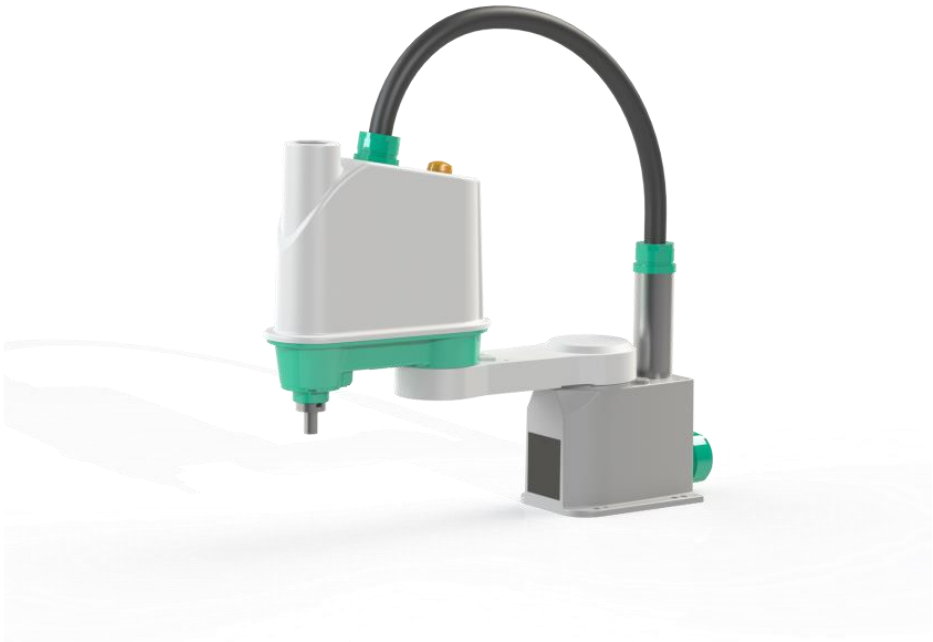
CKD

SCARA Robot

KHE Ceiling Type Specifications

INSTRUCTION MANUAL

SM-A20059-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

Introduction

Thank you very much for your purchase of CKD's robot system.
This manual describes the basic specifications of the ceiling type specifications of the industrial robot, and how to unpack and install the robot, how to connect wiring, how to install the hand, and how to maintain and inspect the robot.
The same description as that of the standard machine is omitted. Use this manual together with the instruction manual "STA1105 KHE−400 Robot Manual."
Read this manual before unpacking the product.
Before beginning the work according to this manual, read through the "STA1112 KHE Series Safety Manual" so that you can understand the safety measures.

This manual has the following chapters.

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

Installation
Section 2: Unpacking and Transportation
This section describes how to unpack the robot and how to transport it to the installation site.
This section also describes precautions for temporarily storing the unpacked robot.

Section 3: Installation of the Robot
This section describes the installation environment, required space, and installation procedure for the robot.

Sections 4 and 5: Setting of the Hand
These sections describe how to install the hand on the robot arm and how to wire and pipe the hand.
Lastly, these sections describe the permissible load conditions of the hand.

Maintenance
Sections 6: Maintenance
These sections describe how to maintain respective units of the robot.

Section 7: Replacement Parts
This section describes replacement parts of the robot.

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Use Range

This product is the horizontally articulated type industrial robot in which the manipulator has two horizontally rotating joints and the mechanical interface on its tip moves vertically and rotates horizontally.
The product has been developed with intention of adapting it to automation of wide range of work including conveying work such as movement and alignment of workpieces and assembly work such as insertion of parts and screw tightening.
The customer should also use this product with the aim to adapt it to automation of these work and incorporate it to the automation equipment.

This product is not intended to apply it to work that contacts a human (such as work related to medical care and nursing care), incorporate it to the equipment that supports human life (such as life support device and incubator), incorporate it to the equipment on which a human rides (including transport equipment such as car, aerospace equipment such as airplane, and game equipment such as roller coaster), and incorporate it to the equipment that protects human life and human body (such as safety device).
This product is not intended to incorporate it to the equipment aimed to control large quantity of heat (such as nuclear power controller and incinerator controller).
This product is prohibited from being used to apply it to work or incorporate it to the equipment that is likely to threaten human life and harm a human body directly due to a failure or malfunction. If this product is used, it will be guaranteed under customer's responsibility.

Use Method

The use conditions for the KHE series robot are described. If the product is used in the state that differs from the conditions, unexpected risk may occur. Abide by the conditions for use.

1. Main Specifications of Product: See Specifications "1.4 Specifications Table" and Installation "3.1 Installation Environment."

2. Restrictions on Use: Table 1 and 2 give "Restricted Specification Sheet" indicating restrictions on use.

Table 1 Restricted Specification Sheet (1)

1. Purpose and application of using product (restrictions on use)	
1) Intended use	Allow the robot to achieve operation along with the purposes (article conveyance, assembly, inspection, machining, etc.). (1) During teaching and adjustment operation −Operation is likely to be performed by turning on the servo power within the movable range of the robot. −A person who observes teaching and operation checking worker as a co-worker is arranged outside the movable range. (1) Teach the position where the robot operates. (2) Create the operation sequence (program, etc.). (3) Transfer and check signal and data with the external equipment. (4) Check operation at low speed (250 mm/sec or less). (2) During operation −Danger prevention measures that prevent contact with the robot (installation of the fence or enclosure) are taken to keep a person away from the operating robot. −When the operating robot is approached, measures shall be taken to turn off the servo power. (1) Start the robot. (2) Perform operation along with the purpose at the specified speed. (3) Stop the robot. (3) During maintenance and inspection −Contents performed within the movable range of the robot when the primary power is off (1) Check the bolts for looseness and backlash and re-tighten them. (2) Check the cable clamp for looseness. (3) Inspect damage. (4) Clean dust. (5) Inspect and apply antirust agent. (6) Check the timing belt for looseness and crack. (7) Check the cable and air tube for wear. (8) Check the operation when each axis is pushed and moved by hand. (9) Replace the consumable parts for the robot and controller. (10) Replace the battery for memory in the controller. −Contents performed within the movable range of the robot when the primary power is on (1) Check the grease state and apply grease (when the servo power is off). (2) Push each axis by hand and check it for backlash (when the servo power is on). (3) Check abnormal vibration and sound during operation (when the servo power is on). (4) Check the teaching point for misalignment (when the servo power is on). (5) Replace the battery for robot position detector (when the servo power is off).

Table 2 Restricted Specification Sheet (2)

2) Predictable misuse	−Use for work which applies excessive impact to the robot or to which excessive impact is applied by the robot −Modification of robot body, controller, and optional parts and energization with these covers removed −Operation in other than the specified installation state (floor, suspension, and wall-mounted) −Operation on the frame that does not satisfy the specified strength −Operation in other than the specified environment
3) Unexpected start	−Malfunction caused by excessive noise −Robot start caused by start signal unexpectedly sent from the peripheral equipment to the robot −Unintended start caused by abnormal communication data −Malfunction caused by voltage fluctuation

2. Replacement of product components (restrictions on time)		
1) Mechanical restriction 2) Electrical restriction	Replace consumable parts as required or periodically through daily inspection, regular inspection (every 3 and 6 months and every year) and overhaul (every 5 years).	
3. Movable range of product (restriction on space)		
1) Operating range	Axis 1	Conforms to 1.4 Specifications Table .
	Axis 2	Conforms to 1.4 Specifications Table .
	Axis 3	Conforms to 1.4 Specifications Table .
	Axis 4	Conforms to 1.4 Specifications Table .
	Additional axis	Conforms to individual specifications.
	—	—
	—	—
2) Interface	−The product shall be installed at a location suitable for outer shape and operating range. −Space required for maintenance and inspection shall be secured.	
3) Work environment	−Danger prevention measures that prevent contact with the robot (installation of the fence or enclosure) shall be taken. −Space shall be secured to prevent a person from being caught between the robot and the fence or enclosure.	
4. Life cycle of product		
During the life cycle of assembly, shipment test, transportation, installation, teaching, operation, maintenance and disposal, risk assessment is carried out for “installation” stage (transportation and installation), “use” stage (teaching, operation, and maintenance) and disposal.		

Target	Knowledge, experience, and condition
5. Person who approaches the machine	
1) Transportation and install	Knowledge: Person who has understood the instruction manual Experience: — Condition: Qualified person on forklift or crane (as required)
2) Teaching/adjustment operation worker (including co-worker)	Knowledge: Person who has understood the instruction manual Experience: Person who has acquired the operation of the robot to be used Condition: Person who has received special training pertaining to the operation such as teaching of the industrial robot and to whom work has been permitted by the employer
3) Operation worker (operator)	Knowledge: Person who has understood the instruction manual Experience: Person who has understood the work regulation Condition: —
4) Maintenance and inspection worker	Knowledge: Person who has understood the instruction manual Experience: Person who has acquired the operation of the robot to be used and person who has acquired maintenance work of the target robot Condition: Person who has received special training pertaining to the operation such as inspection of the industrial robot and to whom work has been permitted by the employer
5) Disposal worker	Knowledge: Person who has understood the instruction manual and the disposal method for each local government Experience: — Condition: —
6. Other	

Warranty

We conduct a strict tests and inspections before delivery to ensure that the product satisfies our performance standards.
We provide warranty to cover defects of the product based on the following prerequisites.

1. Warranty period The warranty period of the product is either of the following, whichever is earlier.
   1) 18 months after delivery from our factory
   2) 12 months after installation at your site
   3) Operating time of 2400 hours.

2. Warranty scope
   1) We provide warranty for the product. Note that only the specifications and functions defined in the product specifications, catalog, and instruction manual are covered by the warranty. Any secondary or incidental damages caused by failure of the product are not covered by the warranty in any circumstances.
   2) We provide repair of a faulty product for free only if the product has been handled and used according to the instruction manual that comes with the product.
      Any repairing after the warranty period passes will be charged.

3. Disclaimer The warranty shall not apply to the following cases.
   a) Any failure or damage arising from your careless use or misuse that is not defined in the instruction manual.
   b) Any failure caused by aging or normal wear and tear (discoloration, deterioration of consumables[*1]).
   c) Any failure regarding sensuous phenomena such as noise not affecting the functions
   d) When any modification or disassembly without our consent is confirmed
   e) Any failure or damage arising from insufficient maintenance and inspection or inappropriate repair
   f) Any failure or damage due to act of God, fires, and other force majeure
   g) Internal data such as programs and points created or modified by users
   h) When a product purchased in Japan is taken abroad

4. Precautions
   1) CKDshall not guarantee the standard performance of the product if you use the product beyond the specifications.
   2) If the customer did not observe the "DANGER," "WARNING," and "CAUTION" described in this instruction manual, CKDwill not assume the responsibility for any consequential accident resulting in injury or death, damage or trouble.
   3) "DANGER," "WARNING," "CAUTION" and other descriptions stipulated in this instruction manual are only those which can be assumed by CKD without predicting all events in all situations. Please note that the range is limited.

(*1) Consumable parts refer to the replacement parts for maintenance as listed in instruction Manual "STA1105 KHE400 Robot Manual."

Standards, laws and regulations regarding safety of industrial robots

The international industrial standard ISO/DIS 12100 "Safety of machinery" defines measures for reducing risks regarding machinery.

Step 1: Fundamental safe design measures - Restrictions on force, speed, and energy

Step 2: Safety protection - Installation of protective fences, etc.
Additional protection measures - Installation of emergency stop devices

Step 3: Information for use - Warning labels, alerts, instruction manuals

Based on the above, the ISO/IEC defines the "Guide 51" that groups various standards in a hierarchal structure. Safety standards for industrial robots are standardized as separate safety standards for machinery in layer C.

- ISO 10218, ISO 10218-1

After risk assessment is carried out, provision of residual risk information to the user is standardized.

- IEC 82079-1

Comply with the standards, laws and regulations in the countries where you use industrial robots.

Safety Precautions

This manual contains important information for the safe use of the robot body and the prevention of injury to the operator and others and the prevention of damage to property.
Read and understand the meanings of the following indications and symbols first, and observe these precautions.

[Meanings of Indications]

Indication	Meaning
⚠ DANGER	Indicates the imminent danger that incorrect operation could cause death or serious injury.
⚠ WARNING	Indicates the danger that incorrect operation could cause death or serious injury.
⚠ CAUTION	Indicates the possibility that incorrect operation could cause injury[1] to operator or damage to the property[2].

1) Injury indicates injuries such as wounds, burns, and electric shock that do not require hospitalization or long-term outpatient treatment.
2) Damage to property indicates extensive damage related to the destruction of assets or materials.

[Meanings of symbols]

Symbol	Meaning
	Indicates a prohibited action. The specific content of the prohibition is shown pictorially or in text form inside the symbol or nearby it.
	Indicates a required action. The specific content of the required action is shown pictorially or in text form inside the symbol or nearby it.
	Indicates a danger and precaution. The specific content of the precaution is shown pictorially or in text form inside the symbol or nearby it.

⚠ CAUTION
• To install and operate the robot safely, read and understand the separate Instruction Manual "Safety Manual" in advance.

[Installation]

Strictly observe the following to use the robot safely.

⚠ DANGER	
 Prohibited	• Do not install and run the equipment if it is damaged or parts are missing. Otherwise, electric shock, fire, or malfunction may result. • Do not install the equipment in a place where liquid such as water is applied. Otherwise, electric shock, fire, or malfunction may result. • Do not place a flammable material near the equipment. Fire may result if the equipment ignites due to failure.
 Required	• Always secure the robot with the attached clamp before transporting the robot. Failure to do so could lead to injuries if the arm moves when the robot is lifted. • Install the equipment before wiring. Wiring before installation may cause electric shock and injury. • Use the power supply voltage and capacity specified byCKD. Otherwise, equipment failure or fire may result. • Use the power cable specified by CKD. Using cables not specified by CKD may cause fire or malfunction. • Ensure that the equipment is grounded by a grounding wire. Otherwise, electric shock or fire may result due to malfunction or electric leakage. Malfunction due to noise may also result.

