MITSUBISHI
Mitsubishi Industrial Robot

CR1/CR1B Controller

INSTRUCTION MANUAL

Controller setup, basic operation, and maintenance

MELFA

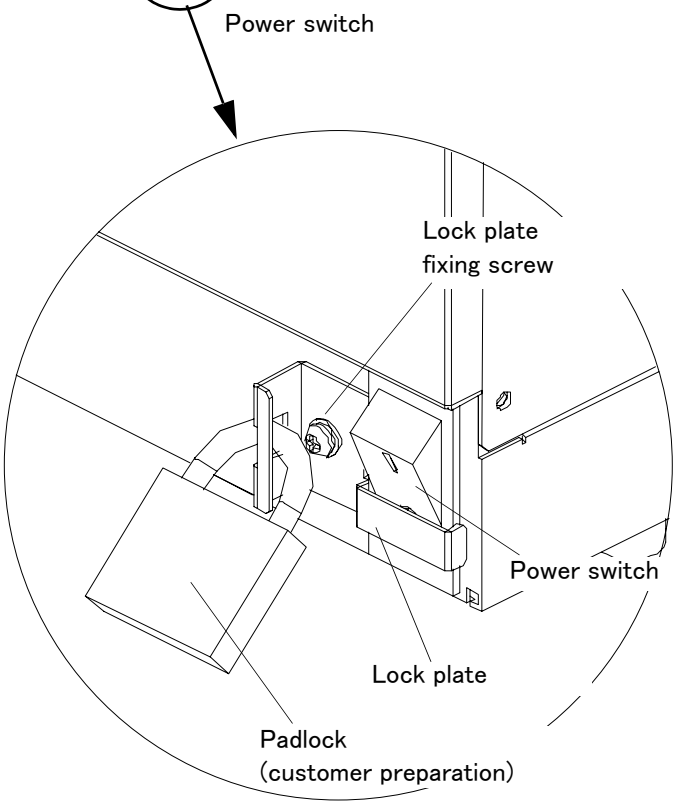
BFP-A8054-J

The operation-lock of the power switch

The power switch has operation-lock function. It is the mechanism in which the mistaken power supply ON is prevented with the padlock etc. at the time of the maintenance of the robot system. Prepare lock devices, such as the padlock, by the customer.
The usage of lock function is shown in the following.

CR1-500/CR1B-500 series

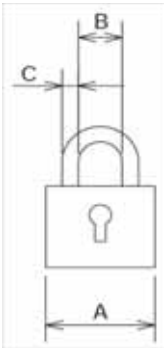
*The figure is the example of CR1-500 series. Also "CR1B-500" series is the same. The difference is the direction of the power switch.



<Operation method>
(1) The lock method (power supply OFF)
1) Turn OFF the power switch.
2) Loosen the fixing screw and remove the lock plate.
3) Cover the power switch with lock plate and fix it by fixing screw securely.
4)Install the padlock (customer preparation) in the hole of the lock plate.
The lock is completed.

(2) The release method (power supply ON)
1) Remove the padlock.
2) Loosen the fixing screw and remove the lock plate.
3) Fix the lock plate securely with the fixing screw in the position separated from the power switch.
The lock release is completed.

The recommended dimension of the padlock



dimension of the padlock

Dimension(mm)		
A	B	C
25	14	4mm or less

⚠ Safety Precautions

Always read the following precautions and the separate "Safety Manual" before starting use of the robot to learn the required measures to be taken.

⚠CAUTION All teaching work must be carried out by an operator who has received special training. (This also applies to maintenance work with the power source turned ON.)
Enforcement of safety training

⚠CAUTION For teaching work, prepare a work plan related to the methods and procedures of operating the robot, and to the measures to be taken when an error occurs or when restarting. Carry out work following this plan. (This also applies to maintenance work with the power source turned ON.)
Preparation of work plan

⚠WARNING Prepare a device that allows operation to be stopped immediately during teaching work. (This also applies to maintenance work with the power source turned ON.)
Setting of emergency stop switch

⚠CAUTION During teaching work, place a sign indicating that teaching work is in progress on the start switch, etc. (This also applies to maintenance work with the power source turned ON.)
Indication of teaching work in progress

⚠WARNING Provide a fence or enclosure during operation to prevent contact of the operator and robot.
Installation of safety fence

⚠CAUTION Establish a set signaling method to the related operators for starting work, and follow this method.
Signaling of operation start

⚠CAUTION As a principle turn the power OFF during maintenance work. Place a sign indicating that maintenance work is in progress on the start switch, etc.
Indication of maintenance work in progress

⚠CAUTION Before starting work, inspect the robot, emergency stop switch and other related devices, etc., and confirm that there are no errors.
Inspection before starting work

The points of the precautions given in the separate "Safety Manual" are given below.
Refer to the actual "Safety Manual" for details.

⚠CAUTION Use the robot within the environment given in the specifications. Failure to do so could lead to a drop or reliability or faults. (Temperature, humidity, atmosphere, noise environment, etc.)

⚠CAUTION Transport the robot with the designated transportation posture. Transporting the robot in a non-designated posture could lead to personal injuries or faults from dropping.

⚠CAUTION Always use the robot installed on a secure table. Use in an instable posture could lead to positional deviation and vibration.

⚠CAUTION Wire the cable as far away from noise sources as possible. If placed near a noise source, positional deviation or malfunction could occur.

⚠CAUTION Do not apply excessive force on the connector or excessively bend the cable. Failure to observe this could lead to contact defects or wire breakage.

⚠CAUTION Make sure that the workpiece weight, including the hand, does not exceed the rated load or tolerable torque. Exceeding these values could lead to alarms or faults.

⚠WARNING Securely install the hand and tool, and securely grasp the workpiece. Failure to observe this could lead to personal injuries or damage if the object comes off or flies off during operation.

⚠WARNING Securely ground the robot and controller. Failure to observe this could lead to malfunctioning by noise or to electric shock accidents.

⚠CAUTION Indicate the operation state during robot operation. Failure to indicate the state could lead to operators approaching the robot or to incorrect operation.

⚠WARNING When carrying out teaching work in the robot's movement range, always secure the priority right for the robot control. Failure to observe this could lead to personal injuries or damage if the robot is started with external commands.

⚠CAUTION Keep the jog speed as low as possible, and always watch the robot. Failure to do so could lead to interference with the workpiece or peripheral devices.

⚠CAUTION After editing the program, always confirm the operation with step operation before starting automatic operation. Failure to do so could lead to interference with peripheral devices because of programming mistakes, etc.

⚠CAUTION Make sure that if the safety fence entrance door is opened during automatic operation, the door is locked or that the robot will automatically stop. Failure to do so could lead to personal injuries.

⚠CAUTION Never carry out modifications based on personal judgments, or use non-designated maintenance parts.
Failure to observe this could lead to faults or failures.

⚠WARNING When the robot arm has to be moved by hand from an external area, do not place hands or fingers in the openings. Failure to observe this could lead to hands or fingers catching depending on the posture.

⚠CAUTION

Do not stop the robot or apply emergency stop by turning the robot controller's main power OFF. If the robot controller main power is turned OFF during automatic operation, the robot accuracy could be adversely affected.Moreover, it may interfere with the peripheral device by drop or move by inertia of the arm.

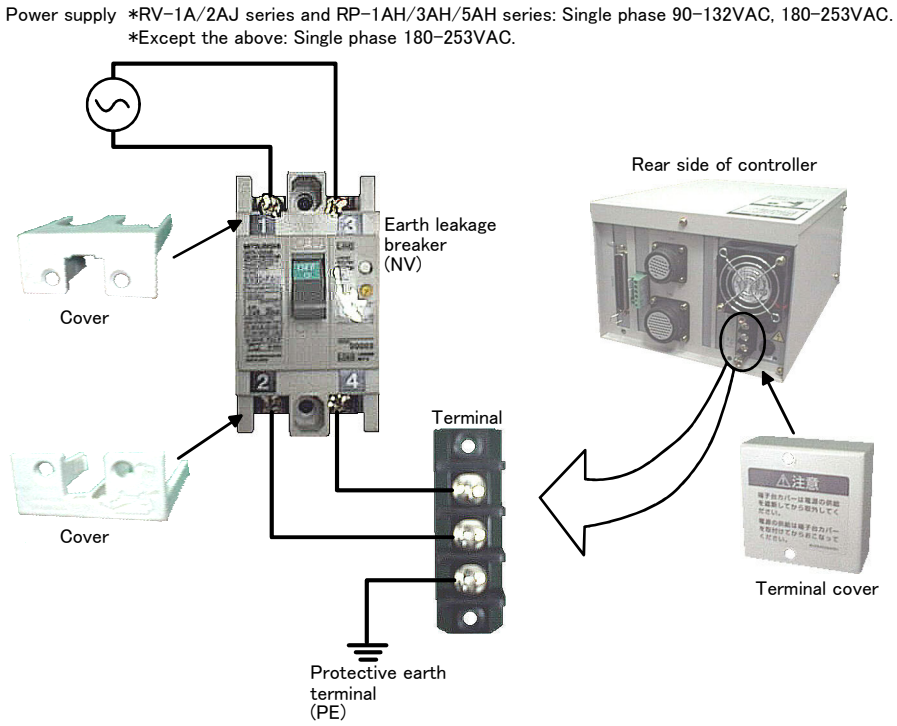
⚠CAUTION

Do not turn off the main power to the robot controller while rewriting the internal information of the robot controller such as the program or parameters.
If the main power to the robot controller is turned off while in automatic operation or rewriting the program or parameters, the internal information of the robot controller may be damaged.

Precautions for the basic configuration are shown below.(When CR1-571 is used for the controller.)

⚠CAUTION

Provide an earth leakage breaker that packed together on the primary power supply of the controller as protection against electric leakage. Confirm the setting connector of the input power supply voltage of the controller, if the type
which more than one power supply voltage can be used. Then connect the power supply.
Failure to do so could lead to electric shock accidents.



Revision history

Date of print	Specifications No.	Details of revisions
2000-02-17	BFP-A8054Z-*	・First print
2000-03-24	BFP-A8054	・The earth leakage breaker packaged is added. ・Writing error correction.
2000-04-11	BFP-A8054-A	・RP-1AH/3AH/5AH series was added.
2000-06-09	BFP-A8054-B	・The power supply voltage of CR1 controller was corrected.
2000-12-18	BFP-A8054-C	・Writing error correction.
2001-03-21	BFP-A8054-D	・Writing error correction.
2001-09-06	BFP-A8054-E	・RV-2A/3AJ series was added. ・The power supply voltage of CR1 controller was corrected. ・Writing error correction.
2002-03-18	BFP-A8054-F	・CR1-MB (controller protection box) was added. ・Writing error correction.
2002-12-11	BFP-A8054-G	・How to inspect, clean and replace the filter was added. ・"The procedures for installing the pneumatic hand interface" is added. ・Writing error correction.
2005-02-23	BFP-A8054-H	・CR1B-571controller was added. ・Change title. ・Changed the filter cleaning and replacement procedures. ・Changed the filter model name. ・Writing error correction.
2009-09-30	BFP-A8054-J	・The EC Declaration of Conformity was changed. (Correspond to the EMC directive; 2006/42/EC)

■ Introduction

Thank you for purchasing the Mitsubishi industrial robot.
This instruction manual explains the unpacking methods, installation, basic operation, maintenance and inspection of the controller.
The optional equipments and power supply voltage are different according to connecting robot type.
Refer to separate "Standard Specifications Manual" for detail.
Always read through this manual before starting use to ensure correct usage of the robot.
The information contained in this document has been written to be accurate as much as possible. Please interpret that items not described in this document "cannot be performed."

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1 Before starting use

This chapter explains the details and usage methods of the instruction manuals, the basic terminology and the safety precautions.

1.1 Using the instruction manuals

1.1.1 The details of each instruction manuals

The contents and purposes of the documents enclosed with this product are shown below. Use these documents according to the application.
For special specifications, a separate instruction manual describing the special section may be enclosed.

Safety Manual	Explains the common precautions and safety measures to be taken for robot handling, system design and manufacture to ensure safety of the operators involved with the robot.
Standard Specifications	Explains the product's standard specifications, factory-set special specifications, option configuration and maintenance parts, etc. Precautions for safety and technology, when incorporating the robot, are also explained.
Robot Arm Setup & Maintenance	Explains the procedures required to operate the robot arm (unpacking, transportation, installation, confirmation of operation), and the maintenance and inspection procedures.
Controller Setup, Basic Operation and Maintenance	Explains the procedures required to operate the controller (unpacking, transportation, installation, confirmation of operation), basic operation from creating the program to automatic operation, and the maintenance and inspection procedures.
Detailed Explanation of Functions and Operations	Explains details on the functions and operations such as each function and operation, commands used in the program, connection with the external input/output device, and parameters, etc.
Explanations of MOVEMASTER COMMANDS	Explains details on the MOVEMASTER commands used in the program. (For RV-1A/2AJ, RV-2A/3AJ and RV-3S/3SJ/3SB/3SJB series)
Troubleshooting	Explains the causes and remedies to be taken when an error occurs. Explanations are given for each error No.

1.1.2 Symbols used in instruction manual

The symbols and expressions shown in Table 1-1 are used throughout this instruction manual. Learn the meaning of these symbols before reading this instruction manual.

Table 1-1:Symbols in instruction manual

Symbol	Meaning
⚠DANGER	Precaution indicating cases where there is a risk of operator fatality or serious injury if handling is mistaken. Always observe these precautions to safely use the robot.
⚠WARNING	Precaution indicating cases where the operator could be subject to fatalities or serious injuries if handling is mistaken. Always observe these precautions to safely use the robot.
⚠CAUTION	Precaution indicating cases where operator could be subject to injury or physical damage could occur if handling is mistaken. Always observe these precautions to safely use the robot.
[JOINT]	If a word is enclosed in brackets or a box in the text, this refers to a key on the teaching pendant.
[+/FORWD]+[+X] (A) (B)	This indicates to press the (B) key while holding down the (A) key. In this example, the [+/Forward] key is pressed while holding down the [+X/+Y] key.
[STEP/MOVE]+([COND]-[RPL]) (A) (B) (C)	This indicates to hold down the (A) key, press and release the (B) key, and then press the (C) key. In this example, the [Step/Move] key is held down, the [Condition] key is pressed and released, and the [Replace] key is pressed.
T/B	This indicates the teaching pendant.

1.2 Safety Precautions

Always read the following precautions and the separate "Safety Manual" before starting use of the robot to learn the required measures to be taken.

⚠CAUTION All teaching work must be carried out by an operator who has received special training. (This also applies to maintenance work with the power source turned ON.)
Enforcement of safety training

⚠CAUTION For teaching work, prepare a work plan related to the methods and procedures of operating the robot, and to the measures to be taken when an error occurs or when restarting. Carry out work following this plan. (This also applies to maintenance work with the power source turned ON.)
Preparation of work plan

⚠WARNING Prepare a device that allows operation to be stopped immediately during teaching work. (This also applies to maintenance work with the power source turned ON.)
Setting of emergency stop switch

⚠CAUTION During teaching work, place a sign indicating that teaching work is in progress on the start switch, etc. (This also applies to maintenance work with the power source turned ON.)
Indication of teaching work in progress

⚠DANGER Provide a fence or enclosure during operation to prevent contact of the operator and robot.
Installation of safety fence

⚠CAUTION Establish a set signaling method to the related operators for starting work, and follow this method.
Signaling of operation start

⚠CAUTION As a principle turn the power OFF during maintenance work. Place a sign indicating that maintenance work is in progress on the start switch, etc.
Indication of maintenance work in progress

⚠CAUTION Before starting work, inspect the robot, emergency stop switch and other related devices, etc., and confirm that there are no errors.
Inspection before starting work

1.2.1 Precautions given in the separate Safety Manual

The points of the precautions given in the separate "Safety Manual" are given below.
Refer to the actual "Safety Manual" for details.

⚠CAUTION Use the robot within the environment given in the specifications. Failure to do so could lead to a drop or reliability or faults. (Temperature, humidity, atmosphere, noise environment, etc.)

⚠CAUTION Transport the robot with the designated transportation posture. Transporting the robot in a non-designated posture could lead to personal injuries or faults from dropping.

⚠CAUTION Always use the robot installed on a secure table. Use in an instable posture could lead to positional deviation and vibration.

⚠CAUTION Wire the cable as far away from noise sources as possible. If placed near a noise source, positional deviation or malfunction could occur.

⚠CAUTION Do not apply excessive force on the connector or excessively bend the cable. Failure to observe this could lead to contact defects or wire breakage.

⚠CAUTION Make sure that the workpiece weight, including the hand, does not exceed the rated load or tolerable torque. Exceeding these values could lead to alarms or faults.

⚠WARNING Securely install the hand and tool, and securely grasp the workpiece. Failure to observe this could lead to personal injuries or damage if the object comes off or flies off during operation.

⚠WARNING Securely ground the robot and controller. Failure to observe this could lead to malfunctioning by noise or to electric shock accidents.

⚠CAUTION Indicate the operation state during robot operation. Failure to indicate the state could lead to operators approaching the robot or to incorrect operation.

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⚠CAUTION Keep the jog speed as low as possible, and always watch the robot. Failure to do so could lead to interference with the workpiece or peripheral devices.

⚠CAUTION After editing the program, always confirm the operation with step operation before starting automatic operation. Failure to do so could lead to interference with peripheral devices because of programming mistakes, etc.

⚠CAUTION Make sure that if the safety fence entrance door is opened during automatic operation, the door is locked or that the robot will automatically stop. Failure to do so could lead to personal injuries.

⚠CAUTION Never carry out modifications based on personal judgments, or use non-designated maintenance parts.
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⚠WARNING When the robot arm has to be moved by hand from an external area, do not place hands or fingers in the openings. Failure to observe this could lead to hands or fingers catching depending on the posture.

⚠CAUTION Do not stop the robot or apply emergency stop by turning the robot controller's main power OFF.
If the robot controller main power is turned OFF during automatic operation, the robot accuracy could be adversely affected.

⚠CAUTION Do not turn off the main power to the robot controller while rewriting the internal information of the robot controller such as the program or parameters. If the main power to the robot controller is turned off while in automatic operation or rewriting the program or parameters , the internal information of the robot controller may be damaged.

2 Unpacking to installation

2.1 Confirming the products

Confirm that the parts shown in the standard configuration of the controller shown in Table 2-1 are enclosed with the purchased product.
Users who have purchased options should refer to the separate "Standard Specifications". The primary power supply cable and grounding cable must be prepared by the customer.

