MELFA

Industrial Robots

Instruction Manual
(Setup, Basic Operation, Maintenance)

CR3
Controller

Art. no.: 160278
10 10 2003
Version A
BFP-A8324

Supplemental Instruction
(For CE specification: CR3-535M-S12)

Thank you for purchasing the Mitsubishi Industrial Robot MELFA Series. This document additionally explains to the Mitsubishi Industrial Robot "CR3 Controller INSTRUCTION MANUAL/ Controller setup, basic operation, and maintenance" (BFP-A8324).
Therefore, check the content, and use it together with your instruction manual.

Supplemental details
In the case of CE specification, the transformer box has been installed in the bottom of the controller. For this reason, mass is approx. 135kg. The transport method is shown below.

P2-6　2.2.2 Transportation procedures “Fig.2-1：Transporting the controller”

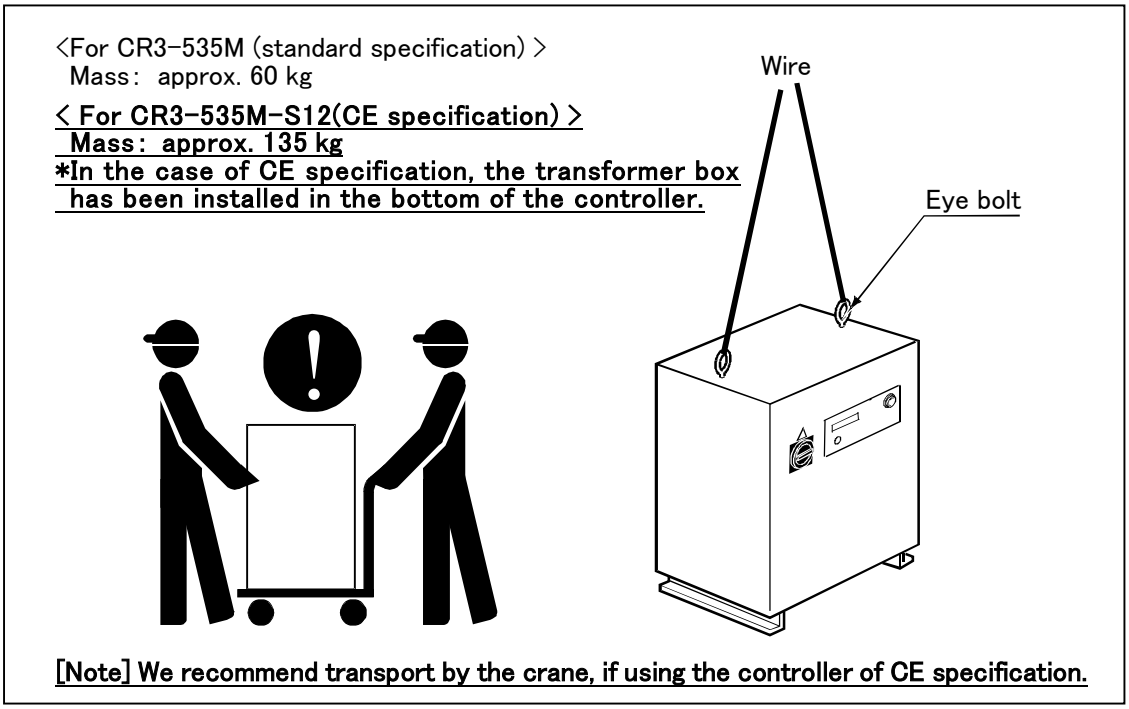

Fig.2-1：Transporting the controller

⚠ 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.
⚠ 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.

Revision history

Date of print	Specifications No.	Details of revisions
2003-10-10	BFP-A8324	・First print.

■ 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."

・No part of this manual may be reproduced by any means or in any form, without prior consent from Mitsubishi.
・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.

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.
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.

⚠ 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.

⚠ 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
1	Controller	CR3-535M	1 units	With machine cable.
2	Safety Manual	BFP-A8006	1 copy	
3	Standard Specifications	BFP-A8322	1 of these copy	RV-6S series type. (CR3-535M/CR2B-574 controller)
		BFP-A8320		RV-12S series type. (CR3-535M controller)
4	Instruction Manual (Robot arm setup and maintenance)	BFP-A8323	1 of these copy	RV-6S series type. (CR3-535M/CR2B-574 controller)
		BFP-A8321		RV-12S series type. (CR3-535M controller)
5	Instruction Manual (Controller setup, basic operation and maintenance)	BFP-A8324	1 copy	This book
6	Instruction Manual (Detailed explanations of functions and operations)	BFP-A5992	1 copy	
7	Instruction Manual (Troubleshooting)	BFP-A5993	1 copy	
8	Guarantee Card		1 copy	

2.2 Installation

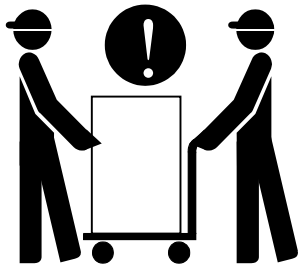
2.2.1 Unpacking procedures

The controller is shipped from the factory packaged in cardboard.

2.2.2 Transportation procedures

The following shows how to transport the controller.

<CR3-535M> Mass : approx. 60kg



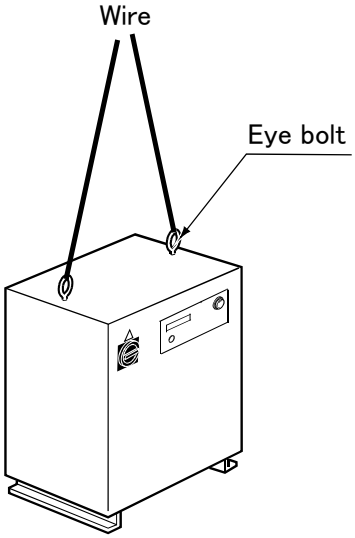
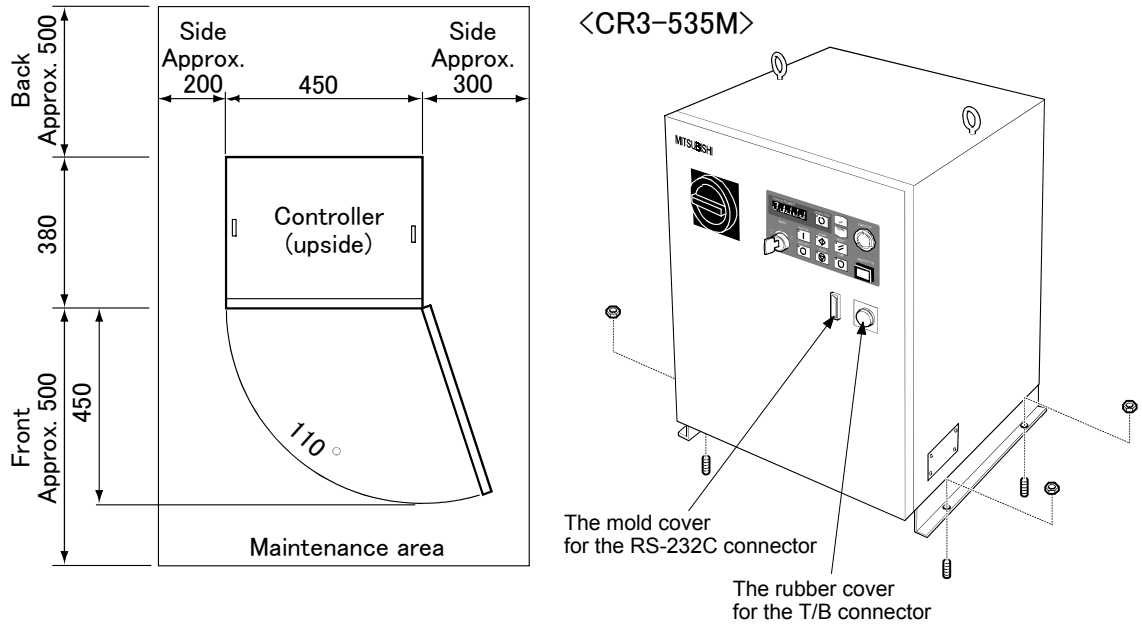


Fig.2-1 : Transporting the controller

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

2.2.3 Installation procedures



(View from upside)

(Anchor bolt installation: 4 places)

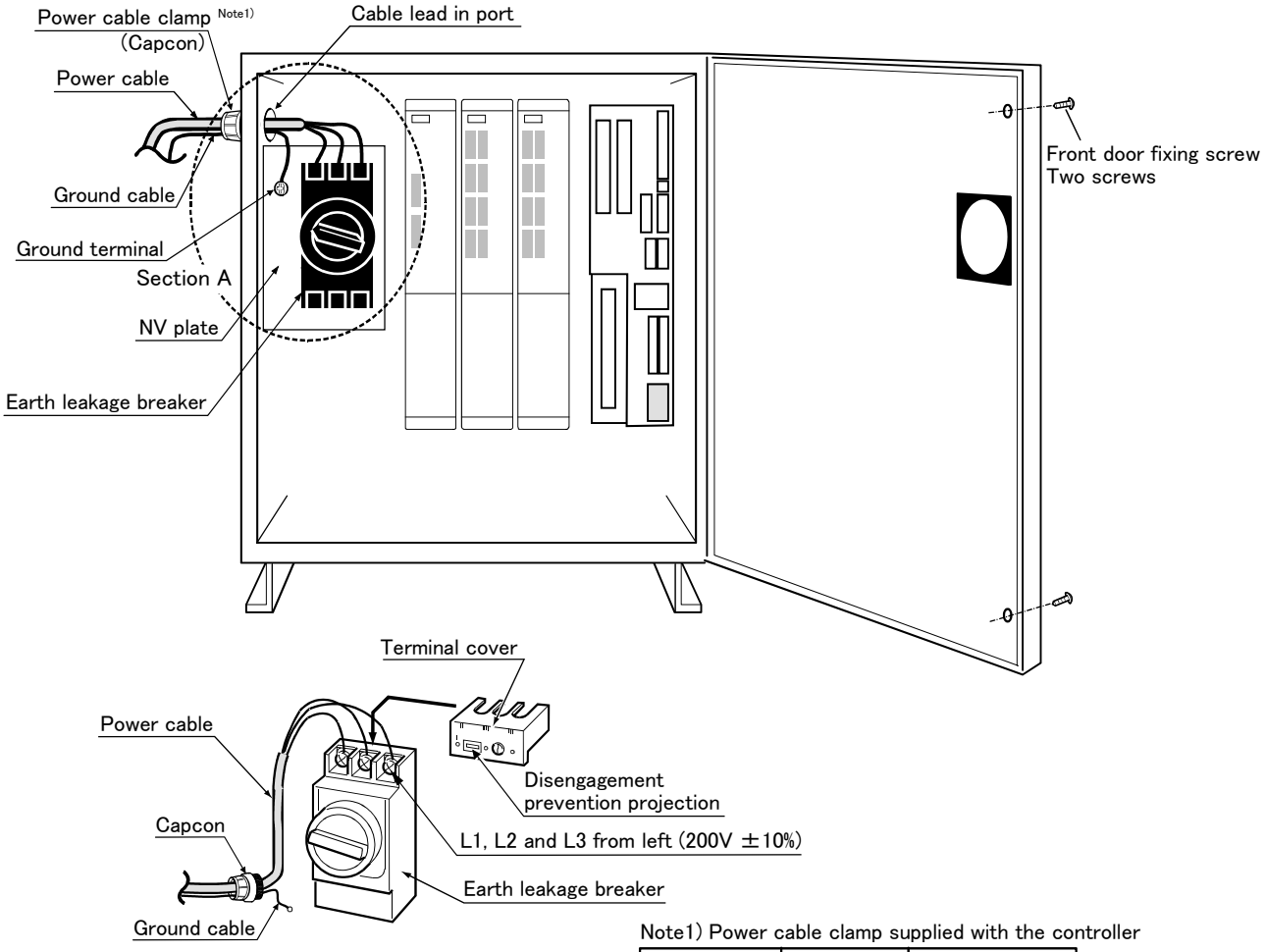
Fig. 2-2 : Installation dimensions

(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.