⚠ CAUTION	
 Prohibited	• Never lift the robot by the arm 2 cover. Doing so will apply an excessive force to the mechanism section of the robot body and could lead to faults.
 Required	• When storing the robot, secure it to the base. The robot will be unstable if just set down without securing it, and it could tilt over.
 Caution	• When operating the robot after long-hour stop at a low temperature (10℃ or less), be sure to perform a continuous operation at a low speed (approximately 20% of the maximum speed) for a few minutes. Otherwise, a motor overload error may occur due to solidified grease.

[Maintenance and inspection]

Strictly observe the following in order to use the controller safely.

⚠ DANGER	
 Prohibited	• Do not burn, disassemble, or recharge the battery. Otherwise it may blow out.
 Required	• Before conducting maintenance and inspection, be sure to disconnect the power plug of the controller from the power outlet. • When disposing of the battery, observe the customer-defined rules.

⚠ CAUTION	
 Prohibited	• Do not replace or modify parts that are not stated in the instruction manual. Performance degradation, failure or accident may result.
 Required	• Use replacement parts specified by CKD. • Regularly conduct maintenance and inspection. Otherwise, equipment failure or accident may result.
 Caution	• The Axis 4 motor of the KHE series robot is not provided with a brake. At servo OFF, therefore, the Axis 4 may rotate due to the dead weight of the tool and hand, offset condition or touch by hand. Once the Axis 4 rotates, the Axis 3 will move up or down. Be careful not to have your hand or leg caught in it. • A brake release switch is provided at the base rear. If the brake release switch is pressed while a heavy load such as a hand or workpiece is mounted on the Axis 3, the Axis 3 will drop. Be careful not to have your hand or leg caught in it.

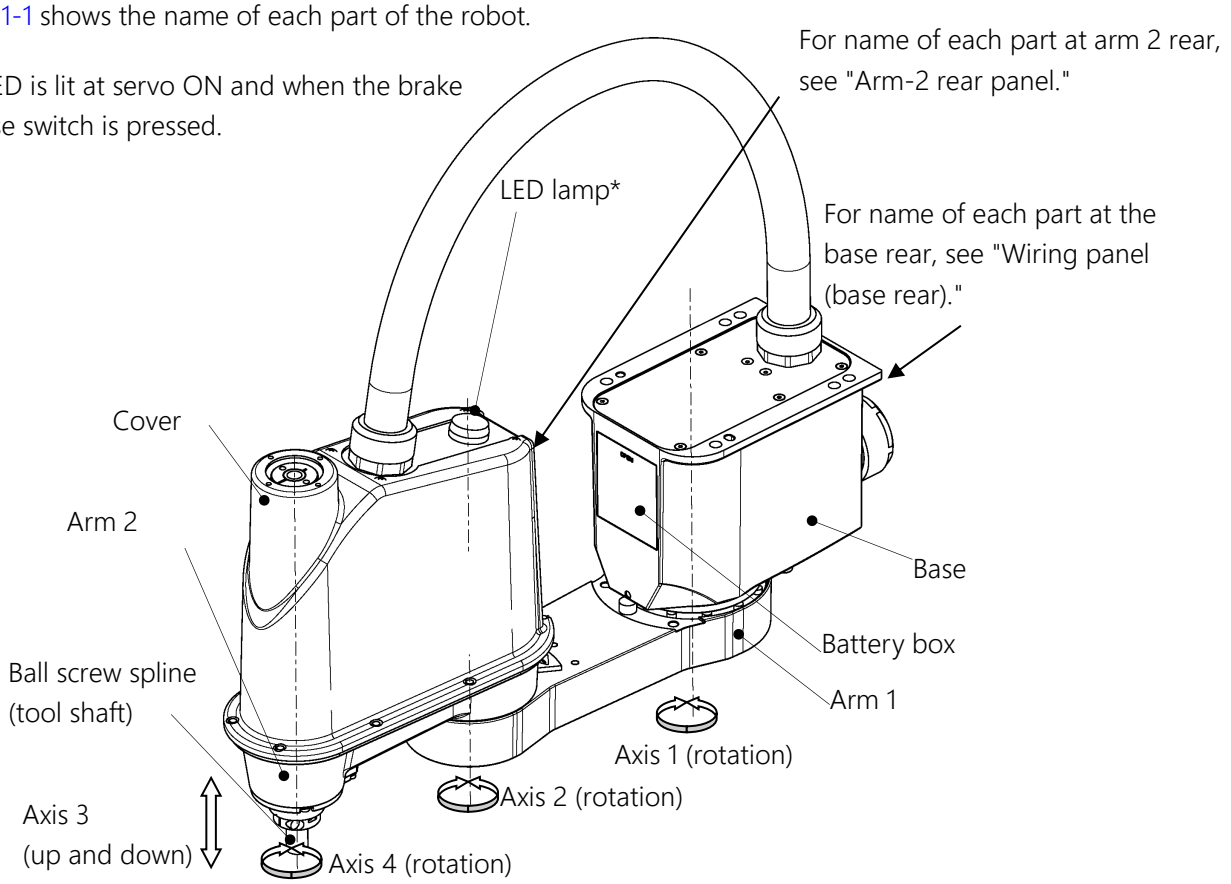
Specifications

This part describes the basic specifications, name of each part, coordinate system and external dimensions of the KHE series robot.

1.Specifications

1.1 Name of Each Part

Fig. 1-1 shows the name of each part of the robot.



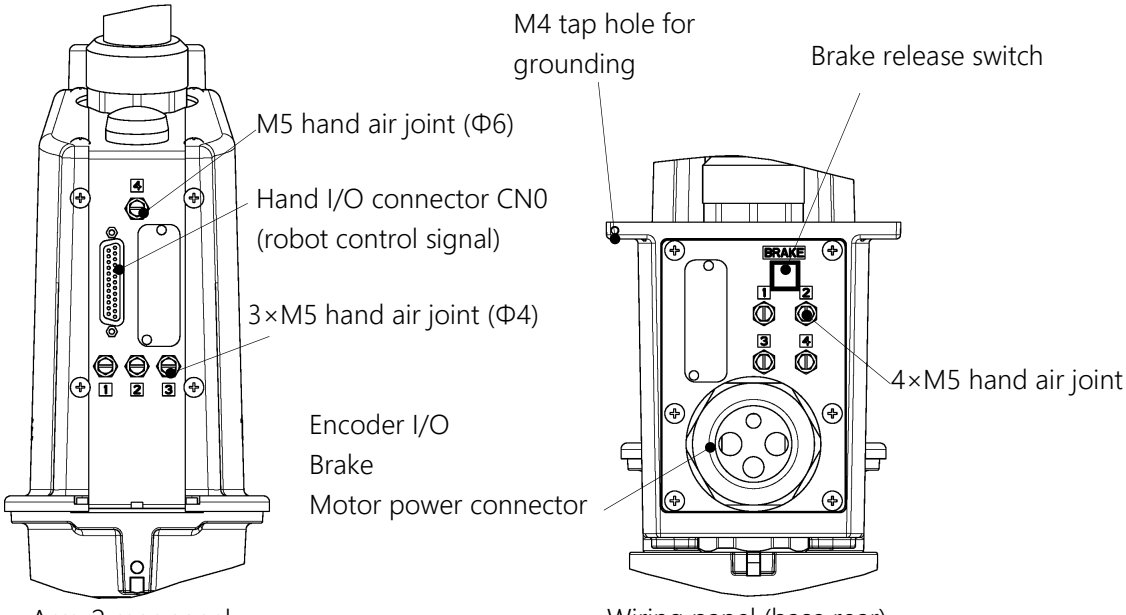


Fig. 1-1 Name of each part

1.2 Coordinate System

The coordinate system is the same as that for the standard machine. For details, see the "SM-A22045-A KHE-400 Robot Manual."

1.3 External Dimensions

Fig. 1-2 refers to the external dimensions of the KHE400-T.

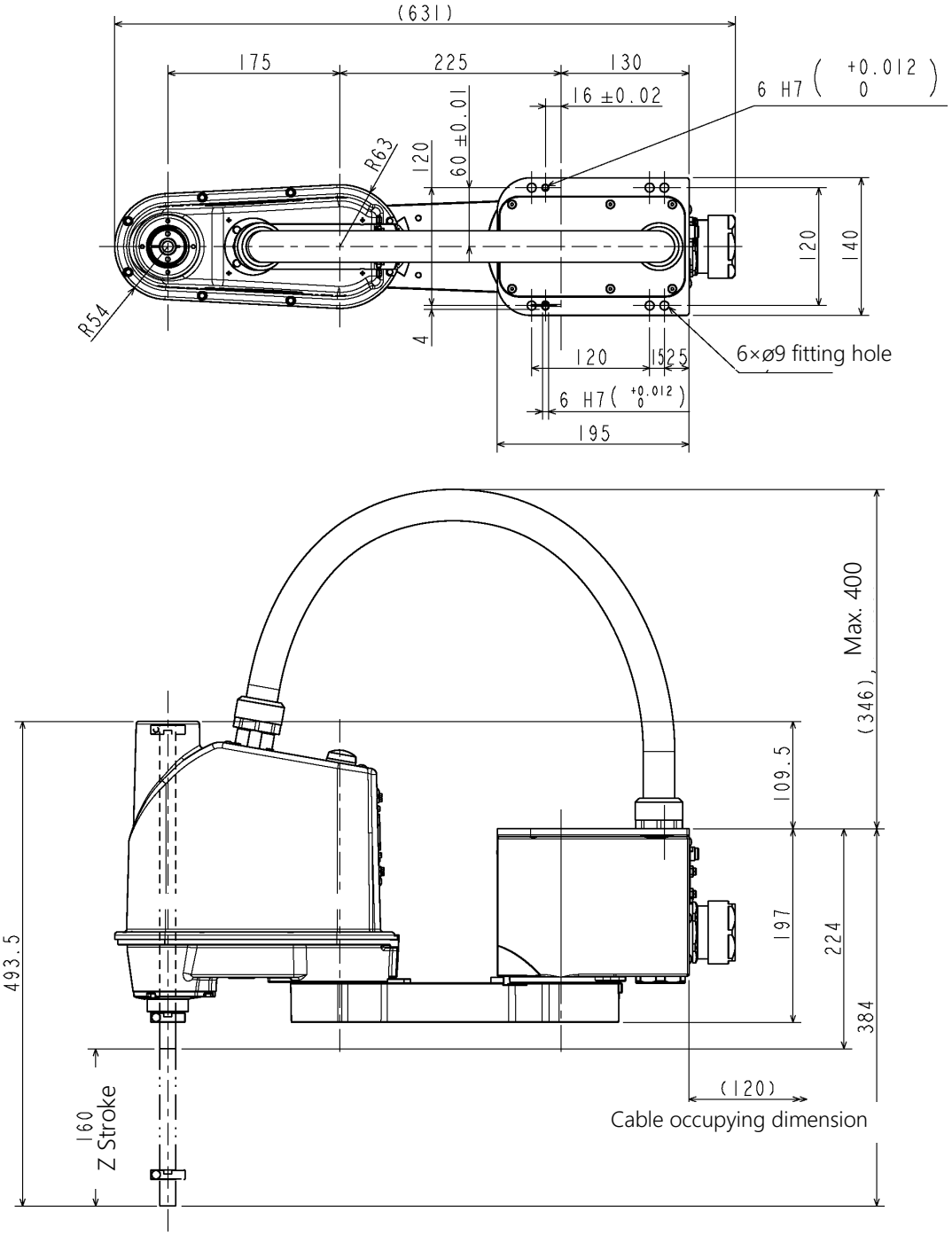


Fig. 1-2 External dimensions of the robot (KHE400)

1.4 Specifications Table

Item		Specifications
Structure		Horizontally articulated type SCARA robot
Model		KHE400-T
Applicable controller		KSL3000
Mass of robot body		15 kg
Number of controlled axes		Four (4)
Arm length		400 mm (225 mm + 175 mm)
Motor capacity/current limit	Axis 1	400 W / 20.3 Ao-p
	Axis 2	200 W / 11.7 Ao-p
	Axis 3	100 W / 6.60 Ao-p
	Axis 4	100 W / 6.1 Ao-p
Operating range	Axis 1	±130 deg
	Axis 2	±145 deg
	Axis 3	0 to 160 mm
	Axis 4	±360 deg
Maximum speed *1	Axis 1	672 deg/s
	Axis 2	780 deg/s
	Axis 3	1120 mm/s
	Axis 4	1800 deg/s
	Composite speed of axes 1 and 2	7.0 m/s
Rated payload mass*1		1 kg
Maximum payload mass*1		5 kg
Permissible load inertia*1		0.06 kg・m^2
Repeatability*2	Composite speed of axes 1 and 2	±0.01 mm
	Axis 3	±0.01 mm
	Axis 4	±0.007 deg
Cycle time (when payload mass is 2 kg)*3		0.39 sec
Drive system		AC servo motor
Position detection method		Absolute
User wiring/piping	Wiring	Input: 8, output: 8
	Piping	Φ4 mm×3, Φ6 mm×1
Paint color*4 Material color*4		Arm 2: PANTONE 293C or equivalent Base and arm 1: White AN-90 or equivalent Arm cover: White AN-90 or equivalent
Noise level*5		68 dB (A)
Power supply capacity*6		2.6 kVA

*1: The speed and acceleration are limited in accordance with the operation pattern, the load mass, and the offset value.
*2: Repeatability in one direction during 30 trials at a constant ambient temperature of 20°C. It is not absolute positioning accuracy. As for X-Y and C, they represent values at the upper limit of Z. Trajectory accuracy is not guaranteed.

*3: Continuous operation with standard cycle operation pattern and exceeding the effective load ratio cannot be performed.
During shuttle for rough positioning in horizontal direction of 300 mm and vertical direction of 25 mm.

*4: The color may differ according to each production lot. Be aware that there is no problem in the very nature of the product quality.

*5: The measurement conditions are as follows.

Operating condition:	Rated load, concurrent operation of axes 1 and 2, maximum speed, and maximum acceleration
Measurement position:	Height of 1.6 m from the robot installation surface at a distance of 1 m from four front, rear, right and left directions of the robot

*6: The measurement conditions are as follows.

