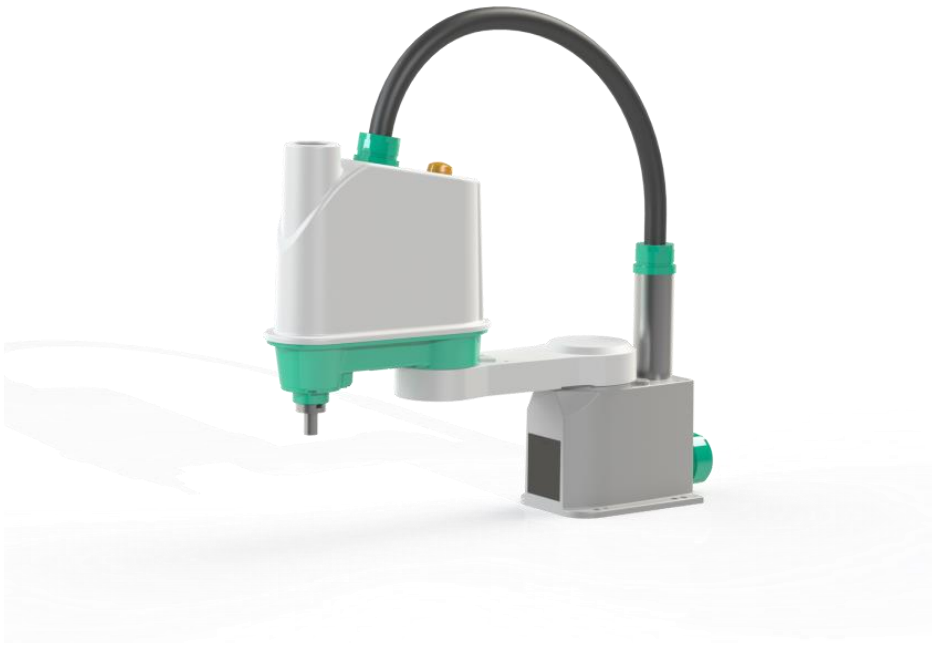
CKD

SCARA Robot

KHE Series Safety Manual

INSTRUCTION MANUAL

SM-A20047-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

This manual is applicable to the following robot.
KHE Series: KHE-400

Introduction

Thank you very much for your purchase of CKD's robot system.
This manual describes the safety measures for the system robot KHE series built by CKD.
Please read through this manual carefully and handle the robot according to the instructions given throughout the manual so that you can completely understand the performance of the robot and use its functions safety over the long years to come.

This manual has the following chapters.

- Use Range
  This chapter describes the use range intended by this product.

- Use Method
  This chapter describes main specifications and safe use method of this product.

- Warranty
  This chapter describes the scope of warranty.

- Standards, laws and regulations regarding safety of industrial robots
  This chapter describes main standards, laws and regulations that should be observed to use the robot.

- Safety Precautions
  This chapter describes important information on using the robot safely and properly.

- Service Network
  This chapter describes technical inquiry and service contact.

- Locations of Warning Labels
  This chapter describes the locations of warning labels affixed to the robot and controller.

- Safety Measures
  This chapter describes the safety functions of the robot and controller, and safety precautions for installing and operating the robot.

- Applicable Standards and Safety Measures
  This chapter describes the standards and safety measures with which the robot and controller are compliant.

Contents

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” in the Robot Manual.
2. Restrictions on Use: Tables 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	Refer to the Instruction Manual “THE Series Robot Manual: Specifications.”
	Axis 2	Refer to the Instruction Manual “THE Series Robot Manual: Specifications.”
	Axis 3	Refer to the Instruction Manual “THE Series Robot Manual: Specifications.”
	Axis 4	Refer to the Instruction Manual “THE Series Robot Manual: Specifications.”
	Additional axis	Conforms to individual Delivery 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 AY15enclosure.	
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.		
5. Person who approaches the machine		
Target	Knowledge, experience, and condition	
1) Transportation and install	Knowledge: Person who has understood the instruction manual	
	Experience: —	
	Condition: Person who has received training pertaining to 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 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 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: —	

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) CKD shall 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, CKD will 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 no that the range is limited.

(*1) Consumable parts refer to the replacement parts for maintenance as listed in instruction Manual “Robot Manual: Maintenance.”

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, international standard ISO/IEC defines “Guide 51” that groups various safety standards in a hierarchical 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 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 this manual in advance.

[Installation]

Safety precautions on transportation and installation are described. Refer to the Instruction Manual “THE Series Robot Manual: Installation” together with this manual to strictly observe the following items.

⚠ DANGER	
 Prohibited	• Do not 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 by CKD. 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. • Install the controller outside the dangerous area where the operator can watch the robot movements. Otherwise, it is very dangerous should the robot start during the controller operation. • 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. • For the controller, secure an ample space for ventilation. (For details, refer to the “TSL Series Controller Manual: Installation.”) Otherwise, the controller will heat and go wrong.
 Required	• When storing the robot, secure it to the base. The robot will be unstable if just set down without securing it, and it will tilt over.
 Caution	• When operating the robot after long-hour stop at a low temperature (10°C 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.

[Teaching and Operation]

Safety precautions on teaching and operation are described. Refer to the Instruction Manual “KSL3000 Series Robot Controller: Operation” together with this manual to strictly observe the following items.

⚠ DANGER	
 Prohibited	• During operation, NEVER enter the dangerous area of the robot. Otherwise, you will be injured seriously. (The dangerous area means the robot working area where a hazardous situation may occur if a person gets in.) • DO NOT leave in the working range any machinery or materials which will hinder the operation. If the equipment went wrong, a person nearby may be injured or involved in an accident. • Anyone other than the operator MUST NOT approach the equipment. Should a person other than the operator negligently touch a dangerous part of the equipment, the person may get injured or involved in a serious accident. • NEVER perform an inappropriate operation which is not described in the instruction manual. Otherwise, the equipment may malfunction, resulting in personal injury or serious accident.
 Required	• If you feel even a little that you are exposed to danger or the equipment works abnormally, press the EMERGENCY stop pushbutton switch to stop the equipment. If the equipment is used as it is, you may be injured or involved in a serious accident. When this happens, ask our after-sale service agent for repair. • During operation, be sure to close the equipment cover. Should the equipment cover be opened during operation, you may be struck by an electric shock or get injured. • Only a well-trained and qualified person is allowed to perform the operation. Should the equipment be operated improperly, it may malfunction, causing a personal injury or serious accident. • If the equipment becomes faulty, turn off the power, identify and remove the cause of the abnormality, maintain the peripheral equipment, and completely restore the faulty equipment. Then start the equipment at a low speed. If the abnormality is left, the equipment may malfunction, causing a serious accident.