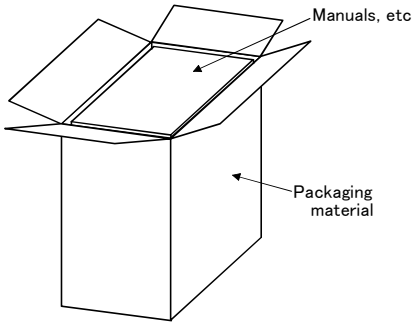
Table 2-1 : Standard configuration

No.	Part name	Type	Qty.	Remarks
For the RV-3S/RV-3SJ series				
1	Controller	CR1B-571	1 unit	With machine cable.
2	Earth leakage breaker(NV)		1 pc.	Cover and installation screw(2 pc) is attached.
3	Safety Manual	BFP-A8006	1 copy	
4	CD-ROM (Instruction manual)	BFP-A8317	1 disk	
	Standard Specifications	BFP-A8387	(1 copy)	Found on CD-ROM
	Instruction Manual (Robot arm setup and maintenance)	BFP-A8388	(1 copy)	Found on CD-ROM
	Instruction Manual (Controller setup, basic operation and maintenance)	BFP-A8054	(1 copy)	This book Found on CD-ROM
	Instruction Manual (Detailed explanations of functions and operations)	BFP-A5992	(1 copy)	Found on CD-ROM
	Instruction Manual (Explanations of MOVEMASTER COMMANDS)	BFP-A8056	(1 copy)	Found on CD-ROM
	Instruction Manual (Troubleshooting)	BFP-A5993	(1 copy)	Found on CD-ROM
5	Guarantee Card		1 copy	
For other models				
1	Controller	CR1-571	1 unit	With machine cable
2	Earth leakage breaker(NV)		1 pc.	Cover and installation screw(2 pc) is attached.
3	Safety Manual	BFP-A8006	1 copy	
4	Standard Specifications	BFP-A8050	1 of these copy	RV-1A/2AJ series type.
5		BFP-A8182		RV-2A/3AJ series type.
6		BFP-A8104		RP-1AH/3AH/5AH series type.
7		BFP-A8176		RH-15UHC series type.
8	Instruction Manual (Robot arm setup and maintenance)	BFP-A8052	1 of these copy	RV-1A/2AJ series type.
9		BFP-A8183		RV-2A/3AJ series type.
10		BFP-A8111		RP-1AH/3AH/5AH series type.
11		BFP-A8177		RH-15UHC series type.
12	Instruction Manual (Controller setup, basic operation and maintenance)	BFP-A8054	1 copy	This book
13	Instruction Manual (Detailed explanations of functions and operations)	BFP-A5992	1 copy	
14	Instruction Manual (Explanations of MOVEMASTER COMMANDS)	BFP-A8056	1 copy	For RV-1A/2AJ and RV-2A/3AJ series type.
15	Instruction Manual (Troubleshooting)	BFP-A5993	1 copy	
16	Guarantee Card		1 copy	

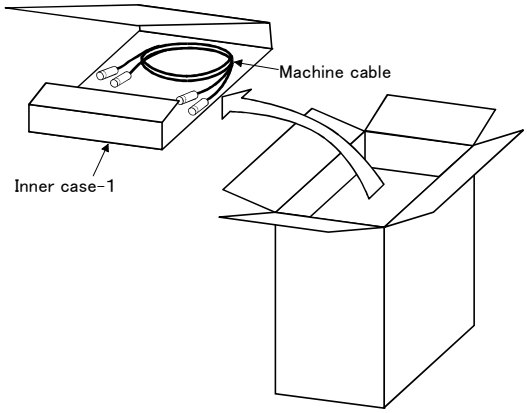
2.2 Installation

2.2.1 Unpacking procedures

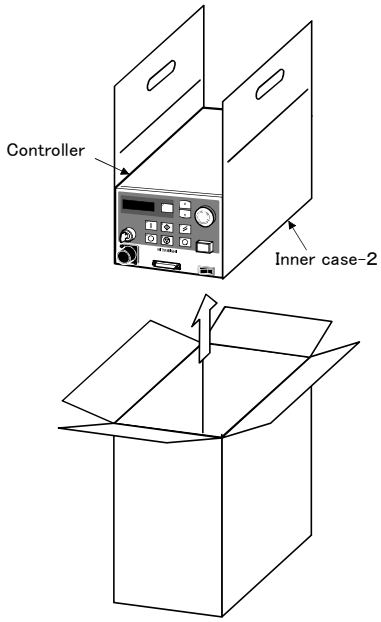
1. Open the top of the cardboard box, and remove the instruction manual.



2. Remove the inner case-1, and remove the machine cable.



3. Remove the inner case-2, and remove the controller.



Note)The packaging material is required when transporting the controller again, so keep it in safekeeping.

Fig.2-1 : Unpacking the controller

2.2.2 Transportation procedures **Mass: Approx. 8kg**

Fig.2-2 : Transporting the controller

(1) Transport the controller by placing hands between the lower clearance created with the rubber foot on the front and back sides, and lifting up the controller. Do not hold the switches or connectors.

2.2.3 Installation procedures

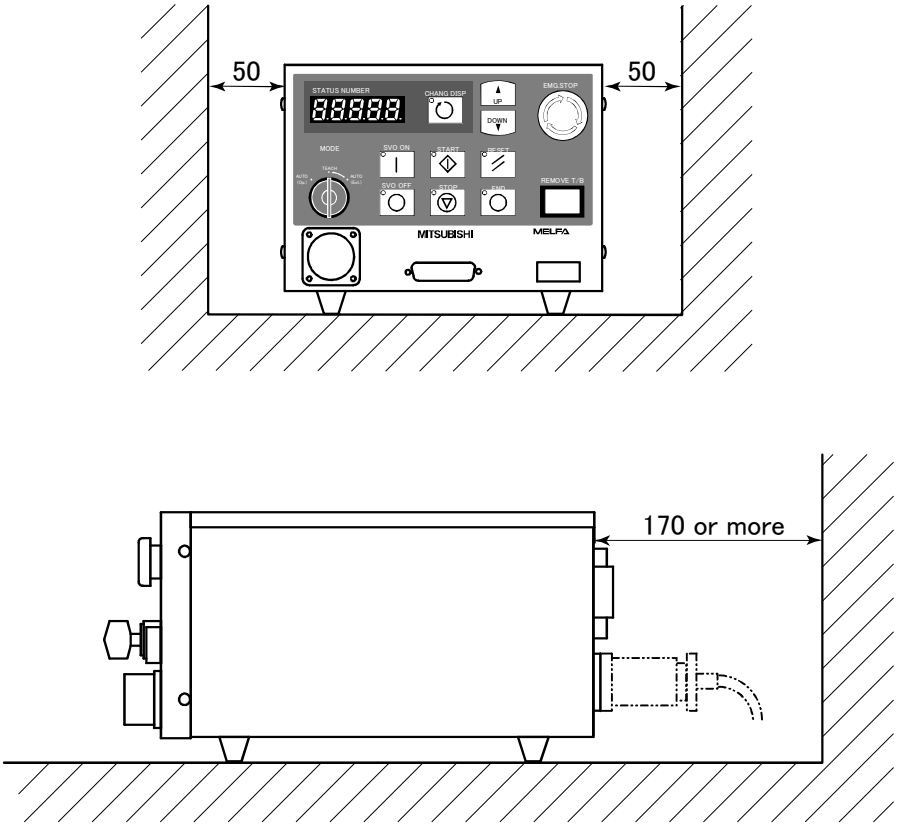


Fig.2-3 : Installation dimensions

[Caution] A suction port is installed on the bottom of the controller, so do not remove the rubber foot and install the controller flat on a surface.

2.2.4 Connecting the power cable and grounding cable

The power supply voltage is classified as follows by the use robot type. The connection of the cable is to proceed in each explanation clause, and do it.

*RV-1A/2AJ series

Power supply voltage : Choose 1-phase 100VAC or 1-phase 200VAC. (Default setting is 1-phase 100VAC.)

Explanation clause : Do it from the following "(1)Setting the power specifications (CR1-571 controller only)".

*RP-1AH/3AH/5AH series

Power supply voltage : Choose 1-phase 100VAC or 1-phase 200VAC. (Default setting is 1-phase 200VAC.)

Explanation clause : Do it from the following "(1)Setting the power specifications (CR1-571 controller only)".

*Except the above

Power supply voltage : 1-phase 200VAC fixation. (Default setting is 1-phase 200VAC.)

Explanation clause : Proceed to "(2) Connecting the power and grounding cable" on page 9.

⚠CAUTION Use an earth leakage breaker in the package on the primary power supply of the controller to protect against leakage currents. Failure to observe this could lead to electric shock accidents.

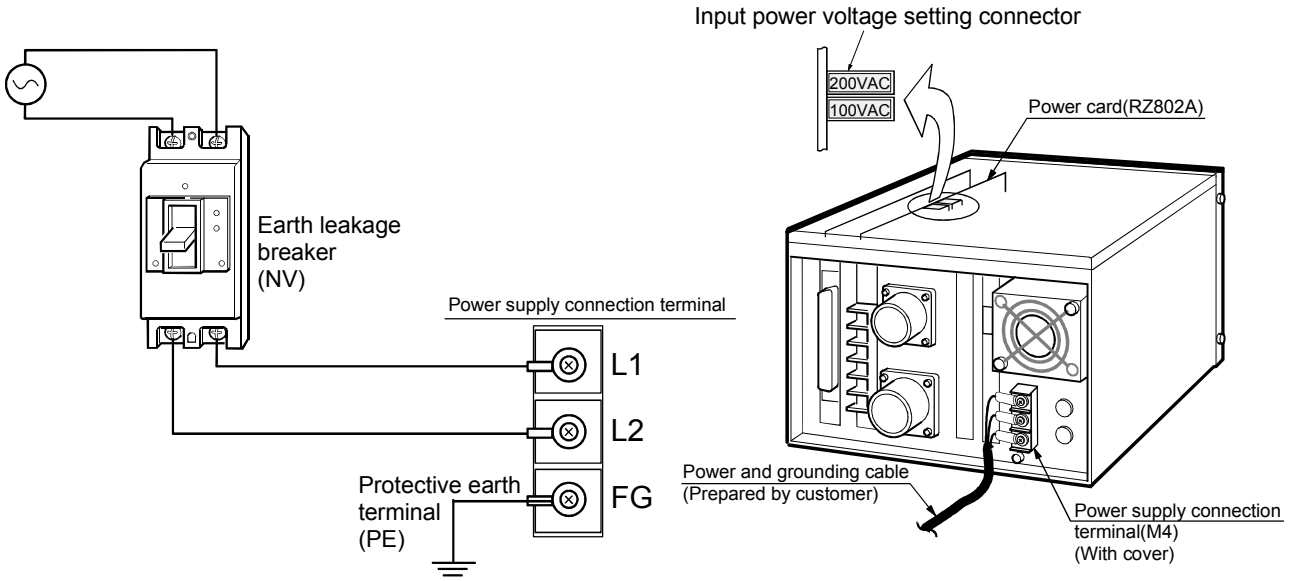


Fig.2-4 : Connecting the power cable and grounding cable

(1) Setting the power specifications (CR1-571 controller only)

1) Remove the controller cabinet cover.
2) Set the input power voltage setting connector on the power card (RZ802A: refer to Fig. 2-4) in the controller as follows.
   <When using as single-phase 200VAC>
   Insert the "input power voltage setting connector" into the connector indicated as 200VAC (CON200V: refer to Fig. 2-4) on the power card (RZ802A).
   <When using as single-phase 100VAC>
   Insert the "input power voltage setting connector" into the connector indicated as 100VAC (CON100V: refer to Fig. 2-4) on the power card (RZ802A).
3) Install the controller cabinet cover.

⚠ CAUTION (To the user of the CR1-571 controller)
If the voltage set with "input power voltage setting connector" and the actual input voltage differ (ex. When input voltage is 200VAC even though 100VAC is set), the error "input Power Voltage Setting Incorrect" (error No.850) will occur.
Error No. 850 will also occur if the robot arm designed for 200 VAC is set to 100 VAC.

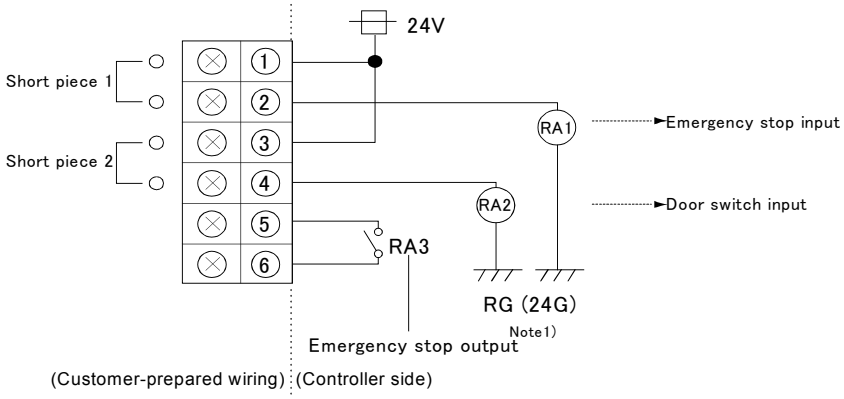
(2) Connecting the power and grounding cable

1) Prepare the 2 power cables and 1 grounding cable (both AWG#14($2mm^2$) or more).
2) Remove the two M4 screws for the power supply terminal block cover on the rear of the controller.
3) Confirm that the primary power is set to the power specifications set in "(1)Setting the power specifications (CR1-571 controller only)" above.
4) Confirm that the primary power is OFF, and that the power switch on the front of the controller is OFF.
5) Connect the 1 power cable to the power supply terminal on the back of the controller. (L1 and L2 from the top.) Connect the opposition side to the secondary terminal of the earth leakage breaker packaged. (Terminal of the bottom side.)
6) Connect the grounding cable to the grounding terminal on the power supply terminal block. (Lowest terminal.)
7) Connect the one rest of the power cable with the primary terminal of the earth leakage breaker. (Terminal of the upside)
8) Install the power supply terminal block cover removed in step "2)".

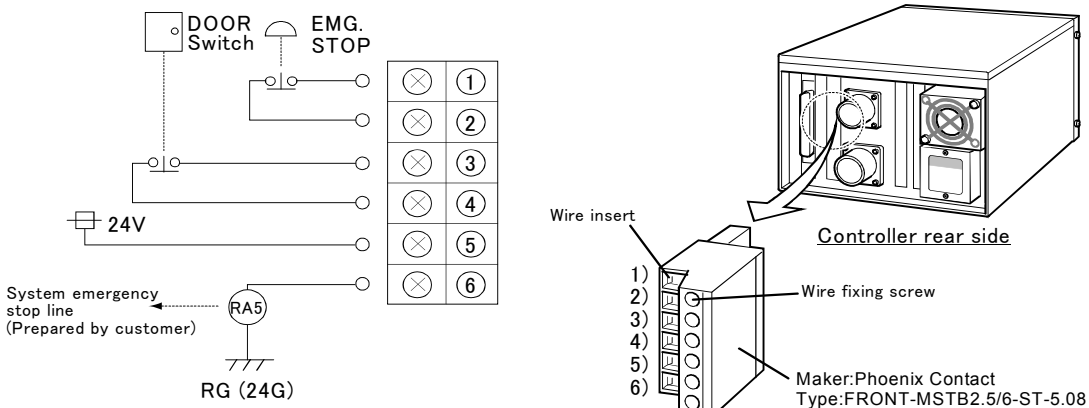
This completes the connection of the power and grounding cables.

Note) Do the installation of the earth leakage breaker packaged by the customer. The length of the power cable varies according to the distance between the installation place and the controller.

2.2.5 Connecting the external emergency stop



Composition of external emergency stop and door switch



Example of wiring for external emergency stop and door switch (customer-prepared wiring)

Terminal block array of external emergency stop

Note 1) Emergency stop output opens when either one of the emergency stop switches shown below or an input signal turns on.
- ·Emergency stop switch of the controller.
- ·Emergency stop switch or deadman switch of the T/B (option).
- ·External emergency stop input.
- ·External door input.
- ·The T/B mount/dismount switch is OFF when the T/B is unconnected.

Fig.2-5 : Connecting the external emergency stop

For safety purposes, install the External emergency stop switch at an easy-to-operate place. The external emergency stop input and door switch input terminal block are short-circuited with a short bar (short piece) as shown in Fig. 2-5.
Connect the external emergency stop switch and door switch with the following procedures.
Refer to the standard specifications for details on the door switch functions.

1) Prepare the emergency stop switch and door switch.
2) Loosen the wire fixing screw on the terminal block, and remove the short bars 1 and 2.
3) Securely connect the external emergency stop contact across "1)-2)" on the terminal block, and connect the door switch contact across "3)-4)" on the terminal block. The connection method is indicated below.
   a) Loosen the wire fixing screw on the terminal block, and open the wire insertion port.
   b) Peel 5 to 7mm of the sheath off the wire (AWG#24 to 16 recommended).
   c) Insert the wire into the wire insertion port.
   d) Securely tighten the wire fixing screw to fix the wire.

2.2.6 Connecting to the robot arm

Refer to the separate manual "Robot arm setup and maintenance", and connect the controller and robot arm with machine cables.

2.3 Setting the origin

Refer to the separate manual "Robot arm setup and maintenance", and set the origin.

2.4 Confirming the operation

Refer to the separate manual "Robot arm setup and maintenance", and confirm the robot operation with jog operation.

3 Installing the option devices

The T/B can be installed in the power OFF state as described in the separate manual "Robot arm setup and maintenance", or can be installed/removed in the power ON state as described in "4.2.1 Installing and removing the T/B" on page 29 of this manual. Refer to the respective explanations.
Refer to the separate "Standard Specifications" for the optional devices other than those described in this manual.

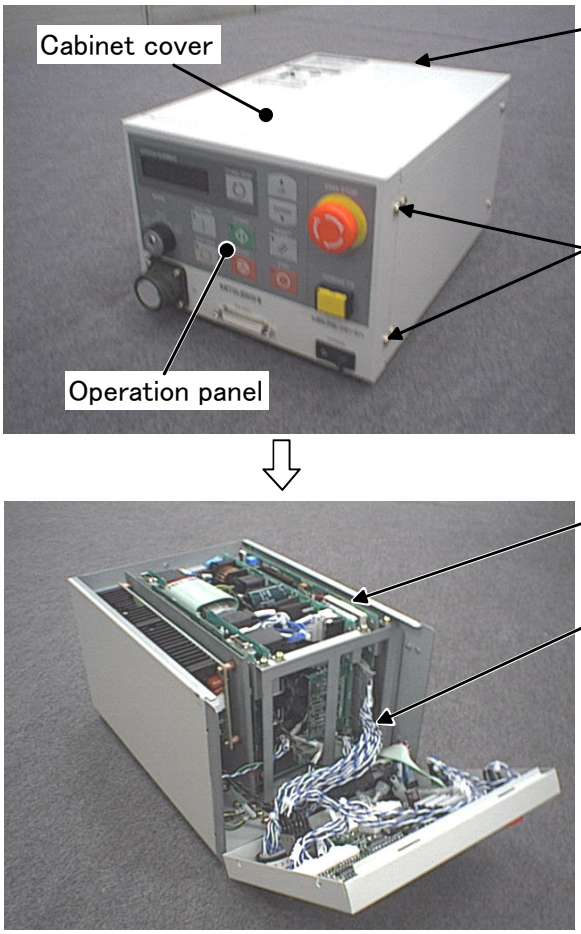
3.1 Installing the pneumatic hand interface and motorized hand interface

The method for installing the pneumatic hand interface and motorized hand interface is explained below.

⚠ CAUTION

Always turn the controller supply base power and controller power switch OFF before starting this work.

(1) Removing the controller cover
1) Remove the cabinet cover installation screws from the side of the controller, and remove the cabinet cover.
2) Remove the operation panel installation screws from the side of the controller, and remove the operation panel.



⚠ CAUTION

Wait at least three minutes after turning OFF the supply base power before removing the cabinet cover (top plate). Do not supply the power until the top plate is installed. Failure to observe this could lead to electric shocks.

⚠ CAUTION

The operation panel is connected with cables. Take care not to pull the cables with force.

Fig.3-1 : Removing the controller cover

(2) Removing the RZ386 or RZ387 card

1) Remove the connection cable A connector.

