

# ***DENSO ROBOT***

Horizontal articulated

**H\*-D SERIES**

**INSTALLATION & MAINTENANCE GUIDE**

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# Preface

Thank you for purchasing this high-speed, high-accuracy assembly robot.

Before operating your robot, read this manual carefully to safely get the maximum benefit from your robot in your assembling operations.

## Robot series and/or models covered by this manual

Series	Model	
	Floor-mount	Overhead-mount
HM-D (Medium-sized, horizontal articulated)	HM-4070*D HM-4085*D	HMS-4070*D
HS-D (Small-sized, horizontal articulated)	HS-4055*D	HSS-4055*D
HC-D (Compact-sized, horizontal articulated)	HC-4545*D HC-4245*D HC-4555*D HC-4255*D	———

**NOTE 1:** Model names listed above apply to the models of robot systems. The model names of robot units are followed by M. If the robot system model is HS-4055\*D, for example, the robot unit model is HS-4055\*DM.

**NOTE 2:** The H\*-D series may provide an extended-joint support system (capable of controlling up to two extended-joints). For details about the extended-joint support system, refer to the SUPPLEMENT (No. 410002-6090) to the robot instruction manuals.

## Important

To ensure operator safety, be sure to read the precautions and instructions in "SAFETY PRECAUTIONS," pages 1 through 9.

# How the H\*-D documentation set is organized

The H\*-D documentation set consists of the following six books. If you are unfamiliar with this robot series, please read all six books and understand them fully before operating your robot.

## **BEGINNER'S GUIDE**

Introduces you to the DENSO robot. Taking an equipment setup example, this book guides you through running your robot with the teach pendant, making a program in WINCAPSII, and running your robot automatically.

## **INSTALLATION & MAINTENANCE GUIDE - this book -**

Provides an explanation of the robot outline, instructions for installing the robot components, and maintenance & inspection procedures.

## **SETTING-UP MANUAL**

Describes how to set-up or teach your robot with the teach pendant, mini pendant or operating panel.

## **WINCAPSII GUIDE**

Provides instructions on how to use the teaching system installed on the PC, connected to the robot and its controller, for developing and managing programs.

## **PROGRAMMER'S MANUAL**

Describes the PAC programming language, steps to develop programs in PAC, and command specifications.

## **ERROR CODE TABLES**

List error codes that will appear on the teach pendant, mini pendant, operating panel, or PC screen if an error occurs in the robot series or WINCAPSII.

# How this book is organized

This book is just one part of the H\*-D documentation set. This book consists of SAFETY PRECAUTIONS, chapters one through six, and appendix.

## **SAFETY PRECAUTIONS**

Defines safety terms and related symbols and provides precautions that should be observed. Be sure to read this section before operating your robot.

## **Chapter 1 General Information about Robot**

This chapter describes the components and specifications of the robot. Read this chapter before installing and operating the robot to familiarize yourself with the robot.

## **Chapter 2 Installing Robot Components**

This chapter describes the procedures and precautions for transporting the robot during installation, and for designing end-effectors.

## **Chapter 3 Optional Devices**

This chapter describes the configurations and functions of the optional devices. Consult this chapter according to the optional devices to be used.

## **Chapter 4 Customizing Your Robot**

This chapter describes how to customize your robot.

## **Chapter 5 Robot Controller Interface**

This chapter describes the connections between the robot controller and other devices and precautions for connecting them.

## **Chapter 6 Maintenance and Inspections**

This chapter describes the regular maintenance and inspections necessary for maintaining the performance and functions of the robot.

## **Appendix**



# SAFETY PRECAUTIONS

Be sure to observe all of the following safety precautions.

Strict observance of these warning and caution indications are a **MUST** for preventing accidents, which could result in bodily injury and substantial property damage. Make sure you fully understand all definitions of these terms and related symbols given below, before you proceed to the text itself.

 <b>WARNING</b>	Alerts you to those conditions, which could result in serious bodily injury or death if the instructions are not followed correctly.
 <b>CAUTION</b>	Alerts you to those conditions, which could result in minor bodily injury or substantial property damage if the instructions are not followed correctly.

## Terminology and Definitions

**Maximum space:** Refers to the volume of space encompassing the maximum designed movements of all robot parts including the end-effector, workpiece and attachments. (Quoted from the RIA\* Committee Draft.)

**Restricted space:** Refers to the portion of the maximum space to which a robot is restricted by limiting devices (i.e., mechanical stops). The maximum distance that the robot, end-effector, and workpiece can travel after the limiting device is actuated defines the boundaries of the restricted space of the robot. (Quoted from the RIA Committee Draft.)

**Motion space:** Refers to the portion of the restricted space to which a robot is restricted by software motion limits. The maximum distance that the robot, end-effector, and workpiece can travel after the software motion limits are set defines the boundaries of the motion space of the robot. (The "motion space" is Denso-proprietary terminology.)

**Operating space:** Refers to the portion of the restricted space (or motion space in Denso) that is actually used by the robot while performing its task program. (Quoted from the RIA Committee Draft.)

**Task program:** Refers to a set of instructions for motion and auxiliary functions that define the specific intended task of the robot system. (Quoted from the RIA Committee Draft.)

(\*RIA: Robotic Industries Association)

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## 1. Introduction

This section provides safety precautions to be observed during installation, teaching, inspection, adjustment, and maintenance of the robot.

## 2. Installation Precautions

### 2.1 Insuring the proper installation environment

#### 2.1.1 For standard type

The standard type has not been designed to withstand explosions, dust-proof, nor is it splash-proof. Therefore, it should not be installed in any environment where:

- (1) there are flammable gases or liquids,
- (2) there are any shavings from metal processing or other conductive material flying about,
- (3) there are any acidic, alkaline or other corrosive gases,
- (4) there is cutting or grinding oil mist,
- (5) it may likely be submerged in fluid,
- (6) there is sulfuric cutting or grinding oil mist, or
- (7) there are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise.

#### 2.1.2 For dust-proof, splash-proof type

The dust-proof, splash-proof type is an IP54-equivalent dust-proof and splash-proof structure, but it has not been designed to withstand explosions.

Note that the robot controller is not a dust- or splash-proof structure. Therefore, when using the robot controller in an environment exposed to mist, put it in an optional protective box.

The dust-proof, splash-proof type should not be installed in any environment where:

- (1) there are any flammable gases or liquids,
- (2) there are any acidic, alkaline or other corrosive gases,
- (3) there are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise,
- (4) it may likely be submerged in fluid,
- (5) there are any grinding or machining chips or shavings,
- (6) any machining oil other than DENSO authorized oil is in use, or

Note: DENSO authorized oil: Yushiron Oil No. 4C (non-soluble)

- (7) there is sulfuric cutting or grinding oil mist.

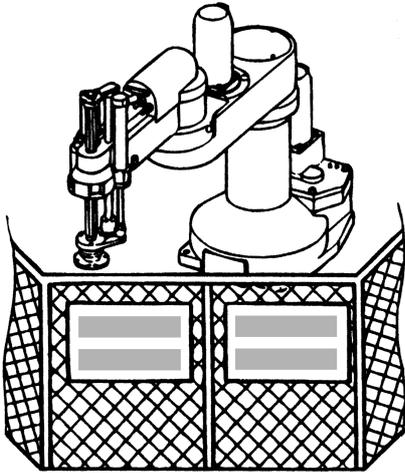
### 2.2 Service space

The robot and peripheral equipment should be installed so that sufficient service space is maintained for safe teaching, maintenance, and inspection.

- 2.3 Control devices outside the robot's restricted space** The robot controller, teach pendant, mini pendant and operating panel should be installed outside the robot's restricted space and in a place where you can observe all of the robot's movements when operating the robot controller, teach pendant, mini pendant or operating panel.
- 2.4 Positioning of gauges** Pressure gauges, oil pressure gauges and other gauges should be installed in an easy-to-check location.
- 2.5 Protection of electrical wiring and hydraulic/pneumatic piping** If there is any possibility of the electrical wiring or hydraulic/pneumatic piping being damaged, protect them with a cover or similar item.
- 2.6 Positioning of emergency stop switches** Emergency stop switches should be provided in a position where they can be reached easily should it be necessary to stop the robot immediately.
- (1) The emergency stop switches should be red.
  - (2) Emergency stop switches should be designed so that they will not be released after pressed, automatically or mistakenly by any other person.
  - (3) Emergency stop switches should be separate from the power switch.
- 2.7 Positioning of operating status indicators** Operating status indicators should be positioned in such a way where workers can easily see whether the robot is on temporary halt or on an emergency or abnormal stop.

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## 2.8 Setting-up the safety fence or enclosure



A safety fence or enclosure should be set up so that no one can easily enter the robot's restricted space. If it is impossible, utilize other protectors as described in Section 2.9.

- (1) The fence or enclosure should be constructed so that it cannot be easily moved or removed.
- (2) The fence or enclosure should be constructed so that it cannot be easily damaged or deformed through external force.
- (3) Establish the exit/entrance to the fence or enclosure. Construct the fence or enclosure so that no one can easily get past it by climbing over the fence or enclosure.
- (4) The fence or enclosure should be constructed to ensure that it is not possible for hands or any other parts of the body to get through it.
- (5) Take any one of the following protections for the entrance/exit of the fence or enclosure:
  - 1) Place a door, rope or chain across the entrance/exit of the fence or enclosure, and fit it with an interlock that ensures the emergency stop device operates automatically if it is opened or removed.
  - 2) Post a warning notice at the entrance/exit of the fence or enclosure stating "In operation--Entry forbidden" or "Work in progress--Do not operate" and ensure that workers follow these instructions at all times.

When making a test run, before setting up the fence or enclosure, place an overseer in a position outside the robot's restricted space and one in which he/she can see all of the robot's movements. The overseer should prevent workers from entering the robot's restricted space and be devoted solely to that task.

## 2.9 Positioning of rope or chain

If it is not possible to set up the safety fence or enclosure described in Section 2.8, hang a rope or chain around the perimeter of the robot's restricted space to ensure that no one can enter the restricted space.

- (1) Ensure the support posts cannot be moved easily.
- (2) Ensure that the rope or chain's color or material can easily be discerned from the surrounds.
- (3) Post a warning notice in a position where it is easy to see stating "In operation--Entry forbidden" or "Work in progress --Do not operate" and ensure that workers follow these instructions at all times.
- (4) Set the exit/entrance, and follow the instructions given in Section 2.8, (3) through (5).

## 2.10 Setting the robot's motion space

The area required for the robot to work is called the robot's operating space.

If the robot's motion space is greater than the operating space, it is recommended that you set a smaller motion space to prevent the robot from interfering or disrupting other equipment.

Refer to the "INSTALLATION & MAINTENANCE GUIDE" Chapter 4.

## 2.11 No robot modification allowed

Never modify the robot unit, robot controller, teach pendant , mini pendant or other devices.

## 2.12 Cleaning of tools

If your robot uses welding guns, paint spray nozzles, or other end-effectors requiring cleaning, it is recommended that the cleaning process be carried out automatically.

## 2.13 Lighting

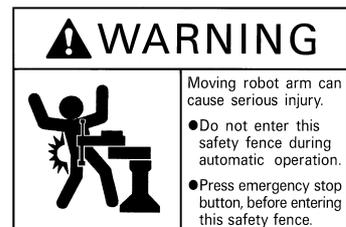
Sufficient illumination should be assured for safe robot operation.

## 2.14 Protection from objects thrown by the end-effector

If there is any risk of workers being injured in the event that the object being held by the end-effector is dropped or thrown by the end-effector, consider the size, weight, temperature and chemical nature of the object and take appropriate safeguards to ensure safety.

## 2.15 Affixing the warning label

Place the warning label packaged with the robot on the exit/entrance of the safety fence or in a position where it is easy to see.

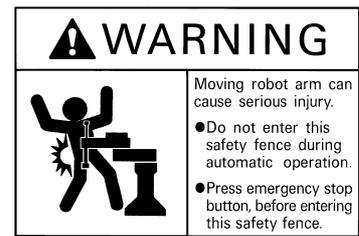


### 3. Precautions while robot is running



**Warning**

Touching the robot while it is in operation can lead to serious injury. Please ensure the following conditions are maintained and that the cautions listed from Section 3.1 onwards are followed when any work is being performed.



- 1) Do not enter the robot's restricted space when the robot is in operation or when the motor power is on.
- 2) As a precaution against malfunction, ensure that an emergency stop device is activated to cut the power to the robot motor upon entry into the robot's restricted space.
- 3) When it is necessary to enter the robot's restricted space to perform teaching or maintenance work while the robot is running, ensure that the steps described in Section 3.3 "Ensuring safety of workers performing jobs within the robot's restricted space" are taken.

#### 3.1 Creation of working regulations and assuring worker adherence

When entering the robot's restricted space to perform teaching or maintenance inspections, set "working regulations" for the following items and ensure workers adhere to them.

- (1) Operating procedures required to run the robot.
- (2) Robot speed when performing teaching.
- (3) Signaling methods to be used when more than one worker is to perform work.
- (4) Steps that must be taken by the worker in the event of a malfunction, according to the contents of the malfunction.
- (5) The necessary steps for checking release and safety of the malfunction status, in order to restart the robot after robot movement has been stopped due to activation of the emergency stop device
- (6) Apart from the above, any steps below necessary to prevent danger from unexpected robot movement or malfunction of the robot.
  - 1) Display of the control panel (See Section 3.2 on the following page)
  - 2) Assuring the safety of workers performing jobs within the robot's restricted space (See Section 3.3 on the following page)
  - 3) Maintaining worker position and stance  
Position and stance that enables the worker to confirm normal robot operation and to take immediate refuge if a malfunction occurs.

- 4) Implementation of measures for noise prevention
- 5) Signaling methods for workers of related equipment
- 6) Types of malfunctions and how to distinguish them

Please ensure “working regulations” are appropriate to the robot type, the place of installation and to the content of the work.

Be sure to consult the opinions of related workers, engineers at the equipment manufacturer and that of a labor safety consultant when creating these “working regulations”.

### **3.2 Display of operation panel**

To prevent anyone other than the worker from accessing the start switch or the changeover switch by accident during operation, display something to indicate it is in operation on the operating panel, teach pendant or mini pendant. Take any other steps as appropriate, such as locking the cover.

### **3.3 Ensuring safety of workers performing jobs within the robot's restricted space**

When performing jobs within the robot's restricted space, take any of the following steps to ensure that robot operation can be stopped immediately upon a malfunction.

- (1) Ensure an overseer is placed in a position outside the robot's restricted space and one in which he/she can see all robot movements, and that he/she is devoted solely to that task.
  - ① An emergency stop device should be activated immediately upon a malfunction.
  - ② Do not permit anyone other than the worker engaged for that job to enter the robot's restricted space.
- (2) Ensure a worker within the robot's restricted space carries the portable emergency stop switch so he/she can press it (the robot stop button on the teach pendant or mini pendant) immediately if it should be necessary to do so.

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### **3.4 Inspections before commencing work such as teaching**

Before starting work such as teaching, inspect the following items, carry out any repairs immediately upon detection of a malfunction and perform any other necessary measures.

- (1) Check for any damage to the sheath or cover of the external wiring or to the external devices.
- (2) Check that the robot is functioning normally or not (any unusual noise or vibration during operation).
- (3) Check the functioning of the emergency stop device.
- (4) Check there is no leakage of air or oil from any pipes.
- (5) Check there are no obstructive objects in or near the robot's restricted space.

### **3.5 Release of residual air pressure**

Before disassembling or replacing pneumatic parts, first release any residual air pressure in the drive cylinder.

### **3.6 Precautions for test runs**

Whenever possible, have the worker stay outside of the robot's restricted space when performing test runs.

### **3.7 Precautions for automatic operation**

#### (1) At start-up

Before the robot is to be started up, first check the following items as well as setting the signals to be used and perform signaling practice with all related workers.

- 1) Check that there is no one inside the robot's restricted space.
  - 2) Check that the teach pendant and tools are in their designated places.
  - 3) Check that no lamps indicating a malfunction on the robot or related equipment are lit.
- (2) Check that the display lamp indicating automatic operation is lit during automatic operation.

#### (3) Steps to be taken when a malfunction occurs

Should a malfunction occur with the robot or related equipment and it is necessary to enter the robot's restricted space to perform emergency maintenance, stop the robot's operation by activating the emergency stop device. Take any necessary steps such as placing a display on the starter switch to indicate work is in progress to prevent anyone from accessing the robot.

### 3.8 Precautions in repairs

- (1) Do not perform repairs outside of the designated range.
- (2) Under no circumstances should the interlock mechanism be removed.
- (3) When opening the robot controller's cover for battery replacement or any other reasons, always turn the robot controller power off and disconnect the power cable.
- (4) Use only spare tools authorized by DENSO.

### 4. Daily and periodical inspections

- (1) Be sure to perform daily and periodical inspections. Before starting jobs, always check that there is no problem with the robot and related equipment. If any problems are found, take any necessary measures to correct them.
- (2) When carrying out periodical inspections or any repairs, maintain records and keep them for at least 3 years.

### 5. Management of floppy disks

- (1) Carefully handle and store the "Initial settings" floppy disks packaged with the robot, which store special data exclusively prepared for your robot.
- (2) After finishing teaching or making any changes, always save the programs and data onto floppy disks.  

Making back-ups will help you recover if data stored in the robot controller is lost due to the expired life of the back-up battery.
- (3) Write the names of each of the floppy disks used for storing task programs to prevent incorrect disks from loading into the robot controller.
- (4) Store the floppy disks where they will not be exposed to dust, humidity and magnetic field, which could corrupt the disks or data stored on them.



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**Appendix**

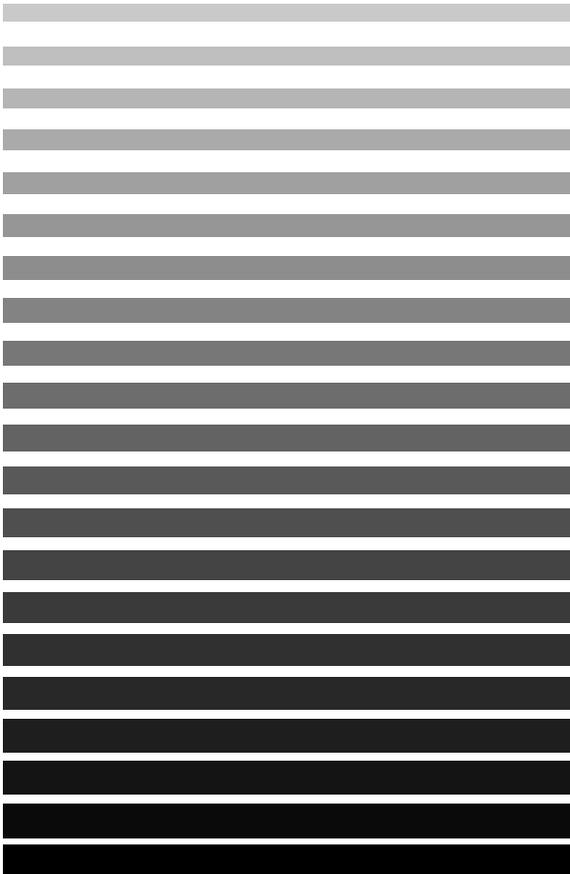
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# Chapter 1

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## General Information about Robot



This chapter describes the components and specifications of the robot. Read this chapter before installing and operating the robot to familiarize yourself with the robot.



# 1.1 Items Contained in the Package

## 1.1.1 Standard Items

The items listed in Table 1-1 are contained in the product package.

Table 1-1 Standard Items

No.	Item	Qty.
(1)	Robot unit (HM/HS/HC)	1
(2)	Robot controller	1
(3)	Power supply cable (5 m) (Note 1)	1
(4)	Air regulator	1
(5)	Robot control cable (Note 2) (Option)	1 set
(6)	Manuals 1) BEGINNER'S GUIDE 2) INSTALLATION & MAINTENANCE GUIDE 3) SETTING-UP MANUAL 4) PROGRAMMER'S MANUAL 5) ERROR CODE TABLES 6) NetwRC CD (containing WINCAPSII beta version and robot documents)	1 each
(7)	Spare fuse for robot controller	3
(8)	Initialization floppy disk (1.44 MB format) (Note 3)	1
(9)	Pendantless connector (Dummy connector)	1
(10)	Connector set for end-effector control signals (for CN20 and CN21)	1 set
(11)	Power connector for I/O	1
(12)	Direction indicator label (Note 4)	1
(13)	Warning label (Note 5)	1
(14)	Spare output IC for robot controller	1
(15)	CALSET pin (for HC series only)	1

Note 1: Not only the standard power cable but also the UL-compliant one is available. The CE-compliant one consists of a power connector only.

Note 2: Choose a robot control cable set from Table 1-2. The internal cable bending radius shall at least be 200 mm (see the caution on the next page).

Note 3: Preserve the initialization floppy disk in a safe place. The disk contains arm data in WINCAPSII format. If a memory error appears on the teach pendant due to memory failure, use the disk to load the arm data to the robot controller. (Refer to Section 6.11 "Using the Initialization Floppy Disk.")

Note 4: Attach the direction indicator label in a position on the robot unit that can be easily seen after installation.

---

Note 5: Attach the warning label on the robot safety fence or other location where operators will notice it.

If necessary, prepare a plate for attaching the seal.

**TIP:** The H\*-D series may provide an extended-joint support system (capable of controlling up to two extended-joints). For details about the extended-joint support system, refer to the SUPPLEMENT (No. 410002-6090) to the robot instruction manuals.

**Table 1-2 Robot Control Cable Sets (Option)**

<b>No.</b>	<b>Cable set</b>	<b>Part No.</b>
1	Standard cable set (3 m)	410149-0580
2	Standard cable set (6 m)	410149-0590
3	Standard cable set (3 m) destined for Europe	410149-0560
4	Standard cable set (6 m) destined for Europe	410149-0570

### 1.1.2 Optional Items

The table below lists the optional components.

**Optional Components (1)**

Classification	No.	Item	Remarks	Part No.
I/O cables	1	I/O cable set	(8 m) (Consists of Nos.1-1 to 1-3, one each)	410149-0330
	1-1	Input cable	(8 m)	410141-1630
	1-2	Output cable	(8 m)	410141-1650
	1-3	Hand I/O cable	(8 m)	410141-1740
	2	I/O cable set (Only hand I/O cable is a high-strength type.)	(8 m) (Consists of Nos.2-1 to 2-3, one each)	410149-0350
	2-1	Input cable	(8 m)	410141-1630
	2-2	Output cable	(8 m)	410141-1650
	2-3	Hand I/O cable (high-strength)	(8 m)	410141-1670
	3	I/O cable set	(15 m) (Consists of Nos.3-1 to 3-3, one each)	410149-0340
	3-1	Input cable	(15 m)	410141-1640
	3-2	Output cable	(15 m)	410141-1660
	3-3	Hand I/O cable	(15 m)	410141-1750
	4	I/O cable set (Only the hand I/O cable is a high-strength type.)	(15 m) (Consists of Nos.4-1 to 4-3, one each)	410149-0360
	4-1	Input cable	(15 m)	410141-1640
	4-2	Output cable	(15 m)	410141-1660
	4-3	Hand I/O cable (high-strength)	(15 m)	410141-1680
Operation devices	5	Operating panel ( <b>Note 1</b> )	(4 m)	410100-0970
	6	Operating panel ( <b>Note 1</b> )	(8 m)	410100-0980
	7	Teach pendant ( <b>Note 1</b> )	(4 m)	410100-0940
	8	Teach pendant ( <b>Note 1</b> )	(8 m)	410100-0950
	9	Teach pendant ( <b>Note 1</b> )	(12 m)	410100-0960
	10	Mini-pendant (Version 1.7 or later) (Incl. WINCAPSII Light)	(4 m)	410109-0020
	11	Mini-pendant (Version 1.7 or later) (Incl. WINCAPSII Light)	(8 m)	410109-0040
	12	Mini-pendant (Version 1.7 or later) (Incl. WINCAPSII Light)	(12 m)	410109-0060
	13	Pendant extension cable ( <b>Note 2</b> )	(4 m) For TP/MP/OP	410141-2390
	14	Pendant extension cable ( <b>Note 2</b> )	(8 m) For TP/MP/OP	410141-2400

**Note1:** The total cable length must not be more than 12 m when the operating panel and the teach pendant are to be connected in series.

**Note2:** The total cable length must not be more than 12 m when the pendant extension cable is connected to the TP, MP or OP. Do not connect two or more pendant extension cables to the TP, MP or OP.

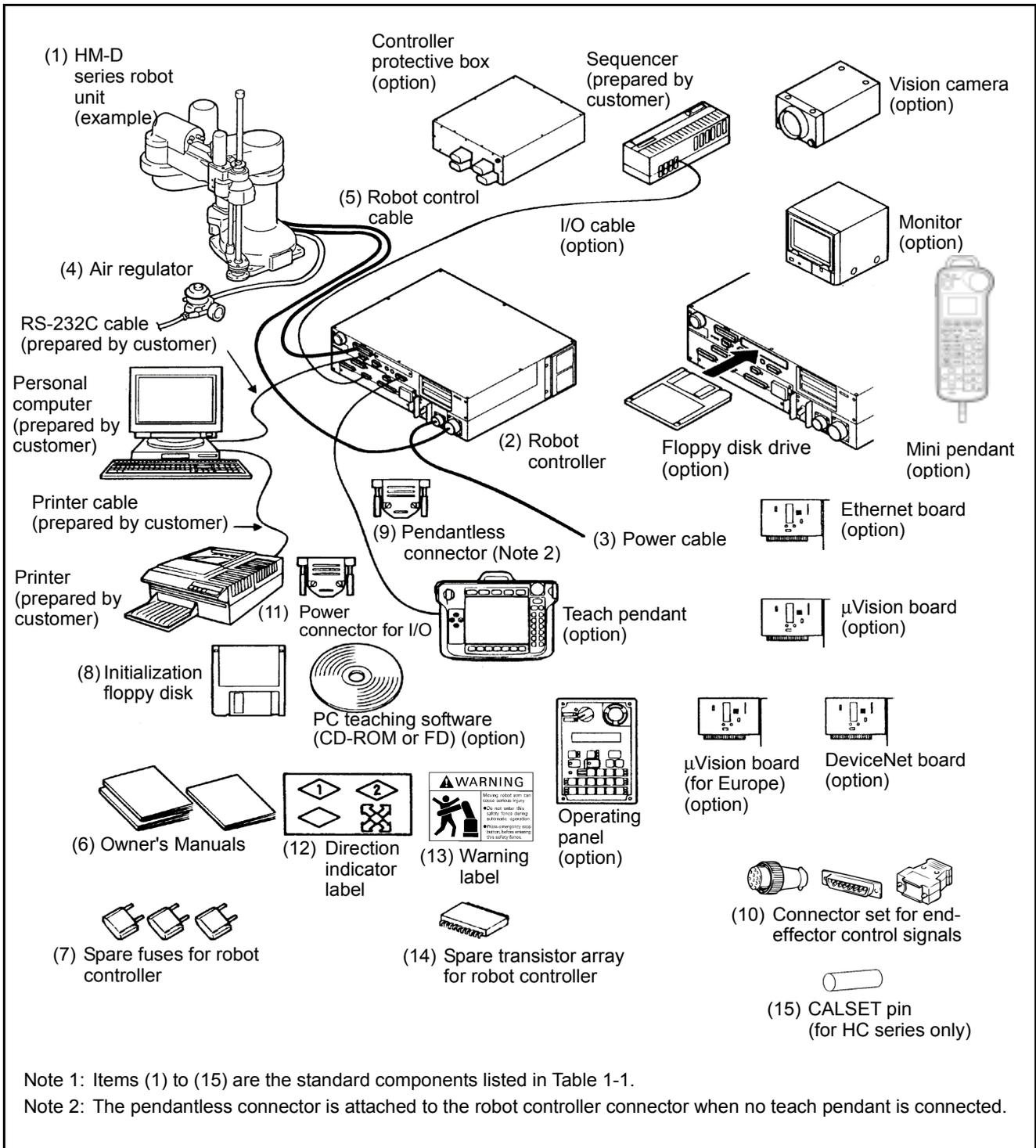
**Table 1-3 Optional Items (2)**

<b>Classification</b>	<b>No.</b>	<b>Item</b>	<b>Remarks</b>	<b>Part No.</b>
PC teaching software	15	WINCAPSII	(in CD-ROM)	410090-0860
	16	WINCAPSII	(in floppy disk)	410090-0870
Visual equipment	17	μVision (built-in visual) board	(NTSC)	410010-2070
	18	μvision (built-in visual) board (for Europe)	(PAL)	410010-2080
	19	Camera		463980-0030
	20	Monitor		463980-0021
	21	Camera cable	(3 m)	463981-0110
	22	Camera cable	(5 m)	463981-0120
	23	Camera cable	(15 m)	463981-0160
	24	Monitor cable	(BNC) (1 m)	463981-0010
	25	Monitor cable	(BNC) (3 m)	463981-0030
Optional boards for the robot controller	26	Monitor cable	(BNC) (5 m)	463981-0050
	27	Ethernet board		410010-0710
	28	Built-in floppy disk drive	(for 1.44 MB floppy disk)	410010-0520
	29	DeviceNet slave board	(Slave station)	410010-0720
	30	DeviceNet master board	(Master station)	410010-0740
Controller-related components	31	PROFIBUS slave board	(Slave station)	410010-1190
	32	Controller protection box	(FB-10)	410181-0060
Manuals (Printed materials)	33	I/O connector set for RC5	For parallel I/O	410159-0070
	35	H*-D INSTALLATION & MAINTENANCE GUIDE		410002-1410
	36	BEGINNER'S GUIDE		410002-1340
	37	SETTING-UP MANUAL	(Common to all robot series)	410002-1320
	38	PROGRAMMER'S MANUAL (I)	(Common to all robot series)	410002-2050
	39	PROGRAMMER'S MANUAL (II)	(Common to all robot series)	410002-2060
	40	ERROR CODE TABLES	(Common to all robot series)	410002-1430
41	WINCAPS II GUIDE	(Common to all robot series)	410002-0930	

# 1.2 Robot Configuration

## 1.2.1 Robot Components

Figure 1-1 shows the entire configuration of the robot.



Note 1: Items (1) to (15) are the standard components listed in Table 1-1.

Note 2: The pendantless connector is attached to the robot controller connector when no teach pendant is connected.

Figure 1-1 H\*-D Series Robot Components

## 1.2.2 Names of the Robot Unit Components

Figures 1-2 through 1-4 show the names of the components of the robot unit and the rotation direction of each axis.

### ■ HM-D/HS-D Series

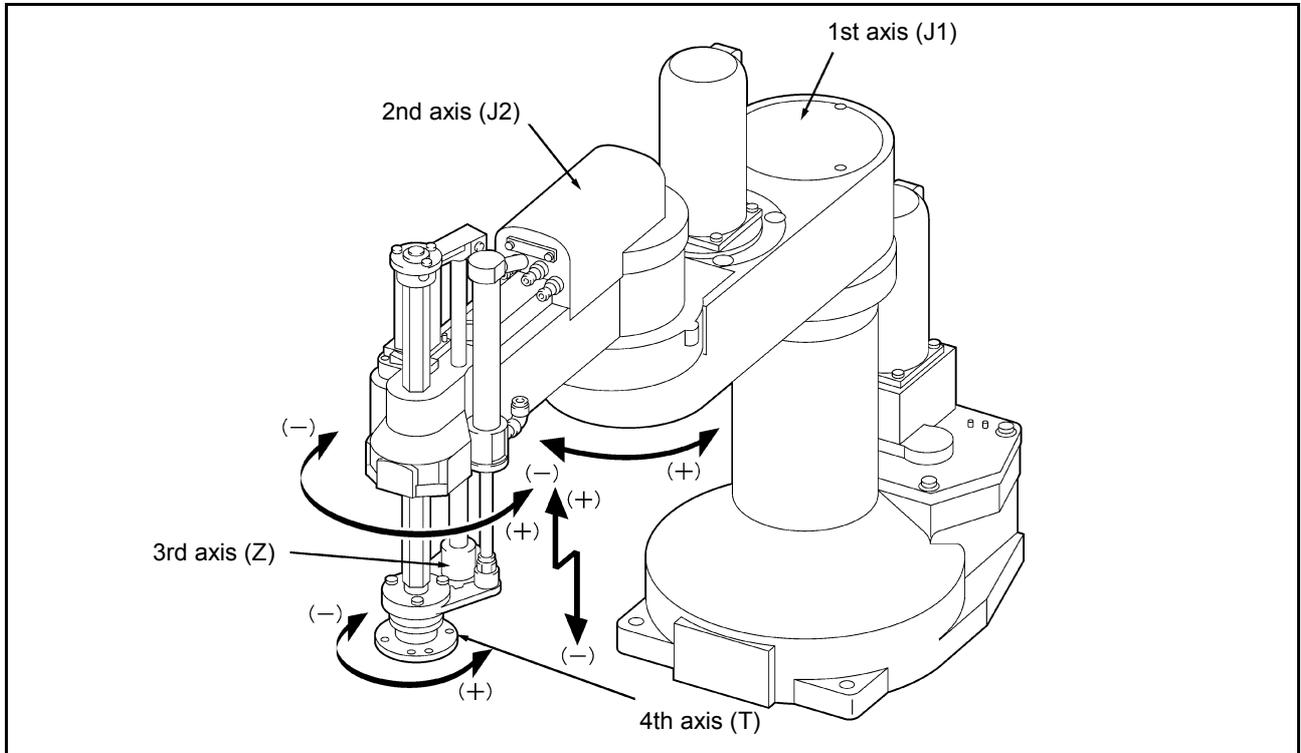


Figure 1-2 Components of HM-D/HS-D series (Floor-mount)

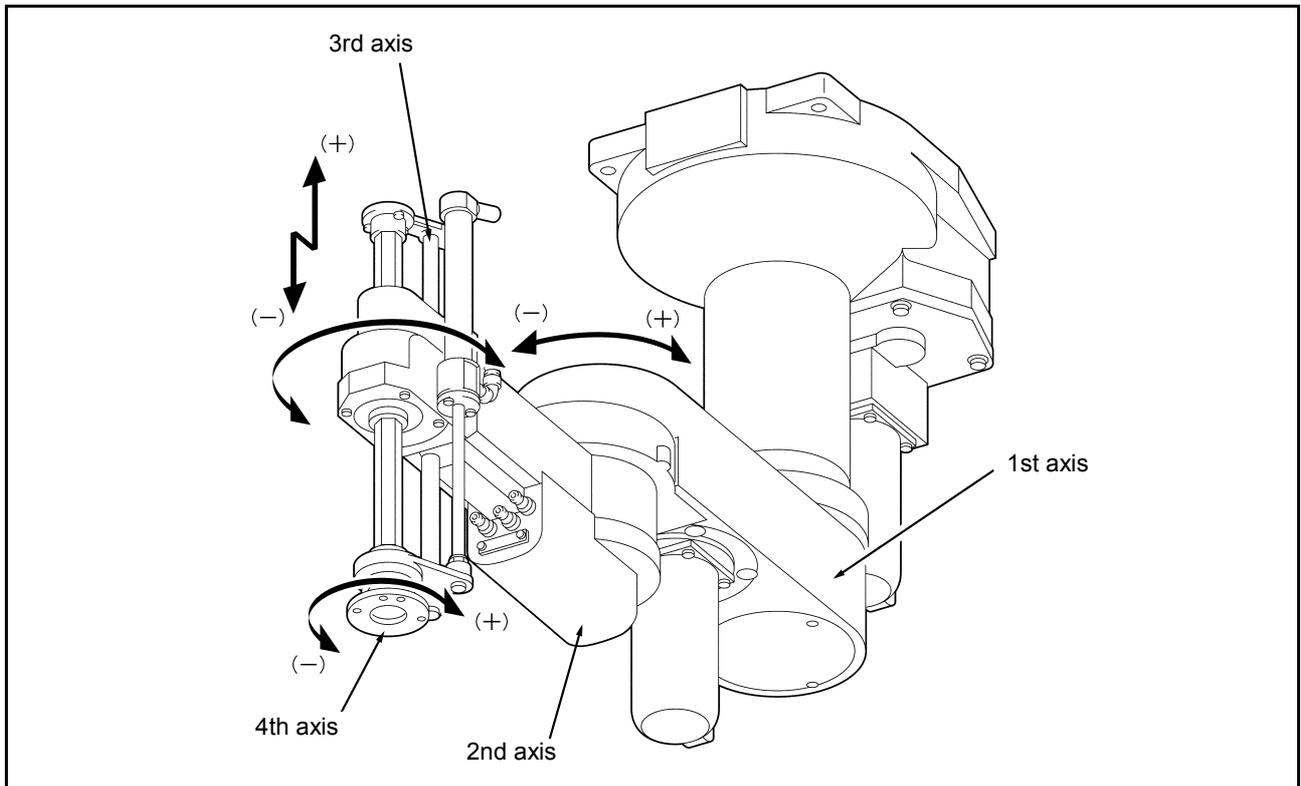


Figure 1-3 Components of HMS-D/HSS-D series (Overhead-mount)

■ HC-D Series

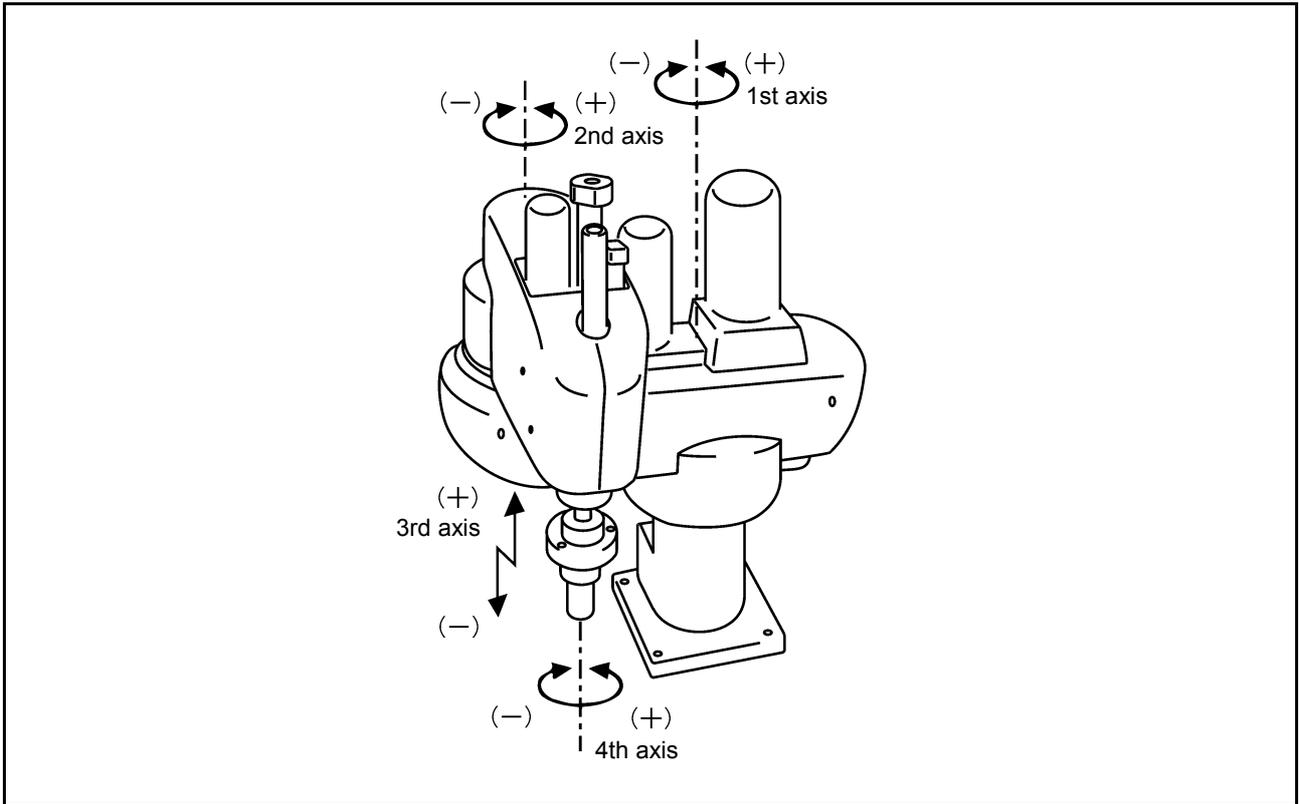


Figure 1-4 Components of HC-D series

### 1.2.3 Names of the Robot Controller Components

Figure 1-5 and Table 1-4 show the names of the robot controller components.

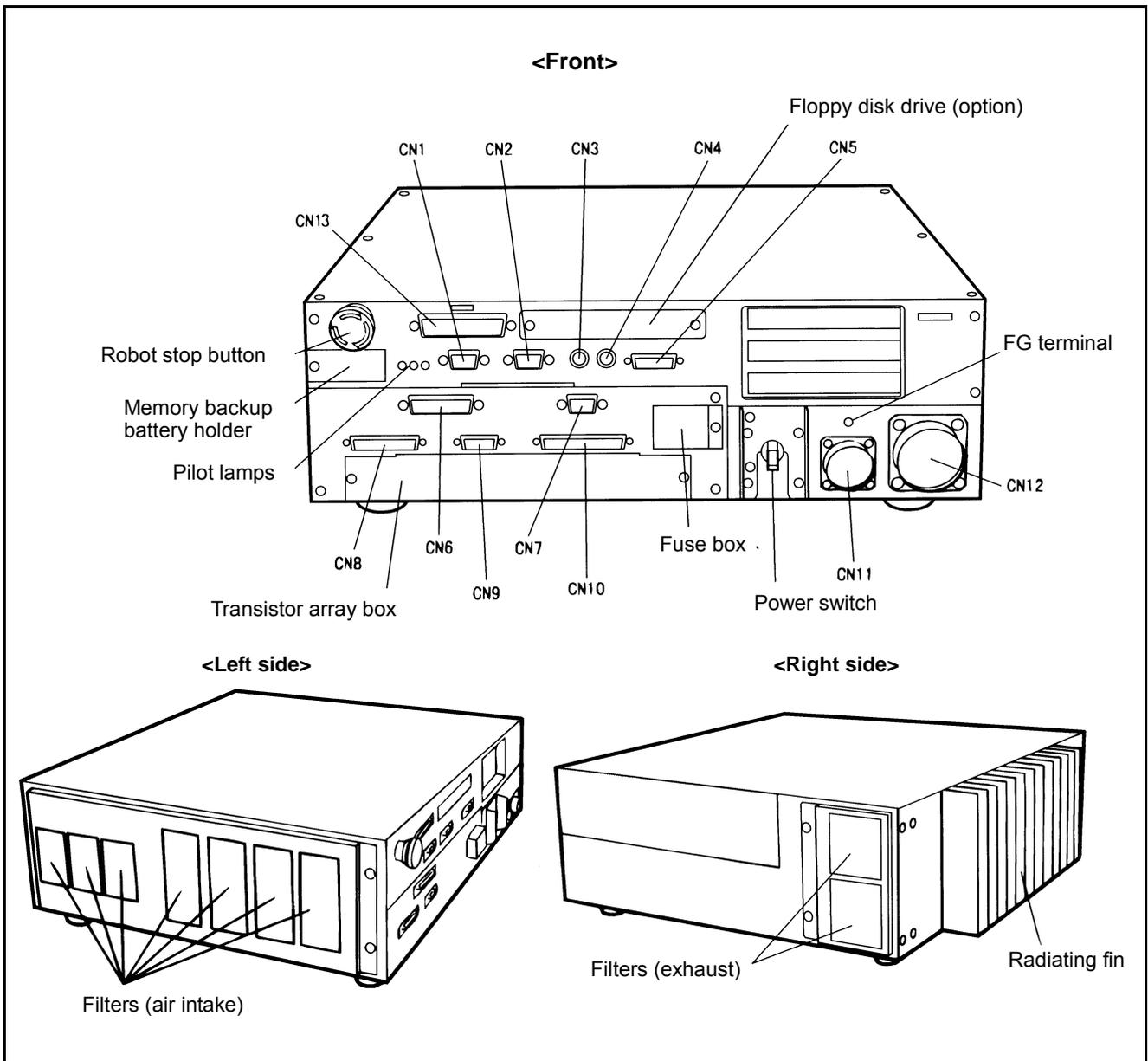


Figure 1-5 Names of Robot Controller Components

Table 1-4 Connector Names

Connector No.	Marking	Name	Connector No.	Marking	Name
CN1	RS232C	Serial interface connector	CN8	INPUT	Connector for user input or system input
CN2	CRT	CRT connector	CN9	HAND I/O	Connector for end-effector I/O
CN3	KEYBD	Keyboard connector	CN10	OUTPUT	Connector for user output or system output
CN4	MOUSE	Connector for PS/2 mouse	CN11	INPUT AC	Power connector
CN5	PENDANT	Connector for teach pendant	CN12	MOTOR	Motor connector
CN6	PRINTER	Printer connector (Not used)	CN13	ENCODER	Encoder connector
CN7	I/O POWER	Power connector for I/O			

 **Caution:** The robot controller connectors are of a screw-lock type or ring-lock type. Lock the connectors securely. If even one of the connectors is not locked, weak contact may result thereby causing an error.

Be sure to turn the robot controller OFF before connecting/disconnecting the power connector or motor connector. Otherwise, the internal circuits of the robot controller may be damaged.

# 1.3 Robot Specifications

## ■ HM-D/HS-D Series

### [ 1 ] Robot Unit Specifications

Table 1-5 lists the robot unit specifications of the HM-D/HS-D series.

**Table 1-5 Robot Unit Specifications of the HM-D/HS-D Series**

Item		Specifications		
Model of robot system (Note 1)		HS(S)-4055*D	HM(S)-4070*D	HM(S)-4085*D
Model of robot unit		HS(S)-4055*DM	HM(S)-4070*DM	HM(S)-4085*DM
Overall arm length		250 (J1: 1st axis) + 300 (J2: 2nd axis) = 550 mm	350 (J1: 1st axis) + 350 (J2: 2nd axis) = 700 mm	425 (J1: 1st axis) + 425 (J2: 2nd axis) = 850 mm
Z-axis (3rd axis) vertical stroke*		* = 1: 100 mm, 2: 200 mm, 3: 300 mm		* = 2: 200 mm, 3: 300 mm
Wrist rotation angle (4th axis)		T: 540°		
Motion angle and stroke		J1 (1st axis): ±165°, J2 (2nd axis): ±138°, Z (3rd axis): 200 mm, T (4th axis): ±270°		
Axis combination		J1 (1st axis) + J2 (2nd axis) + Z (3rd axis) + T (4th axis)		
Maximum payload		10 kg		
Composite speed (Note 2)	At the center of the end-effector mounting face	7,900 mm/s (6,000 mm/s)	9,700 mm/s (7,350 mm/s)	11,000 mm/s (8,000 mm/s)
	Z and T	Z (3rd axis): 2,260 mm/s (2,000 mm/s), T (4th axis): 930/s° (709°/s)		
Position repeatability (Note 3)		At the center of the end-effector mounting face: 0.025 mm  Z (3rd axis): ±0.025 mm		At the center of the end-effector mounting face: 0.030 mm  Z (3rd axis): ±0.025 mm
Maximum force-fit		98N (one second or less)		
Maximum allowable inertia moment around T axis		0.078kgm <sup>2</sup> max. (with 10 kg payload)		
Position detection		Simplified absolute encoder		
Drive motor		AC servomotors for all axes + Gravity air balance cylinder, Z axis (3rd axis) equipped with brake		
Air source	Operating pressure	0.05 to 0.35 MPa		
	Maximum allowable pressure	0.59 MPa		
Weight		Approx. 50 kg	Approx. 55 kg	Approx. 60 kg

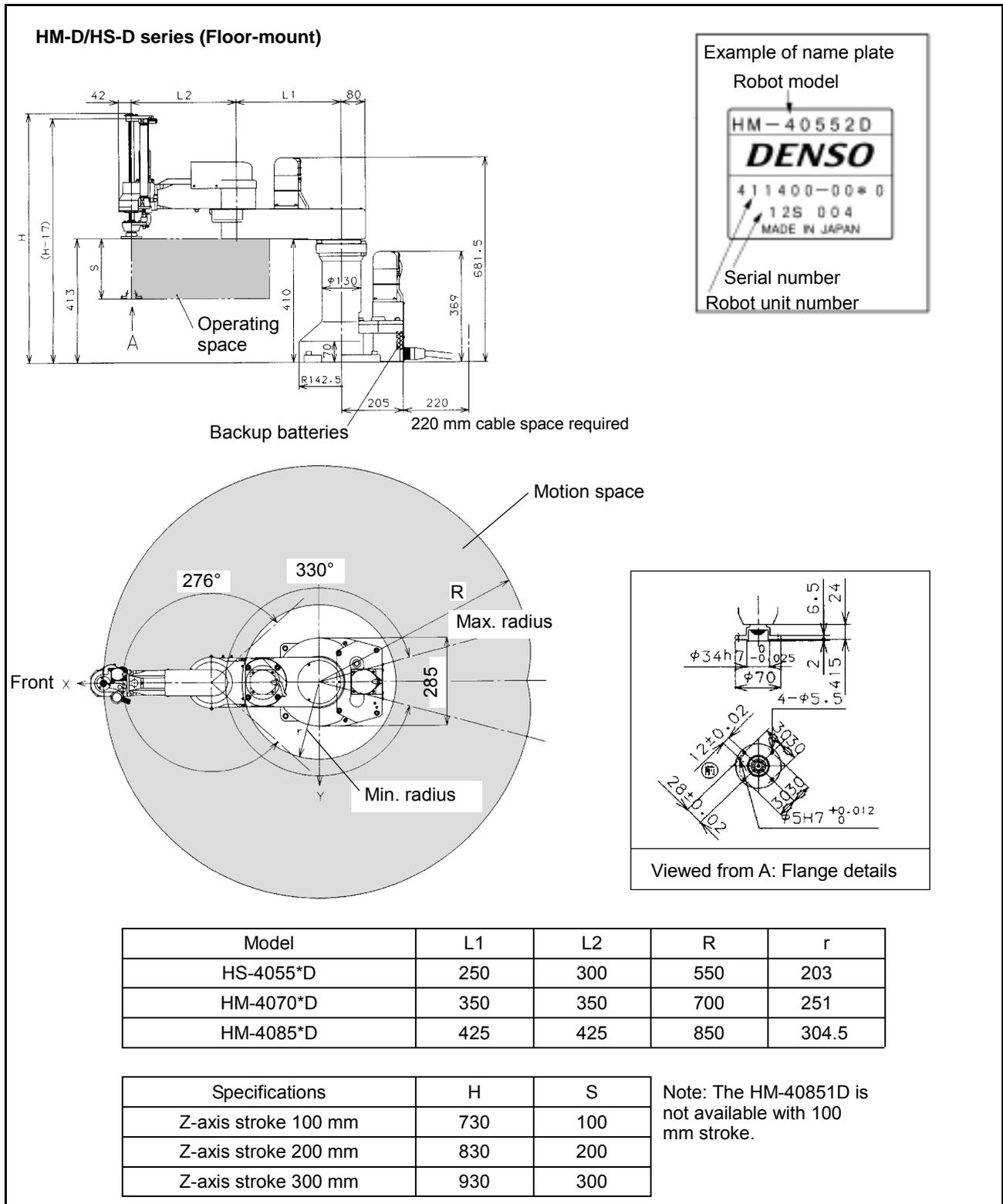
Note 1: The model of robot system refers to the model of a complete set, including a robot unit and robot controller. An asterisk (\*) in models denotes the Z-axis stroke: 1=100 mm, 2=200 mm, and 3=300 mm. The (S) in models denotes “overhead-mount” type robot.

Note 2: Values in parentheses apply when the control set of motion optimization is set to OFF.

Note 3: Provided that the ambient temperature is constant.

## [ 2 ] Outer Dimensions and Motion Space of the Robot Unit

Figures 1-6 and 1-7 show the outer dimensions and motion space of the HM-D/HS-D series.



Motion space

276°

330°

R

Max. radius

285

Min. radius

Front x

Viewed from A: Flange details

Model	L1	L2	R	r
HS-4055*D	250	300	550	203
HM-4070*D	350	350	700	251
HM-4085*D	425	425	850	304.5

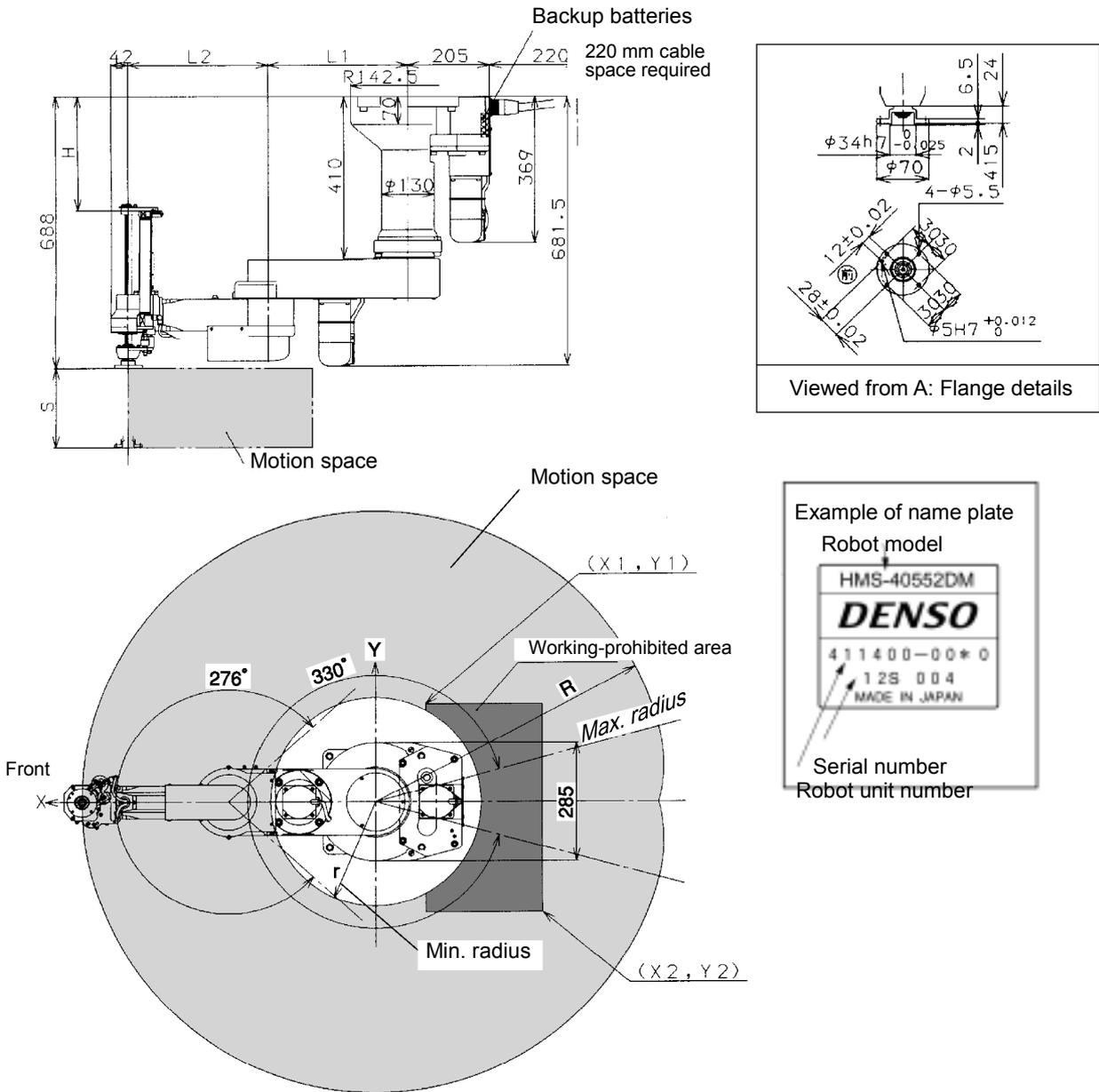
Specifications	H	S
Z-axis stroke 100 mm	730	100
Z-axis stroke 200 mm	830	200
Z-axis stroke 300 mm	930	300

Note: The HM-40851D is not available with 100 mm stroke.

**Figure 1-6 Outer Dimensions and Motion Space of Floor-mounted HM-D/HS-D Series**

### HMS-D/HSS-D series (Overhead-mount)

The working-prohibited area is determined as illustrated below where no person should work.



Model	L1	L2	R	r	X1	Y1	X2	Y2
HSS-4055*D	250	300	550	203	-61	236	-398	-266
HMS-4070*D	350	350	700	251	-120	236	-398	-266

Specifications	H	S
Z-axis stroke 100 mm	388	100
Z-axis stroke 200 mm	288	200
Z-axis stroke 300 mm	188	300

Figure 1-7 Outer Dimensions and Motion Space of Overhead-mounted HM-D/HS-D Series

### [ 3 ] Robot Positioning Time

Positioning time for the HM-D/HS-D series

1. Figures 1-9 through 1-23 show the positioning times used to calculate the cycle time.
2. Positioning time means the time from the start of robot operation to the arrival at the target positioning point.
3. After the robot moves to and passes the target positioning point, vibration will be dampened and the robot positioned at the target positioning point as shown in Figure 1-8. This vibration dampening time is not considered in the graph.

- Caution (1)** The vibration dampening time depends on factors such as the weight of the end-effector. If the robot is to be used in such a way that it overshoots or if the vibration dampening time is of great concern, test the robot carefully beforehand.
- (2)** If acceleration begins before residual vibration of the robot stops, an overcurrent error (code starts from ERROR6120; the first digit represents the axis number) may be displayed. In this case, take one of the following measures:
- Lower the deceleration of the preceding operation with a DECEL command to reduce residual vibration.
  - Keep the robot in stand-by with a DELAY command until residual vibration stops.
  - Lower acceleration with an ACCEL command.
- (3)** Operate the robot with the optimum payload setting in accordance with the end-effector weight and workpiece weight. If not, a robot failure may result.
- (4)** In the locating time graph, the Z-axis stroke of 300 mm is represented near the upper end. Near the lower end, the horizontal movement time along the J1/J2 axis increases. (Refer to p. 1-23.)

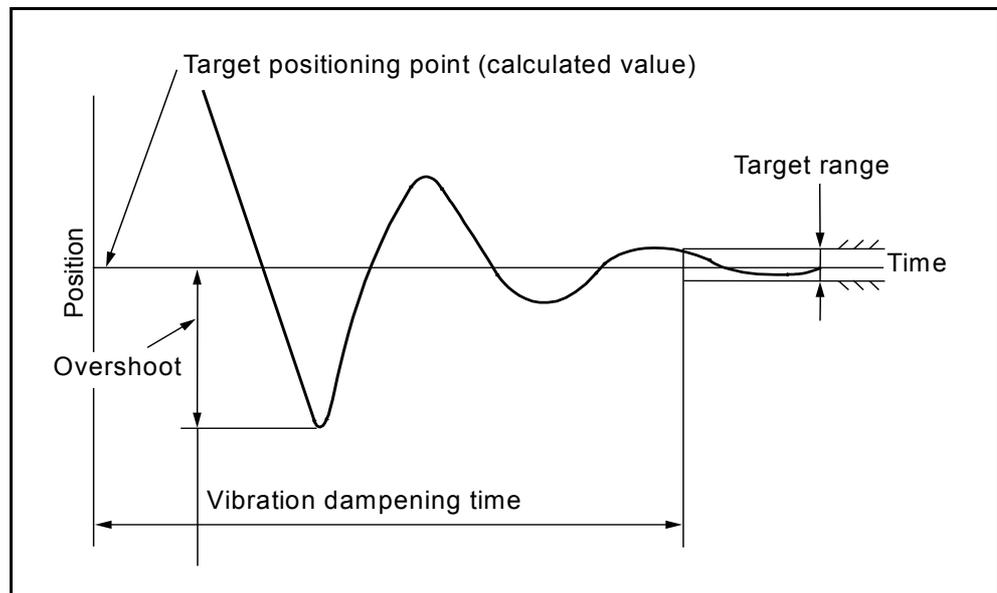


Figure 1-8 Vibration Dampening Time

(1) HM/HMS-4070\*D

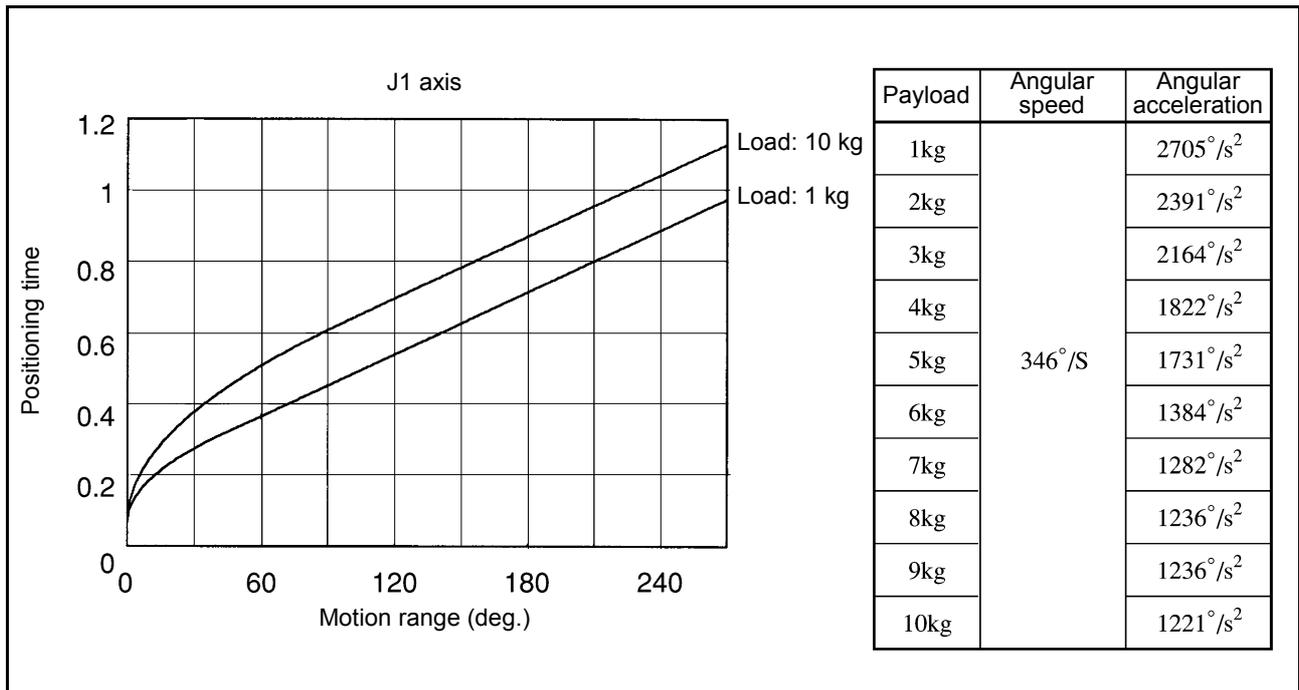


Figure 1-9 Movement of J1 axis

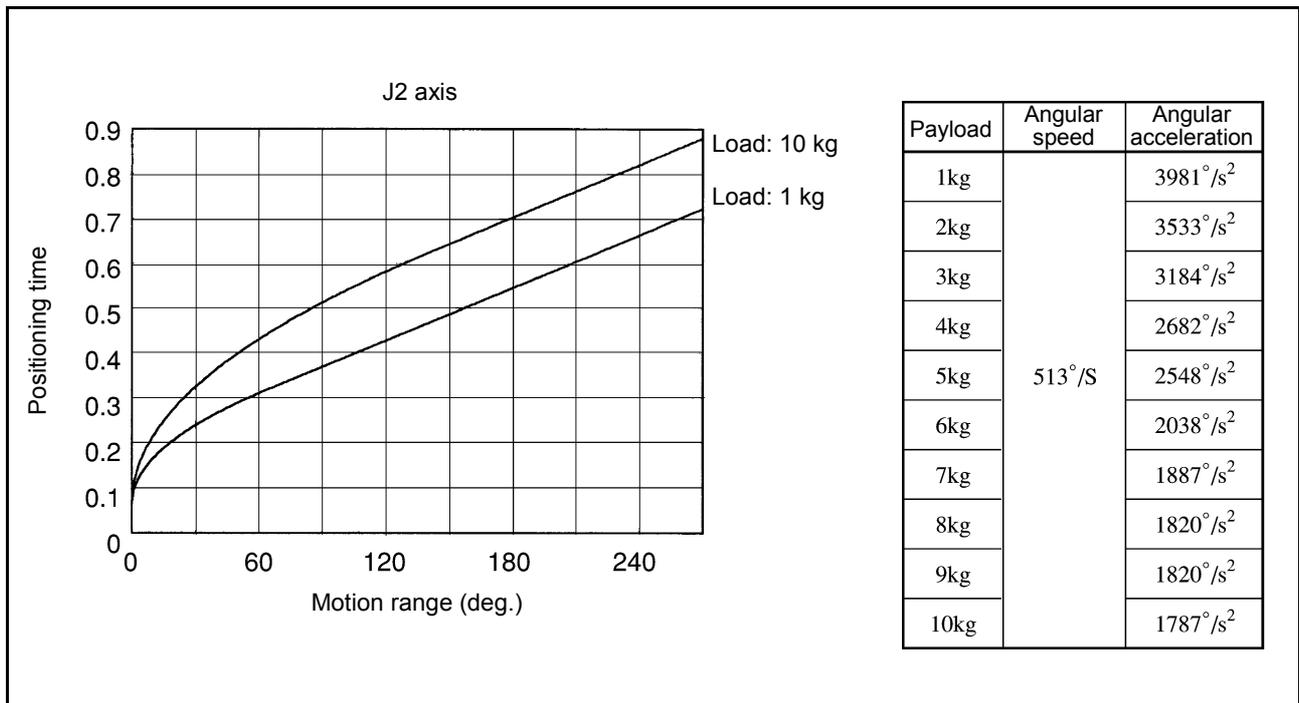


Figure 1-10 Movement of J2 axis

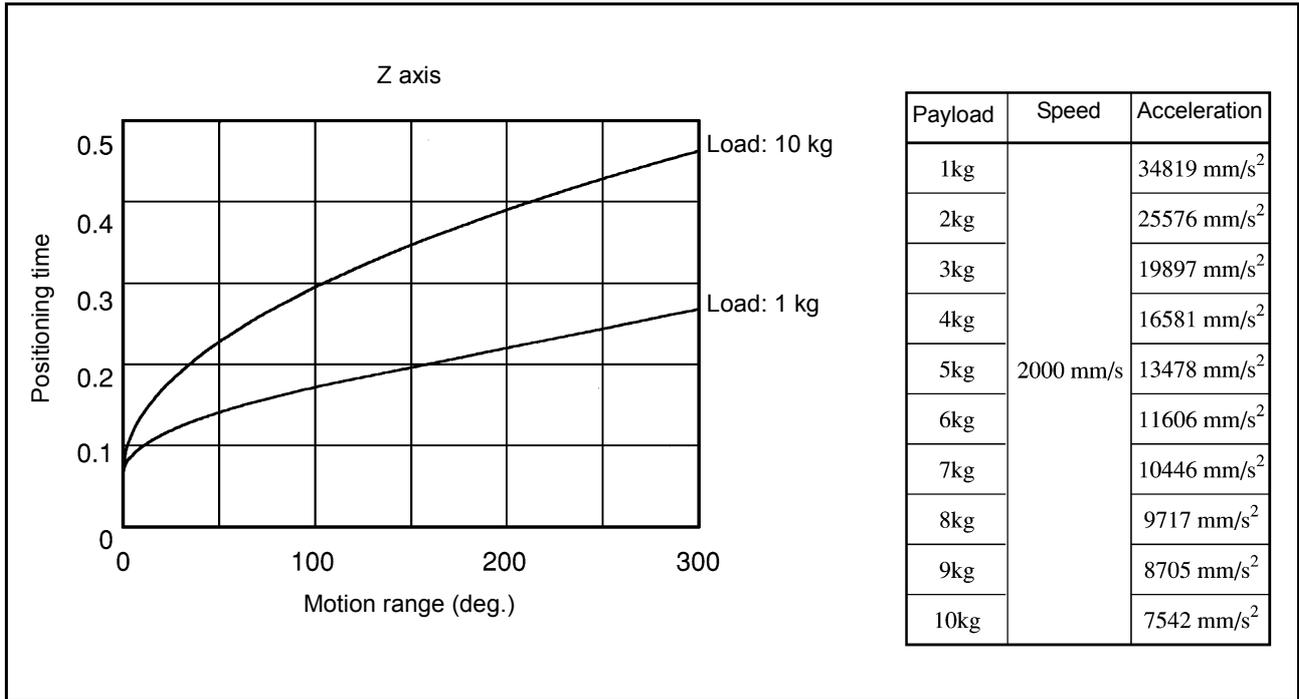


Figure 1-11 Movement of Z axis

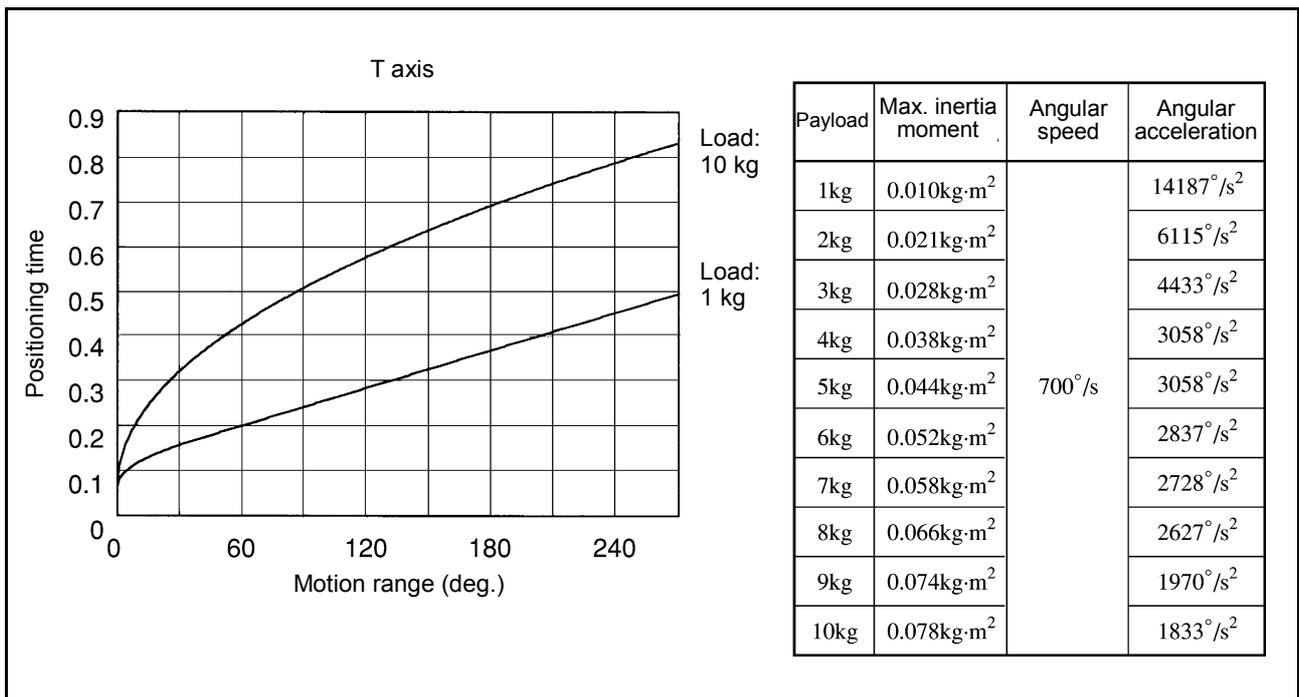
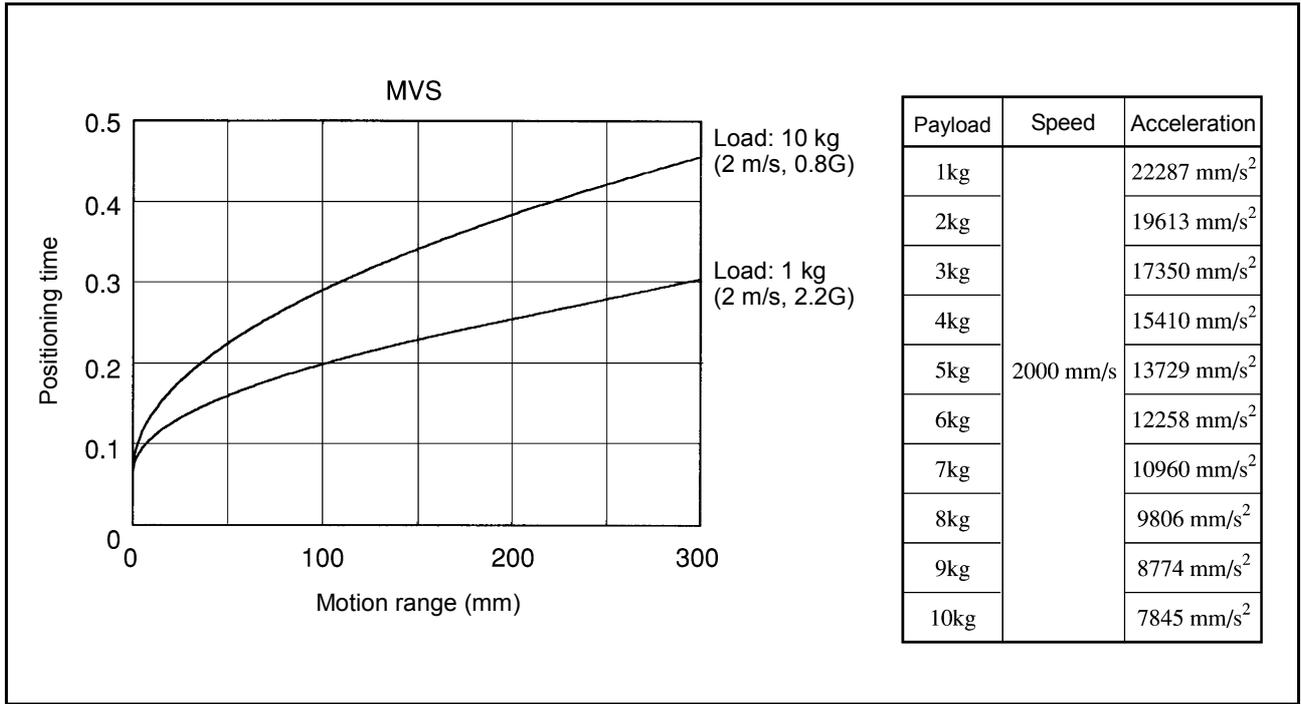
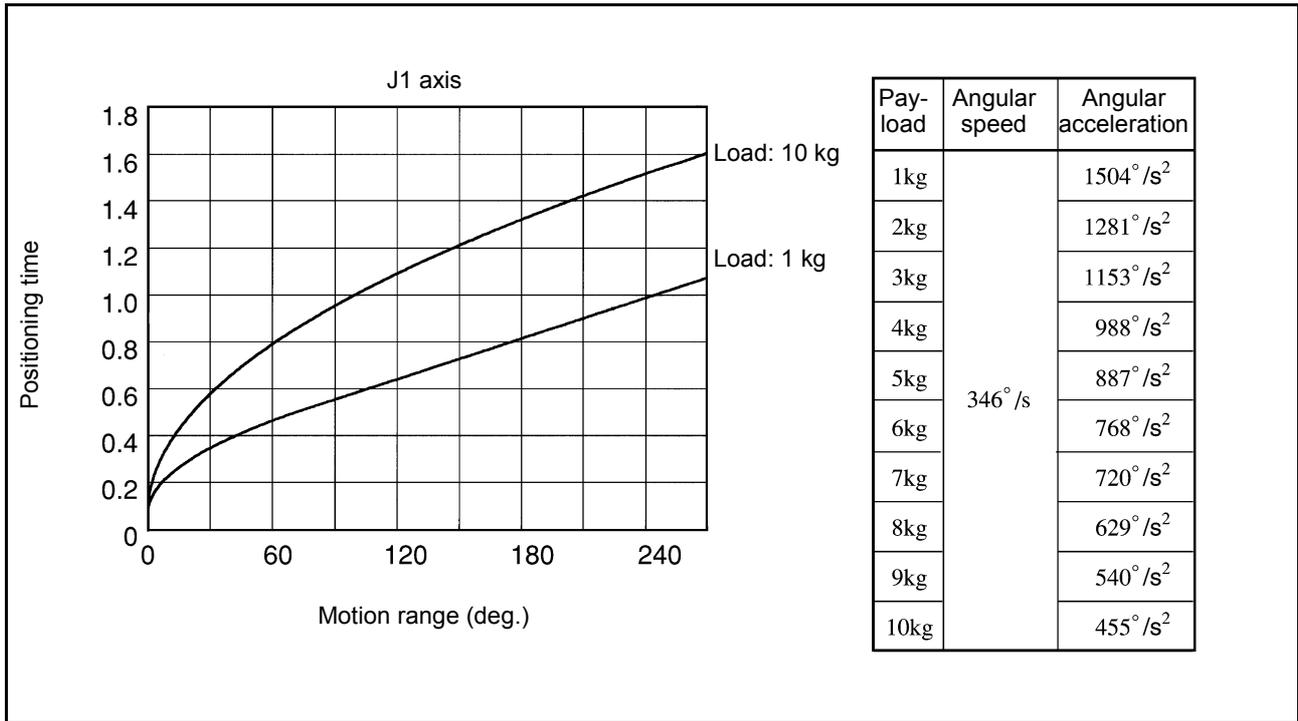


Figure 1-12 Movement of T axis

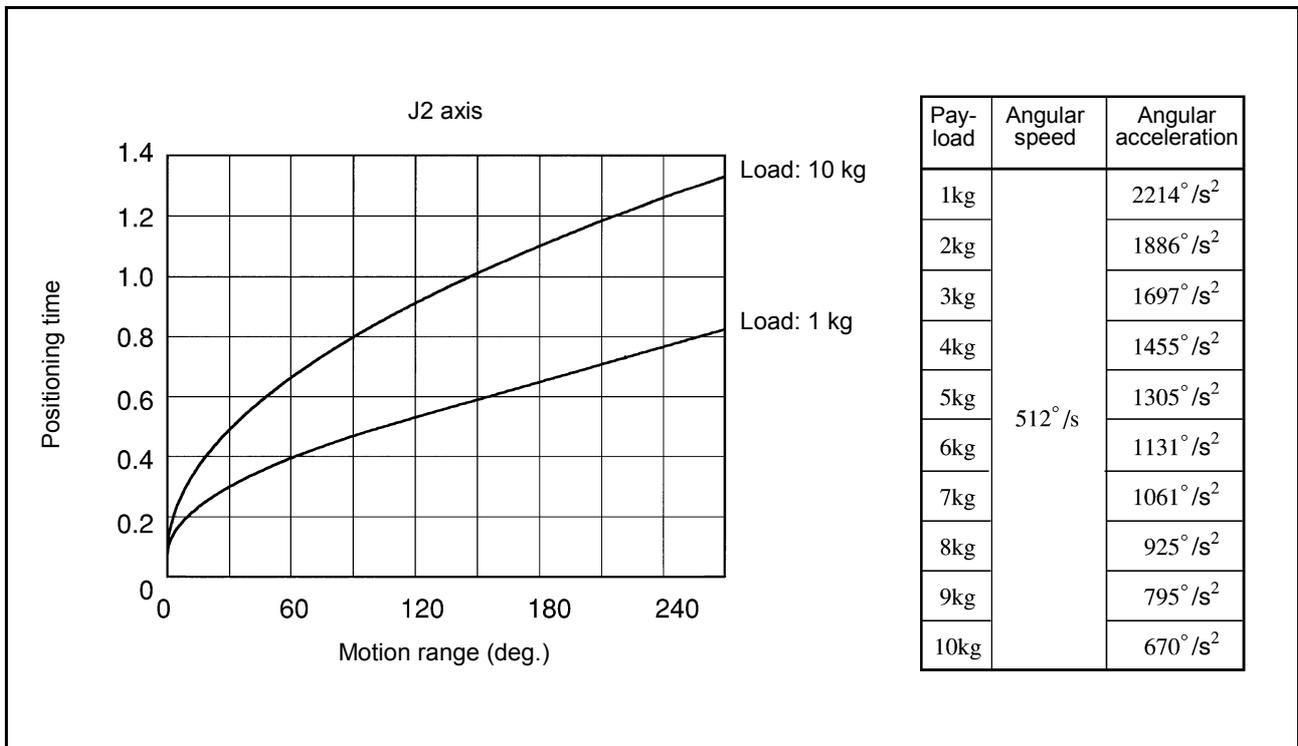


**Figure 1-13 All Axes (MV S motion)**

(2) HM-4085\*D



**Figure 1-14 Movement of J1 axis**



**Figure 1-15 Movement of J2 axis**

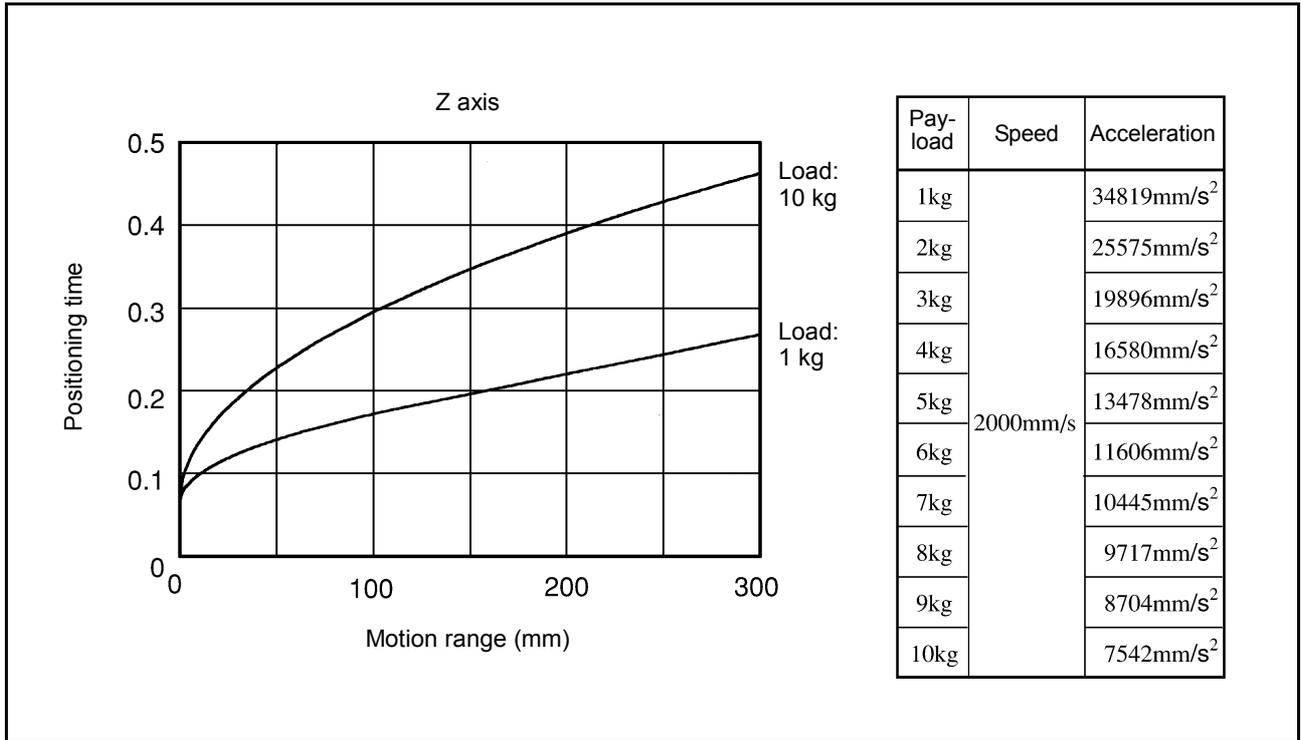


Figure 1-16 Movement of Z axis

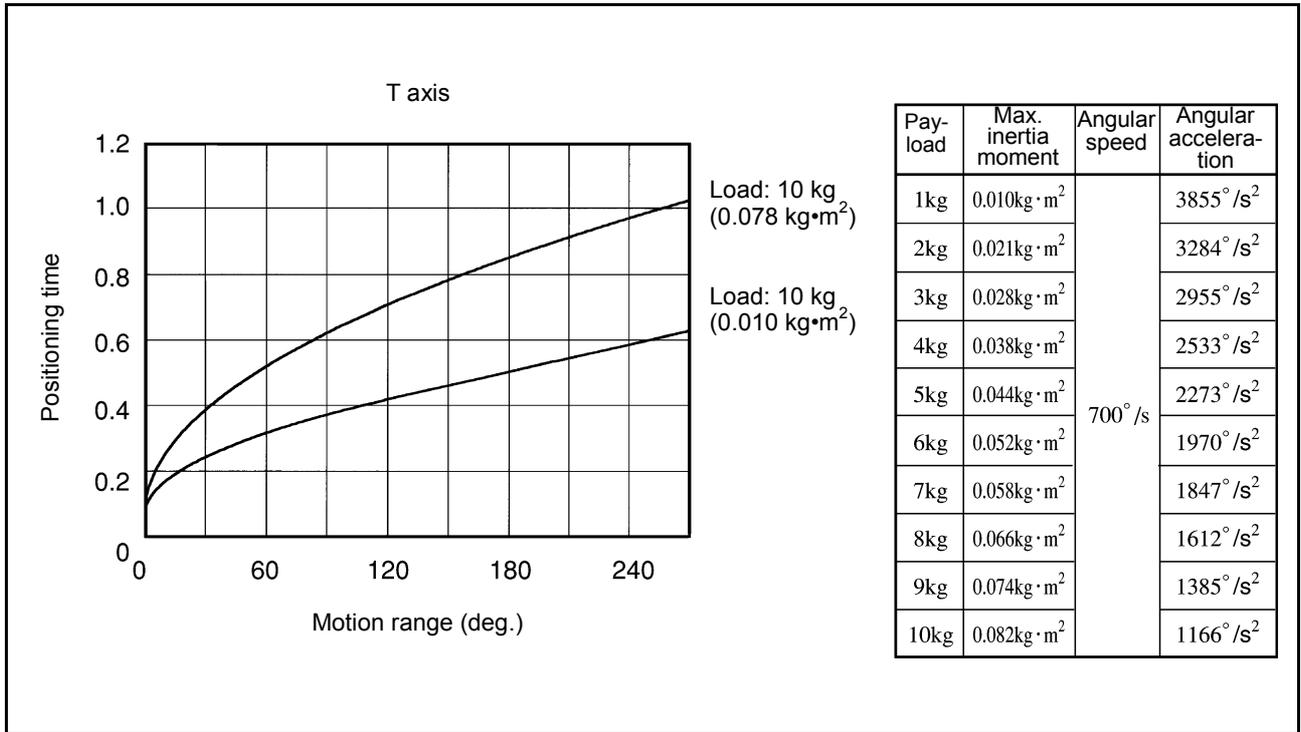


Figure 1-17 Movement of T axis

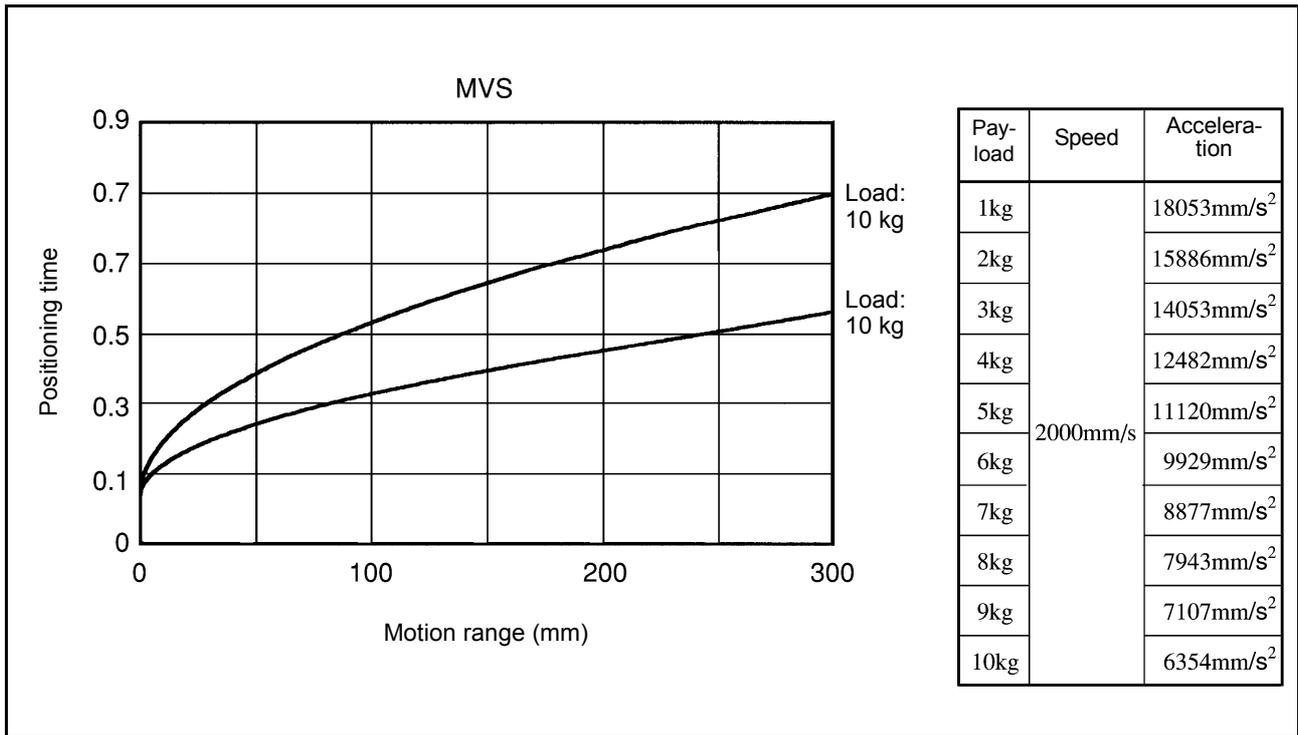
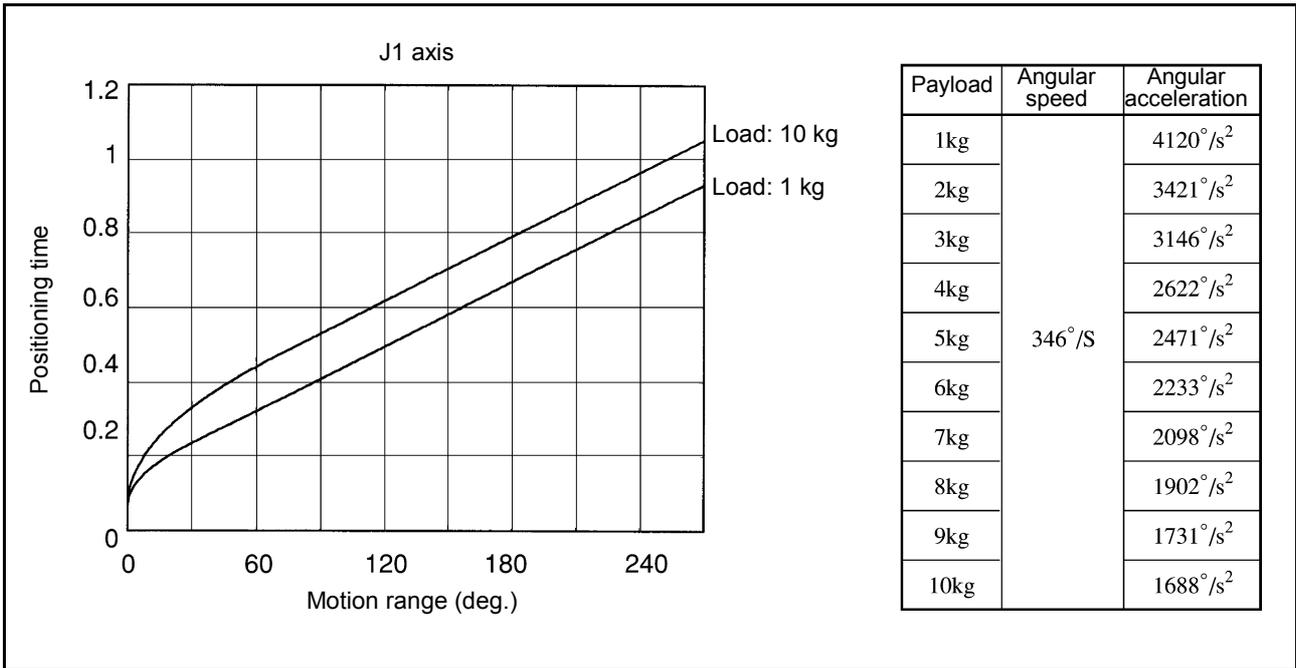
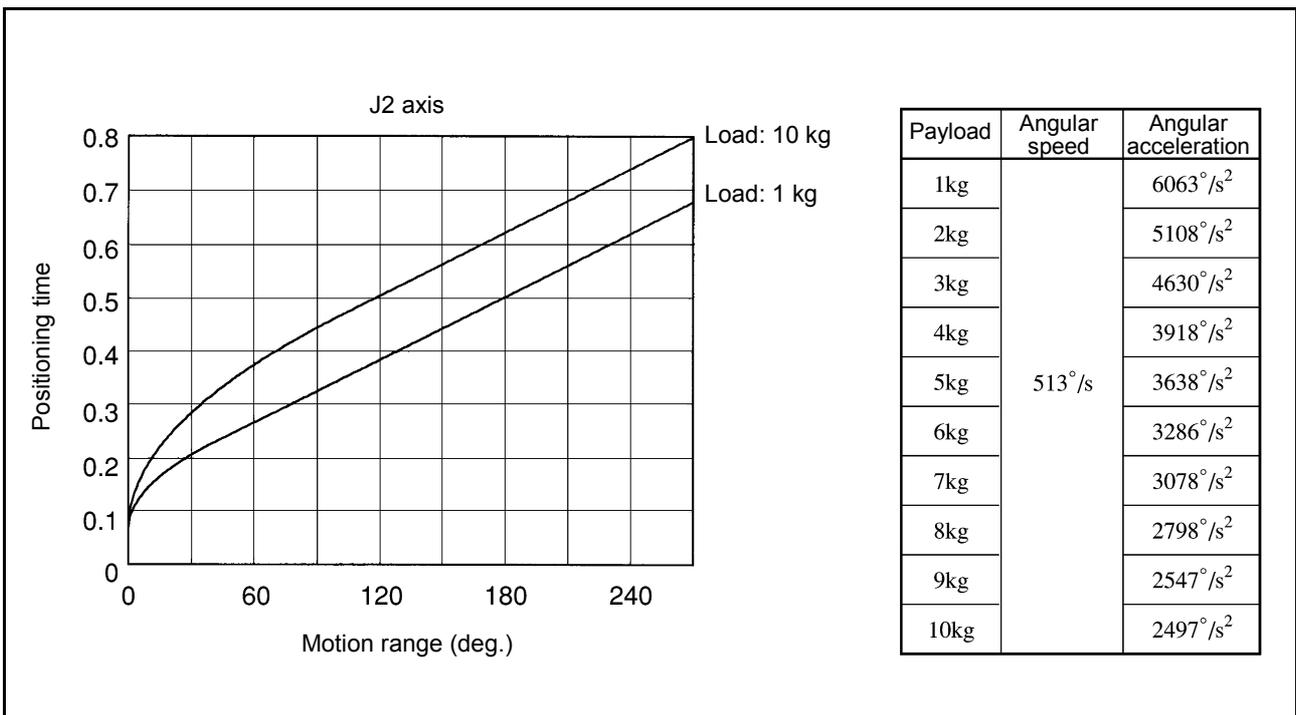


Figure 1-18 All Axes (MV S motion)

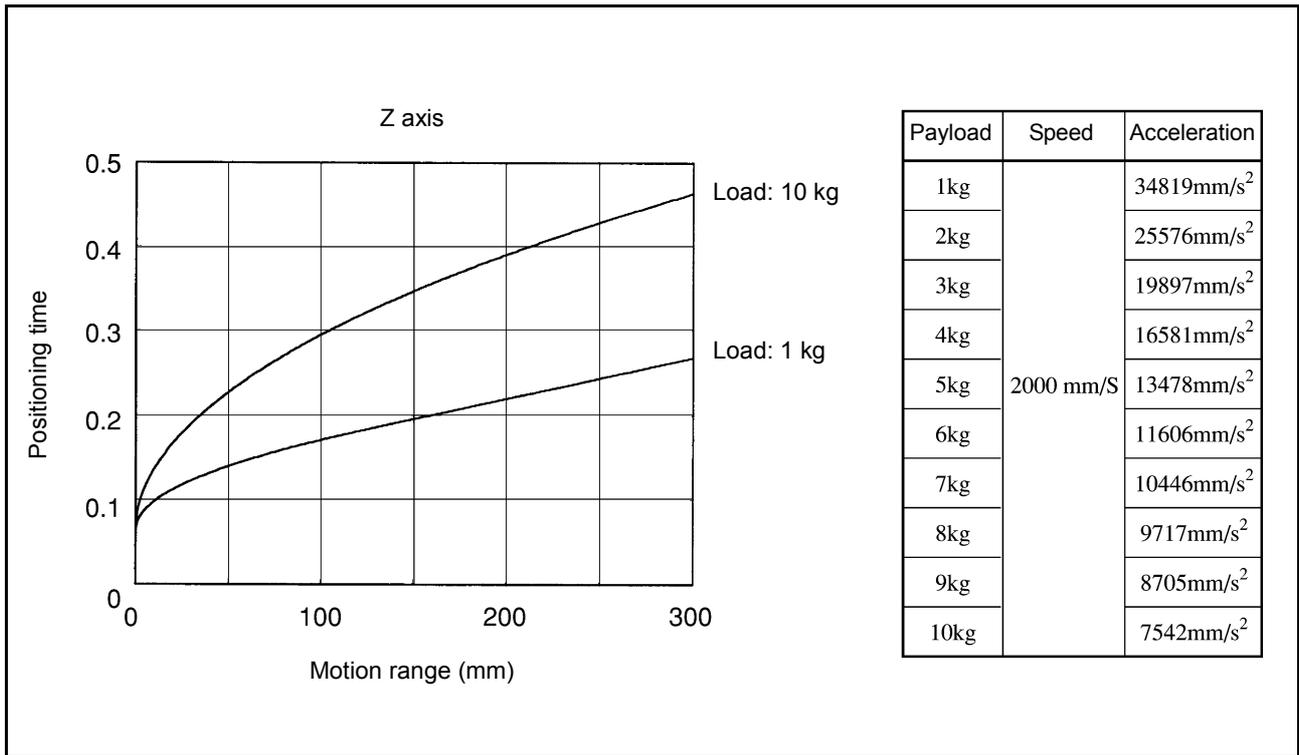
(3) HS/HSS-4055\*D



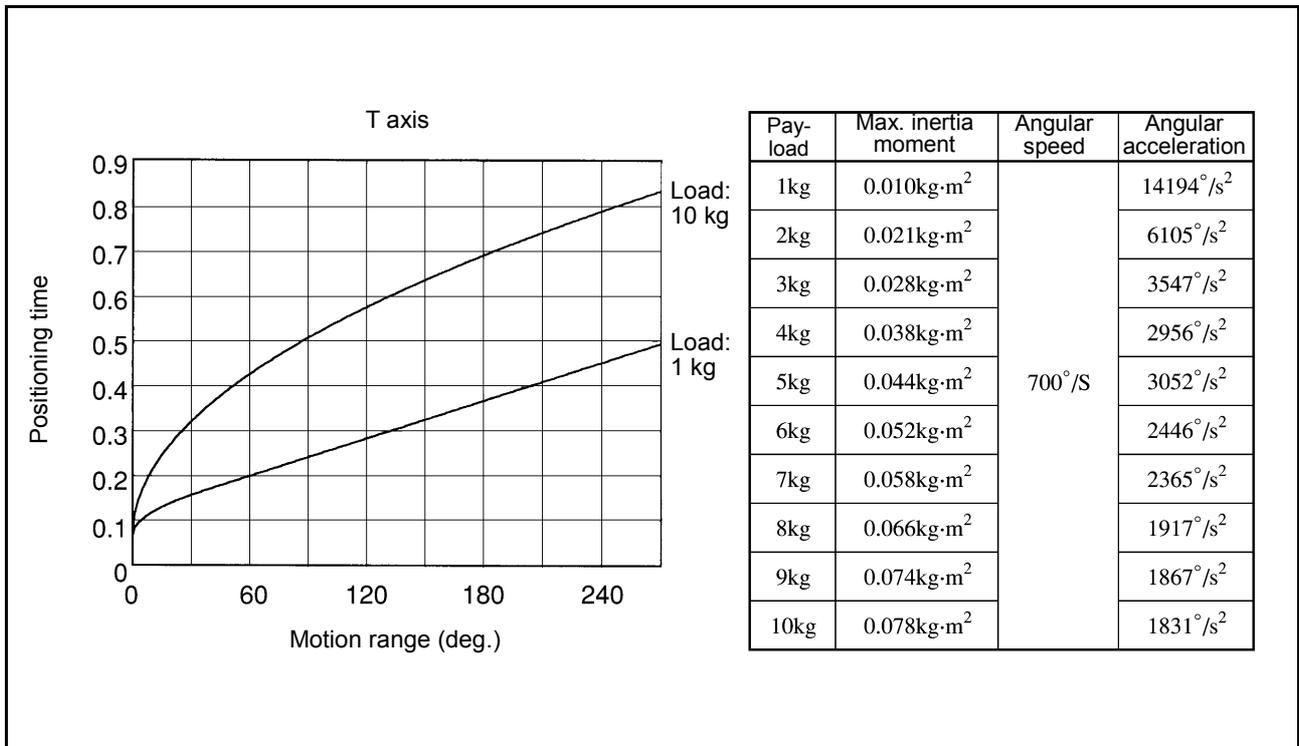
**Figure 1-19 Movement of J1 axis**



**Figure 1-20 Movement of J2 axis**



**Figure 1-21 Movement of Z axis**



**Figure 1-22 Movement of T axis**

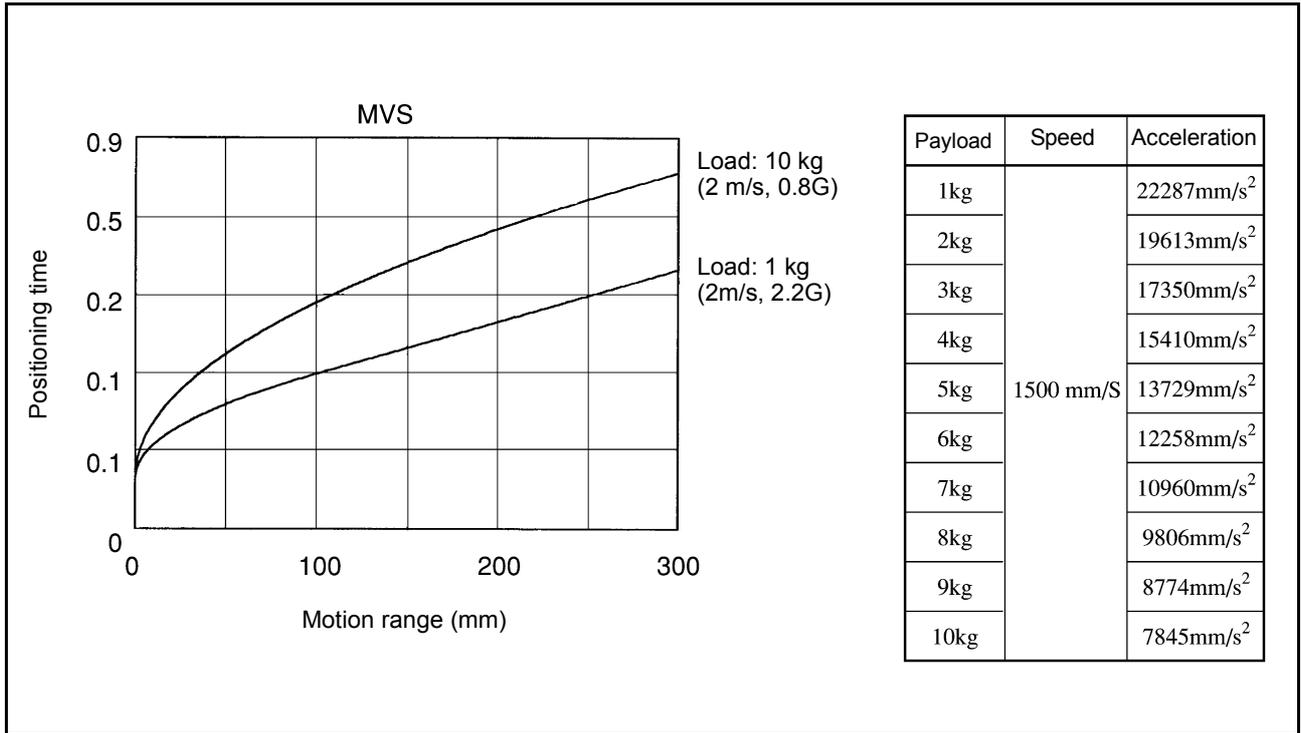


Figure 1-23 All Axes (MV S motion)

## [ 4 ] Notes for setting the positioning speed

### ■ HM-40703D/HS-40553D

- (1) When traversing the robot arm horizontally at high speeds, teach the robot so that Z axis is as close as possible to its upper end.
- (2) To stabilize positioning of Z axis near its lower end, the following maximum speed limiting control is automatically provided for J1 and J2 axes depending on the Z-axis coordinate value, only when the robot arm travels through PTP movement (P for interpolation control).

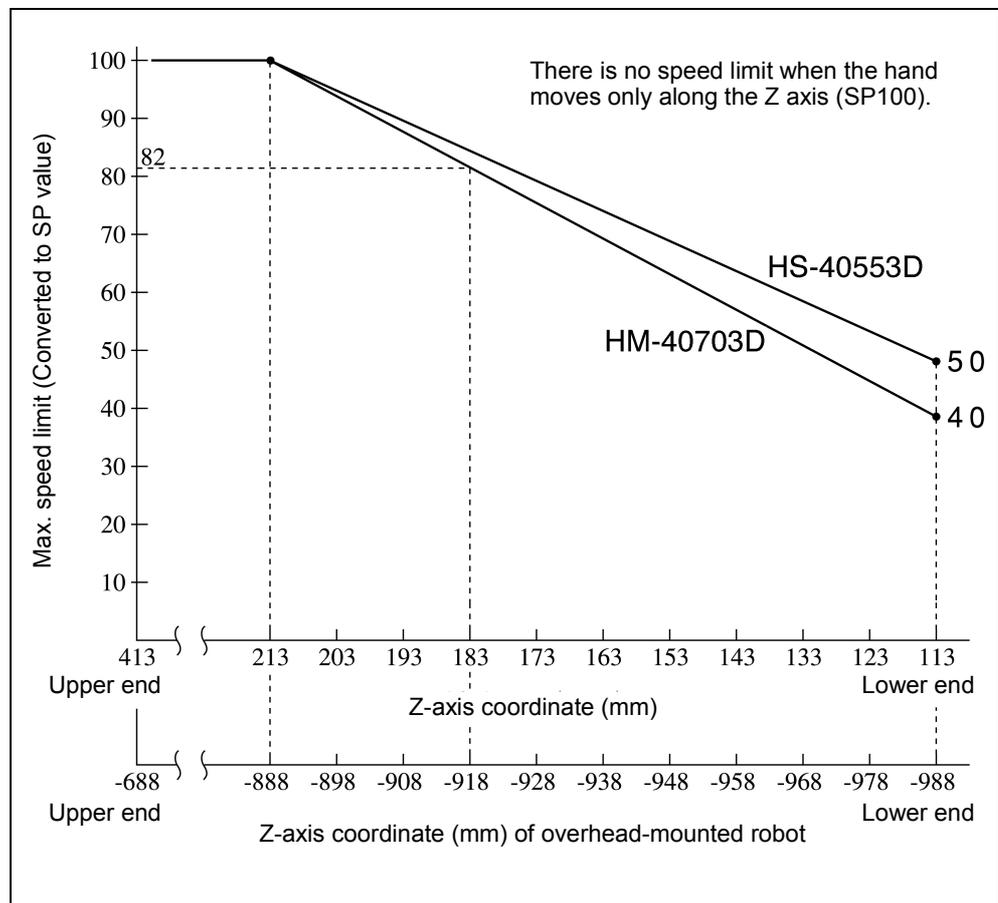
The positioning time of J1 and J2 axes shown in Figures 1-9, 1-10, 1-19, and 1-20 therefore becomes longer according to the maximum speed limit shown below.

$$\frac{[\text{Travel time given in Fig. 1-9, 1-10, 1-19, or 1-20 (sec.)}]}{\text{Max. speed limit}} \times 100 \text{ (sec.)}$$

For example, when the HM-40703D robot arm moves by SP100 from the start point (Z-axis coordinate 183 mm) to the target point (Z-axis coordinated 113 mm), the maximum speed limits are as follows:

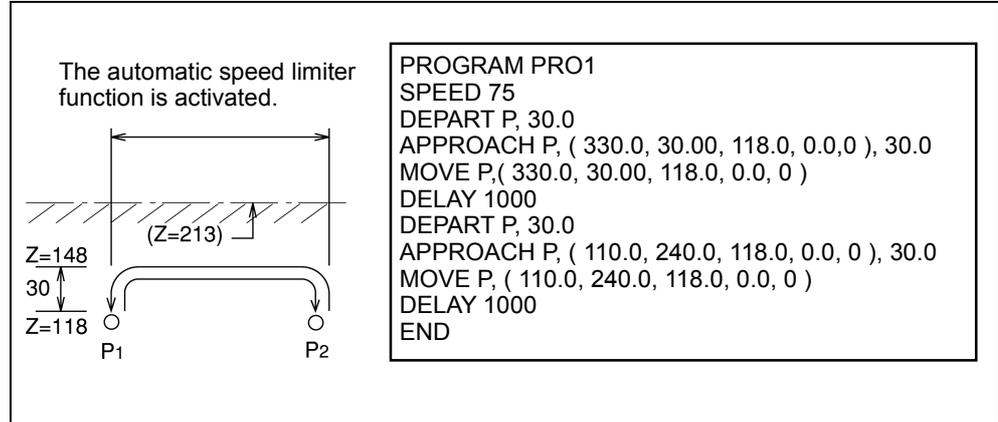
- 82 when Z-axis coordinate is 183 mm
- 40 when Z-axis coordinate is 113 mm

At this time, the maximum speed is the smaller value (at the lowest end) of 40.



- (3) The automatic speed limiter function may sometimes make the cycle time longer in an operation in the auto mode. This problem can, however, be solved to make the cycle time shorter through programming.

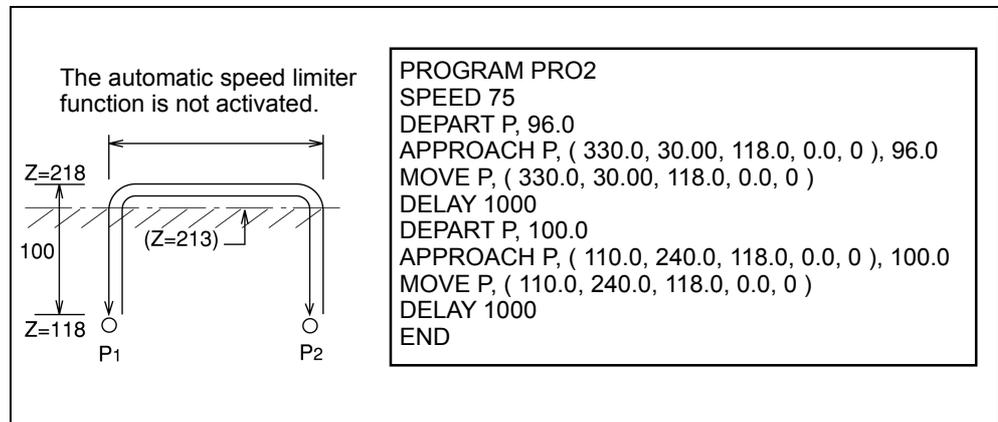
**Program example:** To pick & place from P1 to P2 as shown below, write a program shown in Figure B.



**Figure A. Motion Trajectory of Program Example 1**

**Figure B. Program Example 1**

When program example 1 runs in auto mode, the Z-axis upper end is Z = 148 mm, meaning that the automatic speed limiter function is activated when the robot makes a horizontal traverse motion, which results in a longer cycle time. To make the cycle time shorter, allow a greater up-and-down motion for Z axis as shown in Figure A'. In this case, the program looks like Figure B'.



**Figure A'. Motion Trajectory of Program Example 2**

**Figure B'. Program Example 2**

Change program example 1 into program example 2, defining a figure of 213 mm or more for the Z-axis upper end (in example 2, Z = 218 mm). This disables the automatic speed limiter function during a horizontal traverse motion. This results in a shorter cycle time than program example 1. (In the example, the cycle time is shortened by approx. 0.3 sec.)

## ■ HM-4085\*D

- (1) When traversing the robot horizontally at high speeds, teach the robot so that Z axis is as close as possible to its upper end.
- (2) To stabilize positioning of Z axis near its lower end, the following maximum speed limiting control is automatically provided for J1 and J2 axes depending on the Z-axis coordinate value, only when the robot is moved through PTP movement (MV, MVP, DRV, APR).

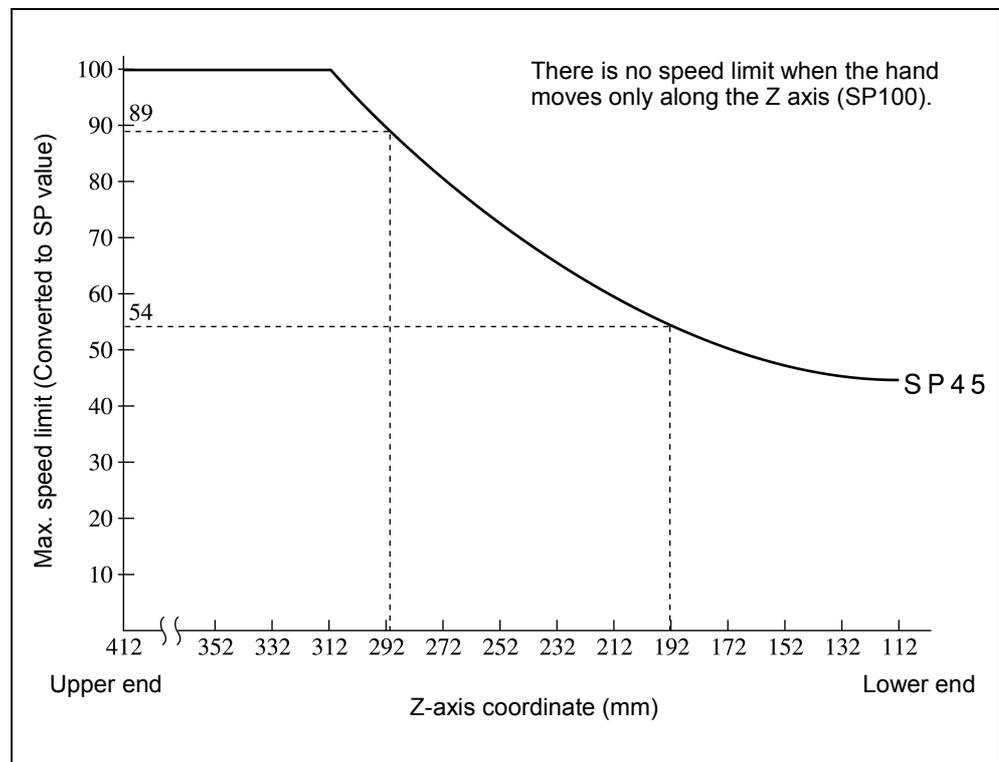
The positioning time of J1 axis and J2 axis shown in Figures 1-14 and 1-15 therefore becomes longer according to the maximum speed limit shown below.

$$\frac{[\text{Movement time given in Fig. 1-14, or 1-15 (sec.)}]}{\text{Max. speed limit}} \times 100 \text{ (sec.)}$$

For example, when the HM-40853D robot arm moves by SP100 from the start point (Z-axis coordinate 292 mm) to the target point (Z-axis coordinated 192 mm), the maximum speed limits are as follows:

89 when Z-axis coordinate is 292 mm  
54 when Z-axis coordinate is 192 mm

At this time, the maximum speed is the smaller value (at the lowest end) of 54.



## [ 5 ] Air piping and signal wiring

The HM-D/HS-D series robot is provided with 4 air pipes for air chuck and 2 sets of 12 hand control signal lines. The overhead-mount robot has the same piping/wiring arrangements but they are upside down.

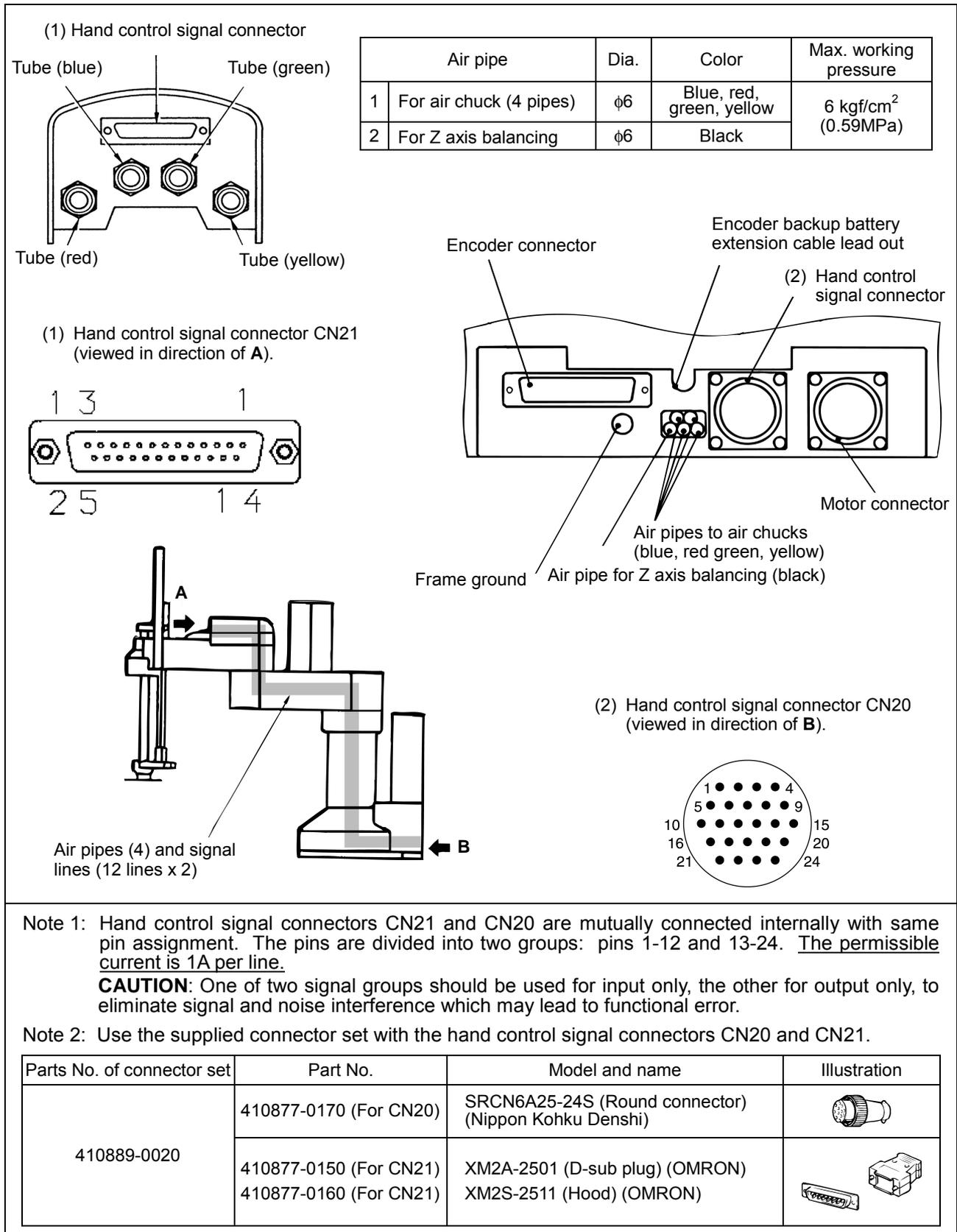


Figure 1-24 Air Piping and Signal Wiring, Inside Robot Unit

## ■ HC-D Series

### [ 1 ] Robot Unit Specifications

Table 1-6 lists the robot unit specifications of the HC-D series.

**Table 1-6 Robot Unit Specifications of the HC-D Series**

Model of robot system (Note 1)	HC-4545*D	HC-4245*D	HC-4555*D	HC-4255*D
Model of robot unit	HC-4545*DM	HC-4245*DM	HC-4555*DM	HC-4255*DM
Overall arm length	225 (J1: 1st axis) + 225 (J2: 2nd axis) = 450 mm		225 (J1: 1st axis) + 325 (J2: 2nd axis) = 550 mm	
Vertical stroke*	* = 1: 150 mm, 2: 250mm			
Wrist rotation angle	±360°			
Motion angle and stroke	J1 (1st axis): ±155°, J2 (2nd axis): ±138°, Z (3rd axis): 150 mm (250 mm), T (4th axis): ±360°			
Axis combination	J1 (1st axis) + J2 (2nd axis) + Z (3rd axis) + T (4th axis)			
Maximum payload	5 kg			
Composite speed at the center of the end-effector mounting face	4750 mm/s (Z: 1360 mm, T: 803°/s)	4750 mm/s (Z: 1360 mm, T: 1687°/s)	6150 mm/s (Z: 1360 mm, T: 803°/s)	6150 mm/s (Z: 1360 mm, T: 1687°/s)
Position repeatability (Note 2)	At the center of the end-effector mounting face (incl. wrist): ±0.025 mm Z (3rd axis): ±0.025 mm			
Maximum force-fit	98N (10 seconds or less)			
Maximum allowable inertia moment	0.044 kgm <sup>2</sup> (with 5 kg payload)	0.025 kgm <sup>2</sup> (with 5 kg payload)	0.044 kgm <sup>2</sup> (with 5 kg payload)	0.025 kgm <sup>2</sup> (with 5 kg payload)
Position detection	Simplified absolute encoder			
Drive motor	AC servomotors for all axes + Gravity air balance cylinder, Z axis equipped with brake			
User air piping	6 systems (Φ4), 3 solenoid valves (2-position, double solenoid) contained.			
User signal line	10 (for proximity sensor signals, etc.)			
Maximum movement in calibration	At the center of the end-effector mounting face: 0.6 mm Wrist rotation: 0.08°	At the center of the end-effector mounting face: 0.6 mm Wrist rotation: 0.16°	At the center of the end-effector mounting face: 0.7 mm Wrist rotation: 0.08°	At the center of the end-effector mounting face: 0.7 mm Wrist rotation: 0.16°
Air source	Operating pressure	For gravity balance: 0.05 to 0.35 MPa For valves: 0.1 to 0.59 MPa		
	Maximum allowable pressure	0.59 MPa		
Weight	Approx. 35 kg		Approx. 38 kg	

Note 1: The model of robot system refers to the model of a complete set, including a robot unit and robot controllers.

Note 2: Provided that the ambient temperature is constant.

## [ 2 ] Outer Dimensions and Motion Space of the Robot Unit

Figure 1-25 shows the outer dimensions and motion space of the HC-D series. For the installation of the robot basement, refer to Section 2.2, "Installing the Robot Unit," ■ HC-D Series, "[ 2 ] Installing the Robot."

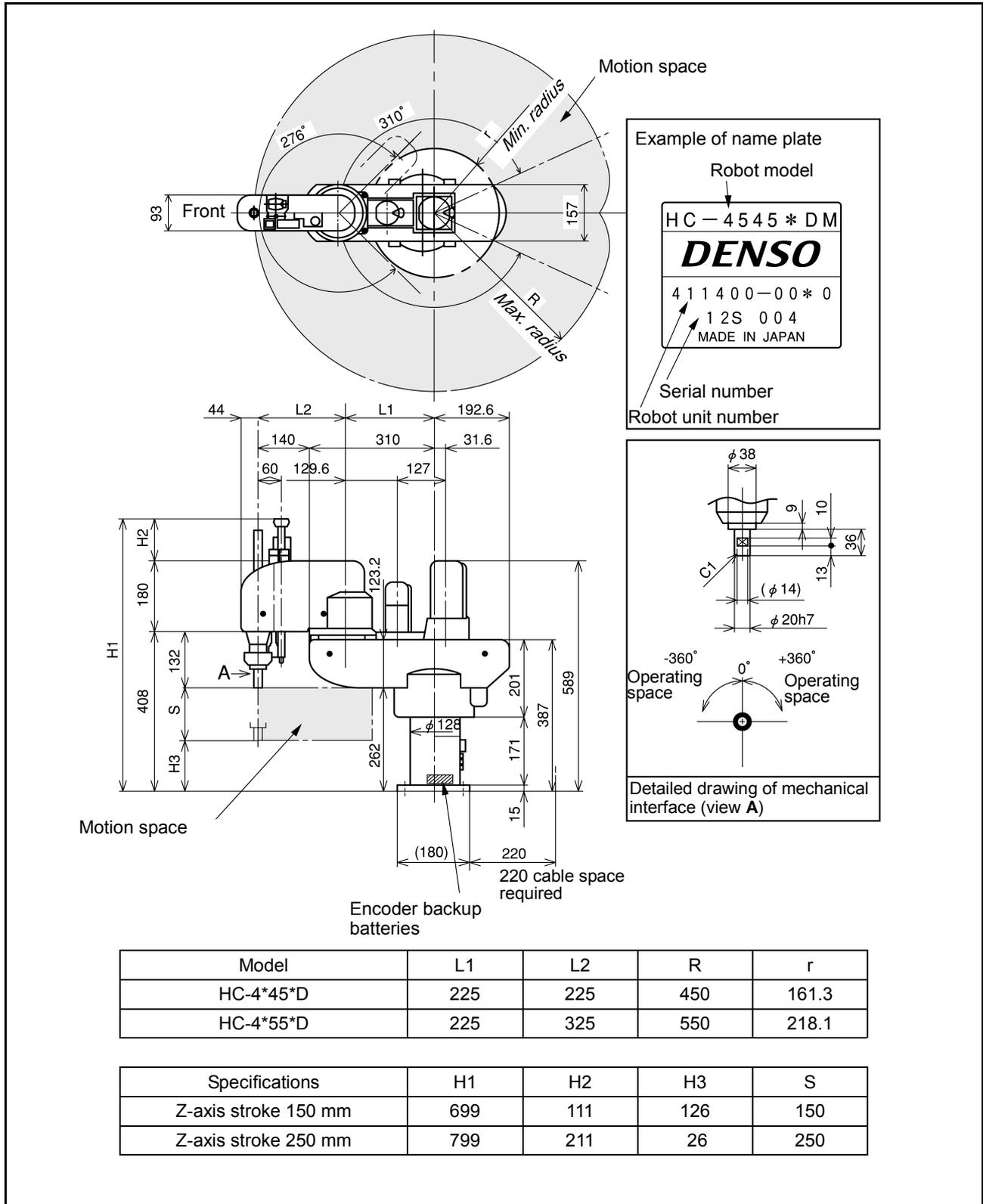


Figure 1-25 Outer Dimensions and Motion Space of HC-D Series

## [ 3 ] Robot Positioning Time

Positioning time for the HC-D series

1. Figures 1-27 through 1-36 show the positioning times used to calculate the cycle time.
2. Positioning time means the time from the start of robot operation to the arrival at the target positioning point.
3. After the robot moves to and passes the target positioning point, vibration will be dampened and the robot positioned at the target positioning point as shown in Figure 1-26. This vibration dampening time is not considered in the graph.

- Caution (1)** The vibration dampening time depends on factors such as the weight of the end-effector. If the robot is to be used in such a way that it overshoots or if the vibration dampening time is of great concern, test the robot carefully beforehand.
- (2)** If acceleration begins before residual vibration of the robot stops, an overcurrent error (code starts from ERROR6120; the first digit represents the axis number) may be displayed. In this case, take one of the following measures:
- Lower the deceleration of the preceding operation with a DECEL command to reduce residual vibration.
  - Keep the robot in stand-by with a DELAY command until residual vibration stops.
  - Lower acceleration with an ACCEL command.
- (3)** Operate the robot with the optimum payload setting in accordance with the end-effector weight and workpiece weight. If not, a robot failure may result.
- (4)** In the locating time graph, the Z-axis stroke of 250 mm is represented near the upper end. Near the lower end, the horizontal movement time along the J1/J2 axis increases. (Refer to p.1-36.)
- (5)** The T-axis positioning time differs depending upon the robot specifications.  
For the HC-4545\*D, see Figure 1-29.  
For the HC-4245\*D, see Figure 1-30.  
For the HC-4555\*D, see Figure 1-34.  
For the HC-4255\*D, see Figure 1-35.