Operating condition:	Rated load and 2 kg, concurrent operation of all axes, maximum speed, and maximum acceleration
Measuring instrument:	Power analyzer (POWER ANALYZER 3390)

⚠ CAUTION

- Micro vibration may occur on the robot tip depending on the posture of the robot. If micro vibration occurs, decrease the speed and decelerate the robot.
- When moving axes 1, 2 and 4, do so by raising the Z axis (axis 3) as much as possible.
  If axes 1, 2 and 4 are moved while the Z axis is down, it may damage the ball screw spline (the shaft of the Z axis) early. If you must move axis 1, 2 or 4 while lowering the Z axis, adjust the operating speed and acceleration/deceleration using the SPEED instruction or the ACCEL/DECEL instruction in order to prevent the ball screw spline from vibrating. When moving axes 1, 2 and 4 while the Z axis is down, be extra careful not to make contact with obstacles.
- Even if axes 1, 2 and 4 are moved at low speed, the ball screw spline (the shaft of the Z axis) may be damaged before alarm is generated.

Installation

This part describes information you should know before unpacking, transporting, installing, and operating the robot.

2. Unpacking and Transportation

The worker should receive safety training defined by each country's laws and regulations.
Be aware that the failure and accident resulting from the work done by the customer will not be under our warranty.

Recommended protector:

Type and name	Protection part and use	Recommended example
Helmet	Protection part: Head Use: Protect from a falling object. Protect from collision with the arm.	
Safety glasses	Protection part: Eyes Use: Protect from a flying object. Protect from collision with the arm.	
Protective gloves	Protection part: Hands and fingers Use: Protect hands and fingers when caught in the machine. Prevent a carried object from dropping.	
Protective shoes	Protection part: Feet and toes Use: Protect from a falling object.	

2.1 Unpacking

The robot and controller are shipped in wooden frame. Open the packages in a location easily accessible, where the equipment is to be installed. Take careful precautions not to damage the robot.
After opening the packages, make sure that all the accessories are present and that nothing has been damaged during transport.
For robot and controller accessories, see the accessory list packed with the controller.
For details about unpacking of the controller, see the "STA1107 Controller Manual."

⚠ CAUTION

- If any parts of the equipment are found damaged or any accessories are missing after the shipment containing the equipment 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.

2.2 Transportation

Move the robot 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 fixing jigs 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 wooden frame or corrugated cardboards.

2.3 Mass and Dimensions

Fig. 2-1 shows the mass and external dimensions of the robot.

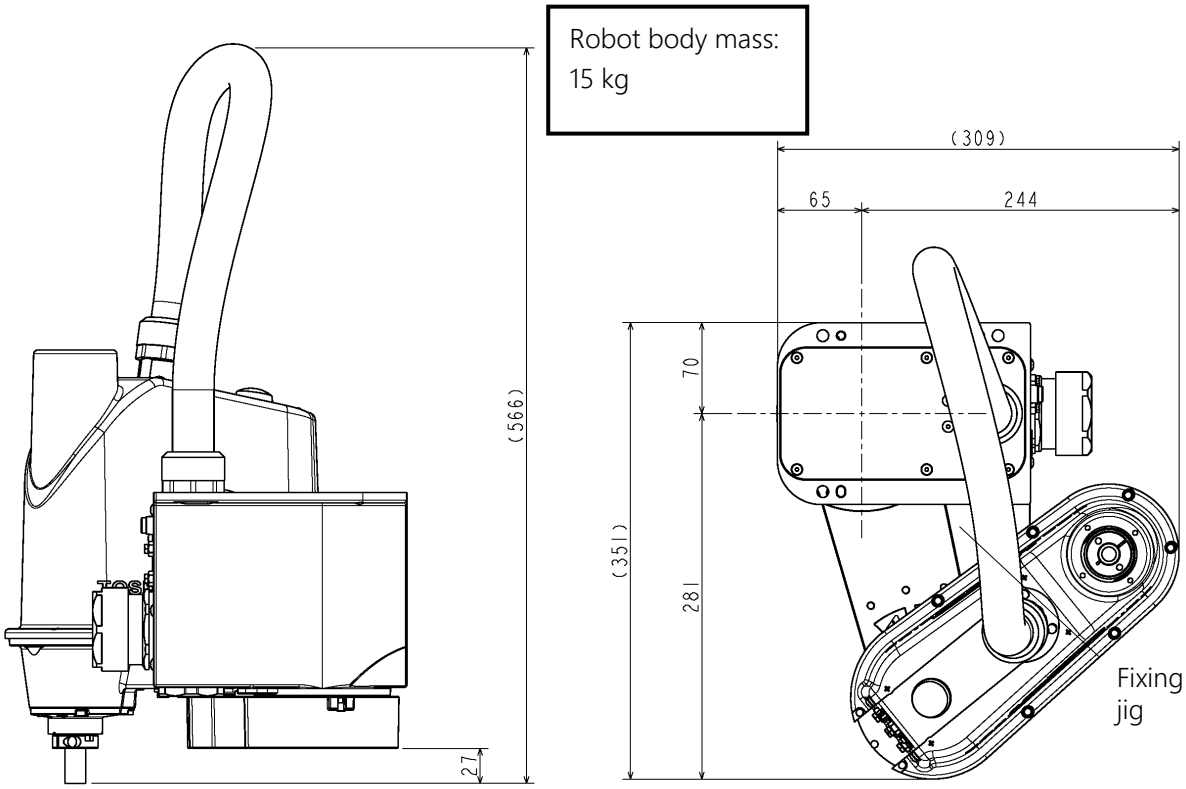


Fig. 2-1 Outer dimensions at transport (KHE400-T)

2.4 Transporting the Robot

In principle, the robot should be transported in the state shown in Fig. 2-2 below.
Fold back and secure the arm with the attached fixing jig. (The equipment is shipped in this posture. After you have unpacked the shipment, you should move it as it is.) At this time, be careful not to impose a large force on the spline shaft. The KHE400-T robot cannot be lifted up and transported.

⚠ CAUTION

- Be sure to secure the arm with the attached clamp before transporting the robot.

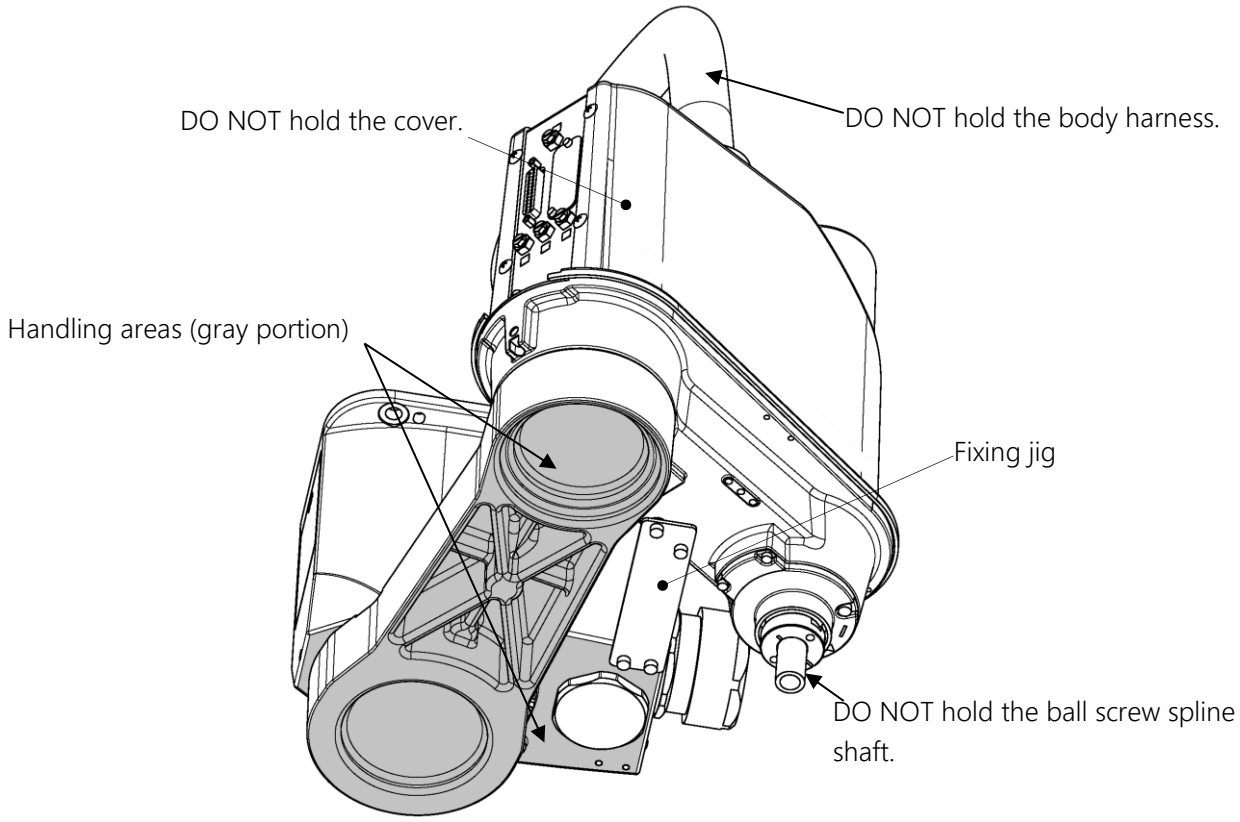


Fig. 2-2 Handling areas of the robot (KHE400-T)

After the installation, remove the fixing jig.

Fig. 2-3 shows an example of transporting the robot.

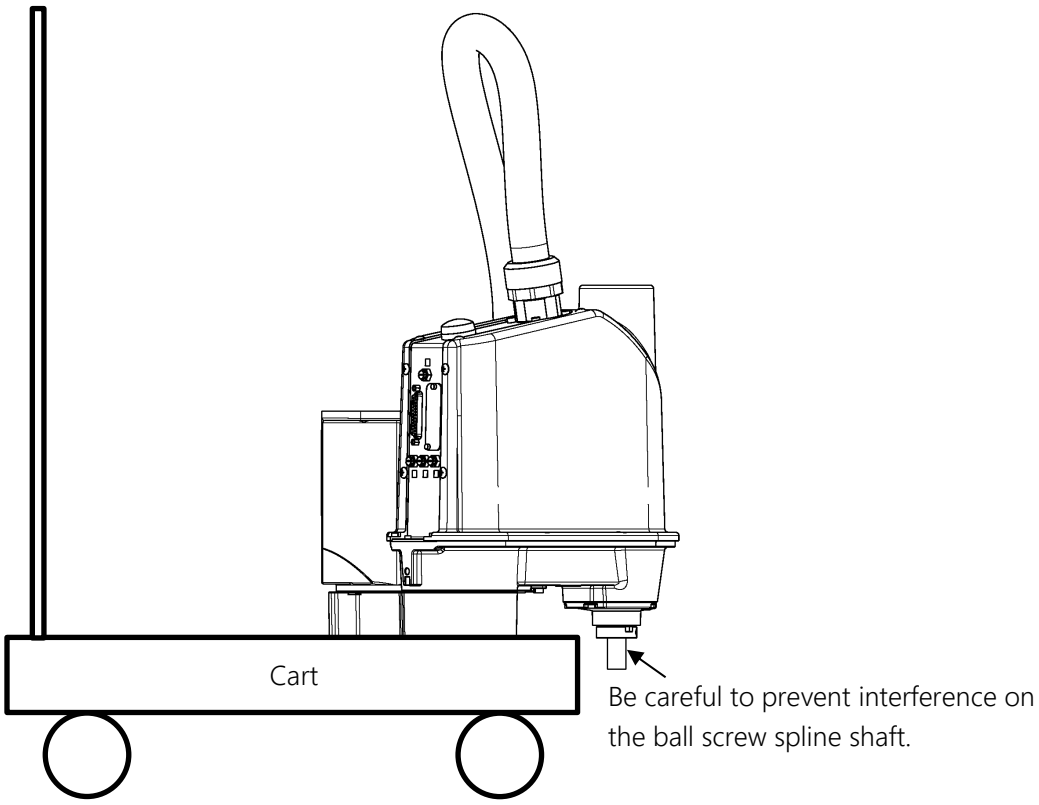


Fig. 2-3 Example of transporting the robot

⚠ CAUTION

- When lifting up the robot by workers, hold the gray portions by hands as shown in Fig. 2-2
  If the arm 2 cover, body harness, or ball screw spline shaft is held by hands, an unusually large force is exerted, resulting in a malfunction.
- When carrying the robot by workers, take careful precautions to prevent their hand or leg from being caught in the equipment.
- The work should be performed by two (2) or more workers.
- NEVER touch the ball screw spline shaft by bare hands.
  Touching it by bare hands leads to early rust development. Be sure to wear the gloves.

2.5 Storage

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

2.5.1 Storage Precautions for the Robot

⚠ CAUTION

- Secure the base completely to prevent the robot from falling over.
  When placed directly on the floor, the robot is unstable and will fall over.
- Keep the robot away from direct sunlight, high temperature and high humidity.
  The resin covers and timing belts may deteriorate.
- Seal the equipment in a vinyl bag to prevent rust development and contaminant. Put a desiccant in the bag to absorb moisture.
  As the ball screw spline shaft is susceptible to rust development, coat it with corrosion inhibitor or grease the entire ball screw spline shaft.
  For the application method, see "STA1105 KHE400 Robot Manual."
- Before the use, apply the grease to the ball screw spline 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. (See "STA1105 KHE400 Robot Manual.")

3. Installation of the Robot

The worker should receive safety training defined by each country's laws and regulations.
Be aware that the failure and accident resulting from the work done by the customer will not be under our warranty.

Recommended protector:

Type and name	Protection part and use	Recommended example
Helmet	Protection part: Head Use: Protect from a falling object. Protect from collision with the arm.	
Safety glasses	Protection part: Eyes Use: Protect from a flying object. Protect from collision with the arm.	
Protective gloves	Protection part: Hands and fingers Use: Protect hands and fingers when caught in the machine. Prevent a carried object from dropping.	
Protective shoes	Protection part: Feet and toes Use: Protect from a falling object.	

3.1 Installation Environment

Table 1 shows the environmental conditions for the location in which the robot are to be installed.

