MITSUBISHI Mitsubishi Industrial Robot

CR4/CR7/CR8 Controller

INSTRUCTION MANUAL

Controller setup, basic operation, and maintenancence



▲ 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.

	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.) \rightarrow Enforcement of safety training
▲ CAUTION	For teaching work, prepare a work plan related to the methods and procedures of oper- ating the robot, and to the measures to be taken when an error occurs or when restart- ing. Carry out work following this plan. (This also applies to maintenance work with the power source turned ON.) \rightarrow Preparation of work plan
	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.) \rightarrow 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.) \rightarrow Indication of teaching work in progress
AWARNING	Provide a fence or enclosure during operation to prevent contact of the operator and robot. → Installation of safety fence
	Establish a set signaling method to the related operators for starting work, and follow this method. $ ightarrow$ Signaling of operation start
	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. \rightarrow Indication of maintenance work in progress
A 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.

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.) 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. Always use the robot installed on a secure table. Use in an instable posture could lead to positional deviation and vibration. Wire the cable as far away from noise sources as possible. If placed near a noise source, positional deviation or malfunction could occur. 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. 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. 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. Indicate the operation state during robot operation. Failure to indicate the state could lead to operators approaching the robot or to incorrect operation. 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. 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. 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. 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. 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. 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. 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.

Revision history

Date of print	Specifications No.	Details of revisions
2000-03-21	BFP-A8077Z	• First print.
2000-04-05	BFP-A8077	• Formal style.
2000-12-18	BFP-A8077-A	 The explanation of the CR8 controller was added. Error in writing correction.
2003-01-27	BFP-A8077-B	 About MC control output (AXMC) for addition axes was added. Error in writing correction.

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."

The contents of this manual correspond to the following controller types.

- <Controller type>
- · CR4-533M · CR4-533CA
- · CR4-533CB
- · CR4-533CD
- · CR7-533M
- · CR8-533M

- The details of this manual are subject to change without notice.
- An effort has been made to make full descriptions in this manual. However, if any discrepancies or unclear points are found, please contact your dealer.
- · Please contact your nearest dealer if you find any doubtful, wrong or skipped point.

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1 Before starting use

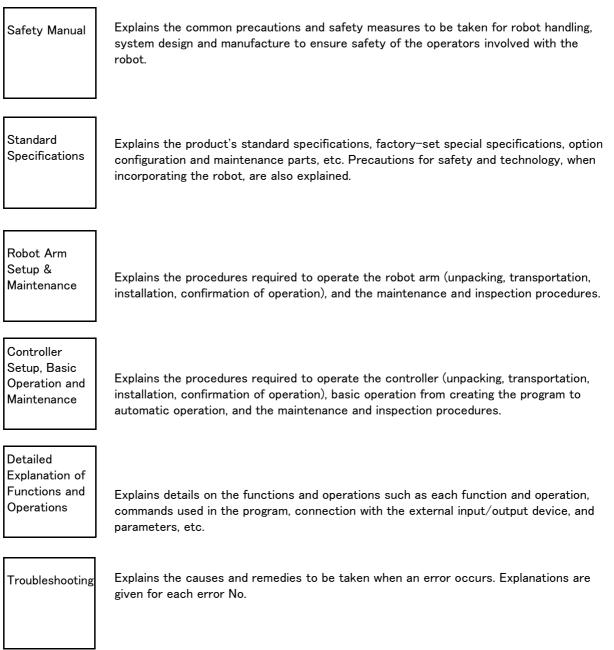
This chapter explains the details and usage methods of the instruction manuals, the basic terminology and the safety precautions.

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.



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.

Symbol	Meaning
<u> </u>	Precaution indicating cases where there is a risk of operator fatality or seri- ous injury if handling is mistaken. Always observe these precautions to safely use the robot.
	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.
	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.
$\begin{bmatrix} STEP \neq MOVE \end{bmatrix} + (\begin{bmatrix} COND \end{bmatrix} \rightarrow \begin{bmatrix} RPL \downarrow \end{bmatrix}) \\ (A) \qquad (B) \qquad (C) \end{bmatrix}$	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 \downarrow key is pressed.
Т / В	This indicates the teaching pendant.

Table 1-1 : Symbols in instruction manual

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.) \rightarrow Enforcement of safety training
▲ CAUTION	For teaching work, prepare a work plan related to the methods and procedures of oper- ating the robot, and to the measures to be taken when an error occurs or when restart- ing. Carry out work following this plan. (This also applies to maintenance work with the power source turned ON.) \rightarrow Preparation of work plan
	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.) \rightarrow 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.) \rightarrow Indication of teaching work in progress
⚠ DANGER	Provide a fence or enclosure during operation to prevent contact of the operator and robot. \rightarrow Installation of safety fence
▲ CAUTION	Establish a set signaling method to the related operators for starting work, and follow this method. \rightarrow 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. \rightarrow 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. \rightarrow 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 envi- ronment, 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 drop-ping.
▲ 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.
A 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.
	Securely ground the robot and controller. Failure to observe this could lead to mal- functioning 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.
	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 opera- tion, 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.
	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.

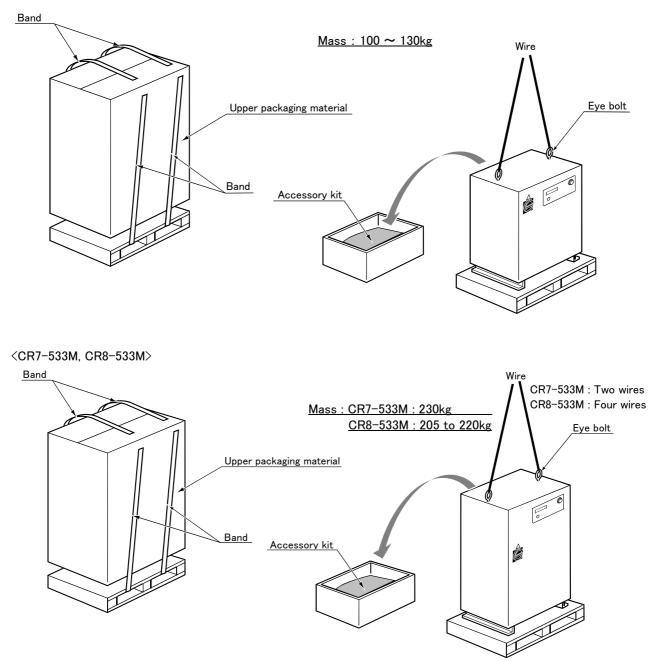
No.	Part name	Туре	Qty.	Remarks
1	Controller	CR4-533CA CR4-533CB CR4-533CD CR7-533M CR8-533M	1 of these units	With machine to machine cable
2	Safety Manual	BFP-A8006	1 сору	
3	Standard Specifications	BFP-A8027		RV-20A type
		BFP-A8028		RH-1000GHDC-SA/GJDC-SA type
		BFP-A8029	1 of these	RH-1000GHLC-SA/GJLC-SA type
		BFP-A8030	copy	RH-1500GJC-SA,SB/ GC-SA,SB type
		BFP-A8031		RC-1000GHWDC-SA/GHWLC-SA type
		BFP-A8142		RV-100TH/150TH/100THL/150THL type
4	Instruction Manual (Robot arm setup and maintenance)	BFP-A8035	1 of these copy	RV-20A type
		BFP-A8036		RH-1000G/1500G series type
		BFP-A8037		RC-1000GHWDC-SA/GHWLC-SA type
		BFP-A8038		RV-100TH/150TH/100THL/150THL type
5	Instruction Manual (Controller setup, basic operation and maintenance)	BFP-A8077	1 сору	This book
6	Instruction Manual (Detailed explanations of functions and operations)	BFP-A5992	1 сору	
7	Instruction Manual (Troubleshooting)	BFP-A5993	1 сору	
8	Guarantee Card		1 сору	

Table 2-1 : Standard configuration

2.2 Installation

2.2.1 Unpacking procedures

<CR4-533M, CR4-533CA, CR4-533CB>



[Caution] The packaging material is required when transporting the controller again, so keep it in safekeeping.