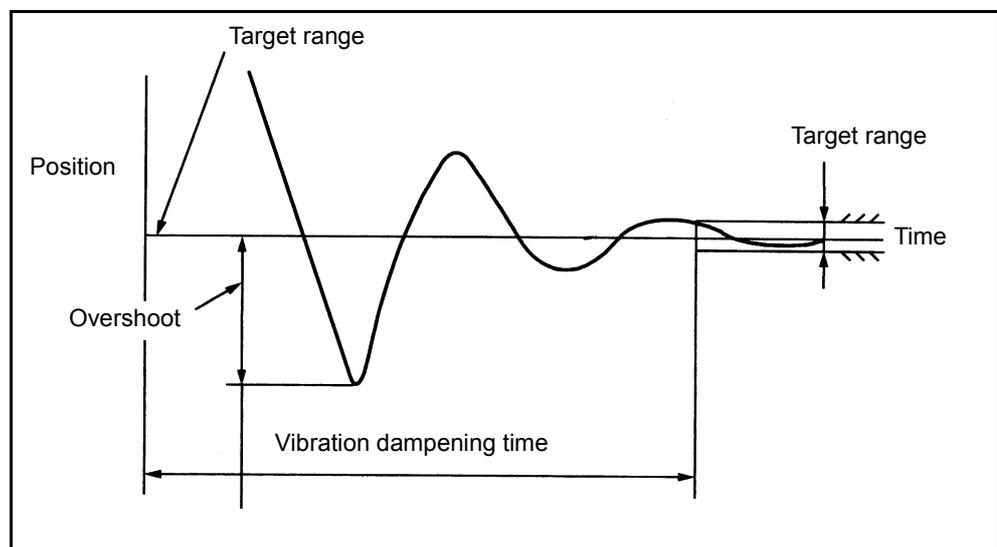


Figure 1-26 Vibration Dampening Time

(1) HC-4\*45\*D

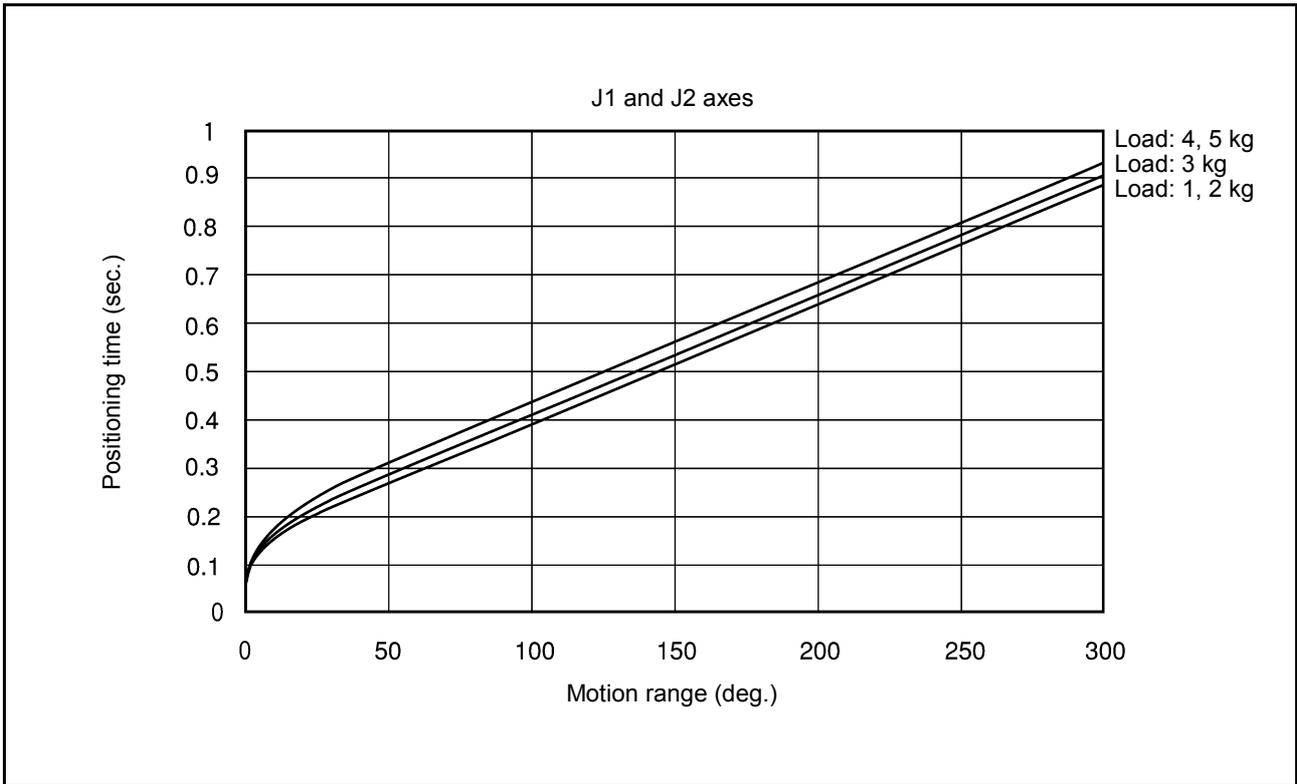


Figure 1-27 Movements of J1 and J2 Axes

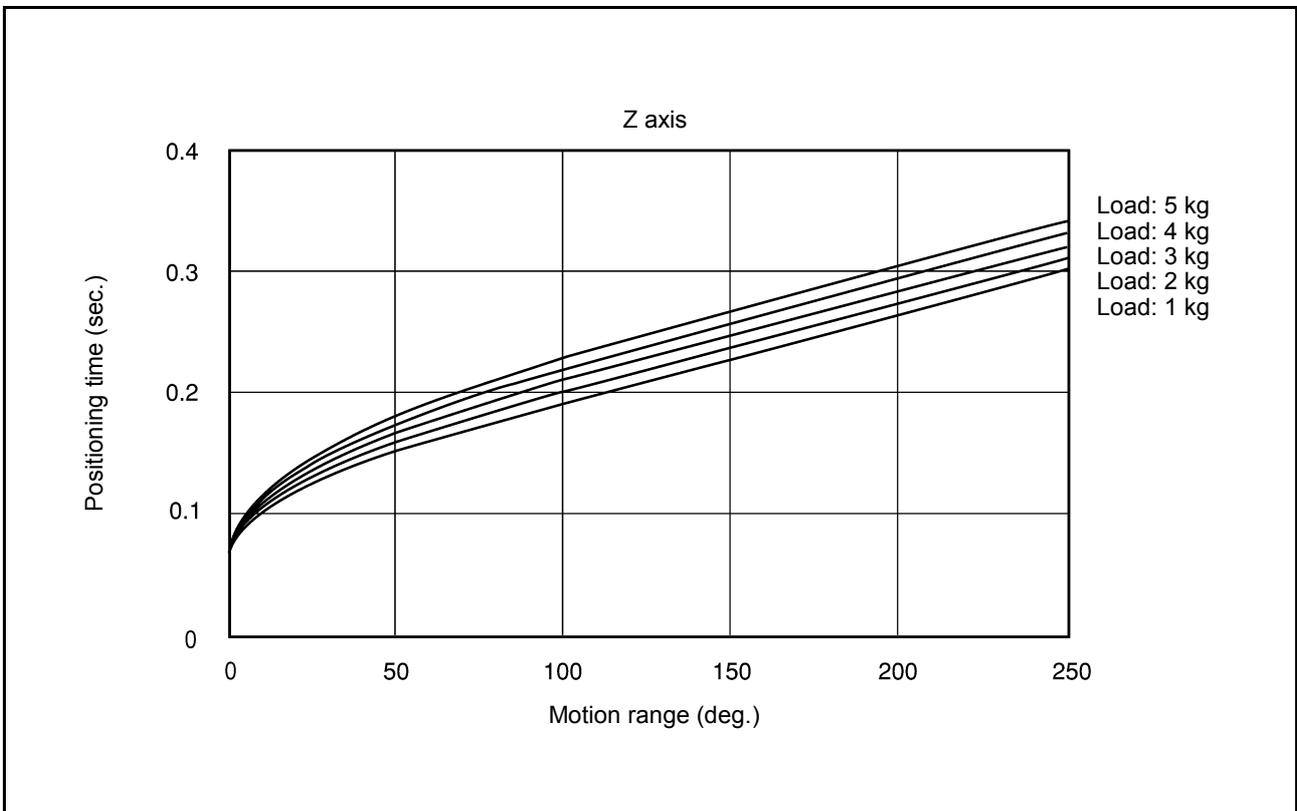
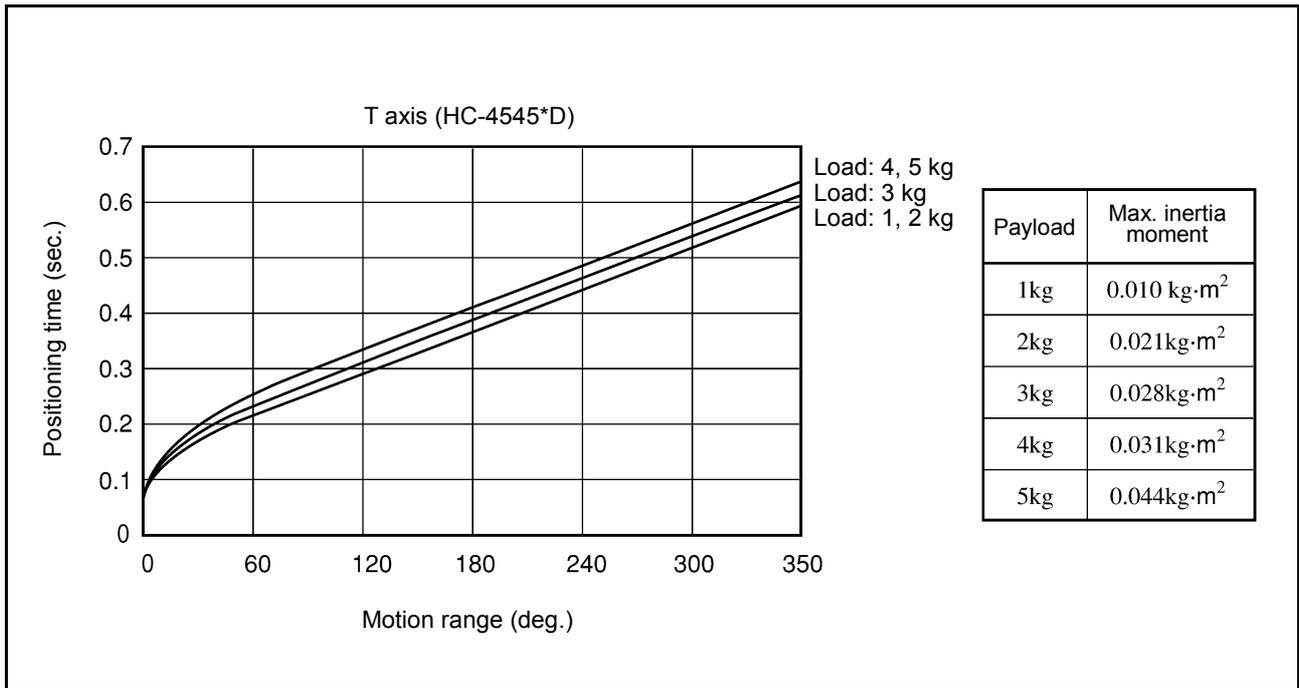
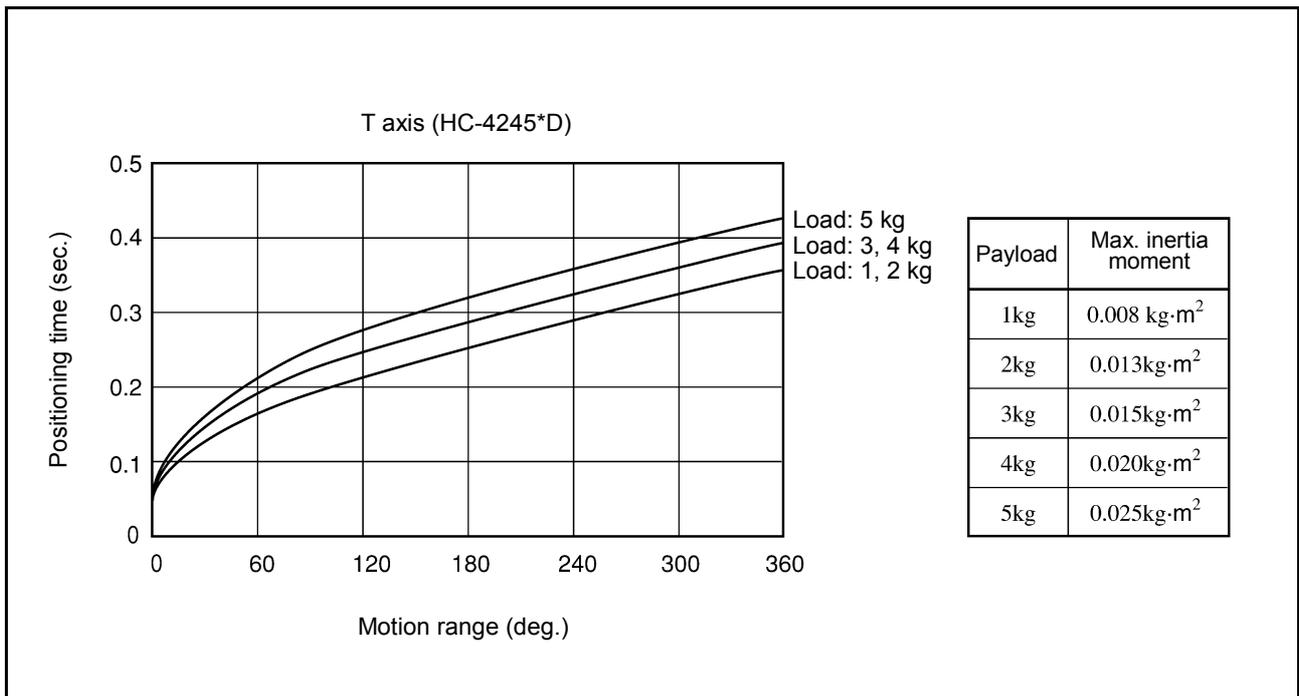


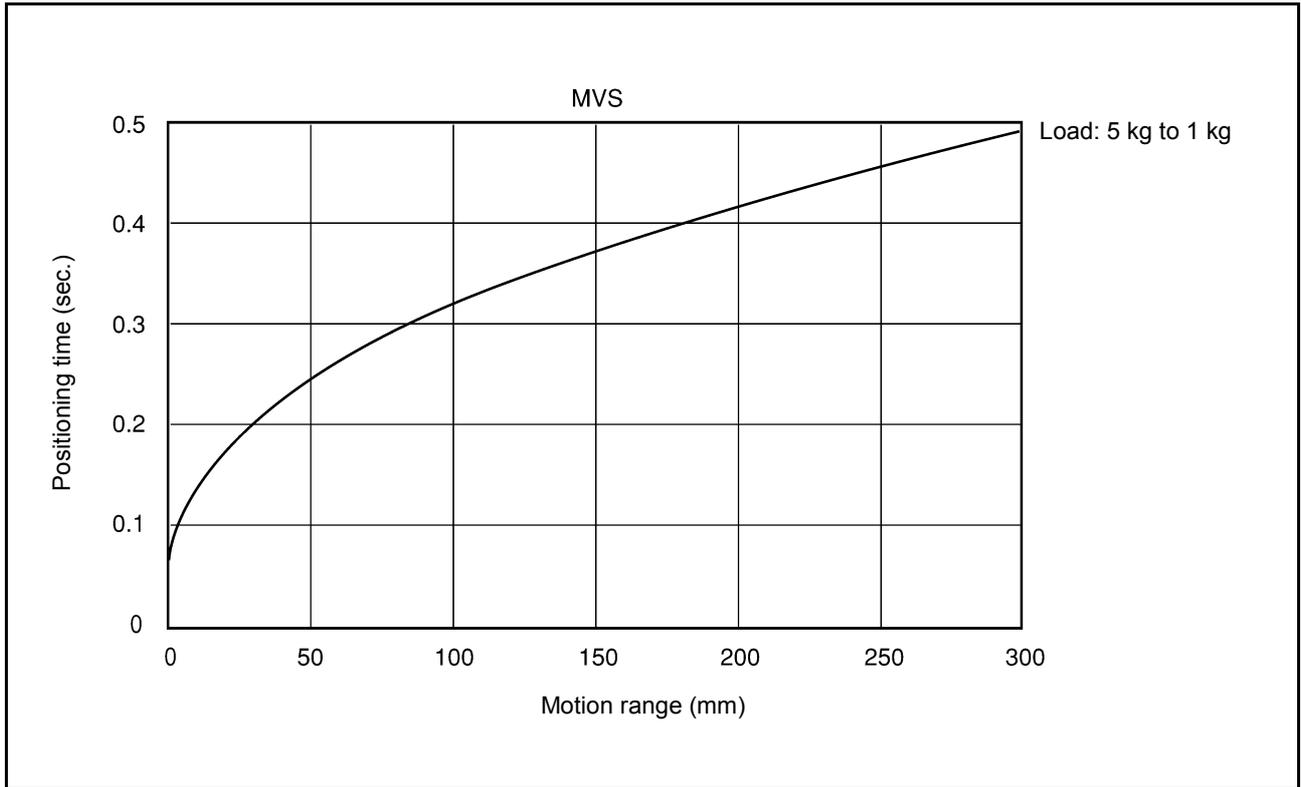
Figure 1-28 Movement of Z axis



**Figure 1-29 Movement of T axis**



**Figure 1-30 Movement of T axis**



**Figure 1-31 All Axes (MV S motion)**

(2) HC-4\*55\*D

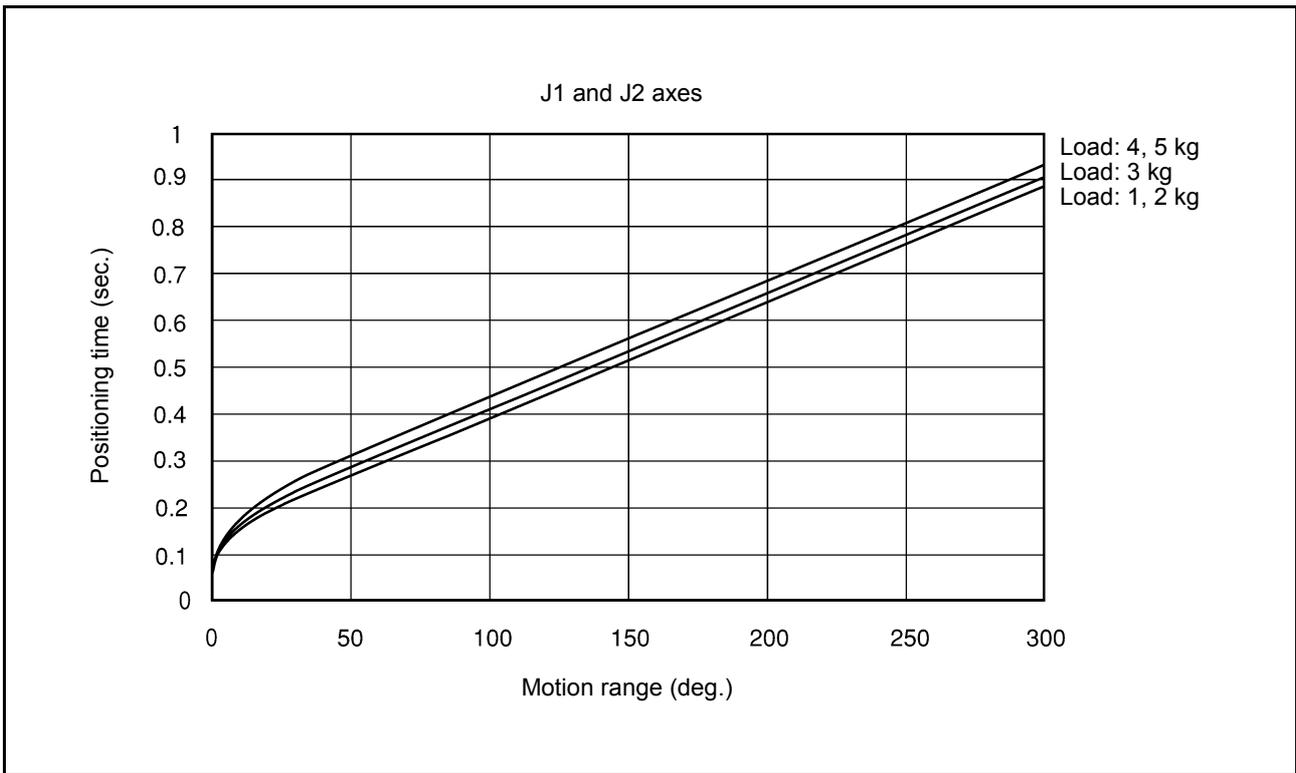


Figure 1-32 Movements of J1 and J2 Axes

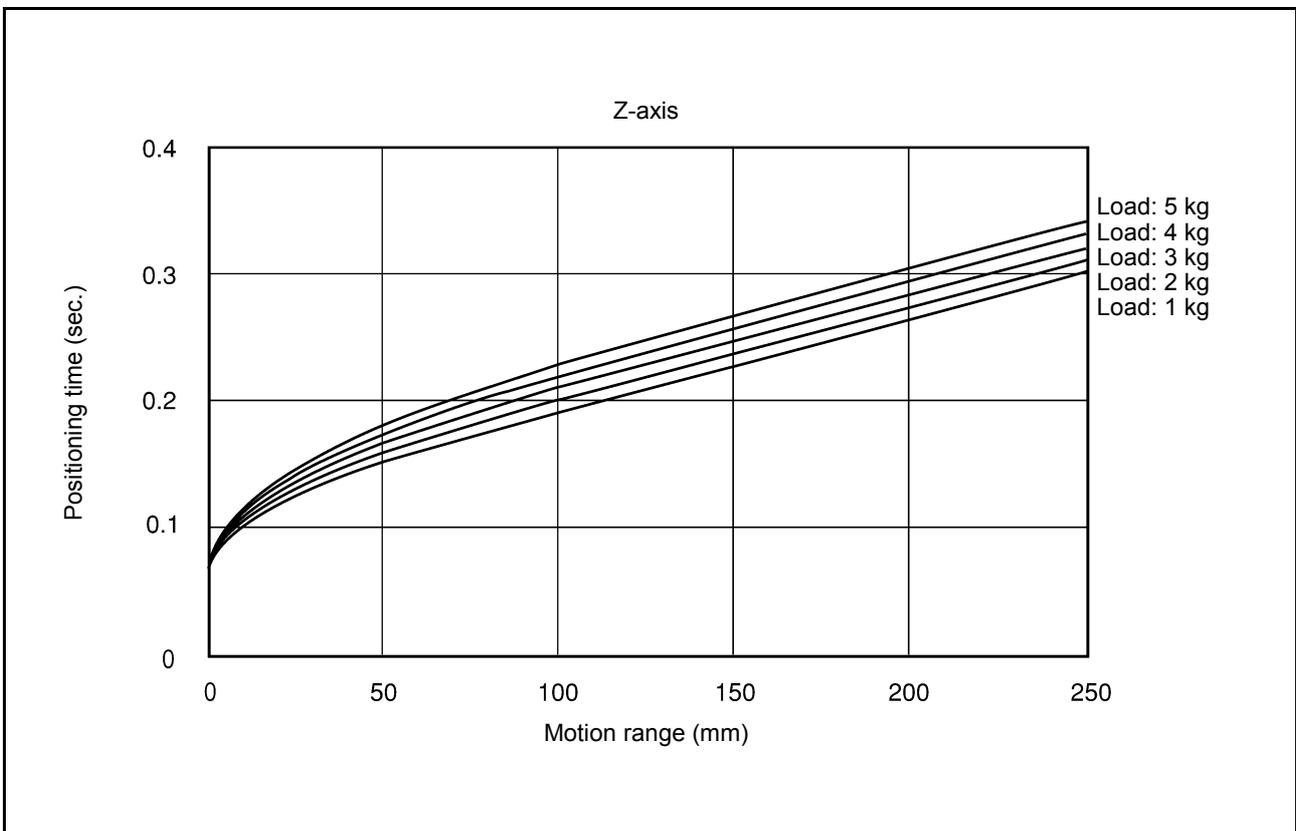
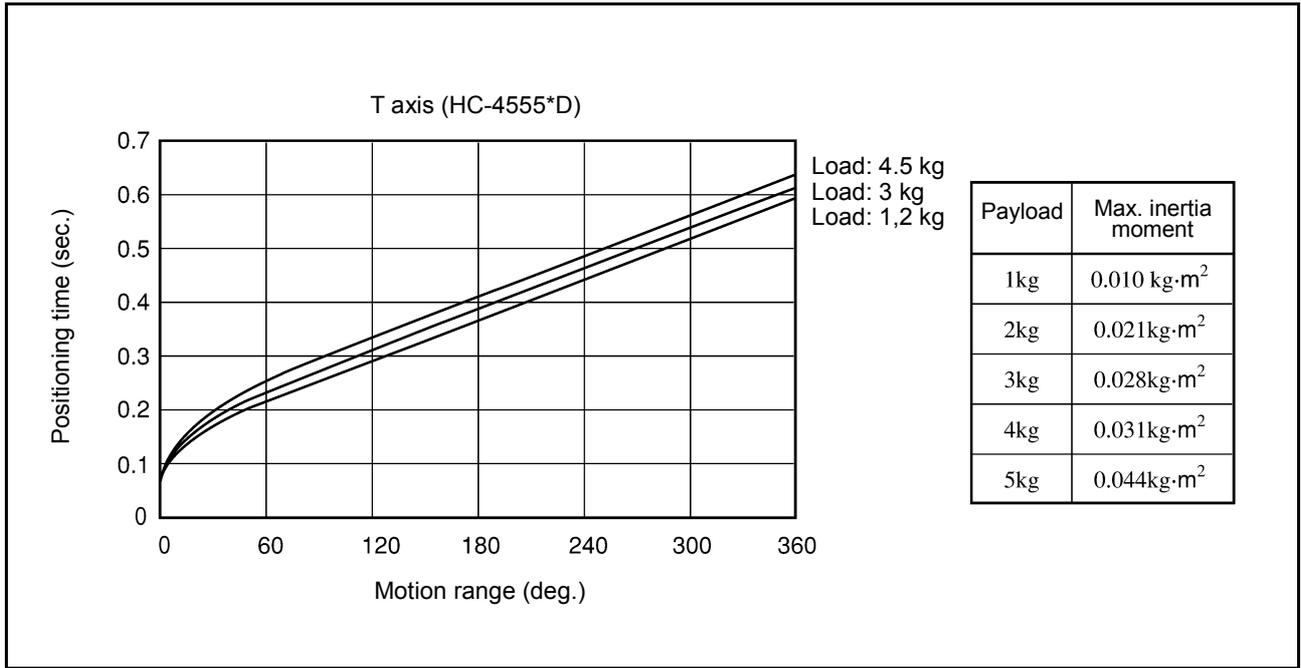
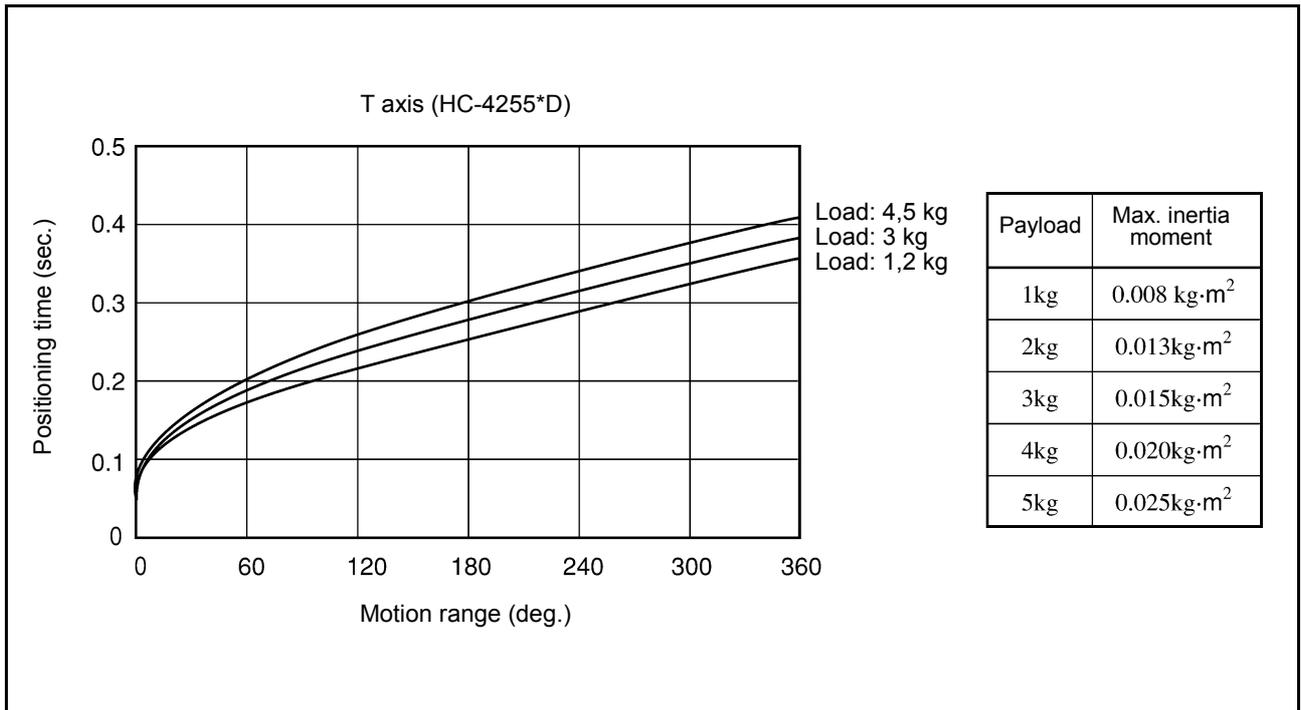


Figure 1-33 Movement of Z axis



**Figure 1-34 Movement of T axis**



**Figure 1-35 Movement of T axis**

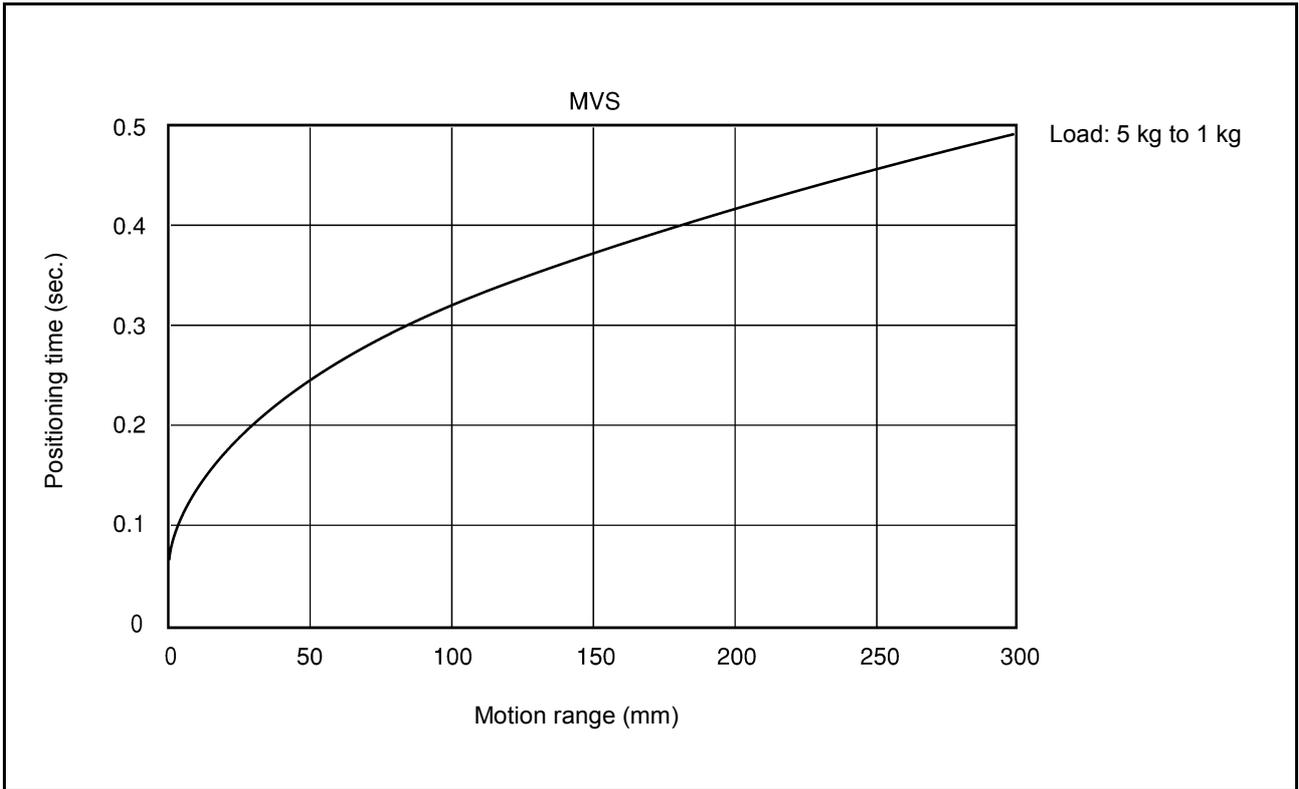


Figure 1-36 All Axes (MV S motion)

## [ 4 ] Notes for setting the positioning speed

### ■ HC-D series with Z-axis stroke of 250 mm

- (1) When traversing the robot horizontally at high speeds, teach the robot so that Z axis is as close as possible to its upper end.
- (2) To stabilize positioning of Z axis near its lower end, the following maximum speed limiting control is automatically provided for J1 and J2 axes depending on the Z-axis coordinate value, only when the robot is moved through PTP movement (MV, MVP, DRV, APR).

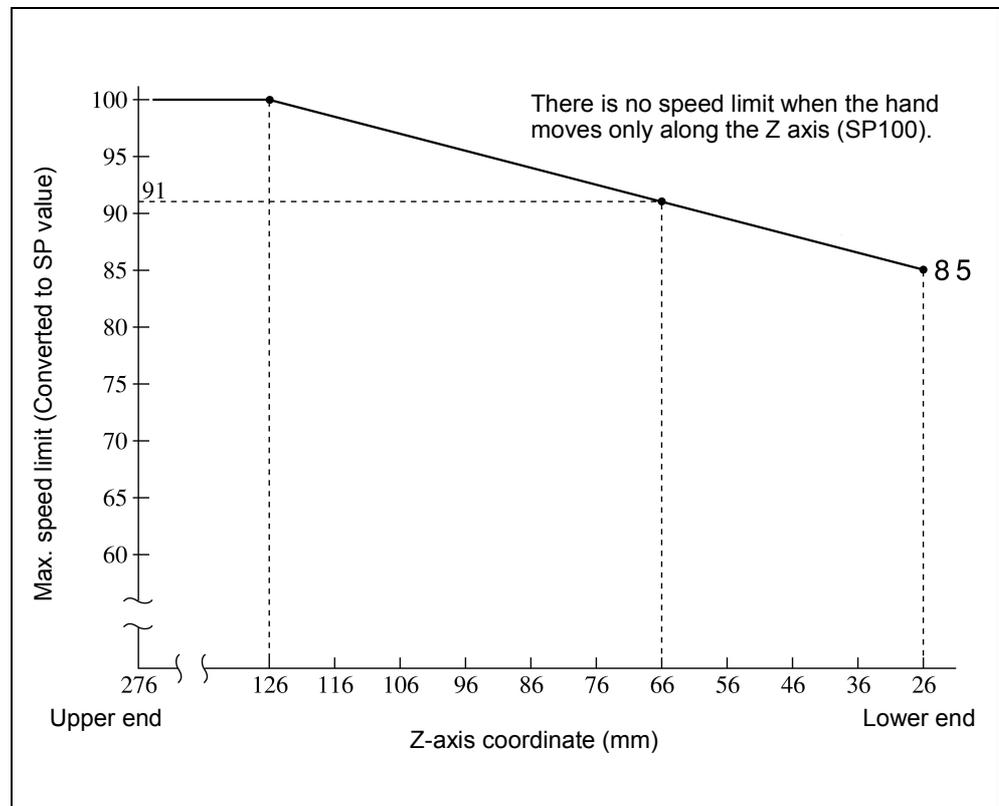
The positioning time of J1 and J2 axes shown in Figure 1-27 therefore becomes longer according to the maximum speed limit shown below.

$$\frac{\text{[Movement time given in Fig. 1-27 (sec.)]}}{\text{Max. speed limit}} \times 100 \text{ (sec.)}$$

For example, when the HC-D robot arm moves by SP100 from the start point (Z-axis coordinate 66 mm) to the target point (Z-axis coordinated 26 mm), the maximum speed limits are as follows:

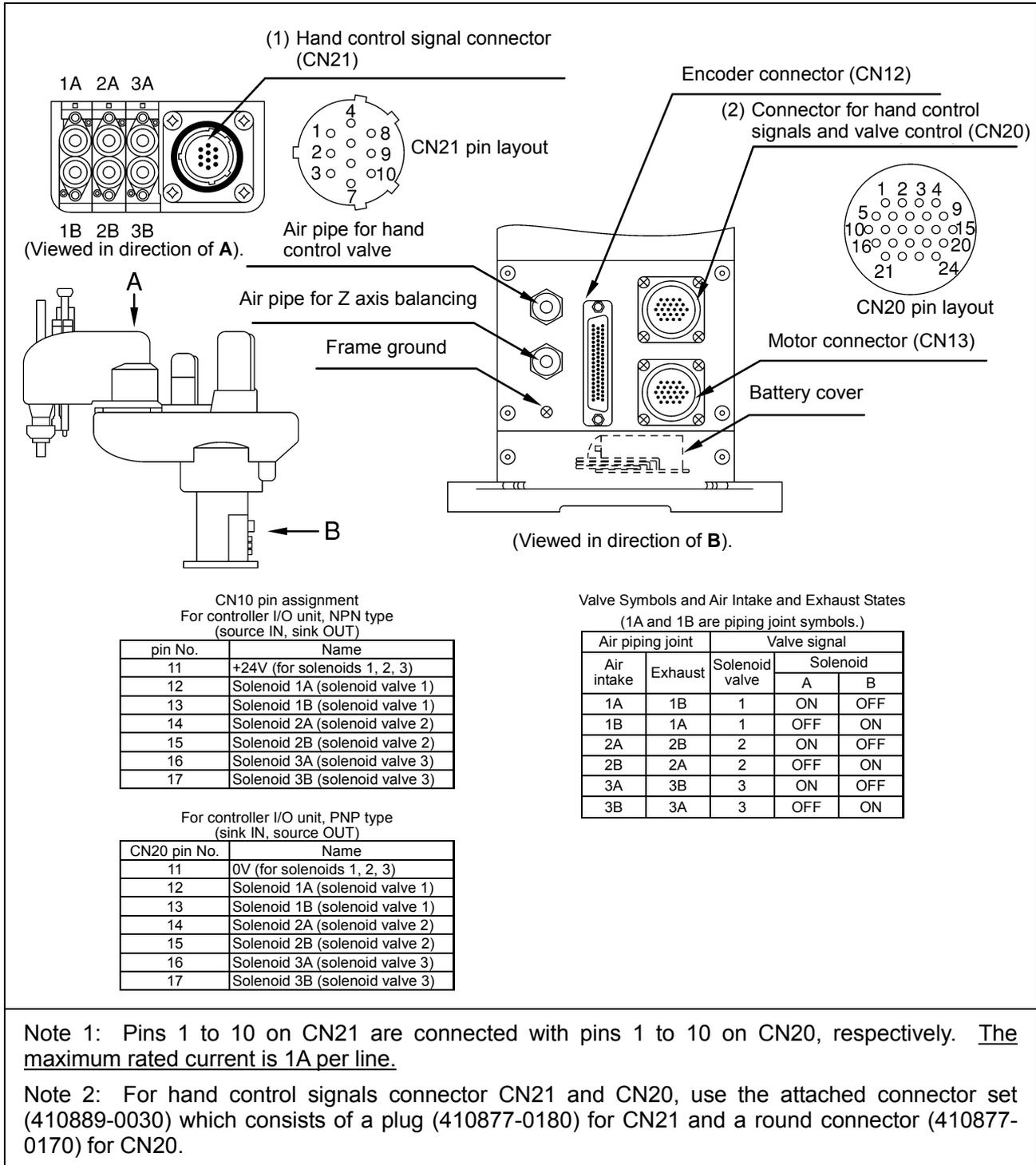
- 91 when Z-axis coordinate is 66 mm
- 85 when Z-axis coordinate is 26 mm

At this time, the maximum speed is the smaller value (at the lowest end) of 40.



## [ 5 ] Air piping and signal wiring

The HC-D series robot is equipped with six air pipes (with three integrated electromagnetic valves) and 10 signal lines. Those electromagnetic valves may be driven by the robot controller by connecting pins 11 to 17 on CN20 with the valve output ports on CN4 of the controller.



**Figure 1-37 Air Piping and Signal Wiring, Inside Robot Unit**

**Note:** Do not use the above signal lines for current of 10mA or less.

# 1.4 Robot Controller Specifications

## 1.4.1 Specifications and Outer Dimensions

### [ 1 ] Controller Specifications

Table 1-7 lists the specifications of the H\*-D series robot controller.

**Table 1-7 Specifications of H\*-D Series Robot Controller**

Item		Specification
Applicable robot		Medium-/small-sized, horizontal articulated type Compact-sized, horizontal articulated type
Model		RC5-H4A RC5-HC4A
Control system		PTP, CP 3-dimensional linear, 3-dimensional circular
No. of controllable axes		Up to four axes simultaneously
Drive system		All axes: all digital AC servo
Memory capacity		1.25 MB (equivalent to 5000 steps, 13,000 points)
Language used		DENSO robot language (conforming to SLIM)
Usable programs		255
Teaching system		1) Remote teaching 2) Numerical input (MDI) 3) Direct teaching
External signals (I/O)	Input signal	20 user open points (PLC 12, hand input 8) + 36 fixed system points
	Output signal	32 user open points (PLC 24, hand output 8) + 33 fixed system points
External communication		RS-232C:1 line Ethernet:1 line (option)
Timer function		0.02 to 10 sec.(in increment of 1/60 sec.)
Self-diagnosis function		Overrun, servo error, memory error, input error, etc.
Error display		Error codes will be displayed on the external I/O , the operating panel (option) or mini pendant (option). Error messages will be displayed in English on the teach pendant (option).
Power source		3-phase, 200 VAC-15% to 230 VAC+10%, 50/60 Hz, 2.0 kVA Single-phase, 200 VAC-10% to 230 VAC+10%, 50/60 Hz, 2.0 kVA
Environmental conditions (in operation)		Temperature: 0 to 40°C Humidity: 90% RH or less (no condensation allowed)
Degree of protection		IP20
Cables	Robot control cable	3 m or 6 m (selective)
	I/O cable	8 m, 15 m (option)
	Power supply cable	5 m
Weight		Approx. 16 kg (excluding attached cables)

**⚠ CAUTION**

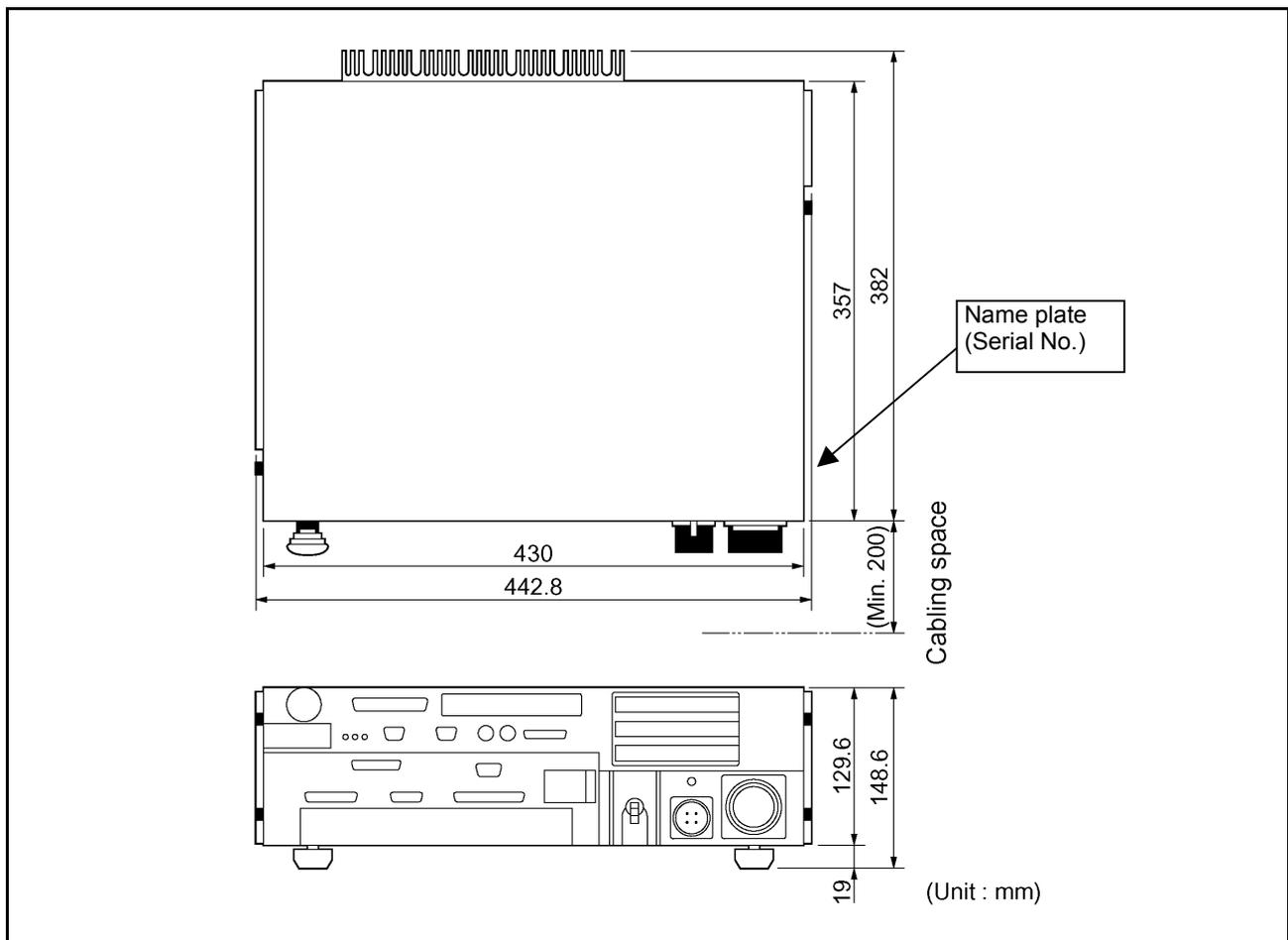
- DO NOT touch fins. Hot surface may cause severe burns.
- DO NOT insert fingers or foreign objects into opening, or personal injury may occur.
- DO NOT touch inside of controller before turning off power switch, disconnecting cable from controller and waiting 3 minutes or more, or you can receive electric shock.
- DO NOT connect or disconnect connectors while the robot controller is turned ON.  
Doing so will result in an electric shock or controller failure.

**⚠ CAUTION IN INSTALLATION**

- This controller does not meet dust-proof, splash-proof or explosion-proof specifications.
- Read the owner's manuals before installation.
- Do not place anything on the controller.

### [ 2 ] Outer Dimensions of the Robot Controller

Figure 1-38 shows the outer dimensions of the H\*-D series robot controller.



**Figure 1-38 Outer Dimensions of HM-D/HS-D Series Robot Controller**

## 1.4.2 Controller Setting Table

The controller setting table given on the next page is attached to the controller. It shows the parameters that are set before delivery of the robot, as well as the next replacement dates of the memory backup battery and encoder backup battery.

- Parameters (① in the controller setting table)

Only parameters changed from the standard values are entered. Blanks indicate that the standard value is set.

For further information about parameters, see Chapter 4 “Customizing Your Robot.”

- Main software Ver. (② in the table)

The version of the main software for the controller is entered.

- Sub software Ver. (③ in the table)

The version of the control software is entered.

- Battery replacement date (④ in the table)

In this battery replacement date box the next battery replacement date is entered.

- SER No. (⑤ in the table)

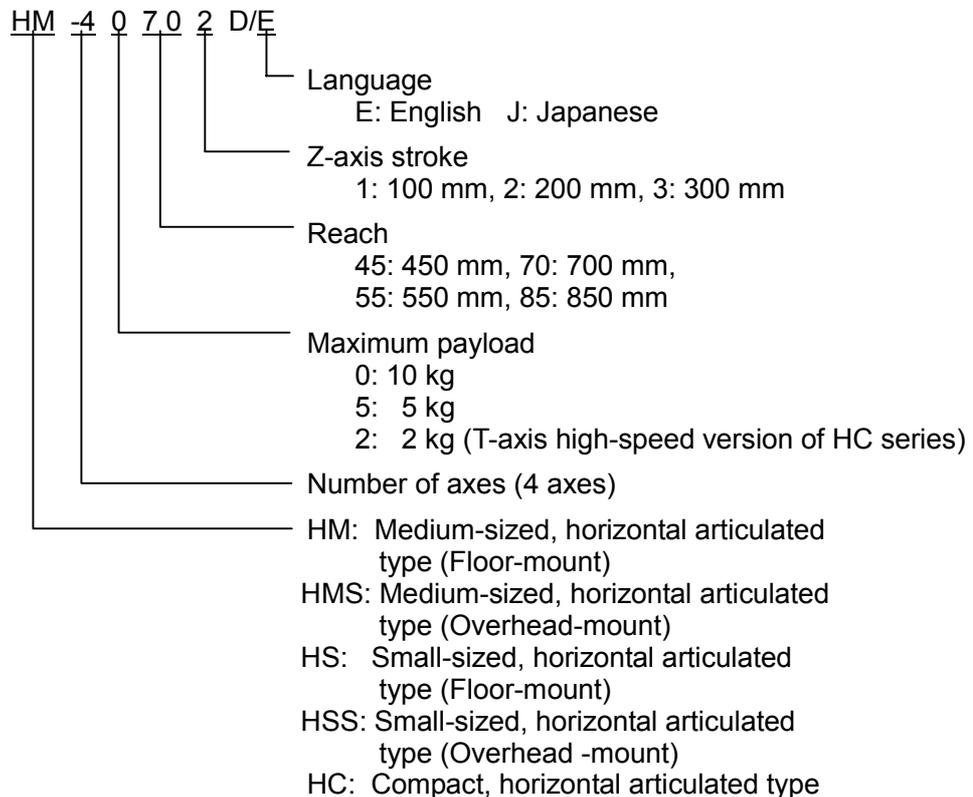
The serial number of the robot is entered.

- TYPE (⑥ in the table)

The model of the robot system is entered.

The coding of the set model is described below:

### Horizontal articulated type (H\*-D series)



## コントローラ設定表/THE SETPRM LIST

注記1. 標準値から変更された個所のみ値を示します。空欄のものは標準値が設定されています。

2. パラメータ値を変更した場合は、必ず下表の値の書き直し、または記入をしてください。

Note1. Only the different value from the defaults of the SETPRM are written. The blank means default.

2. Write the new values on this list when you modify the SETPRM values.

① 1 パラメータ/PARAMETER			② サブアッセンブリ/SUBASSEMBLY		
パラメータ PARAMETER	値 VALUE		名称 BOARD	型式 BOARD TYPE	備考 REMARK
正方向 ソフト リミット PLIM	1		メインボード MAIN BOARD	RP227	
	2		1/0ボード I/O BOARD	RP228, 229	
	3		電源ボード POWER SUPPLY BOARD	RP214A, B	
	4		ハーネスボード HARNES BOARD	RP231	
	5		NFボード NF BOARD	RP235A	
	6		コンパクトABSボード C-ABS BOARD	RP240A	
	7		ブレーキリレーボード BRAKE RELAY BOARD	RP242	
	8		回生抵抗ボード RESISTER BOARD	RP243	
負方向 ソフト リミット NLIM	1		IPMボード (L) IPM BOARD (L)	RP232	
	2		IPMボード (M) IPM BOARD (M)	RP232	
	3		IPMボード (S) IPM BOARD (S)	RP232	
	4		IPMボード (SS) IPM BOARD (SS)	RP232	
	5		拡張ボード1 EXTENSION BOARD 1		
	6		拡張ボード2 EXTENSION BOARD 2		
	7		拡張ボード3 EXTENSION BOARD 3		
	8		メモリボード MEMORY BOARD	RP234	
RANG	1		FD		
	2				
	3				
	4				
	5				
	6				
	7				
	8				
I/Oモード I/O MODE					
②			③ その他の変更点/OTHER MODIFICATIONS		
②			<div style="border: 1px solid black; height: 100px; width: 100%;"></div>		
②					
③					
④					
⑤					
⑥					

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## 1.5 Warranty

DENSO manufactures robots under strict quality control. In case of failure, we warranty the robot under the following conditions:

### **Warranty Period**

The warranty shall be effective for one year from the date of purchase.

### **Warranty Coverage**

DENSO shall repair the robot free of charge when a failure occurs and is attributable to the design, manufacture or material of the robot within the warranty period in spite of proper use.

### **Items Not Covered**

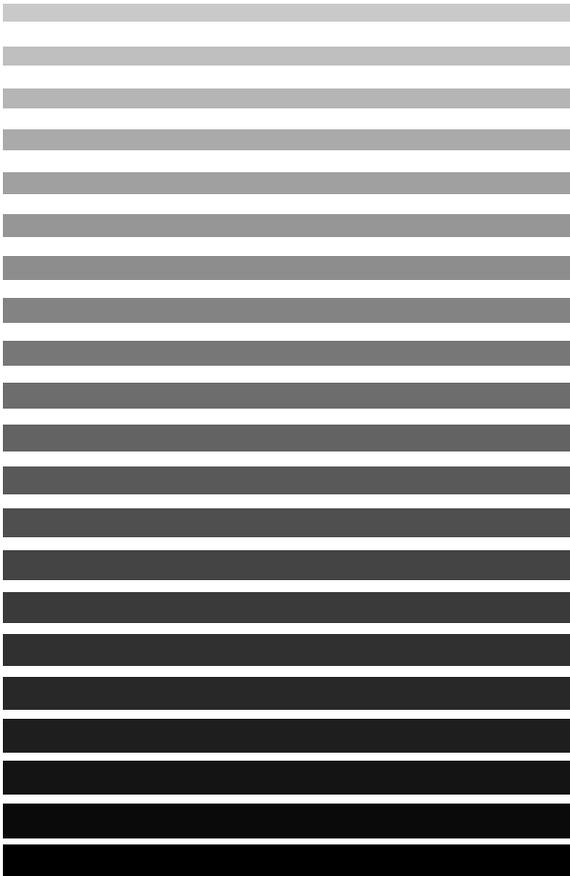
Failures, which arise from one of the following, shall not be covered by the warranty even if the robot is under warranty:

- (1) Failures caused by improper repair, modification, transfer or handling by you or a third party;
- (2) Failures caused by the use of a part or oil/fat other than those specified by DENSO;
- (3) Failures caused by a fire, salt damage, earthquake, storm/flood or other acts of God;
- (4) Failures caused by the use of the robot in an environment other than the environment specified by DENSO, such as dust and water ingress;
- (5) Failures caused by a worn-out consumable, such as a fan filter;
- (6) Failures caused by improper performance or non-performance of lubrication, maintenance or inspections stated in this owner's manual; and
- (7) Damages other than the robot repair costs.

# Chapter 2

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## Installing Robot Components



This chapter describes the procedures and precautions for transporting the robot during installation, and for designing end-effectors.

For safe operation of the robot, read "SAFETY PRECAUTIONS, 2. Installation Precautions."



## 2.1 Preparing a Proper Environment for Installation

Before installing the robot unit and robot controller, confirm that the operating environment is in conformity with each item of the "SAFETY PRECAUTIONS, 2. Installation Precautions," and that the surrounding environment of the location where the robot is to be used meets the specifications as described below. Also, take proper measures to protect the components from vibration.

In an inappropriate environment, the robot will not operate to its full capacity or performance, components may not last long, and unexpected failure may result.

### 2.1.1 Installation Environments

The H\*-D series robot is not explosion-proof, dust-proof or splash-proof, so it should not be installed in any environment where:

- (1) there are flammable gases or liquids,
- (2) there are any shavings from metal processing or other conductive material flying about,
- (3) there are any acidic, alkaline or other corrosive gases,
- (4) there is cutting or grinding oil mist,
- (5) there is sulfuric cutting or grinding oil mist, or
- (6) there are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise.

---

## 2.1.2 Ambient Temperature and Humidity

Keep the ambient temperature between 0°C and 40°C during operation.  
Keep the ambient humidity at 90% or below to prevent dew condensation.

## 2.1.3 Vibration

Do not install the robot in an environment where it will be exposed to excessive vibration or impact.

## 2.1.4 Connecting the Robot Unit and Robot Controller

Before delivery, the robot unit and the robot controller are adjusted to each other as a set. When two or more robots are to be used, use the robots and robot controllers that have been adjusted to each other as a set.

**Caution: The robot unit and robot controller in a set are given the same serial number. For the position of the serial number, see "1.3 [ 2 ] Outer Dimensions and Motion Space of the Robot Unit" and "1.4 [ 2 ] Outer Dimensions of the Robot Controller."**

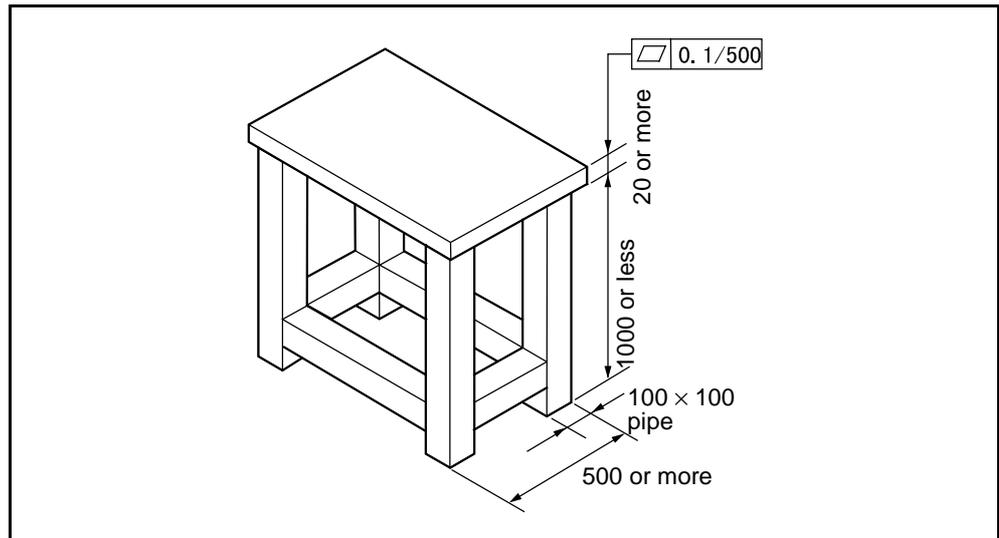
## 2.1.5 Installation Environment of the Robot Unit

Table 2-1 lists the installation requirements for the robot unit. Prepare a highly rigid mount as shown in Figures 2-1 and 2-2.

 **Caution: Do not electric-weld the equipment including the robot. A large current may flow through the motor encoder or robot controller resulting in a failure. If electric welding is required, remove the robot unit and the robot controller from the equipment beforehand.**

**Table 2-1 Installation Requirements for the Robot Unit**

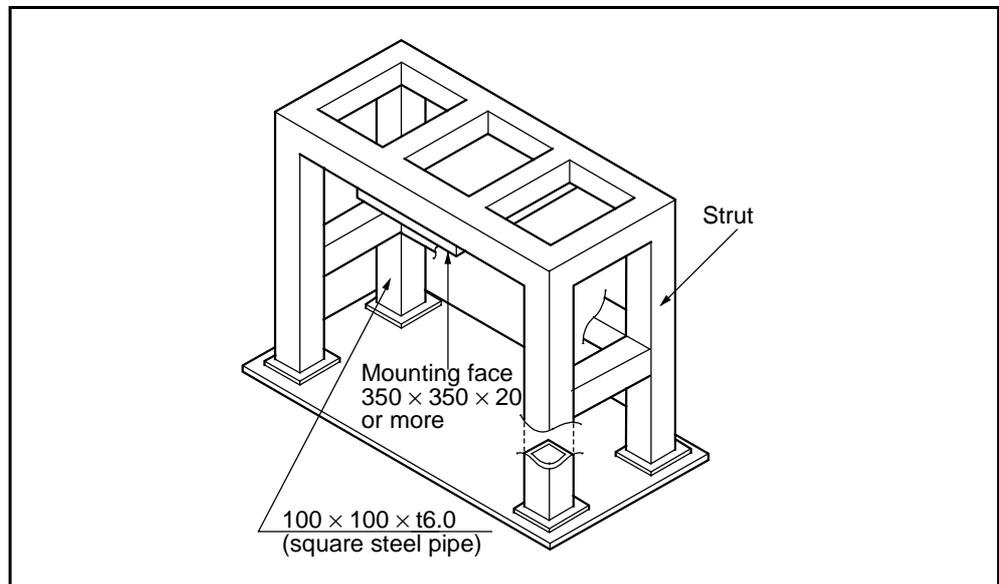
Item	Environments and Conditions
Flatness of the mount	0.1/500 mm (See Figure 2-1.)
Rigidity of the mount	Use steel materials. (See Figure 2-1 or Figure 2-2.)
Installation type	Floor-mount or Overhead-mount (HMS/HSS-D)
Ambient temperature	During operation : 0 to 40°C During storage and transportation : -10 to 60°C
Humidity	During operation : 90% or less (No dew condensation allowed.) During storage and transportation : 75% or less (No dew condensation allowed.)
Vibration	During operation : 4.9 m/s <sup>2</sup> (0.5G) or less During storage and transportation : 29.4 m/s <sup>2</sup> (2.5G) or less
Safe installation environment	The robot should not be installed in an environment where: <ul style="list-style-type: none"> <li>• there are flammable gases or liquids,</li> <li>• there are any shavings from metal processing or other conductive material flying about,</li> <li>• there are any acidic, alkaline or other corrosive gases,</li> <li>• there is cutting or grinding oil mist,</li> <li>• there is sulfuric cutting or grinding oil mist,</li> <li>• there are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise, or</li> <li>• it may be directly exposed to water, oil or cutting chips.</li> </ul>
Working space, etc.	<ul style="list-style-type: none"> <li>• Sufficient space must be available for inspection and disassembly.</li> <li>• Keep wiring space (230 mm or more) behind the robot, and fasten the wiring to the mounting face or beam so that the weight of the cables will not be directly applied to the connectors.</li> </ul>
Installation conditions	Grounding resistance: 100 Ω or less See Figures 2-9 and 2-14 for the HM-D/HS-D series and HC-D series, respectively.



**⚠ Caution** (1): When the robot operates at high speed, the robot mount undergoes large reaction forces. The mount must be rigid enough so that it will not vibrate or be displaced due to reaction forces. It is also advisable to mechanically join the robot mount with heavy equipment.

(2): Some mounts may produce a resonance sound (howling). If this sound is loud, increase the rigidity of the mount or slightly modify the robot speed.

Figure 2-1 Robot Mount Sample for Floor-mount



**⚠ Caution** (1): When the robot operates at high speed, the top plate structure undergoes large reaction forces. Design the vibration-proof mount so that the top plate will not vibrate due to reaction forces. Also design the top plate structure so that it separates from other top plate structures in the equipment.

(2): Some mounts may produce a resonance sound (howling). If this sound is loud, increase the rigidity of the mount or slightly modify the robot speed.

Figure 2-2 Robot Mount Sample for Overhead-mount

## 2.2 Installing the Robot Unit

### ■ HM-D/HS-D Series

#### [ 1 ] Transporting the Robot Unit

**⚠ Caution:** Before handling or installing the robot unit, be sure to read "SAFETY PRECAUTIONS, 2. Installation Precautions."

The transporting jobs should be handled by at least two persons. Be sure to put on helmet, safety shoes, and globes.

The HM-D series and HS-D series weigh about 55 kg and 50 kg, respectively. Select a crane suitable for the robot weight.

- (1) Remove the motor and encoder cables from the robot main unit.
- (2) Wind the air pipes around the robot base (see Figure 2-3).
- (3) Wind and fasten the fabric belt around the root of the 1st-axis arm (see Figure. 2-4).

**⚠ Caution:** Do not use a metal chain because it could damage the robot unit and/or slip, causing the robot unit to drop off during transportation.  
  
Avoid winding the fabric belt round the first axis arm head because it could slip off.

- (4) Press the robot second axis arm against the mechanical end.

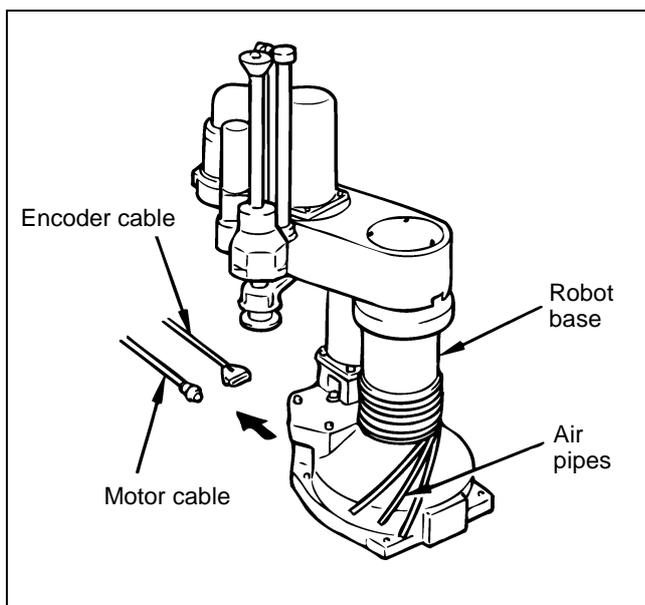


Figure 2-3 Arranging the Air Pipes

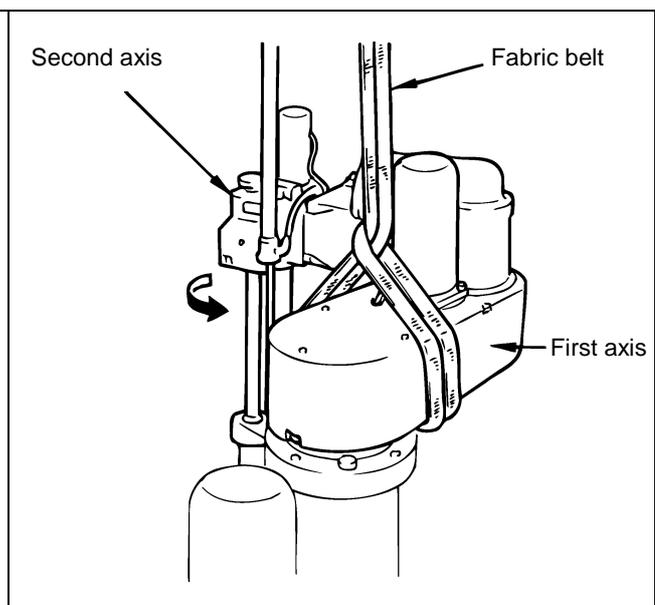


Figure 2-4 Use of Fabric Belt

- (5) Operator A removes the 4 bolts securing the robot unit to the pallet shown in Figure 2-5.

**⚠ Caution: Operator B should support the robot first axis arm to prevent the unit from overturning while operator A removes the bolts.**

- (6) Operator B operates the crane to carry the robot unit to the installation point.

The robot unit has heavy base; operator A should support the first axis arm head from above and below as shown in Figure 2-6 so that the unit is properly balanced while operator B transports it by crane.

**⚠ Caution: Do not hold at the cover over the second axis arm, this cover is made of plastic and could be deformed or broken. Check that there are no obstacles in the path through which the robot is to be carried. Check before operation of the crane that its fabric belt are not loose or dislocated.**

- (7) Lift the robot unit down onto the installation point; as soon as this is done, operator B should temporarily clamp the robot unit with the four bolts previously removed.

**NOTE: After temporary bolting, replace the motor and encoder cables previously detached.**

- (8) Fix the robot unit properly, referring to the procedures given in "[ 2 ] Installing the Robot Unit" on the next page.

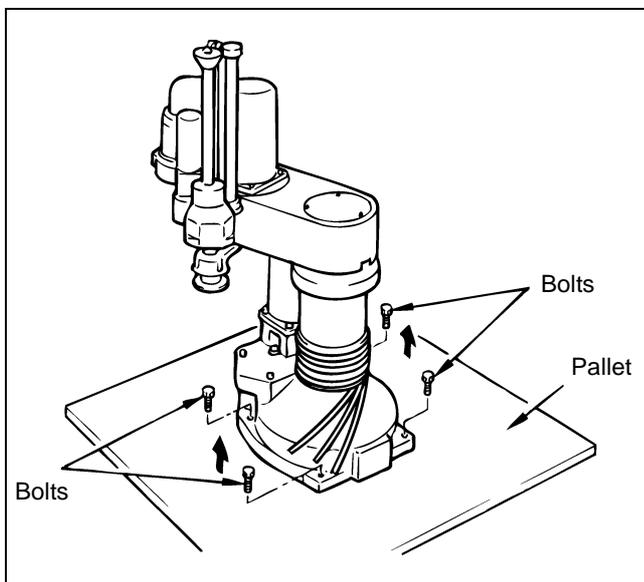


Figure 2-5 Unbolting

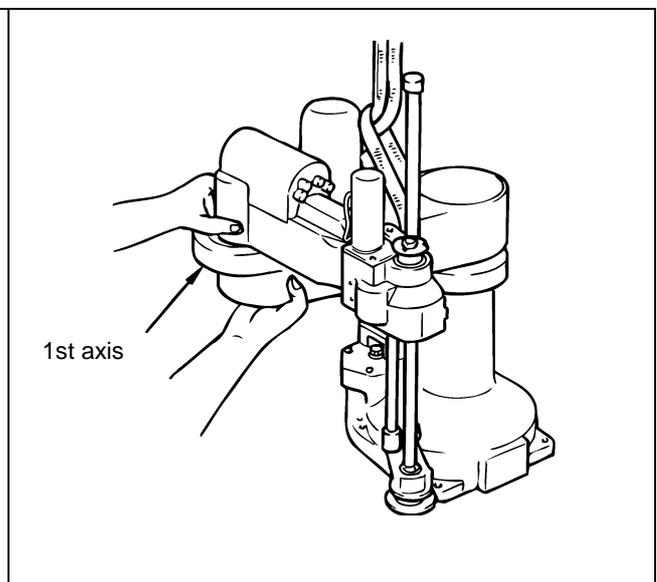


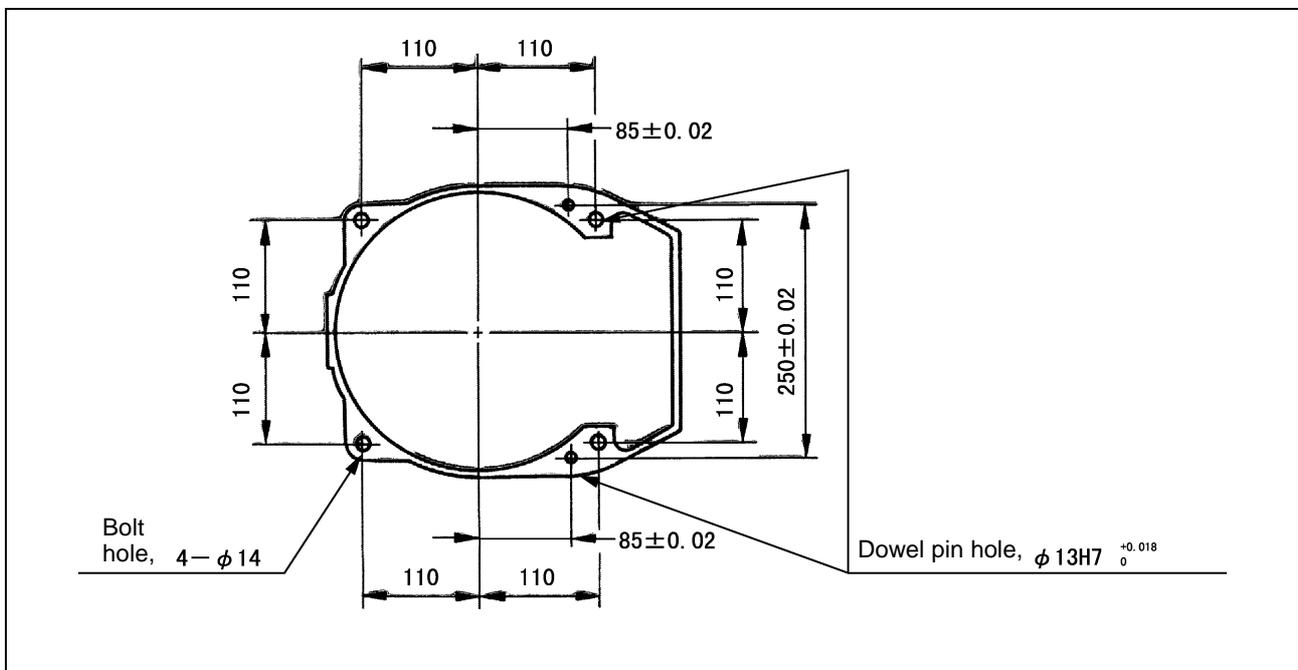
Figure 2-6 Supporting the Robot

### [ 2 ] Installing the Robot Unit

- (1) Drill four M12, coarse bolt holes and two dowel pin holes on the mount stand, according to the dimensions specified in Figure 2-7, at the points where the robot unit is to be anchored.
- (2) Lift the robot unit down and place it precisely on the mount stand following instructions in the section describing transportation.
- (3) Drive two 13 mm dia. parallel dowel pins into the drilled pin holes.

**Caution: Never skip this step since these pins reduce chance of drop off of the robot unit during maintenance and misalignment due to vibration.**

- (4) Tighten the M12x40 hexagon socket head bolts to a torque of  $1100 \pm 220$  kgf•cm.



**Figure 2-7 Bolt/Pin Hole Positions for Robot Unit**  
(Dimensions of the robot base, viewed from the bottom)

### [ 3 ] Overhead-mounting the Robot

To overhead-mount the robot, an overhead-mount frame and suspension jig are required. Set up those items, referring to Figure 2-8 and Table 2-1-1.

**Caution** (1) Install the robot according to "2.2 Installing the Robot Unit." Use bolts of strength class 12.9.  
(2) Keep a space of 250 mm or larger for the wiring behind the robot. Fasten the wiring to the mounting face or beam so that the weight of the cables will not be directly applied to the connectors.

#### Overhead-mount Frame

Figure 2-8 shows an example of overhead-mount frame.

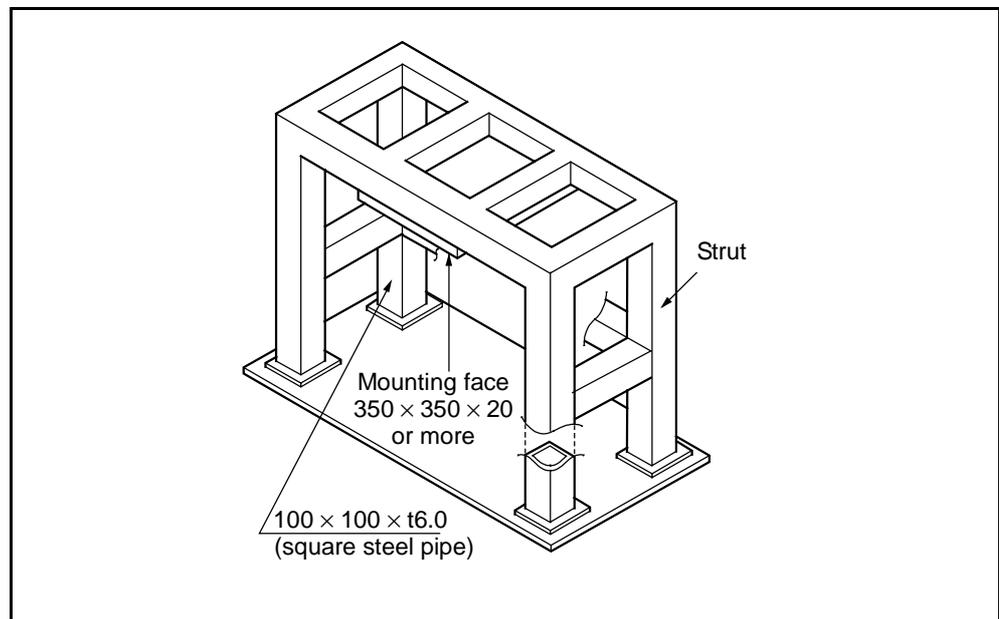


Figure 2-8 Example of Overhead-mount Frame

**Caution:** When the robot is running at high speed, large reaction forces are exerted on the top plate structure. Take proper measures to protect the top plate from vibration caused by reaction forces. Separate the robot installation top plate structure from other top plate structures within the equipment.

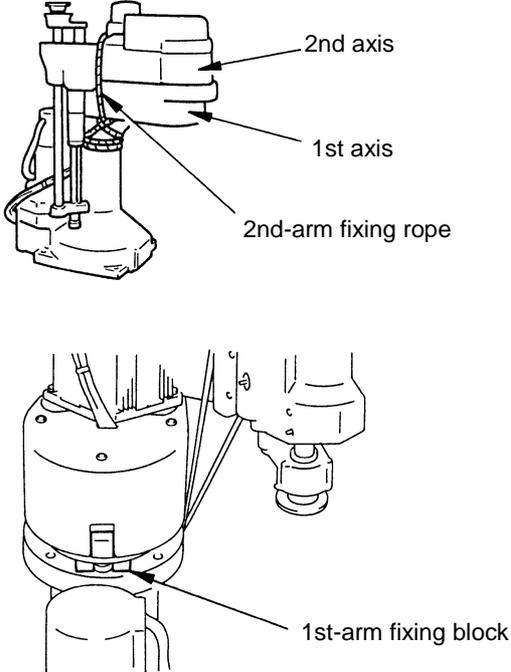
**Table 2-1-1 Tools Required for Overhead-mounting**

Tools required	Specifications
Crane	Hoisting load: 0.6 ton or more (Crane qualification required)
Belt sling	Belt width: 50 mm, Safe load: 6 kN or greater Length: 3 m or more (To be prepared according to the width of the installation place)  Recommended sling: FUJII-DENKO "Tsuyoron sling" Type F-I (with eyes at both ends) Model F-I-50
Fixing bolts	4 bolts (M12 x 40, strength class 12.9)

### Overhead-mount Example

The basic procedure of overhead-mounting is given on the following pages. Follow this procedure to install the robot unit.

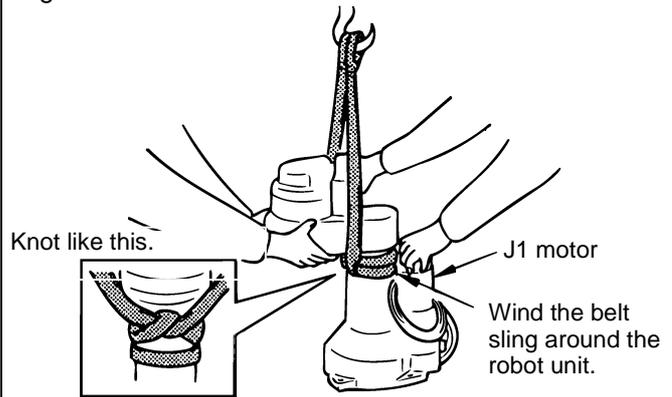
- Caution** (1) Since the robot unit weighs approx. 60 kg, prepare a crane and a forklift with a lifting load of 0.6 ton or more.  
 (2) The overhead mounting job must be performed under the supervision of a qualified operator for sling, crane and forklift operation.  
 (3) Wear safety shoes and a helmet.

Installation procedure	
<p>(1) When unpacked, the overhead-mount robot unit is fastened with rope as shown at right.</p> <p>First, make sure that the robot's 1st and 2nd arms are firmly fastened so that they cannot rotate.</p> <p><b>⚠ Caution: NEVER remove the 2nd-arm fixing rope or 1st-arm fixing block until the installation of the robot unit is completed.</b></p> <p><b>This is to prevent the robot arms from rotating unexpectedly due to gravity during mounting jobs.</b></p>	<p style="text-align: center;">Figure 1</p> 

- (2) Transport the robot unit to a place right under the installation site. Then wind the belt sling around the robot base as shown at right.

Wind the belt sling two turns and make a knot on the side opposite to the J1 motor.

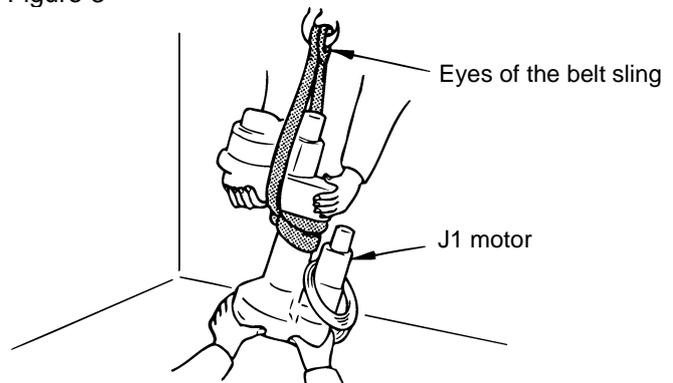
Figure 2



- (3) Load the eyes of the belt sling on the hook of the crane. While having two workers keep the robot posture, slowly raise the crane. (See Figure 3.)

**⚠ Caution: Before starting this job, make the work floor clear of obstacles.**

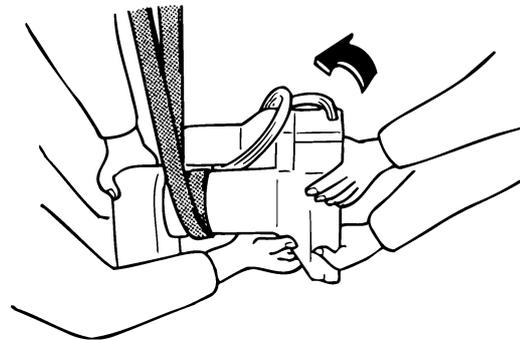
Figure 3



- (4) If the crane hoists the robot unit until the robot unit may be turned upside down, stop the crane and have three workers turn the robot unit upside down, as shown at right.

**⚠ Caution: When turning the robot unit upside down, hold the robot base and arms, not the covers, motors, or wirings.**

Figure 4

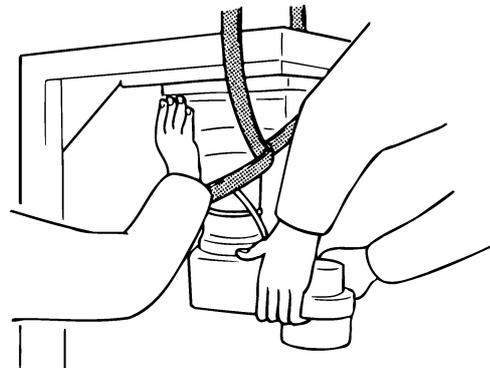


- (5) While having two workers keep the robot in the upside down position, raise the crane slowly so that the robot base comes into contact with the robot installation face of the overhead-mount frame.

Secure the robot base with four bolts as shown in Figure 6.

Bolt tightening torque:  $110 \pm 22 \text{ Nm}$   
 $(1100 \pm 220 \text{ kgf}\cdot\text{cm})$

Figure 5



- (6) After completing bolting, unhook the belt sling from the crane, then remove the 2nd-arm fixing rope and 1st-arm fixing block.

**NOTE:** Store the 2nd-arm fixing rope and 1st-arm fixing block for future removal of the robot unit.

Figure 6

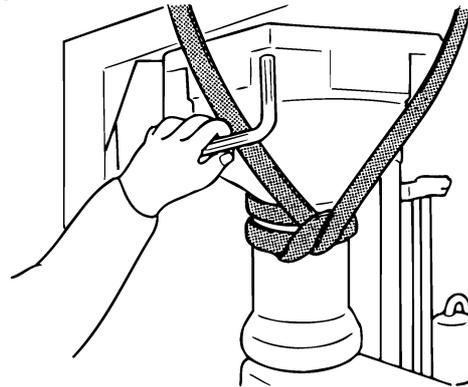


Figure 7

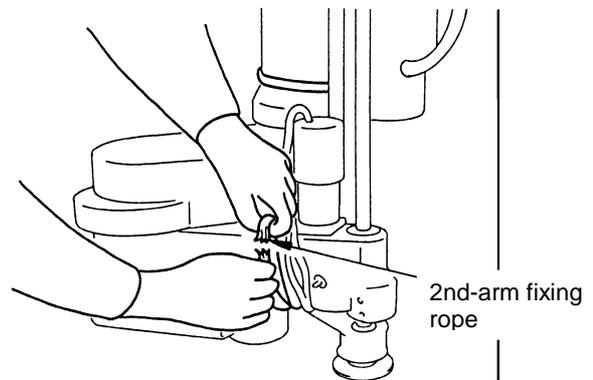
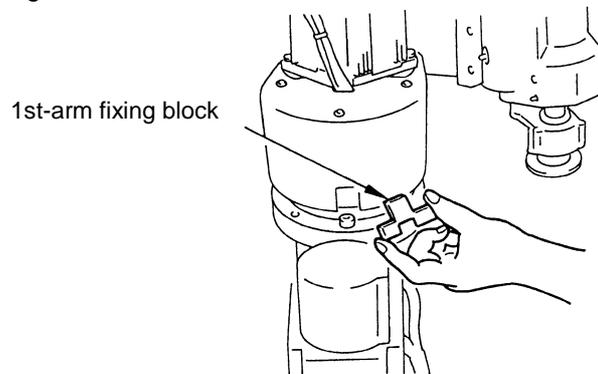


Figure 8



#### [ 4 ] Grounding the Robot Unit

Ground the earth terminal of the robot unit using a wire of 5.5 mm<sup>2</sup> or more. Use a dedicated grounding wire and grounding electrode. Do not use the grounding wire or grounding electrode for other electric power or power equipment such as a welder.

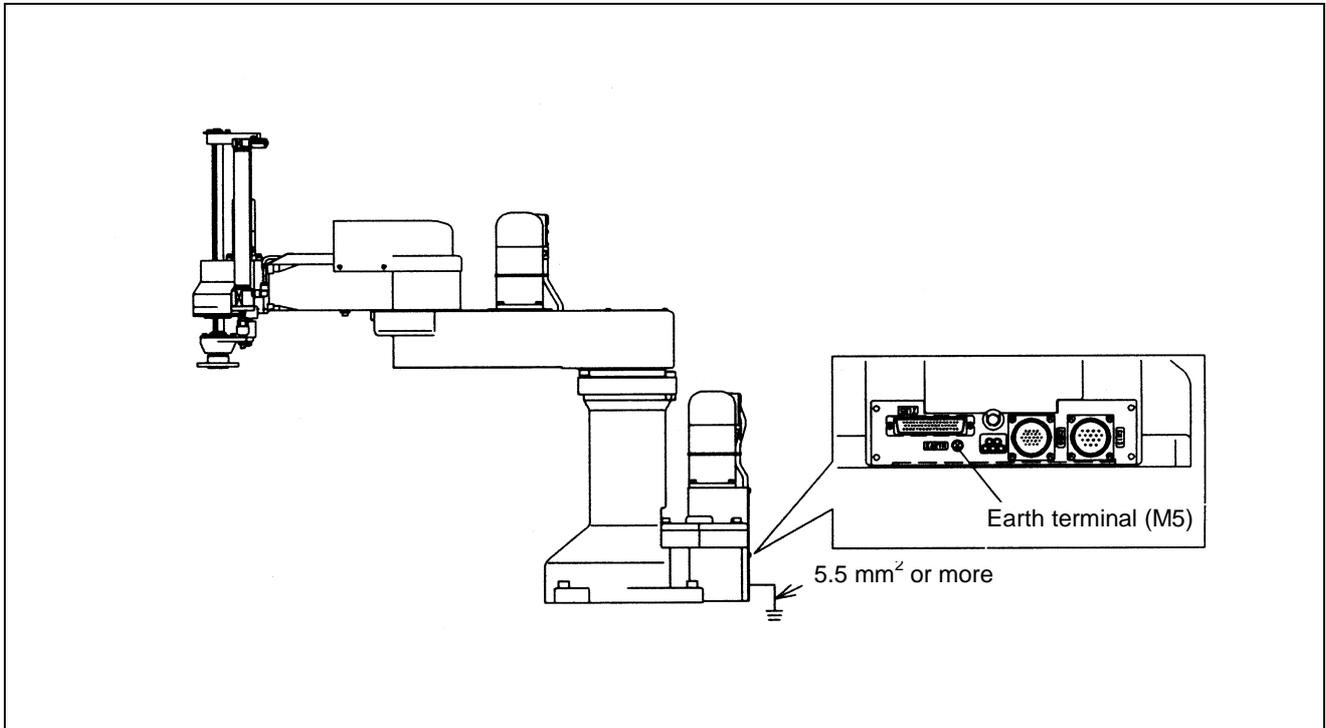


Figure 2-9 Grounding the Robot Unit

### ■ HC-D Series

**⚠ Caution:** Before handling or installing the robot unit, be sure to read "SAFETY PRECAUTIONS, 2. Installation Precautions."

#### [ 1 ] Transporting the Robot Unit

This section gives the transporting procedure assuming that you have set up the robot mount bed and prepared robot mounting bolt holes in it. If you have not done it yet, first read "[ 2 ] Installing the Robot Unit."

**⚠ Caution:** (1) The transporting jobs should be handled by at least two persons. The robot unit weighs approx. 35 kg.  
(2) Be sure to put on helmet, safety shoes, and gloves.

- (1) Disconnect the motor cable and encoder cable from the robot unit. (See Figure 2-10.)
- (2) Disconnect the air pipe from the joint. Disconnect the grounding wire from the terminal. (See Figure 2-10.)
- (3) Remove the handle and tools (if installed) from the T axis.
- (4) Turn the 2nd axis until it comes into contact with the mechanical end. (See Figure 2-11.)

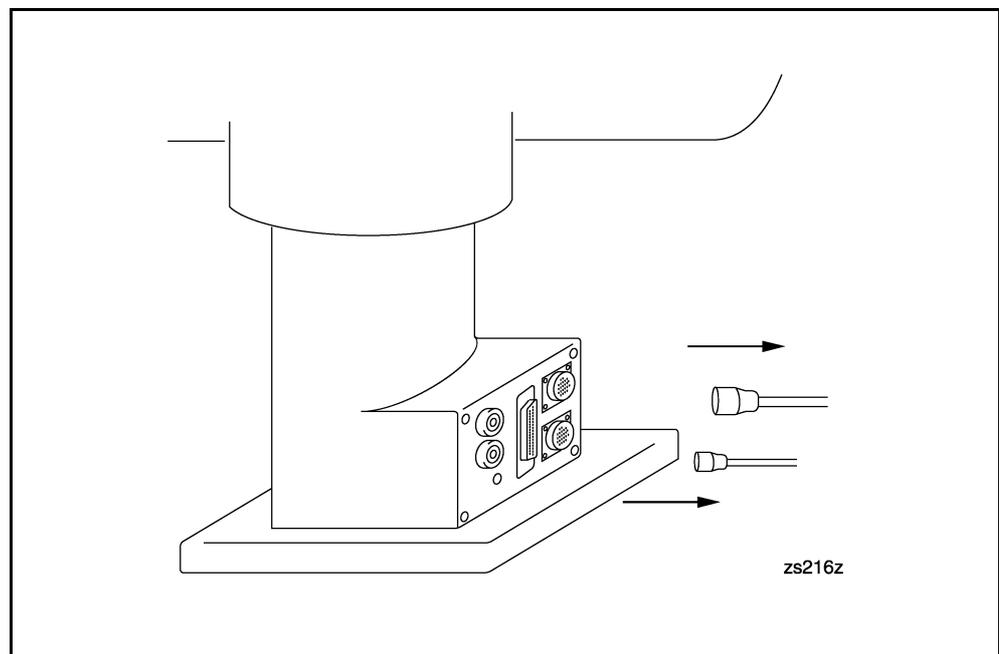


Figure 2-10 Disconnecting the Cables and Air Pipes

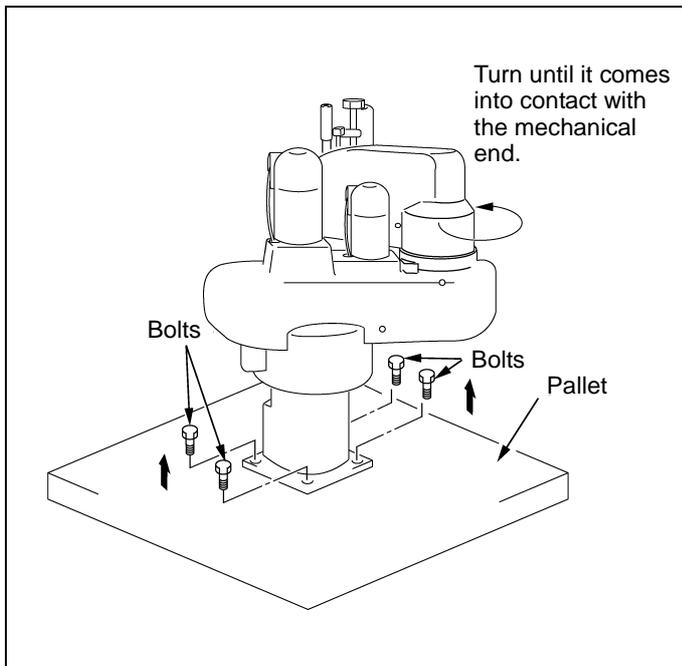
- (5) Remove the four bolts which secure the robot unit. (See Figure 2-11.)

**⚠ Caution:** When worker A is removing those bolts, worker B should support the 1st axis as shown in Figure 2-12 to prevent the robot unit from overturning.

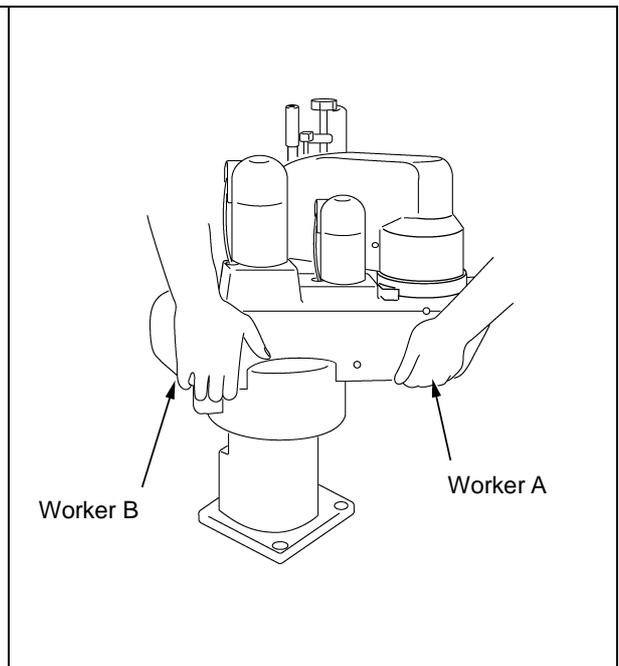
- (6) Worker A and B should hold the robot unit as specified. in Figure 2-12.

**⚠ Caution:** (1) Do not hold the robot at sections other than those specified in Figure 2-12. The resin cover could break, resulting in injury.  
(2) Before starting transportation, make sure that there are no obstacles in the path to the mounting bed.

- (7) Put the robot unit on the mount bed and secure it with four bolts temporarily.  
(8) Fix the robot unit, referring to "[ 2 ] Installing the Robot" on next page.



**Figure 2-11 Unbolting**



**Figure 2-12 Supporting the Robot Unit**

### [ 2 ] Installing the Robot Unit

- (1) Drill four M10 bolt holes in the mount bed prepared for the robot unit according to the dimensions shown in Figure 2-13.
- (2) At the reference planes, fix dowel keys or pins.

**Caution: Be sure to fix them. It can minimize teaching-point positioning errors that could occur due to vibration during operation or the removal/installation of the robot unit during maintenance.**

- (3) Put the robot unit on the mount bed, following the transport instructions given in "[ 1 ] Transporting the Robot Unit."
- (4) Set a long-hole washer to each of four socket-head bolts (M10x35, JIS strength class 12.9), and then torque those bolts to  $70 \pm 14\text{N}\cdot\text{m}$  ( $710 \pm 142\text{kg}\cdot\text{cm}^2$ ).

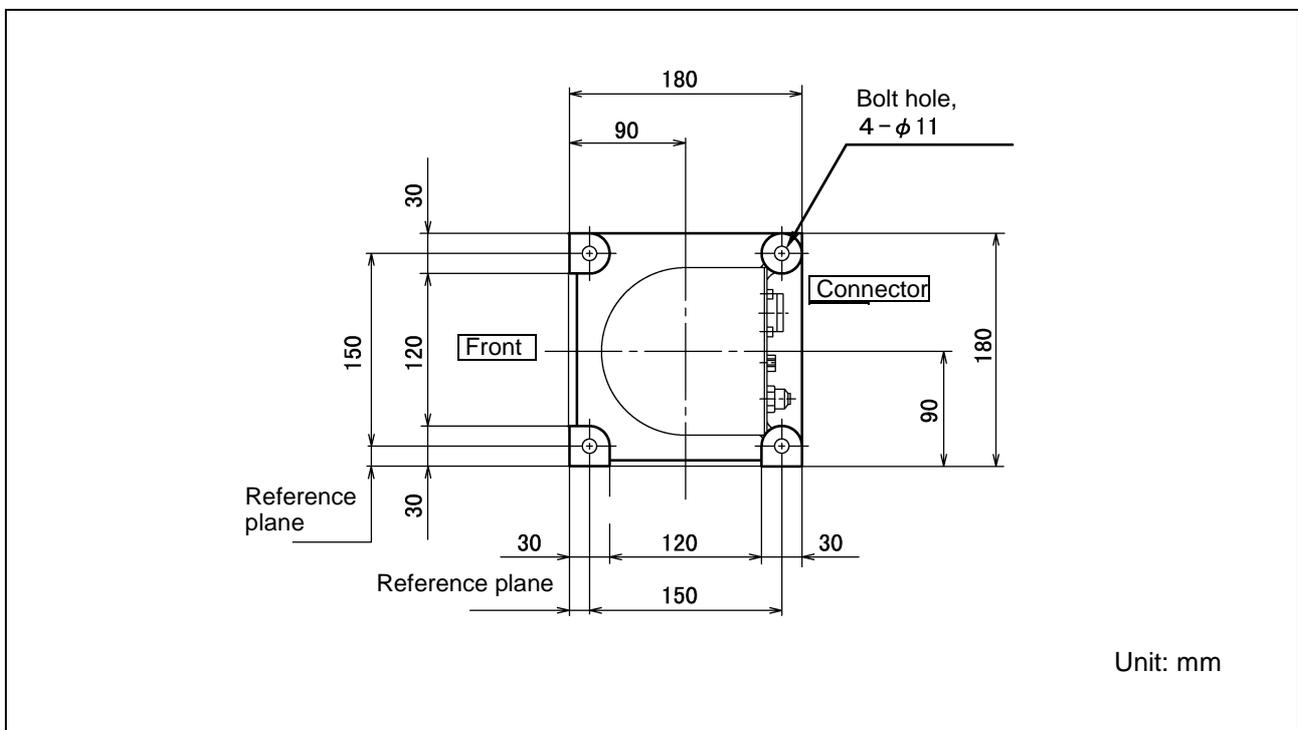
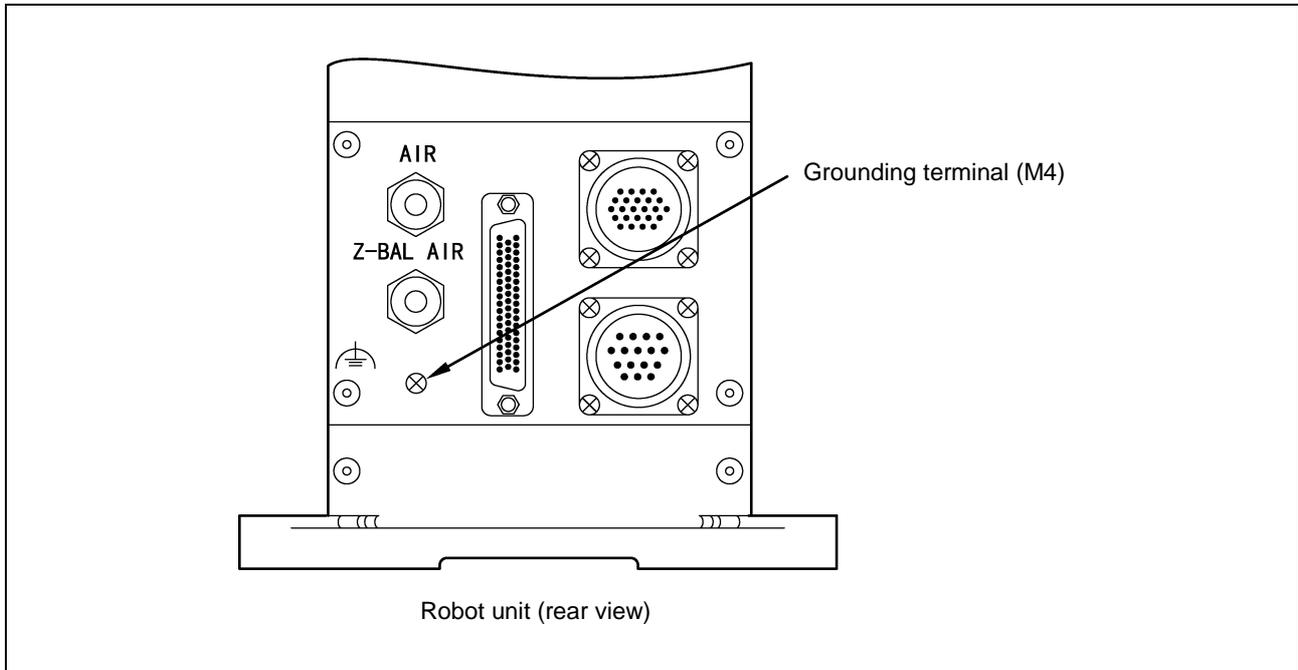


Figure 2-13 Bolt Holes for Mounting the Robot Unit (top view)

### [ 3 ] Grounding and Air Piping for the Robot Unit

Figure 2-14 shows the grounding and source air piping for the robot unit. The grounding terminal should be grounded with a wire of 5.5 mm<sup>2</sup> or more.

**Caution: Never share the grounding wire with other power facilities or welding machine.**



**Figure 2-14 Grounding and Air Piping**

## 2.3 Installing the Robot Controller

Before installing the robot controller to the target position, you need to secure the robot controller to the controller mounting panel as described in Subsection 2.3.1.

The robot controller supported by the mounting panel may be either stand-alone or wall-mounted.

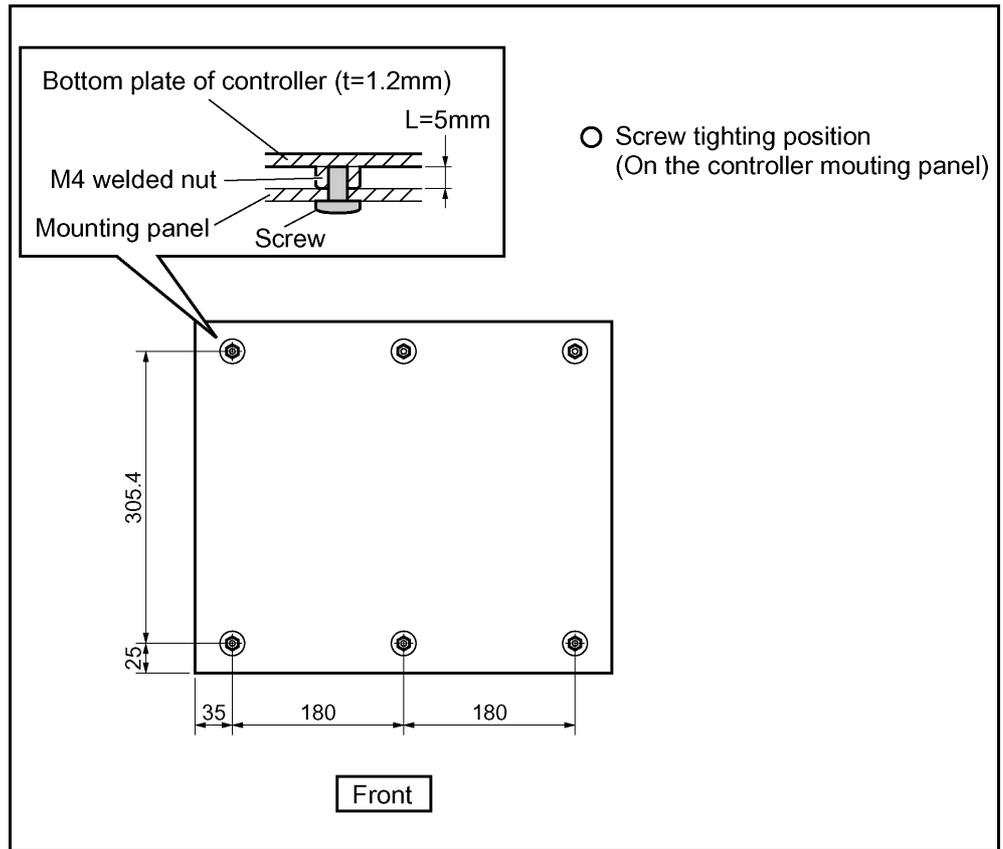
 **Caution:** When using the robot controller in any environment where there is mist, put the controller in an optional robot controller protective box. The robot controller is not dust-proof, splash-proof, or explosion-proof.

### 2.3.1 Securing the Robot Controller to the Controller Mounting Panel

- (1) Figure 2-15 shows the bottom view of the robot controller. Marked with "O," the M4-nut welded holes may be used for securing the robot controller to the mounting panel.
- (2) Prepare a mounting panel large enough to mount the robot controller. Secure the robot controller to the mounting panel at six nut-welded holes marked with "O" in Figure 2-15 using six M4 screws.

 **Caution** (1) The controller mounting screws must not be more than the thickness of the mounting panel plus 5 mm in length. If they exceed 5 mm, the nut welded holes may be damaged.

(2) Fix the robot controller at all of the six nut-welded holes.



**Figure 2-15 Location of Mounting Screw Holes**  
(on the bottom of the robot controller)

### 2.3.2 Installing the Robot Controller

The robot controller may be installed stand-alone or on the wall.

#### [ 1 ] Stand-alone

Install the robot controller as shown in Figure 2-16.

**Caution: Do not place anything within 200 mm from the air inlet and air outlet of the robot controller.**

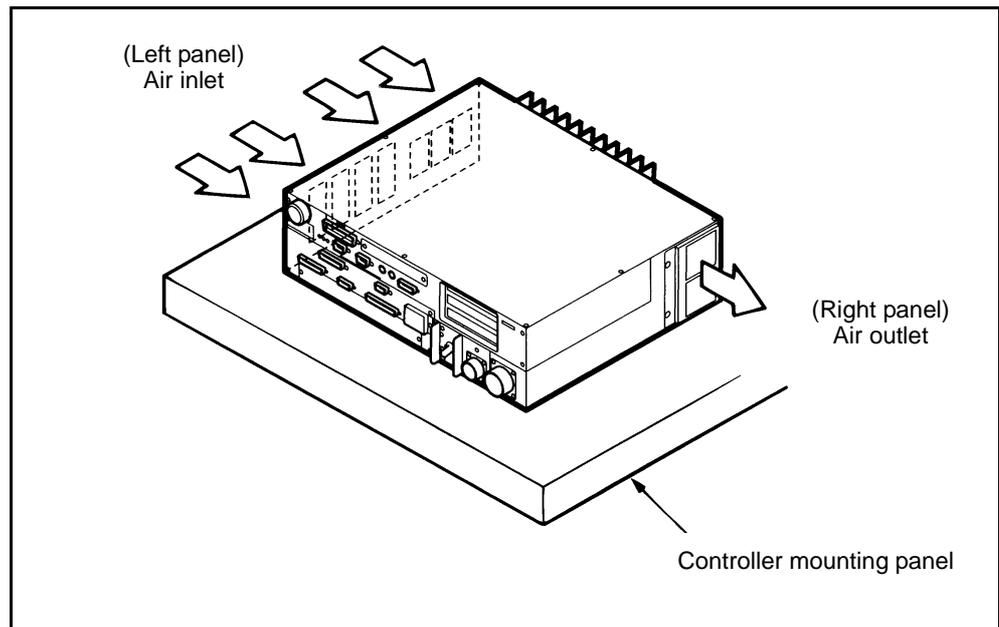


Figure 2-16 Stand-alone Installation

## [ 2 ] Wall-mounted

Install the robot controller as shown in Figure 2-17.

**⚠ Caution: Do not place anything within 200 mm from the air inlet and air outlet on the robot controller.**

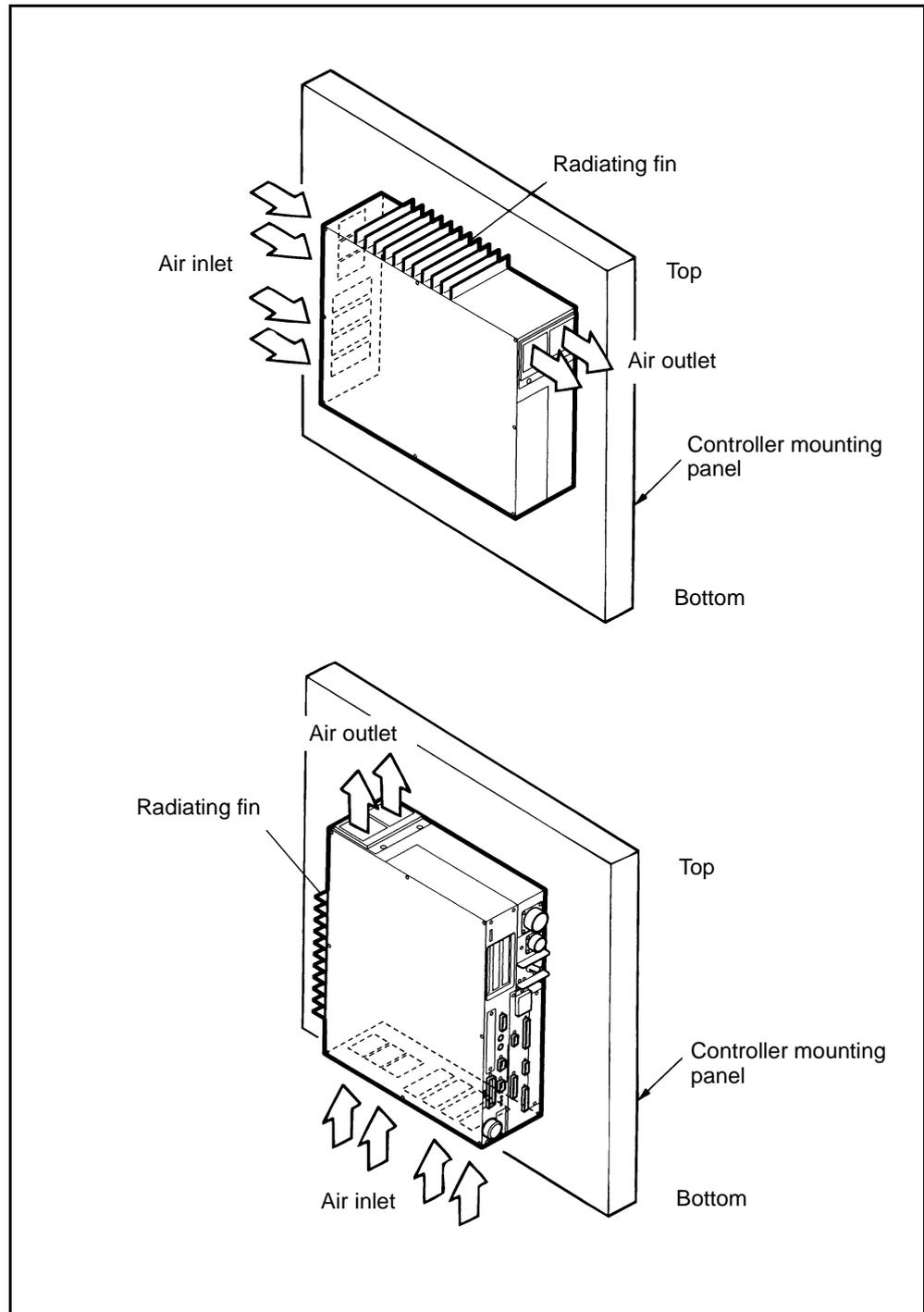


Figure 2-17 Wall-mounted Installation

## 2.4 Electrical Wiring and Air Piping of the Robot Unit

### ■ HM-D/HS-D Series

Make electrical wiring and air piping of the hand or tool to be attached to the arm end, referring to the example given below.

Use robot instrumentation cables (manufactured by Daikyo Denshi) or equivalent for electrical wiring.

#### [ 1 ] Piping for Air Balance Cylinder

Install piping for the air balance cylinder as shown in Figure 2-18. Apply air pressure within the range listed below.

At the primary side of the air regulator, install the air filter as shown in Figure 2-18. (Max. air flow volume required for the robot: 70 N liter/min)

Connect air pipes to the robot unit as shown in Figure 2-19.

Air source pressure	0.35 to 0.59 MPa
---------------------	------------------

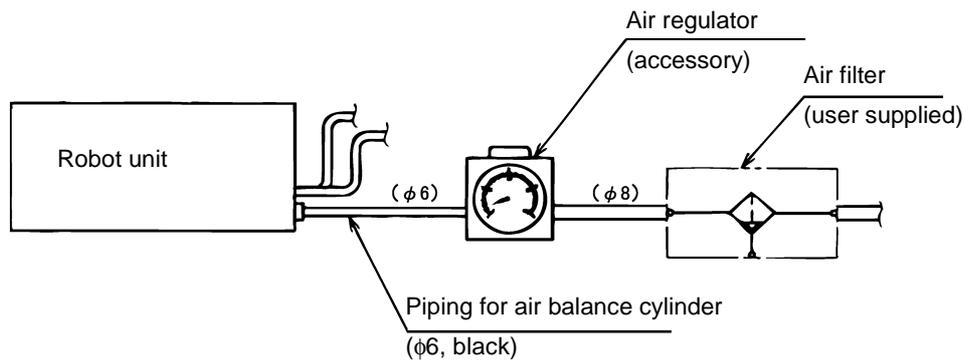


Figure 2-18 Air Piping to the Robot Unit

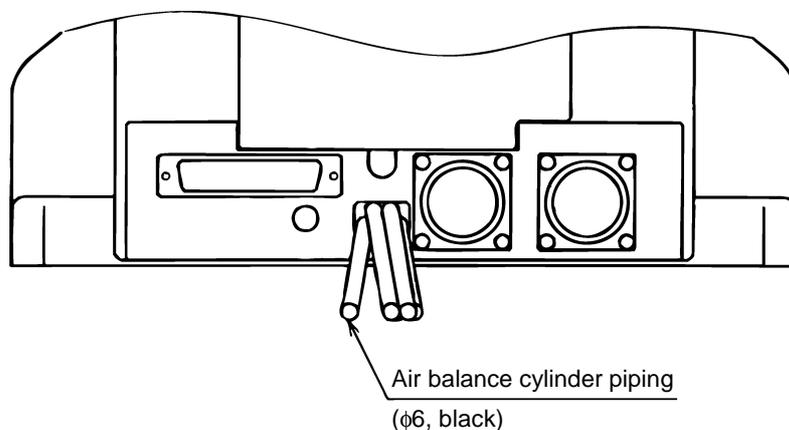


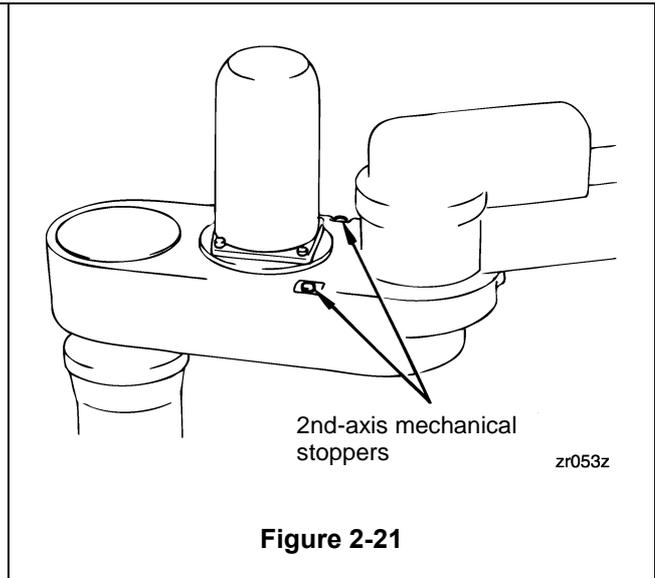
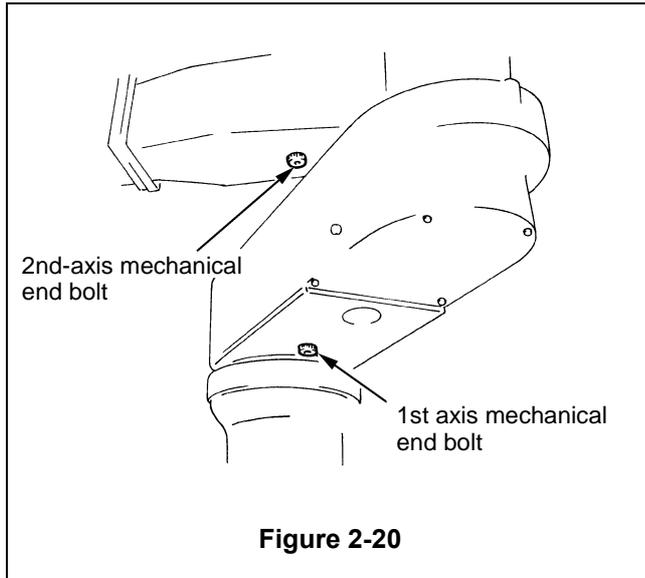
Figure 2-19 Air Piping on the Robot Unit

## [ 2 ] Wiring and Piping for the Robot Unit

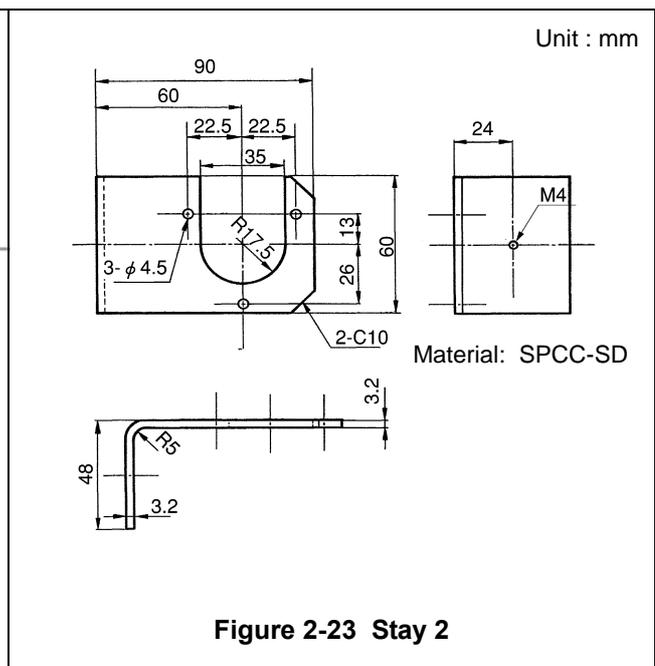
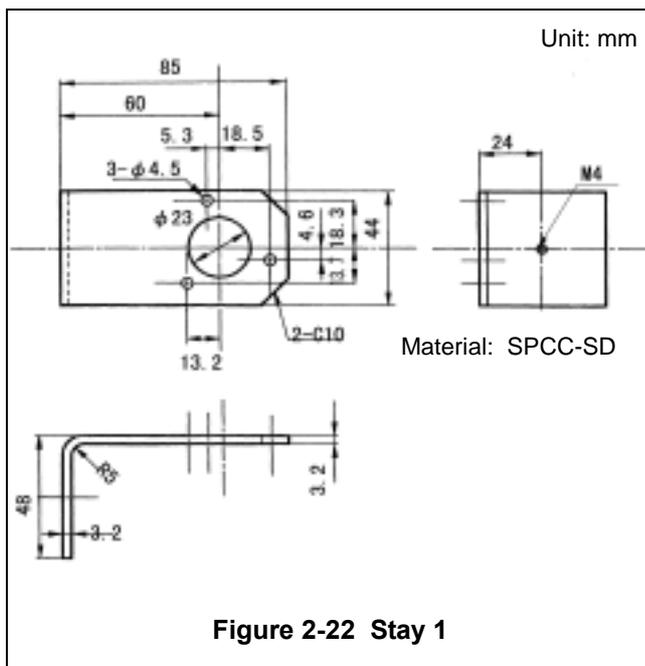
Wiring and piping stays are required.

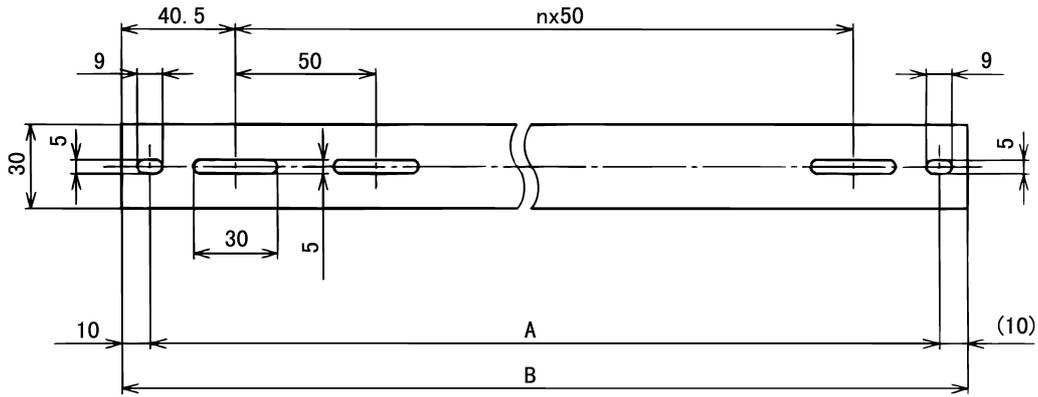
**Caution:** Do not remove the 1st-axis/2nd-axis mechanical end bolts or 2nd-axis mechanical stoppers shown below or use them for installing the wiring stays.

Doing so may result in the following problems: The CALSET initial position will be deviated when CALSET is performed (see "4.4.2 CALSET Operation"); software limit will become inactive; the robot will fail to run as programmed; the robot will interfere with its peripheral devices; and so on.



- (1) Make stays as required.  
 Figures 2-22 to 2-26 show the drawings of stays 1 to 5.



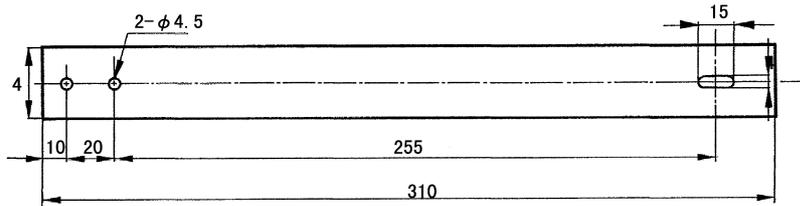


Material: SPCC-SD t=1.0  
zr054z

Z-axis stroke	A	B	n
100	211	231	3
200	311	331	5
300	411	431	7

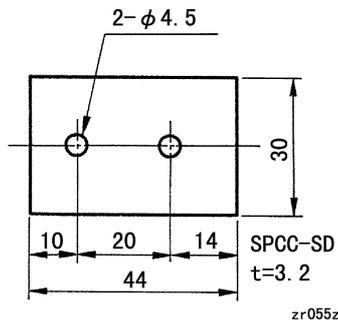
Unit: mm

**Figure 2-24 Stay 3**



Material: SPCC-SD, t=2.0

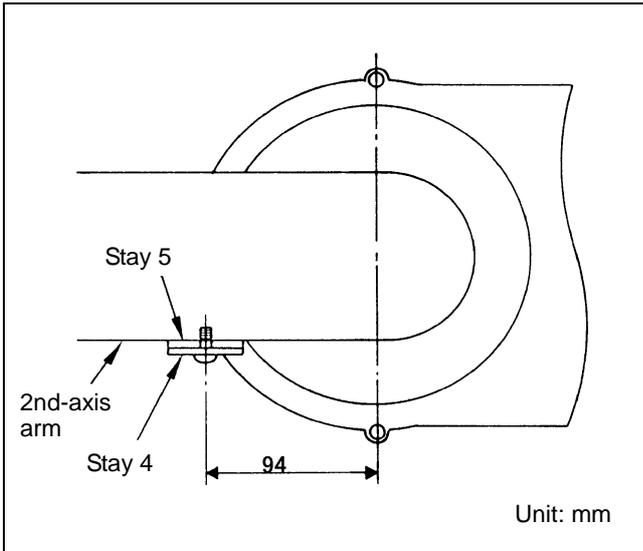
**Figure 2-25 Stay 4**



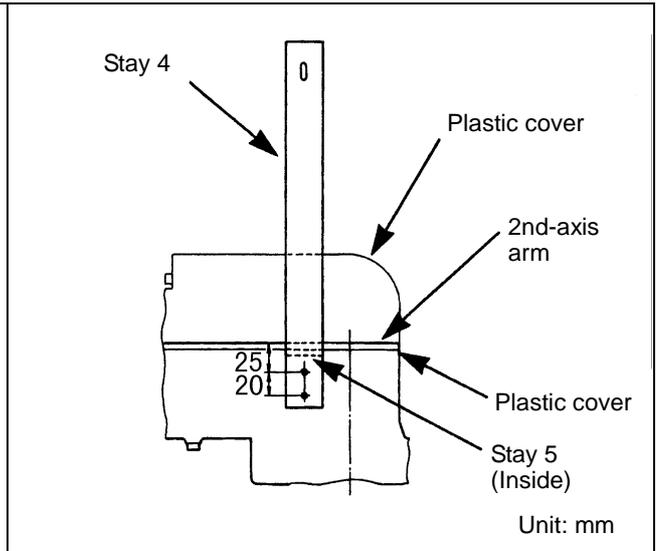
**Figure 2-26 Stay 5**

- (2) Secure stays 4 and 5 together to the holes provided in the 2nd axis arm with M4x10 or M4x12 bolts.

**Caution:** The robot 2nd-axis arm is 5 mm thick. Take care not to insert the tip of the drill or tap more than 8 mm into the arm; Doing so will damage the internal wires or bearing holders.



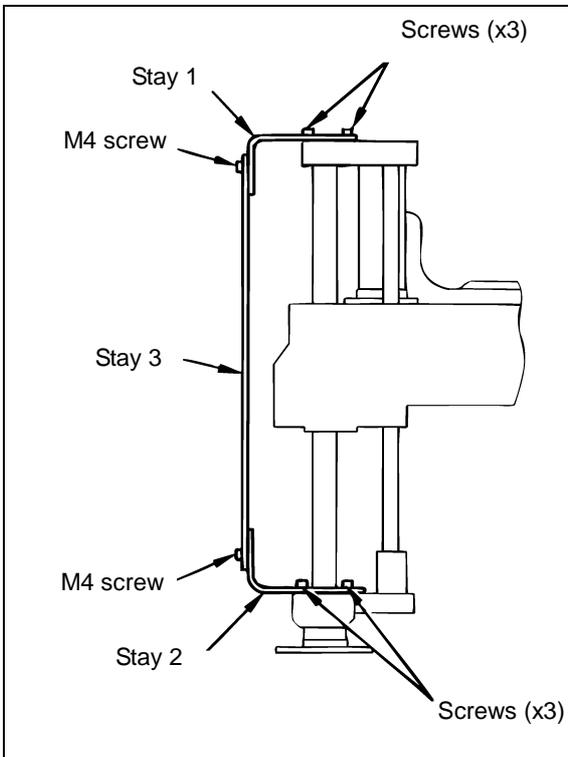
**Figure 2-27 Installing Stays 4 and 5 (I)**



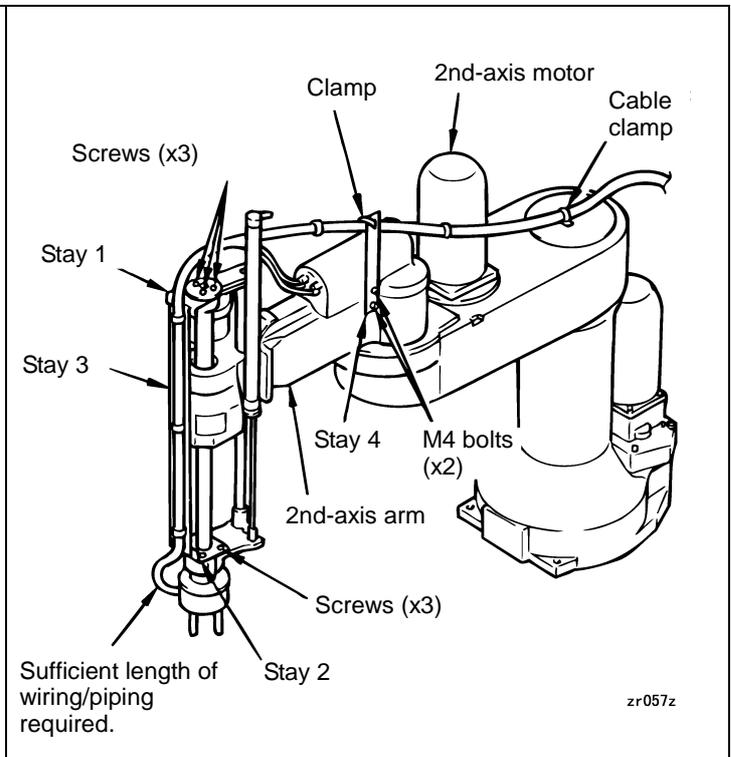
**Figure 2-28 Installing Stays 4 and 5 (Z)**

- (3) Secure stays 1 and 2 together to the bearing covers located at the top and bottom of the vertical axis arm. (See Figure 2-29.)
- (4) Install stay 3 to the stays 1 and 2 with M4 bolts. (See Figure 2-30.)
- (5) Properly wire and pipe as shown in Figure 2-30. The 4th axis may rotate 540 degree, so sufficient length of wiring and piping is required.