Table 1 Environmental conditions for robot

Item	Specifications
Temperature	In operation: 0 to 40°C In storage: -10°C to 50°C
Humidity	20 to 80% (Non-condensing) DO NOT install the equipment 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.
IP (Ingress Protection) rating	Equivalent to IEC60529 IP10 (robot side), and equivalent to IP20 (for the controller)
Overvoltage category	IEC60664-1 Class III

Item	Specifications
Protection against electric shock	IEC61140 Class I
Pollution degree	IEC60664-1 Pollution Degree 3
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 environmental requirements	No iron powder, no oil, no salt content, and no organic solvent. No water splash on the robot/controller.

⚠ DANGER

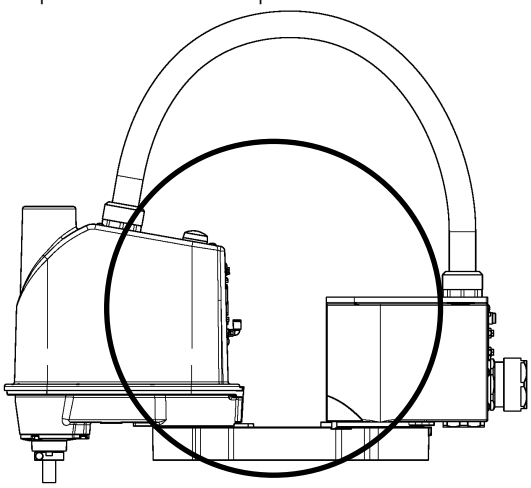
- Do not place the robot or controller near combustible.
  Doing so could lead to fires if it ignites due to a fault, etc.

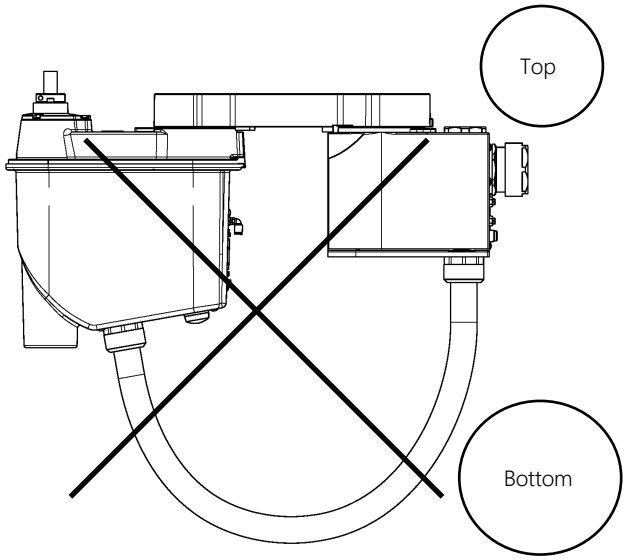
⚠ CAUTION

- 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 temperature can reduce the performance and lifespan of the battery.
  If using the robot under high temperatures, please consult with the CKD sales office.
- If the robot is operated at high speed when started in a low-temperature environment, the torque increases, and an error can occur.
  In a low-temperature environment, be sure to operate the robot at low speed in continuous operation mode for several minutes after starting it, which softens the grease. Then, change to high-speed operation.

3.2 Installation

Before the robot can be installed, the installation layout must be studied in consideration of the working envelope, the coordinate system, and the maintenance clearance. Use of this robot in other than a suspended attitude is prohibited.





3.2.1 Installing the Robot

The robot is secured by using the mounting holes on the base (six (6) places).
Use attached hexagon socket head cap screws M8×20.
Table 2 lists the load on the frame during horizontal movement, and Fig. 3-1 shows the robot installation method. Place the robot on the pallet and use the forklift to bring it to the installation frame. The pinholes are provided on the base unit. If the robot position is to be aligned in the base coordinate system or the robot must be replaced, the robot can be positioned by the pinholes.

⚠ 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.
- Install the robot on a level place.
  Failure to do so could lead to a drop in performance or faults.
- When transporting the robot to the frame using the lifter, do work slowly with the robot kept in low position.
- When transporting the robot to the frame using the lifter, the robot may tilt and fall; therefore, transport it with a hand on the robot.
  Be careful to prevent a hand from being caught.
- When raising the robot to the installation surface using the lifter, do work slowly.
- Secure the frame to the external area (floor or wall), and do not move it.

Table 2 Load on the frame during horizontal movement

Model	Load on the frame during horizontal movement (Nm)	Robot body mass (kg)
KHE400-T	150	15

*This value is a reference value. When designing the frame, consider safety factor.

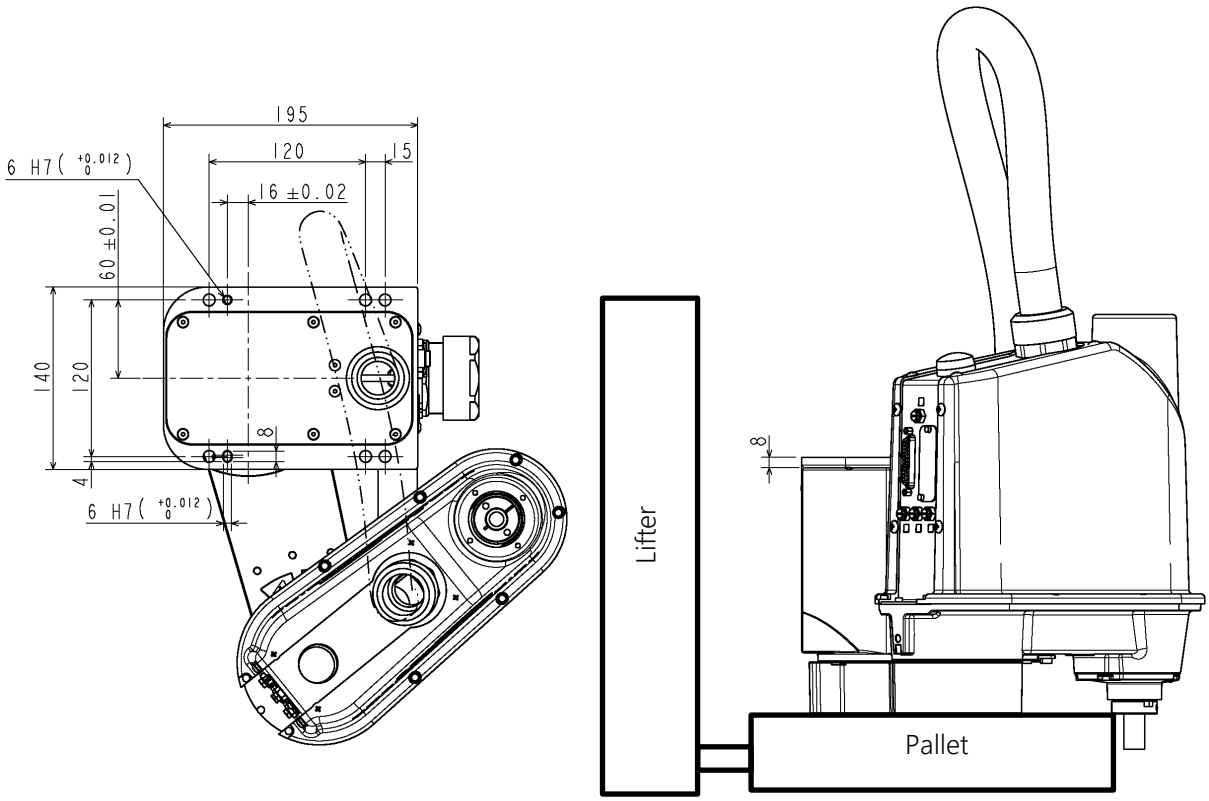


Fig. 3-1 Setting method (KHE400-T)

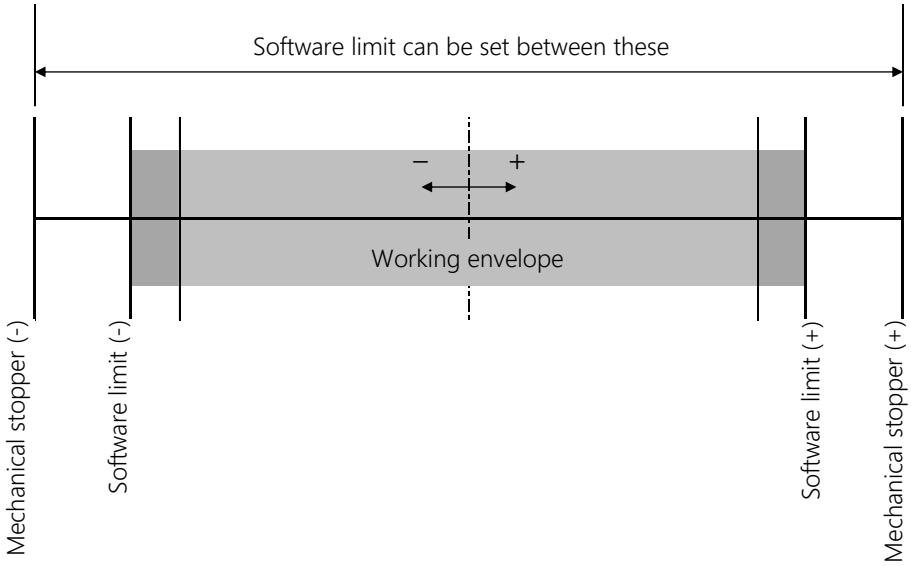
3.2.2 Operating Range

Fig. 3-2 shows the operating range.

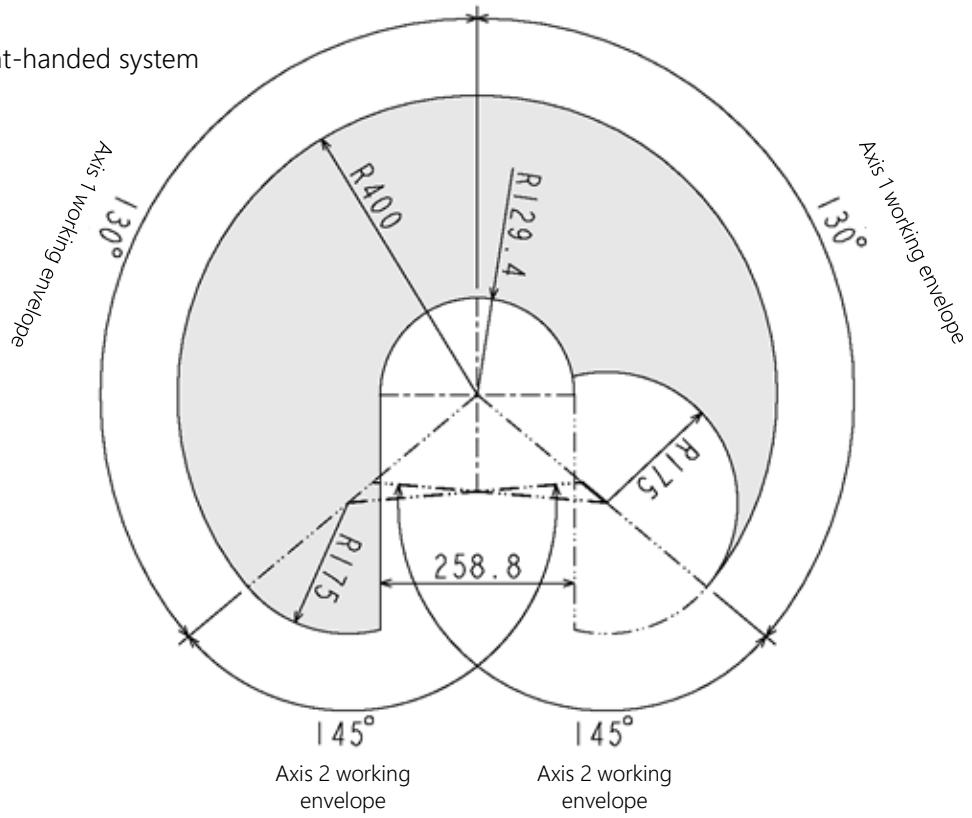
Each axis can operate within the working envelope. To prevent the equipment from moving out of the working envelope by misoperation, the robot is equipped with mechanical stoppers outside the working envelope.

Additionally, there are software limits that the user can set up.

For details, refer to the "ST80725 User Parameters Instruction Manual" provided separately.



For right-handed system



For left-handed system

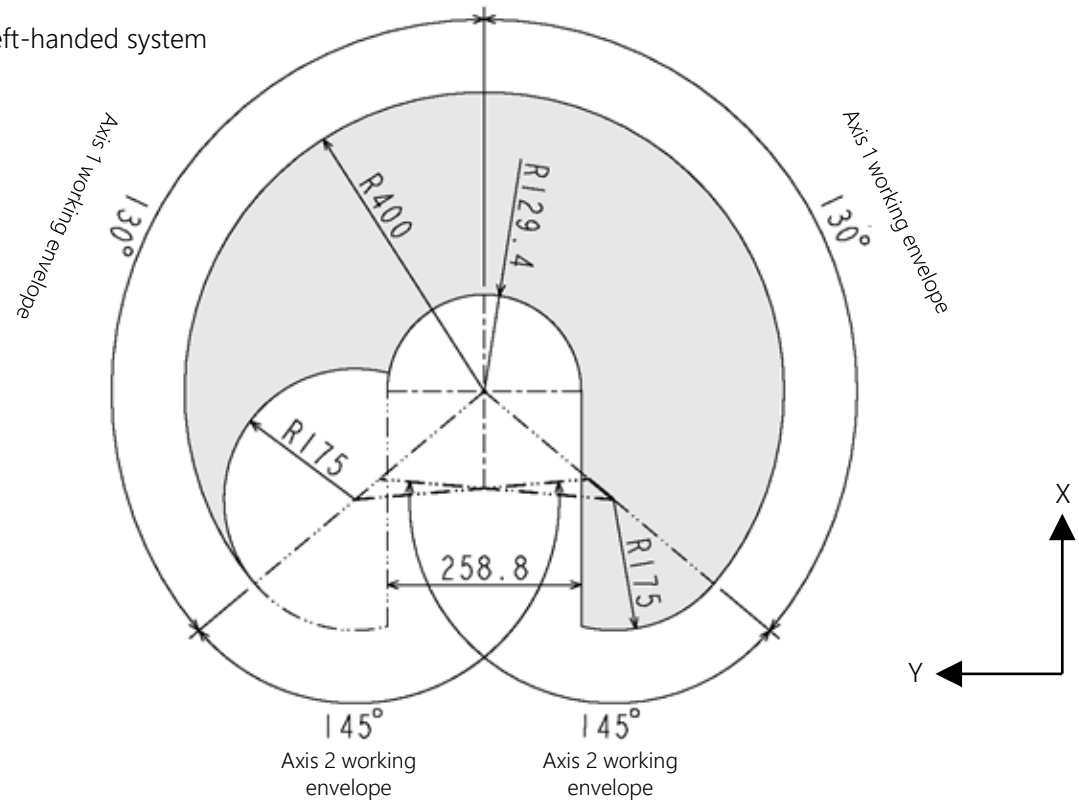


Fig. 3-2 Operating range

3.2.3 Changing axis-1 and 2 working envelope

The robot is equipped with the mechanical stoppers to restrict the working envelop of each axis mechanically. Changing the mechanical working envelope of the robot by changing this mechanical stoppers refers to "working envelope change."
This section explains how to change axis-1 and 2 working envelope of the robot.

