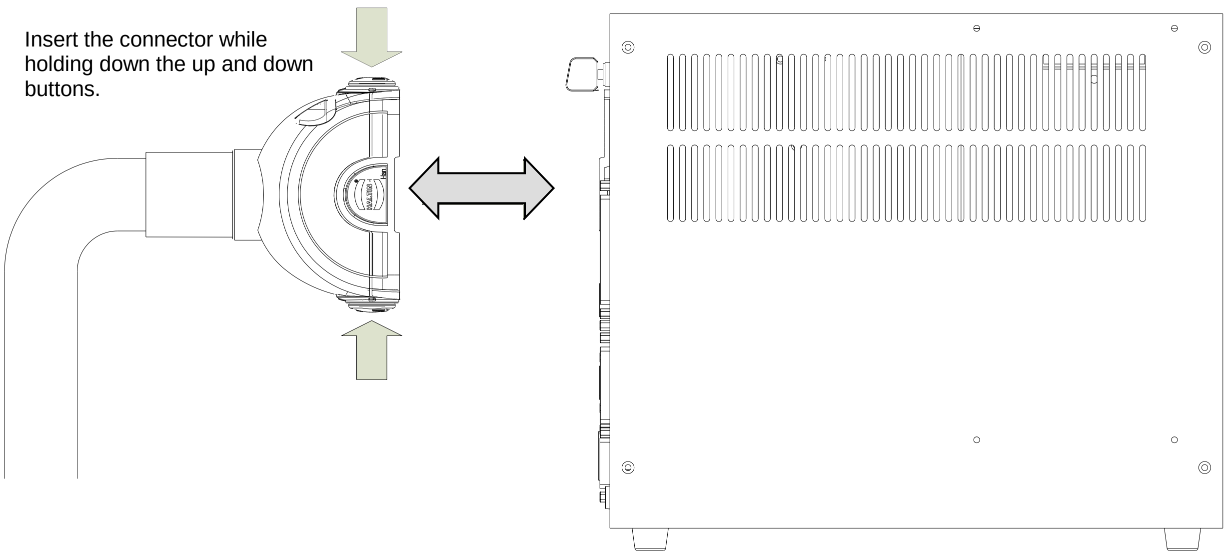


Fig. 8.3 Connecting and disconnecting the ROBOT connector (KSL3000)

b) Square connectors: INPUT, OUTPUT, TP, HOST/TCPRG, COM1
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 Phillips head screwdriver (No. 1). 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, and then pull out the cable side connector.

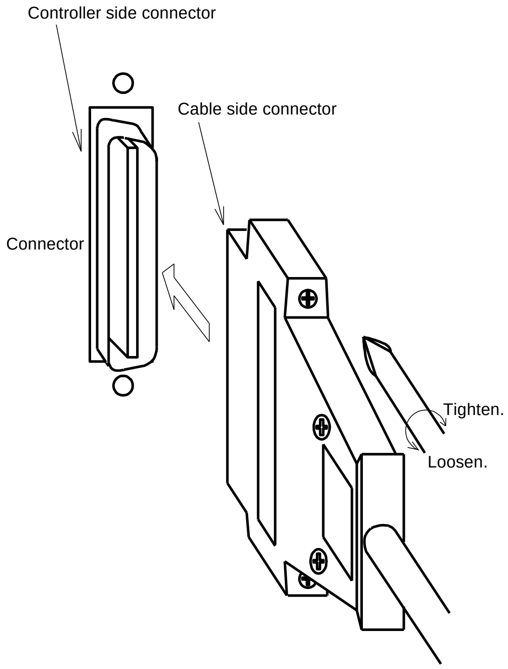
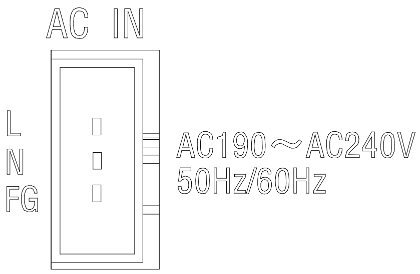


Fig. 8.4 Connecting and disconnecting a square connector (KSL3000)

8.1.9 Examples of Connector Terminal Arrangement (Controller side)

a) Power cable connector "ACIN"



Connects to controller.

Type: 03JFAT-SAYGF-I

Manufacturer: J.S.T. Mfg. Co., Ltd.

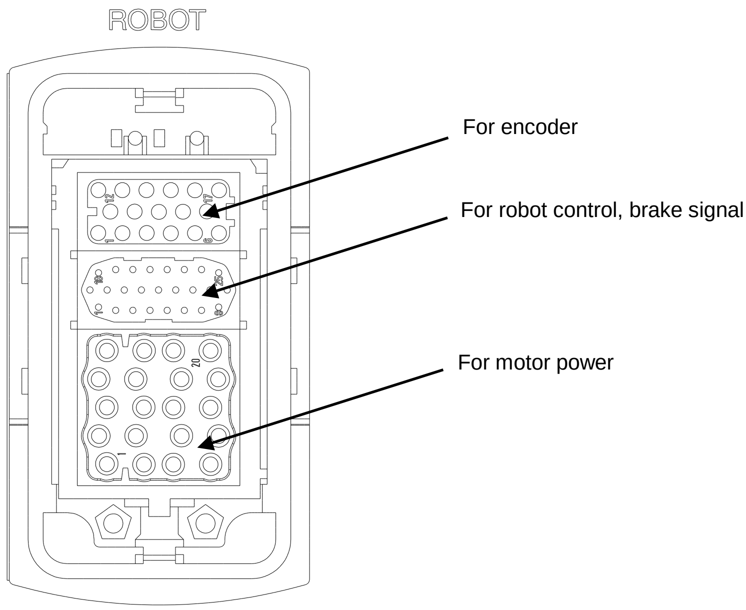
1(L)

2(N) Single phase, 190 ~ 240 VAC, 50/60 Hz

3(FG) Grounding (JIS Class D or higher)

> ⚠ **DANGER**
>
> - Completely connect the grounding cable. Otherwise, an electric shock or fire may be caused if a fault or electric leak occurs, or misoperation may be caused by noise.

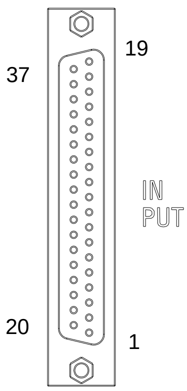
b) Connector for motor, encoder, robot control signal cable, and brake signal cable "ROBOT"



Connects to controller.

Manufacturer: Harting Co., Ltd.

c) Universal input signal cable connector "INPUT"



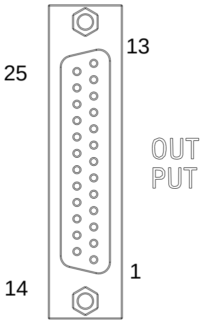
Connects to controller.

Type: XM3B-3722-112

Manufacturer: OMRON Corporation

The mating components are attached to the controller.
For details, refer to the "Instruction Manual: Interface".

d) Universal output signal cable connector "OUTPUT"



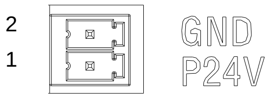
Connects to controller.

Type: XM3B-2522-112

Manufacturer: OMRON Corporation

The mating components are attached to the controller.
For details, refer to the "Instruction Manual: Interface".

e) Connector for supplying power to I/O signals



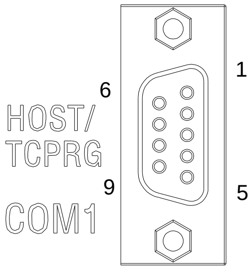
Connects to controller.

Type: ML-4000-CWJH 02PGY

Manufacturer: Sato Parts Co., Ltd.

The mating components are attached to the controller.
For details, refer to the "Instruction Manual: Interface".

f) Communication connector HOST/TCPRG, COM1

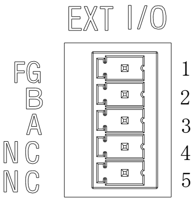


Connects to controller.

Type: XM2C-0942-132L

Manufacturer: OMRON Corporation

g) Connector for distribution I/O cable connection EXT I/O (Back of controller)



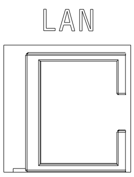
Connects to controller.

Type: ML-4000-CWJH 05PGY

Manufacturer: Sato Parts Co., Ltd.

The mating components are attached to the controller.
For details, refer to the "Instruction Manual: Interface".

h) Connector for ethernet LAN (Back of controller)



Connects to controller.

Type: J0026D21BNL

Manufacturer: PULSE Electronics

8.2 Controller Connector Signals

8.2.1 Connector Signal Connection Diagrams

Diagrams showing which signals correspond to which terminals are shown in Section 2 of the KSL3000 Interface Manual STE85364.

8.2.2 Jumpers for Safety Related Signals

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

System input signals	INPUT-12	(STOP)	
	INPUT-14	(SVOFF)	
	INPUT-32	(BREAK)	
	INPUT-18, 19	(EMS1B–EMS1C)	
	INPUT-36, 37	(EMS2B–EMS2C)	
	INPUT-17, 35	(INCOM–P24V)	Presuming standard P24V(+) common

These signals are already jumpered for the connectors provided for the KSL3000 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 INPUT connector.

Unless the following signals are used as the system signals, jumper them also.

INPUT-13	(LOW_SPD)
INPUT-31	(CYCLE)

Connector jumpers

INPUT			
12-16	14-16	32-16	32-37
(13-16)	(31-16)	18-19	17-35

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.

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Tables and Drawings

9. Tool Interface (KHL-300 and KHL-400)

9.1 Mounting Tool

The tool is mounted on the end of the tool shaft. Dimensions of the tool shaft section are shown in Fig. 9.1. As shown in Fig. 9.1, the tool is centered with the ϕ12H7 mating section. The tool direction is adjusted by means of the 4 x 4 keys and secured with four (4) M4 bolts.
The tool flange is optional.

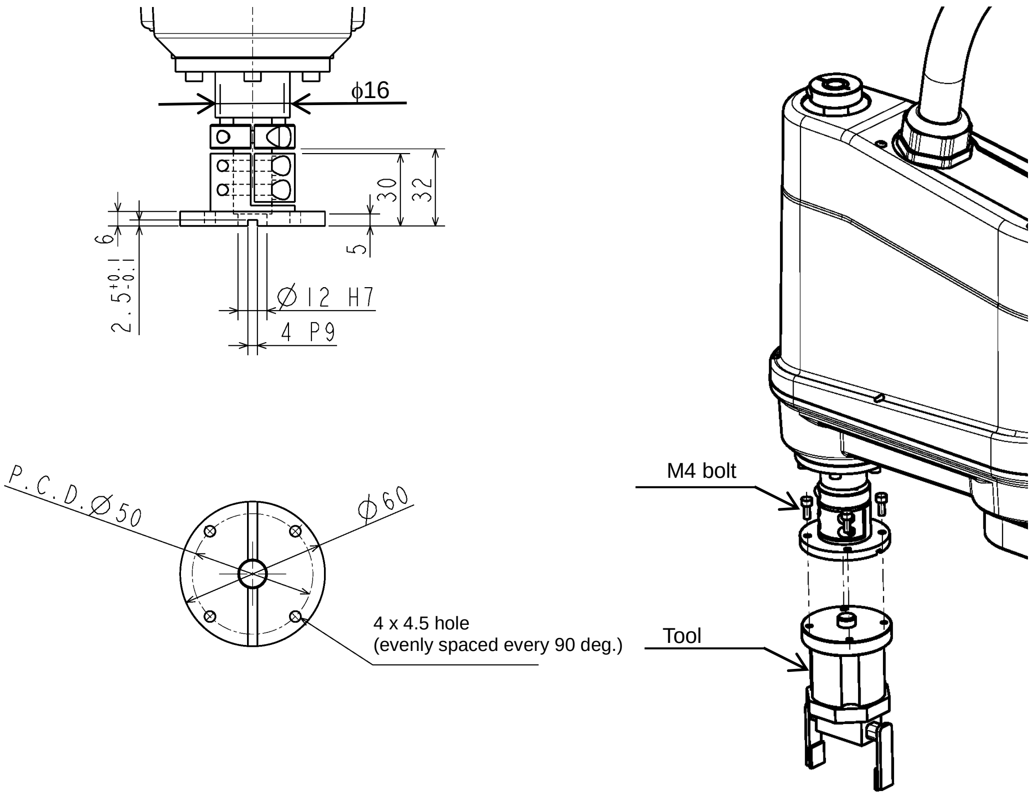


Fig. 9.1 Tool mounting dimensions (KHL-300 and KHL-400)

9.2 Tool Air Piping

The customer is requested to install the tool air piping using the following accessories.

- Air tube x3 (red, white, blue)

Fig. 9.2 shows an installation example of tool air piping for your reference.

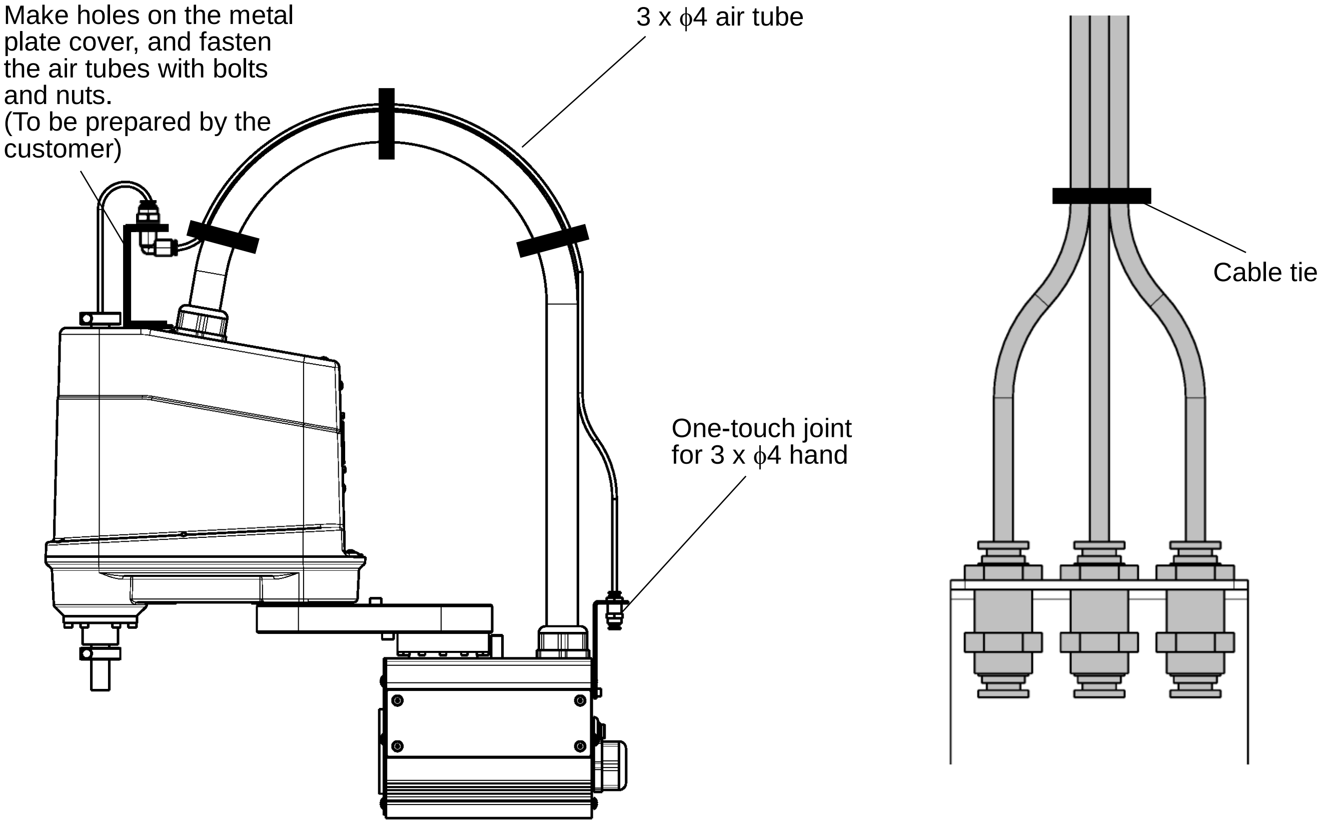


Fig. 9.2 Tool air piping installation example (KHL-300 and KHL-400)

CAUTION

- Air tubes are consumable supplies. Check the air tubes during periodic inspection, and change them if any damage is found.
- The customer is requested to prepare solenoid valve air.
- Fig. 9.2 is a reference example. Tool air piping is not guaranteed. The warranty does not cover breakdowns of the harness, the air tubes or their accessories due to piping by the customer.

9.3 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.

9.3.1 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. 9.3.
The permissible load conditions are shown in Table 9.1.

Table 9.1 Permissible load conditions (KHL-300 and KHL-400)

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.

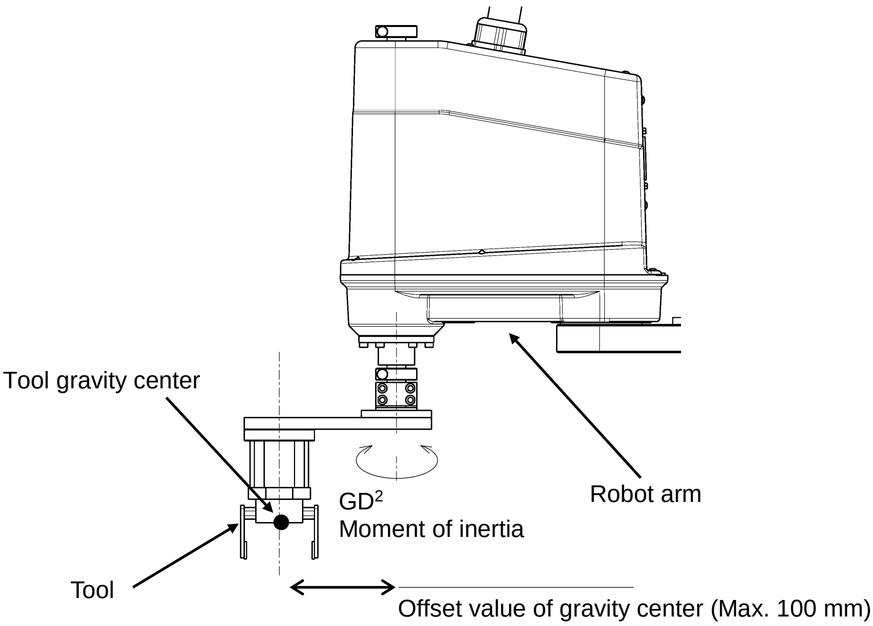


Fig. 9.3 Robot tool

9.3.2 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 L mm.

PAYLOAD = {M, L}

M	:	Load mass	(unit: kg)
L	:	Offset value of gravity center	(unit: mm)

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 100 mm gravity center offset.

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

(Program example 2)

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

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

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

c) Setting of PAYLOAD command

In the default state, or when the PAYLOAD command is not used, the maximum speed and acceleration/deceleration are set to 100 % and the servo gain is set to the value under the minimum load. See "Setting Maximum Speed and Robot Acceleration/Deceleration for Load Conditions" of 9.3.3, 10.3.3.

⚠ CAUTION

- Be sure to use the PAYLOAD command.
- Failure to use the PAYLOAD command will cause malfunctioning of the robot or shortening of the life of the mechanisms. In the worst case, the mechanism will be damaged.
- Even when the PAYLOAD command is used, regulate the speed by using the SPEED or DECEL command while confirming the workpiece behavior subject to handling.
- Micro vibration may occur depending on the robot posture. If micro vibration occurs, reduce the acceleration speed to use the robot.

⚠ CAUTION

- The load moment of inertia should be within the tolerances given in Tables 19.1, 20.1, 21.1 and 22.1.
- Even if there is no offset of load gravity center, if the moment of inertia is large, the robot may vibrate. When this happens, figure out the virtual gravity center offset (L mm) from the following equation, using the moment of inertia (J kg·m^2) and mass (M kg).