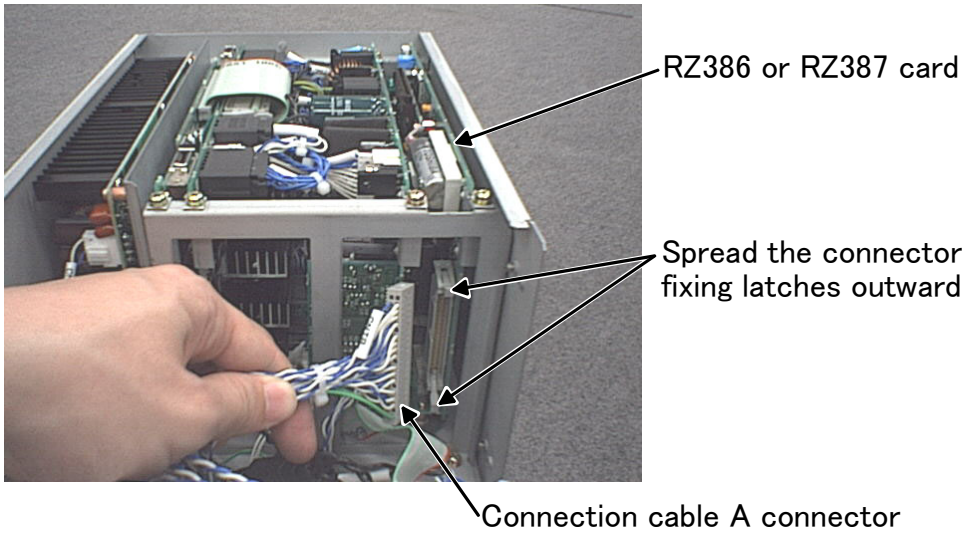


Fig.3-2 : Removing the connection cable A

2) Remove the three installation screws from the RZ386 or RZ387 card, and pull out the card to a height where the hand interface can be installed.

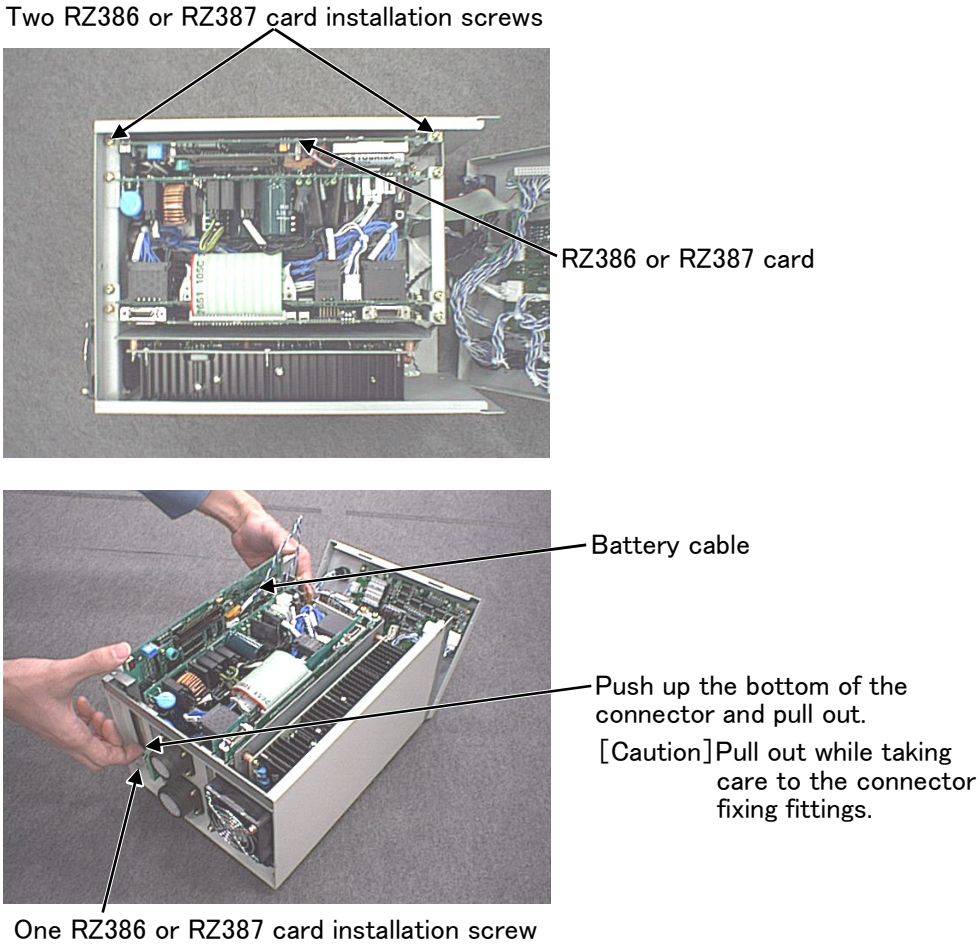


Fig.3-3 : Pulling out the RZ386 or RZ387 card

(3) Installing the pneumatic hand interface or motorized hand interface
Install the pneumatic hand interface or motorized hand interface.

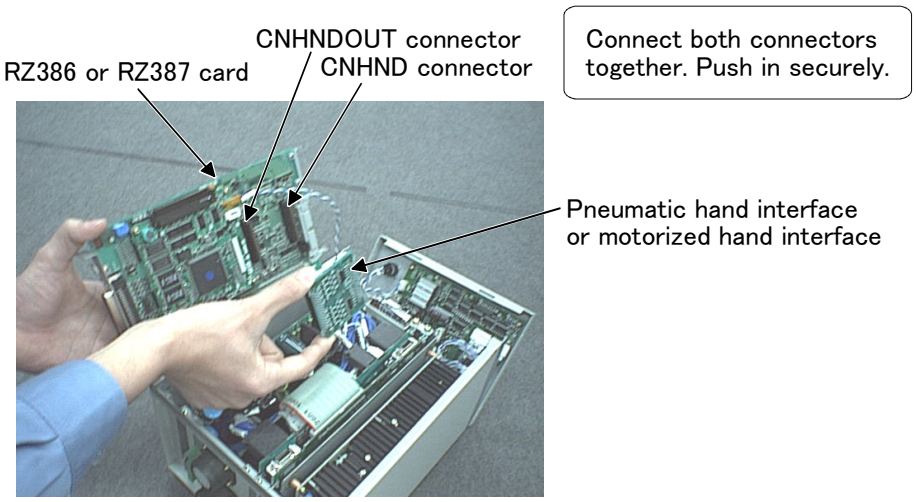


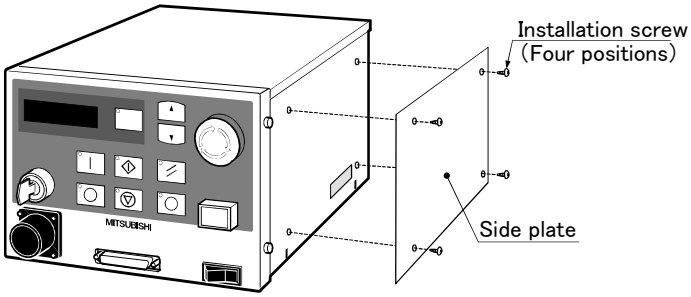
Fig.3-4 : Installing the hand interface

(4) Assembling the controller
1) Install the RZ386 or RZ387 card at the original position, removed in step "(2)" "2)", and securely fix with the three installation screws. Return the battery cable to the original position.
2) Install the connection cable A connector, removed in step "(2)" "1)" on the original position of the RZ386 or RZ387 card. Fix by pressing the connector fixing latches inward until a "click" is heard.
3) Install the operation panel, removed in step "(1)" "2)" at the original position. Take care not to catch the cable at this time. The cable could be damaged if forcibly bent and pressed in.
4) Install the cabinet cover, removed in step "(1)" "1)" at the original position.
Take care not to catch the battery cable at this time.

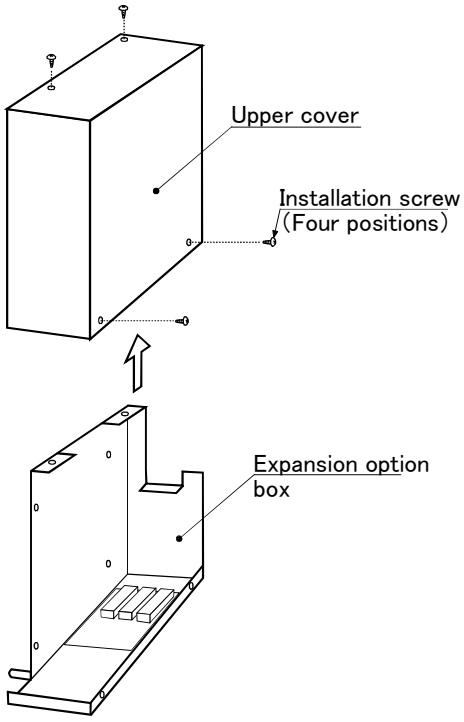
This completes the installation of the pneumatic hand interface or motorized hand interface.

3.2 Installing the expansion option box

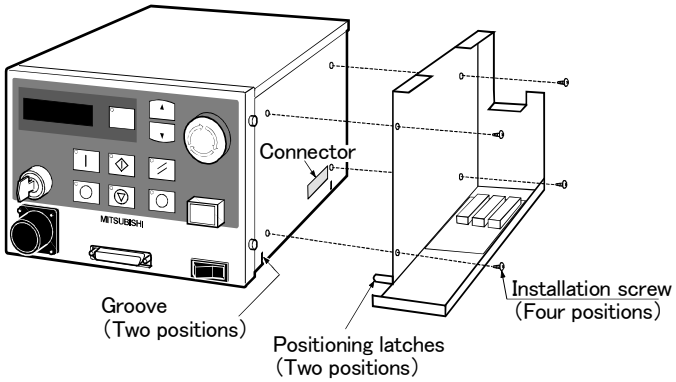
The procedures for installing the expansion option box are indicated below.



1) Loosen the four screws from the side of the controller, and remove the side plate.

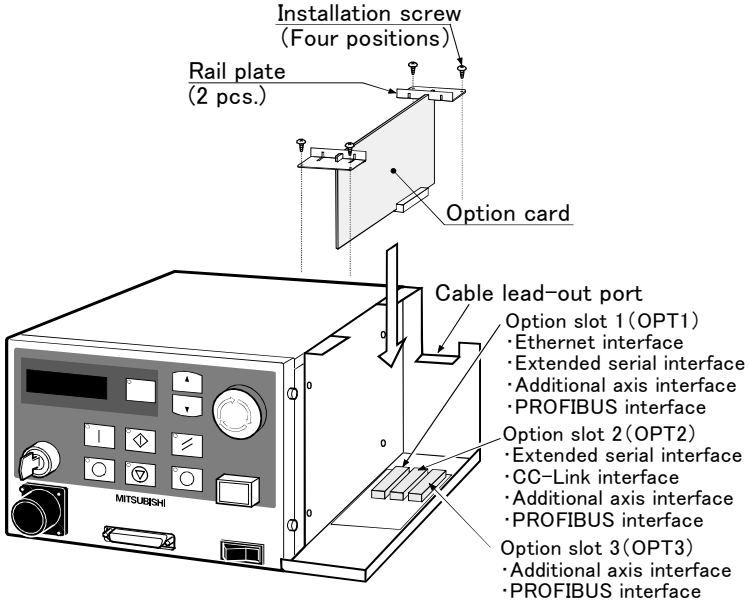


2) Remove the four screws from the expansion option box and remove the upper cover.



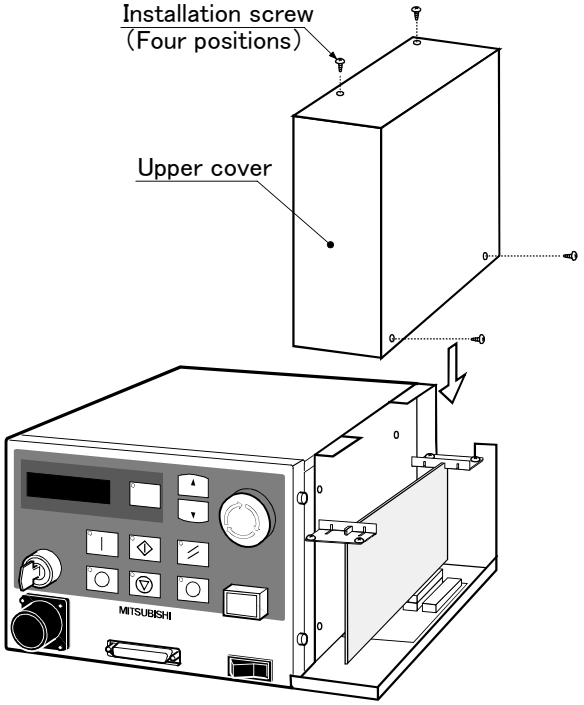
3) Connect the connectors from the side of the controller with the connectors from the expansion option box.
At this time, insert and position the positioning latches on the expansion option box into the groove on the side of the controller.

4) Securely fix both pieces with the screws removed in step 1).



5) Insert the option card to be mounted into the corresponding slot, and fix with the rail plate. Lead any required cables from the cable lead-out port on the rear side.

Note) The No. of the slot for inserting each option is determined. Refer to the instruction manual provided with each option for the corresponding slot Nos.



6) Install the upper cover removed in step "2)".

7) This completes the installation of the expansion option box.

3.3 Installation of the controller protection box (CR1B-MB)

Shows the installation method of using the controller protection box (hereinafter referred to as the protection box) to protect the controller from using environment such as oil-mist in the following.
For outside dimensions, refer to separate manual "Standard specifications manual".

3.3.1 Name of each part

Fig. 3-5 shows the names of each part of the protection box. Put the controller in this box, and use it.

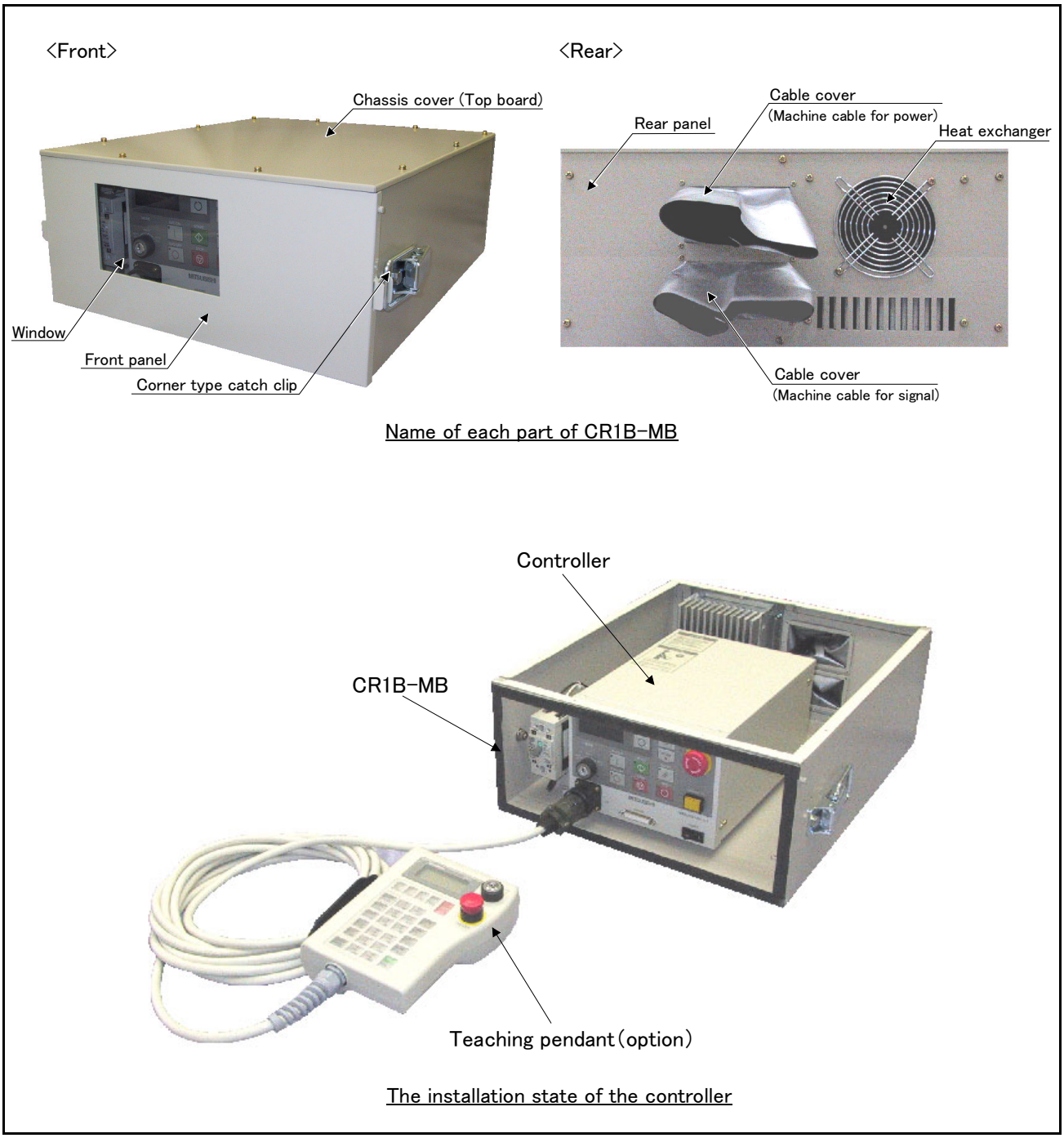


Fig.3-5 : Name of each part of protection box (CR1B-MB)

3.3.2 Confirmation before installation

(1) Confirming the products

The configuration part of the protection box is shown in Table 3-1. Confirm the parts.

Table 3-1 : Configuration device

Part name	Type	Qty.	Remarks
Controller protection box	CR1B-MB	1 unit	
Serial number posting label		1	
Protection seal transparent		1	Protection for the serial number posting label
Cable tie		2	
Power supply wiring cable		1	For connecting the power relay terminal and the controller inside the box.
Grounding cable		1	For connecting the FG terminal and the controller inside the box.
External emergency stop box (Controll box)	HW1X-BV401R	1 unit	Single emergency line. Install at a location outside the protection box where operation can be performed easily. The outside dimensions is shown in Fig. 3-10.

(2) Customer preparation parts

Prepare the cable etc. which show in the following by the customer.

- Power cable(AWG#14($2mm^2$)) ..... 2 cables
- Grounding cable(AWG#14($2mm^2$))..... 1 cable
- External emergency stop box cables(AWG#24 ～ 16 recommendation) 2 cables
- External emergency stop box cable clamp ..... 1 piece

Fit the size to the use external emergency stop box cable, and make preparation.
Table 3-2 shows the recommendation cable clamp as a reference.

Table 3-2 : Cable clamp for external emergency stop box (recommendation)

Type	JIS wiring tube	Adaptation cable outside diameter	Manufacturer
OA-W1606	G1/2	φ4 ～ 6	OHM electric Corp
OA-W1608		φ6 ～ 8	
OA-W1609		φ7 ～ 9	
OA-W1611		φ9 ～ 11	
OA-W1613		φ11 ～ 13	

(3) Copy of the manufacture number of the controller.

Write the manufacture number (serial number) printed on the rear of controller to the attached serial number copy seal by immortality ink.

3.3.3 Unpacking procedures

The protection box is shipped from the factory packaged in cardboard.
Unpack the cardboard packing, and take out the protection box and accessories.

3.3.4 Transportation procedures

Transport the protection box by placing hands between the lower clearance created with the rubber foot on the front and back sides, and lifting up. (Mass of the protection box: 10kg.)

3.3.5 Installation procedures

(1) Installation dimensions

Secure and install the space shown in the Fig. 3-6.