⚠CAUTION Install the rubber cover for the T/B connector when the T/B un-connection.
In the same way, install the mold cover for the RS-232C connector when the RS-232C cable un-connection. When it is not so, it has the possibility that the controller breaks down due to the penetration such as oil.

2.2.4 Connecting the power cable and grounding cable

The following shows how to connect the power and grounding cables.



(a) Details of section A

Note1) Power cable clamp supplied with the controller

Part name	Type	Remarks
Capcon	OA-W2216	Waterproof type

Manufactured by OHM ELECTRIC CO., LTD. :
http://www.ohm.co.jp/

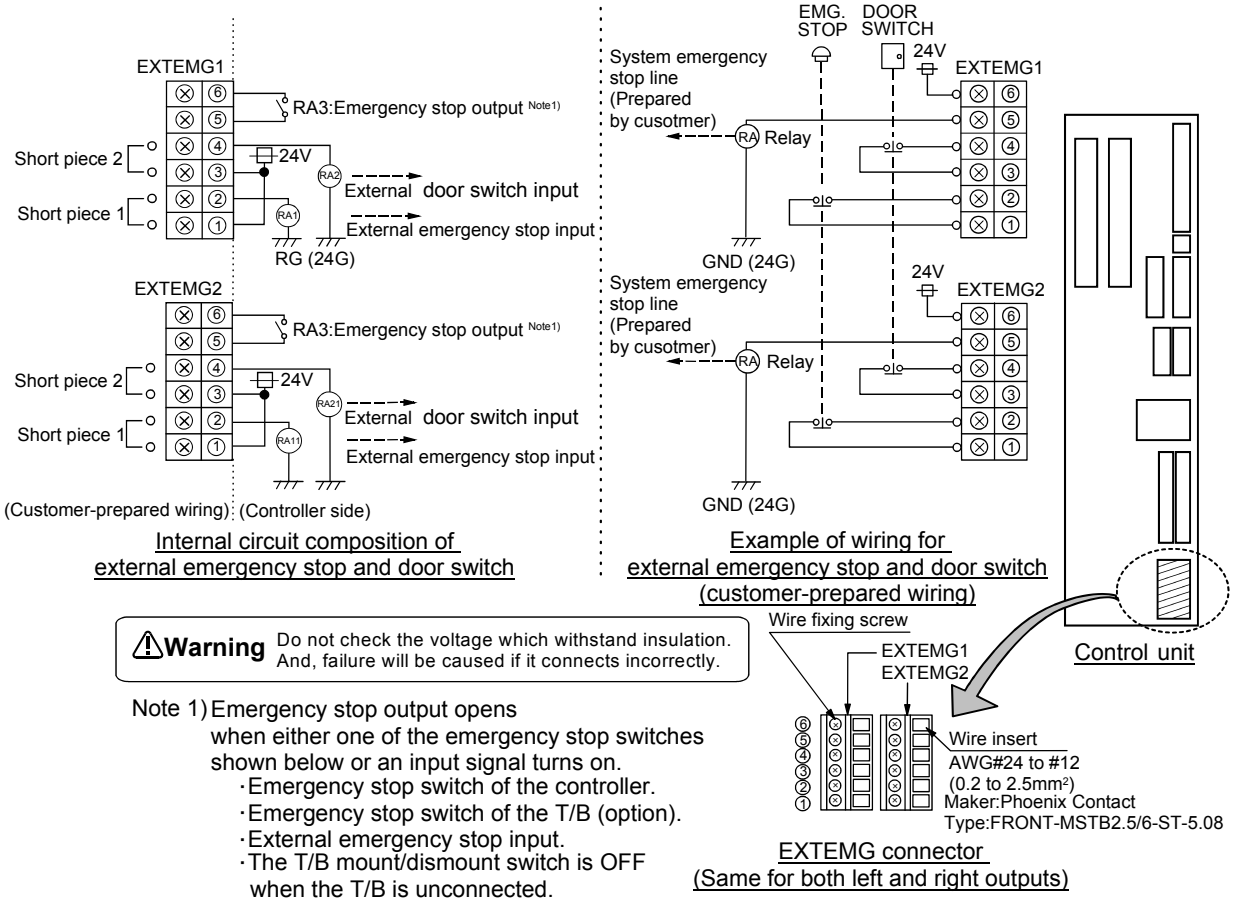
Fig.2-3 : Connecting the power cable and grounding cable

(1) Prepare the power cable and grounding cable (both must be AWG#14(2mm^2) or more thickly).
(2) Loosen the two screws fixing the controller's front door, and open the front door.
(3) Pull out the disengagement prevention projection on the terminal cover surface of the earth leakage breaker by disengaging it with your finger.
(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 both the power cable and ground cable from the cable inlet hole located on the side of the controller, and fix them using a power cable clamp (Capcon).
(7) Connect the power cable to the earth leakage breaker terminal (M5 screw). (L1, L2 and L3 from left)
(8) Connect the grounding cable to the NV plate terminal (M5 screw).
(9) Insert the earth leakage breaker 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 of the CR3-535M controller.

2.2.5 Connecting the external emergency stop

The following shows how to connect the external emergency stop.



⚠Warning Do not check the voltage which withstand insulation. And, failure will be caused if it connects incorrectly.

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 of the T/B (option).
- ·External emergency stop input.
- ·The T/B mount/dismount switch is OFF when the T/B is unconnected.

Fig.2-4 : 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. 2-4.
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.

[Caution] When wiring the emergency stop switch (duble emergency line type), wire both contacts to the two terminal blocks on the controller. If both contacts are wired to only one of the terminal blocks, errors cannot be cancelled using the door switch.

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. 2-5 shows an example of its circuit, and Fig. 2-6 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.

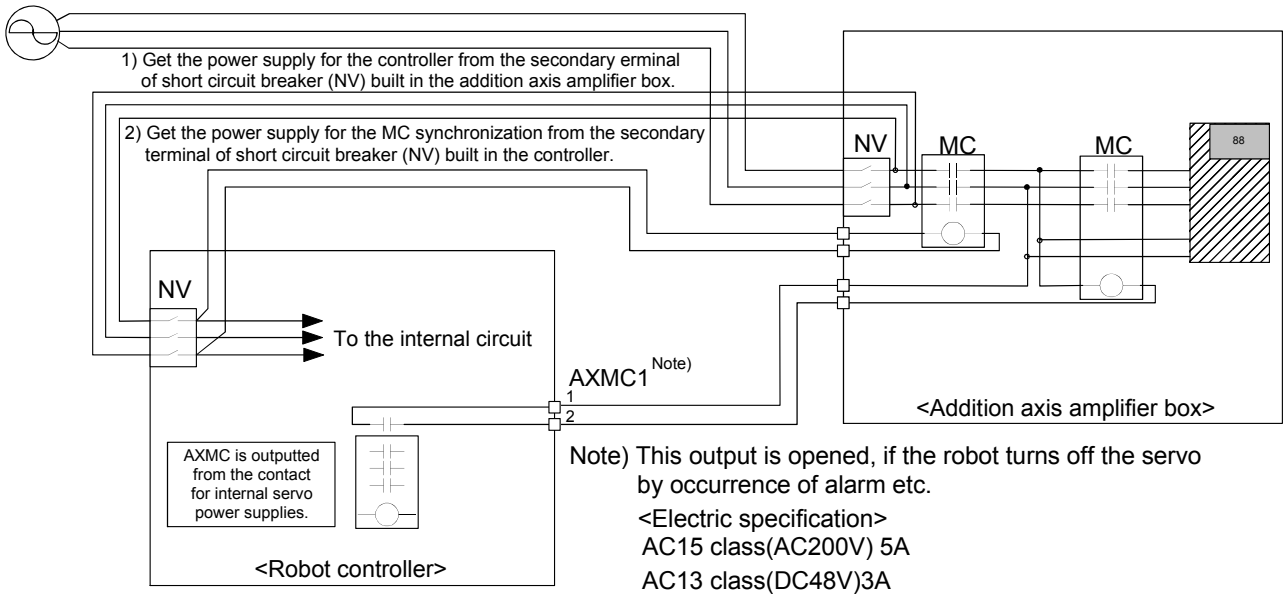


Fig.2-5 : Example of circuit for addition axes of MC control output.