  $L = \sqrt{(J \times 10^6 / M)}$

  Then, designate the following command.

  PAYLOAD = {M, L}

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.

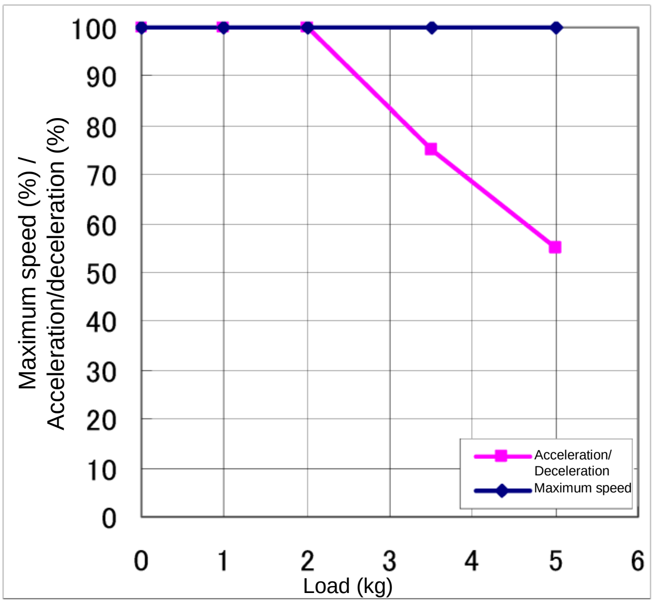
  DO PAYLOAD = {M, L} M: Mass [kg] L: Offset [mm]
  EXE

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

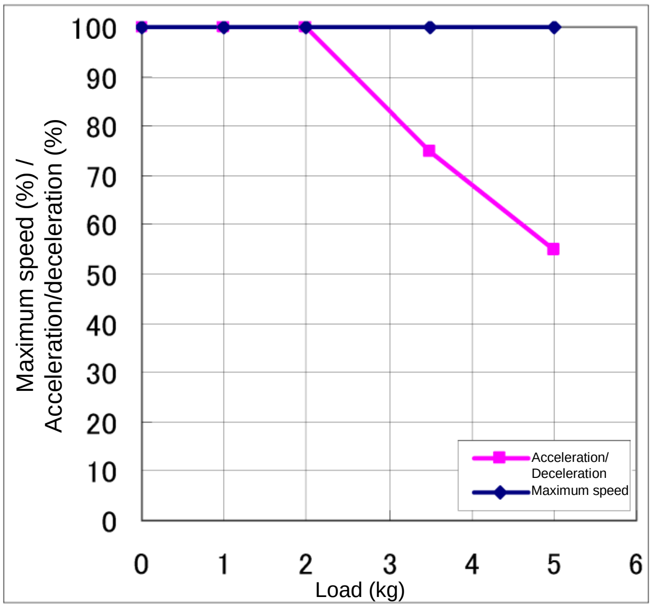
9.3.3 Setting Maximum Speed and Robot Acceleration/Deceleration for Load Conditions

When the PAYLOAD command is used, the maximum speed and acceleration/deceleration of the robot are automatically changed according to the load conditions.

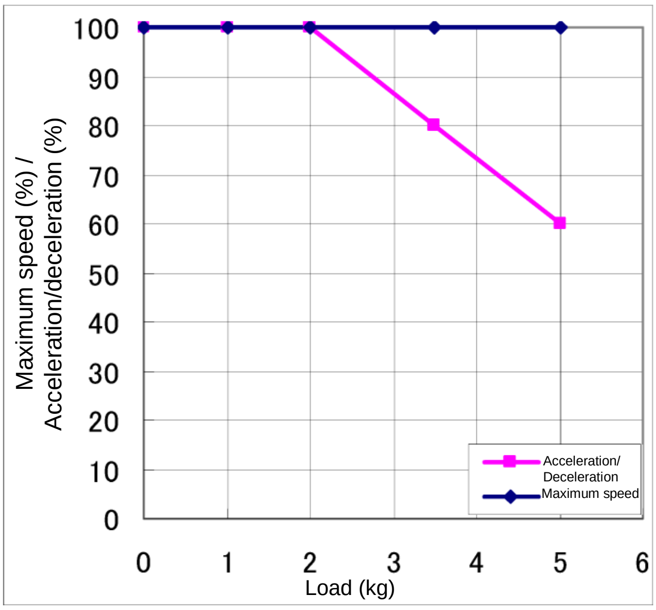
The maximum speed and acceleration/deceleration change with the load mass, as shown in Figs. 9.4 to 19.5.



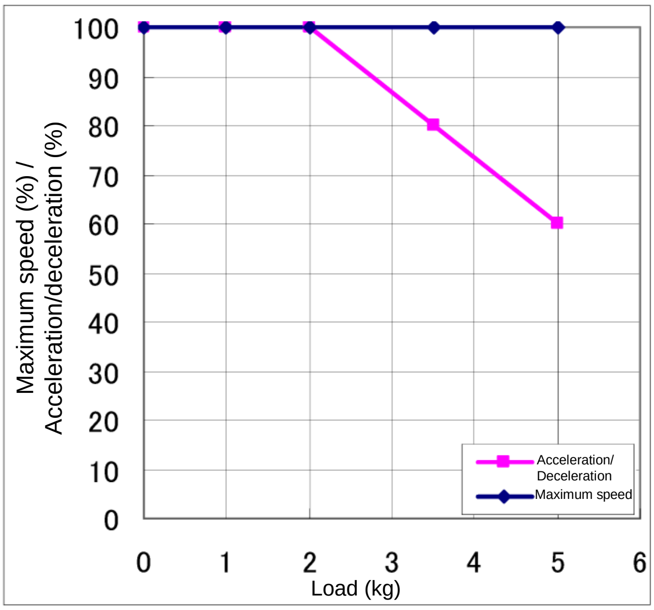
Setting of maximum speed and acceleration/deceleration in relation to load mass (Axis 1)



Setting of maximum speed and acceleration/deceleration in relation to load mass (Axis 2)

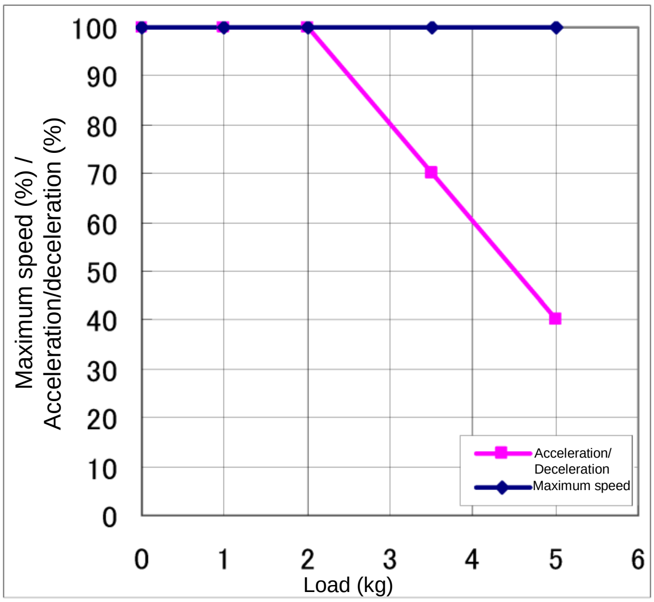


Setting of maximum speed and acceleration/deceleration in relation to load mass (Axis 3)

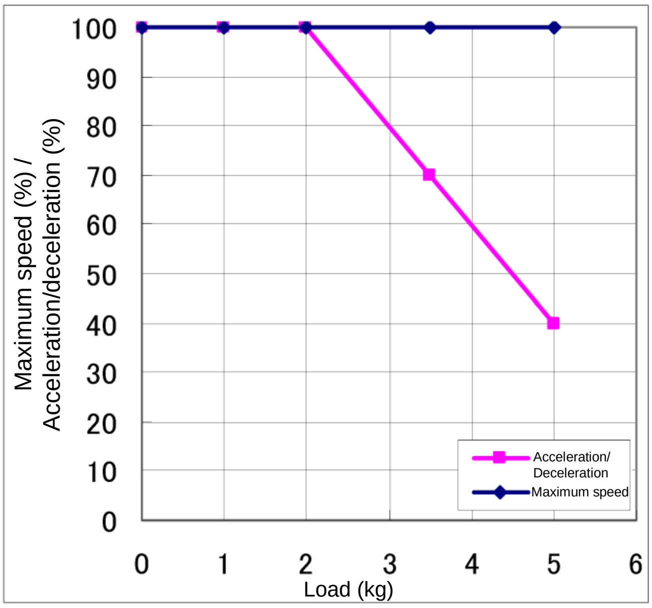


Setting of maximum speed and acceleration/deceleration in relation to load mass (Axis 4)

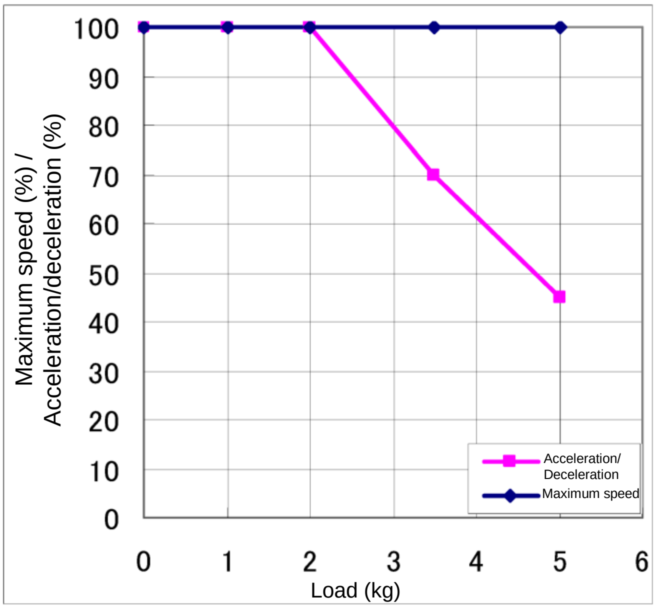
Fig. 9.4 Setting of maximum speed and acceleration/deceleration in relation to load mass (KHL-300)



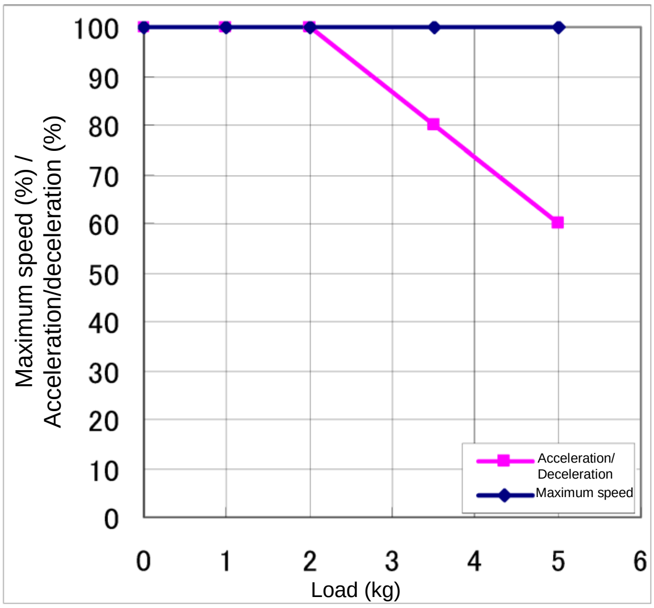
Setting of maximum speed and acceleration/deceleration in relation to load mass (Axis 1)



Setting of maximum speed and acceleration/deceleration in relation to load mass (Axis 2)



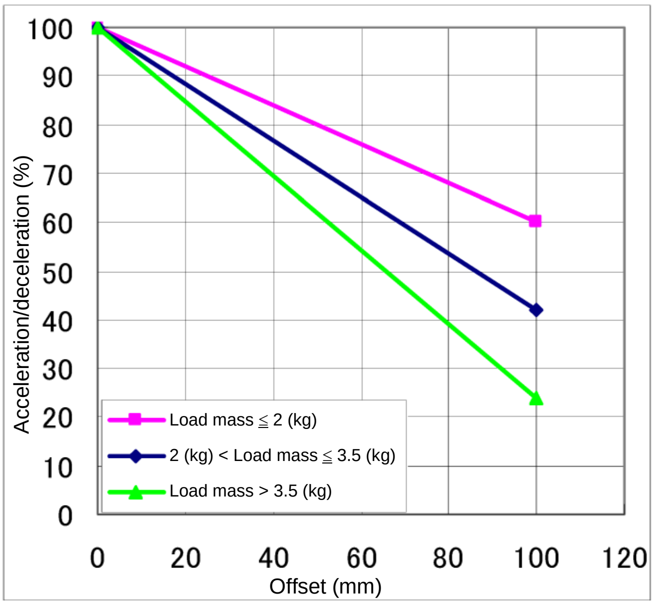
Setting of maximum speed and acceleration/deceleration in relation to load mass (Axis 3)



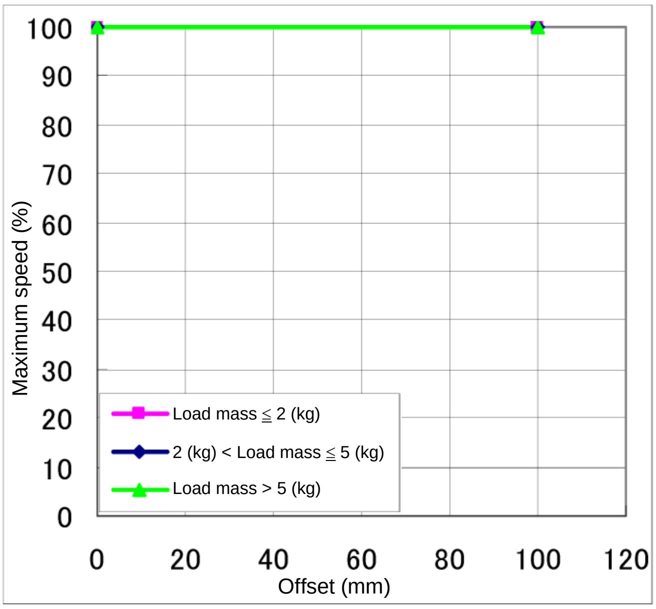
Setting of maximum speed and acceleration/deceleration in relation to load mass (Axis 4)

Fig. 9.5 Setting of maximum speed and acceleration/deceleration in relation to load mass (KHL-400)

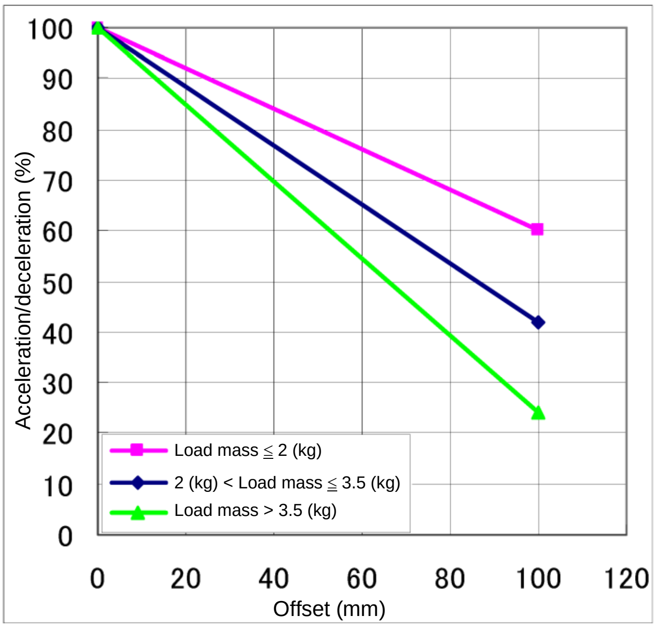
Additionally, if there is an offset of load gravity center, the maximum speed and acceleration/deceleration change as shown in Fig. 19.6 to Fig. 19.9.



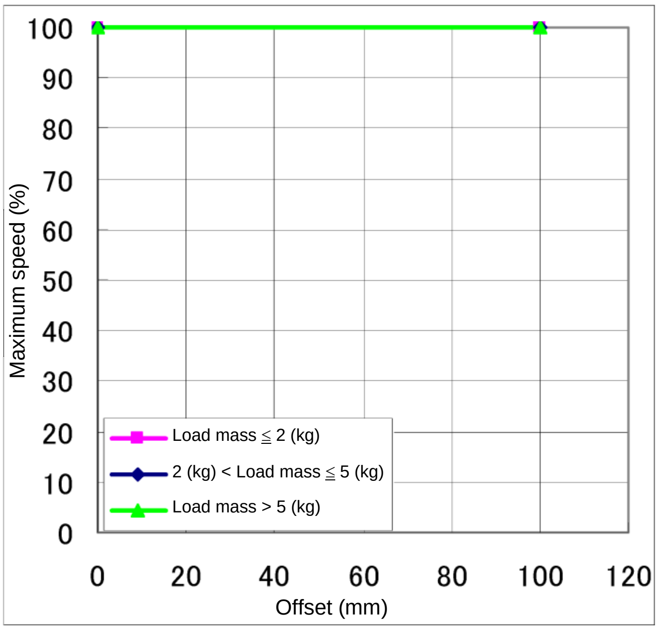
Setting of acceleration/deceleration in relation to offset (Axis 1)



Setting of maximum speed in relation to offset (Axis 1)

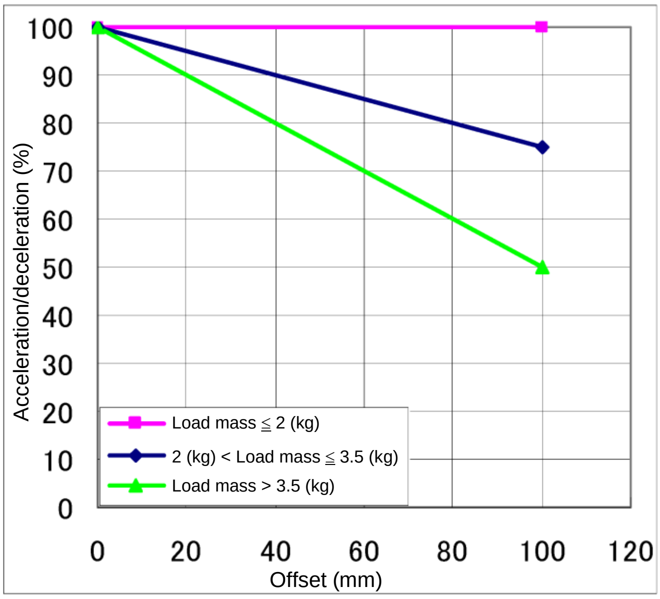


Setting of acceleration/deceleration in relation to offset (Axis 2)

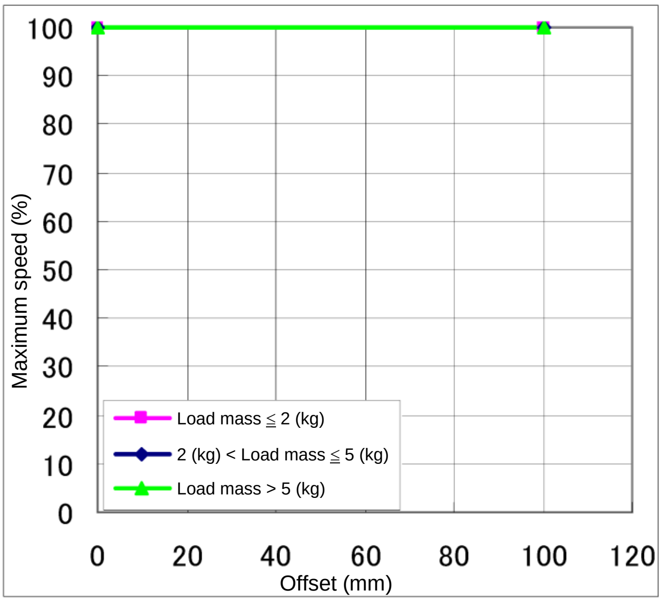


Setting of maximum speed in relation to offset (Axis 2)