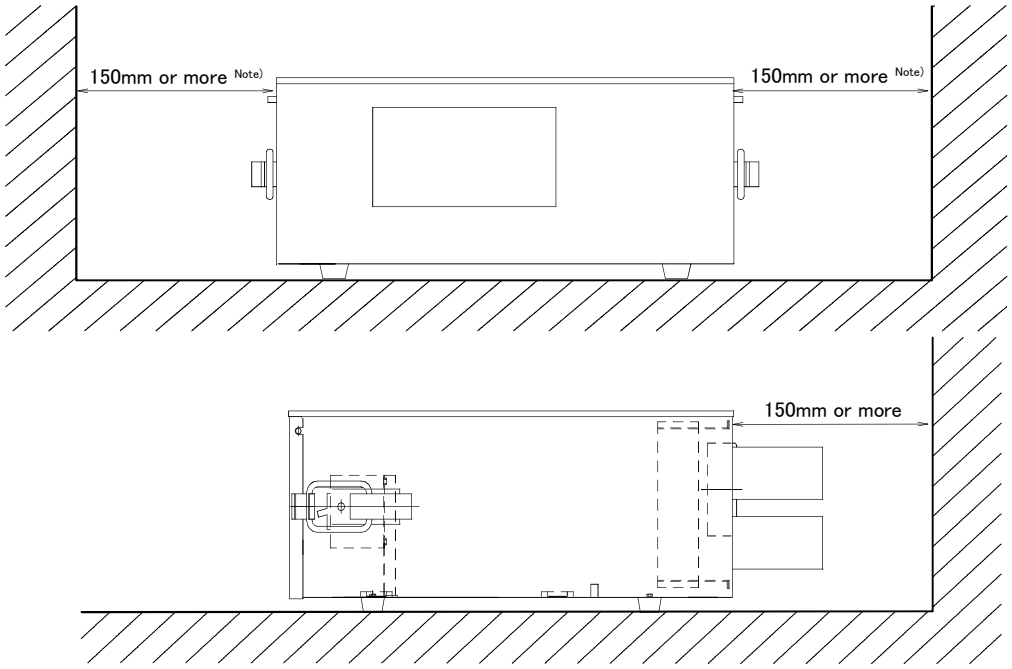


Fig.3-6 : Installation dimensions

CAUTION The fan installed at the back inside of the protection box for heat exchange. Take care to not obstruct the rotation of air.

(2) Installation of controller

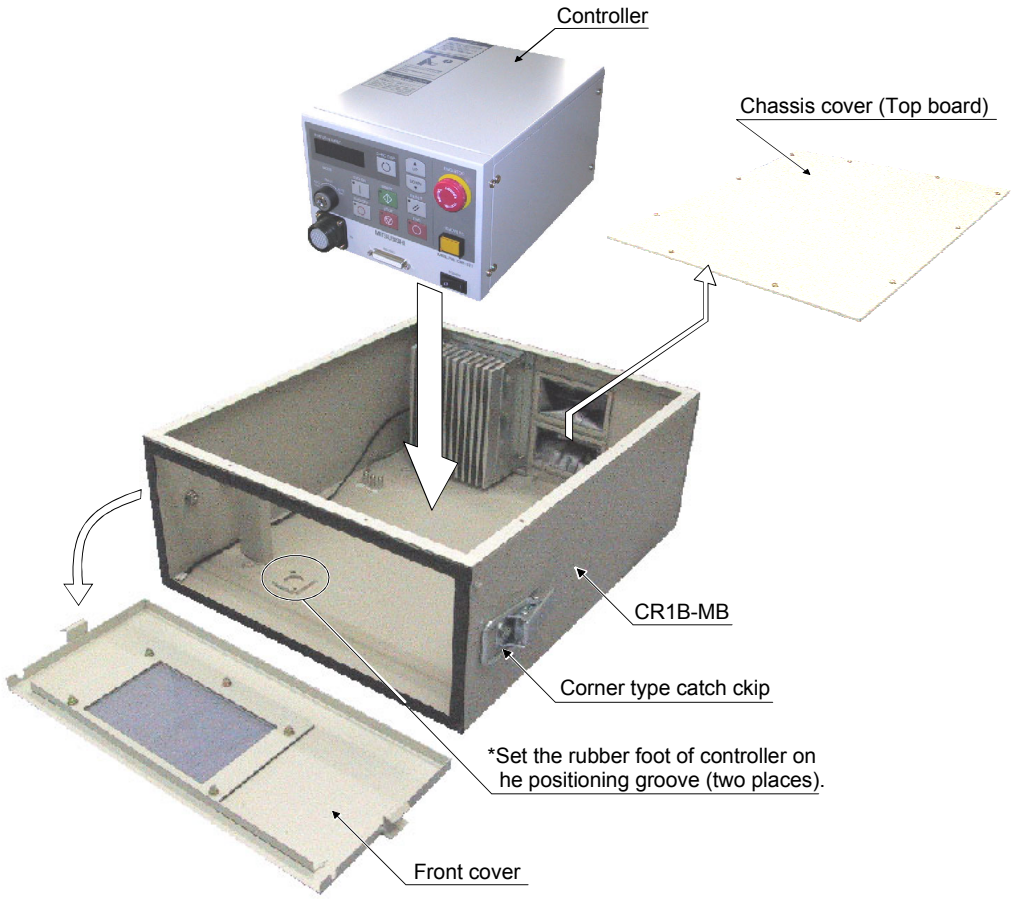


Fig.3-7 : Installation of controller

1) Remove the catch clip (two places of the right and left.) fixing the front cover of protection box, and remove the front cover.
2) Remove the top cover of protection box by removing the ten installation screws.
3) Install the controller into the protection box. Turn the front of the controller into front of the protection box, set the rubber foot on the positioning groove to fix the controller.
If you use the expansion option box (CR1-EB3), install it first. (Refer to "3.2 Installing the expansion option box" on page 15.)

⚠CAUTION If the protection box is carried with controller installed, lift it horizontally surely.
Lifting the protection box obliquely or vertically could lead to personal injuries or damage from dropping the controller inside the box.

(3) Installation of earth leakage breaker

Fig. 3-8 shows the installation method of earth leakage breaker.

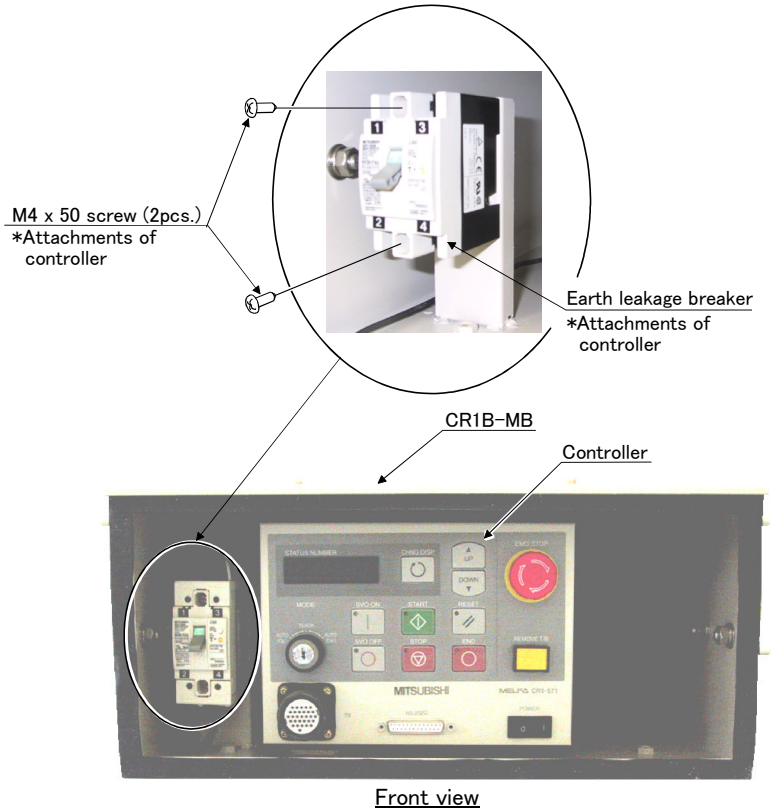
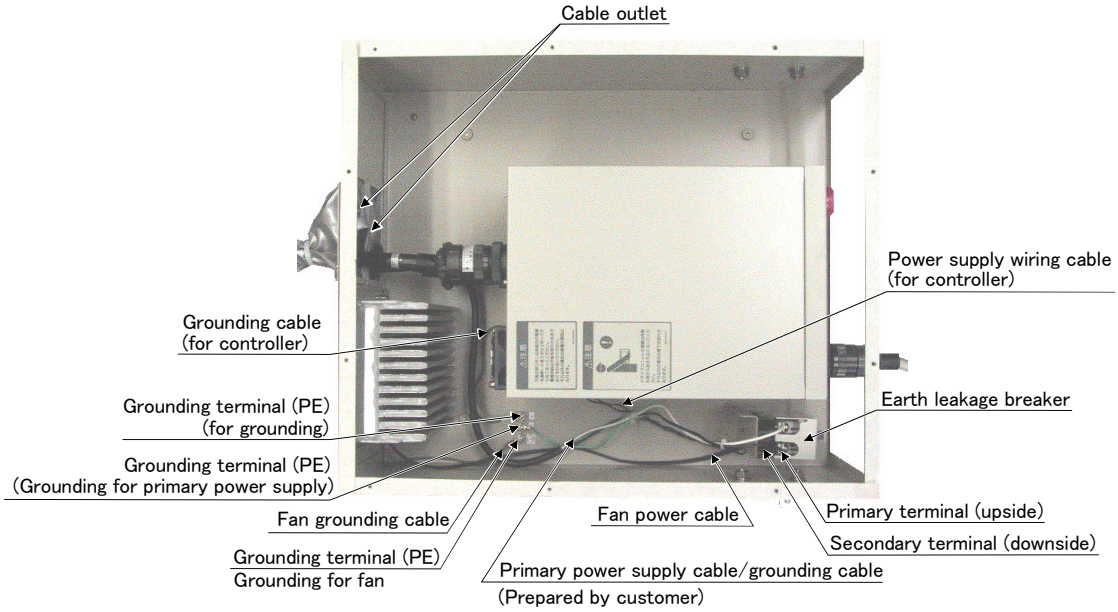


Fig.3-8 : Installation of earth leakage breaker

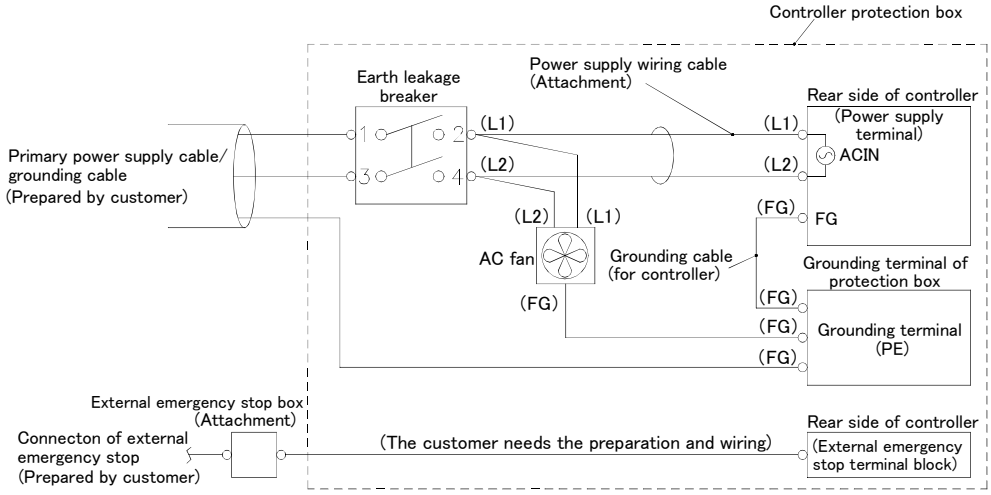
1) Install the earth leakage breaker securely with attached installation screw (2-M4x50) as shown in the Fig. 3-8. The upside is ON in the installation direction.

(4) Connecting the power cable, grounding cable, fan power cable

Fig. 3-9 shows wiring configuration and wiring system diagram of power, grounding, fan power cable.



Appearance diagram



Wiring system diagram

Fig.3-9 : Connecting the power cable, grounding cable

1) Confirm the setting of input power voltage setting connector of controller. The power supply voltage is different by the use robot type. Refer to the separate "Manual/Standard Specifications" for confirm the power voltage which can be used. Set the input power voltage referring to "2.2.4 Connecting the power cable and grounding cable" on page 8.

2) Connecting the power cable and grounding cable
Prepare the 2 primary power cables and 1 grounding cable (both AWG#14(2mm2) or more).
At inside of the protection box, use the attached power supply wiring cable for the connection of earth leakage breaker and controller, and use the attached grounding cable for the grounding of controller.
Connect the both power cable and grounding cable referring to Fig. 3-9 and "2.2.4 Connecting the power cable and grounding cable" on page 8.
Connect the grounding cable prepared by customer to grounding terminal (PE), connect the attached grounding cable for controller grounding to another grounding terminal (PE).
Pull out the primary power supply cable and grounding cable from the cable outlet of the protection box, and then fix them with a cable tie together with the machine cable.

3) Connect the power cable of fan on the protection box to secondary terminal of earth leakage breaker, and connect the grounding cable of fan to the grounding terminal on the protection box.

(5) Connection of the external emergency stop

⚠CAUTION Install the attached external emergency stop box to the place easy to operate for safety surely.
Because the controller is enclosed in the protection box, the emergency stop switch located on the front side of the controller cannot be operated.

Install the attached external emergency stop box to the place easy to operate.
The outside and installation dimensions of the external emergency stop box are shown in Fig. 3-10 for your reference.
For the cable connection method, refer to "2.2.5 Connecting the external emergency stop" on page 10.
Please prepare a cable clamp that is fit for the external emergency stop box cable.
For details of the external emergency stop box, refer to the Instruction Manual attached to the product.
Also, pull out the external emergency stop cable from the cable outlet of the protection box, and then fix them with a cable tie together with the machine cable.

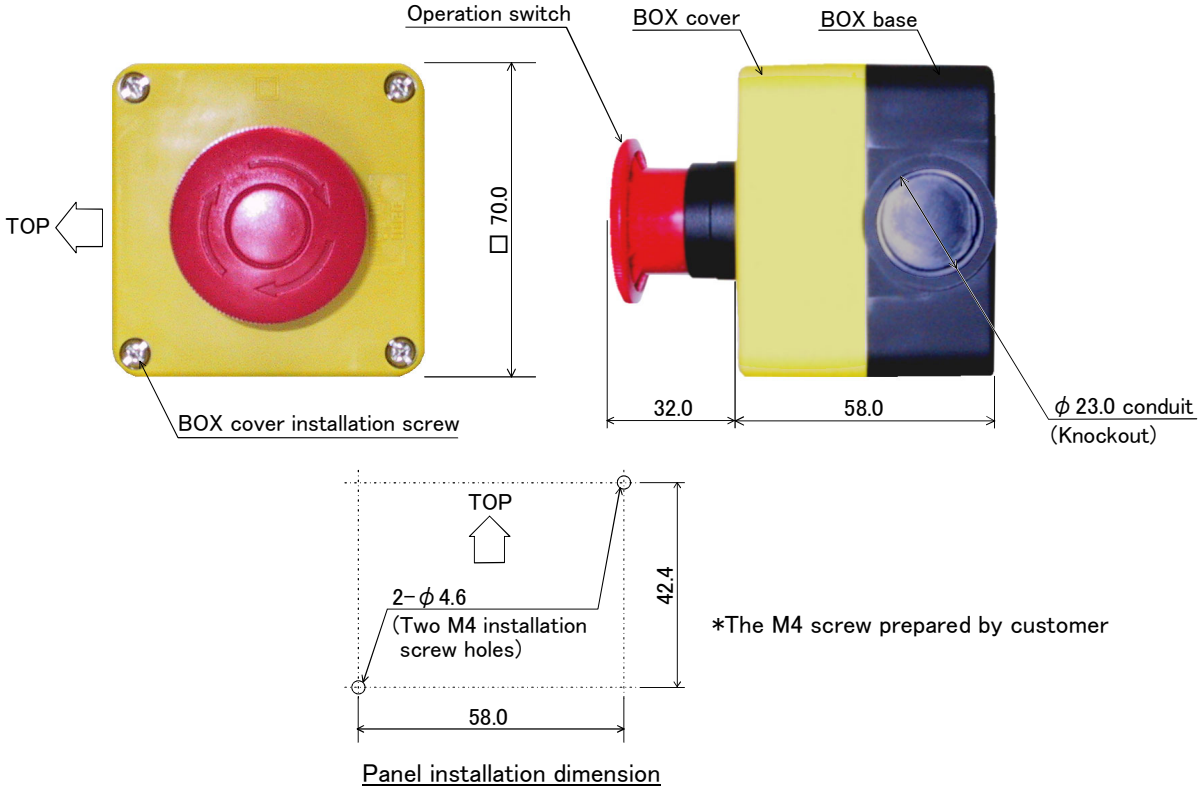


Fig.3-10 : The outside dimensions and installation dimensions of emergency stop box

(6) Connecting to the robot arm
Refer to the separate manual "Robot arm setup and maintenance", and connect the controller and robot arm with machine cables.
Lead the machine cable from the cable outlet on the rear of the protection box.

(7) Block the cable outlet

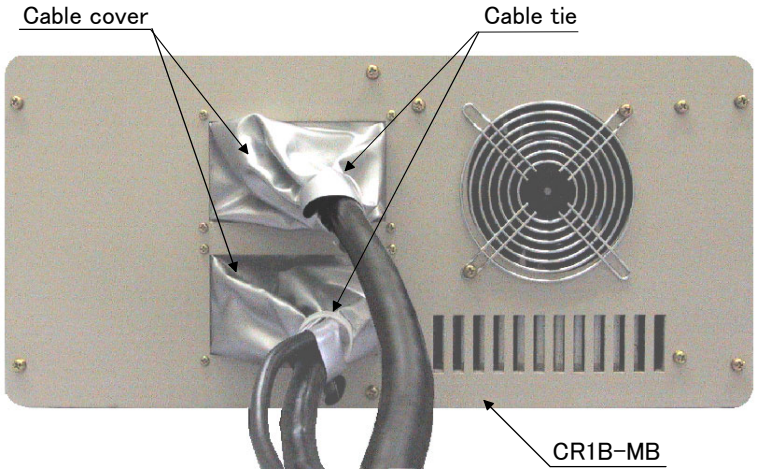


Fig.3-11 : Block the cable outlet

The cable cover is attached to the cable outlet.(two places of top and bottom.)
Fix the cable taken out from cable outlet by using the cable tie from the top of the cable cover, and block the cable outlet so that the oil-mist etc. not come in.

(8) Sticking the serial number posting label
Stick the serial number posting label written down in "3.3.2 Confirmation before installation" on page 18 to front panel as shown in Fig. 3-12. And stick the protection seal transparent last.

Fig.3-12 : Sticking the serial number posting label

(9) Installation of top board and front panel

Remove the sheet on the surface of packing stuck on the top board contact part at the up side of the protection box. Reinstall the top board and securely fix with tentwelve screws. Reinstall the front panel, and close the catch clip (two places of the right and left) for fixing the panel.

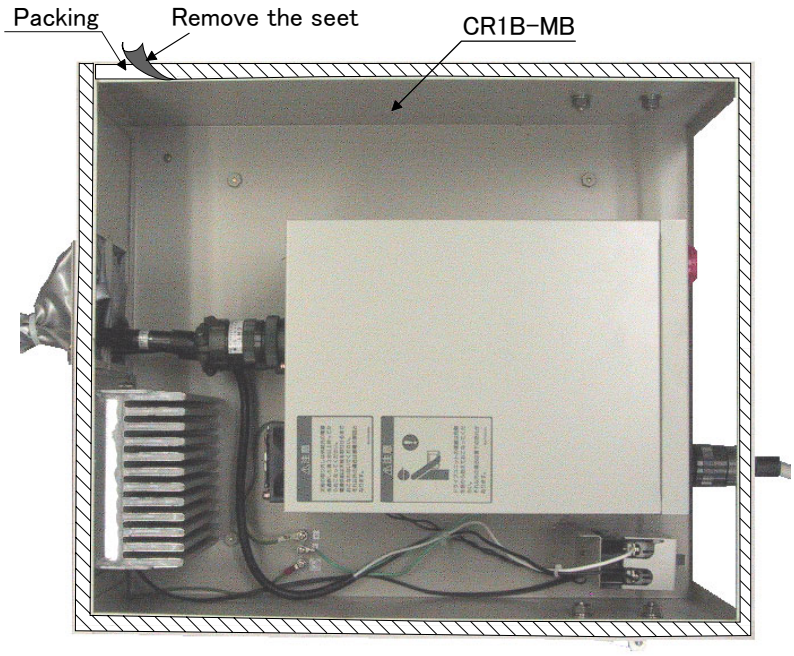


Fig.3-13 : Installation of top board, front panel

This completes the installation of the protection box.