**Caution: Take care not to pinch the cables and pipes between the 2-axis motor and arm.**



**Figure 2-29 Installing Stays 1 and 2**



**Figure 2-30 Wiring and Piping**

### [ 3 ] Mounting the Encoder Backup Battery Externally

The HM-C/HS-C series has a built-in encoder backup battery. You may change the installation position of the battery from the inside of the robot unit to an easy-to-access position (e.g., in the control panel) separately from the robot unit. To do so, an optional extension cable with a length of 6 meters (Parts No. 410141-0780) is required.

Follow the procedures below to mount the battery externally.

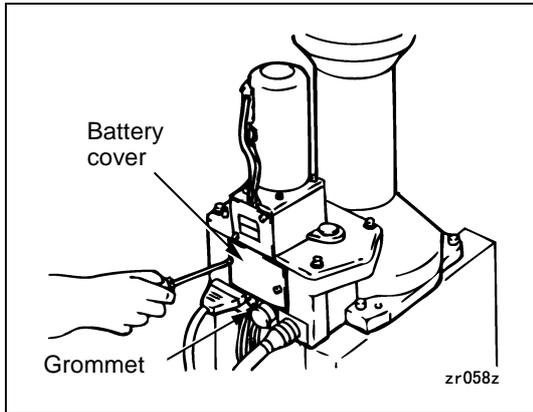


Figure 2-31

- (1) Remove the battery cover and the grommet from the robot unit. (See Figure 2-31.)
- (2) Remove the battery from the cover, then disconnect connector A and connect the extension cable to connector A. (See Figure 2-32.)

**Caution:** Be sure to finish battery replacement job within three minutes. Otherwise, the motor encoder data will be lost, resulting in ERROR410. The robot will no longer run.

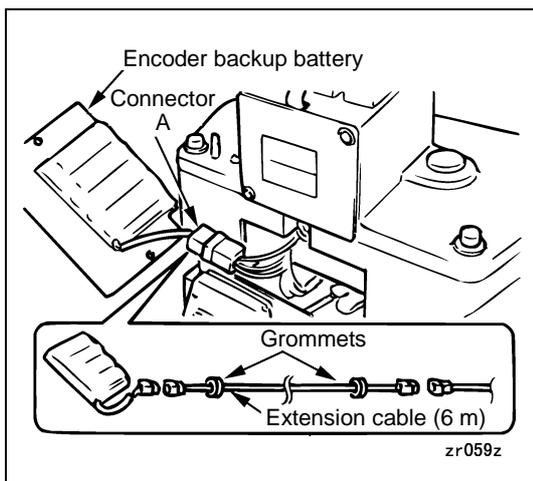


Figure 2-32

- (3) Fit the grommet of the extension cable into the notch of the connector retainer, and then mount the cover onto the robot unit.
- (4) Install the battery to the desired easy-to-access position (e.g., in the control panel).

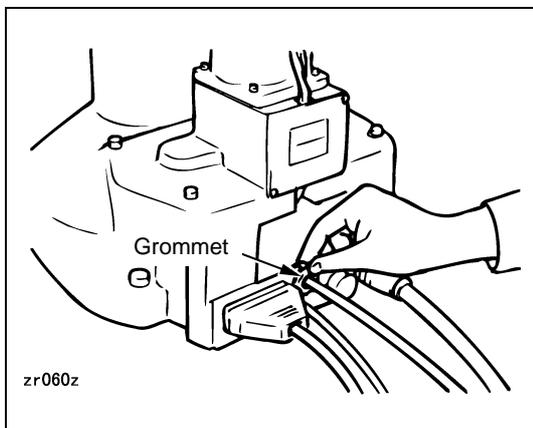


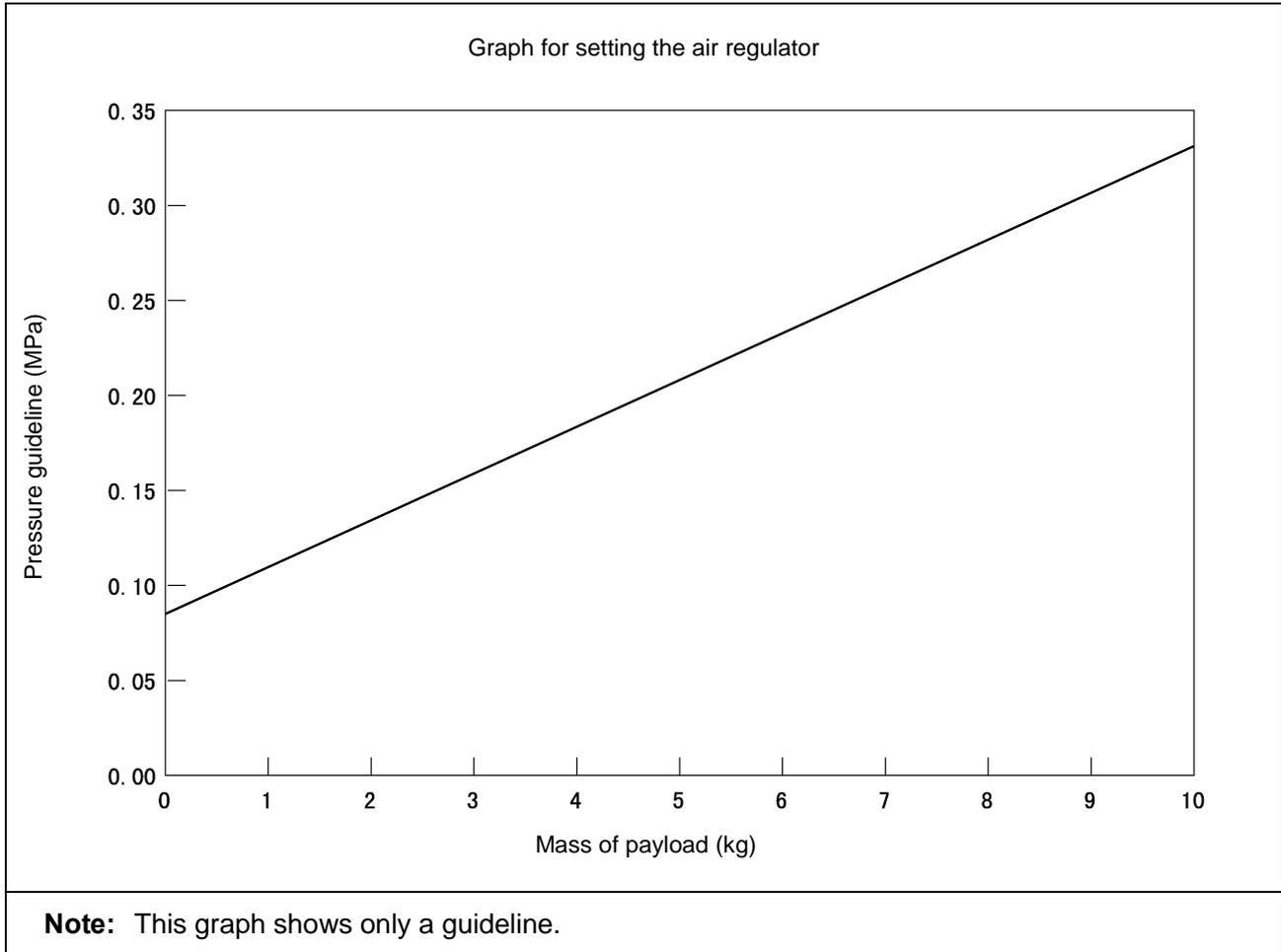
Figure 2-33

## [ 4 ] Adjusting the Air Balance

Adjust the air pressure by using the air regulator so that the end-effector plus payload chucked by the end-effector will balance with gravity.

For details, refer to Table 2-2 below and the SETTING-UP MANUAL, Section 5.3, "Adjusting the air pressure balance of the Z-axis, [F1 Arm]—[F12 Maint.]—[F4 Adj.Z.Bal]."

**Table 2-2 Air Pressure Guideline**



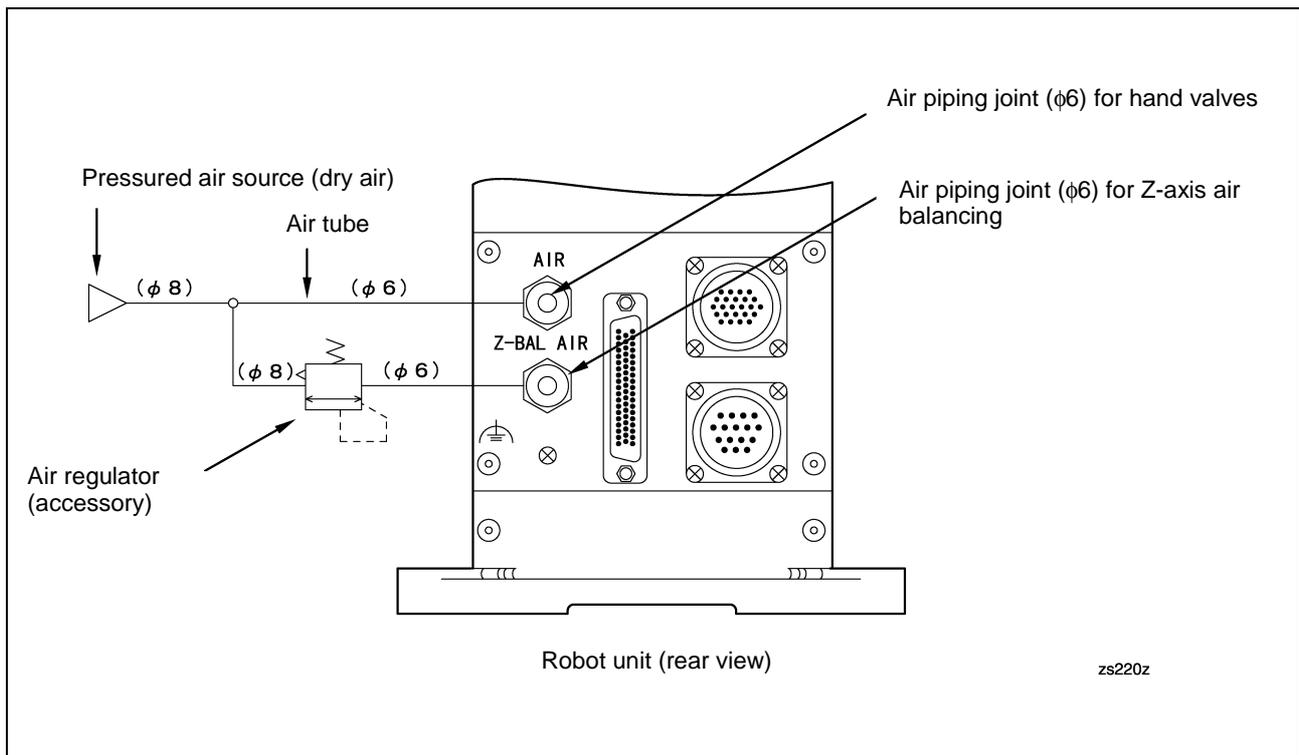
### ■ HC-D Series

#### [ 1 ] Source Air Piping

Connect the source air pipe to the AIR joint prepared for hand valves. Connect the regulated air pipe to the Z-BAL AIR joint prepared for Z-axis air balancing. The source air pressure is listed below.

Apply dry air to the robot unit. The valves and air balance cylinder integrated in the robot unit require no lubrication.

Air source pressure	0.59 MPa
---------------------	----------



**Figure 2-34 Air Piping of the Robot Unit**

## [ 2 ] Installing the Flange Kit (option)

The flange kit consists of a flange, fixing bolt (M5x16), and setscrew (M4x6). Figure 2-35 shows the installation position of the flange kit.

- (1) Wipe off oil from the circumference of the T-axis shaft in which the flange should be fitted.
- (2) Loosen the setscrew of the flange to insert the flange into the T-axis shaft.
- (3) Push the flange until it comes into contact with nut end "A," and then rotate the flange so that the setscrew becomes aligned with the flat section of the T-axis shaft.
- (4) Gradually tighten the setscrew until it comes into contact with the flat section of the T-axis shaft and the flange can be rotated without looseness. Then torque the setscrew to  $1.6 \pm 0.3 \text{ N}\cdot\text{m}$  ( $16 \pm 3.2 \text{ kgf}\cdot\text{cm}$ ).
- (5) Tighten the fixing bolt (M5x16) to  $8.8 \pm 0.9 \text{ N}\cdot\text{m}$  ( $90 \pm 9 \text{ kgf}\cdot\text{cm}$ ) for securing the flange.

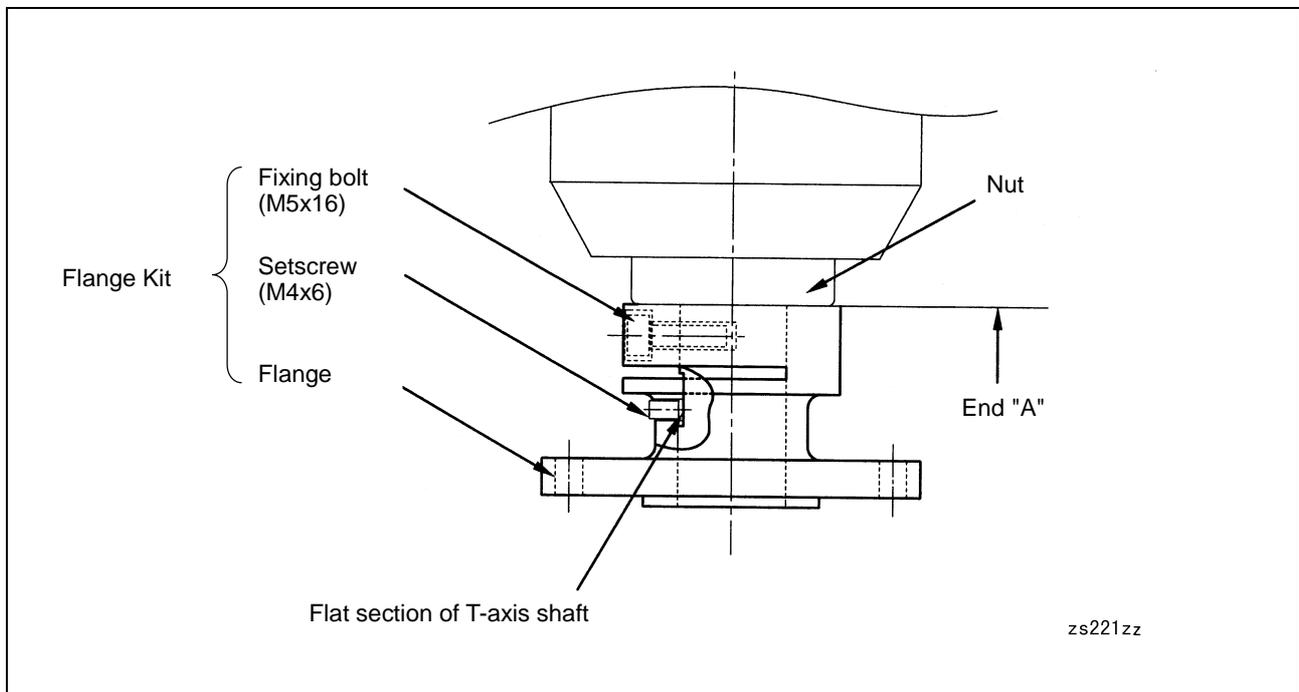


Figure 2-35 Installing the Flange Kit

### [ 3 ] Mounting the Encoder Backup Battery Externally

The HM-C/HS-C series has a built-in encoder backup battery. You may change the installation position of the battery from the inside of the robot unit to an easy-to-access position (e.g., in the control panel) separately from the robot unit. To do so, an optional extension cable with a length of 6 meters (Parts No. 410141-0780) is required.

Follow the procedures below to mount the battery externally.

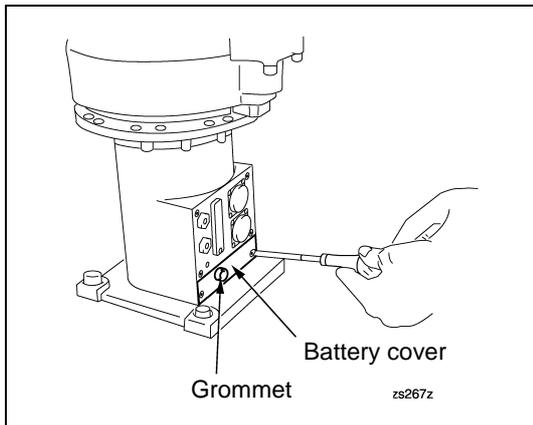


Figure 2-36

- (1) Remove the battery cover and the grommet from the robot unit. (See Figure 2-36.)
- (2) Remove the battery from the cover, then disconnect connector A and insert the extension cable to connector A. (See Figure 2-37.)

**Caution:** Be sure to finish battery replacement within three minutes. Otherwise, the motor encoder data will be lost, resulting in ERROR410. The robot will no longer run.

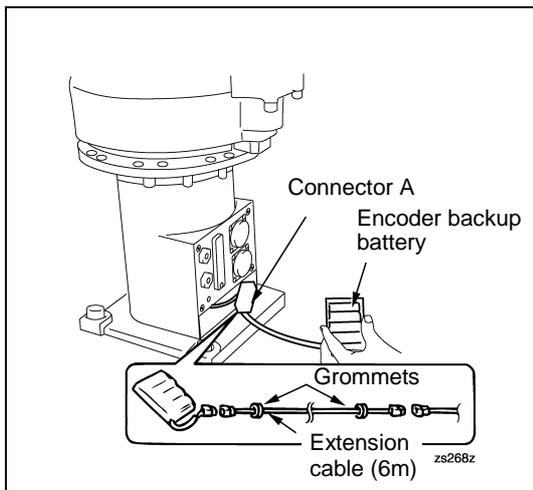


Figure 2-37

- (3) Fit the grommet of the extension cable into the notch of the connector retainer, and then mount the cover onto the robot unit.
- (4) Install the battery to the desired easy-to-access position (e.g., in the control panel).

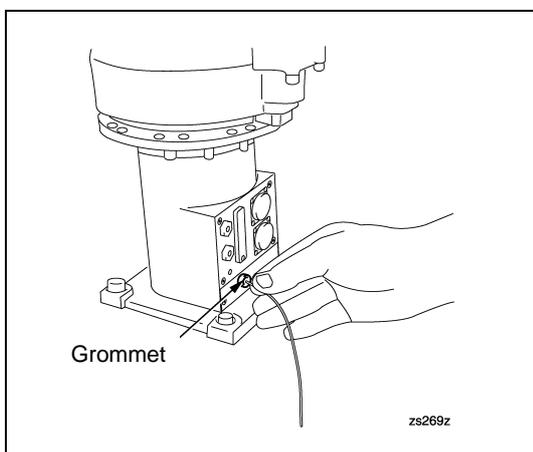


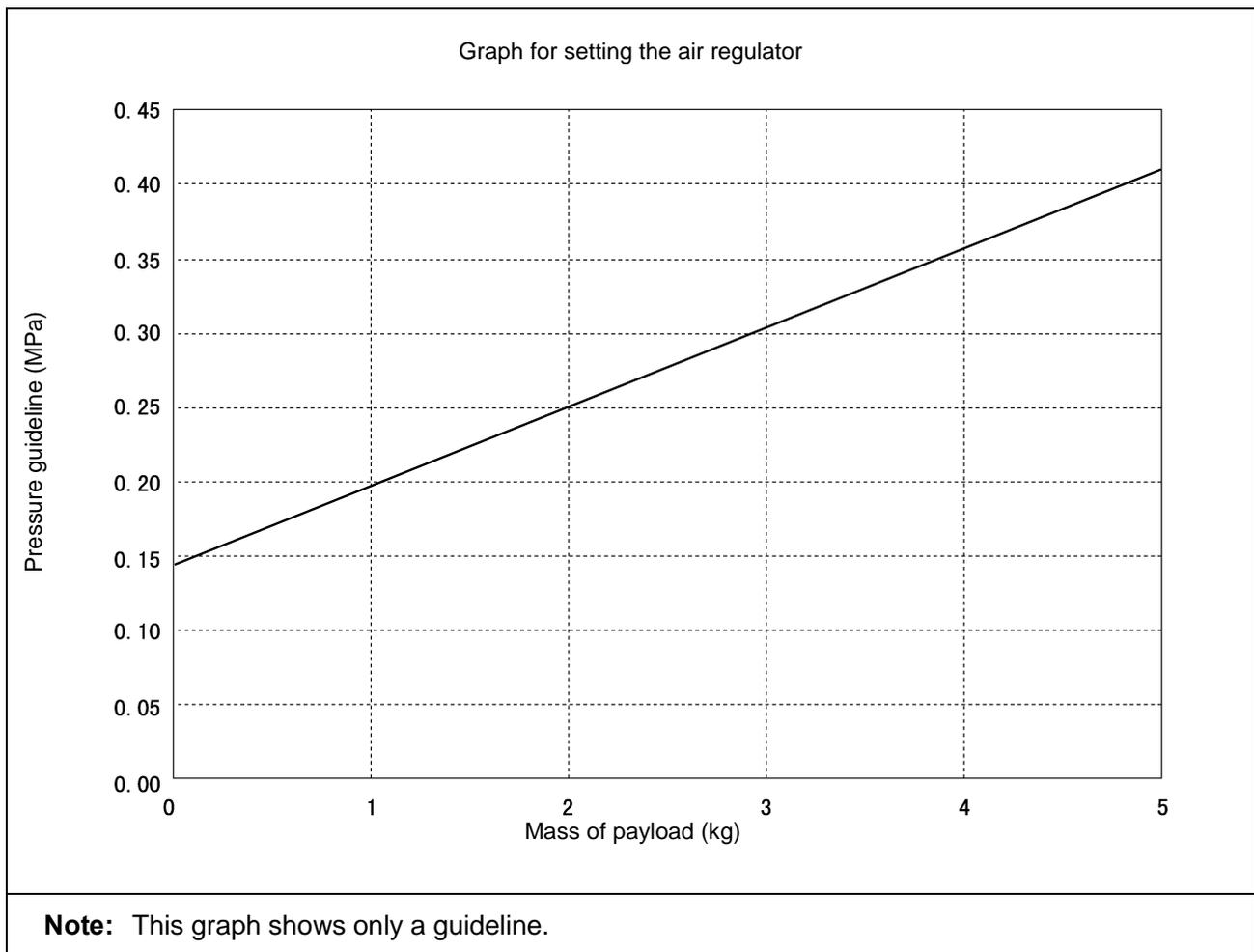
Figure 2-38

## [ 4 ] Adjusting the Air Balance

Adjust the air pressure by using the air regulator so that the end-effector plus payload chucked by the end-effector will balance with gravity.

For details, refer to Table 2-3 below and the SETTING-UP MANUAL, Section 5.3, "Adjusting the air pressure balance of the Z-axis, [F1 Arm]—[F12 Maint.]—[F4 Adj.Z.Bal]."

**Table 2-3 Air Pressure Guideline**



## 2.5 Engineering-design Notes for End-effectors

Design an end-effector so that it will satisfy conditions (1) through (3) described below.

**⚠ Caution:** Strictly observe these engineering-design notes. Otherwise, the clamped sections of the robot unit will become loose, rattle or be out of position. In the worst case, the mechanical parts of the robot unit and the robot controller may be damaged.

### (1) Mass of an end-effector

The total mass of an end-effector (including workpiece) should be less than the maximum allowable payload of the robot. Be sure to include the mass of wirings and piping used for end-effectors.

**Total mass of end-effector (incl. workpiece) ≤ Maximum allowable payload**

NOTE: The maximum allowable payload refers to a mass of payload that you have preset.

### (2) End-effector center of gravity

The center of gravity of an end-effector (including workpiece) should be located within the range specified in Figures 2-39 and 2-40 for the HM-D/HS-D series and HC-D series, respectively.

#### ■ HM-D/HS-D Series

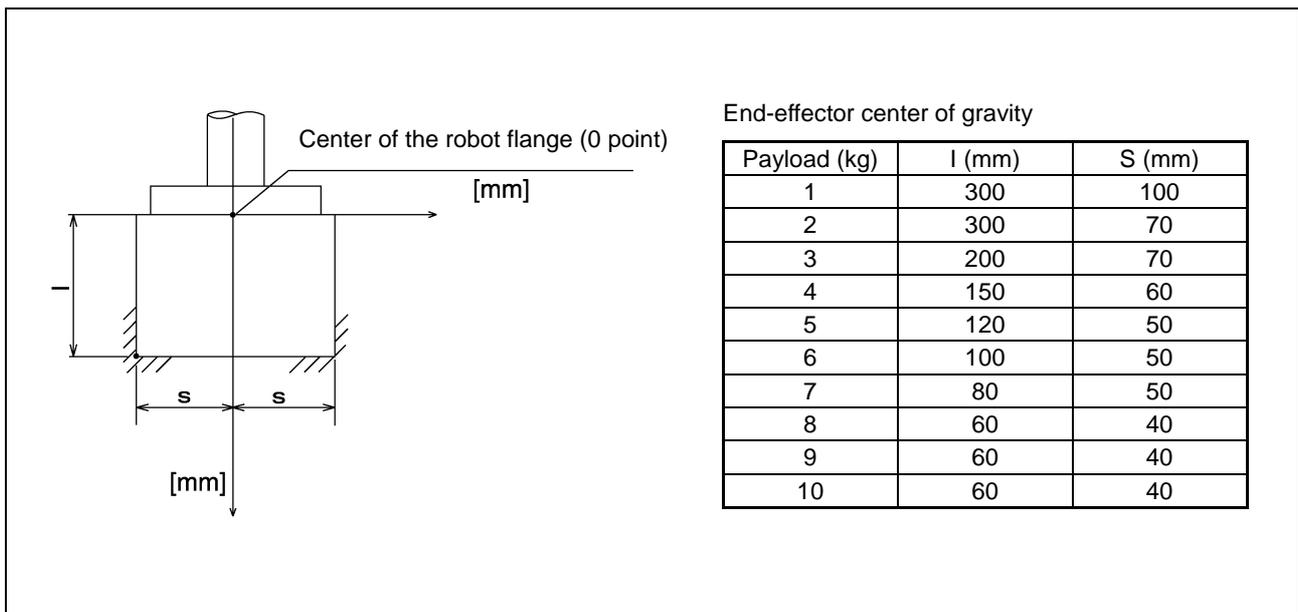


Figure 2-39 Allowable Range of Center of Gravity of End-effector (HM-D/HS-D Series)

■ HC-D Series

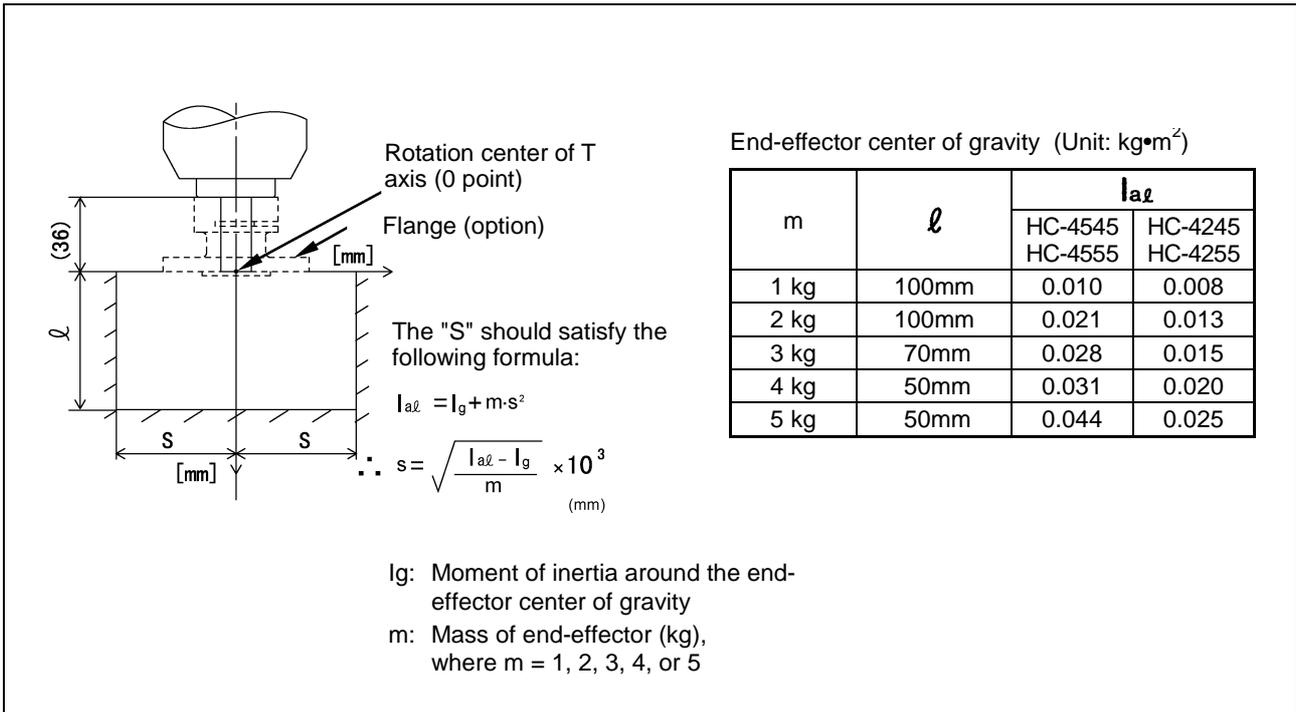


Figure 2-40 Allowable Range of Center of Gravity of End-effector (HC-D Series)

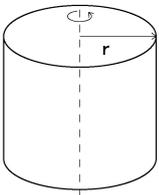
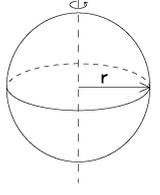
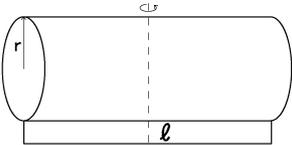
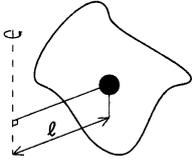
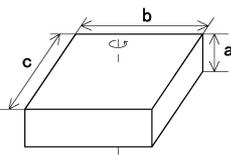
### (3) Moment of inertia around the T axis

The moment of inertia of an end-effector (including workpiece) around the T axis should be less than the maximum allowable moment of inertia around the T axis of the robot.

**End-effector moment of inertia (incl. workpiece) around the T axis ≤ Maximum allowable moment of inertia**

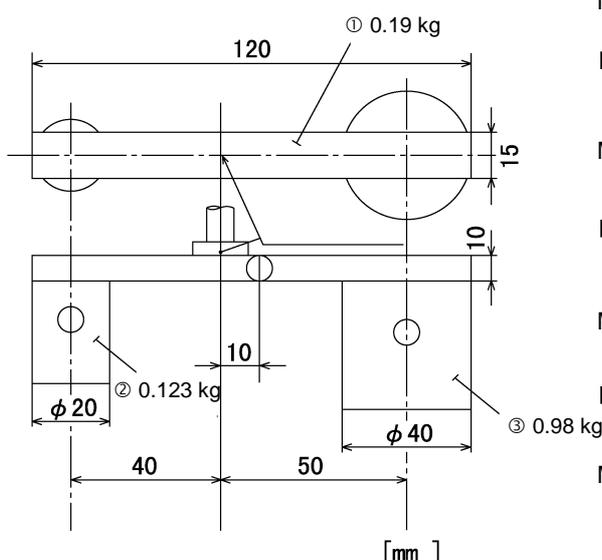
Calculate the moment of inertia around the T axis, referring to Table 2-4.

**Table 2-4 Moment-of-inertia Formulas**

<p>1. Cylinder (1) (Axis of rotation = Center axis)</p>  $I = \frac{mr^2}{2}$	<p>4. Sphere (Axis of rotation = Center axis)</p>  $I = \frac{2mr^2}{5}$												
<p>2. Cylinder (2) (The axis of rotation passes through the center of gravity.)</p>  $I = \frac{m}{4} \left( r^2 + \frac{l^2}{3} \right)$	<p>5. Center of gravity not on the axis of rotation. I<sub>g</sub>: Moment of inertia around center of gravity</p>  $I = I_g + m l^2$ <p style="text-align: right;">[kgm<sup>2</sup>]</p>												
<p>3. Rectangular parallelepiped (The axis of rotation passes through the center of gravity.)</p>  $I = \frac{m}{12} (b^2 + c^2)$	<table style="width: 100%; border: none;"> <tr> <td style="padding-right: 10px;">I:</td> <td>Moment of inertia</td> <td style="text-align: right;">(kgm<sup>2</sup>)</td> </tr> <tr> <td>m:</td> <td>Mass</td> <td style="text-align: right;">(kg)</td> </tr> <tr> <td>r:</td> <td>Radius</td> <td style="text-align: right;">(m)</td> </tr> <tr> <td>a, b, c, l:</td> <td>Length</td> <td style="text-align: right;">(m)</td> </tr> </table>	I:	Moment of inertia	(kgm <sup>2</sup> )	m:	Mass	(kg)	r:	Radius	(m)	a, b, c, l:	Length	(m)
I:	Moment of inertia	(kgm <sup>2</sup> )											
m:	Mass	(kg)											
r:	Radius	(m)											
a, b, c, l:	Length	(m)											

Calculation example : When calculating the moment of inertia of a complicated shape, divide it into simple parts as much as possible for easier calculations.

As shown in the figure below, divide the end-effector into three parts (①, ②, ③).



Moment of inertia around T-axis of ①: I<sub>1</sub> (from 3 and 5 in Table 2-4)

$$I_1 = \frac{0.19}{12} (0.12^2 + 0.015^2) + 0.19 \times 0.01^2 = 2.51 \times 10^{-4} \text{ [kgm}^2 \text{]}$$

Moment of inertia around T-axis of ②: I<sub>2</sub> (from 1 and 5 in Table 2-4)

$$I_2 = \frac{0.123 \times 0.01^2}{2} + 0.123 \times 0.04^2 = 2.03 \times 10^{-4} \text{ [kgm}^2 \text{]}$$

Moment of inertia around T-axis of ③: I<sub>3</sub> (from 1 and 5 in Table 2-4)

$$I_3 = \frac{0.98 \times 0.02^2}{2} + 0.98 \times 0.05^2 = 2.65 \times 10^{-3} \text{ [kgm}^2 \text{]}$$

Moment of inertia around T-axis of entire end-effector: I

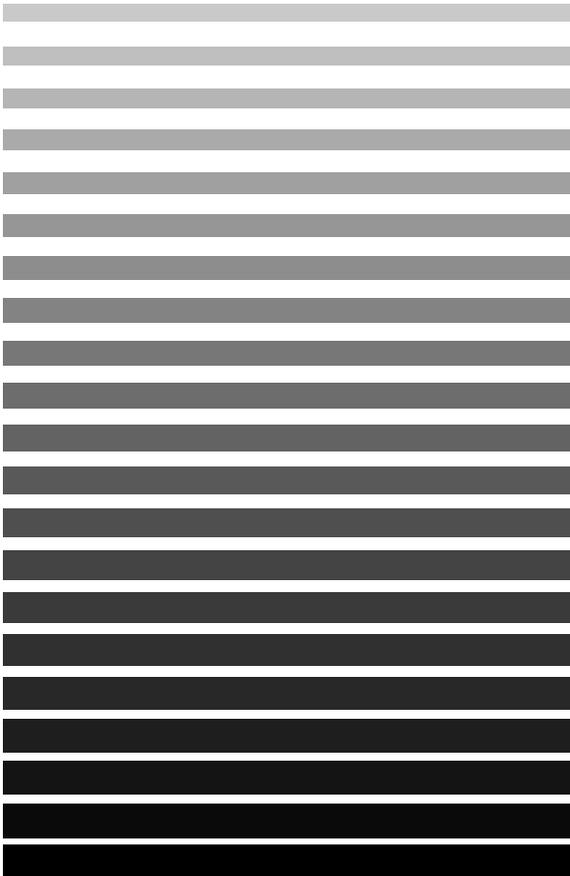
$$I = I_1 + I_2 + I_3 = 0.003 \text{ [kgm}^2 \text{]}$$

**Figure 2-41 Calculation Example of End-effector Moment of Inertia Around T Axis**



# Chapter 3

## Optional Devices



This chapter describes the configurations and functions of these optional devices--operating panel, teach pendant, PC teaching system "WINCAPSII," floppy disk drive,  $\mu$ Vision board, Ethernet board, DeviceNet board, and PROFIBUS-DP board.



## 3.1 Operating Panel

The operating panel is a fixed type operation console that allows you to recover the robot from a stop due to problems caused by peripheral units, etc. The panel has minimum necessary teaching/operating functions.

To the operating panel you may connect a teach pendant which is designed for teaching and other fine operations.

The **ROBOT STOP** button and the **STOP** key on the operating panel and the teach pendant are available anytime. For other functions, you may select the operating panel or teach pendant. To switch between the operating panel and teach pendant, use the mode selector switch on the operating panel.

### 3.1.1 Operating Panel Functions

#### Operating

The operating panel provides these functions--motor power ON/OFF, CAL execution, program selection, speed change, automatic operation start/stop and manual operation. For further information, see the SETTING-UP MANUAL.

#### Display

The operating panel has an LCD capable of displaying 2 lines of 16 characters. It displays the current robot position, ongoing program number, error code when an error occurs, and related information in alphanumerical characters.

#### Teaching

With the operating panel, you may run the robot manually and start programs. As listed below, you may also edit variables, get robot arm positions into variables in teaching, and move the robot arm by specifying a desired variable, depending upon the version of the main software. Choosing work coordinates or tool coordinates is also possible. For details, refer to the SETTING-UP MANUAL.

Version of main software	Function	Description
Version 1.2 or later	Editing variables	You may edit variables by entering numerical values.
Version 1.4 or later	Teaching the current position	You may get the current position into P variables, J variables, and T variables. It is used for position teaching.
	Choosing work coordinates or tool coordinates	You may choose work coordinates or tool coordinates.
Version 1.6 or later	Operating the robot arm by specifying a desired variable	You may move the robot arm according to the specified variable. It is used to confirm variables you have preset in teaching.

#### Connecting the Teach Pendant

You may connect the teach pendant to the **TP** terminal at the bottom of the operating panel. Setting the mode selector switch on the operating panel to the **TP** position allows you to operate the robot from the teach pendant.

When the mode selector switch is set to the **MANUAL** or **AUTO** position, the robot is operated from the operating panel.

### 3.1.2 Names of Operating Panel Components

Figure 3-1 shows the names of the operating panel components.

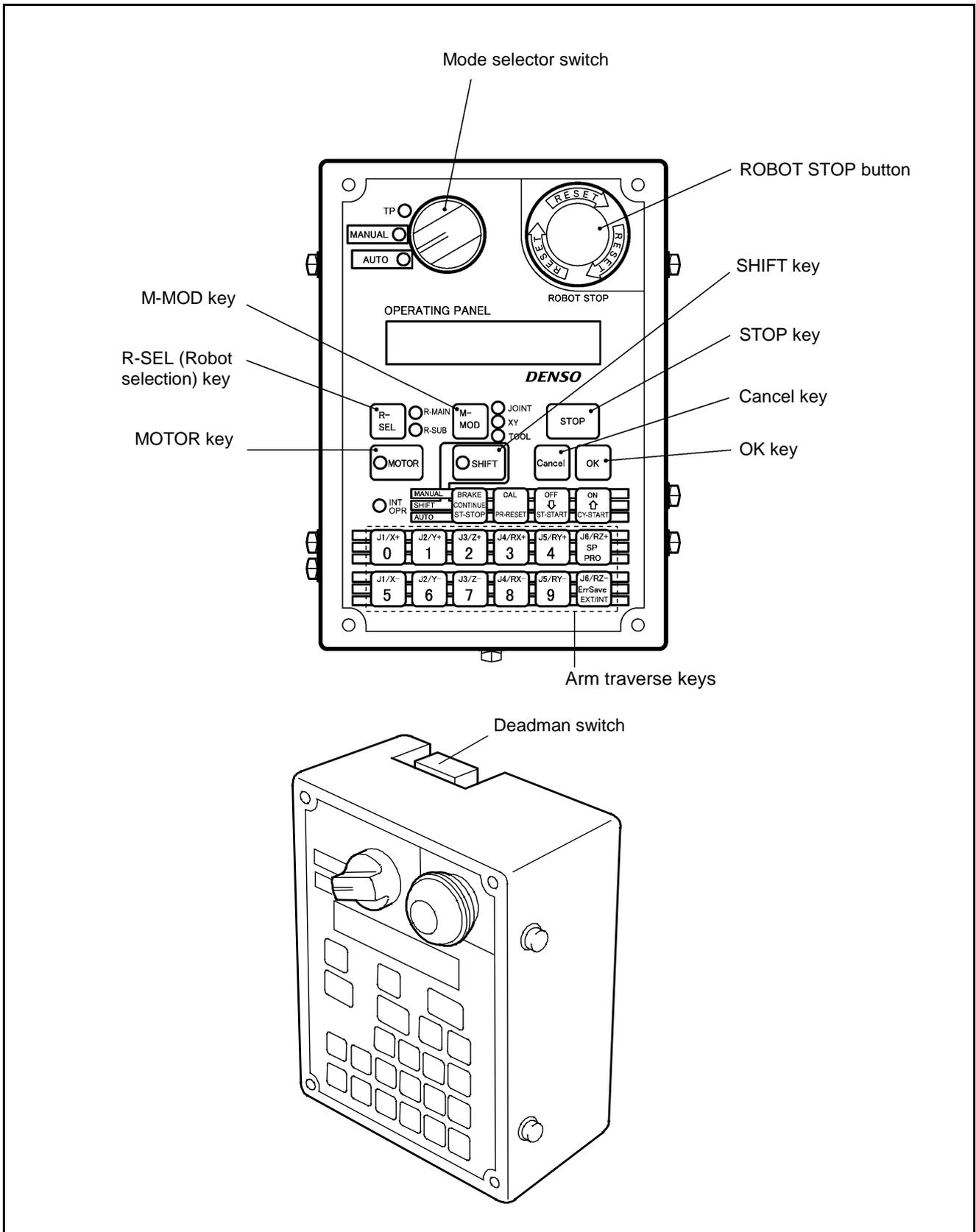


Figure 3-1 Names of Operating Panel Components

### 3.1.3 Operating Panel Specifications

Table 3-1 lists the operating panel specifications.

**Table 3-1 Operating Panel Specifications**

Item	Specifications
Model	OP-RC5-1
Display	Liquid crystal display with backlight, 16 characters × 2 lines
Power source	24 VDC (supplied from robot controller)
Operation	23 flat key switches, ROBOT STOP button, mode selector switch, deadman switch
Installation conditions	Temperature: 0 to 40°C Humidity: 90% RH or less (Dew condensation shall not be allowed.)
Dimensions (H x W x D)	140 × 100 × 40 mm (Excluding projections such as switches)
Weight	Approx. 0.7 kg
Cable length	4 m or 8 m
Others	Equipped with a socket for connecting the teach pendant (See Note.)

(Note) When no teach pendant is connected, a pendantless connector should be connected to the TP socket.



**Caution:** The operating panel is a fixed type operation console. Be sure to secure it to the equipment.

### 3.1.4 Mounting and Connecting the Operating Panel

#### Mounting the operating panel

The operating panel is a fixed type operation console. Mount it to the equipment, referring to Figure 3-2.

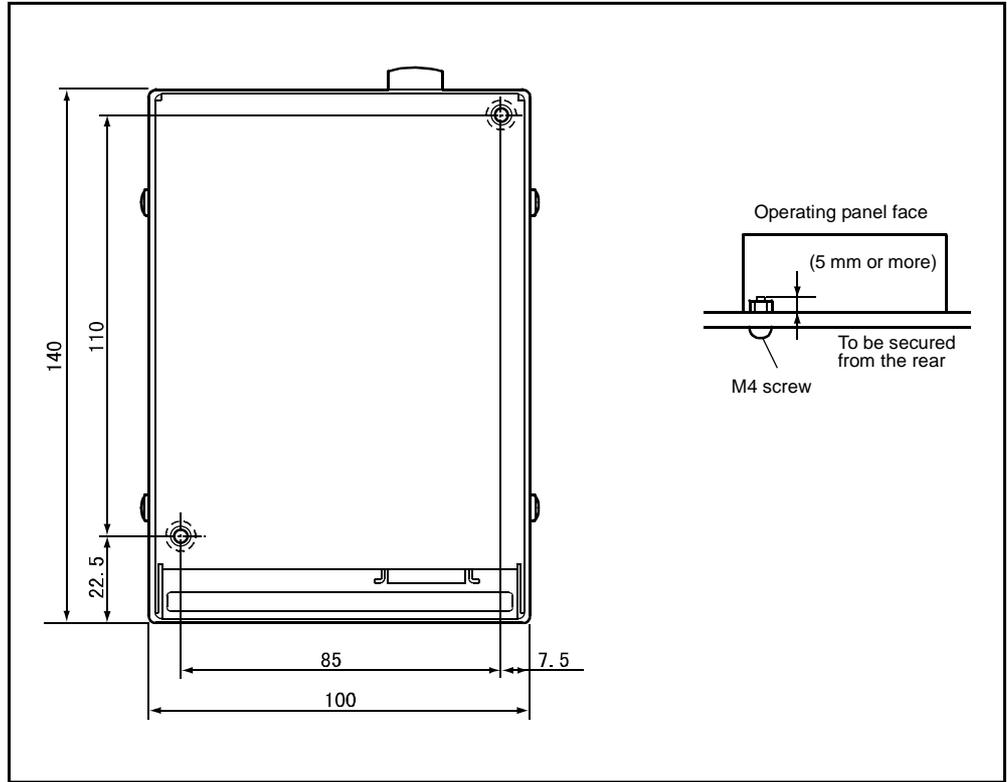


Figure 3-2 Mounting the Operating Panel

### Connecting the operating panel

As shown in Figure 3-3, the operating panel can be connected to the robot controller. A teach pendant can also be connected to the operating panel.

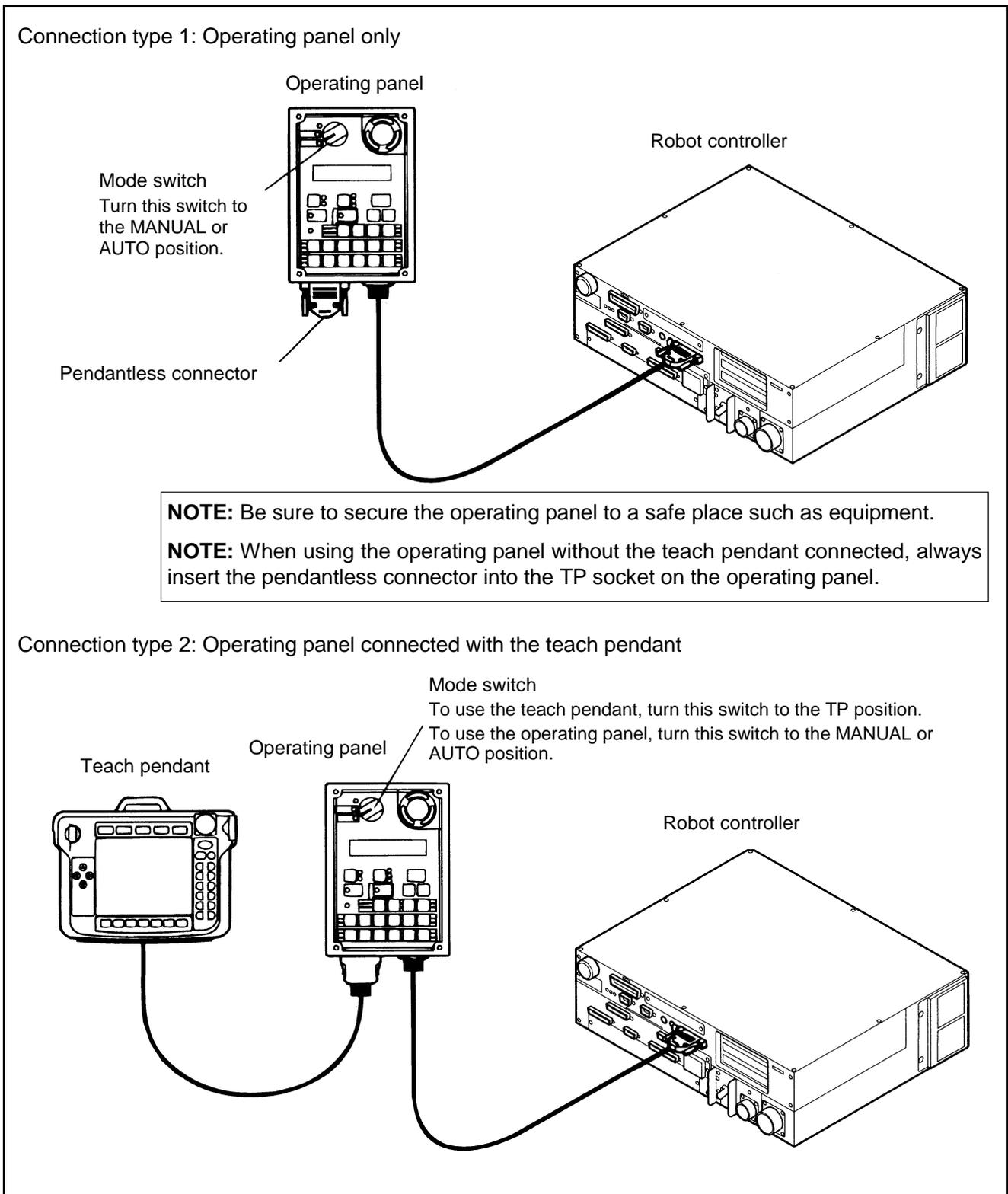


Figure 3-3 Connecting the Operating Panel to the Robot Controller and the Teach Pendant

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## 3.2 Teach Pendant

The teach pendant is an entry/operation device for creating programs and teaching. The teach pendant can perform all operations except automatic external operation.

### 3.2.1 Teach Pendant Functions

For instructions on how to operate the teach pendant, refer to the SETTING-UP MANUAL.

#### **Programming and teaching**

This function allows you:

- to enter commands and store the robot arm position. You may specify a program and enter program steps one by one,
- to modify, delete, or copy those commands and robot arm positions, and
- to check edited programs in running them in Teach check mode.

#### **Operating the robot**

This function turns power to the motor ON/OFF, executes CAL, starts and stops automatic operation, and performs manual operation.

#### **Displaying**

This function displays the contents of programs, the progress of running programs, ongoing step number, current robot position or error messages.

### 3.2.2 Names of Teach Pendant Components

Figure 3-4 shows the names of the teach pendant components.

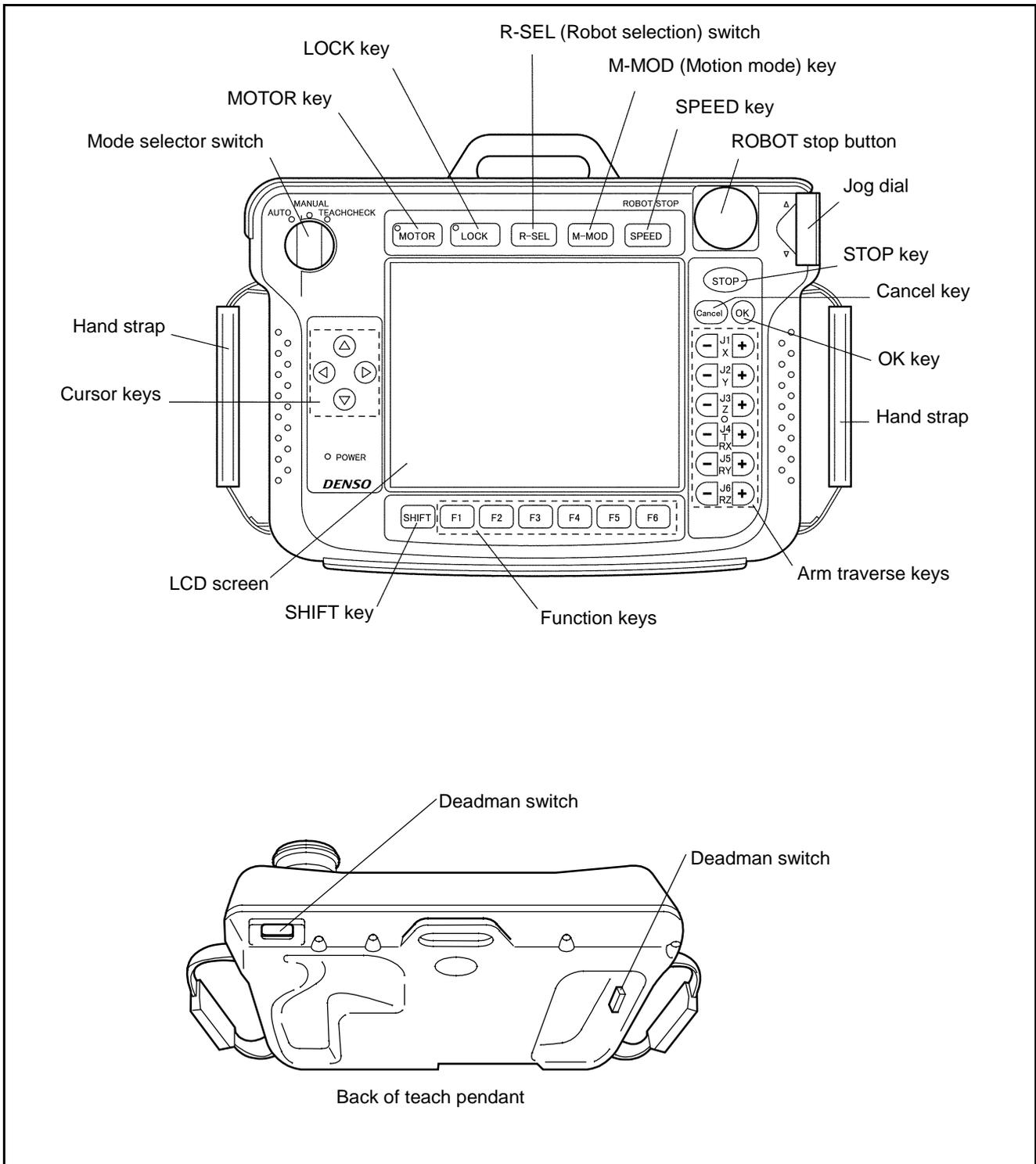


Figure 3-4 Names of Teach Pendant Components

---

### 3.2.3 Teach Pendant Specifications

#### [ 1 ] Specifications

Table 3-2 lists the teach pendant specifications.

**Table 3-2 Teach Pendant Specifications**

<b>Item</b>	<b>Specifications</b>
Model	TP-RC5-1
Display	Liquid crystal display with backlight, 640 × 480 pixels
Power source	24 VDC (supplied from robot controller)
Operation	Robot stop button, deadman switch, jog dial, MOTOR power on/off key, AUTO/MANUAL selector switch, function keys, arm traverse keys, LOCK key, R-SEL (robot selection) key, M-MOD (motion mode) key, SPEED key, cursor keys, STOP key, OK key, Cancel key
Installation conditions	Temperature: 0 to 40°C Humidity: 90% RH or less (Dew condensation shall not be allowed.)
Outside dimensions (W x H x D)	260 × 186 × 60 mm (excluding projections)
Weight	1 kg
Cable length	4 m, 8 m, or 12 m

[ 2 ] Outer Dimensions

Figure 3-5 shows the outer dimensions of the teach pendant.

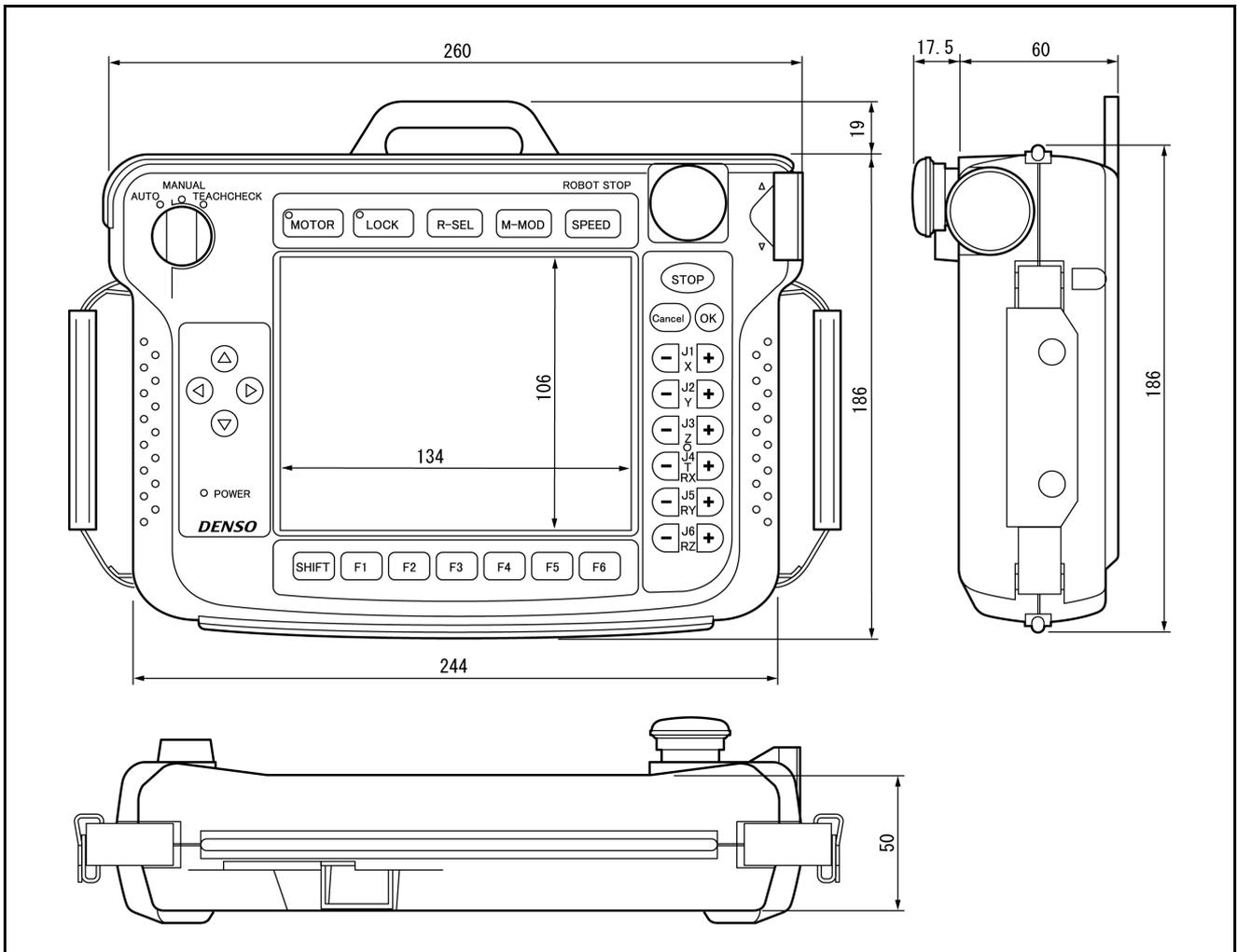


Figure 3-5 Outer Dimensions of the Teach Pendant

---

## [ 3 ] Pendantless State

### What is Pendantless State?

The state without having connected the operating panel and the teach pendant to the robot controller is called a pendantless state.

### Setting the Pendantless State

As described below, there are four ways to set the pendantless state:

- (1) Turning ON the power to the robot controller without the operating panel and the teach pendant.
- (2) Disconnecting the connected teach pendant.
- (3) Disconnecting the connected operating panel.
- (4) Disconnecting the connected operating panel and teach pendant.

**Caution: Refer to the operation procedures described in "[ 4 ] Connecting and Disconnecting Operating Panel and Teach Pendant" on the next page when connecting or disconnecting the operating panel and the teach pendant with the power to the robot controller ON.**

### Pendantless State Precautions

Since no teach pendant is connected in the Pendantless state, the robot cannot enter the manual operation mode or the teach check mode.

The robot is therefore in the Auto mode whenever the Enable Auto input is free. The external mode cannot be switched, and the program cannot start to run.

When operating the robot in the Pendantless state perform the following steps:

- (1) Set the robot not to start to operate when the Enable Auto input is free.
- (2) Enable Auto input free state and automatic mode output. Refer to "5.3.2.2 Auto Mode (Output) and 5.5.2.2 Auto Mode (Output)".

Set the equipment to make an emergency stop in an AND state.

Add (1) and (2) above with the external sequence circuit.

[ 4 ] Connecting and Disconnecting Operating Panel and Teach Pendant

The operating panel and the teach pendant can be connected or disconnected with the power to the robot controller ON. Connect or disconnect them according to the procedure described below.

Table 3-3 shows the state of change resulting from connecting or disconnecting the operating panel and/or the teach pendant.

Each letter in the table represents the appropriate connecting and disconnecting procedure (×: no procedure applicable).

Table 3-3 Table Showing Change of State by Connection and Disconnection

Before change \ After change	Pendantless mode	OP connected	TP connected	OP and TP connected
Pendantless mode	×	(A)	(B)	(A)
OP connected	(D)	×	×	(C)
TP connected	(D)	×	×	×
OP and TP connected	(D)	(D)	×	×

**Caution:** The operating panel and the teach pendant cannot be connected or disconnected while a program is being executed.

**Table 3-4 Connection and Disconnection Procedures**

Procedure	Steps
(A)	<p>Step 1 Select the AUTO mode, and activate an emergency stop.</p> <p>Step 2 Disconnect the connector from CN5 on the robot controller.</p> <p>Step 3 Connect the connector used for pendantless operation to CN5 of the robot controller.</p> <p>Step 4 Error 2187 occurs. Clear it from the external device.</p>
(B)	<p>Step 1 Select the AUTO mode, and activate an emergency stop.</p> <p>Step 2 Perform disconnection. See the SETTING-UP MANUAL, Section 5.9, "Preparing the Robot Controller to Unplug the Teach Pendant."</p> <p>Step 3 Disconnect the connector from CN5 on the robot controller within 15 seconds.</p> <p>Step 4 Connect the connector for Pendantless operation to CN5 on the robot controller.</p>
(C)	<p>Step 1 Set the mode selector switch on the operating panel to TP.</p> <p>Step 2 Set the mode selector switch on the teach pendant to AUTO, and activate an emergency stop.</p> <p>Step 3 Perform disconnection. See the SETTING-UP MANUAL, Section 5.9, "Preparing the Robot Controller to Unplug the Teach Pendant."</p> <p>Step 4 Disconnect the teach pendant from the operating panel within 15 seconds.</p> <p>Step 5 Connect the connector used for Pendantless operation to the operating panel.</p> <p>Step 6 Set the mode selector switch on the operating panel to MANUAL.</p>
(D)	<p>Step 1 Disconnect the connector used for pendantless operation from CN5 on the robot controller.</p> <p>Step 2 Connect the operating panel or teach pendant to CN5 on the robot controller.</p>

## 3.3 Mini Pendant

The mini pendant is an entry/operation device for operating the robot manually, starting programs, and teaching. It has no programming function.

Using the mini pendant together with WINCAPSII or WINCAPSII Light enables efficient programming and teaching.

### 3.3.1 Mini Pendant Functions

For instructions on how to operate the mini pendant, refer to the SETTING-UP MANUAL.

#### **Teaching**

This function allows you to store the robot arm position (limited to editing of P variables, J variables and T variables). You can check edited programs in running them step by step.

#### **Operating the robot**

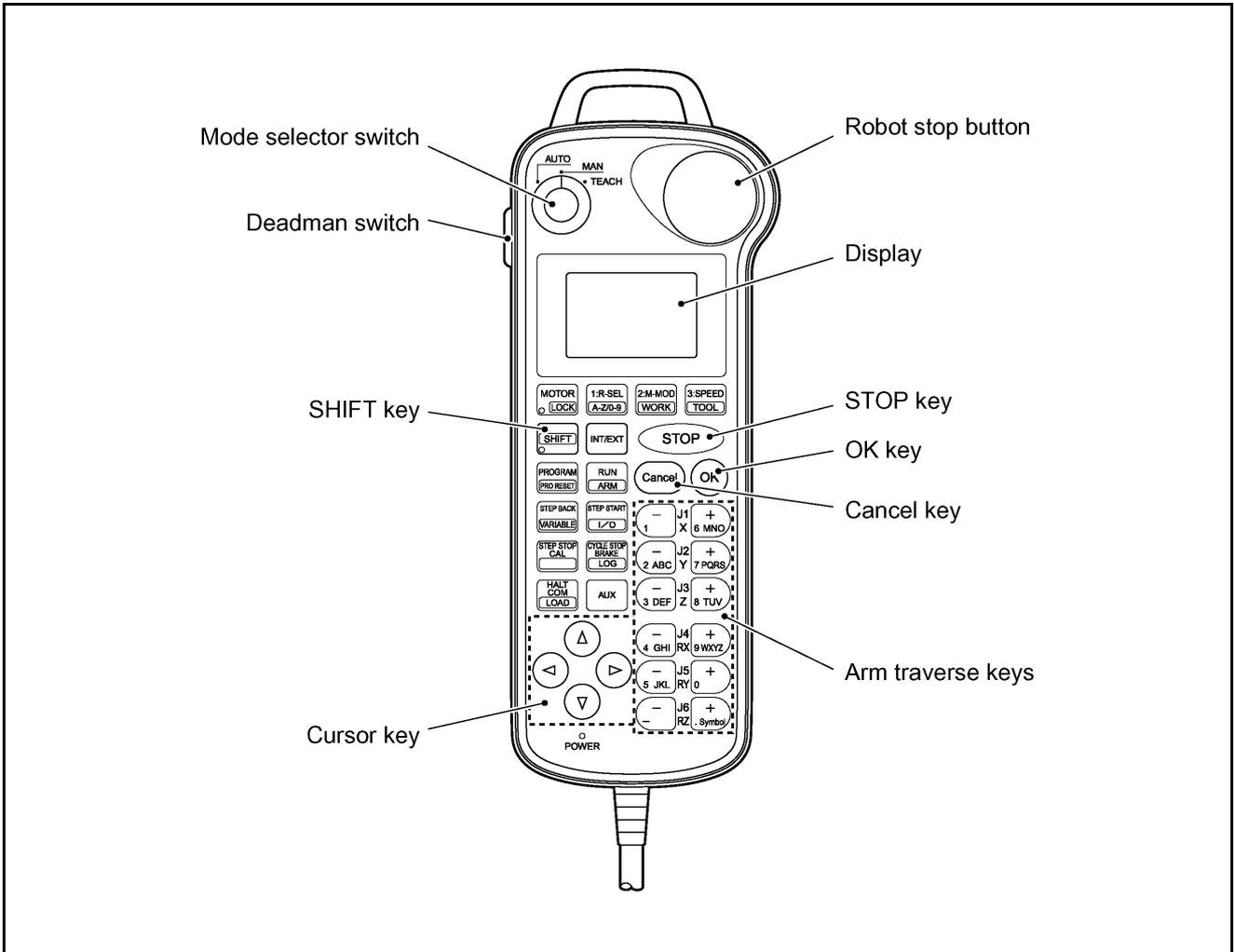
This function turns power to the motor ON/OFF, executes CAL, starts and stops automatic operation, and performs manual operation.

#### **Displaying**

This function displays the current robot arm position, running program number, ongoing step number or error codes.

### 3.3.2 Names of Mini Pendant Components

The figure below figure shows the names of the mini pendant components.



**Names of Mini Pendant Components**

### 3.3.3 Mini Pendant Specifications

#### [ 1 ] Specifications

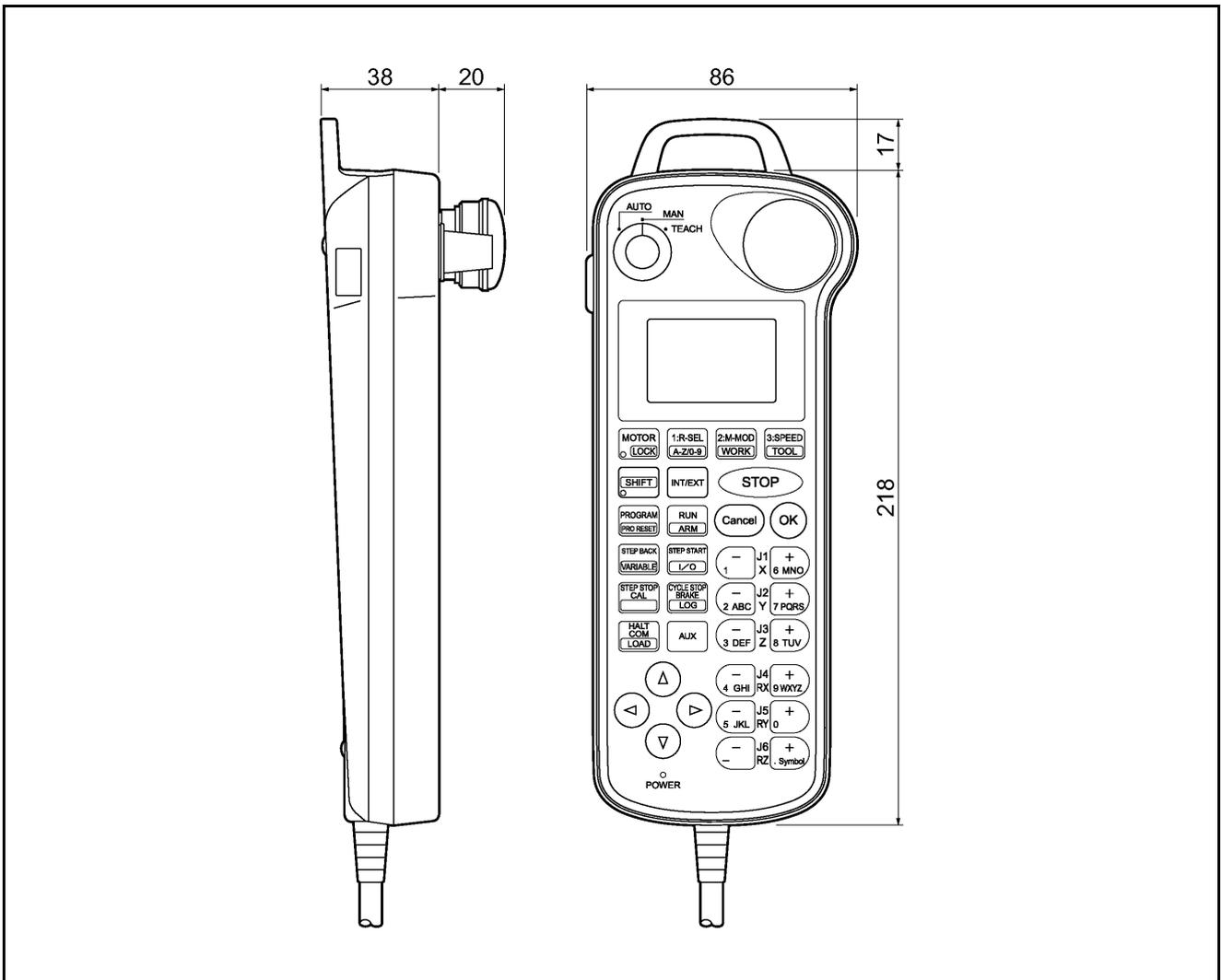
The table below lists the mini pendant specifications.

**Mini Pendant Specifications**

Item	Specifications
Model	MP5J4K (with 4 m cable) MP5J8K (with 8 m cable) MP5J12K (with 12 m cable)
Display	Liquid crystal display, 128 × 64 pixels
Power source	24 VDC (supplied from robot controller)
Operation	33 membrane switches, robot stop button, mode selector switch, deadman switch
Installation conditions	Temperature: 0 to 40°C Humidity: 90% RH or less (Dew condensation shall not be allowed.)
Outside dimensions (W) x (H) x (D)	86 x 218 × 38 mm (excluding projections such as switches)
Weight	Approx. 0.3 kg (excluding cables. See note below.)
Cable length	4 m, 8 m, or 12 m
Accessory	WINCAPSII Light
(Note) Cable weight Approx. 0.2 kg (4 m), 0.4 kg (8 m), 0.6 kg (12 m)	

## [ 2 ] Outer Dimensions

The figure below shows the outer dimensions of the mini pendant.



Outer Dimensions of the Mini Pendant

## [ 3 ] Connecting the Mini Pendant

You may connect the mini pendant to the "pendant" connector on the robot controller. When it is connected, neither the teach pendant nor operating panel can be used concurrently.

### 3.3.4 Specifications of WINCAPSII Light

WINCAPSII Light that comes with the mini pendant is PC teaching system software. It is a functionally limited version of WINCAPSII.

Except that WINCAPSII Light is limited to the following functions, it is the same as WINCAPSII. Refer to WINCAPSII given in the next section.

#### **Entering and editing robot programs**

In WINCAPSII Light, you may enter or edit robot programs. You may also develop new programs by making use of existing programs.

#### **Reading/writing programs and data**

WINCAPSII Light may read programs, variables, coordinate values, CALSET data, log data, and other data from the robot controller and display them on the PC screen or can write them to the robot controller.

**NOTE:** To use this function, the robot controller and the PC must be connected with each other using a communications cable.

#### **Saving programs and data**

WINCAPSII Light may store programs, CALSET data, log data, and other data onto the hard disk or floppy disks. It may also read out those stored data and re-edit or write them to the robot controller.

#### **Getting a snapshot**

WINCAPSII Light may get a snapshot containing robot motion data from the robot controller and display the robot motion at one particular point in time on the PC screen, enabling you to check it.

---

## 3.4 PC Teaching System Software, "WINCAPSII"

The PC teaching system facilitates the creation and editing of robot programs. Use this system to improve creation and/or robot management programs. For further information about how to use this teaching system, refer to the WINCAPSII GUIDE.

### 3.4.1 Functions in WINCAPSII

WINCAPSII has the following functions:

#### **Entering and editing robot programs**

In WINCAPSII, you may enter or edit robot programs. You may also develop new programs by making use of programs supplied as a library or with existing programs.

#### **Reading/writing programs and data**

WINCAPSII may read programs, variables, coordinate values, CALSET data, log data, and other data from the robot controller and display them on the PC screen or can write them to the robot controller.

**NOTE:** To use this function, the robot controller and the PC must be connected with each other using a communications cable.

#### **Saving programs and data**

WINCAPSII may store programs, CALSET data, log data, and other data onto the hard disk or floppy disks. It may also read out those stored data and re-edit or write them to the robot controller.

#### **Printing programs and data**

If you connect a printer to the PC, WINCAPSII may print out programs, CALSET data, log data, and other data.

#### **Simulating the robot motion**

WINCAPSII may simulate the robot motion in animation on the PC screen.

**NOTE:** To use this function, the robot controller and the PC must be connected with each other using an interface cable.

During automatic operation or manual operation using the teach pendant, the simulated image moves corresponding to the actual robot motion.

### 3.4.2 Operating Environment Required

The PC teaching system software requires the operating environment listed below.

**Table 3-5 Operating Environment for the PC Teaching System Software**

CPU	Pentium or higher capacity
OS	Windows 95 or upper version (See Note 1.)
Memory	32 MB or more (64 MB recommended)
Hard disk	A free area of 80 MB or more is required at installation.
Monitor resolution	640 × 480 or higher
<p><b>Note 1</b> <b>WINCAPSII cannot run properly on earlier versions of Windows 95.</b></p> <p><b>The version of Windows 95 can be checked with [Control Panel – System – Information]. If A, B or C is not displayed (no symbol) at the end of the version information (4.00, 95<u>B</u>), update your Windows 95 with the Windows 95 Service Pack 1 that is available from the Microsoft's web site.</b></p>	

### 3.4.3 Communications Cable

To enable the computer and the robot controller to communicate with each other, they must be connected with a communications cable. Use the appropriate RS-232C for cross cable wiring, as shown in Figures 3-6 and 3-7.

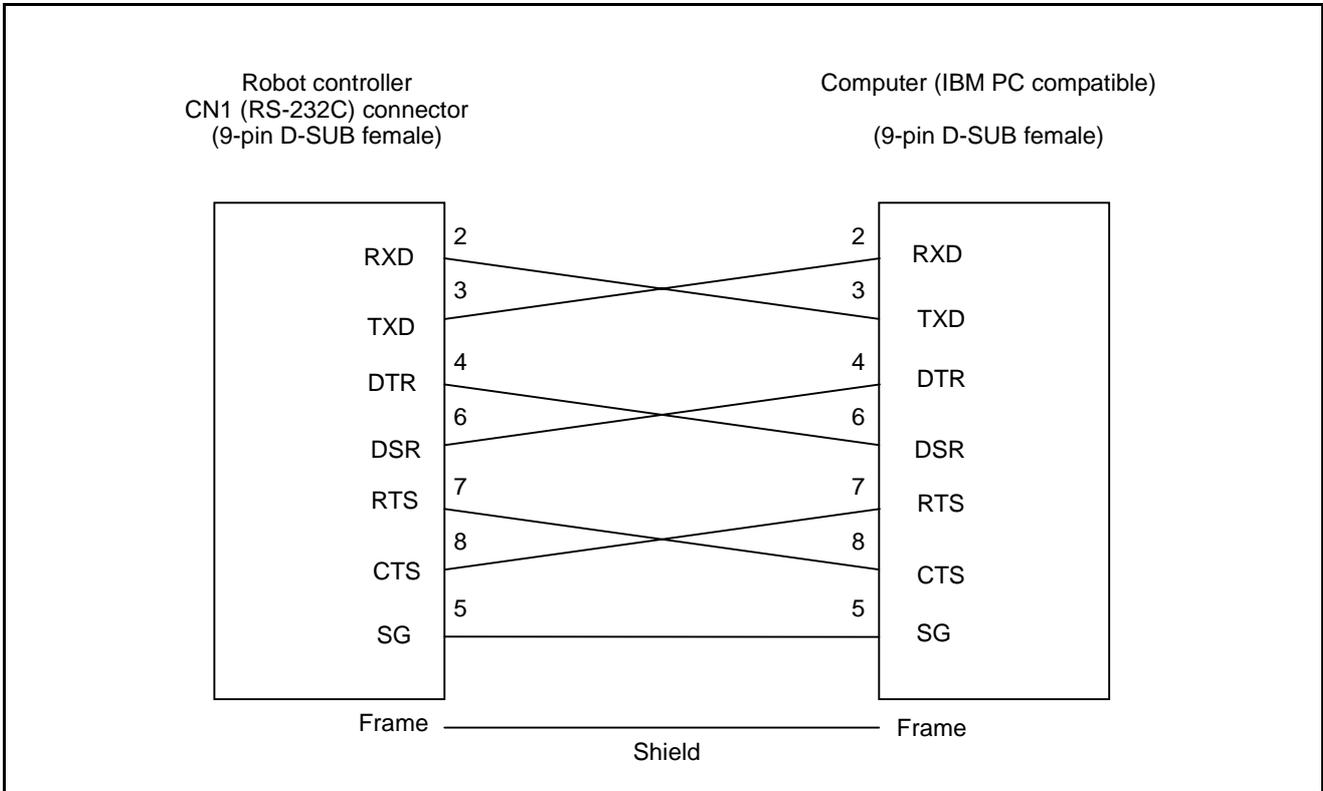


Figure 3-6 RS-232C Communication Cable Wiring Diagram (IBM PC compatible)

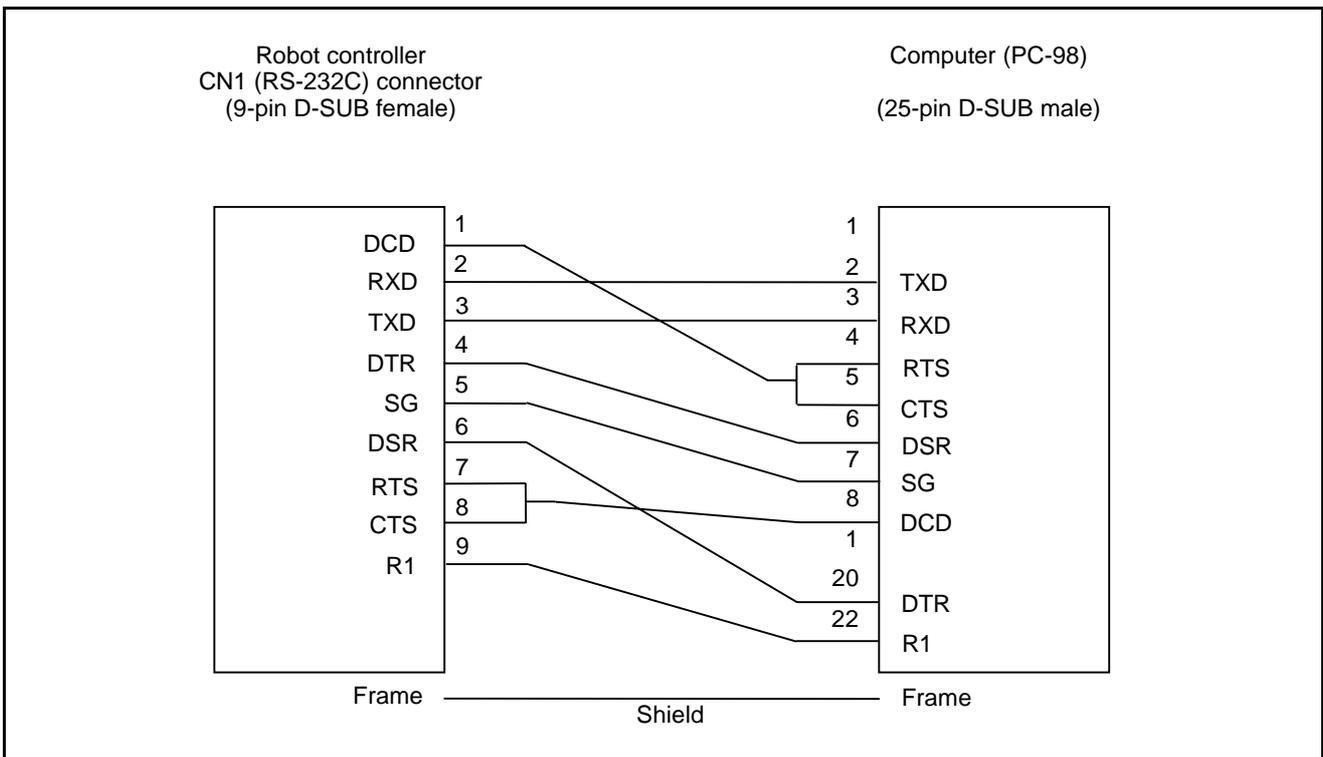


Figure 3-7 RS-232C Communications Cable Wiring Diagram (PC-98)

## 3.5 Floppy Disk Drive

The floppy disk drive is an optional storage device that stores or reads data such as robot programs, to/from a floppy disk. It may be built in the robot controller.

### 3.5.1 Floppy Disk Drive Functions

The floppy disk drive has the following functions:

#### Formatting

This function initializes a floppy disk so that it can store data. You need to initialize a new floppy disk before use.

Floppy disks will be initialized in MS-DOS format.

#### Saving

This function stores programs, CALSET data, etc. from the robot controller onto a floppy disk.

#### Loading

This function reads programs, CALSET data, etc. from a floppy disk to the robot controller.

 **Caution NEVER load the CALSET data prepared for other robots. If loaded, the robot will malfunction. It is DANGEROUS.**

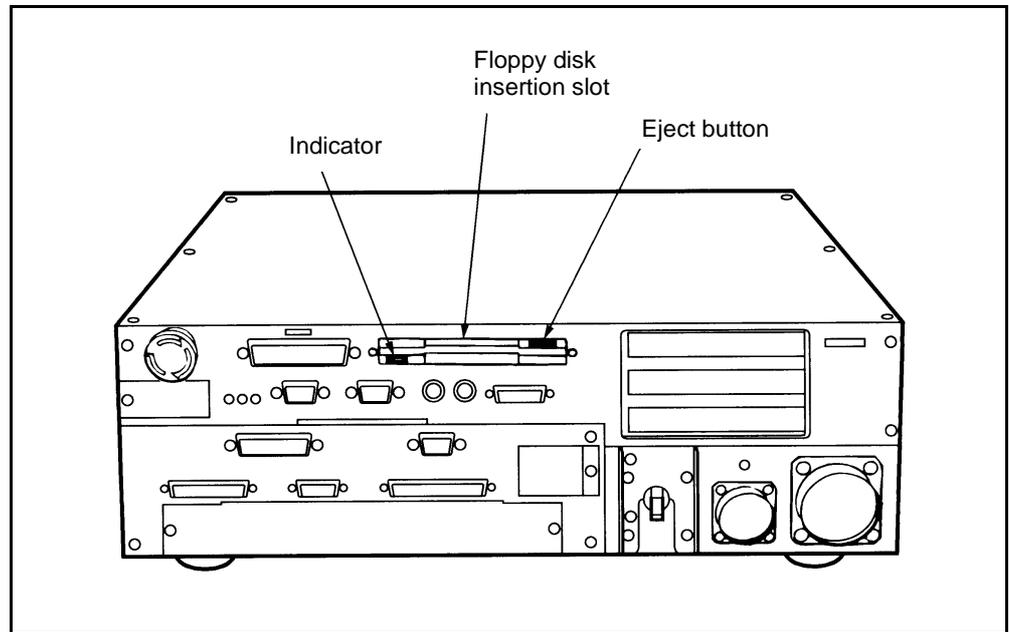
### 3.5.2 Floppy Disk Drive Specifications

Table 3-6 lists the specifications of the built-in floppy disk drive.

**Table 3-6 Built-in Floppy Disk Drive Specifications**

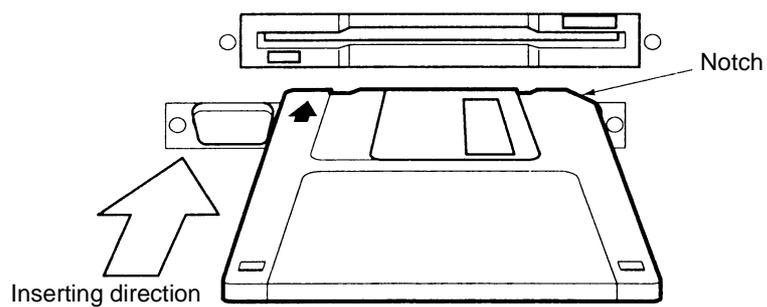
Item	Specifications	
Power source	5 VDC (supplied from the robot controller)	
Environmental conditions	Temperature : 5 to 40°C Humidity : 20% to 80% (without dew condensation)	
Weight	155 g (body alone)	
Applicable floppy disk	Type	2HD, 3.5-inch floppy disk
	Storage capacity	1.44 MB

### 3.5.3 Location of the Floppy Disk Drive and its Component Names



**Figure 3-8 Location of the Floppy Disk Drive and its Component Names**

Floppy disk insertion slot	Insert a floppy disk through this slot. (See Figure 3-9.).
Eject button	Push this button to eject the floppy disk.
Indicator	This lamp comes ON when the floppy disk is accessed.



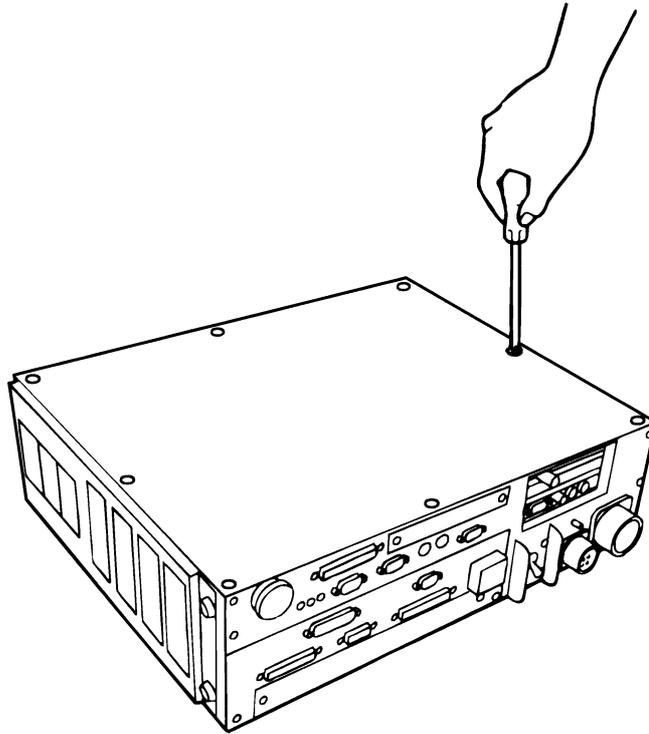
**Figure 3-9 Inserting a Floppy Disk**

**Caution: Do not eject the floppy disk when the indicator is lit. Doing so will damage or destroy data stored on the floppy disk.**

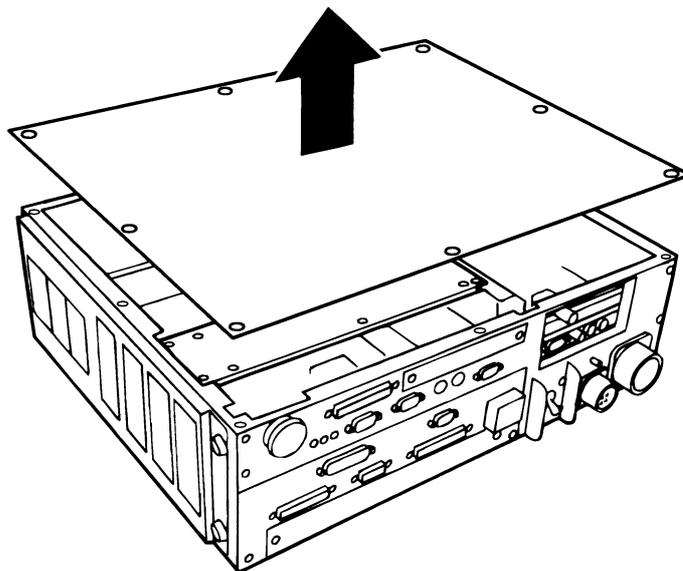
### 3.5.4 Mounting the Floppy Disk Drive

Mount the floppy disk drive into the robot controller according to the following procedure:

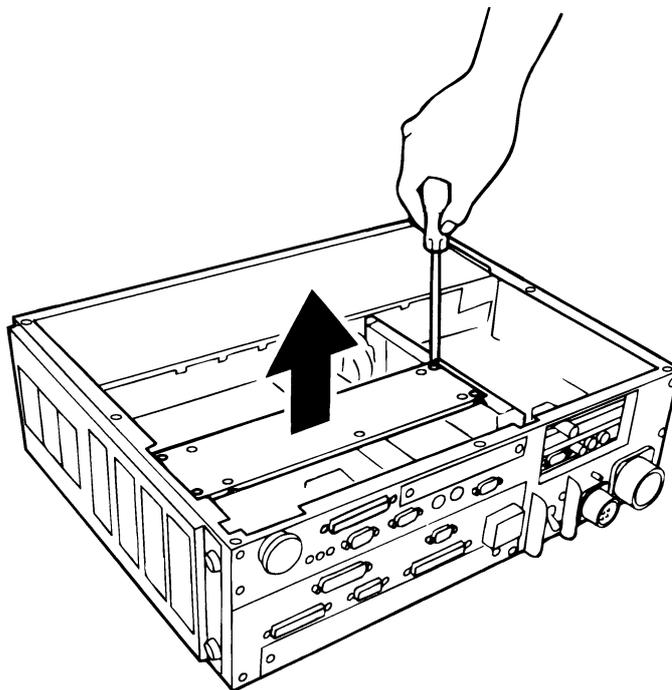
**Step 1** Remove the eight screws from the controller top cover.



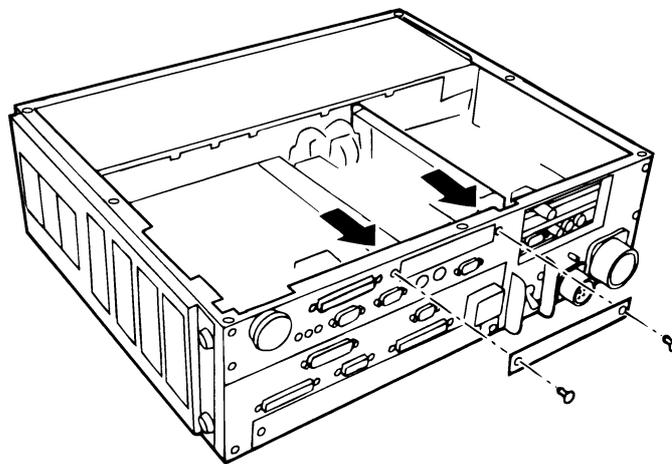
**Step 2** Lift the top cover up and off the robot controller.



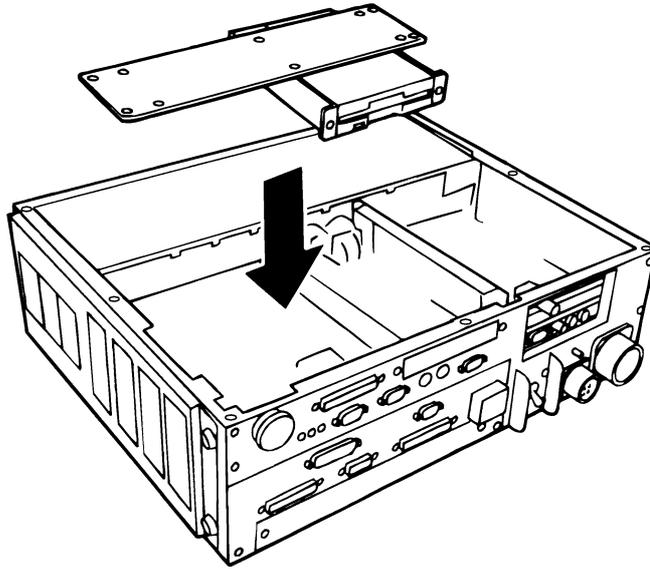
**Step 3** Remove the four screws from the upper plate and take off the upper plate.



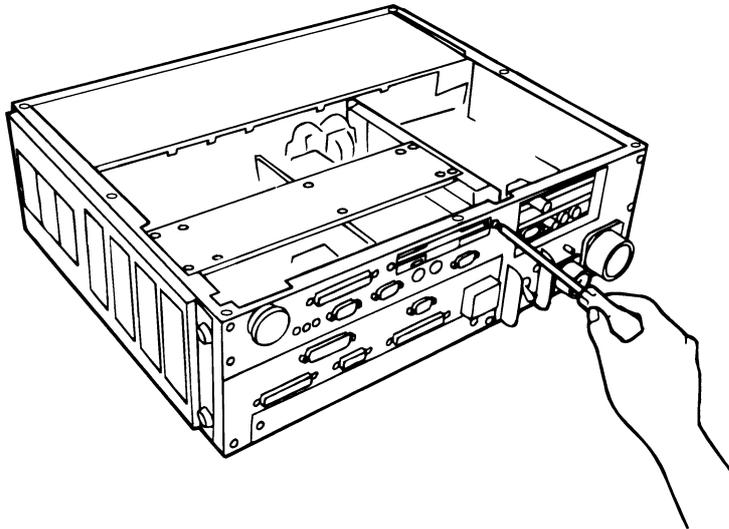
**Step 4** Push the two pins of the blind plate outwards and remove the blind plate.



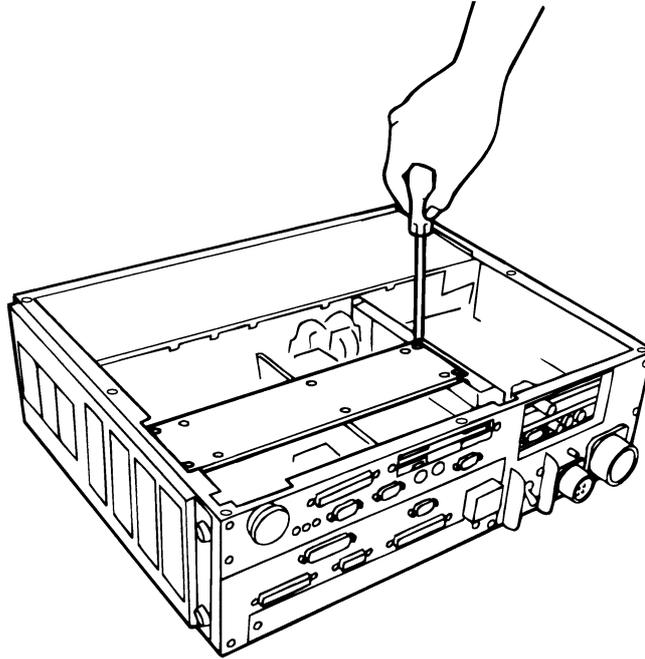
- Step 5** Mount the floppy disk drive in the appropriate position of the robot controller. The floppy disk drive is secured to a disk drive mounting plate.



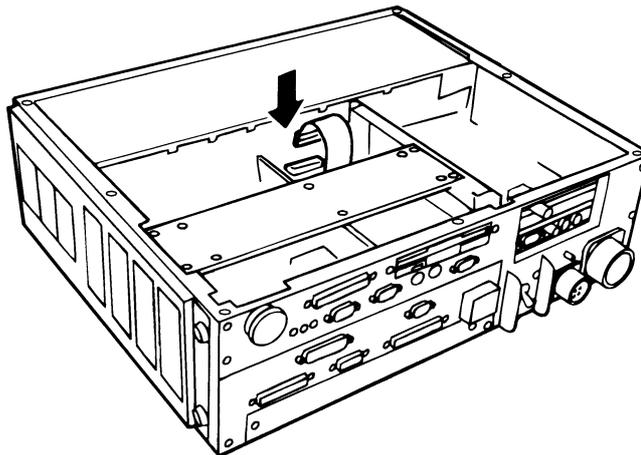
- Step 6** Secure the front panel of the floppy disk drive with two screws.



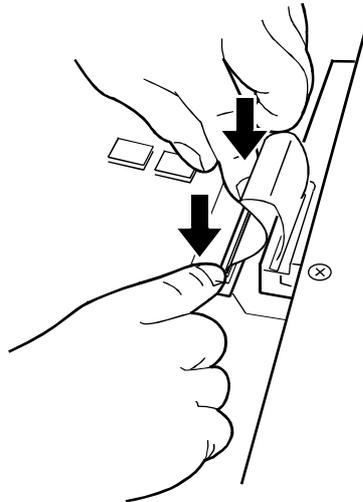
**Step 7** Secure the floppy disk drive mounting plate with four screws.



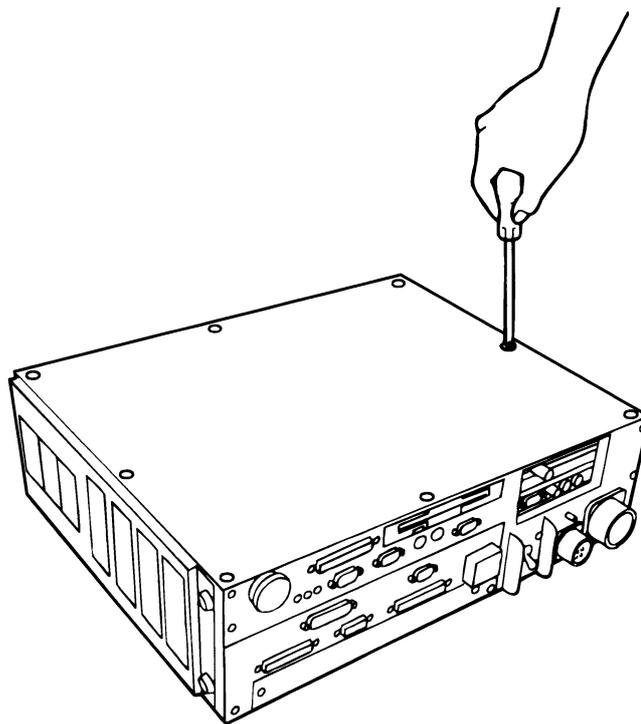
**Step 8** Connector J6 FDD 26P on the printed circuit board has a cable lock. If the connector is locked, lift and unlock it. The lock is made of resin. Do not apply excessive force to it since the lock could easily break. Handle it with extra care. Fully insert the flat cable of the floppy disk drive into connector J6 FDD 26P on the circuit board. If the flat cable is inserted fully, the blue line marked on the connecting section will become aligned with the top edge of the connector.



**Step 9** Securely push in the connector lock.



**Step 10** Put the top cover and secure it with eight screws.



The mounting of the floppy disk drive is completed.

## 3.6 $\mu$ Vision Board

### 3.6.1 $\mu$ Vision Board Specifications

If the robot controller has a built-in  $\mu$ Vision board, it can handle a variety of image processor functions.

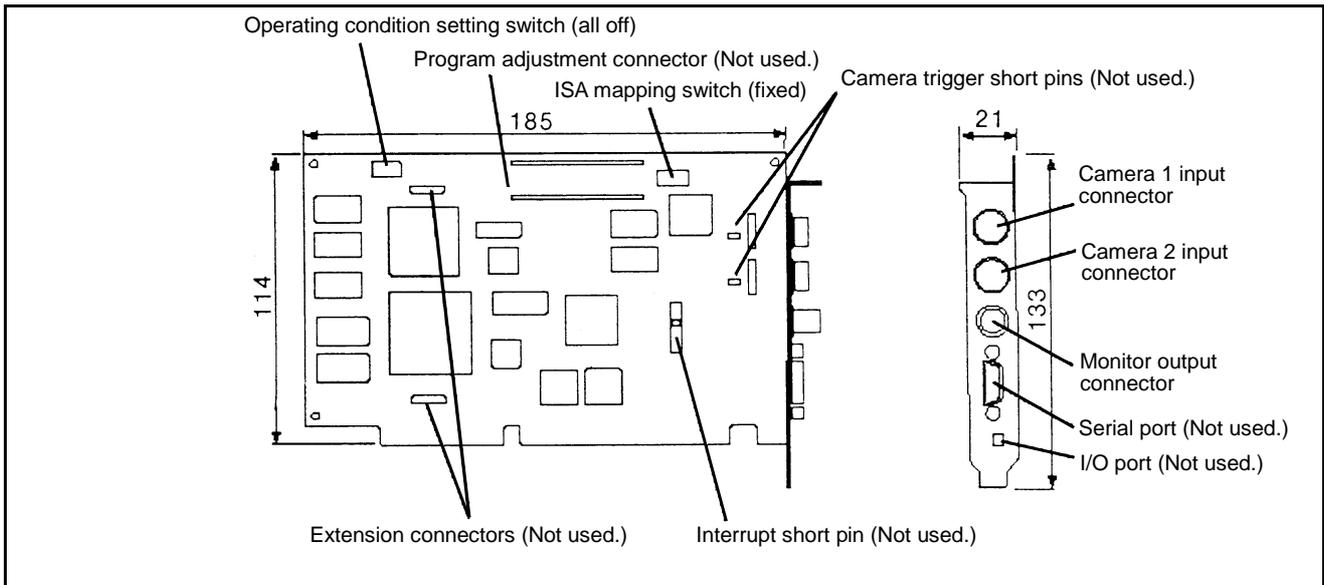
Similar to other commands, image processing commands are already incorporated and no special operations or programming are required.

**Table 3-7  $\mu$ Vision Board Specifications**

Item	Specifications
CPU	32-bit CPU
Image storage memory for processed images (Horizontal x Vertical)	512 × 480 pixels, 8 bits × 4 screens
Overlay memory for drawn images (Horizontal x Vertical)	624 × 480 pixels, 2 bits × 2 screens
Search model registration memory	1 MB (H255 × V255 × 8 models), Up to 100 models registrable <b>Note (1)</b>
Image input, number of channels	EIA/CCIR monochrome, 256 gradations, 2 channels
Image output	EIA/CCIR monochrome, 256 gradations, 1 channel
Image processing	Binary feature extract (area, center of gravity, main axis angle, luminance integration), histogram, edge detection, image-to-image operation, filtering, labeling, light/dark image search, code recognition (QR code)
Processing range specification (window)	Up to 512 windows registrable (shape: straight line, rectangle, circle, ellipse, sector)
Self-diagnosis function	Memory check, incorrect input, incorrect processing range, improper camera connection, etc.
Error display	Errors will be displayed on the teach pendant (option).
Power source	5 VDC, 12 V (supplied from controller ISA) <b>Note (2)</b>
Environmental conditions (during operation)	Temperature: 0 to 40°C Humidity: 90 %RH or less (Dew condensation shall not be allowed.)
Outside dimensions (H x W x D)	21.4 × 114 × 185 mm (excluding projections of connectors)

**Note (1)** The number of registrable models will differ depending upon the model image and/or size.

**(2)** Since power is supplied from the inside of the robot controller, no external power source is required.



**Figure 3-10** μVision Board

**Note (1)** Switches and the short pins on the μVision board have been set at the factory. Do not change the settings. A failure may result.

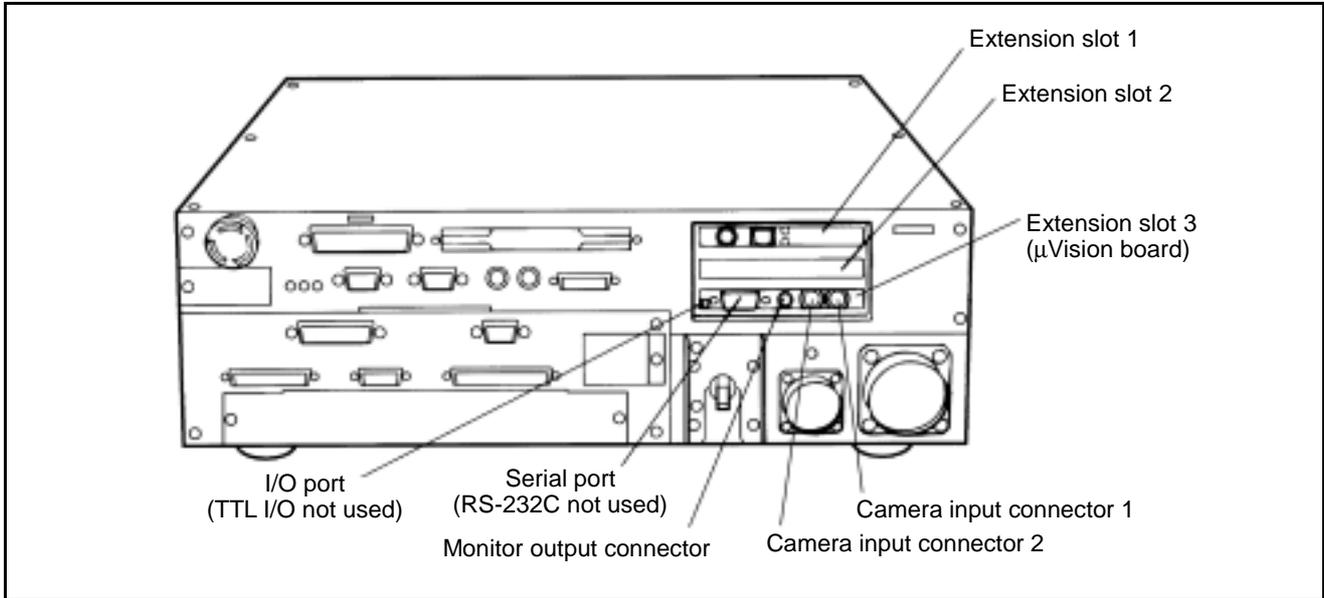
**Note (2)** Do not connect anything to the unused connectors on the board. A failure may result.

**Note (3)** The serial port and the I/O port on the board are unusable. Do not connect anything to them. A failure may result.

## [ 1 ] Location of the $\mu$ Vision Board and Names of Connectors

Insert a  $\mu$ Vision board into extension slot 3 shown in Figure 3-11.

Inserting the board in a wrong slot may damage the internal circuits of the robot controller. For the installation procedure, refer to Subsection 3.11, "Mounting Extension Boards."



**Figure 3-11 Location of  $\mu$ Vision Board and Names of Connectors**

Camera input connector 1	Used for connection with camera 1 (12-pin, round connector)
Camera input connector 2	Used for connection with camera 2 (12-pin, round connector)
Monitor output connector	Used for connection with the monitor (BNC).
Serial port	RS-232C port (not used)
I/O port	TTL level input/output: 1 point each (not used)

**Table 3-8 Camera Input Connector Pin Layout  
(Manufacturer: Hirose Electric HR10A-10R-12S or equivalent)**

Pin No.	Signal name	Remarks
1	GND	Camera power GND
2	+12V	Camera power 12V
3	GND	Camera power GND
4	VIDEO	Video signal
5	HDGND	HD synchronous signal GND
6	HD	Horizontal synchronous signal
7	VD	Vertical synchronous signal
8	NC	Not connected
9	NC	Not connected
10	NC	Not connected
11	TRIG	Trigger signal (not used)
12	VDGND	VD synchronous signal GND

[ 2 ] Block Diagram and Internal Configuration of  $\mu$ Vision Board

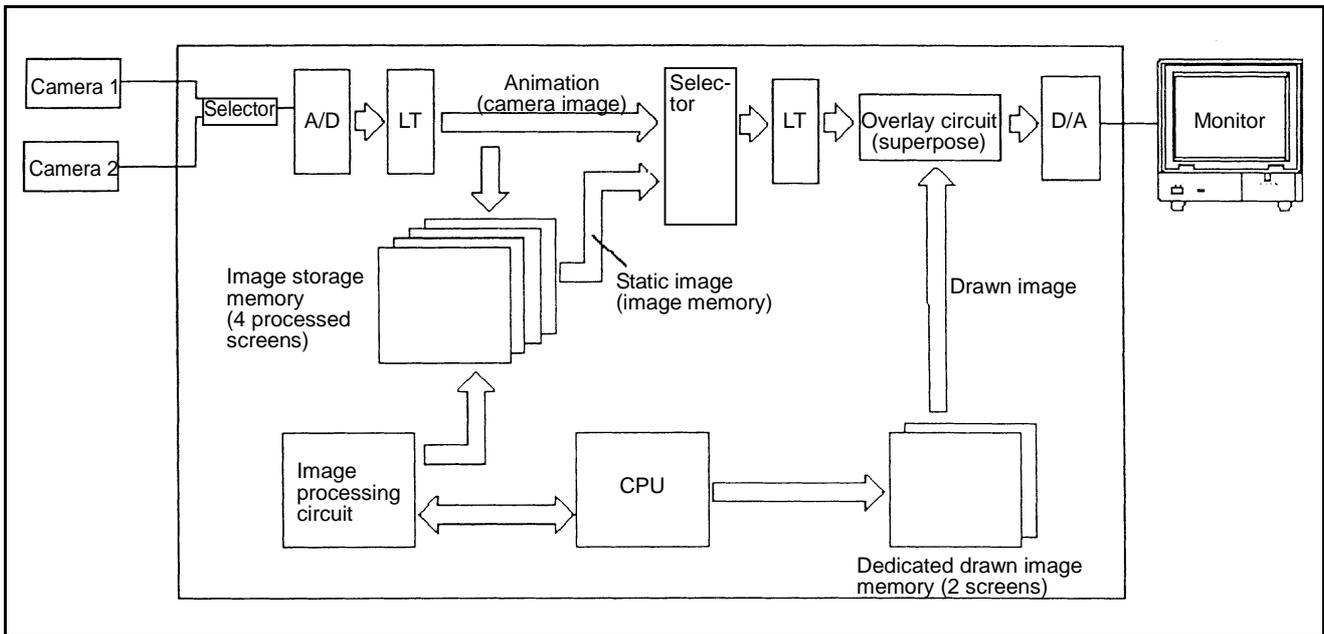
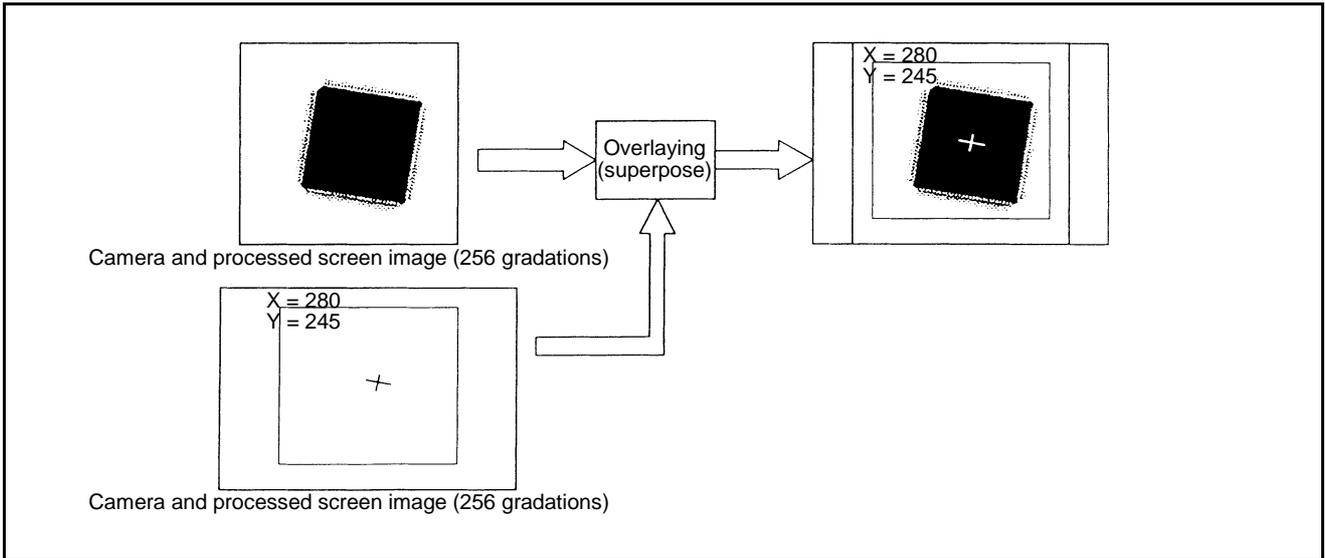


Figure 3-12 Block Diagram of  $\mu$ Vision Board

Figure 3-12 illustrates the processing flow of the  $\mu$ Vision board as a reference. The actual circuit configuration is different from this diagram.

Camera selector	Switches between camera 1 and 2.
A/D	Converts analog signals into digital signals (8-bit).
Monitor selector	Selects whether to display the camera live image or static image on the monitor.
LT	Converts 8-bit data values using the appropriate table.
Overlay circuit	Overlays a drawn image, which is stored in the dedicated drawn image memory, on the camera live image or static image (see Figure 3-13, Overlay Concept).
D/A	Converts digital data into analog signals.
Image storage memory	Stores camera live images. When outputted onto the monitor screen, those images will be handled as static images. Up to four screens can be stored on this board.
Dedicated drawn image memory	Stores drawn images of characters and figures. Those images can be displayed on the monitor screen via the overlay circuit. Up to two screens can be stored on this board.
Image processing circuit	Processes images.
CPU	Manages the entire system.



**Figure 3-13 Overlay Concept**

### 3.6.2 Peripheral Devices

#### [ 1 ] General Information about the Camera

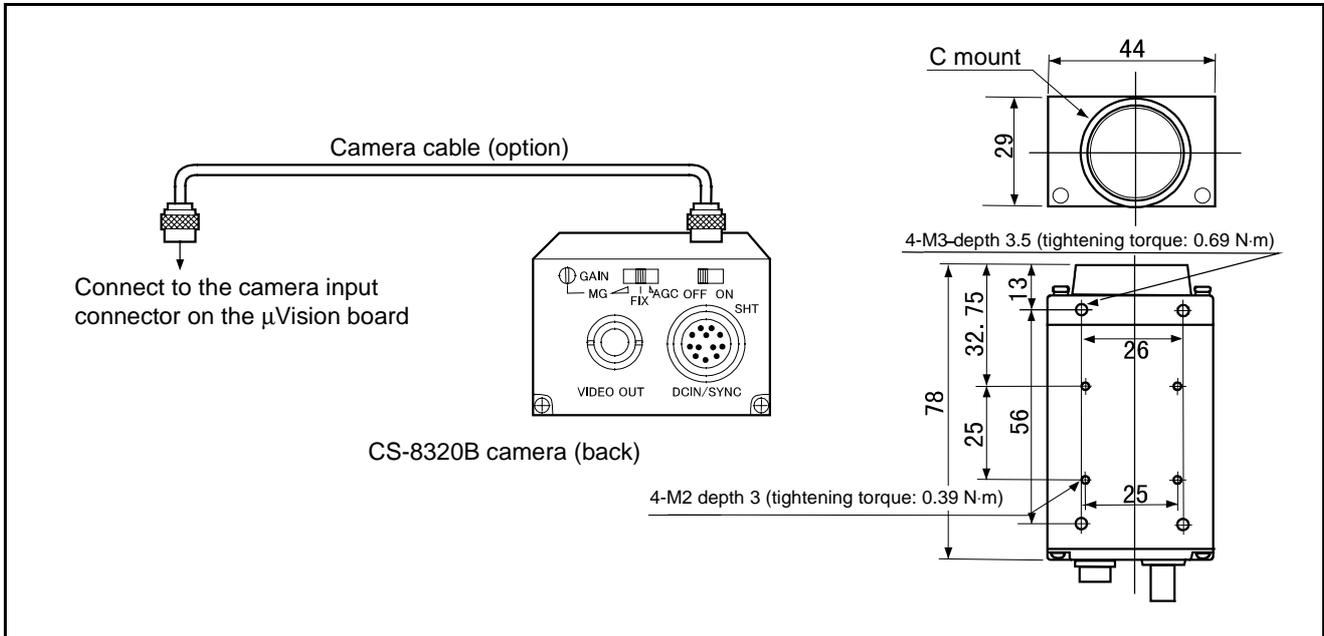


Figure 3-14 Camera Dimensions and its Parts Names

Table 3-9 Camera Specifications

Item	Specifications
Manufacturer	Tokyo Electronic Industry Co., Ltd.
Manufacturer's model	CS8320B
Image pickup interline transfer system	CCD pixels: 768 (H) $\times$ 493 (V)
Lens mount	C mount
Image output NTSC signal	1.0 V <sub>p-p</sub> /75 $\Omega$
Power source/Ambient temperature	Supplied from power adapter, 0 to +40°C
Weight	120 g
Vibration-proof	98 m/s, 10G (10 to 50 Hz, 30 minutes in each of X, Y and Z directions)

#### Cables (Option)

Cable length	Camera cable model
3 m	CPC3440-03
5 m	CPC3440-05
15 m	CPC3440-15

- 
- Caution**
- (1) When mounting the camera to the equipment, tighten the screws securely to the specified torque. See Figure 3-14.
  - (2) Do not apply a strong impact or vibration to the camera. A failure may result.
  - (3) When opening the camera top cover and changing the settings, be sure to turn the controller power off or disconnect the camera cable.
  - (4) For setting up cameras, refer to the instruction manual that comes with the camera.

[ 2 ] General Information about the Monitor

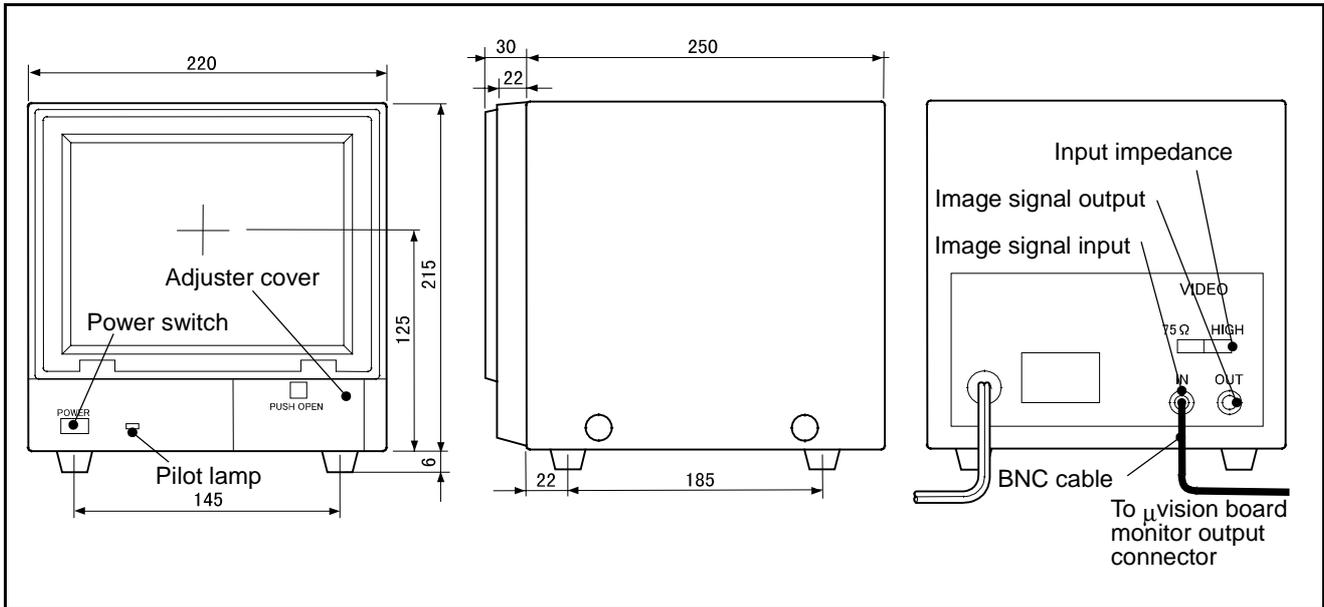


Figure 3-15 Monitor Dimensions and its Parts Names

Table 3-10 Monitor Specifications

Item	Specifications
Manufacturer	Chuo Musen Co., Ltd.
Manufacturer's model	TMP-232-03
Cathode-ray tube	9-inch, monochrome
Image input NTSC signal	0.7 Vp-p (straight polarity)
Power supply	100 VAC, 50/60 Hz
Power consumption	Approx. 30 W
Ambient temperature	0 to 40°C
Humidity	90% or less (without dew condensation)

Cables (Option)

Cable length	BNC coaxial cable type
1 m	3CV-PP (1)
3 m	3CV-PP (3)
5 m	3CV-PP (5)

**Caution** (1) NEVER disassemble the monitor.  
 (2) Be sure to set a ferrite core clamp (ZCAT1518) that comes with the BNC cable, to the monitor output connector side on the μVision board.

## 3.7 Ethernet Board

If the robot controller has a built-in Ethernet board, it can communicate with the PC teaching system according to the TCP/IP protocol.

This board is helpful for communication between a single PC teaching system and more than one robot controller. It also provides faster communication than an RS-232C cable, contributing to improved response of the PC teaching system.

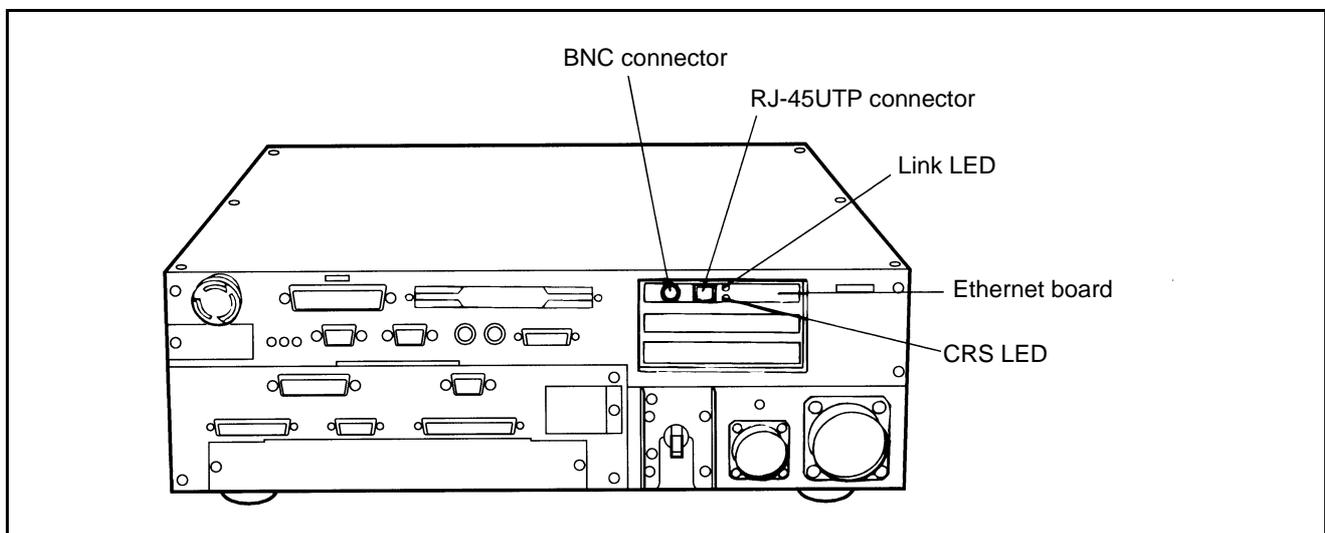
### 3.7.1 Ethernet Board Position and Connector Names

Insert the Ethernet board in extension slot 1 (upper slot) or extension slot 2 (middle slot). See Figure 3-16.

Inserting the board into a wrong slot may damage the internal circuits of the robot controller. For installation procedure of the Ethernet board, refer to Subsection 3.11, "Mounting Extension Boards."

**Table 3-11 Ethernet Board Specifications**

Item	Specifications
Standard	10Base2, 10BaseT (IEEE 802.3)
Baud rate	10 Mbits/sec.



**Figure 3-16 Location of Ethernet Board and its Parts Names**

Table 3-12 LEDs and Connectors on the Ethernet Board

Name	Function
Link LED	Lights if the UTP port detects a signal.
CRS LED	Lights if a carrier signal is detected. This LED will remain ON if no cable is connected to the UTP connector or BNC connector.
RJ-45 UTP connector	Used for 10BaseT connection.
BNC connector	Used for 10Base2 connection. <b>Caution</b> (1) When not using 10Base2, attach a BNC connector cap (that comes with the Ethernet board) to the BNC connector. (2) When using 10Base2, cover all exposed metallic parts of connectors and the T-branch connector with insulator tape.

## 3.8 DeviceNet Slave Board

### 3.8.1 Overview

If the robot controller has a built-in DeviceNet slave board, it can communicate with external devices according to the DeviceNet-compliant protocol.

As a slave unit for serial communications which is compliant with the open network DeviceNet, the robot controller may easily exchange I/O data with a variety of DeviceNet-compliant control devices of many manufacturers.

#### [ 1 ] Features

**(1) DeviceNet-compliant**

The DeviceNet is an internationally open network developed by Allen-Bradley and is designed to allow control devices (e.g., sensors and actuators) to communicate with each other.

**(2) Can be networked with control devices of various manufacturers**

The robot controller equipped with DeviceNet slave board can be networked with DeviceNet-compliant control devices of various domestic and foreign manufacturers since the communications specifications are open.

**(3) Easy wiring and maintenance**

The 5-core special cable and detachable connector of the DeviceNet slave board make it easy to install wiring between nodes (communications units) and disassembly/restructure the network. This will sharply reduce cost in wiring and maintenance, as well as making replacement of units easy at the time of failure.

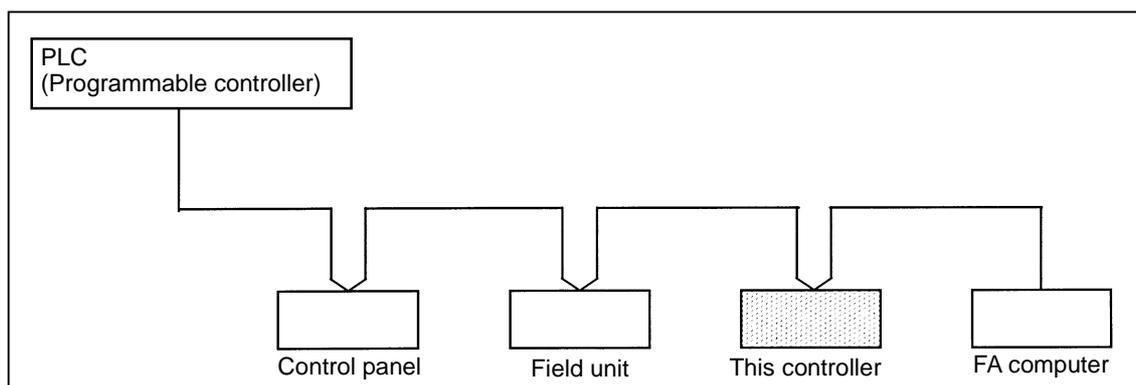
**(4) Sufficient number of I/Os**

The controller is capable of handling a large quantity of I/O data as listed below. Further, increase or decrease of the number of user-input I/Os is possible in units of 8 steps.