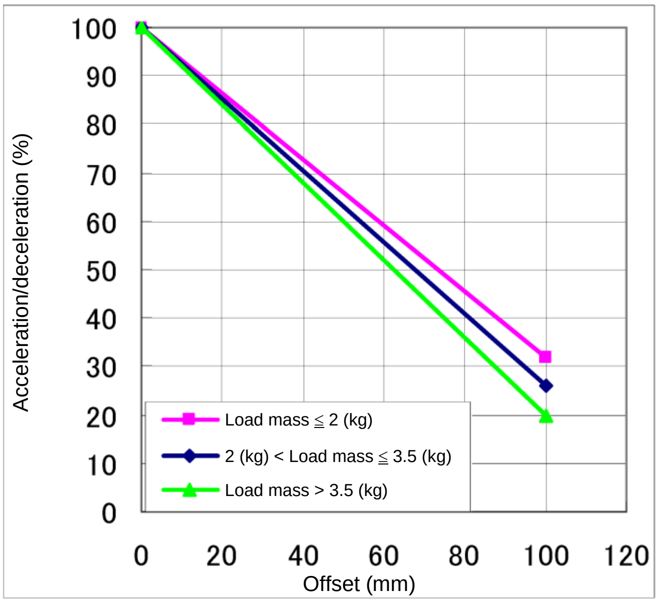
Fig. 9.6 Setting of maximum speed and acceleration/deceleration in relation to gravity center offset (Axes 1 and 2) (KHL-300)



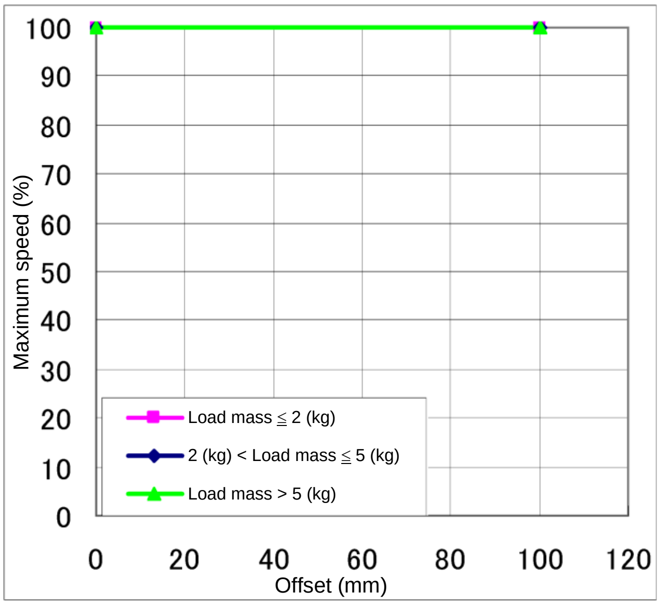
Setting of acceleration/deceleration in relation to offset (Axis 3)



Setting of maximum speed in relation to offset (Axis 3)

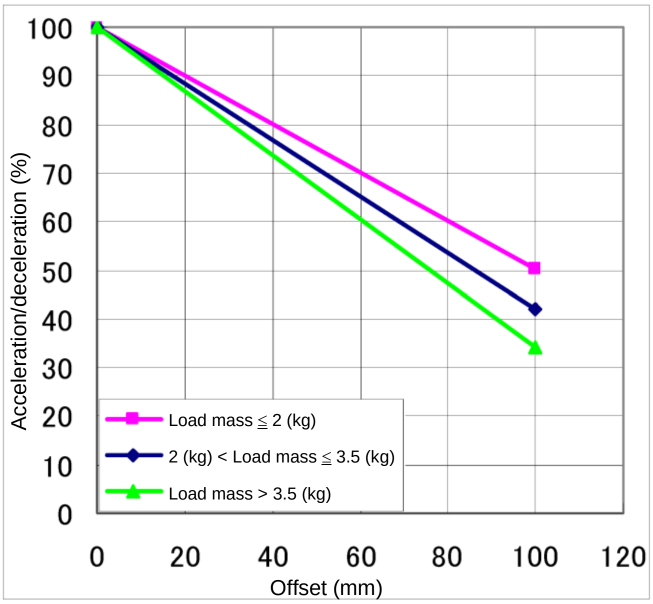


Setting of acceleration/deceleration in relation to offset (Axis 4)

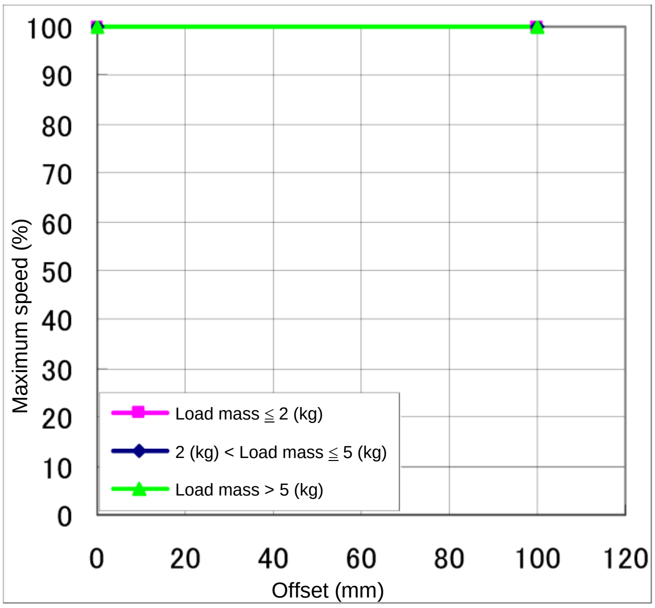


Setting of maximum speed in relation to offset (Axis 4)

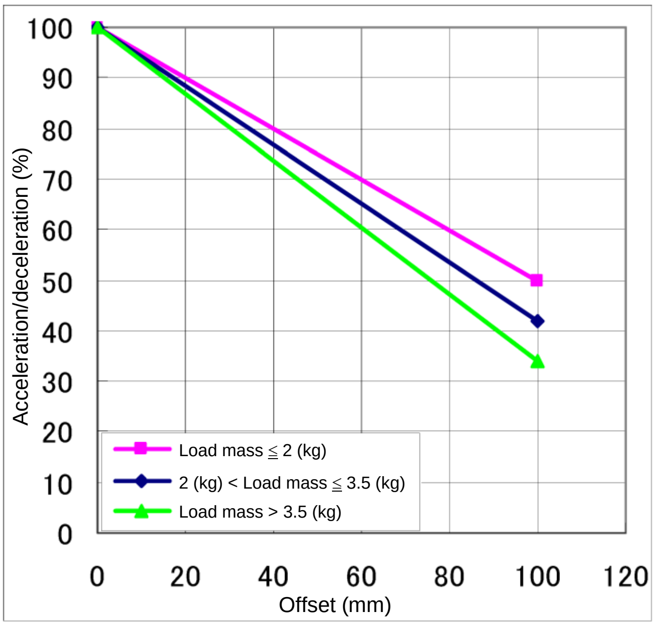
Fig. 9.7 Setting of maximum speed and acceleration/deceleration in relation to gravity center offset (Axes 3 and 4) (KHL-300)



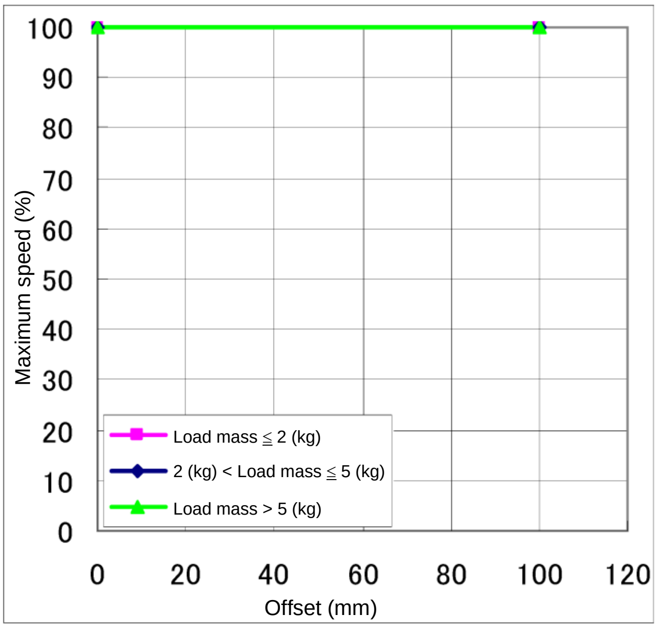
Setting of acceleration/deceleration in relation to offset (Axis 1)



Setting of maximum speed in relation to offset (Axis 1)

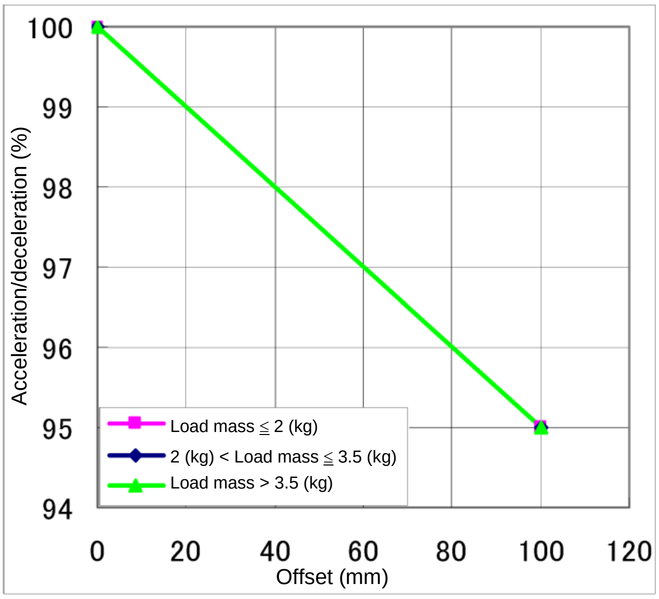


Setting of acceleration/deceleration in relation to offset (Axis 2)

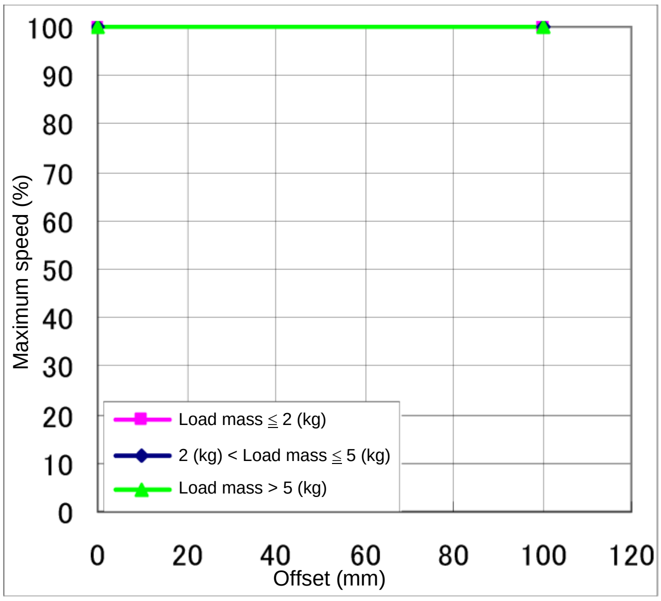


Setting of maximum speed in relation to offset (Axis 2)

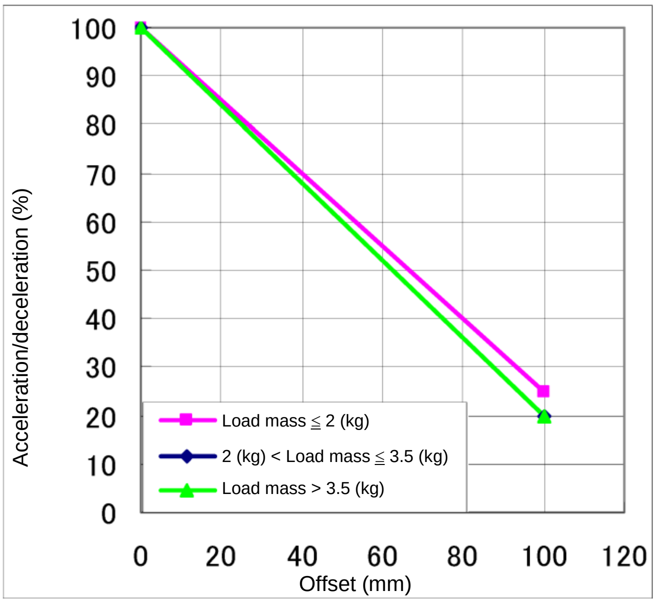
Fig. 9.8 Setting of maximum speed and acceleration/deceleration in relation to gravity center offset (Axes 1 and 2) (KHL-400)



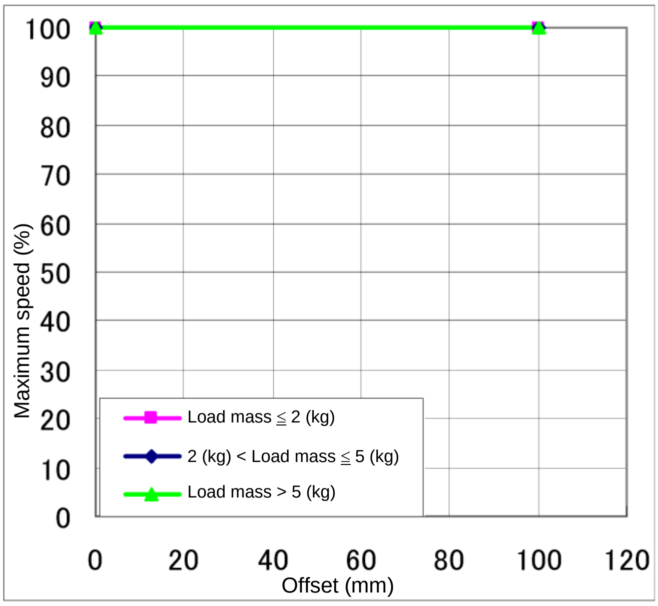
Setting of acceleration/deceleration in relation to offset (Axis 3)



Setting of maximum speed in relation to offset (Axis 3)



Setting of acceleration/deceleration in relation to offset (Axis 4)



Setting of maximum speed in relation to offset (Axis 4)

Fig. 9.9 Setting of maximum speed and acceleration/deceleration in relation to gravity center offset (Axes 3 and 4) (KHL-400)

10. Tool Interface (KHL-500, KHL-600 and KHL-700)

10.1 Mounting Tool

The tool is mounted on the end of the tool shaft. Dimensions of the tool shaft section are shown in Fig. 10.1. As shown in Fig. 10.1, the tool is centered with the ϕ12H7 mating section. The tool direction is adjusted by means of the 4 x 4 keys and secured with four (4) M4 bolts.
The tool flange is optional.

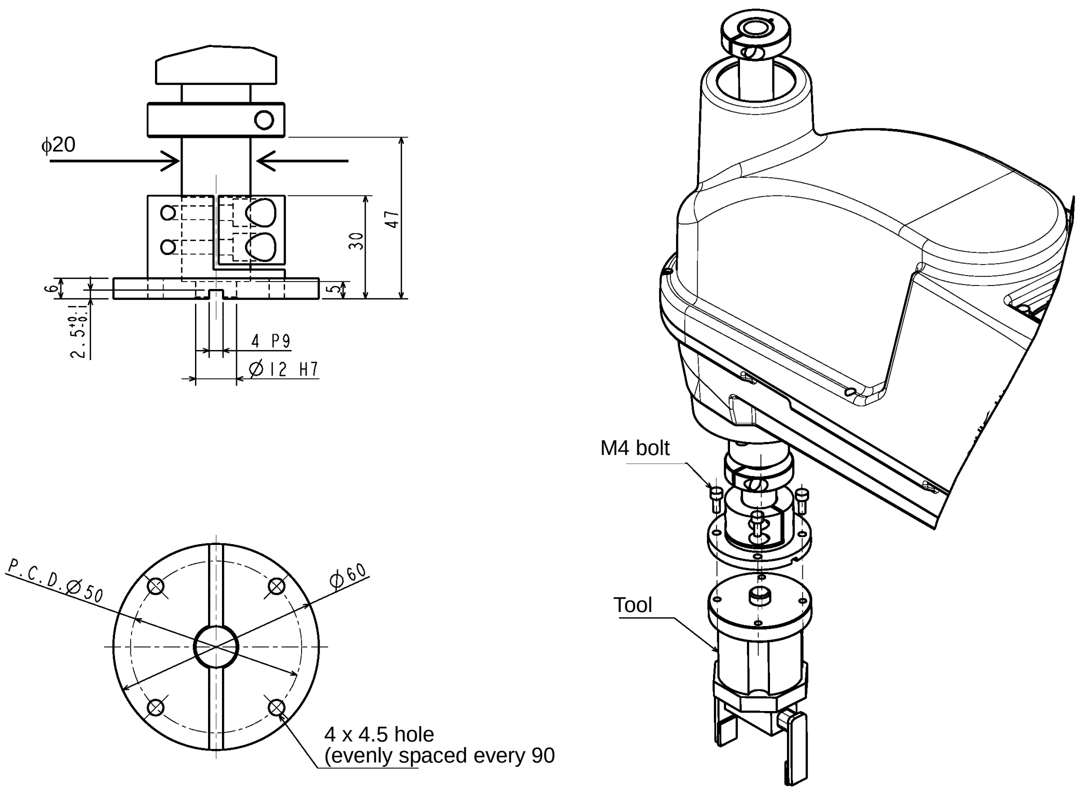


Fig. 10.1 Tool mounting dimensions (KHL-500, KHL-600 and KHL-700)

10.2 Tool Air Piping

The customer is requested to install the tool air piping using the following accessories.

- Air tube x3 (red, white, blue)

Fig. 10.2 shows an installation example of tool air piping for your reference.

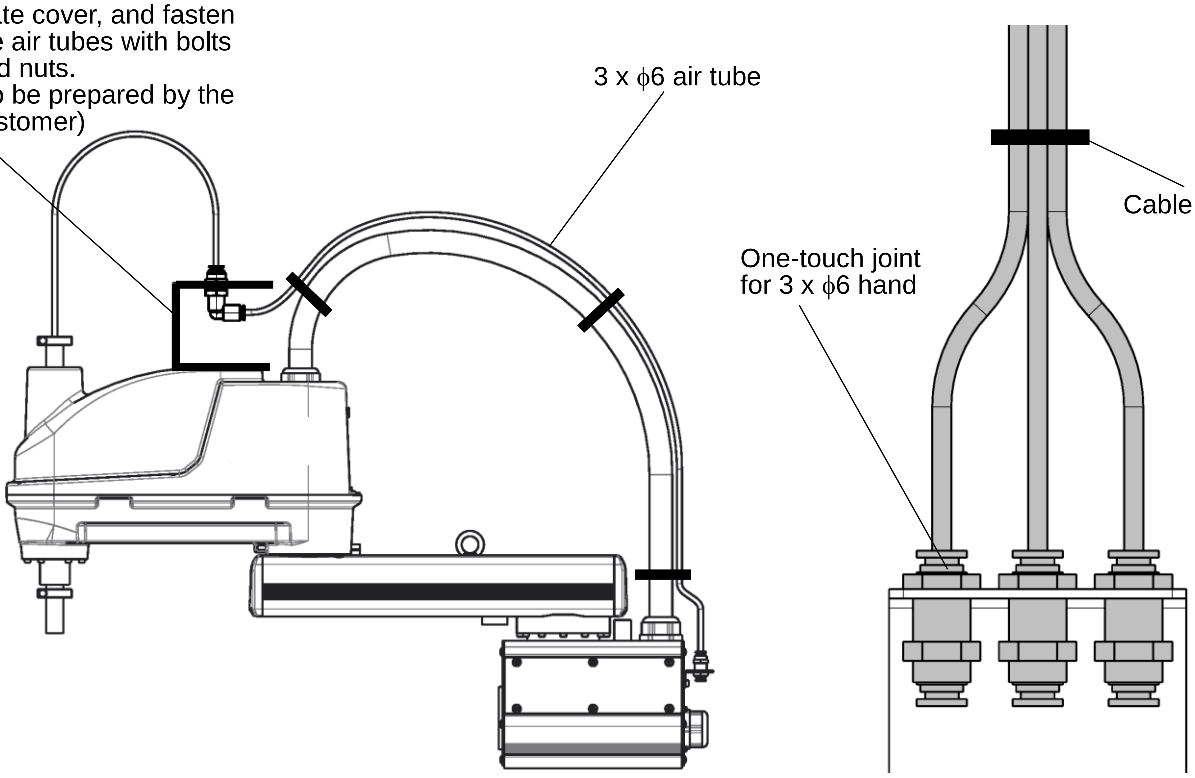


Fig. 10.2 Tool air piping installation example (KHL-500, KHL-600 and KHL-700)

CAUTION

- Air tubes are consumable supplies. Check the air tubes during periodic inspection, and change them if any damage is found.
- The customer is requested to prepare solenoid valve air.
- Fig. 10.2 is a reference example. Tool air piping is not guaranteed. The warranty does not cover breakdowns of the harness, the air tubes or their accessories due to piping by the customer.