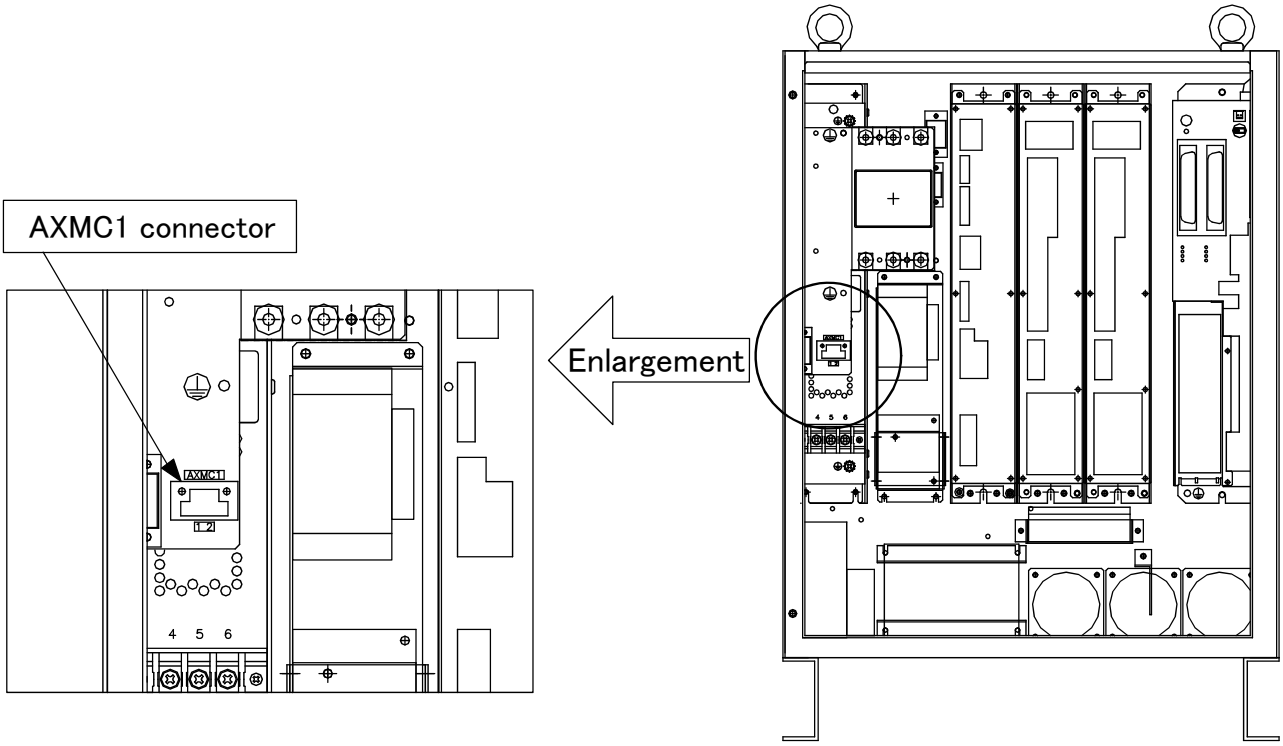


Fig.2-6 : Arrangement figure of the AXMC1 connector.

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 18 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 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.

⚠CAUTION Confirm that the controller's main power supply and controller power switch are OFF before starting this work. Wait at least 3 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 three 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)

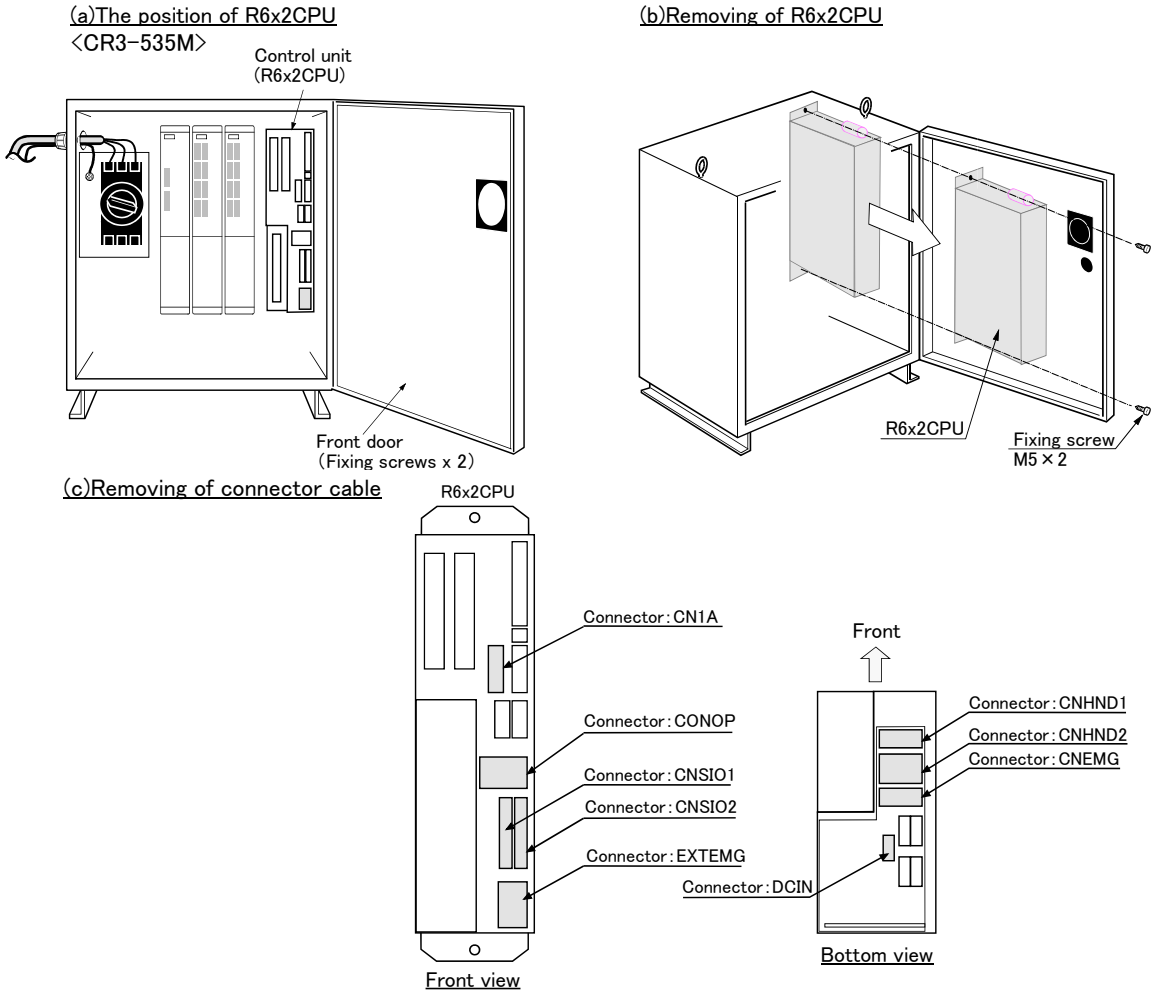
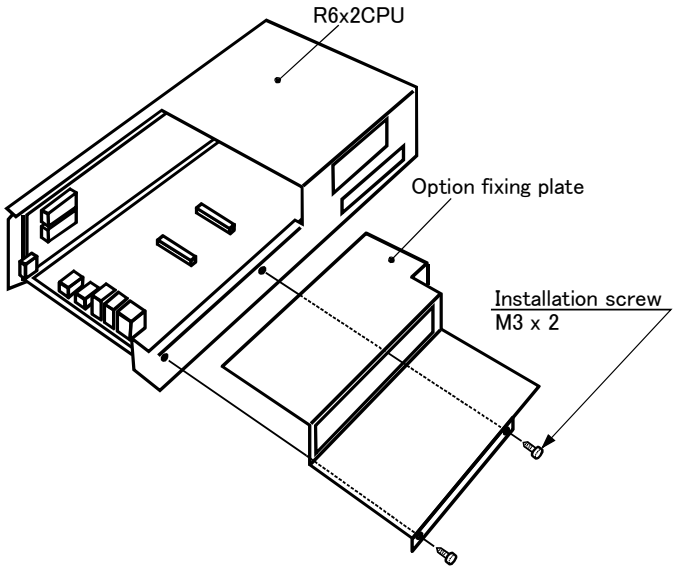
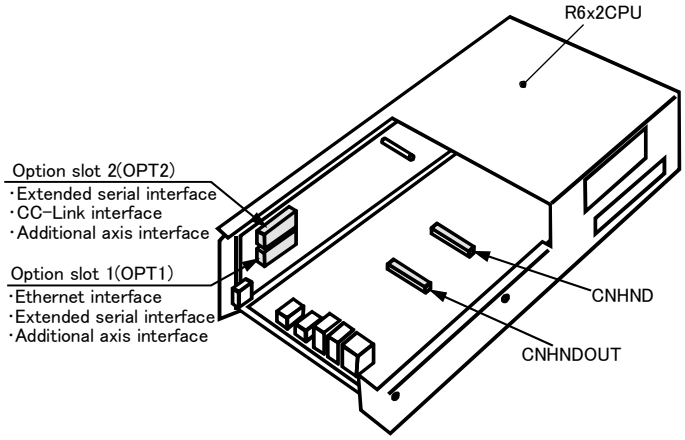


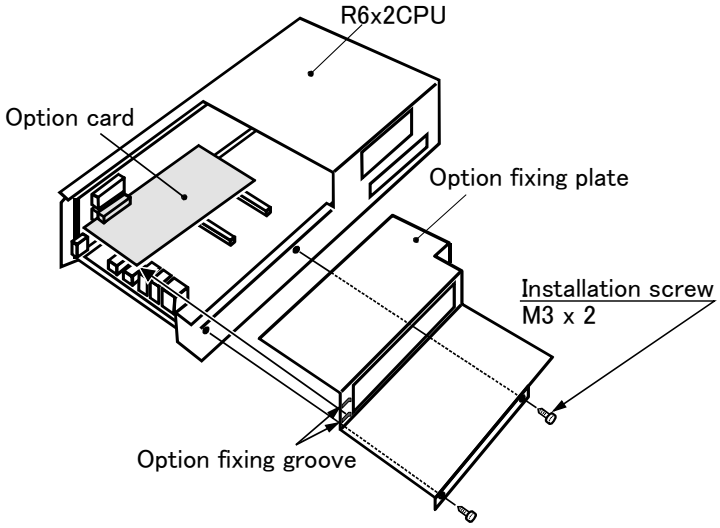
Fig.3-1 : Removing the R6x2CPU



(4) Remove the two 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.



(6) Install the option fixing plate, removed in step "(4)", 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.

(7) Install the R6x2CPU onto the controller.
Connect the connectors 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 of the CR3-535M controller.

3.2 The procedures for installing the pneumatic hand interface

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

⚠CAUTION 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.