⚠ WARNING	
 Prohibited	• NEVER enter the movable range of the robot. Otherwise, physical injury accident may result. • DO NOT bring your hand close to the movable part of the robot. Otherwise, your hand may get caught and injured.

⚠ CAUTION	
 Prohibited	• DO NOT change the data of the system parameter file other than USER.PAR without prior permission. Otherwise, the robot will operate abnormally, resulting in damage or an accident.
 Required	• In principle, teaching operation should be performed outside the dangerous area of the robot. (The dangerous area means the robot working area where a hazardous situation may occur if a person gets in.) If it should be performed inevitably within the dangerous area, strictly observe the following matters. (1) The teaching operation should be always performed by two persons. One person performs the job and the other person watches outside the dangerous area. Also, both persons should try to prevent mis-operation with each other. (2) When performing the teaching operation in the dangerous area, the operator must carry the controller's master key switch and the teaching pendant in order to prevent a third person from operating the machine. (3) The operator should do the job in an attitude ready to press the EMERGENCY stop pushbutton switch at any time. Also, the operator should perform the job at a position from which the operator can evacuate immediately at the time of an emergency after confirming the robot working area and shields nearby. (4) The supervisor should keep watch on the job at a position where the supervisor can see the entire robot system and operate the EMERGENCY stop pushbutton switch at the time of an emergency. Also, the supervisor should keep anyone away from the dangerous area. • If an abnormality has occurred or the POWER LED lamp on the controller remains off after the power to the equipment was turned on, turn off the power immediately and confirm the wiring. Otherwise, you may be struck by an electric shock or a fire may break out. • Unless the robot operates toward a designated direction at manual guide, conduct emergency stop to stop the equipment. Otherwise the robot may be damaged or you may be involved in an accident. When this happens, call us at the after-sale service agent. • Pushbutton operations of the teach pendant should always be confirmed visually. Otherwise, you may be involved in an accident due to mis-operation. • When performing an automatic operation after the power is turned on, be sure to reset the current program before starting the automatic operation. If the program is executed continuously, the robot can interfere with the peripheral equipment, resulting in damages or accidents. • Before operating the equipment, perform the following prior inspection. (1) Make sure that visual appearance of the robot, controller, peripheral equipment and cables is in good condition. (2) Make sure that no obstacle stands in or near the operating range of the robot and peripheral equipment. (3) Make sure that the emergency stop and other safety devices operate properly. (4) Make sure that no abnormal noise or vibration is involved in the robot operation. If the above prior inspection is skipped, the equipment may be damaged or you may be involved in an accident.

⚠ CAUTION	
 Caution	• The speed of the end of the arm during test operation is set so that it does not exceed 250 mm/sec according to the requirements described in “5.6.2 Deceleration control operation” in –Safety requirements in ISO10218-1 Robots for Industrial Environments. This setting is given priority over 20% of the maximum robot speed. • The speed of automatic operation is initially set at 100% of the maximum robot speed. • When the robot servo power is turned off, the arm may move by reaction against torsion of the body harness.

[Maintenance and inspection]

Safety precautions on maintenance are described. Refer to the Instruction Manual “THE Series Robot Manual: Maintenance” together with this manual to strictly observe the following items.

⚠ 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. Refer to the Instruction Manual “KHE Series Robot Manual: Maintenance.” • 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.

[Disposal]

Safety precautions on disposal are described. Refer to the Instruction Manual “KHE Series Robot Manual: Installation” together with this manual to strictly observe the following items.

⚠ DANGER	
 Prohibited	• Do not burn, disassemble, or recharge the battery. Otherwise, it may blow out.

⚠ CAUTION	
 Required	• When disassembling and disposing of the battery, were safety protectors (safety glasses, protective shoes, gloves, etc.). When the battery is disassembled, it may be broken and a flying object may enter your eye, your hand or finger may be cut by a corner of the parts, or the lifted parts may drop on your hand or foot.
 Caution	• Do not leave wooden box, corrugated cardboard, plastic bag, cushion material, etc. that have become unnecessary after unpacking as they are. When disposing of them, observe the customer-defined rules and local government’s instructions about the disposal method.

1. Warning Labels

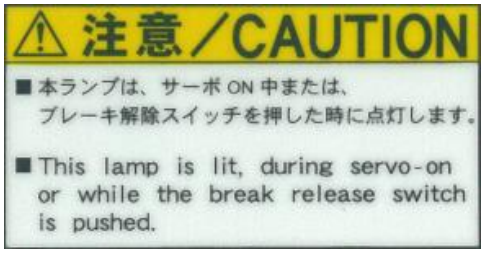
1.1 Warning indication contents

The entry contents of the warning labels affixed to the robot and controller are described.

Label layout	Entry contents
	MODEL: Robot model SER.NO.: Robot serial number/controller serial number
• MODEL, SER.NO., and Mfd.DATE are information required for receiving after-sale service. When calling us at the after-sale service agent, notify the service representative of these information. • During installation, transportation, and disposal, be sure to confirm the mass before carrying the robot. Increase the number of persons and use the transport equipment as required. The transport equipment should be operated by an operator who has received training pertaining to the transport equipment.	

Label layout	Entry contents
	• Use the robot body and controller in combination with the correct serial numbers entered on the label. • If an abnormality occurs, turn off the power to the controller, and then contact our service department. • Do not modify this robot and controller without our permission.
• If the robot is operated in combination with wrong serial numbers, a phenomenon such as coordinate shift occurs because the individual parameters of the robot do not match. Confirm the serial numbers of the robot and controller and connect and install them in a correct combination. • If the robot and controller are modified without our permission, they may cause failure or runaway. Do not modify them without our permission. For technical inquiry, call us at the after-sale service agent.	

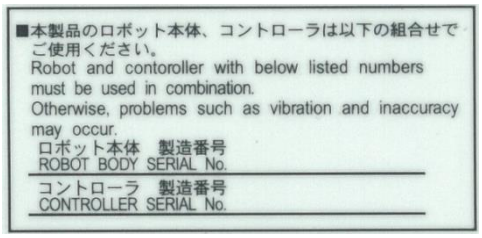
Label layout	Entry contents
	• Do not bring your hand close to the operating part of the robot. Otherwise, your hand and fingers may be caught by the part and get injured.
• If your hand is brought close to the operating part of the robot, it may be caught by the arm or shaft and get injured. When installing and transporting the robot and while carrying it for disposal, secure the arm and shaft with attached clamps so that they do not move. When having to enter the movable range of the robot for teaching or maintenance operation, a trained operator should always perform the operation. Install safety fences to prevent entry of any person (entry into the movable range of the robot and approach of part of body to the operating part) during operation.	