The method for changing the axis-3 and axis-4 working envelopes is the same as that for the standard machine. Therefore, for the method, see the "STA1105 KHE400 Robot Manual."

⚠ CAUTION

- If a working envelope is to be changed, design and manufacture mechanical stoppers in accordance with your operating conditions, referring to this manual.
- If a working envelope is changed after the mechanical stoppers, be sure to change the software limits in order to prevent the robot from coming into contact with the mechanical stoppers during operation.
- The mechanical stoppers are not to strictly limit the movable range of the robot.
  Do not go into the robot's working envelope when you turn on the robot.
- If the robot collides with a mechanical stopper, the robot will stop by recognizing the collision, but the mechanical stopper may be damaged. Do not use the mechanical stopper any more.
- The mechanical stopper reference drawings in this manual do not satisfy your operating conditions. Design, manufacture, and mount mechanical stoppers in accordance with your operating conditions such as the working envelope.
- A failure of the robot arising from mechanical stoppers is excluded from the warranty.
- If mechanical stoppers are changed, the function described in "How to Restore Data by HOME3 or HOME4" is disabled.

As shown in Fig. 3-3 and Fig. 3-6, the working envelope can be changed by changing the position of mechanical stoppers.

Table 3 Working envelope before and after change

		Before change	After change
Axis-1 working envelope	+ direction	130°	95°
	- direction	130°	95°
Axis-2 working envelope	+ direction	145°	120°
	- direction	145°	145°

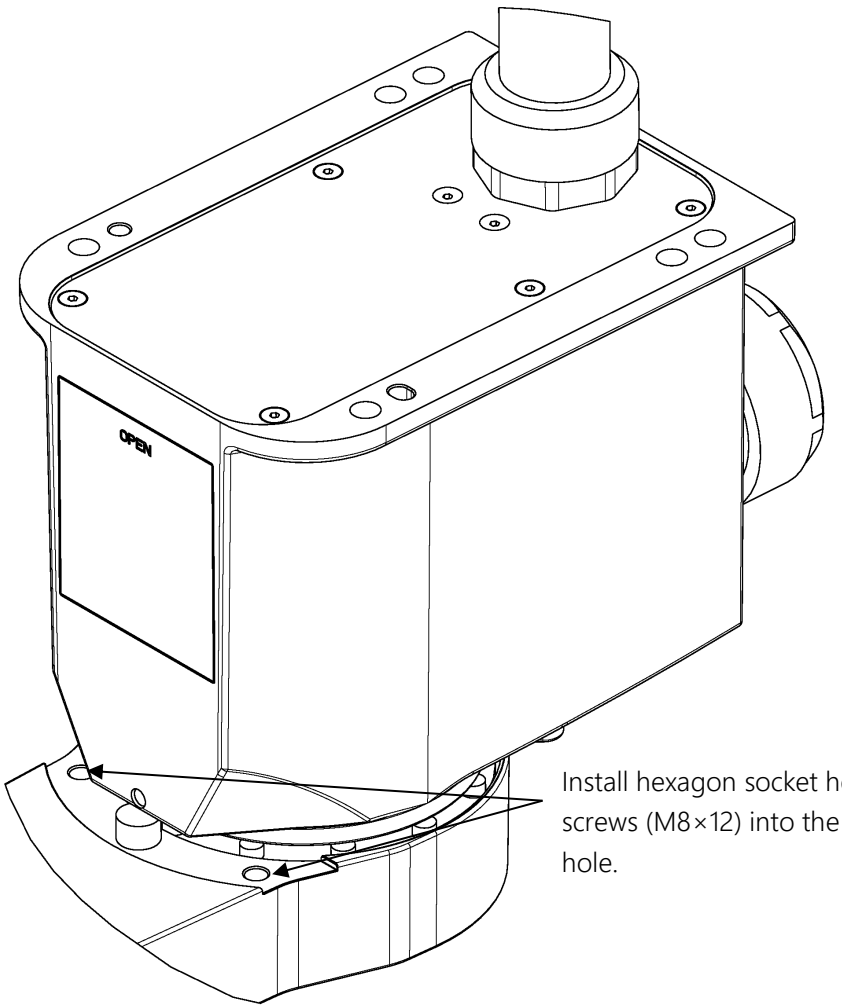


Fig. 3-3 Example of changing axis-1 working envelope

When the axis-2 working envelope is changed, it can be set to any working envelope by changing the shapes of mechanical stoppers. Fig. 3-4 shows the mounting position of the axis-2 mechanical stoppers, and Fig. 3-5 shows the example of changing the axis-2 mechanical stopper. The customer should design and manufacture the mechanical stoppers as required.

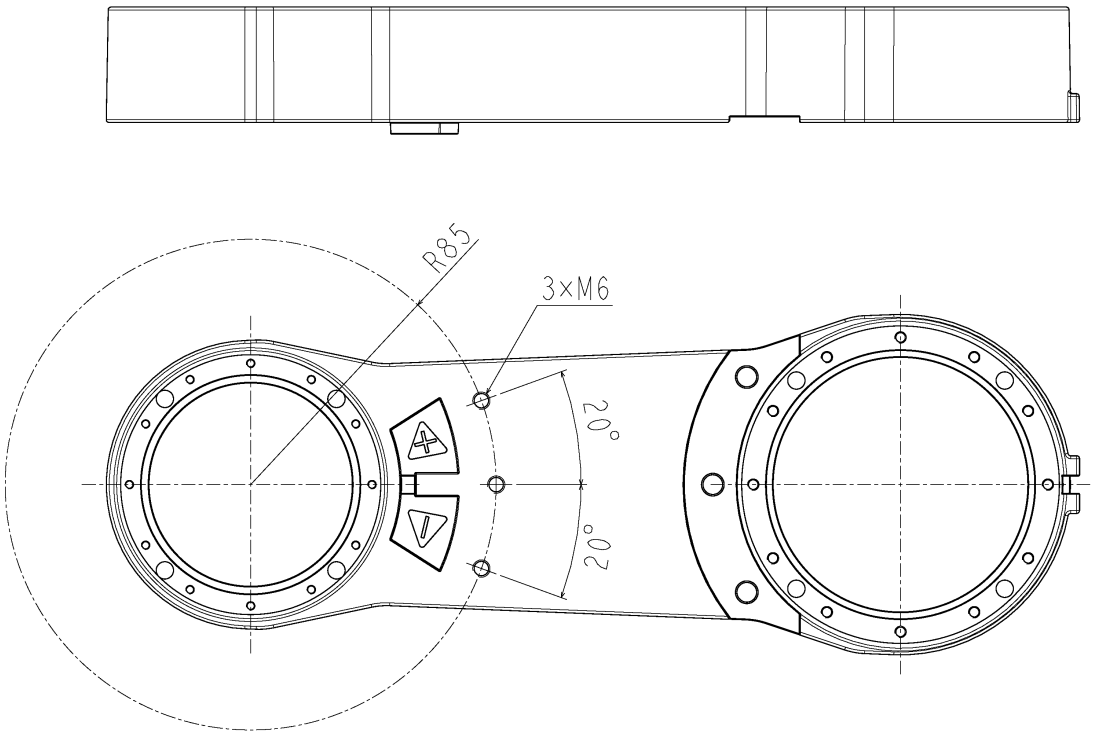


Fig. 3-4 Mounting position of axis-2 mechanical stopper

Example of changing axis-2 mechanical stopper
Set working envelope: 120°, -145°

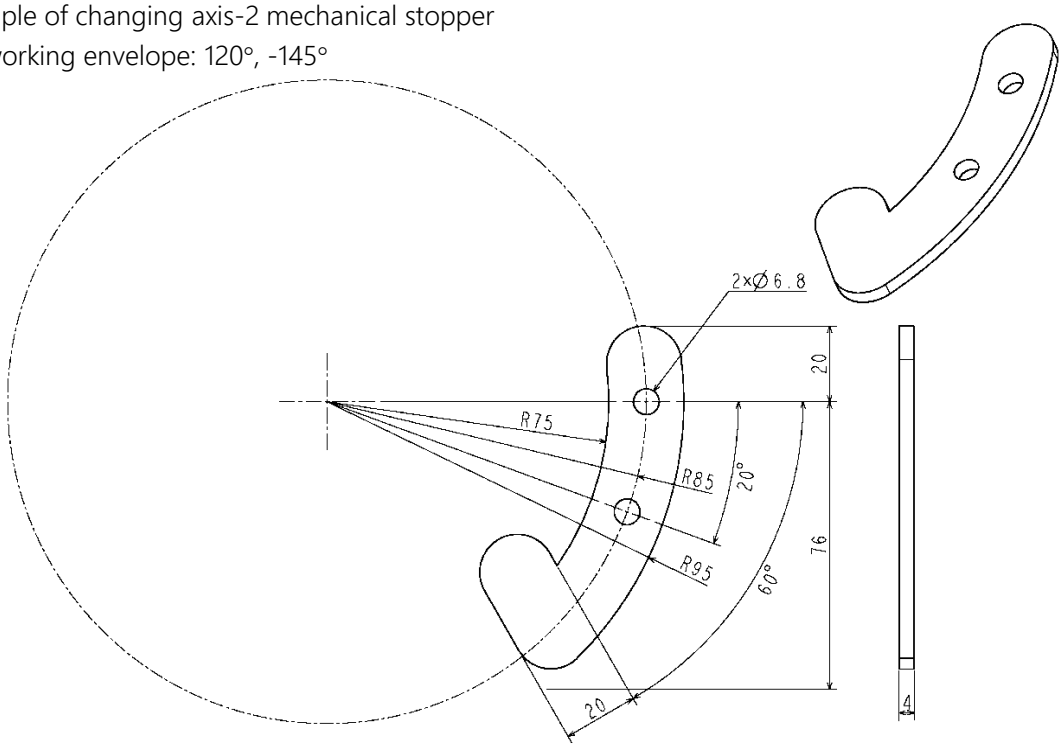


Fig. 3-5 Example of changing axis-2 mechanical stopper

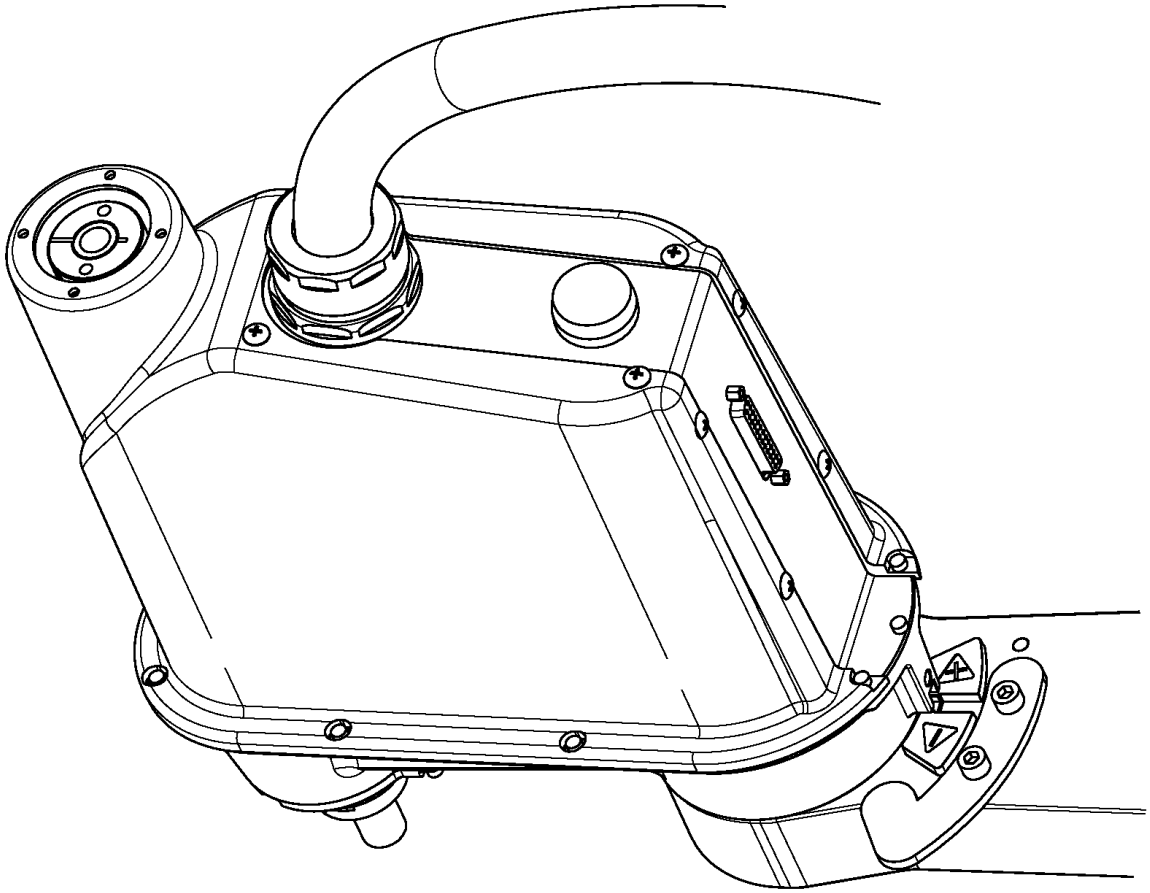


Fig. 3-6 Example of changing axis-2 working envelope

If a working envelope is changed, user parameter must be changed.
For how to change the software limit, see "STA1105 KHE400 Robot Manual."

