

DENSO ROBOT

RC7J CONTROLLER INTERFACE MANUAL

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Preface

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

This manual covers interfacing required when you integrate your robot system configured with the RC7J robot controller into your facilities. And also it provides instructions for installing the robot controller, and maintenance & inspection procedures.

Before use, read this manual carefully together with related manuals to safely get the maximum benefit from your robot in your assembling operations.

Robot models covered by this manual

All robot models configured with the RC7J controller

Important

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

How the documentation set is organized

The documentation set consists of the following books. If you are unfamiliar with this robot and option(s), please read all books and understand them fully before operating your robot and option(s).

GENERAL INFORMATION ABOUT ROBOT

Provides the packing list of the robot and outlines of the robot system, robot unit, and robot controller.

INSTALLATION & MAINTENANCE GUIDE

Provides instructions for installing the robot components and customizing your robot, and maintenance & inspection procedures.

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.

SETTING-UP MANUAL

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

WINCAPSII GUIDE

Provides instructions on how to use the teaching system WINCAPSII which runs on the PC connected to the robot controller for developing and managing programs.

PROGRAMMER'S MANUAL (I), (II)

Describes the PAC programming language, program development, and command specifications in PAC.

RC7J CONTROLLER INTERFACE MANUAL - this book -

Describes the RC7 controller, interfacing with external devices, system- and user-input/output signals, and I/O circuits. And also it provides instructions for installing the robot controller, and maintenance & inspection procedures.

ERROR CODE TABLES

List error codes that will appear on the teach pendant, operating panel, or PC screen if an error occurs in the robot series or WINCAPSII. These tables provide detailed description and recovery ways.

OPTIONS MANUAL

Describes the specifications, installation, and use of optional devices.

How this book is organized

This book is just one part of the robot documentation set. This book consists of SAFETY PRECAUTIONS and chapters one through nine.

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 Outline of the RC7J Controller

Provides an outline of the RC7J controller. The robot controller is available in several models that will differ in detailed specifications to match robot models to be connected.

Chapter 2 General Information about the Interface

Introduces you to the interface required for connecting the robot controller with a PLC or other external equipment.

Chapter 3 System I/O Signals

Describes system I/O signals, and describes I/O signals that execute I/O commands.

Chapter 4 I/O Circuits and Connectors (NPN type)

Describes the I/O circuits and connector pin layout of an NPN I/O board (source input and sink output). The NPN I/O board is designed for the use in Japan.

Chapter 5 I/O Circuits and Connectors (PNP type)

Describes the I/O circuits and connector pin layout of a PNP I/O board (sink input and source output).

Chapter 6 Installation & Maintenance for the RC7J controller

Provides instructions for installing the robot controller, and maintenance & inspection procedures.

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.

 WARNING	Alerts you to those conditions, which could result in serious bodily injury or death if the instructions are not followed correctly.
 CAUTION	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 WAVE-proprietary terminology.)

Operating space: Refers to the portion of the restricted space (or motion space in Denso robot) 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)

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 structure, but it has not been designed to withstand explosions. (The H*-E-W and the wrist of the VM-D-W/VS-E-W are an IP65-equivalent dust-proof and splash-proof structure.)

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 not specified in this manual is in use, or
Note: Yushiron Oil No. 4C (non-soluble) is specified.
- (7) there is sulfuric cutting or grinding oil mist.

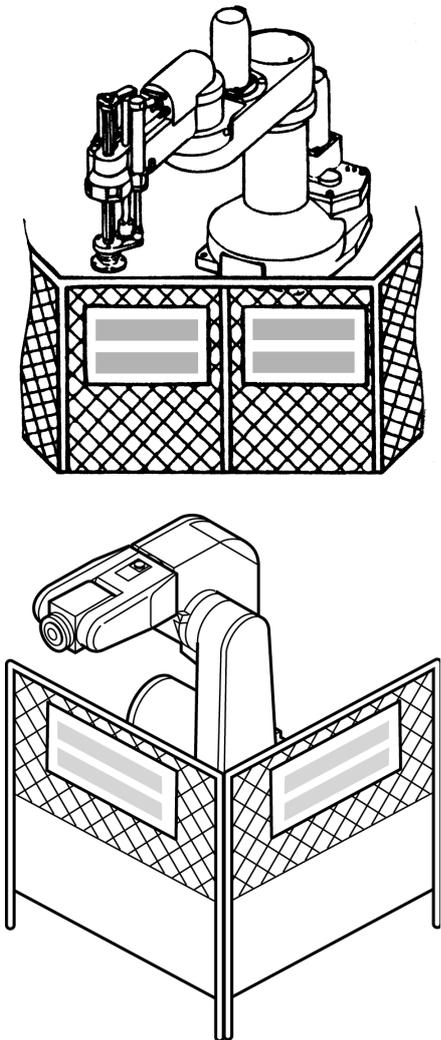
2.2 Service space

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

SAFETY PRECAUTIONS

- 2.3 Control devices outside the robot's restricted space** The robot controller, teach 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, 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.

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).

SAFETY PRECAUTIONS

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."

2.11 No robot modification allowed

Never modify the robot unit, robot controller, teach 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

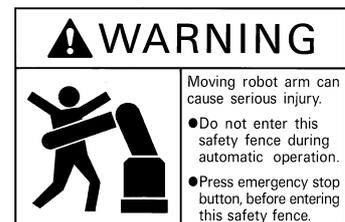
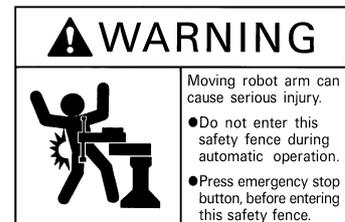
Sufficient illumination should be assured for safe robot operation.

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 or teach 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) immediately if it should be necessary to do so.

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 specified in this manual.

