THL Series

Industrial Robot

Robot controller TSL3000
Robot controller TSL3000E
Robot controller TS3000
Robot controller TS3000E

INSTRUCTION MANUAL

SAFETY MANUAL

Notice

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

November, 2011

TOSHIBA MACHINE CO., LTD.

NUMAZU, JAPAN

This Instruction Manual applies to the following robots:

THL Series: THL300, THL400, THL500, THL600, THL700, THL800, THL900, THL1000

The information contained in this manual is subject to change without prior notice to effect improvements.

Preface

This manual describes the safety measures for the system robots (THL series) built by Toshiba Machine. You are requested to read through this manual and handle the robot, strictly observing the instructions given throughout the manual, so that you can completely understand the performance of the robot and use its functions safely over the long years to come.

This manual consists of the following sections.

- Cautions on Safety
  This section deals with the important information on using the robot safely and properly.
- Locations of Warning Labels
  This section describes the locations of warning labels affixed to the robot and controller.
- Safety Measures
  This section describes the safety functions of the robot and controller, and safety cautions on installing and operating the robot.
- Compliant Standards and Safety Performance
  This section describes the compliant standards and safety performance of the robot and controller.

Cautions on Safety

This manual contains the important information on the robot and controller to prevent injury to the operators and persons nearby, to prevent damage to assets and to ensure correct use.
Make sure that the following details (indications and symbols) are well understood before reading this manual. Always observe the information that is noted.
[Explanation of indications]

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

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

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

[Explanation of symbols]

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

[Operation]

! DANGER	
 Prohibited	• During operation, NEVER enter the dangerous area of the robot. Otherwise, you will be injured seriously. (The dangerous area signifies an area near the robot, where, if a person has entered, he or she will be jeopardized.) • DO NOT leave in the working range any machinery or materials that will hinder the operation. If the equipment went wrong, a person nearby will be injured or involved in an accident. • Anyone other than the operator MUST NOT approach the equipment. Should he negligently touch a dangerous part of the equipment, he will get injured or involved in a serious accident. • NEVER perform an inappropriate operation which is not described in the instruction manual. Otherwise, the equipment will start by mistake, resulting in personal injury or serious accident.
 Mandatory	• 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 will 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 cover be opened during operation, you will 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 will start by mistake, causing a personal injury or serious accident. • If the equipment has malfunctioned, turn the power off, identify and remove the cause of the abnormality, maintain the peripheral equipment and completely restore the malfunctioned equipment. Then start the equipment at a low speed. If the equipment starts, leaving the abnormality, you will be involved in a serious accident.

WARNING	
 Prohibited	• NEVER enter the movable range of the robot. Otherwise, an accident causing injury or death will occur. • NEVER put your hands close to the moving part of the robot. Otherwise, your hands will get caught in the moving part and get injured.

CAUTION	
 Prohibited	• DO NOT change the data of the system parameter files. Otherwise, the robot will operate abnormally, resulting in damage or an accident.
 Mandatory	• In principle, teaching operation should be performed outside the dangerous area of the robot. (The dangerous area signifies an area near the robot, where, if a person has entered, he or she will be jeopardized.) 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 (2) 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) If the operator performs teaching operation within the dangerous area, he or she should hold the controller master key and teach pendant to prevent an unrelated person from operating the robot. (3) The operator should do the job in an attitude ready to press the EMERGENCY stop pushbutton switch at any time. Also, he should perform the job at a position from which he can evacuate immediately at the time of an emergency after confirming the robot working range and shields nearby. (4) The supervisor should keep watch on the job at a position where he can see the entire robot system and operate the EMERGENCY stop pushbutton switch at the time of an emergency. Also, he should keep anyone from entering the dangerous area.

! CAUTION	
 Mandatory	• If an abnormality has generated or the POWER LED lamp on the control panel remains off after the power of the equipment was turned on (TS3000 and TS3000E), turn off the main power immediately and confirm the wiring. Otherwise, you will be struck by an electric shock or a fire will break out. • Unless the robot operates toward a designated direction at manual guide, shut down the system by activating emergency stop. Otherwise, the robot will be damaged or you will be involved in an accident. When this happens, call us at the after-sale service agent. • Pushbutton operations of the control panel (TS3000 and TS3000E) and teach pendant should be confirmed visually. Otherwise, you will be involved in an accident due to incorrect operation. • Before operating the equipment, perform the following 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 will be damaged or you will be involved in an accident.

CAUTION	
 Caution	• The speed of test operation is initially set at 20% of the maximum robot speed and limited to 250mm/sec. Based on requirements by 5.6.2 Reduced speed control operation of ISO10218-1 Safety requirements for industrial robots, during test operation the speed of the TCP(Tool Center Point) does not exceed 250mm/s. This limitation takes higher priority than robot maximum speed limit setting of 20% during test operation. • The speed of automatic operation is initially set at 100% of the maximum robot speed. • When the robot servo is turned off, the arm may move by the counterforce of the twist of the main body harness.

[Installation and transportation]

Strictly observe the following items to use the robot safely.

! DANGER	
 Prohibited	• DO NOT install or operate the robot if any part is damaged or missing. Otherwise, electric shocks, fires or faults will be caused. • DO NOT install the robot at a place where it is exposed to splash of water or other fluids. Otherwise, electric shocks, fires or faults will be caused. • DO NOT place the robot near a combustible material. If it ignites due to a fault, etc., a fire will break out.
 Mandatory	• Always secure the robot with attached clamps before carrying it. Otherwise, you will be injured if the arm moves when the robot is lifted. • Wire the robot after installation. Otherwise, electric shocks or injuries will be caused. • Always use the line voltage and power capacity designated by Toshiba Machine. Otherwise, the equipment will be damaged or a fire will break out. • Always use the designated power cables. (For details, see the "Transportation and Installation Manual.") If a cable other than the designated is used, fires or faults will be caused. • Install the controller outside the dangerous area where the operator can always watch the robot movements. Otherwise, it is very dangerous should the robot start during the controller operation.
 Always ground	• Completely connect the grounding cable. Otherwise, electric shocks or fires will be caused if a fault or fault current occurs. Also, it could cause mis-operation by noise.

 **CAUTION**	
 Prohibited	• NEVER lift the robot by the arm 2 cover. Otherwise, an excessive force will be exerted on the robot mechanism, resulting in damage of the robot. • For the controller, secure an ample space for ventilation. (For details, see the "Transportation and Installation Manual.") Otherwise, the controller will heat and go wrong.
 Mandatory	• When lifting the robot, lift it up slowly as the robot will tilt slightly. If it is lifted up suddenly, it will cause a very hazardous situation. • When storing the robot, secure it to the base completely. If the robot is just placed on the floor, it becomes unstable and will fall down.
 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.

[Maintenance and inspection]

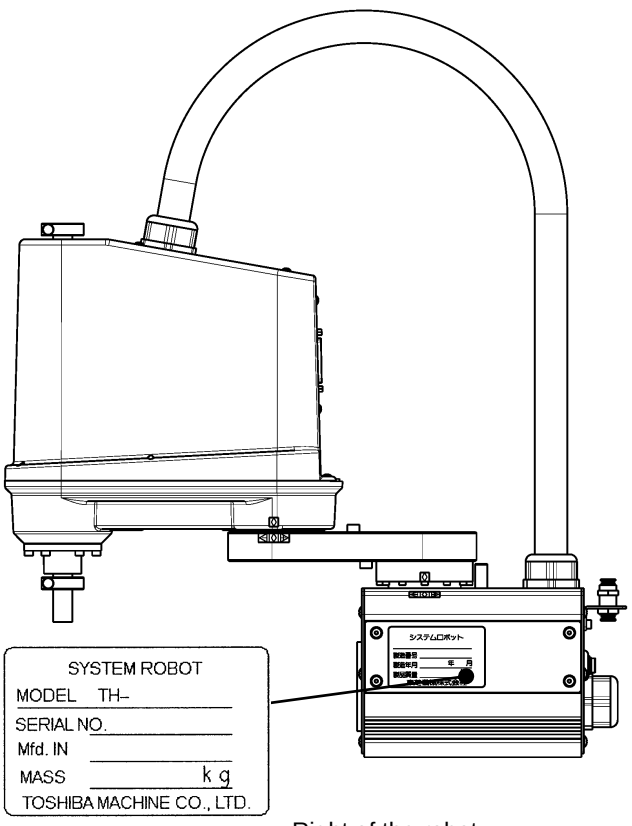
Strictly observe the following items to use the robot safely.