10.3 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.

10.3.1 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. 10.3. The permissible load conditions are shown in Table 10.1.

Table 10.1 Permissible load conditions (KHL-500, KHL-600 and KHL-700)

Conditions	Permissible values
Mass	Max. 10 kg
Load inertia	Max 0.20 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.

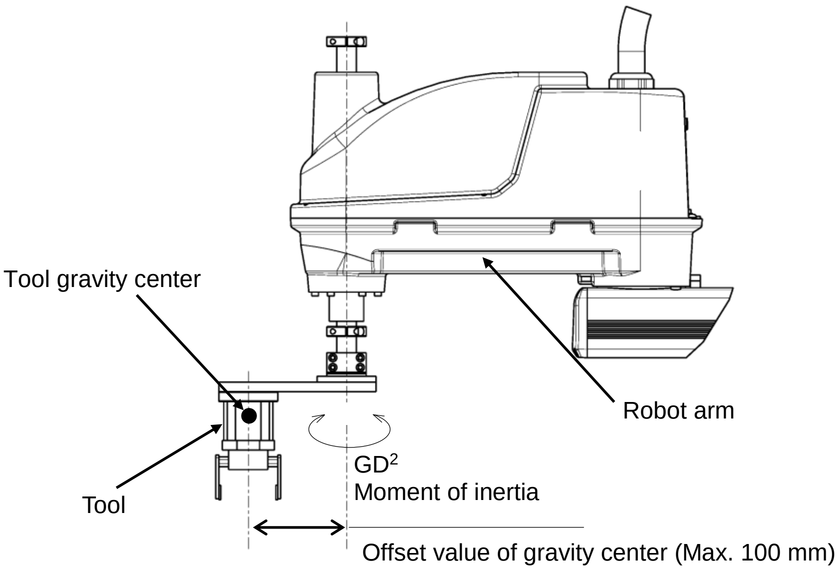


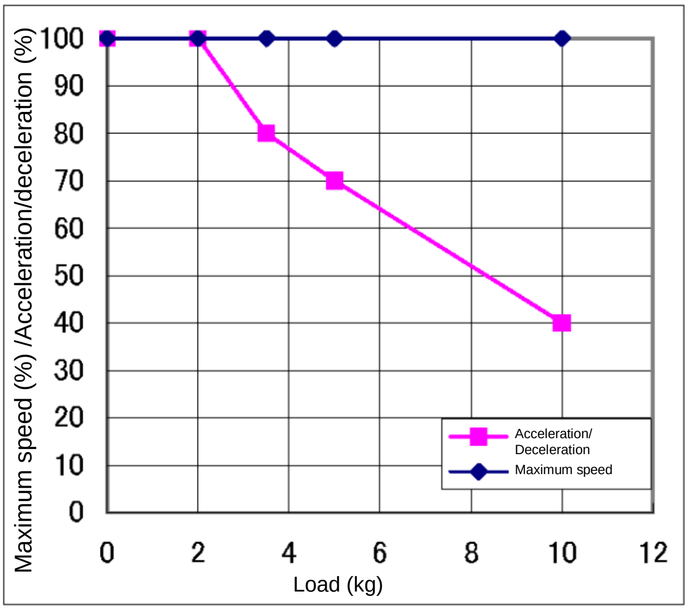
Fig. 10.3 Robot tool

10.3.2 Load Conditions and Program Setting

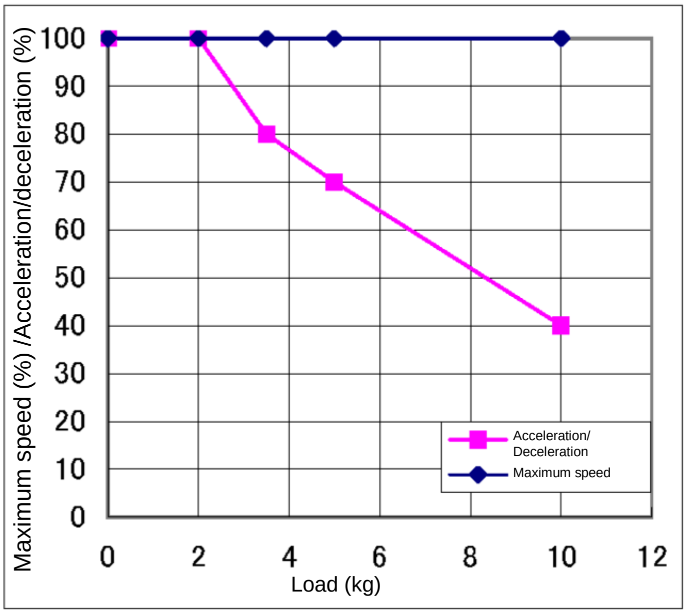
For load conditions and program setting, see "9.3.2 Load Conditions and Program Setting".

10.3.3 Setting Maximum Speed and Robot Acceleration/Deceleration for Load Conditions

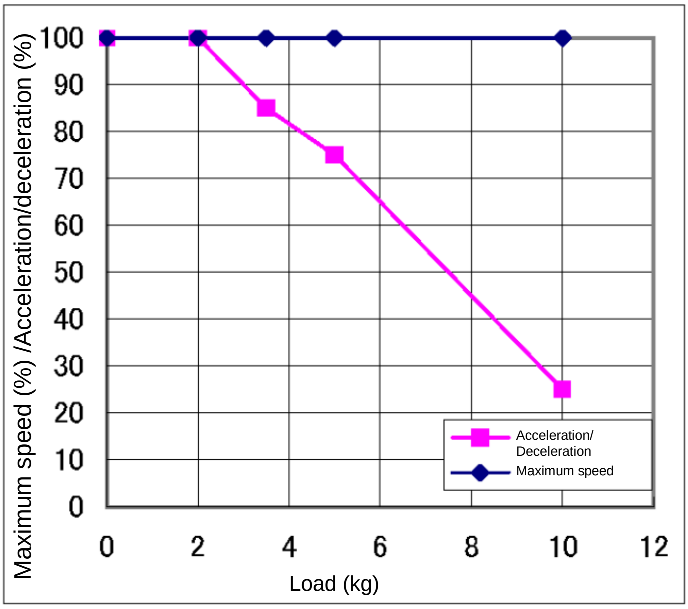
When the PAYLOAD command is used, the maximum speed and acceleration/ deceleration of the robot are automatically changed according to the load conditions. The maximum speed and acceleration/deceleration change with the load mass, as shown in Figs. 10.4 to 10.6.



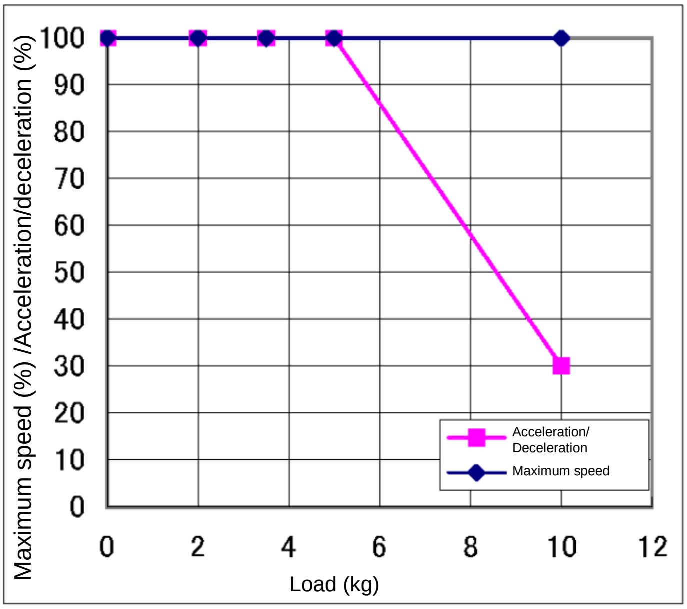
Setting of maximum speed and acceleration/deceleration in relation to load mass (Axis 1)



Setting of maximum speed and acceleration/deceleration in relation to load mass (Axis 2)

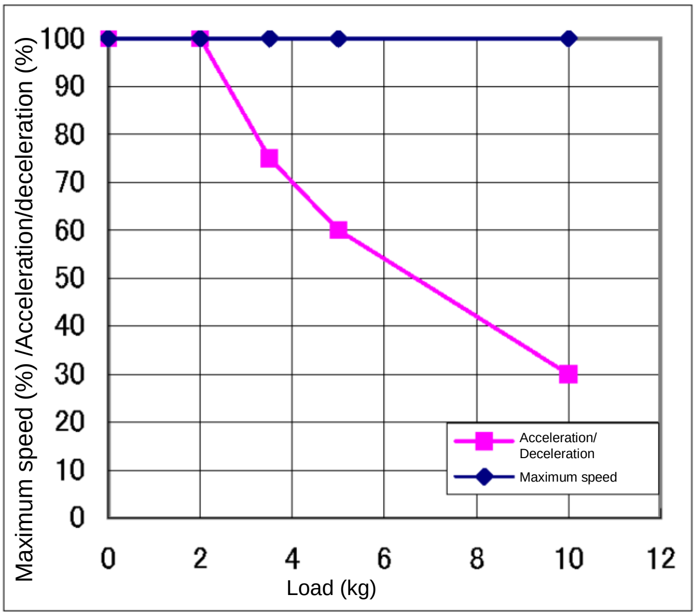


Setting of maximum speed and acceleration/deceleration in relation to load mass (Axis 3)

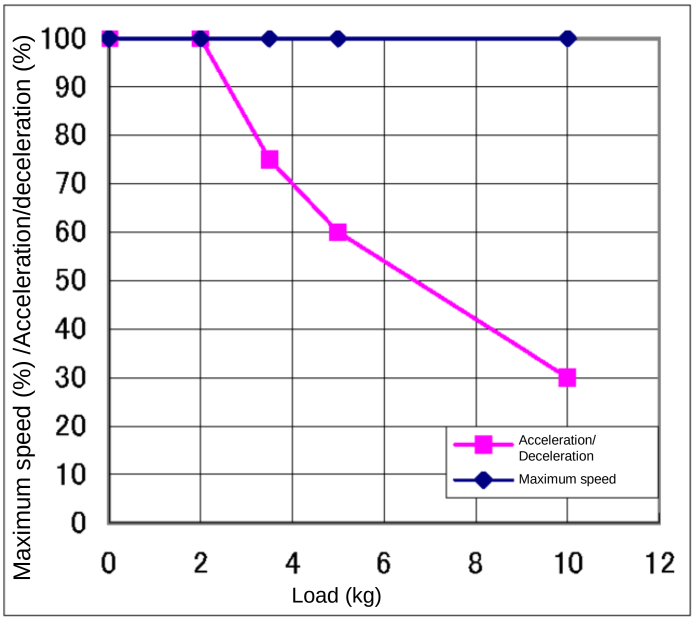


Setting of maximum speed and acceleration/deceleration in relation to load mass (Axis 4)

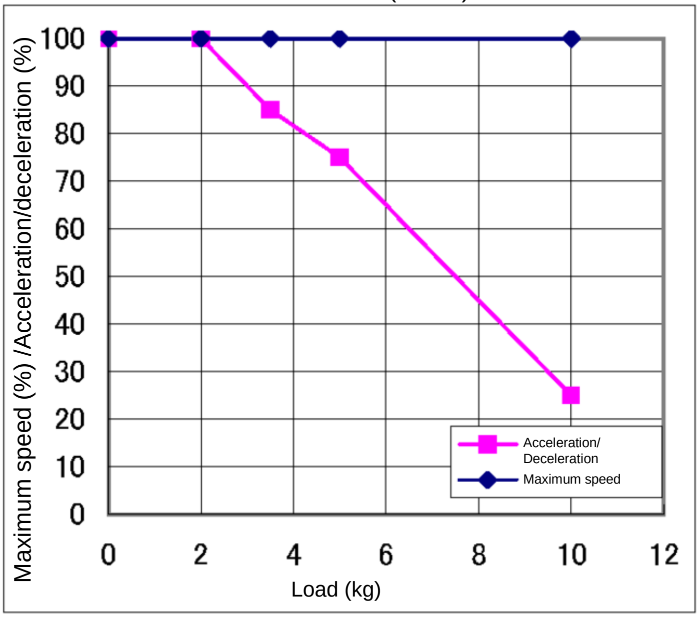
Fig. 10.4 Setting of maximum speed and acceleration/deceleration in relation to load mass (KHL-500)



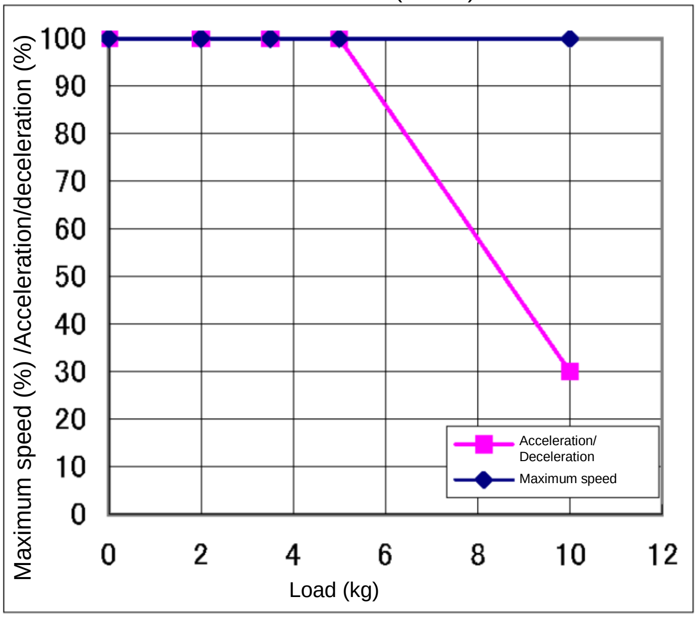
Setting of maximum speed and acceleration/deceleration in relation to load mass (Axis 1)



Setting of maximum speed and acceleration/deceleration in relation to load mass (Axis 2)

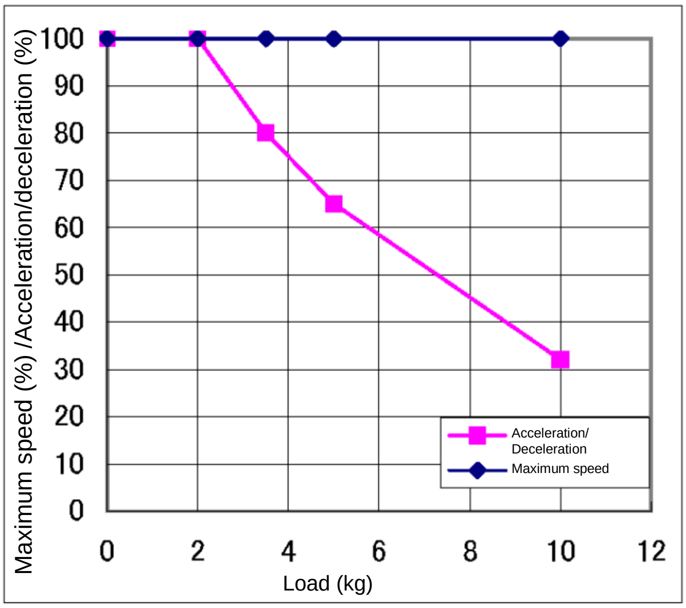


Setting of maximum speed and acceleration/deceleration in relation to load mass (Axis 3)

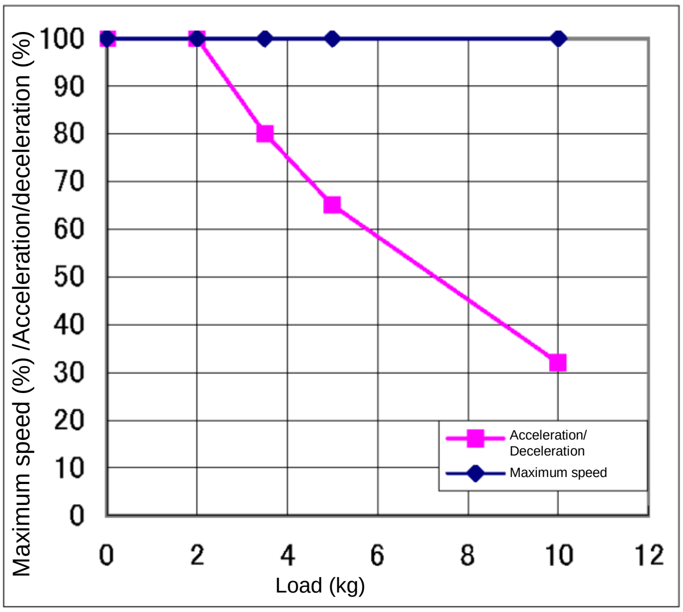


Setting of maximum speed and acceleration/deceleration in relation to load mass (Axis 4)

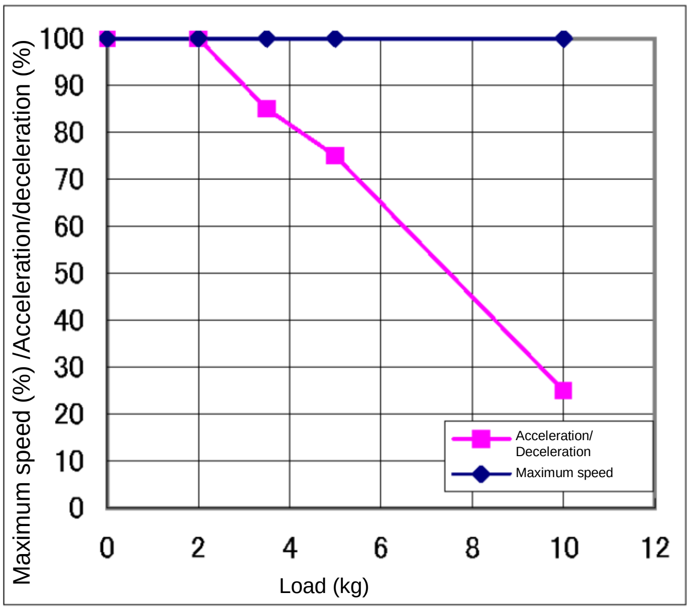
Fig. 10.5 Setting of maximum speed and acceleration/deceleration in relation to load mass (KHL-600)