3.3.6 Handling the protection box

(1) Operation with removing the panel

The power supply ON/OFF of the controller, the operation of the front panel, the operation under the condition that T/B is connected are carried out under the condition that the front panel of protection box is removed.

(2) Installation of the expansion option box(CR1-EB3) later

When the expansion option box installed later, take out the controller once. The method of installation of the expansion option box is shown in the ″3.2 Installing the expansion option box″ on page 15.

(3) Installation of optional equipment

Any other equipments aren't installed inside the protection box except for the expansion option box.
Install the necessary equipment such as parallel I/O unit to outside of the protection box.

4 Basic operations

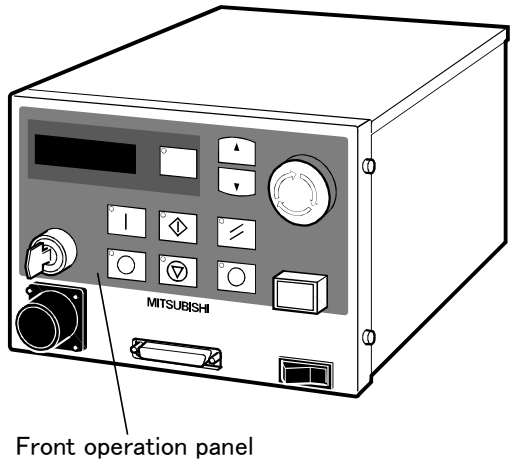
In this chapter, the following items will be explained regarding the basic operations for handling the robot.

Handling the controller	The functions of the various keys on the controller are explained.
Handling the teaching pendant	The methods of installing/removing the T/B, and the functions of the various keys are explained.
Turning the power ON/OFF	The items to confirm before turning on the controller power, and the methods of turning the power ON and OFF are explained.
Operating the robot with jog operation	The methods for manually operating the robot arm using the teaching pendant are explained. This is mainly used for teaching work.
Opening and closing the hand	The methods of opening and closing the hand using the teaching pendant are explained.
Program creation to automatic operation	The procedures of creating the program are explained in order.

4.1 Handling the controller

4.1.1 Functions of each key

<Front>



<Front side of operation panel>

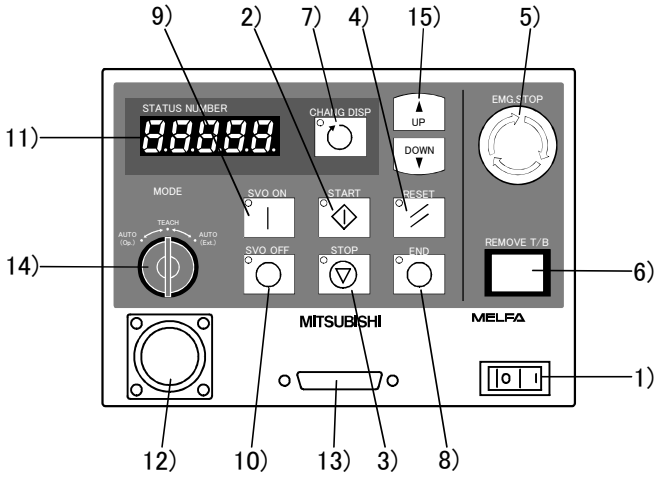


Fig.4-1 : Names of controller parts

1) POWER switch ..... This turns the control power ON/OFF.
2) START button ..... This executes the program and operates the robot. The program is run continuously.
3) STOP button ..... This stops the robot immediately. The servo does not turn OFF.
4) RESET button ..... This resets the error. This also resets the program's halted state and resets the program.
5) Emergency stop switch ..... This stops the robot in an emergency state. The servo turns OFF.
6) T/B remove switch ..... This is used to connect/disconnect the T/B without turning OFF the controller's control power.
7) CHNGDISP button ..... This changes the details displayed on the display panel in the order of "Override" → "Program No." → "Line No.".
8) END button ..... This stops the program being executed at the last line or END statement.
9) SVO.ON button ..... This turns ON the servo power. (The servo turns ON.)
10) SVO.OFF button ..... This turns OFF the servo power. (The servo turns OFF.)
11) STATUS NUMBER (display panel) ..... The alarm No., program No., override value (%), etc., are displayed.
12) T/B connection connector ..... This is a dedicated connector for connecting the T/B.
13) Personal computer connection connector ..... This is an RS-232C specification connector for connecting the personal computer.
14) MODE changeover switch ..... This changes the robot's operation mode. Note1)
AUTO (Op.) ..... Only operations from the controller are valid. Operations for which the operation mode must be at the external device or T/B are not possible.
TEACH ..... When the T/B is valid, only operations from the T/B are valid. Operations for which the operation mode must be at the external device or controller are not possible.
AUTO (Ext.) ..... Only operations from the external device are valid. Operations for which the operation mode must be at the T/B or controller are not possible.
15) UP/DOWN button ..... This scrolls up or down the details displayed on the "STATUS. NUMBER" display panel.

⚠ CAUTION Note1) The servo will turn OFF when the controller's [MODE] switch is changed. Note that axes not provided with brakes could drop with their own weight. Carry out the following operations to prevent the servo from turning OFF whenthe [MODE] switch is changed.

The servo on status can be maintained by changing the mode with keeping pressing lightly the deadman switch of T/B. The operating method is shown below.

■ When the mode is changed from TEACH to AUTO.
1) While holding down the deadman switch on the T/B, set the [ENABLE/DISABLE] switch to "DISABLE".
2) While holding down the deadman switch on the T/B, set the controller [MODE] switch to "AUTO".
3) Release the T/B deadman switch.

■ When the mode is changed from AUTO to TEACH.
1) While the [ENABLE/DISABLE] switch on the T/B is "DISABLE", hold down the deadman switch.
2) While holding down the deadman switch on the T/B, set the controller [MODE] switch to "TEACH".
3) While holding down the deadman switch on the T/B, set the [ENABLE/DISABLE] switch to "ENABLE", then do the operation of T/B that you wish.

◇◆◇ What are the operation rights? ◇◆◇

Even when multiple devices, such as a T/B and personal computer, are connected to the controller, the operation at one time is limited to one device. This limited device (has the operation rights)

◇◆◇ What operations require the operation rights? ◇◆◇

Operations that start the robot, such as program start and alarm reset, and operations that can cause starting require the operation rights.
Conversely, operation that stop the robot, such as stopping and servo OFF, can be used without the operation rights for safety purposes.
Refer to the separate manual "Explanation of functions and operations" for details on the functions related to operation rights.

4.2 Handling the T/B

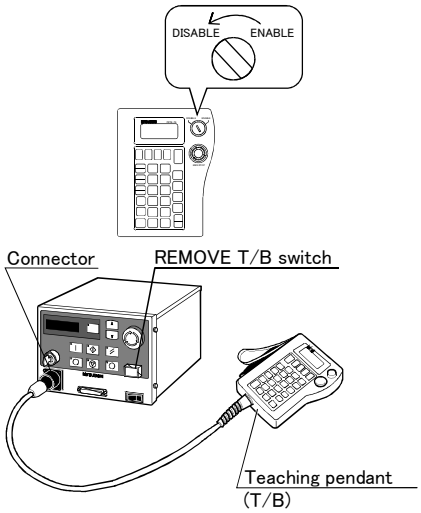
4.2.1 Installing and removing the T/B

By using the "REMOVE T/B" switch, the T/B can be installed and removed while the controller's control power is ON.

(1) Installing with the control power OFF

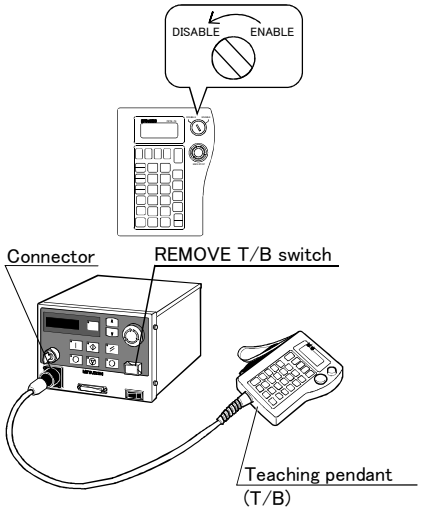
Refer to the separate manual "From robot arm setup to maintenance" for details on installing the T/B with the power OFF.

(2) Removing with the control power ON



1) Set the T/B [ENABLE/DISABLE] switch to "DISABLE".
2) Press the [REMOVE T/B] switch on the controller. (Indented state) The switch's LED will start flickering.
3) Securely hold the T/B connector, and turn it to the left to remove it.
4) Remove the T/B connector within 5 seconds after the LED starts flickering. The switch's LED will turn OFF when the work is completed.

(3) Installing with the control power ON



1) Set the T/B [ENABLE/DISABLE] switch to "DISABLE".
2) Connect the T/B connector. The switch's LED will start flickering.
3) Press the [REMOVE T/B] switch on the side of the controller within 5 seconds after installing the T/B. (Projected state) The switch's LED will light when the work is completed.

⚠ WARNING The T/B emergency stop is invalid while the [REMOVE T/B] switch is pressed (indented state) even after the T/B is connected. This state will cause an emergency stop within 5 seconds, but as the T/B is invalid, starting operations from devices other than the T/B will be valid.

◇◆◇ When an emergency stop state occurs ◇◆◇

If the emergency stop state occurs during the above operations, cancel it with the following procedures.

(1) Press the [REMOVE T/B] switch on the side of the controller, and light the switch's LED. (Projected state)
(2) Set the T/B [ENABLE/DISABLE] switch to "ENABLE".
(3) Press the T/B [ERROR RESET] key.

4.2.2 Functions of each key

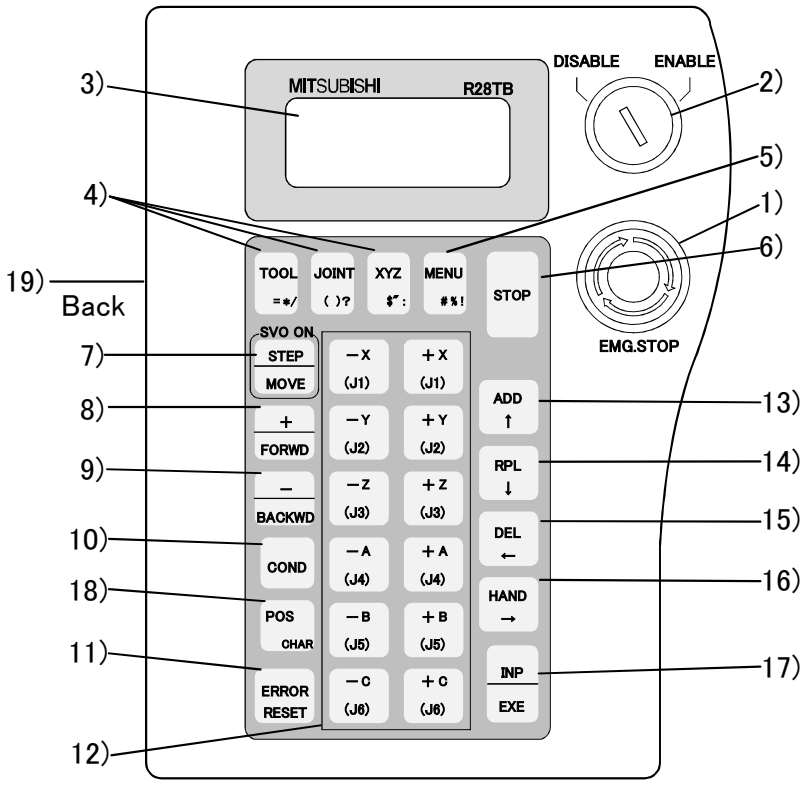


Fig.4-2 : Teaching pendant (Front side of R28TB)

1) [EMG. STOP] switch
This is a push-button switch with lock function for emergency stop. When this switch is pressed, the servo will turn OFF and the robot will stop immediately regardless of the T/B enable/disable state. To cancel this state, turn the switch clockwise.

2) [ENABLE/DISABLE] switch
This changeover switch is used to enable or disable the T/B key operations. To carry out operations using the T/B, always set this switch to "ENABLE" (valid). Operations with the T/B will be enabled, and operations from the controller and external sources will be disabled. The T/B will have the operation rights. To operate with the controller or external source, set this switch to "DISABLE" (invalid).

3) Display LCD
The program contents and robot state are displayed with the T/B key operations.

4) [TOOL] key
This selects the TOOL JOG mode.

4) [JOINT] key
This selects the JOINT JOG mode.

4) [XYZ] key
This selects the XYZ JOG, 3-AXIS XYZ or CYLINDER JOG mode.

5) [MENU] key
This returns the display screen to the "menu screen"

6) [STOP] key
This stops the program and decelerates the robot to a stop. This is the same function as the [STOP] switch on the front of the controller, and can be used even when the T/B [ENABLE/DISABLE] switch is set to DISABLE.

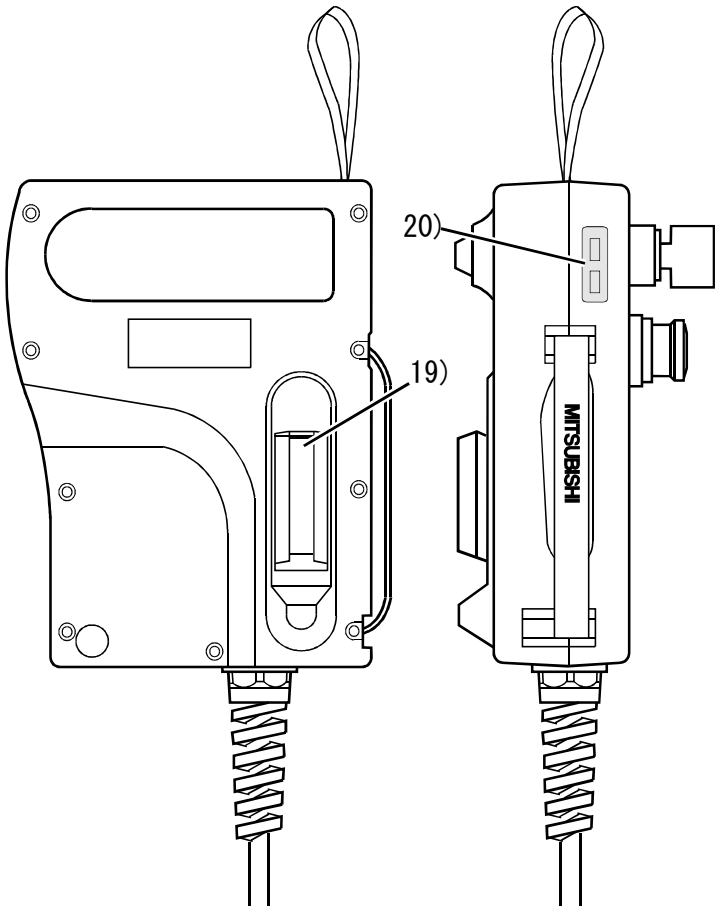
7) [STEP/MOVE] key
Jog operations are possible when this key is pressed simultaneously with the 12) jog operation key. Step jump is carried out when pressed simultaneously with the [INP/EXE] key. This also turns the servo ON.

8) [+/FORWD] key
Step feed is carried out when this key is pressed simultaneously with the [INP/EXE] key. On the edit screen, the next program line is displayed. When pressed simultaneously with the [STEP/MOVE] key, the override will increase.

9) [-/BACKWD] key
On the edit screen, the previous program line is displayed. When pressed simultaneously with the [INP/EXE] key, the axis will return along the robot's operation path. When pressed simultaneously with the [STEP/MOVE] key, the override (speed) will decrease.

10) [COND] key
This is used to edit the program.

11) [ERROR RESET] key
This key resets an error state that has occurred. When pressed simultaneously with the [INP/EXE] key, the program will be reset.



12) [Jog operation] key (12 keys from [−X (J1)] to [+C (J6)]
In this manual, these keys are generically called the "jog operation" keys. When JOINT JOG is selected, each axis will rotate, and when XYZ JOG is selected, the robot will move along each coordinate system. These keys are also used to input numeric values such as when selecting a menu or inputting a step No.

13) [ADD/ ↑] key
This additionally registers the position data. It also moves the cursor upward.

14) [RPL/ ↓] key
It also moves the cursor downward .

15) [DEL/ ←] key
This deletes the position data. It also moves the cursor to the left .

16) [HAND/ →] key
When pressed simultaneously with the [+C (J6)] or [−C (J6)] key, hand 1 will open or close. In the same manner, hand 2 will open/close when pressed simultaneously with the [+B (J5)] or [−B (J5)] key, hand 3 with the [+A (J4)] or [−A (J4)] key, and hand 4 with the [+Z (J3)] or [−Z (J3)] key. This key also moves the cursor to the right .

Fig.4-3 : Teaching pendant (Rear and side of R28TB)

17) [INP/EXE] key
This inputs the program, and carries out step feed/return.

18) [POS CHAR] key This changes between numbers and alphabetic characters when editing the position data, etc.

19) Deadman switch
When the [ENABLE/DISABLE] switch 2) is set to "ENABLE", and this key is released or pressed with force, the servo will turn OFF. Press this switch lightly when carrying out functions with the servo ON, such as jog operations. If emergency stop or servo OFF operation have been applied, and the servo is OFF, the servo will not turn ON even when this switch is pressed. In this case, carry out the servo ON operation again.

20) Contrast setting switch (Top: Dark, bottom: light)
This sets the display LCD brightness.

◇◆◇ Remove the protection seal of the teaching pendant before using ◇◆◇

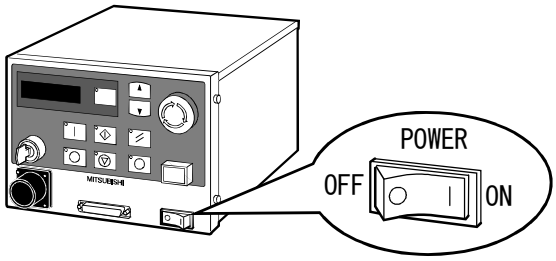
Installed the protection seal on the teaching pendant to prevent the damage of the display LCD and the key seat when shipping. Remove the protection seal when using. The operation of the key and the confirmation of the display is possible without removing the protection seal, however the adhesive may be left on the teaching pendant as the time passes.

4.3 Turning the power ON and OFF

4.3.1 Turning the control power ON

⚠ CAUTION Always confirm the following items before turning the controller power ON.

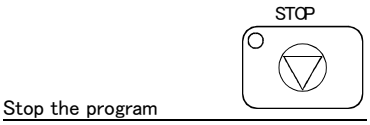
1) Make sure that there are no operators in the robot operation range.
2) Make sure that the controller and robot arm are securely connected with the machine cable.
3) Make sure that the external emergency stop switch is connected to the controller.
4) Make sure that the controller's power cable and grounding cable are correctly connected.
5) Make sure that the grounding cable is connected to the robot arm.
6) Make sure that there are no obstacles, such as tools, in the robot operation range.



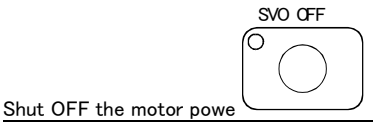
Turn the controller [POWER] switch ON.
″ □ . 100″ will appear on the STATUS NUMBER display.
This completes the turning ON of the control power.

◇◆◇ What is the main power, control power and servo power? ◇◆◇
Main power ------This supplies power to the controller. (Primary power)
Control power --- This supplies power to the control sections (PCB, etc.) in the controller.
Servo power -----This supplies power to the motor that drives the robot.
When energized, this is called servo ON, and when shut off, this is called servo OFF.

4.3.2 Shutting OFF the control power



1) If the robot is operating, press the controller [STOP] switch, and stop the robot.