Fig.2-1 : Unpacking the controller

The controller is shipped from the factory packaged in cardboard. Unpack the controller with the following procedure.

- (1) Remove the bands.
- (2) Remove the upper packaging material.
- (3) Remove the accessory kit placed on the top of the controller.
- (4) Attach the wire hooks to the eye bolts enclosed with the controller, and suspend the controller with a crane to remove it from the packaging material.

2.2.2 Transportation procedures

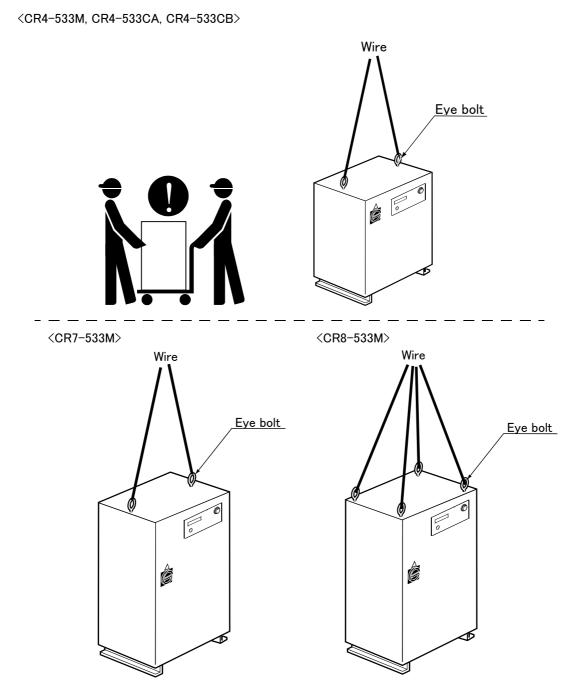


Fig.2-2 : Transporting the controller

■ CR4-533M. CR4-533CA, CR4-533CB

Two workers must transport the controller using a crane or lifter.

CR7-533M, CR8-533M

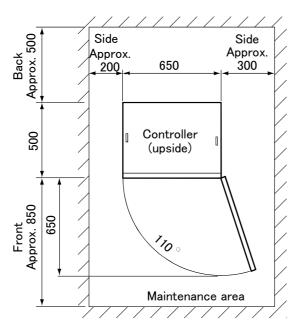
Catch tow wires into the eye bolts, and suspend the controller.

2.2.3 Installation procedures

The installed size according to controller's type-identifier is shown as follows.

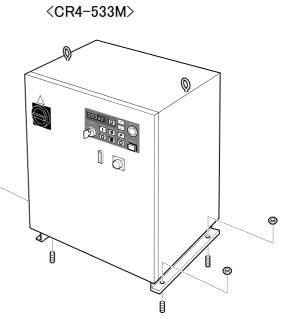
9

Q

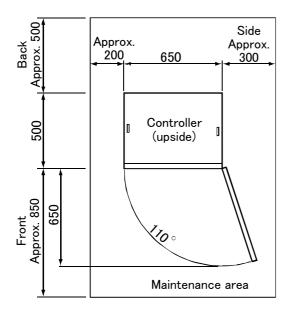


(View from upside)

Fig. 2-3 : Installation dimensions (CR4-533M)



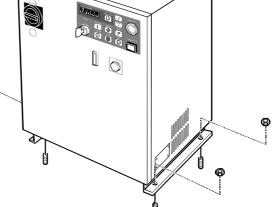
(Anchor bolt installation: 4 places)



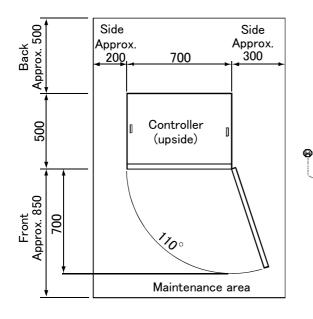
(View from upside)

Fig. 2-4 : Installation dimensions (CR4-533CA)

<CR4-533CA>

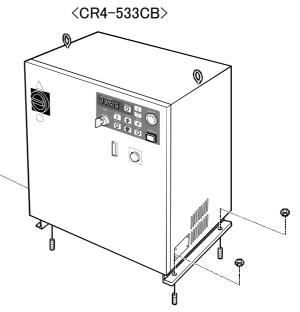


(Anchor bolt installation: 4 places)

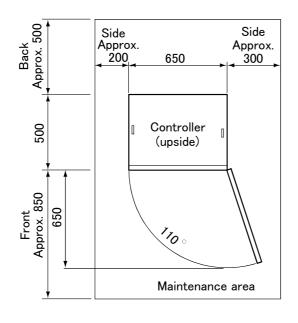


(View from upside)

Fig. 2-5 : Installation dimensions (CR4-533CB)

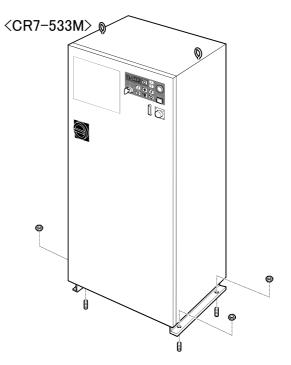


(Anchor bolt installation: 4 places)



(View from upside)

Fig. 2-6 : Installation dimensions (CR7-533M)



(Anchor bolt installation: 4 places)

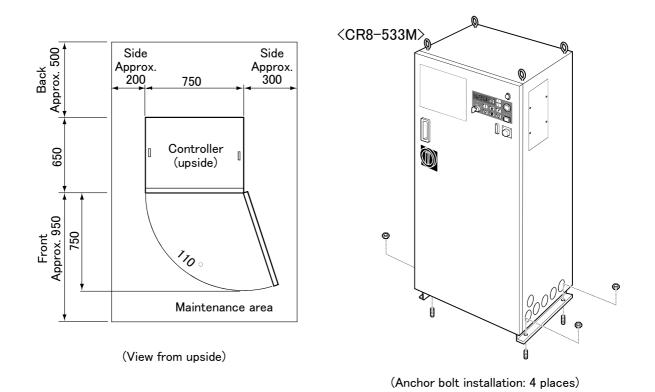
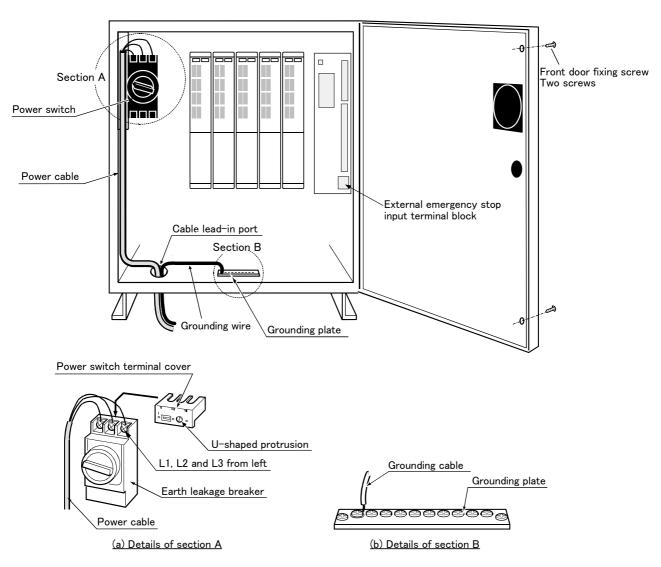


Fig. 2-7 : Installation dimensions (CR8-533M)

- (1) Install the controller so that it is level.
- (2) Do not block the ventilation holes on the side and rear surfaces of the controller.
- (3) When storing the controller in a cabinet,etc., take special care to the heat dissipation and ventilation properties so that the ambient temperature is within the specification values.

2.2.4 Connecting the power cable and grounding cable

The power cable and grounding cable connection method of each model is shown as follows.