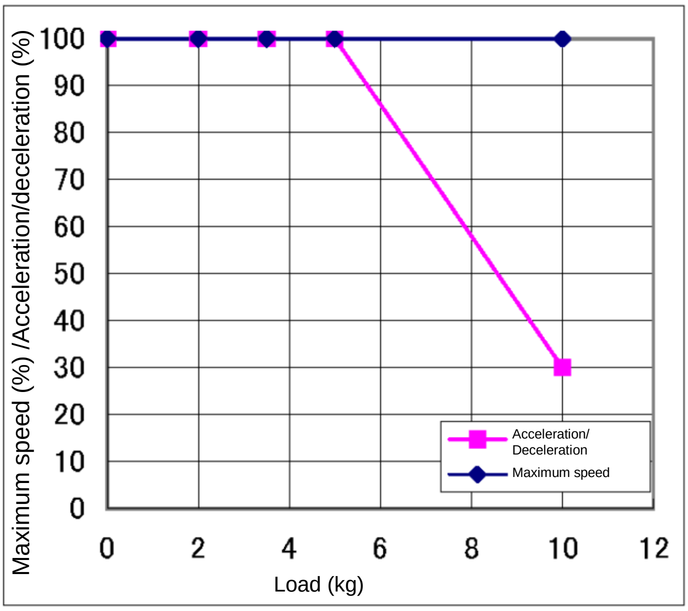
Setting of maximum speed and acceleration/deceleration in relation to load mass (Axis 1)



Setting of maximum speed and acceleration/deceleration in relation to load mass (Axis 2)



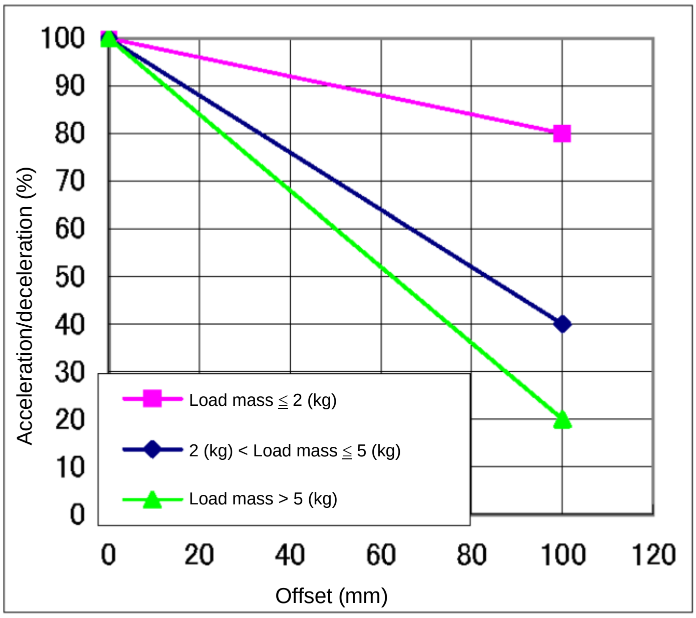
Setting of maximum speed and acceleration/deceleration in relation to load mass (Axis 3)



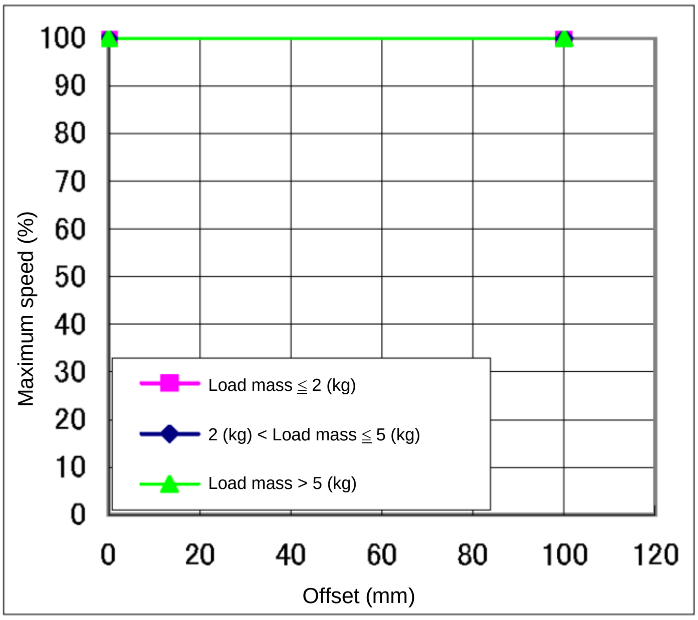
Setting of maximum speed and acceleration/deceleration in relation to load mass (Axis 4)

Fig. 10.6 Setting of maximum speed and acceleration/deceleration in relation to load mass (KHL-700)

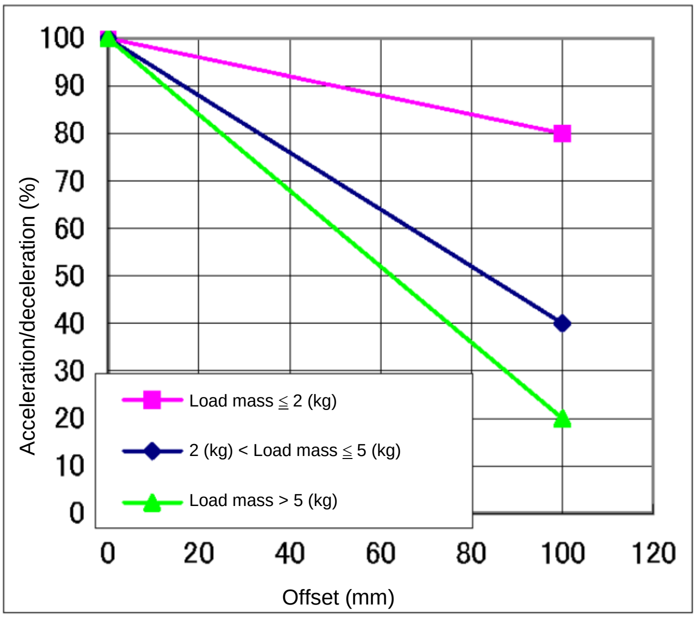
Additionally, if there is an offset of load gravity center, the maximum speed and acceleration/deceleration change as shown in Fig. 20.7 to Fig. 20.12.



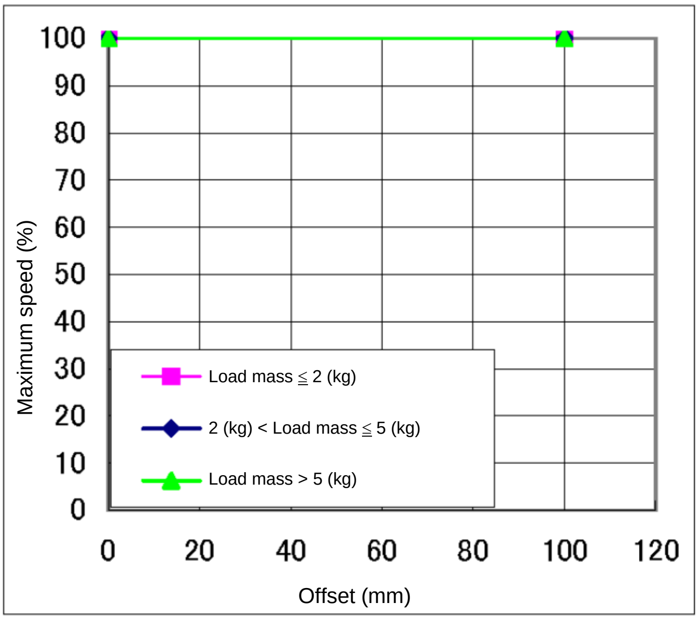
Setting of acceleration/deceleration in relation to offset (Axis 1)



Setting of maximum speed in relation to offset (Axis 1)

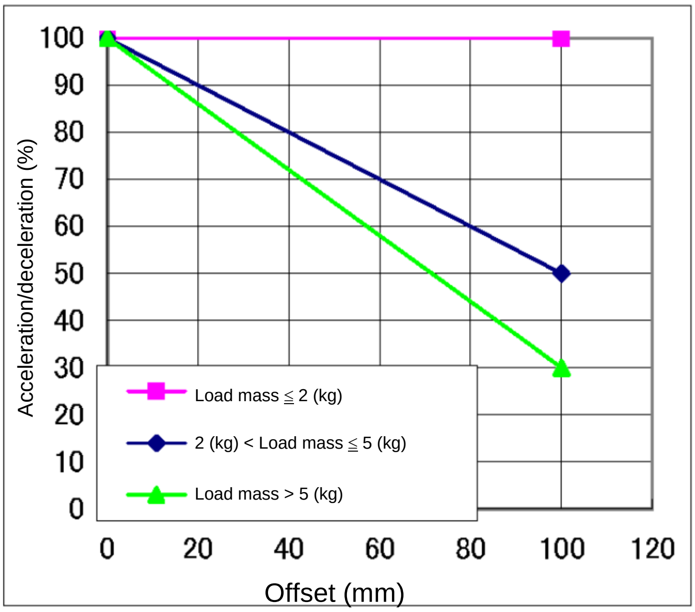


Setting of acceleration/deceleration in relation to offset (Axis 2)

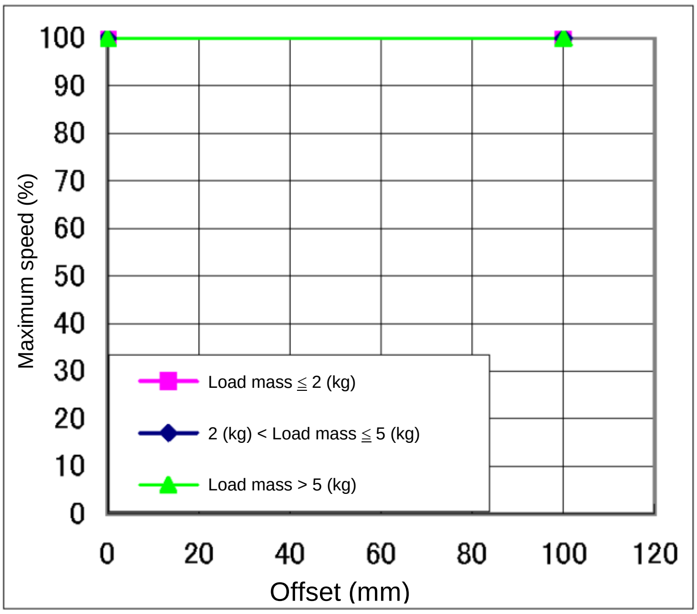


Setting of maximum speed in relation to offset (Axis 2)

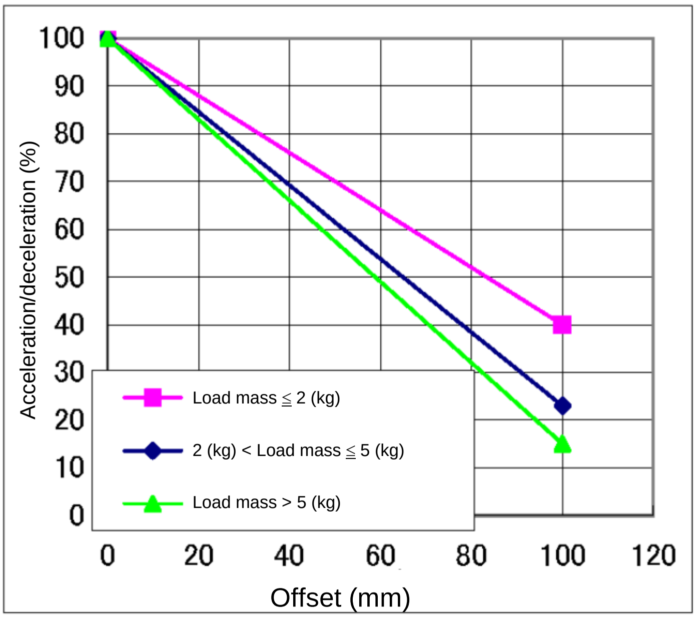
Fig. 10.7 Setting of maximum speed and acceleration/deceleration in relation to gravity center offset (Axes 1 and 2) (KHL-500)



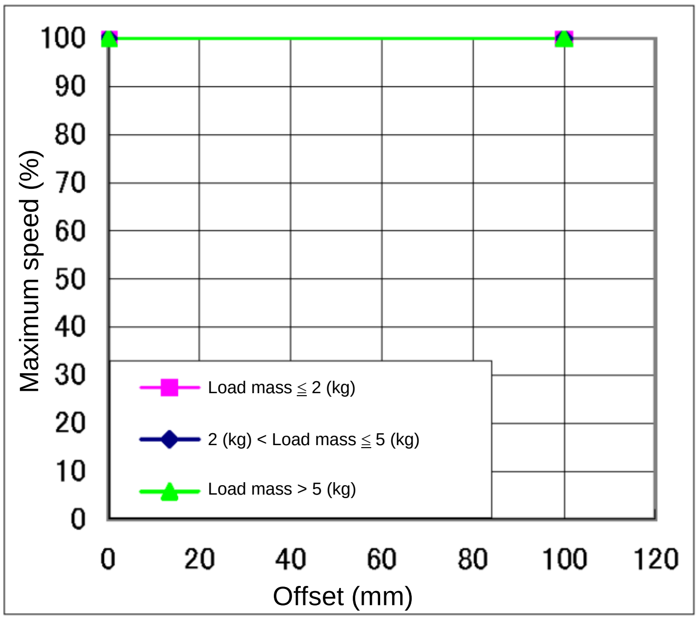
Setting of acceleration/deceleration in relation to offset (Axis 3)



Setting of maximum speed in relation to offset (Axis 3)

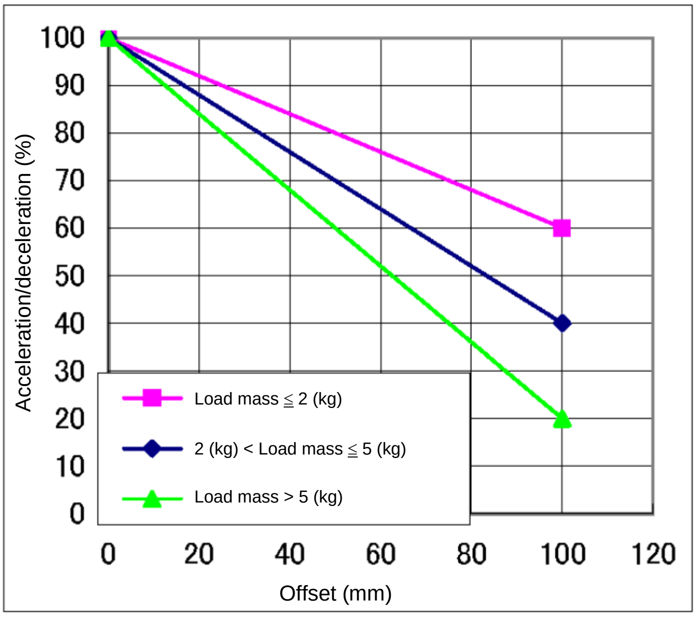


Setting of acceleration/deceleration in relation to offset (Axis 4)

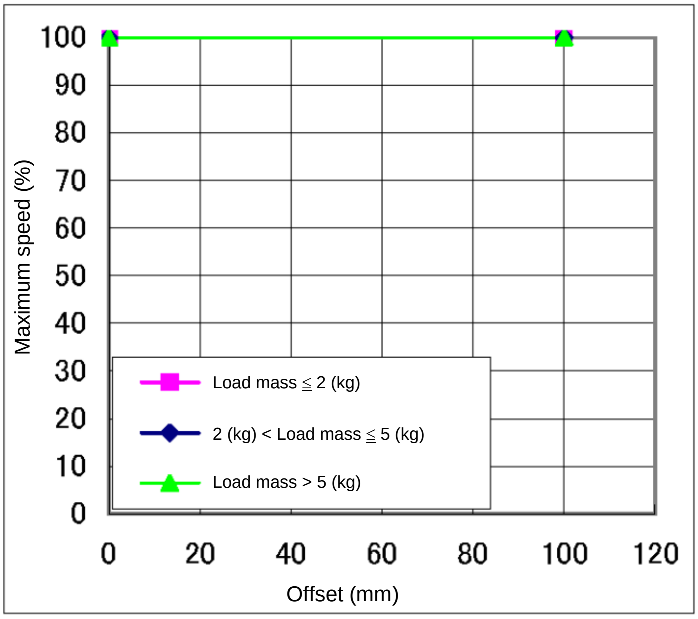


Setting of maximum speed in relation to offset (Axis 4)

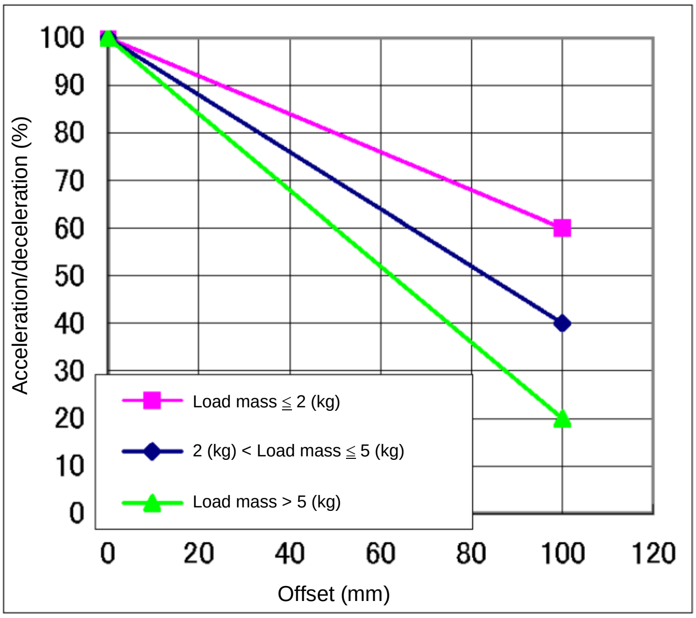
Fig. 10.8 Setting of maximum speed and acceleration/deceleration in relation to gravity center offset (Axes 3 and 4) (KHL-500)



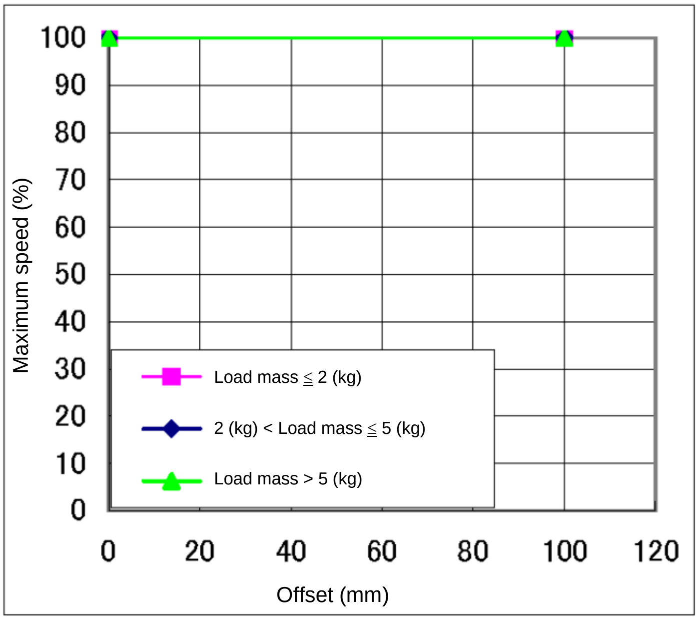
Setting of acceleration/deceleration in relation to offset (Axis 1)



Setting of maximum speed in relation to offset (Axis 1)

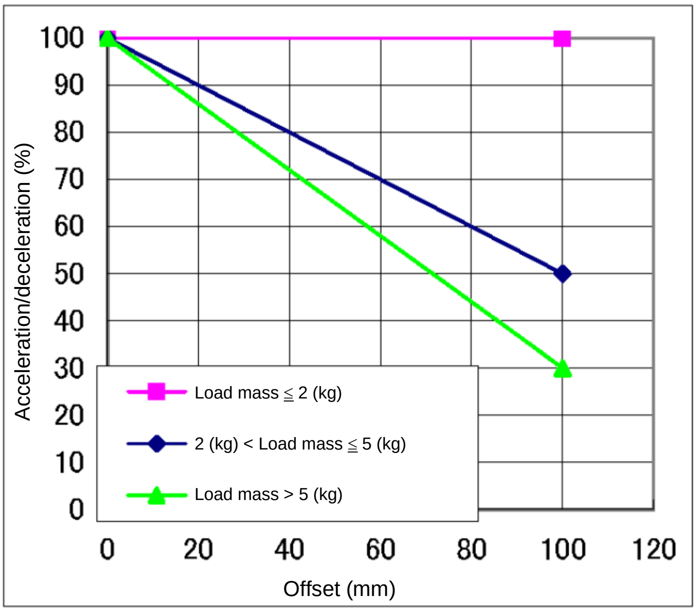


Setting of acceleration/deceleration in relation to offset (Axis 2)