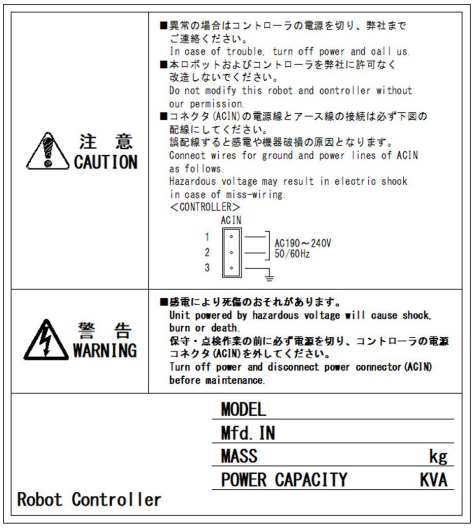
Label layout	Entry contents
	• The lamp on the robot arm 2 is lit during servo ON or when the brake release switch is pressed.
• The lamp on the robot arm 2 is lit during servo ON or when the brake release switch is pressed. If the brake release switch is not pressed, the robot may wait for operation instruction during program operation. Because the robot may start moving suddenly, do not get close to the robot. When getting close to the robot, confirm that the program has stopped, and then switch the operation mode to TEACH. If the brake release switch is pressed, the axis 3 may drop. While using the support that prevents drop, perform the operation.	

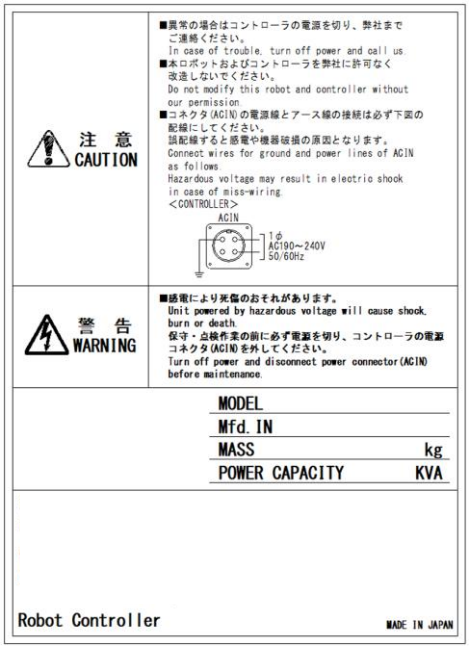
Label layout	Entry contents
	• High temperature If you touch the hot section, you may get burned. Perform maintenance, inspection, and adjustment operations after the hot section has cooled down.
• If continuous operation is performed at a high load factor, the periphery of axis 2 of the robot may become hot, and you may get injured only by continuing to touch it in a short time. After the hot section has cooled down sufficiently, perform the operation that touches the robot. Protect your hands with gloves impervious to heat as required, and then perform the operation.	

Label layout	Entry contents
	• Before maintenance or inspection, be sure to turn off the power to the controller. Otherwise, an electric shock or abnormal operation of the robot may cause death or injury.
• If maintenance or inspection is performed without turning off the primary power to the controller, the conductive or charging portion may be touched by mistake, resulting in an electric shock. The robot may also start moving according to an unexpected command from the external equipment, and it may be contacted to cause death or injury. When performing maintenance or inspection, be sure to turn off the primary power and remove the power connector. Also, post a notice indicating that operation is in progress to prevent the primary power from being turned on during operation. When having to perform operation with the power turned on, a trained operator should always perform the operation.	

<table>
<tr><th>Label layout</th><th>Entry contents</th></tr>
<tr><td> 
</td><td>• Do not enter the movable range of the robot. Otherwise, physical injury accident may result.</td></tr>
<tr><td colspan="2">• If the movable range of the robot is entered, you may contact the robot that has started to move, resulting in death or injury.
When having to enter the movable range of the robot for teaching or maintenance, a trained operator should always perform the operation. Take measures to prevent any person other than teaching or maintenance operator from entering the movable range.</td></tr>
</table>

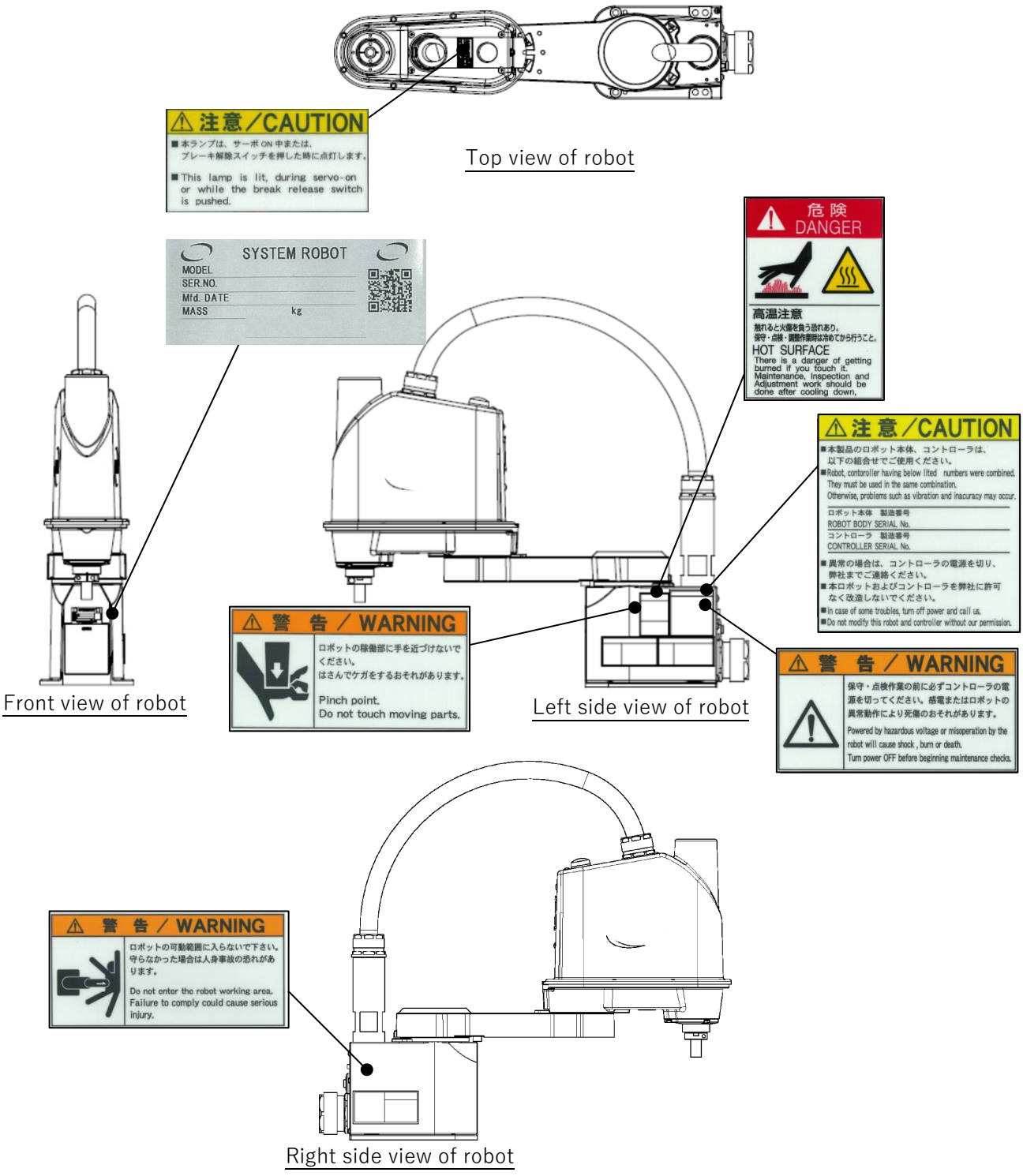
Label layout	Entry contents
	• Use the robot body and controller in combination with the correct serial numbers entered on the label. • Robot body serial number • Controller serial number
• If the robot is operated in combination with wrong serial numbers, a phenomenon such as coordinate shift occurs because the individual parameters of the robot do not match. Confirm the serial numbers of the robot and controller and connect and install them in a correct combination.	