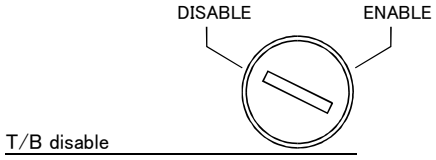
2) After the robot has stopped, press the controller [SVO OFF] switch, and turn the servo OFF.

3) Turn the controller [POWER] switch OFF.

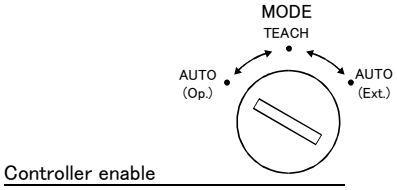
The control power will be shut OFF.

4.4 Turning the servo power ON/OFF

4.4.1 Turning the servo power ON (servo ON)



1) Confirm that the T/B [ENABLE/DISABLE] switch is set to "DISABLE".

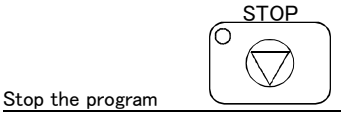


2) Confirm that the [MODE] switch on the front of the controller is set to "Auto (Op.)".

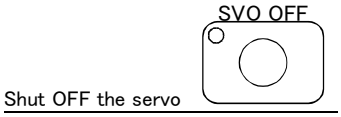
3) Press the [SVO ON] switch on the front of the controller.
The switch's lamp will light indicating that the servo is ON.

⚠ CAUTION Make sure that there are not operators in the robot operation range before turning ON the servo.

4.4.2 Shutting OFF the servo power (servo OFF)



1) If the robot is operating, press the controller [STOP] switch on the front of the controller, and stop the robot.



2) After the robot has stopped, press the controller [SVO OFF] switch on the front of the controller, and turn the servo OFF. The switch's lamp will light indicating that the servo is OFF.

◇◆◇ Operation rights not required ◇◆◇

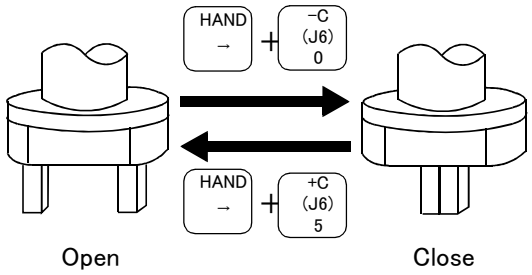
This operation does not require the operation rights, so the servo can be turned OFF at any time by pressing the [SVO OFF] switch.

4.5 Jog operation

Refer to the separate manual "Robot arm setup and maintenance" when carrying out jog operation.
The following jog operation modes are available. Use these according to the purpose.
Table 4-1 : Jog modes

Jog mode	Main application	Explanation
JOINT JOG	・Moves each joint. ・Moves the robot arm largely. ・Changes the robot posture.	Separate manual "Robot arm setup and maintenance"
XYZ JOG	・Accurately sets the teaching position. ・Moves the axis straight along the XYZ coordinate system. ・Moves the axis straight while maintaining the robot posture. ・Changes the posture while maintaining the hand position.	
TOOL JOG	・Accurately sets the teaching position. ・Moves the axis straight along the hand direction. ・Changes the posture while maintaining the hand position. ・Rotates the hand while maintaining the hand position.	
3-AXIS XYZ JOG	・When the axis cannot be moved with XYZ JOG that maintains the posture. ・When the tip is to be moved linearly but the posture is to be changed.	
CYLINDER JOG	・Moves in a cylindrical shape centering on the Z axis while maintaining the posture. ・Moves linearly in a radial shape centering on the Z axis while maintaining the posture.	

4.6 Opening and closing the hand



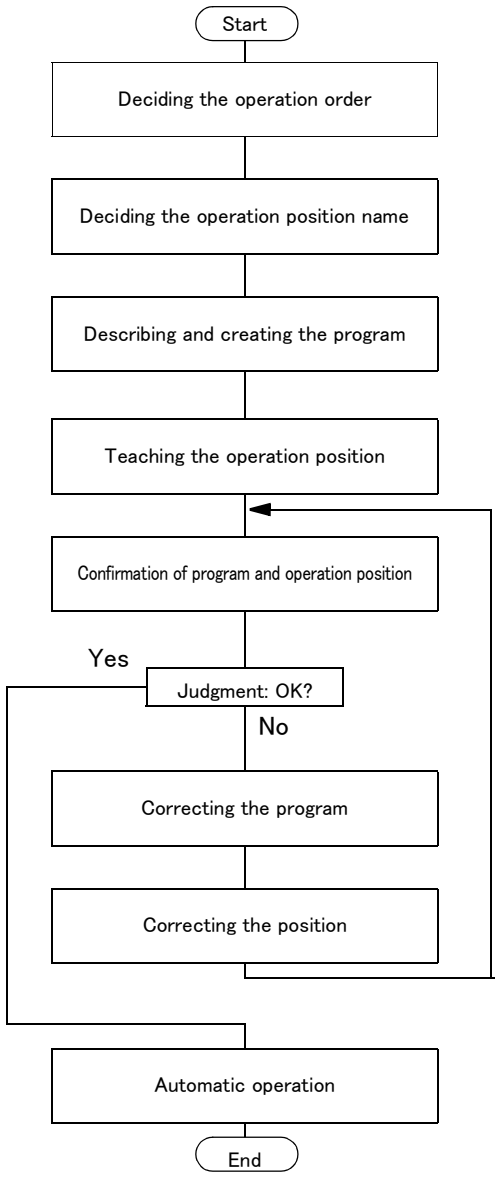
Hands 1 to 4 can be opened and closed with the T/B.

Opening and closing hand 1
Open: Press [HAND] + [+C (J6)] key
Close: Press [HAND] + [−C (J6)] key
Opening and closing hand 2
Open: Press [HAND] + [+B (J5)] key
Close: Press [HAND] + [−B (J5)] key
Opening and closing hand 3
Open: Press [HAND] + [+A (J4)] key
Close: Press [HAND] + [−A (J4)] key
Opening and closing hand 4
Open: Press [HAND] + [+Z (J3)] key
Close: Press [HAND] + [−Z (J3)] key

4.7 Programming

The procedures from creating the program to automatic operation are explained in order using a simple procedure as an example.

(1) Creation procedures



Decide the robot operation order, operation path (necessity of linear movement), and the work at each operation position (hand open/close, etc).

Teach the robot operation position in the position variables.
Decide the position variable name.

Based on the decided operation order and operation position name, convert the robot operations and work into commands. Describe the commands in the program and save in the controller.

Move the robot to each operation position with jog operation, and teach each position in the position variables.

Execute the program saved in the controller line by line, and confirm that the program and operation positions are correctly saved.

If any mistakes were found in the robot operation or work during the program confirmation, correct the program.

If any mistakes were found in the robot operation position during the program confirmation, correct the taught position.

Automatically execute the completed program.

Fig.4-4 : Program creation procedures

(2) Robot work

Assume that the robot is going to carry the workpiece from the left to the right.

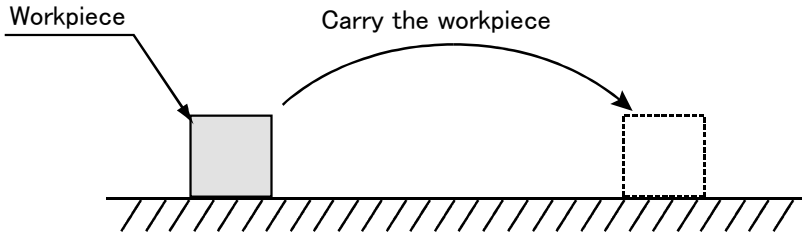
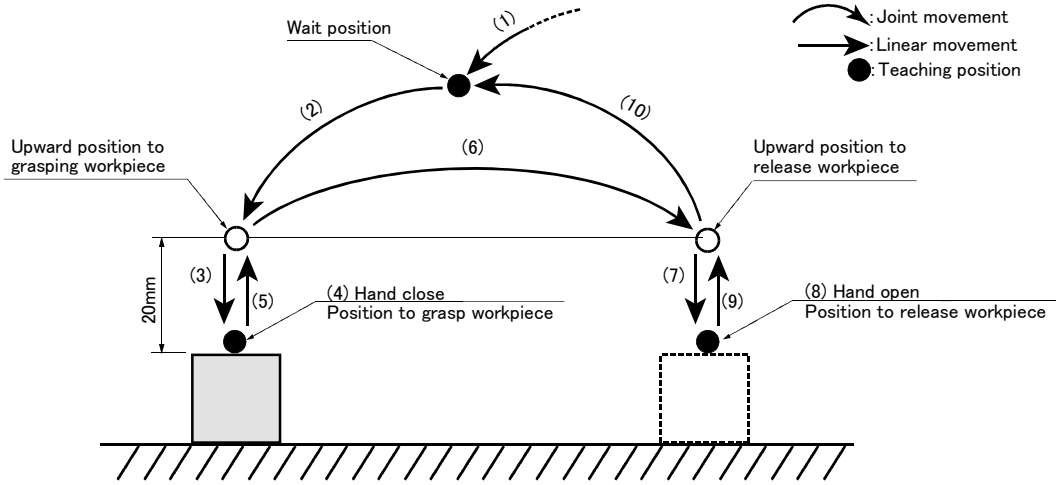


Fig.4-5 : Example of work

4.7.1 Creating the program

(1) Deciding the operation order



Start

(1) Move to wait position (joint movement).
(2) Move to 20mm upward workpiece (joint movement).
(3) Move to position to grasp workpiece (linear movement).
(4) Grasp workpiece (hand close).
(5) Move 20mm upward (linear movement).
(6) Move to 20mm upward position to release workpiece (joint movement).
(7) Move to position to release workpiece (linear movement).
(8) Release workpiece (hand open).
(9) Move 20mm upward (linear movement).
(10) Move to wait position (joint movement).

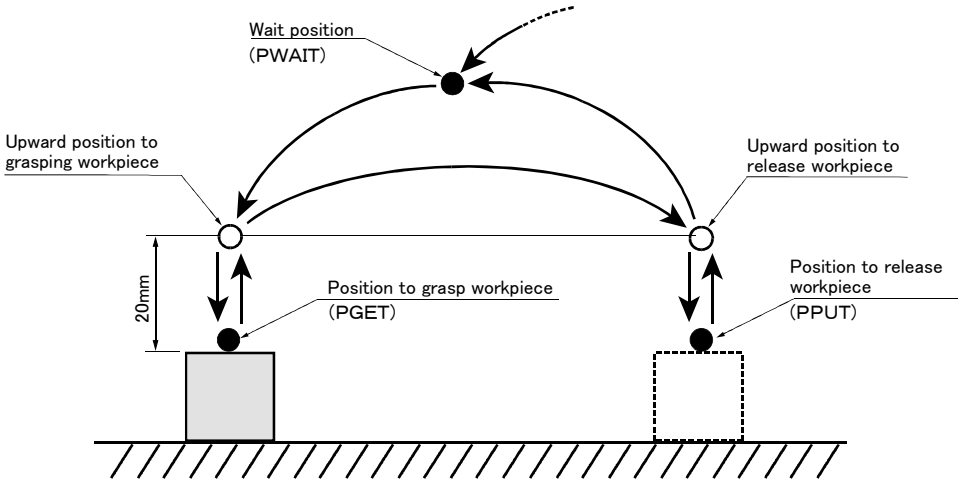
End

Fig.4-6 : Deciding the operation order

◇◆◇ Joint movement and linear movement ◇◆◇

The operation for which the robot movement path is not designated in particular is the "joint movement". The operation for which the movement path is designated as linear is "linear movement".
If the robot could interfere with the peripheral devices, such as the workpiece, when moving to grasp or release the workpiece, designate "linear movement" to prevent any interference.

(2) Deciding the operation position name



Name	Position variable name	Teaching	Remarks
Wait position	PWAIT	Required	
Upward position to grasping workpiece	—	Not required	Designate with commands.
Position to grasp workpiece	PGET	Required	
Upward position to release workpiece	—	Not required	Designate with commands.
Position to release workpiece	PPUT	Required	

Position variable name ···· Designate a random character string starting with "P".
Up to eight characters can be designated.

Fig.4-7 : Deciding the operation position name

◇◆◇ Teaching the operation position ◇◆◇

The operation position does not necessarily need to be taught.
The positions shown with white circles in Fig. 4-7 can be designated with commands as "position 20mm away from target position". Refer to "(3) Describing and creating the program" on page 38.

⚠CAUTION The designation of the direction separated from the target position differs according to the robot type.
The position is along the Z axis of the TOOL coordinate system, and the direction is designated with the + and − signs.
Refer to the section on the TOOL JOG operation in the separate "Instruction Manual/ Robot arm setup and maintenance", and confirm the Z axis direction of the TOOL coordinate system. Then, designate the correct sign (direction) that matches the robot being used.
Designating the reverse direction could lead to interference with the peripheral devices and damage.
Generally (in the default state), the hand retract direction is the "−" sign with the vertical articulate type robot, and the "+" sign is the robot's upward direction with the other robots.

(3) Describing and creating the program

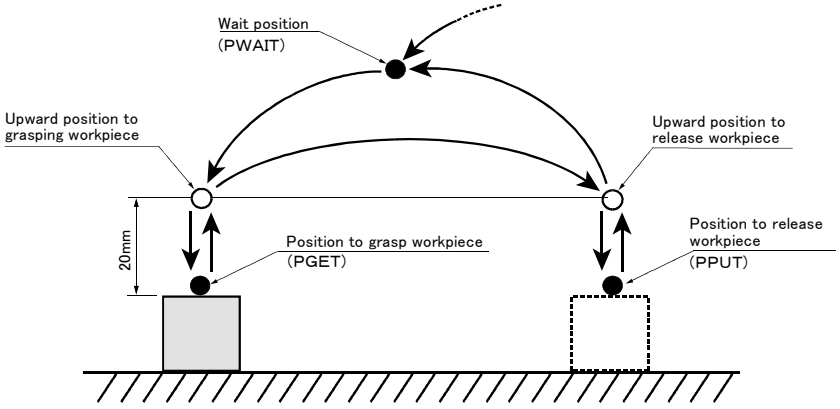
■ Convert the target robot operations and work into commands.

Refer to the separate manual "Instruction Manual: Detailed explanations of functions and operations" for details on the commands.

Table 4-2 : Commands used

Target operation and work	Command	Example of designation	
Joint movement	MOV	Move to position variable PWAIT	MOV PWAIT
		Move to 20mm upward position variable PGET	MOV PGET,+20 Note)
Linear movement	MVS	Move to position variable PGET	MVS PGET
		Move to 20mm upward position variable PGET	MVS PGET,+20 Note)
Hand open	HOPEN	Open hand 1	HOPEN 1
Hand close	HCLOSE	Close hand 1	HCLOSE 1
Wait	DLY	Wait 1 second	DLY 1.0
End	END	End the program	END

■ Program the converted commands



Start
(1) Move to wait position (joint movement) ..... 10 MOV PWAIT
(2) Move to 20mm upward workpiece (joint movement) ..... 20 MOV PGET,+20 Note)
(3) Move to position to grasp workpiece (linear movement) ..... 30 MVS PGET
(4) Grasp workpiece (hand close) ..... 40 HCLOSE 1
(5) Waits for 1 seconds ..... 50 DLY 1.0
(6) Move 20mm upward (linear movement) ..... 60 MVS PGET,+20 Note)
(7) Move to 20mm upward position to release workpiece (joint movement) ... 70 MOV PPUT,+20 Note)
(8) Move to position to place workpiece (linear movement) ..... 80 MVS PPUT
(9) Release workpiece (hand open) ..... 90 HOPEN 1
(10) Waits for 1 seconds ..... 100 DLY 1.0
(11) Move 20mm upward (linear movement) ..... 110 MVS PPUT,+20 Note)
(12) Move to wait position (joint movement) ..... 120 MOV PWAIT
End ..... 130 END

Hand ···· Up to four hands can be installed. However, in the above program, the 1st hand connected to hand 1 is the target.

Fig.4-8 : Describing the program

⚠CAUTION Note) Upward movement is designated at a position along the Z axis of the TOOL coordinate system, and the direction is designated with the + and − signs.
Refer to the section on the TOOL JOG operation in the separate "Installation Manual/ Robot arm setup and maintenance", and confirm the Z axis direction of the TOOL coordinate system. Then, designate the correct sign (direction) that matches the robot being used.
Designating the reverse direction could lead to interference with the peripheral devices and damage.
Generally (in the default state), the hand retract direction is the "−" sign with the vertical articulate type robot, and the "+" sign is the robot's upward direction with the other robots.

◇◆◇ Program format ◇◆◇

The program format is configured of the "line No. command parameter affixed to command" as shown in Fig. 4-8.

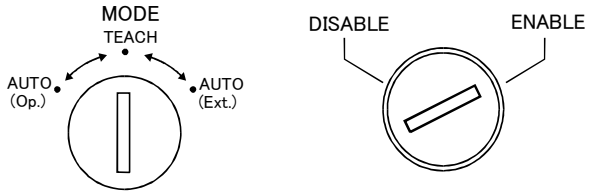
Example) １０　ＭＯＶ　ＰＷＡＩＴ

Line No. Command Parameter affixed to command

The program is executed in order from the line No. with the smallest number.

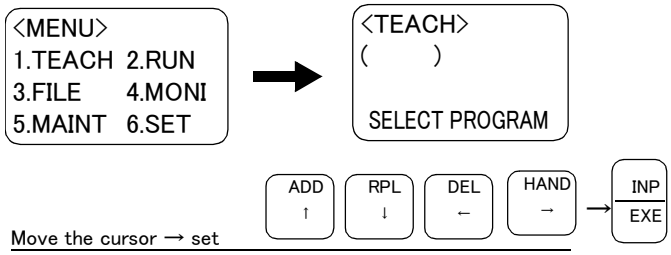
■ Input the described program into the controller.
The T/B is used for this operation.

Preparing the T/B

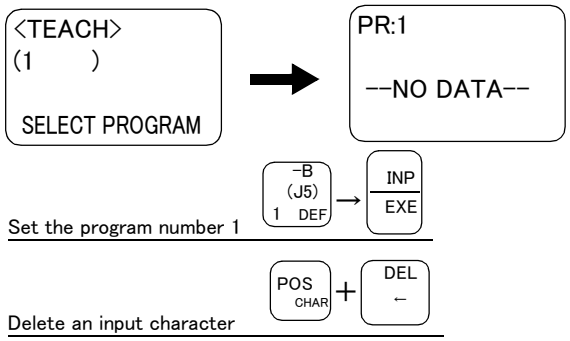


1) Set the controller [MODE] switch to "TEACH".
2) Set the T/B [ENABLE/DISABLE] switch to "ENABLE".

Opening the program editing screen



3) In the <MENU> screen, press the arrow keys (" ↑ ", " ↓ ", " ← ", " → ") and move the cursor to "1. TEACH", and then press the [INP] key. The <TEACH> screen will appear.



4) Press the [1] → [INP] keys.
The program No. 1 editing screen will appear.

◇◆◇ Using the T/B ◇◆◇

Set the controller [MODE] switch to "TEACH" and the T/B [ENABLE/DISABLE] switch to "ENABLE".
Operations from the T/B are not possible unless the controller [MODE] switch is set to "TEACH".

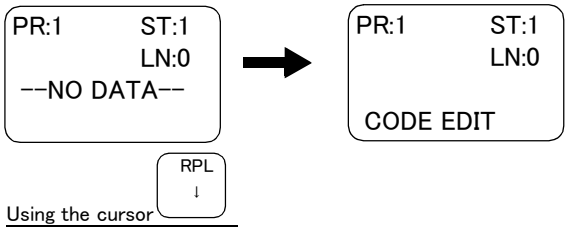
◇◆◇ Inputting numbers and spaces ◇◆◇

To input a number, press the key having a number on the lower left.
To input a space, press the key having "SPACE" on the lower left.