DANGER	
 Prohibited	• DO NOT incinerate, disassemble or charge the battery. Otherwise, it will rupture.
 Mandatory	• Be sure to turn off the main power of the controller before starting inspection or maintenance. • When disposing of the battery, follow the user's provided regulations.

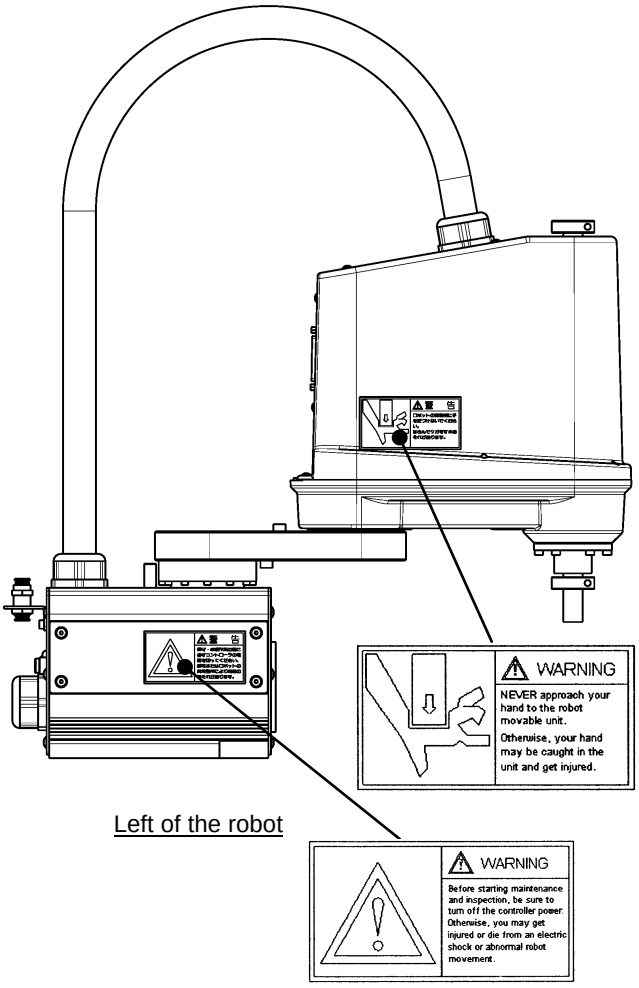
CAUTION	
 Prohibited	• The user NEVER replace or modify parts other than those described in the instruction manual. Otherwise, the robot performance will deteriorate, or faults or accidents will be caused.
 Mandatory	• Always use the Toshiba Machine designated spare parts when replacing the parts. • Perform maintenance and inspection regularly. Otherwise, the equipment will go wrong or you will be involved in an accident.
 Caution	• The axis 4 motor of the THL series robots is not provided with a brake. With the servo off, therefore, Axis 4 may rotate due to the dead weight of the tool and hand, offset condition or touch by hand. Once Axis 4 rotates, Axis 3 will move up or down. Take careful precautions not to have your hand and leg caught in it. • A brake release switch is provided at the back of the base (THL300, THL400) and at the upper part of the axis 2 arm cover (THL500 – THL1000). If the brake release switch is pressed while a heavy load such as a hand or workpiece is mounted on arm 3, arm 3 will drop. Take careful precautions not to have your hand or leg caught in it.

Locations of Warning Labels

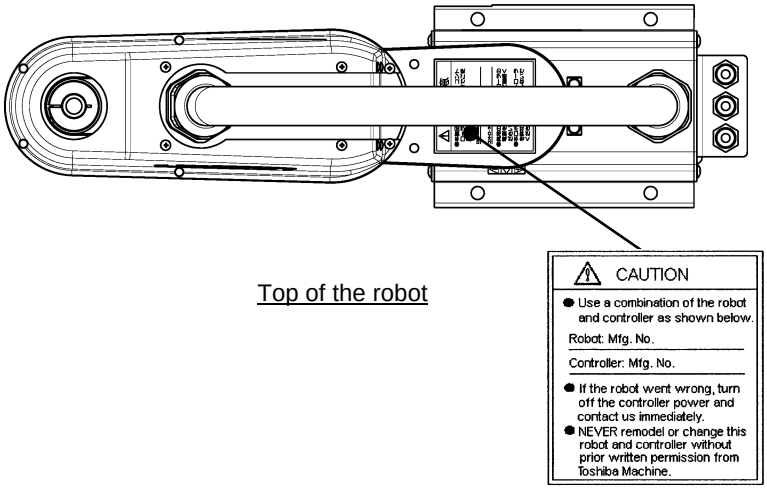
(1) Locations of robot warning labels (THL300, THL400)