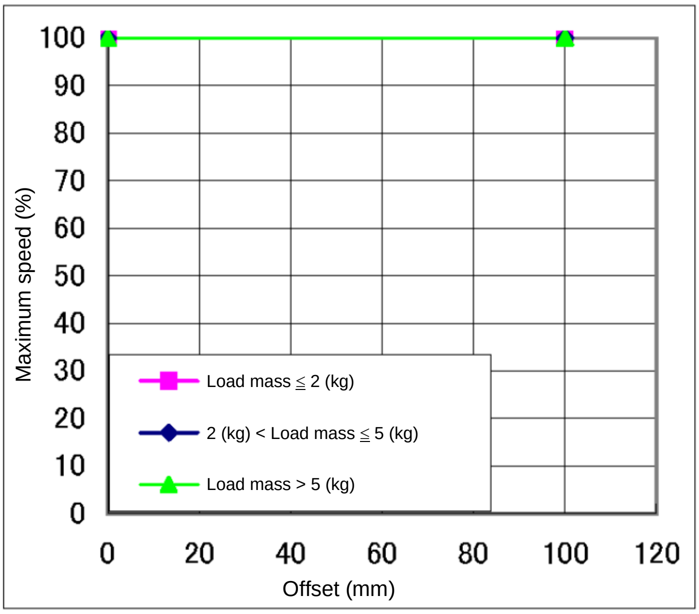


Setting of maximum speed in relation to offset (Axis 2)

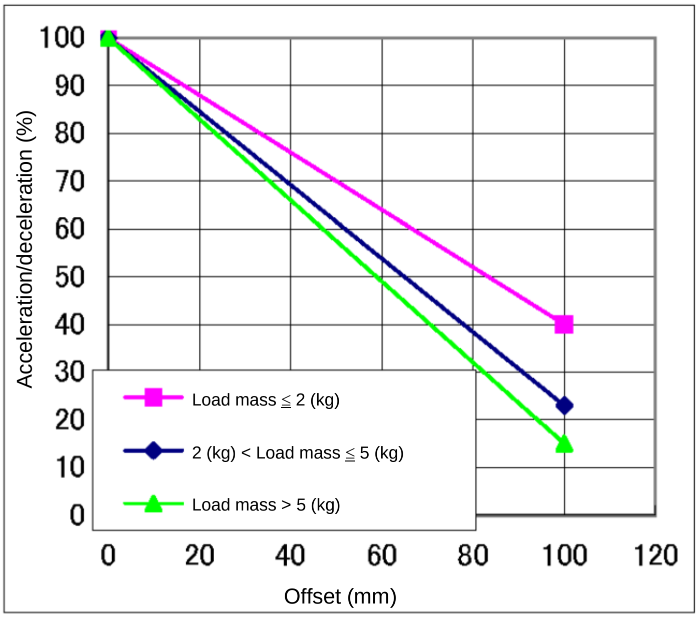
Fig. 10.9 Setting of maximum speed and acceleration/deceleration in relation to gravity center offset (Axes 1 and 2) (KHL-600)



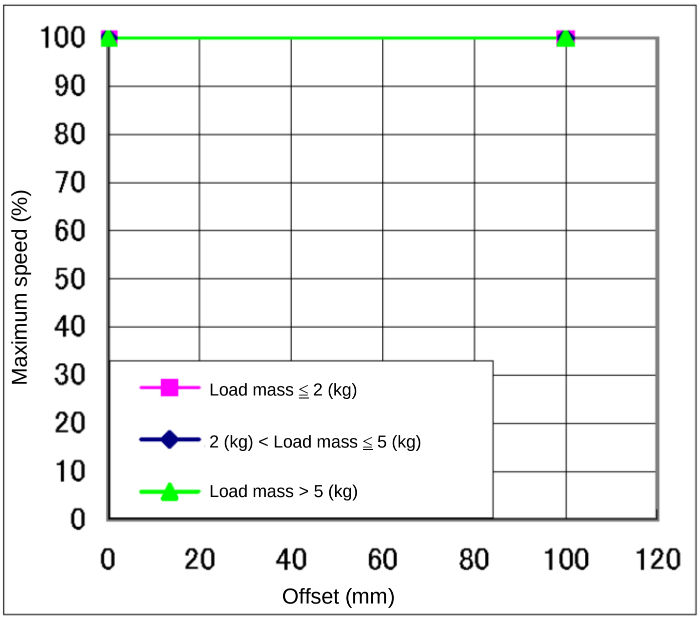
Setting of acceleration/deceleration in relation to offset (Axis 3)



Setting of maximum speed in relation to offset (Axis 3)

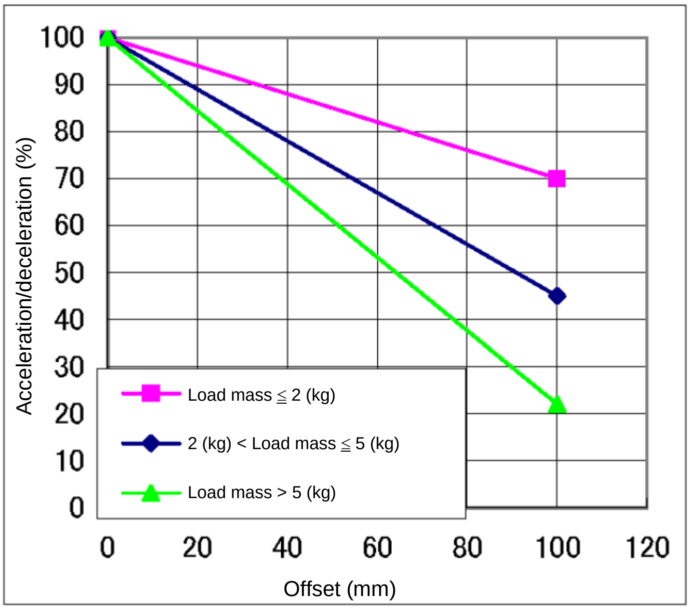


Setting of acceleration/deceleration in relation to offset (Axis 4)

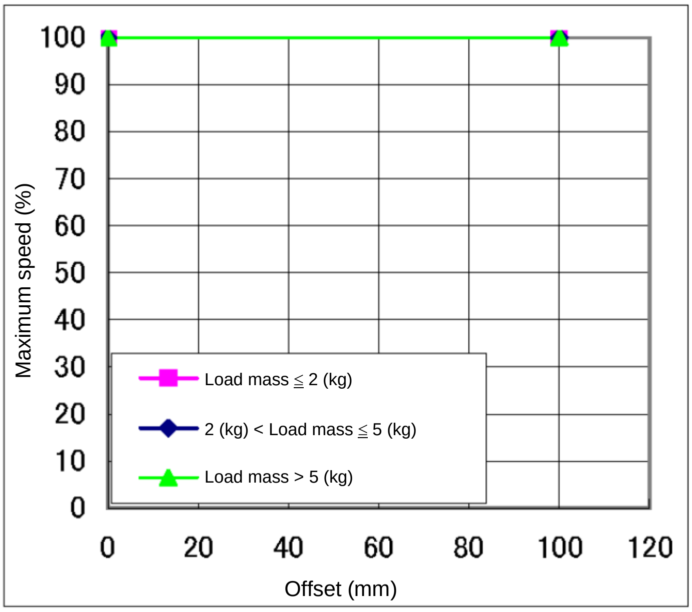


Setting of maximum speed in relation to offset (Axis 4)

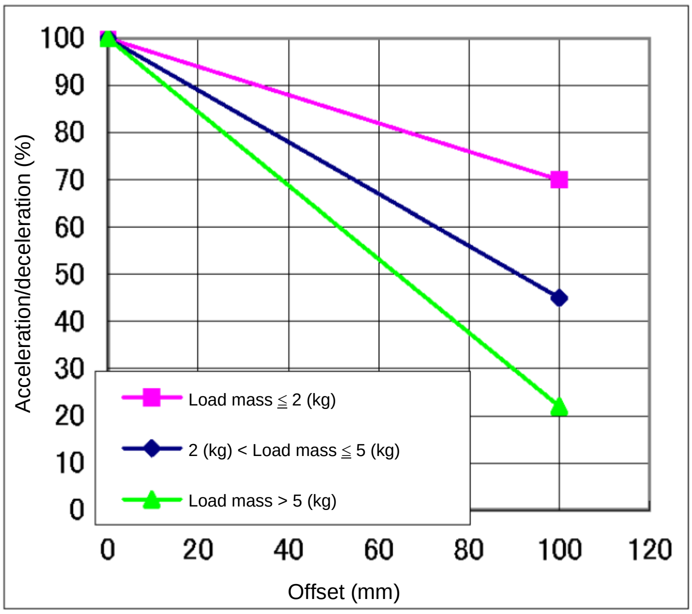
Fig. 10.10 Setting of maximum speed and acceleration/deceleration in relation to gravity center offset (Axes 3 and 4) (KHL-600)



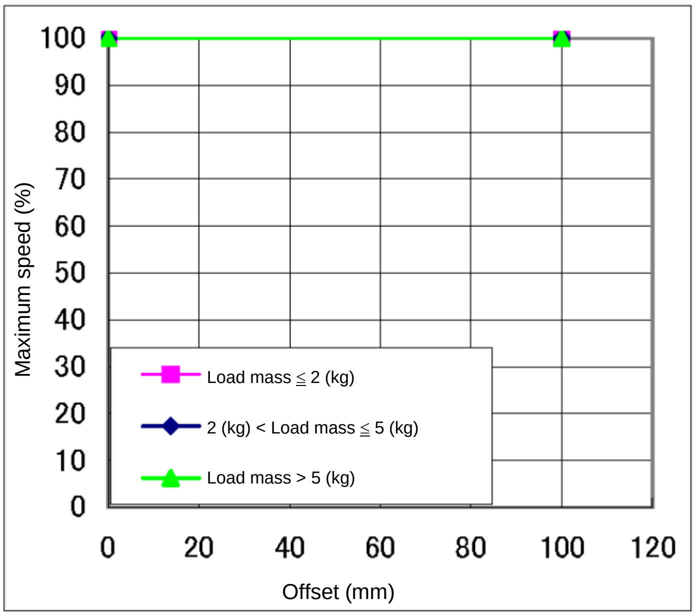
Setting of acceleration/deceleration in relation to offset (Axis 1)



Setting of maximum speed in relation to offset (Axis 1)

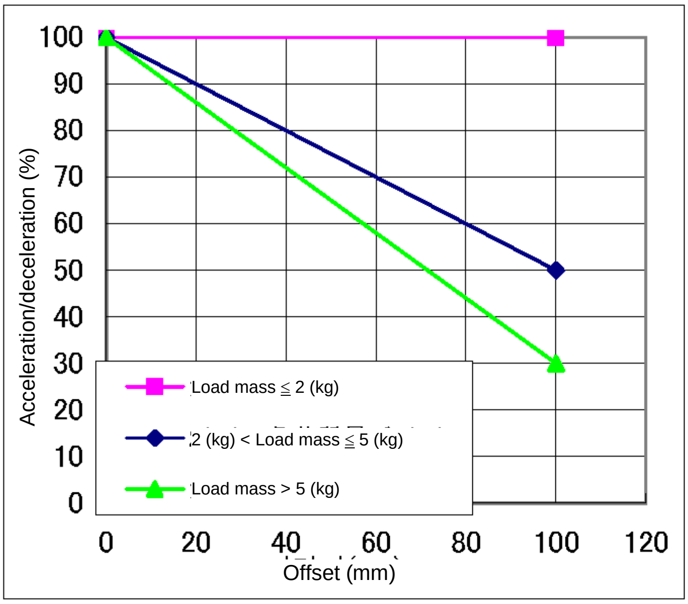


Setting of acceleration/deceleration in relation to offset (Axis 2)

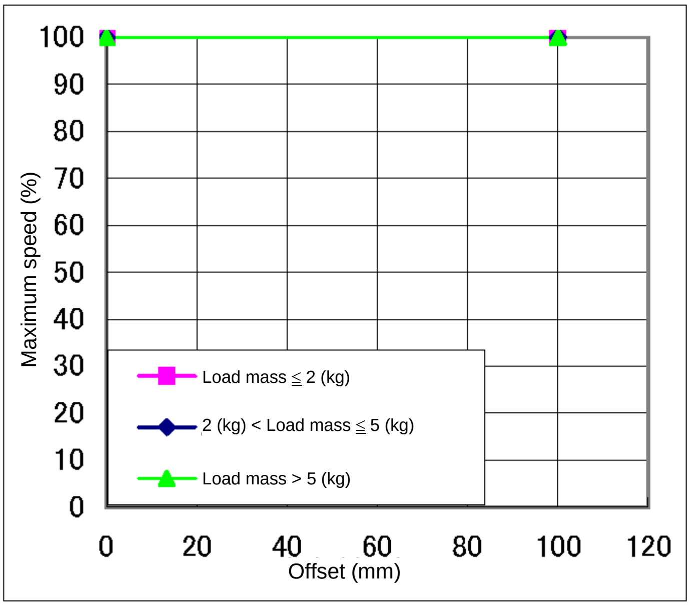


Setting of maximum speed in relation to offset (Axis 2)

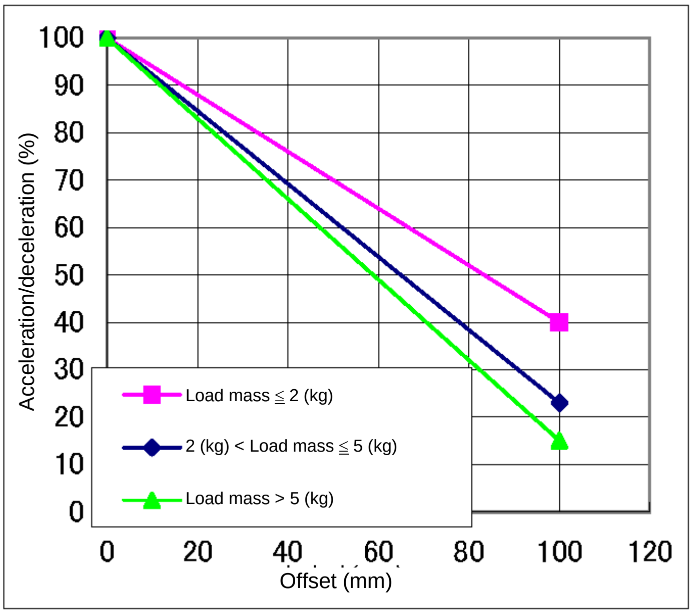
Fig. 10.11 Setting of maximum speed and acceleration/deceleration in relation to gravity center offset (Axes 1 and 2) (KHL-700)



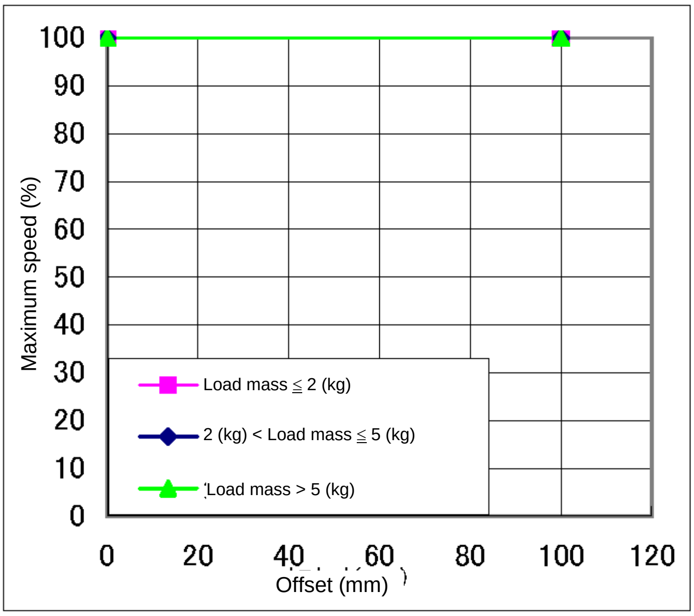
Setting of acceleration/deceleration in relation to offset (Axis 3)



Setting of maximum speed in relation to offset (Axis 3)



Setting of acceleration/deceleration in relation to offset (Axis 4)



Setting of maximum speed in relation to offset (Axis 4)

Fig. 10.12 Setting of maximum speed and acceleration/deceleration in relation to gravity center offset (Axes 3 and 4) (KHL-700)

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Tables and Drawings

11. Tool Interface (KSL3000)

11.1 Tool Wiring

Eight (8) input signals are provided for sensors, etc. and eight (8) control signals for solenoid valves, etc. A supply power signal of 24 VDC is also provided. They are connected to the controller. The wiring arrangement for these cables is shown in Fig. 11.9. The wires are connected to the connectors on the upper side of Arm 2. The user should provide the following connectors to connect the cables.

D-SUB connector (standard) Type: <Hood> XM2S–2511 (Maker: OMRON)
<Basic body> XM3A–2521 (Maker: OMRON)

Adaptive cable Conductive cross section area: 0.2 mm^2 to 0.5 mm^2

Each connector and cable are connected by soldering.

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 base rear cover from the base section, remove connectors JOES and JOFS on the rear side, then connect the cables running from the PLC, etc. through the cable inlets provided on the base rear cover. Also, the D-SUB 25 pins can be used separately for KHL-500 to KHL-700. (See Figs. 11.1, 11.2.) For ahead of the JOES and JOFS 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 SMP–10V–BC (Maker: J.S.T. Mfg.)
JOFS SMP–11V–BC (Maker: J.S.T. Mfg.)

Type of contact: BHF–001T–0.8SS (Maker: J.S.T. Mfg.)

Adaptive cable Conductive cross section area: 0.2 mm^2 to 0.3 mm^2

Opposite connector type (KHL-500 to KHL-700)

Type of connector: JOEP SMR–10V–B (Maker: J.S.T. Mfg.)
JOFP SMR–11V–B (Maker: J.S.T. Mfg.)

Type of contact: BYM–001T–0.6 (Maker: J.S.T. Mfg.)