<CR4-533M、CR4-533CA、CR4-533CB>

Fig.2-8 : Connecting the power cable and grounding cable(CR4-533M/CR4-533CA/CR4-533CB)

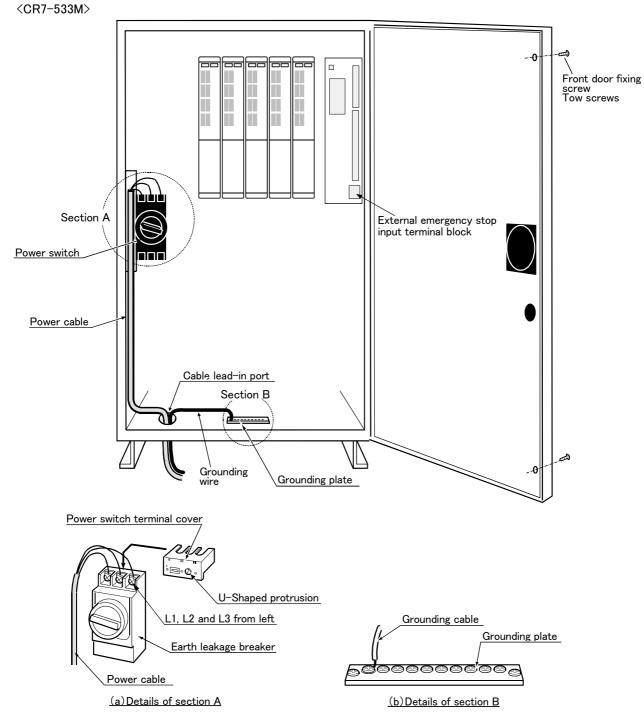
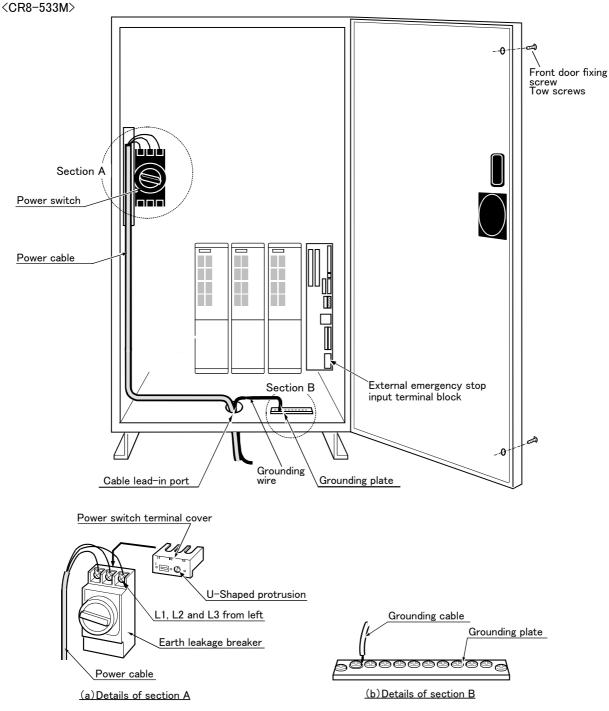


Fig.2-9 : Connecting the power cable and grounding cable(CR7-533M)





(1) Prepare the power cable and grounding cable (both must be $2mm^2$ or more).

(2) Loosen the two screws fixing the controller's front door, and open the front door.

- (3) Hold the U-shape protrusion on the front of the power switch terminal cover, and pull it out.
- (4) Confirm that the primary power matches the specifications.
- (5) Confirm that the primary power is OFF and that the controller power switch is OFF.
- (6) Insert the power cable and grounding cable from the cable lead-in port on the bottom of the controller.
- (7) Connect the power cable to the power switch terminal. (L1, L2 and L3 from left)
- (8) Connect the grounding cable to the grounding plate terminal.
- (9) Insert the power switch terminal cover removed in step (3) until a "click" is heard.
- (10) Close the controller's front door, and fix with the fixing screws.

This completes the connection of the power and grounding cables.

2.2.5 Connecting the external emergency stop

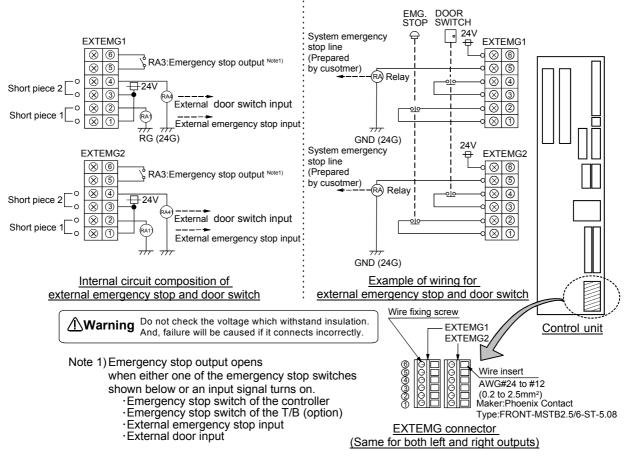


Fig.2-11 : Connecting the external emergency stop

For safety purposes, install the External emergency stop switch at an easy-to-operate place.

The external emergency stop input terminal block is short-circuited with a short piece at shipment as shown in Fig. 2-11.

Connect the external emergency stop switch with the following procedure. The emergency stop circuit in the controller is redundant (duplex), so use a 2-contact type switch for the emergency stop switch.

- (1) Prepare the "emergency stop switch" (2b contact).
- (2) Remove the two short pieces 1 and 2.
- (3) Securely connect the external emergency stop's two contacts across "1)-2)", and the door switch's contacts across "3)-4)" on the connector.

This completes the connection of the external emergency stop.

2.2.6 MC control output (AXMC) for addition axes

When an additional axis is used, the servo ON/OFF status of the additional axis can be synchronized with the servo ON/OFF status of the robot itself by using the output contact (AXMC1) provided on the inside of the controller and configuring a circuit so that the power to the servo amplifier for the additional axis can be turned off when this output is open.

Fig. 2–12 shows an example of its circuit, and Fig. 2–13 and Fig. 2–14 show the layout drawings of the output contact (AXMC1). When you are using an additional axis, please perform appropriate circuit connections by referring to these drawings.

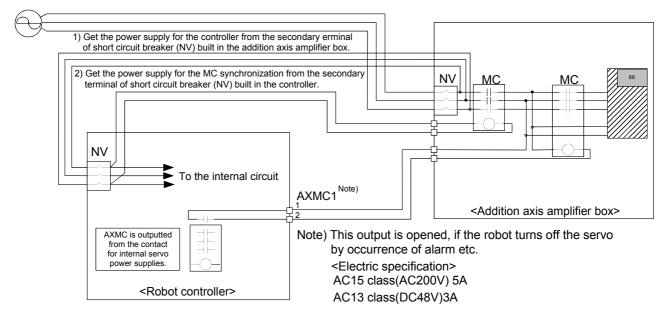


Fig.2-12 : Example of circuit for addition axes of MC control output.

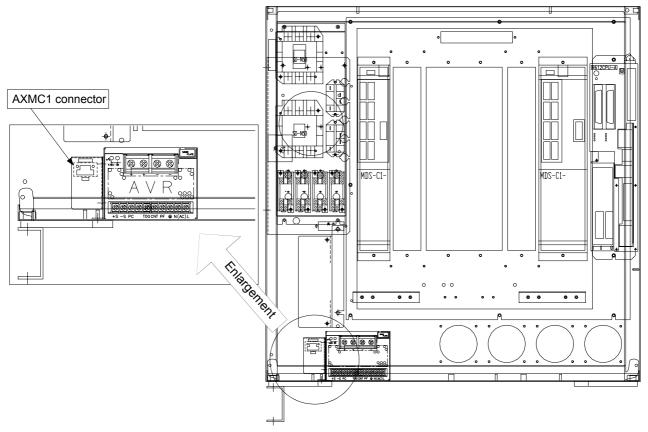


Fig.2-13 : Arrangement figure of the AXMC1 connector. (CR4-533M/533CA/533CB/533CD controller)

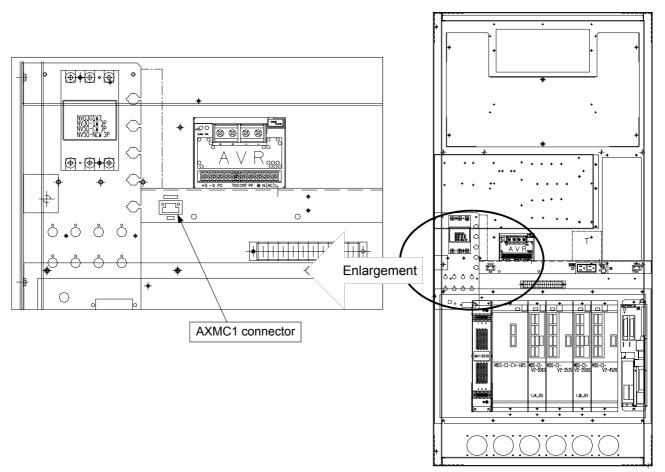


Fig.2-14 : Arrangement figure of the AXMC1 connector. (CR8-533M controller)

2.2.7 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 26 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.