4. Setting Hand

The worker should receive safety training for laborer engaged in industrial robot-related work defined by each country's laws and regulations.

Be aware that failure and accident resulting from the work done by the customer will not be under our warranty.

Recommended protector:

Type and name	Protection part and use	Recommended example
Helmet	Protection part: Head Use: Protect from a falling object. Protect from collision with the arm.	
Safety glasses	Protection part: Eyes Use: Protect from a flying object. Protect from collision with the arm.	
Protective gloves	Protection part: Hands and fingers Use: Protect hands and fingers when caught in the machine. Prevent a carried object from dropping.	
Protective shoes	Protection part: Feet and toes Use: Protect from a falling object.	

4.1 Mounting hand

Mounting the hand is the same as that for the standard machine. For details, see the "STA1105 KHE400 Robot Manual."

4.2 Mounting camera and air valve

Mounting the hand is the same as that for the standard machine. For details, see the "STA1105 KHE400 Robot Manual."

4.3 Hand air piping

The hand air piping should be installed by the customer. Fig. 4-1 shows an example of installing hand air piping for reference.

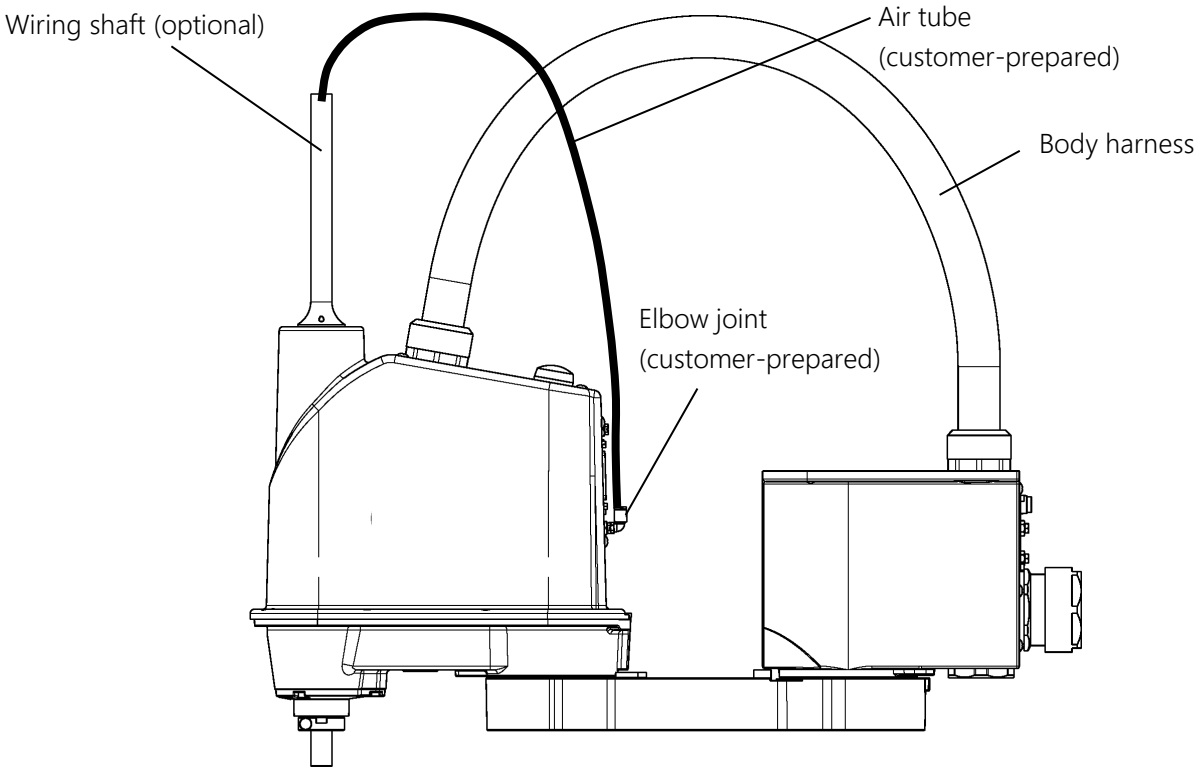


Fig. 4-1 Example of hand air piping and wiring

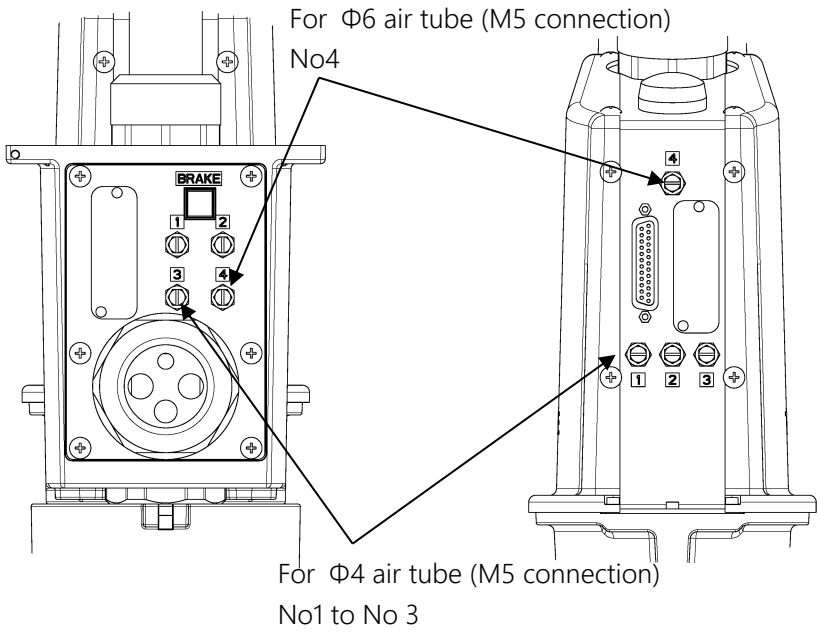


Fig. 4-2 Configuration of hand air piping

Table 4 Extension shaft (optional)

Product name	Type	Shibaura Dwg. No.	Unit code
Wiring shaft		L19080G01	Y610D05Z0

⚠ CAUTION

- The air tube is a consumable product. Check the state by periodic inspection, and replace the air tube if it is damaged.
- The solenoid valve air tubes should be prepared by the customer.
- Fig. 4-1 shows a piping example. Note that the damaged air tube is not under our warranty.
- Wiring together with the body harness imposes forcible force on the body harness, which can lead to break.

4.4 Permissible load conditions and program setting

Mounting the hand is the same as that for the standard machine. For details, see the "STA1105 KHE400 Robot Manual." This section describes the permissible load conditions of the robot and how to set up the program according to the load.

5. User Wiring

The worker should receive safety training defined by each country's laws and regulations.
Be aware that the failure and accident resulting from the work done by the customer will not be under our warranty.

5.1 Hand wiring

Hand wiring is controlled from the controller or from separately placed PLC (prepared by the customer).

5.1.1 Wiring controlled from the controller

Eight input signals for components such as sensors, eight control signals for components such as solenoid valves, 24 VDC/PGND are provided as hand wiring and connected to the controller. Fig. 5-4 to Fig. 5-7 are the wiring diagrams. The wiring is connected to the connector on the arm-2 rear.
Prepare the attached connector and connect the cable.
D-SUB connector (standard) type: <Shell> XM2S-2511 (manufacturer: OMRON)
<Connector> XM3A-2521 (manufacturer: OMRON)
Applicable cross sectional area of wire conductor AWG 22 to 28 (single wire and twisted wire)
The connector and wires are connected by soldering.
The signal line from the controller passes inside the robot and is wired to hand wiring connector "CN0."
Connect the manufactured cable connector to "CN0."

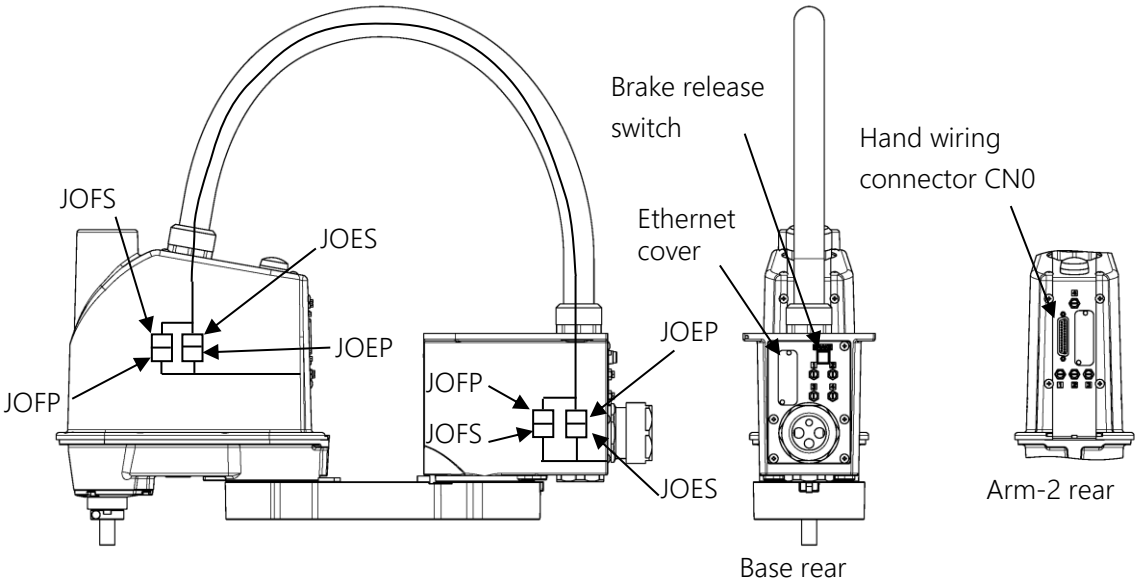


Fig. 5-1 Hand wiring

The CN0 connector is normally placed on the arm-2 rear shown in Fig. 5-1. However, it can be moved to the base. Fig. 5-2 shows how to move the connector.

The connector can be removed from Arm 2 and connected to the base side.
When it is passed through inside the base, the ethernet cover is removed and the notch is used.
After the wire is passed inside the base, it is connected with JOES and JOFS.
Block the notch hole with grommet.

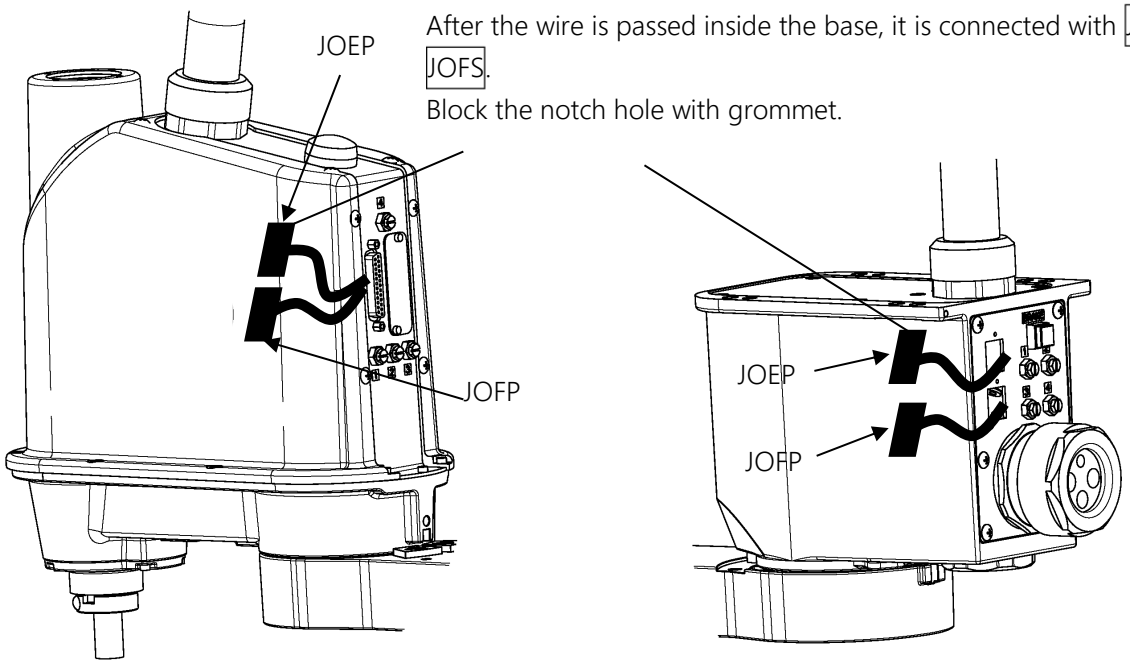


Fig. 5-2 Moving CN0 connector

5.1.2 Wiring controlled from separately placed PLC

If wiring is controlled from separately placed PLC, the base rear cover is removed from the base unit.
After the base rear cover is removed, rear side connectors JOES and JOFS are disconnected, passed through the notch of the base rear cover, and connected to the cable from PLC.
From JOES and JOFS on, prepare the following plug connectors and connect the cable.