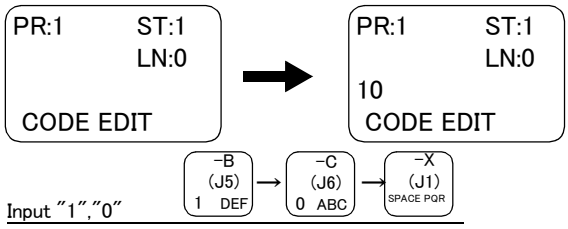
◇◆◇ Correcting incorrect numbers ◇◆◇

Press the [DEL] key while holding down the [CHAR] key to delete the character, and then input it again.
If the cursor is returned by pressing the [←] key, and a character is input, it will be inserted.

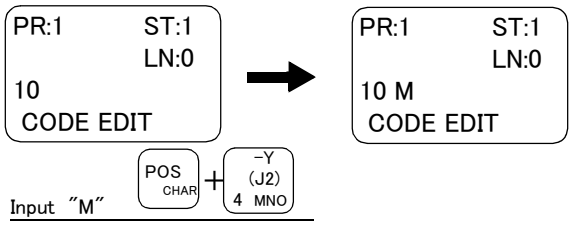
Input the program 10 MOV PWAIT



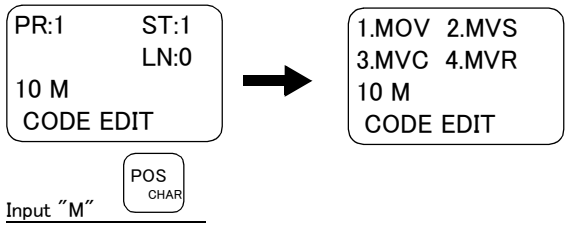
5) Press the [↓] key three times.
The cursor will move to the command editing line.



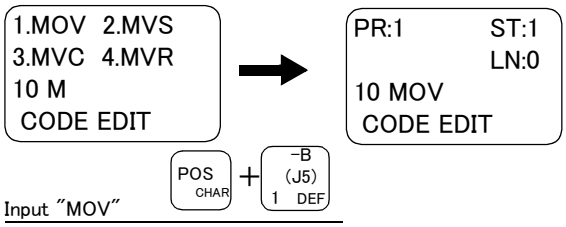
6) Press the [1], [0] and [SPACE] keys.
The line No. "10" will be input.



7) Press the [M] key while holding down the [POS CHAR] key. "M" will appear.



8) Hold down the [CHAR] key. The four commands assigned to "M" will appear.



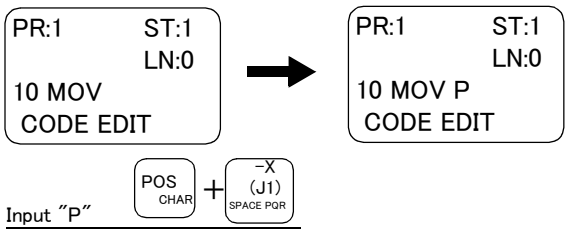
9) Press the [1] key while holding down the [CHAR] key.
The "MOV" command will be input.

◇◆◇ Inputting characters ◇◆◇

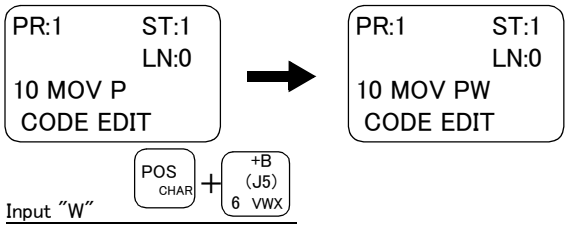
The characters that can be input are indicated, three in a group, on the lower right of each key.
To input a character, hold down the [CHAR] key and press the key having the character to be input. Each time the corresponding character key is pressed while the [CHAR] key is pressed, the three characters will appear alternately.
Release the [CHAR] key when the target character appears, and set the character.

◇◆◇ Inputting commands ◇◆◇

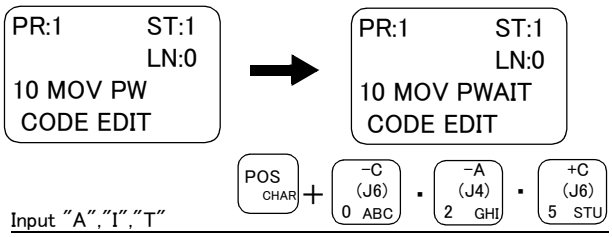
The commands can be input one character at a time (ex., for "M" → "O" → "V" for the MOV command), but if the head character of the command is input, the command can be selected as a number from the list of commands that appears.
After inputting the head character of the command, press the [CHAR] key. The list of commands will appear.
While holding down the [CHAR] key, press the numeral key for the target command No., and select the command
If the target command is not found in the list, press the [CHAR] key again to update the list.



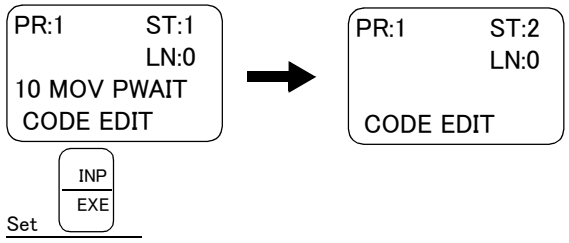
10) Press the [P] key while holding down the [CHAR] key, and then release the [CHAR] key.
"P" will be input.



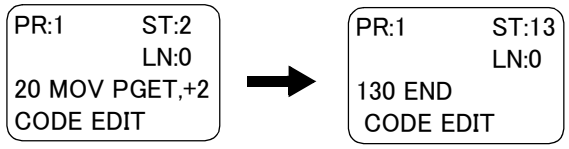
11) Press the [W] key twice while holding down the [CHAR] key, and then release the [CHAR] key.
"W" will be input.



12) Input "A", "I" and "T" in the same manner.



13) Press the [INP] key.
"10 MOV PWAIT" will be set.



14) Input the program from line 20 to line 130 in the same manner.

This completes the inputting of the program.

◇◆◇ Displaying the previous and next command line ◇◆◇

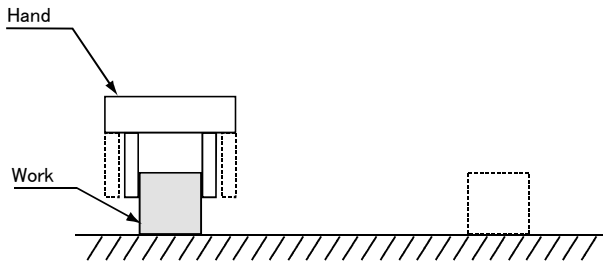
To display the previous line, press the [BACKWD] key, and to display the next line, press the [FORWD] key.

◇◆◇ Displaying a specific line ◇◆◇

Press the [↑] and move the cursor to LN:. Input the No. of the line to be displayed in the parentheses, and then press the [INP] key. The designated line will appear.

■ Teach the robot operation position.

Set the position with jog operation (Teaching PGET)

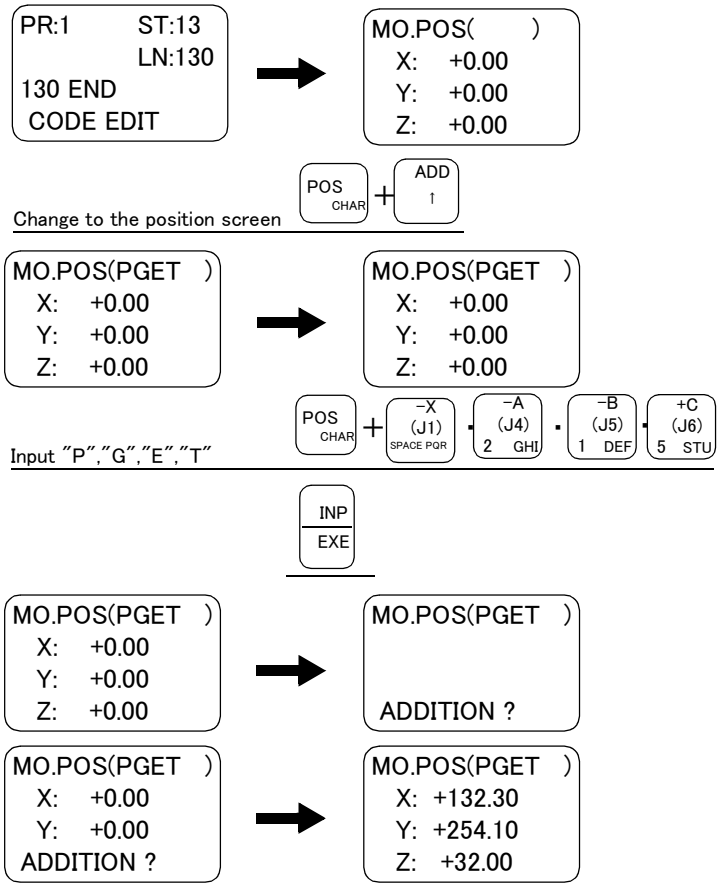


1) Move the robot with jog operation, and set the end of the hand to the position for grasping the workpiece. When the position has been set, open and close the hand to confirm that the workpiece can be grasped. Refer to "4.5 Jog operation" on page 34 for details on the jog operation, and section "4.6 Opening and closing the hand" on page 34 for detains on opening and closing the hand.

◇◆◇ Effective use of jog mode ◇◆◇

When the robot's current position is greatly separate from the target position, move the robot in axis units with the "JOINT JOG mode", to approach the position.
If the target position is nearby, move linearly with the "XYZ JOG mode", and finely adjust the position. The position can be set accurately by delaying the override (operation speed) at this time.

Registering the position (Teaching PGET)



2) On the command editing screen, press the [ADD] key while holding down the [POS] key. The position editing screen will appear.

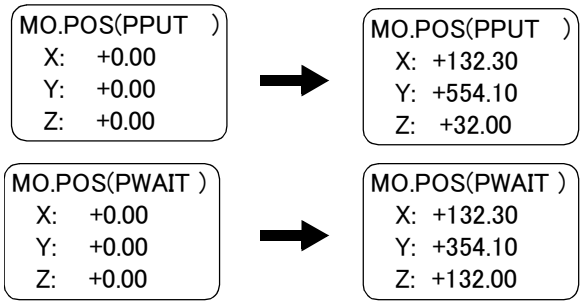
3) Input "PGET" in the parentheses at MO.POS, and then press the [INP] key. The position variable name PGET will be called, and the currently registered coordinate value will appear.

Refer to " ◇◆◇ Inputting characters ◇◆◇ " on page 40 for details on inputting characters.

4) Press the [ADD] key while holding down the [STEP] key, and release only the [ADD] key. The buzzer will sound a "beep", and a confirmation message will appear.
While holding down the [STEP] key, press the [ADD] key again.
The buzzer will sound a "beep", and the message "ADDING" will appear. Then, the current position will be registered.

◇◆◇ Changing between the command editing screen and position editing screen. ◇◆◇

The commands are edited on the command editing screen, and the positions are edited on the position editing screen.
To change from the command editing screen to the position editing screen, press the [POS] + [ADD] keys.
To change from the position editing screen to the command editing screen, press the [COND] key.

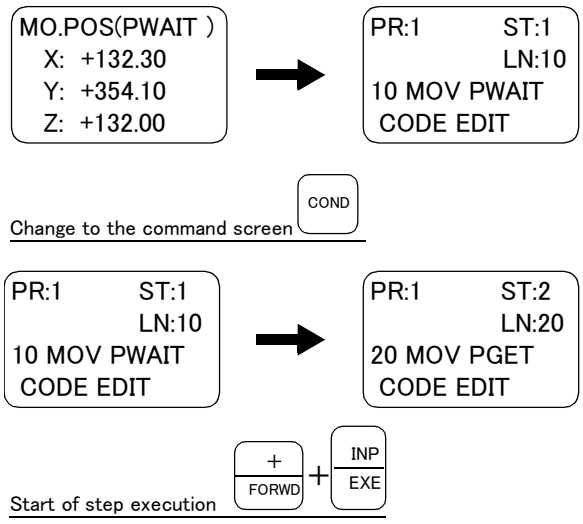


5) Teach PPUT (position to place workpiece) and PWAIT (wait position) in the same manner.

This completes teaching of the robot operation positions.

(4) Confirming the program

Using the T/B execute the program line by line (step operation), and confirm the operation.
The following operations are carried out while lightly pressing the deadman switch on the T/B.



1) Press the [COND] key, and display the command editing screen.

2) While holding down the [FORWD] key, hold down the [EXE] key.
The robot will start moving.

When the execution of one line is completed, the robot will stop, and the next line will appear on the screen.
If [EXE] is released during this step, the robot will stop.

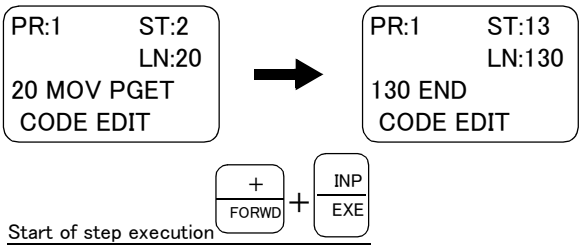
⚠ CAUTION Take special care to the robot movements during operation. If any abnormality occurs, such as interference with the peripheral devices, release the [EXE] key and stop the robot.

◇◆◇ Step operation ◇◆◇

"Step operation" executes the program line by line. The operation speed is slow, and the robot stops after each line, so the program and operation position can be confirmed.
During execution, the lamp on the controller's [START] switch will light.

◇◆◇ Immediately stopping the robot during operation ◇◆◇

- Press the [EMG. STOP] (emergency stop) switch.
  The servo will turn OFF, and the moving robot will immediately stop.
  To resume operation, reset the alarm, turn the servo ON, and start step operation.
- Release or forcibly press the "deadman" switch.
  The servo will turn OFF, and the moving robot will immediately stop.
  To resume operation, lightly press the "deadman" switch, and start step operation.
- Release the [EXE] key.
  The step execution will be stopped. The servo will not turn OFF.
  To resume operation, press the [EXE] key.

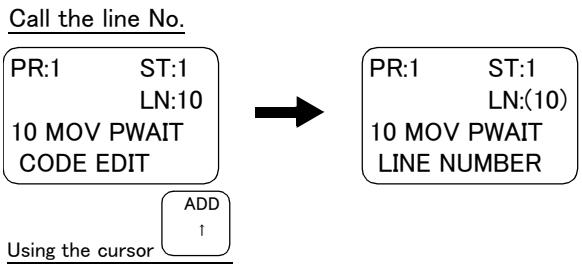


3) Carry out step operation up to the END command at line No. 130, and confirm the operation in the same manner.
If the robot operation or position is incorrect, refer to the following operations and make corrections.

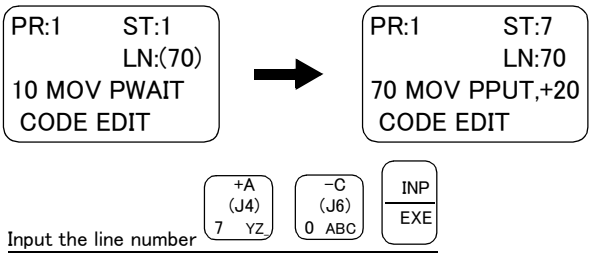
(5) Correcting the program

■ Correcting the commands

As an example, the joint movement at line No. 70 will be changed to linear movement.
(Change 70 MOV PPUT, +20 to 70 MVS PPUT, +20) Note)



1) Press the [↑] key to move the cursor to LN: ( ).



2) Press the [7], [0] and [INP] keys. Line No. 70 will appear.

⚠ CAUTION

Note) Upward movement is designated at a position along the Z axis of the TOOL coordinate system, and the direction is designated with the + and − signs.
Refer to the section on the TOOL JOG operation in the separate "Installation Manual/ Robot arm setup and maintenance", and confirm the Z axis direction of the TOOL coordinate system. Then, designate the correct sign (direction) that matches the robot being used.
Designating the reverse direction could lead to interference with the peripheral devices and damage.
Generally (in the default state), the hand retract direction is the "−" sign with the vertical articulate type robot, and the "+" sign is the robot's upward direction with the other robots.

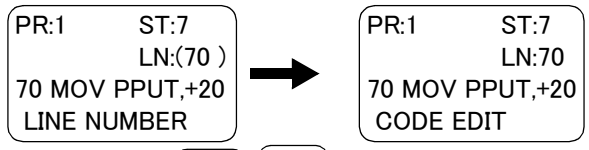
◇◆◇ Cursor movement ◇◆◇

When the cursor is at a command line display, the command can be edited. When at a line No. display (LN:), the line No. is designated.
The cursor is moved with the [↑], [↓], [←] and [→] keys.

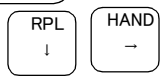
◇◆◇ Calling out a line No. ◇◆◇

When designating and calling out a line No., move the cursor to the line No. display (LN:), input the line No., and then press the [INP] key.
The displayed line can be scrolled up or down by pressing the [FORWD] or [BACKWD] key.

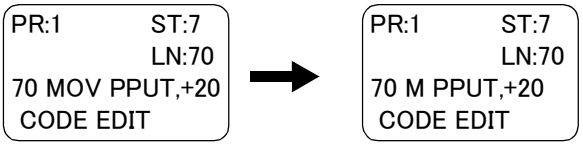
Change to the command



Using the cursor

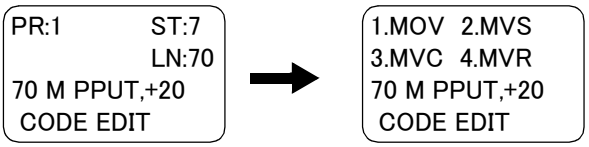


3) Press the [↓] key and move the cursor to the command line.
Press the [→] key six times, and move the cursor to the right of "V".



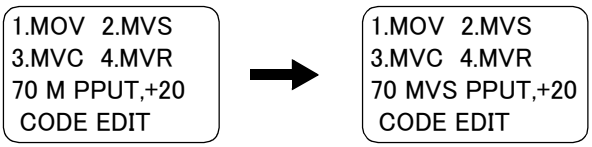
Deleting a character

4) Press the [DEL] key, and delete "OV". "M" will remain displayed.

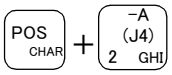


Display the command list

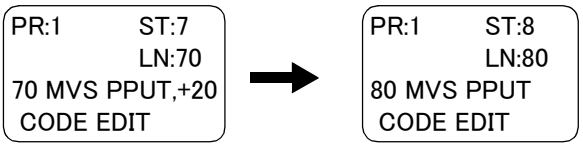
5) Hold down the [CHAR] key.
The four commands assigned to "M" will appear.



Select the "MVS" command



6) Press the [2] key while holding down the [CHAR] key, and select "MVS".



Set line 70

7) Press the [INP] key, and set line No. 70. The next line will appear on the screen.

Line No. 70 has been changed to linear movement with the above operation.

◇◆◇ Correcting a character ◇◆◇

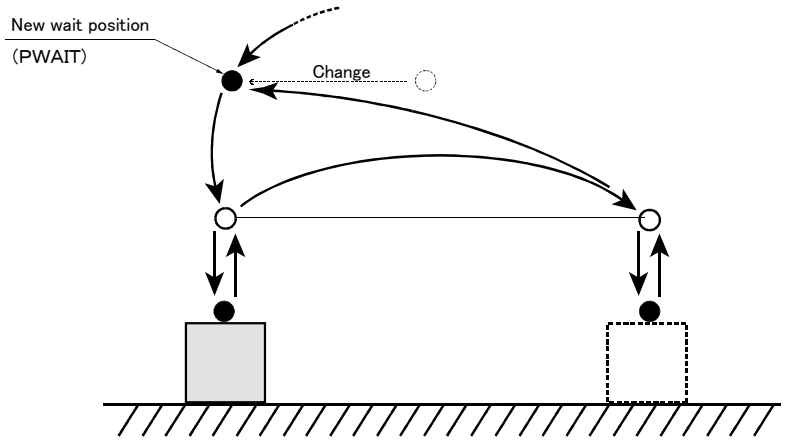
Move the cursor to the right of the incorrect character, and press the [DEL] key to delete in the left direction. Then, input the correct character. The input character will be inserted at the cursor position.
If the cursor is returned by pressing the [←] key, and a character is input, it will be inserted.