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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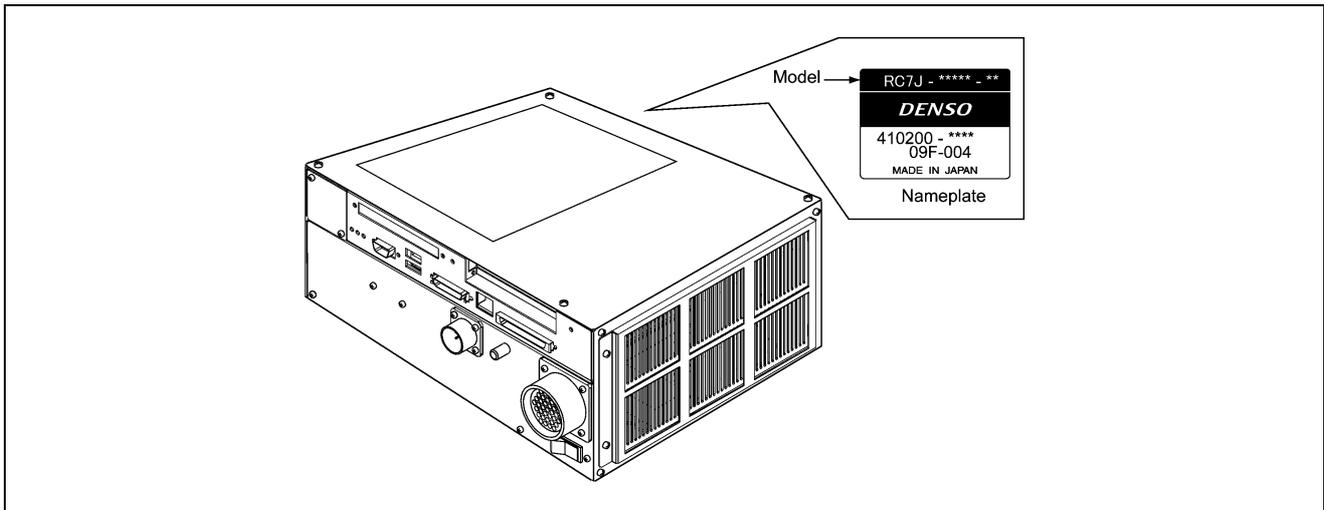
Chapter 1

General Information about RC7 Controller

The RC7 controller is available in several models which differ in detailed specifications to match robot models.

1.1 Controller Model Name on Nameplate

The model name of the controller is printed on the nameplate attached to the rear side of the controller as shown below. The model name is coded as listed below.



Coding of Controller Model Name

RC7J - <u>VPF</u> <u>5/6</u> <u>B</u> <u>A</u>			
Position	Code sample	Denotes:	Coding
(a)	VPF	Robot model name	VPF:VP-F, VSF:VS-F, VCF:VC-F, HSF:HS-F,
(b)	6	No. of controllable axes	4: 4 axes, 5/6: 5 or 6 axes, 6: 6 axes
(c)	B	Engineering symbol 1	A: Encoders connected via parallel interface to CN13 B: Encoders connected via bus to CN12
(d)	A	Engineering symbol 2	Blank or A
(e)	-	Types	Blank:I/O of NPN type AN: Robot System "Type A" and I/O of NPN type BN: Global type (:Robot System "Type A" and I/O of NPN type) BP: Global type (:Robot System "Type A" and I/O of PNP type) (Note: For Robot System "Type A, refer to next page.)

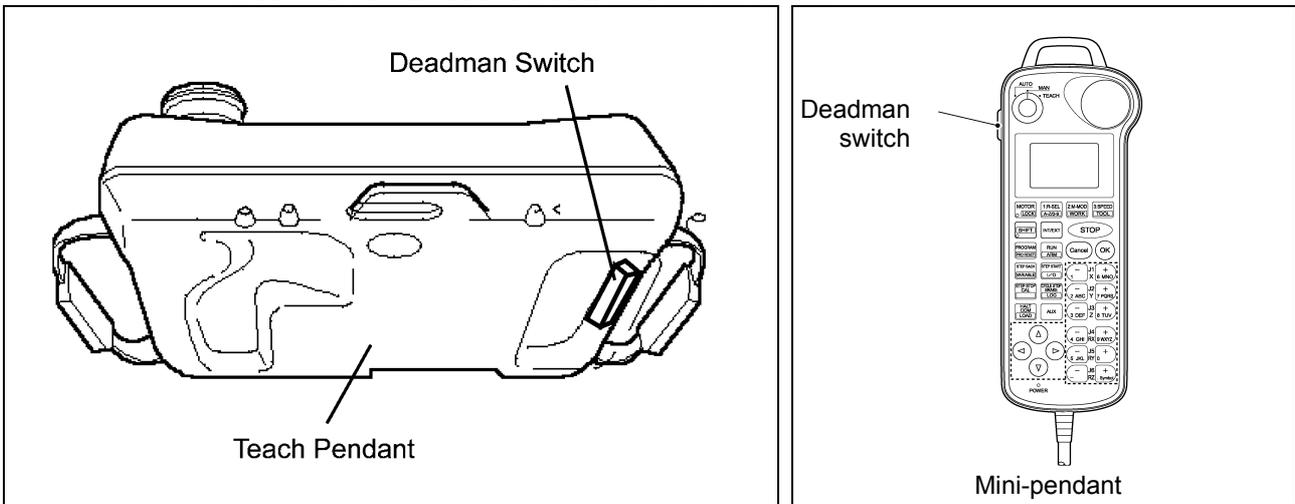
<Notes for Robot System “ Type A”>

1 Modified Deadman Switch Functions in Robot System "Type A"

In Robot System "Type A" designed for the RC7 controller, the functions of the deadman switches provided on the optional devices have been partially modified regarding the motor power ON/OFF control. Accordingly, the description given in the instruction manuals that come with "Type A" is different from the actual functions. When reading the deadman switch related sections, be careful with the following modification.

1.1 Deadman switches on optional devices (Teach pendant and mini-pendant)

Deadman switches are located as shown below.



1.2 Modified deadman switch functions

When you operate the teach pendant or mini-pendant in Manual mode or Teach check mode, the deadman switch controls the motor power ON/OFF function in Robot System "Type A," while it does not in the description given in the instruction manuals.

Robot System "Type A"	Description given in the instruction manuals
(1) Unless the deadman switch is held down, you may <u>neither</u> operate the robot <u>nor turn the motor power ON.</u>	(1) Unless the deadman switch is held down, you may not operate the robot, <u>but you may turn the motor power ON.</u>
(2) When the robot is in operation, releasing the deadman switch will stop not only the robot but <u>also turn the motor power OFF.</u>	(2) When the robot is in operation, releasing the deadman switch will stop the robot <u>but not turn the motor power OFF (servo lock).</u>

How to identify your robot system as "Type A"

Check the controller model on the nameplate located on the side of the robot controller or the robot model shown on the status bar of the teach pendant screen. The model name of "Type A" contains letter "A" as shown below.