Connector type:	JOES	SMP-10V-BC (J.S.T. MFG. (JST))
	JOFS	SMP-11V-BC (J.S.T. MFG. (JST))
Contact type:		BHF-001T-0.8SS (J.S.T. MFG. (JST))
Applicable wire:		Cross sectional area of conduct AWG 22 to 28

Mating connector type

Connector type	JOEP	SMR-10V-B (J.S.T. MFG. (JST))
	JOFP	SMR-11V-B (J.S.T. MFG. (JST))
Contact type		BYM-001T-0.6 (J.S.T. MFG. (JST))

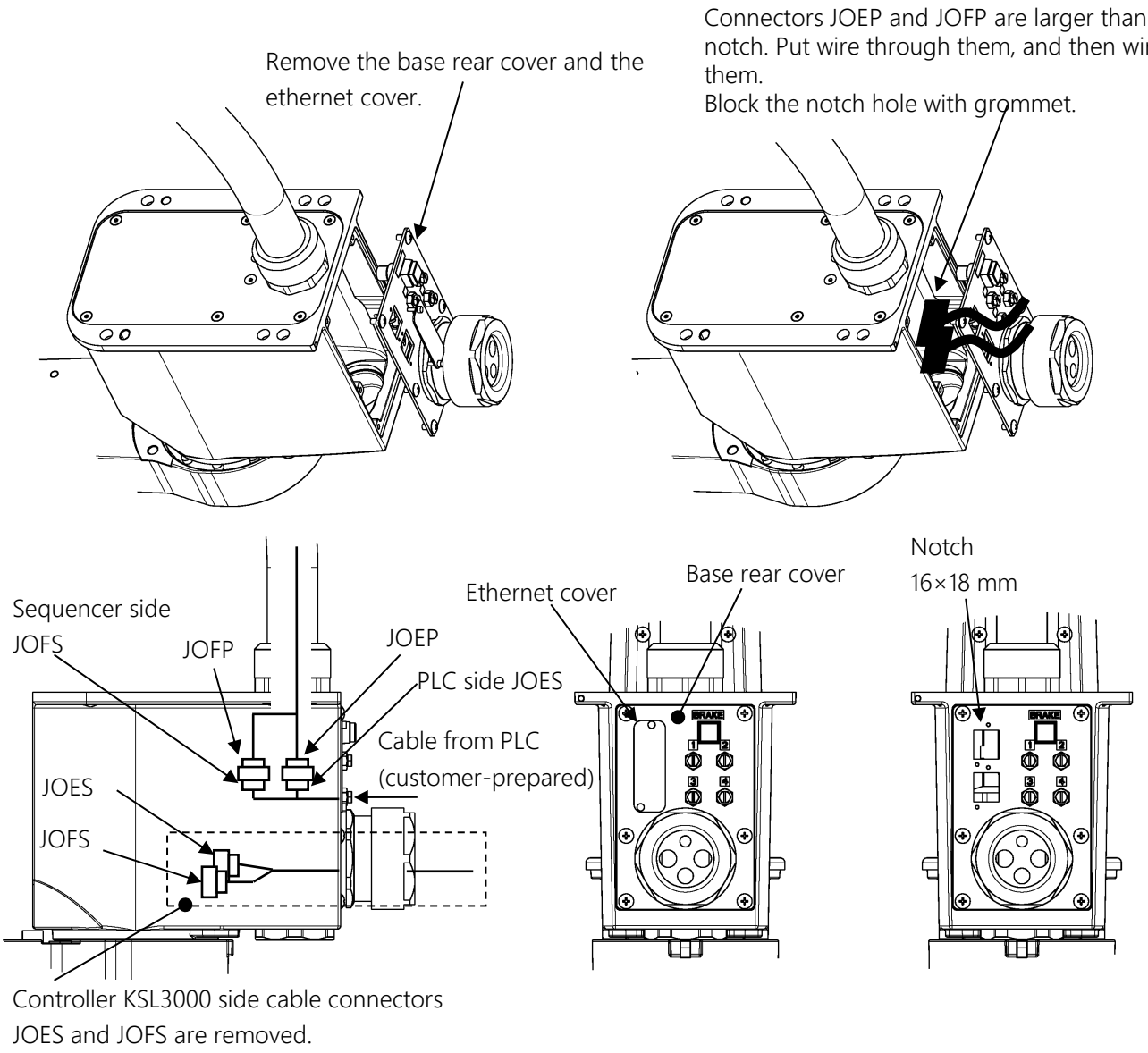


Fig. 5-3 Wiring to PLC

5.1.3 Specifications of hand connector CN0

The CN0 specifications are the same as those for the standard machine. For details, see the "STA1105 KHE400 Robot Manual."

The items that are different from those for the standard machine are described below.

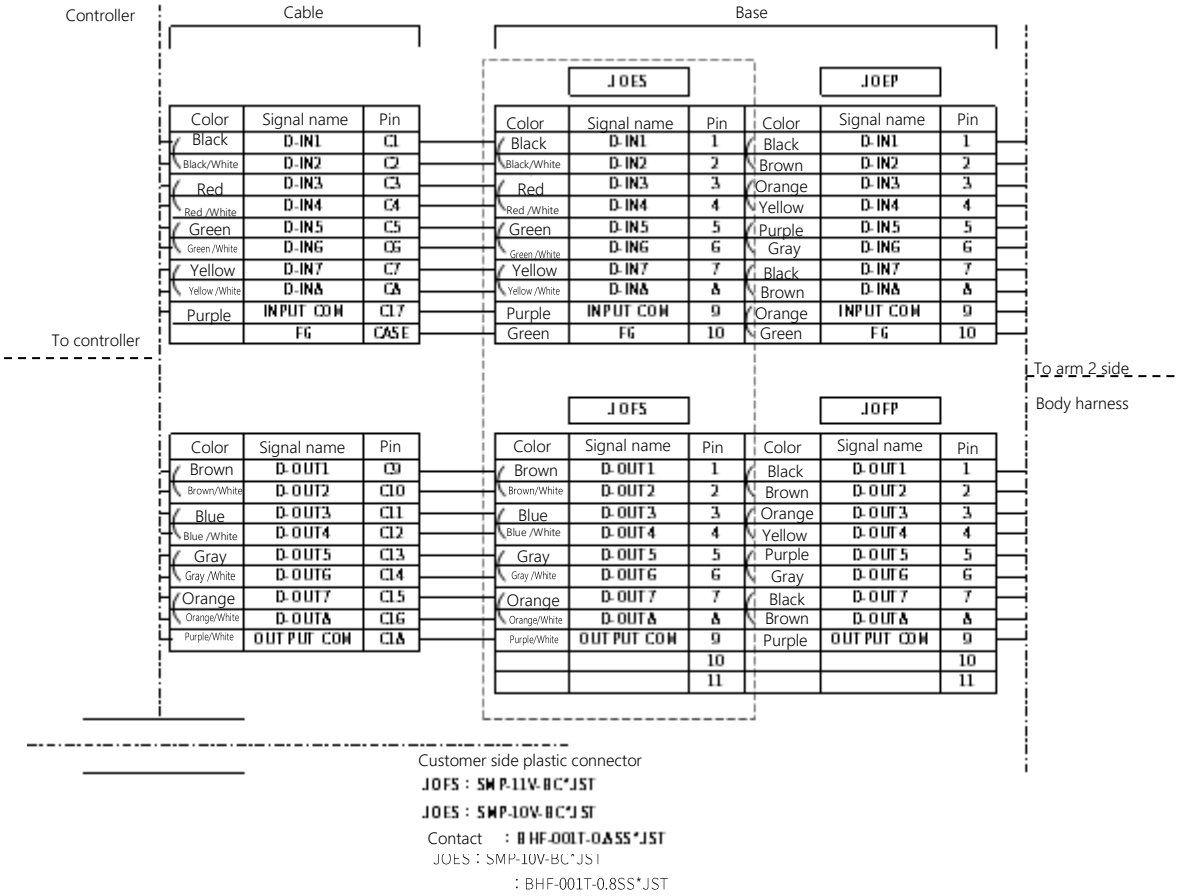
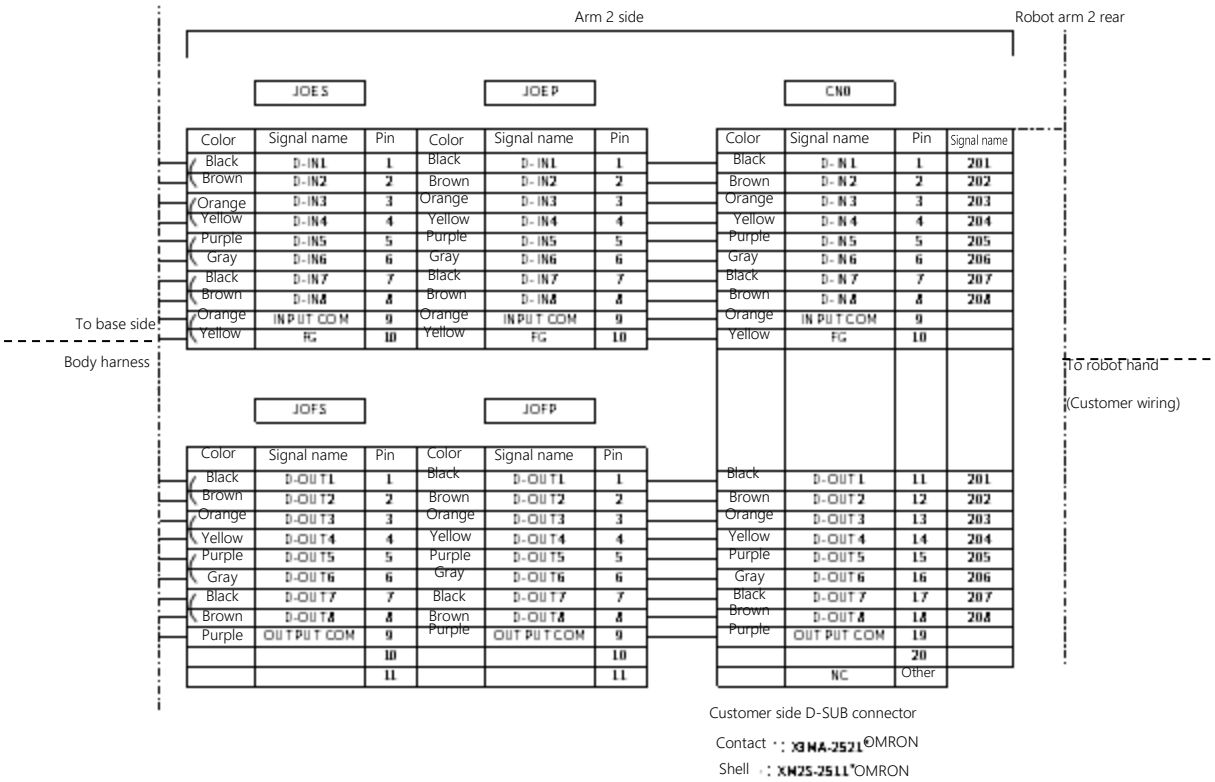


Fig. 5-4 Hand wiring diagram base side (common to Type-N, P KSL3000)



Color	Signal name	Pin
Black	D-IN1	1
Brown	D-IN2	2
Orange	D-IN3	3
Yellow	D-IN4	4
Purple	D-IN5	5
Gray	D-IN6	6
Black	D-IN7	7
Brown	D-IN8	8
Orange	INPUT COM	9
Yellow	FG	10

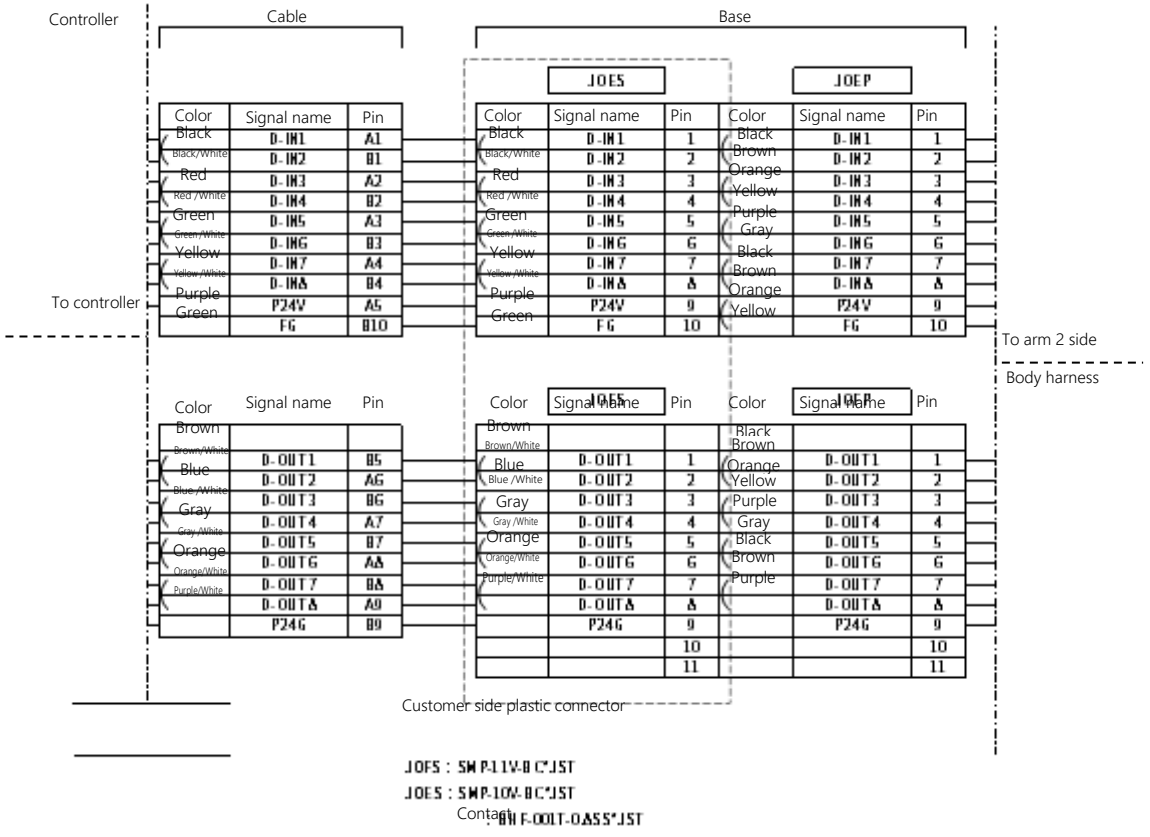
Color	Signal name	Pin
Black	D-IN1	1
Brown	D-IN2	2
Orange	D-IN3	3
Yellow	D-IN4	4
Purple	D-IN5	5
Gray	D-IN6	6
Black	D-IN7	7
Brown	D-IN8	8
Orange	INPUT COM	9
Yellow	FG	10

Color	Signal name	Pin	Signal name
Black	D-IN1	1	201
Brown	D-IN2	2	202
Orange	D-IN3	3	203
Yellow	D-IN4	4	204
Purple	D-IN5	5	205
Gray	D-IN6	6	206
Black	D-IN7	7	207
Brown	D-IN8	8	208
Orange	INPUT COM	9	
Yellow	FG	10	

Color	Signal name	Pin
Black	D-OUT1	1
Brown	D-OUT2	2
Orange	D-OUT3	3
Yellow	D-OUT4	4
Purple	D-OUT5	5
Gray	D-OUT6	6
Black	D-OUT7	7
Brown	D-OUT8	8
Purple	OUTPUT COM	9
		10
		11