The option card, mounted on the control unit (R6x2CPU), is mounted after removing R6x2CPU from the controller. The procedures are explained in "3.1Removing and Installing the R6x2CPU (Installing the Option Card)" below, so refer to that section when installing the option card.

3.1 Removing and Installing the R6x2CPU (Installing the Option Card)

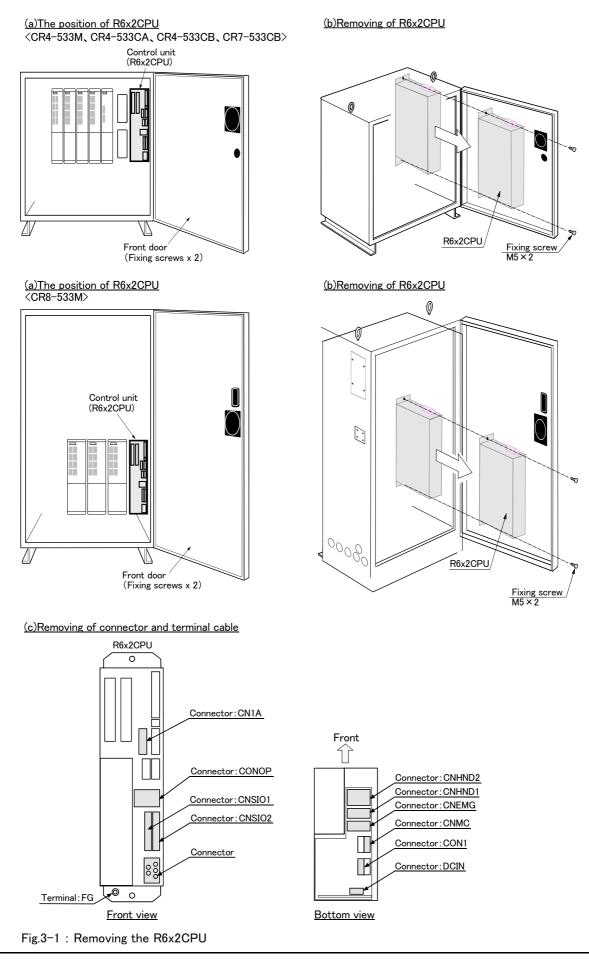
The option card, mounted on the control unit (R6x2CPU), is mounted after removing R6x2CPU from the controller. The procedure of removing is explained below.



Confirm that the controller's main power supply and controller power switch are OFF before starting this work. Wait at least 15 minutes after turning the power OFF before opening the controller front door.

On the R6x2CPU, the cables are connected with the connectors and terminal block. Take care not to pull the cables when removing.

- (1) Wait at least fifteen minutes after turning the power OFF, then loosen the fixing screws on the controller front door, and open the front door.
- (2) Remove the two M5 screws (top/bottom) fixing the R6x2CPU, and then pull out the R6x2CPU. Take care not to pull the cables at this time.
- (3) Disconnect the connectors and FG cable connected to the R6x2CPU, and pull out the unit. The connectors and terminal block to be disconnected are shown in Fig. 3-1 (c)



Removing and Installing the R6x2CPU (Installing the Option Card) 3-19

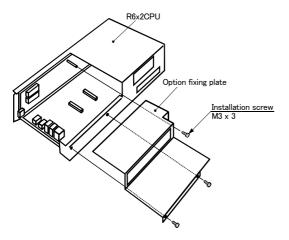
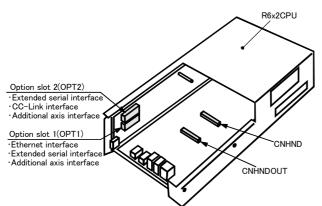


Fig.3-2 : Removing the option fixing plate

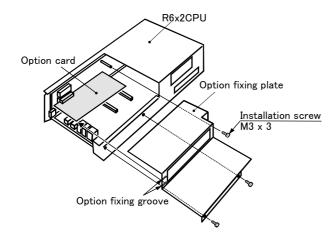


(4) Remove the three M3 screws to remove the R6x2CPU option fixing plate.

(5) Insert the option card.

The position of the slot will differ according to the options. Refer to the instruction manual of the option being used, check the slot position, and then insert the option.

Fig.3-3 : Option slot



(6) Install the option fixing plate, removed in step "(3)", onto the R6x2CPU.

When the option card has been inserted into option slot 1 or 2, install so that the option card fits into the option fixing groove on the option fixing plate, and then fix securely with screws.

Fig.3-4 : Installing the option fixing plate

(7) Install the R6x2CPU onto the controller.

Connect the connectors and FG cables disconnected in step (3), and then securely fix the R6x2CPU onto the controller at the original position with the screws removed in step (2). Close the controller's front door, and fix with the fixing screws.

This completes the removal and installation of the R6x2CPU.

3.2 The procedures for installing the pneumatic hand interface

The procedures for installing the pneumatic hand interface, mounted on R6x2CPU, are explained below.



Confirm that the controller's main power supply and controller power switch are OFF before starting this work

- (1) Refer to steps "(1)" to "(4)" of section "3.1Removing and Installing the R6x2CPU (Installing the Option Card)", remove the R6x2CPU from the controller, and remove the option fixing plate.
- (2) The pneumatic hand interface is mounted on the RZ181 card in the R6x2CPU. Install by securely inserting the CNHDNOUT/CNHND connectors on the card into the pneumatic hand interface connectors.

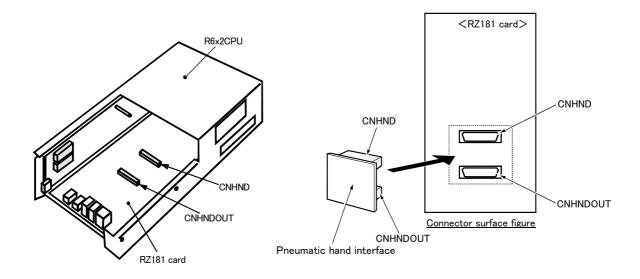


Fig.3-5 : Installing the pneumatic hand interface

(3) Refer to steps "(6)" and "(7)" of section "3.1Removing and Installing the R6x2CPU (Installing the Option Card)", install the option fixing plate, and install the R6x2CPU onto the controller at the original position.

This completes the installation of the pneumatic hand interface.