Robot controller example: RC7-VSF6B-**BP**

Robot example:

VS-6356F **A**

Symbol denoting "Type A"

2 “Single point of control” function

The “Single point of control” function is added only for Robot System “Type A”. This function limits the robot-start that other equipments except specified one device (for example: Teach Pendant) cannot enable to start the robot. The “Auto mode” of this function is usable in either “Internal Auto Limited Mode” or “External Auto Limited Mode” by setting the parameter.

2.1 Internal Auto Limited Mode

The operational permit of “Internal Auto Limited Mode” is the same range as the “Internal Auto Mode”. Program Start can be executed from the teach pendant, but cannot be executed from the external device. The switching between Internal Auto and External Auto cannot be operated by the teach pendant.

2.2 External Auto Limited Mode

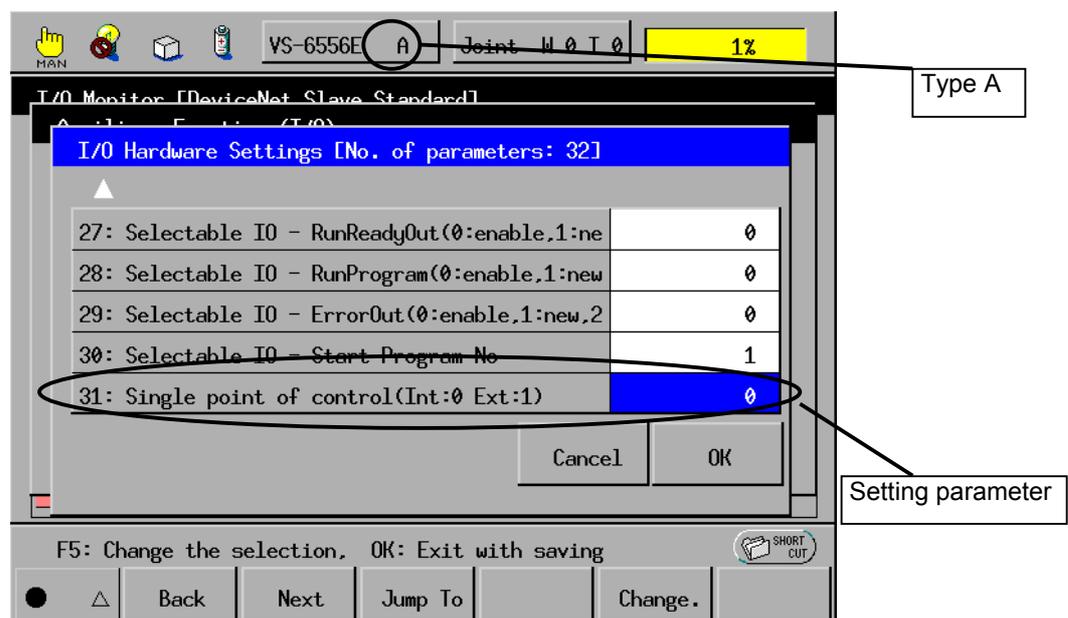
The operational permit of “External Auto Limited Mode” is the same range as the “External Auto Mode”. Program Start can be executed from the external device, but cannot be executed from the teach pendant. The switching between Internal Auto and External Auto cannot be operated by the teach pendant.

2.3 Setting the parameter

Access: [Top screen] - [F4 I/O] - [F6 Aux.] - [F1 Set H/W] - [F3 Jump To] - “31”

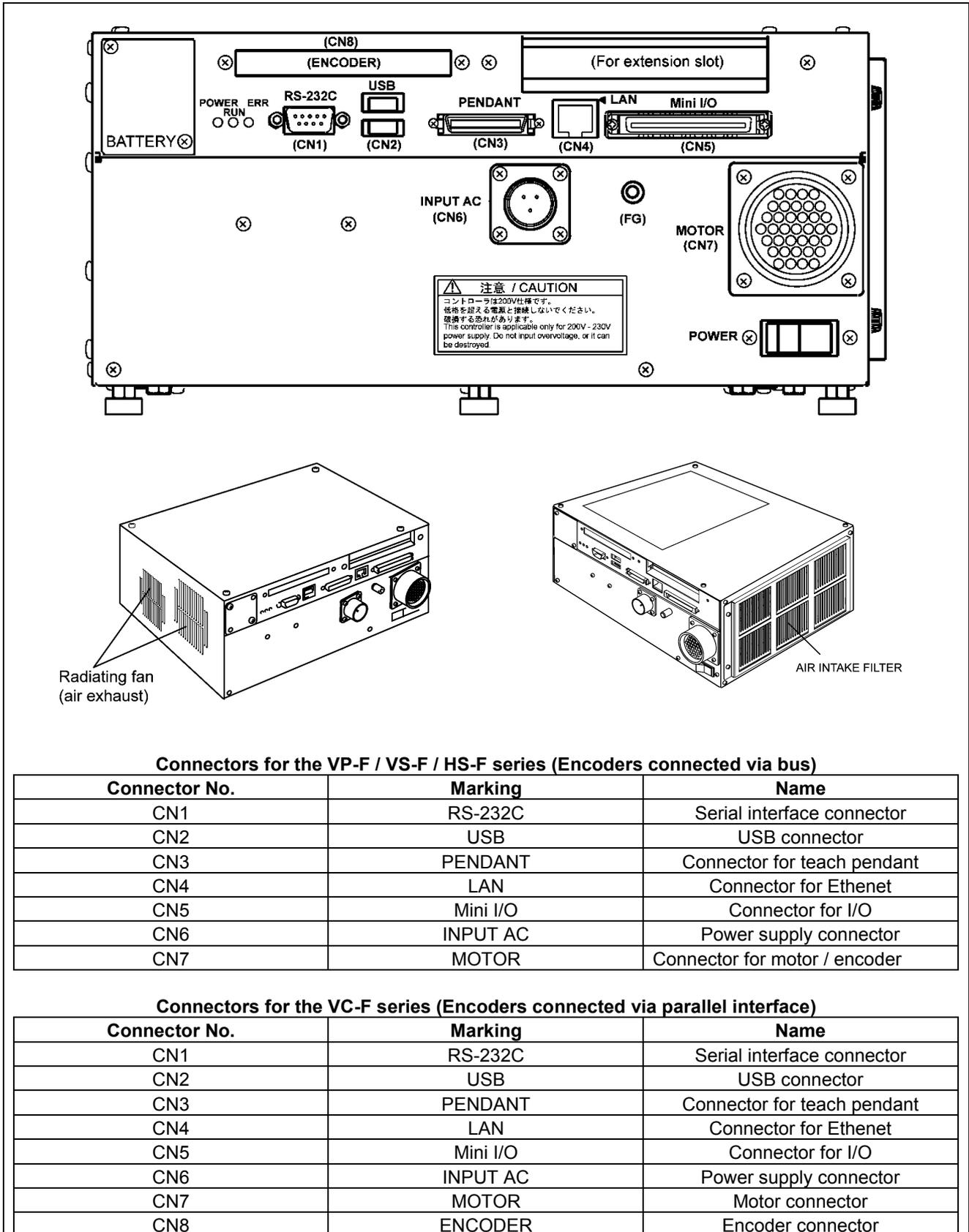
Select the Internal Auto Limited Mode (Int:0) or the External Auto Limited Mode (Ext:1).