Number of I/Os		
Transmission	Standard assignment mode	24 to 224
	Compatible assignment mode	24 to 224
Reception	Standard assignment mode	24 to 216
	Compatible assignment mode	40 to 232

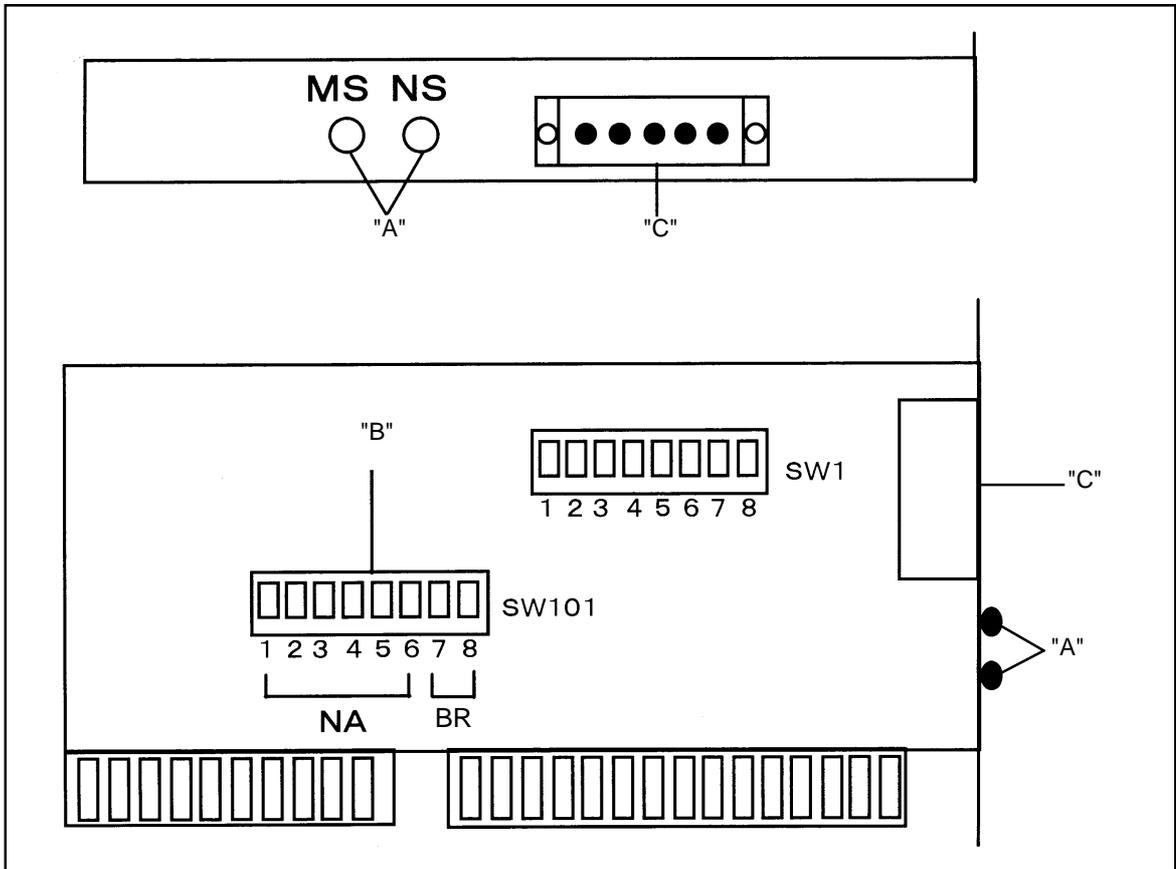
#### [ 2 ] Typical Network

The figure below illustrates a typical network.



### 3.8.2 Product Specifications

The figure below shows the location of the LEDs, DIP switches, and DeviceNet connector on the DeviceNet slave board.



## [ 1 ] Components and Functions

### (A) Status indicator LEDs

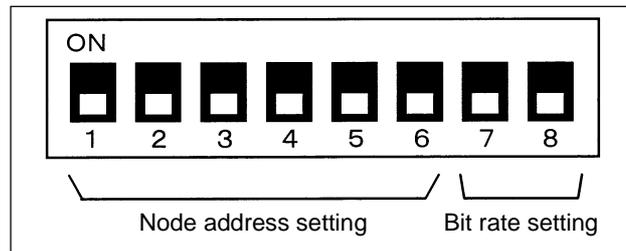
The status indicators MS and NS ("A" in the figure given on the previous page) can light or flash in green or red. Each of the ON, flashing, and OFF states of those indicators shows the module or network status as listed below.

The flashing interval is once per second (0.5 second of ON and 0.5 second of OFF).

LED name	Color	State	Definition	Explanation
MS (Module Status)	Green		Normal state	<ul style="list-style-type: none"> <li>The unit works normally.</li> </ul>
			Setup not completed	<ul style="list-style-type: none"> <li>Reading the DIP switch settings.</li> </ul>
	Red		Fatal error	<ul style="list-style-type: none"> <li>Hardware failure.</li> </ul>
			Recoverable error	<ul style="list-style-type: none"> <li>Wrong DIP switch settings, etc.</li> </ul>
	-		No power supplied	<ul style="list-style-type: none"> <li>No power is supplied to the DeviceNet module.</li> <li>Resetting data.</li> <li>Waiting for initialization.</li> </ul>
	NS (Network Status)	Green		Communications link established
			Communications link not established	The network is working normally, but the line is not connected yet.
Red			Fatal communications error	The unit detects any error disabling communication on the network. <ul style="list-style-type: none"> <li>Node address double-assigned.</li> <li>"Bus off" detected.</li> </ul>
			Recoverable communications error	Communications error in some slaves.
-			Network power supply failure	<ul style="list-style-type: none"> <li>Not connected to the master unit.</li> <li>Communications line broken.</li> </ul>
 : ON  : Flashing  : OFF				

### (B) DIP switch (SW101)

Use the DIP switch for setting the node address and bit rate as shown below.



**NOTE:** Always turn off the controller power (including the network power) before setting the DIP switch.

### Setting the node address

Set the node address of the robot controller using selectors 1 through 6 of the DIP switch, referring to the table below. You may freely set any of 0 through 63 to a node address unless the address is double-assigned on the same network including the master and slaves. Double assignment will cause an address double-assignment error, disabling the network.

**Node Address Setting by the DIP Switch**

DIP switch						Node address	DIP switch						Node address
1 (32)	2 (16)	3 (8)	4 (4)	5 (2)	6 (1)		1 (32)	2 (16)	3 (8)	4 (4)	5 (2)	6 (1)	
0	0	0	0	0	0	0	0	0	0	0	0	32	
0	0	0	0	0	1	1	0	0	0	0	1	33	
0	0	0	0	1	0	2	0	0	0	1	0	34	
0	0	0	0	1	1	3	0	0	0	1	1	35	
0	0	0	1	0	0	4	0	0	0	1	0	36	
0	0	0	1	0	1	5	0	0	0	1	0	37	
0	0	0	1	1	0	6	0	0	0	1	1	38	
0	0	0	1	1	1	7	0	0	0	1	1	39	
0	0	1	0	0	0	8	0	0	1	0	0	40	
0	0	1	0	0	1	9	0	0	1	0	0	41	
0	0	1	0	1	0	10	0	0	1	0	1	42	
0	0	1	0	1	1	11	0	0	1	0	1	43	
0	0	1	1	0	0	12	0	0	1	1	0	44	
0	0	1	1	0	1	13	0	0	1	1	0	45	
0	0	1	1	1	0	14	0	0	1	1	1	46	
0	0	1	1	1	1	15	0	0	1	1	1	47	
0	1	0	0	0	0	16	0	1	0	0	0	48	
0	1	0	0	0	1	17	0	1	0	0	0	49	
0	1	0	0	1	0	18	0	1	0	0	1	50	
0	1	0	0	1	1	19	0	1	0	0	1	51	
0	1	0	1	0	0	20	0	1	0	0	0	52	
0	1	0	1	0	1	21	0	1	0	0	1	53	
0	1	0	1	1	0	22	0	1	0	0	1	54	
0	1	0	1	1	1	23	0	1	0	0	1	55	
0	1	1	0	0	0	24	0	1	1	0	0	56	
0	1	1	0	0	1	25	0	1	1	0	0	57	
0	1	1	0	1	0	26	0	1	1	0	1	58	
0	1	1	0	1	1	27	0	1	1	0	1	59	
0	1	1	1	0	0	28	0	1	1	0	0	60	
0	1	1	1	0	1	29	0	1	1	0	1	61	
0	1	1	1	1	0	30	0	1	1	1	0	62	
0	1	1	1	1	1	31	0	1	1	1	1	63	

**Note 1 :** Selector OFF and ON are expressed by 0 and 1, respectively.

**Note 2 :** Before shipment from the factory, "Node address" is set to 0 by default.

### Setting the bit rate

To match the bit rate of the robot controller with that of the network, use selectors 7 and 8 of the DIP switch, referring to the table below:

**Bit Rate Setting By DIP Switch**

Selectors on the DIP switch		Bit rate
Selector 7	Selector 8	
0	0	125 kbps
0	1	250 kbps
1	0	500 kbps
1	1	500 kbps

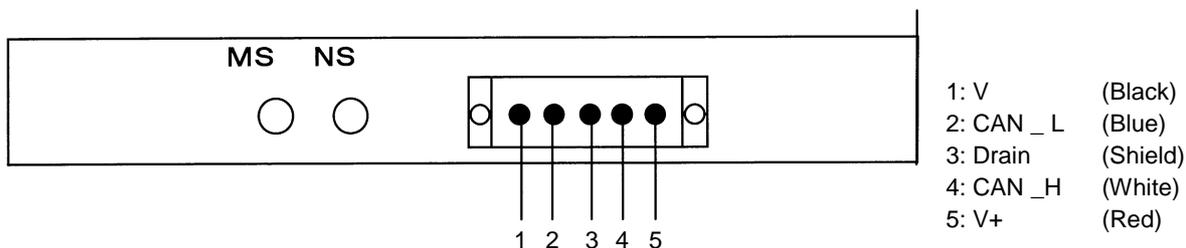
**Note 1:** Selector OFF and ON are expressed by 0 and 1, respectively. (Before shipment from the factory, both of these selectors are set to 0 (=500 kbps) by default.)

**Note 2:** On the same network, set the same bit rate to all nodes (master and slaves). Otherwise, slaves whose bit rate is different from that of the master cannot communicate only, but also they may cause a communications error between correctly set nodes.

### (C) DeviceNet connector

The robot controller uses an open type screw connector whose pin arrangement is shown below.

**NOTE:** When the controller power (including the network power) is on, do not disconnect/connect the communication connector or touch its pins. Doing so will result in a failure.



It is recommended that either of the following crimp terminals be used for the communications cable.

No.	Crimp terminal	Tools required
(1)	AI series (Phoenix Contact)	ZA3 (Phoenix Contact)
(2)	TC series (Nichifu) For thin cables: TME TC-0.5 For thick cables: TME TC-2-11 (for power supply) TME TC-1.25-11 (for communication)	NH-32

[ 2 ] General Specifications

The following tables list the controller environmental and communication specifications.

(1) Environmental requirements

Item	Specifications
Power requirements	5 VDC (supplied via the controller ISA bus)
Operating temperature	0 to 40°C
Operating humidity	90% RH or less (without condensation)

(2) DeviceNet communications specifications

Item	Specifications			
Communications protocol	DeviceNet-compliant			
Connection supported	Master/slave connection : Polling I/O function Compliant with DeviceNet communications rules			
Connection type (Note 1)	Multi-drop type with possible combination of T-branch (to trunk and branch lines)			
Bit rate	500, 250, 125 kbps (selectable by switch)			
Communications media	Special cable consisting of 5 wires (2 for signals, 2 for power supply and 1 as a shield wire)			
Communications cable length	Bit rate	Max. network length	Branch length	Total branch length
	500 kbps	100 m or less (Note 2)	6 m or less	39 m or less
	250 kbps	250 m or less (Note 2)	6 m or less	78 m or less
	125 kbps	500 m or less (Note 2)	6 m or less	156 m or less
Power supply for communication	External supply of 24 VDC ±10%			
Internal power consumption	Communication power source: 30 mA max.			
Max. number of connectable nodes	64 nodes (including configurator (converter) if connected)			
Number of I/Os	Standard assignment mode: 40 points for system input 32 points for system output 24 points to 216 for user input 24 to 224 points for user output The number of I/Os can be set in unit of 8 points. Compatible assignment mode: 24 points for system input 32 points for system output 40 to 232 points for user input 24 to 224 points for user output The number of I/Os can be set in unit of 8 points.			
Error check	CRC			
(Note 1) Terminator resistors are needed at both ends of the trunk line. (Note 2) These values may apply when a special thick cable is used as a trunk line. If a special fine cable is used, the max. network length is 100 m or less.				

### 3.8.3 Assignment of Serial I/O Data

Two types of serial I/O data assignment modes are available--standard assignment mode and compatible assignment mode (which is compatible with our previous models). In each of those assignment modes, serial input/output data are assigned as shown in [ 1 ] and [ 2 ].

The controller equipped with a DeviceNet slave board transfers the system input/output data only through the DeviceNet, disabling the parallel ports. The controller, however, can handle the user input/output data using both parallel ports and DeviceNet.

Signals such as *robot stop*, *enable auto*, and *CPU normal* are transferred only through the parallel ports.

#### [ 1 ] Standard Assignment Mode

##### (1) Input Data

No.	Content	No.	Content	No.	Content	No.	Content
512	Step stop (all tasks)	520	Bit 0 in data area 1	528	Bit 0 in data area 2	536	Bit 8 in data area 2
513	–	521	Bit 1 in data area 1	529	Bit 1 in data area 2	537	Bit 9 in data area 2
514	Halt (all tasks)	522	Bit 2 in data area 1	530	Bit 2 in data area 2	538	Bit 10 in data area 2
515	Strobe signal	523	Bit 3 in data area 1	531	Bit 3 in data area 2	539	Bit 11 in data area 2
516	Skip interrupt	524	Bit 4 in data area 1	532	Bit 4 in data area 2	540	Bit 12 in data area 2
517	–	525	Bit 5 in data area 1	533	Bit 5 in data area 2	541	Bit 13 in data area 2
518	–	526	Bit 6 in data area 1	534	Bit 6 in data area 2	542	Bit 14 in data area 2
519	Command data odd parity	527	Bit 7 in data area 1	535	Bit 7 in data area 2	543	Bit 15 in data area 2

No.	Content	No.	Content	No.	Content
544	Bit 0 in command area	552	INPUT 552	760	INPUT 760
545	Bit 1 in command area	553	INPUT 553	761	INPUT 761
546	Bit 2 in command area	554	INPUT 554	762	INPUT 762
547	Bit 3 in command area	555	INPUT 555	763	INPUT 763
548	–	556	INPUT 556	764	INPUT 764
549	–	557	INPUT 557	765	INPUT 765
550	–	558	INPUT 558	766	INPUT 766
551	–	559	INPUT 559	767	INPUT 767

**Note 1:** Numerals in the No. column denote the I/O port numbers of the controller.

**Note 2:** The input data is handled in bytes (8 points). The default is 64 points. Up to 256 points can be used.

### (2) Output Data

No.	Content	No.	Content	No.	Content	No.	Content
768		776	Robot warning	784	Bit 0 in status area	792	Bit 8 in status area
769	Robot running	777	Continue start permitted	785	Bit 1 in data area	793	Bit 9 in status area
770	Robot alarm	778	Reserved	786	Bit 2 in status area	794	Bit 10 in status area
771	Servo ON	779	Reserved	787	Bit 3 in status area	795	Bit 11 in status area
772	Robot initialization finished	780	Reserved	788	Bit 4 in status area	796	Bit 12 in status area
773	Auto mode	781	Reserved	789	Bit 5 in status area	797	Bit 13 in status area
774	External mode	782	Command process finished	790	Bit 6 in status area	798	Bit 14 in status area
775	Battery warning	783	Status area odd parity	791	Bit 7 in status area	799	Bit 15 in status area

No.	Content	No.	Content		No.	Content
800	OUTPUT 800	808	OUTPUT 808		1016	OUTPUT 1016
801	OUTPUT 801	809	OUTPUT 809		1017	OUTPUT 1017
802	OUTPUT 802	810	OUTPUT 810		1018	OUTPUT 1018
803	OUTPUT 803	811	OUTPUT 811		1019	OUTPUT 1019
804	OUTPUT 804	812	OUTPUT 812		1020	OUTPUT 1020
805	OUTPUT 805	813	OUTPUT 813		1021	OUTPUT 1021
806	OUTPUT 806	814	OUTPUT 814		1022	OUTPUT 1022
807	OUTPUT 807	815	OUTPUT 815		1023	OUTPUT 1023

**Note 1:** Numerals in the No. column denote the I/O port numbers of the controller.

**Note 2:** The output data is handled in bytes (8 points). The default is 56 points.  
Up to 256 points can be used.

## [ 2 ] Compatible Assignment Mode

### (1) Input Data

No.	Content	No.	Content	No.	Content	No.	Content
512	Step stop (all tasks)	520	Program selection bit	528	Motor power ON	536	INPUT 536
513	Continue start	521	Bit 1 for program selection	529	CAL execution	537	INPUT 537
514	Halt (all tasks)	522	Bit 2 for program selection	530	–	538	INPUT 538
515	Operation ready start	523	Bit 3 for program selection	531	SP100	539	INPUT 539
516	Skip interrupt	524	Bit 4 for program selection	532	Switching to external mode	540	INPUT 540
517	Program start	525	Bit 5 for program selection	533	Program reset	541	INPUT 541
518	–	526	Bit 6 for program selection	534	Robot alarm	542	INPUT 542
519	–	527	Program selection parity	535	–	543	INPUT 543

No.	Content	No.	Content	No.	Content
544	INPUT 544	552	INPUT 552	760	INPUT 760
545	INPUT 545	553	INPUT 553	761	INPUT 761
546	INPUT 546	554	INPUT 554	762	INPUT 762
547	INPUT 547	555	INPUT 555	763	INPUT 763
548	INPUT 548	556	INPUT 556	764	INPUT 764
549	INPUT 549	557	INPUT 557	765	INPUT 765
550	INPUT 550	558	INPUT 558	766	INPUT 766
551	INPUT 551	559	INPUT 559	767	INPUT 767

**Note 1:** Numerals in the No. column denote the I/O port numbers of the controller.

**Note 2:** The input data is handled in bytes (8 points). The default value is 64 points. Up to 256 points can be used.

### (2) Output Data

No.	Content	No.	Content	No.	Content	No.	Content
768	–	776	Robot power ON finished	784	Error code, unit, 2 <sup>0</sup>	792	Error code, hundreds, 2 <sup>0</sup>
769	Robot running	777	Servo ON	785	Error code, unit, 2 <sup>1</sup>	793	Error code, hundreds, 2 <sup>1</sup>
770	Robot alarm	778	CAL finished	786	Error code, unit, 2 <sup>2</sup>	794	Error code, hundreds, 2 <sup>2</sup>
771	Auto mode	779	Teaching	787	Error code, unit, 2 <sup>3</sup>	795	Error code, hundreds, 2 <sup>3</sup>
772	External mode	780	Single cycle end	788	Error code, tens, 2 <sup>1</sup>	796	–
773	Program start reset	781	Battery warning	789	Error code, tens, 2 <sup>2</sup>	797	–
774	–	782	Robot warning	790	Error code, tens, 2 <sup>3</sup>	798	–
775	–	783	Continue start permitted	791	Error code, tens, 2 <sup>4</sup>	799	–

No.	Content	No.	Content	No.	Content
800	OUTPUT 800	808	OUTPUT 808	1016	OUTPUT 1016
801	OUTPUT 801	809	OUTPUT 809	1017	OUTPUT 1017
802	OUTPUT 802	810	OUTPUT 810	1018	OUTPUT 1018
803	OUTPUT 803	811	OUTPUT 811	1019	OUTPUT 1019
804	OUTPUT 804	812	OUTPUT 812	1020	OUTPUT 1020
805	OUTPUT 805	813	OUTPUT 813	1021	OUTPUT 1021
806	OUTPUT 806	814	OUTPUT 814	1022	OUTPUT 1022
807	OUTPUT 807	815	OUTPUT 815	1023	OUTPUT 1023

**Note 1:** Numerals in the No. column denote the I/O port numbers of the controller.

**Note 2:** The output data is handled in bytes (8 points). The default is 56 points. Up to 256 points can be used.

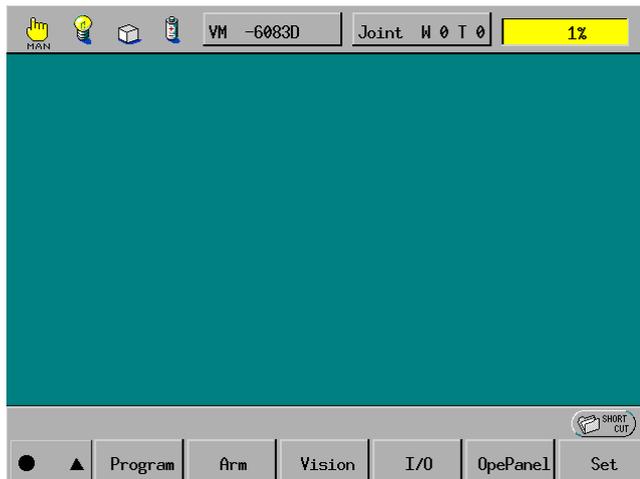
### 3.8.4 Parameter Entry Procedure

#### [ 1 ] Entering the Number of Input/Output Slots

This controller allows you to increase or decrease the number of input/output slots in bytes. The number of input slots can be set in the range from 8 (default) to 32 (max.), and the number of output slots in the range from 7 (default) to 32 (max.). The setting procedure is given below:

#### ▶ STEP 1

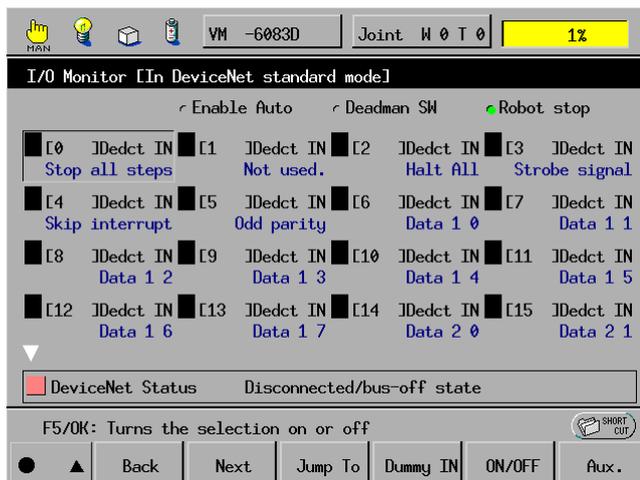
Press [F4 I/O] on the following screen.



F4

#### ▶ STEP 2

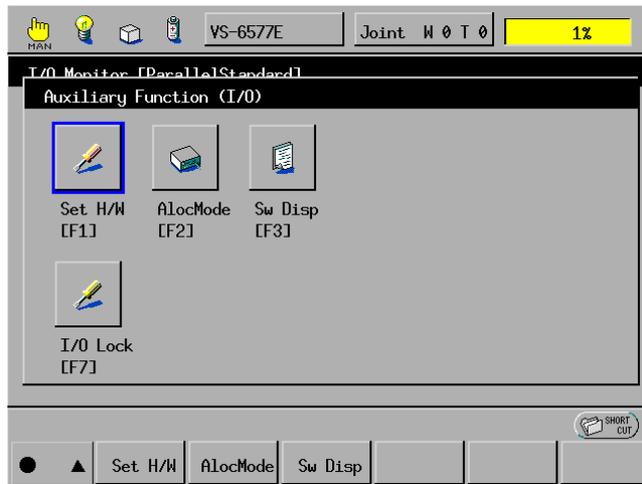
Press [F6 Aux.] on the following screen.



F6

▶ **STEP 3**

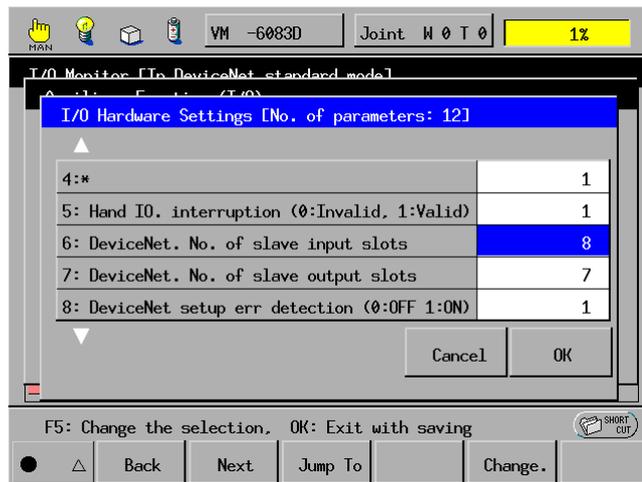
Press [F1 Set H/W] on the following screen.



F1

▶ **STEP 4**

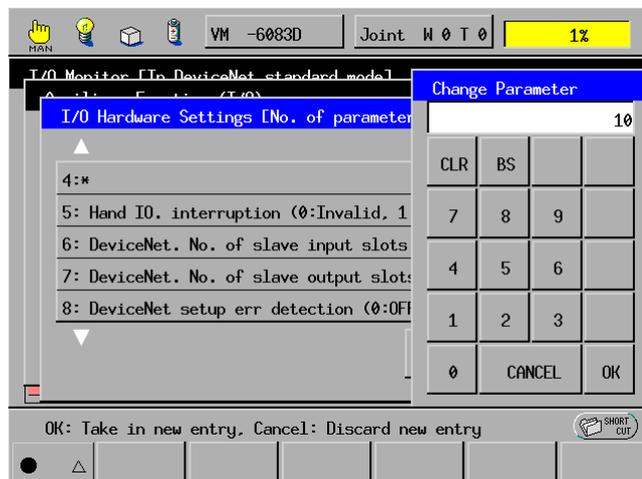
Select the box for changing the number of DeviceNet input/output slots and then press [F5 Change].



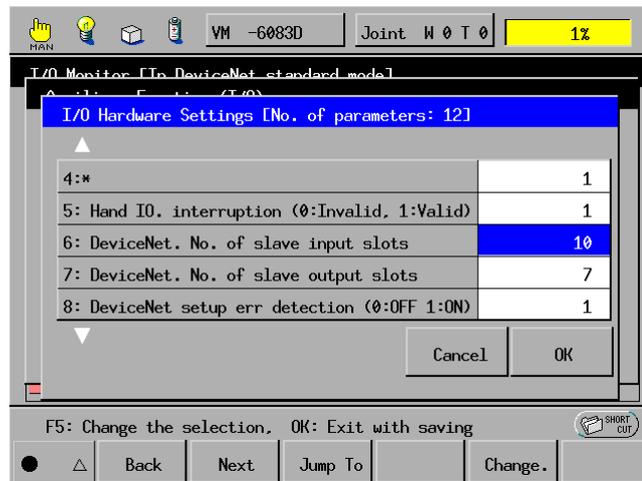
F5

▶ **STEP 5**

Enter a required number of slots on the following screen and press OK. The quick reference table given in the next subsection [ 2 ] will be helpful for you to determine the number of input/output slots.

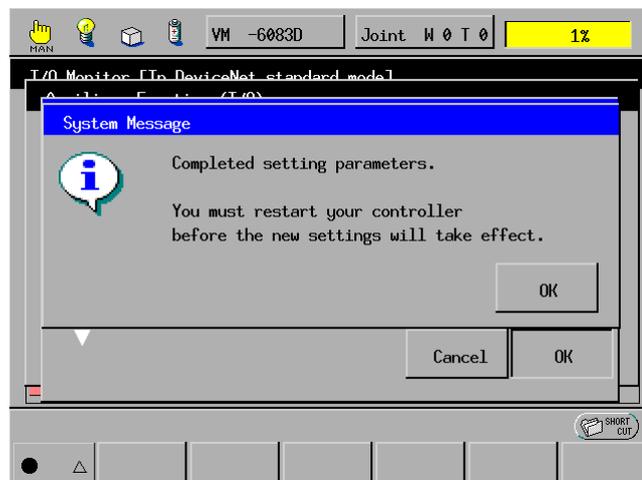


- **STEP 6** Check that the number has been correctly changed (from 8 to 10 in this example) and press OK.



- **STEP 7** Turn the controller power OFF and then turn it back ON according to the message on the following screen.

**NOTE:** The internal data that you have changed will not go into effect until you turn the controller power off and on.



## [ 2 ] Quick Reference Table for the Number of Input/Output Slots

The table below lists the correspondence between the number of input/output slots in DeviceNet and the number of user input/output points.

DeviceNet No. of input slots	Max. number of user input points	
	In standard assignment mode	In compatible assignment mode
8	24	40
9	32	48
10	40	56
11	48	64
12	56	72
13	64	80
14	72	88
15	80	96
16	88	104
17	96	112
18	104	120
19	112	128
20	120	136
21	128	144
22	136	152
23	144	160
24	152	168
25	160	176
26	168	184
27	176	192
28	184	200
29	192	208
30	200	216
31	208	224
32	216	232

DeviceNet No. of output slots	Max. number of user output points	
	In standard assignment mode	In compatible assignment mode
7	24	24
8	32	32
9	40	40
10	48	48
11	56	56
12	64	64
13	72	72
14	80	80
15	88	88
16	96	96
17	104	104
18	112	112
19	120	120
20	128	128
21	136	136
22	144	144
23	152	152
24	160	160
25	168	168
26	176	176
27	184	184
28	192	192
29	200	200
30	208	208
31	216	216
32	224	224

### 3.8.5 Field Network Error Indication (Version 1.5 or later)

In Main Software Version 1.5 or later, the "10: FieldNetwork ErrDisplay" parameter is newly added to the I/O Hardware Settings window (Access: [F4 I/O]—[F6 Aux.]—[F1 Set H/W]). This parameter allows you to choose whether a network error will display "every time" it occurs or at the "first time."

This parameter takes effect in the DeviceNet masters and slaves and the PROFIBUS slaves.

The addition of this parameter disables the "8: DeviceNet Setup ErrDisplay" in the I/O Hardware Settings window.

This parameter is set to "0" (EveryTime) by default for safe operation of the facilities. Every time an I/O operation is carried out, an error will display if any.

To check program operations using dummy I/Os for setting up facilities where no connection to the network has been established, set this parameter to "1" (First Time). Doing so will not display errors once detected, allowing you to check program operations.

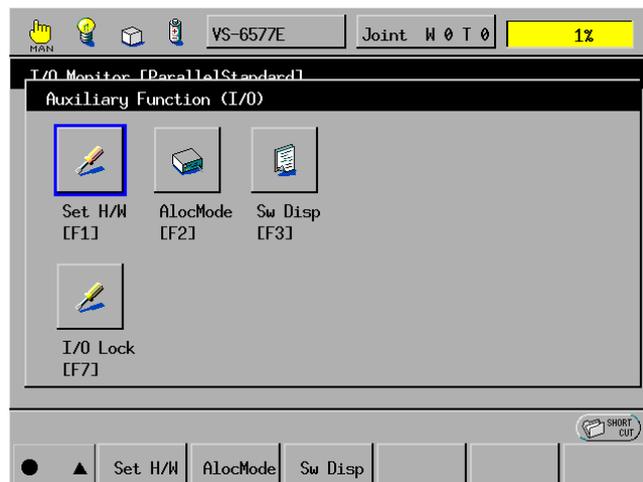
**NOTE: After completion of setting-up, be sure to set this parameter back to "0."**

#### ■ Changing the FieldNetwork ErrDisplay parameter

Access: [F4 I/O]—[F6 Aux.]—[F1 Set H/W]

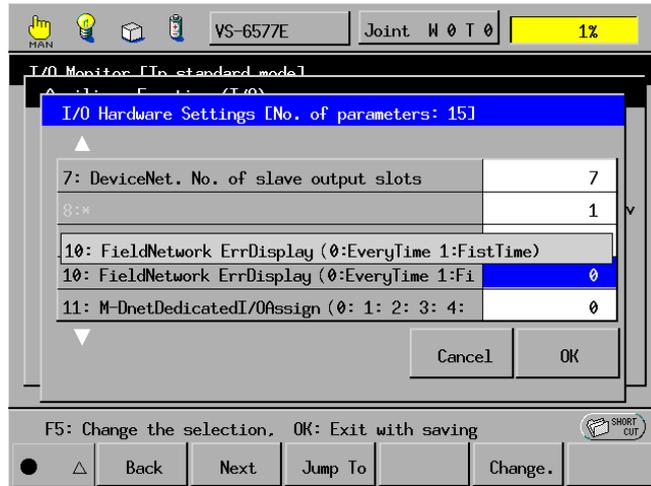
#### ► STEP 1

Press [F1 Set H/W] in the Auxiliary Function (I/O) window.



▶ STEP 2

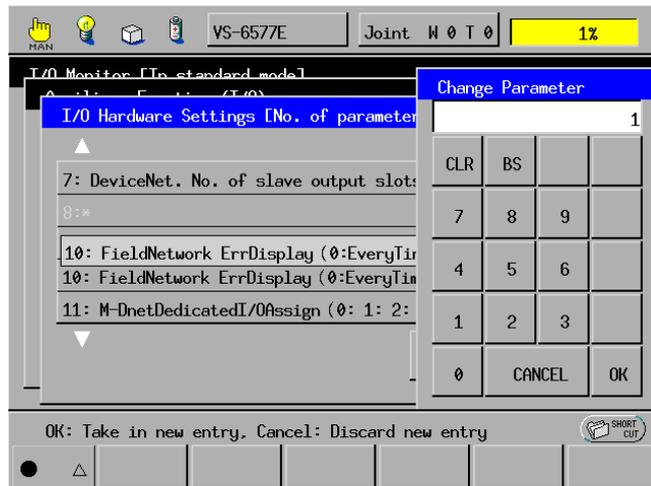
Select "10: FieldNetwork ErrDisplay" and press [F5 Change.].



F5

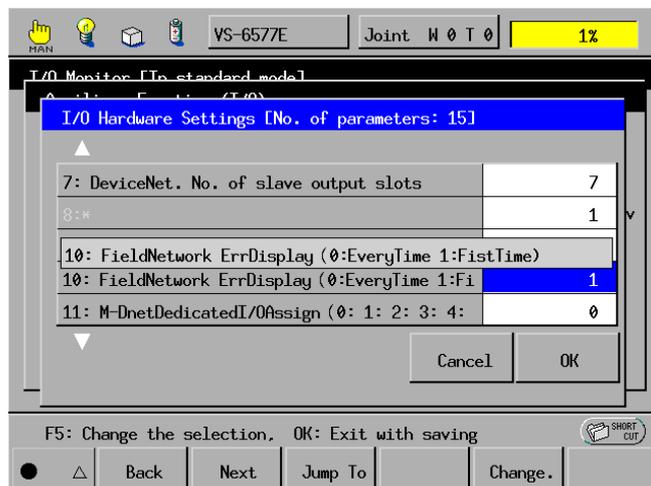
▶ STEP 3

Enter "1" in this example and press [OK].



▶ STEP 4

Check the newly entered value and press [OK].



▶ STEP 5

Following the system message, switch the controller power off and then on.



**NOTE:** If this message appears, you must switch the controller off.

### 3.8.6 Network Error Detector Suppression (Version 1.7 or later)

If facilities are powered up, the network components will immediately start to establish connections between the master and slaves.

If connected as a slave, the robot controller will start to establish connection with the master (PLC). The time required for the establishment will differ depending upon manufacturers of masters.

Also if the robot controller RC5 equipped with DeviceNet master board is connected as a master with RC5 slaves, then the time required for establishing connections will vary depending upon differences between setting-up times of individual controllers.

If it takes long time to establish connection after the controller is turned on, then the controller system may interpret it as a network error. To prevent such a network error from occurring, Main Software Version 1.7 or later newly supports the network error detector suppression that suppresses the detector for the specified time after the controller is turned on.

You may set the suppression time length (from 0 to 65535 ms) to the "17: Insensitive time to network error (ms)" parameter in the I/O Hardware Settings window (Access: [F4 I/O]—[F6 Aux.]—[F1 Set H/W]).

The initial value of the parameter is 8000, meaning that no network error will be detected for 8 seconds after completion of controller initialization.

If a network error occurs when the controller is turned on, then it will be detected 8 seconds later.

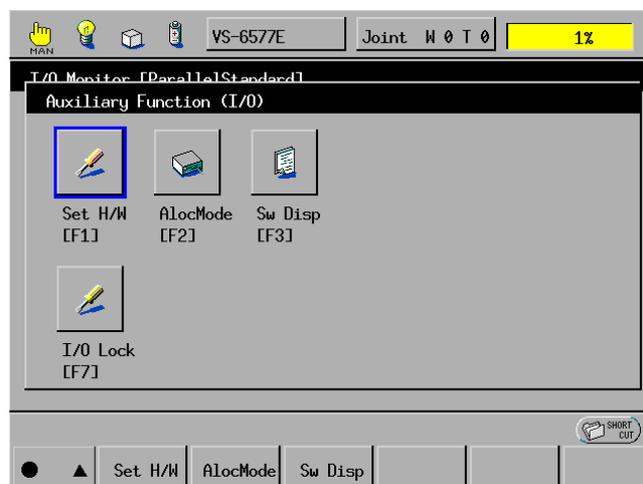
This parameter takes effect only immediately after the controller is turned on. After that, it does not influence network error detection so that any network error will be detected the moment it occurs.

#### ■ Changing the Network ErrDetection Suppression Time parameter

Access: [F4 I/O]—[F6 Aux.]—[F1 Set H/W]

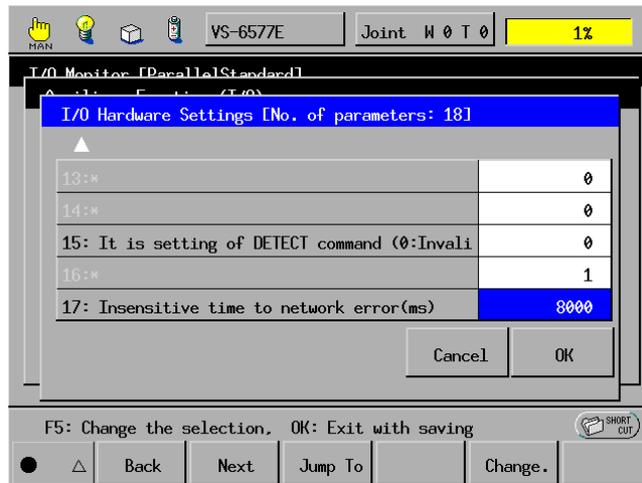
#### ▶ STEP 1

Press [F1 Set H/W] in the Auxiliary Function (I/O) window.



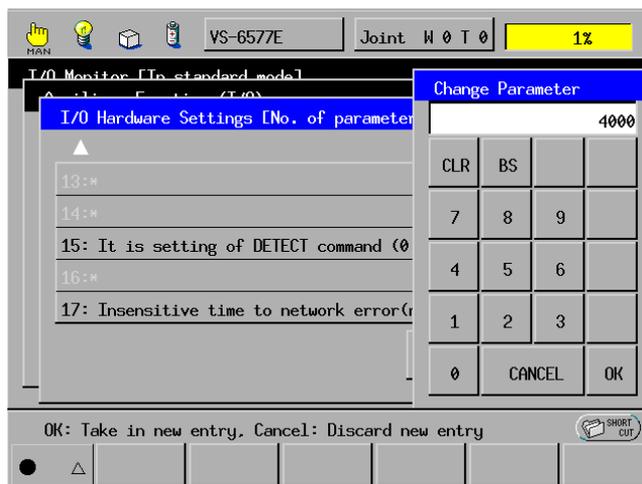
F1

- ▶ **STEP 2** Select "17: Insensitive time to network error" and press [F5 Change.].

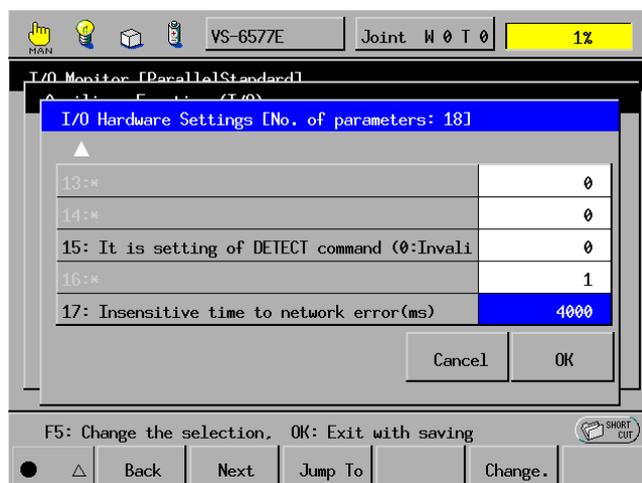


F5

- ▶ **STEP 3** Enter "4000" in this example and press [OK].



- ▶ **STEP 4** Check the newly entered value and press [OK].



► STEP 5

Following the system message, switch the controller power off and then on.



**NOTE:** If this message appears, you must switch the controller off.

### 3.8.7 Error Code Table

Here, only the error codes relative to DeviceNet communication errors are described in the table below. For other error codes, refer to the ERROR CODE TABLES, "2 Controller Error Code Table."

DeviceNet Error Code Table

Error code	What has happened:	What to do:	LEDs	
			MS	NS
1201	Preparing for communications (link not established) <ul style="list-style-type: none"> <li>The DeviceNet module is working normally, but has not established link with the master device.</li> </ul>	Establish the link from the master device.	 G	 G
1202	Preparing for communications (link not established) <ul style="list-style-type: none"> <li>The DeviceNet module is working normally and has established explicit link with the master device, but not established an I/O link.</li> </ul>	Establish the I/O link from the master device.	 G	 G
1203	Preparing for communications (communications idling) <ul style="list-style-type: none"> <li>The DeviceNet module is working normally, but cannot receive data except empty data from the master device.</li> </ul>	Check the contents of I/O data that the master device sends.	 G	 G
1204	Preparing for communications (I/O timeout) <ul style="list-style-type: none"> <li>The DeviceNet module is working normally, but cannot receive data from the master device within the specified time.</li> </ul>	Check that the DeviceNet cable is not broken or its connector is firmly plugged in.  Check the DeviceNet cable length and that a terminator resistor is attached to each end of the trunk line.	 G	 R
1205	Initial setting error in the communications processor <ul style="list-style-type: none"> <li>Failed to establish the initial link with the DeviceNet communication processor.</li> </ul>	Turn the controller power off and then on, and do the same operation again.	-	-
1210	A DeviceNet internal communications error has occurred.	Turn the controller power off and then on, and do the same operation again.	-	-
1213	The network is broken or "bus off." <ul style="list-style-type: none"> <li>The DeviceNet cable is broken or not connected.</li> </ul>	Check whether the DeviceNet cable is connected with the robot controller. If this error occurs after you change the DIP switch setting, check whether the bit rate setting made with the DIP switch matches the network's bit rate.	 G	 R
1215	Preparing for communications (Initial setting error) <ul style="list-style-type: none"> <li>No initial settings have been received from the robot.</li> </ul>	Check whether the bit rate setting made with the DIP switch matches the network's bit rate..	 G	
1216	Data length setting error <ul style="list-style-type: none"> <li>DeviceNet INSLOT or OUTSLOT is not 32 or less.</li> </ul>	Turn the controller power off and then on. Then, set correct DeviceNet INSLOT and OUTSLOT values.	 R	
1217	Node address double-assign error <ul style="list-style-type: none"> <li>The same node address is double assigned to the robot controller and any other online node.</li> </ul>	Assign an exclusive node address to each node (including the robot controller) on the same DeviceNet.	 G	 R

 : ON       : Flashing       : OFF      - : Indefinite

Error code	What has happened:	What to do:	LEDs	
			MS	NS
1230	Retry error in the DPRAM built in the robot controller	Turn the controller power off and then on, and do the same operation again.	–	–
1232	Reset command received • The robot controller has received a reset command from the master device.	Turn the controller power off and then on, and do the same operation again.	 G	 G
1234	DeviceNet internal RAM error	Turn the controller power off and then on, and do the same operation again.	 R	●
1235	Reserved for System	–	 R	●
1236	DeviceNet internal DPRAM error	Turn the controller power off and then on, and do the same operation again.	 R	●
1237	DeviceNet EEPROM error	Turn the controller power off and then on, and do the same operation again.	 R	●
1238	Retry error in the DeviceNet DPRAM	Turn the controller power off and then on, and do the same operation again.	 R	●

 : ON

 : Flashing

● : OFF

– : Indefinite

RC5 EDS File (\$ DeviceNet Manager Generated Electronic Data Sheet)

[File]

DescText= "RC5 EDS File";  
 CreateDate= 11-14-1997;  
 CreateTime= 15:00:00;  
 ModDate= 06-26-1999;  
 ModTime= 10:57:07;  
 Revision= 1.1;

[Device]

VendCode = 171; \$ Vendor Code  
 ProdType = 12; \$ Product Type  
 ProdCode = 1; \$ Product Code  
 MajRev = 1; \$ Major Rev  
 MinRev = 1; \$ Minor Rev  
 VendName = "Denso Corporation";  
 ProdTypeStr = "Communication Adapter";  
 ProdName = "RC5";  
 Catalog = "";

[IO\_Info]

Default = 0X0001; \$ Poll Only  
 PollInfo = 0X0001, \$ Poll Only  
 1, \$ Default Input = Input1  
 1; \$ Default Output = Output1

\$Input Connections

Input1 =  
 7, \$ From 7 to 32 Bytes, Variability  
 0, \$ All bits are significant  
 0x0001, \$ Poll Only Connection  
 "Data", \$ Name  
 6, \$ Path Length  
 "20 07 24 02 30 04", \$ Register Object Instance 2 Attribute 4  
 "Robot Output Data"; \$ Help

\$Output Connections

Output1 =  
 8, \$ From 8 to 32 Bytes, Variability  
 0, \$ All bits are significant  
 0x0001, \$ Poll Only Connection  
 "Data", \$ Name  
 6, \$ Path Length  
 "20 07 24 01 30 04", \$ Register Object Instance 1 Attribute 4  
 "Robot Input Data"; \$ Help

## 3.9 DeviceNet Master Board

### 3.9.1 Overview

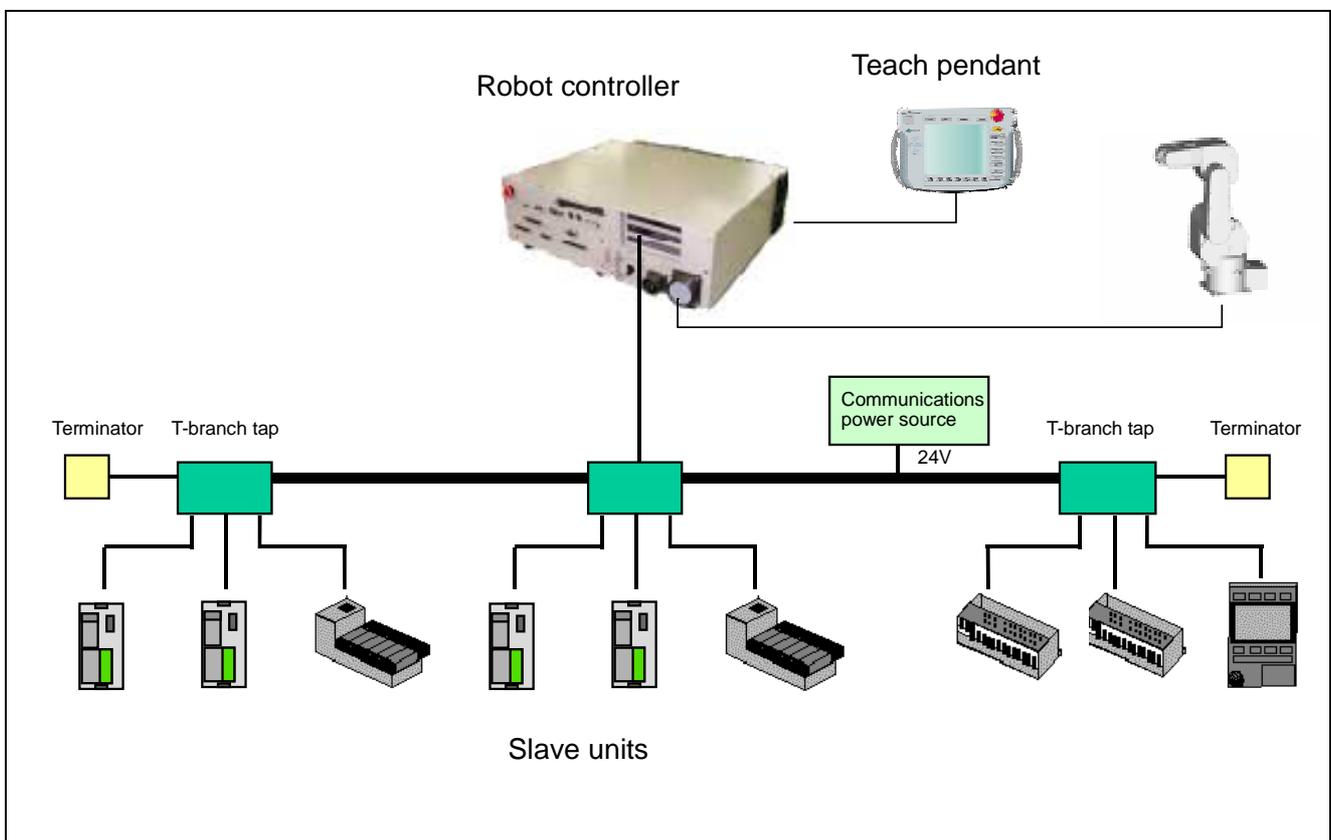
If the robot controller has a built-in DeviceNet master board, it can communicate with external devices according to the DeviceNet-compliant protocol.

The robot controller works as a master unit for serial communications which is compliant with the open network DeviceNet.

For details about the DeviceNet master board, refer to the SUPPLEMENT "DeviceNet Master Unit."

### 3.9.2 Typical Network Configuration

The figure below shows a typical network configuration.



### 3.9.3 General Specifications

#### (1) Environmental requirements

Item	Specifications
Power requirements	5 VDC (supplied via the controller ISA bus)
Operating temperature	0 to 40°C
Operating humidity	90% RH or less (without condensation)

#### (2) DeviceNet communications specifications

Item	Specifications			
Communications protocol	DeviceNet-compliant			
Connection supported	- Polling I/O function - Bit strobe function Compliant with DeviceNet communication rules			
Connection type <b>(Note 1)</b>	Multi-drop type with possible combination of T-branch (to trunk and branch lines)			
Bit rate	500, 250, 125 kbps (selectable by switch)			
Communications media	Special cable consisting of 5 wires (2 for signals, 2 for power supply, and 1 as a shield wire)			
Communications cable length	Bit rate	Max. network length	Branch length	Total branch length
	500 kbps	100m or less <b>(Note 2)</b>	6m or less	39m or less
	250 kbps	250m or less <b>(Note 2)</b>	6m or less	78m or less
	125 kbps	500m or less <b>(Note 2)</b>	6m or less	156m or less
Power supply for communication	External supply of 24 VDC $\pm$ 10%			
Internal power consumption	Communication power source: 30 mA max.			
Max. number of connectable nodes	64			
Number of I/Os	- Input 1024 points - Output 1024 points			
Error check	CRC			
<b>(Note 1)</b> Terminator resistors are needed at both ends of the trunk cable.				
<b>(Note 2)</b> These values may apply when a special thick cable is used as a trunk line. If a special fine cable is used, the max. network length is 100 m or less.				

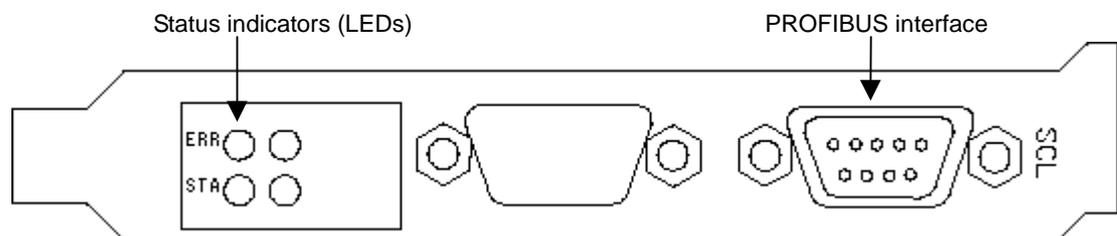
## 3.10 PROFIBUS-DP Slave Board

If the robot controller has a built-in PROFIBUS-DP slave board, it may communicate with external devices according to the PROFIBUS-DP-compliant communications protocol. The robot controller works as a slave unit, which can exchange I/O data with PROFIBUS-DP-compliant field devices of different manufacturers.

For details about the PROFIBUS-DP slave board, refer to the SUPPLEMENT "PROFIBUS-DP Slave Board."

### 3.10.1 Specifications

Item	Specifications					
Communications protocol	PROFIBUS-DP-compliant					
Transmission speed	9.6K, 19.2K, 93.75K, 187.5K, 500K, 1.5M, 3M, 6M, and 12M bps, with automatic recognition					
Interface connector	9-pin, D-sub connector					
Communications media	RS-485 interface cable (Type A recommended)					
Communications distance (when Type A interface cable is used)	Transmission speed (bps)	9.6 K to 93.75 K	187.5 K	500 K	1.5 M	3 M to 12 M
	Distance/segment	1200 m	1000 m	400 m	200 m	100 m
PROFIBUS address	1 to 125					
Max. number of stations	126 (when the repeater is used)					
Number of I/Os	Standard assignment: 40 points for system input 32 points for system output 24 (default) to 216 points for user input 32 (default) to 224 points for user output  Compatible assignment: 24 points for system input 32 points for system output 40 (default) to 232 points for user input 32 (default) to 224 points for user output					
Board model	CIF30-DPS					



Name	Explanation	
Status indicators (LEDs)	ERR	Lights when an error occurs in the PROFIBUS-DP slave board.
	STA	Lights when the network is established.
PROFIBUS interface	9-pin, D-sub connector RS-485	

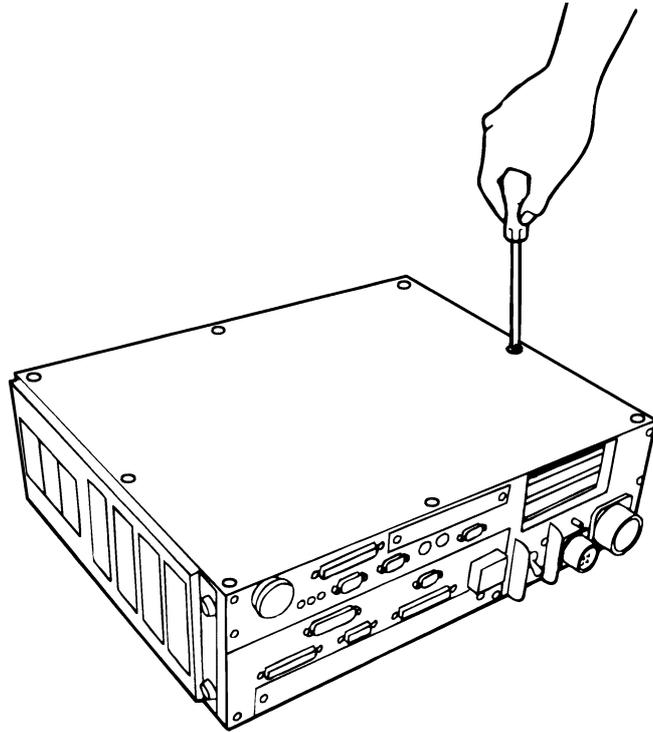
## 3.11 Mounting Extension Boards

This section describes how to mount the  $\mu$ Vision board, Ethernet board, and DeviceNet board.

When mounting only one of these boards, skip the steps for mounting other boards.

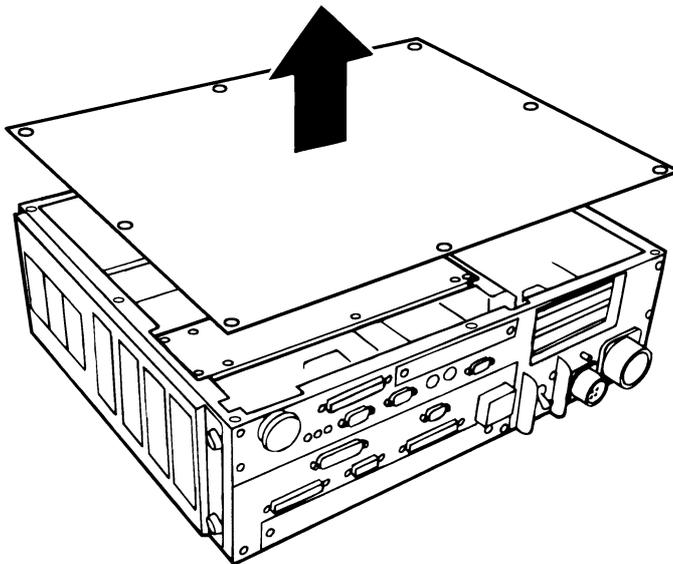
### ► STEP 1

Remove the eight screws from the controller top cover.



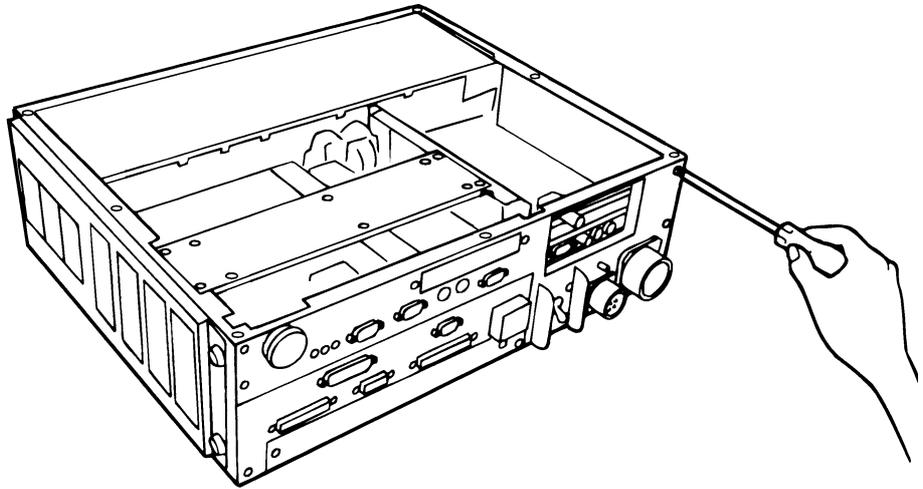
### ► STEP 2

Lift and remove the top cover from the robot controller.



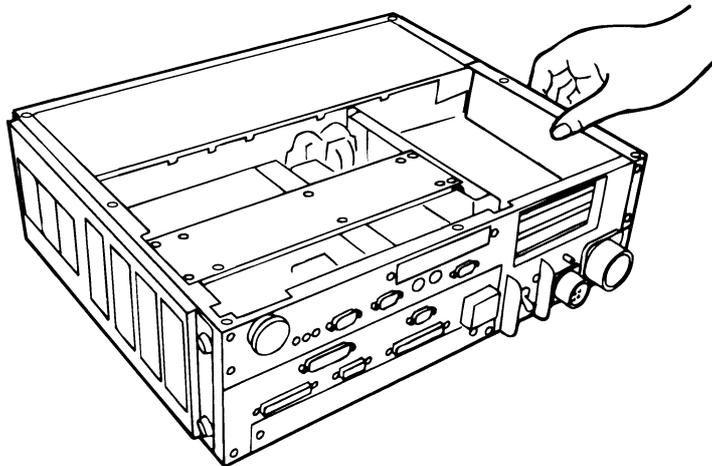
▶ **STEP 3**

Remove the two screws fastening the side plate from the front panel of the robot controller as shown below.



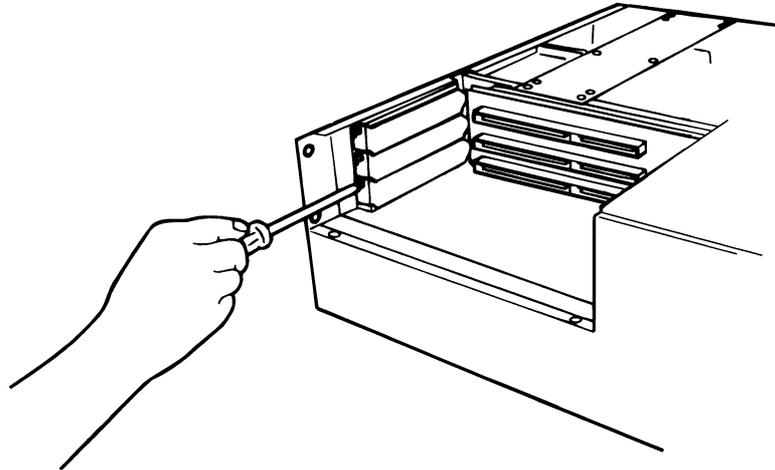
▶ **STEP 4**

Remove the side plate.



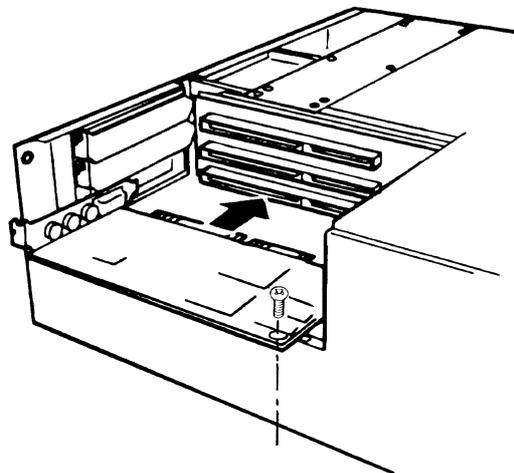
### ▶ STEP 5

Remove the panel fastening screw and then the panel hole blind plate. To mount a  $\mu$ Vision board, remove the lower blind plate. To mount an Ethernet board or DeviceNet board, remove the upper or the middle blind plate and then skip to STEP 7.



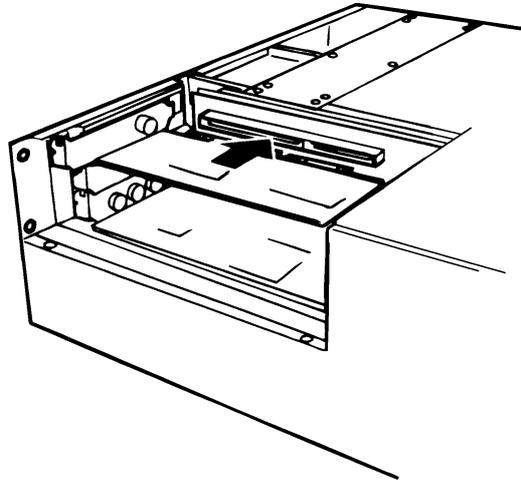
### ▶ STEP 6

Fully insert the  $\mu$ Vision board in the lower slot connector and secure it with an attached machine screw.



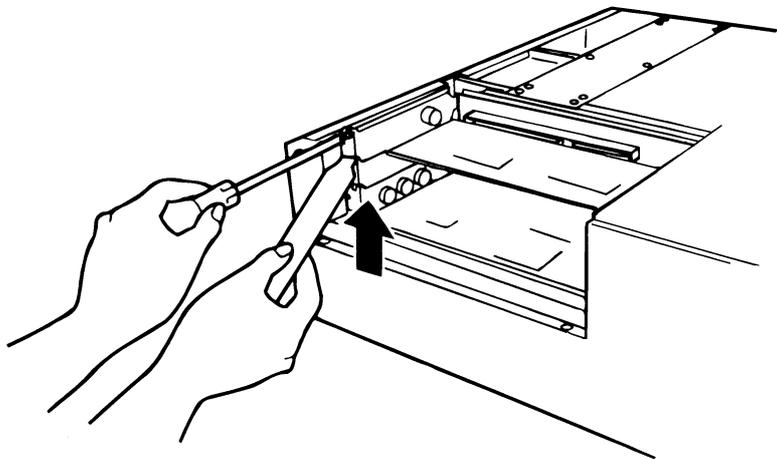
▶ **STEP 7**

Fully insert the Ethernet board or DeviceNet board into the upper or the middle slot connector.



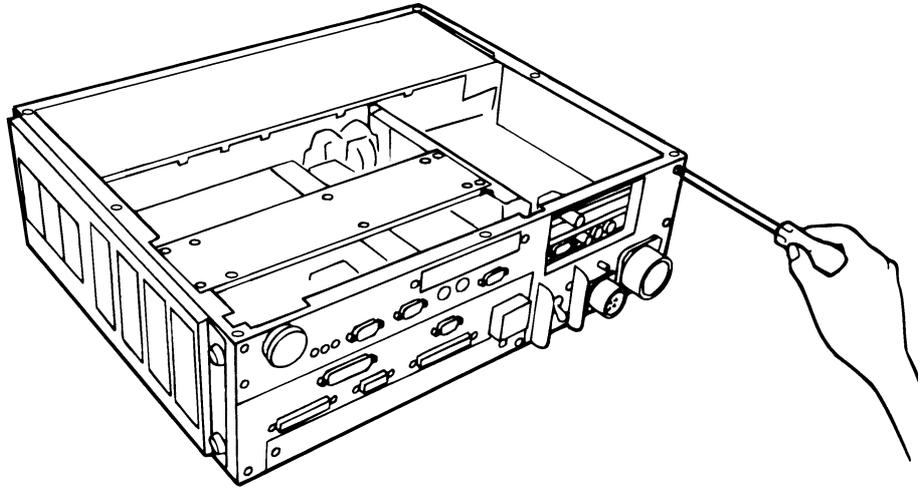
▶ **STEP 8**

Using the removed panel hole blind plate, push up the panel of each extension board. Secure the extension board with a panel fastening screw.



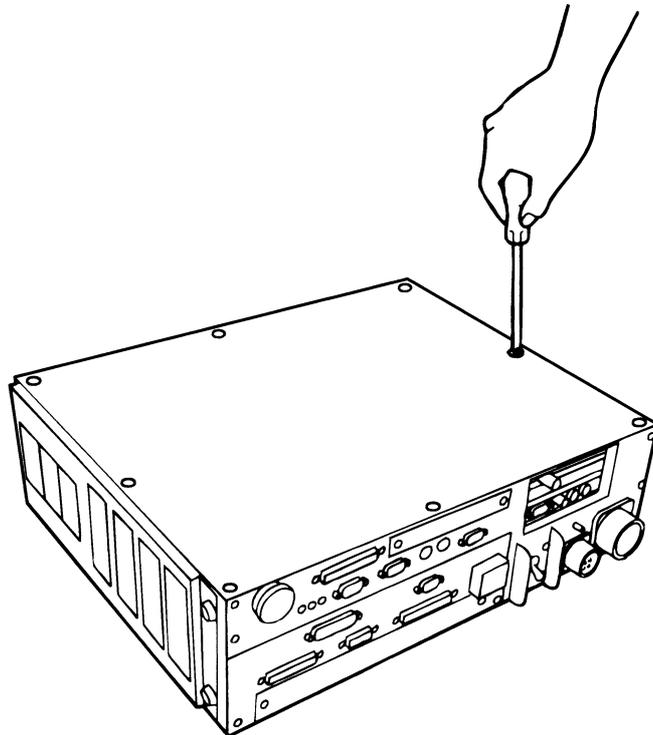
► STEP 9

Install the side plate and tighten the two screws.



► STEP 10

Put the top cover and secure it with eight screws.



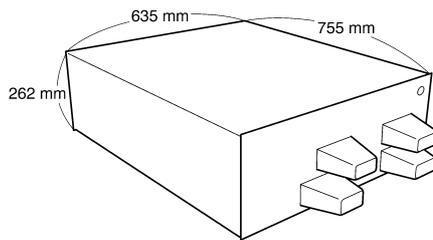
The mounting of the extension boards is completed.

## 3.12 Controller Protective Box (FB-10)

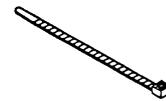
A controller protective box is an optional heat exchanger box to protect the robot controller from an undesirable environment (dust, oil mist) in plant.

### 3.12.1 Components in Package

Check that the following components are contained in the package of the controller protective box.

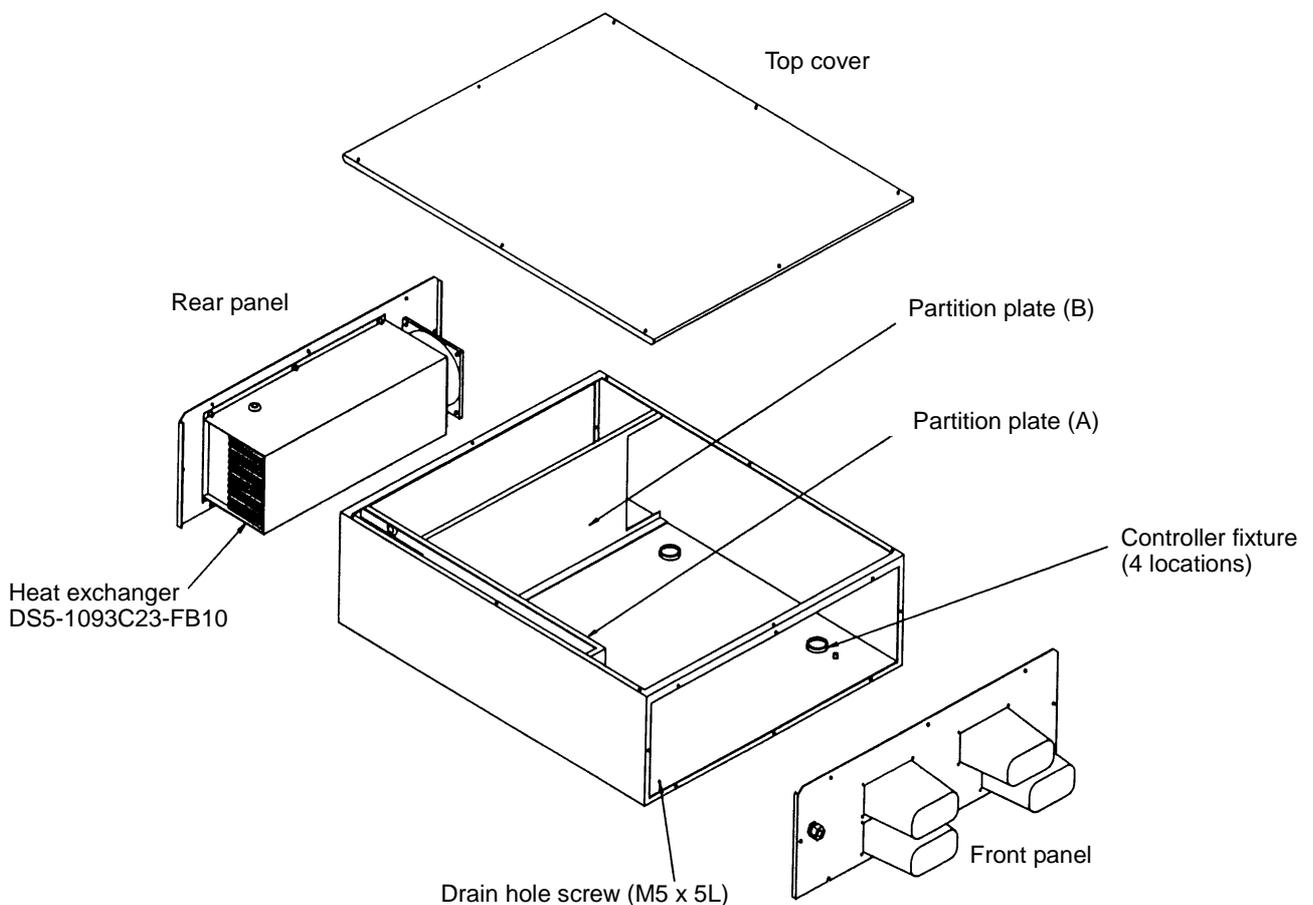


Controller protective box (1 pc)



Binding band (4 pcs)

### 3.12.2 Names of the Components



### 3.12.3 Setting up the Controller Protective Box

#### Placing the controller protective box

Place the controller protective box on a flat, level plane.

#### Preparing a power supply

Make a single-phase 200 VAC(35W) power supply ready for use.

Connect the power supply to the fan motor drive terminal.

Recommended cable: 1.25 mm<sup>2</sup> x 3-core (outside diameter: 11 to 13 mm)

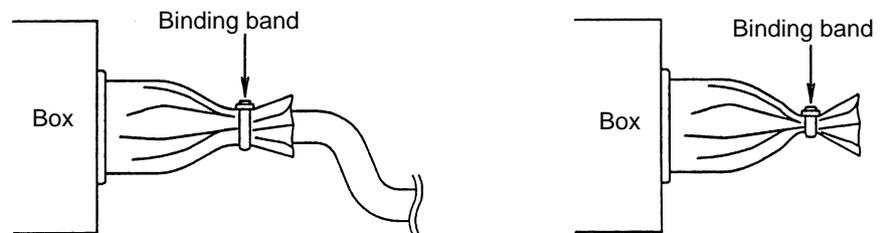
**Note 1:** Make the controller protective box share the same circuit breaker of the power supply (200 VAC) with the robot controller.

**Note 2:** Ground the controller protective box to prevent an electric shock.

#### Setting the robot controller into the protective box

- (1) Remove the top cover from the controller protective box.
- (2) Put the robot controller into the protective box so that its rubber feet will be fitted into the controller fixtures of the protective box.
- (3) Route the necessary cables through the ducts and connect them. As shown below, tie up each duct with an attached binding band.

**Note:** Tying up duct(s) not in use



**Note:** Tie up the opening of each duct not in use with an attached binding band to prevent entry of dust, water, etc. into the controller protective box.

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## 3.12.4 Precautions

- (1) The controller protective box is a dust-proof, splash-proof structure equivalent to JIS IP53.

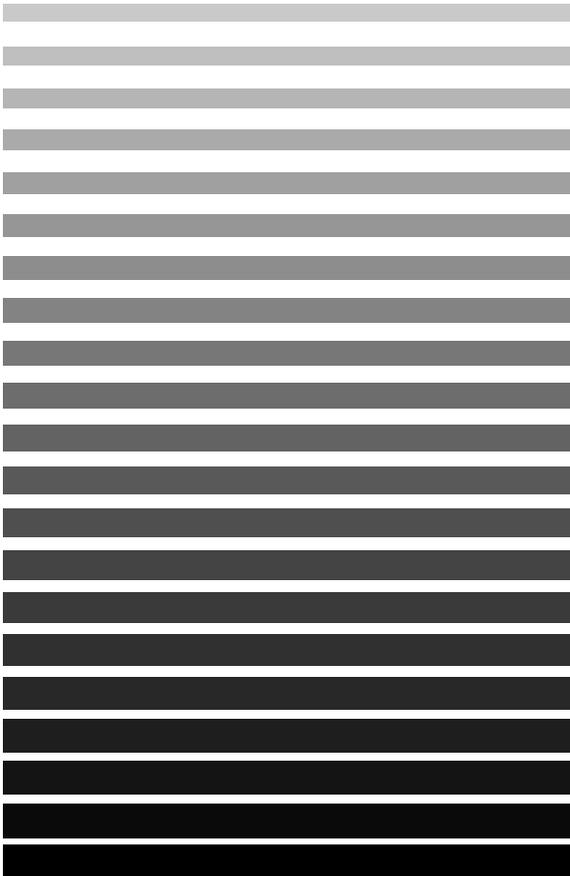
The controller protective box is not explosion-proof and must not be installed in the following environments and locations to ensure safety:

- in an environment full of combustible gas, flammable liquid, etc;
  - in an environment full of acid or alkali corrosive gas;
  - in a location close to electric noise sources, such as large inverters, high-output high-frequency generators, large conductors and welders;
  - in a location where the controller protective box will not be used outside the ambient temperature range from 0°C to 40°C;
  - in a location where the controller protective box will be exposed to rain or dew;
  - in an environment where the controller protective box will be exposed directly to water, oil or chips;
  - in an environment where fine chips will be produced from cutting, etc;
  - in an environment using oil other than DENSO's recommended oil. DENSO's recommended oil: YUSHIRON OIL No. 4
- (2) Seal the mounting face and screws of the controller protective box when using it in an environment full of oil mist. Otherwise oil mist may accumulate on the fin, resulting in a collection of oil. Periodically clean the controller protective box.
- (3) If oil mist, etc. collects in the controller protective box, remove the drain hole screw and drain off the oil.
- (4) The controller protective box is not equipped with a power switch. Use external means to turn the controller on or off.
- (5) The controller protective box must be installed horizontally. Vertical installation will cause accidents.

# Chapter 4



## Customizing Your Robot



This chapter describes how to customize your robot.



## 4.1 What Is Customization?

You may customize your robot by modifying or setting the following:

- Software motion limits for defining motion space
- Mechanical ends for defining restricted space
- Control set of motion optimization
- Robot installation conditions

You are recommended to define new motion space and restricted space in order to prevent interference with other devices or entanglement of the end-effector wiring and piping.

**WARNING:**

Always set the software motion limits and mechanical ends so that the motion space will be within the restricted space. Otherwise, the robot will bump the mechanical stops, causing serious accidents.

## 4.2 Modifying Software Motion Limits to Define New Motion Space

### 4.2.1 What Is a Software Motion Limit?

A limit to the operation range of the robot defined by the software is called a software motion limit. Software motion limits become valid after CAL of the robot has been completed and the robot has entered the range set by the limits.

A mechanical motion limit is called a mechanical end and set by a mechanical stop. To prevent the robot from striking against a mechanical stop, each software motion limit is set slightly in front of the mechanical end as shown in Figure 4-1. Although there is no mechanical stop for the sixth axis, a software motion limit is set.

If the robot reaches a software motion limit during manual or automatic operation, an error message will be displayed (error code starting from 6070; the first digit represents the axis number) and the robot will come to a stop. The power to the motor is also turned OFF in such a case during automatic operation.

All axes are assigned a software motion limit in both the positive and negative direction of the operation range. The software motion limit in the positive direction is called the positive-direction software motion limit and that in the negative direction is called the negative-direction software motion limit.

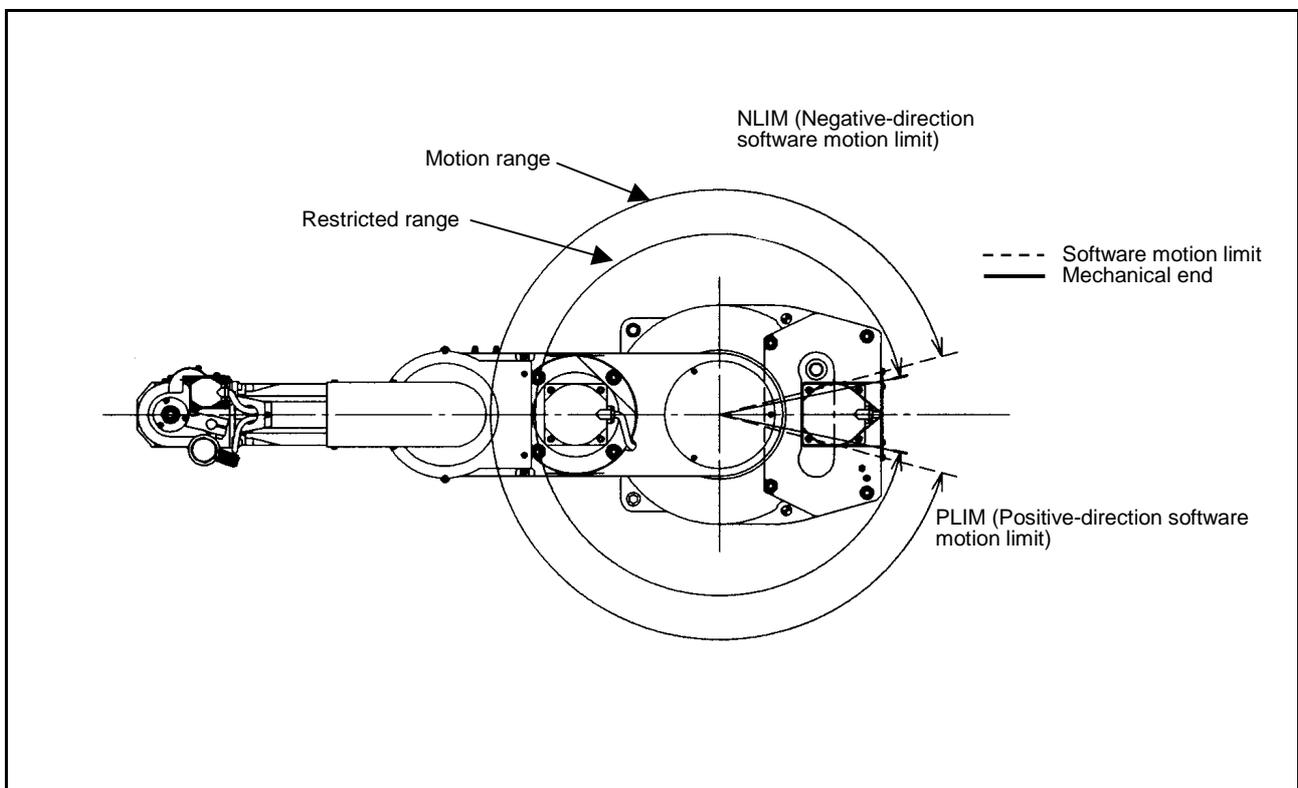


Figure 4-1 Software Motion Limits and Mechanical Ends

## 4.2.2 Software Motion Limits (Factory defaults)

Table 4-1 shows the factory defaults of software motion limits.

**Table 4-1 Software Motion Limits (Factory defaults)**

Robot series		HM-D/HS-D			HC-D	
3rd-axis (Z-axis) stroke		100 mm	200 mm	300 mm	150 mm	250 mm
1st axis	Positive direction	166	←	←	155.5	←
	Negative direction	-166	←	←	-155.5	←
2nd axis	Positive direction	139	←	←	138.5	←
	Negative direction	-139	←	←	-138.5	←
3rd axis	Positive direction	414	←	←	276.5	←
	Negative direction	312	212	112	125.5	25.5
3rd axis (Overhead-mount robot)	Positive direction	-687	←	←	No setting	No setting
	Negative direction	-789	-889	-989	No setting	No setting
4th axis	Positive direction	271	←	←	360.5	←
	Negative direction	-271	←	←	-360.5	←

### 4.2.3 Changing Software Motion Limits

If the robot interferes with another device, change the software motion limits to make the motion space smaller as shown in Figure 4-2.

Or, if the air piping and wiring of the end-effector become taut as the robot moves, change the software motion limit to make the motion space smaller as shown in Figure 4-2.

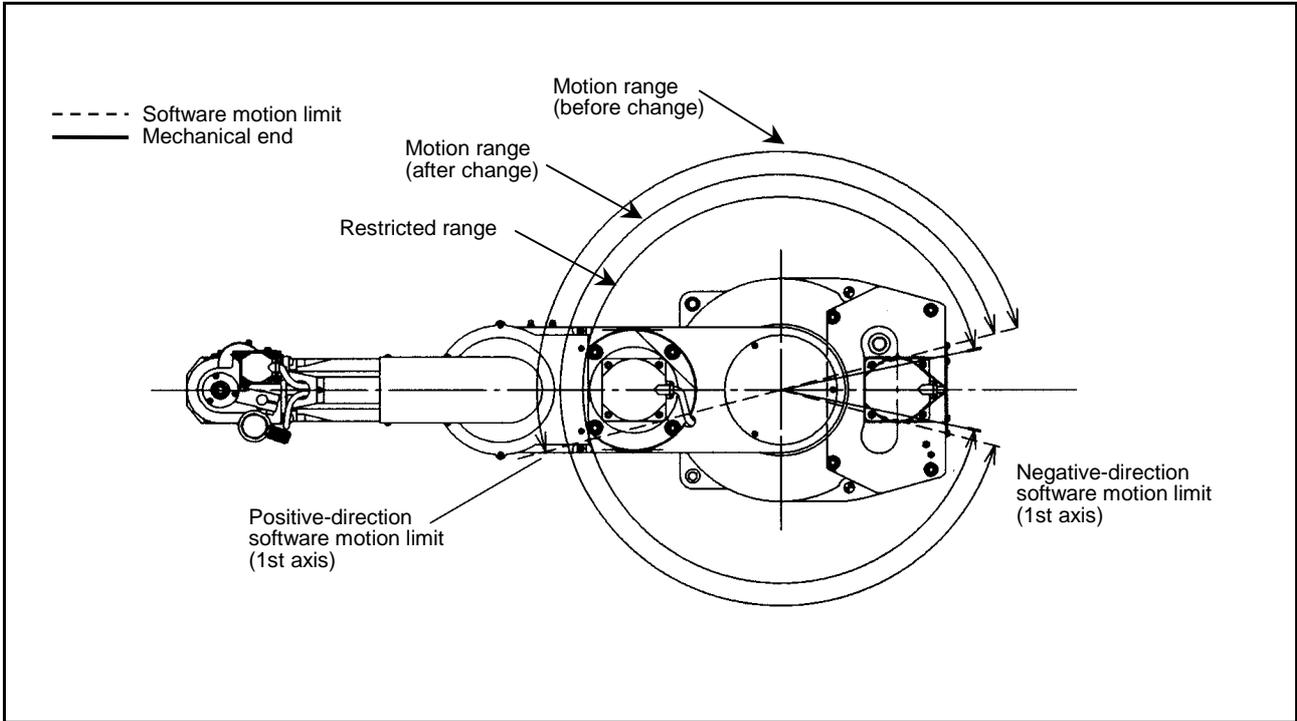


Figure 4-2 Changing Software Motion Limits (Example)

### 4.2.4 Precautions When Changing the Software Motion Limits

- (1) The software motion limits are invalid until CAL is completed.
- (2) Confirm the operating range of the robot in the actual working environment.  
Set the software motion limits using the correct unit.  
If the operating range is too small, the robot may seem to become inoperable.

### 4.2.5 Procedure for Changing the Software Motion Limits

Described below is the procedure for changing the software motion limits.

#### ▶ STEP 1

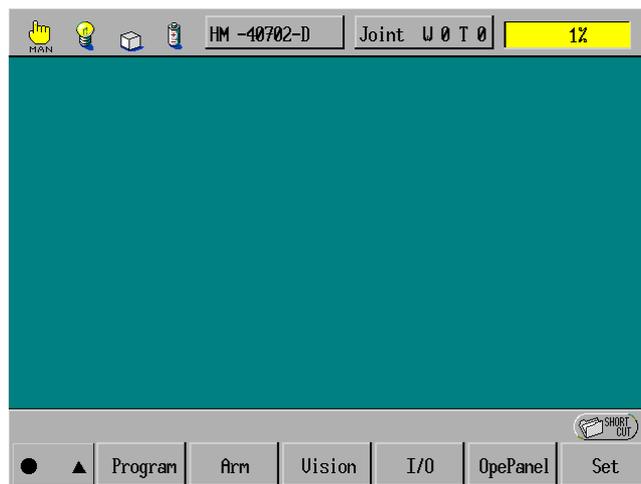
Turn the power switch of the robot controller ON.

#### ▶ STEP 2

Set the mode selector switch of the teach pendant to MANUAL.

#### ▶ STEP 3

Press [F2 Arm] on the top screen of the teach pendant.

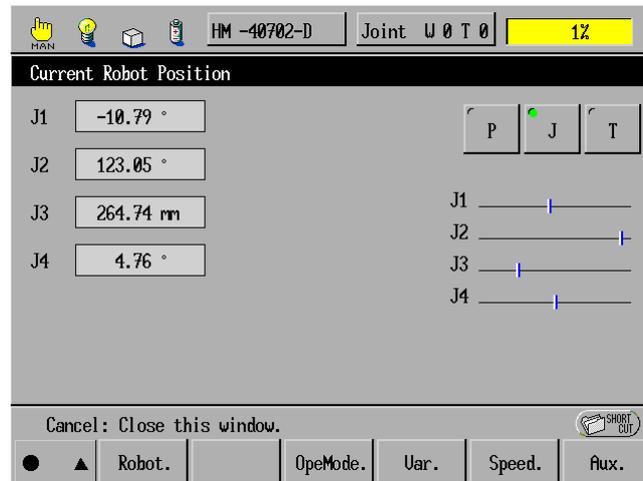


F2

The Current Robot Position window appears as shown in Step 4.

## ▶ STEP 4

Press the **SHIFT** key and then press [**F12 Maint.**].



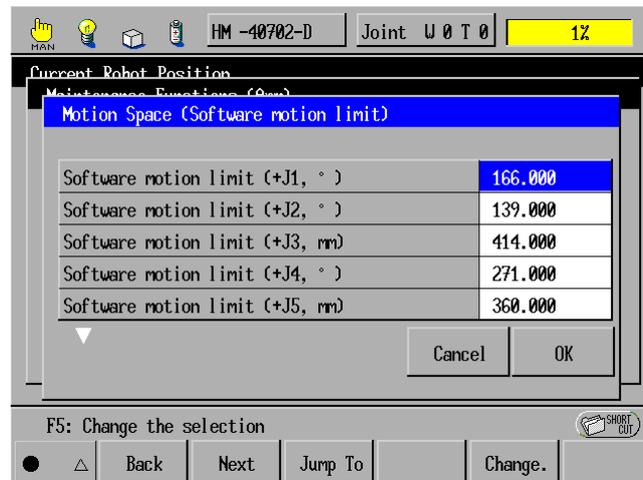
F12

The Maintenance Functions (Arm) window will appear.

## ▶ STEP 5

In the Maintenance Functions (Arm) window, press [**F1 M Space**]. The Motion Space window will appear as shown below.

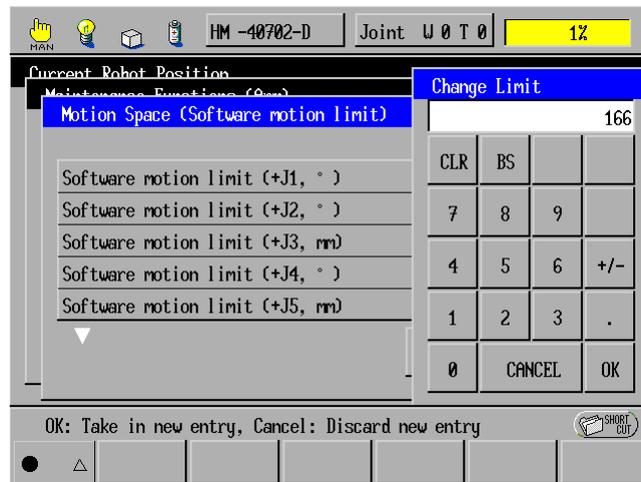
Select the item to be modified, then press [**F5 Change**].



F5

▶ **STEP 6**

The numeric keypad will appear as shown below.  
**Enter a desired value using the numeric keys, then press OK.**



▶ **STEP 7**

The new value will be set on the line of the item selected in the Motion Space window.  
 If two or more items must be changed, repeat Steps 4 and 5.

▶ **STEP 8**

**Press OK in the Motion Space window.**

▶ **STEP 9**

**Turn the robot controller off.**

**Caution:** The new setting(s) (software motion limit(s)) for the motion space will take effect after the power is turned ON again and CAL is completed.

## 4.3 Changing the Mechanical Ends to Define New Restricted Space

### 4.3.1 What Is a Mechanical End Change?

Change of the mechanical end refers to changing the mechanical ends on the 1st axis (and 2nd axis) by setting a mechanical stop(s).

### 4.3.2 Changing the Mechanical Ends

#### ■ HM-D/HS-D Series

##### [ 1 ] Mechanical ends (Factory defaults)

On the HM-D/HS-D series, a bolt is screwed in No.1 position (Figure 4-3) at the factory. The bolt serves as a mechanical stop for both the positive and negative mechanical ends. As shown in Figure 4-3 and Table 4-2, the default stroke of the 1st axis is A-A'.

To change the mechanical ends, an additional mechanical stop bolt specified below is required in addition to the current mechanical stop bolt preset in No. 1 position.

Bolt specifications: M10x12 SCM435 (JIS G4105) HRC 34 to 44

**⚠ Caution:** Do not move the 1st axis beyond points A and A' at the (+) and (-) ends, respectively. Overrunning may damage wirings inside the robot unit.

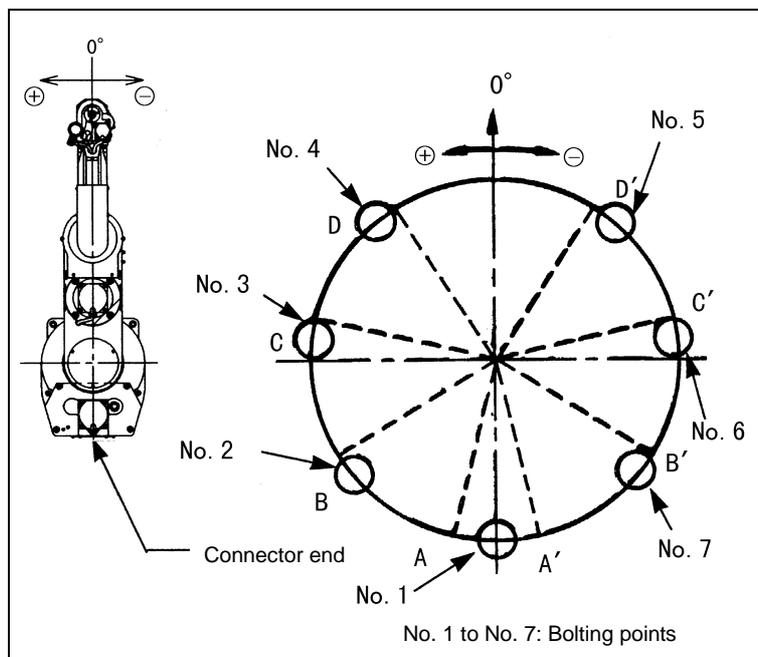


Figure 4-3 Bolting Points on the 1st Axis of HM-D/HS-D Series

Table 4-2 1st Axis Stroke on HM-D/HS-D Series

Location of mechanical stop in (+) direction		Location of mechanical stop in (-) direction	
A	167°	A'	-167°
B	122°	B'	-122°
C	77°	C'	-77°
D	32°	D'	-32°

**Note 1:** The software motion limits should be set 2° inside the above angles.

**Note 2:** Operating space must always contain 0°

### [ 2 ] After Changing Mechanical Ends

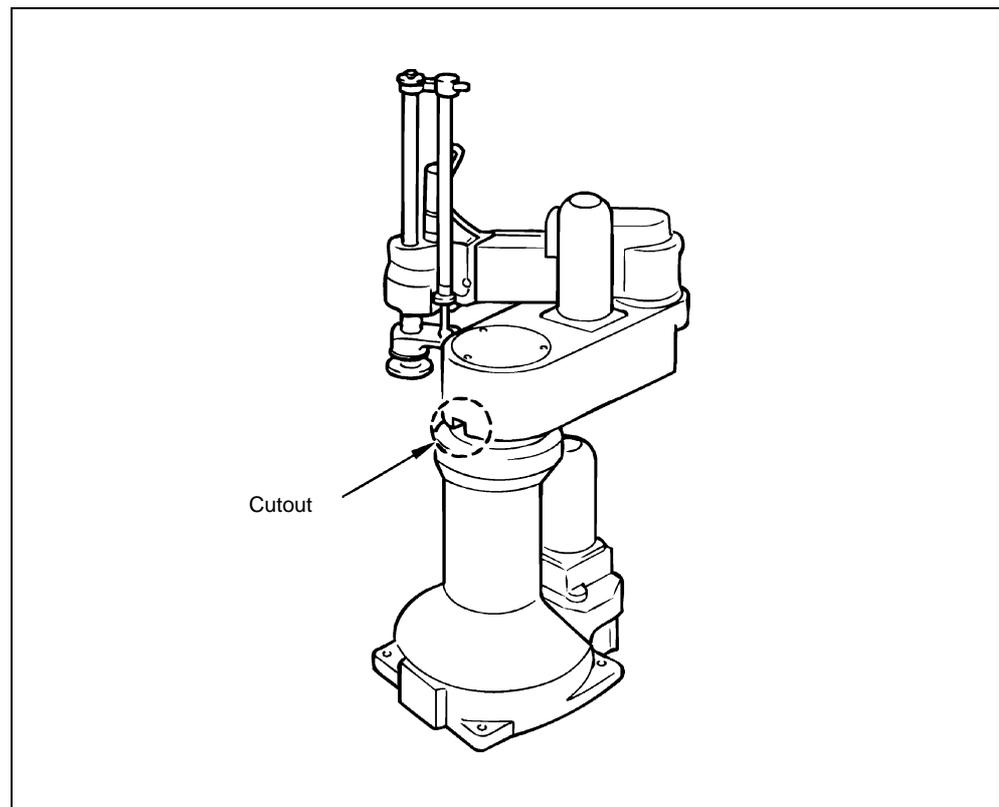
If you change the mechanical ends, you need to change the software motion limits and coordinates of zero point and perform CALSET.

### [ 3 ] Changing the Mechanical Ends

#### (1) Changing the position of the mechanical stop bolt

Turn the 1st-axis arm until the cutout provided in its rear (see Figure 4-4 below) comes to the current position of the mechanical stop bolt, then remove the bolt.

Turn the 1st-axis arm to bring the cutout to a desired mechanical end (see Figure 4-3) and then screw the removed bolt.



**Figure 4-4 Changing the Position of the Mechanical Stop Bolt(s)**

**Note 1:** To screw mechanical stop bolt(s) into hole C, C', D and/or D' (Figure 4-3), open the 1st axis cover and turn the axis until the desired inside cutout appears.

**Note 2:** The tightening torque of mechanical stop bolts is  $70 \pm 14\text{N}\cdot\text{m}$ .

#### (2) CALSET by entering XY coordinates

Move (by hand or in manual mode) the robot arm to known coordinate, and then enter that coordinates. This step should be repeated three to ten times at different coordinates. Advantage here is, CALSET can be performed within the robot working space and no additional space is required. You may enter coordinates by entering numeric values or by teaching points.

## [ 4 ] Setting the software motion limits and origin coordinates (RANG)

Table 4-3 lists the origin coordinates (RANG) and software motion limits suitable for each bolting point of a mechanical stop bolt on the HM-D/HS-D series. If you add a mechanical stop bolt or change the bolt position, you need to change the (+) and (-) software motion limits and RANG to values listed below.

**Table 4-3 Location of Mechanical Stop Bolts, Software Motion Limits, and RANG**

Bolting point. Parameters	1 (Typical)	2	3	4	5	6	7
(+) software motion limit	166.000	12.321	75.057	30.366			
RANG 1	167.774	121.147	77.914	32.803			
(-) software motion limit	-166.000				-30.366	-75.057	-120.321

**Example 1:** If you add a mechanical stop bolt into No. 2 position (without removing the bolt from No. 1 position).

Change the (+) software motion limit to 120.321 and RANG1 to 121.147.

**Example 2:** If you add a mechanical stop bolt into No. 6 position (without removing the bolt from No. 1 position).

Change the (-) software motion limit to -75.057.

**Example 3:** If you add a mechanical stop bolt into Nos. 2 and 7 positions each (removing the bolt from No. 1 position).

Change the (+) software motion limit to 120.321, RANG1 to 121.147 and (-) software motion limit to -120.321.

■ HC-D Series

[ 1 ] Mechanical ends (Factory defaults)

On the HC-D series, a mechanical stop is set in No.1 position (Figure 4-5) at the factory. The mechanical stop serves for both the positive and negative mechanical ends. As shown in Figure 4-5 and Table 4-4, the default stroke of the 1st and 2nd axes are A-A' and a-a', respectively.

To change the mechanical ends on the 1st axis, an additional (-) mechanical stop specified in Figure 4-6 is required in addition to the current mechanical stop preset in No. 1 position.

By changing the mechanical ends on the 2nd axis, you may limit the robot movement for right-hand or left-hand posture.

**⚠ Caution:** Do not move the 1st axis beyond points A and A' at the (+) and (-) ends, respectively. Or do not move the 2nd axis beyond points a and a' at the (+) and (-) ends, respectively. Doing so may damage wirings inside the robot unit.

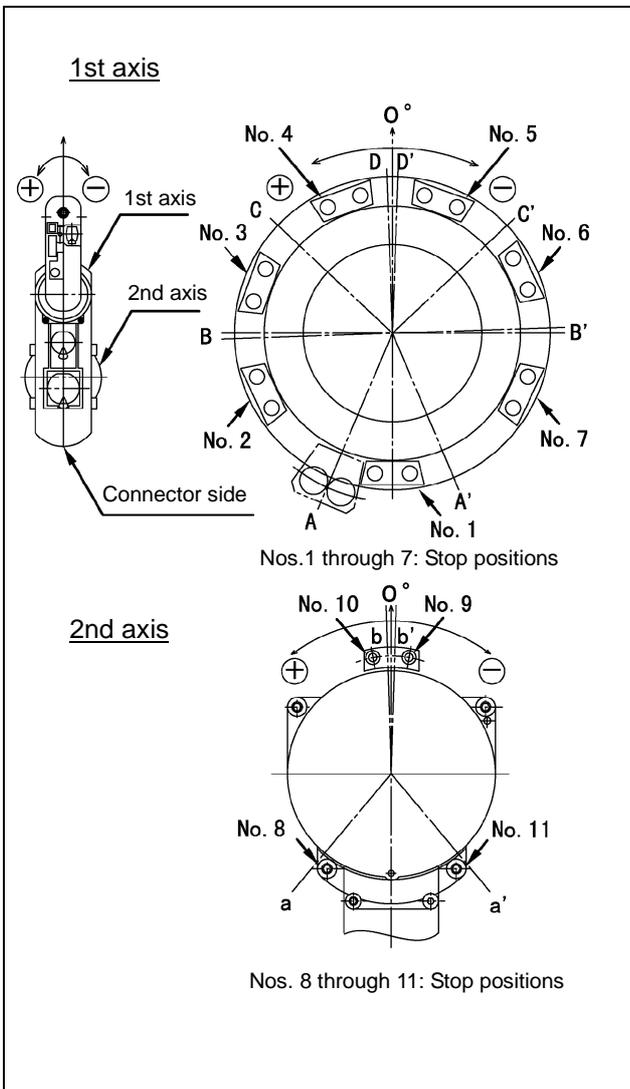


Table 4-4 1st Axis Stroke on HC-D Series

	Mechanical stop in (+) direction		Mechanical stop in (-) direction	
1st axis	A	157°	A'	-157°
	B	92°	B'	-92°
	C	47°	C'	-47°
	D	2°	D'	-2°
2nd axis	a	140°	a'	-140°
	b	2°	b'	-2°

**Note 1:** The software motion limits should be set 2° inside the above angles.  
**Note 2:** Operating space must always contain 0°.

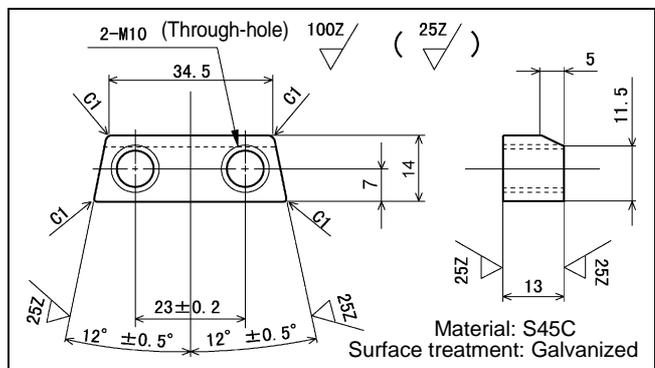


Figure 4-5 Mechanical Stop Positions on the 1st and 2nd Axes

Figure 4-6 Mechanical Stop

## [ 2 ] After Changing the Mechanical Ends

If you change the mechanical ends, you need to change the software motion limits and coordinates of zero point and perform CALSET.

## [ 3 ] Changing the Mechanical Ends

### (1) Changing the 1st-axis mechanical ends

- 1) Remove the machine screws from the 1st arm cover and take off the cover.
- 2) If you want to change the current mechanical stop position, remove the fixing bolt from that mechanical stop and pull out the stop horizontally. (See Figure 4-7.)
- 3) Secure the mechanical stop removed in step 2) and a new stop prepared in Figure 4-6 to the desired number positions, referring to Table 4-4.

Tightening torque of fixing bolts (M10x25, JIS strength class 12.9):  
 $69.6 \pm 13.9 \text{ N}\cdot\text{m}$

- 4) Reinstall the 1st arm cover.

### (2) Changing the 2nd-axis mechanical ends

If you want to fix the robot to the right-hand or left-hand posture, change the mechanical ends of the 2nd axis.

- 1) Rotate the 2nd arm to an angle at which you can easily remove the mechanical stops.

**NOTE:** Take care not to let the robot's end-effector bump against the peripheral equipment or workers.

- 2) For the right-hand posture, shift the mechanical stop preset in No. 11 position to No. 9 position; for the left-hand posture, shift the mechanical stop preset in No. 8 position to No. 10 position.

Tightening torque of fixing bolts (M6x16, JIS strength class 12.9):  
 $14.7 \pm 2.9 \text{ N}\cdot\text{m}$

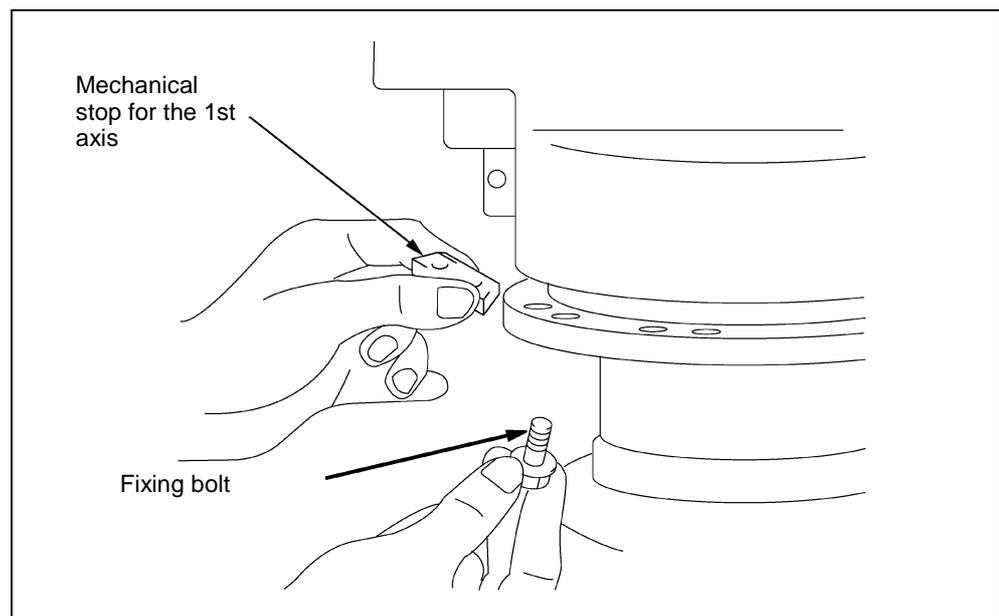


Figure 4-7 Mechanical Stop of the 1st Axis

[ 4 ] Setting the software motion limits and origin coordinates (RANG)

Table 4-5 lists the origin coordinates (RANG) and software motion limits suitable for each of mechanical stop positions on the HC-D series. If you add a mechanical stop or change the stop position, you need to change the (+) and (-) software motion limits and RANG to values listed below.

Table 4-5 Location of Mechanical Stops, Software Motion Limits, and RANG

1st axis	Mechanical stop position	No. 1 (Typical)	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7
	Parameters							
	(+) software motion limit	155.500	90.00	45.00	0.00			
	RANG 1	(157.00)	92.00	47.00	2.00			
	(-) software motion limit	-155.500				0.00	-45.00	-90.00
Remarks		For details, refer to "[ 3 ] Changing the Mechanical Ends" on the previous page.				For details, refer to "[ 3 ] Changing the Mechanical Ends" on the previous page.		
2nd axis	Mechanical stop position	No. 8 (typical)	No. 9	No. 10	No. 11 (typical)			
	Parameters							
	(+) software motion limit	138.500		0.50				
	RANG 1		-2.00		(-140.00)			
	(-) software motion limit		-0.50		-138.500			
Remarks		The robot posture is fixed to right-hand. For details, refer to "[ 3 ] Changing the Mechanical Ends" on the previous page.		The robot posture is fixed to left-hand. For details, refer to "[ 3 ] Changing the Mechanical Ends" on the previous page.				

**Example 1:** If you add a mechanical stop into No. 2 position (without removing the stop from No. 1 position).

Change the (+) software motion limit to 90.00 and RANG1 to 92.00.

**Example 2:** If you add a mechanical stop into No. 6 position (without removing the stop from No. 1 position).

Change the (-) software motion limit to -45.00.

**Example 3:** If you add a mechanical stop into Nos. 2 and 7 positions each (removing the stop from No. 1 position).

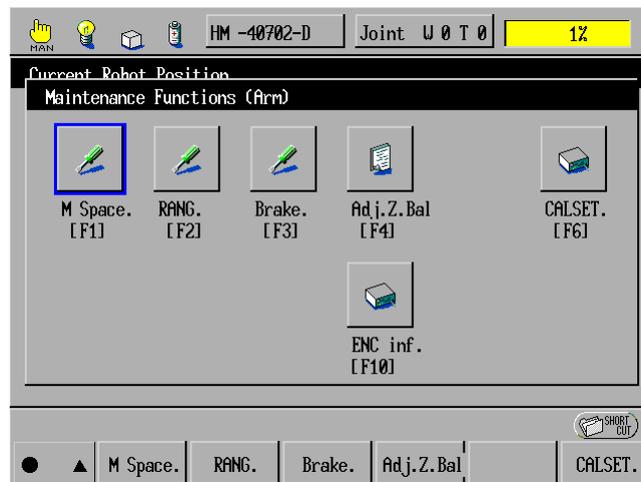
Change the (+) and (-) software motion limits to 90.00, RANG1 to 92.00.

### 4.3.3 Changing Positive-Direction Software Motion Limits (PLIMs) and RANG Values

If you change the positive-direction mechanical ends, you need to change the preset positive-direction software motion limits (PLIMs) and RANG according to steps 1 through 35 given below.

#### Changing Positive-Direction Software Motion Limits (PLIMs)

- ▶ **STEP 1** | Set the power switch of the robot controller to ON.
- ▶ **STEP 2** | Set the mode selector switch of the teach pendant to MANUAL.
- ▶ **STEP 3** | Press [F2 Arm] on the top screen.  
The Current Robot Position window appears.
- ▶ **STEP 4** | In the Current Robot Position window, press [F12 Aux.].  
The Maintenance Functions (Arm) window appears as shown below.

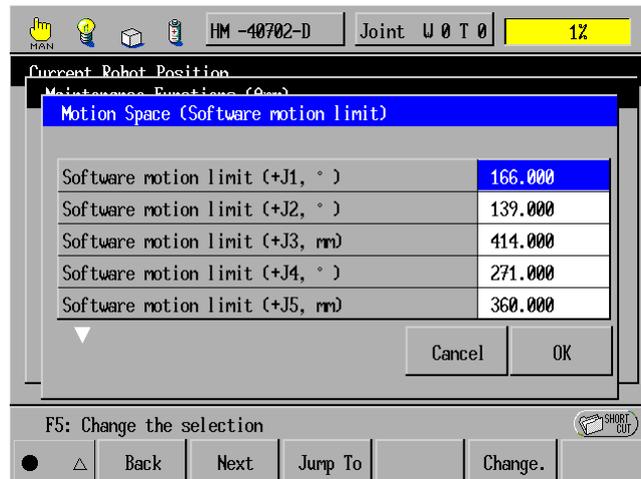


F1

Press [F1 M Space.].

### ▶ STEP 5

The Motion Space window appears as shown below.



### ▶ STEP 6

In the Motion Space window, using the jog dial or cursor keys, select the **Software motion limit (+J1, deg)** field.

### ▶ STEP 7

**Press [F5 Change.].**  
The numeric keypad appears.

### ▶ STEP 8

**Using the numeric keys, enter the positive-direction software motion limit value, then press OK.**  
The screen returns to the Motion Space window.

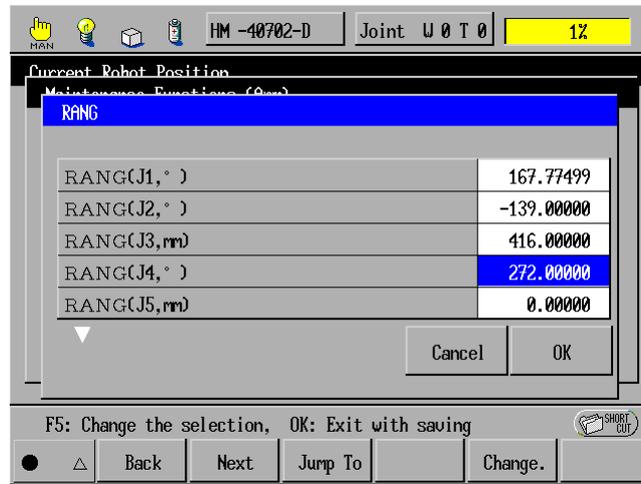
### ▶ STEP 9

**Press OK.**  
The screen returns to the Maintenance Functions (Arm) window.

## Changing the RANG Values

### ▶ STEP 10

In the Maintenance Functions (Arm) window, press [F2 RANG.]. The RANG window appears as shown below.

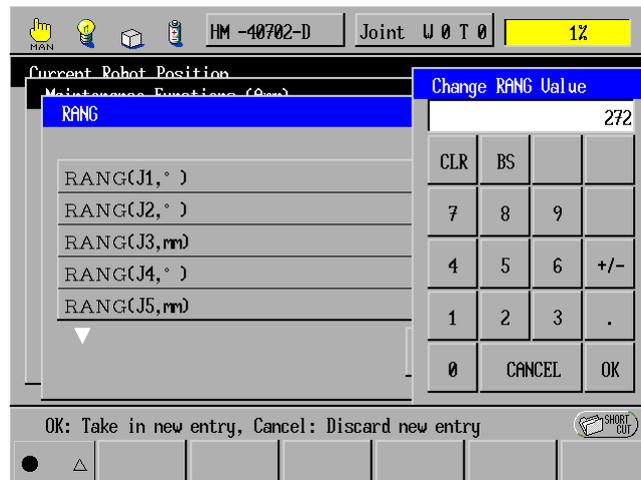


F5

Press [F5 Change.].

### ▶ STEP 11

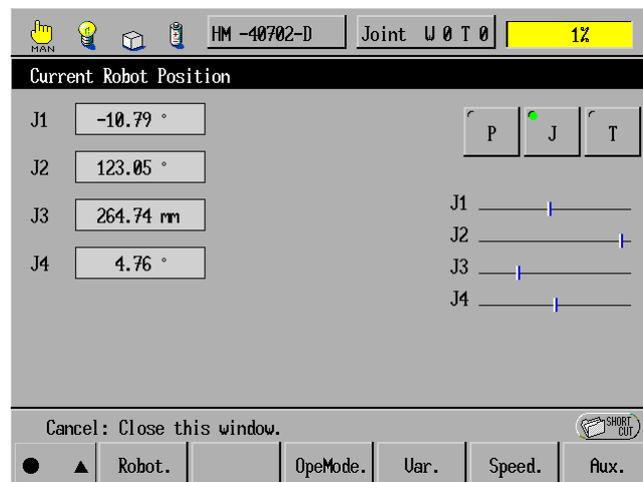
The numeric keypad appears.



- ▶ **STEP 12** | Using the numeric keys, enter RANG values and then press OK.  
The screen returns to the RANG window.
- ▶ **STEP 13** | Press OK.  
The screen returns to the Maintenance Functions (Arm) window.
- ▶ **STEP 14** | Set the power switch of the robot controller to OFF.

### Executing CAL

- ▶ **STEP 15** | Confirm that the pilot lamp of the robot controller goes off, and set the power switch to ON again.
- ▶ **STEP 16** | Press MOTOR to turn ON the power to the motor.
- ▶ **STEP 17** | Press [F2 Arm] on the top screen.  
The Current Robot Position window appears as shown below.

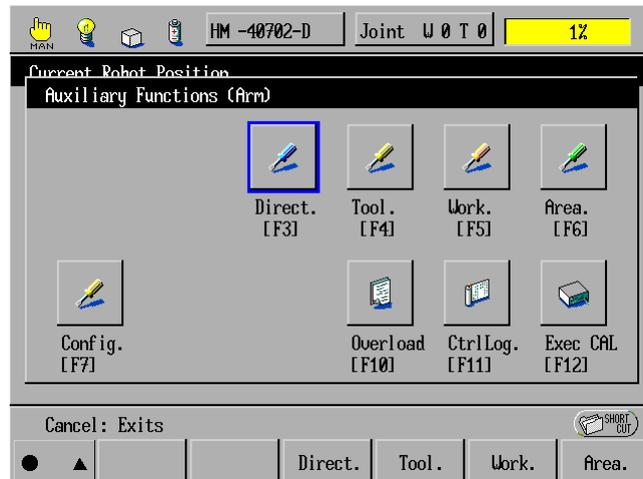


F6

Press [F6 Aux.].

## ▶ STEP 18

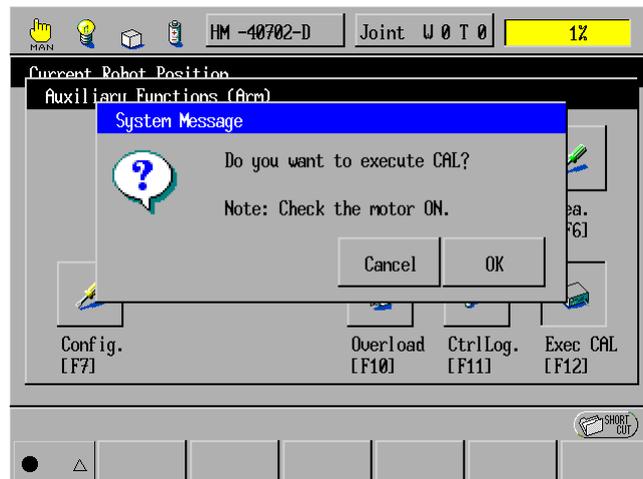
The Auxiliary Functions (Arm) window appears as shown below.



Press [F12 Exec CAL].

## ▶ STEP 19

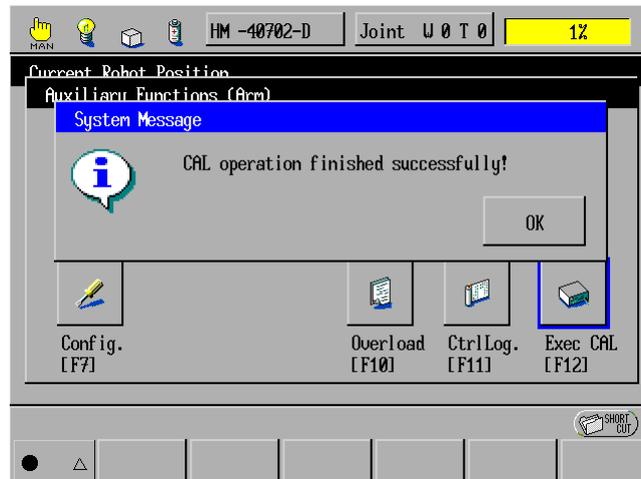
The message window appears asking whether you want to carry out CAL.



Press OK.

### ▶ STEP 20

The message window appears informing you that CAL is completed.



### ▶ STEP 21

Press OK.

### ▶ STEP 22

Press the MOTOR key to turn the motor OFF.

### ▶ STEP 23

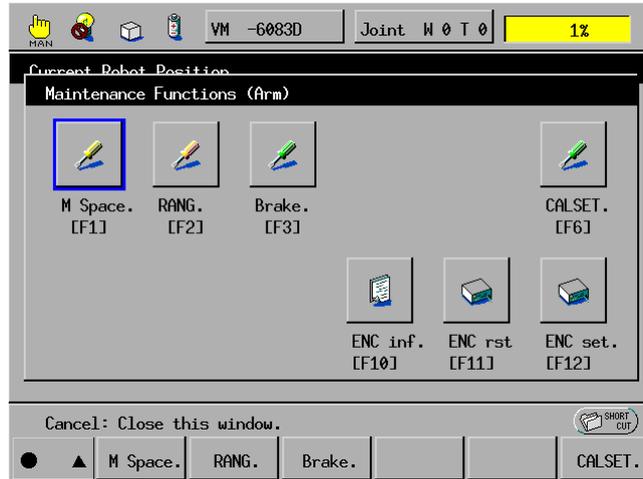
Press Cancel.

The screen returns to the Current Robot Position window.

## Performing CALSET of the 1st Axis

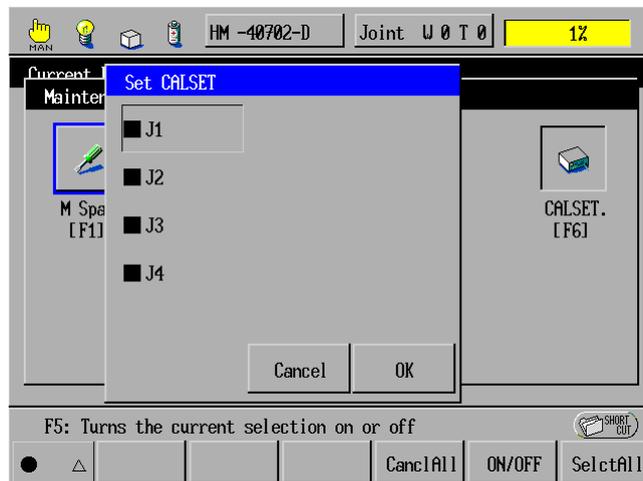
▶ **STEP 24** | Press **SHIFT**.

▶ **STEP 25** | Press **[F12 Maint.]**.  
The Maintenance Functions (Arm) window appears as shown below.



Press **[F6 CALSET.]**.

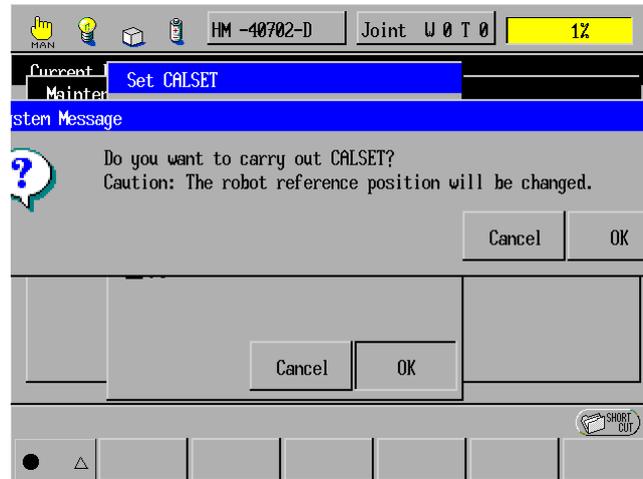
▶ **STEP 26** | The Set CALSET window appears as shown below.



Touch the **J1** field and confirm that the mark turns green, then press **OK**.

### ▶ STEP 27

The message window appears asking you whether you want to execute CALSET.



Press **OK**.

### ▶ STEP 28

The message window appears informing you that CALSET is completed.  
Press **OK**.

### ▶ STEP 29

Press **MOTOR** to turn **ON** the power to the motor.

### ▶ STEP 30

Press **Cancel**.

### ▶ STEP 31

The screen returns to the **ROBOT CURRENT POSITION** window.  
Press **[F6 Aux.]**.

### ▶ STEP 32

The **Auxiliary Functions (Arm)** window appears.  
Press **[F12 Exec CAL]**.

### ▶ STEP 33

The message window appears asking you whether you want to execute CAL.  
Press **OK**.

### ▶ STEP 34

The message window appears informing you that CAL is completed.

---

## ▶ STEP 35

Press OK.

**Caution:** After CALSET is completed, move the first axis over the full stroke in the manual mode (speed = 10% or less) to confirm that the positive-direction and negative-direction software motion limits function properly. If they are valid, the axis stops just before the mechanical end, and ERROR6071 appears.

In the following cases, reset the bolt positions, the positive-direction software motion limits, the RANG values and the negative-direction software motion limits to the original settings, and repeat the procedure from the beginning:

- 1) The software motion limits do not function when the axis is near a mechanical end, and another error (6111, 6121 or 6171) occurs.
- 2) A software motion limit error (ERROR6071) occurs although the axis is not near a mechanical end.

### 4.3.4 Changing Negative-Direction Software Motion Limits (NLIMs)

If you change the negative-direction mechanical ends, you need to change the preset negative-direction software motion limits (NLIMs) according to steps 1 through 17 given below.

▶ **STEP 1**

Set the power switch of the robot controller to ON.

▶ **STEP 2**

Set the mode selector switch of the teach pendant to MANUAL.

▶ **STEP 3**

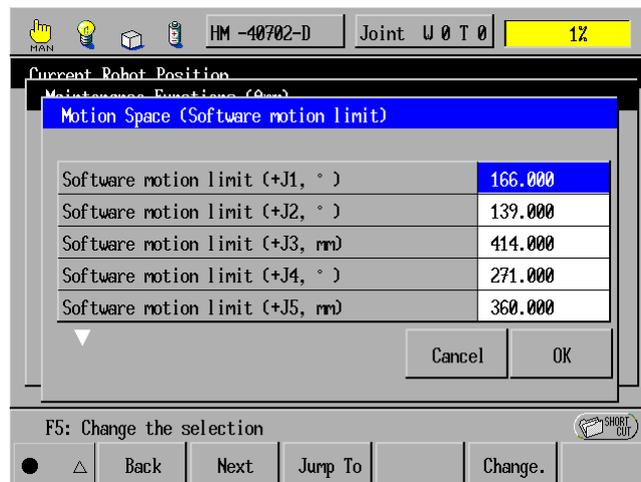
On the top screen, press [F2 Arm].  
The Current Robot Position window appears.

▶ **STEP 4**

Press [F12 Aux.].  
The Maintenance Functions (Arm) window appears.

▶ **STEP 5**

In the Maintenance Function (Arm) window, press [F1 M Space].  
The Motion Space window appears as shown below.



▶ **STEP 6**

Using the jog dial or cursor keys, select the Software motion limit (-J1, deg) field.

▶ **STEP 7**

Press [F5 Change.].  
The numeric keypad appears.

▶ **STEP 8**

Using the numeric keys, enter a negative-direction software motion limit value, then press OK.  
The screen returns to the Motion Space window.

- 
- ▶ **STEP 9** | Press OK.
  - ▶ **STEP 10** | Set the power switch of the robot controller to OFF.
  - ▶ **STEP 11** | Set the power switch of the robot controller to ON.
  - ▶ **STEP 12** | Press MOTOR.
  - ▶ **STEP 13** | On the top screen, press [F2 Arm].  
The Current Robot Position window appears.
  - ▶ **STEP 14** | Press [F6 Aux.].  
The Auxiliary Functions (Arm) window appears.
  - ▶ **STEP 15** | Press [F12 Exec.].  
The message window appears asking you whether you want to execute CAL.
  - ▶ **STEP 16** | Press OK.  
The message window appears informing that CAL is completed.
  - ▶ **STEP 17** | Press OK.

**Caution:** After CALSET is completed, move the first axis over the full stroke in the manual mode (speed = 10% or less) to confirm that the positive-direction and negative-direction software motion limits function properly. If they are valid, the axis stops just before the mechanical end, and ERROR6071 appears.

In the following cases, reset the bolt positions, the positive-direction software motion limits, the RANG values and the negative-direction software motion limits to the original settings, and repeat the procedure from the beginning:

- 1) The software motion limits do not function when the axis is near a mechanical end, and another error (6111, 6121 or 6171) occurs.
- 2) A software motion limit error (ERROR6071) occurs although the axis is not near a mechanical end.

## 4.4 Performing CALSET

### 4.4.1 What Is CALSET?

Calibrating the relationship between position-related information recognized by the robot controller and the actual position of the robot body is called CALSET.

CALSET must be performed when the motor is replaced or when the backup battery for the encoder goes dead and the position-related data retained in the encoder is lost as a result.

After CALSET is completed, the calibrated data of the robot body will be recorded in the robot controller. This data is called calsetting data, and it is different on each robot.

This robot was set before delivery. The initial setting data is stored in the attached floppy disks. Even if the memory backup battery for the robot controller dies and CALSET data is lost, CALSET will not need to be performed. Just reload the data from the floppy disks.

## 4.4.2 CALSET Procedure

Record the positions of 1st to 4th axes by bringing them manually into contact with the mechanical end.

Some space is required to bring each axis of the robot into contact with the mechanical end.

- Caution
- (1) To perform CALSET, release the brake by moving the axis to be CALSET close to the mechanical stop, and bring the axis into contact with the mechanical stop.
  - (2) After CALSET, confirm in the manual mode that the axis stops at the software motion limit before the mechanical end.
  - (3) In automatic operation, start moving the axis at low speed. Carefully confirming safety, gradually increase the speed. Gradually increasing the speed from low facilitates adjustment.
  - (4) The position-related data in programs created before CALSET may vary somewhat after CALSET.

### What is CALSET position?

#### ■ HM-D/HS-D

CALSET position is where calibration is performed. Each axis is provided with two mechanical ends: one in the positive (+) direction and the other in the negative (-) direction. CALSET has been performed on this robot at the factory with the mechanical ends shown in Figure 4-8 as the CALSET position.