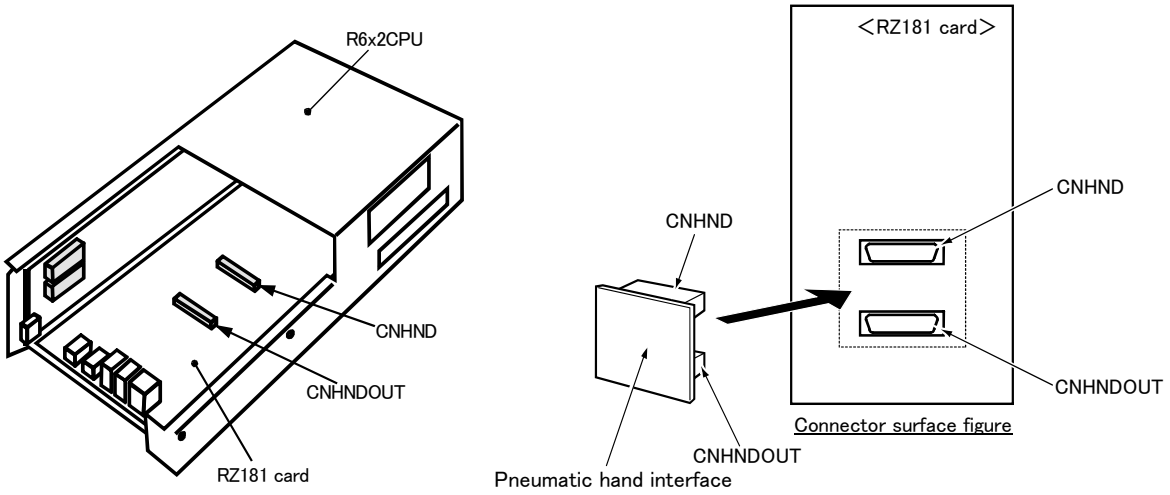


Fig.3-2 : Installing the pneumatic hand interface

(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

<CR3-535M>

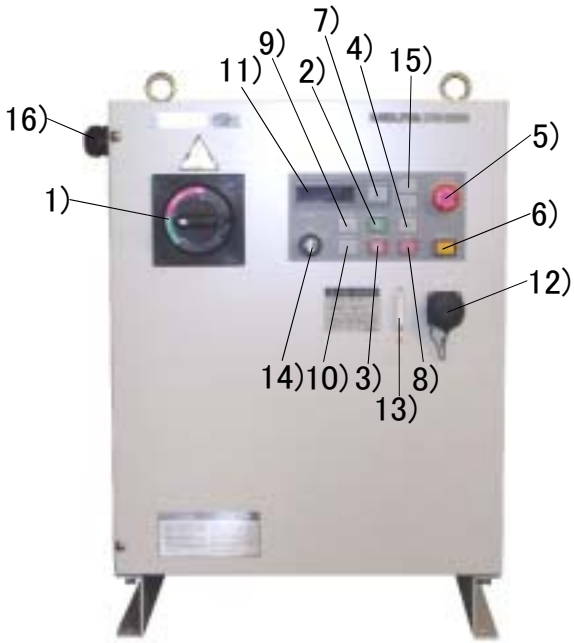


Fig.4-1 : Names of controller parts

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.
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. 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.
16) Power cable clamp ..... Fix the primary power cable.

⚠ CAUTION

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 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

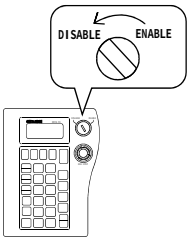
4.2.1 Installing and removing the T/B

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.

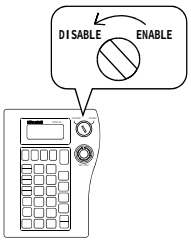
(2) Removing with the control power ON



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

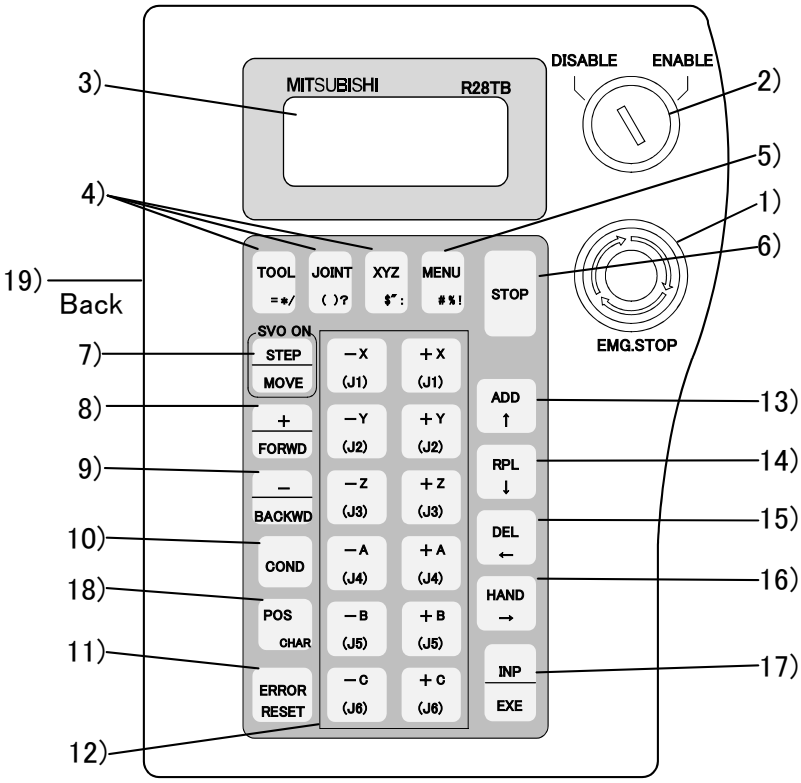


Fig.4-2 : Teaching pendant (Front side of R28TB)

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.

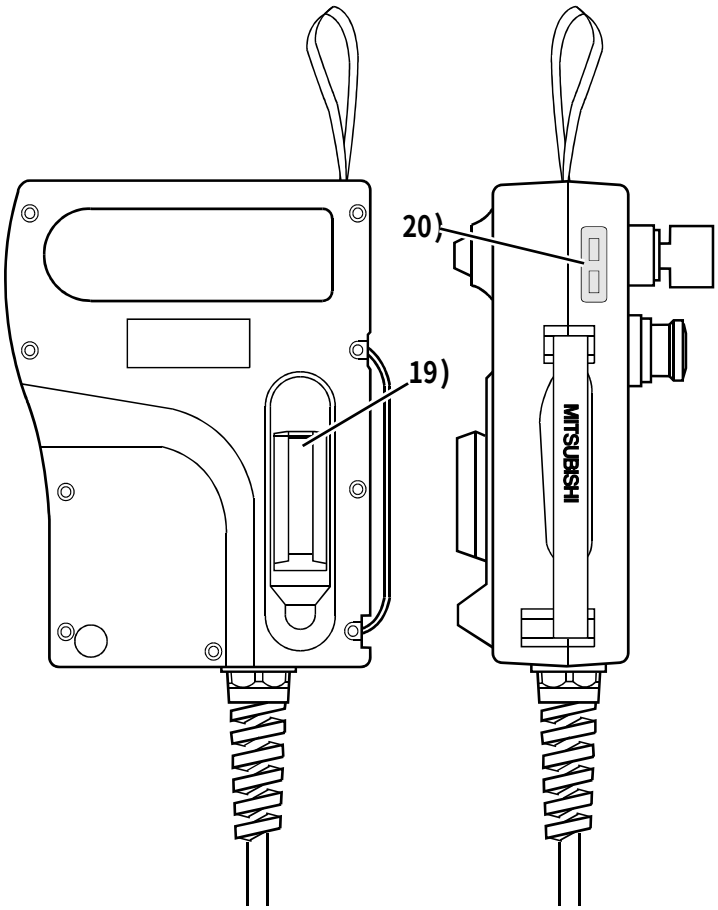
7) [STEP/MOVE] key
Jog operations are possible when this key is pressed simultaneously with the 12) jog operation key. Step jump is carried out when pressed simultaneously with the [INP/EXE] key. This also turns the servo ON.

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 ◇◆◇

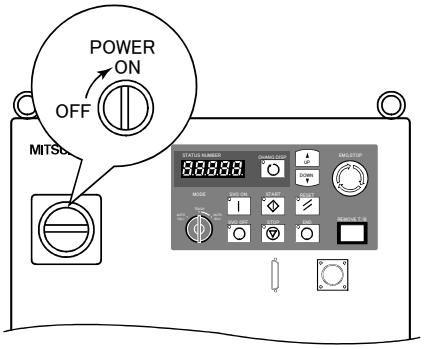
Installed the protection seal on the teaching pendant to prevent the damage of the display LCD and the key seat when shipping. Remove the protection seal when using. The operation of the key and the confirmation of the display is possible without removing the protection seal, however the adhesive may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

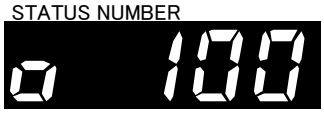
4.3 Turning the power ON and OFF

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.



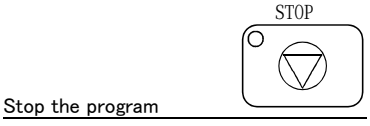


Turn the controller [POWER] switch ON.
" □ . 100" will appear on the STATUS NUMBER display.
This completes the turning ON of the control power.

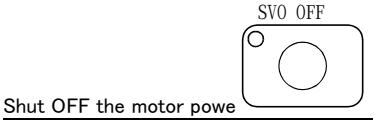
◇◆◇ What is the main power, control power and servo power? ◇◆◇

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.



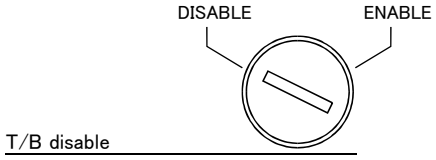
2) After the robot has stopped, press the controller [SVO OFF] switch, and turn the servo OFF.

3) Turn the controller [POWER] switch OFF.

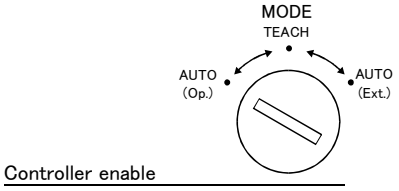
The control power will be shut OFF.

4.4 Turning the servo power ON/OFF

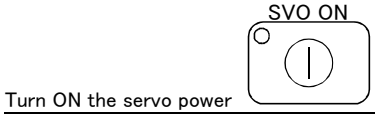
4.4.1 Turning the servo power ON (servo ON)



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



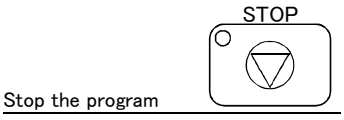
2) Confirm that the [MODE] switch on the front of the controller is set to "TEACH" or "Auto (Op.)".



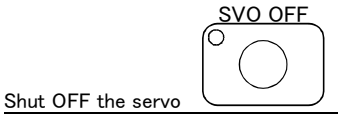
3) Press the [SVO ON] switch on the front of the controller.
The switch's lamp will light indicating that the servo is ON.