Color	Signal name	Pin
Black	D-OUT1	1
Brown	D-OUT2	2
Orange	D-OUT3	3
Yellow	D-OUT4	4
Purple	D-OUT5	5
Gray	D-OUT6	6
Black	D-OUT7	7
Brown	D-OUT8	8
Purple	OUTPUT COM	9
		10
		11

Color	Signal name	Pin	Signal name
Black	D-OUT1	11	201
Brown	D-OUT2	12	202
Orange	D-OUT3	13	203
Yellow	D-OUT4	14	204
Purple	D-OUT5	15	205
Gray	D-OUT6	16	206
Black	D-OUT7	17	207
Brown	D-OUT8	18	208
Purple	OUTPUT COM	19	
		20	
	NC	Other	



Color	Signal name	Pin
Black	D-IN1	A1
Black/White	D-IN2	B1
Red	D-IN3	A2
Red /White	D-IN4	B2
Green	D-IN5	A3
Green /White	D-IN6	B3
Yellow	D-IN7	A4
Yellow /White	D-IN8	B4
Purple	P24V	A5
Green	FG	B10

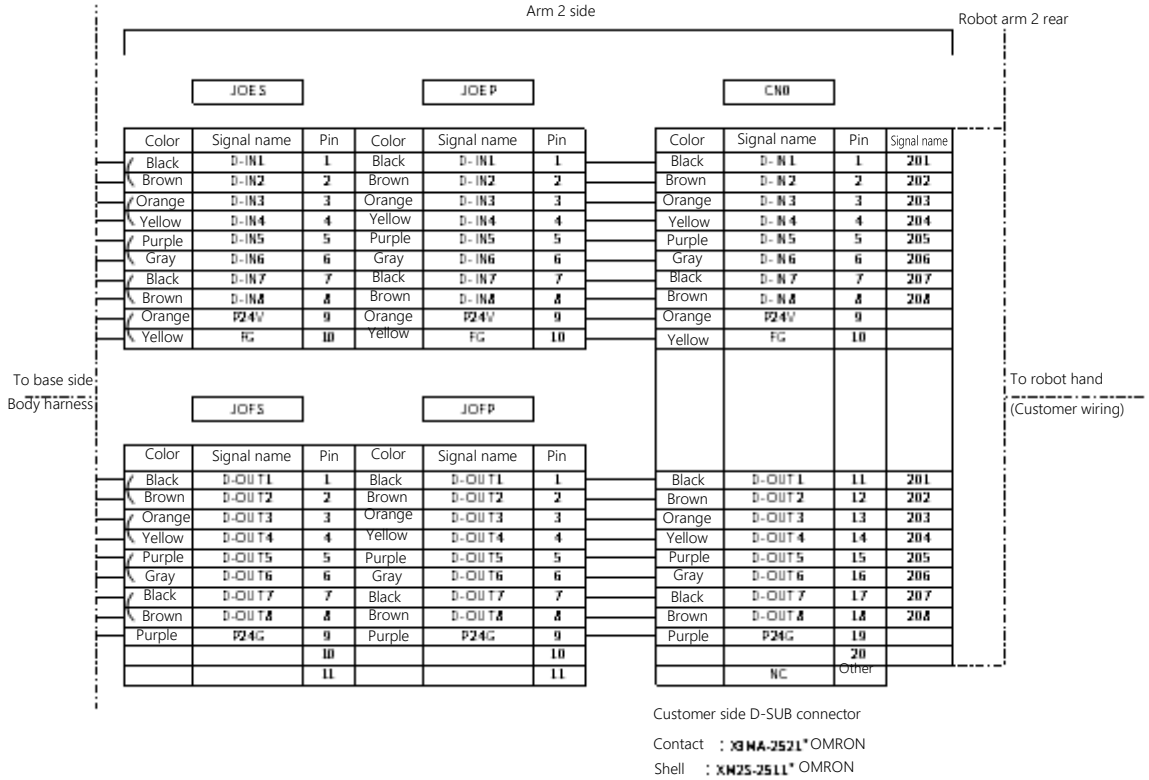
Color	Signal name	Pin
Black	D-IN1	1
Black/White	D-IN2	2
Red	D-IN3	3
Red /White	D-IN4	4
Green	D-IN5	5
Green /White	D-IN6	6
Yellow	D-IN7	7
Yellow /White	D-IN8	8
Purple	P24V	9
Green	FG	10

Color	Signal name	Pin	Signal name
Black	D-IN1	1	1
Brown	D-IN2	2	2
Orange	D-IN3	3	3
Yellow	D-IN4	4	4
Purple	D-IN5	5	5
Gray	D-IN6	6	6
Black	D-IN7	7	7
Brown	D-IN8	8	8
Orange	P24V	9	9
Yellow	FG	10	10

Color	Signal name	Pin
Brown		
Brown/White		
Blue	D-OUT1	B5
Blue /White	D-OUT2	A6
Gray	D-OUT3	B6
Gray /White	D-OUT4	A7
Orange	D-OUT5	B7
Orange/White	D-OUT6	A8
Purple/White	D-OUT7	B8
	D-OUT8	A9
	P24G	B9

Color	Signal name	Pin
Brown		
Brown/White		
Blue	D-OUT1	1
Blue /White	D-OUT2	2
Gray	D-OUT3	3
Gray /White	D-OUT4	4
Orange	D-OUT5	5
Orange/White	D-OUT6	6
Purple/White	D-OUT7	7
	D-OUT8	8
	P24G	9
		10
		11

Color	Signal name	Pin	Signal name
Black			
Brown			
Orange	D-OUT1	1	1
Yellow	D-OUT2	2	2
Purple	D-OUT3	3	3
Gray	D-OUT4	4	4
Black	D-OUT5	5	5
Brown	D-OUT6	6	6
Purple	D-OUT7	7	7
	D-OUT8	8	8
	P24G	9	9
		10	10
		11	11



Color	Signal name	Pin
Black	D-IN1	1
Brown	D-IN2	2
Orange	D-IN3	3
Yellow	D-IN4	4
Purple	D-IN5	5
Gray	D-IN6	6
Black	D-IN7	7
Brown	D-IN8	8
Orange	P24V	9
Yellow	FG	10

Color	Signal name	Pin
Black	D-IN1	1
Brown	D-IN2	2
Orange	D-IN3	3
Yellow	D-IN4	4
Purple	D-IN5	5
Gray	D-IN6	6
Black	D-IN7	7
Brown	D-IN8	8
Orange	P24V	9
Yellow	FG	10

Color	Signal name	Pin	Signal name
Black	D-IN1	1	201
Brown	D-IN2	2	202
Orange	D-IN3	3	203
Yellow	D-IN4	4	204
Purple	D-IN5	5	205
Gray	D-IN6	6	206
Black	D-IN7	7	207
Brown	D-IN8	8	208
Orange	P24V	9	
Yellow	FG	10	

Color	Signal name	Pin
Black	D-OUT1	1
Brown	D-OUT2	2
Orange	D-OUT3	3
Yellow	D-OUT4	4
Purple	D-OUT5	5
Gray	D-OUT6	6
Black	D-OUT7	7
Brown	D-OUT8	8
Purple	P24G	9
		10
		11

Color	Signal name	Pin
Black	D-OUT1	1
Brown	D-OUT2	2
Orange	D-OUT3	3
Yellow	D-OUT4	4
Purple	D-OUT5	5
Gray	D-OUT6	6
Black	D-OUT7	7
Brown	D-OUT8	8
Purple	P24G	9
		10
		11

Color	Signal name	Pin	Signal name
Black	D-OUT1	11	201
Brown	D-OUT2	12	202
Orange	D-OUT3	13	203
Yellow	D-OUT4	14	204
Purple	D-OUT5	15	205
Gray	D-OUT6	16	206
Black	D-OUT7	17	207
Brown	D-OUT8	18	208
Purple	P24G	19	
		20	
	NC	Other	

Maintenance Manual

This manual describes how to maintain respective units of the KHE series robot.

6. Maintenance Outline

The basic structure of the ceiling type specifications is the same as that for the standard machine although the fitting orientation of the arm is different.
For other inspection items, see the "SM-A20045-A5 KHE-400 Robot Manual."
The items that are different from those for the standard machine are described below.

6.1 Configuration of Mechanical Components

Fig. 6-1 shows the configuration of mechanical components.

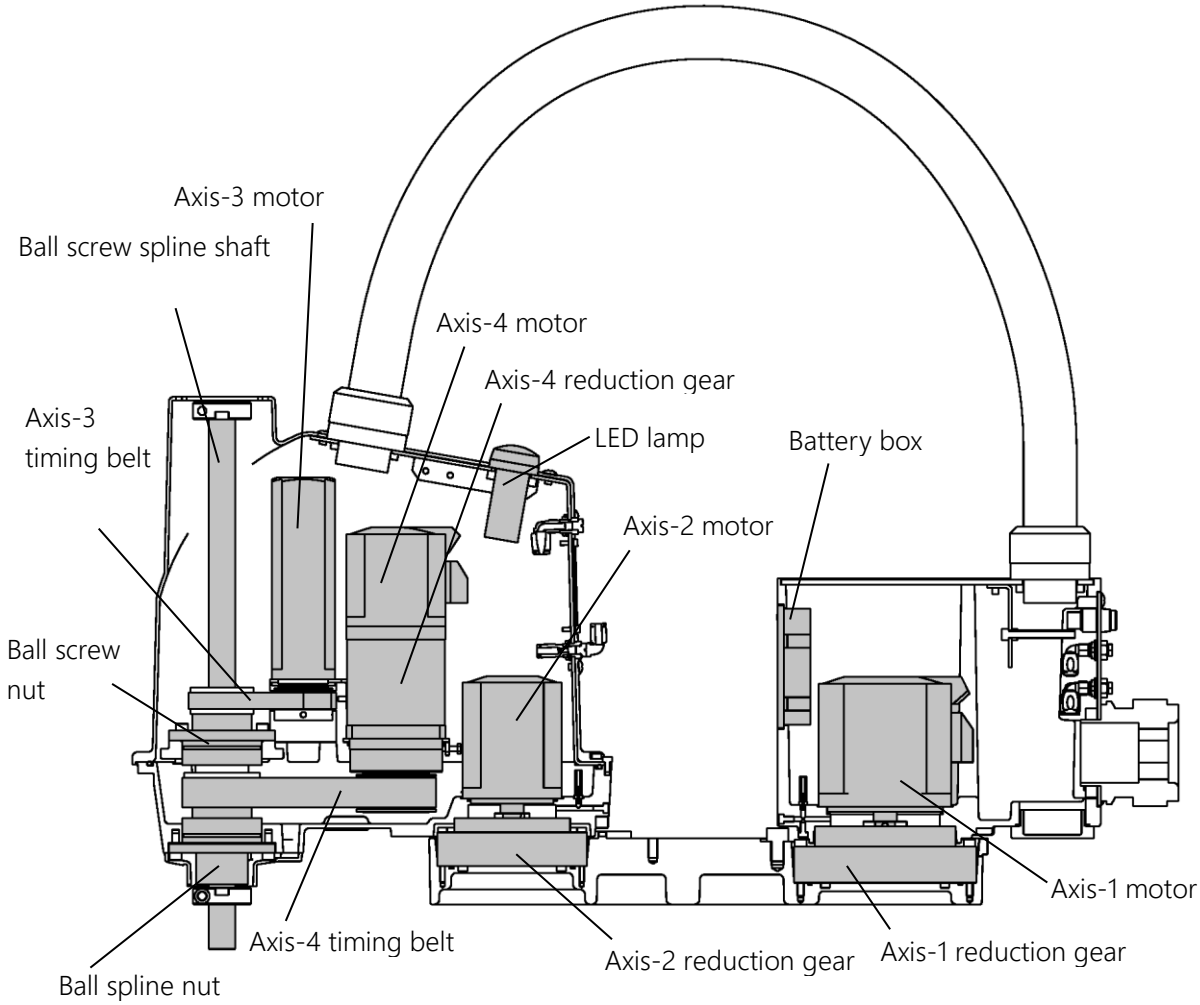


Fig. 6-1 Configuration of mechanical components

7. Replacement Parts for Maintenance

7.1 Notes on Replacement Parts for Maintenance

⚠ CAUTION

- In the list of maintenance and replacement parts for the robot, items other than encoder backup battery is all special-specification products; therefore, when purchasing or ordering them, be sure to contact CKD.
- The worker should receive safety training for laborer engaged in industrial robot-related work defined by each country's laws and restrictions. CKD Service Department also accepts replacement work at an extra cost.
- Be aware that CKD' warranty does not cover failures and accidents resulting from the replacement of parts by the customer.

7.2 List of Replacement Parts – Robot

No	Part name	Model	Drawing No.	Unit code	Manufacturer	Q'ty	Remarks
1	AC servo motor		S948801	Y610D04M0	SHIBAURA MACHINE	1	Axis 1
2			S948802	Y610D04N0		1	Axis 2
3			S948803	Y610D04P0		1	Axis 3
4			S948804	Y610D04Q0		1	Axis 4
5	Reduction gear		S948805	Y610D04R0	SHIBAURA MACHINE	1	Axis 1
6			S948806	Y610D04S0		1	Axis 2
7			S958005	Y610D05P0		1	Axis 4
8	Timing pulley		S958020 * (B side)	Y610D04T0	SHIBAURA MACHINE	1	Axis 3
9			S958021 * (M side)			1	Axis 3
10			S958022 * (B side)			1	Axis 4
11			S958023 * (M side)			1	Axis 4
12	Timing belt		S958024			1	Axis 3
13			S958025			1	Axis 4
14	Ball screw spline unit		H852810	Y610A3NE0	SHIBAURA MACHINE	1	
15	Body harness		F127660	Y610D0A50	SHIBAURA MACHINE	1	
16	LED Lamp		M332780	Y610D05H0	SHIBAURA MACHINE	1	
17	Grease	SFB No.1 (For reduction gear)			Nidec-Shimpo Corp.		Axis 1 Axis 2
18		AFF grease (For ball screw)			THK		Axis 3
19	Encoder backup battery	Alkaline AA-cell battery				3	All axes

*(B side) means the ball screw side, and (M side) means the motor side.