Label layout	Entry contents
	• If an abnormality occurs, turn off the power to the controller, and then contact CKD. • Do not modify this robot and controller without our permission. • Be sure to connect power wire and ground wire of the connector (ACIN) as shown in the following diagram. Mis-wiring causes an electric shock or equipment destruction. • An electric shock may result in death or injury. Before maintenance or inspection, be sure to turn off the power and remove the power connector (ACIN) of the controller • MODEL: Controller model • Mfd.IN: Manufacture date • MASS: Controller mass • POWER CAPACITY: Power capacity
• If the robot and controller are modified without our permission, they may cause failure or runaway. Do not modify them without our permission. For technical inquiry, call us at the after-sale service agent. • Mis-wiring the power wire and ground wire for use causes an electric shock or equipment destruction. Before connecting them, use a tester to confirm whether they are correctly wired. Also, confirm that the primary power supply voltage is within the use range. • If maintenance or inspection is performed without turning off the primary power to the controller, the conductive or charging portion may be touched by mistake, resulting in an electric shock to cause death or injury. When performing maintenance or inspection, be sure to turn off the primary power and remove the power connector. Also, post a notice indicating that operation is in progress to prevent the primary power from being turned on during operation. When having to perform operation with the power turned on, a trained operator should always perform the operation. • MODEL and Mfd.IN are information required for receiving after-sale service. When calling us at the after-sale service agent, notify the service representative of these information. • During installation, transportation, and disposal, be sure to confirm the mass before carrying the robot. Increase the number of persons and use the transport equipment as required. The transport equipment should be operated by an operator who has received training pertaining to the transport equipment.	

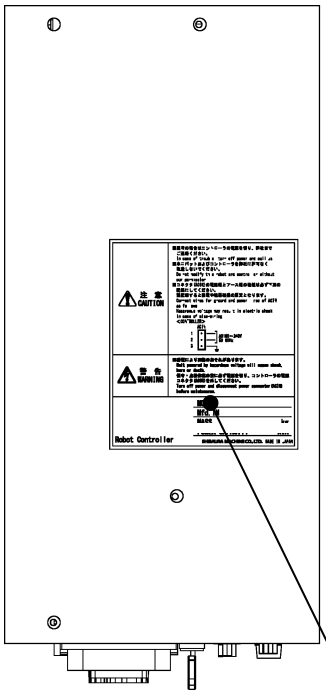
Label layout	Entry contents
	• If an abnormality occurs, turn off the power to the controller and contact CKD. • Do not modify this robot and controller without our permission. • Be sure to connect power wire and ground wire of the connector (ACIN) as shown in the following diagram. Mis-wiring causes an electric shock or equipment destruction. • An electric shock may result in death or injury. Before maintenance or inspection, be sure to turn off the power and remove the power connector (ACIN) of the controller. • MODEL: Controller model • Mfd.IN: Manufacture date • MASS: Controller mass • POWER CAPACITY: Power capacity

- If the robot and controller are modified without our permission, they may cause failure or runaway.
  Do not modify them without our permission. For technical inquiry, call us at the after-sale service agent.
- Mis-wiring the power wire and ground wire for use causes an electric shock or equipment destruction.
  Before connecting them, use a tester to confirm whether they are correctly wired. Also, confirm that the primary power supply voltage is within the use range.
- If maintenance or inspection is performed without turning off the primary power to the controller, the conductive or charging portion may be touched by mistake, resulting an electric shock to cause death or injury.
  When performing maintenance or inspection, be sure to turn off the primary power and remove the power connector. Also, post a notice indicating that operation is in progress to prevent the primary power from being turned on during operation.
  When having to perform operation with the power turned on, a trained operator should always perform the operation.
- MODEL and Mfd.IN are information required for receiving after-sale service. When calling us at the after-sale service agent, notify the service representative of these information.
- During installation, transportation, and disposal, be sure to confirm the mass before carrying the robot.
  Increase the number of persons and use the transport equipment as required. The transport equipment should be operated by an operator who has received training pertaining to the transport equipment.

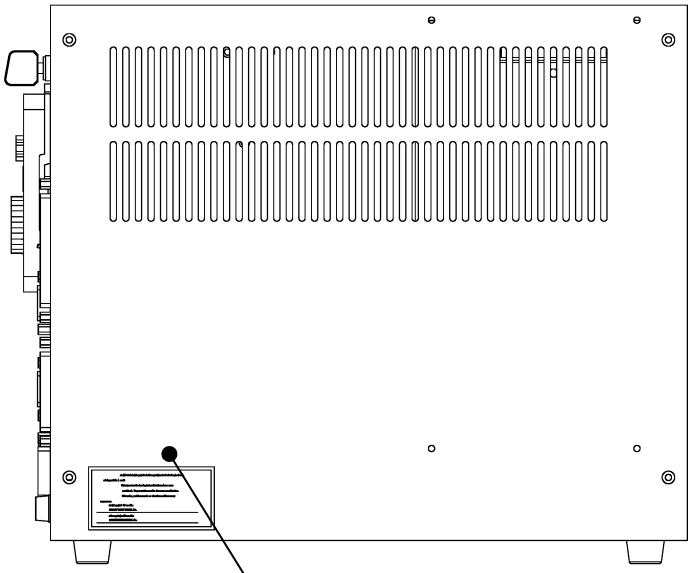
1.2 Locations of robot warning labels (for KHE400)



1.3 Locations of controller warning labels (for KSL3000)



Top view of controller



Right side view of controller

■本製品のロボット本体、コントローラは以下の組合せでご使用ください。
Robot and contoroller with below listed numbers must be used in combination.
Otherwise, problems such as vibration and inaccuracy may occur.
ロボット本体　製造番号
ROBOT BODY SERIAL No.
コントローラ　製造番号
CONTROLLER SERIAL No.