Right of the robot

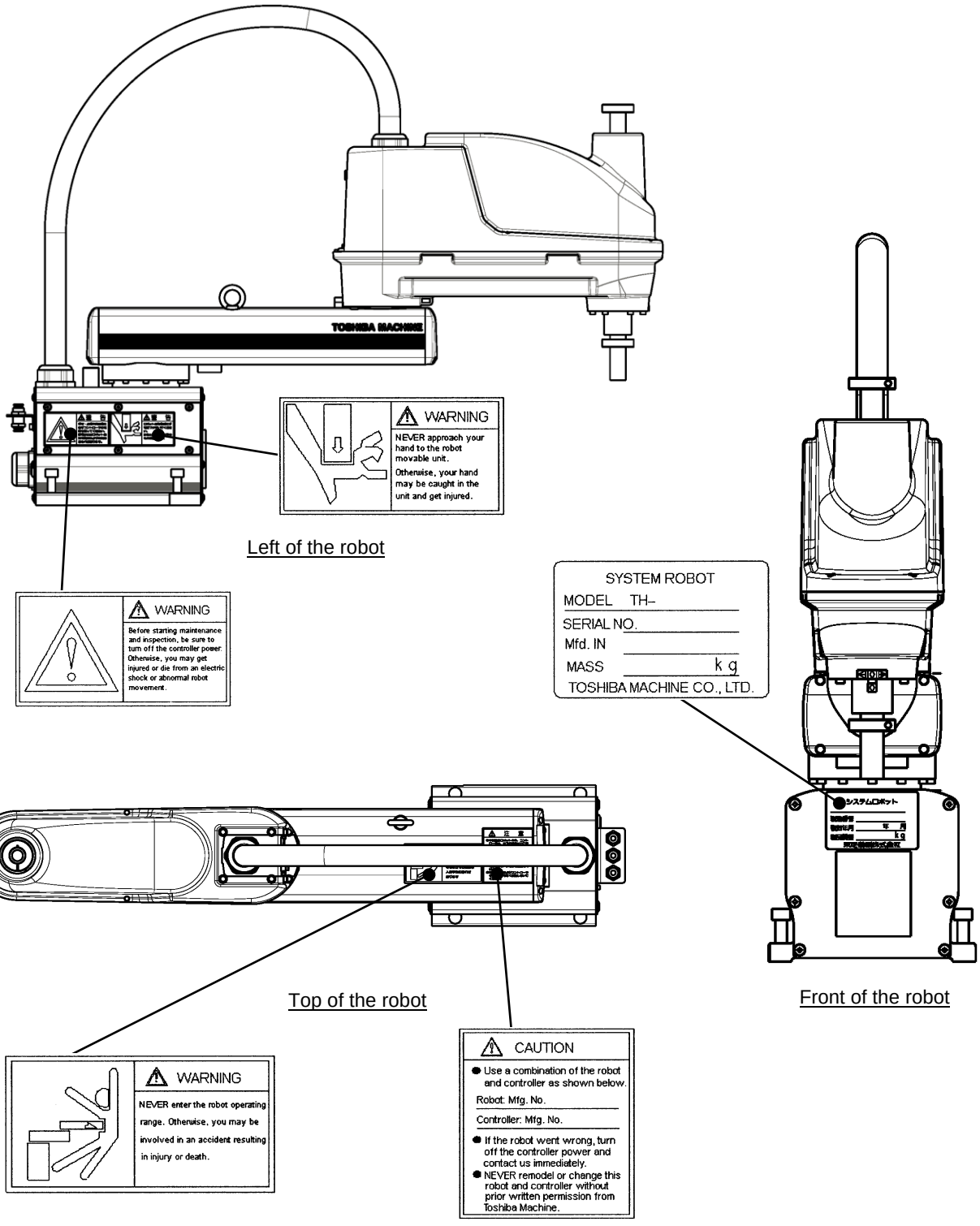


Left of the robot

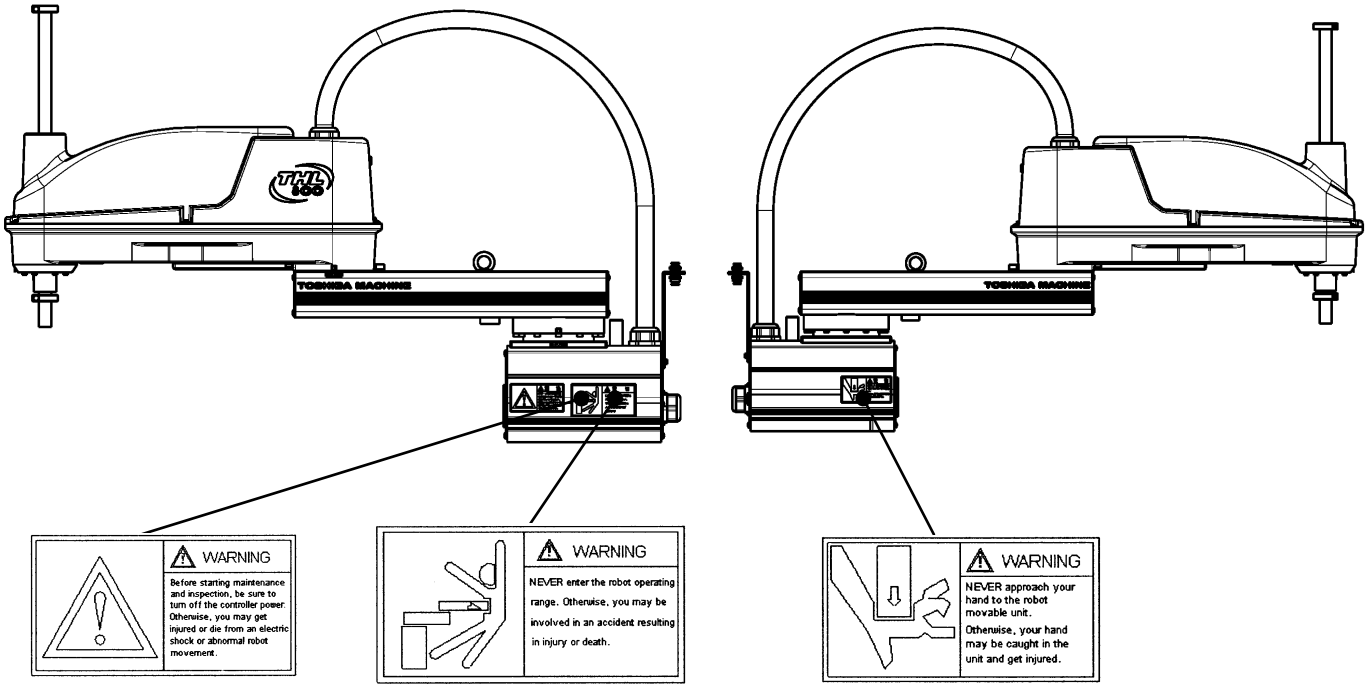


Top of the robot

(2) Locations of robot warning labels (THL500, THL600, THL700)

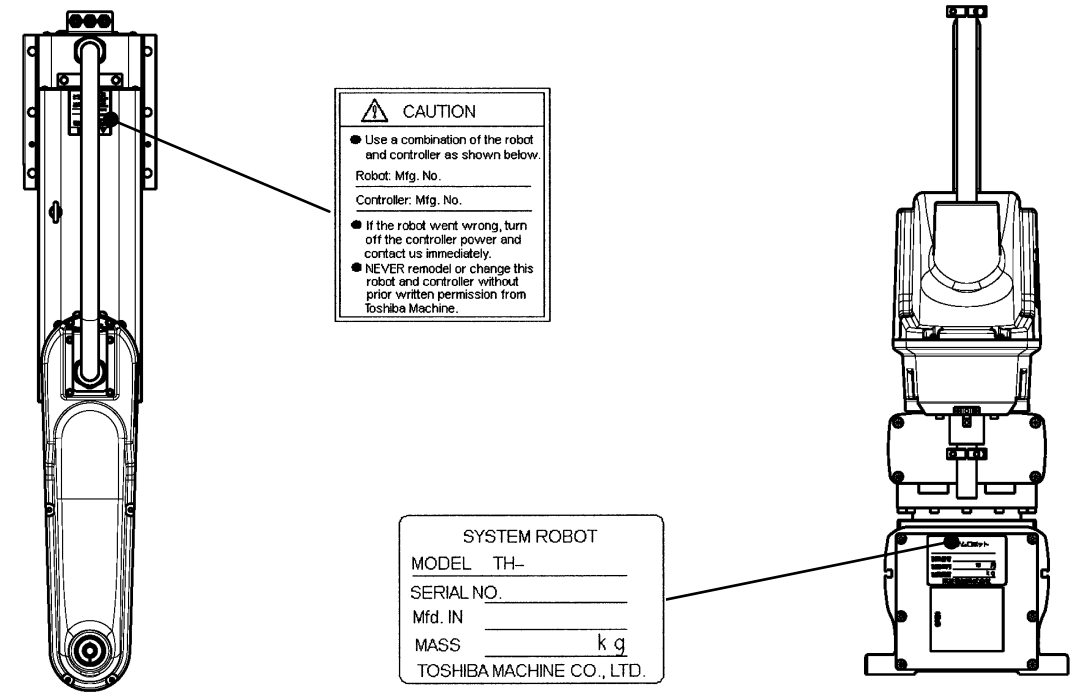


(3) Locations of robot warning labels (THL800, THL900, THL1000)