D-SUB 25 pin connector types

Connector type (male)	<Hood> XM2S-2511 (maker: OMRON)
	<Body> XM3A-2521 (maker: OMRON)
Connector type (female)	<Body> XM3D-2521 (maker: OMRON)

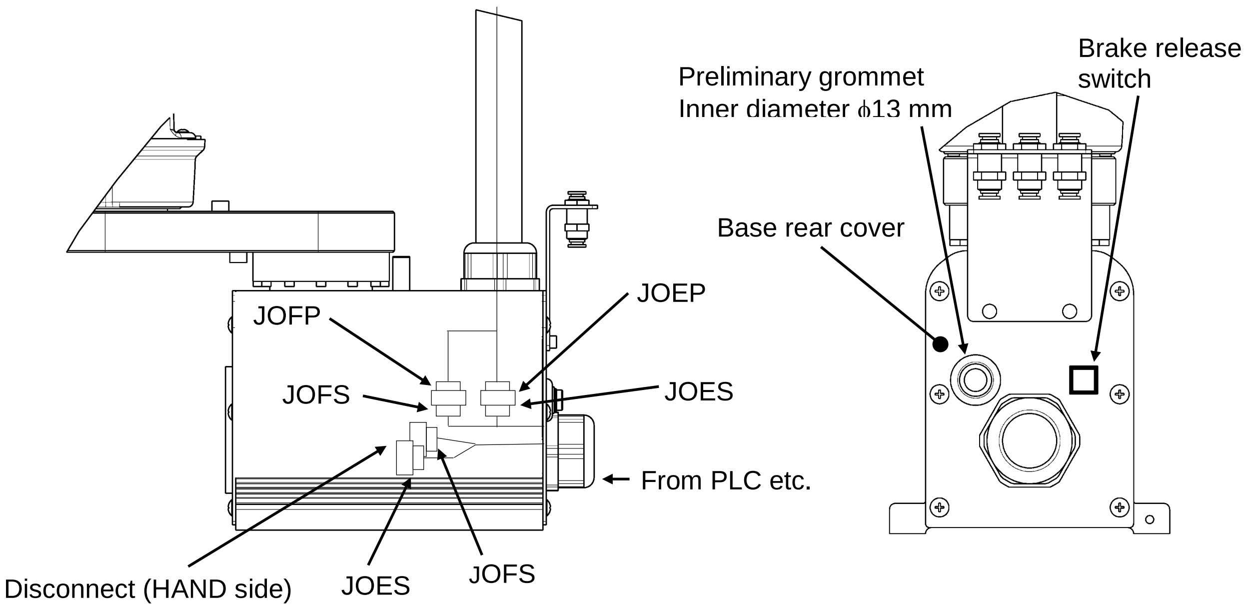


Fig. 11.1 Wiring to PLC, etc. (KHL-300, KHL-400 and KSL3000)

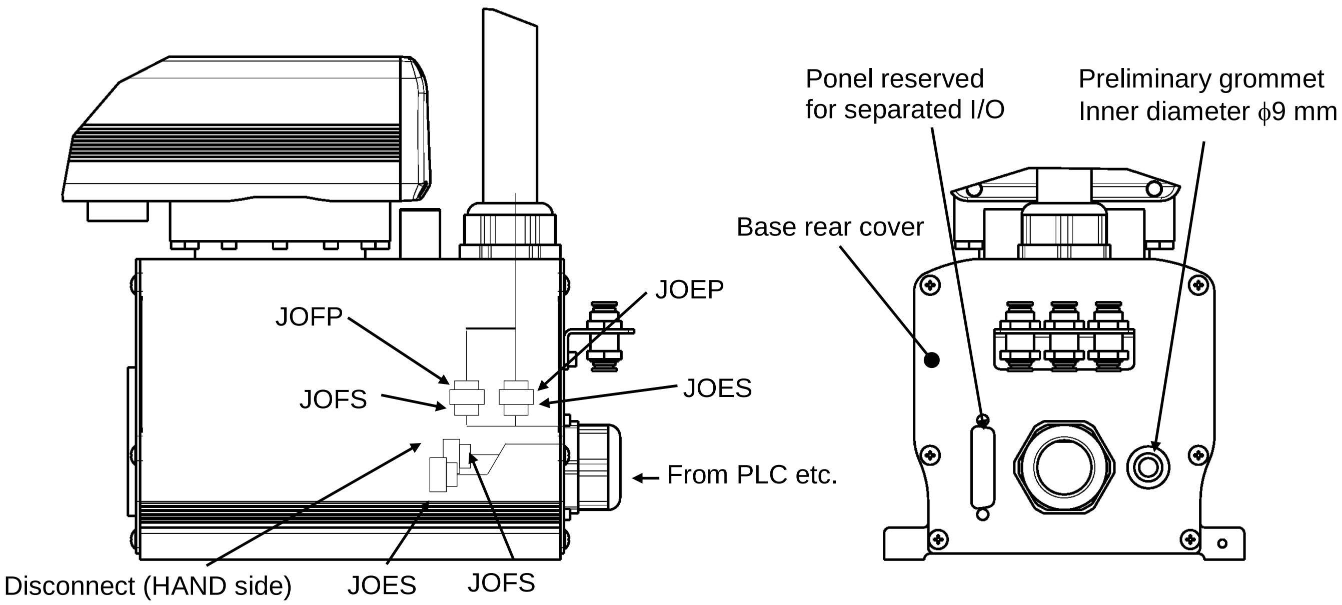


Fig. 11.2 Wiring to PLC, etc. (KHL-500, KHL-600, KHL-700 and KSL3000)

Table 11.1 Input/output signal connector CN0 (KSL3000, Type-N)

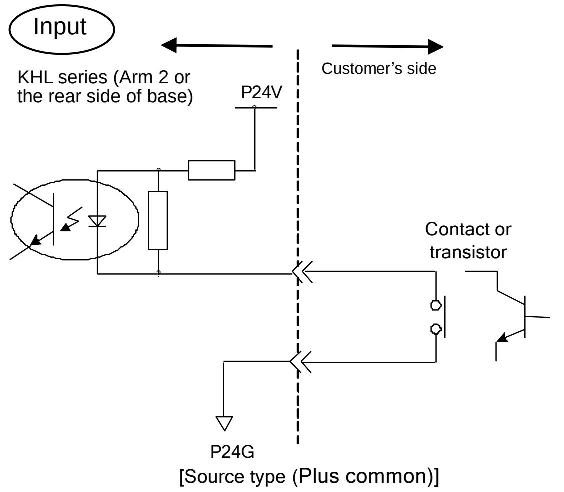
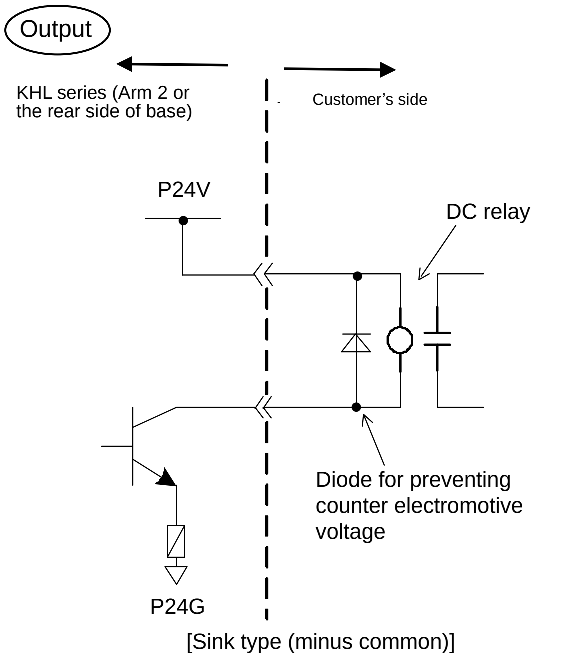
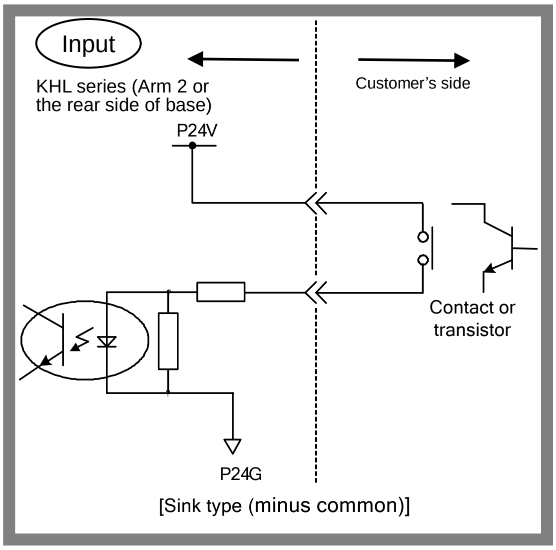
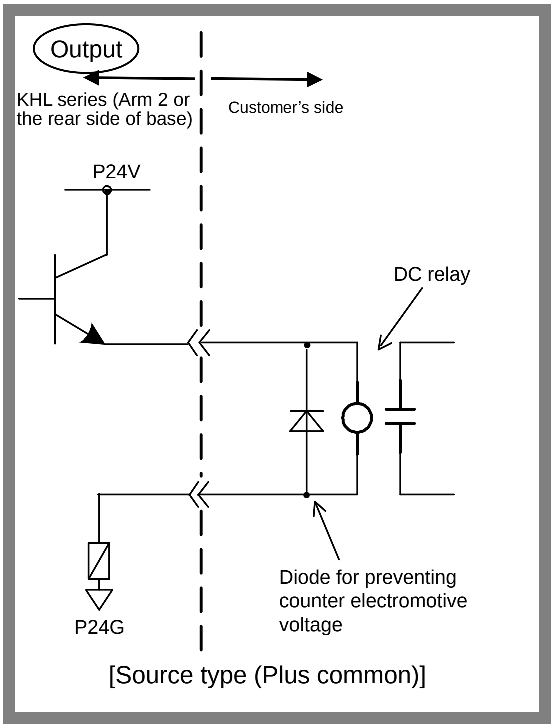
Pin (D-SUB)	Signal name		Signal No.	Input/output circuit and example of connections
1	D-IN1	Input signal 1	201	
2	D-IN2	Input signal 2	202	
3	D-IN3	Input signal 3	203	
4	D-IN4	Input signal 4	204	
5	D-IN5	Input signal 5	205	
6	D-IN6	Input signal 6	206	
7	D-IN7	Input signal 7	207	
8	D-IN8	Input signal 8	208	
9	DC 24VGND (P24G)			
10	Shield (FG)			
11	D-OUT1	Output signal 1	201	
12	D-OUT2	Output signal 2	202	
13	D-OUT3	Output signal 3	203	
14	D-OUT4	Output signal 4	204	
15	D-OUT5	Output signal 5	205	
16	D-OUT6	Output signal 6	206	
17	D-OUT7	Output signal 7	207	
18	D-OUT8	Output signal 8	208	
19	DC 24V (P24V)			

Table 11.2 Input/output signal connector CN0 (KSL3000, Type-P)

Pin (D-SUB)	Signal name		Signal No.	Input/output circuit and example of connections
1	D-IN1	Input signal 1	201	
2	D-IN2	Input signal 2	202	
3	D-IN3	Input signal 3	203	
4	D-IN4	Input signal 4	204	
5	D-IN5	Input signal 5	205	
6	D-IN6	Input signal 6	206	
7	D-IN7	Input signal 7	207	
8	D-IN8	Input signal 8	208	
9	DC 24VGND (P24G)			
10	Shield (FG)			
11	D-OUT1	Output signal 1	201	
12	D-OUT2	Output signal 2	202	
13	D-OUT3	Output signal 3	203	
14	D-OUT4	Output signal 4	204	
15	D-OUT5	Output signal 5	205	
16	D-OUT6	Output signal 6	206	
17	D-OUT7	Output signal 7	207	
18	D-OUT8	Output signal 8	208	
19	DC 24VGND (P24G)			

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

No-voltage contact specifications:

Contact rating: 24 VDC, 10 mA or over (circuit current: approx. 7 mA)

Minimum contact current: 24 VDC, 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 P24V 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 (P24G) of the robot controller.

Output specifications:

Rated voltage	:	24 VDC (max. 30 VDC)
Rated current	:	100 mA

- If the P24V 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.

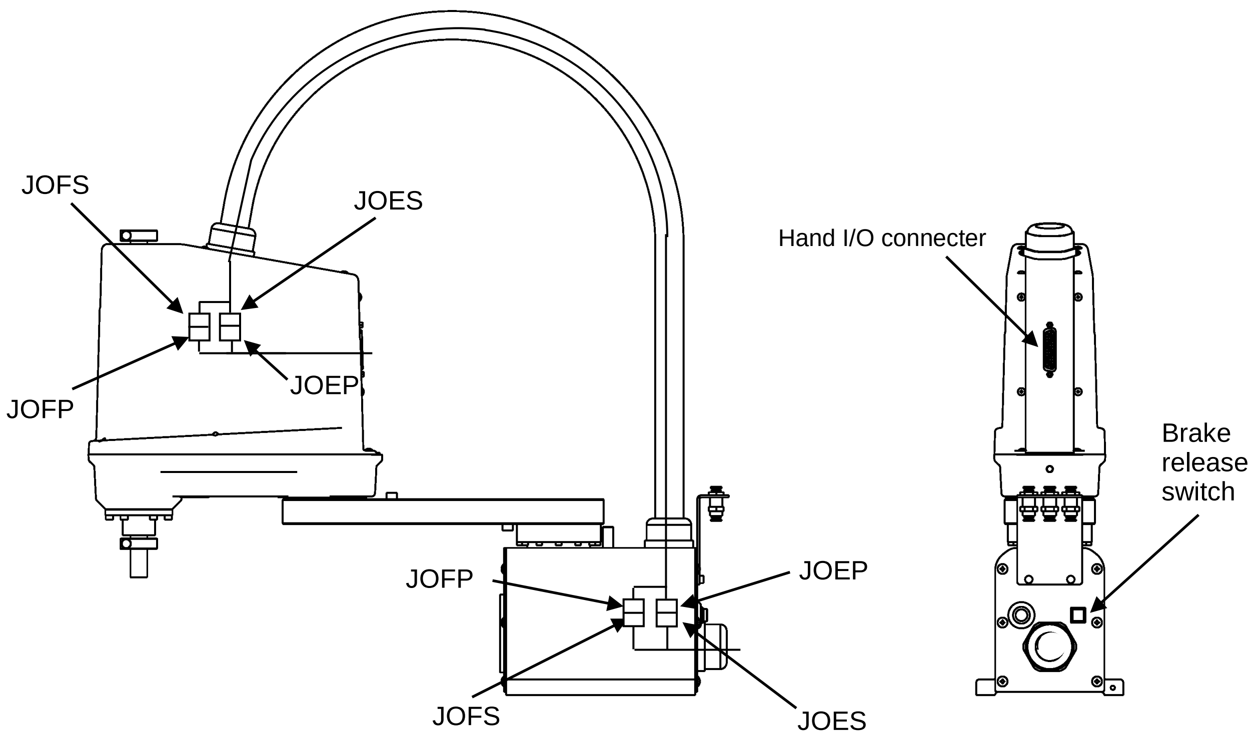


Fig. 11.3 Tool wiring (KHL-300 and KHL-400)

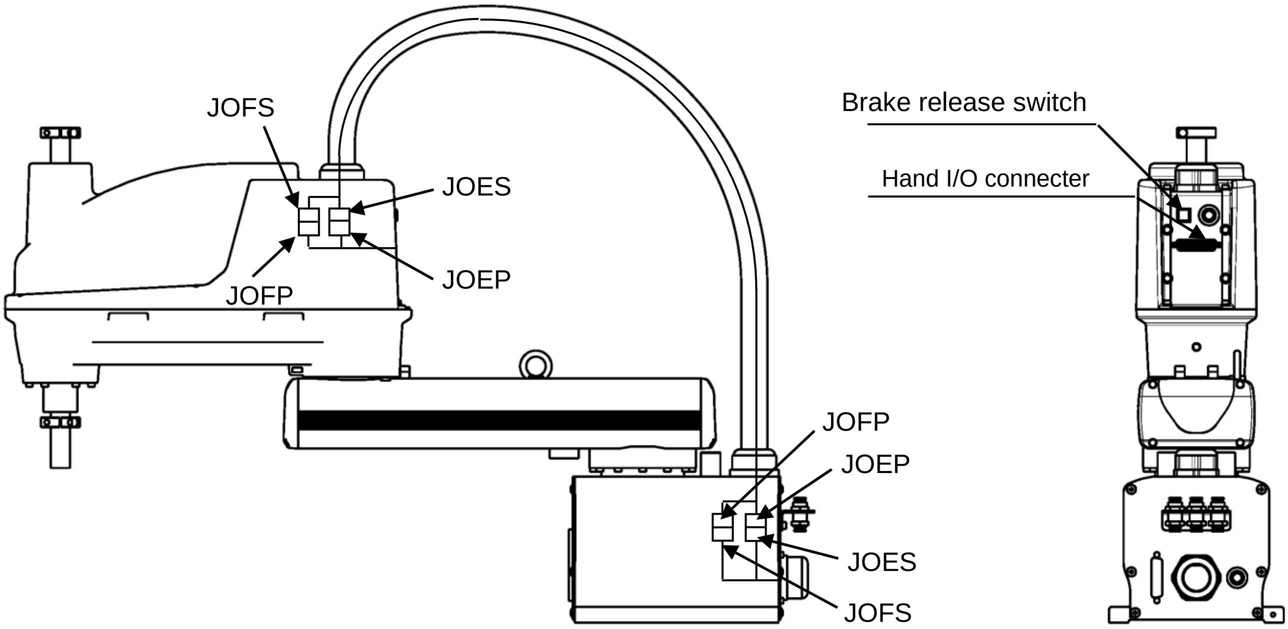


Fig. 11.4 Tool wiring (KHL-500, KHL-600 and KHL-700)

CAUTION

- Be sure to connect all connectors properly. Otherwise, the robot may malfunction.

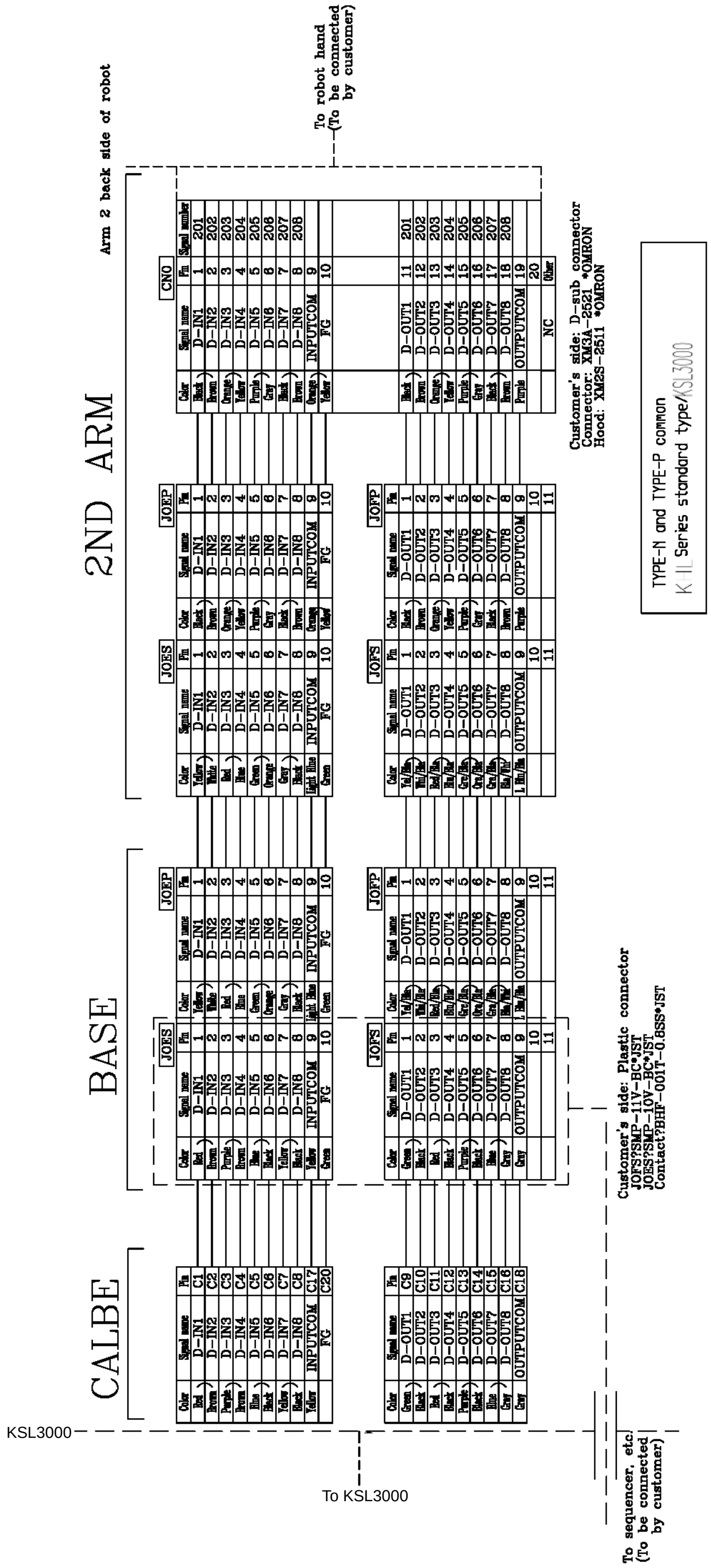


Fig. 11.5 Tool wiring (Common to Type-N, Type-P and KSL3000)

11.2 Tool Cable wiring

The customer is requested to install the cable wiring of the tool (the electric chuck, etc) which is prepared by the customer.