注 意 CAUTION	■異常の場合はコントローラの電源を切り、弊社までご連絡ください。 In case of trouble, turn off power and call us. ■本ロボットおよびコントローラを弊社に許可なく改造しないでください。 Do not modify this robot and controller without our permission. ■コネクタ(ACIN)の電源線とアース線の接続は必ず下図の配線にしてください。 誤配線すると感電や機器破損の原因となります。 Connect wires for ground and power lines of ACIN as follows. Hazardous voltage may result in electric shock in case of miss-wiring. <CONTROLLER> ACIN 1 2 3 AC190～240V 50/60Hz
警 告 WARNING	**■感電により死傷のおそれがあります。** **Unit powered by hazardous voltage will cause shock, burn or death.** **保守・点検作業の前に必ず電源を切り、コントローラの電源コネクタ(ACIN)を外してください。** **Turn off power and disconnect power connector (ACIN) before maintenance.**
Robot Controller	MODEL Mfd. IN MASS kg POWER CAPACITY KVA MADE IN JAPAN

2. Safety Measures

This section describes the necessity of safety measures, safety functions provided for the robot and robot controller, and general safety measures to be taken.

2.1 Cautions on safety

Our SCARA robot and robot controller are equipped with various safety functions.
When the robot is actually operated, however, the following dangers will be supposed.

a) Danger supposed in normal automatic operation
- Operator's mis-operation and mis-judgment, and incomplete program.
- Unexpected robot movement and release or drop of workpiece due to fault of an electronic control device.

b) Danger supposed at teaching and inspection
- Danger of an operator entering the movable range of the robot.
- Operator's negligence from confusion or experience at generation of an unexpected abnormality, and operator's mis-operation due to shortage of behavior and knowledge.
- Approach of an operator to the robot due to unexpected complex movement of the robot.
- Abnormal movement, etc. caused by mis-wiring, poor contact, deterioration and noise

c) Danger supposed in a related machine, etc.
- Sudden movement of the robot with a command from a related machine, etc.
- Sudden movement of a related machine after the robot movement.
- Danger of an operator being caught or entangled in the robot when teaching, inspecting or adjusting the robot while moving a related machine.

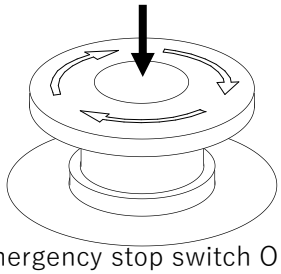
To use the robot safely, safety measures should be taken according to the operating conditions.
Otherwise, an unexpected disaster may occur.
If there are safety rules and regulations, strictly observe the rules and regulations in each country. Also, refer to all manuals relating to this robot and robot controller.

2.2 Safety functions

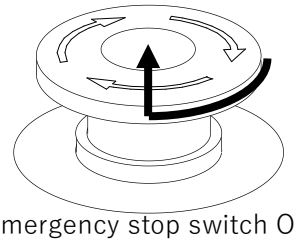
This robot and robot controller are equipped with various safety functions and additional protection functions.

2.2.1 Emergency stop function

An emergency stop pushbutton switch is provided on the teach pendant. This switch can stop the robot immediately and shut down the robot's power source. (Stop category 1) The emergency stop function is always enabled regardless of the operating condition of the robot.
The emergency stop pushbutton switch is equipped with a lock mechanism. To reset the emergency stop state, pull up the upper part of the switch while turning it as shown in the following figure.
The controller also has the external emergency stop contacts, so an emergency stop switch can be added as required. Select ISO 13850-compliant emergency stop switches as the additional ones.



Emergency stop switch ON



Emergency stop switch OFF

Precautions for the emergency stop switch
Note the following to select an emergency stop pushbutton switch.