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

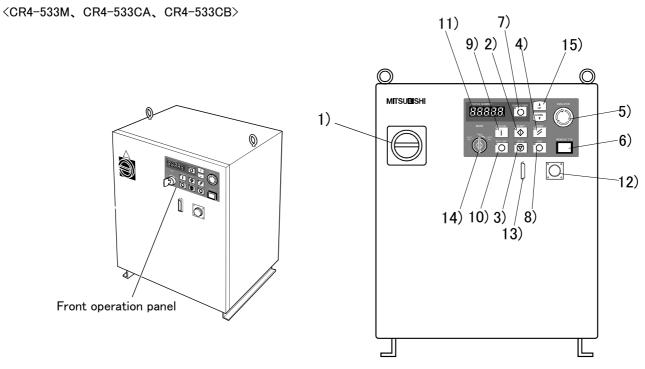


Fig.4-1 : Names of controller parts (CR4-533M, CR4-533CA, CR4-533CB)

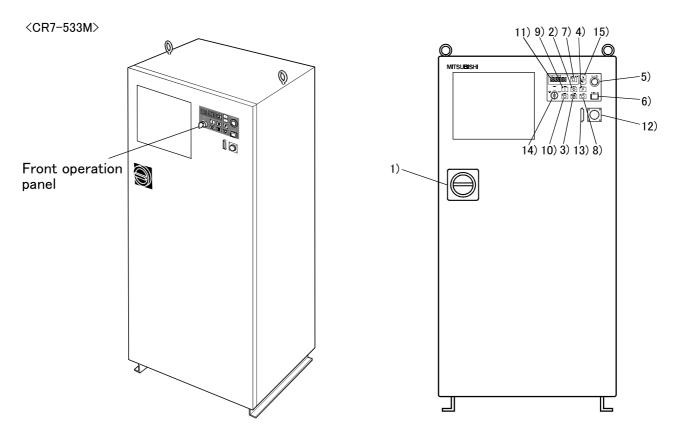


Fig.4-2 : Names of controller parts (CR7-533M)

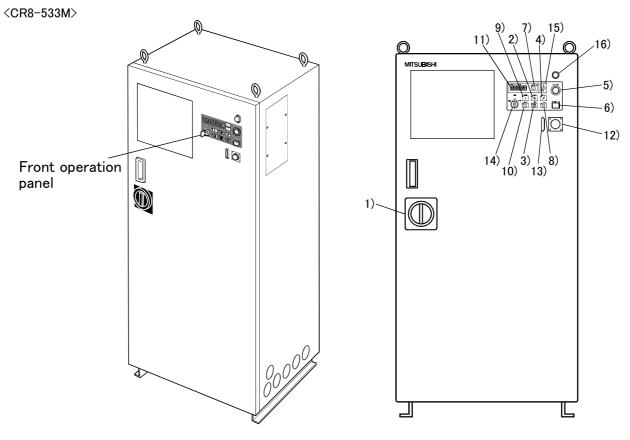


Fig.4-3 : Names of controller parts (CR8-533M)

1) POWER switch	. This turns the control power ON/OFF. (With earth leakage breaker function)
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.
	. This changes the details displayed on the display panel in the order of "Override" \rightarrow "Program No." \rightarrow "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	
	This is an RS-232C specification connector for connecting the personal computer.
14) MODE changeover switch	.This changes the robot's operation mode. ^{Note)}
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.
	This is indicator for primary power supply. This indicator is turned on when the primary power supply is being supplied.

Action Note) 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. *The controller for this function are CR1/CR2A and the CR2/CR4/CR7/CR8/CR9 to which the CPU unit type is B. The CPU unit type is indicated on the unit upside of the right end inside the controller. 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. Mene the mode is changed from TEACH to AUTO. While holding down the deadman switch on the T/B, set the [ENABLE/DISABLE] switch to "DISABLE". While holding down the deadman switch on the T/B, set the controller [MODE] switch to "AUTO". 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.

$\diamond \blacklozenge \diamondsuit$ What are the operation rights? $\diamond \blacklozenge \diamondsuit$

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)

$\diamond \blacklozenge \diamond$ What operations require the operation rights? $\diamond \blacklozenge \diamond$

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.

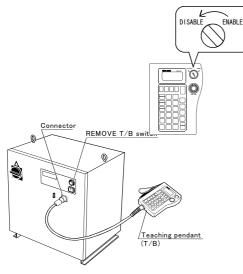
Refer to the separate manual "Explanation of functions and operations" for details on the functions related to operation rights.

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.

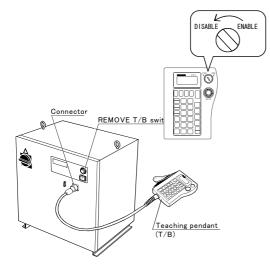
- (1) Installing with the control power OFF Refer to the separate manual "From robot arm setup to maintenance" for details on installing the T/B with the power OFF.
- (2) Removing with the control power ON



(3) Installing 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.
- 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.



- 1) Set the T/B [ENABLE/DISABLE] switch to "DISABLE".
- 2) Connect the T/B connector. The switch's LED will start flickering.
- 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.

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.

$\diamond igods \diamond$ When an emergency stop state occurs $\diamond igods \diamond$

- 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

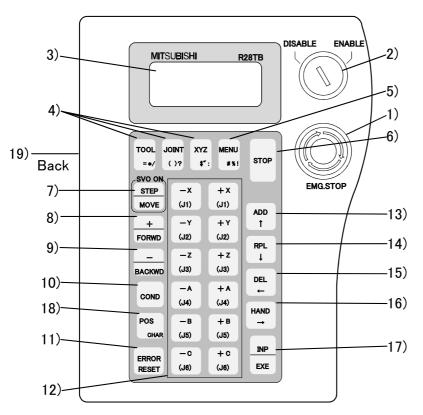


Fig.4-4 : Teaching pendant (Front side of R28TB)

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).
- 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

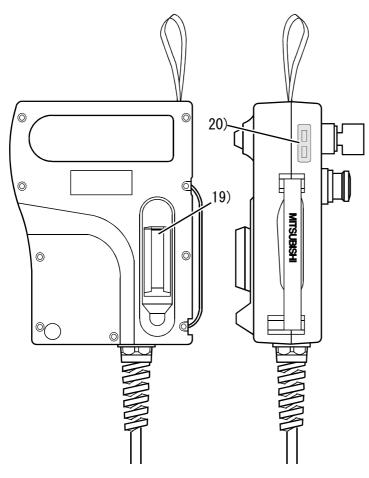
On the edit screen, the previous program line is displayed. When pressed simultaneously with the [INP/EXE] key, the axis will return along the robot's operation path. When pressed simultaneously with the [STEP/MOVE] key, the override (speed) will decrease.

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/ 1] key

This additionally registers the position data. It also moves the cursor upward.

- 14) [RPL/ ↓] key This corrects the position data. It also moves the cursor downward .
- 15) [DEL/ ←] key
 This deletes the position data. It also moves the cursor to the left .

16) [HAND/ \rightarrow] 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.4-5 : 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.

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

 $\diamond \blacklozenge \diamond$ Remove the protection seal of the teaching pendant before using $\diamond \blacklozenge \diamond$

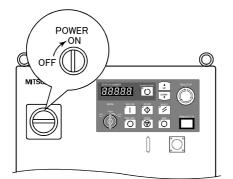
Installed the protection seal on the teaching pendant to prevent the damage of the display LCD and the key seat when shipping. Remove the protection seal when using. The operation of the key and the confirmation of the display is possible without removing the protection seal, however the adhesive may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

Always confirm the following items before turning the controller power $\ensuremath{\mathsf{ON}}$.

- 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.

" \Box . 100" will appear on the STATUS NUMBER display.

This completes the turning ON of the control power.

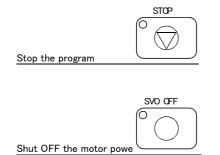
$\diamond igodold \diamond$ What is the main power, control power and servo power? $\diamond igodold \diamond$

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

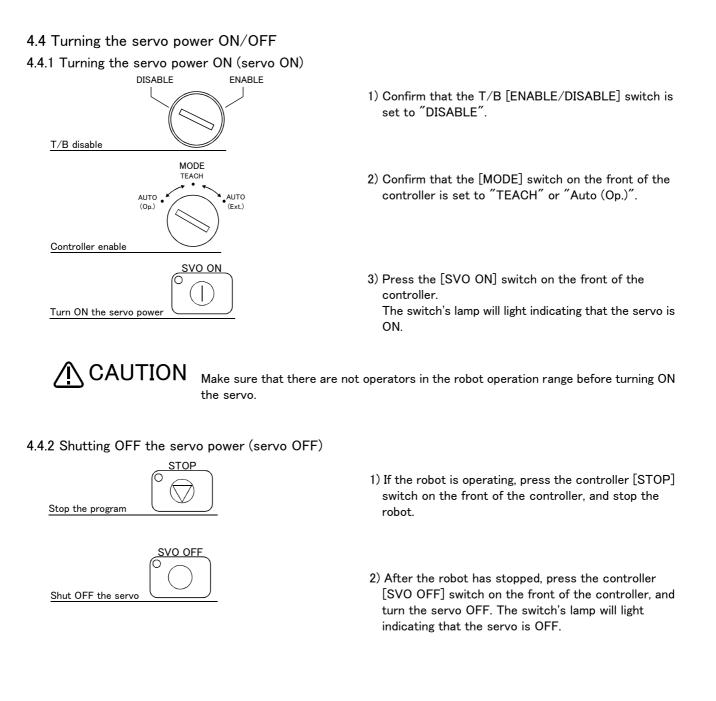


1) If the robot is operating, press the controller [STOP] switch, and stop the robot.