◇◆◇ After correcting a program ◇◆◇

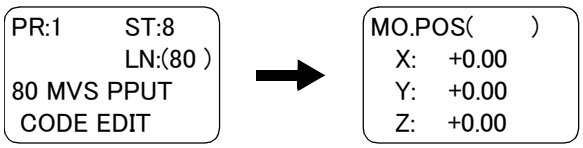
After correcting the program, carry out step operation, and confirm that the program has been corrected.

■ Correcting the taught position

As an example, the wait position (PWAIT) will be corrected.

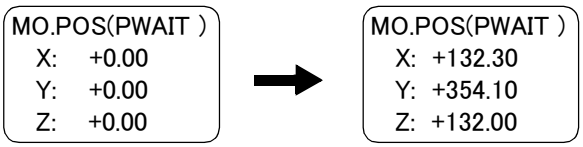


Change the movement position



POS CHAR + ADD ↑

Change to the position screen



POS CHAR + −X (J1) SPACE PQR · +B (J5) 6 VWX · −C (J6) 0 ABC ·

Input "P","W","A","I","T"

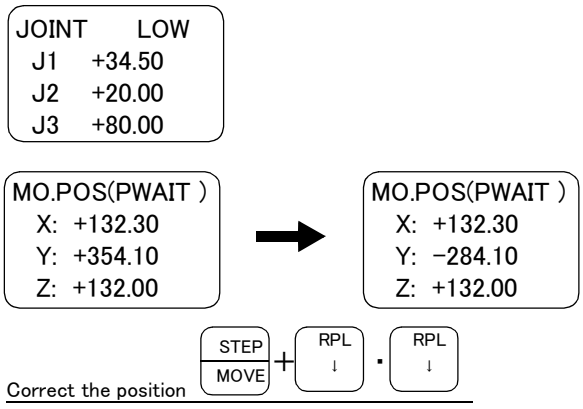
−A (J4) 2 GHI · +C (J6) 5 STU INP EXE

1) On the command editing screen, press the [ADD] key while holding down the [CHAR] key.
The position editing screen will appear.

2) Input "PWAIT" in the parentheses at MO.POS, and then press the [INP] key.
The position variable name PWAIT will be called out, and the currently registered coordinate value will appear.

◇◆◇ Calling out a position variable ◇◆◇

Input the name of the variable to be called out in the parentheses at MO. POS on the position editing screen. Then, press the [INP] key.
The displayed position variable can be scrolled up or down by pressing the [FORWD] or [BACKWD] key.



3) Move the robot to the new wait position with jog operation.

4) Press the [RPL] key while holding down the [STEP] key, and release only the [RPL] key.
The buzzer will sound a "beep", and a confirmation message will appear.
While holding down the [STEP] key, press the [RPL] key again.
The buzzer will sound a "beep", and the message "Replacing" will appear. Then, the current position will be registered.

This completes correction of the wait position.

◇◆◇ After correcting a program ◇◆◇

After correcting the program, carry out step operation, and confirm that the program has been corrected.

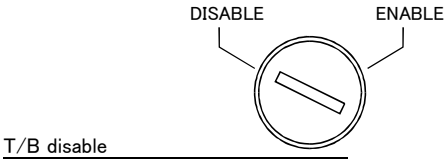
(6) Start automatic operation.

⚠ CAUTION Before starting automatic operation, always confirm the following item. Starting automatic operation without confirming these items could lead to property damage or physical injury.

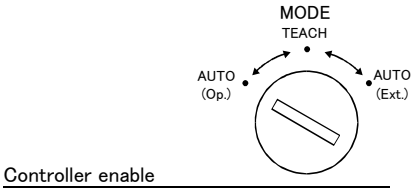
- Make sure that there are no operators near the robot.
- Make sure that the safety fence is locked, and operators cannot enter unintentionally.
- Make sure that there are no unnecessary items, such as tools, inside the robot operation range.
- Make sure that the workpiece is correctly placed at the designated position.
- Confirm that the program operates correctly with step operation.

In the following explanation, automatic operation will be carried out with the controller.

Prepare the controller

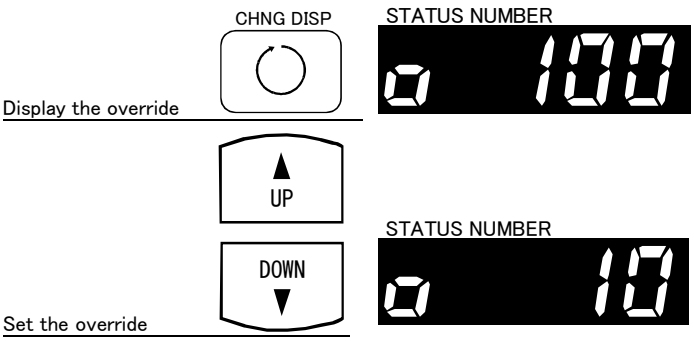


1) Set the T/B [ENABLE/DISABLE] switch to "DISABLE".



2) Set the controller [MODE] switch to "AUTO (Op.)".

Set the operation speed



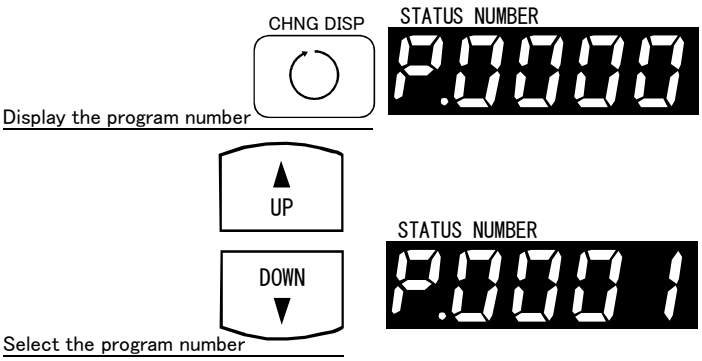
3) Press the controller [CHNG DISP] switch twice, and display the "OVERRIDE" on the STATUS NUMBER display panel. (A "(" will appear at the lower left.)
Press the [DOWN] key several times, and display "10".
The operation speed will be set to 10%.

⚠ CAUTION The servo will turn OFF when the controller's [MODE] switch is changed.
Note that axes not provided with brakes could drop with their own weight.
Carry out the following operations to prevent the servo from turning OFF when the [MODE] switch is changed.

◇◆◇ Operations to change [MODE] switch without turning servo OFF ◇◆◇

(1) While holding down the deadman switch on the T/B, set the [ENABLE/DISABLE] switch to "DISABLE".
(2) While holding down the deadman switch on the T/B, set the controller [MODE] switch to "AUTO (Op.)".
(3) Release the T/B deadman switch.

Select the program number

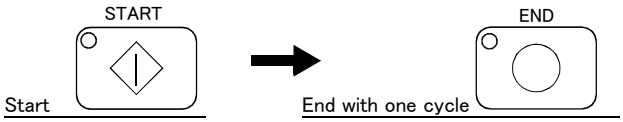


4) Press the [CHNG DISP] switch, and display the "program No." on the STATUS NUMBER display panel. (A "P" will appear at the head.)

Confirm that the program No. targeted for automatic operation is displayed.
With the previous operation, the program was created in program No. 1, so "P. 0001" will appear.

If the correct program No. is not displayed, press the [UP] and [DOWN] keys to display the correct program No.

Start automatic operation



5) After pressing the controller [START] switch, press the [END] switch.
The robot operation will start and will stop after one cycle.

⚠ CAUTION

When executing the work example given in "Fig. 4-5Example of work" on page 35, always press the [END] switch and end the program after one cycle. If the [END] switch is not pressed, the hand will interfere with the existing workpiece when it goes to pale the workpiece in the second cycle.

⚠ CAUTION

Before starting automatic operation, always confirm that the target program No. is selected.

⚠ CAUTION

Take special care to the robot movements during automatic operation. If any abnormality occurs, press the [EMG. STOP] switch and immediately stop the robot.

◇◆◇ Operating from the controller ◇◆◇

Set the T/B [ENABLE/DISABLE] switch to "DISABLE" and the controller [MODE] switch to "AUTO (Op.)".
Operations from the controller are not possible unless the controller [MODE] switch is set to "AUTO (Op.)".

◇◆◇ Operation speed ◇◆◇

The operation speed for automatic operation with the controller can be set.
When the override is displayed on the STATUS NUMBER display panel (with a " □ " displayed on the lower left) the override display will increment or decrement each time the [UP] or [DOWN] key is pressed. The max. speed is 100%.
Initially set a low speed, and gradually increase it.

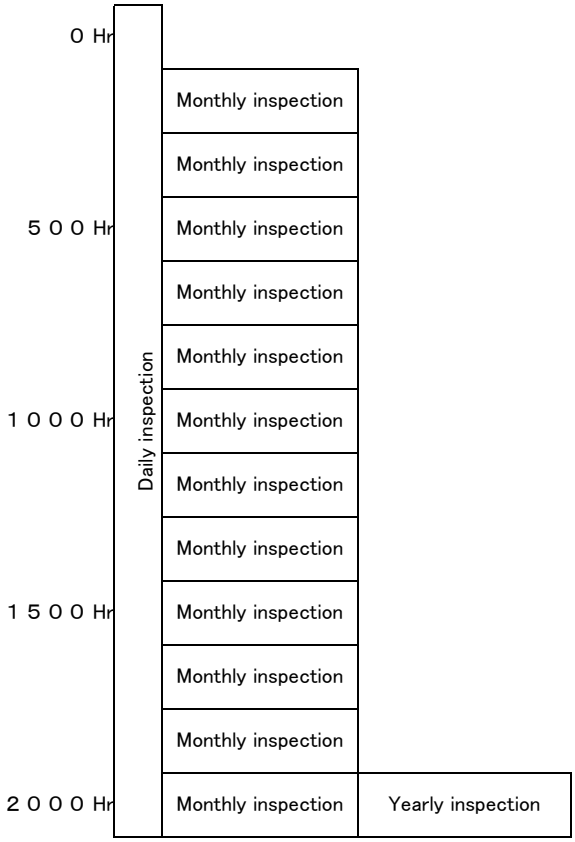
5 Maintenance and Inspection

The maintenance and inspection procedures to be carried out to use the robot for a long time without trouble are described in this chapter. The types and replacement methods of consumable parts are also explained.

5.1 Maintenance and inspection interval

Maintenance and inspection are divided into the inspections carried out daily, and the periodic inspections carry out at set intervals. Always carry these out to prevent unforeseen trouble, to maintain the product for a long time, and to secure safety.

(1) Inspection schedule



<Guideline for inspection period>

For one shift

8 Hr/day x 20 days/month x 12 months = approx. 1800 Hr

10 Hr/day x 20 days/month x 12 months = approx. 2400 Hr

For two shifts

15 Hr/day x 20 days/month x 12 months = approx. 3600 Hr

[Caution] According to the schedule on the above, when using the double shift, you should make the inspections at half the regular intervals.

Fig.5-1 : Inspection schedule

5.2 Inspection items

The controller inspection items are shown below.
Refer to section "Maintenance and Inspection" in the separate manual "Robot arm setup and maintenance", and inspect the robot arm at the same time.

5.2.1 Daily inspection items

Carry out daily inspections following the procedures given in Table 5-1.

Table 5-1 : Daily inspection items (details)

Procedure	Inspection items (details)	Remedies
Before turning the power ON (Check the following inspection items before turning the power ON.)		
1	Is the power cable securely connected? (Visual)	Securely connect.
2	Are the machine cables between the robot arm and controller securely connected? (Visual)	Securely connect.
3	Is the controller cover cracked, has any foreign matter adhered, or is there any interference?	Replace with a new part, or take remedial measures.
After turning the power ON (Turn the power ON while monitoring the robot.)		
1	Is there any abnormal movement or noise when the power was turned ON?	Refer to the Troubleshooting section and remedy.
During operation (Try moving with an original program.)		
1	Check that the operation point is not deviated. If deviated, check the following items. 1) Are any of the installation bolts loose? 2) Are the bolts at the hand installation section loose? 3) Is the position of the jigs, other than the robot, deviated? 4) If the positional deviation cannot be eliminated, refer to "Troubleshooting", and remedy.	Refer to the Troubleshooting section and remedy.
2	Is there any abnormal movement or noise? (Visual)	Refer to the Troubleshooting section and remedy.

5.2.2 Periodic inspections

Carry out periodic inspections following the procedures given in Table 5-2.

Table 5-2 : Periodic inspection items (details)

Procedure	Inspection items (details)	Remedies
Monthly inspection items		
1	Are any of the connector fixing screws or terminal block terminal screws loose?	Securely tighten the screws.
2	Is the controller filter (bottom side) dirty? (Visual)	Clean or replace with a new part. Inspect, clean and replace the filter by refer to "5.3.1 Cleaning and replacing the filter" on page 52.
Yearly inspection items		
1	Replace the backup battery in the controller.	Exchange it referring to "5.3.2 Replacing the battery" on page 53.

5.3 Maintenance and inspection procedures

The procedures for carrying out periodic maintenance and inspection are described below. Thoroughly comprehend the procedures, and follow the instructions. This work can be commissioned to the Mitsubishi Service Dept. for a fee. (Never disassemble, etc., any of the parts not described in this section.)

The maintenance parts required for the maintenance and inspection are shown in section "5.4 Maintenance parts" on page 40. Contact your dealer for these parts when required.

5.3.1 Cleaning and replacing the filter

A filter has been installed in the front part of the controller's bottom surface.

The following shows the procedure for inspecting, cleaning and replacing the filter:

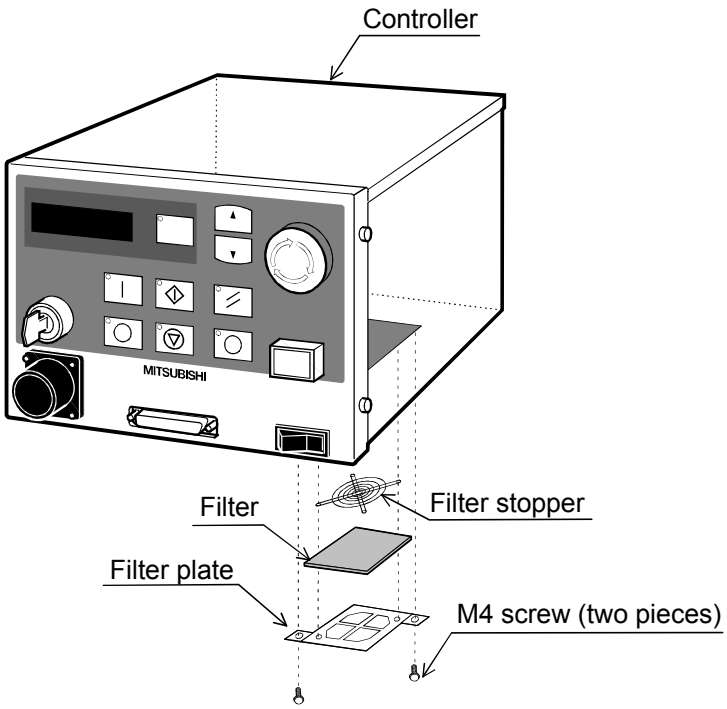


Fig.5-2 : How to remove the filter

1) Remove the filter plate in the bottom side of the controller by unscrewing the M4 screws (2 pcs.).
2) Remove the filter from the filter plate, and then remove dust and particles accumulated on the filter.
   If the filter is heavily soiled, wash it using neutral a detergent diluted with water, dry it completely, and then mount it to the filter plate. Also, if the surface of the cleaned filter is forming nap, replace with a new filter.
3) Attach the cleaned or new filter to the filter plate, and install it to the controller with the M4 screws (2 pcs.).

This completes the inspection, cleaning and replace of the filter for the controller.

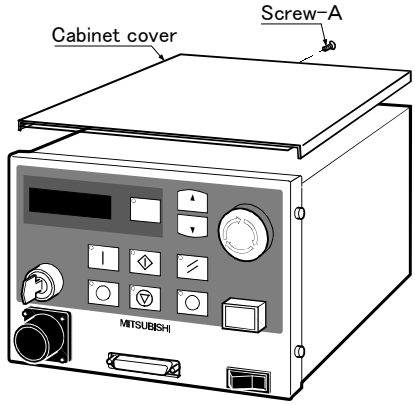
5.3.2 Replacing the battery

⚠ CAUTION

The procedures for replacing the battery are described below.
If the system is used after the battery cumulative time over error (Error No. 7520) occurs, the backup fault alarm will occur. If the backup fault alarm occurs, the contents of the memory cannot be guaranteed, so save important program and position data on a floppy disk using personal computer support software, etc.

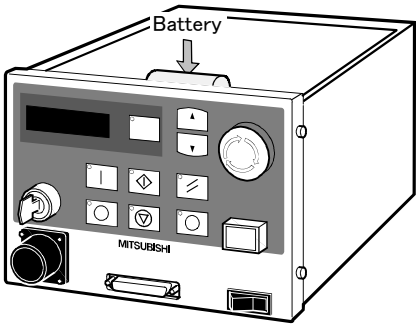
⚠ CAUTION

Replace the batteries for the controller and robot arm at the same time. Replace the controller battery within 15 minutes after removing the old battery.



1) Turn the controller power ON once. (For approx. one minute.)

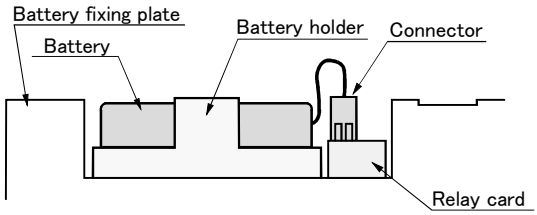
2) Turn the controller power and base power OFF, and wait for at least three minutes. Then, loosen the cabinet cover fixing screw A, and remove the cover.



3) Remove the old battery installed in the battery holder on the battery fixing plate. (Hold the connector and pull the battery upward.)

4) Fix the new battery into the battery holder.

5) Hold both ends of the new battery's cable connector and insert into the connectors on the relay card. Complete the work within 15 minutes after removing the old battery.



Details of battery section

6) Refer to the separate manual "Detailed Explanation of Functions and Operations", and reset the battery cumulative time over alarm.

[Caution]
If the old battery is replaced because it has been used up, it is necessary to set the origin again. Refer to the separate "Standard Specifications Manual" and reset the origin.

This completes the replacement of the controller battery.

5.4 Maintenance parts

The consumable parts that must be replaced periodically are shown in Table 5-3, and spare parts that may be required during repairs are shown in Table 5-4. Purchase these parts from the dealer when required. Some Mitsubishi-designated parts differ from the maker's standard parts. Thus, confirm the part name, robot arm and controller serial No. and purchase the parts from the dealer.

Table 5-3 : Controller consumable part list

No.	Part name	Type	Qty.	Usage section	Maker
1	Lithium battery	ER6 BKO-NC2157H01	1	Control unit	Mitsubishi Electric System & Service;Co.,Ltd.
2	Filter	BKO-FA0773H01	1	Bottom of the controller	

Table 5-4 : Controller spare part list

No.	Part name	Type	Qty.	Usage section	Maker
1	Fuse	LM16	1	RZ386 or RZ387 board	Mitsubishi Electric System & Service;Co.,Ltd.
2		LM32	1		
3		LM32	1	CR1-571 : RZ802x board CR1B-571 : RZ808x board	
4		HM32	1		
5		MF60NR5A05	2	Rear side of the controller	

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