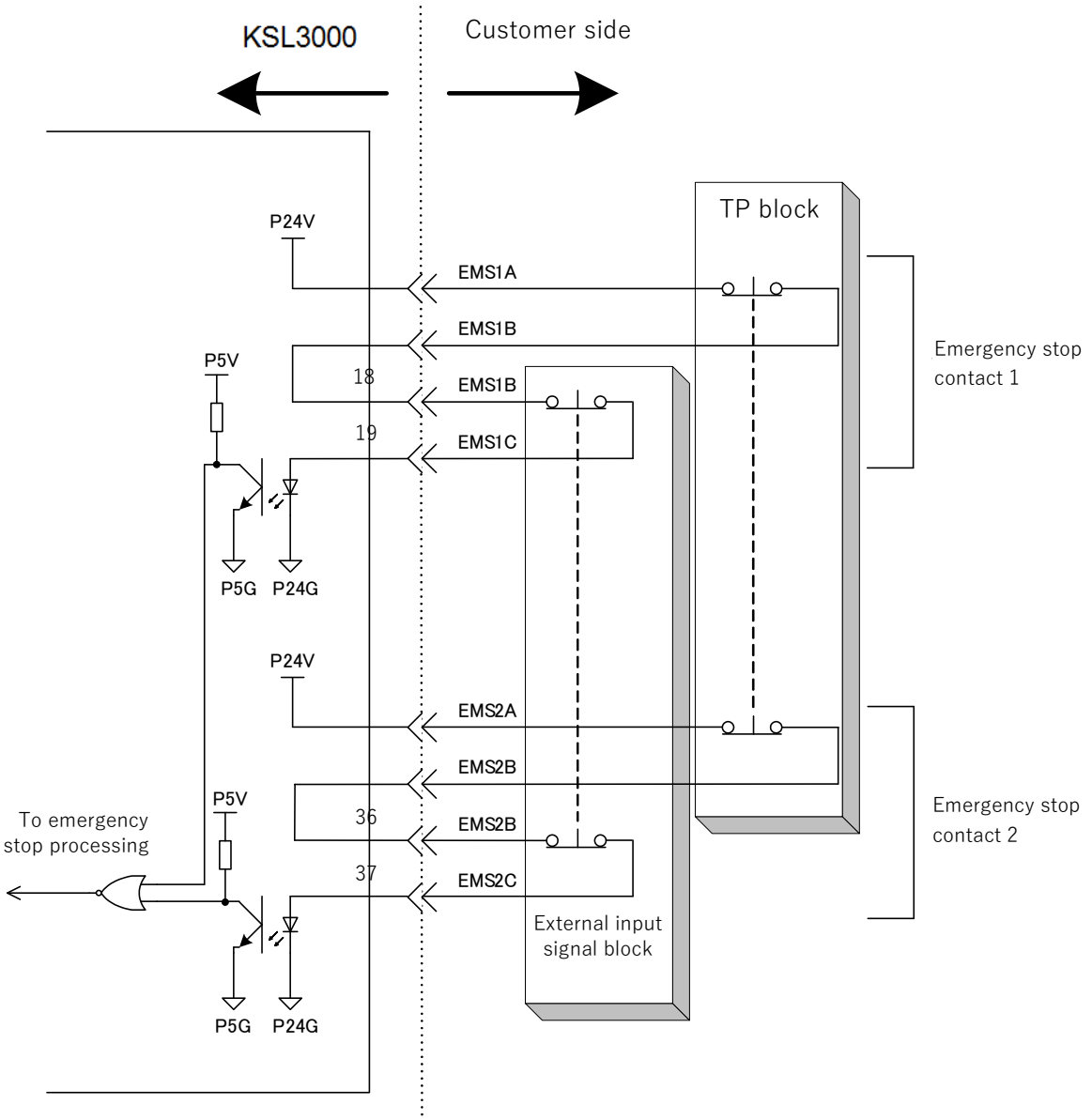
- An emergency stop device must be installed at a location that requires emergency stop and is easy to approach.
- An emergency stop device must be a device that, after functioning, does not allows the circuit to automatically recover until restored manually, and that has a structure where the contact does not recover until the device is reset.
- An emergency stop device must has an appropriate shape like those listed below so that it can eliminate danger according to the structure and characteristics of the machine.
    1) Mushroom-shaped pushbutton
    2) Cable pull switch, lever switch
    3) Switch operated by belly or knee
    4) Pedant switch with no protection cover
- The actuator of an emergency stop device with a pushbutton switch must be red, and the background color of the surrounding must be yellow.
- The cable of an emergency stop device with a cable pull switch must always have a proper tension, and must be distinguished by color (red and yellow).

2.2.2 Safety contact input function

KSL3000 have the duplicated safety contact input function that is a different system from emergency stop. Connect interlock switches, such as a limit switch and a foot switch, which operate simultaneously with a door of a safety fence.

1) External emergency stop contacts of KSL3000 are shown in the figure below.
   Connect emergency stop button switches to the 18-19 pins and 36-37 pins of the INPUT

connector on the front of KSL3000 for use. For output common Type-N and Type-P, the emergency stop button switches are also connected to the same pin numbers.

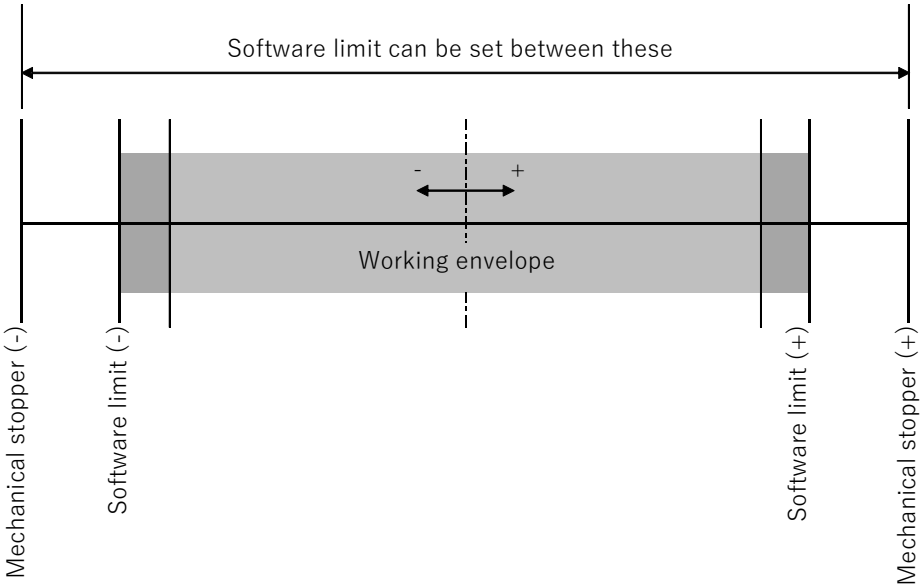


2.2.3 Working range limiting function

This robot is equipped with mechanical stoppers to prevent overrun.
The mechanical stoppers are provided on axis 1, axis 2, and axis 3 in order to prevent the movable part of the robot from overrunning.
The robot working range can be limited by changing the mechanical stopper positions, depending on the robot model.
For change of the mechanical stopper positions, refer to the Instruction Manual “KHE Series Robot Manual: Installation.”

Software limits can be set as the controller side functions. The software limits are the auxiliary functions of the mechanical stoppers that prevent collision with the mechanical stoppers due to a mis-operation during manual guide or program error. The software limits should be set inside the robot working range limited by the mechanical stoppers.
For change of software limits, refer to the Instruction Manual “KHE Series Robot Manual: Installation.”

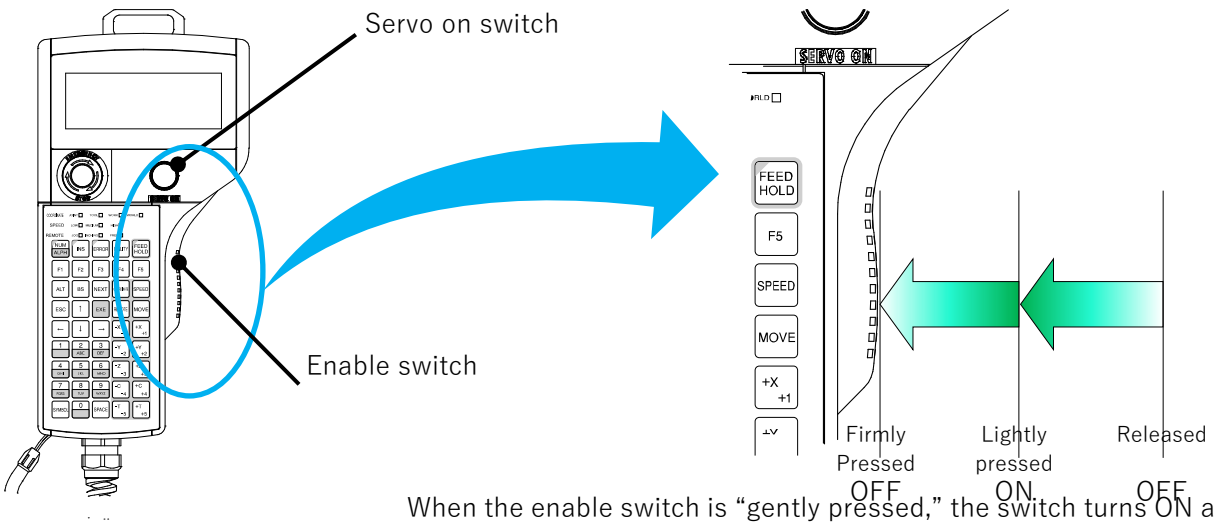
When the robot operates abnormally, it is unlikely that the software limits are able to limit the working range.
The safety functions aimed to protect human body should be performed with the mechanical stoppers.