⚠ 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 ◇◆◇

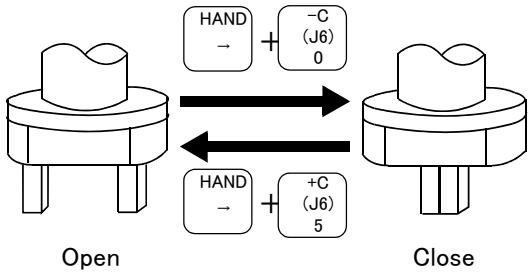
This operation does not require the operation rights, so the servo can be turned OFF at any time by pressing the [SVO OFF] switch.

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

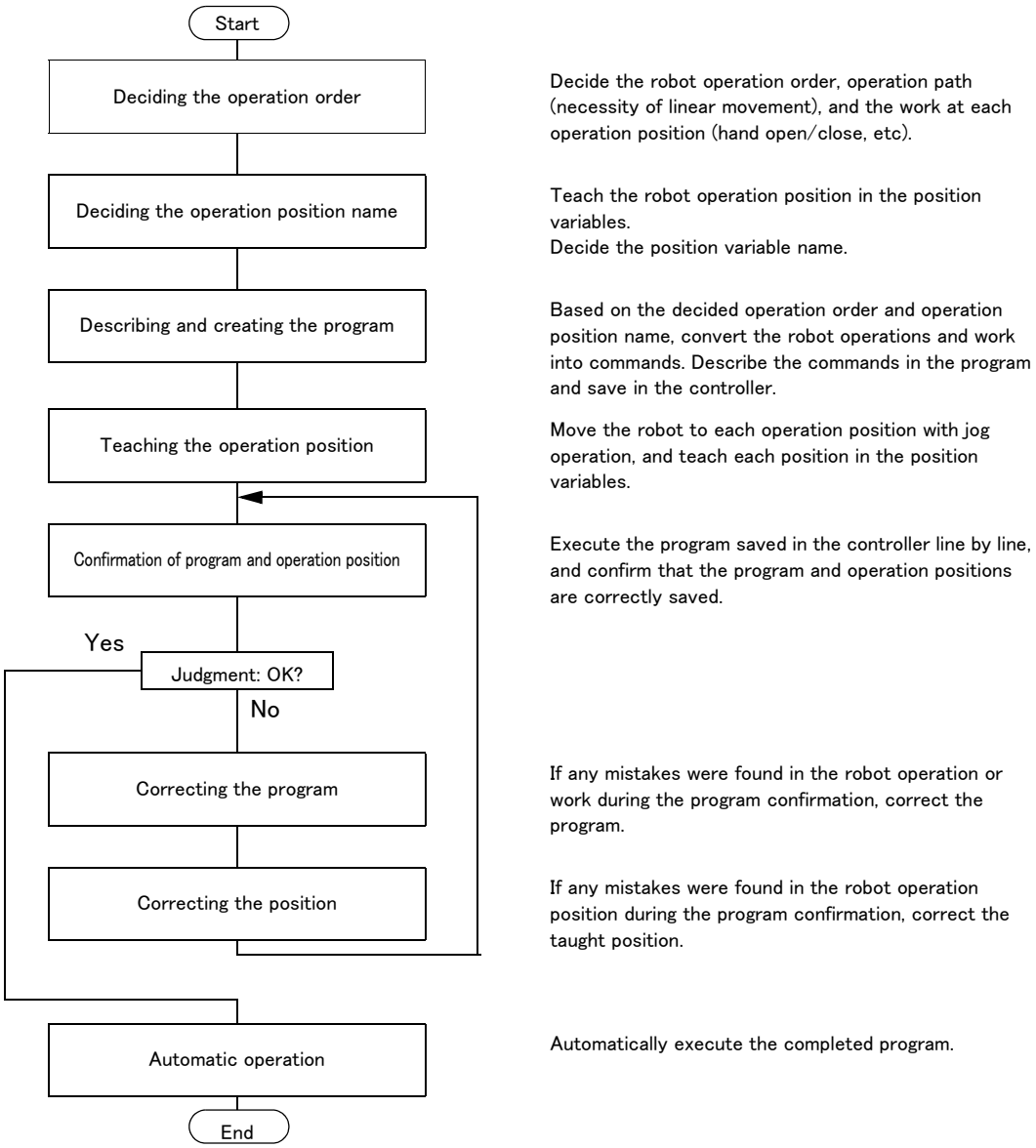


Fig.4-4 : Program creation procedures

(2) Robot work

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

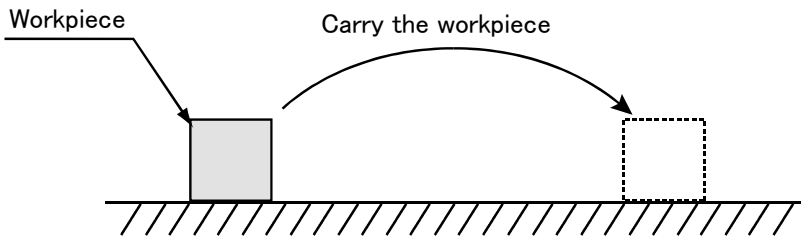
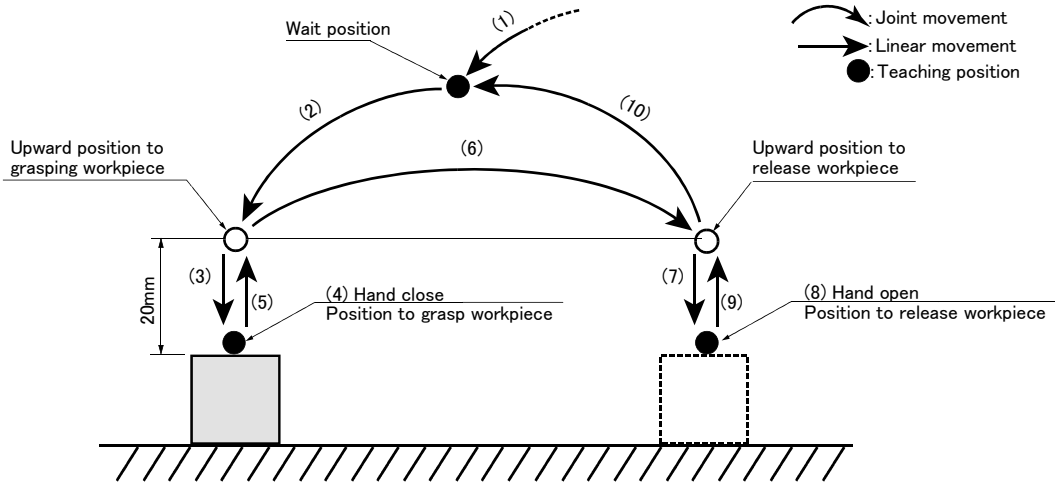


Fig.4-5 : Example of work

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 place workpiece (joint movement).
(7) Move to position to place workpiece (linear movement).
(8) Release workpiece (hand open).
(9) Move 20mm upward (linear movement).
(10) Move to wait position (joint movement).

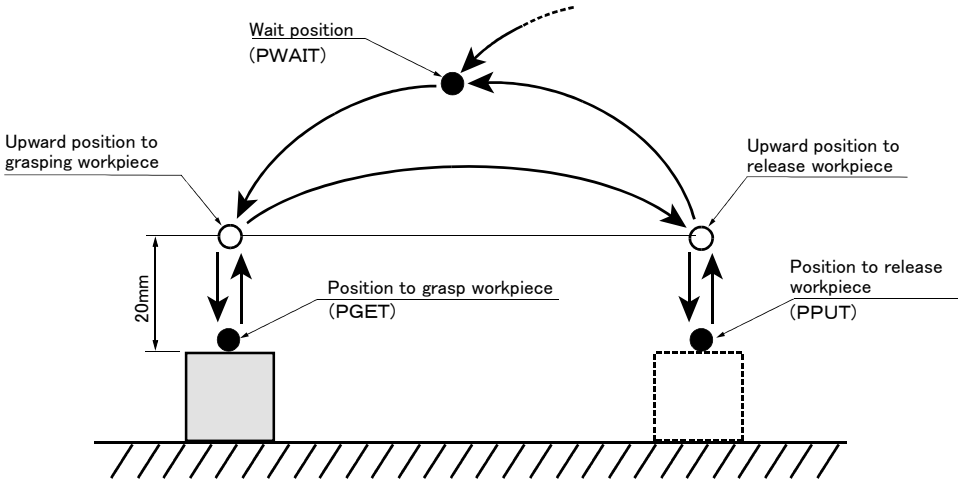
End

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 28.

⚠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

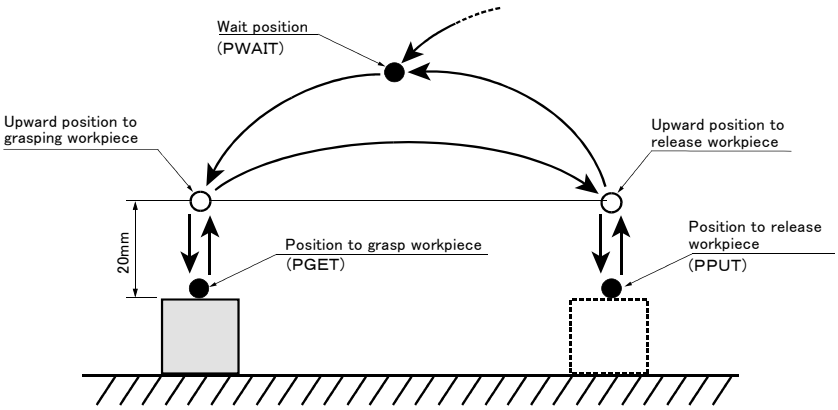
(3) Describing and creating the program

■ 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 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

■ 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
.....50 DLY 1.0
(5) Move 20mm upward (linear movement) .....60 MVS PGET,+20 Note)
(6) Move to 20mm upward position to place workpiece (joint movement) .....70 MOV PPUT,+20 Note)
(7) Move to position to place workpiece (linear movement) .....80 MVS PPUT
(8) Release workpiece (hand open) .....90 HOPEN 1
.....100 DLY 1.0
(9) Move 20mm upward (linear movement) .....110 MVS PPUT,+20 Note)
(10) 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.

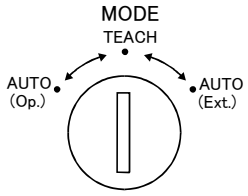
Example) 1 0 M O V P W A I T

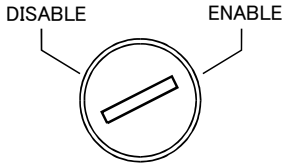
Line No. Command Parameter affixed to command

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.