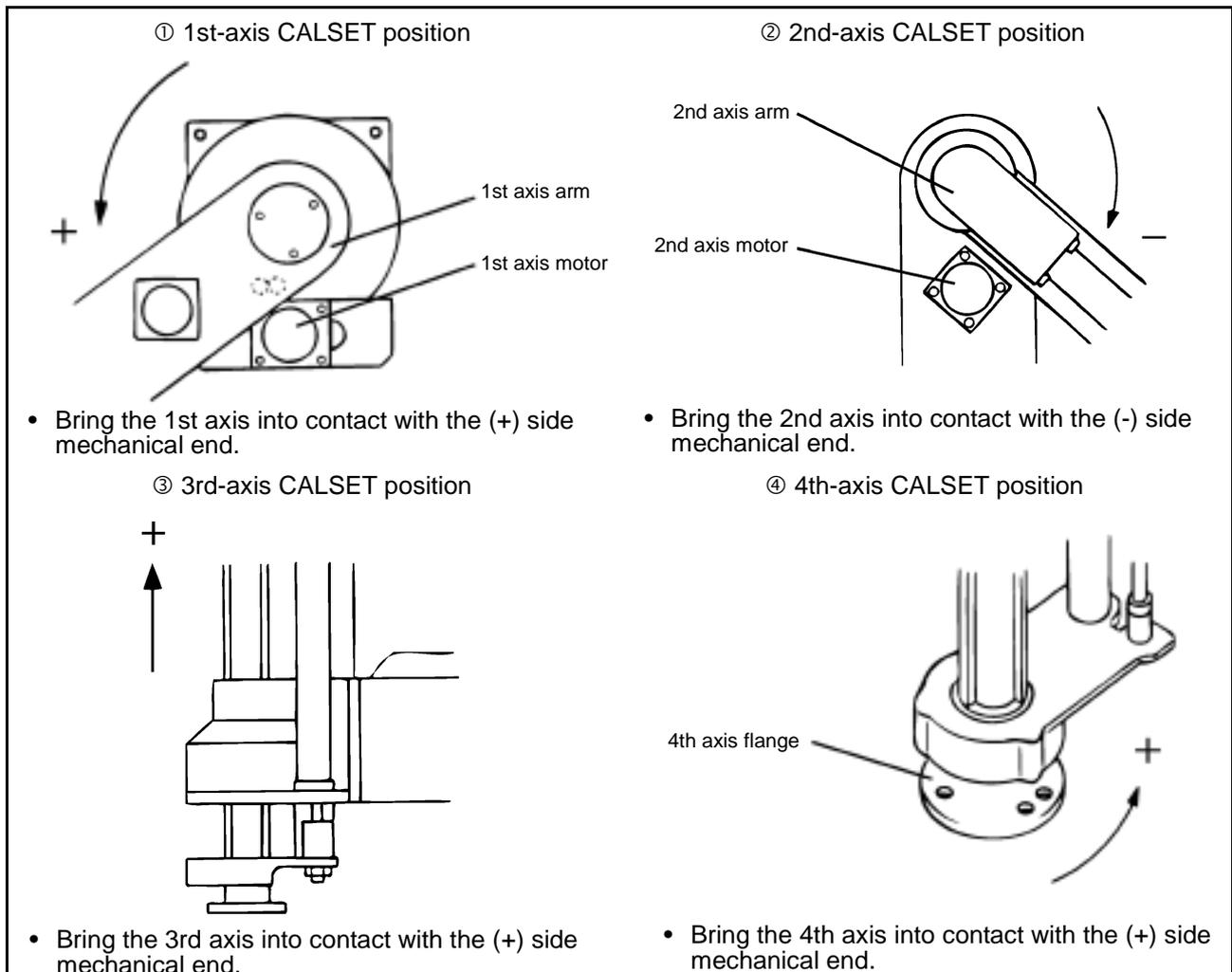
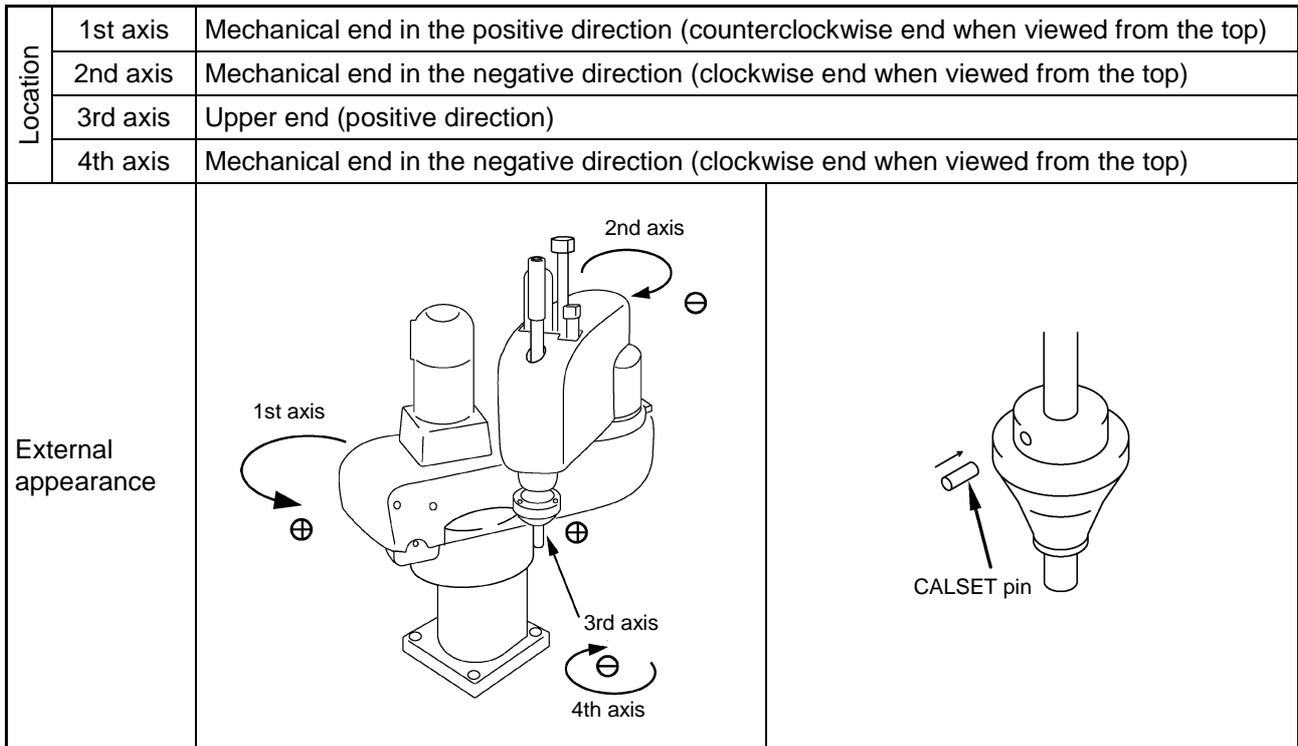


Figure 4-8 CALSET Position When Shipped

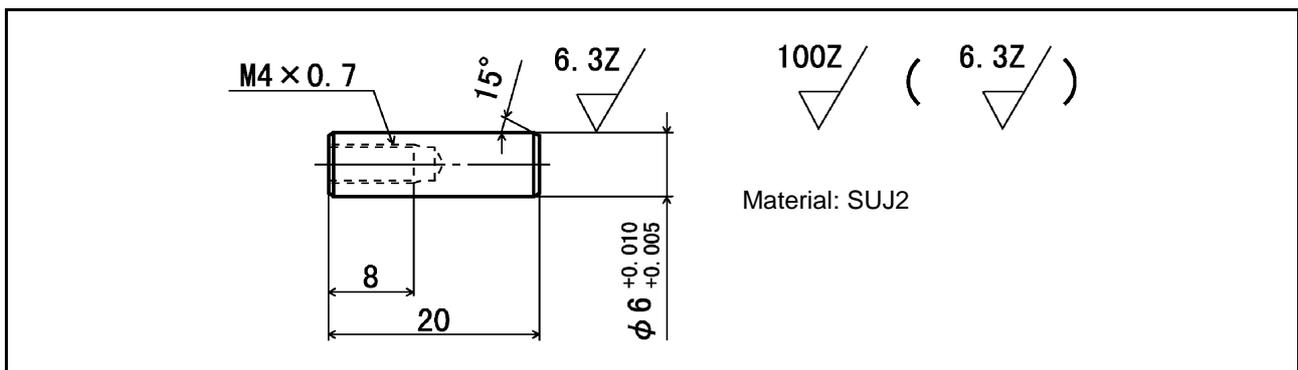
## ■ HC-D

CALSET position is where calibration is performed. Each axis is provided with two mechanical ends: one in the positive (+) direction and the other in the negative (-) direction. CALSET has been performed on this robot at the factory with the mechanical ends shown in Figure 4-9 as the CALSET position.

To perform the CALSET procedure for 4 axes, you need a CALSET pin specified in Figure 4-10. Insert the pin into the location shown in Figure 4-9. After completion of CALSET, remove the pin and store it.



**Figure 4-9 CALSET Position as Shipment**



**Figure 4-10 CALSET Pin (provided as a robot component)**

## 4.4.3 Performing CALSET

### [ 1 ] CALSET of a Single Axis

Performing CALSET of a specified single axis only is called single-axis CALSET.

Single-axis CALSET when the motor of an axis is replaced so that the axis must be CALSET, or when some axes cannot be moved to the CALSET positions (mechanical stop positions) at any given time because of interference between the equipment installed near the robot and the robot.

In the procedure below, releasing the brake is required only for the 3rd axis.

#### ▶ STEP 1

Move the axis to be CALSET to the mechanical stop position.

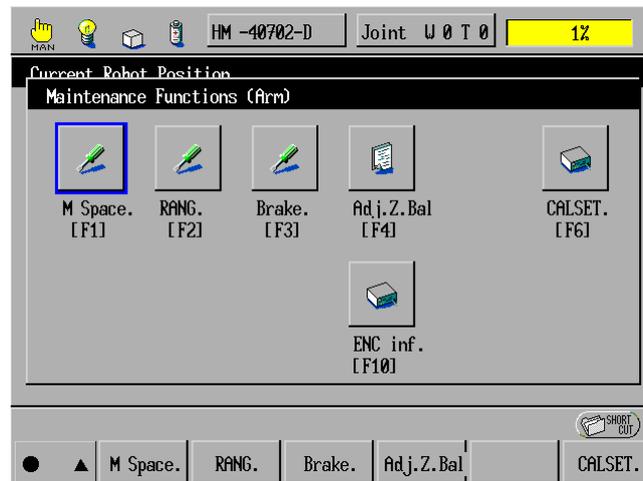
#### ▶ STEP 2

On the top screen of the teach pendant, press [F2 Arm].

#### ▶ STEP 3

Press the SHIFT key and [F12 Maint.].

The Maintenance Functions (Arm) window appears as shown below.

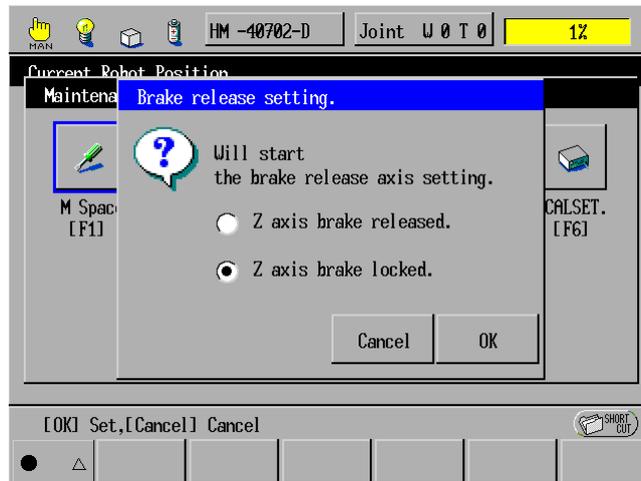


F3

Press [F3 Brake.].

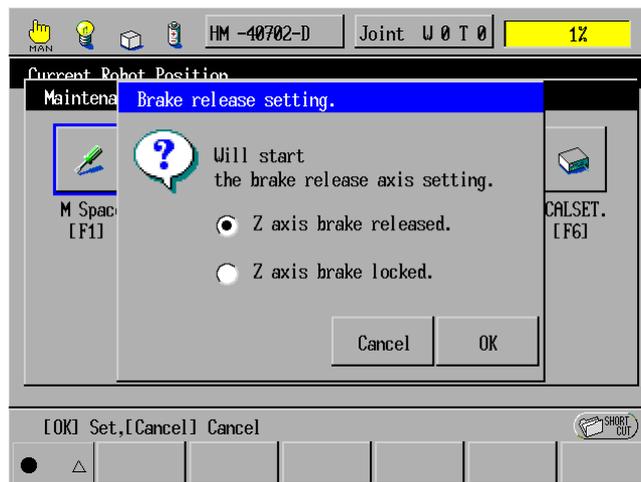
► STEP 4

The Brake release setting window appears as shown below.



► STEP 5

Select "Z axis brake released."



► STEP 6

Confirm that there is no danger even if the arm falls as a result of the brake being released.

Then press OK.

## ▶ STEP 7

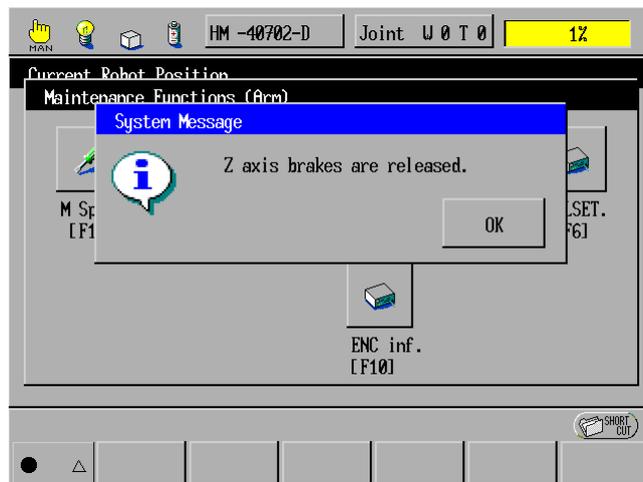
The system message appears asking you whether you want to change the brake settings.



Press OK.

## ▶ STEP 8

The system message appears informing that the brake is released and warning against drop of arms.



Press OK.

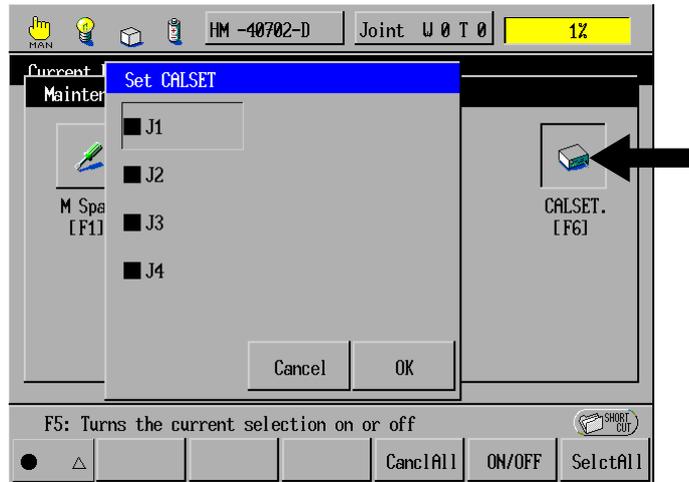
## ▶ STEP 9

Press the axis to be CALSET against the mechanical stop by hand.

► STEP 10

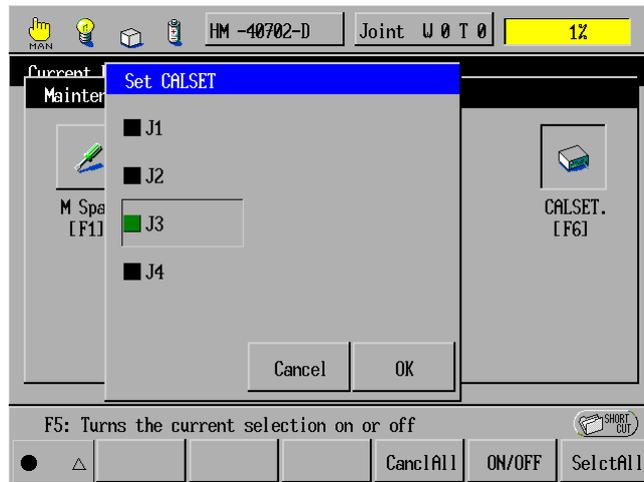
Press [F6 CALSET].

The Set CALSET window appears as shown below.



► STEP 11

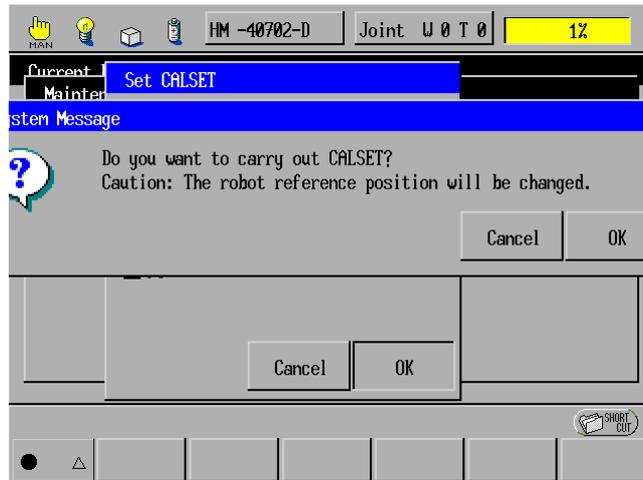
Press the axis number to be CALSET to turn ON CALSET (green display). Turn OFF CALSET (black display) for the other axes that are not to be set.



Press OK.

## ▶ STEP 12

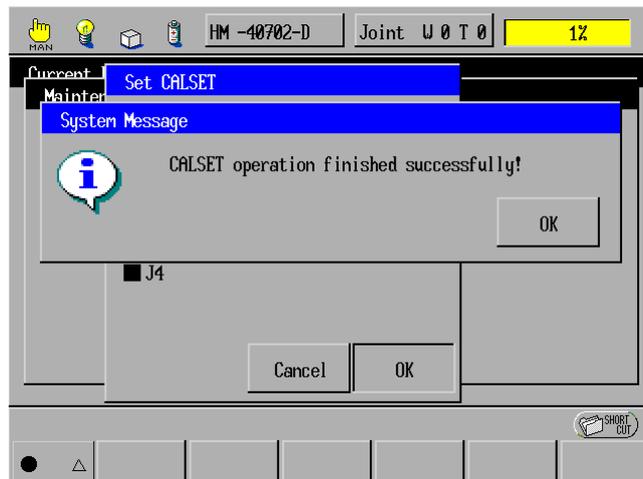
The system message appears asking whether you want to carry out CALSET with a caution that the robot reference position will change.



Press OK.

## ▶ STEP 13

The system message appears informing that CALSET is completed.



Press OK.

## ▶ STEP 14

**Press the ROBOT STOP button.**  
The robot brake becomes activated.

## ▶ STEP 15

Turn the ROBOT STOP button to cancel robot stop.

### ▶ STEP 16

Press the **MOTOR** key to turn the motor **ON**.

**Caution:** A “motor lock overload” error may occur just after the power to the motor is turned **ON**. In this case, try to turn **ON** the power to the motor several times, or release the brake, move the axis a little in the opposite direction of the mechanical end, and turn **ON** the power to the motor again.

### ▶ STEP 17

Move the **CALSET** axis in the opposite direction from the mechanical end via the manual operation from the teach pendant.

### ▶ STEP 18

Perform **CAL**. The single-axis **CALSET** of the specified axis is completed.

## [ 2 ] CALSET of All Axes

The **CALSET** of all axes is called all-axis **CALSET**.

The procedure is the same as that for single-axis **CALSET** except for the selection of all axes for **CALSET** in step 11. For details of the procedure, see “[ 1 ] **CALSET** of a Single Axis.”

---

## 4.5 Setting Control Set of Motion Optimization

The optimum speed or acceleration will vary depending upon the payload and center of gravity of the end-effector or workpiece that is to be set at the end of the robot flange. Set the payload and center of gravity position of the end-effector or workpiece and the control set of motion optimization according to the payload and position of the robot.

The mass of payload is a total mass of an end-effector and workpiece, expressed in gram.

For further information, see the PROGRAMMER'S MANUAL, Section 4.7, "Setting the Master Control Parameters in User Preferences." For the setting procedure, refer to the SETTING-UP MANUAL, Section 2.9 "Setting the Master Control Parameters of the Payload, Center of Gravity, and Control Set of Motion Optimization."

## 4.6 Setting Robot Installation Conditions

Depending on whether the robot is floor-mounted or overhead-mounted, the optimum operating conditions differ.

However, as for the H\*-D series, the installation condition is fixed to either floor-mount or overhead-mount depending upon its robot type.

You need not to change the installation settings in the H\*-D series.

## 4.7 Switching to the Vibration Suppression Control (Applicable to the HM-D/HS-D series only)

**--for the time when the moment of inertia exceeds the max. limit--**

The HM-D/HS-D series is so designed that the maximum allowable moment of inertia is  $0.078 \text{ kgm}^2$ . Assuming that the robot will be used under that moment of inertia, the gain is set.

If the actual moment of inertia exceeds the maximum allowable value, therefore, the robot may cause low-frequency vibration during T-axis motion, resulting in a halt as an error.

To prevent it, you may switch to the vibration suppression control that allows the robot to run in a stable motion even if the moment of inertia exceeds the maximum allowable limit. On the User Preferences window of the teach pendant, you may select the normal control (0) or vibration suppression control (1).

Control method    0: Normal control (factory default)  
                           1: Vibration suppression control

Under the vibration suppression control, however, the residual vibration may increase and an overcurrent error or related errors may easily occur in high-speed running. In such a case, adjust the reduced ratios of the programmed speed and acceleration.

### Operating procedure

#### ▶ STEP 1

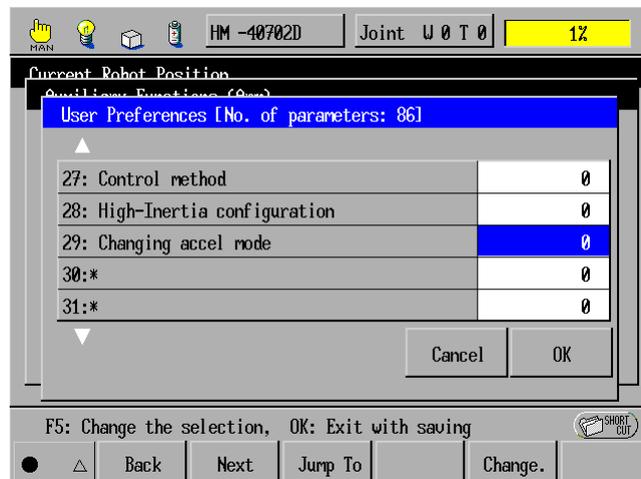
Turn the motor power off.

#### ▶ STEP 2

Call up the User Preferences window.  
 Access: [F2 Arm]—[F6 Aux.]—[F7 Config.]

#### ▶ STEP 3

Display "29: Changing accel mode" using the job dial or [F3 Jump To].

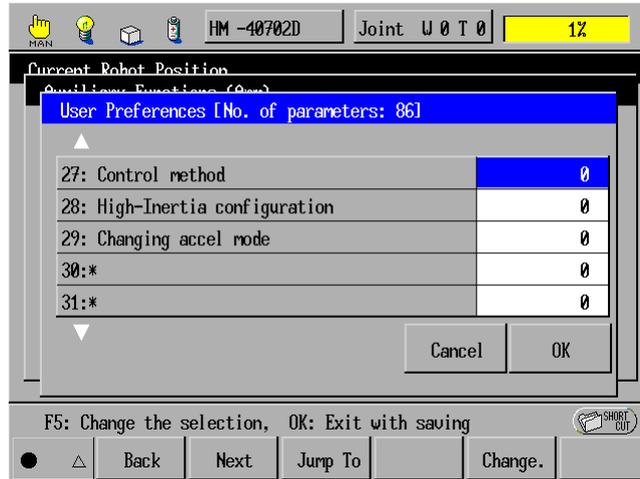


### ▶ STEP 4

Check that the "Changing accel mode" is set to 0. If it is not set to 0, change it to 0.

### ▶ STEP 5

Move the cursor to the "27: Control method."

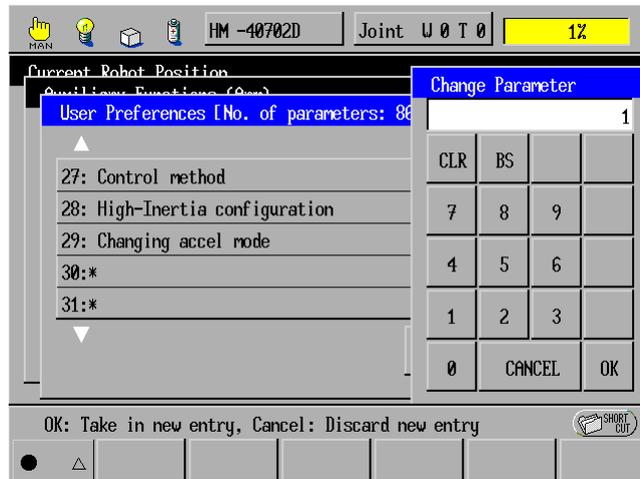


F5

Press [F5 Change.].

### ▶ STEP 6

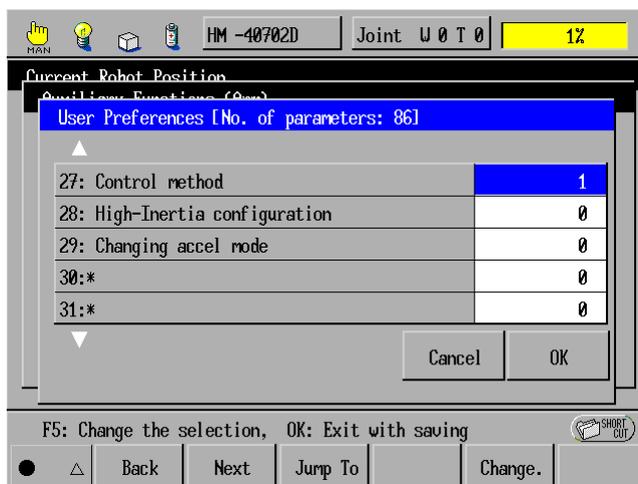
The numeric keypad will appear as shown below.



Enter 1 and press the OK button.

## ► STEP 7

The "Control method" is changed to 1.



Turn the controller power off and then on to restart.  
The new setting will go into effect.

## 4.8 Setting the High-Inertia Configuration

(Applicable to the HM-D/HS-D series only)

--for the time when the moment of inertia exceeds the max. limit--

Like the vibration suppression control, the high-inertia configuration allows the robot to run in a stable motion even if the moment of inertia exceeds the maximum allowable limit. On the User Preferences window of the teach pendant, you may select (1) or deselect (0) the high-inertia configuration.

High-inertia configuration 0: Deselect (Normal gain, factory default)  
1: Select

As shown below, the maximum allowable moment of inertia (MMI) when the high-inertial configuration is selected is less than that under the vibration suppression control.

MMI under usual control < MMI with high-inertial configuration < MMI under vibration suppression control

Unlike the vibration suppression control, the high-inertia configuration does not increase the residual vibration or cause an overcurrent error or related errors in high-speed running.

### Operating procedure

#### ▶ STEP 1

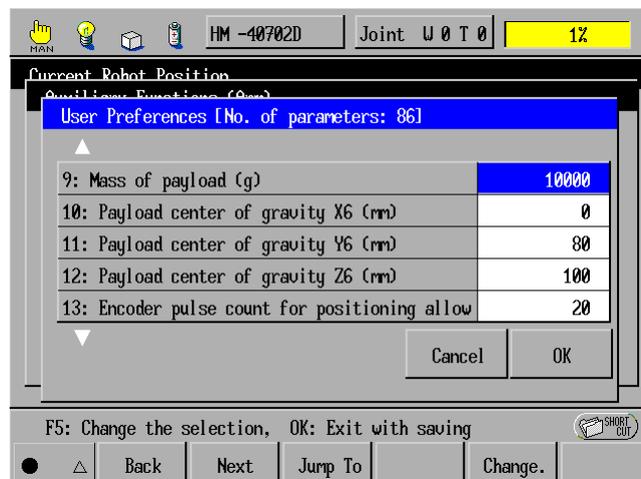
Turn the motor power off.

#### ▶ STEP 2

Call up the User Preferences window.  
Access: [F2 Arm]—[F6 Aux.]—[F7 Config.]

#### ▶ STEP 3

Display "9: Mass of payload (g)" using the job dial or [F3 Jump To].

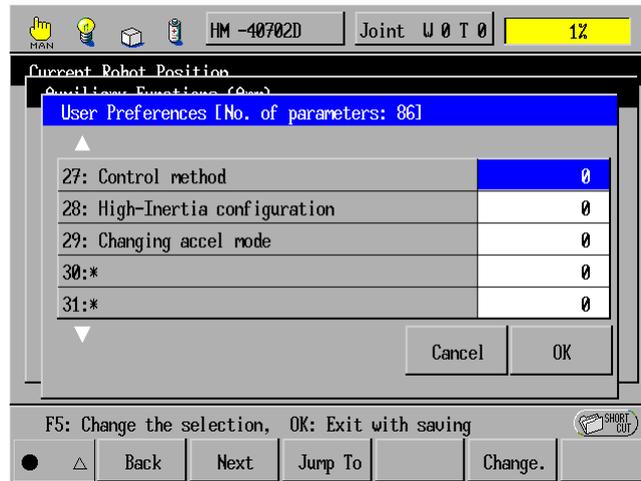


## ▶ STEP 4

Check that the "Mass of payload (g)" is set to 10000. If it is not set to 10000, change it to 10000.

## ▶ STEP 5

Move the cursor to the "27: Control method."



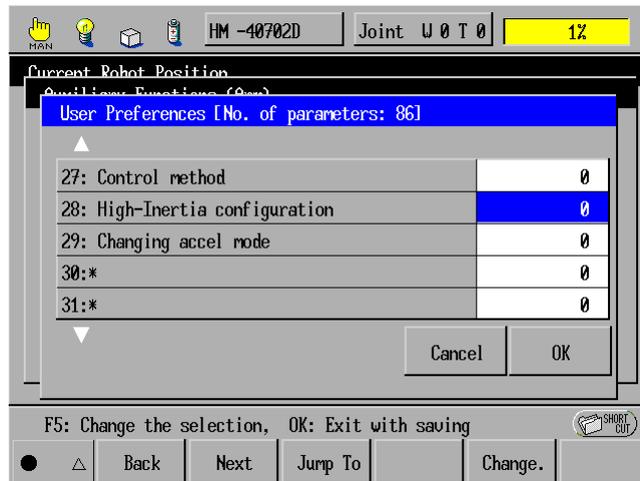
Check that the "Control method" is set to 0. If it is not set to 0, change it to 0. Then turn the controller off and then on to restart.

## ▶ STEP 6

Check that the "29: Changing accel mode" is set to 0. If it is not set to 0, change it to 0.

► STEP 7

Move the cursor to the "28: High-Inertia configuration."

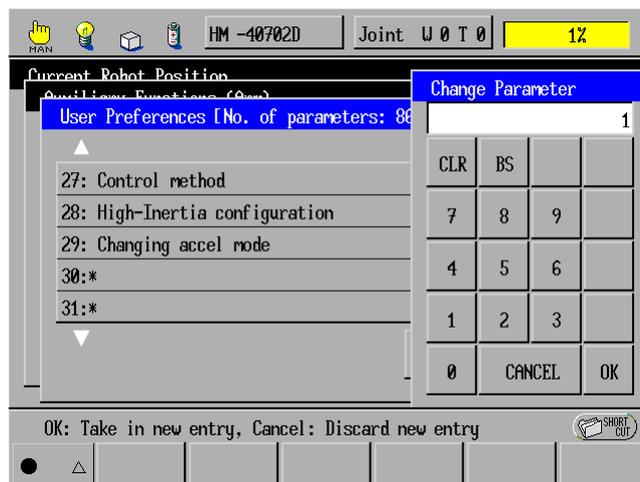


F5

Press [F5 Change.].

► STEP 8

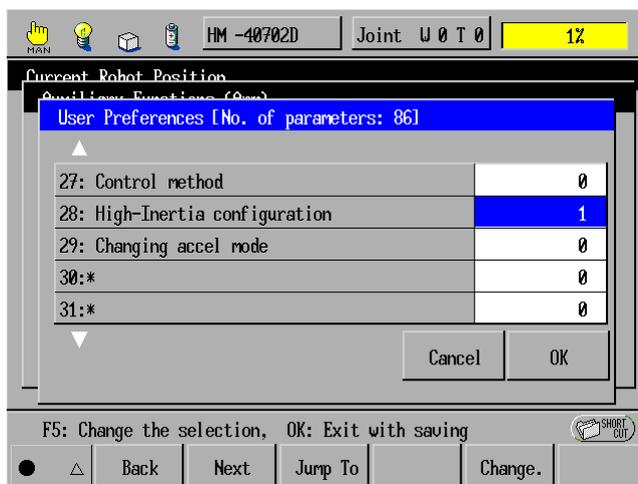
The numeric keypad will appear as shown below.



Enter 1 and press the OK button.

## ▶ STEP 9

The "High-Inertia configuration" is changed to 1.

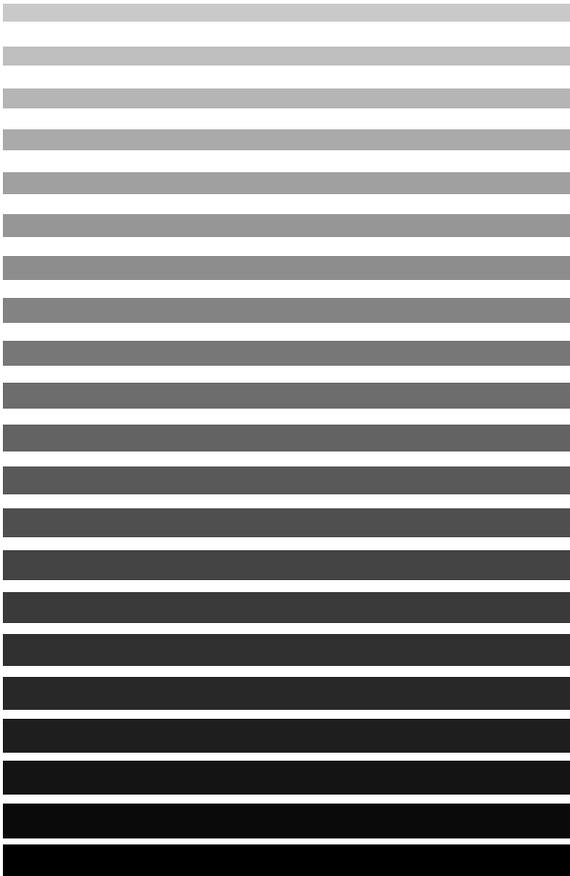


Turn the controller power off and then on to restart.  
The new setting will go into effect.

# Chapter 5



## Robot Controller Interface



This chapter describes the necessary requirements to connect the PLC and other external devices to the controller.



## 5.1 General Information about the Interface

### 5.1.1 Standard Mode and Compatible Mode

The robot controller can be operated in two different modes – standard mode and compatible mode. The default is standard mode. Select either mode before operating the robot controller.

In the standard mode, all of the advantages can be expected from the new model of the robot controller by simultaneously running two or more programs with multitasking.

The compatible mode focuses on compatibility with conventional DENSO robots. Use this mode whenever compatibility is required. For example, when replacing a conventional robot with a new model. However, there are some restrictions on the use of new functions, such as multitasking, in this mode.

### 5.1.2 Switching between Modes

Switch from one mode to the other using the teach pendant or the PC teaching system.

**Caution: After switching between those modes, restart the robot controller to make the new setting go into effect.**

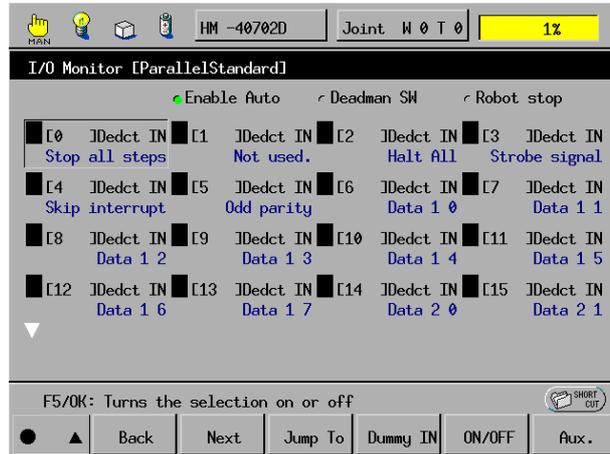
## [ 1 ] Switching from the Teach Pendant

Follow the procedure below when switching from one mode to the other from the teach pendant:

### ▶ STEP 1

On the top screen, press [F4 I/O].

The I/O Monitor window appears.

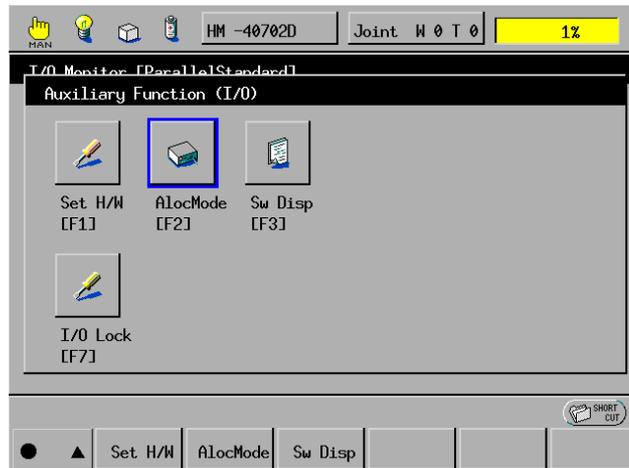


F6

Press [F6 Aux.].

### ▶ STEP 2

The Auxiliary Functions (I/O) window appears as shown below.



F2

Press [F2 AlocMode]. (For Version 1.6 or later)

**NOTE:** For Version 1.5 or earlier, press [F1 Set H/W] and select the Allocation mode field in the I/O Hardware Settings window.

### ▶ STEP 3

The Choose allocation window appears as shown below.

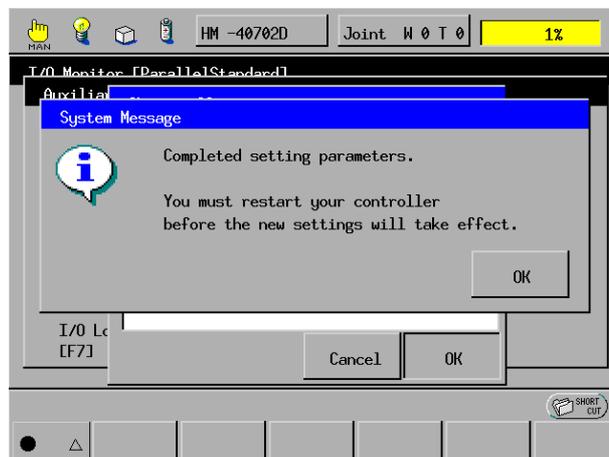
**NOTE:** If your robot controller has a built-in DeviceNet master, the Select Port Assignment window will appear instead of the Select I/O Assignment Mode window. Refer to the DeviceNet Master Unit user's manual, Chapter 3, "I/O Assignment."



Using the jog dial or cursor keys, select the desired assignment mode. Then press OK.

### ▶ STEP 4

The following system message appears.



Press OK.

### ▶ STEP 5

The screen returns to the Auxiliary Functions (I/O) window.

**Turn the controller power OFF.**

### ▶ STEP 6

**Turn the controller power ON again.**

The I/O assignment mode is switched.

## [ 2 ] Switching from the Computer

Follow the procedure below when switching from one mode to the other from the computer.

### ▶ STEP 1

**Start WINCAPSII on the computer. Log in with Programmer.**

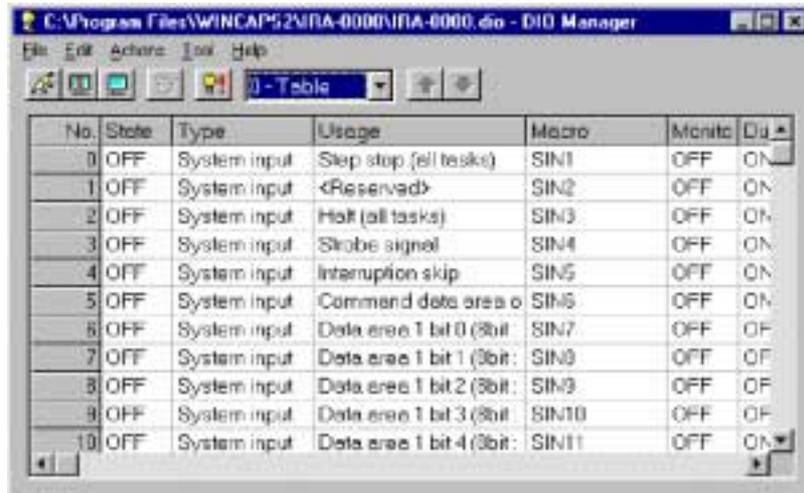
Start WINCAPSII according to the procedure given in WINCAPSII GUIDE, Chapter 3, Section 3.1.

For details on the user level of Programmer, refer to the WINCAPSII GUIDE, Chapter 1, Section 1.3.

### ▶ STEP 2

**Click on the DIO Manager button in the System Manager.**

DIO Manager starts and the DIO Manager window opens.

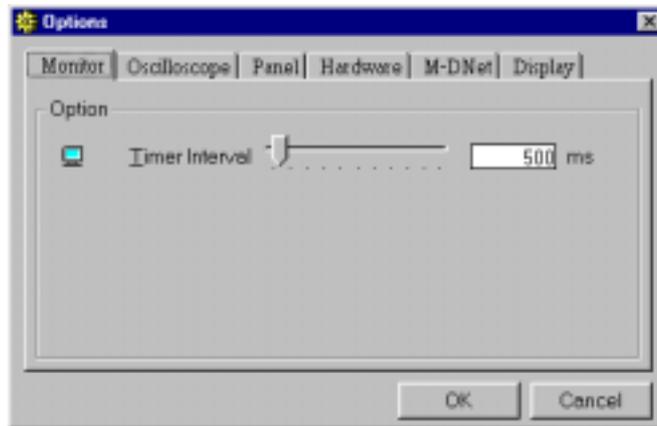


The screenshot shows the DIO Manager window with a menu bar (File, Edit, Actions, Tools, Help) and a toolbar. Below the toolbar is a table with the following data:

No.	State	Type	Usage	Macro	Monitor	Dir
0	OFF	System input	Step stop (all tasks)	SIN1	OFF	ON
1	OFF	System input	<Reserved>	SIN2	OFF	ON
2	OFF	System input	Halt (all tasks)	SIN3	OFF	ON
3	OFF	System input	Strobe signal	SIN4	OFF	ON
4	OFF	System input	Interruption skip	SIN5	OFF	ON
5	OFF	System input	Command data area 0	SIN6	OFF	ON
6	OFF	System input	Data area 1 bit 0 (8bit)	SIN7	OFF	OF
7	OFF	System input	Data area 1 bit 1 (8bit)	SIN8	OFF	OF
8	OFF	System input	Data area 1 bit 2 (8bit)	SIN9	OFF	OF
9	OFF	System input	Data area 1 bit 3 (8bit)	SIN10	OFF	OF
10	OFF	System input	Data area 1 bit 4 (8bit)	SIN11	OFF	ON

### ▶ STEP 3

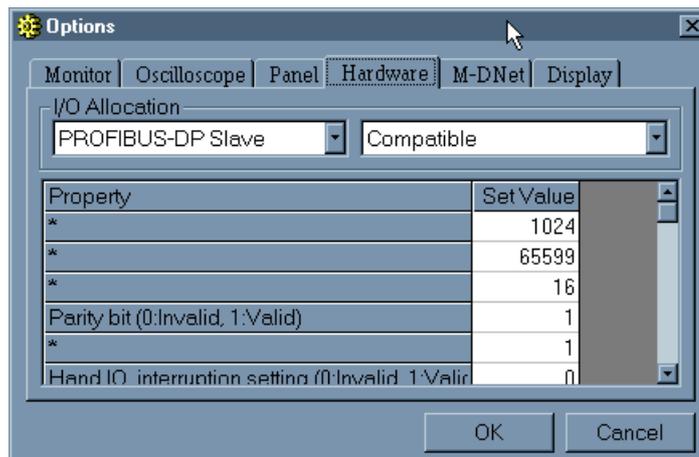
Select the **SETTING** command from the Tools menu of DIO Manager. The Options window will appear as shown below.



### ▶ STEP 4

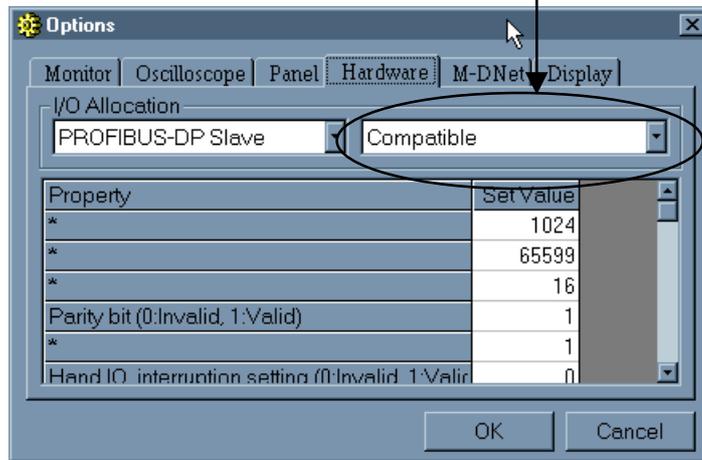
Click on the **Hardware** tab in the Options window.

The hardware settings will appear.



## ▶ STEP 5

Select the desired assignment mode from the right-hand popup menu in the I/O Allocation frame (Ver. 1.6 or later).



## ▶ STEP 6

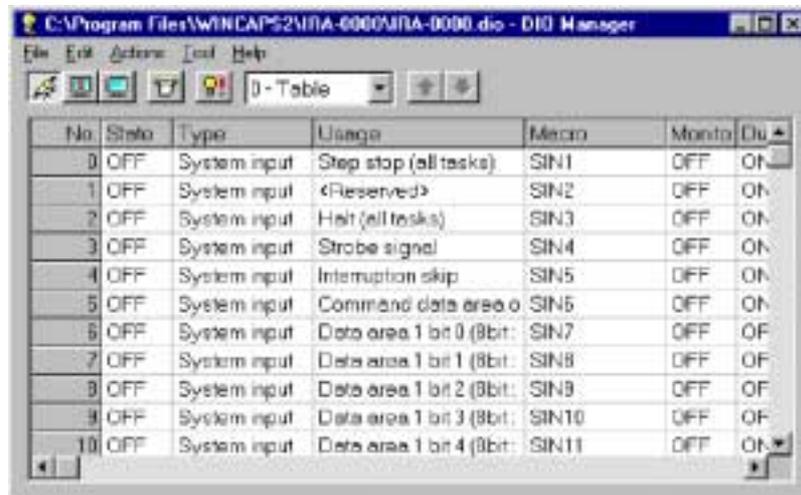
Click on OK in the Options window.

The Options window closes.

## ▶ STEP 7

Click on the Connect button  to connect the computer to the robot controller.

The Connect button appears in a pressed state.



▶ **STEP 8**

**Click on the Transfer button.**

The Transfer Environment Table window appears.



▶ **STEP 9**

**Check off the check box by clicking on the Hard setting field.**

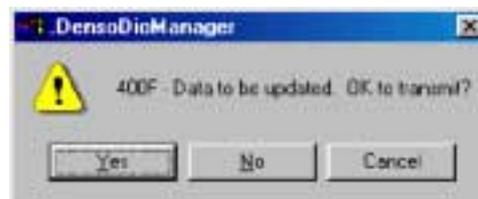


**Click on the Transfer button.**

▶ **STEP 10**

The following message window appears confirming that you are sure to update the data.

**Click on the Yes button.**



---

▶ **STEP 11**

The Transmitting hard setting table window appears displaying a bar graph that indicates the transfer progress.



▶ **STEP 12**

After the Transmitting hard setting table window disappears, turn the controller power OFF.

▶ **STEP 13**

Turn the controller power ON.  
The I/O assignment mode is switched.

### 5.1.3 Robot Controller Appearance and Connector Names

Figure 5-1 shows the appearance of the Robot Controller and Table 5-1 lists the connector names.

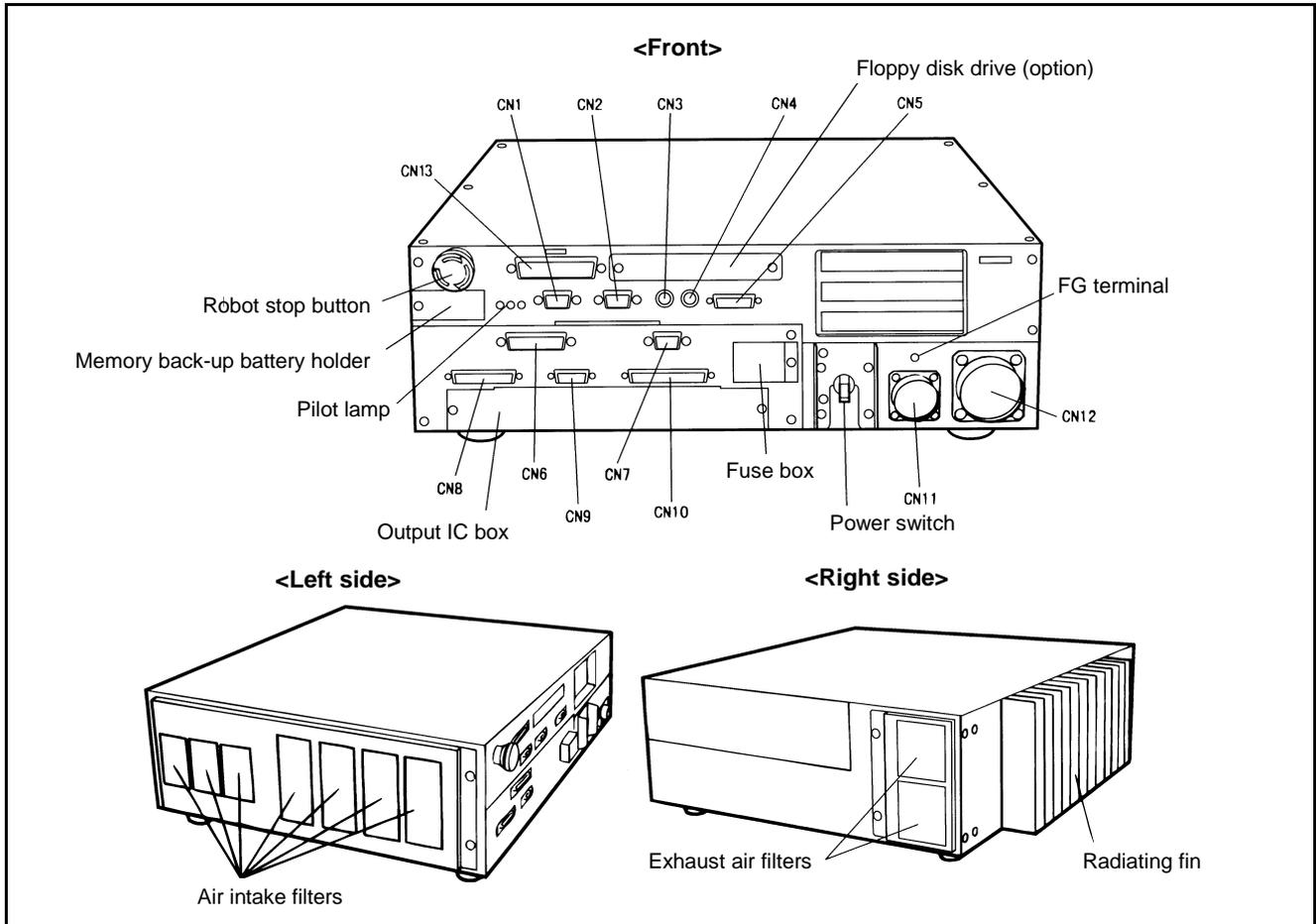


Figure 5-1 Robot Controller Appearance

Table 5-1 Connector Names

No.	Mark	Name	No.	Mark	Name
CN1	RS232C	Serial communication connector	CN8	INPUT	User-input/system-input connector
CN2	CRT	CRT connector	CN9	HAND I/O	End-effector I/O connector
CN3	KEYBD	Keyboard connector	CN10	OUTPUT	User-output/system-output connector
CN4	MOUSE	PS/2 mouse connector	CN11	INPUT AC	Power connector
CN5	PENDANT	Teach pendant connector	CN12	MOTOR	Motor connector
CN6	PRINTER	Printer connector (Not used.)	CN13	ENCODER	Encoder connector
CN7	I/O POWER	I/O power connector			

**⚠ Caution** The robot controller connectors have a screw or ring locking mechanism. Lock them securely. If not securely locked, an incomplete contact may occur, resulting in an error.

Engaging or disengaging the power connector or motor connector with the robot controller being powered on may damage the internal circuits of the controller. Turn OFF the power switch before engaging or disengaging any of the connectors.

## 5.1.4 Example of Control System Configuration

Figure 5-2 shows an example of the control system configuration.

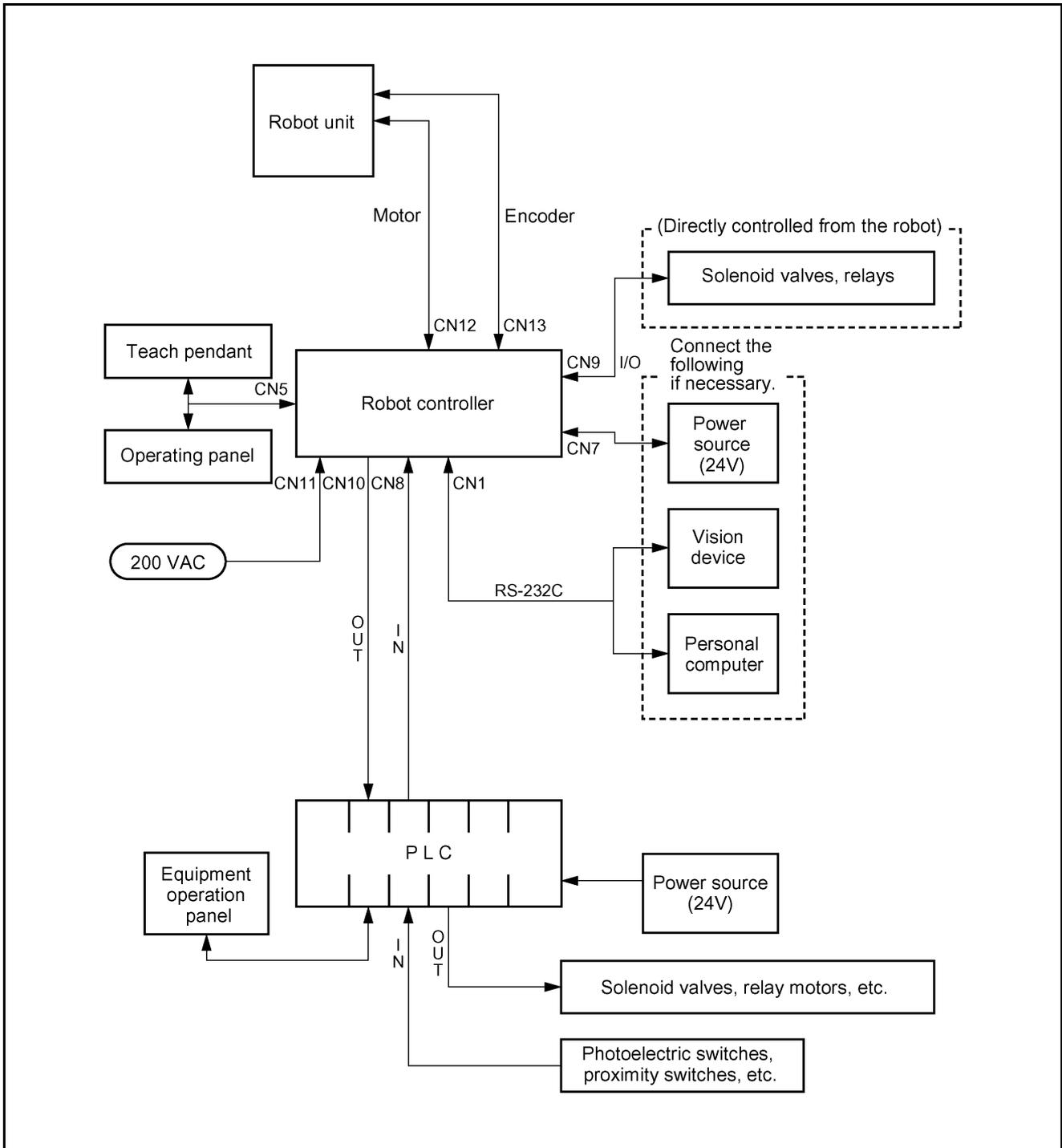


Figure 5-2 System Configuration Example

## 5.1.5 Types and General Information about I/O Signals

This section describes the I/O signals for the Robot Controller.

The I/O signals are grouped into user I/O signals and system I/O signals.

User I/O signals are compatible with conventional signals, including the pin pattern, in compatible mode. Note that the connector pin meanings are different between standard mode and compatible mode. Some of the signal lines used for user I/O in compatible mode are used for system input in standard mode.

Additionally, part of the signal lines used for system I/O in compatible mode is used for command execution I/O signals in standard mode.

### 5.1.5.1 Standard Mode

In standard mode, 30 input points for command execution are used to direct program start and other instructions as I/O commands.

Table 5-2 shows the types of I/O signals used in standard mode.

Table 5-2 Types of System I/O Signals Used in Standard Mode

Fixed by system		
Type	No. of points	Function
System input	5	Robot stop, Enable Auto, interrupt skip, instantaneous stop (all tasks), step stop (all tasks)
System output	12	Robot initialization complete, automatic operation mode, external mode, servo ON, robot-in-operation, normal CPU, robot failure, robot warning, dead battery warning, continue start permitted, SS mode, emergency stop
Input for command execution	30	Command (4 bits) data area 1 (8 bits), data area 2 (16 bits), odd parity bit, strobe signal
Output for command execution	18	Command processing complete, status area (16 bits), odd parity bit
Controlled by user program		
Type	No. of points	Function
User input	12	Inputs to read the external I/O status with an IN command or IO [ ] variable. Used for analysis condition identification, condition satisfaction wait, data input from the external device, etc.
User output	24	Outputs to issue a signal to the external device during program execution with a SET command, RESET command, etc.
Hand input	8	Inputs to read the external I/O status with an IN command or IO [ ] variable. Used to confirm the end-effector check status, etc.
Hand output	8	Outputs to issue a signal to the external device with a SET command, RESET command, etc. Used to control the opening and closing of the end-effector.

## 5.1.5.2 Compatible Mode

In the compatible mode, the input and output points are arranged in disregard of compatibility with conventional VS series robots.

Table 5-3 shows the types of I/O signals used in compatible mode.

**Table 5-3 Types of I/O Signals Used in Compatible Mode**

<b>Fixed by system</b>		
<b>Type</b>	<b>No. of points</b>	<b>Function</b>
System input	22	Inputs to turn ON the power to the robot from the external device (PLC), start CAL or select and start a program instead of operations by the operating panel or teach pendant.
System output	27	Outputs to inform the external device (PLC) of the robot status, such as robot-in-operation or occurrence of an error.
<b>Controlled by user program</b>		
<b>Type</b>	<b>No. of points</b>	<b>Function</b>
User input	25	Inputs to read the external I/O status with an IN command or IO [ ] variable. Used for analysis condition identification, condition satisfaction wait, data input from the external device, etc.
User output	24	Outputs to issue a signal to the external device during program execution with a SET command, RESET command, etc.
Hand input	8	Inputs to read the external I/O status with an IN command or IO [ ] variable. Used to confirm the end-effector check status, etc.
Hand output	8	Outputs to issue a signal to the external device (valve) with a SET command, RESET command, etc. Used to control the opening and closing of the end-effector.

## **5.2 Using User I/O Signals**

To use user I/O signals you need to first declare, in the program, the use of user I/O as I/O type variables with a DEFIO command. Next, access the user I/O by writing it to the I/O type variables or reading it.

### **5.2.1 I/O Type Variable Declaration**

I/O type variables are classified into I/O type global variables that are available without any declaration, and I/O type local variables that are not available without a declaration.

#### **5.2.1.1 I/O Type Global Variables**

I/O type global variables are used to refer to or change user I/O signals bit by bit. Since they are global variables, they can be used without any declaration. I/O type global variables are expressed in either of the following two ways:

IO[nn] (nn: terminal number) Example: IO[104]

IOnn (nn: terminal number) Example: IO104

#### **5.2.1.2 I/O Type Local Variables**

I/O type local variables are used to collectively refer to or change 1-bit, 8-bit, 16-bit or 32-bit user I/O signals starting from a specified terminal number.

I/O type local variables require a declaration, which will be made with a DEFIO command, before they are used. For further information about declarations with a DEFIO command, refer to the PROGRAMMER'S MANUAL, Chapter 9, Section 9.7 "DEFIO (Statement) [Conforms to SLIM]."

## **5.2.2 User Input Commands**

There are two types of user input commands, IN and WAIT. The IN command substitutes the input result for a variable. The WAIT command waits until the input result meets specified conditions.

### **5.2.2.1 IN Command**

The IN command inputs a signal from the user input specified by an IO type variable and substitutes it for an arithmetic variable.

For further information about the IN command, refer to the PROGRAMMER'S MANUAL, Chapter 13, Section 13.1 "IN."

### **5.2.2.2 WAIT Command**

The WAIT command suspends the execution of the program until specified conditions are met. If an I/O type variable is used for the conditional statement, this command suspends the execution of the program until the status of the signal from a specified user input is checked and meets the specified conditions. For further information about the WAIT command, refer to the PROGRAMMER'S MANUAL, Chapter 12, Section 12.5 "WAIT."

---

## **5.2.3 User Output Commands**

There are three types of user output commands, SET, RESET and OUT. The SET and RESET commands turn ON and OFF all user outputs specified by I/O type variables. The OUT command outputs data to a specified user output.

### **5.2.3.1 SET Command**

The SET command turns ON all user outputs specified by I/O type variables. For further information about the SET command, refer to the PROGRAMMER'S MANUAL, Chapter 13, Section 13.1 "SET."

### **5.2.3.2 RESET Command**

The RESET command turns OFF all user outputs specified by I/O type variables. For further information about the RESET command, refer to the PROGRAMMER'S MANUAL, Chapter 13, Section 13.1 "RESET."

### **5.2.3.3 OUT Command**

The OUT command outputs data to the user output specified by an I/O type variable. For further information about the OUT command, refer to the PROGRAMMER'S MANUAL, Chapter 13, Section 13.1 "OUT."

## 5.3 System I/O Signals **Standard Mode**

### 5.3.1 Types and Functions of System Output Signals (Standard Mode)

Table 5-4 lists the system output signals used in standard mode.

**Table 5-4 Types and Functions of System Output Signals to be Used in Standard Mode**

Application	Signal name	Function
Start-up	Robot initialization complete	Outputs when preparations for operation are ready to start.
	Auto mode	Outputs when the robot is in Auto mode.
	External mode	Outputs when the robot is in external mode.
	Servo ON	Outputs when the power to the motor is turned ON.
Program execution	Robot-in-operation	Outputs when the robot is in operation (the program is being executed).
Error/Warning	Normal CPU	Outputs when the CPU (hardware) of the Robot Controller is normal.
	Robot failure	Outputs when a serious error, such as a servo error and a program error, occurs.
	Robot warning	Outputs when a slight error occurs.
	Dead battery warning	Outputs when the voltage of the encoder back-up battery or memory back-up battery dangerously low.
Continue start	Continue start permitted	Outputs when Continue Start is enabled.
Safe start function	SS mode	Outputs when the robot is in SS mode. Refer to the SETTING-UP MANUAL, Chapter 3, Subsection 3.4.6 "SS (Safe Start) Function."
Emergency stop	Emergency stop	Outputs from a contact exclusively designed for an emergency stop circuitry.

## 5.3.2 Usage of System Output Signals (Standard Mode)

The usage of each system output signal in standard mode is described below:

### 5.3.2.1 Robot Initialization Complete (Output)

#### (1) Function

The signal outputs to the external device that a MODE SWITCHING COMMAND is ready to execute from the device.

#### (2) Terminal number

No.5 of connector CN10.

#### (3) Usage

The "mode switching command" will be executed as soon as this signal and the auto mode signal are turned ON, after the power is turned ON.

#### (4) ON conditions

- ① The signal will be turned ON when the system program for the Robot Controller normally starts, after the power, is turned ON and the mode switching command is ready to execute.
- ② The signal will be turned ON when a robot failure is cleared by the CANCEL key of the operating panel or teach pendant or by a CLEAR ROBOT FAILURE command, after the power is turned OFF.

#### (5) OFF condition

The signal will be turned OFF when a robot failure or robot warning signal is turned ON.

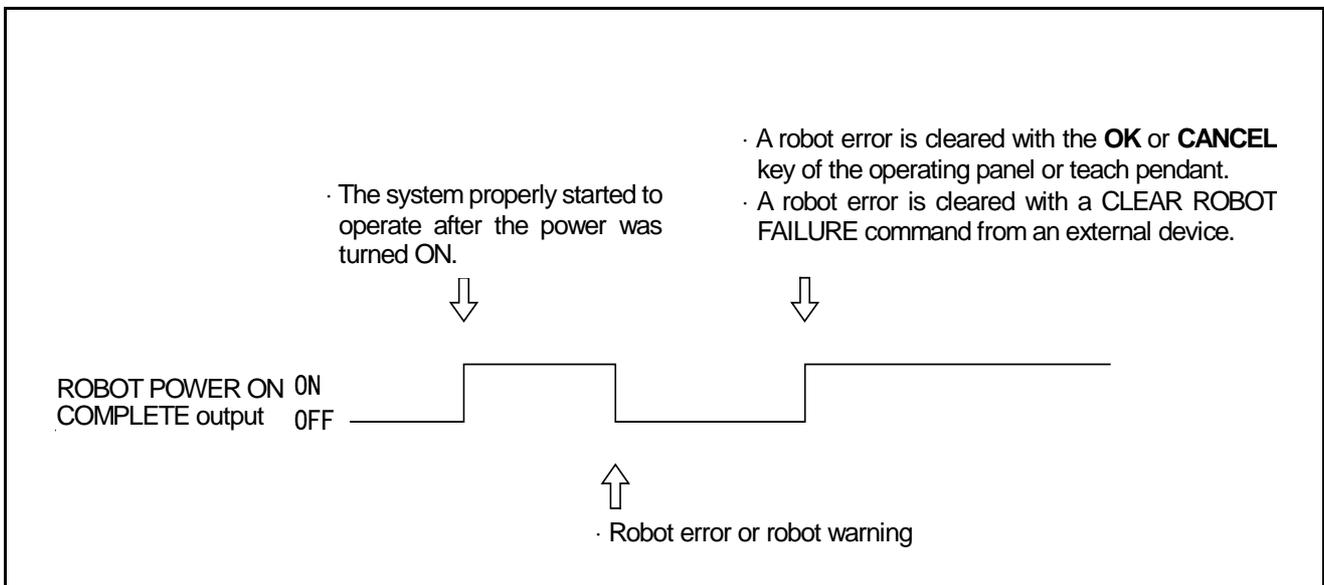


Figure 5-3 Robot Power ON Complete Output

### 5.3.2.2 Auto Mode (Output)

**(1) Function**

The signal outputs to the external device that the robot is in auto mode.

**(2) Terminal number**

No.6 of connector CN10.

**(3) Usage**

Starting the program from the external device requires an EXTERNAL MODE SWITCHING BY MODE SWITCHING COMMAND input and a PROGRAM START BY PROGRAM OPERATION COMMAND input. The signal is used to monitor the auto mode output signal and determine whether to execute the command.

**(4) ON condition**

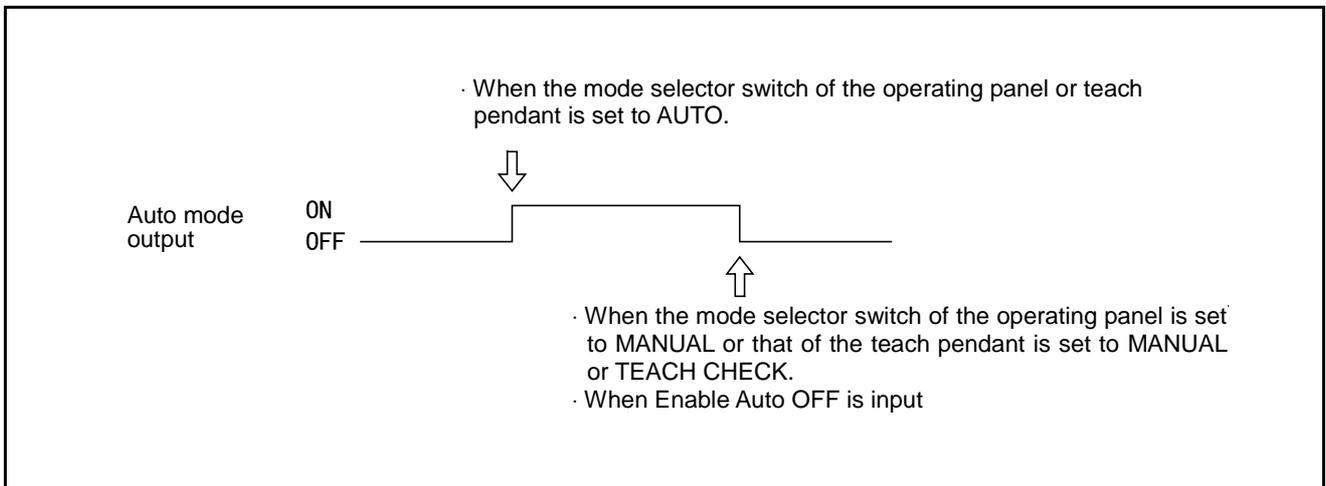
The signal will be output when the robot enters auto mode by setting the mode selector switch of the operating panel or teach pendant to AUTO.

**(5) OFF conditions**

The signal will be turned OFF under the following conditions.

- ① The mode selector switch of the operating panel is set to MANUAL or the teach pendant is set to MANUAL or TEACH CHECK.
  - ② The Enable Auto OFF is input.
- (Note: The signal will not be turned OFF in the pendantless state described in Chapter 3, Subsection 3.2.3, "[ 3 ] Pendantless State.")

**Caution: The signal will not be turned OFF with INSTANTANEOUS STOP, STEP STOP or CYCLE STOP commands.**



**Figure 5-4 Auto mode Output**

### 5.3.2.3 External Mode (Output)

#### (1) Function

The signal outputs to the external device that the robot is in external mode.

#### (2) Terminal number

No.7 of connector CN10.

#### (3) Usage

Starting the program from the external device requires an EXTERNAL MODE SWITCHING BY MODE SWITCHING COMMAND input and a PROGRAM START BY PROGRAM OPERATION COMMAND input. The signal is used to confirm that the robot is in external mode.

#### (4) ON conditions

- ① The signal will be turned ON under the following conditions.  
The external mode is selected on the teach pendant.
- ② The EXTERNAL/INTERNAL is input on the operating panel in AUTO MODE and in the INTERNAL CONTROL ON state.
- ③ The EXTERNAL MODE SWITCHING BY MODE SWITCHING COMMAND is input from the external device.

#### (5) OFF conditions

The signal will be turned OFF under the following conditions.

- ① When internal mode is selected on the teach pendant.
- ② When the mode selector switch of the teach pendant is set to MANUAL or TEACH CHECK in external mode.
- ③ When EXTERNAL/INTERNAL is input on the operating panel in AUTO MODE and in the INTERNAL CONTROL OFF state.
- ④ When ROBOT STOP is input.
- ⑤ When ROBOT FAILURE is outputted.

**Caution: The signal will not be turned OFF with INSTANTANEOUS STOP, STEP STOP or CYCLE STOP.**

- ⑥ When an Enable Auto input is turned OFF.

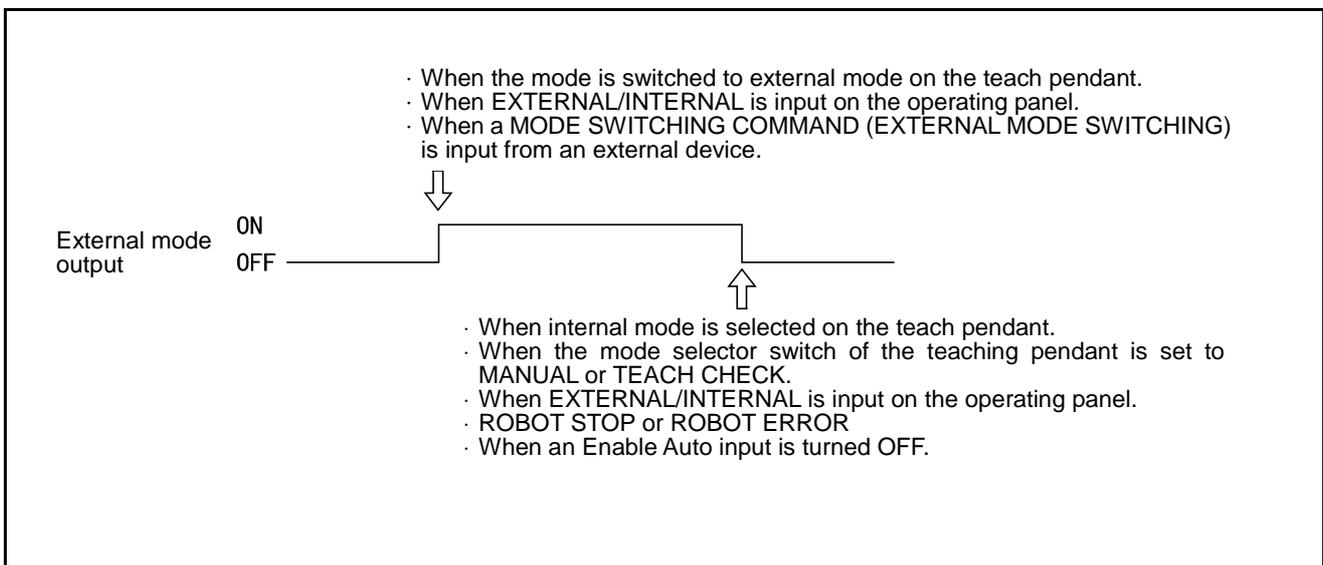


Figure 5-5 External Mode Output

### 5.3.2.4 Servo ON (Output)

**(1) Function**

The signal outputs to the external device that the power to the motor of the robot is turned ON.

**(2) Terminal number**

No.4 of connector CN10.

**(3) Usage**

Starting the program requires the power to the motor to be turned ON. This signal is used to light the motor power ON indicator lamp on an external operating panel.

**(4) ON conditions**

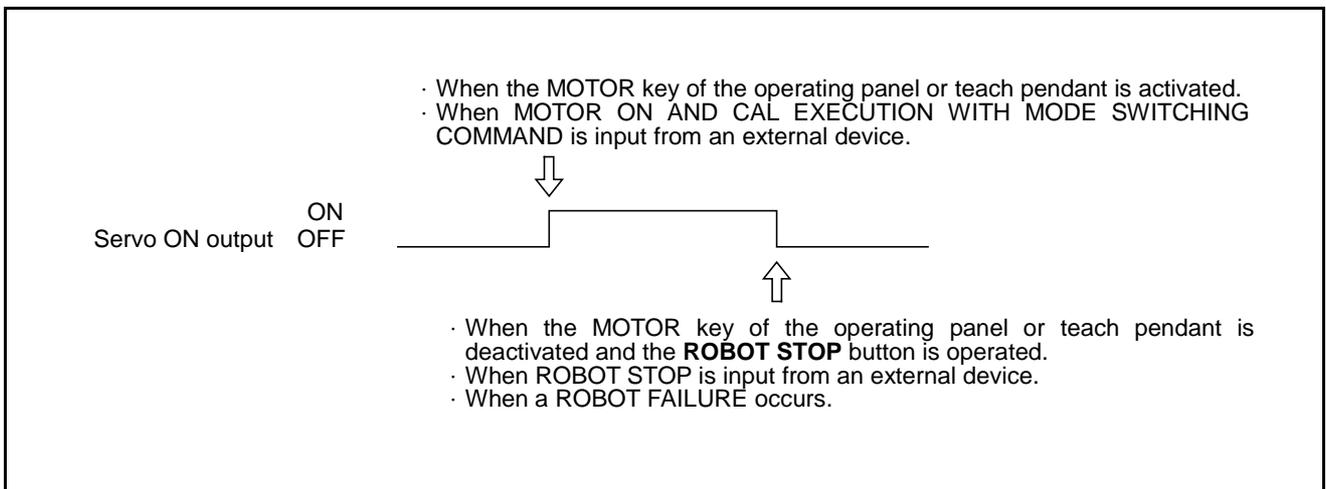
The signal will be turned ON when the power to the motor is turned ON.

- ① When the MOTOR key of the operating panel or teach pendant is activated; or
- ② When the motor runs with a MOTOR ON AND CAL EXECUTION BY MODE SWITCHING COMMAND input from the external device.

**(5) OFF conditions**

The signal will be turned OFF when the power to the motor is turned OFF.

- ① When the MOTOR key of the operating panel or teach pendant is deactivated and the ROBOT STOP button is operated;
- ② When ROBOT STOP is input from the external device;
- ③ When a ROBOT FAILURE is outputted. If errors 0 × 6071 to 607B, 0 × 6671 to 667B, 0 × 607F occur, the servo will be turned OFF in automatic or external mode but will not be turned OFF in the manual or the teach check mode.



**Figure 5-6 Servo ON Output**

---

### 5.3.2.5 Robot-in-operation (Output)

**(1) Function**

This signal outputs to the external device that the robot is in operation.

**(2) Terminal number**

No.2 of connector CN10.

**(3) Usage**

The signal is used to light the robot operating indicator lamp of an external operating panel.

Since the signal is turned OFF with STOP ALL PROGRAMS, outputs to the external device that all programs are stopped.

**(4) ON conditions**

The signal will be turned ON during execution of the program and also while in the WAIT STATE with a condition branch or timer command.

**(5) OFF conditions**

The signal will be turned OFF with STOP ALL PROGRAMS.

<p><b>Caution: STOP ALL PROGRAMS means the operation of the ROBOT STOP or STOP button of the operating panel or teach pendant and INSTANTANEOUS STOP (ALL TASKS), STEP STOP (ALL TASKS) and ROBOT STOP inputs.</b></p>
------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

### 5.3.2.6 Normal CPU (Output)

#### (1) Function

The signal outputs to the external device that the Robot Controller CPU (hardware) is normal.

#### (2) Terminal number

No.1 of connector CN10.

#### (3) Usage

- ① The signal is used to light the Robot Controller external operating panel error indicator lamp.
- ② The signal is used when a normal CPU SIGNAL is turned OFF because of an error and the PLC corrects it.

#### (4) ON conditions

The signal will be turned ON by the hardware when the Robot Controller CPU operates normally with the power turned ON.

#### (5) OFF conditions

The signal will be turned OFF by the hardware when the CPU does not operate normally.

**Caution: The OFF state of this signal indicates that the Robot Controller internal arithmetic circuit may be damaged. Therefore, ROBOT ERROR, ERROR NUMBER, and other outputs may not be correct.**

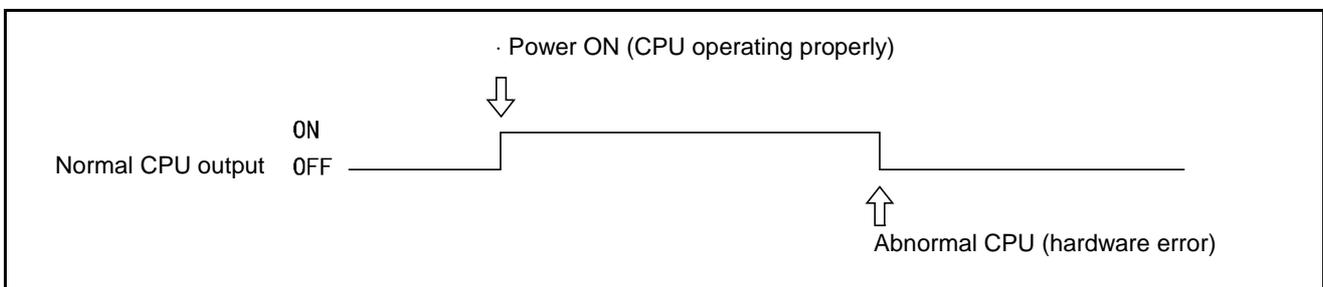


Figure 5-7 Normal CPU Output

### 5.3.2.7 Robot Failure (Output)

#### (1) Function

The signal outputs to the external device that a problem (such as a servo error or a program error) occurs with the robot.

#### (2) Terminal number

No.3 of connector CN10.

#### (3) Usage

- ① The signal is used to light the robot external operating panel error indicator lamp of an.
- ② The signal is used to help the PLC clear an error in response to a ROBOT FAILURE signal.

#### (4) ON conditions

As shown in Figure 5-8, the signal will be turned ON under the following conditions.

- ① When an error, such as a servo error, a program error or program undefined, occurs at the start of the program and during execution of the program.
- ② When an error occurs during execution of the program in internal operation by the operating panel or the teach pendant or in external operation by the PLC.

**Caution: The signal will not be outputted when an error, such as a program input error occurs in manual operation, except when a servo error occurs in manual operation. For further information, see the "ERROR CODE TABLES."**

#### (5) OFF conditions

As shown in Figure 5-8, the signal will be turned OFF under the following conditions.

- ① When a CLEAR ROBOT FAILURE command is inputted and the existing error is cleared.
- ② When the existing error is cleared by operating the **OK** or **Cancel** key on the operating panel or the teach pendant.

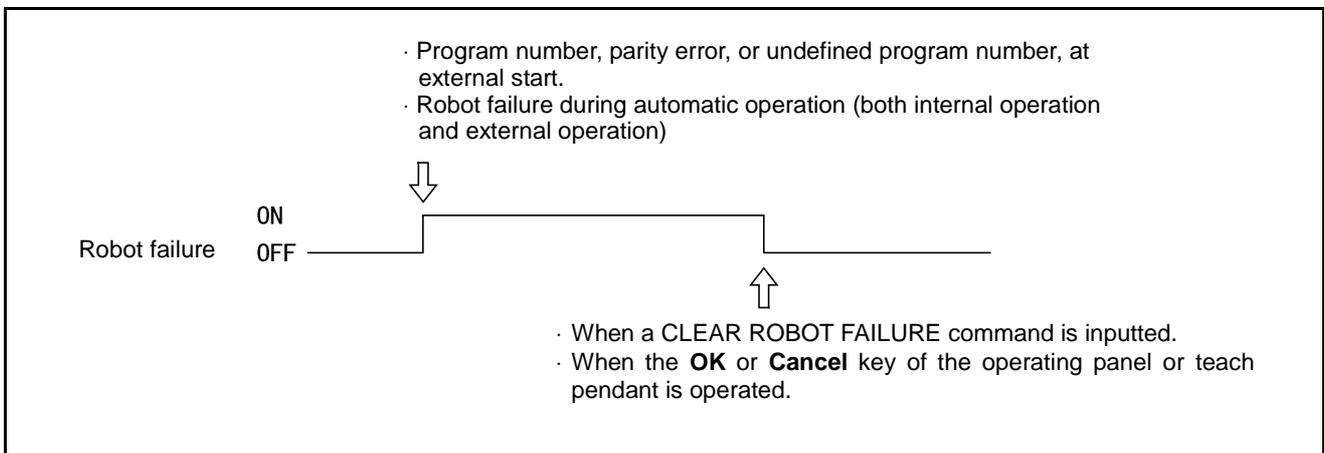


Figure 5-8 Robot Failure Output

### 5.3.2.8 Robot Warning (Output)

**(1) Function**

The signal outputs to the external device that a minor error occurs with an I/O command or during servo processing.

**Caution: The signal will not be outputted if a minor error, such as a program selection error occurs by the operation of the teach pendant or operating panel.**

**(2) Terminal number**

No.9 of connector CN10.

**(3) Usage**

- The signal is used to light the robot warning indicator lamp of the external operating panel.
- The signal is used to help the PLC clear an error in response to a ROBOT WARNING signal.

**(4) ON condition**

As shown in Figure 5-9, the signal will be turned ON if a minor error occurs during I/O processing, execution of the program or servo processing, irrespective of the operation mode.

**(5) OFF conditions**

As shown in Figure 5-9, the robot-warning signal will be turned OFF under the following conditions.

- When a CLEAR ROBOT WARNING command is inputted from the external device and the existing error is cleared.
- When operating the **OK** or **Cancel** key on the operating panel or the teach pendant clears the existing error.

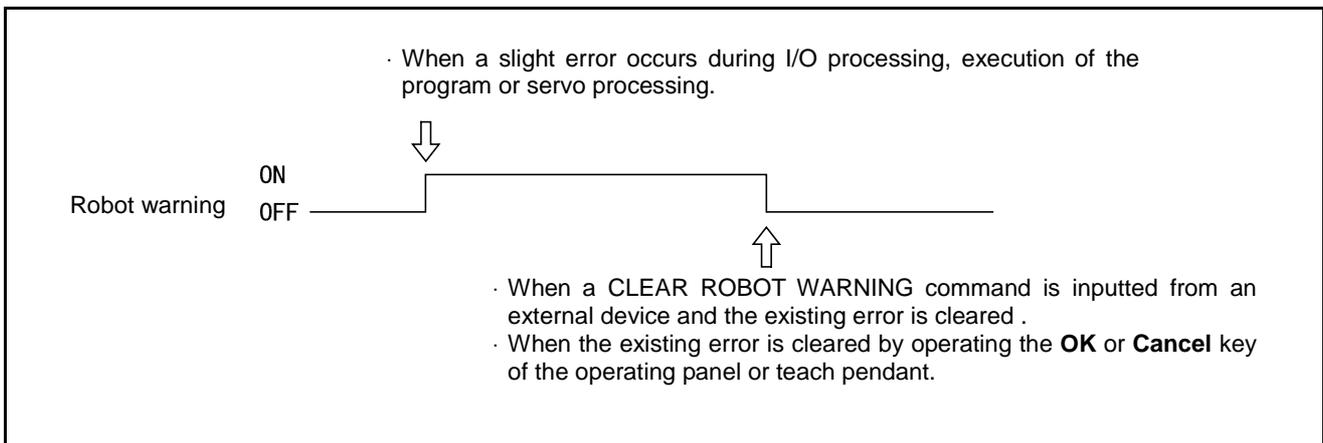


Figure 5-9 Robot Warning Output

### 5.3.2.9 Dead Battery Warning (Output)

**(1) Function**

The signal will be output when the voltage of the encoder back-up battery or memory back-up battery becomes lower than acceptable.

**(2) Terminal number**

No.8 of connector CN10.

**(3) Usage**

The signal is used to check the timing battery replacement. For example, the battery voltage becomes lower than acceptable.

**(4) ON condition**

The signal will be turned ON when the voltage of the encoder back-up battery or memory back-up battery becomes lower than acceptable.

**Caution: The operating panel shows any of ERROR64A1 to 64A6 when the encoder back-up battery voltage is low. Meanwhile, the teach pendant shows ERROR6103 when the memory back-up battery voltage is low. (Refer to Chapter 6, Section 6.5, "Biennial Inspections.")**

**(5) OFF condition**

The signal will be turned OFF when the power is turned ON after the dead battery was replaced.

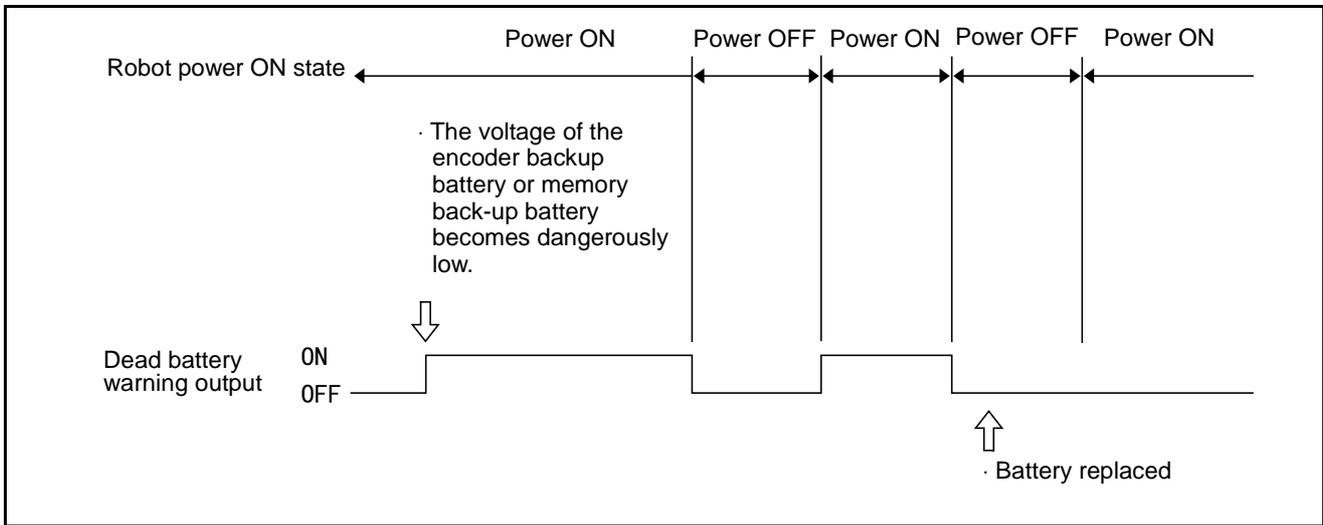


Figure 5-10 Dead Battery Warning Output

### 5.3.2.10 Continue Start Permitted (Output)

**(1) Function**

The controller will output this signal when the continue start is permitted.

**(2) Terminal number**

No.10 of connector CN10.

**(3) Usage**

Use this signal when you want to know whether the continue start is permitted.

**(4) ON condition**

This signal comes on when the continue start is permitted. For details, refer to the SETTING-UP MANUAL.

**(5) OFF condition**

This signal goes off by carrying out the "Task Status Change Operation."

### 5.3.2.11 SS mode (Output)

**(1) Function**

The controller will output this signal during the SS mode.

This mode is effective when the slow mode is selected.

**(2) Terminal number**

No.11 of connector CN10

**(3) Usage**

This signal is used to warn workers that the robot is in the SS mode by beeping or lighting the lamp.

**(4) ON condition**

This signal comes on when the SS mode is selected.

**(5) OFF condition**

The signal goes off when the TS time passes so as to cancel SS mode. This function is effective when the slow mode is selected.

Note: If the TS time passes, this signal goes off even when the robot is operation in the slow mode. After this signal goes off, the robot runs at the original speed.

---

### 5.3.2.12 Emergency Stop (Output from a contact)

#### (1) Function

This signal outputs from a contact exclusively designed for an emergency stop circuitry you may configure. It allows red mushroom buttons provided on the front panel of the robot controller, on the teach pendant, and on the operating panel to be used as emergency stop buttons of the facilities.

A 0.3A fuse is built in the contact.

#### (2) Terminal number

No. 65 of connector CN10: Emergency stop (+)

No. 66 of connector CN10: Emergency stop (-)

#### (3) Usage

This signal is used to stop the facilities or robot in an emergency. (Refer to Subsection 5.6.2.4 "Emergency Stop Circuit.")

#### (4) Contact

This contact is a normal close one (b contact). If any of the emergency stop buttons is pressed, then the contact turns off to output an emergency stop signal.

### 5.3.3 Types and Functions of System Input Signals (Standard Mode)

Table 5-5 shows the system input signals to be used in standard mode:

**Table 5-5 Types and Functions of System Input Signals to be Used in Standard Mode**

<b>Application</b>	<b>Signal Name</b>	<b>Function</b>
Start-up	Enable Auto	Enables switching to automatic operation.
Stop	Robot stop	Stops the robot with canceling signals.
	Instantaneous stop (all tasks)	Immediately stops all programs being executed with canceling signals.
	Step stop (all tasks)	Step-stops all programs being executed with canceling signals.
Program interrupt	Interrupt skip	Interrupts the execution of the current step and starts executing the next step.

## 5.3.4 Usage of System Input Signals (Standard Mode)

The usage of each system input signal in standard mode is described below.

### 5.3.4.1 Enable Auto (Input)

#### (1) Function

- ① The signal enables switching of the robot mode to auto mode (shorted state).
- ② The signal enables switching of the robot mode to manual mode or teach check mode (open state).

#### (2) Terminal number

No. 4 of connector CN8.

#### (3) Usage

The signal is used for the AUTO/TEACHING selector switch of an external operating panel and can be combined with a safety fence switch.

#### (4) Input conditions and operation

- ① As shown in Table 5-6, the selectable operation mode depends on whether this input is shorted or open.
- ② If the input becomes open during automatic operation, the mode will be switched to manual mode and ERROR21FC will be displayed.
- ③ If manual operation or a teach check is conducted with this input shorted, ERROR21F2 will be displayed.
- ④ If the mode selector switch of the teach pendant or operating panel is set to AUTO with this input open, ERROR21F3 will be displayed. Since this state is shown as × in Table 5-5, this error will remain displayed until the robot exits this state.
- ⑤ Although ERROR21FD or ERROR21FC will be displayed when the state is changed from ○ to Δ or ×, they will not be displayed when the state is changed from Δ or × to ○.
- ⑥ When the input is turned OFF (open) in external mode, the external mode output will also be turned OFF.

**Table 5-6 Relationship Between Enable Auto Input and Selectable Mode**

Operation mode	Application	Enable Auto	
		ON (shorted)	OFF (open)
Manual mode	Manual operation with the operating panel or the teach pendant.	Δ	○
Teach check mode	Program check with the teach pendant.	Δ	○
Internal auto mode	Automatic operation with the operating panel or teach pendant.	○	×
External auto mode	Automatic operation with the external device.	○	×

Note: ○ = Mode selectable      × = Mode not selectable  
 Δ = Mode selectable but manual operation program not executable

**Caution:** In the pendantless state described in Chapter 3, Subject. 3.2.3 [ 3 ], auto mode is valid even if the Enable Auto input is open. (The external mode cannot be switched and the program cannot begin execution.)  
 Perform the following when operating the robot in the pendantless state:

- ① Set the robot so that it will not start to operate when the Enable Auto input is open.
- ② Enable Auto input open state and auto mode output (See "5.3.2.2 Auto mode" and "5.5.2.2 "Auto Mode".)  
 Set the equipment to make an emergency stop in an AND state.  
 Add ① and ② with the external sequence circuit.

### 5.3.4.2 Robot Stop (Input)

#### (1) Function

- ① The signal stops the robot from the external device by opening the robot stop input.
- ② The signal readies the power to the robot motor to be turned ON by shorting the robot stop input.

#### (2) Terminal number

No.2 of connector CN8.

#### (3) Input conditions and operation

- ① The robot stops with this input OFF (open).
- ② The power to the robot motor is made ready to be turned ON with this input ON (shorted).
- ③ Irrespective of whether internal mode, operation by the teach pendant, or external mode, remote operation by the external device, is selected, the power to the robot motor cannot be turned ON with this input OFF (open) and neither manual nor automatic operation can be performed until this input is turned ON (shorted). (ERROR2008 will be displayed.)
- ④ By turning OFF (open) this input the following conditions may result.
  - 1) The power to the motor will be turned OFF irrespective of whether manual, automatic, internal or external mode is selected.
  - 2) During execution of the program (Robot-in-operation signal ON), the power to the motor will be turned OFF and the mode will be switched to internal mode after the robot decelerates to a stop;
  - 3) When the program is not executed in manual and auto modes in manual and auto modes, everything will be the same except the power to the motor will be turned OFF. The power to the motor can be turned ON and the suspended operation can, therefore, be resumed by shorting the ROBOT STOP input. (However, the program will be executed from the beginning.)
- ⑤ Opening the ROBOT STOP input and pressing the **ROBOT STOP** button of the operating panel or the teach pendant function is the same.

#### (4) Timing of the input

This input will be processed prior to all commands and input signals.

### 5.3.4.3 Step Stop (All Tasks) (Input)

#### (1) Function

Input this signal to step-stop the program being executed from the external device. All tasks will be step-stopped.

#### (2) Terminal

No.5 of connector CN8.

#### (3) Input conditions and operation

- ① If the state of this signal is changed from ON (shorted) to OFF (open), the robot will stop all tasks as soon as the ongoing step is completed, and the Robot-in-operation signal will be turned OFF. However, auto mode or external mode will remain valid, and the suspended program will be resumed by inputting a program operation command (start). See Figure 5-11.
- ② For resuming the program after a step stop, see Chapter 5, "5.4.3.2 Program Operation Command (0001)".

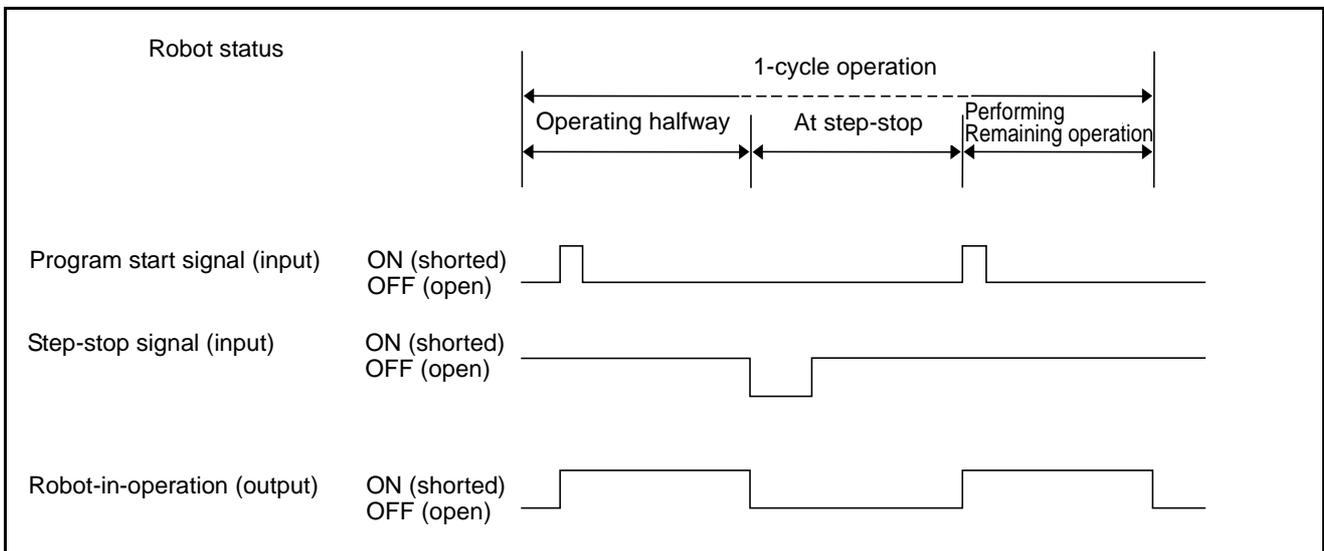


Figure 5-11 Step Stop Signal

### 5.3.4.4 Instantaneous Stop (All Tasks) (Input)

#### (1) Function

Input this signal to instantaneously stop the running programs from an external device. All tasks will stop.

#### (2) Terminal number

No.7 of connector CN8.

#### (3) Input conditions and operation

- ① If the state of this signal is turned from ON (shorted) to OFF (open), the robot will immediately stop in the middle of the ongoing step, and the Robot-in-operation signal will be turned OFF. However, auto mode or external mode will remain valid, and the suspended programs will be resumed by inputting Program start signal.
- ② For resuming the program after an instantaneous stop, see Chapter 5, "5.4.3.2 Program Operation Command (0001)".
- ③ The minimum required pulse width is 50 milliseconds (msec.) or more.

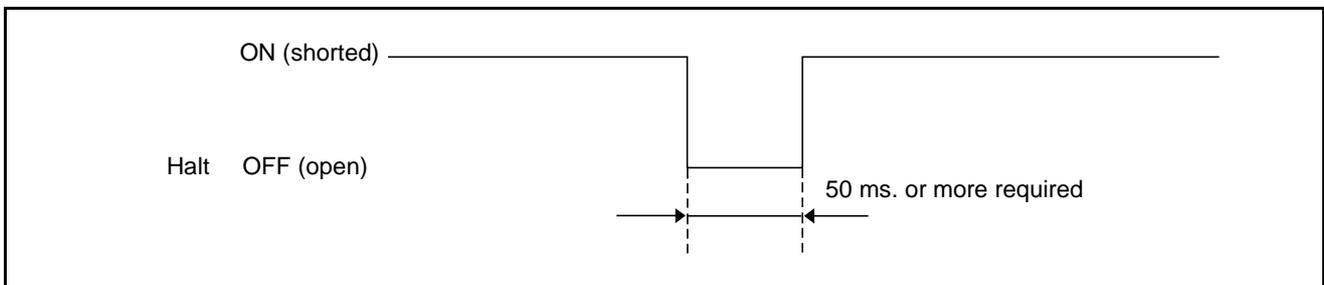


Figure 5-12 Minimum Instantaneous Stop Pulse Width

### 5.3.4.5 Interrupt Skip (Input)

#### (1) Function

If this signal is turned ON (shorted) during execution of the robot operation command, within the range between INTERRUPT ON and INTERRUPT OFF in the program, the correct step operation will immediately stop and the next step will start.

**Caution:** For further information about the INTERRUPT ON and OFF commands, see the PROGRAMMER'S MANUAL, Chapter 12, "12.3 INTERRUPT ON/OFF (Statement)."  
For further information about the robot operation command, see the PROGRAMMER'S MANUAL, Chapter 12, "Robot Control Statements."

#### (2) Terminal number

No.9 of connector CN8.

#### (3) Usage

See the PROGRAMMER'S MANUAL, Chapter 12, "12.3 INTERRUPT ON/OFF."

#### (4) Input conditions and operation

If this signal is turned ON (shorted), the robot will immediately stop the current operation and start executing the next step.

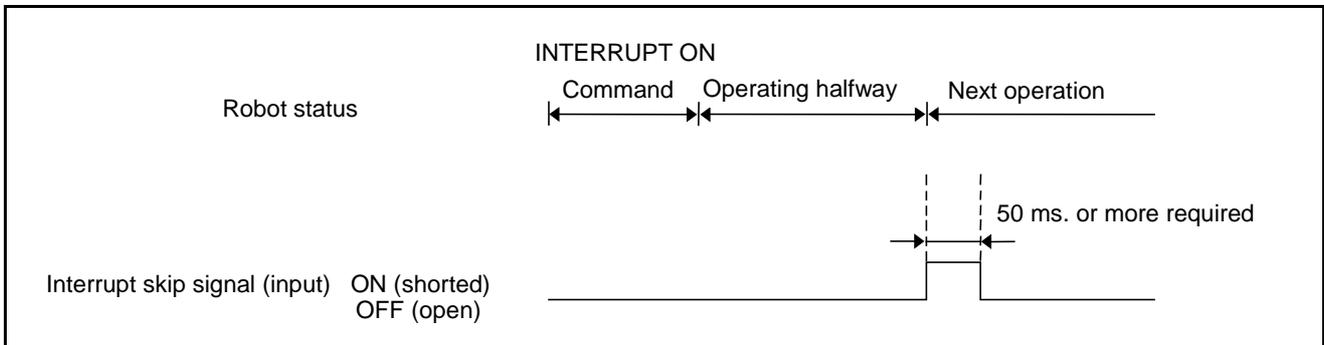
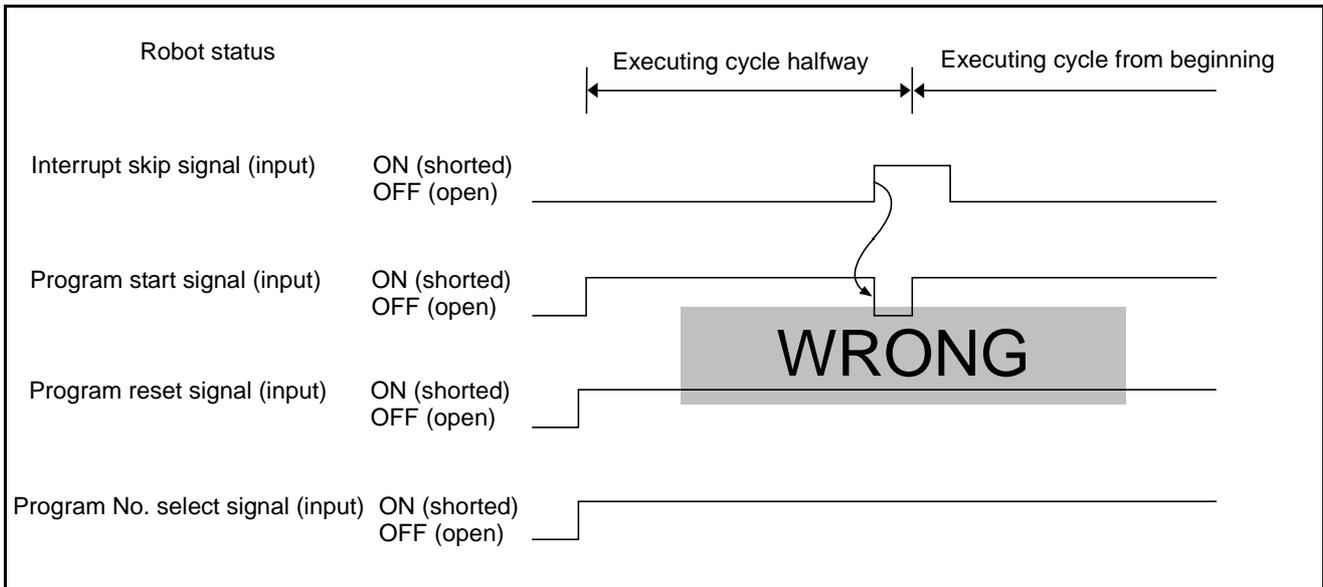


Figure 5-13 Input Conditions and Operation of Interrupt Skip

**⚠ Caution:** When turning ON (shorting) the interrupt skip signal, at a minimum either the program reset signal or the program start signal must be turned OFF (open). If the interrupt skip signal is turned ON, the robot interprets the program start signal as immediately turned OFF (open). Consequently, the program selected with the program No. selection signal will be executed from the beginning. (See Figure 5-14 below.)



**Figure 5-14 Example of Operation When an Interrupt Skip is Input**

## 5.4 Command Execution I/O Signals Dedicated to Standard Mode

In standard mode the I/O commands can be executed using command execution I/O signals. I/O commands execute the following.

- Operate (start and stop) a program for each task.
- Refer to or change variables from the external device.
- Refer to or change inputs and outputs from the external device.

### 5.4.1 General Information about Commands

Table 5-7 shows the I/O commands functions.

**Table 5-7 I/O Command Functions**

Command	Description of function
Program operation	<ul style="list-style-type: none"> <li>· Starts the program cycle (specified program).</li> <li>· Step-stops the program (specified program/all programs).</li> <li>· Immediately stops the program (specified program/all programs).</li> <li>· Resets the program (specified program/all programs).</li> </ul>
Speed setting	<ul style="list-style-type: none"> <li>· Sets the external speed.</li> <li>· Sets the external acceleration.</li> <li>· Sets the external deceleration.</li> </ul>
Error number read	<ul style="list-style-type: none"> <li>· Outputs the error number to the system I/O area.</li> </ul>
Type I variable write	<ul style="list-style-type: none"> <li>· Reads a value from the system I/O area and substitutes it for a Type I variable.</li> </ul>
Type I variable read	<ul style="list-style-type: none"> <li>· Outputs a Type I variable to the system I/O area.</li> </ul>
Mode switching	<ul style="list-style-type: none"> <li>· Switches the robot operation mode.</li> </ul>
Clear robot failure	<ul style="list-style-type: none"> <li>· Clears a robot failure from the external device.</li> </ul>
Internal I/O write	<ul style="list-style-type: none"> <li>· Sets the state of internal inputs and outputs.</li> </ul>
Internal I/O read	<ul style="list-style-type: none"> <li>· Outputs the state of internal inputs and outputs to the system I/O area.</li> </ul>

## 5.4.2 Processing I/O Commands

### 5.4.2.1 General Information about Processing

I/O commands to be executed are processed as shown in Figure 5-15.

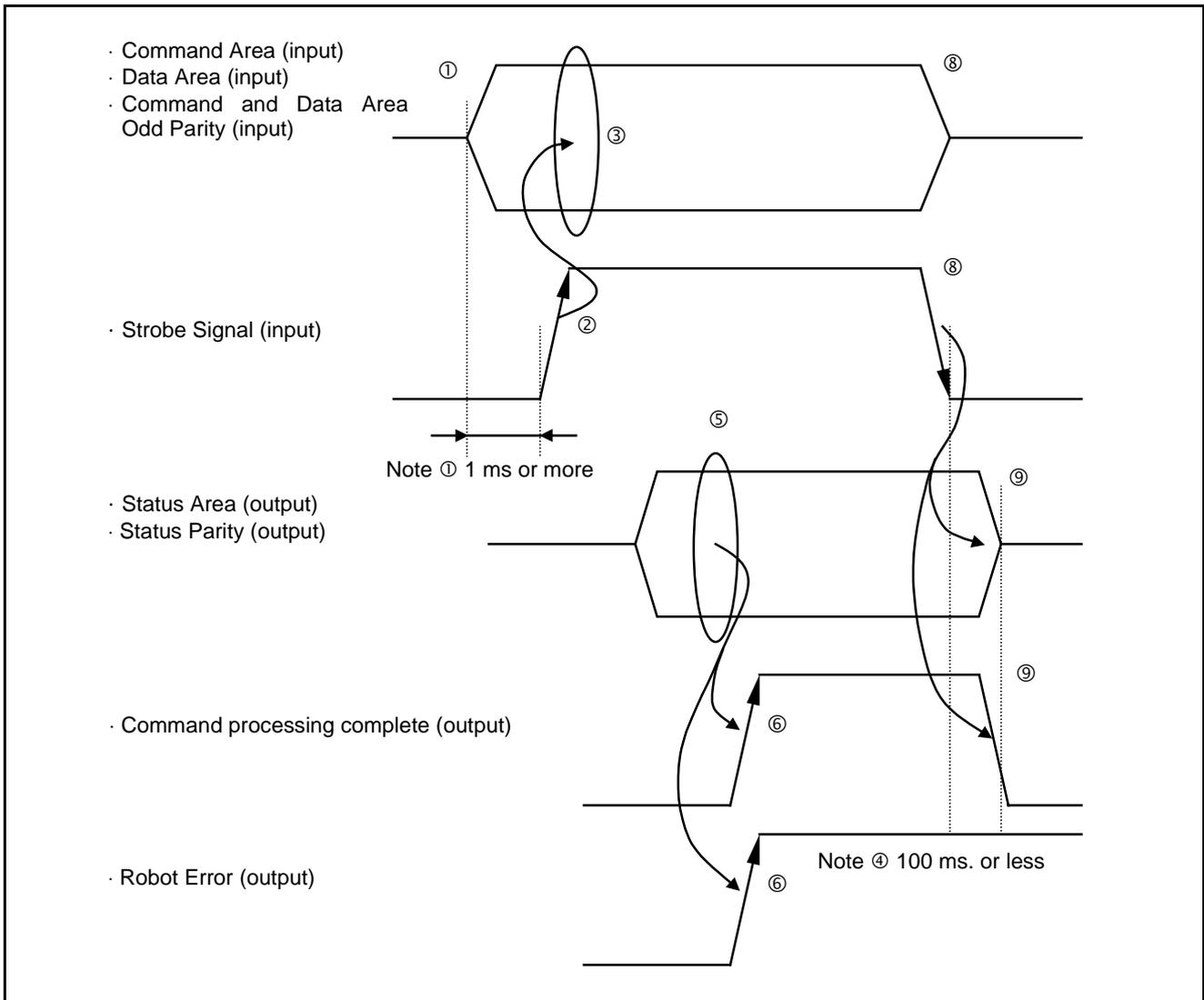


Figure 5-15 Outline of I/O Command Processing

---

① Set a command area, a data area (if necessary) and command and data area odd parity for the command execution I/O signal from the external device to the Robot Controller.

② After the setting is completed, turn ON the strobe signal.

**Caution:** ① The data to be set in ① must be defined more at least 1 msec. before the strobe signal is turned ON.  
② Perform command input with a strobe signal after the system output signal ROBOT INITIALIZATION COMPLETE is output.

③ The controller reads the command area, the data area and the command and data area odd parity as the strobe signal is input.

④ The controller starts processing based on the command it read.

⑤ If the command is one that outputs a status, the controller sets the status area and status parity.

⑥ After command processing has been completed and a status area has been set, the controller turns ON the command processing complete signal.

If an error occurs in the while processing, a robot failure signal will be outputted together with the command processing complete signal.

⑦ The PLC waits until the command processing complete signal is input, and receives the status of the status area, if necessary. In this case, confirmation that no error exists with the robot.

⑧ After the PLC has read the status, it turns OFF the command and data areas and the strobe signal.

⑨ As soon as the strobe signal is turned OFF, the controller turns OFF the status area and the command processing complete signal.

The robot failure signal, which is outputted due to a command processing error, remains ON until a CLEAR ROBOT FAILURE command is executed.

**Caution:** ③ The maximum time taken until the status area and the command processing complete signal are turned OFF, after the strobe signal is turned OFF in ⑧, is 100 msec.  
④ If the strobe signal is turned OFF before the command processing complete signal is turned ON in ⑥, the command processing complete signal and the status area will be output and then turned OFF within 100 msec.

### 5.4.2.2 Using Each Signal Line

#### [ 1 ] Command and Data Areas

This section describes the usage of the command area (4 bits, input), data area 1 (8 bits, input), data area 2 (16 bits, input) and command and data area odd parity (input).

##### (1) Function

Specifies the commands to be executed by the Robot Controller.  
Sets the command area at all times, and data areas 1 and 2, if necessary.

##### (2) Terminal numbers

Command area: No.35 to No.38 of connector CN8.  
Data area 1: No.11 to No.18 of connector CN8.  
Data area 2: No.19 to No.34 of connector CN8.  
Command and data area odd parity: No.10 of connector CN8.

##### (3) Input conditions and operation

- ① Set the command area whenever I/O commands are to be executed.  
Set data for data areas 1 and 2 if commands require them.
- ② "Shorted" represents the bit value = 1.  
"Open" represents the bit value = 0.  
"Parity bit " is odd parity.
- ③ Input the command area, data areas 1 and 2, and command and data area odd parity before the strobe signal (1 msec. or more). Retain the status until the command processing complete signal is output.
- ④ Input 1 or 0 as the parity bit so that the total of 1s existing in the command area, data areas 1 and 2 and the command and data area odd parity will be odd  
The data areas count even commands, which do not require any data area, in a check sum calculation.
- ⑤ Checksum can be set valid or invalid using a parameter. When checksum is invalid, no checksum check will be performed.

---

## [ 2 ] Strobe Signal (Input)

### (1) Function

This signal informs the Robot Controller that the command area, data areas 1 and 2, and the command and data area odd parity bit have been set. Additionally it directs the start of command processing.

<p><b>Caution: Perform command input with a strobe signal after the system output signal ROBOT INITIALIZATION COMPLETE is output.</b></p>
-------------------------------------------------------------------------------------------------------------------------------------------

### (2) Terminal number

No. 8 of connector CN8.

### (3) Input conditions and operation

- ① By turning ON this input in automatic or external mode, the Robot Controller reads the command area, data areas 1 and 2, and the command and data area odd parity bit starts processing.
- ② Retain the status until a command processing complete signal is output and the necessary status data is read. If the strobe signal is turned OFF before a command processing complete signal is output, the status area will not be output.
- ③ By turning OFF this input after the status is read, the command processing complete output, the status area and the status parity will be turned OFF.

### [ 3 ] Command Processing Complete (Output)

#### (1) Function

The signal outputs to the external device that I/O command processing is completed.

#### (2) Terminal number

No. 15 of connector CN10.

#### (3) Usage

The signal is used to confirm that I/O command processing is complete, or as a timing signal for obtaining the result of I/O command processing.

#### (4) ON conditions

- ① The signal will be turned ON upon completion of processing the I/O command given and determination of outputting the status area.
- ② If an error occurs as a result of executing an I/O command, the result will not be output to the status area, but the robot failure signal and the command processing complete signal will be turned simultaneously ON.

#### (5) OFF conditions

- ① The signal will be turned OFF when the strobe signal is turned OFF.
- ② If the strobe signal is turned OFF, before command processing is completed, the command processing complete signal will be output and then turned OFF within 100 msec.

---

## [ 4 ] Status Area

This section describes the usage of the status area (16 bits, output) and of status area odd parity (output).

### (1) Function

The signal outputs the result of I/O command processing to the external device.

### (2) Terminal numbers

Nos. 17 to 32 of connector CN10.

### (3) Usage

The signal is used to execute an I/O command and obtain the result of the PLC.

### (4) ON conditions

① When processing of the I/O given is completed, the status corresponding to the command will be set.

② "ON" represents the bit value = 1.  
"OFF" represents the bit value = 0.  
"Parity bit" is odd parity.

③ Input 1 or 0 as the parity bit so that the total of 1s existing in the command area and status area parity will be odd.

The status area counts even commands, which do not require any data area, in a parity calculation.

④ Parity can be set valid or invalid with a parameter. When parity is invalid, no parity check will be performed.

### (5) OFF conditions

① The signal will be turned OFF when the strobe signal is turned OFF.

② If the strobe signal is turned OFF, before command processing is completed, the status signal will be output and then turned OFF within 100 msec.

### 5.4.3 I/O Commands Details

#### 5.4.3.1 List of I/O Commands

Table 5-8 shows a list of I/O commands.

**Table 5-8 List of I/O Commands**

Command area	Data area 1	Data area 2	Status area
0001 Program operation	00000001 Program reset start 00000010 Program start 00000100 Continue start 00010000 Step stop 00100000 Instantaneous stop 01000000 Reset	Program number Program number <b>(Note)</b> Program number Program number Program number	— — — — —
0010 External speed and acceleration setting	00000001 Speed setting 00000010 Acceleration setting 00000100 Deceleration setting	Set speed value Set acceleration value Set deceleration value	— — —
0100 Error read	—	—	Error number
0101 Type I variable write	Type I variable number	Set variable value (lower 16 bits)	—
0110 Type I variable read	Type I variable number	—	Variable value (lower 16 bits)
0111 Mode switching	00000001 Motor ON, CAL execution 00000010 External speed 100 10000000 External mode switching 10000011 Execution of all above (Motor ON→CAL→SP100→External)	—	—
1000 Clear robot failure	—	—	—
1001 I/O write	Set I/O value	First internal I/O port address	—
1010 I/O read	—	First internal I/O port address	I/O

**(Note)** In execution of Continue Start command, program numbers will be ignored.

---

## 5.4.3.2 Program Operation Command (0001)

### (1) Function

This command controls the operating state of the program specified in data area 2 based on the setting of data area 1.

### (2) Format

Command area (4 bits, input)  
0001

Data area 1 (8 bits, input)  
00000001: Program reset start  
00000010: Program start  
00000100: Continue start  
00010000: Step stop  
00100000: Instantaneous stop  
01000000: Reset

An error (ERROR2032) will occur if data is other than the above is set.

Data area 2 (16 bits, input)  
Program number: Program number to start  
When the number given in data area 2 is nn, the operating state of PROnn will be controlled as given in data area 1. If the program number is negative in the case of a step stop, instantaneous stop or reset command, all programs will stop or be reset. If the program number is negative with a program reset start or program start command, ERROR73E4 will result.

Status area (16 bits, output)  
Nothing will be output.

### (3) Description

#### ① Program reset start

This command is executable only in external mode. If executed in other mode an error will occur.

This command initializes and starts the program of the program number specified in data area 2. PRO0 to PRO32767 can be started.

If the program number specified in data area 2 is negative, an error (ERROR73E4) will occur.

Either of the following operations takes place according to the operating status of the program:

- If the specified program is terminated (stopped), step-stopped or immediately stopped, it will start from the beginning.
- If the specified program is running, an error (ERROR21F5) will be displayed, and the program will stop.

### ② Program start

This command is executable only in external mode. An error (ERROR2032) will occur in other modes.

This command starts the program of the program number specified in data area 2. PRO0 to PRO32767 can be started.

If the program number specified in data area 2 is negative, an error (ERROR73E4) will occur.

One of the following operations takes place according to the operating status of the program.

- If the specified program is terminated (stopped), it will start from the beginning.
- If the specified program is step-stopped, it will resume from the step following the suspended step.
- If the specified program is immediately stopped, it will resume from the step following the suspended step. When the program is instantaneously stopped in while in execution of an operation command, it will resume from the operation still undone.
- If the specified program is running, an error (ERROR21F5) will be displayed, and the program will stop.

### ③ Continue start

This command is executable only in external mode when the Continue Start Permitted signal is on. The data area will be ignored.

### ④ Step stop

This command step-stops the program of the program number specified in data area 2. PRO0 to PRO32767 can be step-stopped.

If the program number specified in data area 2 is negative, all programs being executed will step-stop.

Either of the following operations takes place according to the operating status of the program.

- If the specified program is terminated (stopped), step-stopped or immediately stopped, nothing will happen.
- If the specified program is running, it will step-stop. If started after a step stop, the stopped program will resume from the step following the suspended step.

### ⑤ Instantaneous stop

This command immediately stops the program of the program number specified in data area 2. PRO0 to PRO32767 can be stopped immediately.

If the program number specified in data area 2 is negative, all programs being executed will step-stop.

Either of the following operations takes place according to the operating status of the program:

- If the specified program is terminated (stopped), step-stopped or immediately stopped, nothing will happen.
- If the specified program is running, it will immediately stop. If started after an instantaneous stop, the stopped program will resume from the suspended step. If the program is immediately stopped in the middle of execution of an operation command, it will resume, starting from the last uncompleted operation.

---

⑥ Reset

This command immediately stops and also initializes the program of the program number specified in data area 2. PRO0 to PR032767 can be stopped.

This command cannot be used together with the program start command.

To start a step-stopped or cycle-stopped program from the beginning, use the program reset start command.

If the program number specified in data area 2 is negative, all programs being executed will be reset.

One of the following operations takes place according to the operating status of the program.

- When the specified program is terminated (stopped), nothing will happen.
- When the specified program is step-stopped or immediately stopped, it will be initialized. The initialized program will resume from the beginning.
- When the specified program is running, it will immediately stop and also be initialized. If started after an instantaneous stop, the stopped program will resume from the beginning.

### 5.4.3.3 External Speed and Acceleration Setting (0010)

#### (1) Function

This command sets the external speed, acceleration and deceleration values selected in data area 1 to the values specified in data area 2.

This command is executable only in external mode. An error will occur in other modes.

#### (2) Format

Command area (4 bits, input)

0010

Data area 1 (8 bits, input)

00000001: Speed setting

00000010: Acceleration setting

00000100: Deceleration setting

An error (ERROR2032) will occur if data other than the above is set.

Data area 2 (16 bits, input)

Set values: Speed, acceleration and deceleration to be set

Enter any of the external speed, acceleration and deceleration values specified in data area 1.

The values must be between 1 and 100. If they are out of this range, an error (ERROR2003) will occur.

Status area (16 bits, output)

Nothing will be output.

#### (3) Description

##### ① Speed setting

The external speed is set to the value specified in data area 2. The value must be between 1 and 100. An error (ERROR2003) will occur if the value is out of this range.

The external acceleration and deceleration will be set simultaneously as shown below by setting the external speed:

External acceleration and external deceleration = External speed<sup>2</sup>/100  
(minimum value: 1)

##### ② Acceleration setting

The external acceleration is set to the value specified in data area 2. The value must be between 1 and 100. An error (ERROR2003) will occur if the value is out of this range.

##### ③ Deceleration setting

The external deceleration is set to the value specified in data area 2. The value must be between 1 and 100. An error (ERROR2003) will occur if the value is out of this range.

### 5.4.3.4 Error Read (0100)

#### (1) Function

This command outputs the existing error number to the status area.  
This command is output to the status area only when the strobe signal remains ON.

**Caution: This command will not be output if a minor error occurs, such as a program selection error, caused by the operation of the teach pendant or the operating panel.**

#### (2) Format

Command area (4 bits, input)  
0100  
Data area 1 (8 bits, input)  
Nothing will be input.  
Data area 2 (16 bits, input)  
Nothing will be input.  
Status area (16 bits, output)  
The existing error code will be output.

#### (3) Hexadecimal codes

Refer to Fig. 5-16.

xxxx → 0	xOxO → 5	OxOx → A	
xxxO → 1	xOOx → 6	OxOO → B	
xxOx → 2	xOOO → 7	OOxx → C	
xxOO → 3	Oxxx → 8	OOxO → D	
xOxx → 4	OxxO → 8	OOOx → E	O...ON
		OOOO → F	x...OFF

Figure 5-17 shows an example of error number output when ERROR6174 (overload error with the fourth axis) occurs.

	Thousands of error				Hundreds of error No.				Tens of error No.				Units of error No.			
	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
	x	O	O	x	x	x	x	O	x	O	O	O	x	O	x	x
Terminal No. (Connector CN10)	↑				↑				↑				↑			
ERROR	6				1				7				4			

Figure 5-17 Example of Error Number Output

#### (4) Description

If a command is executed when a robot failure or the robot warning signal is output, the error number, which caused the robot failure or robot warning signal to be output, will be output to the status area.  
If no error exists after an error has been cleared, 0 will be output to the status area. Also, when there is an error that does not output any robot failure or robot warning signal, 0 will be outputted.

### 5.4.3.5 Type I Variable Write (0101)

#### (1) Function

This command substitutes the value specified in data area 2 for the Type I (integer type) global variable of the number specified in data area 1.

#### (2) Format

Command area (4 bits, input)  
0101

Data area 1 (8 bits, input)  
The number of the Type I variable for which a value will be substituted. Any number between I[0] and I[255] can be specified. When the input data in data area 1 is nn, the value specified in data area 2 will be substituted for the Type I variable I [nn].

Data area 2 (16 bits, input)  
The value to be substituted for the Type I variable specified in data area 1. Any value between -32768 and 32767 can be set.

Status area (16 bits, output)  
Nothing will be output.

#### (3) Description

The value specified in data area 2 is substituted for the Type I variable specified in data area 1.

Although the type I variable has a storage area of 32 bits, the 16-bit data in data area 2 will be substituted for the lower 16 bits. Zero will be substituted for the upper 16 bits of the Type I variable.

---

### 5.4.3.6 Type I Variable Read (0110)

#### (1) Function

This command outputs to the status area the value of the Type I (integer type) global variable of the number specified in data area 1.

#### (2) Format

Command area (4 bits, input)  
0110

Data area 1 (8 bits, input)

The number of the Type I variable for which a value will be substituted. Any number between I [0] and I [255] can be specified. When the input data in data area 1 is nn, the value specified in data area 2 will be substituted for the Type I variable I [nn].

Data area 2 (16 bits, input)  
Nothing will be input.

Status area (16 bits, output)

The lower 16 bit value of the Type I variable specified in data area 1 will be output.

#### (3) Description

The value of the Type I variable specified in data area 1 is output to the status area.

Although the Type I variable has a storage area of 32 bits, the lower 16 bits will be output to the status area.

Therefore, any value between -32768 and 32767 can be output properly. However, if the value is out of this range, only the lower 16 bits of the data will be output.

### 5.4.3.7 Mode Switching (0111)

#### (1) Function

This command switches the robot mode from the external device to prepare the robot for operation.

This command is executable only in auto mode. An error will occur in other modes. Before executing this command, select auto mode on the operating panel or the teach pendant.

#### (2) Format

Command area (4 bits, input)

0111

Data area 1 (8 bits, input)

Bit 0 (00000001): Motor ON, CAL execution

Bit 1 (00000010): External speed 100

Bit 7 (10000000): External mode switching

These bits can be set together to execute commands. When two or more bits are set, commands will be executed one after another.

For example, when bits 0, 1 and 7 are set, motor ON, CAL execution, external speed 100 and external mode will be executed in this order.

If bits other than the above are set, an error will result.

Data area 2 (16 bits, input)

Nothing will be input.

Status area (16 bits, output)

Nothing will be output.

#### (3) Description

This command is used for equipment using the robot to switch the operation mode of the robot to external mode from the external device

The processing operations to be executed are specified by the bits set in data area 1 and will be executed from bit 0 to bit 7.

##### ① Motor ON, CAL execution (bit 0)

When this bit is set, the power to the Robot Controller motor will be turned ON and CAL will be executed. If CAL is executed once after the power is turned ON, no processing will take place.

---

② External speed 100 (bit 1)

When this bit is set, the external speed, external acceleration and external deceleration of the Robot Controller will be set to 100.

③ External mode switching (bit 7)

When this bit is set, the mode of the Robot Controller will be switched from automatic to external.

### 5.4.3.8 Clear Robot Failure (1000)

#### (1) Function

This command clears a robot failure that has been caused.

#### (2) Format

Command area (4 bits, input)  
1000

Data area 1 (8 bits, input)  
Nothing will be input.

Data area 2 (16 bits, input)  
Nothing will be input.

Status area (16 bits, output)  
Nothing will be output.

#### (3) Description

If a robot failure occurs, this command clears it. When there is no failure, no processing will take place

When an error is displayed, the same processing as when the **OK** or **Cancel** key of the operating panel or the teach pendant is operated will be performed.

---

### 5.4.3.9 I/O Write (1001)

#### (1) Function

This command substitutes the status specified in data area 1 for the 8-bit internal I/O area starting from the number specified in data area 2.

#### (2) Format

Command area (4 bits, input)  
1001

Data area 1 (8 bits, input)  
The status to be set will be specified in the internal I/O area starting from the number specified in data area 2.

Data area 2 (16 bits, input)  
This is first number of the internal I/O (8-bit) area for which the status will be substituted. The number can be set between 128 and 504. If the number is out of this range, an error (ERROR2034) will occur.

Status area (16 bits, output)  
Nothing will be output.