Right of the robot

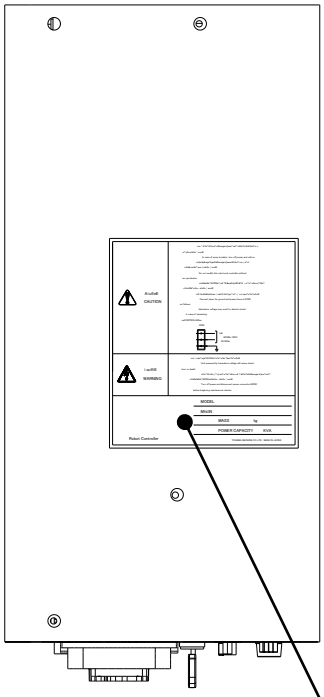
Left of the robot



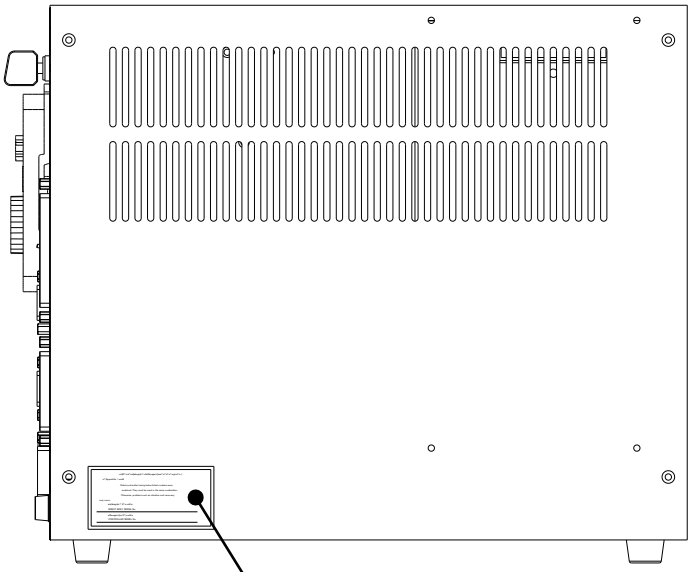
Top of the robot

Front of the robot

(4) Locations of controller warning labels (TSL3000)



Top of the controller



Right side of the controller

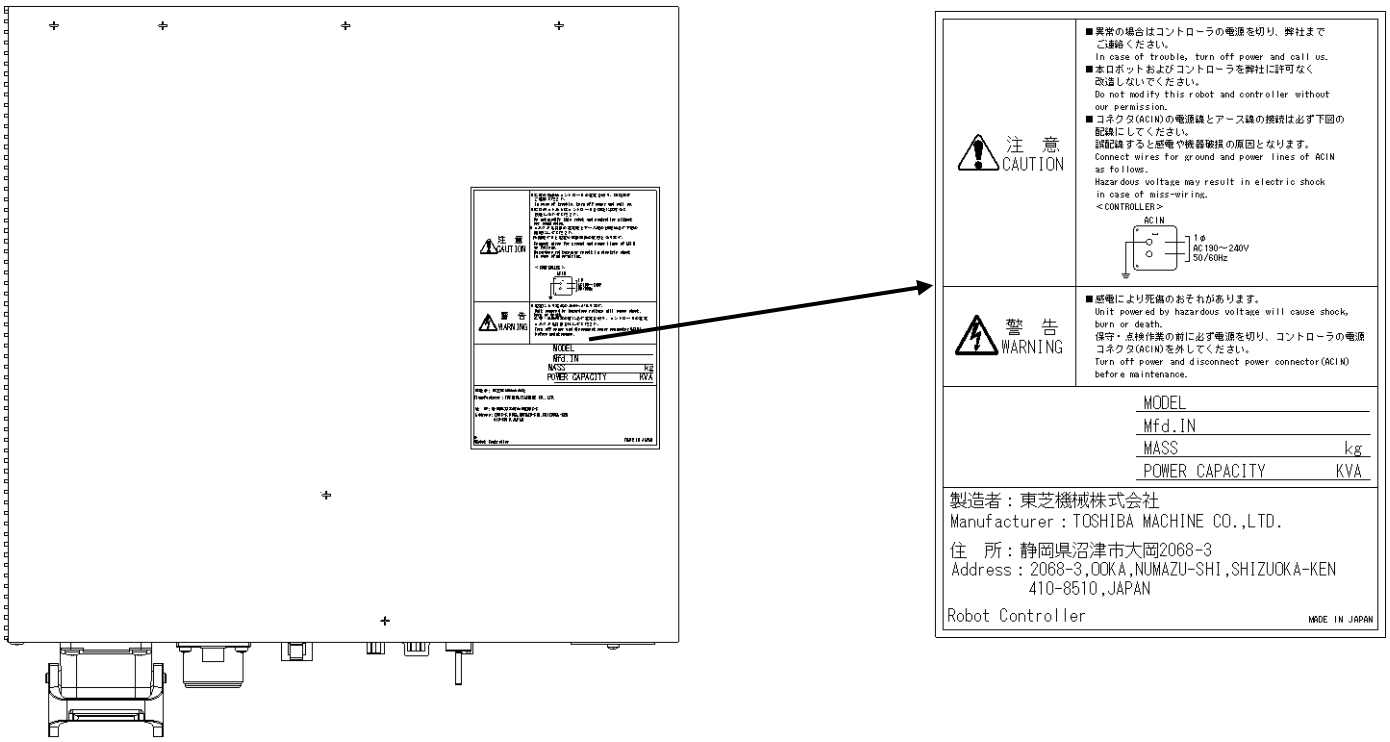
■本製品のロボット本体、コントローラは以下の組合せでご使用ください。
Robot and contoroller with below listed numbers must be used in combination.
Otherwise, problems such as vibration and inaccuracy may occur.

ロボット本体　製造番号
ROBOT BODY SERIAL No.

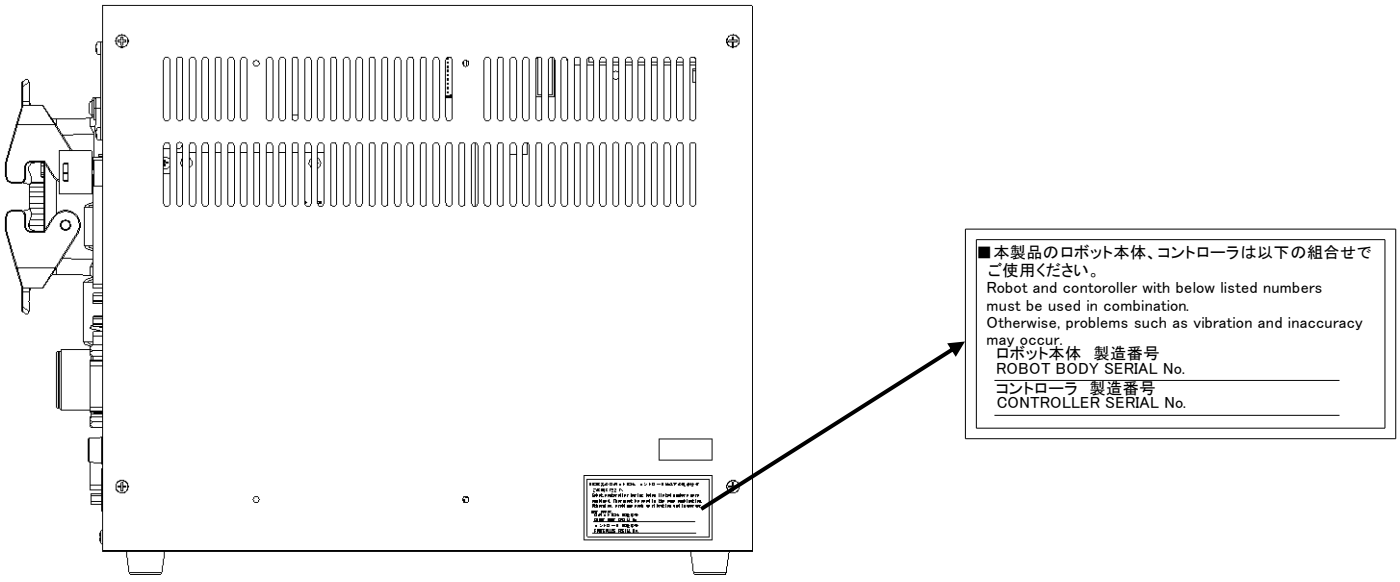
コントローラ　製造番号
CONTROLLER SERIAL No.