2.2.4 Operation switch on teach pendant

An enable switch is provided on the teach pendant in order to enhance the safety. When guiding the robot in manual mode, the operator holds the teach pendant and keeps the enable switch in “gently pressed” state to reset the emergency stop state and turn on the servo power.
The enable switch is of the three-position type; the switch stops the robot immediately and turns off the robot’s power source when it is “released” or “firmly pressed.”
The servo cannot be turned on when the enable switch is OFF. Keep the enable switch ON when guiding the robot with the teach pendant.

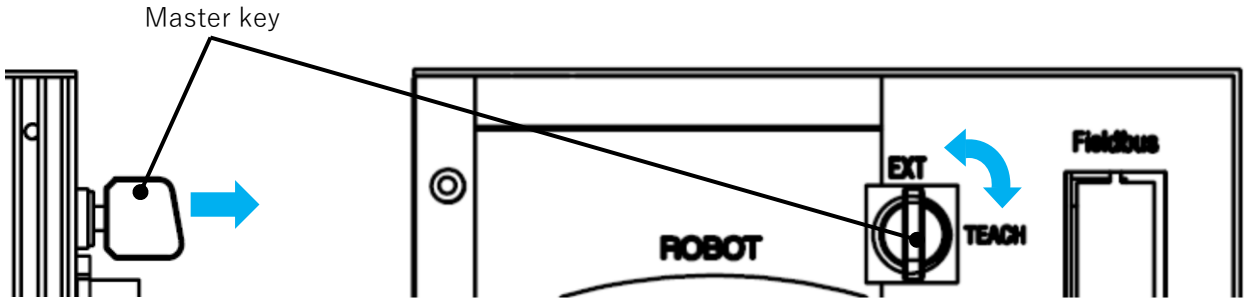
[For KSL-TP1000]



When the enable switch is “gently pressed,” the switch turns ON and the screen and key sheet change to the JOG mode. When the switch is “released” or “firmly pressed,” they do not change to the JOG mode.

2.2.5 Master key switch in front of controller

The master key switch is provided to select the TEACH or EXT mode of the control panel. When having to enter the working range in order to do teaching operation or inspection, the operator should select the TEACH mode and carry a key during the operation to prevent another operator from changing the mode.



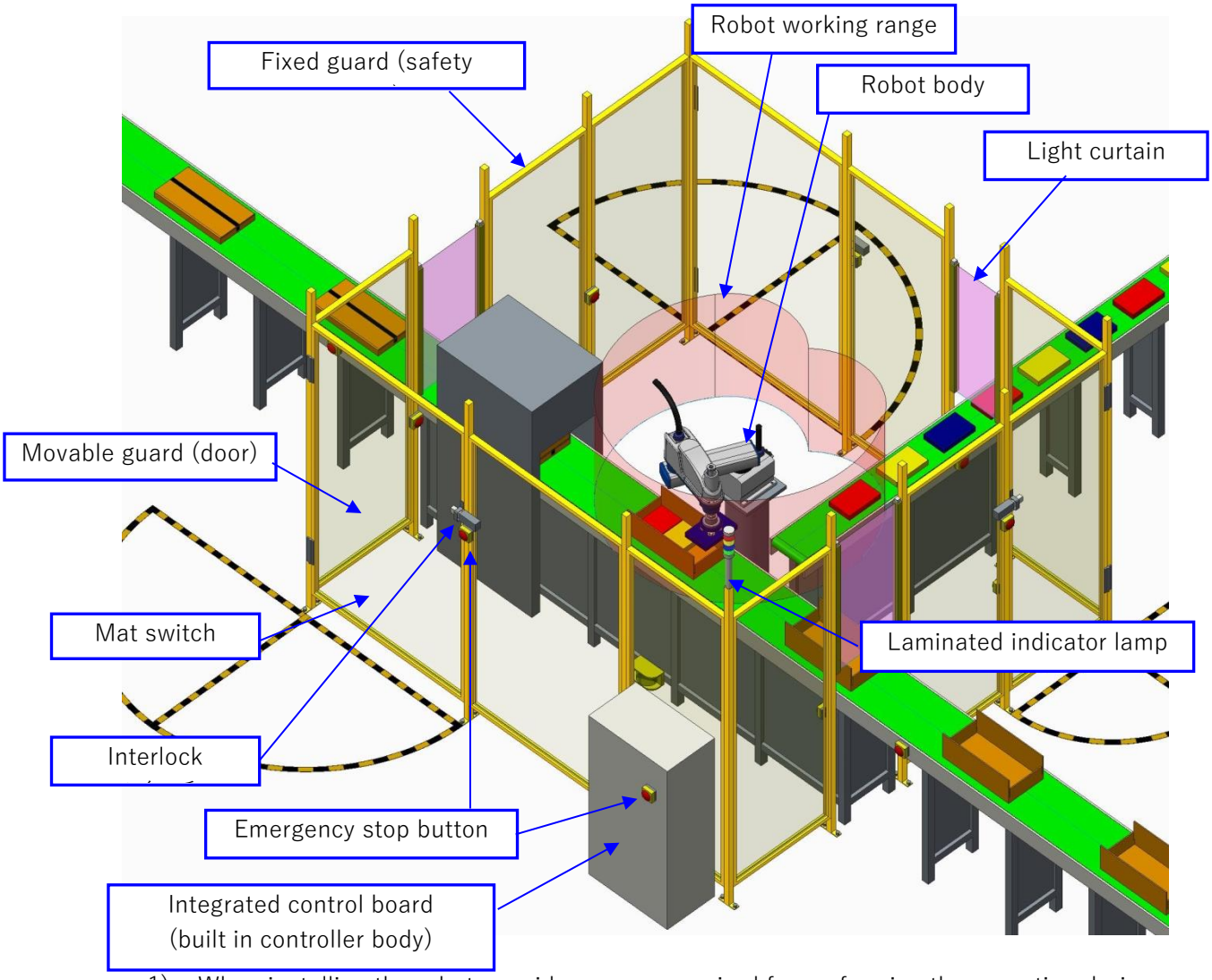
Side view of master key switch

Front view of master key switch

2.3 Examples of safety measures

Most of disasters caused by the robot originate from unsafe human behavior. When using the robot, the operator should foresee what will involve danger and try to prevent such a dangerous condition. Operation should be done only after all safety conditions are satisfied. Examples of main safety measures are shown below.