#### (3) Description

This command substitutes the status specified in data area 1 for the 8-bit internal I/O area starting from the number specified in data area 2.

### 5.4.3.10 I/O Read (1010)

#### (1) Function

This command outputs to the lower 8 bits of the status area the status of the 8-bit internal I/O area starting from the number specified in data area 2.

#### (2) Format

Command area (4 bits, input)  
1010

Data area 1 (8 bits, input)  
Nothing will be input.

Data area 2 (16 bits, input)  
This is the first number of the internal I/O (8-bit) area whose status will be output. The number can be set between 128 and 504. If the number is out of this range, an error (ERROR2034) will occur.

Status area (16 bits, output)  
The status of the 8-bit internal I/O area starting from the number specified in data area 2 will be output to the lower 8 bits of this area.

#### (3) Description

This command outputs to the lower 8 bits of the status area the status of the 8-bit internal I/O area starting from the number specified in data area 2. Zero will be output to the upper 8 bits.

## 5.4.4 Example of Using System I/O Signals in Standard Mode

This section illustrates an example of starting and stopping the robot using system I/O signals.

### (1) Equipment example

Equipment, which makes the robot perform operations by operating an external equipment operating panel connected to the Robot Controller through a PLC as shown in Figure 5-18 and equipped with a display, lamps and switches listed in Table 5-9.

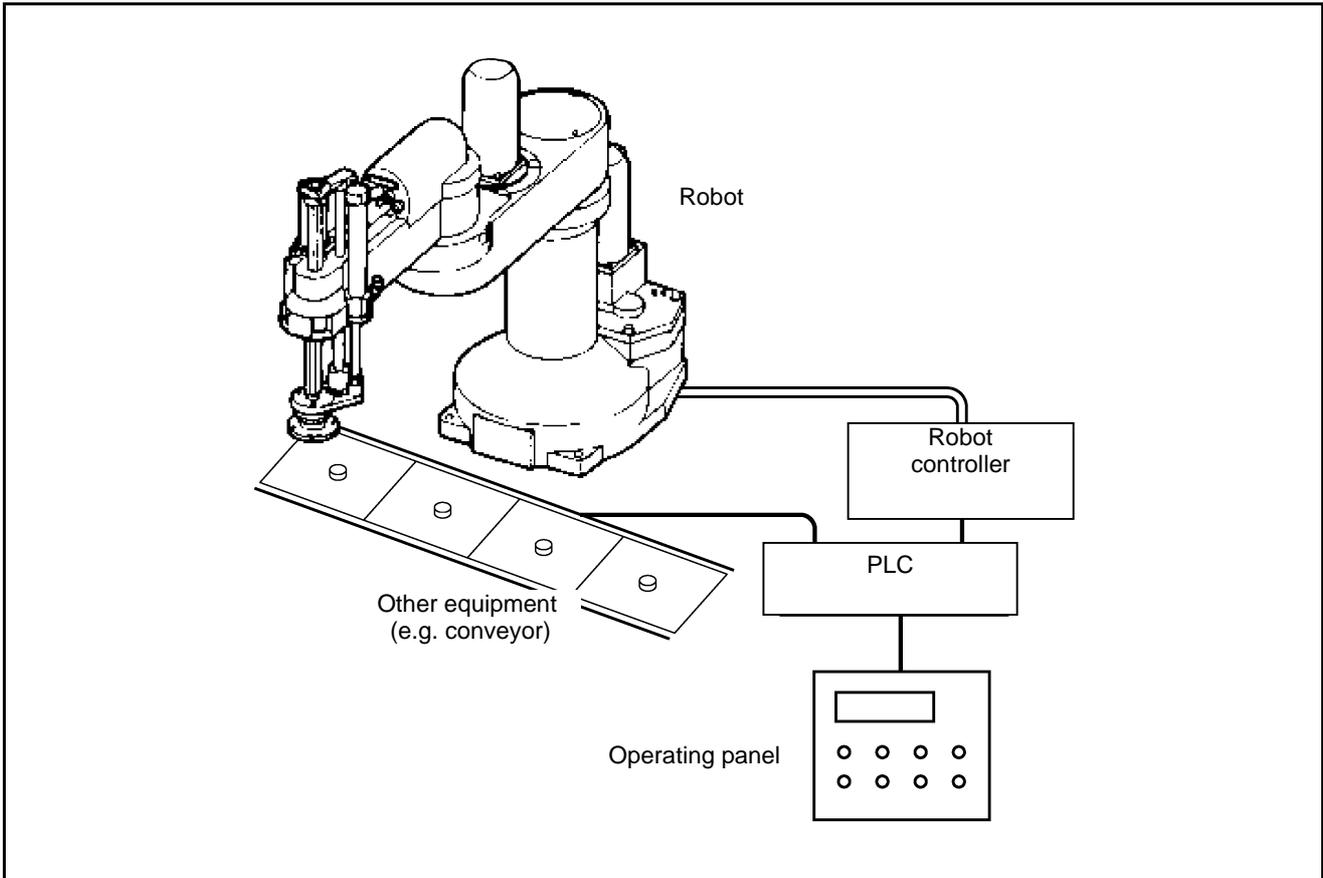


Figure 5-18 Example of Equipment Using a Robot

**Table 5-9 Example of Equipment Operating Panel Functions**

Classification	Part	Application
Display	Display	Displays messages, such as ROBOT PREPARATION OK.
Lamp	① Automatic operation indicator lamp	· Lights during automatic operation. · Turned OFF when the robot is not in automatic operation.
	② Robot external mode indicator lamp	· Lights when the robot is in external mode. · Turned OFF when the robot is not in external mode.
	③ Operation OK indicator lamp	· Lights when the Enable Auto signal is ON. · Turned OFF when the Enable Auto signal is OFF.
Switch	① Robot preparation button	Starts the preparation of the robot.
	② Automatic start button	Starts the operation of the equipment.
	③ Cycle stop button	Stops the equipment after a cycle of operations is completed.
	④ Operation/Adjustment selector switch	Automatic operation of the robot possible when OPERATION is selected. Manual operation or teach check of the robot possible when ADJUSTMENT is selected.
<p><b>Caution: Actual equipment requires emergency stop, interlock and other functions; however, described here are the necessary functions.</b></p>		

### (2) Outline of procedure

Described below is the outline of the procedure when using the equipment taken as an example shown in Figure 5-18.

Follow steps ① to ③.

① Operation preparation start

After setting the MOTOR ON, CAL EXECUTION, EXTERNAL SPEED 100 and EXTERNAL MODE SWITCHING bits, execute the mode switching command to bring the robot into external automatic operation mode. This operation will be completed when the EXTERNAL MODE output signal is turned ON.

② Automatic operation

Start the program by which the robot starts from the operation origin, performs operations, and returns to the operation origin.

③ Operation end

Terminate the day's operations with a cycle stop, and turn OFF the power.

### (3) Start and stop procedure, and system I/O signals

Figures 5-19 and 5-20 show the relationship between the system I/O signals and\*

① The operations by the operator.

② The display on the equipment operating panel, processing by the PLC.

③ The operation of the robot when starting and stopping the robot.

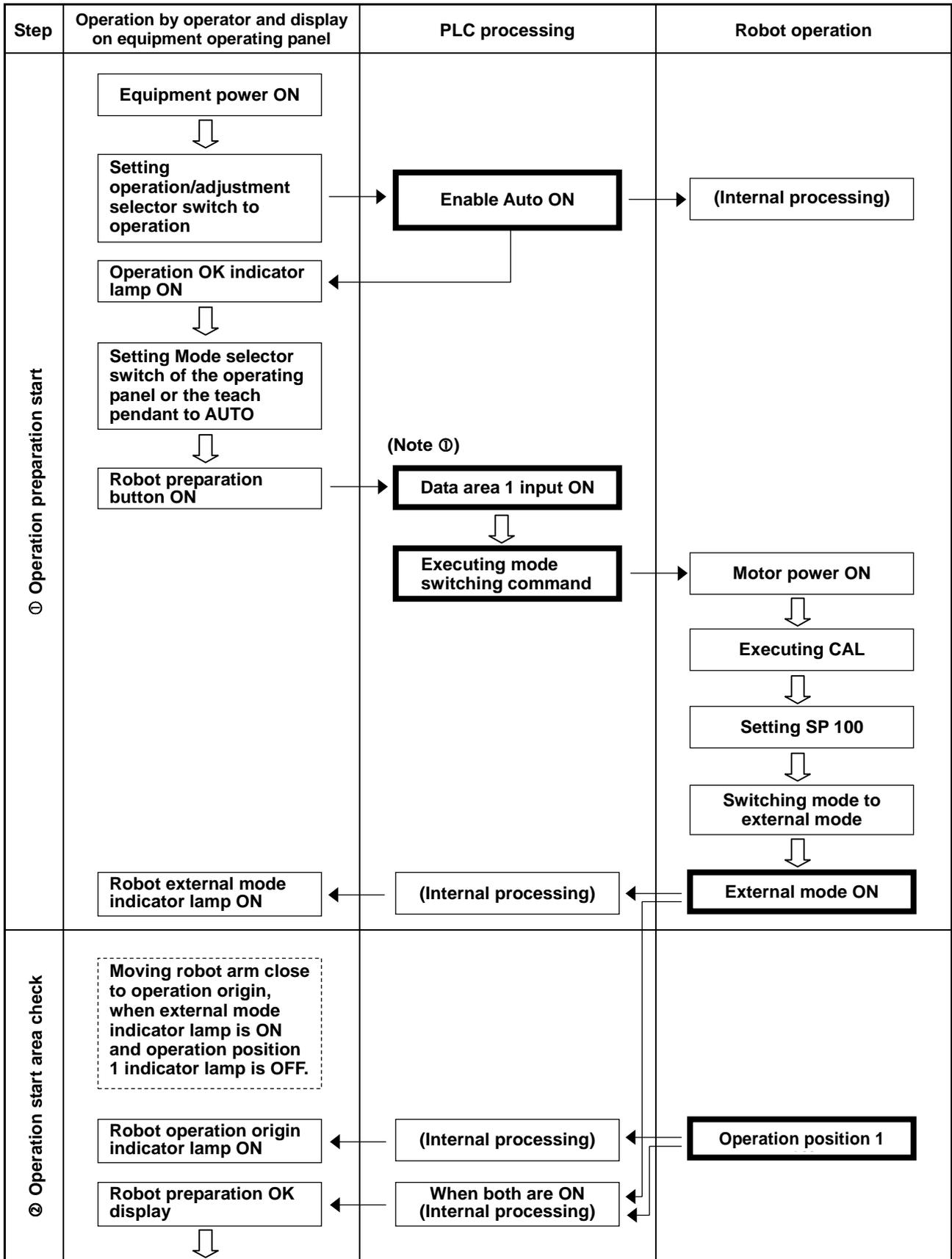


Figure 5-19 Start and Stop Procedure and System I/O Signals-1

(Continued on following page)

(Continued from preceding page)

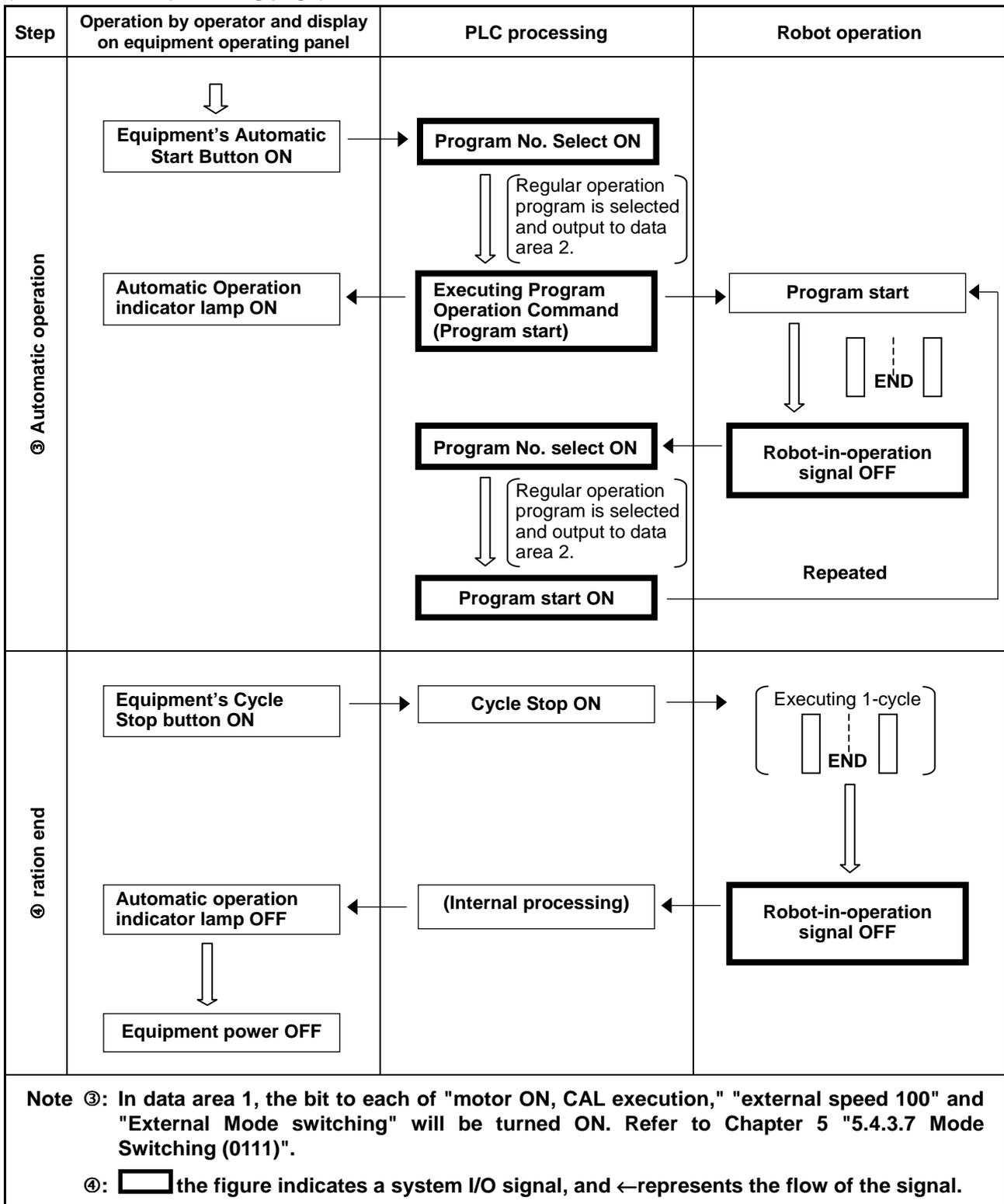


Figure 5-20 Start and Stop Procedure and System I/O Signals-2

## 5.5 System I/O Signals **Compatible Mode**

### 5.5.1 Types and Functions of System Output Signals (Compatible Mode)

Table 5-10 shows the system output signals used in the compatible mode.

**Table 5-10 Types and Functions of System Output Signals to be Used in Compatible Mode**

Application	Signal name	Function
Start-up	Robot power ON complete	Outputs when preparations for operation are ready to start.
	Auto mode	Outputs when the robot is in auto mode.
	Servo ON	Outputs when the power to the motor is turned ON.
	CAL complete	Outputs when calibration is completed.
	External mode	Outputs when the robot is in external mode.
Program pre-execution check	Teaching	Outputs when the robot is in manual or teach check mode.
Program execution	Program start reset	Outputs when execution of the program starts in response to the program start signal received.
	Robot-in-operation	Outputs when the robot is in operation (the program is being executed).
	Continue start permitted	Outputs when the continue start is permitted.
Program end	Single cycle end	Outputs when the program completes a cycle.
Error/warning	Normal CPU	Outputs when the CPU (hardware) of the Robot Controller is normal.
	Robot failure	Outputs when a failure (such as a servo failure and program error) occurs in the robot.
	Robot warning	Outputs when a slight error occurs.
	Dead battery warning	Outputs when the voltage of the encoder backup battery or memory backup battery lowers.
	Error No.	An error number will be outputted in BCD code if an error occurs.
Continue start	Continue start permitted	Outputs when Continue Start is enabled.
Safe start function	SS mode	Outputs when the robot is in SS mode. Refer to the SETTING-UP MANUAL, Chapter 3, Subsection 3.4.6 "SS (Safe Start) Function."
Emergency stop	Emergency stop	Outputs from a contact exclusively designed for an emergency stop circuitry.

## 5.5.2 Usage of System Output Signals in the Compatible Mode

The usage of each system output signal in the compatible mode is described below.

### 5.5.2.1 Robot Power ON Complete

**(1) Function**

The signal outputs to the external device that OPERATION PREPARATION START is possible.

**(2) Terminal number**

No.9 of connector CN10.

**(3) Usage**

OPERATION PREPARATION START will be executed after this signal and the auto mode signal are turned ON after the power was turned ON.

**(4) ON conditions**

- ① The signal will be turned ON when the Robot Controller system program properly starts. Preparations for operation can be started after the power was turned ON.
- ② The signal will be turned ON when the robot failure is cleared by the **OK** or **Cancel** key of the operating panel or the teach pendant or by CLEAR ROBOT FAILURE and OPERATION PREPARATION START signals, after the power was turned OFF.

**(5) OFF conditions**

The signal will be turned OFF when a robot failure or robot warning signal is turned ON.

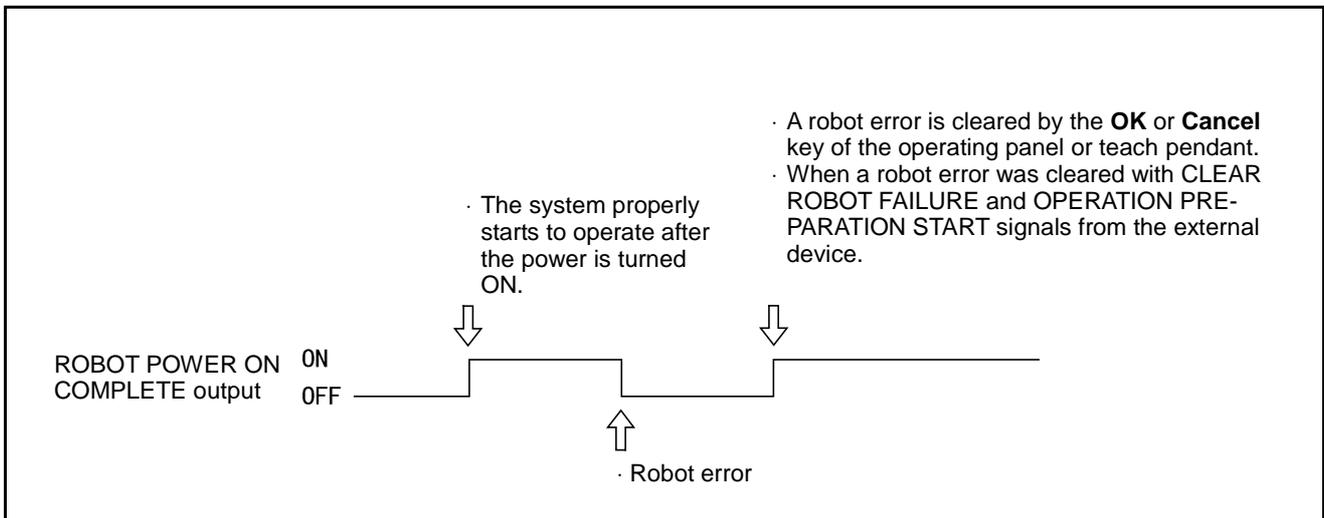


Figure 5-21 Robot Power ON Complete Output

## 5.5.2.2 Auto Mode (Output)

### (1) Function

The signal outputs to the external device that the robot is in the auto mode.

### (2) Terminal number

No.4 of connector CN10.

### (3) Usage

Starting the program from the external device requires an SWITCH EXT MODE input, a PROGRAM NO. SELECT input and a PROGRAM START input. The signal is used to confirm that the robot is in the auto mode.

### (4) ON conditions

The signal will be output when the robot enters the auto mode under the following conditions.

- ① The mode selector switch of the operating panel or the teach pendant is set to AUTO.

### (5) OFF conditions

The signal will be turned OFF under the following conditions.

- ① When the mode selector switch of the operating panel is set to MANUAL or the teach pendant is set to MANUAL or TEACH CHECK.
- ② When Enable Auto OFF is input.

(Caution: The signal will not be turned OFF in the pendantless state described in Chapter 3, Subsection 3.2.3, "[ 3 ] Pendantless State.")

**Caution: The signal will not be turned OFF with INSTANTANEOUS STOP, STEP STOP or CYCLE STOP.**

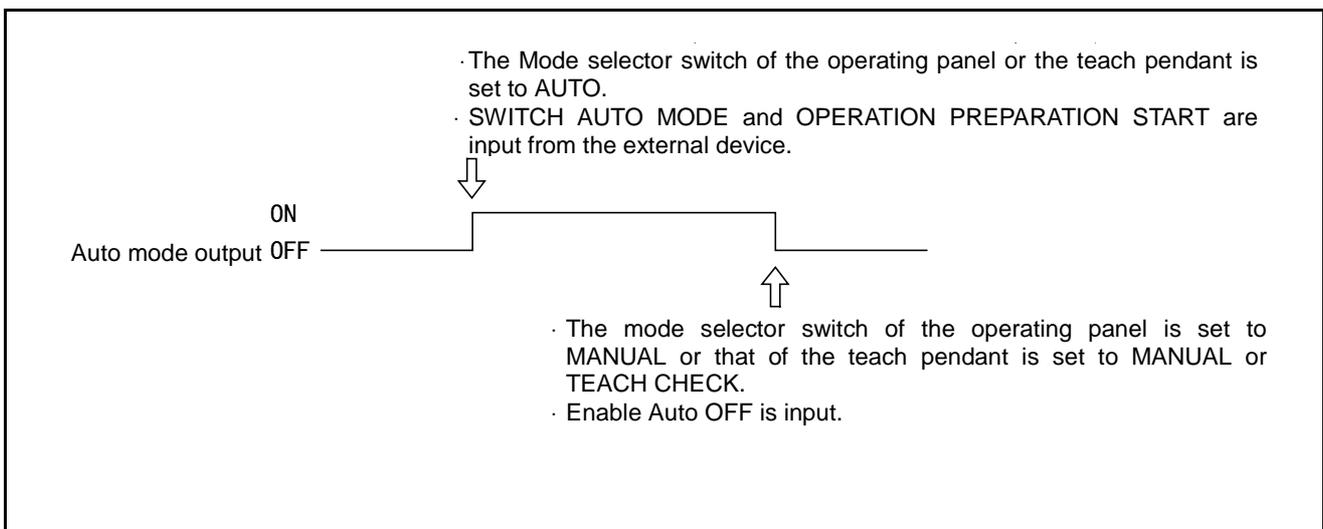


Figure 5-22 Auto Mode Output

### 5.5.2.3 Servo ON (Output)

**(1) Function**

The signal outputs to the external device that the power to the robot motor is turned ON.

**(2) Terminal number**

No. 10 of connector CN10.

**(3) Usage**

Executing CAL from the external device or starting the program requires the power to the motor to be turned ON. This signal is used to confirm that the power to the motor is turned ON and to light the motor power ON indicator lamp on an external operating panel.

**(4) ON conditions**

The signal will be turned ON when the power to the motor is turned ON under the following conditions.

- ① The **MOTOR** switch on the operating panel or the teach pendant is activated.
- ② MOTOR POWER ON + OPERATION PREPARATION START signals are input from the external device.

**(5) OFF conditions**

The signal will be turned OFF when the power to the motor is turned OFF under the following conditions.

- ① The **MOTOR** switch of the operating panel or the teach pendant is deactivated and the **ROBOT STOP** button is operated.
- ② ROBOT STOP is input from the external device.
- ③ ROBOT FAILURE is outputted. If any of errors 0 × 6071 to 607B, 0 × 6671 to 667B, 0 × 607F occurs, the servo ON signal will be turned OFF in External Auto mode but will not be turned OFF in manual or teach check mode.

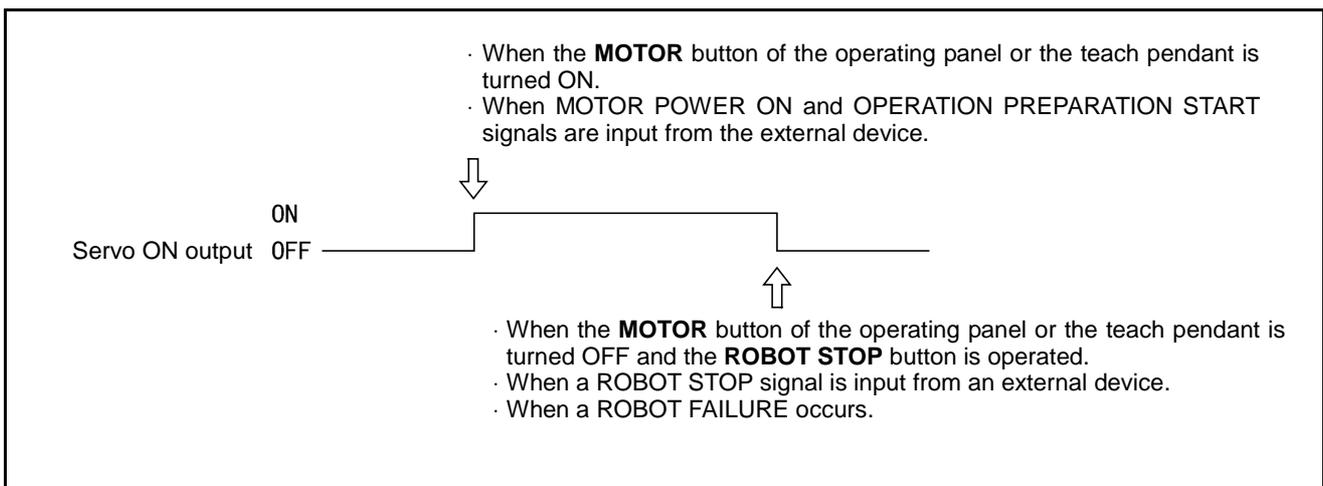


Figure 5-23 Servo ON Output

## 5.5.2.4 CAL Complete (Output)

### (1) Function

The signal outputs to the external device that CAL is completed.

### (2) Terminal number

No. 11 of connector CN10.

### (3) Usage

This signal is used to determine whether to execute CAL.

Once CAL is completed, it does not need to be executed again as long as the power to the Robot Controller is turned ON.

### (4) ON conditions

The signal will be turned ON upon proper completion of CAL under the following conditions.

- ① When CAL is performed by the operating panel or teach pendant.
- ② When CAL EXECUTION and OPERATION PREPARATION START signals are input from the external device.

### (5) OFF conditions

The signal will be turned OFF when CAL is not properly completed as shown in Figure 5-24.

It will remain OFF until CAL is performed again and properly completed.

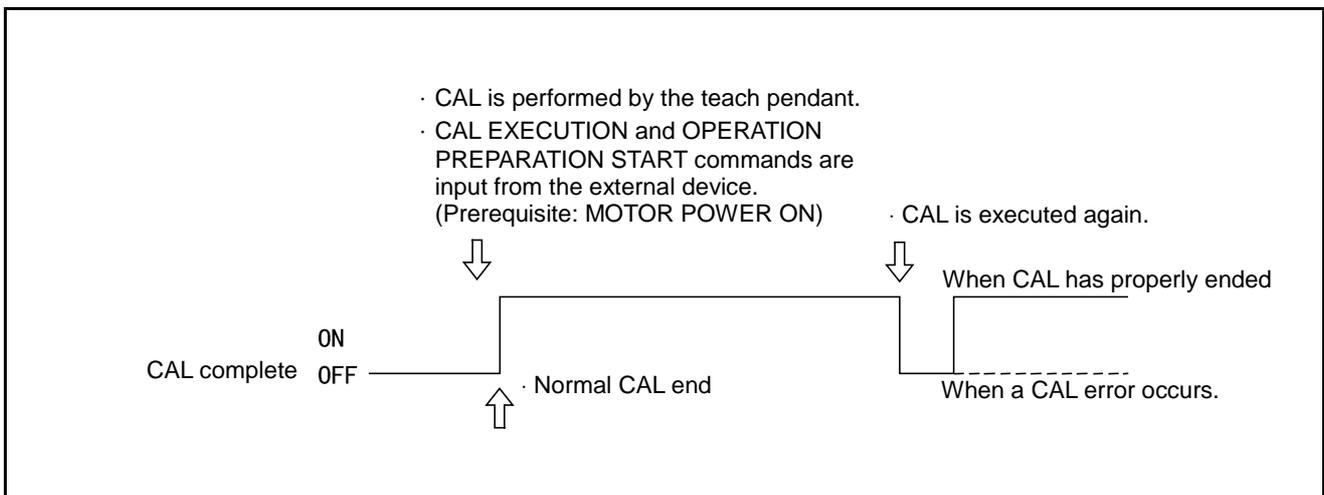


Figure 5-24 CAL Complete Output

### 5.5.2.5 External Mode (Output)

**(1) Function**

The signal outputs to the external device that the robot is in the external mode.

**(2) Terminal number**

No. 5 of connector CN10.

**(3) Usage**

Starting the program from the external device requires an SWITCH EXT MODE input, PROGRAM NO. SELECT input and a PROGRAM START input. The signal is used to confirm to the external device that the robot is in external mode.

**(4) ON conditions**

The signal will be turned ON under the following conditions.

- ① When INTERNAL/EXTERNAL is input on the teach pendant and the external mode is selected.
- ② When EXTERNAL/INTERNAL is input on the operating panel in AUTO MODE and in the INTERNAL CONTROL ON state.
- ③ When SWITCH EXT MODE and OPERATION PREPARATION START signals are input from the external device.

**(5) OFF conditions**

The signal will be turned OFF under the following conditions.

- ① When the mode selector switch of the teach pendant is set to MANUAL or TEACH CHECK in external mode.
- ② When EXTERNAL/INTERNAL is input on the teach pendant and external mode is selected.
- ③ When EXTERNAL/INTERNAL is input on the operating panel in AUTO MODE and in the INTERNAL CONTROL OFF state.
- ④ When ROBOT STOP is input.
- ⑤ When ROBOT FAILURE is outputted.

**Caution: The signal will not be turned OFF with STEP STOP.**

- ⑥ When an Enable Auto input is turned OFF.

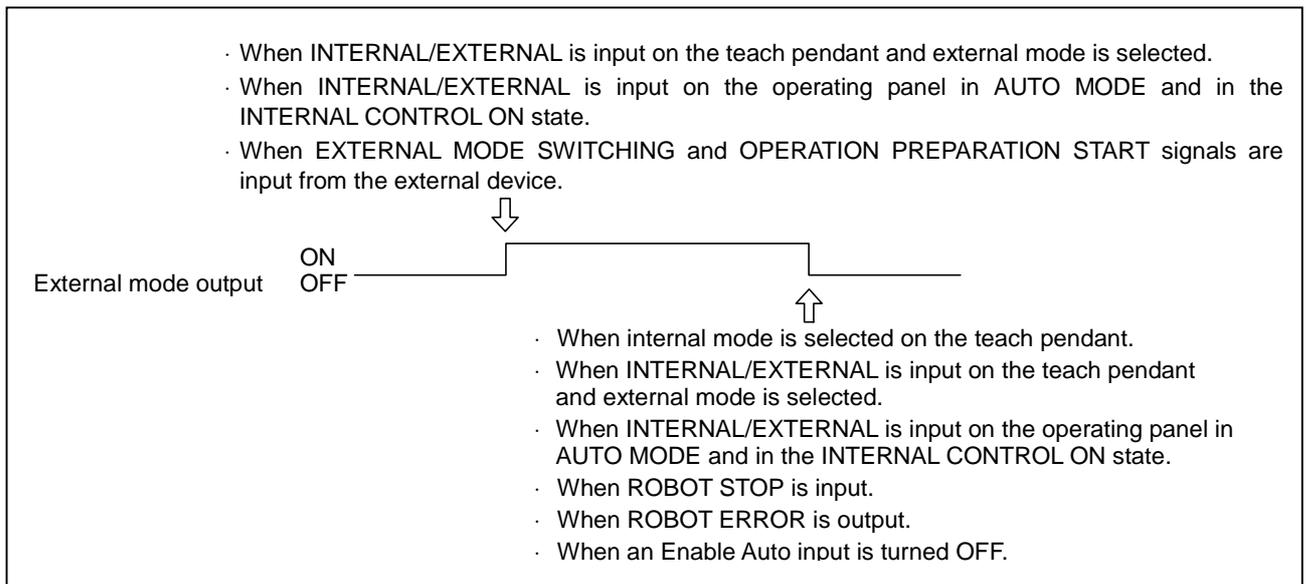


Figure 5-25 External Mode Output

## 5.5.2.6 Teaching (Output)

### (1) Function

The signal outputs to the external device that the robot is in the manual mode or teaches check mode.

### (2) Terminal number

No. 12 of connector CN10.

### (3) Usage

This signal is used to inform an external operating panel that the robot is teaching when they are installed separately from each other.

### (4) ON conditions

The signal will be turned ON when the mode selector switch of the operating panel or the teach pendant is set to MANUAL or TEACH CHECK, as shown in Figure 5-26.

### (5) OFF conditions

The signal will be turned OFF when the mode selector switch of the operating panel or teach pendant is set to AUTO and the Enable Auto input is turned ON.

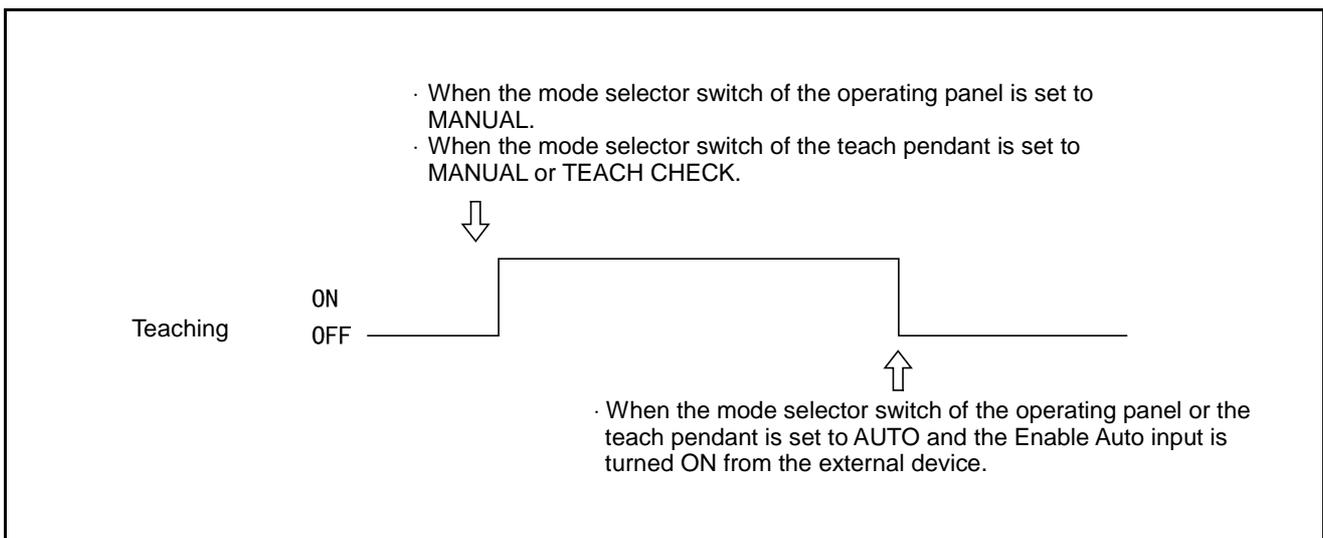


Figure 5-26 Teaching Output

### 5.5.2.7 Program Start Reset (Output)

**(1) Function**

This signal is output to the external device when the robot receives a start signal from the external device and starts to operate.

**(2) Terminal number**

No. 6 of connector CN10.

**(3) Usage**

- ① The signal is used to prompt the external device to receive information that the robot program has started to run, and to process subsequent sequence programs.
- ② The signal is used as a condition to turn OFF the PROGRAM START signal sent from the external device to the robot.

**(4) ON conditions**

The signal will be turned ON immediately after the robot program starts to run, as shown in Figure 5-27.

**(5) OFF conditions**

The signal will be turned OFF automatically when the PROGRAM START signal sent to the robot is turned OFF.

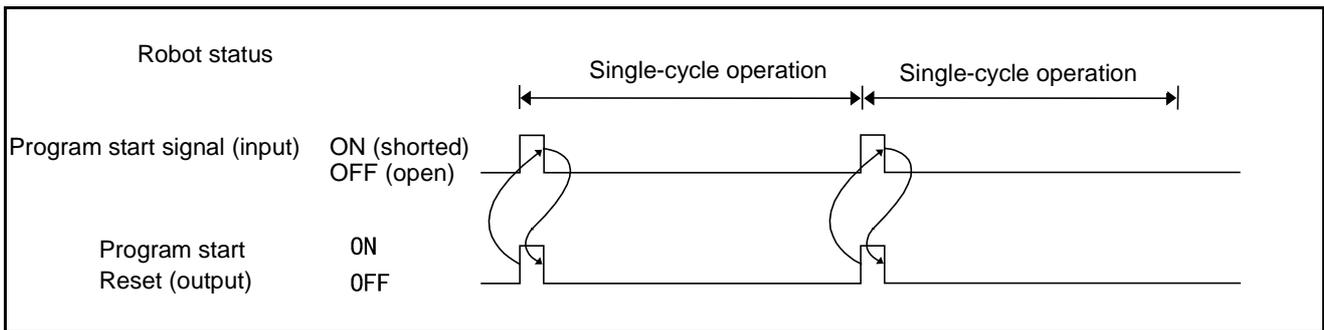


Figure 5-27 Program Start Reset Output ON Condition

---

## 5.5.2.8 Robot-in-operation (Output)

### (1) Function

The signal outputs to the external device that the robot is in operation (executing more than one task ).

### (2) Terminal number

No. 2 of connector CN10.

### (3) Usage

The signal is used to light the robot operating indicator lamp of the external operating panel.

Since the signal is turned OFF with STOP ALL PROGRAMS, it outputs to the external device that all programs are stopped.

### (4) ON conditions

The signal will be turned ON while executing the program and also in the Wait State with a condition branch or timer command.

### (5) OFF conditions

The program will be turned OFF with STOP ALL PROGRAMS.

<p><b>Caution: STOP ALL PROGRAMS means the operation of the ROBOT STOP or STOP button of the operating panel or the teach pendant and INSTANTANEOUS TOP (ALL TASKS), STEP STOP (ALL TASKS) and ROBOT STOP inputs.</b></p>
---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

### 5.5.2.9 Single-Cycle End (Output)

**(1) Function**

The signal outputs to the external device that a single-cycle of the program is completed.

**Caution** ① The single-cycle end signal will be output upon reading END of the program. However, it will be output earlier than the end of the actual robot operation because the Robot Controller pre-reads the program.

② The single-cycle end signal will be output on the premise that only one program is executed at a time. If two or more programs are executed simultaneously (multi-tasks), the single-cycle end signal will be turned ON immediately after any of the programs reads an END command.

**(2) Terminal number**

No. 13 of connector CN10.

**(3) Usage**

The signal is used to operate another equipment in synchronization with a single-cycle end of the program.

**(4) ON conditions**

The signal will be turned ON when the program is read to the end.

**(5) OFF conditions**

The signal will be turned OFF immediately after the program starts to run.

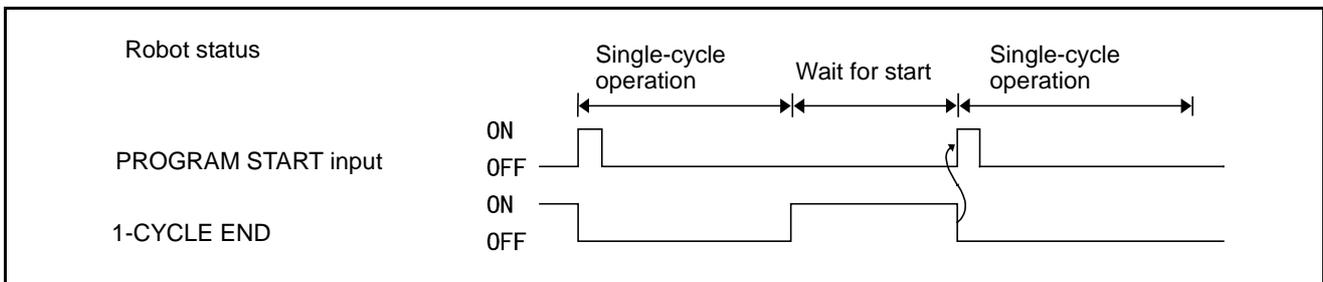


Figure 5-28 Single-Cycle End Output

## 5.5.2.10 Normal CPU (Output)

### (1) Function

The signal outputs to the external device that the CPU (hardware) of the Robot Controller is normal.

### (2) Terminal number

No. 1 of connector CN10.

### (3) Usage

- ① The signal is used to light the Robot Controller error indicator lamp of an external operating panel.
- ② The signal is used when the NORMAL CPU signal is turned OFF because of an error and the PLC corrects it.

### (4) ON conditions

The signal will be turned ON by the hardware when the CPU of the Robot Controller operates normally with the power turned ON.

### (5) OFF conditions

The signal will be turned OFF by the hardware when the CPU does not operate normally.

**Caution: The OFF state of this signal indicates that the internal arithmetic circuit of the Robot Controller may be damaged and ROBOT ERROR, ERROR NUMBER and other outputs may not be correct.**

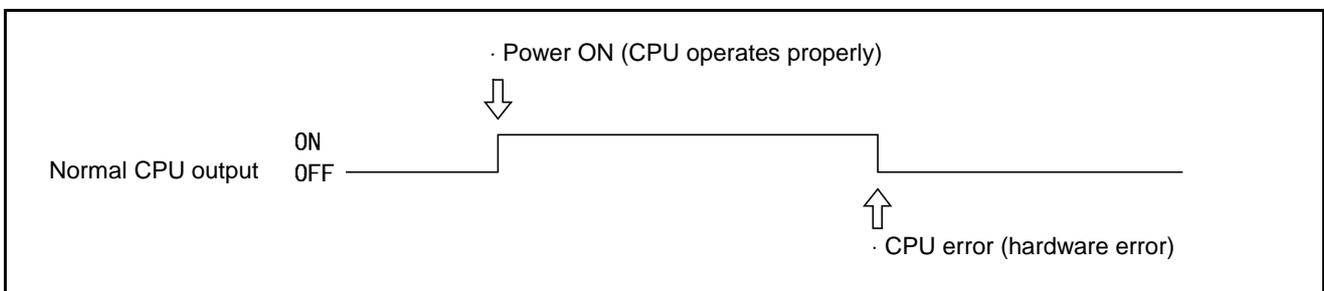


Figure 5-29 Normal CPU Output

### 5.5.2.11 Robot Failure (Output)

**(1) Function**

The signal outputs to the external device that a problem, such as a servo error and a program error, occurs with the robot.

**(2) Terminal number**

No. 3 of connector CN10.

**(3) Usage**

- ① The signal is used to light the robot failure indicator lamp of an external operating panel.
- ② The signal is used to help the PLC clear an error in response to a ROBOT FAILURE signal.

**(4) ON conditions**

As shown in Figure 5-30, the signal will be turned ON under the following conditions.

- ① When an error, such as a servo error, a program error and undefined program, occurs at the start of the program and during execution of the program.
- ② When an error occurs during execution of the program in internal operation by the operating panel or the teach pendant or in external operation by the PLC.
- ③ When an error, such as undefined program, occurs at the start of the program only in external operation.

**Caution: The signal will not be output when an error, such as a program input error occurs in manual operation, except when a servo error occurs in manual operation. For further information, see "ERROR CODE TABLES."**

**(5) OFF conditions**

As shown in Figure 5-30, the signal will be turned OFF under the following conditions.

- ① When a CLEAR ROBOT FAILURE command is input from the external device and the existing error is cleared.
- ② When the existing error is cleared by operating the **Cancel** key of the operating panel or the teach pendant.

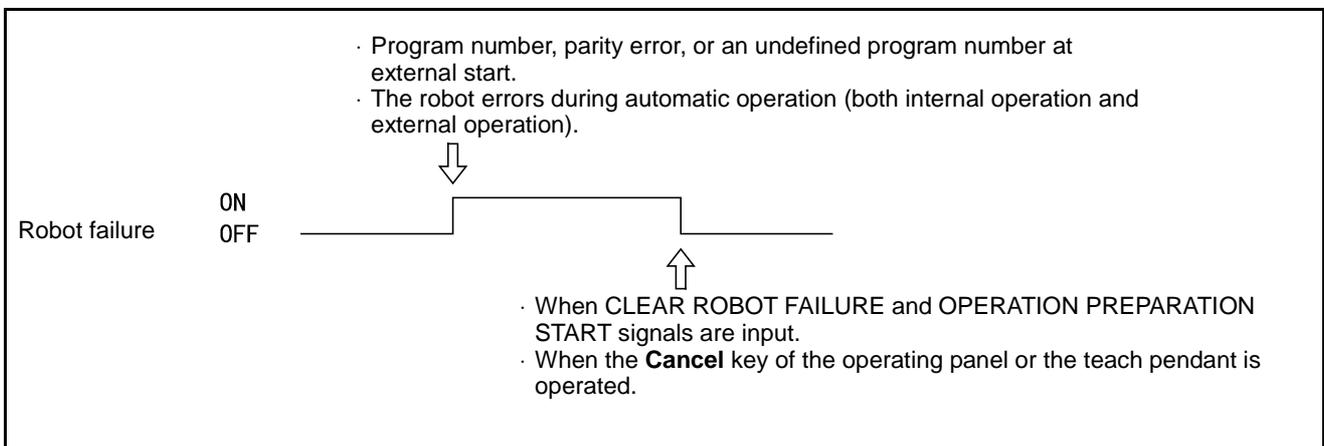


Figure 5-30 Robot Failure Output

## 5.5.2.12 Robot Warning (Output)

### (1) Function

The signal outputs to the external device that a minor error has occurred with an I/O command or during servo processing.

**Caution: The signal will not be output in case of a minor error, such as a program selection error, caused by the operation of the teach pendant or operating panel.**

### (2) Terminal number

No. 15 of connector CN10.

### (3) Usage

- ① The signal is used to light the robot warning indicator lamp of an external operating panel.
- ② The signal is used to help the PLC clear an error in response to a ROBOT WARNING signal.

### (4) ON conditions

As shown in Figure 5-31, the signal will be turned ON when a minor error occurs during I/O processing, execution of the program or servo processing, irrespective of the operation mode.

### (5) OFF conditions

As shown in Figure 5-31, the robot-warning signal will be turned OFF under the following conditions.

- ① When CLEAR ROBOT FAILURE and OPERATION PREPARATION START signals are input from the external device and the existing error is cleared.
- ② When the existing error is cleared by operating the **OK** or **Cancel** key of the operating panel or the teach pendant.

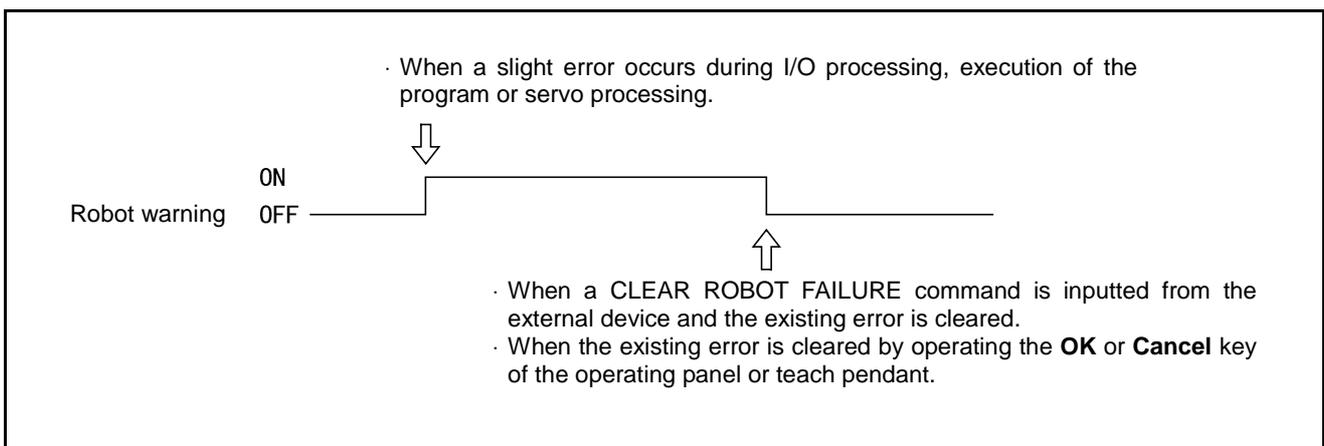


Figure 5-31 Robot Warning Output

### 5.5.2.13 Dead Battery Warning (Output)

**(1) Function**

The signal will be output when the voltage of the encoder back-up battery or memory back-up battery becomes dangerously low.

**(2) Terminal number**

No. 14 of connector CN10.

**(3) Usage**

The signal is used to check the timing of battery replacement (lowering of the battery voltage).

**(4) ON conditions**

The signal will be turned ON when the voltage of the encoder back-up battery or memory back-up battery becomes dangerously low.

**Caution:** Any error of ERROR64A1 to 64A6 indicating the dead encoder back-up battery or ERROR6103 informing the dead memory back-up battery will be displayed on the operating panel and the teach pendant respectively.  
(For details, refer to Section 6.5 "Biennial Inspections.")

**(5) OFF conditions**

The signal will be turned OFF when the power is turned ON after the dead battery was replaced.

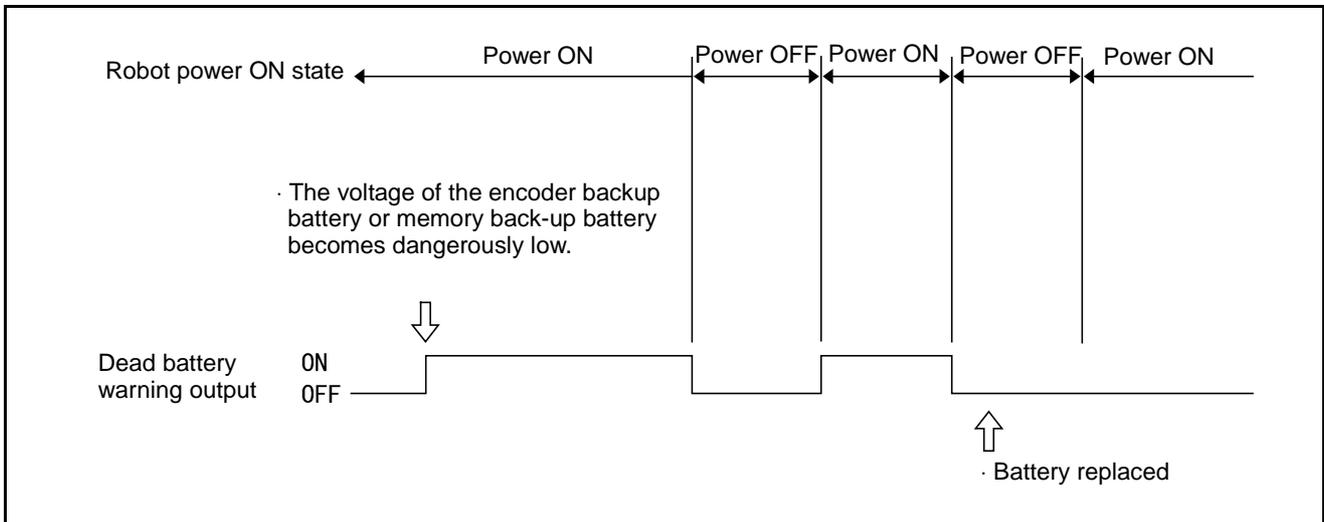


Figure 5-32 Dead Battery Warning Output

## 5.5.2.14 Error No. (Output)

### (1) Function

When an error occurs, the signal outputs the error number in a 3-digit (12-bit) hexadecimal code.

### (2) Terminal numbers

No.17 to No.28 of connector CN10.

### (3) Usage

The signal is used to display an error number on the external device.

### (4) Output conditions

The signal will be output when an error occurs.

### (5) Clear conditions

The signal will be cleared when CLEAR ROBOT FAILURE and OPERATION PREPARATION START signals are inputted or by operating the **Cancel** key of the operating panel or the teach pendant. When this signal is cleared, all states will become OFF (0).

### (6) Hexadecimal codes

See Figure 5-33.

xxxx	→ 0	xOxO	→ 5	OxOx	→ A		
xxxO	→ 1	xOOx	→ 6	OxOO	→ B		
xxOx	→ 2	xOOO	→ 7	OOxx	→ C		
xxOO	→ 3	Oxxx	→ 8	OOxO	→ D		
xOxx	→ 4	OxxO	→ 9	OOOx	→ E	O...ON	
				OOOO	→ F	x...OFF	

Figure 5-33 Hexadecimal Codes

Figure 5-34 shows an example of error number output, when ERROR174 (overload error with the fourth axis) occurs.

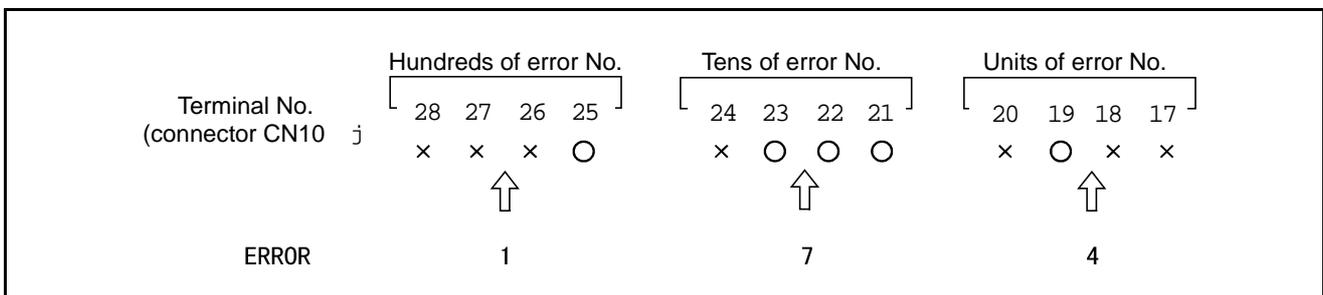


Figure 5-34 Example of Error Number Output

### 5.5.2.15 Continue Start Permitted (Output)

**(1) Function**

The controller will output this signal when the continue start is permitted.

**(2) Terminal number**

No.16 of connector CN10.

**(3) Usage**

Use this signal when you want to know whether the continue start is permitted.

**(4) ON condition**

This signal comes on when the continue start is permitted. For details, refer to the SETTING-UP MANUAL.

**(5) OFF condition**

This signal goes off by carrying out the "Task Status Change Operation."

### 5.5.2.16 SS mode (Output)

**(1) Function**

The controller will output this signal during the SS mode.

This mode is effective when the slow mode is selected.

**(2) Terminal number**

No. 29 of connector CN10

**(3) Usage**

This signal is used to warn workers that the robot is in the SS mode by beeping or lighting the lamp.

**(4) ON condition**

This signal comes on when the SS mode is selected.

**(5) OFF condition**

The signal goes off when the TS time passes so as to cancel SS mode. This function is effective when the slow mode is selected.

Note: If the TS time passes, this signal goes off even when the robot is operation in the slow mode. After this signal goes off, the robot runs at the original speed.

---

## 5.5.2.17 Emergency Stop (Output from a contact)

### (1) Function

This signal outputs from a contact exclusively designed for an emergency stop circuitry you may configure. It allows red mushroom buttons provided on the front panel of the robot controller, on the teach pendant, and on the operating panel to be used as emergency stop buttons of the facilities.

A 0.3A fuse is built in the contact.

### (2) Terminal number

No. 10 of connector CN10: Emergency stop (+)

No. 10 of connector CN10: Emergency stop (-)

### (3) Usage

This signal is used to stop the facilities or robot in an emergency. (Refer to Subsection 5.6.2.4 "Emergency Stop Circuit.")

### (4) Contact

This contact is a normal close one (b contact). If any of the emergency stop buttons is pressed, then the contact turns off to output an emergency stop signal.

### 5.5.3 Types and Functions of System Input Signals (Compatible Mode)

Table 5-11 shows the system input signals to be used in compatible mode.

Table 5-11 Types and Functions of System Input Signals to be Used in Compatible Mode

Application	Signal name	Function
Start-up	Enable Auto	Enables switching to Auto mode.
	Motor power ON + operation preparation start	Turns ON the power to the motor.
	CAL execution + operation preparation start	Executes calibration.
	SP100 + operation preparation start	Sets the speed to 100%.
	Switch Ext Mode + operation preparation start	Switches the mode to external mode.
	Program reset + operation preparation start	Initializes all programs on halt. Starting a program after initialization will execute the program from the beginning.
	Program No. select + program start	Executes a specified program.
Program execution	Program reset + program No. select + program start	Cancels the current program and starts executing a specified program from the beginning.
	Robot stop	Stops the robot by opening signals.
Stop	Robot stop	Stops the robot by canceling signals.
	Step stop	Step-stops all programs by opening signals.
	Instantaneous stop	Instantaneously stops all programs by opening signals.
Error clear	Clear robot failure + operation preparation start	Clears an error.
Program interrupt	Interrupt skip	Interrupts the execution of the current step and starts the next step.
Continue start	Continue start + program start	Executes continue start.

**Caution: Two or more signal names listed in the signal name field indicate that they should be used in combination.**

## 5.5.4 Usage of System Input Signals in Compatible Mode

The usage of each system input signal in compatible mode is described below:

### 5.5.4.1 Enable Auto (Input)

#### (1) Function

- ① The signal enables switching of the robot mode to the Auto mode (shorted state).
- ② The signal enables switching of the robot mode to the manual mode or the teach check mode (open state).

#### (2) Terminal number

No.4 of connector CN8.

#### (3) Usage

The signal is used for the **AUTO/TEACHING** selector switch of the external operating panel and can be combined with the safety fence switch.

#### (4) Input conditions and operation

- ① As shown in Table 5-12, the selectable operation mode depends on whether this input is shorted or open.
- ② If the input becomes open during automatic operation, the mode will be switched to manual mode and ERROR21FC will be displayed.
- ③ If manual operation or a teach check is conducted with this input shorted, ERROR21F2 will be displayed.
- ④ If the mode selector switch of the teach pendant or the operating panel is set to AUTO with this input open, ERROR21F3 will be displayed. Since this state is × in Table 5-5, this error will remain displayed until the robot leaves this state.
- ⑤ Although ERROR21FD or ERROR21FC will be displayed when the state is changed from ○ to Δ or × shown in Table 5-5, they will not be displayed when the state is changed from Δ or × to ○.
- ⑥ When the input is turned OFF (open) in external mode, the external mode output will also be turned OFF.

**Table 5-12 Relationship Between Enable Auto Input and Selectable Mode**

Operation Mode	Application	Enable Auto	
		ON (shorted)	OFF (open)
Manual mode	Manual operation with the operating panel or teach pendant	Δ	○
Teach check mode	Program check with the teach pendant	Δ	○
Internal Auto mode	Automatic operation with the operating panel or teach pendant	○	×
External Auto mode	Automatic operation with the external device	○	×
<b>Note:</b> ○ = Mode selectable      × = Mode not selectable Δ = Mode selectable, but manual operation and program execution impossible			

**Caution:** In the pendantless state described in Chapter 3, subsection 3.2.3 [ 3 ], auto mode is valid even if the Enable Auto input is open (external mode cannot be switched and the program cannot start to run).

Perform the following when operating the robot in the pendantless state:

- ① Set the robot not to start to operate when the Enable Auto input is open.
- ② Enable Auto input open state and auto mode output (See 5.3.2.2 and 5.5.2.2 "Auto Mode ".)  
Set the equipment to make an emergency stop in an AND state.

Add ① and ② with the external sequence circuit.

### 5.5.4.2 Operation Preparation Start (Input)

#### (1) Function

- By turning ON (short) this signal, input signals ① to ④ described in (3), input conditions and operation will be detected and the robot will automatically start to operate. Input these signals with the system output ROBOT POWER ON COMPLETE turned ON.
- By turning ON (short) CLEAR ROBOT FAILURE, an error that has occurred will be cleared.

#### (2) Terminal number

No.8 of connector CN8.

#### (3) Input conditions and operation

Before inputting an operation preparation start signal, turn ON (short) inputs ① to ④ below:

##### ① Motor power ON (input)

- Terminal number: No.19 of connector CN8
- By turning ON (short) the operation preparation start signal with this signal turned ON (shorted), the power to the motor will be turned ON. However, this signal can be used only in the Auto mode.

##### ② CAL execution (input)

- Terminal number: No.20 of connector CN8
- By turning ON (short) the operation preparation start signal with this signal turned ON (shorted), calibration takes place. However, this signal cannot be used when the power to the motor is turned OFF (① not executed).

##### ③ SP100 (input)

- Terminal number: No.22 of connector CN8
- By turning ON (short) the operation preparation start signal with this signal turned ON (shorted), SP100% will be set.

##### ④ Switch Ext Mode (input)

- Terminal number: No.23 of connector CN8
- By turning ON (short) the operation preparation start signal with this signal turned ON (shorted), the mode will be set to the external mode. However, this signal cannot be used when the power to the motor is turned OFF and CAL is not completed.

##### ⑤ Program reset (input)

- Terminal number: No.24 of connector CN8
- By turning ON (short) the operation preparation start signal with this signal turned ON (shorted), all programs will be initialized.

**NOTE:** By turning ON (short) the operation preparation start signal with all inputs ① to ⑤ turned ON (shorted), ① to ⑤ will be executed one by one. Input ② cannot be executed until input ① is completed. Inputs ① to ⑤ will also become valid when part of them are executed by the operating panel or teach pendant.

For the input timing of the operation preparation start signal and ① to ④, see Figure 5-35.

**Caution:** The operation preparation start signal and each input signal, except the Enable Auto signal, will be turned OFF (falling) upon turning ON of the external mode output is turned ON. Although the robot is made to execute all items at start-up, execute only necessary items at the time of recovery from suspension during operation to reduce recovery time. The required time to execute all items may be about 5 seconds depending on CAL time. The time is about 1.3 seconds without CAL. (Once CAL is completed, it does not need to be executed again as long as the power to the Robot Controller is turned ON.) Determine whether to execute CAL according to the CAL complete output.

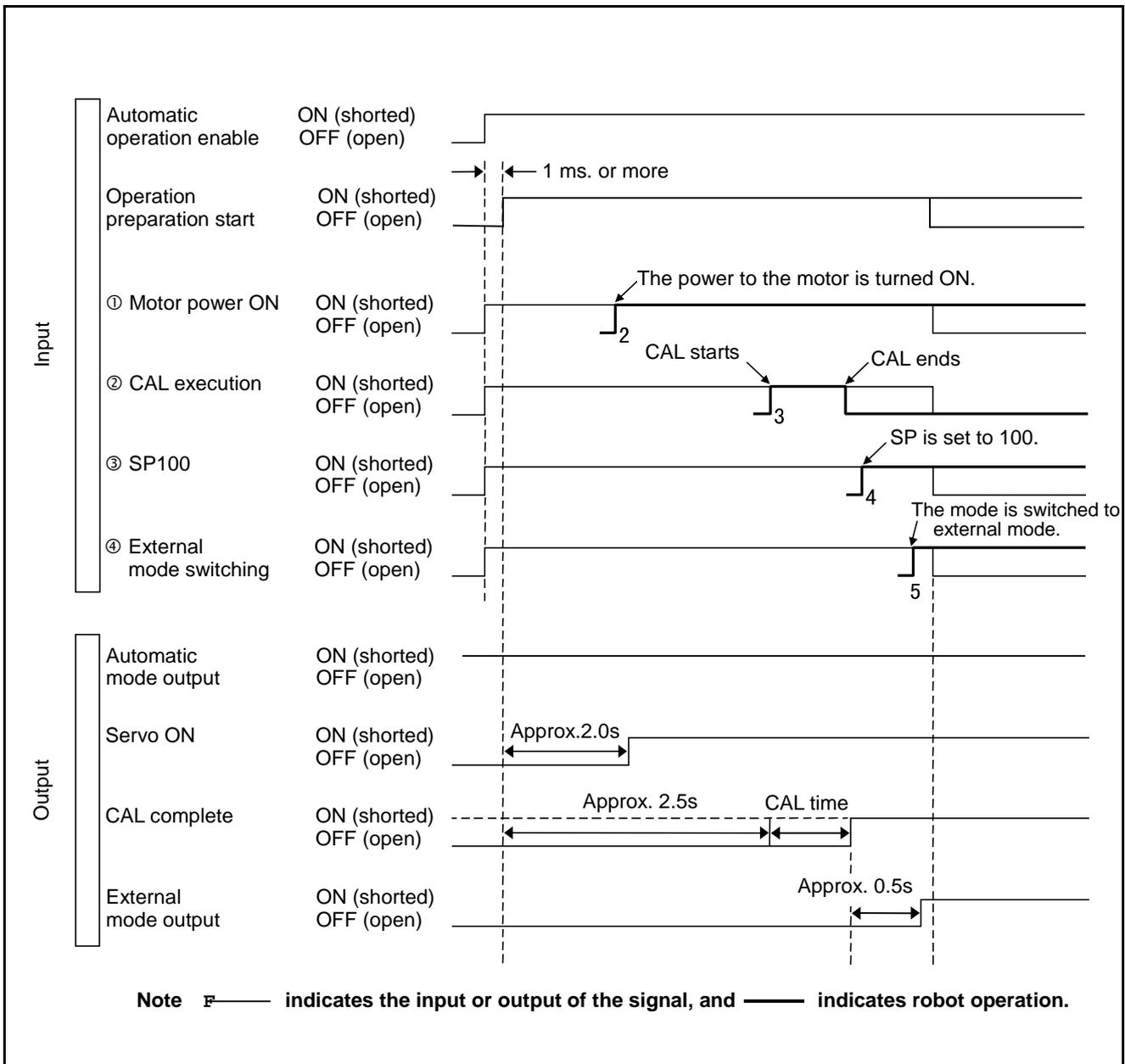


Figure 5-35 Example of Operation Preparation Start Signal Timing Chart

### 5.5.4.3 Program No. Select (Input)

#### (1) Function

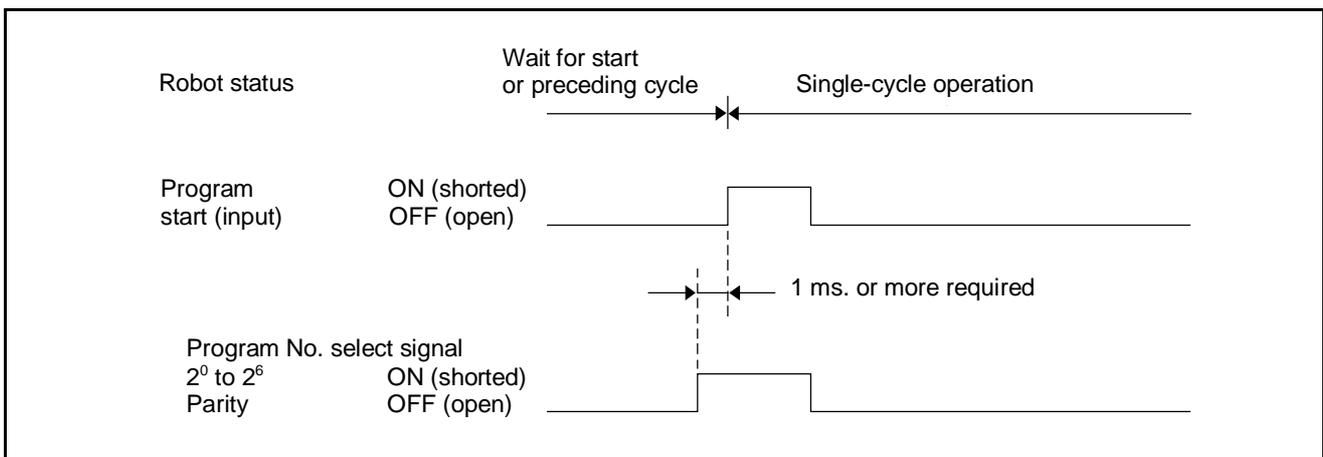
The program number to be executed can be specified from the external device by inputting this signal.

#### (2) Terminal numbers

No.11 to No.18 of connector CN8.

#### (3) Input conditions and operation

- ① This signal is executable only in the external mode. In other modes, an error (ERROR21E2, 21E4, 21E6) will be displayed, and the terminal motor power will be turned OFF.
- ② As shown in Table 5-13, the program No. select signal is made up of eight bits of  $2^0$  to  $2^6$  and the parity bit.
- ③ Input a decimal program number by converting it into binary  $2^0$  to  $2^6$  and parity bit.
- ④ "Short" represents the bit value = 1, "open" represents the bit value = 0, and the parity bit is odd parity.
- ⑤ As shown in Figure 5-36, input the program No. select signal before the program start signal (1 msec. or more), and hold the state until the robot starts to operate. If this condition is not met, ERROR2031 or ERROR2033 will be displayed, the power to the motor will be turned OFF, and the mode will be switched to the Auto mode.



**Figure 5-36 Program No. Select Signal**

- ⑥ Input 1 or 0 as the parity bit so that the total of 1's existing in the eight bits of  $2^0$  to  $2^6$  and the parity bit will be odd.  
 Example: When the program number is 15, the bit status of  $2^0$  to  $2^6$  is (001111), and the total number of 1s is four, an even number. Set 1 as the parity bit to make the total number of 1s five, an odd number.

**Caution** ① The bit value =1 represents short, and the bit value =0 represents open.  
 ② The program numbers executable from the external device are limited to Pro0 to Pro127.

Table 5-13 Example of Program No. Select Signals

Input signal	Program No. (decimal)			
	1	15	26	65
$2^0 = 1$	1	1	0	1
$2^1 = 2$	0	1	1	0
$2^2 = 4$	0	1	0	0
$2^3 = 8$	0	1	1	0
$2^4 = 16$	0	0	1	0
$2^5 = 32$	0	0	0	0
$2^6 = 64$	0	0	0	1
Parity	0	1	0	1

Figure 5-37 shows an example of a program No. select signal sequence circuit considering parity.

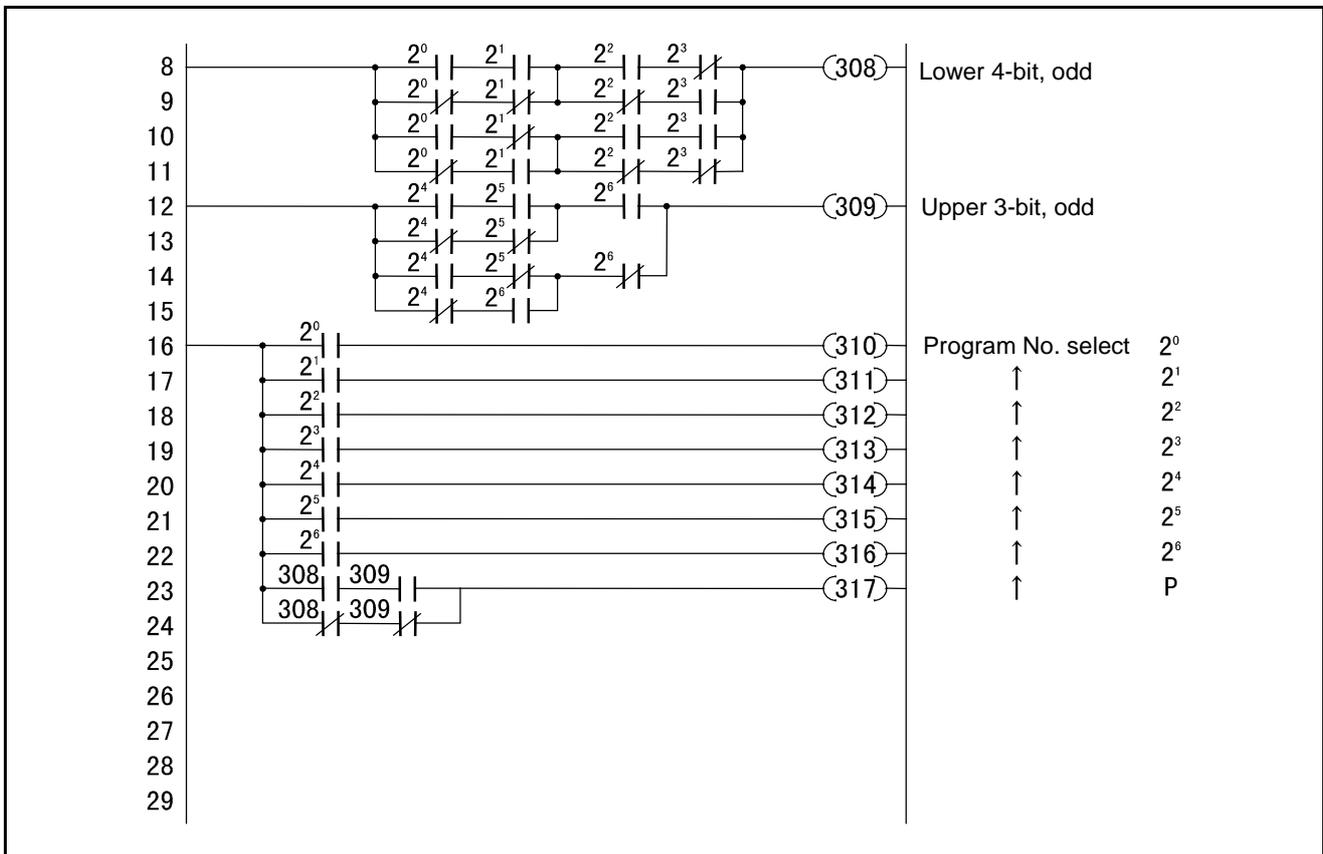


Figure 5-37 Example of Program No. Select Signal Sequence Circuit

### 5.5.4.4 Program Start (Input)

**(1) Function**

This signal starts the program specified with the program No. select signal from the external device.

**(2) Terminal number**

No.10 of connector CN8.

**(3) Input conditions and operation**

By switching the status of this signal from ON (open) to ON (shorted) in external mode, operations ①, ② and ③ described below will take place. (The status of the signal must be switched from OFF to ON.)

- ① If the program start signal is input (switched from OFF to ON) when the robot has not yet completed the program or is at rest after it has completed a cycle of the program, the program No. select signal will be read, the program will execute a cycle, and the robot will come to a stop.

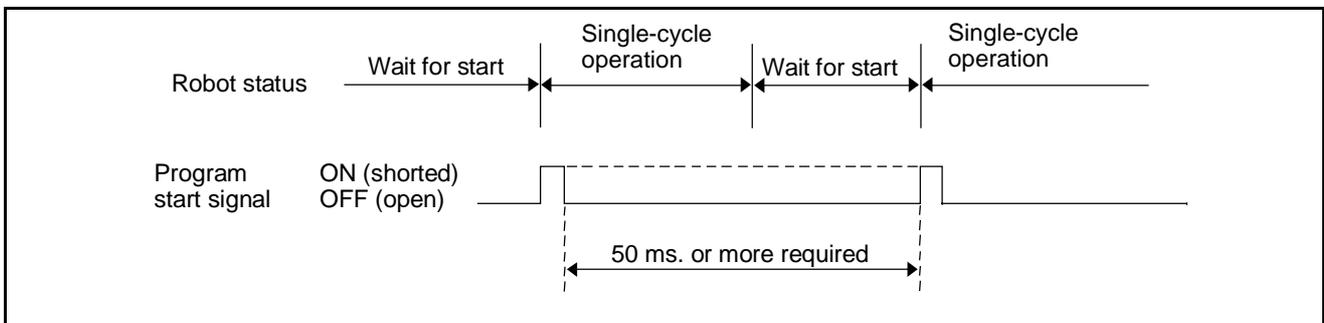
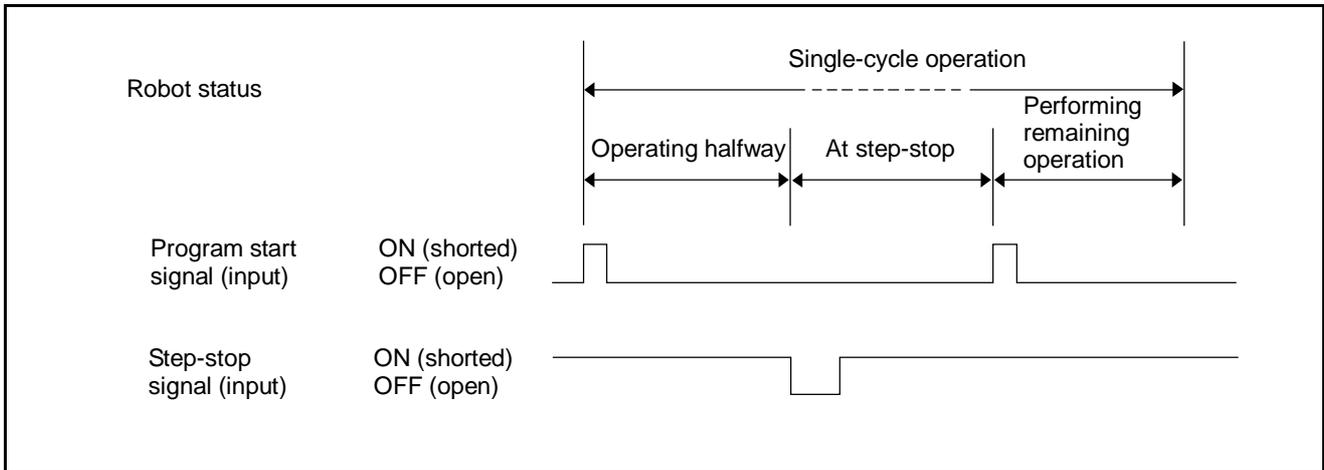


Figure 5-38 Program Start Operation-1

**Caution:** The program start signal requires program start preparation time (50 msec. or more) before input from OFF (open) to ON (shorted).  
 The program start signal must remain OFF (open) during the program start preparation time. If it is turned ON (shorted) during that time, the next cycle will not start to run.  
 To start a new cycle, the status of the external start signal must be switched from OFF to ON before each cycle.

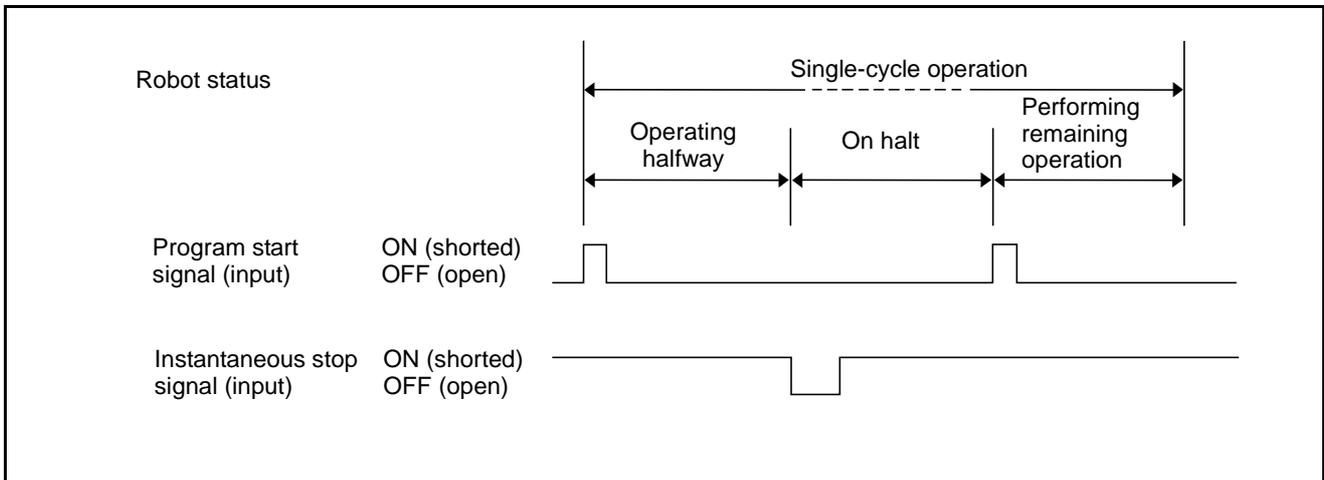
- ② When the status of the program start signal is switched from OFF to ON with the program step-stopped, the program will resume from the step following the suspended step and stop at the cycle end.



**Figure 5-39 Program Start Operation-2**

**Caution:** To cancel the execution of the remaining steps of a step-stopped program and start it from the beginning, input a program reset signal, a program No. select signal and a program start signal at the same time. For further information, refer to Chapter 5 "5.5.4.5 Program Reset (Input)".

- ③ When the status of the program start signal is switched from OFF to ON with the program immediately stopped, the program will resume from the suspended step and stop at the cycle end.



**Figure 5-40 Program Start Operation-3**

**Caution:** To cancel the execution of the remaining steps of an instantaneously stopped program and start it from the beginning, input a program reset signal, a program No. select signal and a program start signal at the same time. For further information, refer to Chapter 5 "5.5.4.5 Program Reset (Input)".

#### (4) Example of program start signal (rise) ON and (fall) OFF timing

##### ① Example of program start signal rise (ON) timing

Figure 5-41 shows how to make the program start signal rise with robot system outputs (external mode output and single-cycle end output).

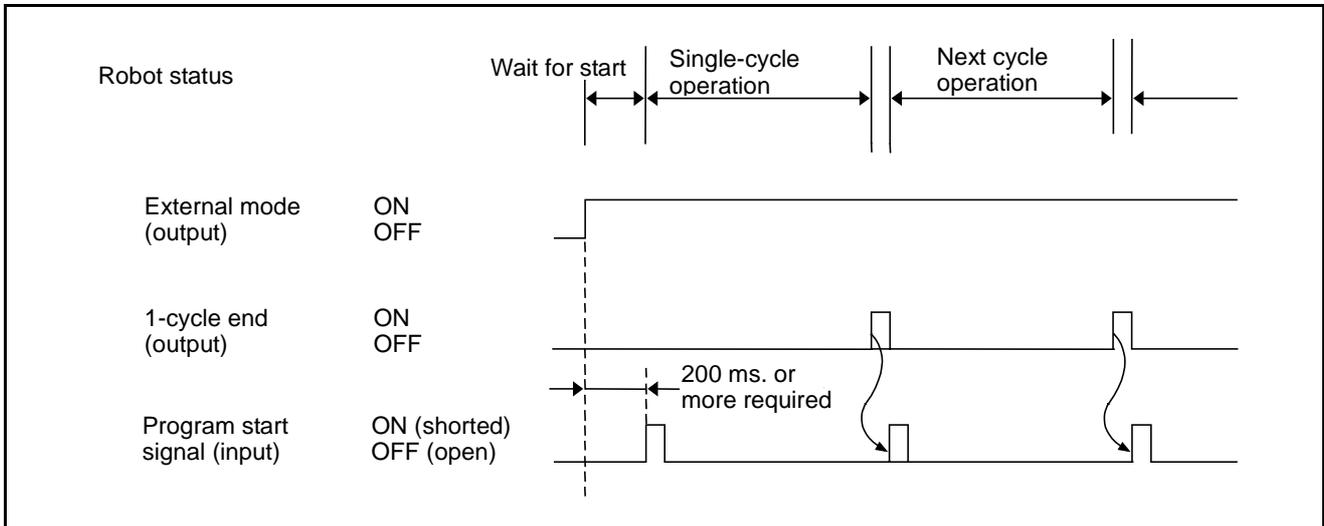
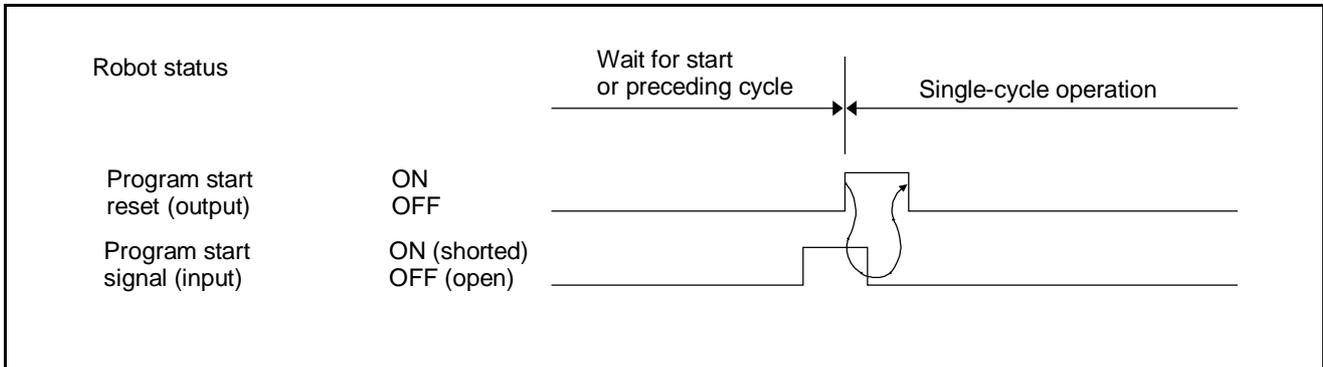


Figure 5-41 Example of Program Start Signal Rise Timing

**Caution:** The program start signal for the first cycle rises as soon as the external mode becomes valid and the conditions of the peripheral devices are met. The program start signal for subsequent cycles rises after output of a single-cycle end signal.

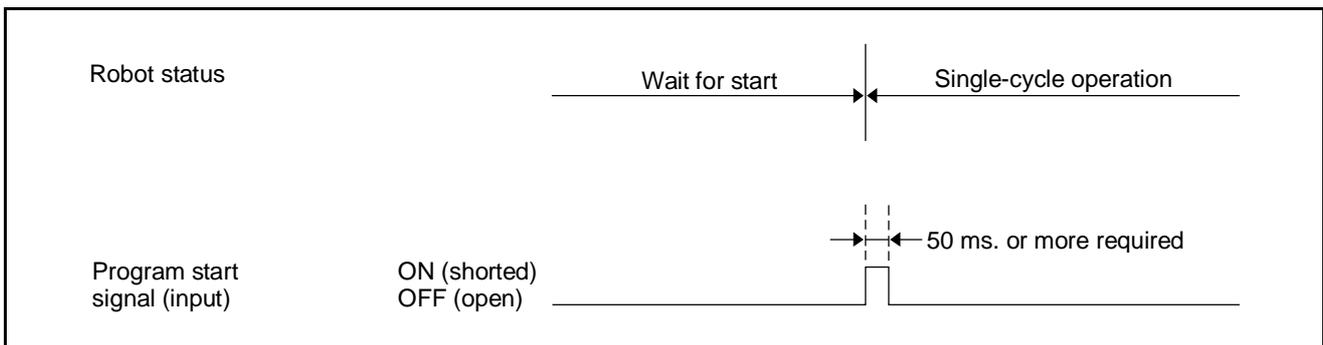
### ② Example of program start signal fall (OFF) timing

- a) Figure 5-42 shows how to make the program start signal fall with a robot system output (program start reset output).  
 When the robot program starts to run, a program start reset signal is output. The external device receives it and makes the program start signal fall (OFF).



**Figure 5-42 Example of Program Start Signal Fall Timing-1**

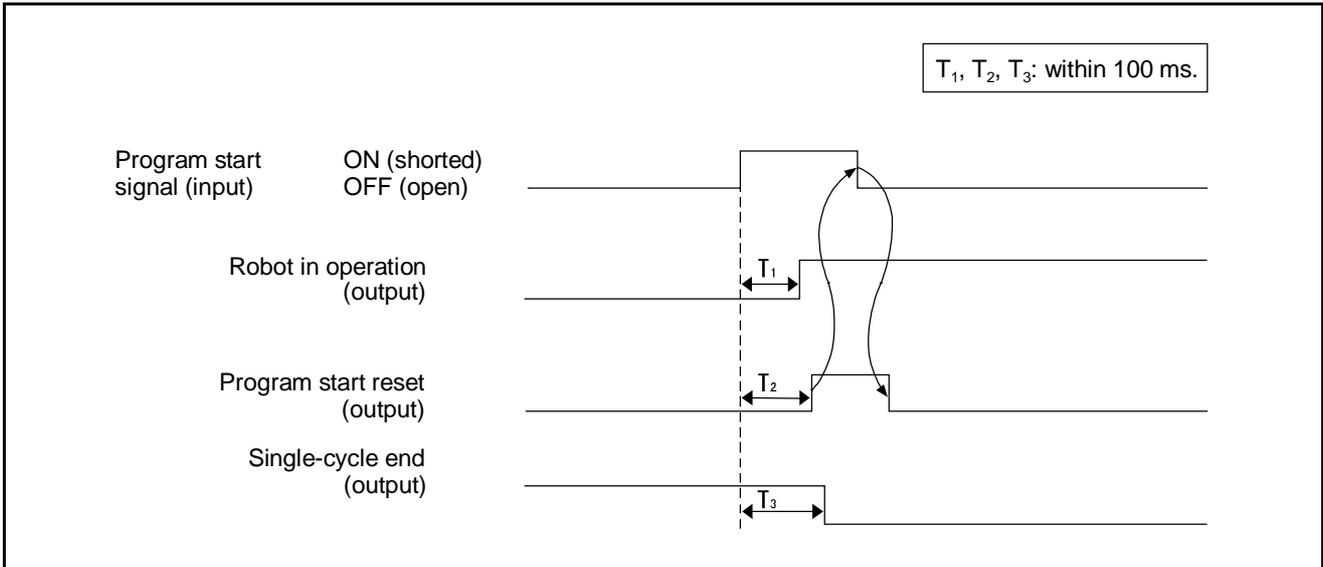
- b) Figure 5-43 shows how to make the program start signal fall with the simplified method (1 shot method using a timer).



**Figure 5-43 Example of Program Start Signal Fall Timing-2**

**Caution** ① Although the 1 shot method is easy, the timer setting for falling to raise the program start signal in the middle of the preceding cycle is difficult.  
 Use this method only to raise the program start signal after the robot stops at the end of each cycle.

② The status of the robot-in-operation, program start reset and single cycle end output signals changes in sequence after the program start signal is input ( $T_1 \rightarrow T_2 \rightarrow T_3$  in Figure 5-44).  
 The change of the status of these signals takes place within 100 msec. after the program start signal rises (ON). See Figure 5-44.



**Figure 5-44 Program Start Signal Rise Output Signal Timing**

### 5.5.4.5 Program Reset (Input)

**(1) Function**

By turning ON (short) this signal, any program can be forcibly executed from the beginning in a step-stopped state and a suspended state.

**Caution: Generally, a step-stopped or suspended program resumes from where it stopped.**

**(2) Terminal number**

No.24 of connector CN8.

**(3) Input conditions and operation**

**When issued with the Program Start**

- ① Figure 5-45 shows the input conditions and an operation timing chart.
- ② Use the program reset signal together with a program No. select signal, and input it before the program start signal (1 msec. or more).
- ③ Turn OFF the program reset signal after the robot starts to operate (after a program start reset signal is output).
- ④ A program No. select signal is required to execute the same program number as the suspended one from the beginning.

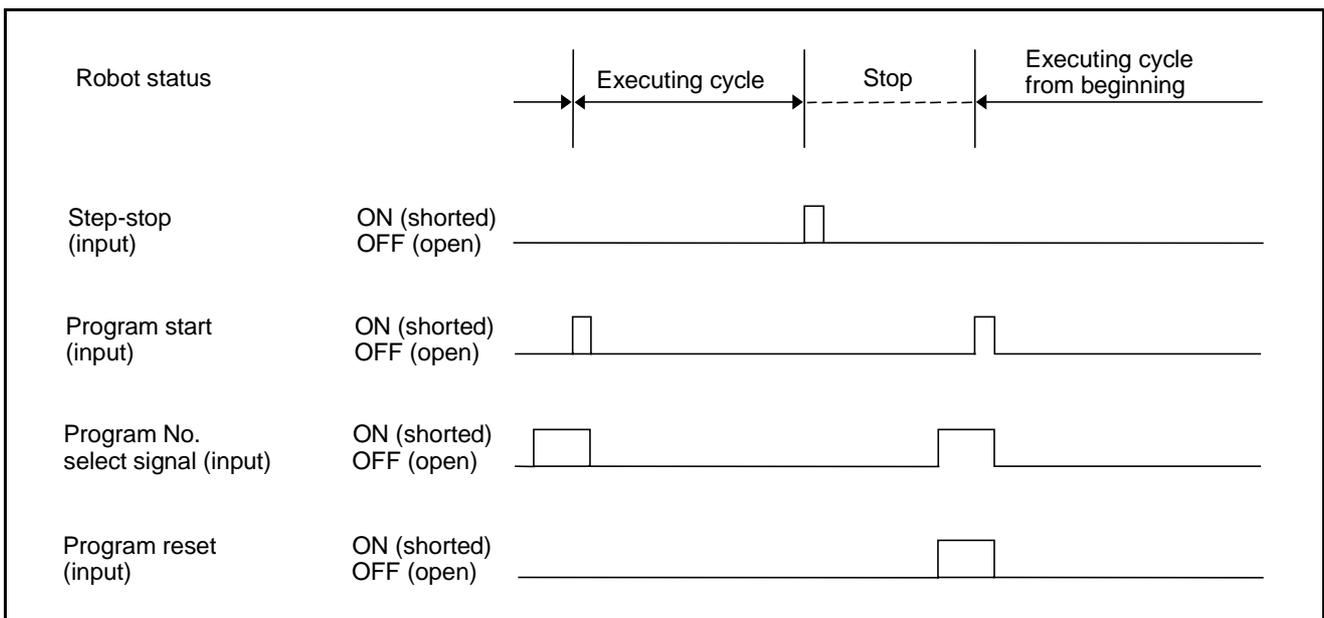
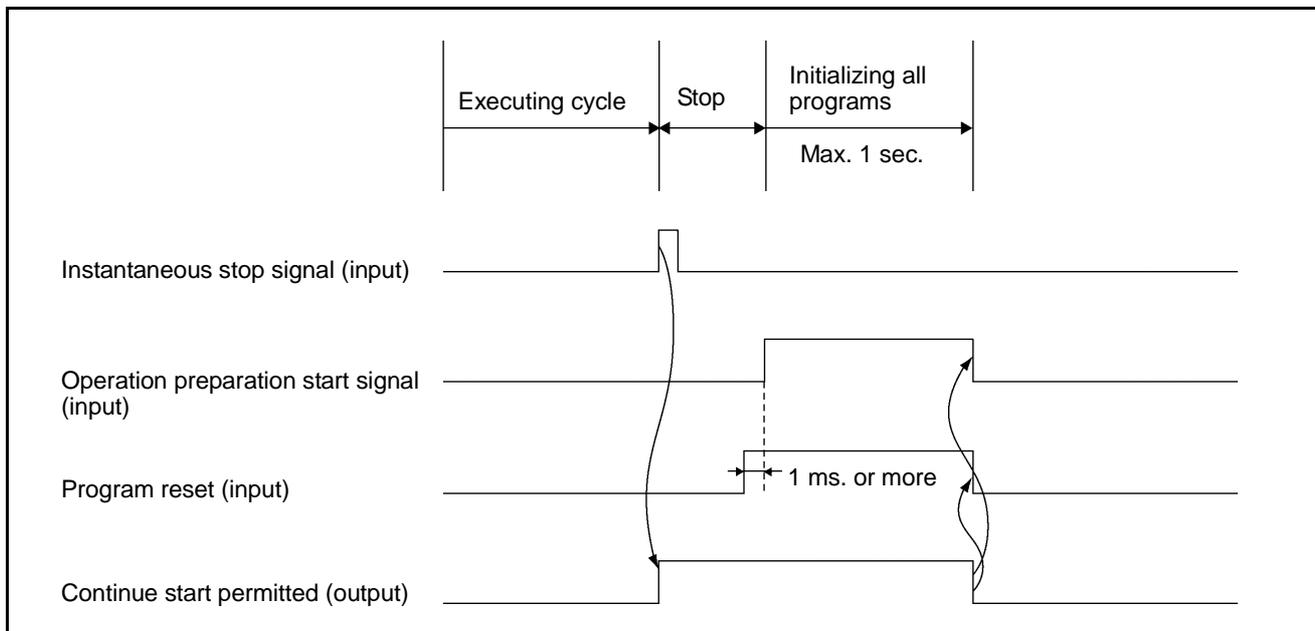


Figure 5-45 Input Conditions and Operation of Program Reset Signal

**When issued with the Operation Preparation Start**

- ① Figure 5-46 shows the input conditions and an operation timing chart.
- ② Input Program Reset before Operation Preparation Start (1 msec. or more).
- ③ After turned ON, this signal may take a maximum of one second for initializing all programs. During the period, do not input signals to the robot.



**Figure 5-46 Input Conditions and Operation of Program Reset Signal**

### 5.5.4.6 Robot Stop (Input)

#### (2) Function

- ① The signal stops the robot with the external device by opening the robot stop input
- ② The signal readies the power to the robot motor to be turned ON by shorting the robot stop input.

#### (2) Terminal number

No.2 of connector CN8.

#### (3) Input conditions and operation

- ① The robot stops with this signal OFF (open).
- ② The power to the robot motor is ready to be turned ON with this signal ON (shorted).
- ③ Irrespective of whether internal mode (operation with the teach pendant) or external mode (remote operation by the external device) is selected, the power to the robot motor cannot be turned ON with this signal OFF (open). Neither manual nor automatic operation can be performed until this signal is turned ON (shorted). (ERROR2008 will be displayed.)
- ④ By turning OFF (open) this signal under the following conditions.
  - 1) The power to the motor will be turned OFF, irrespective of whether Manual, Internal Auto, or External Auto mode is selected.
  - 2) During execution of the program (Robot-in-operation signal ON), the power to the motor will be turned OFF and the mode will be switched to internal mode after the robot decelerates to a stop.
  - 3) When the program is at a stop in the Manual and the Auto mode the power to the motor will be turned OFF. The suspended operation can be resumed by turning ON the power to the motor and shorting the ROBOT STOP signal.
- ⑤ Opening the ROBOT STOP signal and pressing the **ROBOT STOP** button of the operating panel or the teach pendant function the same.

#### (4) Input timing

This signal will be processed prior to all commands and input signals.

## 5.5.4.7 Step Stop (All Tasks) (Input)

### (1) Function

Input this signal to step-stop the program being executed from the external device. All tasks will be step-stopped.

### (2) Terminal number

No.5 of connector CN8.

### (3) Input conditions and operation

- ① If the status of this signal is changed from ON (shorted) to OFF (open), the robot will stop all tasks immediately after the ongoing step is completed, and the Robot-in-operation signal will be turned OFF. However, External Auto mode will remain valid, and the suspended program will be resumed by inputting a program start signal. See Figure 5-47.
- ② Turning OFF (open) this signal when inputting a program start signal makes the robot stop step by step.
- ③ Internal operation with the teach pendant is valid only when the status of this signal is changed from ON (shorted) to OFF (open).
- ④ For resuming the program after a step stop, refer to Chapter 5 "5.5.4.4 Program Start (Input)".

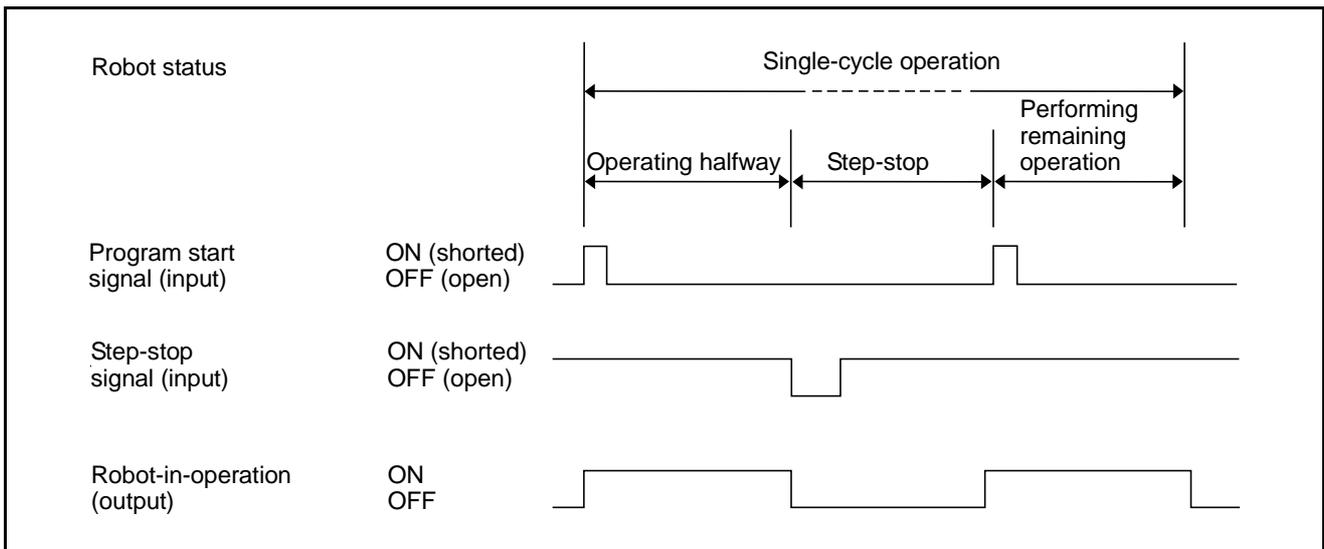


Figure 5-47 Step Stop Signal

### 5.5.4.8 Instantaneous Stop (All Tasks) (Input)

#### (1) Function

Input this signal to instantaneously stop the program being executed from the external device. All tasks will instantaneously stop.

#### (2) Terminal number

No.7 of connector CN8.

#### (3) Input conditions and operation

- ① If the status of this signal is changed from ON (shorted) to OFF (open), the robot will instantaneously stop in the middle of the ongoing step, and the Robot-in-operation signal will be turned OFF. However, Auto mode or external mode will remain valid, and the suspended program will be resumed by inputting a program start signal.
- ② Internal operation by the teach pendant is valid only when the status of this signal is changed from ON (shorted) to OFF (open).
- ③ For resuming the program after an instantaneous stop, refer to Chapter 5 "5.5.4.4 Program Start (Input)".
- ④ The minimum required pulse width is 50 msec. or more.

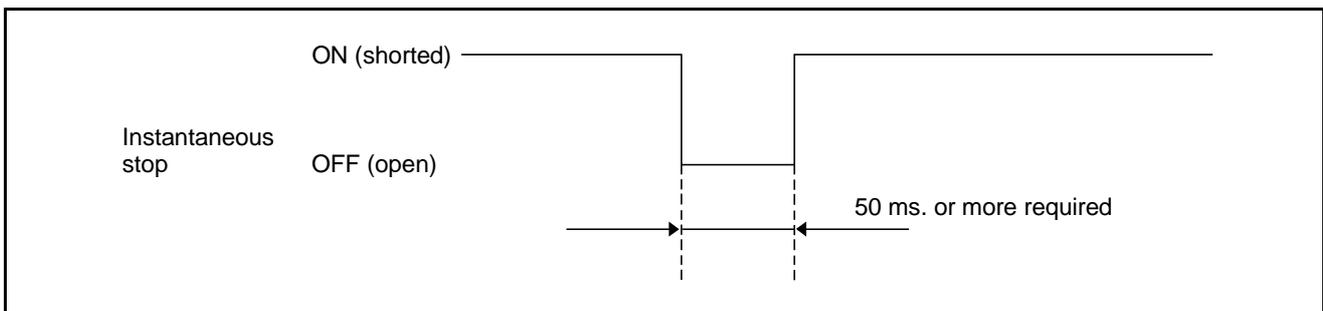


Figure 5-48 Minimum Instantaneous Stop Pulse Width

## 5.5.4.9 Clear Robot Failure (Input)

### (1) Function

The robot can recover from a stopped state, resulting from a robot failure by turning ON (shorted) the operation preparation start signal with this signal ON (shorted).

### (2) Terminal number

No.25 of connector CN8.

**NOTE:** Operation preparation start signal is inputted through No. 8 of connector CN8.

### (3) Usage

The signal is used to clear an error that brought the robot to a stop.

### (4) Input conditions and operation

- ① When a robot failure occurs, clear the error display on the teach pendant and the external output ERROR NUMBER to ready the robot to operate.
- ② When the Clear robot failure signal is turned ON (shorted), other input signals (MOTOR POWER ON, CAL EXECUTION, SP100 and SWITCH EXT MODE), which are to be used in combination with the operation preparation start signal, will be ignored.  
To turn ON the power to the motor after a robot failure is cleared, turn OFF (open) the Clear robot failure signal after turning OFF the Robot failure signal (output) as shown in Figure 5-49.
- ③ Input the Clear robot failure signal before (1 msec. or more) the operation preparation start signal.

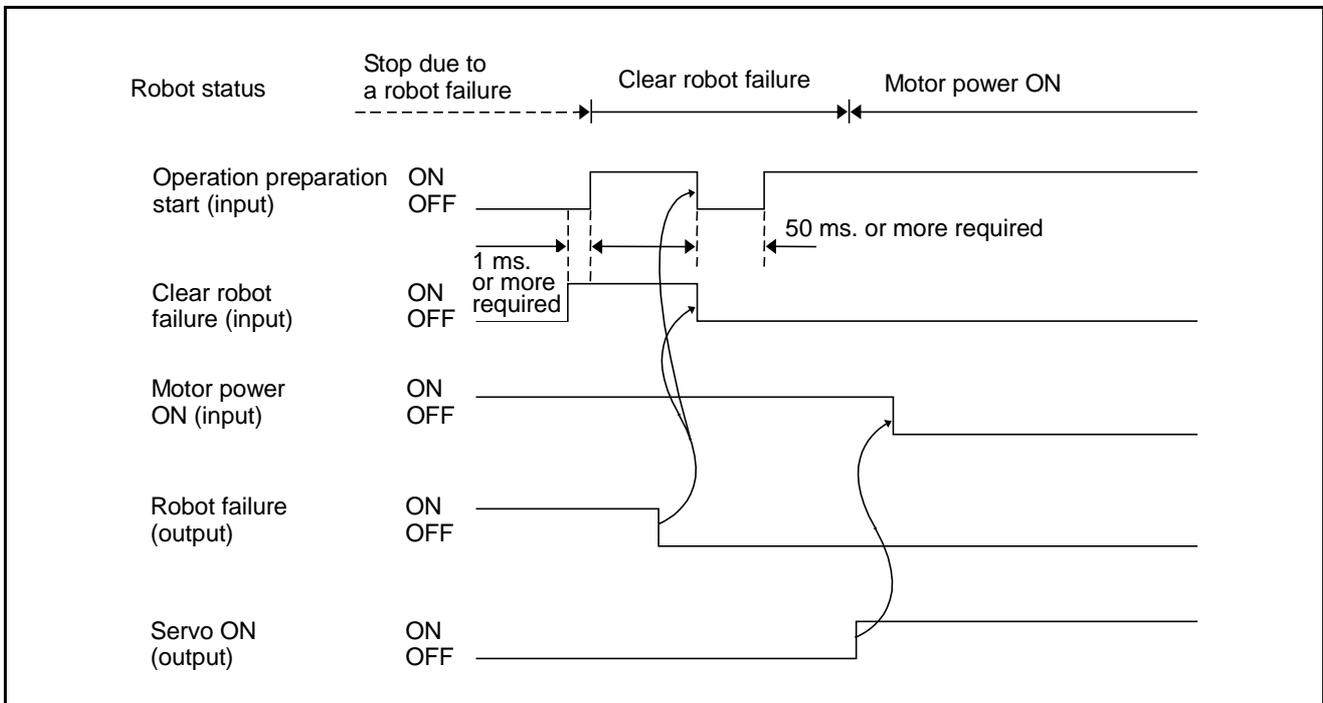


Figure 5-49 Input Conditions and Operation of Clear Robot Failure Signal

### 5.5.4.10 Interrupt Skip (Input)

**(1) Function**

If this signal is turned ON (shorted) during execution of the robot operation command within the range between INTERRUPT ON and INTERRUPT OFF in the program, the operation of the ongoing step will stop and the next step will start.

**Note:** For further information about the INTERRUPT ON and OFF commands, refer to the PROGRAMMER'S MANUAL, Chapter 12 "12.3 INTERRUPT ON/OFF (Statement)."

For further information about robot motion commands, refer to the PROGRAMMER'S MANUAL, Chapter 12 "Robot Control Statements."

**(2) Terminal number**

No.9 of connector CN8.

**(3) Usage**

Refer to the PROGRAMMER'S MANUAL, Chapter 12 "12.3 INTERRUPT ON/OFF."

**(4) Input conditions and operation**

If this signal is turned ON (shorted), the robot will immediately stop the ongoing operation and start executing the next step.

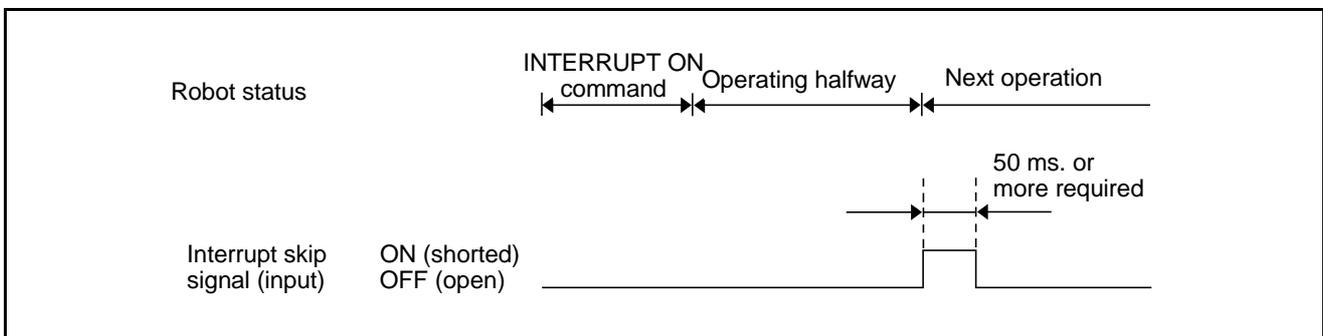
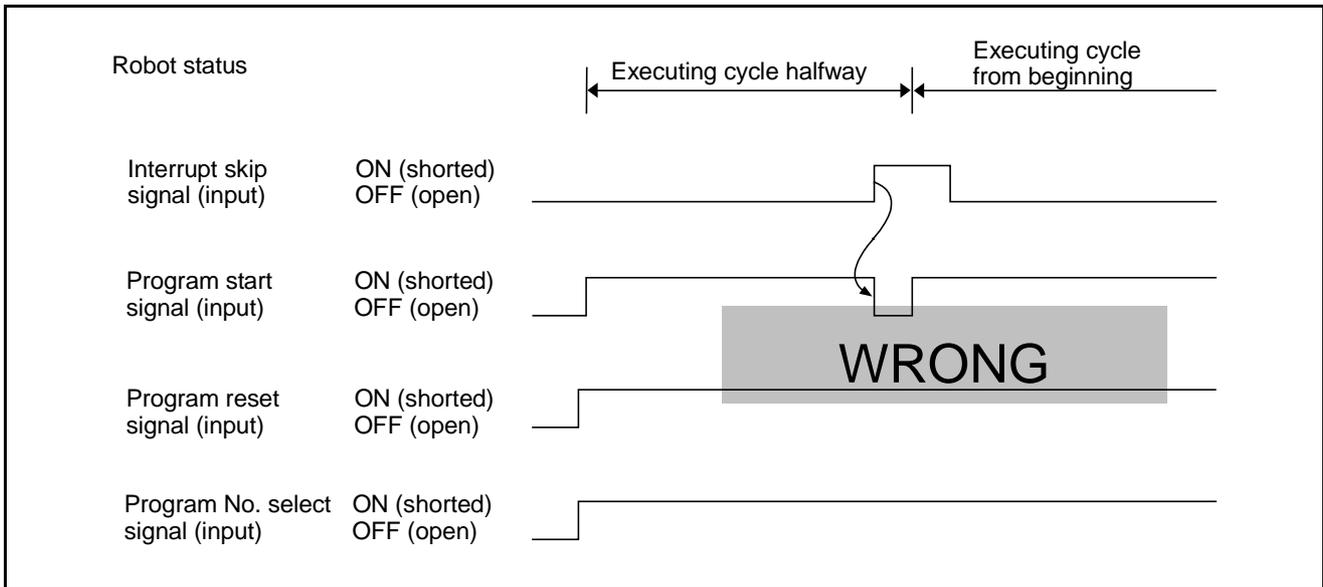


Figure 5-50 Input Conditions and Operation of Interrupt Skip



**Caution:** When turning ON (shorted) the interrupt skip signal, at least either the program reset signal or the program start signal must be turned OFF (open). If the interrupt skip signal is turned ON, the robot interprets the program start signal as instantaneously turned OFF (open). Consequently, the program selected with the program No. select signal will be executed from the beginning. (See Figure 5-51.)



**Figure 5-51 Example of Operation When an Interrupt Skip Signal is Input**

### 5.5.4.11 Continue Start (Input)

**(1) Function**

Turning the program start signal ON when this continue start signal is ON will resume the current program being on halt.

**(2) Terminal number**

No.6 of connector CN8.

**(3) Input conditions and operation**

This signal is executable only in external mode. If this signal is on, program numbers will be ignored at execution of Program start and the current program being on halt will be resumed. If Continue Start Permitted signal is not ON, the controller will issue ERROR27A8.

### 5.5.5 Example of Using System I/O Signals in Compatible Mode

This section describes an example of starting and stopping the robot using system I/O signals.

#### (1) Equipment example

In this example there is equipment which makes the robot perform operations by operating an external equipment operating panel connected to the Robot Controller through a PLC as shown in Figure 5-52 and equipped with a display, lamps and switches listed in Table 5-14.

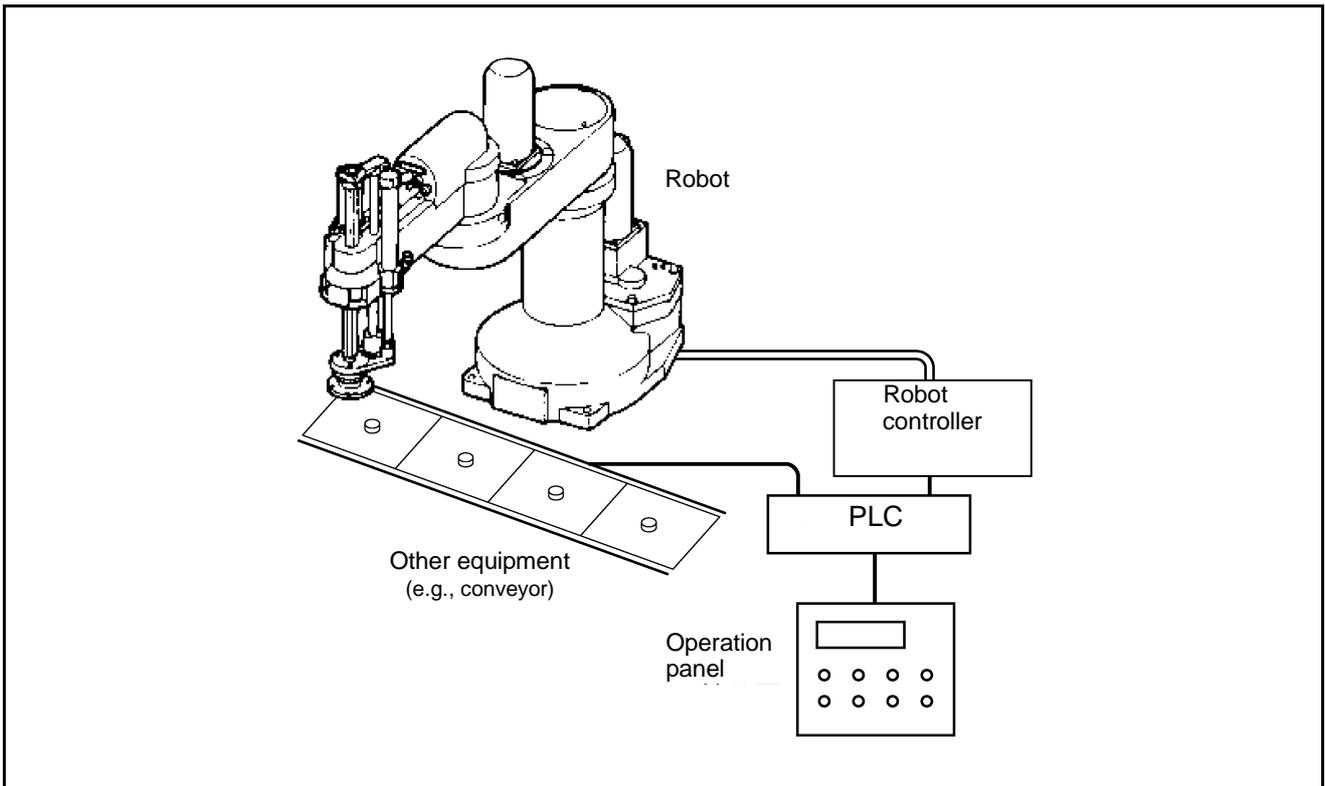


Figure 5-52 Example of Equipment Using a Robot

**Table 5-14 Example of Equipment Operating Panel Functions**

Classification	Part	Application
Display	Display	Displays messages, such as ROBOT PREPARATION OK.
Lamp	① Automatic operation indicator lamp	· Lights during automatic operation. · Not illuminated when the robot is not in automatic operation.
	② Robot external mode indicator lamp	· Lights when the robot is in external mode. · Turned OFF when the robot is not in external mode.
	③ Operation OK indicator lamp	· Lights when the Enable Auto signal is ON. · Turned OFF when the Enable Auto signal is OFF.
Switch	① Robot operation button	Starts the robot preparation.
	② Automatic start button	Starts the operation of the equipment.
	③ Cycle stop button	Stops the equipment after a cycle of operations is completed.
	④ Operation/Adjustment selector switch	Automatic operation of the robot possible when OPERATION is selected. Manual operation or teach check of the robot possible when ADJUSTMENT is selected.
<b>Note: Actual equipment requires emergency stop, interlock and other functions. However, described here are only necessary functions and others are omitted.</b>		

**(2) Outline of procedure**

Described below is the outline of the procedure when using the equipment, as shown in Figure 5-52.

Follow steps ① to ③.

- ① Operation preparation start  
Setting the MOTOR POWER ON, CAL EXECUTION, SP100 and SWITCH EXT MODE bits, brings the robot into the External Auto mode. This operation will be completed when the EXTERNAL MODE output signal is turned ON.
- ② Automatic operation  
Start the program by which the robot starts from the operation origin, performs operations, and returns to the operation origin.
- ③ Operation end  
Terminate the day's operations with a cycle stop, and turn OFF the power.

**(3) Start and stop procedure and system I/O signals**

Figures 5-53 and 5-54 show the relationship between the system I/O signals and the operations by the operator display on the equipment operating panel, processing by the PLC and the operation of the robot when starting and stopping the robot.

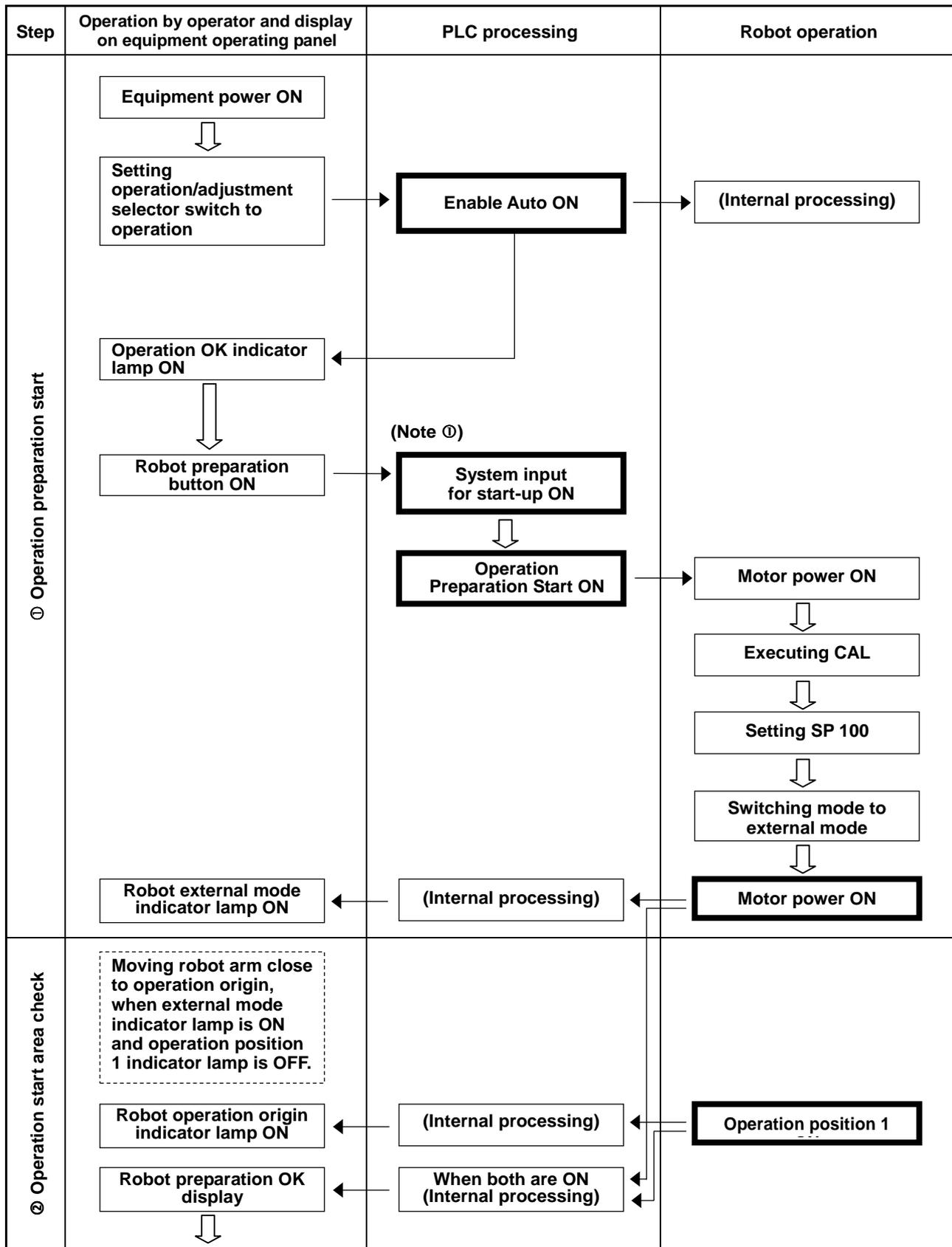


Figure 5-53 Start and Stop Procedure and System I/O Signals-1

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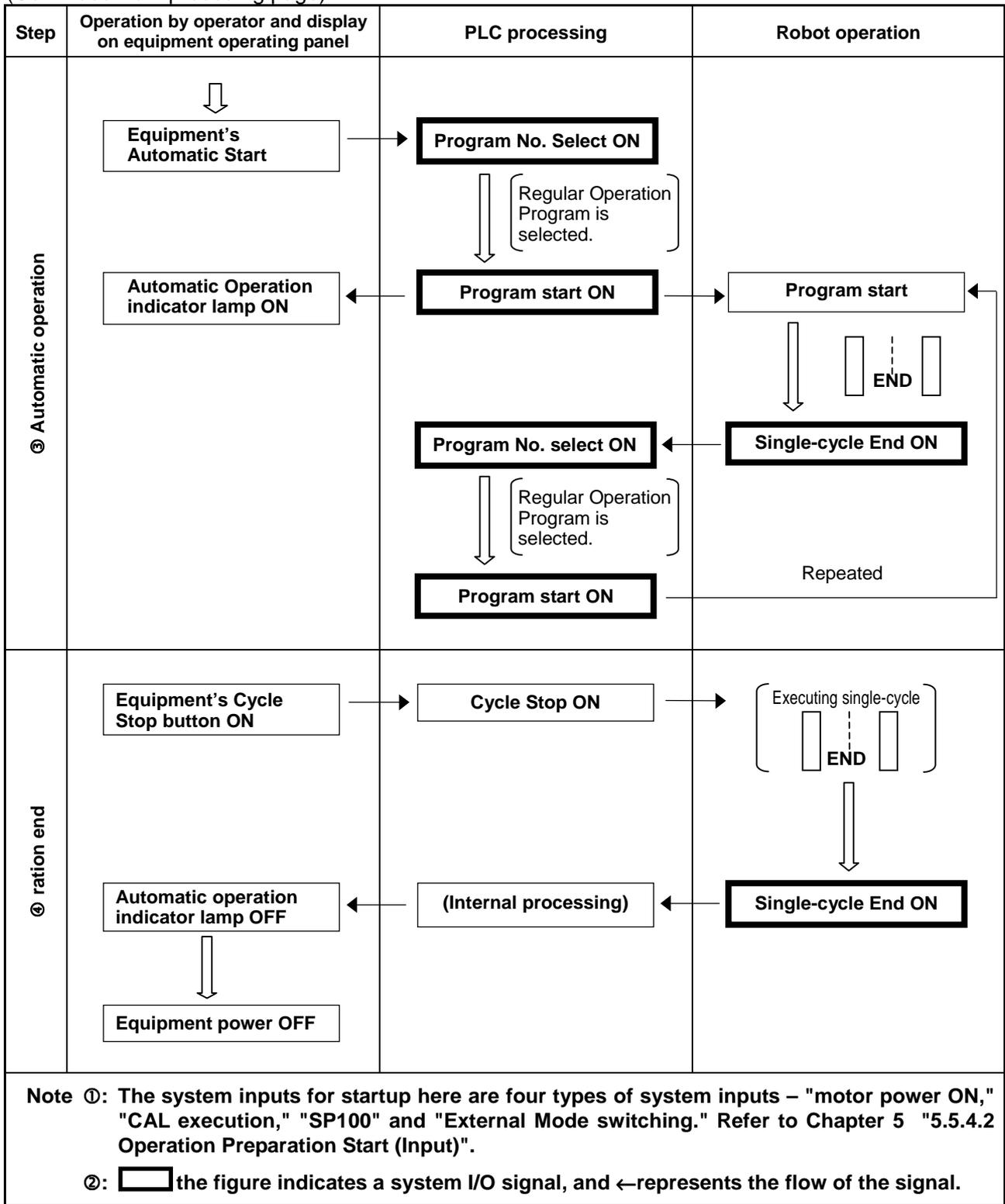


Figure 5-54 Start and Stop Procedure and System I/O Signals-2

## 5.6 I/O Circuits and Connectors (PNP type)

This section explains the I/O circuit of PNP type (sink input and source output). For the circuit of NPN type (source input and sink output), refer to Appendix 1.

### 5.6.1 I/O Signal Connector Pin Layout

This section describes the Robot Controller connector pin layouts for I/O signals.

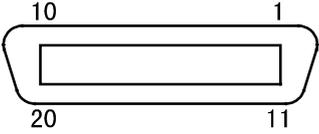
The definitions of the signals and pins of the output connector CN10 and input connector CN8 are different between the standard mode and the compatible mode.

As for the other connectors, the definitions of the pins are common to the standard mode and the compatible mode.

#### 5.6.1.1 Connector Pin Layout Common to Both Modes

(1) HAND I/O CN9: Connector for end-effector I/O (common to both modes)

Table 5-15 CN9 Pin Layout, common to both modes (PNP type)

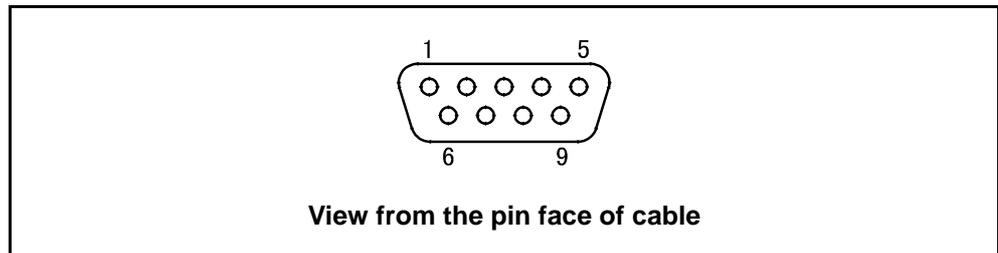


View from the pin face of cable

Terminal No.	Name	Port number	Wire color		Terminal No.	Name	Port number	Wire color	
			Standard	High strength				Standard	High strength
1	Hand output	64	Black	Blue	11	Hand Input	50	Pink	White
2	Hand output	65	Brown	Yellow	12	Hand Input	51	Pink	White
3	Hand output	66	Black	Green	13	Hand Input	52	White	White
4	Hand output	67	Brown	Red	14	Hand Input	53	White	White
5	Hand output	68	Red	Violet	15	Hand Input	54	White	White
6	Hand output	69	Orange	Blue	16	Hand Input (interrupt input)	55	White	Brown
7	Hand output	70	Yellow	Yellow	17	Power E0V for Hand	—	White	Brown
8	Hand output	71	Green	Green	18	Power E24V for Hand	—	White	Brown
9	Hand input	48	Blue	Red	19	Not connected	—	White	Brown
10	Hand input	49	Violet	Violet	20	Not connected	—	White	Brown

(2) I/O POWER CN7: Power connector for I/O (common to both modes)

Table 5-16 CN7 Pin Layout, common to both modes (PNP type)



Terminal No.	Name
1	Internal power source output +24V
2	Internal power source output +24V
3	Internal power source output 0V
4	Internal power source output 0V
5	FG
6	Power input E0V
7	Power input E0V
8	Power input E24V
9	Power input E24V

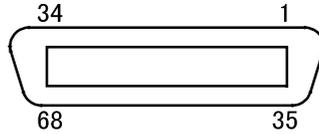
**⚠ Caution:** When using the internal power source, keep the total current capacity below 1.3 A. To use the internal power source of the robot controller, connect the wiring so that the internal power source will be separated from the external power source. Improper wiring may damage the internal circuit.