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の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になります。 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	■感電による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 TOSHIBA MACHINE CO.,LTD. MADE IN JAPAN

(5) Locations of controller warning labels (for the TSL3000E)

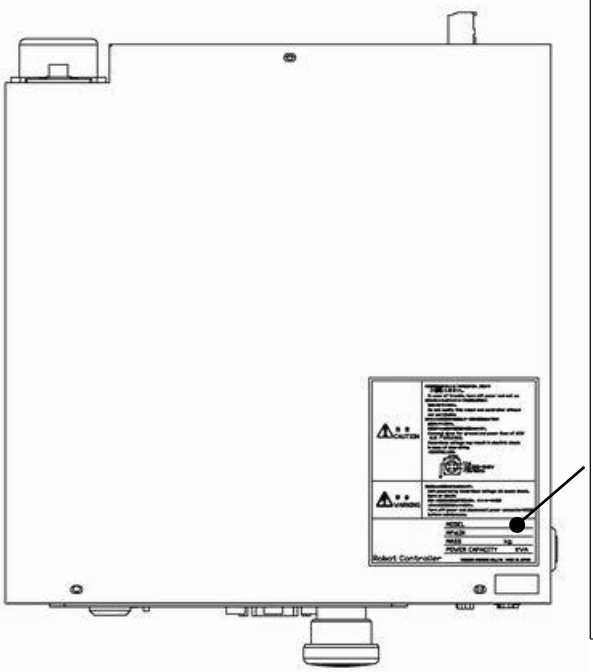


Controller top view



Controller side view

(6) Locations of controller warning labels (TS3000 and TS3000E)



Top of the controller

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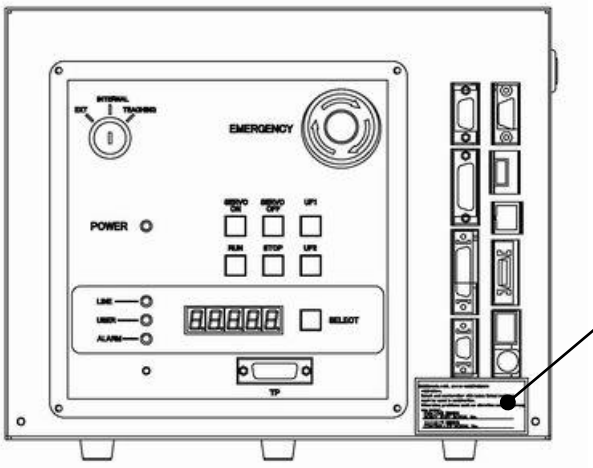
警 告 WARNING	■感電により死傷のおそれがあります。 Unit powered by hazardous voltage will cause shock, burn or death. 保守・点検作業の前に必ず電源を切り、コントローラの電源 コネクタ(ACIN)を外してください。 Turn off power and disconnect power connector(ACIN) before maintenance.
Robot Controller	MODEL Mfd.IN MASS kg POWER CAPACITY KVA TOSHIBA MACHINE CO.,LTD. MADE IN JAPAN



Front of the controller

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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.

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.

1 Cautions on Safety

Toshiba Machine's SCARA robots and robot controller are equipped with various safety functions. When actually operating the robot, however, the following dangers will be supposed.

a) Danger supposed in normal automatic operation
- Operator's mis-operation and mis-judgment, incomplete program.
- Unexpected robot movement, 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, contact failure, 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 them. Also, refer to all manuals relating to the robot and robot controller.

2 Safety Functions

This robot and robot controller have various safety functions as shown below.

a) Emergency stop function

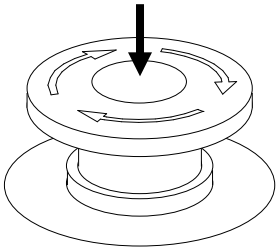
An EMERGENCY stop pushbutton switch is equipped on the robot controller (TS3000 and TS3000E) and teach pendant, respectively. When this switch is pressed, the robot stops immediately and the main power of the robot is turned off.

(Stop category 1)

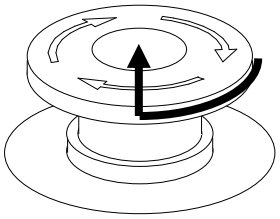
The emergency stop function is always enabled regardless of the operating status of the robot.

An emergency stop button uses a switch with the locking mechanism. To unlock the button, turn and pull up the switch top as shown below.

The external emergency stop contacts are also available. The emergency stop switch can be added as required. The emergency stop switch that complies with ISO13850 should be selected.



Emergency stop switch ON



Emergency stop switch unlock

Notes on Emergency Stop Switch

Select emergency stop switches, observing the following:

- Install each emergency stop device at a location where an emergency stop would be required and where they are easy to access when needed.
- Select emergency stop devices structured in a way that once they are activated, their circuits will only recover automatically after manual recovery, and their contacts cannot be restored before device recovery.
- Select emergency stop devices in any of the following shapes that are suited to the machine structure and are characterized to overcome dangerous situations:
  1) Mushroom-type pushbutton
  2) Rope-pull type, or bar type
  3) Belly or knee type
  4) Pedal switch without a protective cover
- The pushbutton type of emergency stop device shall have a red actuator on a yellow background.
- The rope-pull type of emergency stop device shall always maintain proper tension on the rope, and the rope shall be distinguishable via twisted red and yellow strands.