2.3.1 General cautions on using the robot



1) When installing the robot, provide a space required for performing the operation during installation and subsequent operations (teaching, operation, maintenance and disposal) safely.
   - ISO 13854: Minimum gaps to avoid crushing of parts of the human body

2) Identify the dangerous area, and install safety fences, etc. to prevent entry of any person. The dangerous area signifies an area near the robot, where a person who has entered it will jeopardize.
   - ISO14120: General requirements for the design and construction of fixed and movable guards
   - ISO13857: Safety distances to prevent hazard zone being reached by upper and lower limbs

3) Install an emergency stop switch at a location where it can be pressed immediately by an operator who has determined the occurrence of abnormality outside and inside the safety fence, etc., and connect it to the external emergency stop contacts (EMS1B to 1C and EMS2B to 2C) of the controller.
   - ISO13850: Emergency stop

4) Install interlock devices such as interlock switch, light curtain and mat switch at the entrance and exit doors of the safety fence and connect them to the safety contact input of the controller so that the robot stops if a person enters the dangerous area. The interlock devices should be electrically independent break-contact (normally-closed contact) devices.
   - ISO14119: Interlocking devices associated with guards
   - IEC61496-1,-2: Electro-sensitive protective equipment
   - ISO13855: Positioning of safeguards with respect to the approach speeds of parts of the human body
   - ISO13856-1: Pressure-sensitive protective devices

5) Install the controller at a safe location where an operator can overlook the operation of the robot.

6) To perform transportation, installation, teaching (teaching, program and operation check), maintenance (inspection, adjustment and repair) and disposal, be sure to observe the laws, rules and regulations defined in each country. Also, display the current condition of the robot to prevent an unrelated person from carelessly entering the working range and operating the robot.

7) Before daily operation, perform the following check.
   <Check before operation>
   - Visually confirm that the robot body, controller, peripheral equipment and cables are in good condition.
   - Make sure that no object stands in or new the working range of the robot and peripheral equipment.
   - Make sure that the emergency stop and other safety devices operate properly.
   - Make sure that no abnormal noise or vibration is involved in the robot operation.

8) Be sure to operate the pushbutton switches provided on the teach pendant while visually confirming them.

2.3.2 Cautions on operation

In principle, perform teaching and inspection outside the dangerous area of the robot. To perform them inevitably, strictly observe the following cautions.

1) Teaching should be performed after the drive source is shut off (servo OFF) whenever possible. The drive source should not be allowed to enter automatic state or to be recovered (servo ON) by other operator.
   Inspection should be performed after the primary power is shut off whenever possible. The primary power should not be allowed to enter automatic state or to be recovered by other operator.

2) The switches that change the operating state of the robot (start switch, stop switch, etc.) should not be allowed to be operated by a person other than the operator (by posting the display board, locking the operator panel, arranging watcher, etc.).

3) The following work regulations should be established so that the operation is performed in accordance with the regulations.
   ① Operation methods and procedures for starting the robot, handling the switches, teaching, inspection, and confirming them
   ② Operating speed suitable for situations (the speed is desirably made as slow as possible.)
   ③ Method for exchanging signals between operators
   ④ Recovery method for an abnormality
   ⑤ Method for resetting abnormal state and confirming safety before restarting the robot that has stopped abnormally
   ⑥ Other following methods for preventing the danger caused by unexpected movement of the robot and mis-operation
      • Methods for limiting operation of switches (start switch, stop switch, etc.) that select the operating state of the robot to an operator (by posting the display board, locking the operator panel, arranging watcher, etc.)
      • Method for allowing an operator in the dangerous area to hold the emergency stop device (by using the teach pendant)
      • Position and posture in which safety of an operator can be secured
      • Types and determination method of abnormalities (method for confirming alarm, etc.)
      • Method for preventing and reducing noise
      • Method for changing setup and confirming it (program change procedure, teaching data to be change, method for confirming it, etc.)
      • Method for exchanging signals between robot operator and related equipment operator

   * The work regulation should try to be prepared by inviting suggestions about the description suitable for respective sites from concerned operators, facility design engineers, etc.

4) The operations should always be performed by two persons. One person performs the job and the other person watches outside the dangerous area. Also, both persons should try to prevent mis-operation with each other.

5) The operator should do the job in an attitude ready to press the emergency stop pushbutton switch at any time. Also, the operator should perform the job at a position from which the operator can evacuate immediately at the time of an emergency after confirming the robot working range and shields in the surroundings. Also, the operator should be careful so as not to turn operator's back to the robot during operation.

6) The supervisor should keep on the job at a position where the supervisor can overlook the entire robot system and operate the emergency stop pushbutton switch at the time of an emergency. Also, the supervisor should keep anyone from entering the dangerous area.

2.3.3 Other cautions

1) The gripping unit of the robot should not stick out, except for the part required for operation. Also, even at a sudden stop due to power failure, malfunction or emergency stop during operation, the robot should hold a workpiece in a stable posture.

2) If the robot has malfunctions, turn off the power, remove the cause of the malfunction, maintain the peripheral equipment and completely restore the malfunctioned robot. Then, confirm its movement a low speed. Even if the robot has stopped, do not approach the dangerous area immediately.

3) Turn off the power when the robot is not in use.

Note) Because of space limitations, this document covers only important safety precautions for the robot, but not all general safety information. Before carrying out work, read safety documents compliant with the laws, regulations and standards in each country or receive instructions from the consultants who are familiar with the rules, regulations and standards.
Also, carry out risk assessment and take measures to reduce risk.

2.3.4 Recommended protector

Observe the standards, regulations and rules in each country to carry out risk assessment, and then consider and select use.

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.	
Earplug	Protection part: Ears Use: Protect from noise[*1].	

*1): For details about the noise level and the method for measuring it, refer to the Instruction Manual “THE Series Robot Manual: Specifications.” CKD recommends that the protectors be worn for the operation in the environment where a single robot produces generates noise at 85 db or more based on the Guideline for the Prevention of Noise-Induced Impairments (Labor Standards Bureau Issue No. 546) in accordance with the laws in Japan.