TIP: Before shipping from the factory, the single point of control is set to 0 (Internal Auto Limited Mode) by default.



1.2 Names of the Robot Controller Components

The following figures show the names of the robot controller components.



Connectors for the VP-F / VS-F / HS-F series (Encoders connected via bus)

Connector No.	Marking	Name
CN1	RS-232C	Serial interface connector
CN2	USB	USB connector
CN3	PENDANT	Connector for teach pendant
CN4	LAN	Connector for Ethernet
CN5	Mini I/O	Connector for I/O
CN6	INPUT AC	Power supply connector
CN7	MOTOR	Connector for motor / encoder

Connectors for the VC-F series (Encoders connected via parallel interface)

Connector No.	Marking	Name
CN1	RS-232C	Serial interface connector
CN2	USB	USB connector
CN3	PENDANT	Connector for teach pendant
CN4	LAN	Connector for Ethernet
CN5	Mini I/O	Connector for I/O
CN6	INPUT AC	Power supply connector
CN7	MOTOR	Motor connector
CN8	ENCODER	Encoder connector

Names of RC7J Robot Controller

1.3 Robot Controller Specifications

[1] Specifications

The table below lists the robot controller specifications.

RC7J Robot Controller Specifications

Item		Specifications
Model		RC7J-*****
No. of controllable axes	HS-F:	Up to four axes simultaneously
	VP-F, VC-E (5-axis models):	Up to five axes simultaneously
	VP-F, VS-F, VC-F (6-axis models):	Up to six axes simultaneously
Control system		PTP, CP 3-dimensional linear, 3-dimensional circular
Drive system		All axes: Full-digital AC servo
Language used		DENSO robot language (conforming to SLIM)
Memory capacity		2.25 MB (equivalent to 5000 steps, 20,000 points)
Teaching system		1) Remote teaching 2) Numerical input (MDI)
External signals (I/O)	Input signal	8 user open points + 11 fixed system points (If the optional board for parallel I/O is installed: Additional 40 points)
	Output signal	8 user open points + 12 fixed system points (If the optional board for parallel I/O is installed: Additional 48 points)
External communication		RS-232C: 1 line Ethernet: 1 line USB: 2 lines
Extension slot		1 (For an optional board)
Self-diagnosis function		Overrun, servo error, memory error, input error, etc.
Timer function		0.02 to 10 sec. (in units of 1/60 sec.)
Error display		Error codes will be outputted on the external I/O. Error messages will be displayed in English on the teach pendant (option). Error codes will be displayed on the mini pendant (option).
Cables	Motor & encoder cable (option)	Standard: 4 m, 6 m (selectable) High strength: 6 m, 12 m (selectable)
	I/O cable (option)	8 m, 15 m (selectable)
	Power cable	5 m
Environmental conditions (in operation)		Temperature: 0 to 40°C Humidity: 90% RH or less (no condensation allowed)
Power source		AC200V type: Single-phase, 200 VAC-15% to 230 VAC+10%, 50/60 Hz, 1KVA AC100V type: Single-phase, 100 VAC-10% to 110 VAC+10%, 50/60 Hz, 500VA
Degree of protection		IP20
Weight		Approx. 8 kg (excluding attached cables)

⚠ WARNING

- **DO NOT touch fins. Their hot surfaces may cause severe burns.**
- **DO NOT insert fingers or foreign objects into openings. Doing so may cause bodily injury.**
- **Before opening the controller cover and accessing the inside of the controller for maintenance, be sure to turn off the power switch, disconnect the power cable, and wait 3 minutes or more. This is for protecting you from electric shock.**
- **DO NOT connect or disconnect connectors to/from the controller while the power switch is on. Doing so may cause electric shock or controller failure.**