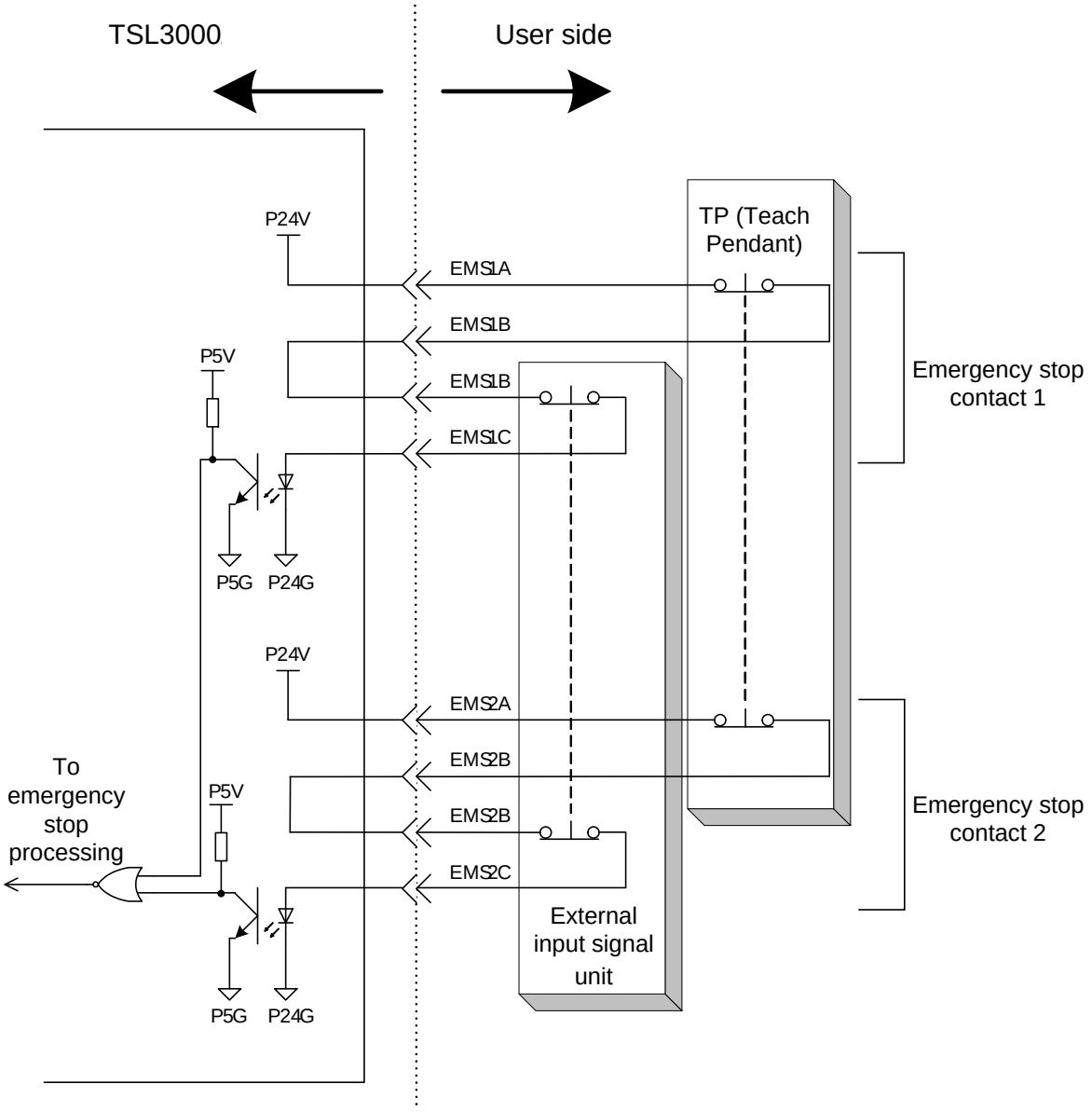
b) Safety contact input function

The controller has the redundant safety contact input function that is separate from the emergency stop system.

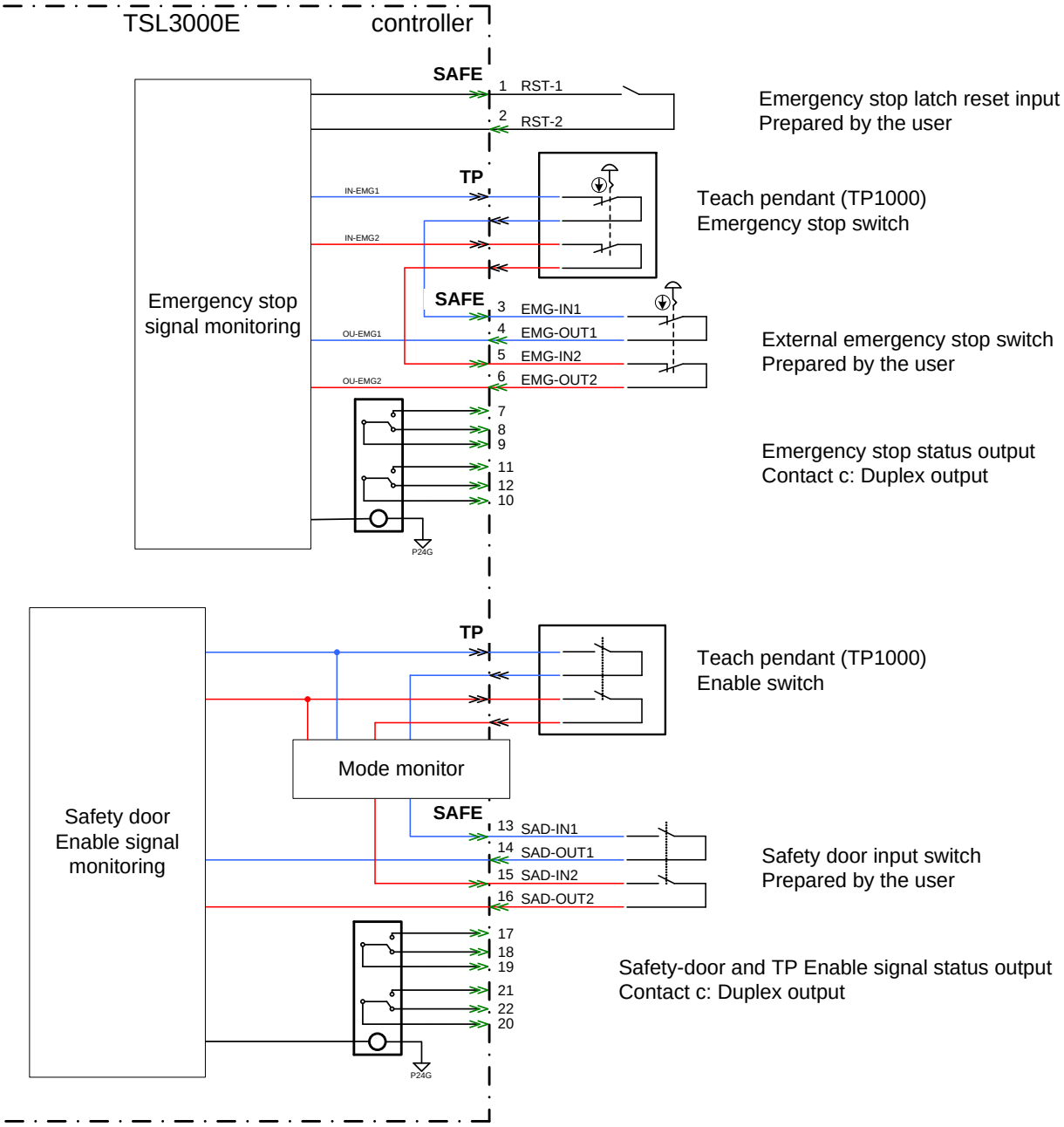
Connect interlock switches such as limit switch and foot switch that work with the safety fence door.