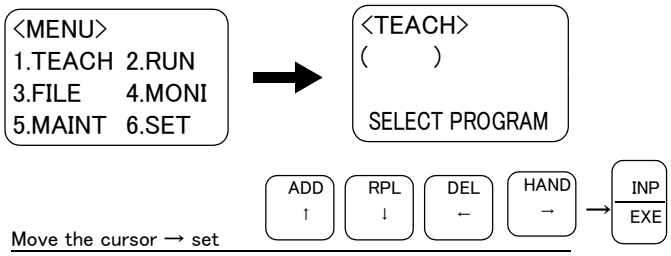
Preparing the T/B



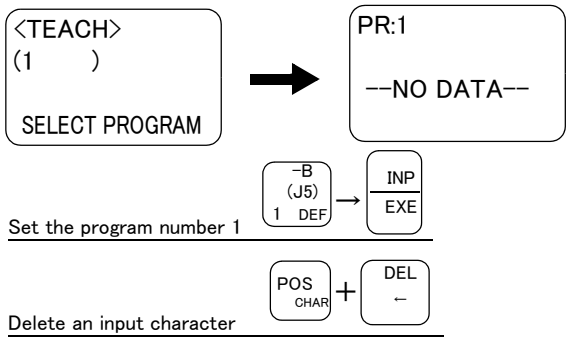


1) Set the controller [MODE] switch to "TEACH".
2) Set the T/B [ENABLE/DISABLE] switch to "ENABLE".

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".

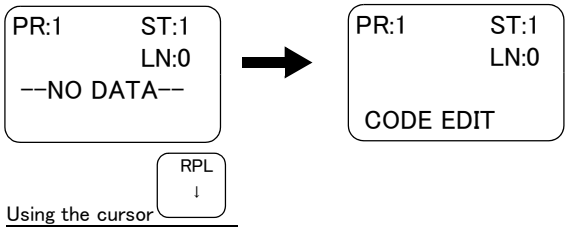
◇◆◇ Inputting numbers and spaces ◇◆◇

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.

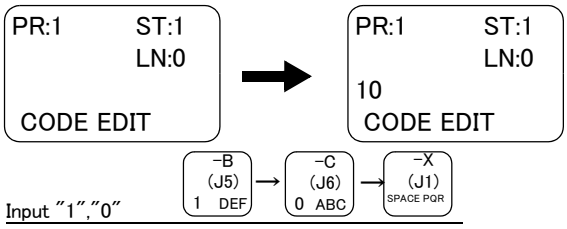
◇◆◇ Correcting incorrect numbers ◇◆◇

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.

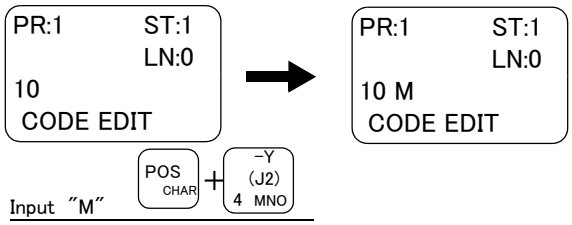
Input the program 10 MOV PWAIT



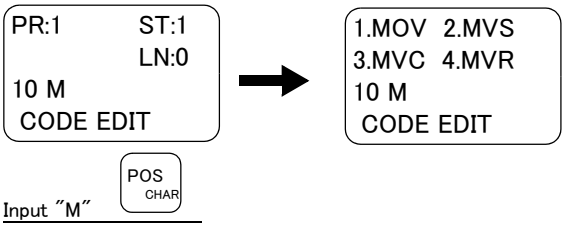
5) Press the [↓] key three times.
The cursor will move to the command editing line.



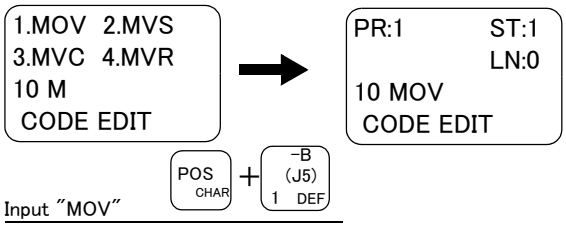
6) Press the [1], [0] and [SPACE] keys.
The line No. "10" will be input.



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.



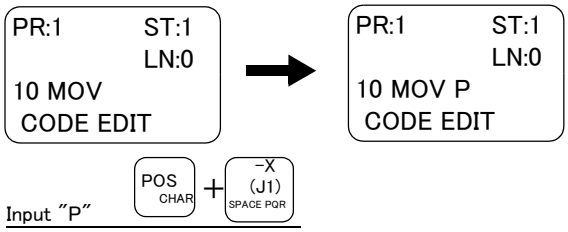
9) Press the [1] key while holding down the [CHAR] key.
The "MOV" command will be input.

◇◆◇ Inputting characters ◇◆◇

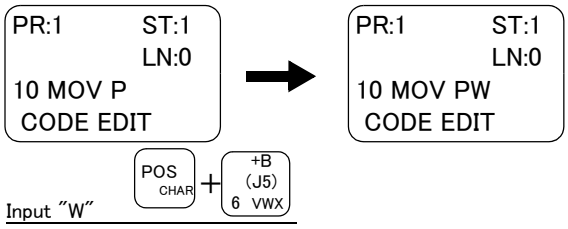
The characters that can be input are indicated, three in a group, on the lower right of each key.
To input a character, hold down the [CHAR] key and press the key having the character to be input. Each time the corresponding character key is pressed while the [CHAR] key is pressed, the three characters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

◇◆◇ Inputting commands ◇◆◇

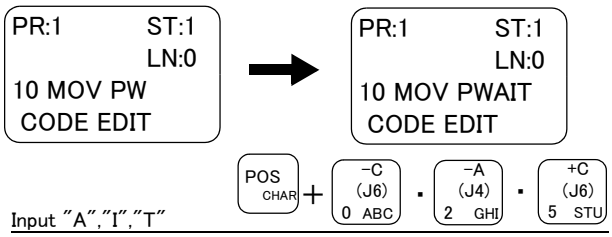
The commands can be input one character at a time (ex., for "M" → "O" → "V" for the MOV command), but if the head character of the command is input, the command can be selected as a number from the list of commands that appears.
After inputting the head character of the command, press the [CHAR] key.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



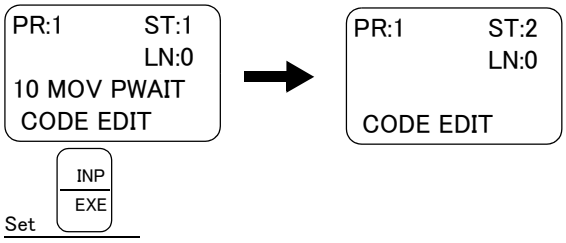
10) Press the [P] key while holding down the [CHAR] key, and then release the [CHAR] key.
"P" will be input.



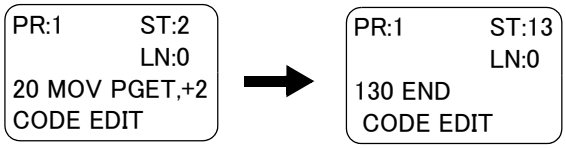
11) Press the [W] key twice while holding down the [CHAR] key, and then release the [CHAR] key.
"W" will be input.



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 ◇◆◇

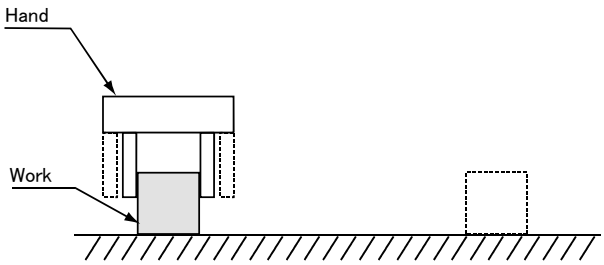
To display the previous line, press the [BACKWD] key, and to display the next line, press the [FORWD] key.

◇◆◇ 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)

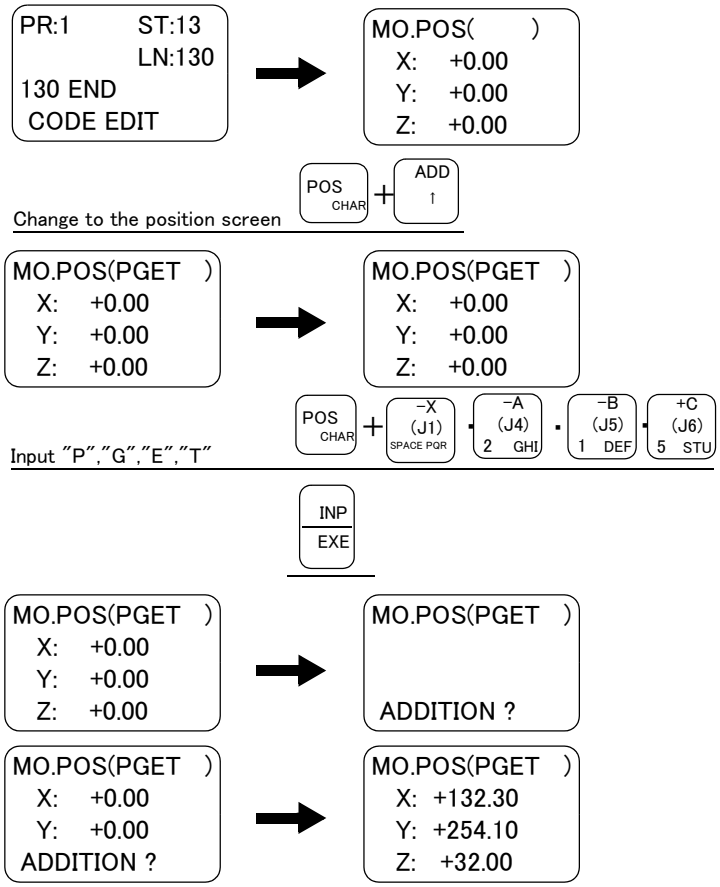


1) Move the robot with jog operation, and set the end of the hand to the position for grasping the workpiece. When the position has been set, open and close the hand to confirm that the workpiece can be grasped. Refer to "4.5 Jog operation" on page 24 for details on the jog operation, and section "4.6 Opening and closing the hand" on page 24 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 30 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.

```
MO.POS(PPUT   )
  X:    +0.00
  Y:    +0.00
  Z:    +0.00
```

→

```
MO.POS(PPUT   )
  X:  +132.30
  Y:  +554.10
  Z:   +32.00
```

```
MO.POS(PWAIT )
  X:    +0.00
  Y:    +0.00
  Z:    +0.00
```

→

```
MO.POS(PWAIT )
  X:  +132.30
  Y:  +354.10
  Z:  +132.00
```

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.

```
MO.POS(PWAIT )
  X:  +132.30
  Y:  +354.10
  Z:  +132.00
```

→

```
PR:1          ST:1
              LN:10
10 MOV PWAIT
 CODE EDIT
```

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

Change to the command screen [COND]

```
PR:1          ST:1
              LN:10
10 MOV PWAIT
 CODE EDIT
```

→

```
PR:1          ST:2
              LN:20
20 MOV PGET
 CODE EDIT
```

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.