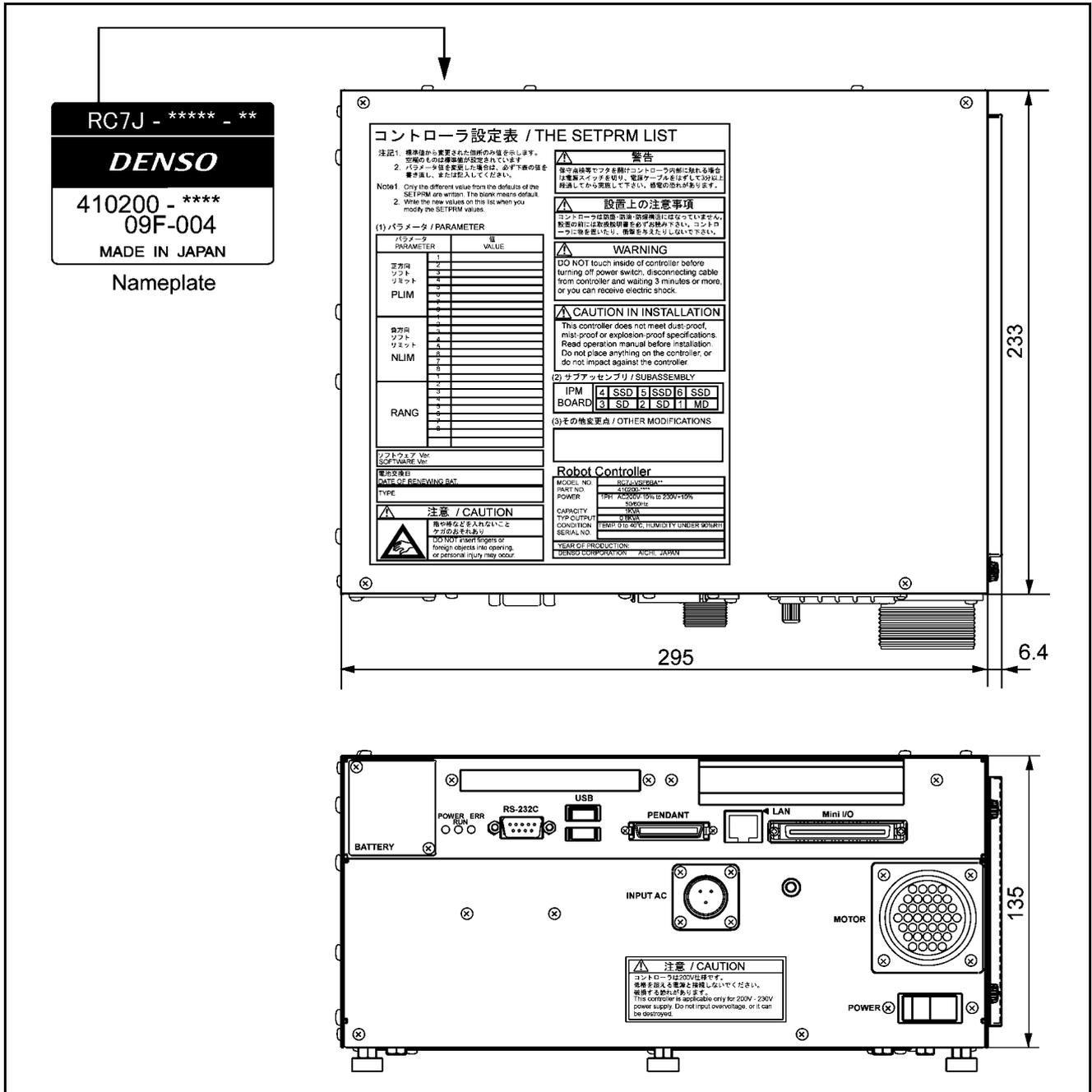
⚠ CAUTION IN INSTALLATION

- **This controller is not designed to be dust-proof, splash-proof, or explosion-proof.**
- **Read operation manuals before installation.**
- **Do not place anything on the controller.**

⚠ 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.

[2] Outer Dimensions

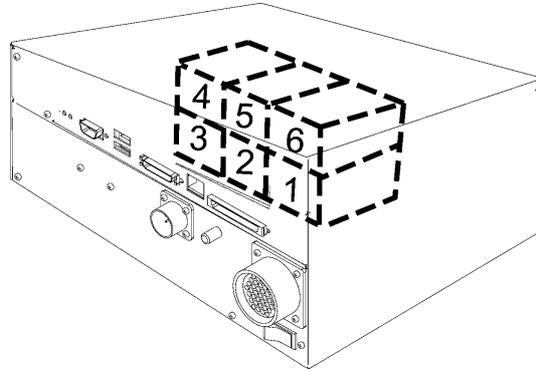
The outer dimensions of the robot controller are shown below.



Outer Dimensions of RC7J Robot Controller

■ Location of IPM boards

The table below shows the location of IPM boards for robot series or models.



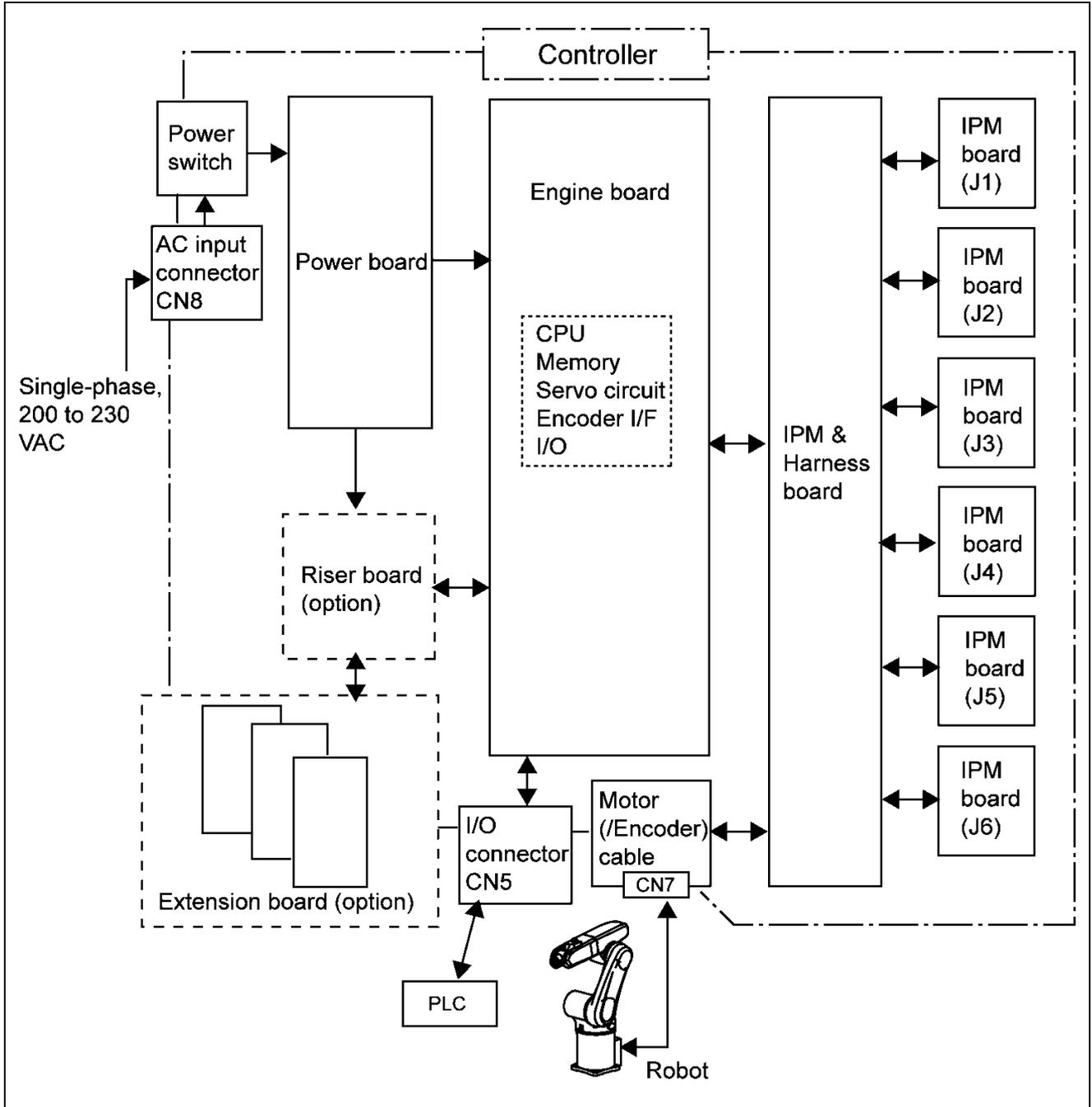
Series & models	Location Item	(6)	(5)	(4)	(3)	(2)	(1)
		VP-F (For 6 axes)	Joints	6	5	4	3
	IPM model	SSD	SSD	SSD	SSD	SSD	SSD
	Motor capacity (W)	30	30	30	50	80	80
VS-F	Joints	6	5	4	3	2	1
	IPM model	SSD	SSD	SSD	SSD	SD	MD
	Motor capacity (W)	50	80	100	200	400	750
VC-F (For 6 axes)	Joints	6	5	4	3	2	1
	IPM model	SSD	SSD	SSD	SSD	SSD	SSD
	Motor capacity (W)	30	30	30	80	80	80
HS-F	Joints	-	-	4	3	2	1
	IPM model	-	-	SD	SD	MD	MD
	Motor capacity (W)	-	-	150	200	400	750