【 About Emergency stop function and Safety contact input function】

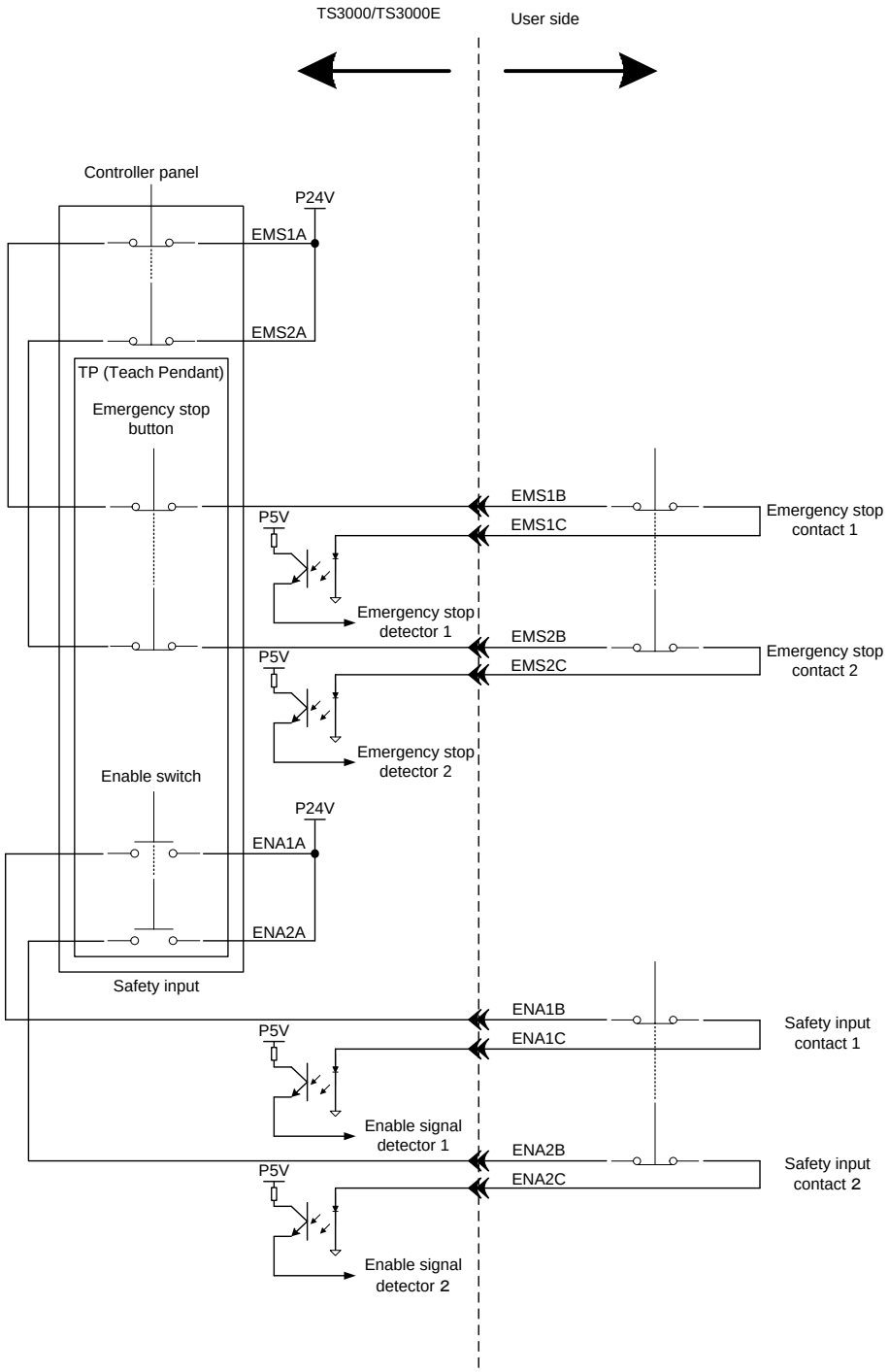
1) The external emergency stop contacts for the TSL3000 are shown in the following figure. Connect an emergency stop button to the INPUT connector pins 18-19 and 36-37 on the front of the TSL3000. Emergency stop buttons for the output common Type-N and Type-P should also be connected to the pins of the same numbers.



2) The external emergency stop contacts for the TSL3000E are shown in the following figure. Connect an emergency stop button to the SAFE connector pins 3-4 and 5-6 on the front of the TSL3000E, and a safety door or the like to the pins 13-14 and 15-16. Then, connect an interlock switch such as a limit switch or a foot switch that operates in conjunction with the door of the safety fence.

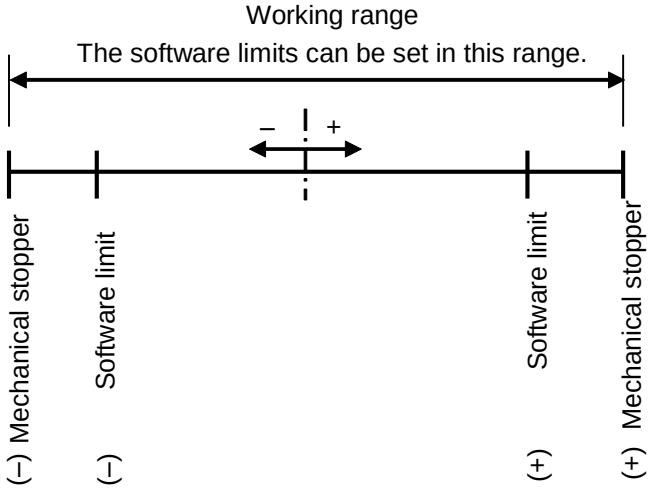


3) The external emergency stop contacts for the TS3000 and TS3000E are shown in the following figure.
Connect an emergency stop button to the EMS connector pins 7-8 and 9-10 on the rear of the TS3000 and TS3000E, and a safety door or the like to the pins 3-4 and 5-6. Then, connect an interlock switch such as a limit switch or a foot switch that operates in conjunction with the door of the safety fence.



c) Mechanical stopper

To prevent overrun, this robot is equipped with mechanical stoppers. The mechanical stoppers are provided on axis 1, axis 2 and axis 3, which prevent the moving part of the robot from overrunning. Some robot models allow the position of the mechanical stopper to be changed to limit the working range. For details about how to change the position of the mechanical stopper, refer to Instruction Manual: Installation and Transport Manual.



d) Working range limiting function

Soft limits can be set as the working range limiting function. The soft limit function prevents collision to the mechanical stopper due to incorrect operation and program error.

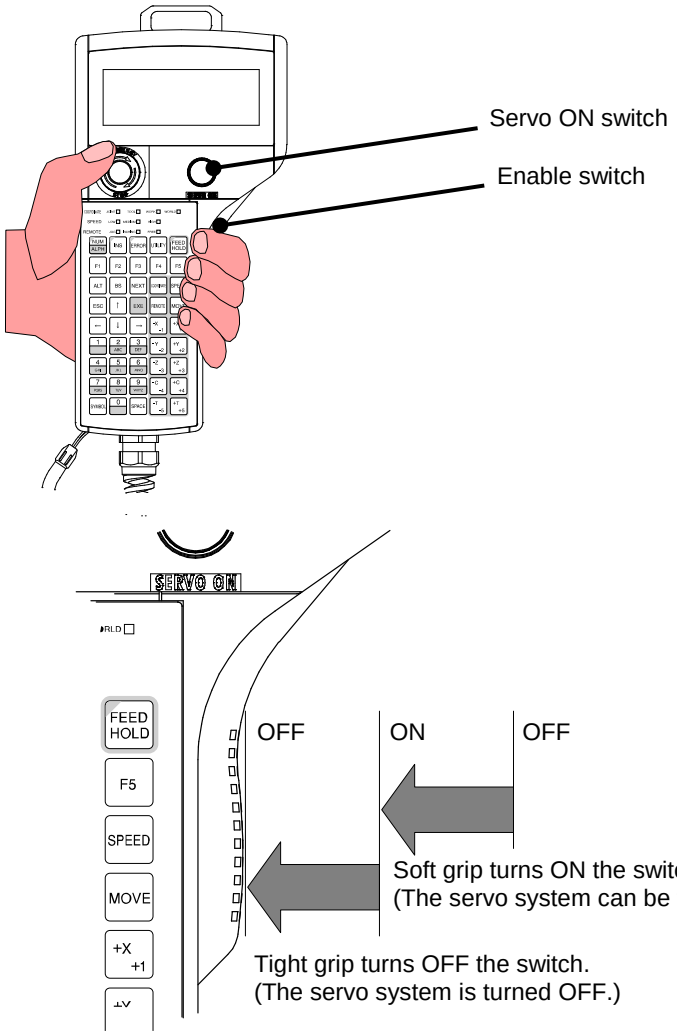
Set software limits inside the robot working range as the auxiliary function of the mechanical stopper.

e) Operation key on teach pendant

An enable switch is equipped on the teach pendant to enhance safety. When manually guiding the robot, the operator should keep pressing this enable switch while carrying the teach pendant to turn the servo power on.

This enable switch is of a 3-position type. The robot can be stopped immediately to turn off the robot power source by releasing or pressing hard the switch.

The example shows the case of TP1000.



* When the enable switch is OFF, the servo system cannot be turned ON. If the robot is manually guided, the switch should always be turned ON.