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.



 $\diamond \blacklozenge \diamond$ Operation rights not required $\diamond \blacklozenge \diamond$

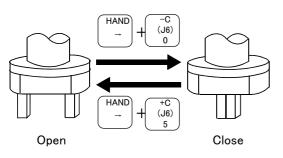
This operation does not require the operation rights, so the servo can be turned OFF at any time by pressing the [SVO OFF] switch.

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. 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. Separate manual "Robot arm TOOL JOG Accurately sets the teaching position. setup and maintenance" · 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

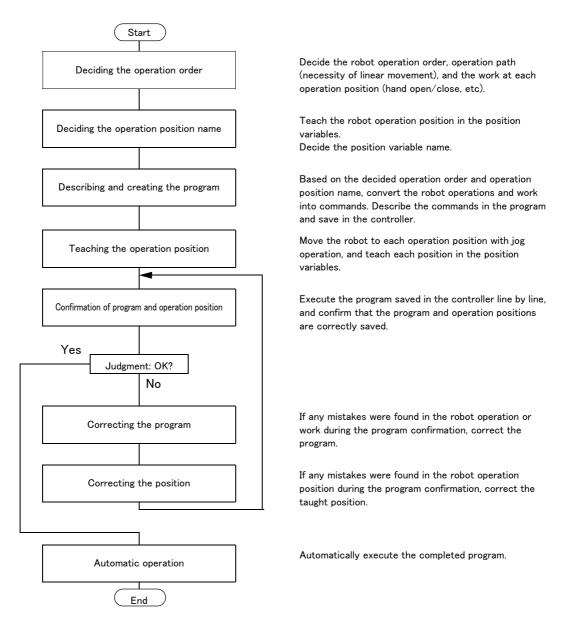
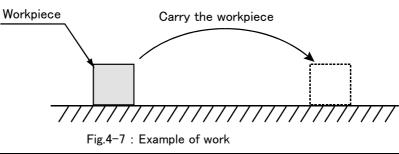


Fig.4-6 : Program creation procedures

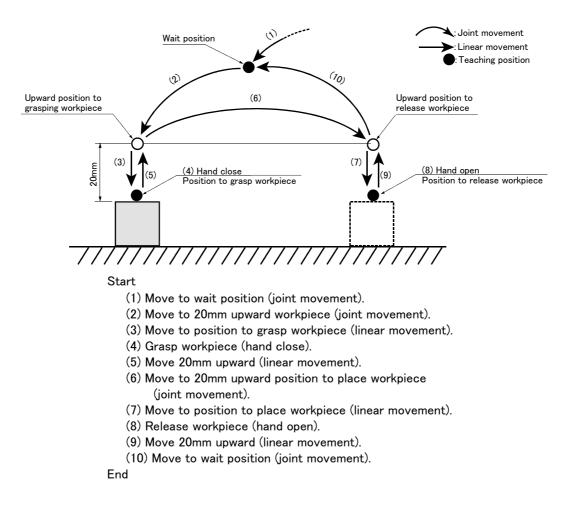
(2) Robot work

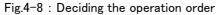
Assume that the robot is going to carry the workpiece from the left to the right.



4.7.1 Creating the program

(1) Deciding the operation order



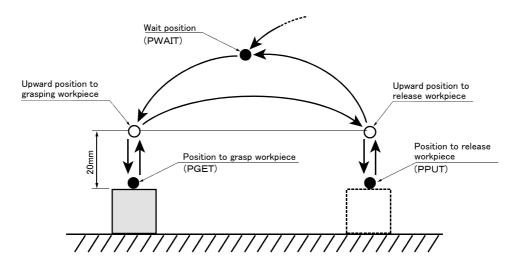


$\diamond igodsim \diamond \diamond$ Joint movement and linear movement $\diamond igodsim \diamond$

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.4-9 : Deciding the operation position name

$\diamond \blacklozenge \diamond$ Teaching the operation position $\diamond \blacklozenge \diamond$

The operation position does not necessarily need to be taught.

The positions shown with white circles in Fig. 4-9 can be designated with commands as "position 20mm away from target position". Refer to "(3) Describing and creating the program" on page 35.

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

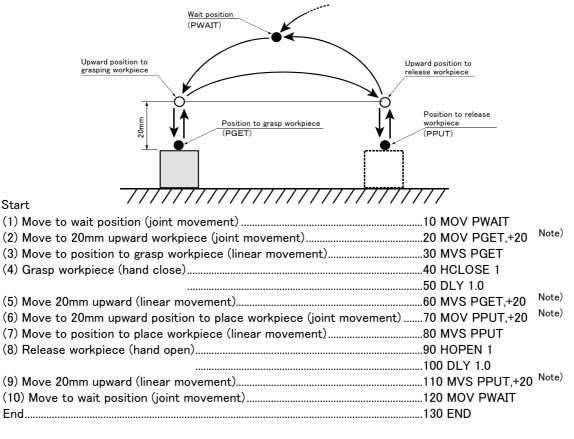
Convert the target robot operations and work into commands.

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

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 PWAIT	
		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		

Table 4-2 : Commands used

Program the converted commands



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

Fig.4-10 : Describing the program

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. $\diamond \blacklozenge \diamond$ Program format $\diamond \blacklozenge \diamond$

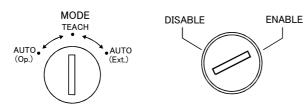
The program format is configured of the "line No. command parameter affixed to command" as shown in Fig. 4-10. Example) <u>10</u> <u>MOV</u> <u>PWAIT</u>

Line No. Command Parameter affixed to command

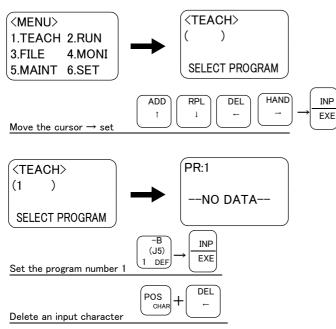
The program is executed in order from the line No. with the smallest number.

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

Preparing the T/B



Opening the program editing screen



- 1) Set the controller [MODE] switch to "TEACH".
- 2) Set the T/B [ENABLE/DISABLE] switch to "ENABLE".
- 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.
- Press the [1] → [INP] keys. The program No. 1 editing screen will appear.

$\Diamond \blacklozenge \diamondsuit$ Using the T/B $\Diamond \blacklozenge \diamondsuit$

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".

$\diamond \blacklozenge \diamond$ Inputting numbers and spaces $\diamond \blacklozenge \diamond$

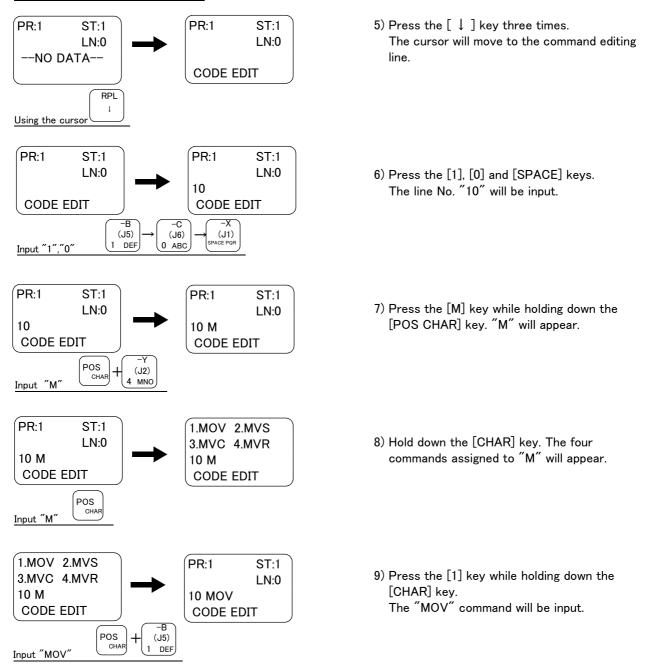
To input a number, press the key having a number on the lower left.