NOTE : No IPM board are installed to locations marked with "-."

1.4 Controller System Configuration

1.4.1 Internal Circuits of the Controller (Typical configuration)

The block diagram below shows the internal circuits of the RC7J controller designed for a 6-joint robot.



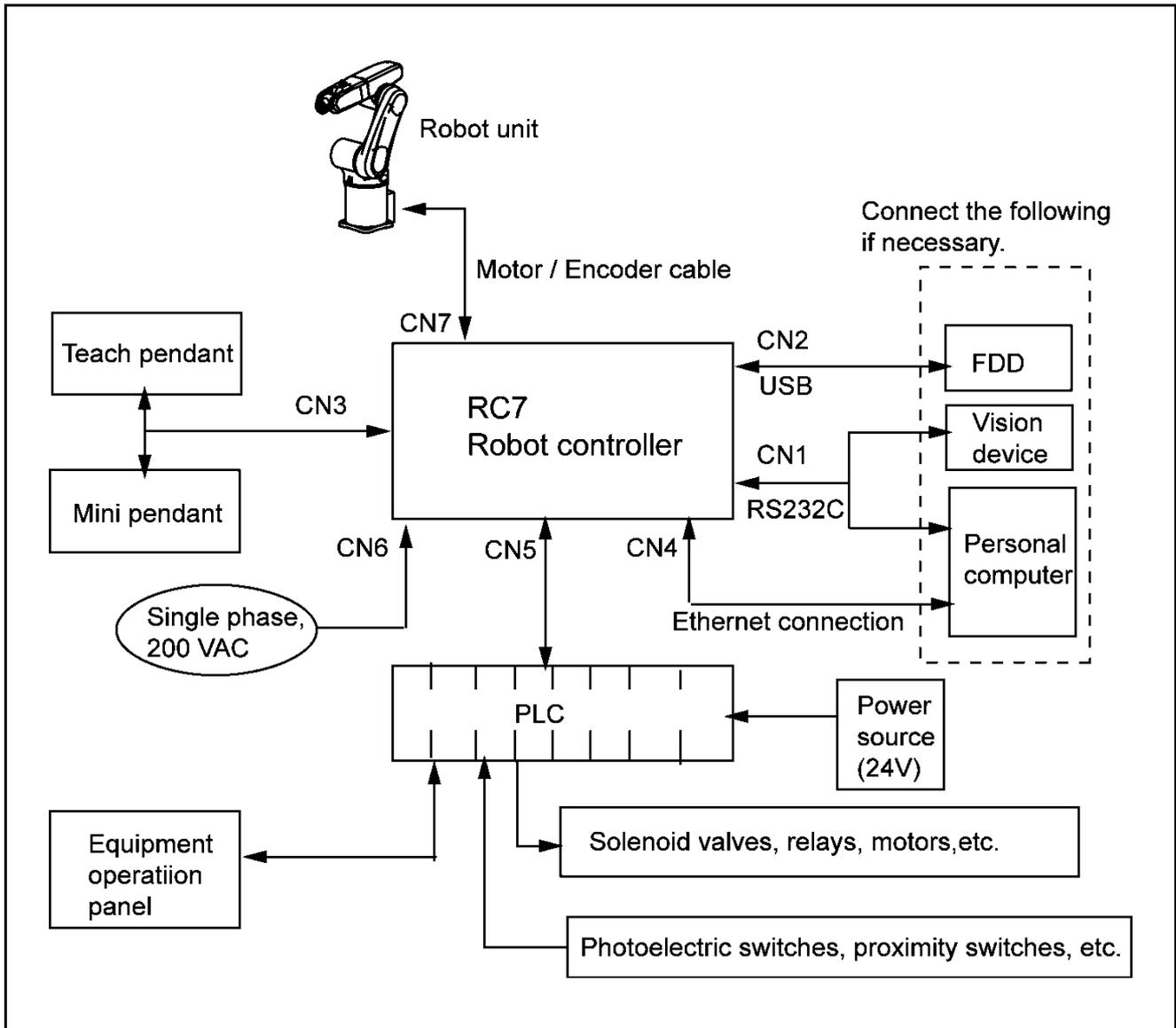
1.4.2 Typical Robot System Configurations

The block diagrams below show typical robot system configurations.