Start of step execution [+ FORWD] + [INP EXE]

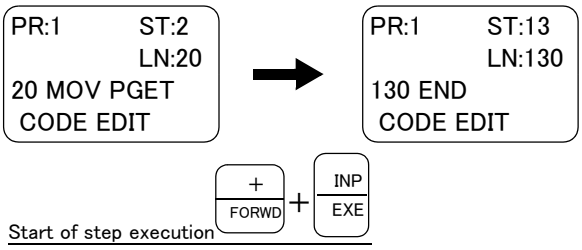
⚠ CAUTION Take special care to the robot movements during operation. If any abnormality occurs, such as interference with the peripheral devices, release the [EXE] key and stop the robot.

◇◆◇ 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.



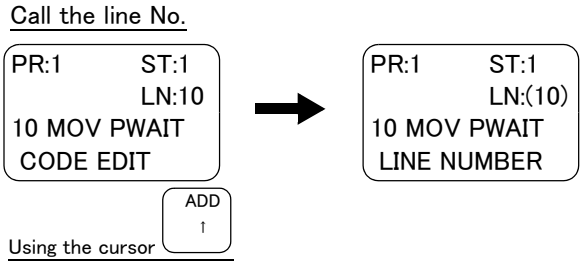
3) Carry out step operation up to the END command at line No. 130, and confirm the operation in the same manner.
If the robot operation or position is incorrect, refer to the following operations and make corrections.

(5) Correcting the program

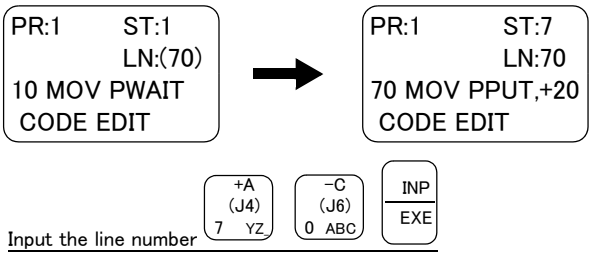
■ Correcting the commands

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

```
PR:1        ST:7
            LN:(70 )
70 MOV PPUT,+20
 LINE NUMBER
```

→

```
PR:1        ST:7
            LN:70
70 MOV PPUT,+20
 CODE EDIT
```

RPL ↓ HAND →

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".

```
PR:1        ST:7
            LN:70
70 MOV PPUT,+20
 CODE EDIT
```

→

```
PR:1        ST:7
            LN:70
70 M PPUT,+20
 CODE EDIT
```

DEL ←

Deleting a character

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

```
PR:1        ST:7
            LN:70
70 M PPUT,+20
 CODE EDIT
```

→

```
1.MOV  2.MVS
3.MVC  4.MVR
70 M PPUT,+20
 CODE EDIT
```

POS CHAR

Display the command list

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

```
1.MOV  2.MVS
3.MVC  4.MVR
70 M PPUT,+20
 CODE EDIT
```

→

```
1.MOV  2.MVS
3.MVC  4.MVR
70 MVS PPUT,+20
 CODE EDIT
```

POS CHAR + −A (J4) 2 GHI

Select the "MVS" command

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

```
PR:1        ST:7
            LN:70
70 MVS PPUT,+20
 CODE EDIT
```

→

```
PR:1        ST:8
            LN:80
80 MVS PPUT
 CODE EDIT
```

INP EXE

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 ◇◆◇

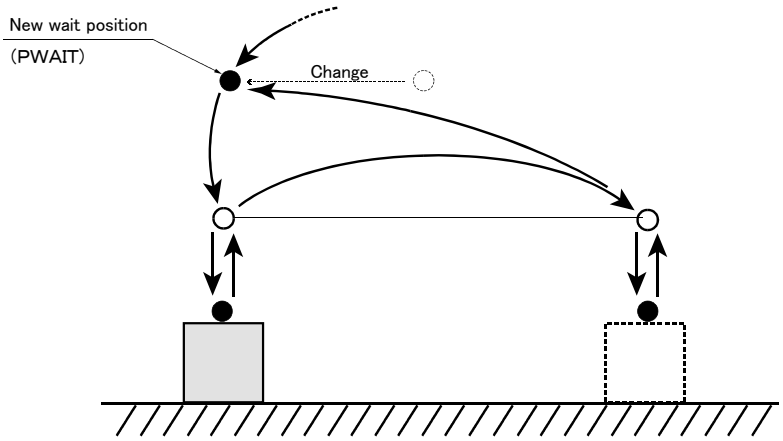
Move the cursor to the right of the incorrect character, and press the [DEL] key to delete in the left direction. Then, input the correct character. The input character will be inserted at the cursor position.
If the cursor is returned by pressing the [←] key, and a character is input, it will be inserted.

◇◆◇ 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

```
PR:1        ST:8
            LN:(80 )
80 MVS PPUT
 CODE EDIT
```

→

```
MO.POS(       )
  X:    +0.00
  Y:    +0.00
  Z:    +0.00
```

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

Change to the position screen

[POS CHAR] + [ADD ↑]

```
MO.POS(PWAIT )
  X:    +0.00
  Y:    +0.00
  Z:    +0.00
```

→

```
MO.POS(PWAIT )
  X:  +132.30
  Y:  +354.10
  Z:  +132.00
```

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.

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

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

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

◇◆◇ 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.

```
JOINT      LOW
 J1    +34.50
 J2    +20.00
 J3    +80.00
```

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

```
MO.POS(PWAIT )
  X:  +132.30
  Y:  +354.10
  Z:  +132.00
```

→

```
MO.POS(PWAIT )
  X:  +132.30
  Y:  -284.10
  Z:  +132.00
```

Correct the position [STEP/MOVE] + [RPL ↓] · [RPL ↓]

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.

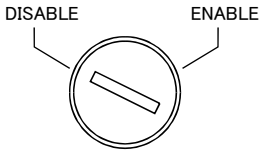
(6) Start automatic operation.

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.

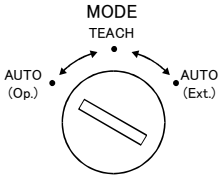
In the following explanation, automatic operation will be carried out with the controller.

Prepare the controller



T/B disable

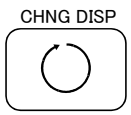
1) Set the T/B [ENABLE/DISABLE] switch to "DISABLE".

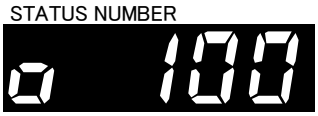


Controller enable

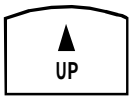
2) Set the controller [MODE] switch to "AUTO (Op.)".

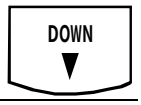
Set the operation speed

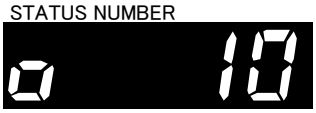




Display the override





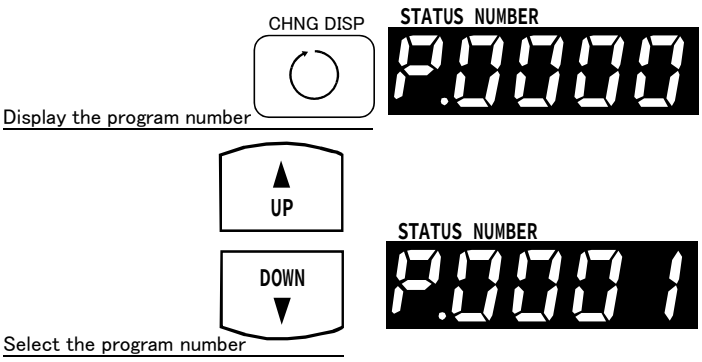


Set the override

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.

Select the program number

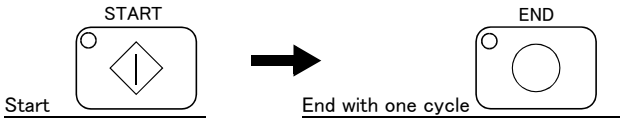


4) Press the [CHNG DISP] switch, and display the "program No." on the STATUS NUMBER display panel. (A "P" will appear at the head.)

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 25, 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.

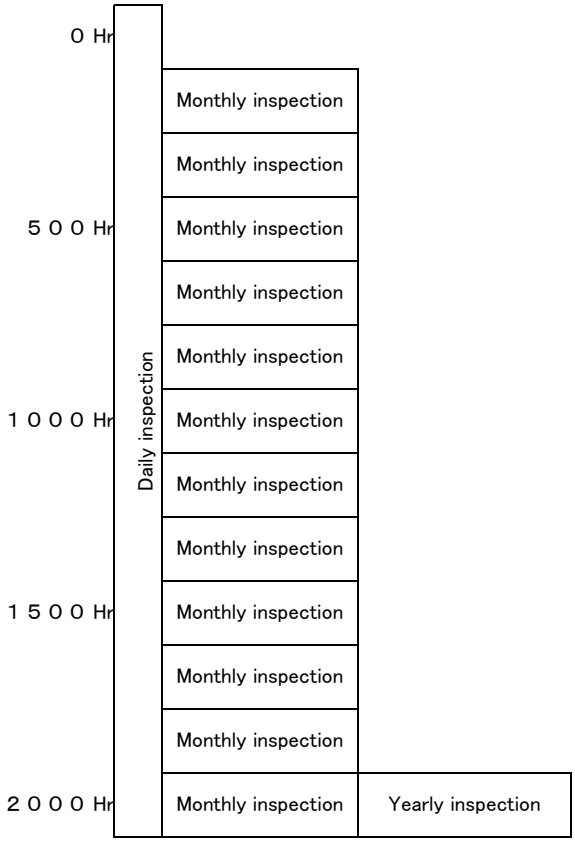
5 Maintenance and Inspection

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



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.

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.
Yearly inspection items		
1	Replace the backup battery in the controller.	Exchange it referring to "5.3.1 Replacing the battery" on page 42.

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.