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

$\diamond \blacklozenge \diamond$ Correcting incorrect numbers $\diamond \blacklozenge \diamond$

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 [\leftarrow] key, and a character is input, it will be inserted.

Input the program 10 MOV PWAIT



$\diamond \blacklozenge \diamond$ Inputting characters $\diamond \blacklozenge \diamond$

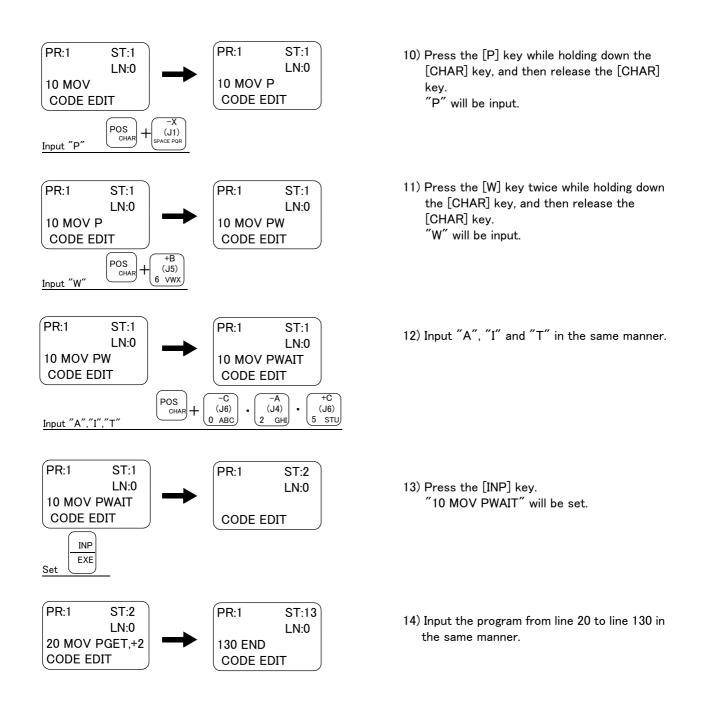
The characters that can be input are indicated, three in a group, on the lower right of each key. To input a character, hold down the [CHAR] key and press the key having the character to be input. Each time the corresponding character key is pressed while the [CHAR] key is pressed, the three characters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

Release the [CHAR] key when the target character appears, and set the character.

$\diamond \blacklozenge \diamond$ Inputting commands $\diamond \blacklozenge \diamond$

The commands can be input one character at a time (ex., for " $M' \rightarrow "O'' \rightarrow "V''$ 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 commanc If the target command is not found in the list, press the [CHAR] key again to update the list.



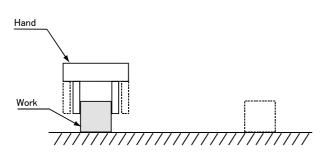
This completes the inputting of the program.

♦♦ 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.

$\diamond \blacklozenge \diamond$ Displaying a specific line $\diamond \blacklozenge \diamond$

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

Teach the robot operation position. Set the position with jog operation (Teaching PGET)



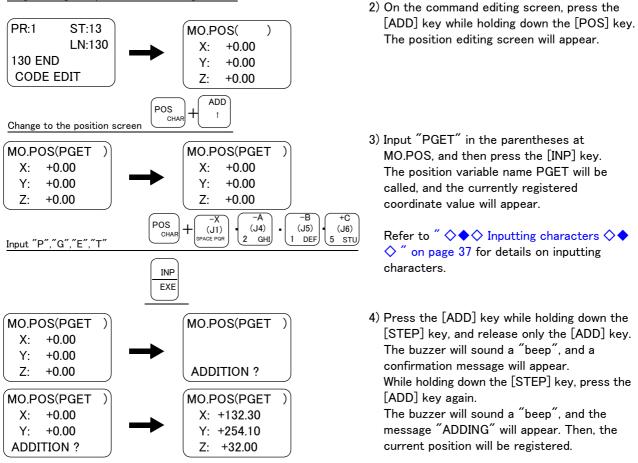
 Move the robot with jog operation, and set the end of the hand to the position for grasping the workpiece. When the position has been set, open and close the hand to confirm that the workpiece can be grasped. Refer to "4.5 Jog operation" on page 31 for details on the jog operation, and section "4.6 Opening and closing the hand" on page 31 for detains on opening and closing the hand.

$\diamond \blacklozenge \diamond$ Effective use of jog mode $\diamond \blacklozenge \diamond$

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.

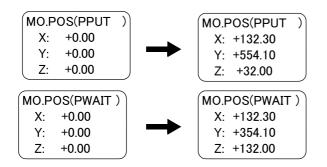
If the target position is nearby, move linearly with the "XYZ JOG mode", and finely adjust the position. The position can be set accurately by delaying the override (operation speed) at this time.

Registering the position (Teaching PGET)



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.

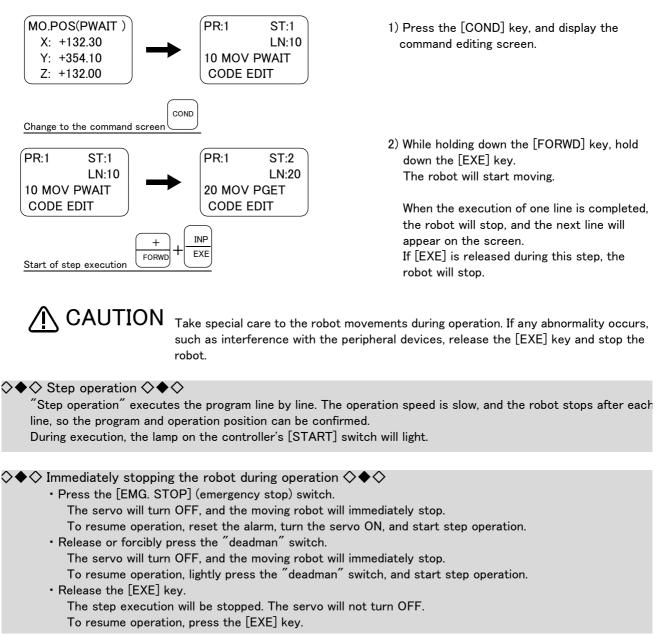


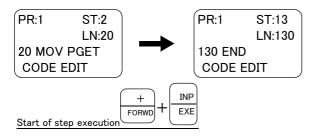
5) Teach PPUT (position to place workpiece) and PWAIT (wait position) in the same manner.

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.

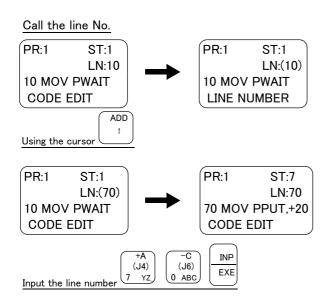




(5) Correcting the program

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 [\uparrow] 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.

 $\diamond \blacklozenge \diamond$ Cursor movement $\diamond \blacklozenge \diamond$

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.