To connect encoders via a time-division multiplexed bus: Connect the robot controller (CN7) to the robot unit with a motor/encoder cable (see below).

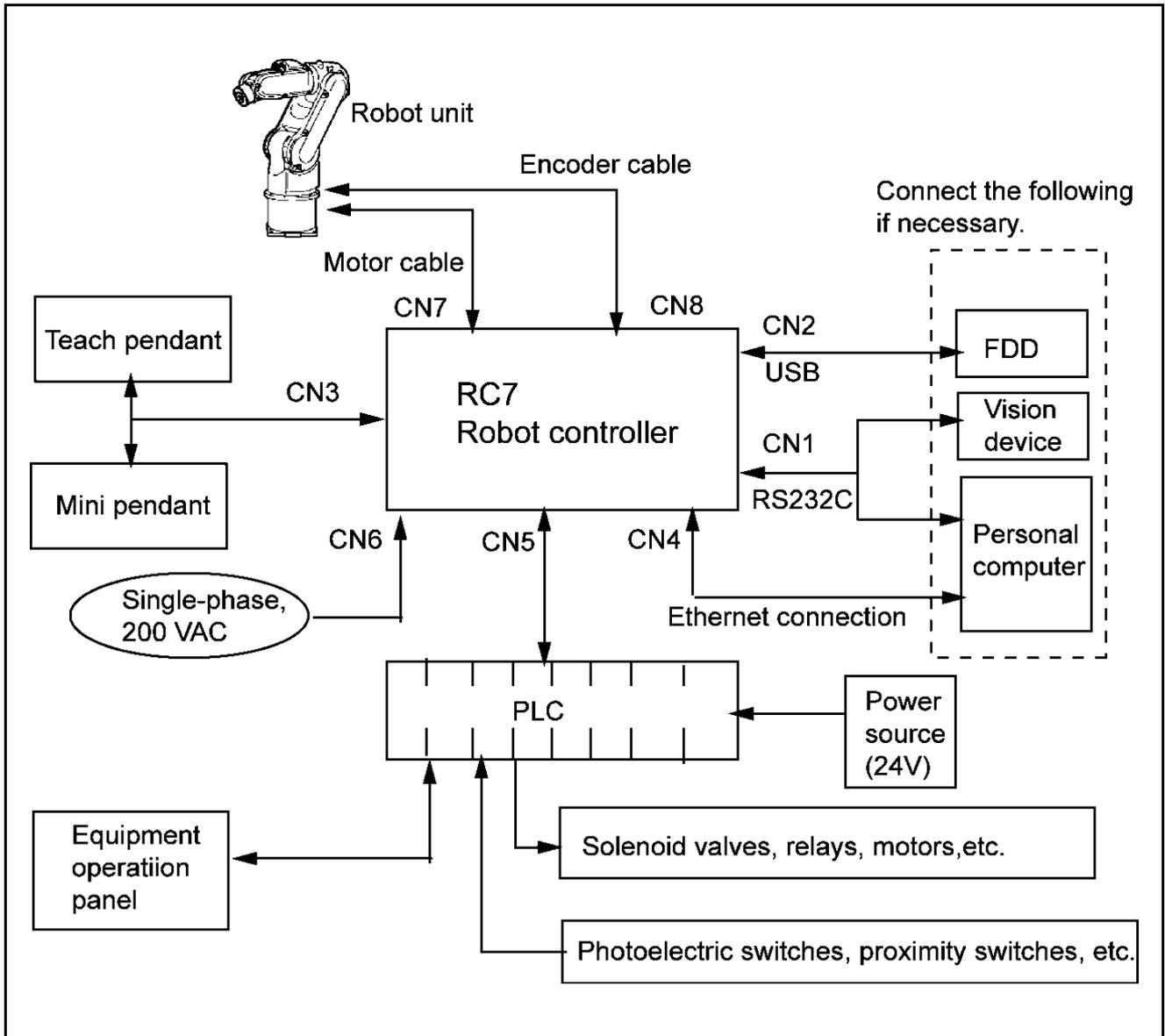
To connect encoders via parallel interface: Connect the robot controller (CN7 and CN8) to the robot unit with a motor cable and encoder cable, respectively.

■ Robot system configuration with encoders connected via a multiplexed bus (Example: VP-F, VS-F and HS-F)



Robot System Configuration with encoders connected via a multiplexed bus (Example)

■ Robot system configuration with encoders connected via a parallel interface
(Example: VC-F)



Robot System Configuration with encoders connected via a parallel interface (Example)

Chapter 2

General Information about the Interface

2.1 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.

2.1.1 Types of System I/O Signals

7 input points for command execution are used to direct program start and other instructions as I/O commands.

The table below lists the types of I/O signals.

Types of System I/O Signals

Fixed by system		
Type	No. of points	Function
System input	4	Robot stop 1, Robot stop 2, Enable Auto, step stop (all tasks)
System output	11	Robot initialization complete, automatic operation mode, robot-in-operation, normal CPU, robot failure, Operation preparation completed, dead battery warning, emergency stop 1, emergency stop 2, deadman 1, deadman 2
Input for command execution	7	Command (3 bits) data area (3 bits), strobe signal
Output for command execution	1	Command processing complete
Controlled by user program		
Type	No. of points	Function
User input	8	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	8	Outputs to issue a signal to the external device during program execution with a SET command, RESET command, etc.

2.2 Using User I/O Signals

User I/O signals are used as I/O type variables. Access the user I/O by writing it to the I/O type variables or reading it.

2.2.1 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.

2.2.2 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

2.2.3 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 (I), Chapter 9, Section 9.7 "DEFIO (Statement) [Conforms to SLIM]."

2.2.4 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.

- **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 (I), Chapter 13, Section 13.1 "IN."

- **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 (I), Chapter 12, Section 12.5 "WAIT."

2.2.5 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.

- **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 (I), Chapter 13, Section 13.1 "SET."

- **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 (I), Chapter 13, Section 13.1 "RESET."