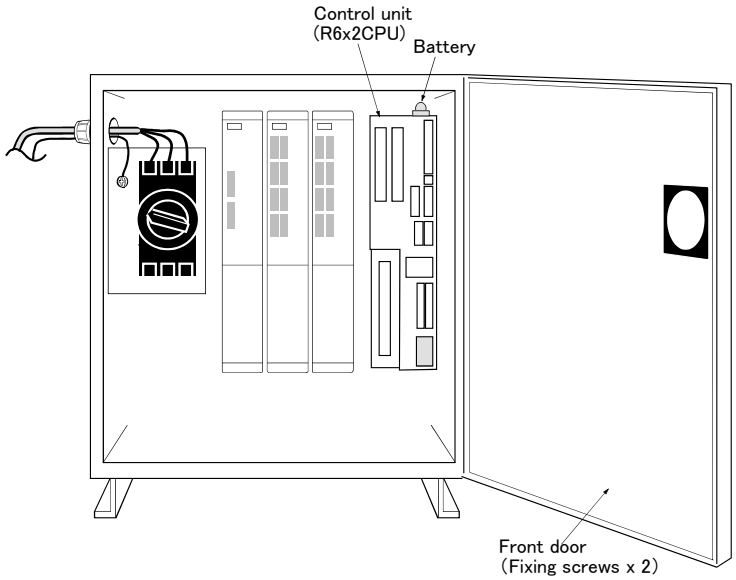
5.3.1 Replacing the battery

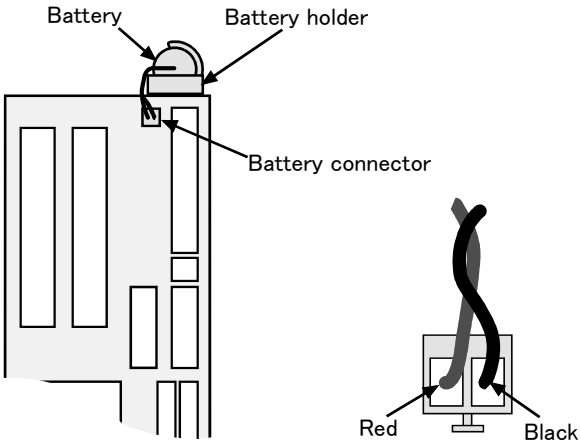
⚠ CAUTION

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.





R6x2CPU

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

2) Wait at least three minutes after turning OFF the power and primary power supply, then loosen the fixing screws on the controller front door, and open the front door.
The battery is on the R6x2CPU.

3) Hold and pull out the old battery connector, and remove from the battery holder.

4) 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 replace the battery of the CR3-535M controller.

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.

Table 5-4 : Controller spare part list

No.	Part name	Type	Qty.	Usage section	Maker
1	Fuse	LM16	1	Control unit	Mitsubishi Electric System & Service;Co.,Ltd.
2		LM05	1		
3		LM32	1		

HEADQUARTERS

MITSUBISHI ELECTRIC EUROPE B.V.
German Branch
Gothaer Straße 8
D-40880 Ratingen
Phone: +49 (0)2102 486-0
Fax: +49 (0)2102 486-1120
e mail: megfamail@meg.mee.com

MITSUBISHI ELECTRIC EUROPE B.V. — FRANCE
French Branch
25, Boulevard des Bouvets
F-92741 Nanterre Cedex
Phone: +33 1 55 68 55 68
Fax: +33 1 55 68 56 85
e mail: factory.automation@fra.mee.com

MITSUBISHI ELECTRIC EUROPE B.V. — IRELAND
Irish Branch
Westgate Business Park, Ballymount
IRL-Dublin 24
Phone: +353 (0) 1 / 419 88 00
Fax: +353 (0) 1 / 419 88 90
e mail: sales.info@meir.mee.com

MITSUBISHI ELECTRIC . EUROPE B.V — ITALY
Italian Branch
Via Paracelso 12
I-20041 Agrate Brianza (MI)
Phone: +39 (0)39 / 60 53 1
Fax: +39 (0)39 / 60 53 312
e mail: factory.automation@it.mee.com

MITSUBISHI ELECTRIC EUROPE B.V. — SPAIN
Spanish Branch
Carretera de Rubí 76-80
E-08190 Sant Cugat del Vallés (Barcelona)
Phone: +34 9 3 / 565 3131
Fax: +34 9 3 / 589 2948
e mail: industrial@sp.mee.com

MITSUBISHI ELECTRIC EUROPE B.V. — UK
UK Branch
Travellers Lane
GB-Hatfield Herts. AL10 8 XB
Phone: +44 (0)1707 / 27 61 00
Fax: +44 (0)1707 / 27 86 95
E-mail: automation@meuk.mee.com

MITSUBISHI ELECTRIC CORPORATION — JAPAN
Office Tower "Z" 14 F
8-12,1 chome, Harumi Chuo-Ku
Tokyo 104-6212
Phone: +81 3 6221 6060
Fax: +81 3 6221 6075

MITSUBISHI ELECTRIC AUTOMATION — USA
500 Corporate Woods Parkway
Vernon Hills, IL 60061
Phone: +1 847 / 478 21 00
Fax: +1 847 / 478 22 83

EUROPEAN REPRESENTATIVES

GEVA — AUSTRIA
Wiener Straße 89
AT-2500 Baden
Phone: +43 (0)2252 / 85 55 20
Fax: +43 (0)2252 / 488 60
e mail: office@geva.at

Getronics b.v. Control Systems — BELGIUM
Pontbeeklaan 43
BE-1731 Asse-Zellik
Phone: +32 (0)2 / 4 67 17 51
Fax: +32 (0)2 / 4 67 17 45
e mail: infoautomation@getronics.com

INEA CR d.o.o. — CROATIA
Drvinje 63
HR-10000 Zagreb
Phone: +385 (0)1/ 36 67 140
Fax: +385 (0)1/ 36 67 140
e mail: —

AutoCont Control Systems s.r.o. — CZECH REPUBLIC
Nemocnicni 12
CZ-70200 Ostrava 2
Phone: +420 (0)69 / 6152 111
Fax: +420 (0)69 / 6152 562
e mail: consys@autocont.cz

Kocks Ostrava s.r.o. — CZECH REPUBLIC
Ul. Jezdiste 808
CZ-72000 Ostrava Hrabova
Phone: +420 596 / 735 095
Fax: +420 596 / 782 707
e mail: —

louis poulsen industri & automation — DENMARK
Geminivej 32
DK-2670 Greve
Phone: +45 (0)43 / 95 95 95
Fax: +45 (0)43 / 95 95 91
e mail: lpia@lpmail.com

Beijer Electronics OY — FINLAND
Ansatie 6a
FIN-01740 Vantaa
Phone: +358 (0)9 / 886 77 500
Fax: +358 (0)9 / 886 77 555
e mail: info@beijer.fi

Kouvalias Industrial Robots — GREECE
25, El. Venizelou Ave.
GR-17671 Kallithea
Phone: +302 (0)10 / 958 92 43
Fax: +302 (0)10 / 953 65 14
e mail: robots@acci.gr

Axicont Automatika Kft. — HUNGARY
Reitter F. U. 132
HU-1131 Budapest
Phone: +36 (0)1 / 412-0882
Fax: +36 (0)1 / 412-0883
e mail: office@axicont.hu

EUROPEAN REPRESENTATIVES

Meltrade Automatika Kft. — HUNGARY
55, Harmat St.
HU-1105 Budapest
Phone: +36 (0)1 / 2605 602
Fax: +36 (0)1 / 2605 602
e mail: office@meltrade.hu

Getronics Industrial Automation B.V. — NETHERLANDS
Donauweg 2 B
NL-1043 AJ Amsterdam
Phone: +31 (0)20 / 587 6700
Fax: +31 (0)20 / 587 6839
e mail: info.gia@getronics.com

Beijer Electronics AS — NORWAY
Teglverksveien 1
NO-3002 Drammen
Phone: +47 (0)32 / 24 30 00
Fax: +47 (0)32 / 84 85 77
e mail: info@beijer.no

MPL Technology Sp. z o.o. — POLAND
ul. Sliczna 36
PL-31-444 Kraków
Phone: +48 (0)12 / 632 28 85
Fax: +48 (0)12 / 632 47 82
e mail: krakow@mpl.pl

ACP Autocomp a.s. — SLOVAKIA
Chalupkova 7
SK-81109 Bratislava
Phone: +421 (02)5292 2254
Fax: +421 (02)5292 2248
e mail: info@acp-autocomp.sk

INEA d.o.o. — SLOVENIA
Stegne 11
SI-1000 Ljubljana
Phone: +386 (0)1- 513 8100
Fax: +386 (0)1- 513 8170
e mail: inea@inea.si

Beijer Electronics AB — SWEDEN
Box 426
S-20124 Malmö
Phone: +46 (0)40 / 35 86 00
Fax: +46 (0)40 / 35 86 02
e mail: info@beijer.se

ECONOTEC AG — SWITZERLAND
Postfach 282
CH-8309 Nürensdorf
Phone: +41 (0)1 / 838 48 11
Fax: +41 (0)1 / 838 48 12
e mail: info@econotec.ch

GTS — TURKEY
Darülaceze Cad. No. 43A Kat. 2
TR-80270 Okmeydani-Istanbul
Phone: +90 (0)212 / 320 1640
Fax: +90 (0)212 / 320 1649
e mail: gts@turk.net

EURASIAN REPRESENTATIVES

ELEKTROSTYLE — RUSSIA
ul. Garschina 11
RU-140070 Moscow Oblast
Phone: +7 095 557-9756
Fax: +7 095 746-8880
e mail: mjuly@elektrostyle.ru

ELEKTROSTYLE — RUSSIA
Krasnij Prospekt 220-1,Office 312
RU-630049 Novosibirsk
Phone: +7 3832 / 10 66 18
Fax: +7 3832 / 10 66 26
e mail: elo@elektrostyle.ru

ICOS — RUSSIA
Ryazanskij Prospekt, 8A, Office 100
RU-109428 Moscow
Phone: +7 095 232-0207
Fax: +7 095 232-0327
e mail: mail@icos.ru

MIDDLE EAST REPRESENTATIVE

ILAN & GAVISH LTD Automation Service — ISRAEL
24 Shenkar St., Kiryat Arie
IL-49001 Petach-Tiqva
Phone: +972 (0) 3 / 922 18 24
Fax: +972 (0) 3 / 924 07 61
e mail: iandg@internet-zahav.net

AFRICAN REPRESENTATIVE

CBI Ltd — SOUTH AFRICA
Private Bag 2016
ZAF-1600 Isando
Phone: +27 (0) 11 / 928 2000
Fax: +27 (0) 11 / 392 2354
e mail: cbi@cbi.co.za

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