Fig. 11.6 to 11.7 shows an installation example of tool cable wiring using the connector (D-SUB) for the reference. Parts used for examples are not accessories. Please design and prepare such parts.

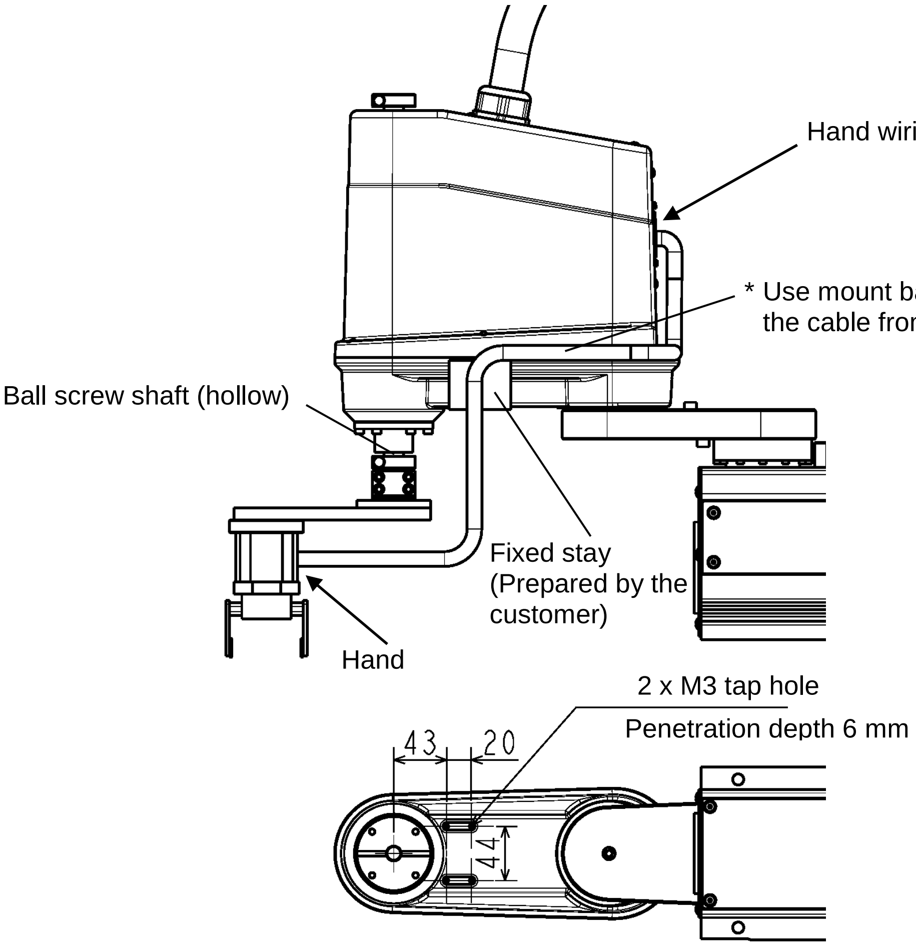


Fig. 11.6 Tool cable wiring installation example using the connector (D-SUB) (KHL-300 and KHL-400)

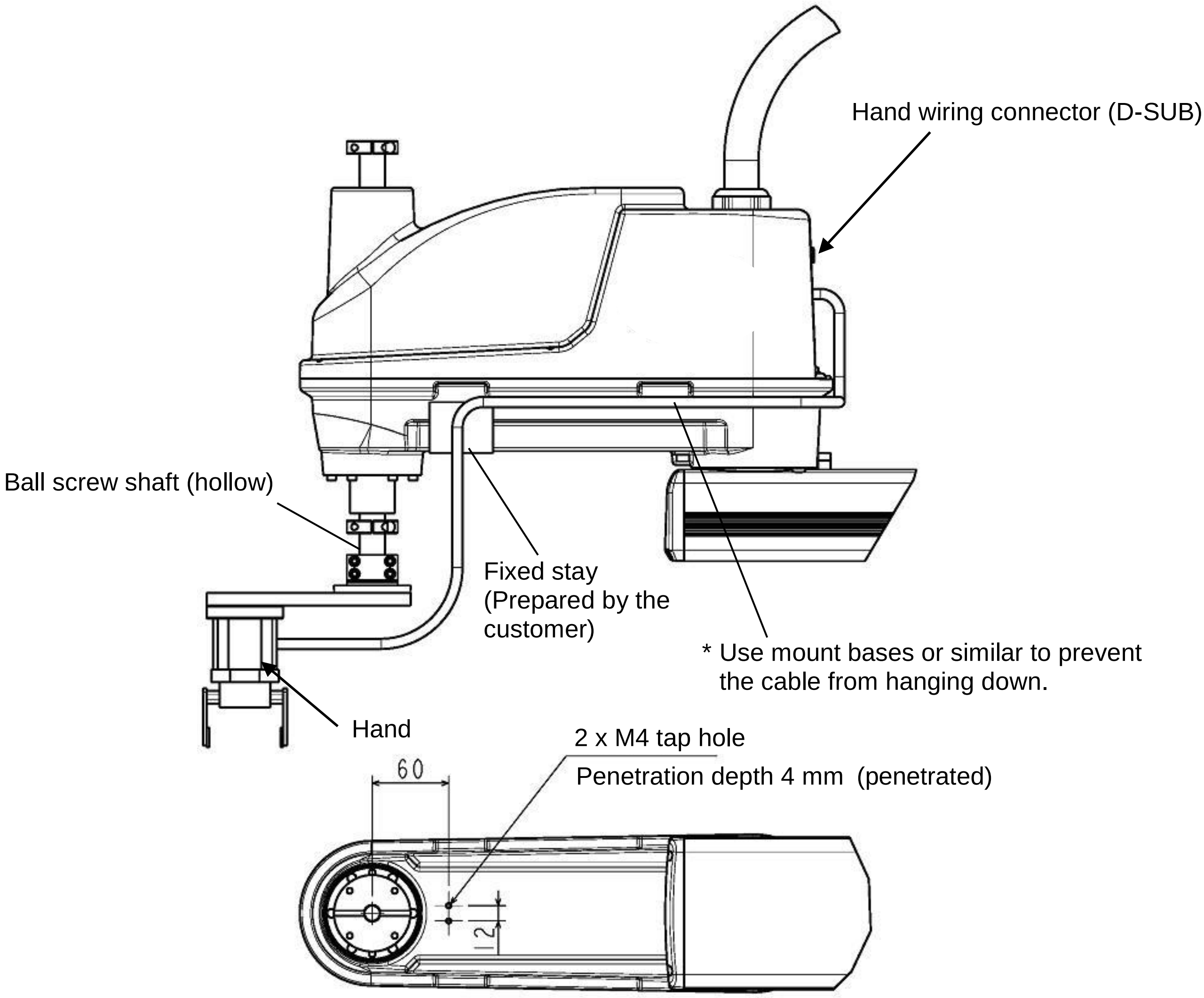


Fig. 11.7 Tool cable wiring installation example using the connector (D-SUB) (KHL-500, KHL-600 and KHL-700)

⚠ CAUTION

- Be sure to use a highly flexible robot cable, which should be secured below the arm with a cable clamp, etc. Unless a robot cable is used, the wire may be broken.
- When performing tool wiring and piping, take all necessary measures against breakage due to rub, etc.
- At robot operation, take careful precautions not to exert a load on respective connectors.
- In operation, confirm that the fixed stay does not interfere with the arm 1, etc.

When wiring is insufficient for the connector (D-SUB), if the cable wiring and robot's wire harness cere bundled, robot's wire harness may be broken and disconnected, due to unexpected fluctuations or un balanced loads on the robot's wire harness during robot operation depending on the weight of the cable wiring the operating speed and range of the robot.If the cable wiring is routed to the tip of the robot, do not bundle it to the robot's wire harness. Prepare a pillar, for example, in order to route the cable wiring.
Fig. 11.8 to 11.9 shows an installation example of tool cable wiring for your reference. Parts used for examples are not accessories. Please design and prepare such parts.

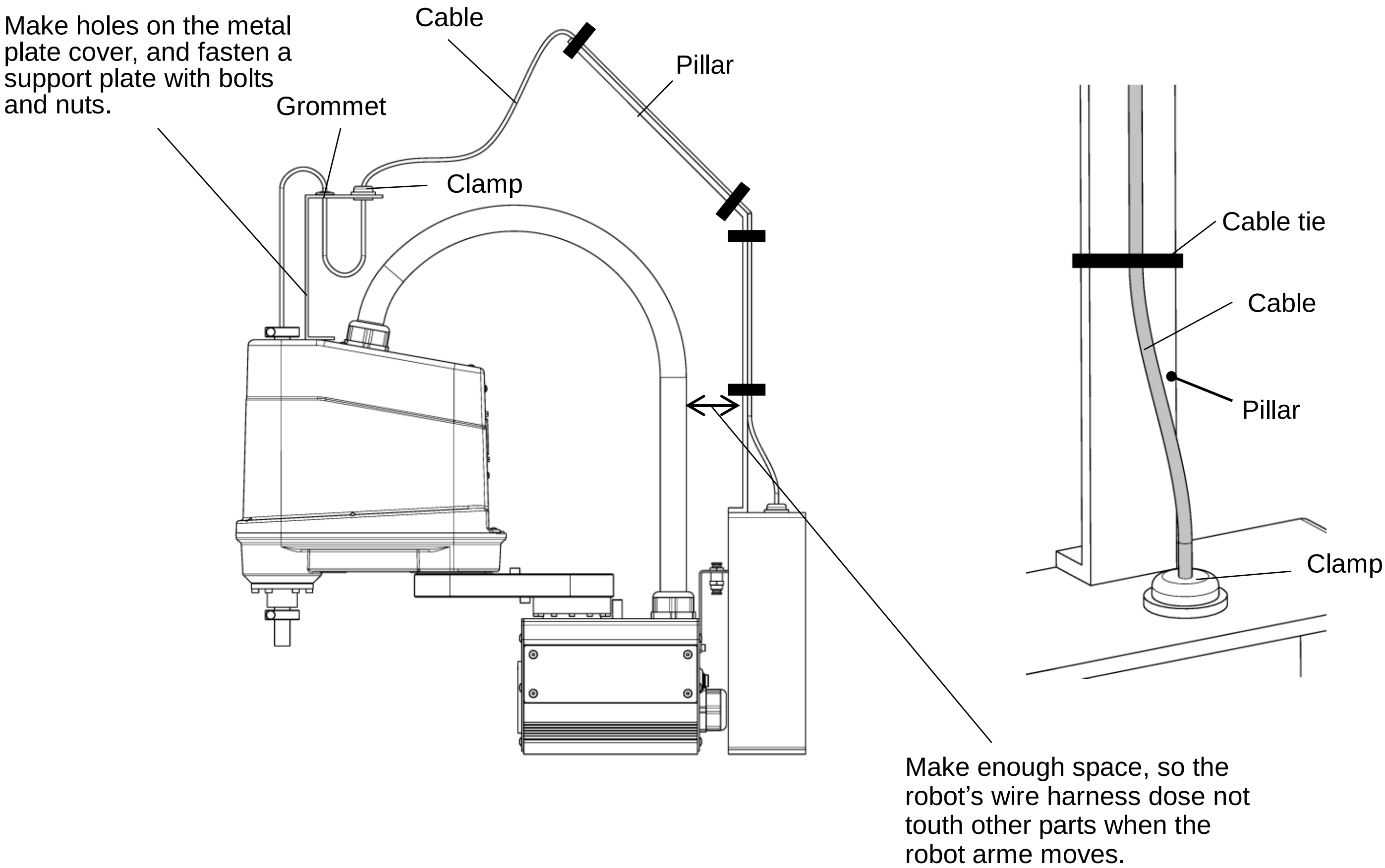


Fig. 11.8　Tool cable wiring installation example (KHL-300/KHL-400)

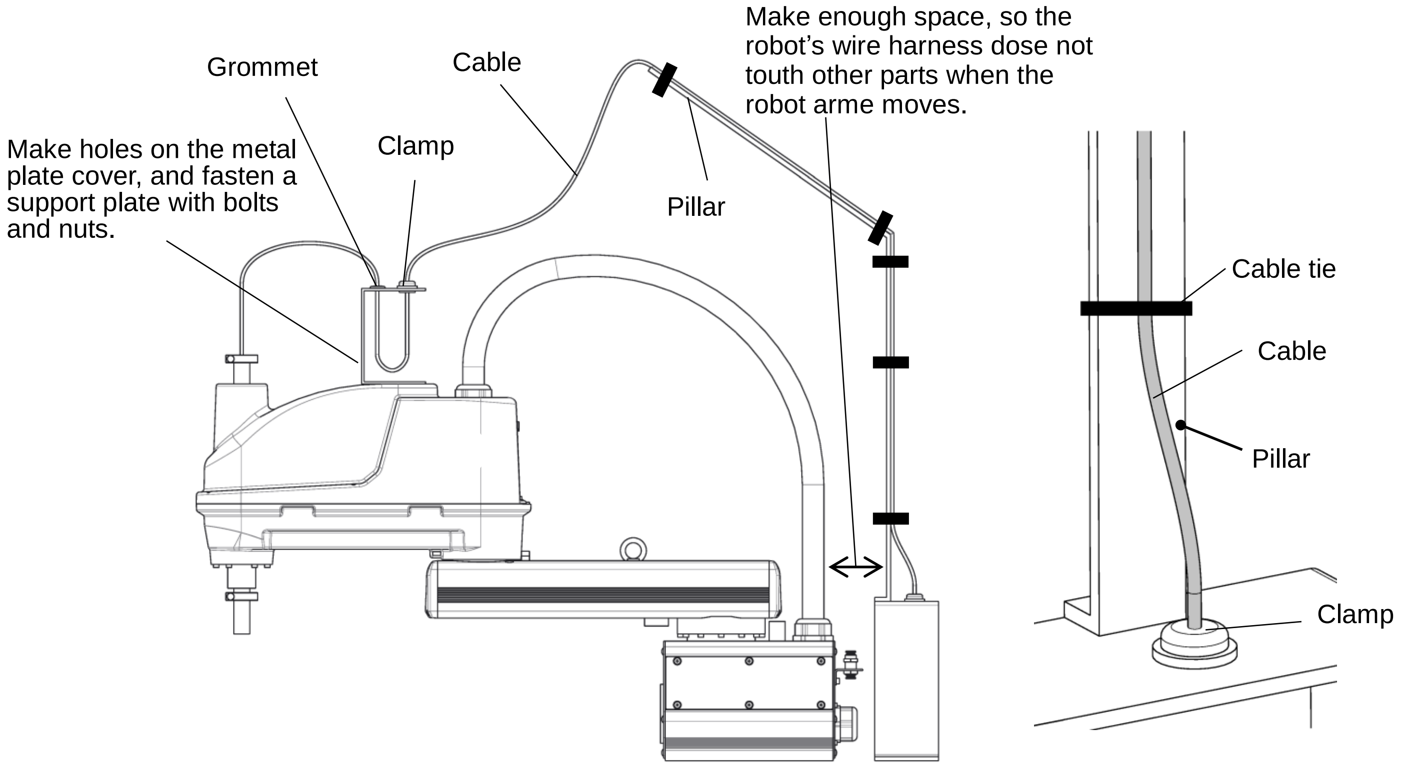


Fig. 11.9 Tool cable wiring installation example (KHL-500/KHL-600/KHL-700)

⚠ CAUTION

- Fig. 11.6 to 11.9 is a reference example and it dose not guarantee the robot’s wire harness. The warranty does not cover breakdowns of the robot’s wire harness due to wiring by the customer.

11.3 The wiring arrangement for the hand I/O cable (Option)

The wiring arrangement for the hand I/O cable (Option) is shown in Fig. 11.10～11.11. And use parts list of the hand I/O cable (Option) is shown in Table 11.3.

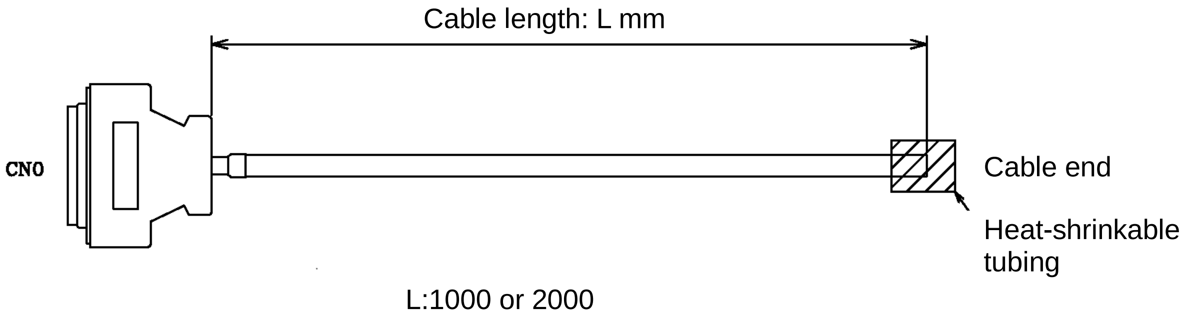


Fig. 11.10 Outline drawing for the hand I/O cable (Option)

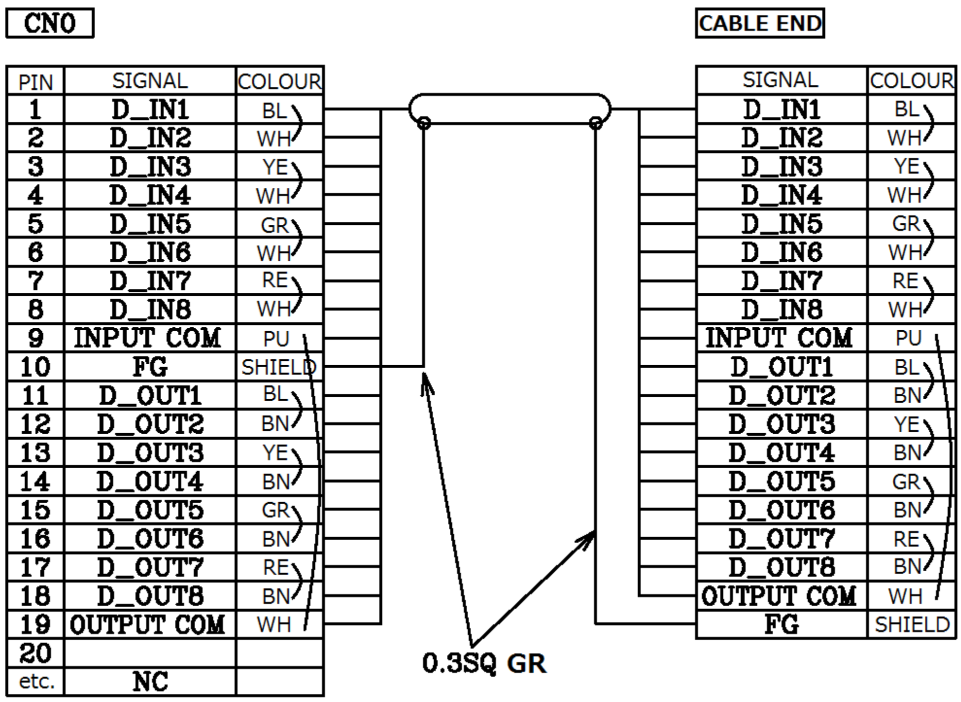


Fig. 11.11 The wiring arrangement for the hand I/O cable (Option)

Table 11.3 Use parts list of the hand I/O cable (Option)

No.	Part name	Type	Maker	Q'ty
1	Cable	RMFEV-SB 0.2SQ-10P	Dyden	1
2	Plug with solder-cup terminal	XM3A-2521	Omron	1
3	D-sub connector	XM2S-2511		1