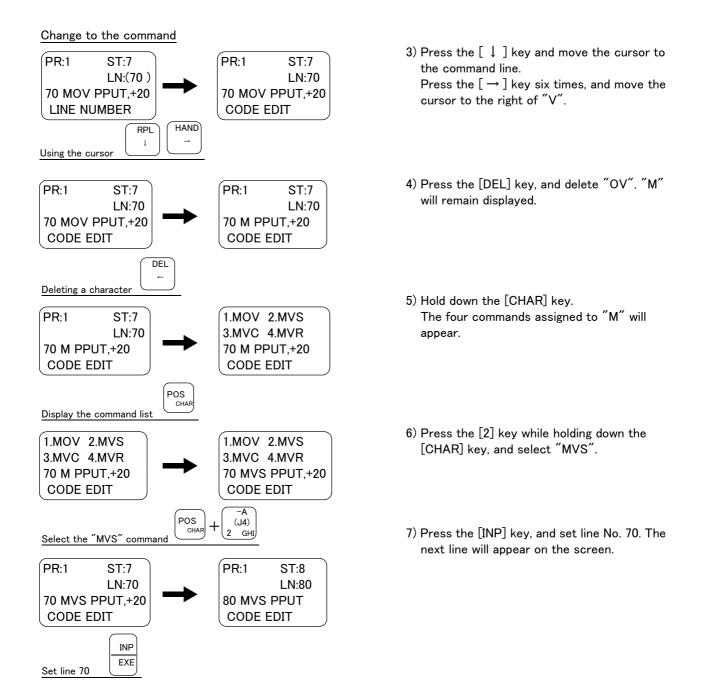
The cursor is moved with the [\uparrow], [\downarrow], [\leftarrow] and [\rightarrow] keys.

$\diamond \blacklozenge \diamond$ Calling out a line No. $\diamond \blacklozenge \diamond$

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.

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.



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

$\diamond \blacklozenge \diamond$ Correcting a character $\diamond \blacklozenge \diamond$

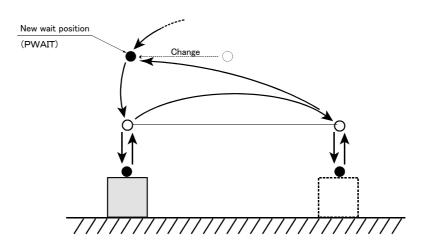
Move the cursor to the right of the incorrect character, and press the [DEL] key to delete in the left direction. Then, input the correct character. The input character will be inserted at the cursor position. If the cursor is returned by pressing the [\leftarrow] key, and a character is input, it will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

$\diamond \blacklozenge \diamond$ After correcting a program $\diamond \blacklozenge \diamond$

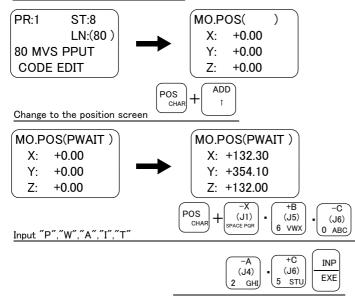
After correcting the program, carry out step operation, and confirm that the program has been corrected.

Correcting the taught position

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



Change the movement position



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

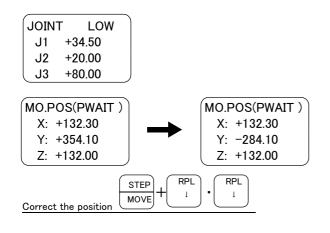
The position editing screen will appear.

 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.

$\diamond \blacklozenge \diamond$ Calling out a position variable $\diamond \blacklozenge \diamond$

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.



This completes correction of the wait position.

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.

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

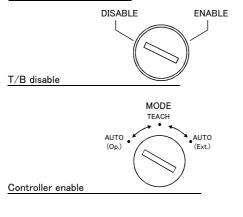
(6) Start automatic operation.



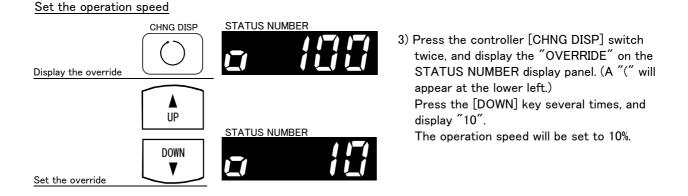
Before starting automatic operation, always confirm the following item. Starting automatic operation without confirming these items could lead to property damage or physical injury.

- 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.
- $\boldsymbol{\cdot}$ 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

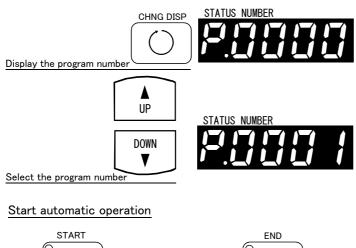


- 1) Set the T/B [ENABLE/DISABLE] switch to "DISABLE".
- Set the controller [MODE] switch to "AUTO (Op.)".



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.

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.

 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. 4-7Example of work" on page 32, 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.



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



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

$\diamond \blacklozenge \diamond$ Operating from the controller $\diamond \blacklozenge \diamond$

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.)".

$\diamond \blacklozenge \diamond$ Operation speed $\diamond \blacklozenge \diamond$

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 " \Box " 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.

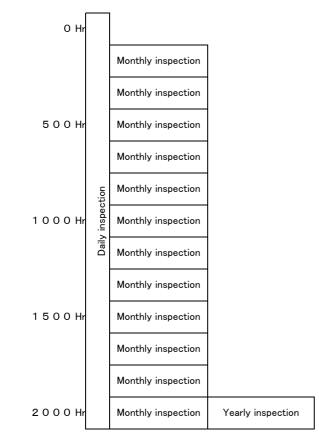
5 Maintenance and Inspection

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



Operating time

<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.

Procedure	Inspection items (details)	Remedies
Before turn	ing the power ON (Check the following inspection items before turning the	e 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 turnin	g 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 oper	ation (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.

Table 5-1 : Daily inspection items (details)

5.2.2 Periodic inspections

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

Table 5-2	•	Periodic	inspection	items	(details)
			mopeouon	rcomo	(uccuns)

Procedure	Procedure Inspection items (details) Remedies						
Monthly inspection items							
1	1 Are any of the connector fixing screws or terminal block terminal screws loose? Securely tighten the screws.						
Yearly inspection items							
1	Replace the backup battery in the controller.	Exchange it referring to $5.3.1$ Replacing the battery" on page 49.					

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.

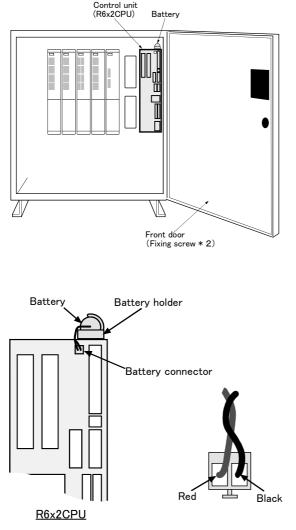
5.3.1 Replacing the battery



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.

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.

<CR4-533M、CR4-533CA、CR4-533CB、CR7-533CB>



<CR8-533M>

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

Front door (Fixing screw * 2)

- Wait at least fifteen minutes after turning the power OFF, then loosen the fixing screws on the controller front door, and open the front door. The battery is on the R6CPU.
- 3) Hold and pull out the old battery connector, and remove from the battery holder.
- Install the new battery into the battery holder. Install so that the lead line come to the front.
- 5) Connect the new battery cable connector to the connector removed in step "3)". Connect so that the red lead line is at the left.
 Connect the new battery within 15 minutes of removing the old battery.
- 6) Close the controller's front door, and fix with the fixing screws.
- 7) Initialize the battery consumption time. Always carry out this step after replacing the battery, and initialize the battery usage time. Refer to the separate "Instruction Manual/Detailed Explanation of Functions and Operations" for details on the initialization methods.

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 Mit-subishi-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	Туре	Qty.	Usage section	Maker
1	Lithium battery	ER6 BKO-NC2157H01	1	Control unit	Mitsubishi Electric

No.	Part name	Туре	Qty.	Usage section	Maker
1	Fuse	LM16	3		
2		LM05	2		
3		LM32	8	Control unit	Mitsubishi Electric
4		LM16	1		
5		HM32	2		

Table 5-4 : Controller spare part list



HEAD OFFICE : MITSUBISHI DENKI BLDG MARUNOUCHI TOKYO 100-8310 TELEX : J24532 CABLE MELCO TOKYO NAGOYA WORKS : 1-14, YADA-MINAMI 5, HIGASHI-KU, NAGOYA, JAPAN