* This figure in the case of TP1000. For the TP3000, see the " TP3000 OPERATOR'S MANUAL"

f) Master switch on the front side of the controller (TSL3000/TSL3000E)
Key switch used to change over the TEACHING and EXT modes. If an operator has to enter the operating range inevitably for teaching operation or inspection, he should carry a key with him so that anyone cannot change over the mode.

g) Master switch on control panel (TS3000/TS3000E)
Master key switch is used to change over the TEACHING, INTERNAL, and EXT modes.
If an operator has to enter the dangerous area inevitably for teaching operation or inspection, he should change the mode to TEACHING and carry the key with him so that anyone cannot operate the robot.

h) CE-compliant safety function (TSL3000E/TS3000E)
TSL3000E indicates the TSL3000 corresponding to category 3.
For the difference from the TSL3000, see "Applicable standards and safety performances."
TS3000E indicates the TS3000 corresponding to category 3.
For the difference from the TS3000, see "Applicable standards and safety performances."
The TSL3000E and TS3000E controller is equipped with the input terminals that connect the safety circuit. In order to satisfy the CE-compliant safety (Category 3, PL = d), TS3000E connect the TS3SFB unit (option). For details about the TS3SFB unit, refer to Instruction Manual: TS3SFB Unit Manual.

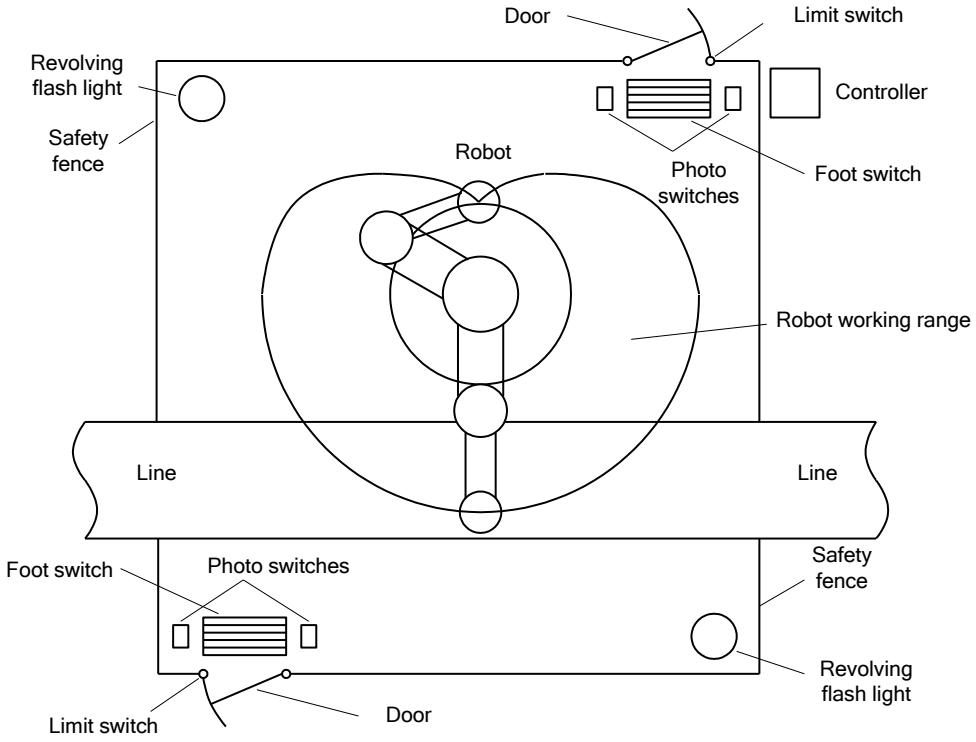
3 Safety Measures

Most of disasters caused by the robot originate from unsafe behavior of man.
When using the robot, he 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.
Main safety measures are as follows:

a) General cautions on using the robot

1) When installing the robot, provide a space required for the job safely.

2) The dangerous area should be identified. For this purpose, necessary measures should be taken to prevent entry of any person, by installing safety fences, etc.
The dangerous area signifies an area near the robot, where, if a person has entered, he will jeopardize.



3) Outside the safety fence, the emergency stop switch should be installed and connected to the external emergency stop contacts (EMS1B and EMS1C, EMS2B and EMS2C) of the robot controller. The emergency stop switch should be installed in the area where the operator who has judged an abnormality can press it immediately. The emergency stop device that complies with ISO13850 should be connected.

4) Interlock switches such as limit switches, photo switches, foot switch, etc. should be equipped on the doorway of each safety fence and connected to the safety contact inputs of the controller so that the robot will stop when a person enters the dangerous area. The interlock switch should be electrically independent and the one with the b close contact (i.e., contact closed at normal operation).

5) The robot controller should be installed outside the dangerous area where an operator can watch the robot movements.

6) Operation should be performed only by a well-trained and qualified operator. Anyone who does not understand and is not familiar with the movements of the robot and related equipment should not execute operation. Also, current condition of the robot should always be displayed to prevent an unrelated person from carelessly entering the working range or operating the robot.

7) Before day's operation, perform the following check. Pushbutton switches equipped on the control panel (TS3000 and TS3000E) and teach pendant should always be operated while confirmed visually.

<Check before operation>

- Make sure that visual appearance of the robot, controller, peripheral equipment and cables is in good condition.
- Make sure that no obstacle stands in or near 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.

b) Cautions on teaching operation

In principle, teaching operation should be performed outside the dangerous area of the robot. If it should be performed inevitably within the dangerous area, strictly observe the following cautions.

1) The teaching operation should always be performed by two (2) 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) The operator should do the job in an attitude ready to press the EMERGENCY stop pushbutton switch at any time. Also, he should perform the job at a position from which he can evacuate immediately at the time of an emergency after confirming the robot operating zone and shields in the surroundings.
Also, he should not turn his back to the robot.

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

c) 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 malfunctioned, turn the power off, identify and remove the cause of the nonconformity, maintain the peripheral equipment and completely restore the malfunctioned robot. Then confirm its movements at a low speed.
Even if the robot has stopped, DO NOT approach the dangerous area immediately.

3) Before entering the dangerous area of the robot for inspection, maintenance or repair, be sure to turn the power off. Also, turn the power off when the robot is not in use.

Note) Because of space limitations, this document covers only important safety precautions for robot operation, but not all general safety information. Thus, it is recommended that the operators should read safety instructions issued by Safety Division of Ministry of Labor and Japan Industrial Safety & Health Association (JISHA) before attempting to operate the robot.

Compliant Standards and Safety Performance

- **Combination of robots and controllers and compliant standards**

Robot	Controller	Machinery directive 2006/42/EC	Low-voltage directive 2006/95/EC	EMC directive 2004/108/EC
THL300 THL400 THL500 THL600 THL700 THL800 THL900 THL1000	TS3000	ISO10218-1:2008 ISO13849-1:1999	IEC60204-1:2006 IEC61800-5-1:2007	EN55011:2009 EN61000-6-2:2005
	TSL3000E TS3000E+TS3FSB	ISO10218-1:2011 ISO13849-1:2008		

The KCs mark safety certification has been obtained for the combination of the THL series and TSL3000 controller.

- **Combination of robots and controllers and safety performance**

Robot	Controller	ISO13849-1:1999 Safety category	ISO13849-1:2008 Performance level
THL300 THL400 THL500 THL600 THL700 THL800 THL900 THL1000	TS3000	Category 2	n/a
	TSL3000E TS3000E+TS3FSB	Category 3	PL=d

The EU directives with which Toshiba Machine robots using TSL3000Eand TS3000E are compliant to satisfy CE marking include machinery directive (2006/42/EC), low-voltage directive (2006/95/EC) and EMC directive (2004/108/EC). Also, this robot has been self-declared to satisfy CE marking as a semifinished machine. Bringing this robot to completion as a robot system requires validation as a result of making an appropriate risk assessment based on the EU directives in combination with the end effector and ancillary safety devices (e.g., safety fence, enclosure, etc.).