5.6.1.2 Connector Pin Layout for Standard Mode

(1) OUTPUT CN10: User-/System-output connector (standard mode)

Table 5-17 CN10 Pin Layout, for standard mode (PNP type)

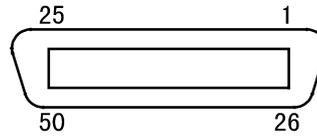
Terminal number	Name	Port number	Wire color	Terminal number	Name	Port number	Wire color
1	Normal CPU	72	Black	35	User output	106	Pink
2	Robot-in-operation	73	Brown	36	User output	107	Pink
3	Robot Failure	74	Red	37	User output	108	Pink
4	Servo ON	75	Orange	38	User output	109	Pink
5	Robot initialization complete	76	Yellow	39	User output	110	Pink
6	Auto mode	77	Black	40	User output	111	White
7	External mode	78	Brown	41	User output	112	White
8	Dead battery warning	79	Red	42	User output	113	White
9	Robot warning	80	Orange	43	User output	114	White
10	Continue start permitted	81	Yellow	44	User output	115	White
11	SS mode	82	Green	45	User output	116	White
12	Reserved	83	Blue	46	User output	117	White
13	Reserved	84	Violet	47	User output	118	White
14	Reserved	85	Gray	48	User output	119	White
15	Command processing complete	86	Pink	49	User output	120	White
16	Status area odd parity	87	Black	50	User output	121	Gray
17	Status area bit 0	88	Black	51	User output	122	Violet
18	Status area bit 1	89	Brown	52	User output	123	Violet
19	Status area bit 2	90	Red	53	User output	124	Violet
20	Status area bit 3	91	Orange	54	User output	125	Violet
21	Status area bit 4	92	Yellow	55	User output	126	Violet
22	Status area bit 5	93	Green	56	User output	127	Violet
23	Status area bit 6	94	Blue	57	Not used.	—	Violet
24	Status area bit 7	95	Gray	58	Not used.	—	Violet
25	Status area bit 8	96	Pink	59	Not used.	—	Violet
26	Status area bit 9	97	Brown	60	Not used.	—	Gray
27	Status area bit 10	98	Red	61	Not used.	—	Gray
28	Status area bit 11	99	Orange	62	Not used.	—	Gray
29	Status area bit 12	100	Yellow	63	Not used.	—	Gray
30	Status area bit 13	101	Green	64	Not used.	—	Gray
31	Status area bit 14	102	Blue	65	Emergency stop +	—	Gray
32	Status area bit 15	103	Pink	66	Emergency stop –	—	Gray
33	User output	104	Black	67	Not used.	—	Blue
34	User output	105	Brown	68	Not used.	—	Blue



View from the pin face of cable

(2) INPUT CN8: User-/System-input connector (standard mode)

Table 5-18 CN8 Pin Layout, for standard mode (PNP type)



View from the pin face of cable

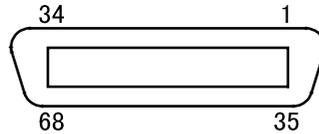
Terminal number	Name	Port number	Wire color	Terminal number	Name	Port number	Wire color
1	Power for robot stop (internal +24V)	—	Black	26	Data area 2 bit 7	21	Pink
2	Robot stop	—	Brown	27	Data area 2 bit 8	22	Pink
3	Power for Enable Auto (internal +24V)	—	Red	28	Data area 2 bit 9	23	Pink
4	Enable Auto	—	Black	29	Data area 2 bit 10	24	White
5	Step-stop (all tasks)	0	Brown	30	Data area 2 bit 11	25	White
6	Not used.	1	Red	31	Data area 2 bit 12	26	White
7	Instantaneous stop (all tasks)	2	Orange	32	Data area 2 bit 13	27	White
8	Strobe signal	3	Yellow	33	Data area 2 bit 14	28	White
9	Interrupt skip	4	Green	34	Data area 2 bit 15	29	White
10	Command and data odd parity	5	Blue	35	Command area 0 bit 0	30	White
11	Data area 1 bit 0	6	Violet	36	Command area 0 bit 1	31	White
12	Data area 1 bit 1	7	Black	37	Command area 0 bit 2	32	Gray
13	Data area 1 bit 2	8	Brown	38	Command area 0 bit 3	33	Gray
14	Data area 1 bit 3	9	Red	39	User input	34	Gray
15	Data area 1 bit 4	10	Orange	40	User input	35	Gray
16	Data area 1 bit 5	11	Yellow	41	User input	36	Gray
17	Data area 1 bit 6	12	Green	42	User input	37	Gray
18	Data area 1 bit 7	13	Blue	43	User input	38	Gray
19	Data area 2 bit 0	14	Violet	44	User input	39	Gray
20	Data area 2 bit 1	15	White	45	User input	40	Gray
21	Data area 2 bit 2	16	Pink	46	User input	41	Gray
22	Data area 2 bit 3	17	Black	47	User input	42	Violet
23	Data area 2 bit 4	18	Brown	48	User input	43	Violet
24	Data area 2 bit 5	19	Red	49	User input	44	Violet
25	Data area 2 bit 6	20	Orange	50	User input	45	Violet

5.6.1.3 Connector Pin Layout for Compatible Mode

(1) OUTPUT CN10: User-/System-output connector (compatible mode)

Table 5-19 CN10 Pin Layout, for compatible mode (PNP type)

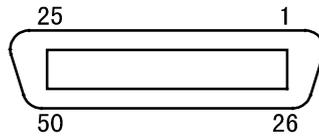
Terminal number	Name	Port number	Wire color	Terminal number	Name	Port number	Wire color
1	Normal CPU	72	Black	35	User output	106	Pink
2	Robot-in-operation	73	Brown	36	User output	107	Pink
3	Robot failure	74	Red	37	User output	108	Pink
4	Auto mode	75	Orange	38	User output	109	Pink
5	External mode	76	Yellow	39	User output	110	Pink
6	Program start reset	77	Black	40	User output	111	White
7	Not used.	78	Brown	41	User output	112	White
8	Not used.	79	Red	42	User output	113	White
9	Robot power ON complete	80	Orange	43	User output	114	White
10	Servo ON	81	Yellow	44	User output	115	White
11	CAL complete	82	Green	45	User output	116	White
12	Teaching	83	Blue	46	User output	117	White
13	Single-cycle complete	84	Violet	47	User output	118	White
14	Dead battery warning	85	Gray	48	User output	119	White
15	Robot warning	86	Pink	49	User output	120	White
16	Continue start permitted	87	Black	50	User output	121	Gray
17	Error units bit 0	88	Black	51	User output	122	Violet
18	Error units bit 1	89	Brown	52	User output	123	Violet
19	Error units bit 2	90	Red	53	User output	124	Violet
20	Error units bit 3	91	Orange	54	User output	125	Violet
21	Error tens bit 0	92	Yellow	55	User output	126	Violet
22	Error tens bit 1	93	Green	56	User output	127	Violet
23	Error tens bit 2	94	Blue	57	Not connected	—	Violet
24	Error tens bit 3	95	Gray	58	Not connected	—	Violet
25	Error hundreds bit 0	96	Pink	59	Not connected	—	Violet
26	Error hundreds bit 1	97	Brown	60	Not connected	—	Gray
27	Error hundreds bit 2	98	Red	61	Not connected	—	Gray
28	Error hundreds bit 3	99	Orange	62	Not connected	—	Gray
29	SS mode	100	Yellow	63	Not connected	—	Gray
30	Not used.	101	Green	64	Not connected	—	Gray
31	Not used.	102	Blue	65	Emergency stop +	—	Gray
32	Not used.	103	Pink	66	Emergency stop -	—	Gray
33	User output	104	Black	67	Not connected	—	Blue
34	User output	105	Brown	68	Not connected	—	Blue



View from the pin face of cable

**(2) INPUT CN8: User-/System-input connector (compatible mode)**

**Table 5-20 CN8 Pin Layout, for compatible mode (PNP type)**



**View from the pin face of cable**

Terminal number	Name	Port number	Wire color	Terminal number	Name	Port number	Wire color
1	Power for robot stop (internal +24V)	-	Black	26	User input	21	Pink
2	Robot stop	-	Brown	27	User input	22	Pink
3	Power for Enable Auto (internal +24V)	-	Red	28	User input	23	Pink
4	Enable Auto	-	Black	29	User input	24	White
5	Step-stop (all tasks)	0	Brown	30	User input	25	White
6	Continue start	1	Red	31	User input	26	White
7	Instantaneous stop (all tasks)	2	Orange	32	User input	27	White
8	Operation preparation start	3	Yellow	33	User input	28	White
9	Interrupt skip	4	Green	34	User input	29	White
10	Program start	5	Blue	35	User input	30	White
11	Program No. select bit 0	6	Violet	36	User input	31	White
12	Program No. select bit 1	7	Black	37	User input	32	Gray
13	Program No. select bit 2	8	Brown	38	User input	33	Gray
14	Program No. select bit 3	9	Red	39	User input	34	Gray
15	Program No. select bit 4	10	Orange	40	User input	35	Gray
16	Program No. select bit 5	11	Yellow	41	User input	36	Gray
17	Program No. select bit 6	12	Green	42	User input	37	Gray
18	Program No. select odd parity bit	13	Blue	43	User input	38	Gray
19	Motor power ON	14	Violet	44	User input	39	Gray
20	CAL execution	15	White	45	User input	40	Gray
21	Reserved	16	Pink	46	User input	41	Gray
22	SP100	17	Black	47	User input	42	Violet
23	Switch Ext Mode	18	Brown	48	User input	43	Violet
24	Program reset	19	Red	49	User input	44	Violet
25	Clear robot failure	20	Orange	50	User input	45	Violet

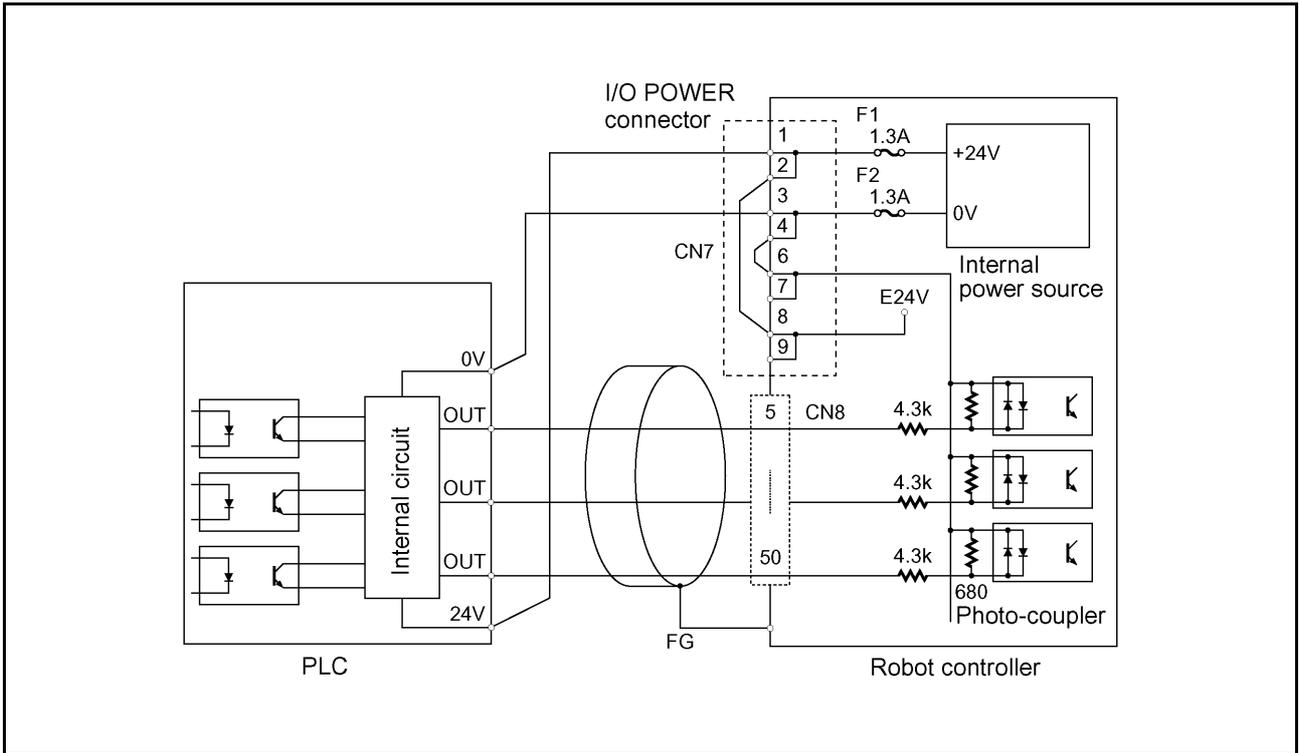
### 5.6.2 Robot Controller I/O Circuits

#### 5.6.2.1 User-Input, System-Input and Hand-Input Circuits

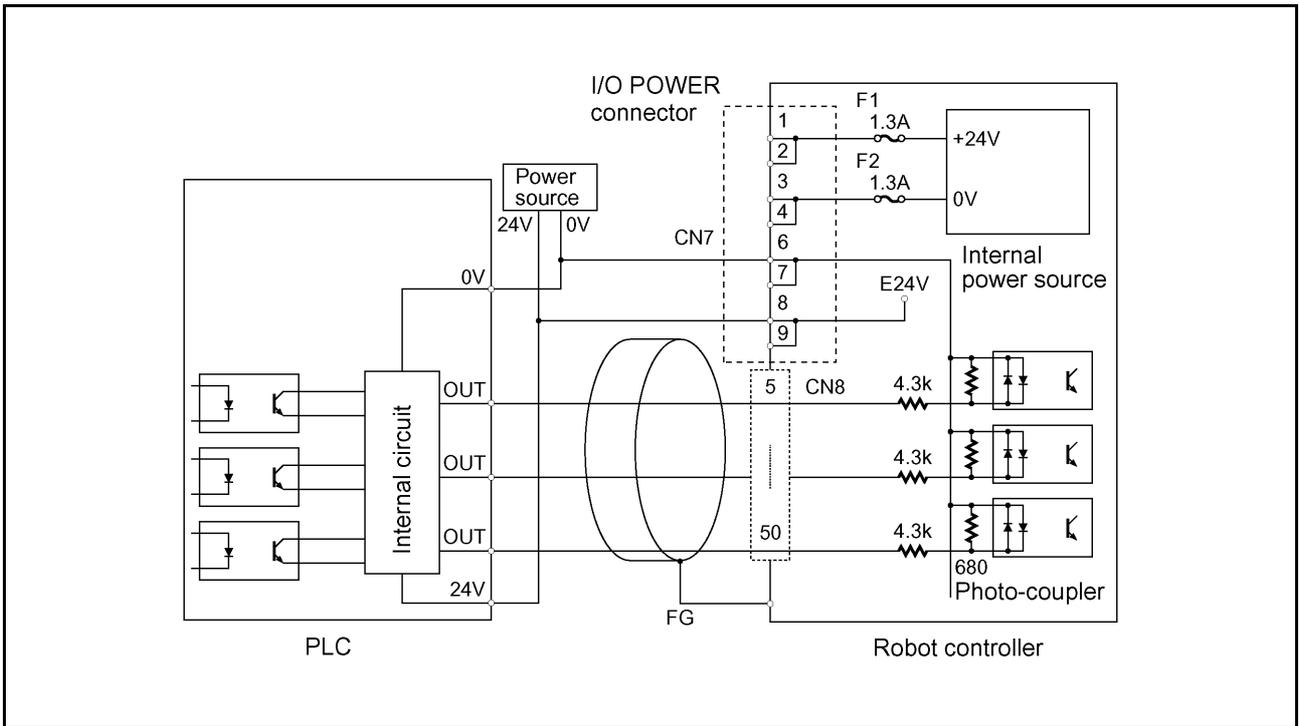
Figures 5-55 and 5-56 show examples of the user-input, system-input and hand-input circuit configurations and connections of the robot controller.

The maximum allowable current capacity of the robot controller's internal power source is 1.3 A. Use the internal power source within this allowable range.

- Caution**
- ① Either an external power supply type or built-in power type Output card is available for the PLC. However, an external power supply type requires an additional power source (24V) to be installed. The power capacity is 15W or more.
  - ② When controlling two or more robots with a single PLC using the internal power source of the robot controller, set a PLC Output card for each robot.
  - ③ Other than a PLC, a proximity switch, or a relay contact may be connected directly to the input terminal of the Robot Controller. In such a case, use the power input to pins 6 to 9 of the I/O power connector. A two-wire photoelectric switch or proximity switch can be connected if its leakage current is 1 mA or less.
  - ④ Use a multi-core shielding cable for the purpose of protecting the robot controller from noise. Ground it to the robot controller.

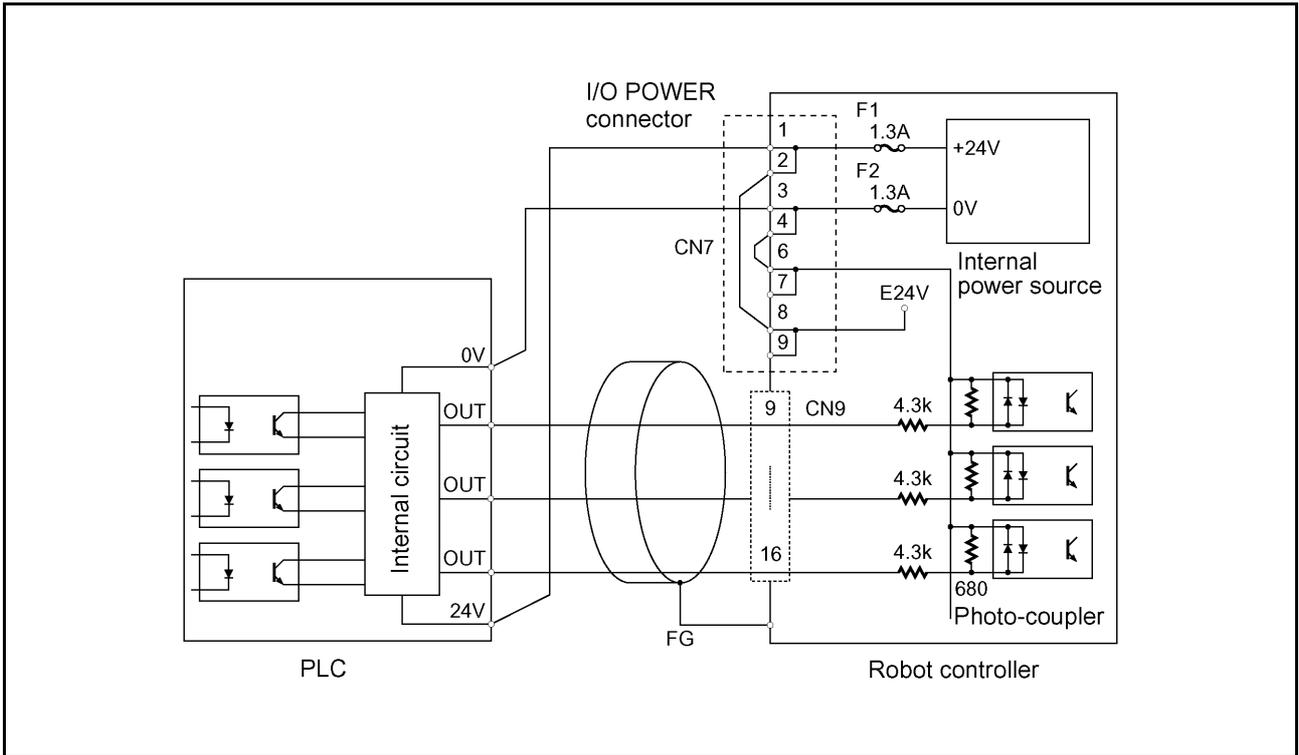


(When the internal power source is used)

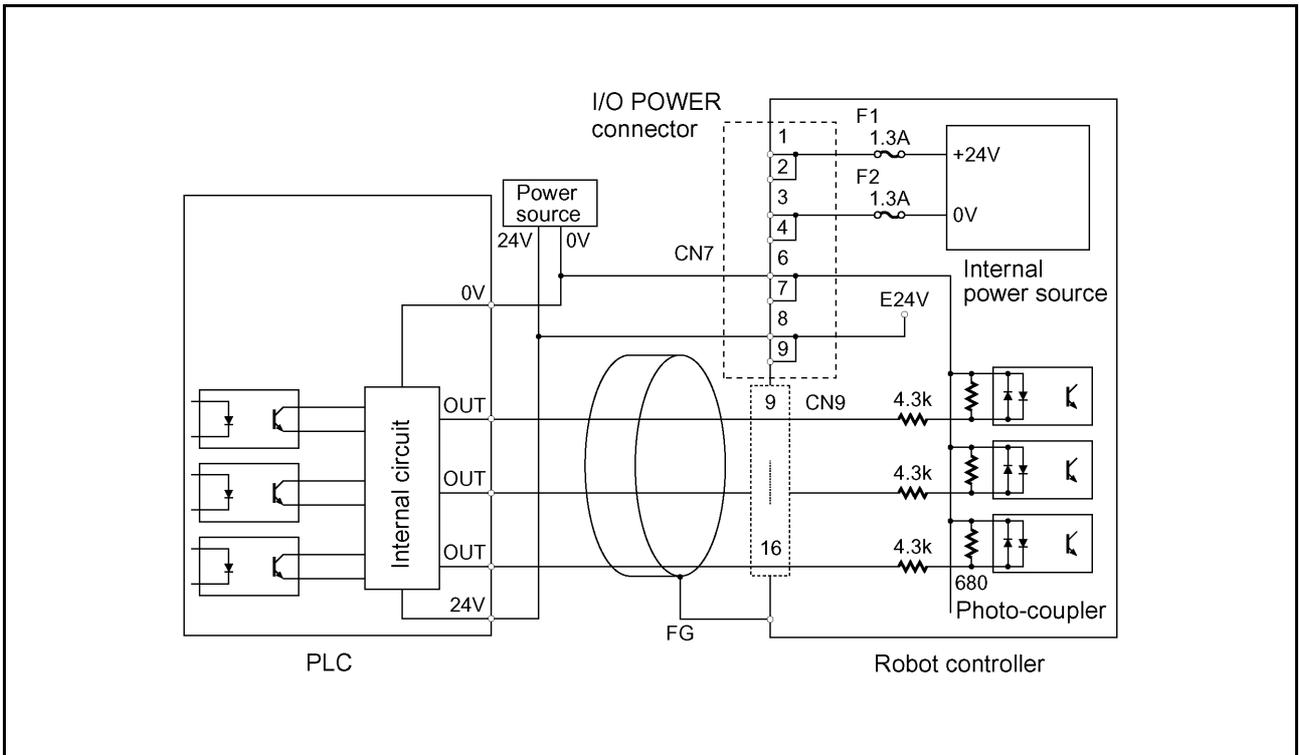


(When an external power source is used)

Figure 5-55 User-Input and System-Input Circuits (PNP type)



(When the internal power source is used)



(When an external power source is used)

Figure 5-56 Hand-Input Circuits (PNP type)

## 5.6.2.2 Robot Stop and Enable Auto Input Circuits

The Robot Stop and Enable Auto signals are important for safety. The input circuit for these signals must have contacts as shown in Figure 5-57.

Use the INPUT CN8 (pins 1 and 3) of the robot controller for the power source, irrespective of whether the power source to be used for other I/O signals is the internal power source or an external power source.

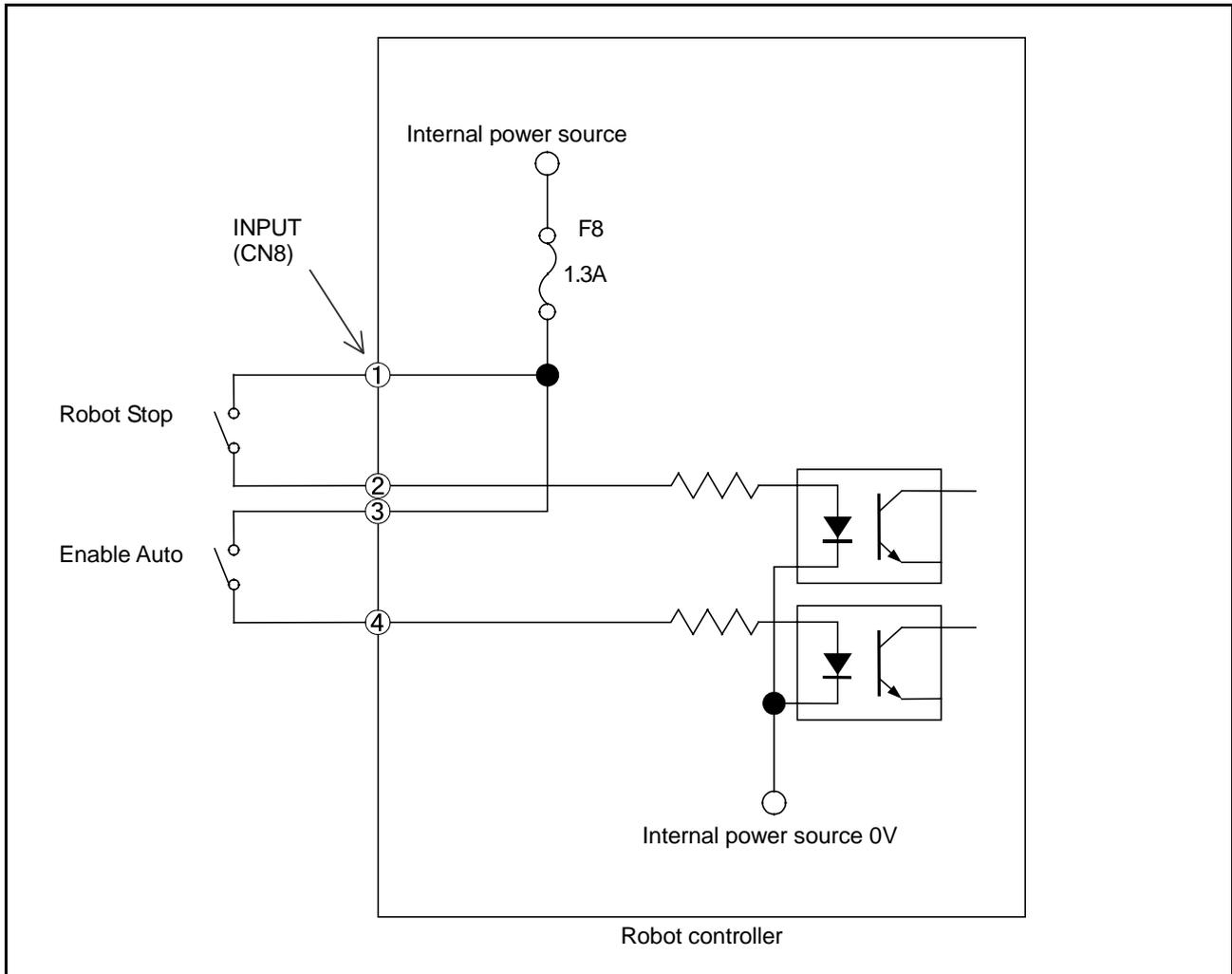


Figure 5-57 Robot Stop and Enable Auto Input Circuits

**TIP:** The configuration sample of an emergency stop output circuitry is shown in Subsection 5.6.2.4.

### 5.6.2.3 User-Output, System-Output, and Hand-Output Circuits

Figures 5-58 and 5-59 show an example of the configuration and connection of the Robot Controller's user-input output, system-output and hand-output circuit.

Since the initial resistance of a lamp is small, the output circuit may be damaged by rush current that flows when the lamp lights.

When directly turning a lamp ON or OFF, use a lamp whose rating is 0.5W or less.

To reduce rush current, connect a resistor R that allows dark current 1/3 or less of the rated current to flow when the lamp goes OFF.

Figure 5-60 shows an example of connecting a lamp.

- (1) **The User-Output, System-Output and Hand-Output Circuit are open collector output circuits.**
- (2) **The maximum allowable source current is 70mA.**  
Keep the current consumption of a device to be connected to the Robot Controller, such as a PLC and a relay coil, below the allowable current.
- (3) **Select an induction load, such as a relay coil, which has a built-in diode (for absorbing inverse electromotive force).**  
To use an induction load without a built-in diode, add a diode equivalent to the 1S1888 (Toshiba) in close vicinity to the coil.

 **Caution: When externally attaching a diode, connect it with correct polarity. Incorrect polarity may damage the Output circuit.**

- (4) **Connecting a lamp requires a circuit through which dark current flows.**

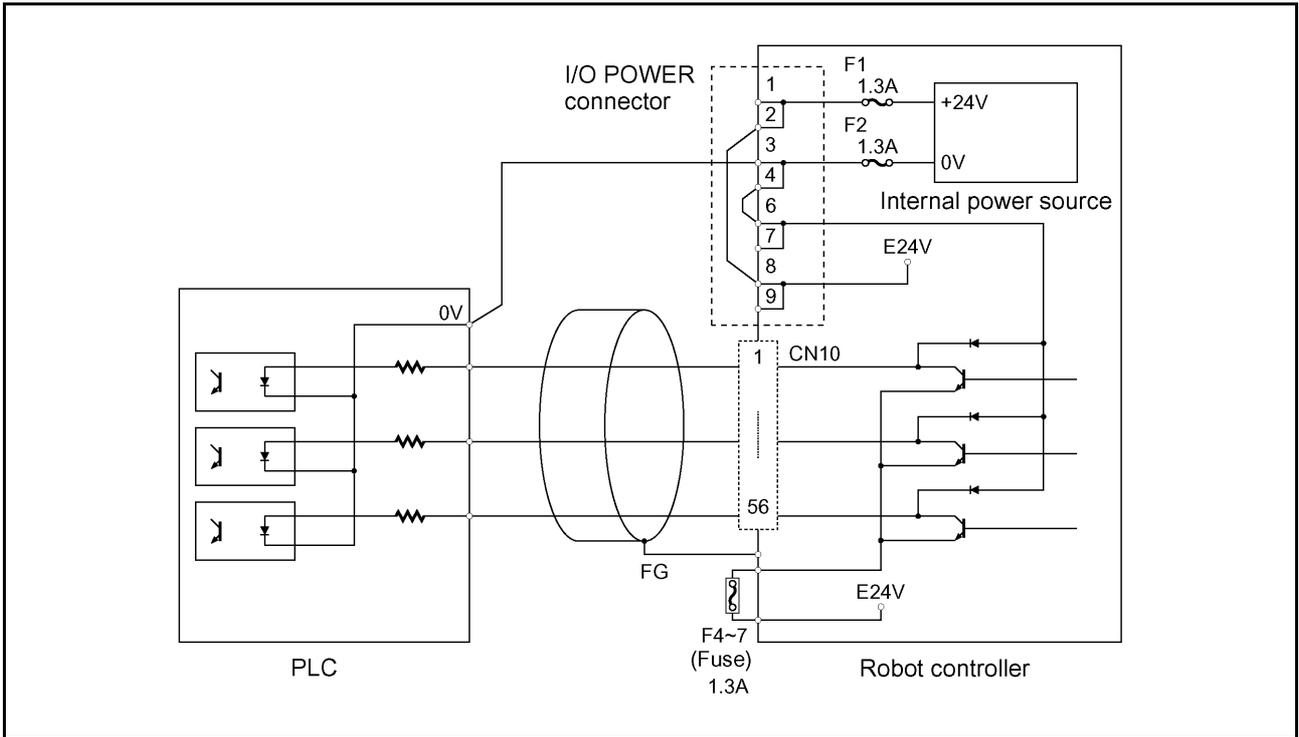
 **Caution: Since the initial resistance of a lamp is small, the output circuit may be damaged by rush current that flows when the lamp lights.**  
Refer to Figure 5-60.

- (5) **When using the internal power source, prepare a PLC input circuit unit that does not contain a power source.**

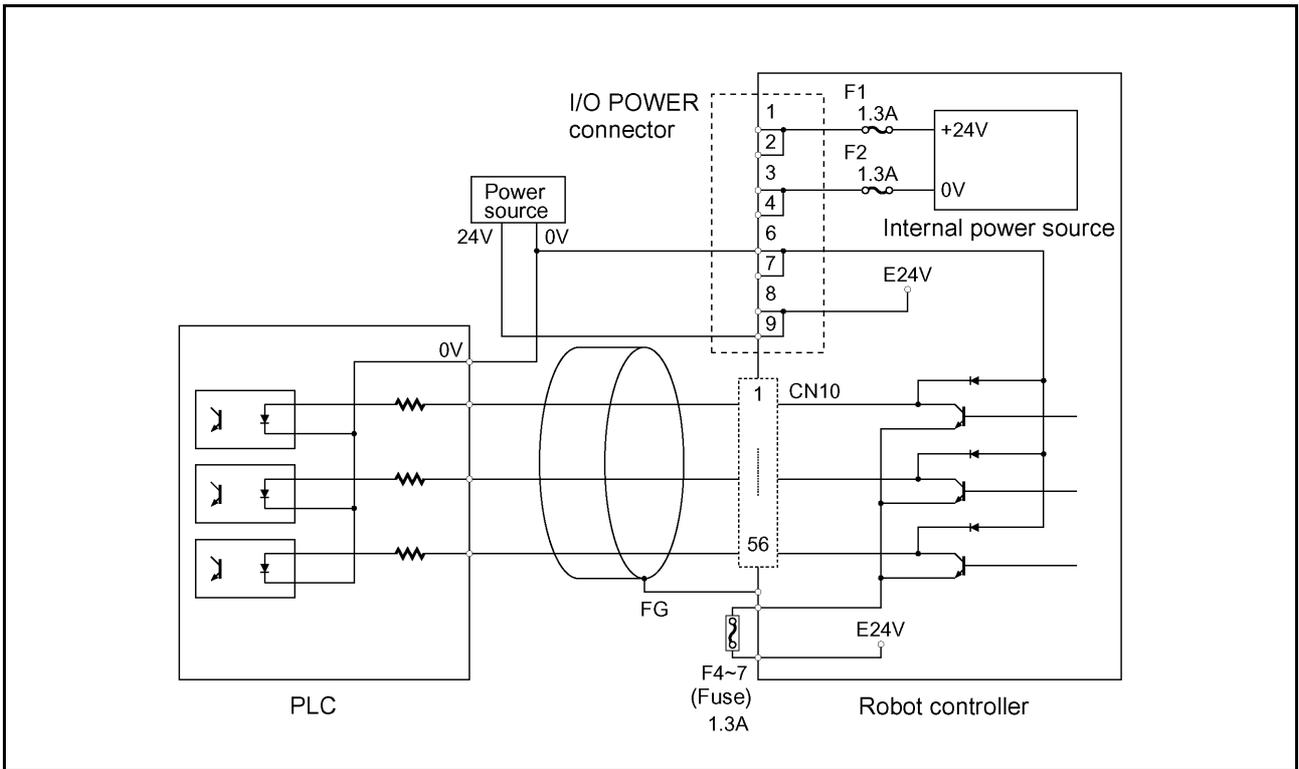
 **Caution: Keep the total current capacity of the internal power source below 1.3A.**

- (6) **Use a multi-core shielding cable for the purpose of protecting the devices from external noise. Ground it to the robot controller.**
- (7) **24V internal power source of the robot controller must not be grounded.**

 **Caution: If the output terminal +24V of internal power source is grounded, there may be a case where the controller is damaged.**

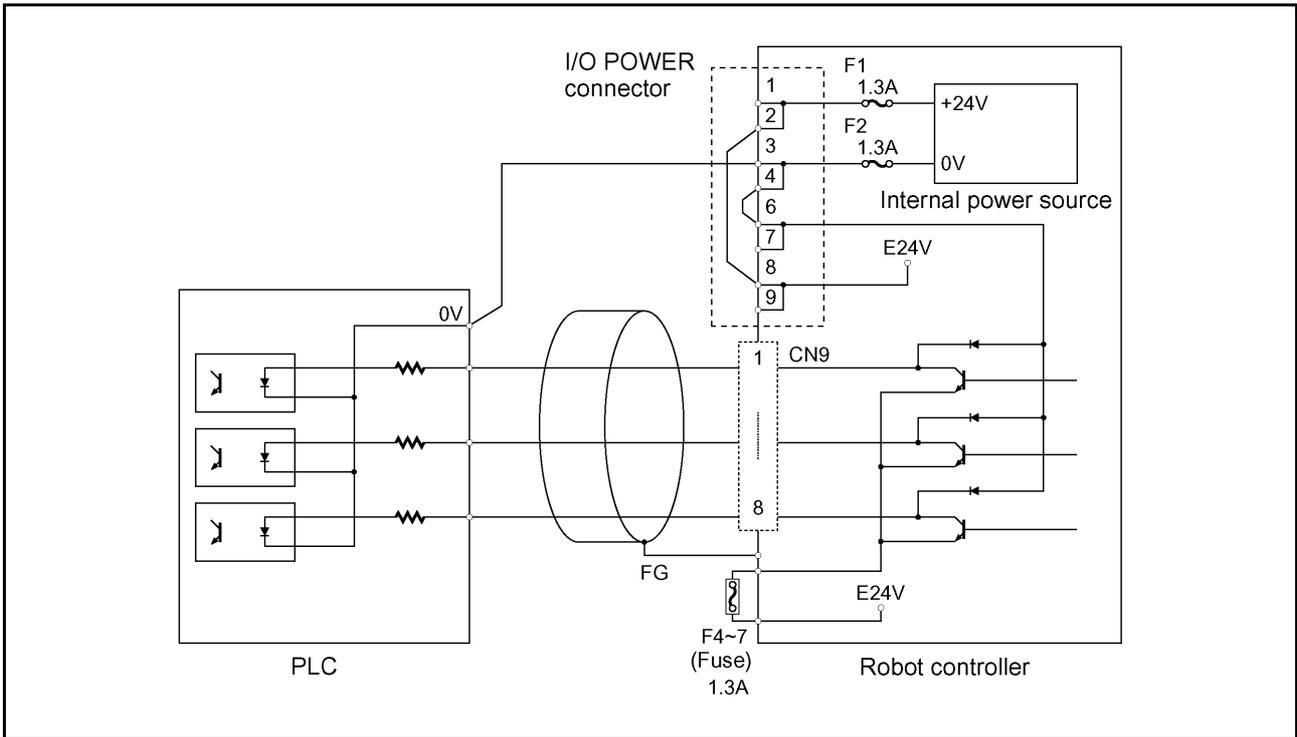


(When the internal power source is used)

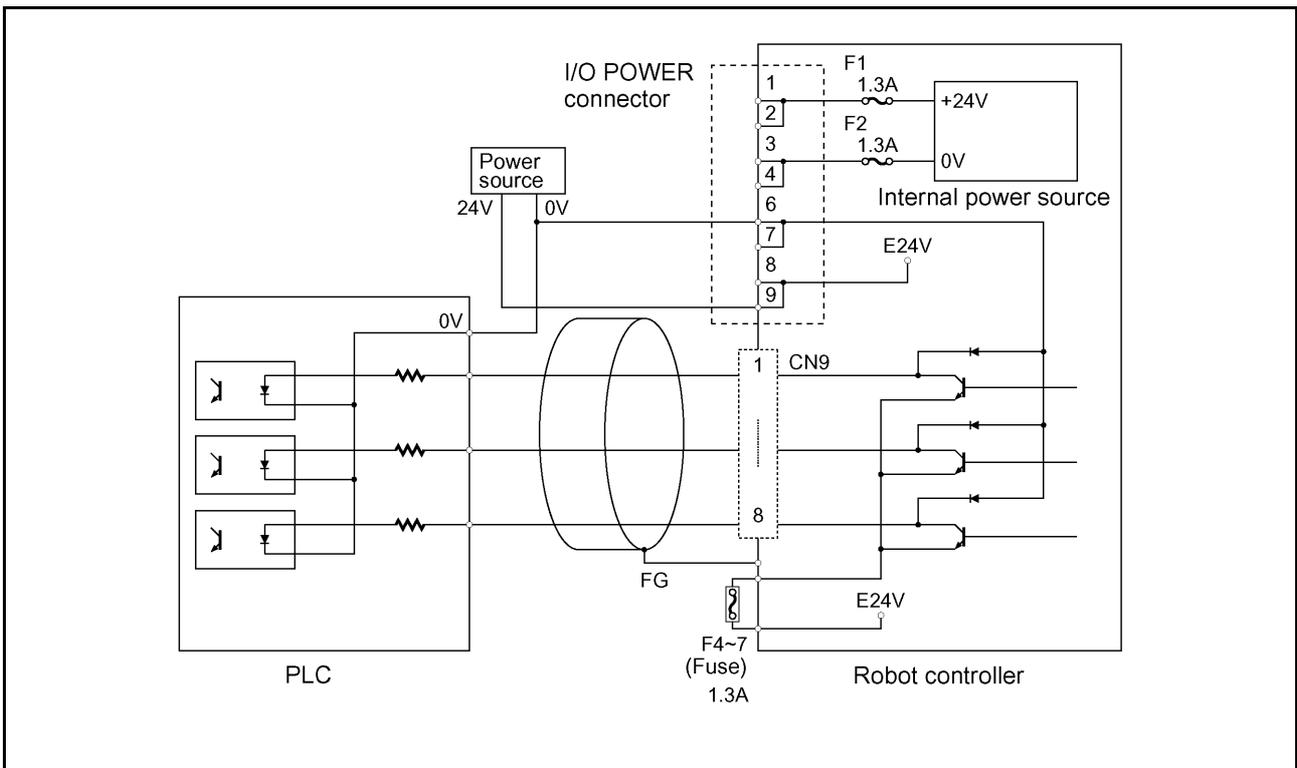


(When an external power source is used)

Figure 5-58 User-Output and System-Output Circuits (PNP type)



(When the internal power source is used)



(When an external power source is used)

Figure 5-59 Hand-Output Circuits (PNP type)

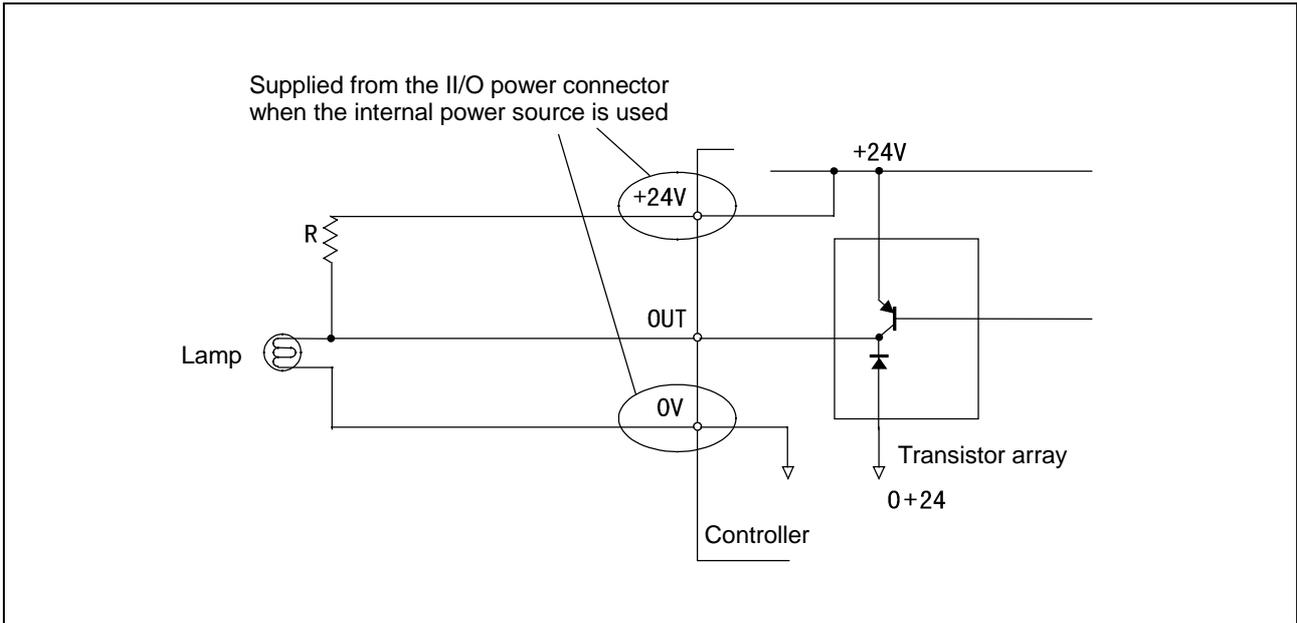
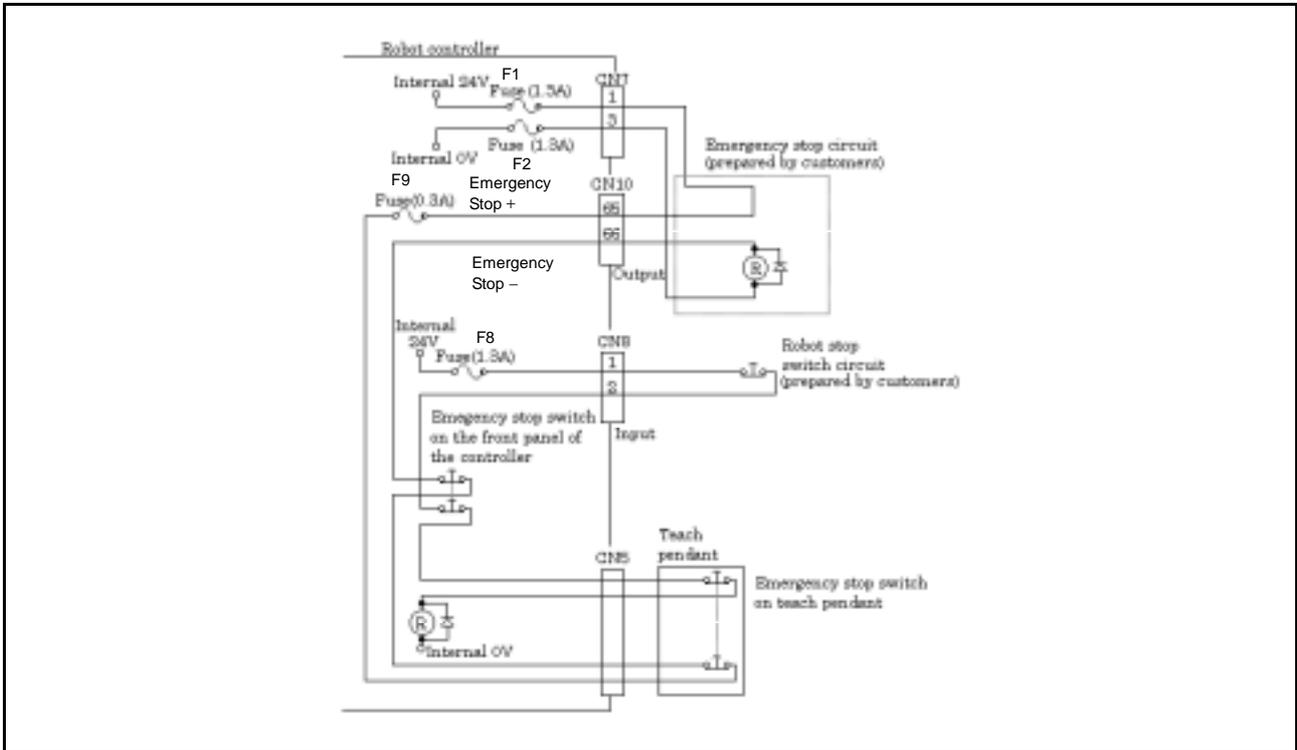


Figure 5-60 Example of Circuit with Lamp (PNP type)

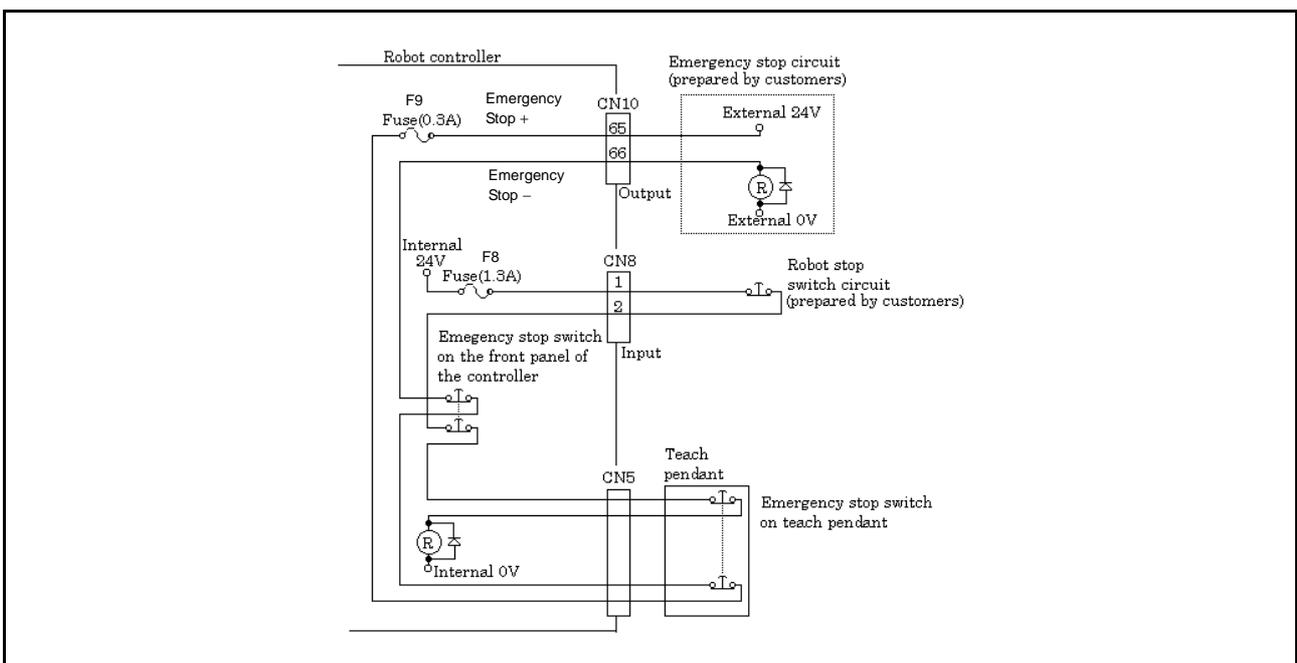
### 5.6.2.4 Emergency Stop Output Circuit

Figure 5-61 shows the examples of configuration and connection of emergency stop circuit for the robot controller.

The red mushroom-shaped switch provided on the robot controller front panel, on the teach pendant, or on the operating panel can be used as a switch for stopping the equipment in case of emergency.



(When the internal power source is used)



(When an external power source is used)

Figure 5-61 Emergency Stop Output Circuit

### 5.6.2.5 I/O Power Connector

For the power source to communicate signals between the robot controller and the external device, the internal power source of the robot controller or an external power source is used.

Figure 5-62 (a) shows an example of connecting I/O power connectors when the internal power source is used, and Figure 5-62 (b) shows an example of connecting I/O power connectors when an external power source is used.

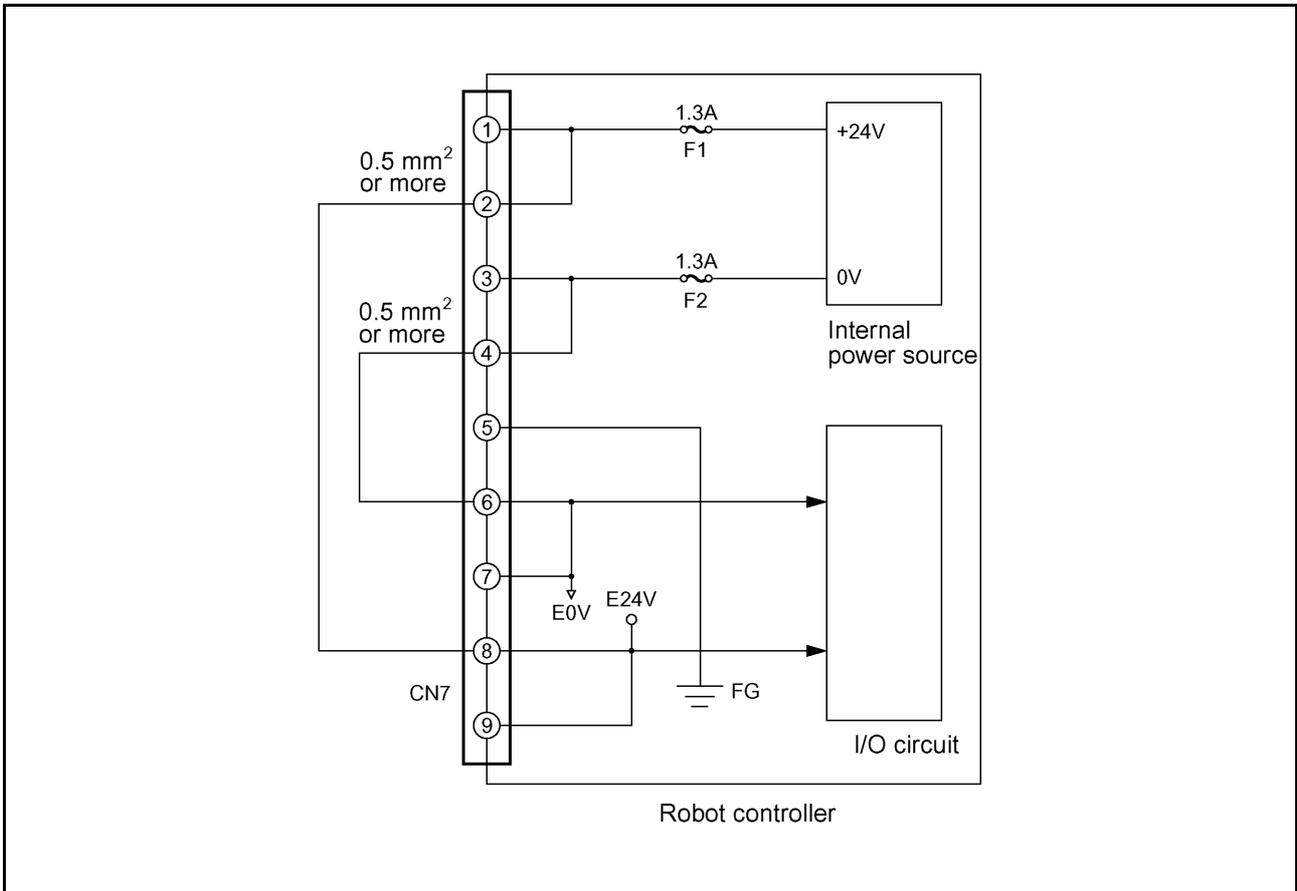


Figure 5-62 (a) I/O Power Connection Sample (When the internal power source is used) (PNP type)

**⚠ Caution:** To use the internal power source of the robot controller, connect the wiring so that the internal power source will be separate from the external power source. Improper wiring may damage the internal circuit.

**The +24V internal power source of the robot controller must not be grounded.**

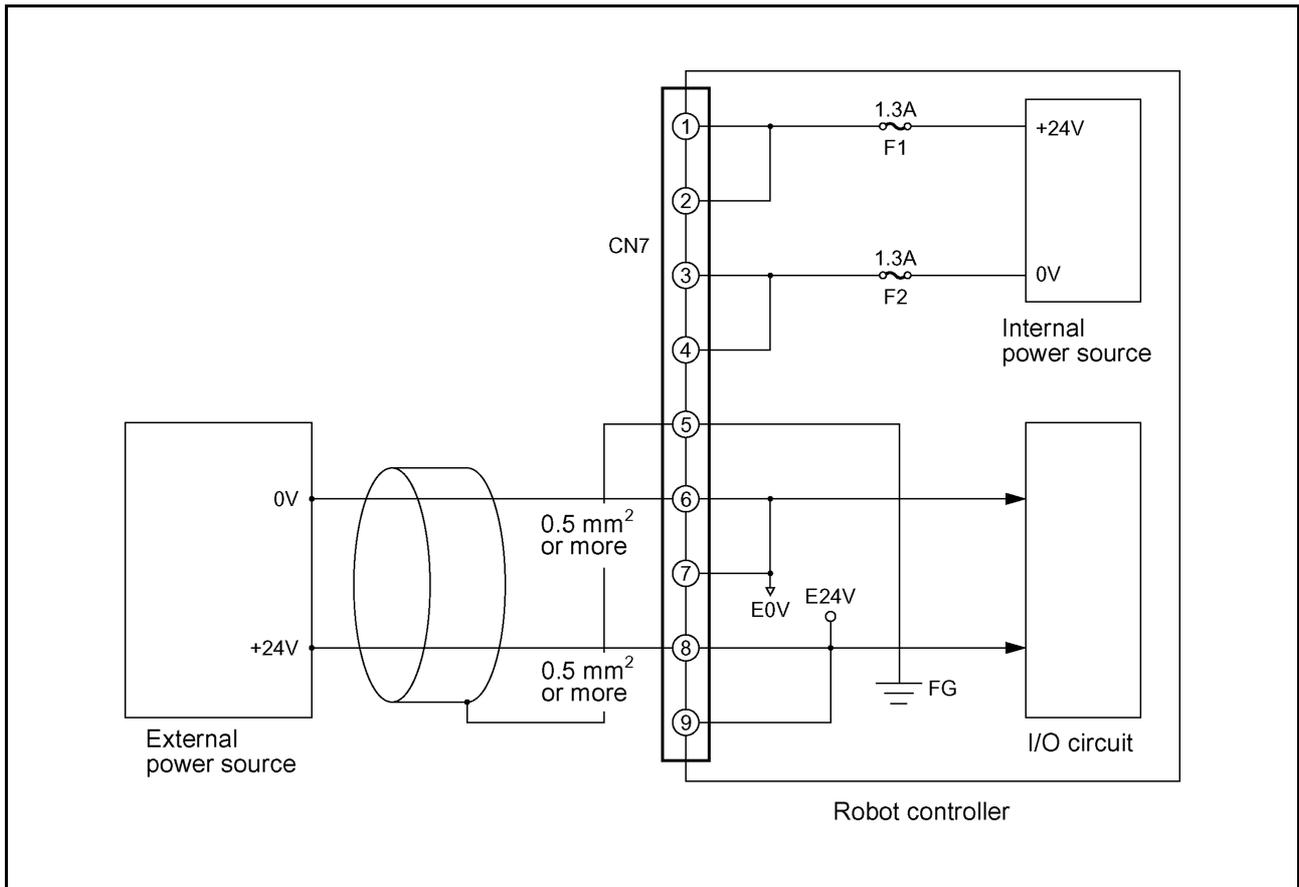


Figure 5-62 (b) I/O Power Connection Sample (When an external power source is used) (PNP type)

**Caution:** Use a cable of 0.5 mm<sup>2</sup> or more in size for the wiring between the external power source and the I/O power input connectors of the robot controller.

### 5.6.3 Wiring Notes for Robot Controller I/O Connectors

After the wiring of the controller's I/O connectors is completed, check the following before turning ON the power:

**Check point (1)**

Using a circuit tester, check across the "+24V terminal" and "0V terminal" of each connector and across the "E24V terminal" and the "E0V terminal" to see that there is no continuity. See Figure 5-63 and Table 5-21.

**⚠ Caution:** If the connector wiring between the robot controller's "+24V terminal" and "0V terminal" and between the "E24V terminal" and the "E0V terminal" is shorted, damage to the power circuit of the Robot Controller will result.

**Check point (2)**

Using a circuit tester, check across "each signal Output terminal" and "+24V terminal" or "E24V terminal" of each connector to see that there is no continuity. See Figure 5-63 and Table 5-21.

**⚠ Caution:** If the wiring between "each signal Output terminal" and "+24V terminal" or "E24V terminal" of each connector is shorted, damage to the Output circuit and power circuit of the robot controller will result.

**⚠ Caution:** Wind adhesive vinyl tape around all ends of the unconnected wiring of each connector to prevent them from contacting other wiring and parts, which results in shorting.

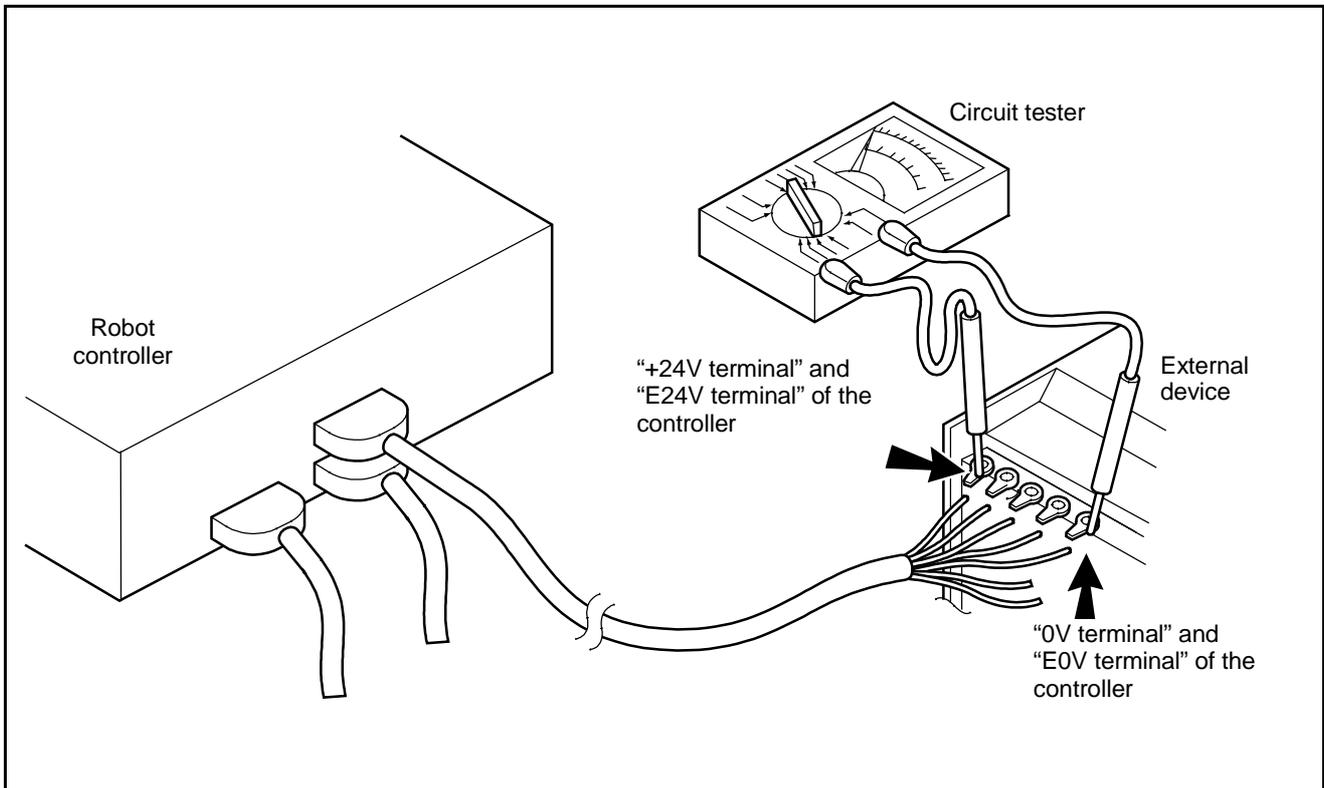
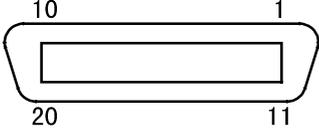
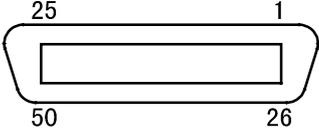
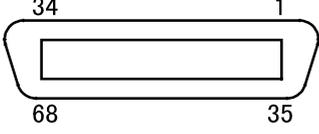


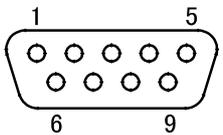
Figure 5-63 Checking Example

**Table 5-21 Connector Terminals and Check Points (PNP type)**

<b>Connector for hand I/O</b>			
			
<b>View from cable side engaging face</b>			
Terminal Number	Name	Meaning	Check point
1 to 8	Hand output terminal	24V at output	<b>(2)</b>
17	Power terminal for hand (E0V)	Power (GND) output	<b>(1)</b>
18	Power terminal for hand (E24V)	24V power output	<b>(1)</b>

<b>Connector for user/system input</b>			
			
<b>View from cable side engaging face</b>			
Terminal Number	Name	Meaning	Check point
1, 3	+24V internal power source terminal	+24V internal power source output	<b>(1)</b>

<b>Connector for user/system output</b>			
			
<b>View from cable side engaging face</b>			
Terminal number	Name	Meaning	Check point
1 to 56	Signal output terminal	24V at output	<b>(2)</b>

<b>Connector for I/O power source</b>			
			
<b>View from cable side engaging face</b>			
Terminal number	Name	Meaning	Check point
1, 2	+24V internal power source terminal	+24V internal power source output	<b>(1)</b>
3, 4	0V internal power source terminal	0V internal power source output	<b>(1)</b>
6, 7	E0V (GND) input terminal	Power (GND) input	<b>(1)</b>
8, 9	E24V input terminal	24V power input	<b>(1)</b>

## 5.7 I/O Wiring

### 5.7.1 Multi-core Cables with Connectors

Multi-core cables with connectors to be used for the I/O wiring of the Robot Controller are options. Select an appropriate cable from Table 5-22 if necessary.

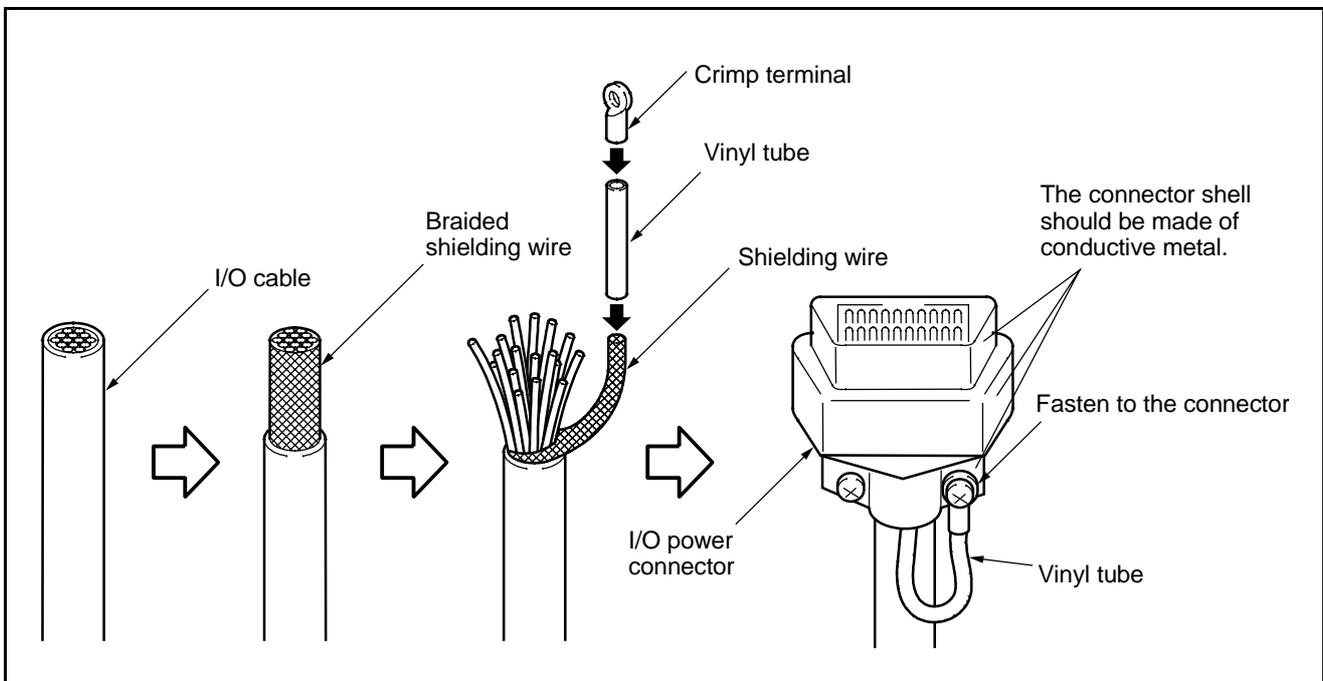
Table 5-22 I/O Cables (Optional items)

Classification	No.	Name	Remarks	Part Number
I/O Cable	1	I/O Cable Set	(8m) (3-cable set of Nos. 1-1 to 1-3)	410149-0330
	1-1	Input Cable	(8m)	410141-1630
	1-2	Output Cable	(8m)	410141-1650
	1-3	Hand I/O Cable	(8m)	410141-1740
	2	I/O Cable Set (hand I/O cable: high strength type)	(8m) (3-cable set of Nos. 2-1 to 2-3)	410149-0350
	2-1	Input Cable	(8m)	410141-1630
	2-2	Output Cable	(8m)	410141-1650
	2-3	Hand I/O Cable (high strength type)	(8m)	410141-1670
I/O Cable	3	I/O Cable Set	(15m) (3-cable set of Nos. 3-1 to 3-3)	410149-0340
	3-1	Input Cable	(15m)	410141-1640
	3-2	Output Cable	(15m)	410141-1660
	3-3	Hand I/O Cable	(15m)	410141-1750
	4	I/O Cable Set (hand I/O cable: high strength type)	(15m) (3-cable set of Nos. 4-1 to 4-3)	410149-0360
	4-1	Input Cable	(15m)	410141-1640
	4-2	Output Cable	(15m)	410141-1660
	4-3	Hand I/O Cable (high strength type)	(15m)	410141-1680

If you do not use optional cables listed on the previous page, use the recommended connectors and cables listed in Table 5-23.

**Table 5-23 Recommended Connectors for I/O Cables and Cable Standards**

Connector name	Connector model/manufacturer	Cable Standards	Remarks
OUTPUT	PCR-E68FS connector PCS-E68LA cover Honda Communications Industry Co., Ltd.	UL2789 - With shield Equivalent to AWG28-68P	<b>Caution:</b> Be sure to modify the shielding wire at the end of the cable to be used, as shown in Figure 5-64. Without this modification, the robot may malfunction due to noise.
HAND I/O	PCR-E20FS connector PCS-E20LA cover Honda Communications Industry Co., Ltd.	UL2789 - With shield Equivalent to AWG28-20P	
INPUT	PCR-E50FS connector PCS-E50LA cover Honda Communications Industry Co., Ltd.	UL2789 - With shield Equivalent to AWG28-50P	
I/O POWER	DE-9P connector DE-C4-J6 cover Japan Aviation Electronics Industry, Ltd.	UL2405 - With shield Equivalent to AWG20-2P	



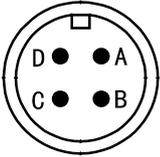
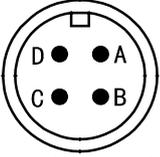
**Figure 5-64 Modifying the Shielding Wire (Example)**

## 5.7.2 Wiring

Observe the following precautions when wiring the primary power source of the robot controller:

- (1) Connect the robot power cable to a power source separate from the welder power source.
- (2) Ground the grounding wire (green) of the robot power cable.
- (3) Ground the grounding terminal of the robot controller using a wire of 1.25 mm<sup>2</sup> or more in size.
- (4) For the robot power supply, use a grounding wire with grounding resistance of 100 Ω or less.
- (5) If the supply power source for the robot controller requires a leakage breaker, use a high frequency-proof leakage breaker for inverters.
- (6) Prepare wires of an appropriate capacity for the 200 VAC main line and other cables according to Tables 5-24 and 5-25.

**Table 5-24 Robot Controller Specifications**

Power voltage:	3-phase, 200 VAC -15% to 230 VAC + 10%, 50/60 Hz	Pin assignment on connector (CN11), 3-phase
		 <p>A: 200 VAC, phase R B: 200 VAC, phase S C: 200 VAC, phase T D: Ground</p> <p>(View from pin face)</p>
Power voltage:	Single-phase, 230 VAC -10% to 230 VAC + 10%, 50/60 Hz	Pin assignment on connector (CN11), single-phase
		 <p>A: 230 VAC, phase R B: 230 VAC, phase S C: Not used. D: Ground</p> <p>(View from pin face)</p>
Max. rush current when the power is turned ON:	50 A (for 1/50 or 1/60 second)	

**Table 5-25 Power Consumption of Robot**

Robot	Power consumption
H*-D series	2.0 kVA

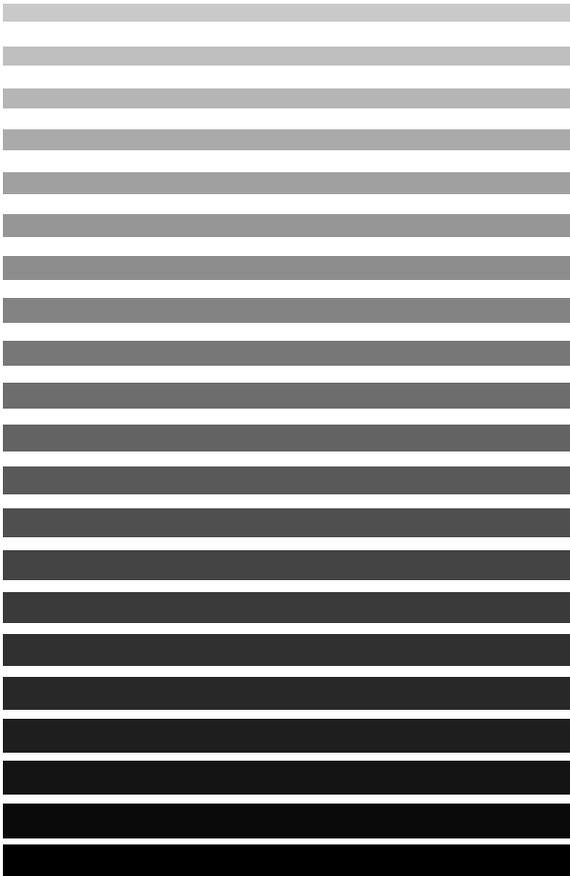
**Caution: If ERROR6102 (power voltage drop) occurs when the robot is in operation, it may be attributable to an insufficient capacity of the primary side power source.**

- (7) Do not bundle the teach pendant cables, I/O cables or motor cables together with high power lines such as 200 VAC lines and peripheral device cables, or route the motor cables near high power devices (motor, welder, parts feeder, etc.).
- (8) Do not route any additional cables or air tubes of end-effectors through the robot unit. Doing so will result in broken cables or tubes.

# Chapter 6



## Maintenance and Inspection



This chapter describes the regular maintenance and inspections necessary for maintaining the performance and functions of the robot.



# 6.1 Maintenance & Inspection Intervals and Purposes

Table 6-1 lists the intervals and purposes of maintenance & inspection required for your robot.

**Table 6-1 Maintenance & Inspection Intervals and Purposes**

■ **HM-D/HS-D series**

No.	Intervals		Purposes
1	Daily	Perform inspection jobs specified in <u>Section 6.2</u> every day before starting operations.	To use your robot safely.
2	Quarterly	Perform inspection jobs specified in <u>Section 6.3</u> every three months.	To check the rotary sections and slideways of the robot and its controller for wear, preventing seizure, breakage, and other serious failures that could result from wear.
3	Biennial	Replace backup batteries as specified in <u>Section 6.5</u> every two years.	To retain the robot-specific data (programs, parameters, etc.) stored in the internal memory of the robot controller and the position data stored in the electronic absolute encoder build in the robot unit.

■ **HC-D series**

No.	Intervals		Purposes
1	Daily	Perform inspection jobs specified in <u>Section 6.2</u> every day before starting operations.	To use your robot safely.
2	Quarterly	Perform inspection jobs specified in <u>Section 6.3</u> every three months.	To maintain the precision of the robot and to prevent failures caused by overheat of the robot controller.
3	Semiyearly	Perform inspection jobs specified in <u>Section 6.4</u> every six months.	To check the rotary sections and slideways of the robot and its controller for wear, preventing seizure, breakage, and other serious failures that could result from wear.
4	Biennial	Replace backup batteries as specified in <u>Section 6.5</u> every two years.	To retain the robot-specific data (programs, parameters, etc.) stored in the internal memory of the robot controller and the position data stored in the electronic absolute encoder build in the robot unit.

 **Caution: Before performing maintenance and inspection jobs, read the SAFETY PRECAUTIONS, "3 Precautions while robot is running" and "4 Daily and periodical inspections."**

## 6.2 Daily Inspections

### 6.2.1 Check Items

Before starting operations, check the items listed in Table 6-2 every day.

**Table 6-2 Daily Inspections Table**

No.	Check:	Controller Power	How to check:	Criterion	What to do: (Note 1)
1	Connectors (CN1 to CN12 on the robot controller) and their mating parts	OFF	Visually	No looseness, disengagement or dirt.	Engage the parts properly and clean them.
2	Cables (connected to CN1 to CN12 on the robot controller) and robot's external cables	OFF	Visually	Free of damage or gouges.	Repair or replace.
3	LCD on the teach pendant	ON	Visually	Properly displayed	Repair or replace.
4	Pilot lamps on the robot controller	ON	Visually	Should light.	Repair or replace.
5	Cooling fan in the robot controller	ON	Visually <b>(Note 2)</b>	Should work properly.	Repair or replace.
6	Calibration	ON	Visually	No error or unusual noise.	Repair or replace.
7	ROBOT STOP button on the operating panel, the teach pendant or the mini pendant	ON	Press the ROBOT STOP button.	The robot should come to an emergency stop.	Repair or replace.
8	Safety door	ON	Operate the safety door switch and open the switch-wiring door.	The robot should come to an emergency stop.	Repair or replace.

Note 1 Some repair and replacement operations, shown in "What to do:" column, may involve special work. Contact the DENSO Robot Service Section.

Note 2 The normal operation of the cooling fan is as shown in Figure 6-1.

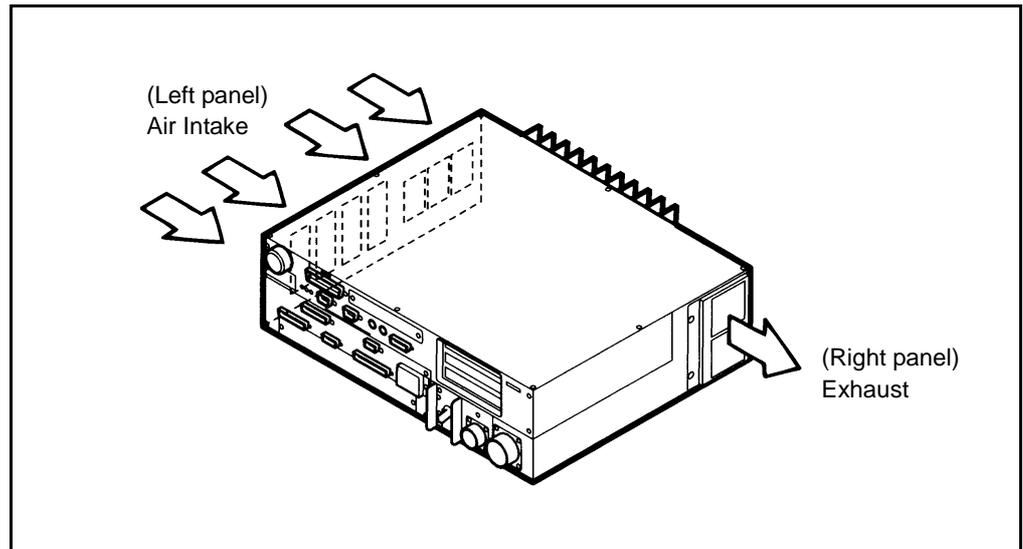


Figure 6-1 Normal Operation of Cooling Fan

## 6.3 Quarterly Inspections

### 6.3.1 Check Items and Lubrication

Check the items and lubricate your robot as listed in Table 6-3 every three months.

Table 6-3 Quarterly Inspections Table

#### ■ HM-D/HS-D series

No.	Check:	Controller Power	How to check:	Criterion	What to do:										
1	Robot base mounting bolts	OFF	Measure the tightening torque with a torque wrench.	No looseness. Specified torque: 110 ±22 N•m	Tighten the bolts to the specified torque.										
2	Axis motor mounting bolts	OFF	Measure the tightening torque with a torque wrench.	No looseness. <table border="1"> <thead> <tr> <th>Motor</th> <th>Specified torque</th> </tr> </thead> <tbody> <tr> <td>1st-axis</td> <td>15 ±3 N•m</td> </tr> <tr> <td>2nd-axis</td> <td>15 ±3 N•m</td> </tr> <tr> <td>3rd-axis</td> <td>4 ±0.8 N•m</td> </tr> <tr> <td>4th-axis</td> <td>2 ±0.4 N•m</td> </tr> </tbody> </table>	Motor	Specified torque	1st-axis	15 ±3 N•m	2nd-axis	15 ±3 N•m	3rd-axis	4 ±0.8 N•m	4th-axis	2 ±0.4 N•m	Tighten the bolts to the specified torque.
Motor	Specified torque														
1st-axis	15 ±3 N•m														
2nd-axis	15 ±3 N•m														
3rd-axis	4 ±0.8 N•m														
4th-axis	2 ±0.4 N•m														
3	Rotary sections and slideways of the robot	OFF	Apply the specified lubricants to the specified points. (Refer to Subsect. 6.3.3.)												
4	Cooling fan filters in the robot controller	OFF	Visually	No dust or dirt.	Clean the cooling fan filters. (Refer to Subsect. 6.3.2.)										

#### ■ HC-D series

No.	Check:	Controller Power	How to check:	Criterion	What to do:										
1	Robot base mounting bolts	OFF	Measure the tightening torque with a torque wrench.	No looseness. Specified torque: 69.6 ±13.9 N•m	Tighten the bolts to the specified torque.										
2	Axis motor mounting bolts	OFF	Measure the tightening torque with a torque wrench.	No looseness. <table border="1"> <thead> <tr> <th>Motor</th> <th>Specified torque</th> </tr> </thead> <tbody> <tr> <td>1st-axis</td> <td>8.8 ±1.76 N•m</td> </tr> <tr> <td>2nd-axis</td> <td>3.9 ±0.78 N•m</td> </tr> <tr> <td>3rd-axis</td> <td>2.0 ±0.60 N•m</td> </tr> <tr> <td>4th-axis</td> <td>2.0 ±0.60 N•m</td> </tr> </tbody> </table>	Motor	Specified torque	1st-axis	8.8 ±1.76 N•m	2nd-axis	3.9 ±0.78 N•m	3rd-axis	2.0 ±0.60 N•m	4th-axis	2.0 ±0.60 N•m	Tighten the bolts to the specified torque.
Motor	Specified torque														
1st-axis	8.8 ±1.76 N•m														
2nd-axis	3.9 ±0.78 N•m														
3rd-axis	2.0 ±0.60 N•m														
4th-axis	2.0 ±0.60 N•m														
3	Cooling fan filters in the robot controller	OFF	Visually	No dust or dirt.	Clean the cooling fan filters. (Refer to Subsect. 6.3.2.)										

### 6.3.2 Cleaning the Cooling Fan Filters in the Robot Controller

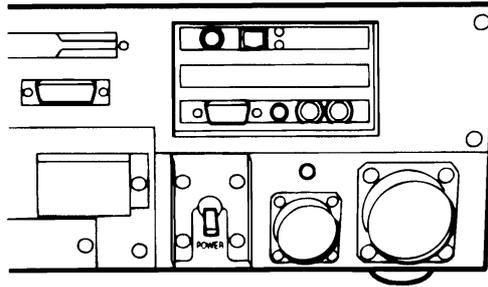
The robot controller has two cooling fan filters—inlet port filter and exhaust port filter.

If either of the filters is clogged, the robot controller becomes badly ventilated to overheat so that the internal electronic devices may fail due to heat.

If a power module error appears, it may be caused by clogged filters, so clean those filters.

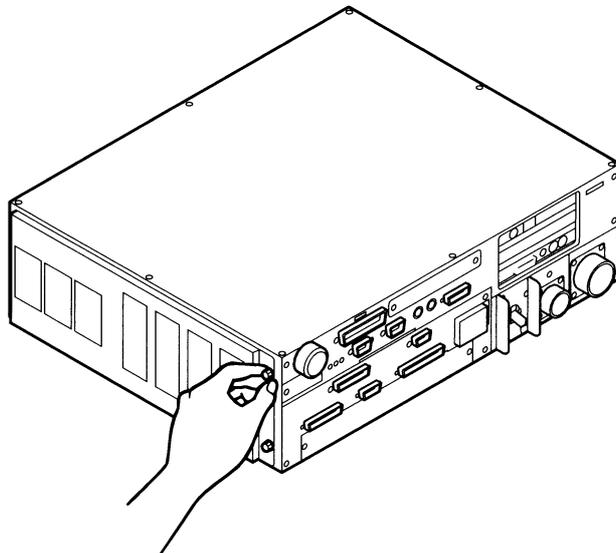
#### ▶ STEP 1

Turn the POWER switch of the robot controller OFF.



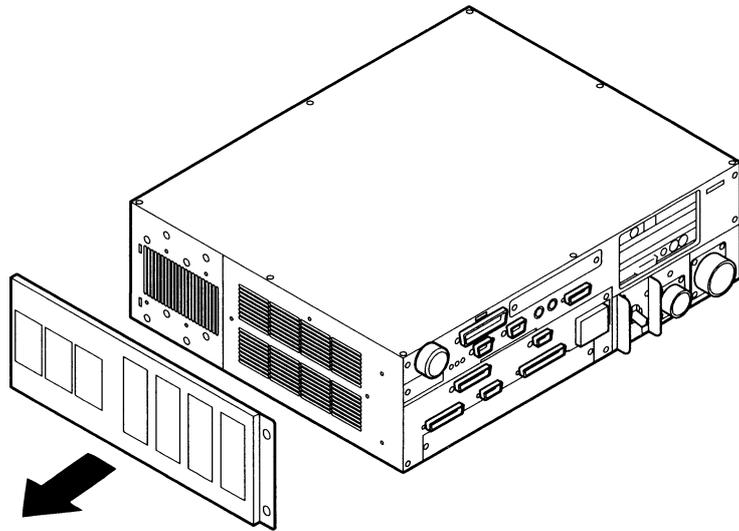
#### ▶ STEP 2

Remove the screws with your fingers to release the inlet port filter.



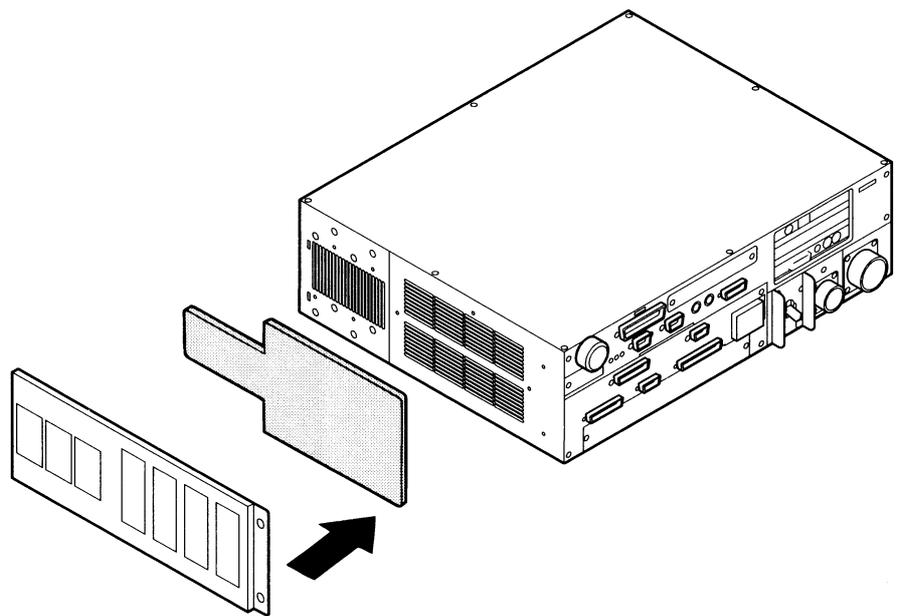
▶ **STEP 3**

Remove the support frame of the inlet port filter.



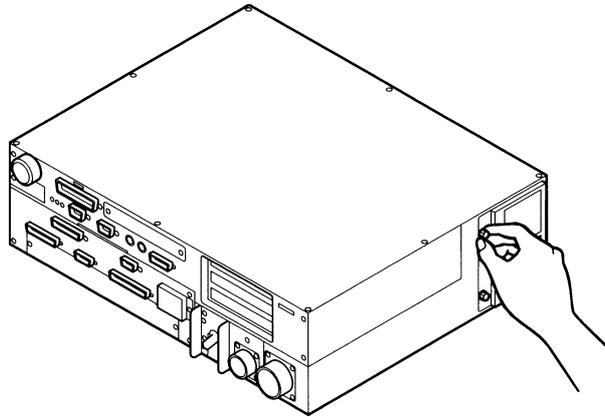
▶ **STEP 4**

Remove the filter element from the support frame.



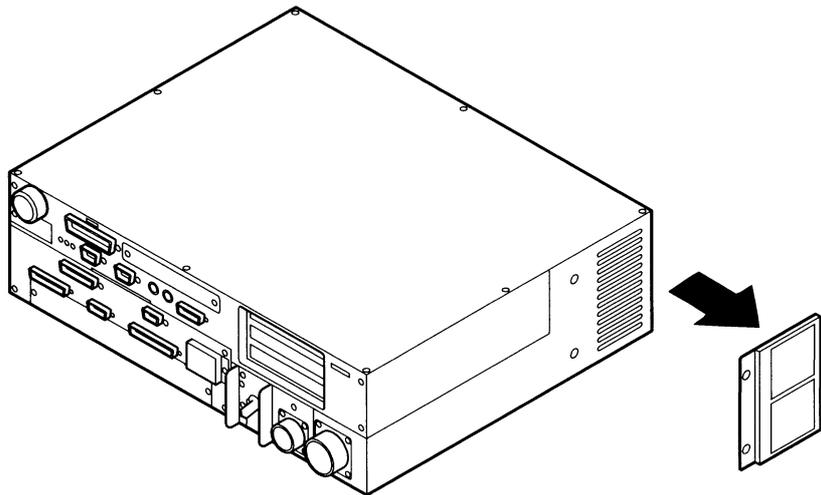
▶ STEP 5

Remove the screws with your fingers to release the exhaust port filter.



▶ STEP 6

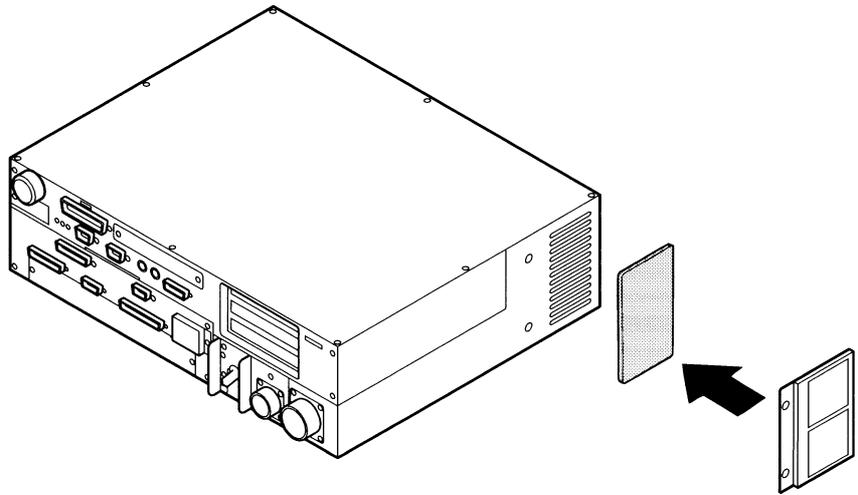
Remove the support frame of the exhaust port filter.



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▶ **STEP 7**

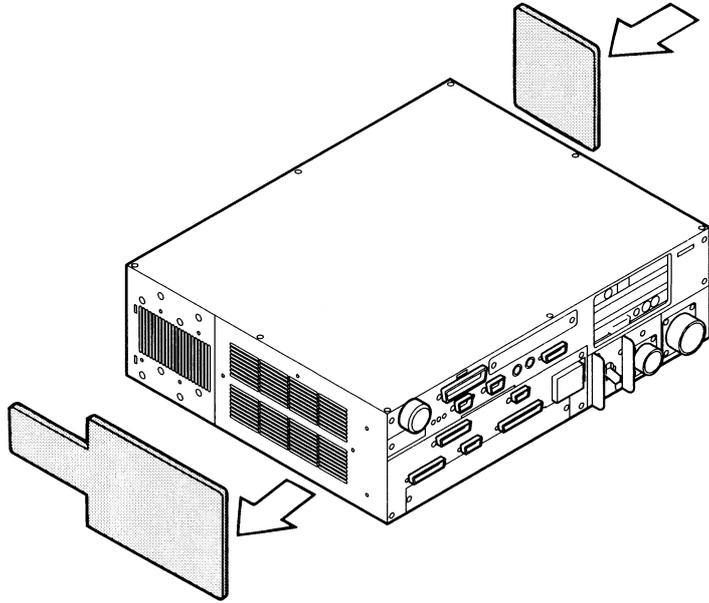
Remove the filter element from the support frame.



### ► STEP 8

Blow compressed air to the filter elements in the direction opposite to the regular air flow.

NOTE: Use dehumidified, oil-free, pure compressed air for cleaning.



If the filters are excessively dirty, wash them with water or warm water (40°C or lower). A neutral detergent is most effective.

Notes: (1) Dry the washed filters completely before replacing them.  
(2) If the filters are still dirty after air blowing or washing, replace them with new ones.

### ► STEP 9

Reinstall the filters in the reverse order of removal.

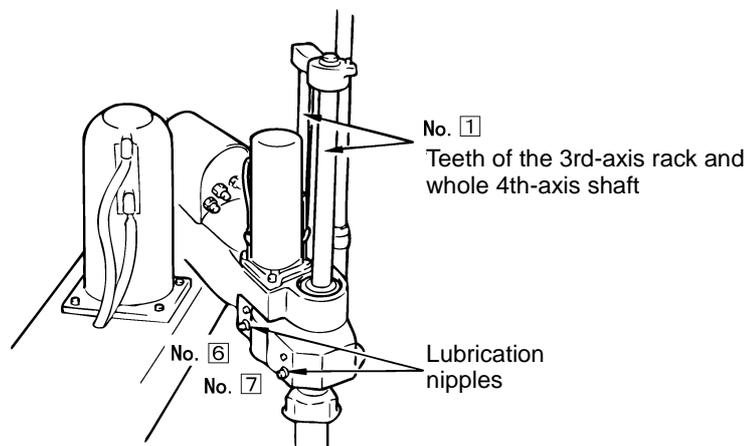
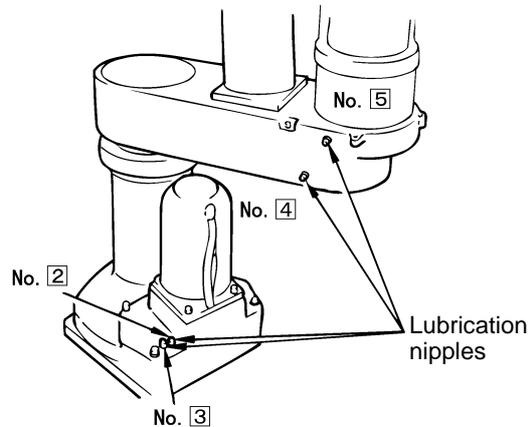
### 6.3.3 Lubrication

On the HM-D/HS-D series, apply the specified lubricants to the rotary sections and slideways of the robot unit as listed below every three months.

**Table 6-4 Lubrication Points and Lubricants**

■ **HM-D/HS-D series**

No.	Lubrication points	Lubricant type	Lubricant amount	Remarks
1	3rd (z)-axis rack and 4th-axis shaft	Epinoc AP1	2 to 3 cc	Lubricate the teeth of the 3rd-axis rack and the whole 4th-axis shaft.
2	Lubrication nipple	↑	2 pushes	Apply lubricant through nipples 2 to 7 as shown below.  NOTE: The lubricant amount is expressed in the number of pushes when you use a recommended grease gun which discharges 1.4 cc of grease each time it is pushed.  (Refer to Section 6.6, "Supplies and Tools for Maintenance.")
3	Lubrication nipple	↑	4 pushes	
4	Lubrication nipple	↑	2 pushes	
5	Lubrication nipple	↑	2 pushes	
6	Lubrication nipple	↑	1 push	
7	Lubrication nipple	↑	2 pushes	



# 6.4 Semiyearly Inspections

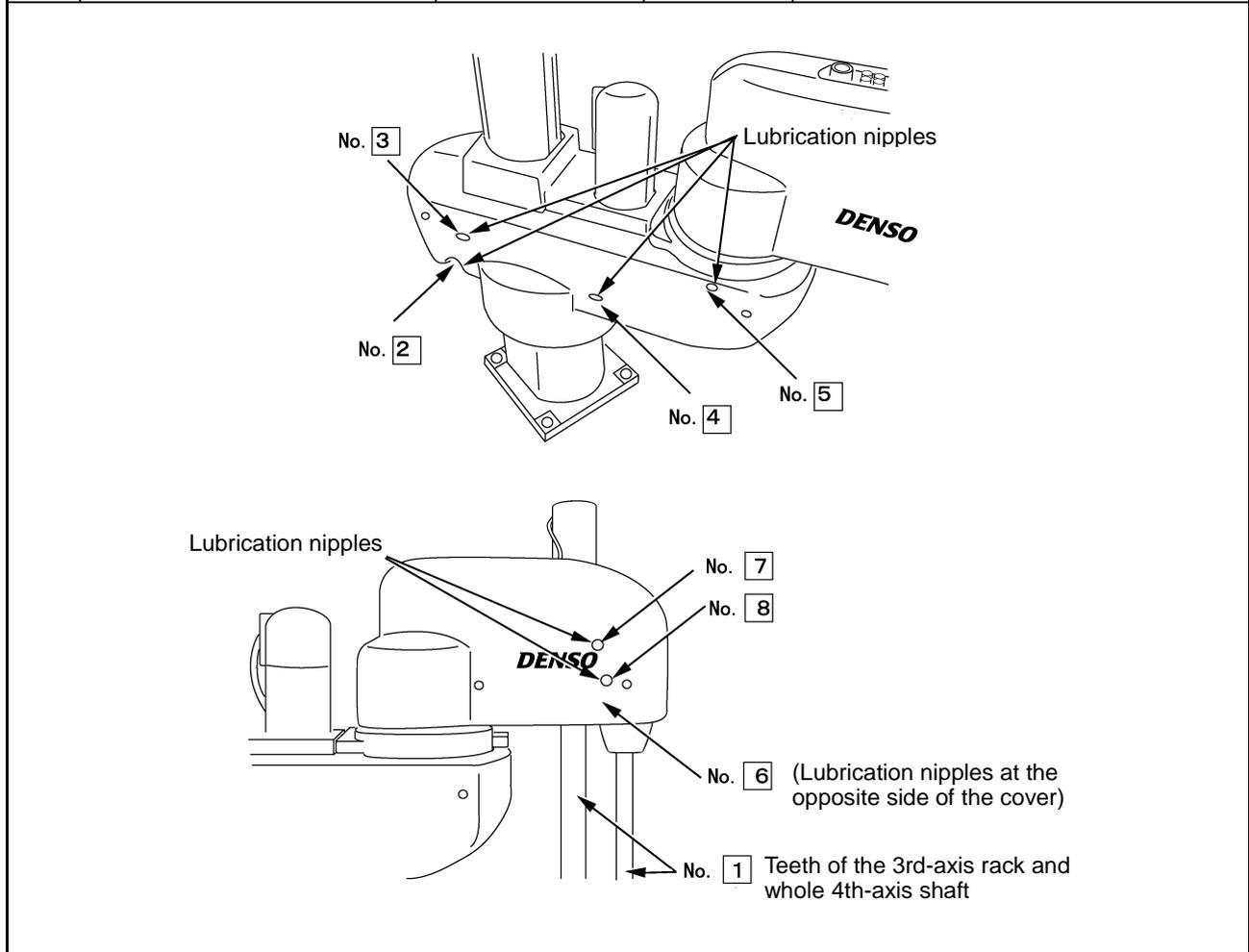
## 6.4.1 Lubrication

On the HC-D series, apply the specified lubricants to the rotary sections and slideways of the robot unit as listed below every six months.

Table 6-5 Lubrication Points and Lubricants

■ HC-D series

No.	Lubrication points	Lubricant type	Lubricant	Remarks
1	3rd (z)-axis rack and 4th-axis	Epinoc AP1	2 to 3 cc	Lubricate the teeth of the 3rd-axis Apply lubricant through nipples 2 to 8 as shown below.
2	1st-axis lubrication nipple①	↑	1.5 cc	
3	1st-axis lubrication nipple②	↑	4 cc	
4	2nd-axis lubrication nipple①	↑	1 cc	
5	2nd-axis lubrication nipple②	↑	3 cc	
6	3rd-axis lubrication nipple	↑	0.25 cc	
7	4th-axis lubrication nipple①	↑	0.25 cc	
8	4th-axis lubrication nipple②	↑	0.5 cc	



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## 6.5 Biennial Inspections

### 6.5.1 Battery Replacement

Replace the two types of backup batteries shown in Table 6-6 during biennial inspections and maintenance.

**Table 6-6 Backup Battery Type**

	<b>Battery type</b>	<b>Used for:</b>	<b>Located:</b>	<b>Refer to:</b>
1	Encoder backup battery	Backs up the position data of the servomotor encoder.	In the robot unit	6.5.2
2	Memory backup battery	Backs up programs, parameters, and CAL data.	In the robot controller	6.5.3

The position data of the encoder contained in the servomotor is stored in the internal memory of the encoder.

Programs, parameters, CAL data, etc. are stored in the internal memory of the robot controller.

The backup battery for each memory retains the above data, while the power to the robot controller is turned OFF. However, these batteries have a limited lifetime and must, therefore, be replaced regularly.

**NOTE:** If two years elapse from replacement of either backup battery, the "Time to change controller backup battery" message will appear on the teach pendant.

 **Caution: Without replacing the backup batteries, important robot-specific data stored in each memory will be lost.**

## 6.5.2 Replacing the Encoder Backup Battery

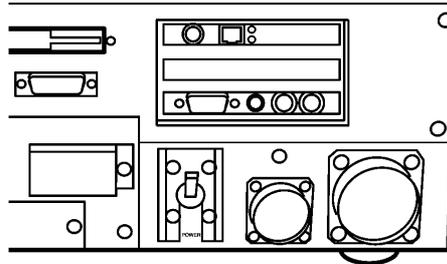
Replace the encoder backup battery according to the procedure given below.

### ■ HM-D/HS-D series

#### ▶ STEP 1

Turn the controller power ON.

**⚠ Caution: Do not turn the motor power ON.**



#### ▶ STEP 2

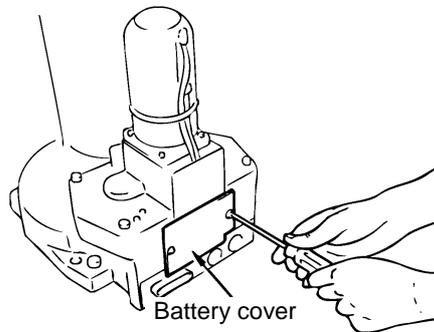
Press and lock the robot stop button on the controller (or on the teach pendant, mini pendant or operating panel) in order to prevent the motor power from becoming turned on accidentally.

**Note: To unlock the robot stop button, slightly turn it clockwise.**

#### ▶ STEP 3

Remove the battery cover from the robot unit.

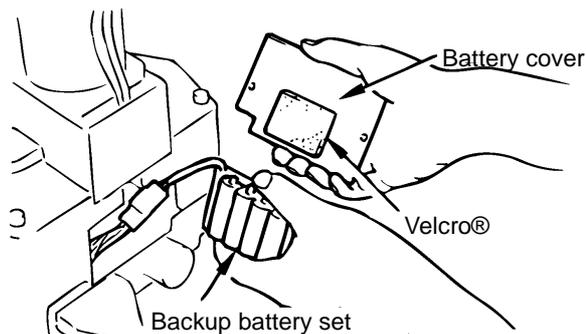
The backup battery is secured to the inside of the battery cover.



#### ▶ STEP 4

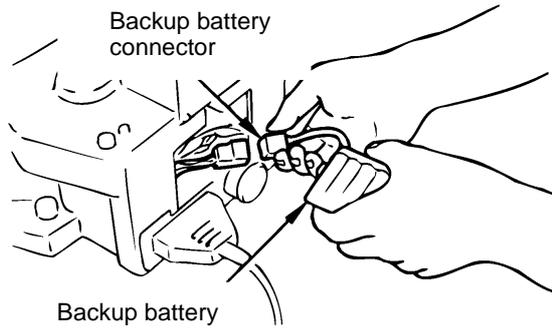
Remove the backup battery from the battery cover.

The battery is attached to the cover with Velcro®.



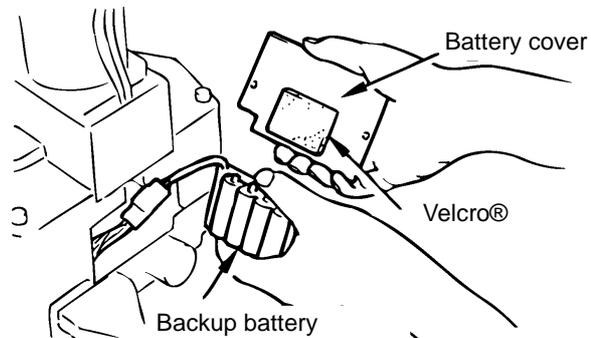
## ▶ STEP 5

Disconnect the backup battery connector and connect a new one.



## ▶ STEP 6

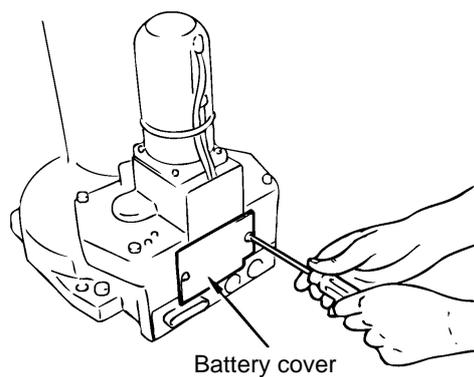
Attach the new backup battery to the battery cover with Velcro®.



## ▶ STEP 7

Fit the cover to the robot unit.

Tightening torque =  $1 \pm 0.2 \text{ N}\cdot\text{m}$

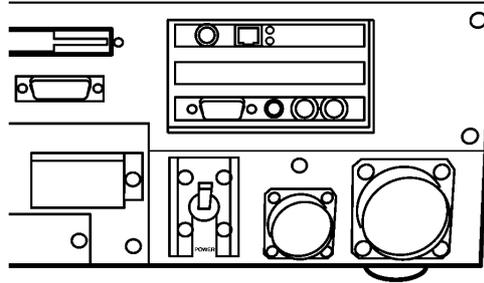


### ■ HC-D series

#### ▶ STEP 1

Turn the controller power ON.

 **Caution: Do not turn the motor power ON.**



#### ▶ STEP 2

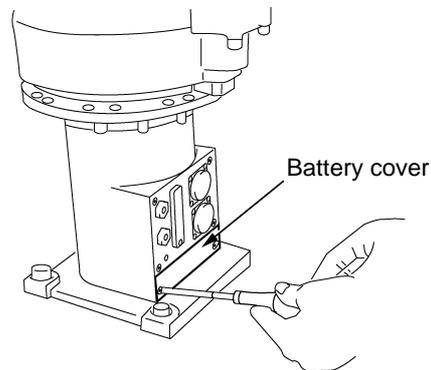
Press and lock the robot stop button on the controller (or on the teach pendant, mini pendant or operating panel) in order to prevent the motor power from becoming turned on accidentally.

**Note: To unlock the robot stop button, slightly turn it clockwise.**

#### ▶ STEP 3

Remove the battery cover from the robot unit.

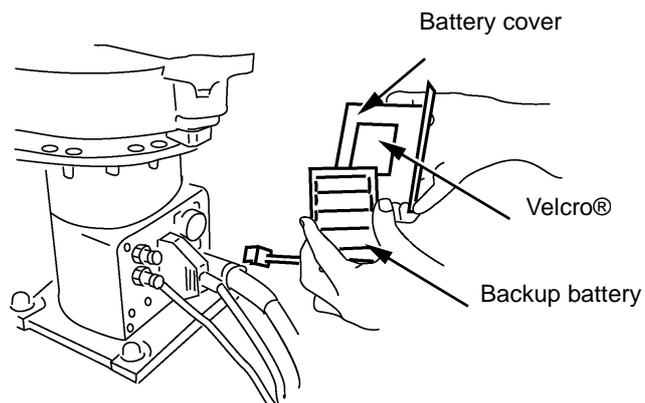
The backup battery is secured to the inside of the battery cover.



#### ▶ STEP 4

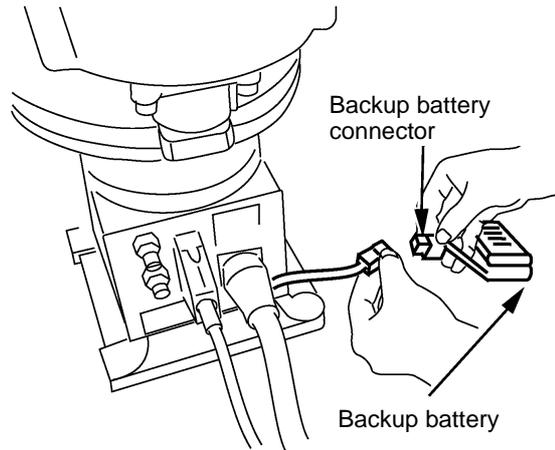
Remove the backup battery from the battery cover.

The battery is attached to the cover with Velcro®.



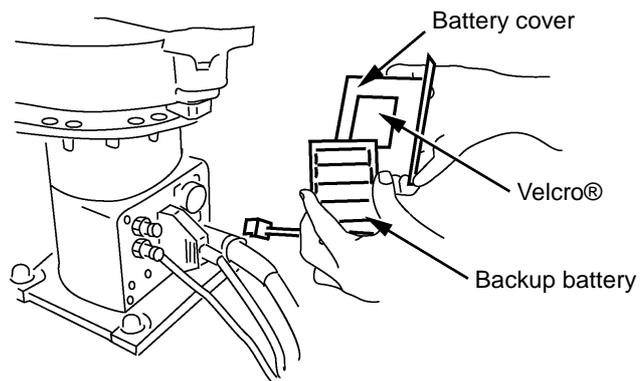
## ▶ STEP 5

Disconnect the backup battery connector and connect a new one.



## ▶ STEP 6

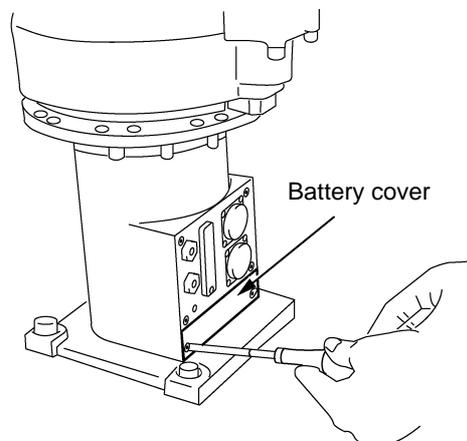
Attach the new backup battery to the battery cover with Velcro®.



## ▶ STEP 7

Secure the battery cover to the robot unit with machine screws.

Tightening torque:  $1 \pm 0.2 \text{ N}\cdot\text{m}$



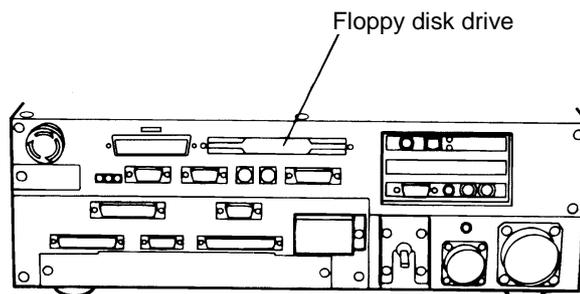
### 6.5.3 Replacing the Memory Backup Battery

This section gives an example of replacing the memory backup battery using a floppy disk.

**Caution:** Before replacing the memory backup battery, save (write) the Robot Controller memory data onto a floppy disk. The built-in floppy disk drive is an option.

#### ▶ STEP 1

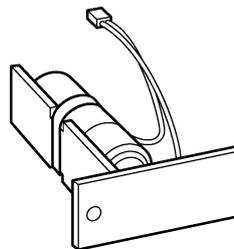
Save (write) the robot controller memory data onto a floppy disk.



For the procedure on saving the memory data, see the SETTING-UP MANUAL, Section 5.7, "Displaying the FDD Access Menu, [F6 Set]—[F3 FD]."

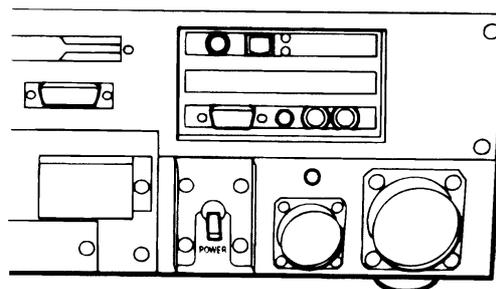
#### ▶ STEP 2

Prepare a new memory backup battery.



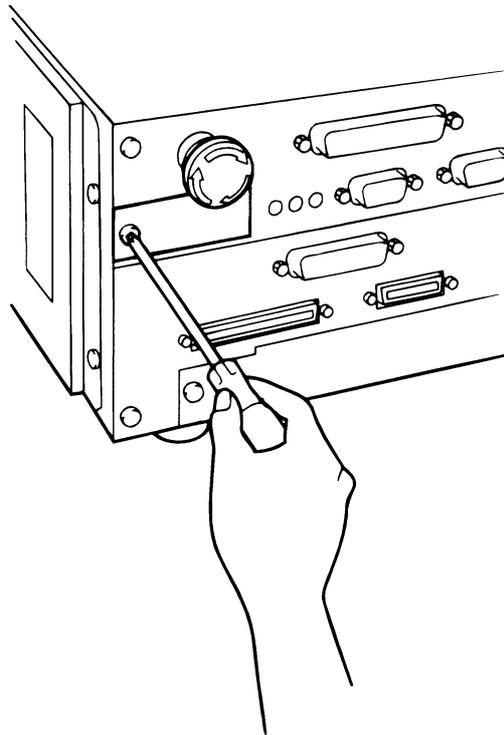
#### ▶ STEP 3

Turn the controller power ON, wait at least one minute, and turn it OFF again.



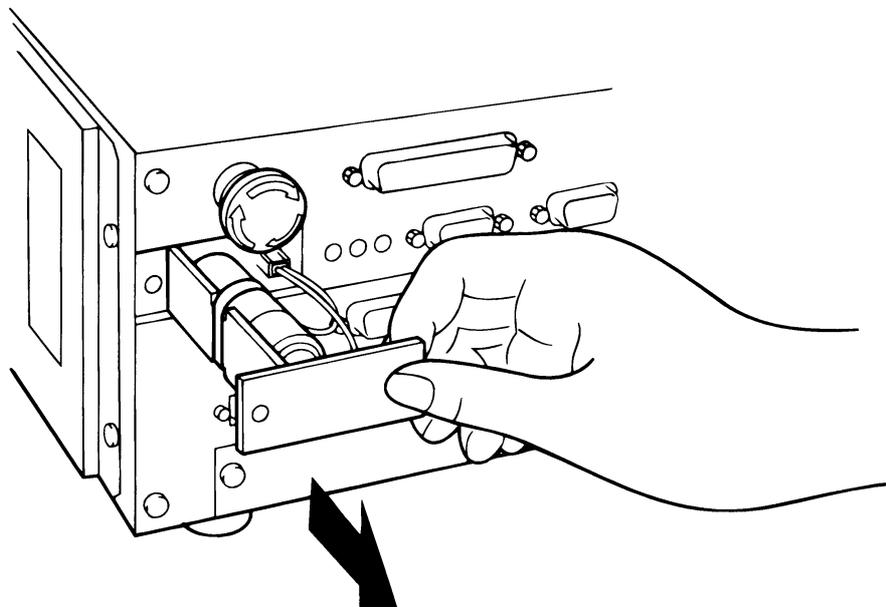
▶ **STEP 4**

Remove the screw to release the backup battery support.



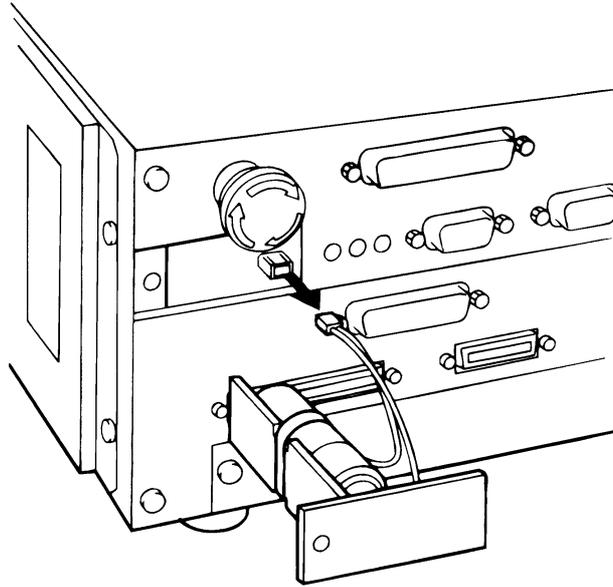
▶ **STEP 5**

Pull out the backup battery support.



▶ STEP 6

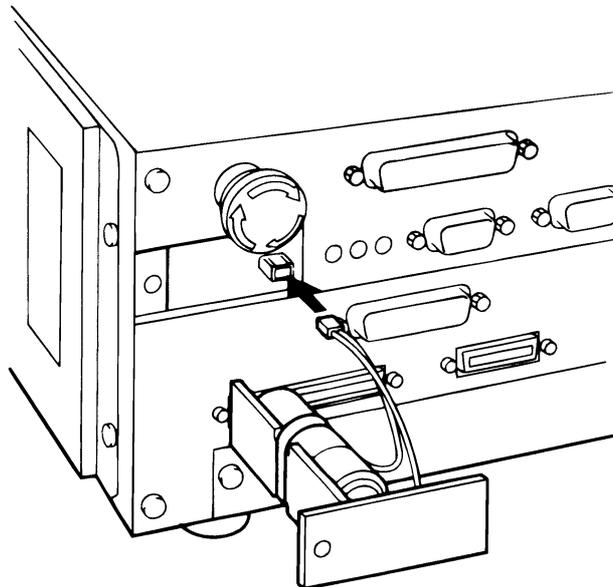
Disconnect the memory backup battery connector.



**⚠ Caution:** Complete the operations in steps 6 and 7 within three minutes. If the battery is disconnected for over three minutes, the memory data will be lost.

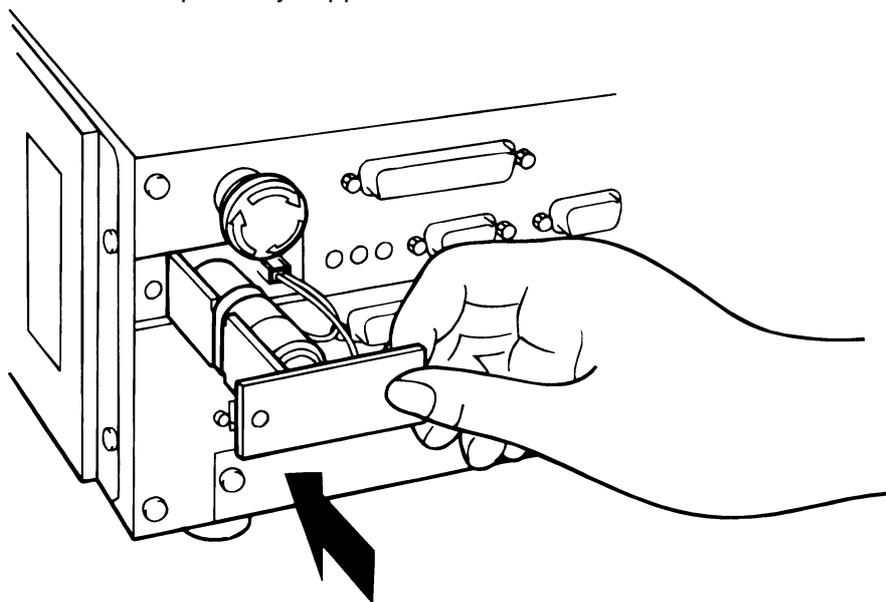
▶ STEP 7

Connect the new backup battery prepared in step 2, to the robot controller.



## ▶ STEP 8

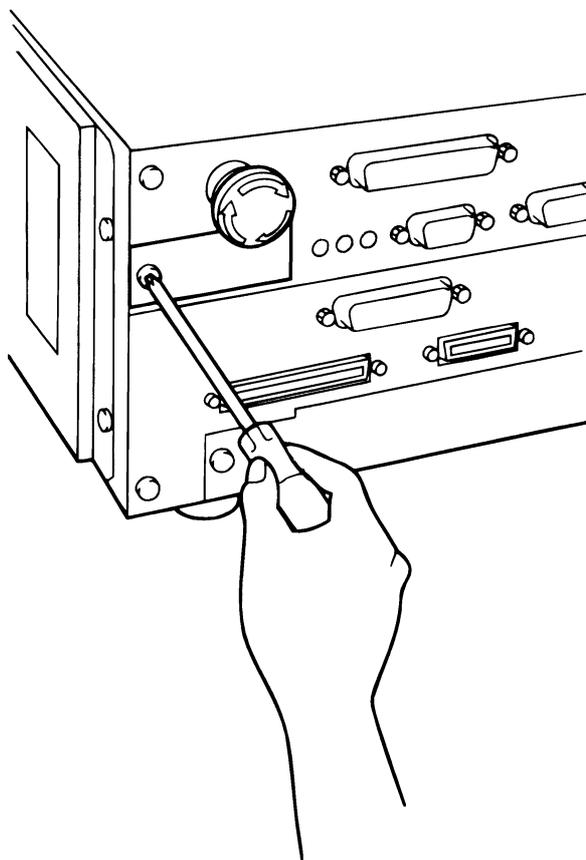
Push the backup battery support into the robot controller.



**⚠ Caution:** Take care not to pinch the battery lead wires between the unit and the cover or internal parts. Shorting may occur, resulting in an unexpected failure.

## ▶ STEP 9

Tighten the screw to secure the backup battery support with a screwdriver.



### 6.5.4 Setting the Next Battery Replacement Date

After replacing the memory backup battery, set the next battery replacement date from the teach pendant, according to the following procedure.

**NOTE:** This procedure cannot be performed with the operating panel.

**NOTE:** Check that the system clock of the robot controller shows the correct date beforehand. If it is incorrect, the next replacement date will also become incorrect.

- ▶ **STEP 1**      **On the top screen of the teach pendant, press [F6 Set].**  
The Settings (Main) window appears.
- ▶ **STEP 2**      **Press [F6 Maint.] in the Settings (Main) window.**  
The Maintenance menu appears.
- ▶ **STEP 3**      **Press [F4 Battery] in the Maintenance menu.**  
The Next Battery Replacement Date window appears.  
In the top of the window, the current setting is displayed.  
The date entry areas show the default replacement date that is two years later the current data at which you open this window, assuming that the battery service life is two years.
- ▶ **STEP 4**      **Press OK.**  
**NOTE:** If you do not want to change the replacement date, press Cancel.  
The message "Are you sure you want to set the next battery replacement date?" appears.
- ▶ **STEP 5**      **Press OK.**  
The screen returns to the Settings (Main) window.

## 6.6 Supplies and Tools for Maintenance

Tables 6-7 lists the supplies and components to be replaced regularly, out of components used in Denso robots. Table 6-8 lists the recommended tools necessary for maintenance and inspection.

### 6.6.1 Supplies and Components Required

Table 6-7 List of Supplies and Components

No	Name	Part No.	Remarks	
1	Grease	410971-0040	2.5 kg can	Epinoc AP-1
2	Grease	410971-0050	16 kg can	
3	Filter (left)	410041-0760	Cooling fan filter (inlet port filter) in the robot controller	
4	Filter (for fan 60)	410041-1220	Cooling fan filter (exhaust port filter) in the robot controller	
5	Memory backup unit	410076-0090	Memory backup battery for controller (with metal plate)	
6	Encoder backup battery	410611-0020		
7	Fuse (1.3A)	410054-0230	Fuse LM13 for controller I/O	
8	Fuse (0.3A)	410054-0240	Fuse LM03 for controller I/O	
9	IC for output (NPN)	410077-0010	IC (M54522P) for controller output	
10	IC for output (PNP)	410077-0020	IC (M54564P) for controller output	

### 6.6.2 Recommended Tools

Table 6-8 List of Recommended Tools

No	Tool name	Recommended tool (manufacturer)	Application
1	Grease gun	(Yamada Corporation) ·Body: KH-32 ·Flexible attachment: SPK-3C	Force grease into nipple

## 6.7 Replacing Fuses

The robot controller is equipped with fuses to protect it from shorting the external wiring.

If any fuse is blown, replace it according to the following procedure

The fuse box containing fuses is mounted on the panel of the robot controller. See Figure 6-2.

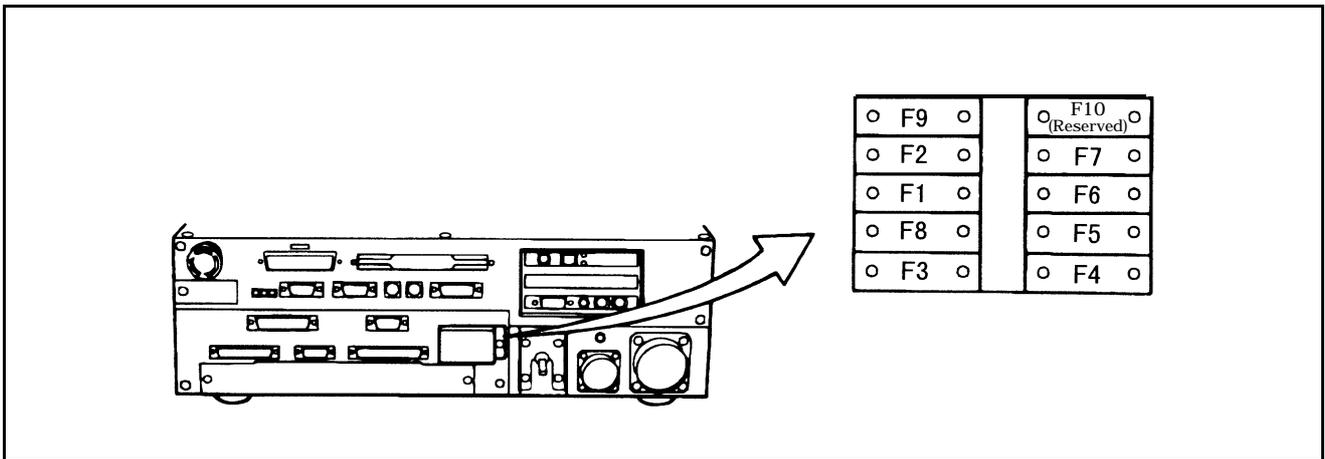


Figure 6-2 Positions and Names of Fuses

Table 6-9 shows the fuses and their corresponding output connectors. In case of an output signal error, check the related fuse.

**Table 6-9 Fuses and Their Corresponding Output Connectors**

Connector No.	Connector terminal No.	Output IC No.	Fuse No.
I/O POWER CN7	1	—	F1 (1.3A)
	2	—	
	3	—	F2 (1.3A)
	4	—	
HAND I/O CN9	17	—	F3 (1.3A)
	1	IC 1	F4 (1.3A)
	2		
	3		
	4		
	5		
	6		
	7		
8			
OUTPUT CN10	1	IC 2	F5 (1.3A)
	2		
	3		
	4		
	5		
	6		
	7		
	8		
	9	IC 3	F6 (1.3A)
	10		
	11		
	12		
	13		
	14		
	15		
	16		
	17	IC 4	F7 (1.3A)
	18		
	19		
	20		
	21		
	22		
	23		
	24		
	25	IC 5	F8 (1.3A)
	26		
	27		
	28		
	29		
	30		
	31		
	32		
	33	IC 6	F9 (0.3A)
	34		
	35		
	36		
	37		
	38		
	39		
	40		
	41	IC 7	F10 (1.3A)
	42		
	43		
	44		
	45		
	46		
	47		
	48		
	49	IC 8	F11 (1.3A)
	50		
	51		
	52		
	53		
	54		
	55		
	56		
65	—	F9 (0.3A)	
INPUT CN8	1	—	F8 (1.3A)
	3	—	

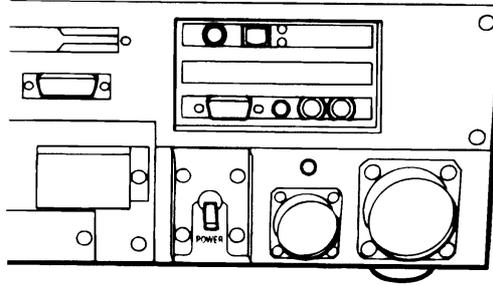
Note: For the connector pin layout, refer to Chapter 5, Subsection 5.6.1, "I/O Signal Connector Pin Layout."

### 6.7.1 Replacing Fuses

Replace fuses according to the following procedure:

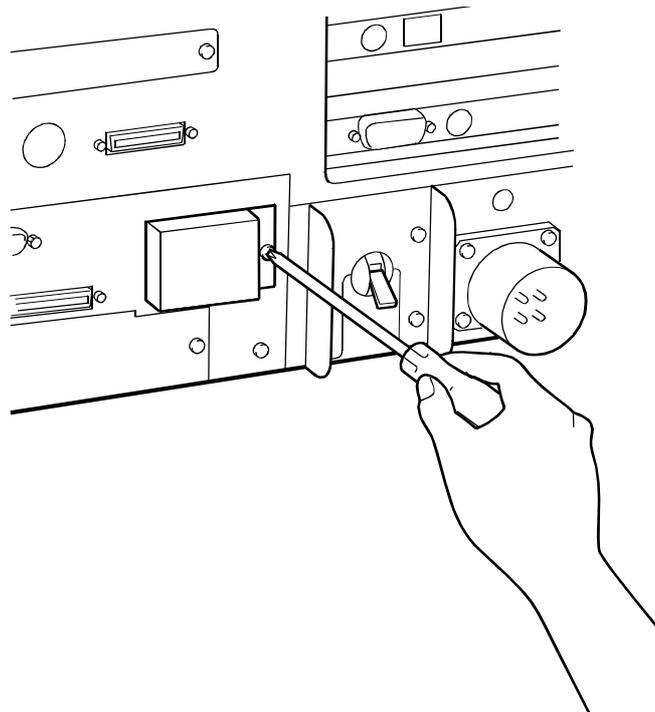
#### ▶ STEP 1

Turn the controller power OFF.



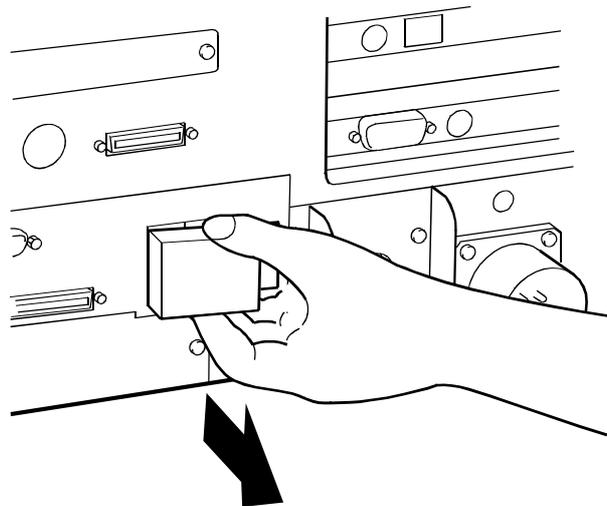
#### ▶ STEP 2

Remove the fuse cover mounting screw with a screwdriver.



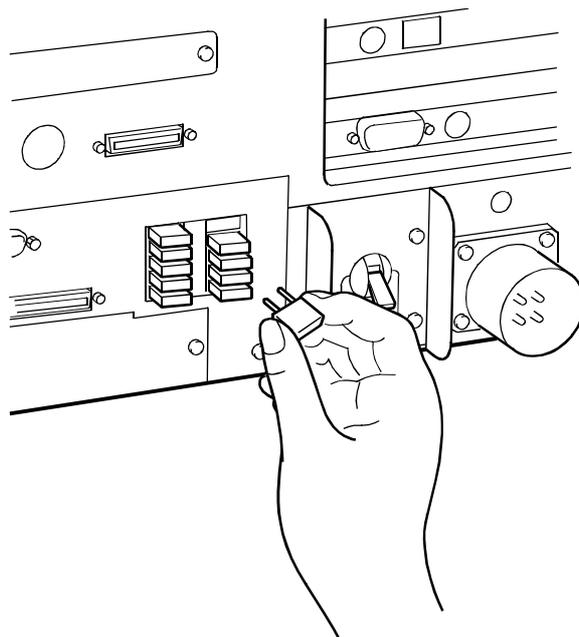
▶ **STEP 3**

Remove the fuse cover.



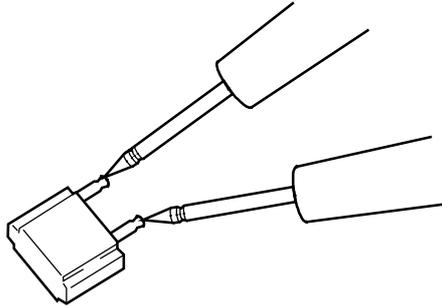
▶ **STEP 4**

Pull out the fuse to be checked.



### ▶ STEP 5

Using a tester, check the removed fuse for continuity.



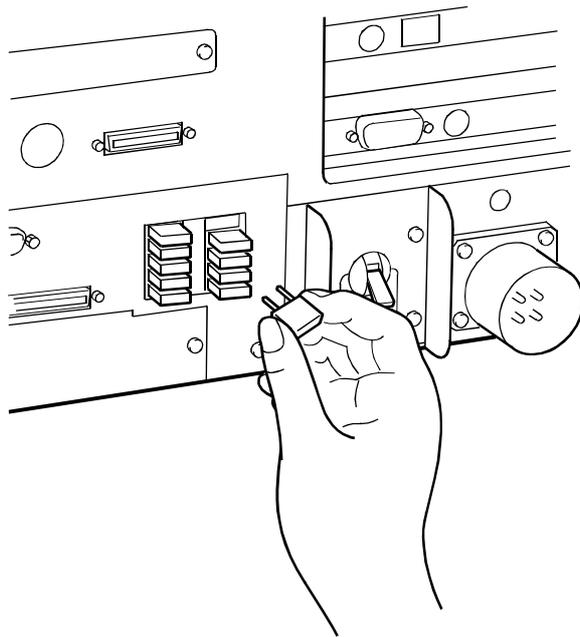
### ▶ STEP 6

If no continuity is observed with the fuse in STEP 5:

- (1) Check the wiring of the related output connector and remove the cause of the blown fuse.
- (2) Insert a new fuse into position in the fuse box.

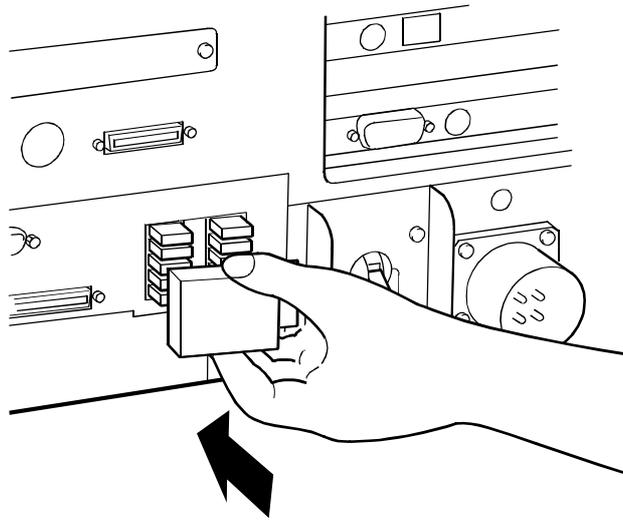
If continuity is observed with the fuse in STEP 5:

Set the removed fuse back into the position in the fuse box.



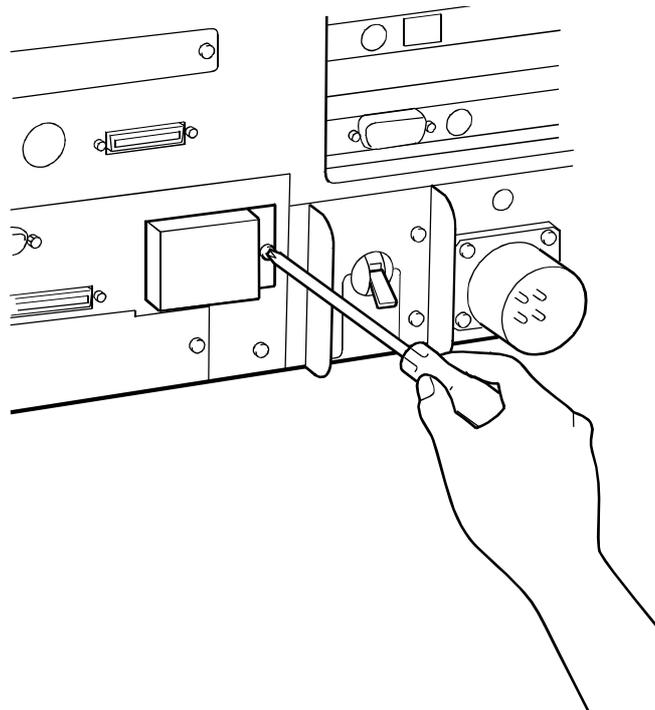
## ▶ STEP 7

Set the fuse cover to the robot controller.



## ▶ STEP 8

Secure the fuse cover with mounting screw with a screwdriver.  
Tightening torque:  $0.6 \pm 0.2$  Nm



## 6.8 Replacing the Output ICs

If an abnormal output signal does not recover its normal status, although the corresponding output fuse is replaced, the IC for output needs to be replaced. The ICs for output are contained in the panel of the robot controller, as shown in Figure 6-3.

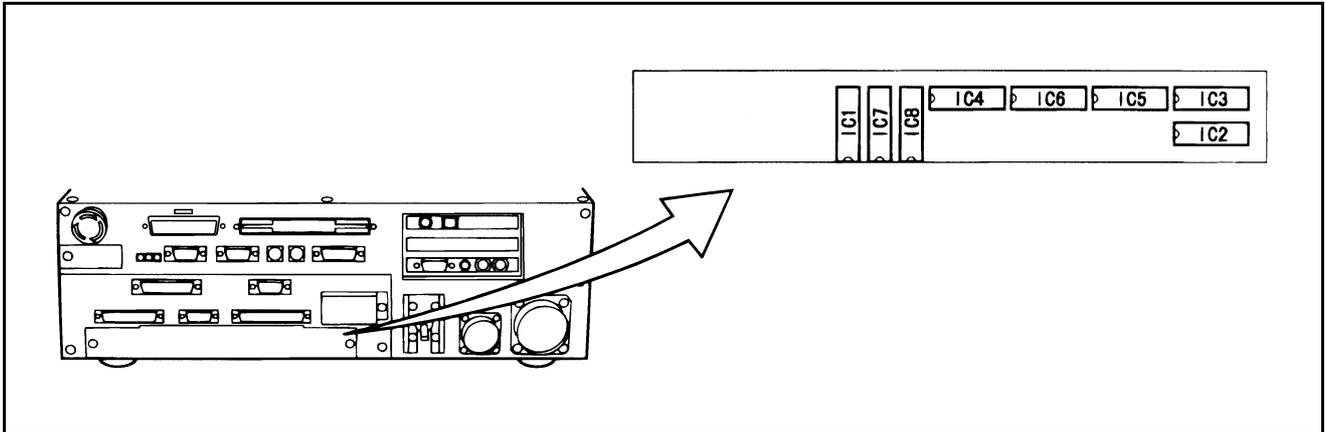


Figure 6-3 Positions and Names of ICs for Output

Table 6-10 shows the IC numbers and fuses corresponding to output signals.

**Table 6-10 Table of Corresponding IC Numbers for Output and Fuses**

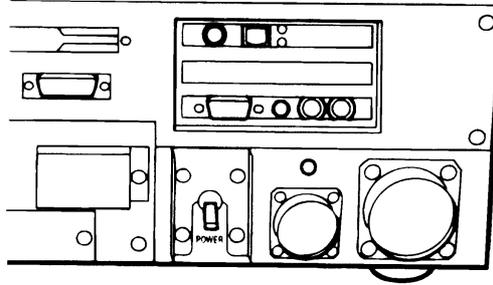
Connector No.	Connector terminal No.	I/O Port No.	Output IC No.	Fuse No.
HAND I/O CN9	1	64	IC 1	F4 (1.3A)
	2	65		
	3	66		
	4	67		
	5	68		
	6	69		
	7	70		
	8	71		
OUTPUT CN10	1	72	IC 2	F4 (1.3A)
	2	73		
	3	74		
	4	75		
	5	76		
	6	77		
	7	78		
	8	79		
	9	80	IC 3	F5 (1.3A)
	10	81		
	11	82		
	12	83		
	13	84		
	14	85		
	15	86		
	16	87		
	17	88	IC 4	F5 (1.3A)
	18	89		
	19	90		
	20	91		
	21	92		
	22	93		
	23	94		
	24	95		
	25	96	IC 5	F6 (1.3A)
	26	97		
	27	98		
	28	99		
	29	100		
	30	101		
	31	102		
	32	103		
	33	104	IC 6	F6 (1.3A)
	34	105		
	35	106		
	36	107		
	37	108		
	38	109		
	39	110		
	40	111		
	41	112	IC 7	F7 (1.3A)
	42	113		
	43	114		
	44	115		
	45	116		
	46	117		
	47	118		
	48	119		
	49	120	IC 8	F7 (1.3A)
	50	121		
	51	122		
	52	123		
	53	124		
	54	125		
	55	126		
	56	127		

## 6.8.1 Replacing an Output IC

Replace an output IC according to the procedure given below:

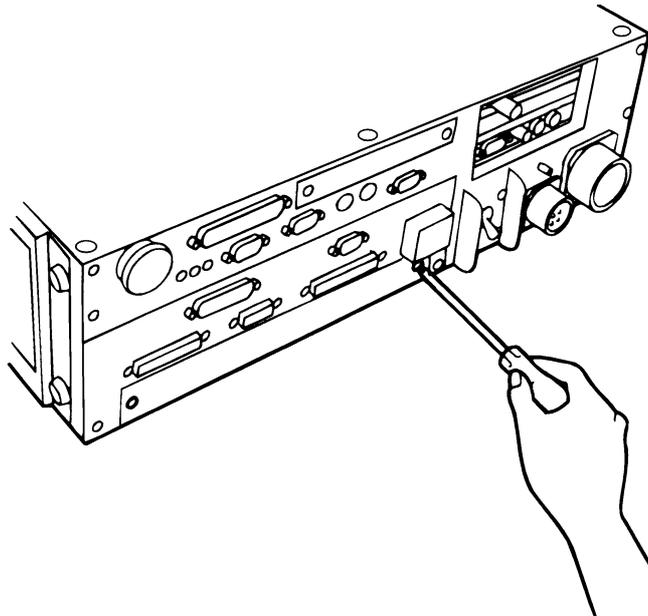
### ▶ STEP 1

Turn the controller power OFF.



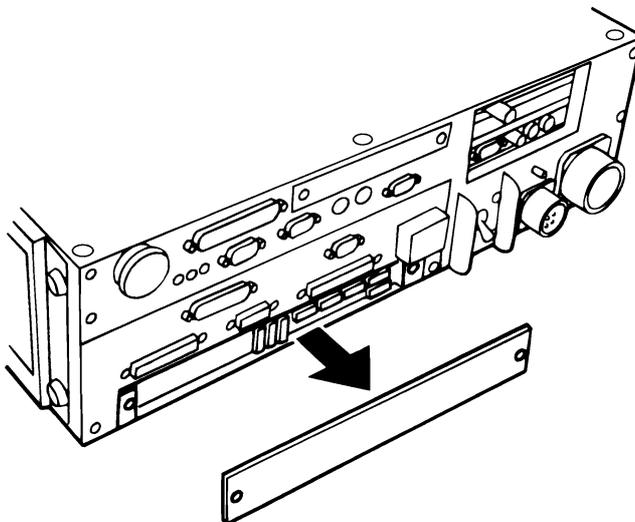
### ▶ STEP 2

Remove the two screws to release the output IC cover with a screwdriver.



### ▶ STEP 3

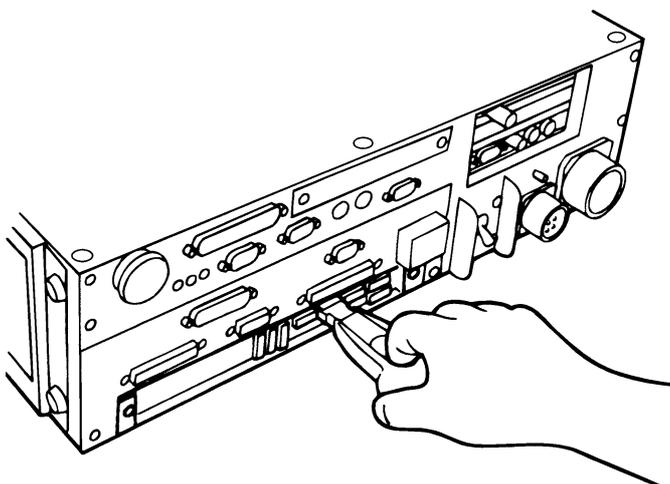
Remove the output IC cover.



### ▶ STEP 4

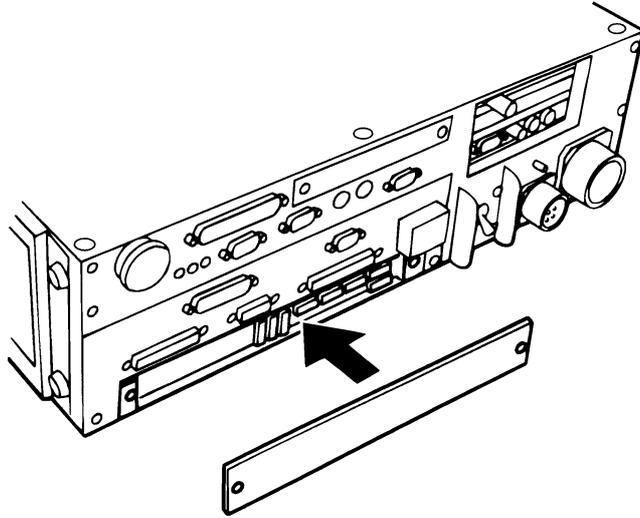
Check the ICs marked with "IC1" to "IC8" on the PC board, and remove the defective output IC with an IC pull-out jig and replace it.

**⚠ Caution:** (1) If any output IC is damaged, remove the cause of damage, and replace it with a new output IC.  
(2) Do not directly touch the elements and their terminals on each PC board.



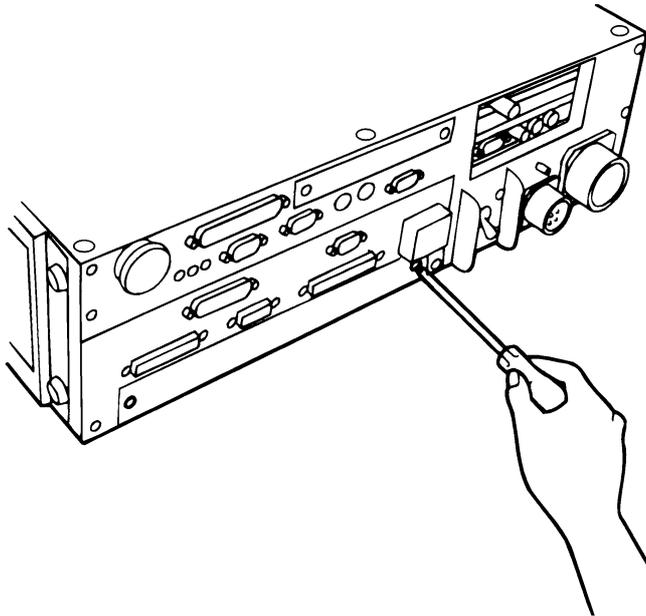
▶ STEP 5

Attach the output IC cover to the robot controller.



▶ STEP 6

Secure the output IC cover with the two mounting screws.  
Tightening screws:  $0.6 \pm 0.2$  Nm.



## 6.9 Checking the Odometer and Trip Meter

You may check the odometer and trip meter which count traversed distance of each axis in the Odometer window of the teach pendant.

The access to the Odometer window is [F6 Set]—[F6 Maint.]—[F5 Odometer].

The Odometer window shows the following items:

[Odometer] Shows the total distance of each axis traversed after the robot leaves the factory. You cannot reset the odometer.

[Trip meter] Shows the distance of each axis traversed after you reset the trip meter to zero.

### 6.9.1 Displaying the Odometer and Trip Meter

#### ▶ STEP 1

Turn the robot controller ON.

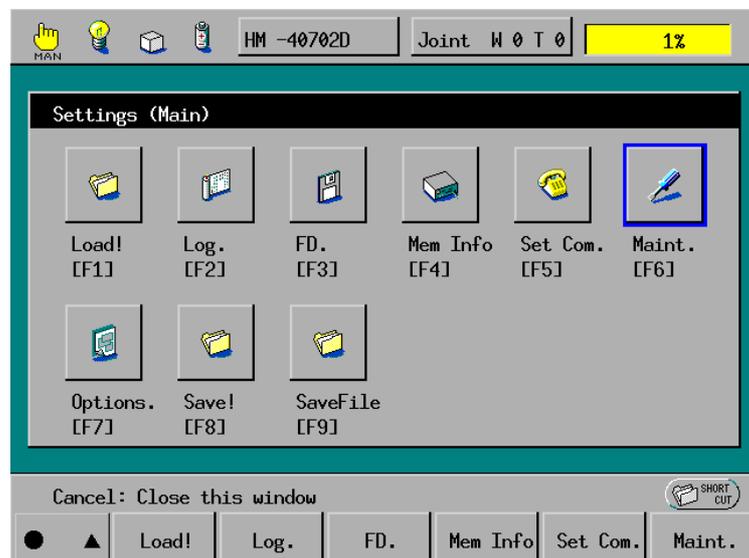
#### ▶ STEP 2

On the teach pendant, set the mode switch to the MANUAL position.

#### ▶ STEP 3

On the top screen, press [F6 Set].

The Settings (Main) window appears as shown below.

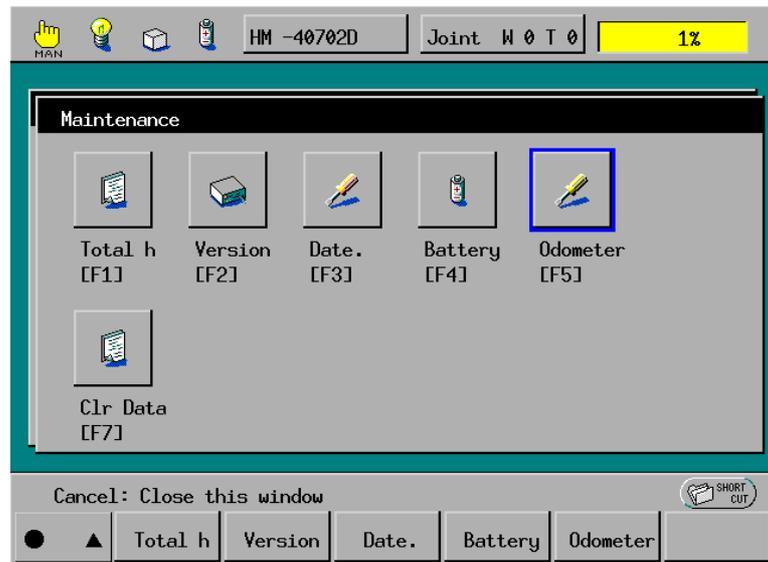


F6

Press [F6 Maint.].

► STEP 4

The Maintenance menu appears as shown below.

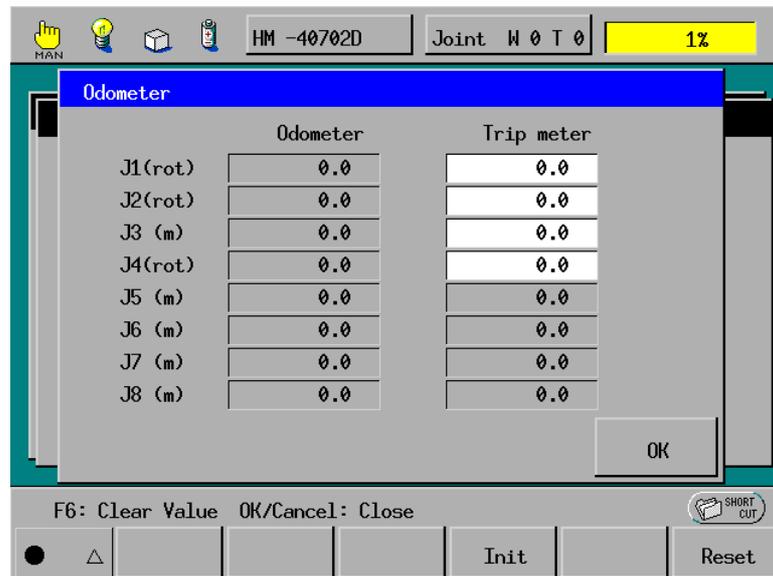


F5

Press [F5 Odometer].

► STEP 5

The Odometer window appears as shown below.



F6

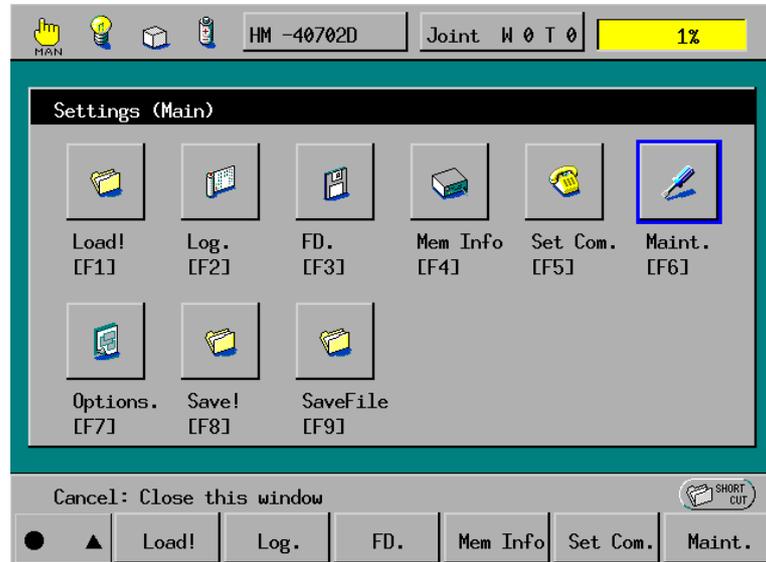
In the above Odometer window, the J1, J2 and J4 are expressed in number of revolutions and J3 in meter.

## 6.9.2 Resetting the Trip Meter to Zero

### ▶ STEP 1

On the top screen, press [F6 Set].

The Settings (Main) window appears as shown below.

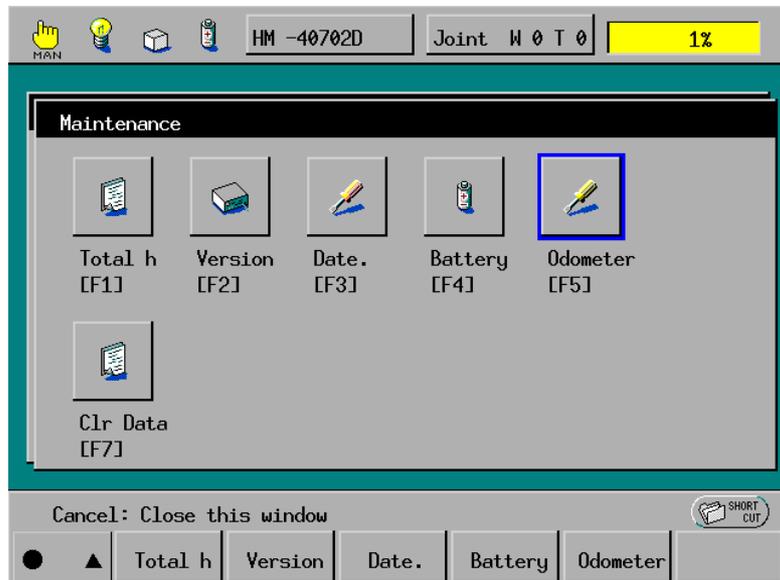


F6

Press [F6 Maint.].

### ▶ STEP 2

The Maintenance menu appears as shown below.

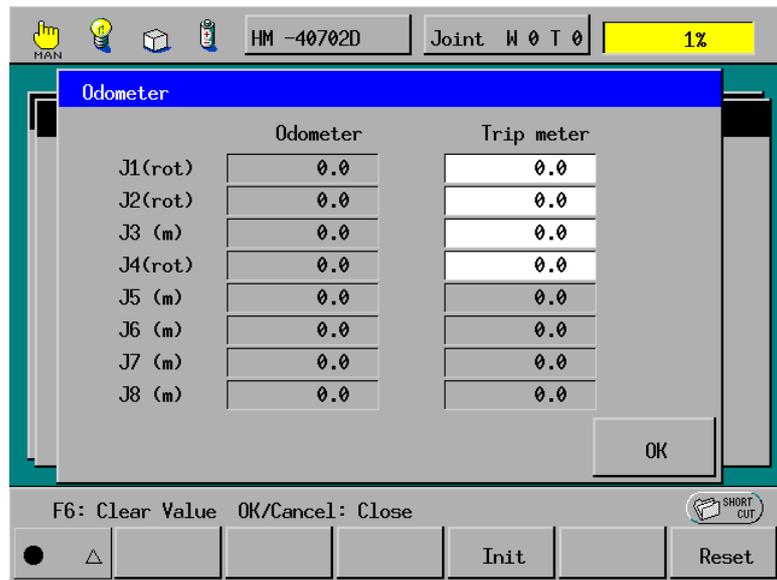


F5

Press [F5 Odometer].

► STEP 3

The Odometer window appears as shown below.

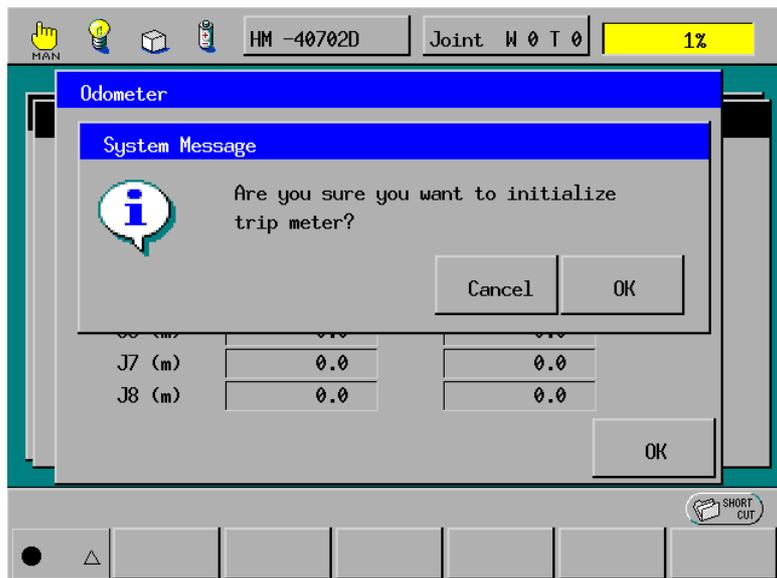


F6

Press [F6 Reset].

► STEP 4

The following message appears.



Press the OK button.

The trip meter has been reset to zero.

## 6.10 Checking the Controller ON-Time and the Robot Running Time and Resetting Their User Counters

You may check the robot controller ON-time and the robot running time in the Total hours window of the teach pendant.

The Total hours window shows the following items:

[Total operation]	Shows the grand total of the robot controller ON-time counted after the controller leaves the factory.
[Total running]	Shows the grand total of the robot running time counted after the robot leaves the factory.
[Cumu. operation]	Shows the total of the robot controller ON-time counted after you reset the user counter to zero.
[Cumu. running]	Shows the total of the robot running time counted after you reset the user counter to zero.
[Operation]	Shows the ON-time of the robot controller counted after it is turned ON this time.
[Running]	Shows the running time of the robot counted after the robot controller is turned ON this time.

### 6.10.1 Displaying the Controller ON-time and the Robot Running Time

#### ▶ STEP 1

Turn the robot controller power ON.

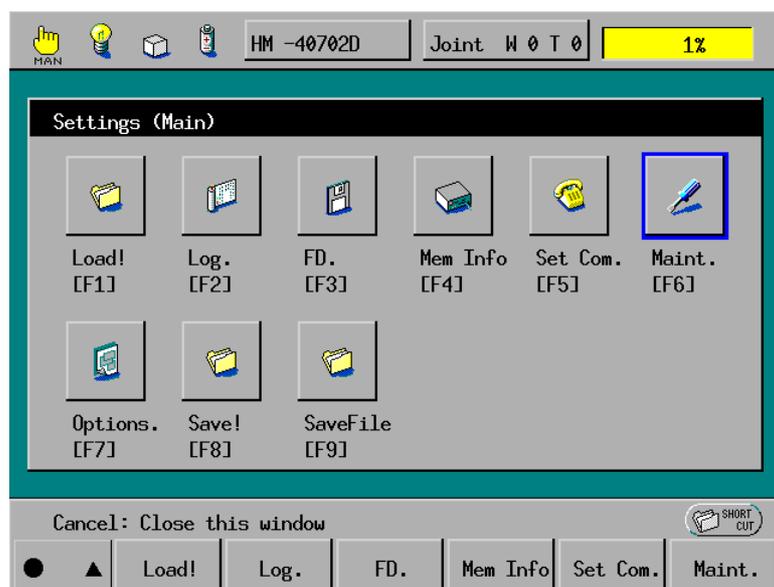
#### ▶ STEP 2

On the teach pendant, set the mode switch to the MANUAL position.

#### ▶ STEP 3

On the top screen, press [F6 Set].

The Settings (Main) window appears as shown below.

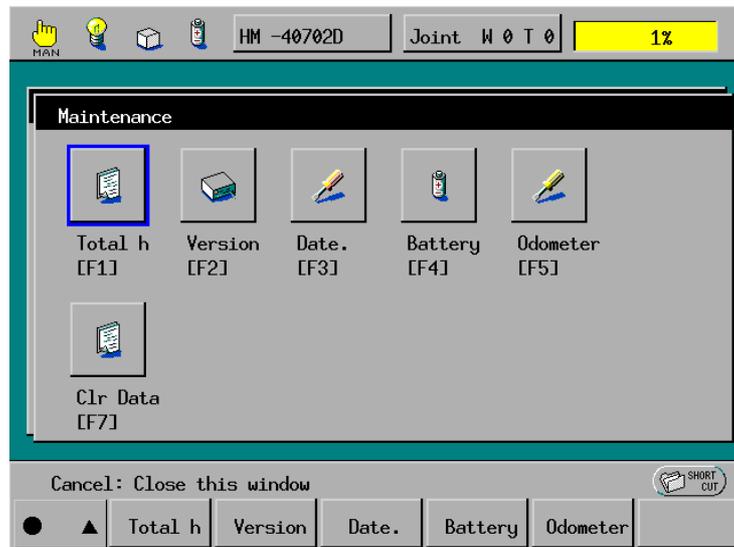


F6

Press [F6 Maint.].

► STEP 4

The Maintenance menu appears as shown below.

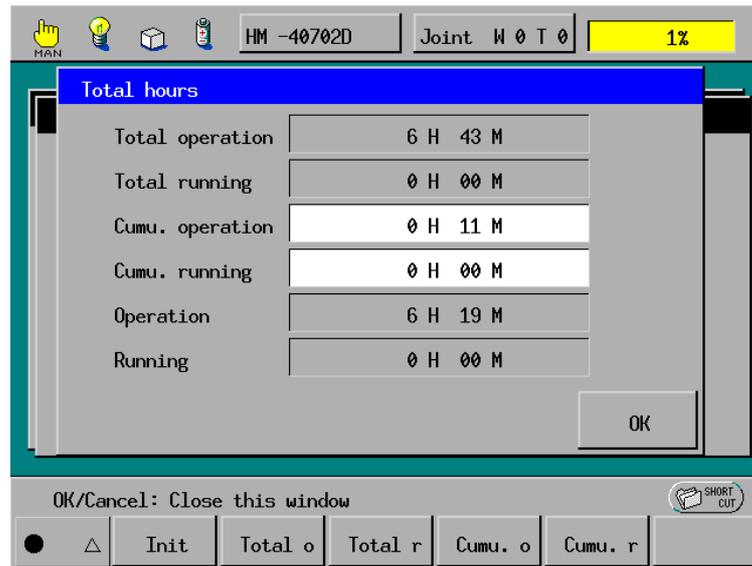


F1

Press [F1 Total h].

► STEP 5

The Total hours window appears as shown below.

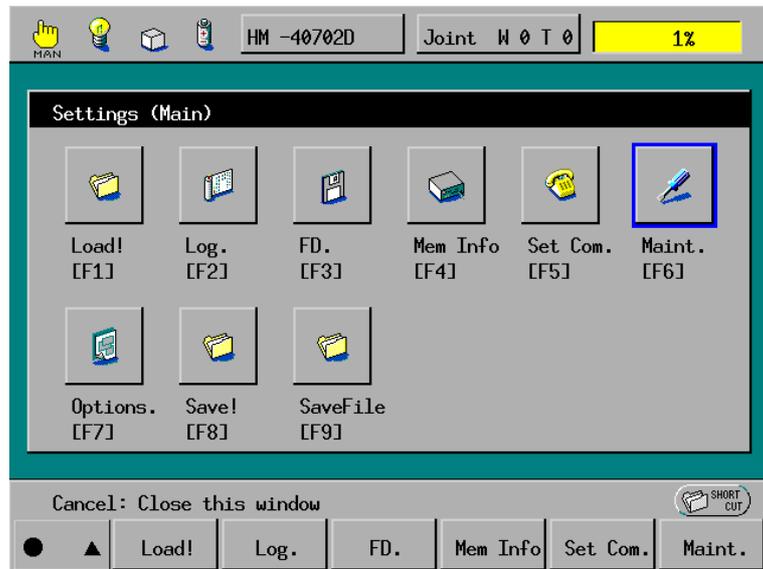


## 6.10.2 Resetting the User Counters of the Controller ON-Time and the Robot Running Time

### ► STEP 1

On the teach pendant, press [F6 Set].

The Settings (Main) window appears as shown below.

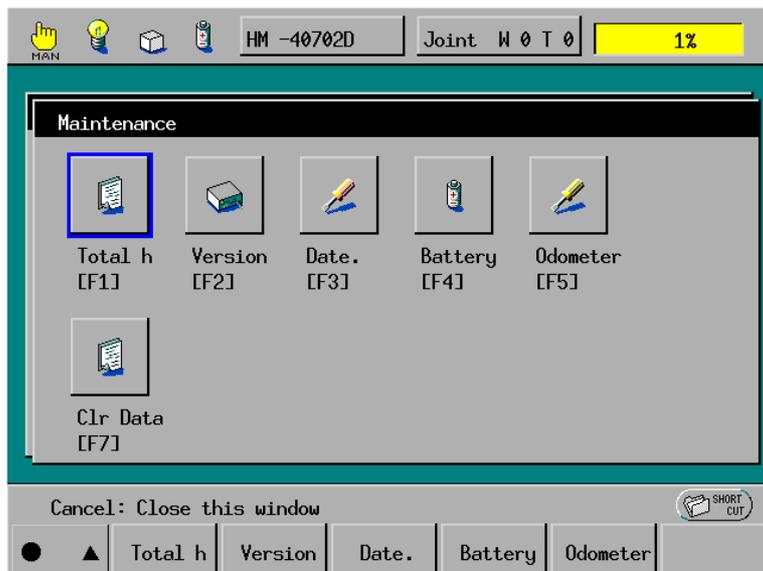


F6

Press [F6 Maint.].

### ► STEP 2

The Maintenance menu appears as shown below.

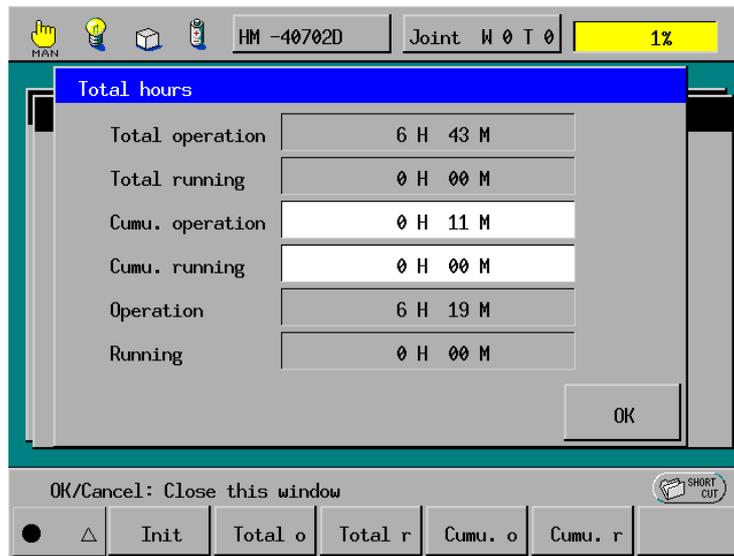


F1

Press [F1 Total h].

► STEP 3

The Total hours window appears as shown below.

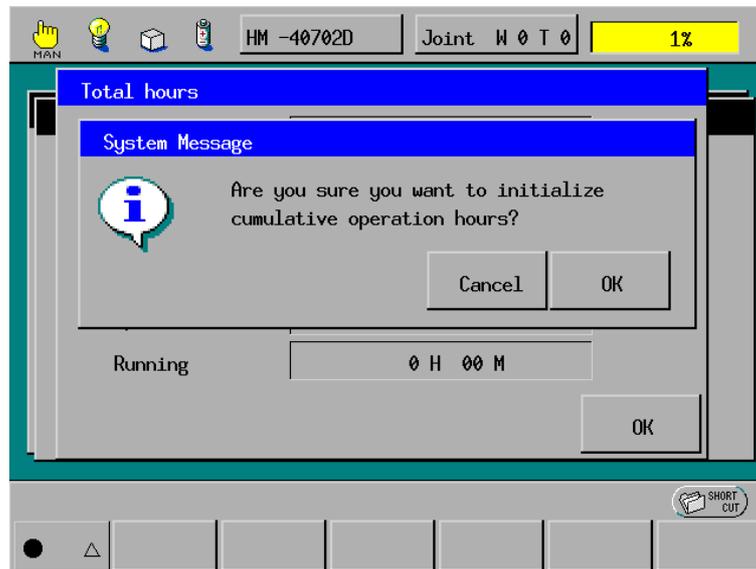


F4

To reset the user counter of the controller ON-time to zero, press [F4 Cumu. o].

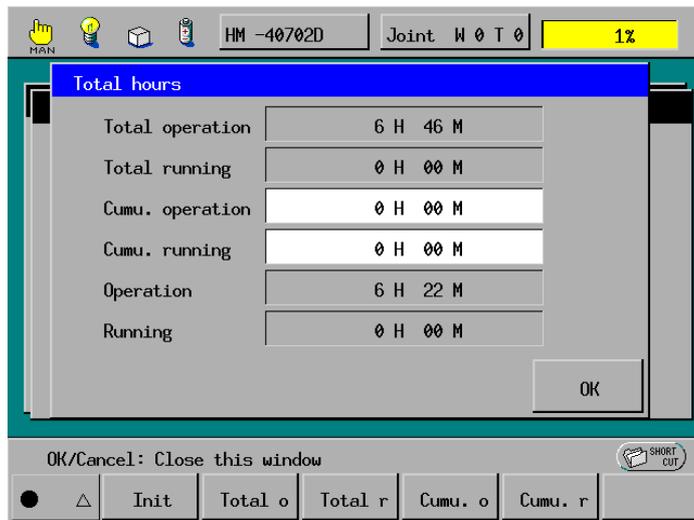
► STEP 4

The following system message appears.



Press the OK button.

The user counter of the controller ON-time has been reset to zero.



## 6.11 Using the Initialization Floppy Disk

The initialization floppy disk (\*.arm) stores arm data in WINCAPSII format.

You transfer the stored arm data to the robot controller in these two steps:

- (1) Create a project by using the data stored in the floppy disk.
- (2) Transfer the trajectory generation file in the project to the robot controller.

### Creating a project to be transferred

#### ► STEP 1

##### Create a new project.

Start WINCAPSII. From the File menu of System Manager, click the New Project.

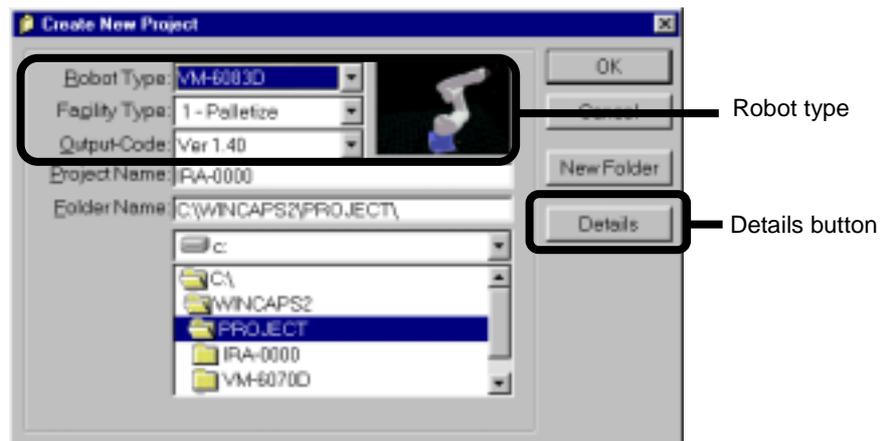


[File menu: Creating a new project]

#### ► STEP 2

##### Select your robot type.

Select the robot type of the controller to which you want to transfer data.

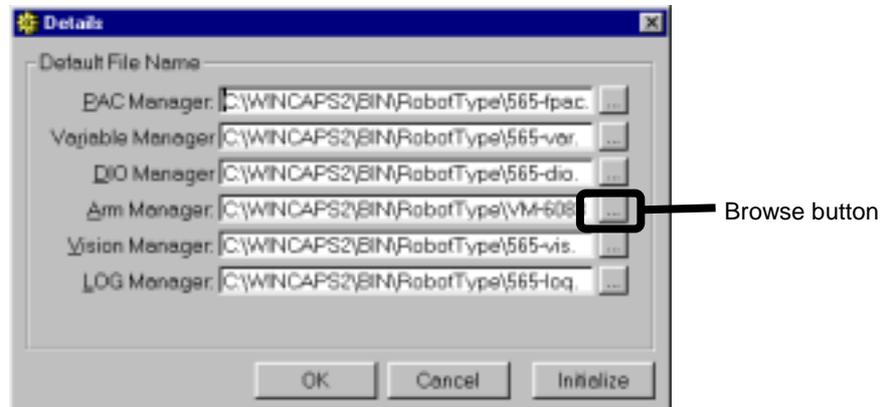


[Create New Project window]

## ▶ STEP 3

### Select arm data.

- (1) Press the Details button to call up the window below.



[Details window]

- (2) Press the Browse button in Arm Manager to call up the Open Project window.

Select desired file in the floppy disk, then press the Open button.



[Selecting a file]

- (3) The screen will return to the Details window where you press OK button.

## ▶ STEP 4

### Create a project.

On the Create New Project window, press OK button. Now, a project to be transferred has been created.

### Transferring the trajectory generation file

#### ▶ STEP 1

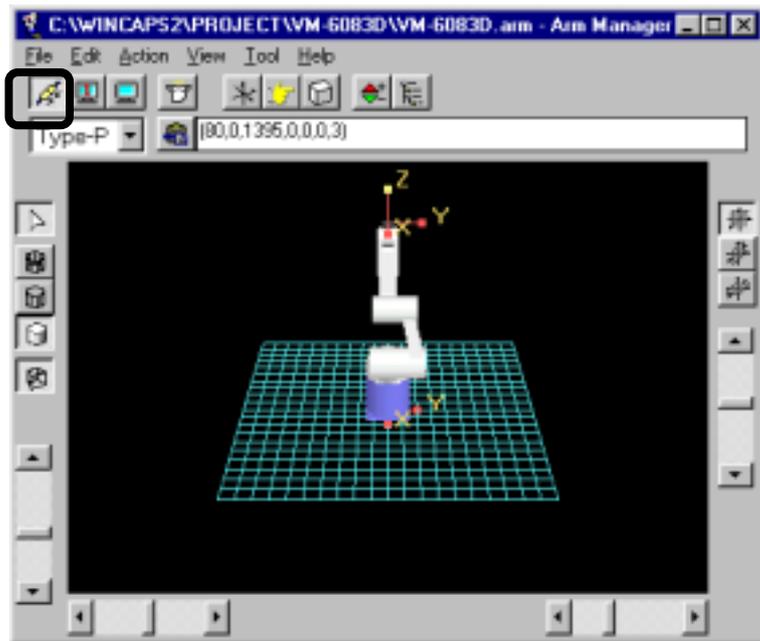
##### Start of Arm Manager

From System Manager, run Arm Manager.

#### ▶ STEP 2

##### Connection with the robot controller

Press the Connect button to connect with the robot controller.

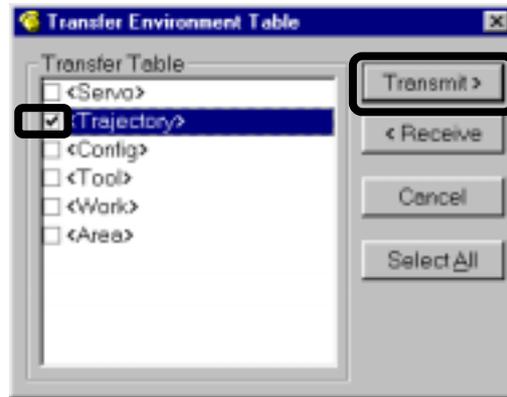


[Arm Manager window]

## ▶ STEP 3

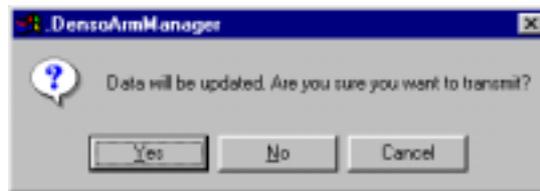
### Data transmission

- (1) From the File menu of Arm Manager window, click Transfer command. The Transfer Environment Table appears as shown below.



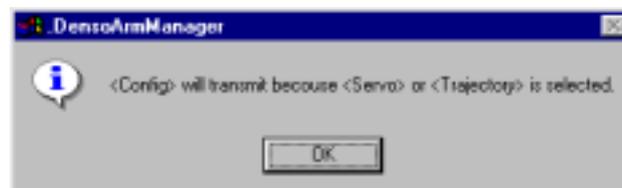
[Transfer Environment Table]

- (2) On the table shown above, select the Trajectory and press the Transmit> button.
- (3) The following message appears.  
Press Yes.



[Confirmation dialog]

The following message appears.  
Press OK.



[Configuration transfer dialog]

During data transfer, the following dialog is displayed.



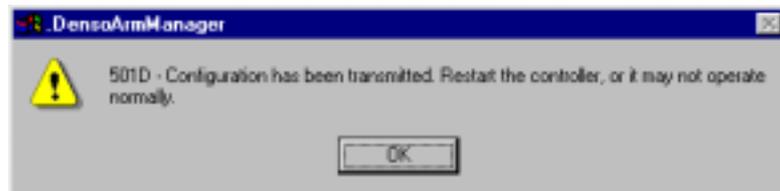
[Transfer Trajectory Generation Table]

(4) Upon completion of transfer, the following message appears.

Press OK.

The arm data stored in the initialization floppy disk has been transferred to the robot controller.

Turn the controller power off and then on.



[Transfer completion message]

## 6.12 Resetting Encoders

You need to reset encoders and perform CALSET if:

- Error 641\* occurs due to run-down encoder backup batteries, or
- Error 677\* occurs due to a great impact applied to the robot when the power is off.

(\* is any of 1 to 4 denoting the object axis.)

This section describes how to reset encoders.

### Resetting procedure (Example of HM-D/HS-D series)

- (1) Check the least significant digit of the displayed error code to know which axis encoder(s) needs to be reset.  
(Example) If Error 6774 is displayed, the 4th-axis encoder needs to be reset; Error 6413, the 3rd-axis encoder needs to be reset.
- (2) Turn the controller power off.
- (3) Remove the cover as shown in Figure 6-4.
- (4) Take out the red 2P connector of the specified axis to be reset.

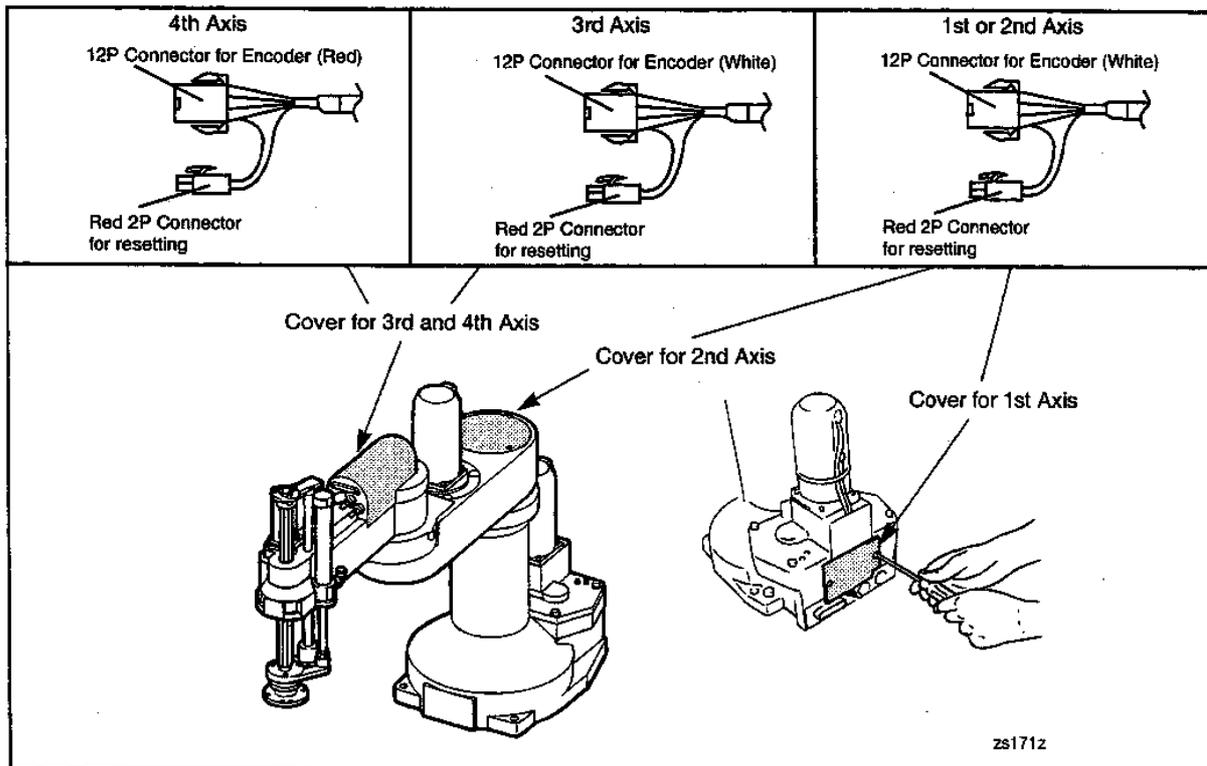


Figure 6-4 Location of the Red 2P Connector

- (5) With a tester probe, short-circuit across both pins of the red 2P connector for resetting as shown below.

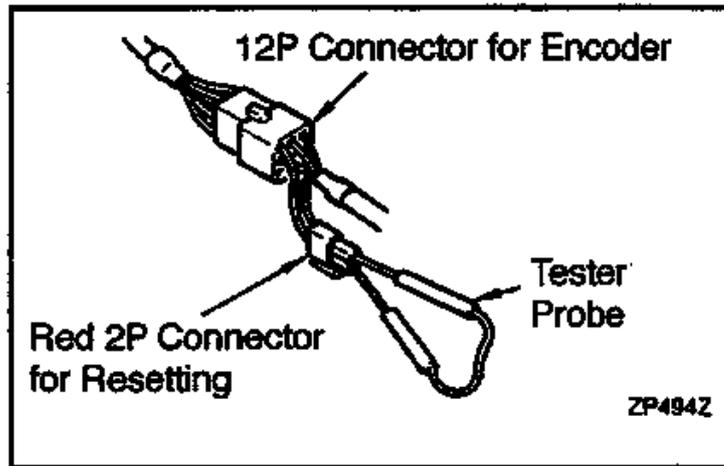


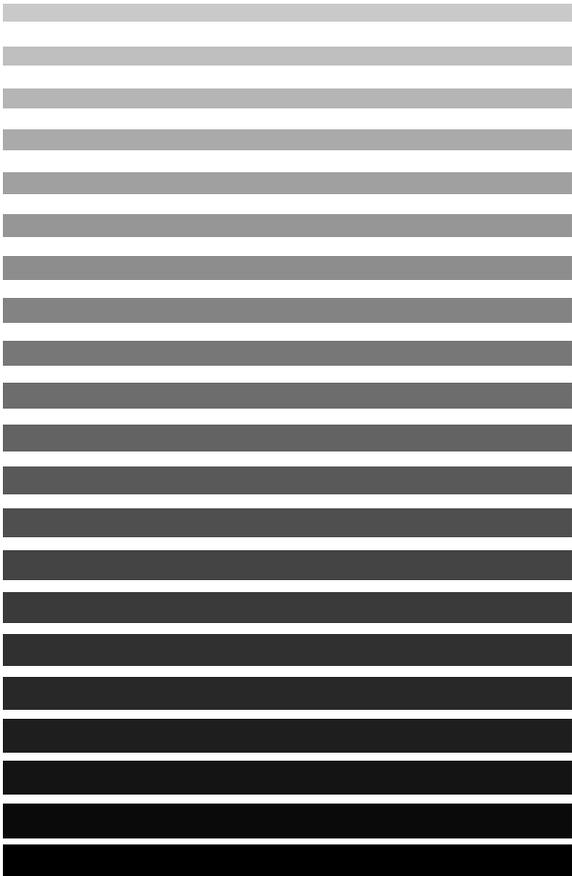
Figure 6-5 Resetting Encoder

- (6) Turn the controller power on.  
After approx. 10 seconds. Resetting will be completed.
- (7) Turn the controller power off and then remove the test probe.
- (8) Set the cover back into place.
- (9) Perform CALSET of a single axis. (Refer to Subsection 4.4.3, [ 1 ].)

**CAUTION:** Be sure to perform CALSET after resetting the encoders. Without CALSET, the software limits will not go into effect, so that the robot may cause collision with the facilities.



# Appendix



Appendix 1  
I/O Circuits and Connectors (NPN type)



# Appendix 1 I/O Circuits and Connectors

## (NPN type)

This section explains the I/O circuit of NPN type (source input and sink output). For the circuit of PNP type (sink input and source output), refer to Chapter 5, Section 5.6, "I/O Circuits and Connectors (PNP type)."

### 1.1 I/O Signal Connector Pin Layout

This section describes the Robot Controller connector pin layouts for I/O signals.

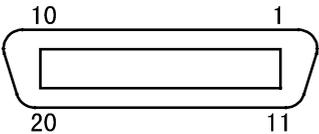
The definitions of the signals and pins of the output connector CN10 and input connector CN8 are different between the standard mode and the compatible mode.

As for the other connectors, the definitions of the pins are common to the standard mode and the compatible mode.

#### 1.1.1 Connector Pin Layout Common to Both Modes

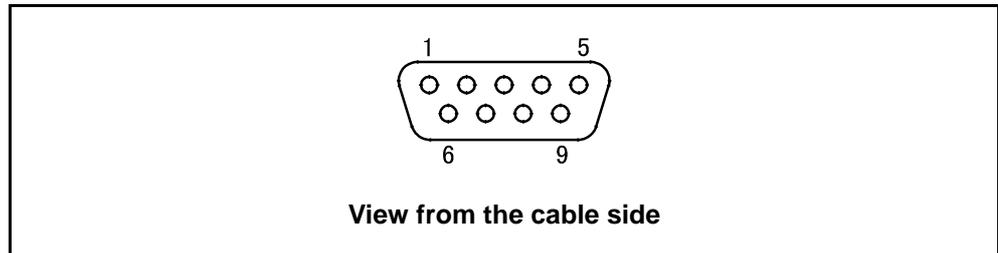
(1) HAND I/O CN9: Connector for end-effector I/O (common to both modes)

Table 1-1 CN9 Pin Layout, common to both modes (NPN type)

 <p>View from the cable side</p>									
Terminal No.	Name	Port number	Wire color		Terminal No.	Name	Port number	Wire color	
			Standard	High strength				Standard	High strength
1	Hand output	64	Black	Blue	11	Hand Input	50	Pink	White
2	Hand output	65	Brown	Yellow	12	Hand Input	51	Pink	White
3	Hand output	66	Black	Green	13	Hand Input	52	White	White
4	Hand output	67	Brown	Red	14	Hand Input	53	White	White
5	Hand output	68	Red	Violet	15	Hand Input	54	White	White
6	Hand output	69	Orange	Blue	16	Hand Input (interrupt input)	55	White	Brown
7	Hand output	70	Yellow	Yellow	17	Power E24V for Hand	—	White	Brown
8	Hand output	71	Green	Green	18	Power E0V for Hand	—	White	Brown
9	Hand input	48	Blue	Red	19	Not connected	—	White	Brown
10	Hand input	49	Violet	Violet	20	Not connected	—	White	Brown

**(2) I/O POWER CN7: Power connector for I/O (common to both modes)**

**Table 1-2 CN7 Pin Layout, common to both modes (NPN type)**



Terminal No.	Name
1	Internal power source output +24V
2	Internal power source output +24V
3	Internal power source output 0V
4	Internal power source output 0V
5	FG
6	Power input E24V
7	Power input E24V
8	Power input E0V
9	Power input E0V

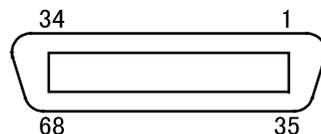
**⚠ Caution:** When using the internal power source, keep the total current capacity below 1.3 A. To use the internal power source of the robot controller, connect the wiring so that the internal power source will be separated from the external power source. Improper wiring may damage the internal circuit.

## 1.1.2 Connector Pin Layout for Standard Mode

### (1) OUTPUT CN10: User-/System-output connector (standard mode)

Table 1-3 CN10 Pin Layout, for standard mode (NPN type)

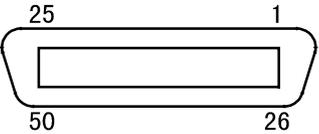
Terminal number	Name	Port number	Wire color	Terminal number	Name	Port number	Wire color
1	Normal CPU	72	Black	35	User output	106	Pink
2	Robot in operation	73	Brown	36	User output	107	Pink
3	Robot failure	74	Red	37	User output	108	Pink
4	Servo ON	75	Orange	38	User output	109	Pink
5	Robot initialization complete	76	Yellow	39	User output	110	Pink
6	Automatic mode	77	Black	40	User output	111	White
7	External mode	78	Brown	41	User output	112	White
8	Dead battery warning	79	Red	42	User output	113	White
9	Robot warning	80	Orange	43	User output	114	White
10	Continue start permitted	81	Yellow	44	User output	115	White
11	SS mode	82	Green	45	User output	116	White
12	Reserved	83	Blue	46	User output	117	White
13	Reserved	84	Violet	47	User output	118	White
14	Reserved	85	Gray	48	User output	119	White
15	Command processing complete	86	Pink	49	User output	120	White
16	Status area odd parity	87	Black	50	User output	121	Gray
17	Status area bit 0	88	Black	51	User output	122	Violet
18	Status area bit 1	89	Brown	52	User output	123	Violet
19	Status area bit 2	90	Red	53	User output	124	Violet
20	Status area bit 3	91	Orange	54	User output	125	Violet
21	Status area bit 4	92	Yellow	55	User output	126	Violet
22	Status area bit 5	93	Green	56	User output	127	Violet
23	Status area bit 6	94	Blue	57	Not used.	—	Violet
24	Status area bit 7	95	Gray	58	Not used.	—	Violet
25	Status area bit 8	96	Pink	59	Not used.	—	Violet
26	Status area bit 9	97	Brown	60	Not used.	—	Gray
27	Status area bit 10	98	Red	61	Not used.	—	Gray
28	Status area bit 11	99	Orange	62	Not used.	—	Gray
29	Status area bit 12	100	Yellow	63	Not used.	—	Gray
30	Status area bit 13	101	Green	64	Not used.	—	Gray
31	Status area bit 14	102	Blue	65	Emergency stop +	—	Gray
32	Status area bit 15	103	Pink	66	Emergency stop -	—	Gray
33	User output	104	Black	67	Not used.	—	Blue
34	User output	105	Brown	68	Not used.	—	Blue



View from the cable side

**(2) INPUT CN8: User-/System-input connector (standard mode)**

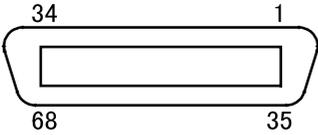
**Table 1-4 CN8 Pin Layout, for standard mode (NPN type)**

<div style="text-align: center;">  <p><b>View from the cable side</b></p> </div>							
Terminal number	Name	Port number	Wire color	Terminal number	Name	Port number	Wire color
1	Power for robot stop (internal +24V)	—	Black	26	Data area 2 bit 7	21	Pink
2	Robot stop	—	Brown	27	Data area 2 bit 8	22	Pink
3	Power for Enable Auto (internal +24V)	—	Red	28	Data area 2 bit 9	23	Pink
4	Enable Auto	—	Black	29	Data area 2 bit 10	24	White
5	Step-stop (all tasks)	0	Brown	30	Data area 2 bit 11	25	White
6	Not used.	1	Red	31	Data area 2 bit 12	26	White
7	Instantaneous stop (all tasks)	2	Orange	32	Data area 2 bit 13	27	White
8	Strobe signal	3	Yellow	33	Data area 2 bit 14	28	White
9	Interrupt skip	4	Green	34	Data area 2 bit 15	29	White
10	Command and data odd parity	5	Blue	35	Command area 0 bit 0	30	White
11	Data area 1 bit 0	6	Violet	36	Command area 0 bit 1	31	White
12	Data area 1 bit 1	7	Black	37	Command area 0 bit 2	32	Gray
13	Data area 1 bit 2	8	Brown	38	Command area 0 bit 3	33	Gray
14	Data area 1 bit 3	9	Red	39	User input	34	Gray
15	Data area 1 bit 4	10	Orange	40	User input	35	Gray
16	Data area 1 bit 5	11	Yellow	41	User input	36	Gray
17	Data area 1 bit 6	12	Green	42	User input	37	Gray
18	Data area 1 bit 7	13	Blue	43	User input	38	Gray
19	Data area 2 bit 0	14	Violet	44	User input	39	Gray
20	Data area 2 bit 1	15	White	45	User input	40	Gray
21	Data area 2 bit 2	16	Pink	46	User input	41	Gray
22	Data area 2 bit 3	17	Black	47	User input	42	Violet
23	Data area 2 bit 4	18	Brown	48	User input	43	Violet
24	Data area 2 bit 5	19	Red	49	User input	44	Violet
25	Data area 2 bit 6	20	Orange	50	User input	45	Violet

### 1.1.3 Connector Pin Layout for Compatible Mode

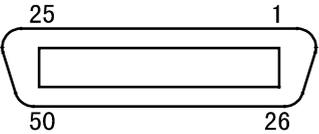
#### (1) OUTPUT CN10: User-/System-output connector (compatible mode)

Table 1-5 CN10 Pin Layout, for compatible mode (NPN type)

 <p style="text-align: center;">View from the cable side</p>							
Terminal number	Name	Port number	Wire color	Terminal number	Name	Port number	Wire color
1	Normal CPU	72	Black	35	User output	106	Pink
2	Robot running	73	Brown	36	User output	107	Pink
3	Robot failure	74	Red	37	User output	108	Pink
4	Auto mode	75	Orange	38	User output	109	Pink
5	External mode	76	Yellow	39	User output	110	Pink
6	Program start reset	77	Black	40	User output	111	White
7	Not used.	78	Brown	41	User output	112	White
8	Not used.	79	Red	42	User output	113	White
9	Robot power ON complete	80	Orange	43	User output	114	White
10	Servo ON	81	Yellow	44	User output	115	White
11	CAL complete	82	Green	45	User output	116	White
12	Teaching	83	Blue	46	User output	117	White
13	Single-cycle complete	84	Violet	47	User output	118	White
14	Dead battery warning	85	Gray	48	User output	119	White
15	Robot warning	86	Pink	49	User output	120	White
16	Continue start permit	87	Black	50	User output	121	Gray
17	Error units bit 0	88	Black	51	User output	122	Violet
18	Error units bit 1	89	Brown	52	User output	123	Violet
19	Error units bit 2	90	Red	53	User output	124	Violet
20	Error units bit 3	91	Orange	54	User output	125	Violet
21	Error tens bit 0	92	Yellow	55	User output	126	Violet
22	Error tens bit 1	93	Green	56	User output	127	Violet
23	Error tens bit 2	94	Blue	57	Not connected	—	Violet
24	Error tens bit 3	95	Gray	58	Not connected	—	Violet
25	Error hundreds bit 0	96	Pink	59	Not connected	—	Violet
26	Error hundreds bit 1	97	Brown	60	Not connected	—	Gray
27	Error hundreds bit 2	98	Red	61	Not connected	—	Gray
28	Error hundreds bit 3	99	Orange	62	Not connected	—	Gray
29	SS mode	100	Yellow	63	Not connected	—	Gray
30	Not used.	101	Green	64	Not connected	—	Gray
31	Not used.	102	Blue	65	Emergency stop +	—	Gray
32	Not used.	103	Pink	66	Emergency stop -	—	Gray
33	User output	104	Black	67	Not connected	—	Blue
34	User output	105	Brown	68	Not connected	—	Blue

**(2) INPUT CN8: User-/System-input connector (compatible mode)**

**Table 1-6 CN8 Pin Layout, for compatible mode (NPN type)**

 <p align="center"><b>View from the cable side</b></p>							
Terminal number	Name	Port number	Wire color	Terminal number	Name	Port number	Wire color
1	Power for robot stop (internal +24V)	-	Black	26	User input	21	Pink
2	Robot stop	-	Brown	27	User input	22	Pink
3	Power for Enable Auto (internal +24V)	-	Red	28	User input	23	Pink
4	Enable Auto	-	Black	29	User input	24	White
5	Step-stop (all tasks)	0	Brown	30	User input	25	White
6	Continue start	1	Red	31	User input	26	White
7	Instantaneous stop (all tasks)	2	Orange	32	User input	27	White
8	Operation preparation start	3	Yellow	33	User input	28	White
9	Interrupt skip	4	Green	34	User input	29	White
10	Program start	5	Blue	35	User input	30	White
11	Program No. select bit 0	6	Violet	36	User input	31	White
12	Program No. select bit 1	7	Black	37	User input	32	Gray
13	Program No. select bit 2	8	Brown	38	User input	33	Gray
14	Program No. select bit 3	9	Red	39	User input	34	Gray
15	Program No. select bit 4	10	Orange	40	User input	35	Gray
16	Program No. select bit 5	11	Yellow	41	User input	36	Gray
17	Program No. select bit 6	12	Green	42	User input	37	Gray
18	Program No. select odd parity bit	13	Blue	43	User input	38	Gray
19	Motor power ON	14	Violet	44	User input	39	Gray
20	CAL execution	15	White	45	User input	40	Gray
21	Reserved	16	Pink	46	User input	41	Gray
22	SP100	17	Black	47	User input	42	Violet
23	Switch Ext Mode	18	Brown	48	User input	43	Violet
24	Program reset	19	Red	49	User input	44	Violet
25	Clear robot failure	20	Orange	50	User input	45	Violet

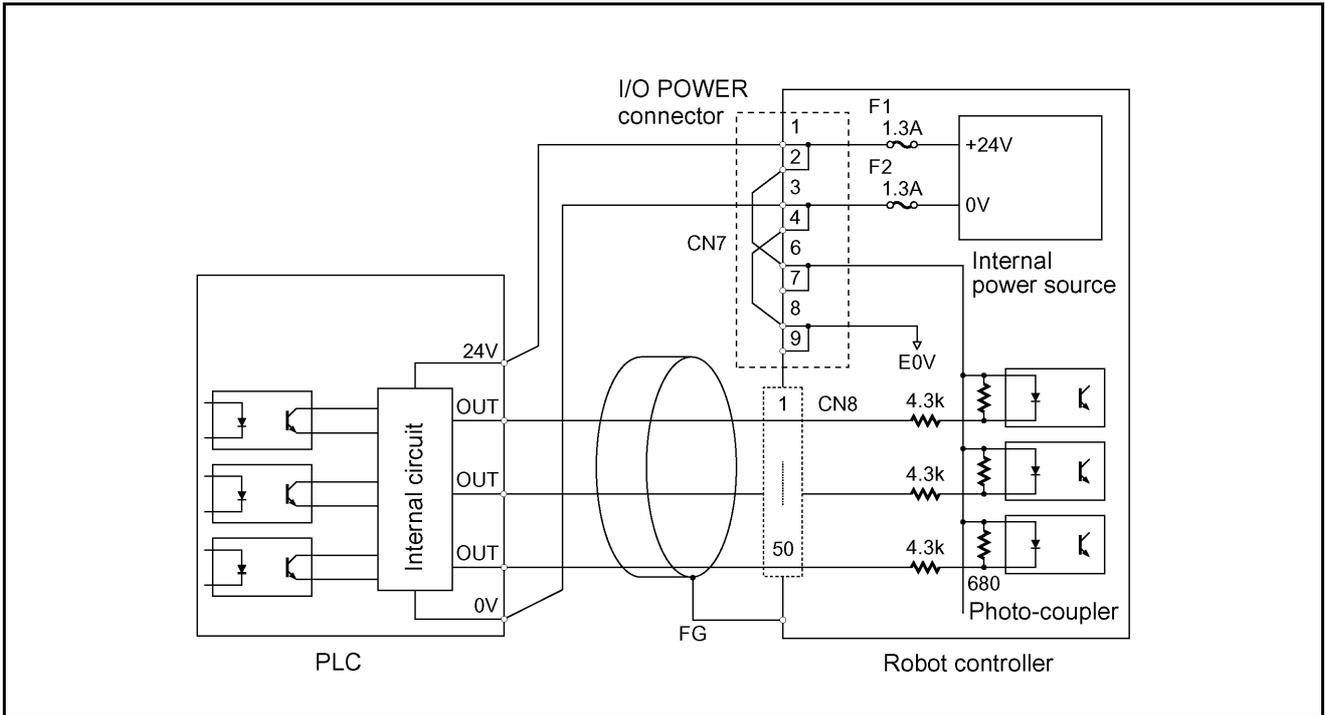
## 1.2 Robot Controller I/O Circuits

### 1.2.1 User-Input, System-Input and Hand-Input Circuits

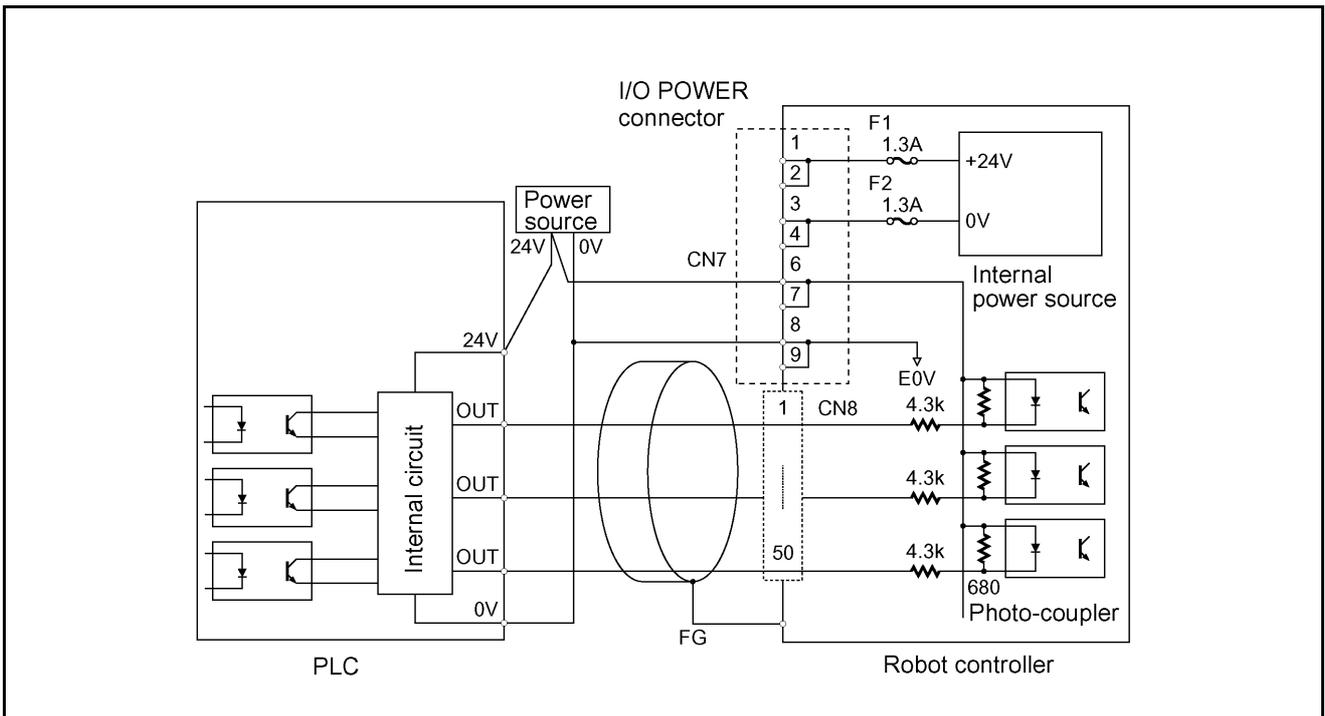
Figures 1-1 and 1-2 show examples of the user-input, system-input, and hand-input circuit configurations and connections of the robot controller.

The maximum allowable current capacity of the robot controller's internal power source is 1.3 A. Use the internal power source within this allowable range.

- Caution**
- ① Either an external power supply type or built-in power type Output card is available for the PLC. However, an external power supply type requires an additional power source (24V) to be installed. The power capacity is 15W or more.
  - ② When controlling two or more robots with a single PLC using the internal power source of the Robot Controller, set a PLC Output card for each robot.
  - ③ Other than a PLC, a proximity switch, or a relay contact may be connected directly to the input terminal of the Robot Controller. In such a case, use the power input to pins 6 to 9 of the I/O power connector. A two-wire photoelectric switch or proximity switch can be connected if its leakage current is 1 mA or less.
  - ④ Use a multi-core shielding cable for the purpose of protecting the Robot Controller from noise. Ground it to the Robot Controller.

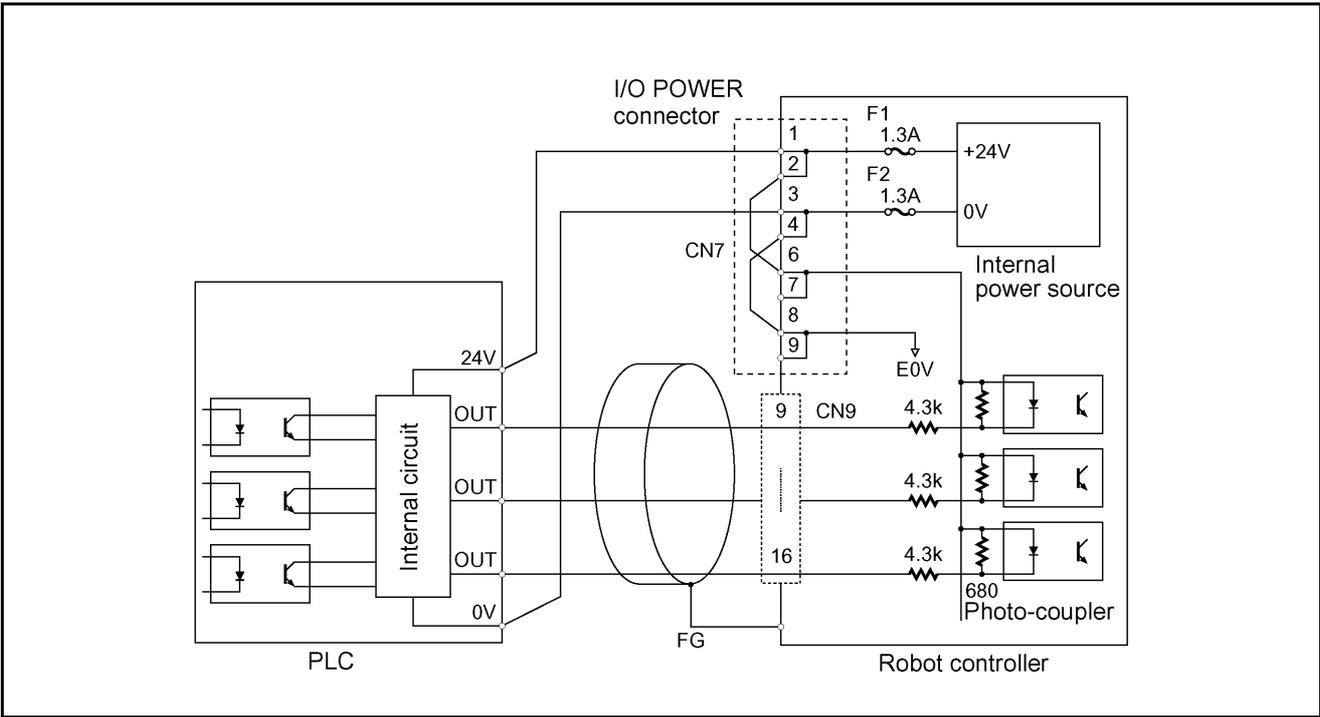


(When the internal power source is used)

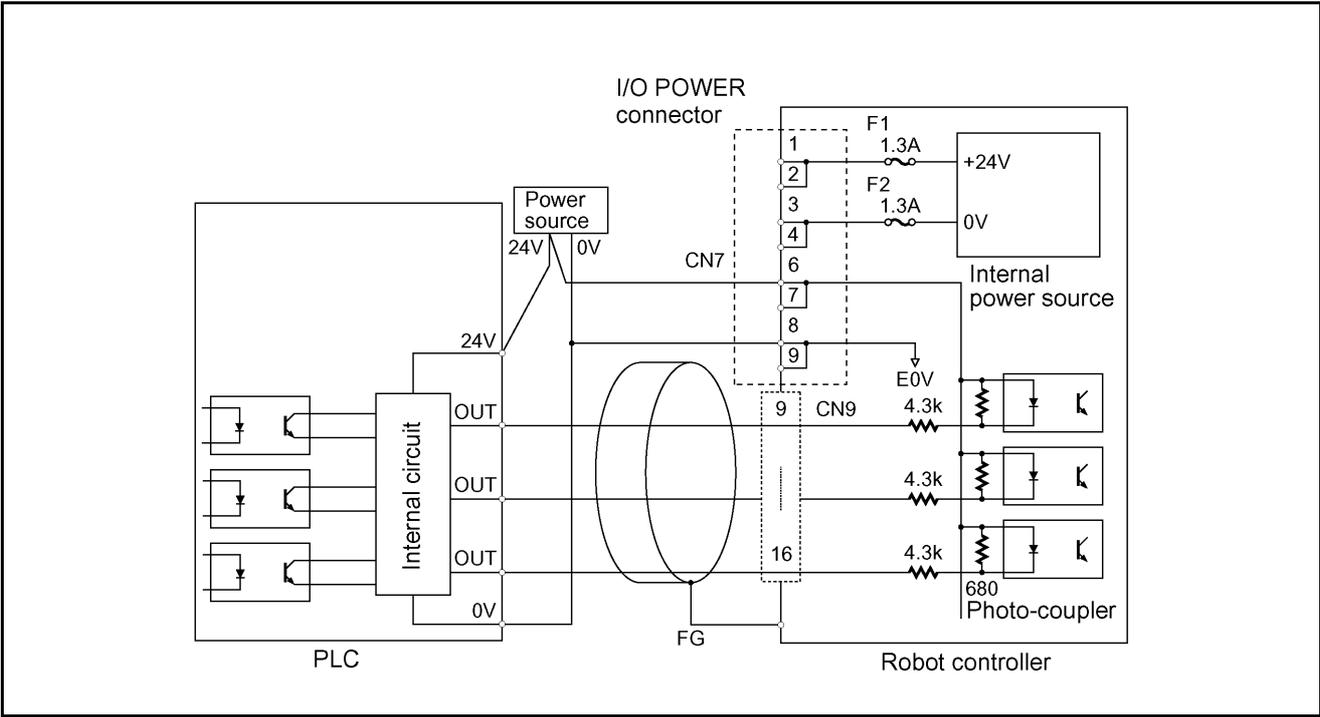


(When an external power source is used)

Figure 1-1 User-Input and System-Input Circuits (NPN type)



(When the internal power source is used)



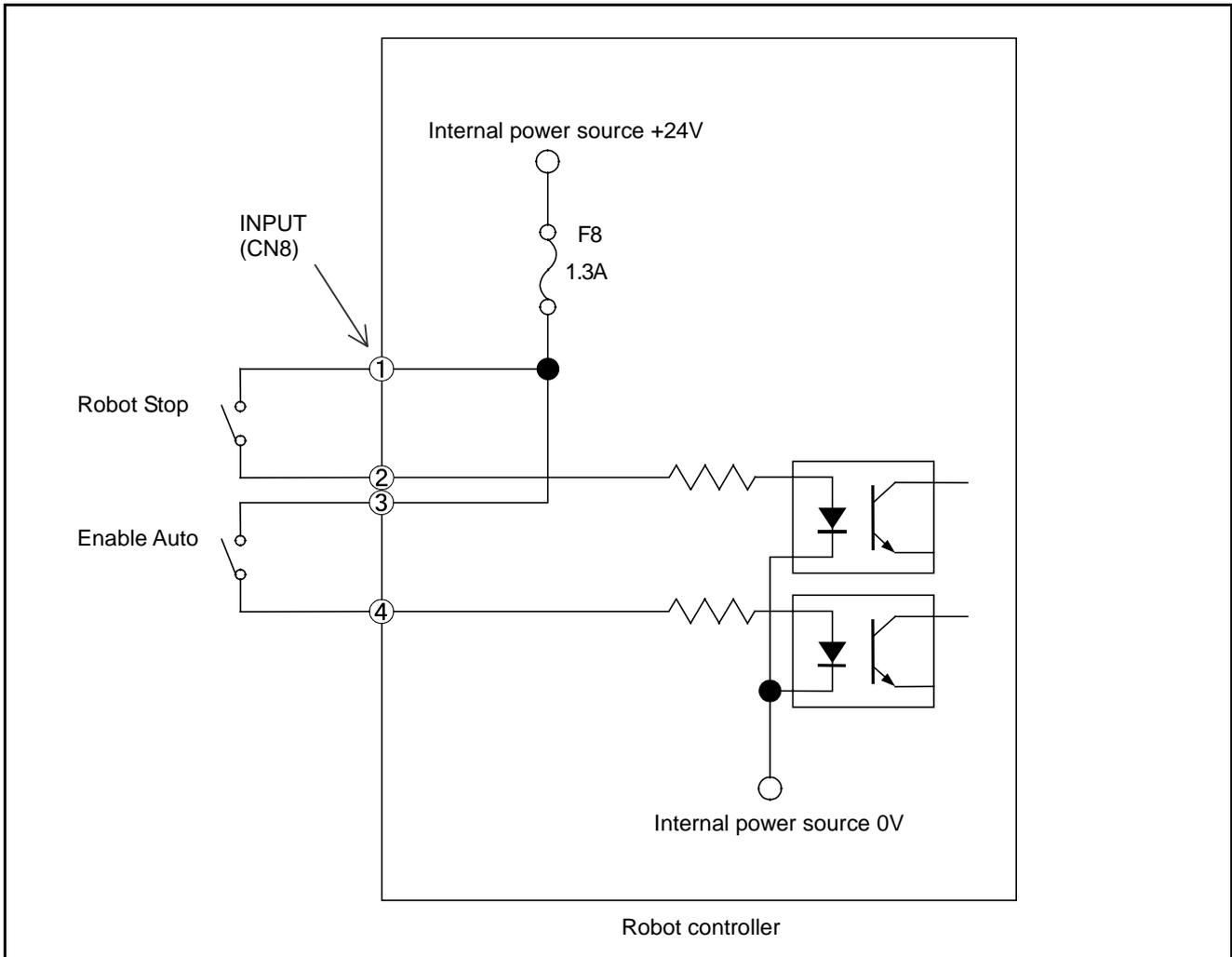
(When an external power source is used)

Figure 1-2 Hand-Input Circuits (NPN type)

## 1.2.2 Robot Stop and Enable Auto Circuits

The Robot Stop and Enable Auto signals are important for safety. The input circuit for these signals must have contacts as shown in Figure 1-3.

Use the INPUT CN8 (pins 1 and 3) of the robot controller for the power source, irrespective of whether the power source to be used for other I/O signals is the internal power source or an external power source.



**Figure 1-3 Robot Stop and Enable Auto Input Circuits**

**TIP:** For the configuration sample of an emergency stop output circuitry is shown in Appendix 1.2.4.

### 1.2.3 User-Output, System-Output, and Hand-Output Circuits

Figures 1-4 and 1-5 show an example of the configuration and connection of the Robot Controller's user-input output, system-output and hand-output circuit.

Since the initial resistance of a lamp is small, the output circuit may be damaged by rush current that flows when the lamp lights.

When directly turning ON and OFF a lamp, use a lamp whose rating is 0.5W or less.

To reduce rush current, select and connect a resistor R that allows dark current 1/3 or less of the rated current to flow when the lamp goes OFF.

Figure 1-6 shows an example of connecting a lamp.

- (1) **The User-Output, System-Output and Hand-Output Circuit are open collector output circuits.**
- (2) **The maximum allowable sink current is 70mA.**  
Keep the current consumption of a device to be connected to the Robot Controller, such as a PLC and a relay coil, below the allowable current.
- (3) **Select an induction load, such as a relay coil, which has a built-in diode (for absorbing inverse electromotive force).**  
To use an induction load without a built-in diode, add a diode equivalent to the 1S1888 (Toshiba) in close vicinity to the coil.

 **Caution:** When externally attaching a diode, connect it with correct polarity. Incorrect polarity may damage the Output circuit.

- (4) **Connecting a lamp requires a circuit through which dark current flows.**

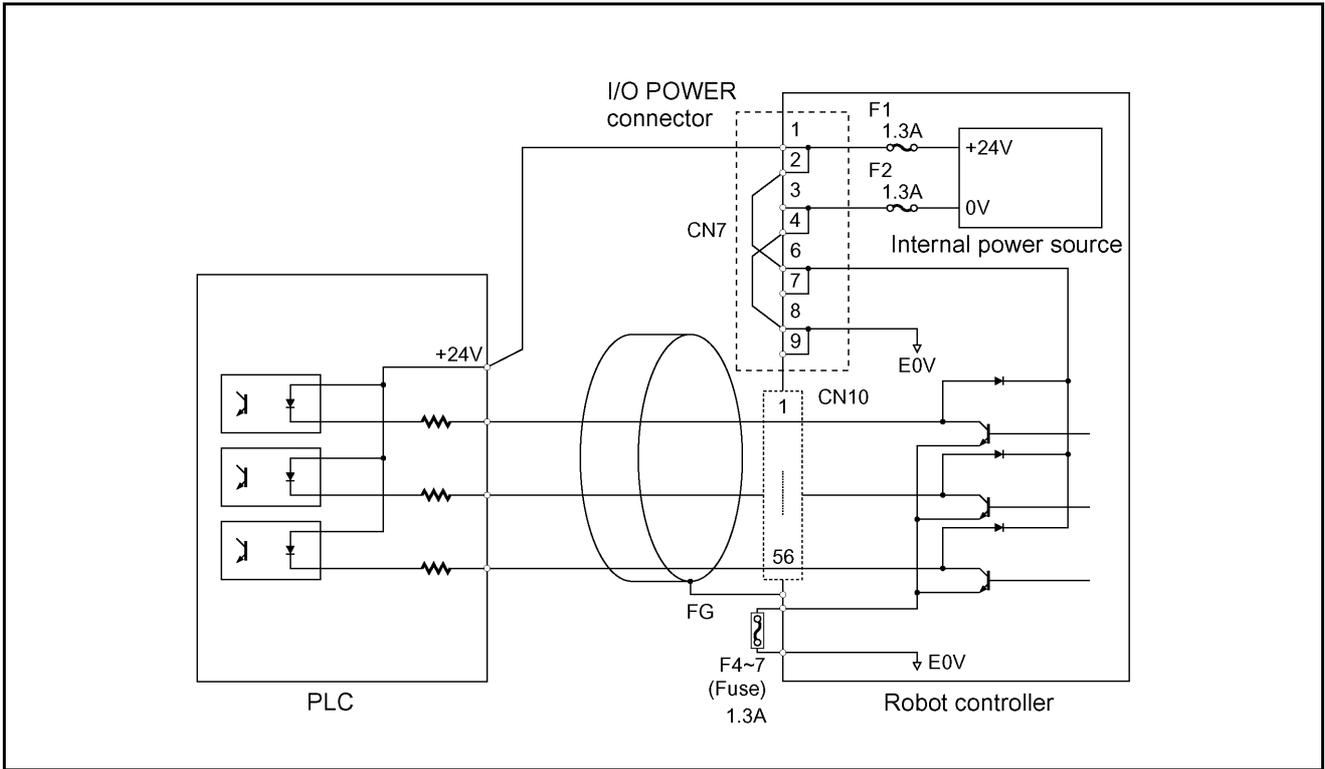
 **Caution:** Since the initial resistance of a lamp is small, the output circuit may be damaged by rush current that flows when the lamp lights.  
Refer to Figure 1-6.

- (5) **When using the internal power source, prepare a PLC input circuit unit that does not contain a power source.**

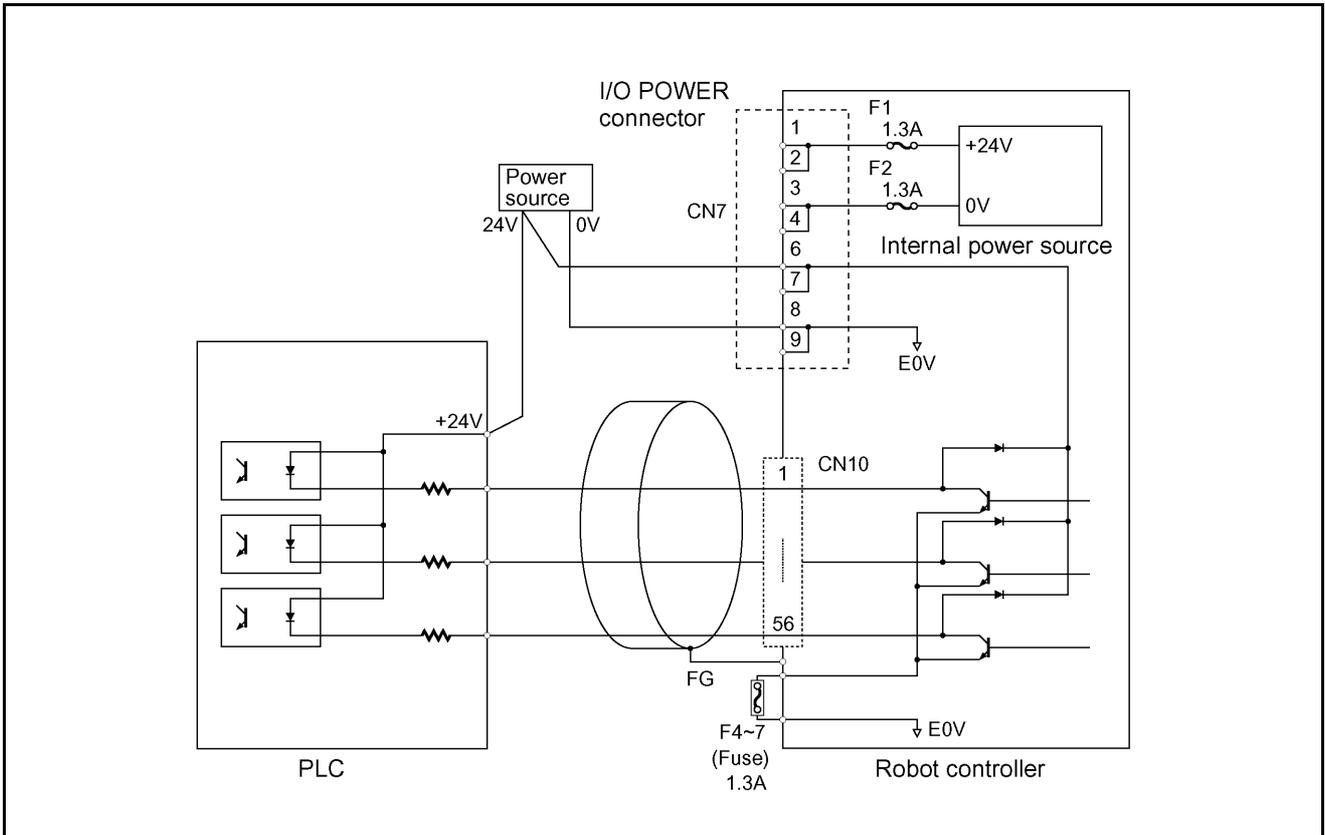
 **Caution:** Keep the total current capacity of the internal power source below 1.3A.

- (6) **Use a multi-core shielding cable for the purpose of protecting the devices from external noise. Ground it to the robot controller.**
- (7) **+24V internal power source of the robot controller must not be grounded.**

 **Caution:** If the output terminal +24V of internal power source is grounded, there may be a case where the controller is damaged.

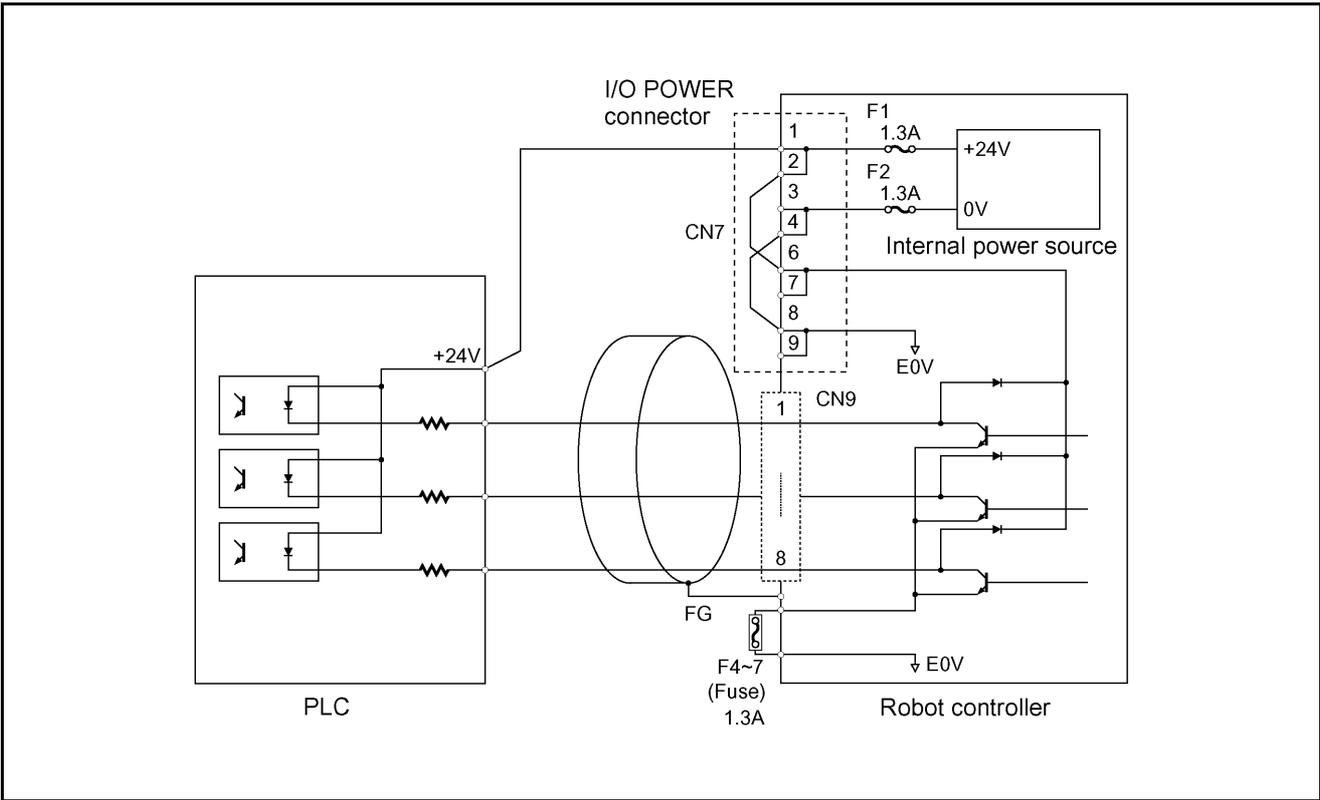


(When the internal power source is used)

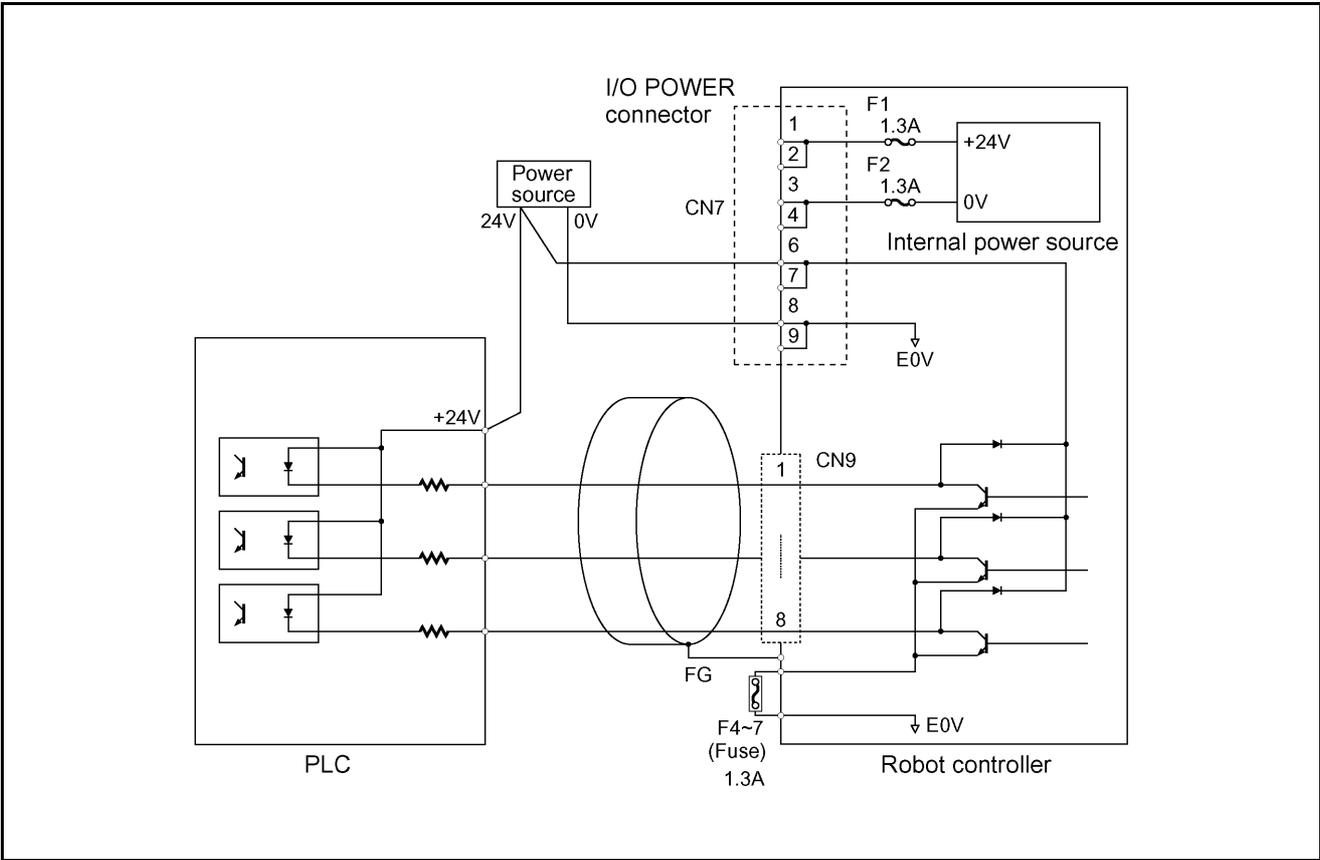


(When an external power source is used)

Figure 1-4 User-Output and System-Output Circuits (NPN type)



(When the internal power source is used)



(When an external power source is used)

Figure 1-5 Hand-Output Circuits (NPN type)

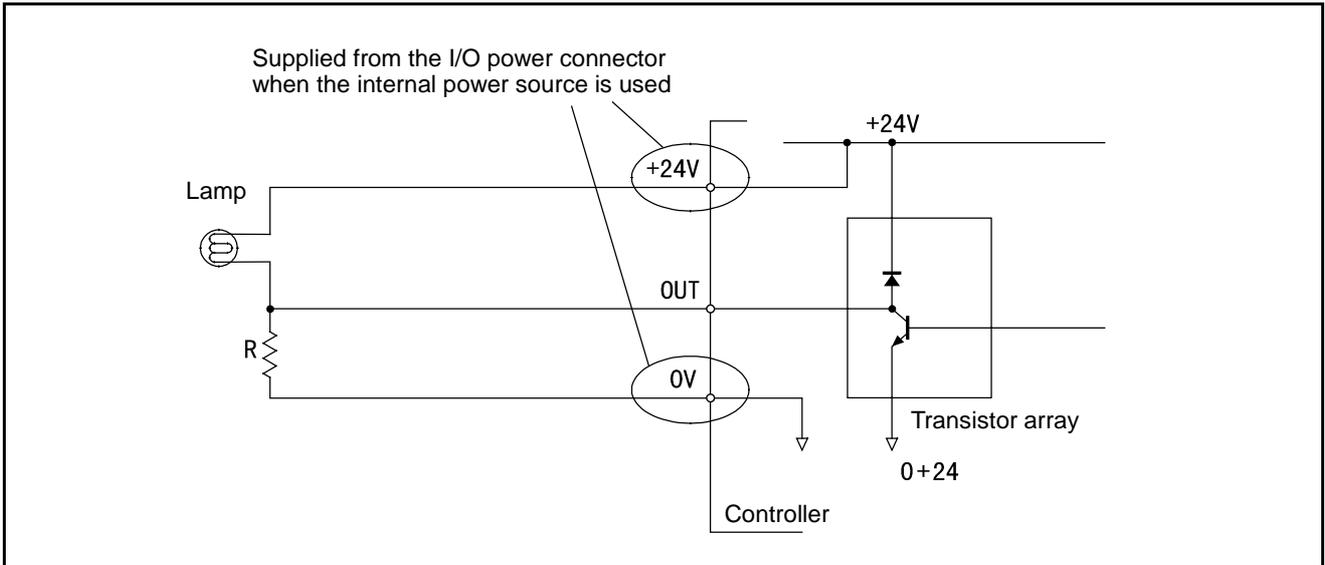
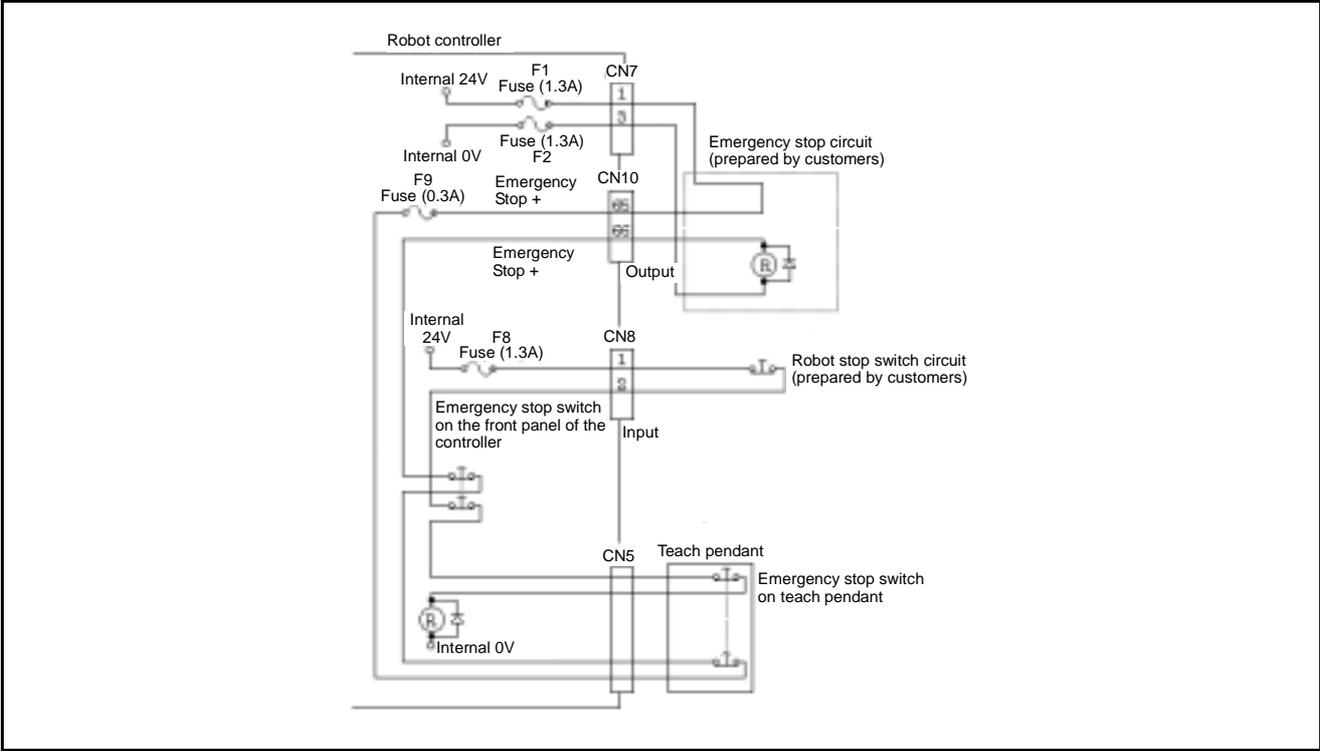


Figure 1-6 Example of Circuit with Lamp (NPN type)

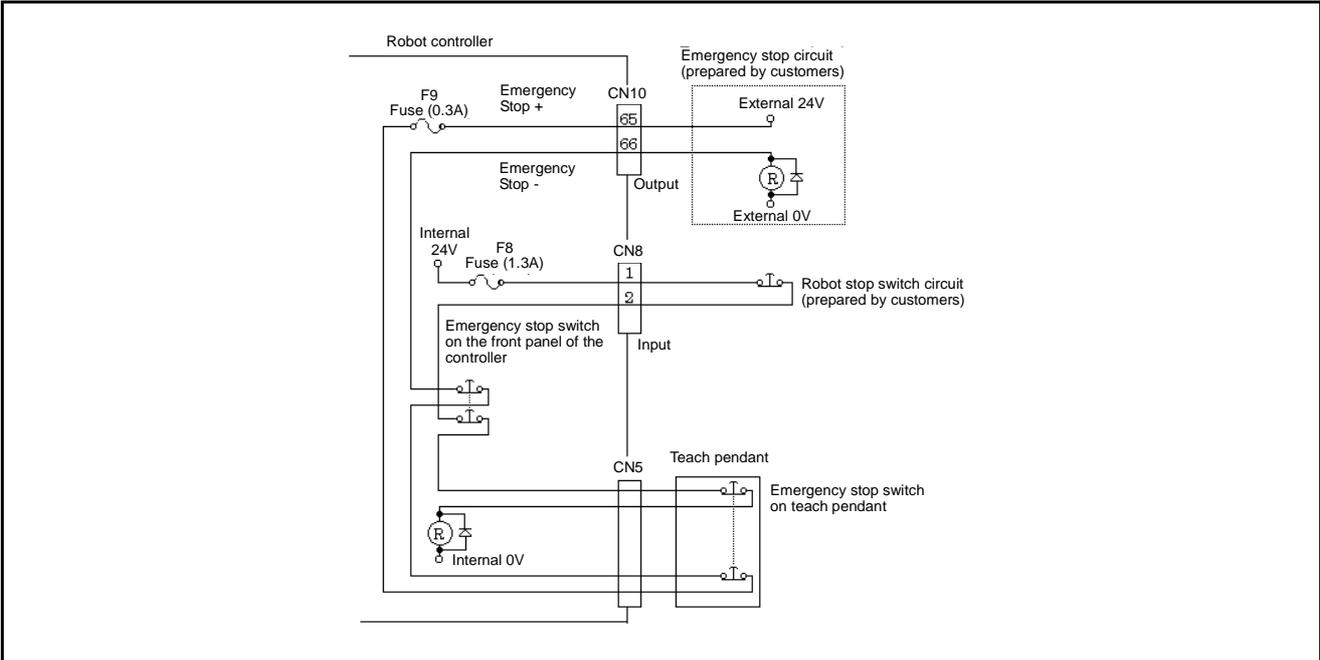
### 1.2.4 Emergency Stop Output Circuit

Figure 1-7 shows the examples of configuration and connection of emergency stop circuit for the robot controller.

The red mushroom-shaped switch provided on the robot controller front panel, on the teach pendant, or on the operating panel can be used as a switch for stopping the equipment in case of emergency.



(When the internal power source is used)



(When an external power source is used)

Figure 1-7 Emergency Stop Output Circuit

## 1.2.5 I/O Power Connector

For the power source to communicate signals between the robot controller and the external device, the internal power source of the robot controller or an external power source is used.

Figure 1-8 (a) shows an example of connecting I/O power connectors when the internal power source is used, and Figure 1-8 (b) shows an example of connecting I/O power connectors when an external power source is used.

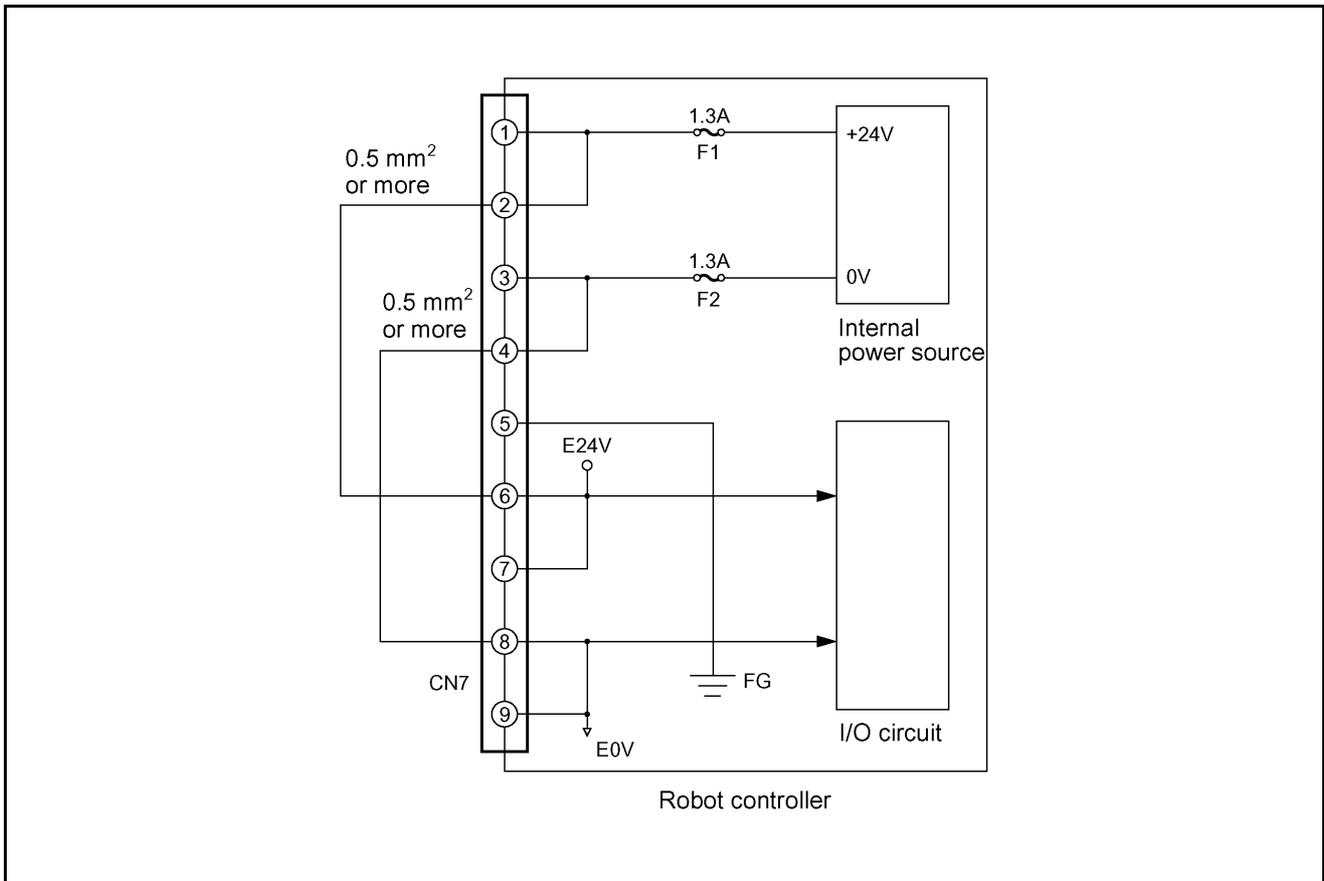


Figure 1-8 (a) I/O Power Connection Sample (When the internal power source is used) (NPN type)



**Caution:** To use the internal power source of the robot controller, connect the wiring so that the internal power source will be separate from the external power source. Improper wiring may damage the internal circuit.

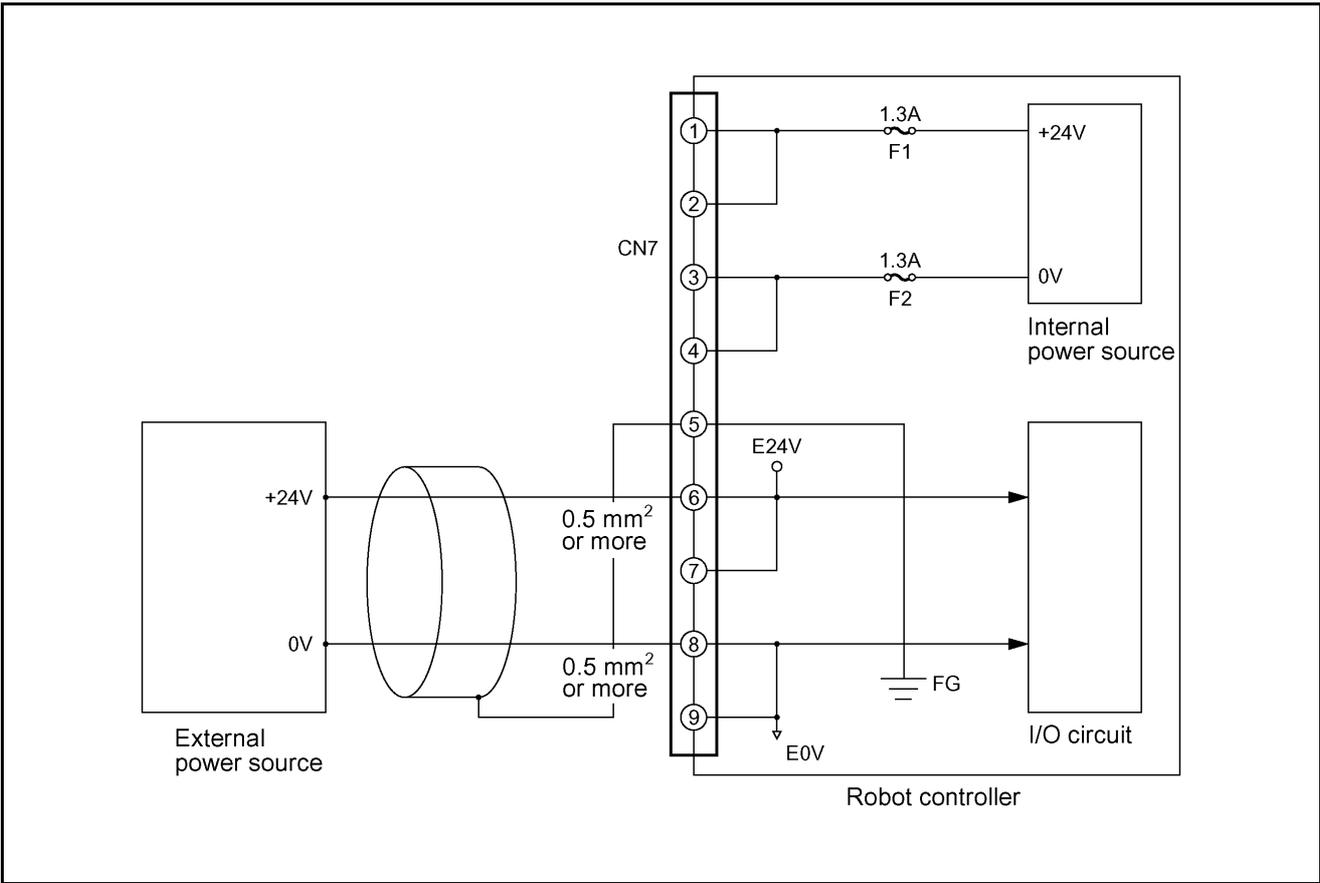


Figure 1-8 (b) I/O Power Connection Sample (When an external power source is used) (NPN type)

**⚠ Caution:** Use a cable of 0.5 mm<sup>2</sup> or more in size for the wiring between the external power source and the I/O power input connectors of the robot controller.

## 1.3 Wiring Notes for the Robot Controller I/O Connectors

After the wiring of the controller's I/O connectors is completed, check the following before turning ON the power:

### Check point (1)

Using a circuit tester, check across the “+24V terminal” and “0V terminal” of each connector and across the “E24V terminal” and the “E0V terminal” to see that there is no continuity. See Figure 1-9 and Table 1-7.

**⚠ Caution:** If the connector wiring between the Robot Controller's “+24V terminal” and “0V terminal” and between the “E24V terminal” and the “E0V terminal” is shorted, damage to the power circuit of the Robot Controller will result.

### Check point (2)

Using a tester, check across “each signal Output terminal” and “+24V terminal” or “E24V terminal” of each connector to see that there is no continuity. See Figure 1-9 and Table 1-7.

**⚠ Caution:** If the wiring between “each signal Output terminal” and “+24V terminal” or “E24V terminal” of each connector is shorted, damage to the Output circuit and power circuit of the Robot Controller will result.

**⚠ Caution:** Wind adhesive vinyl tape around all ends of the unconnected wiring of each connector to prevent them from contacting other wiring and parts, which results in shorting.

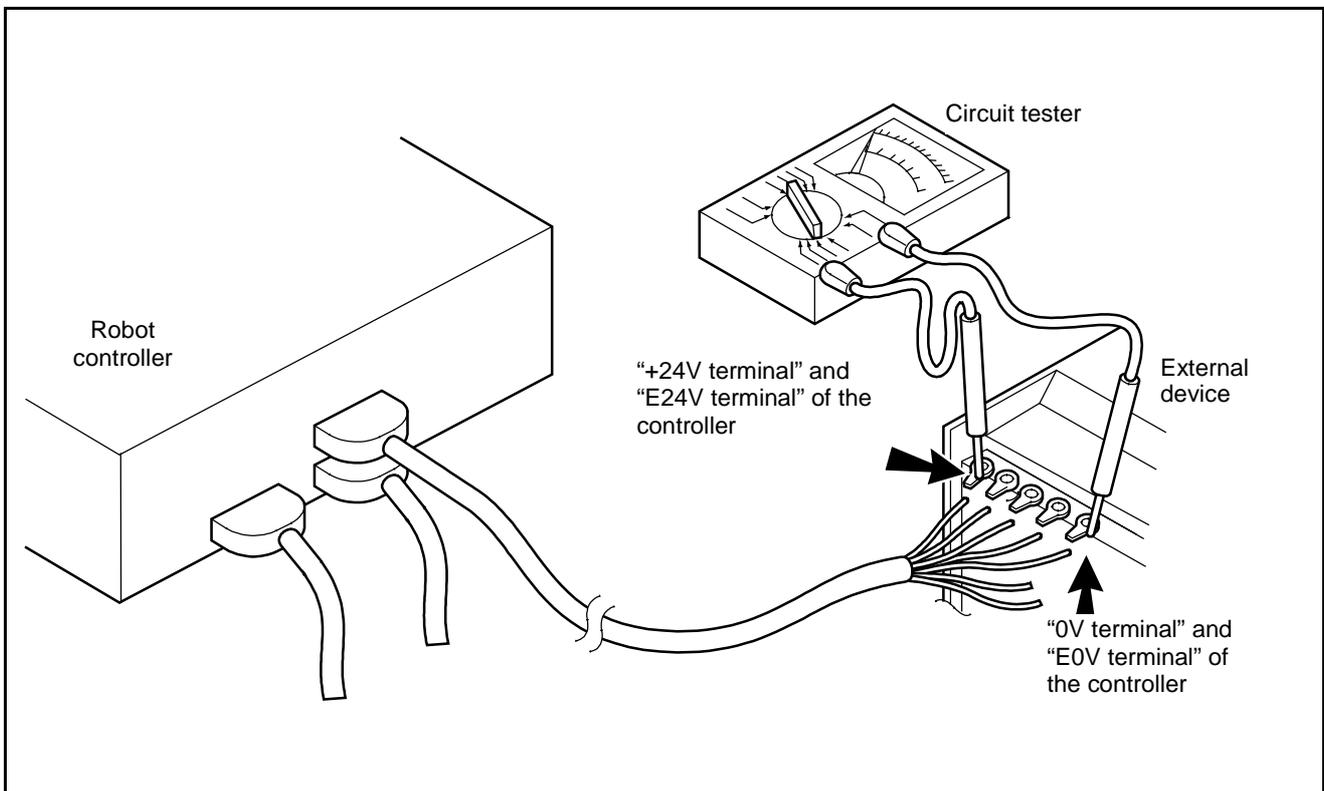
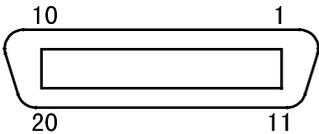


Figure 1-9 Checking Example

Table 1-7 Connector Terminals and Check Points (NPN type)

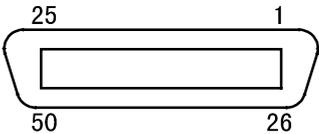
**Connector for hand I/O**



View from cable side engaging face

Terminal Number	Name	Meaning	Check point
1 to 8	Hand output terminal	0V (GND) at output	(2)
17	Power terminal for hand (E24V)	24V power output	(1)
18	Power terminal for hand (E0V)	Power (GND) output	(1)

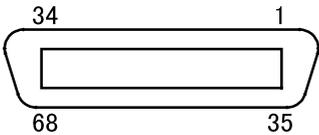
**Connector for user/system input**



View from cable side engaging face

Terminal Number	Name	Meaning	Check point
1, 3	+24V internal power source terminal	+24V internal power source output	(1)

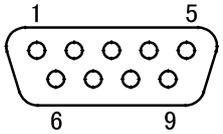
**Connector for user/system output**



View from cable side engaging face

Terminal number	Name	Meaning	Check point
1 to 56	Signal output terminal	0V (GND) at output	(2)

**Connector for I/O power source**

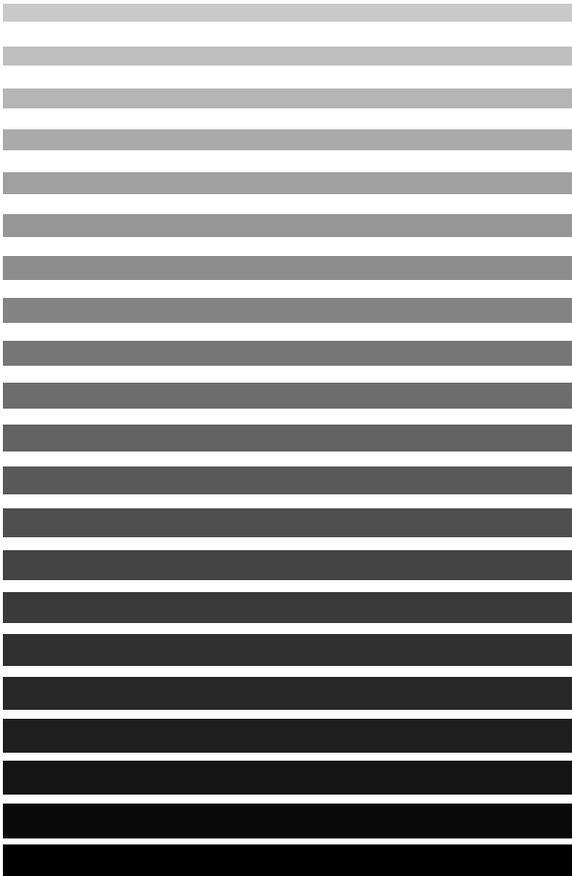


View from cable side engaging face

Terminal number	Name	Meaning	Check point
1, 2	+24V internal power source terminal	+24V internal power source output	(1)
3, 4	0V internal power source terminal	0V internal power source output	(1)
6, 7	E24V input terminal	24V power input	(1)
8, 9	E0V (GND) input terminal	Power (GND) input	(1)



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# **Horizontal Articulated Robot H\*-D SERIES**

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## **INSTALLATION & MAINTENANCE GUIDE**

First Edition    April 2000

Second Edition    June 2001

Third Edition    October 2001

DENSO WAVE INCORPORATED  
Factory Automation Division

10C30C

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The purpose of this manual is to provide accurate information in the handling and operating of the robot. Please feel free to send your comments regarding any errors or omissions you may have found, or any suggestions you may have for generally improving the manual.

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