- **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 (I), Chapter 13, Section 13.1 "OUT."

Chapter 3 System I/O Signals

3.1 Types and Functions of System Output Signals

The table below lists the system output signals.

Types and Functions of System Output Signals

Application	Signal name	Function
Teaching	Deadman (1, 2) output (dual lines)	Outputs while pushing the Deadman-switch (ON).
Start-up	Robot initialized	Outputs to the external device that the "Operation Preparation" command is usable.
	Auto mode	Outputs when the robot is in Auto mode.
	Operation preparation completed	Outputs when preparations for operation are ready to start.
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.
	Dead battery warning	Outputs when the voltage of the encoder back-up battery or memory back-up battery dangerously low.
Emergency stop	Emergency stop (1, 2) output (dual lines)	Outputs from a contact exclusively designed for an emergency stop circuitry.

3.2 Usage of System Output Signals

The usage of each system output signal is described below:

3.2.1 Robot initialized (Output)

(1) Function

The signal outputs to the external device that the "Operation Preparation" command is ready to execute from the device.

(2) Terminal number

No.48 of connector CN5

(3) Usage

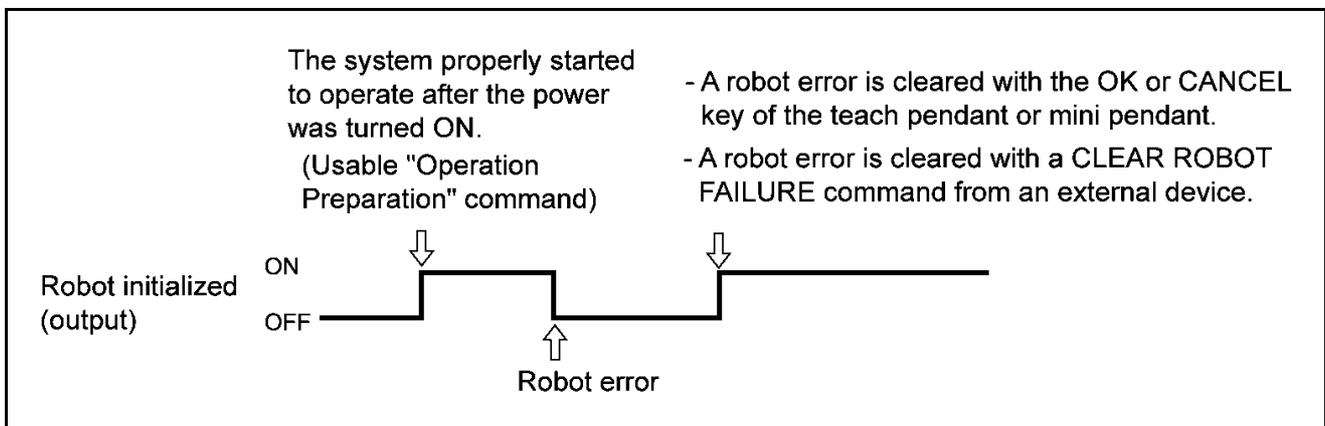
The "Operation Preparation" command will be executed as soon as this signal and the auto mode signal are turned ON, after the power is turned ON.

(4) ON conditions

- (a) The signal will be turned ON when the system program for the Robot Controller normally starts, after the power, is turned ON and the "Operation Preparation" command is ready to execute.
- (b) The signal will be turned ON when a robot failure is cleared by the CANCEL key of the teach pendant, mini 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 signal is turned ON.



Robot Initialized (Output)

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.49 of connector CN5

(3) Usage

Starting the program from the external device requires the "Operation Preparation" command input and the "Program Start" command input. The signal is used to monitor the auto mode output signal and determine whether to execute the command.

(4) ON condition

The Enable Auto ON is input and the signal will be output when the robot enters auto mode by setting the mode selector switch of the teach pendant or mini pendant to AUTO.

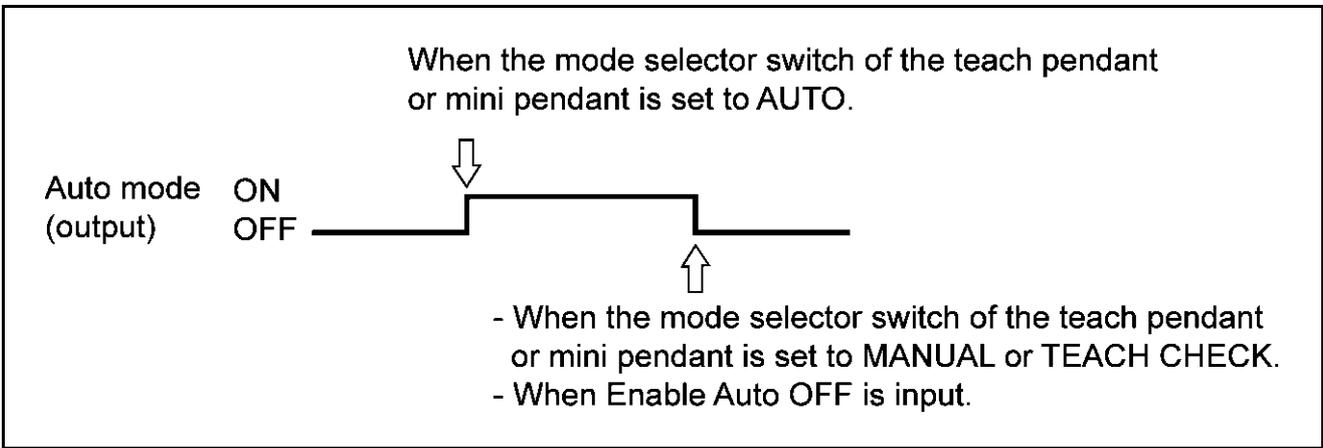
(5) OFF conditions

The signal will be turned OFF under the following conditions.

- (a) The teach pendant or mini pendant is set to MANUAL or TEACH CHECK.
- (b) The Enable Auto OFF is input..

(Note: The signal will not be turned OFF in the pendantless state described in the OPTIONS MANUAL, Chapter 1, Subsection 1.3.3.)

Caution: The signal will not be turned OFF with INSTANTANEOUS STOP, STEP STOP or CYCLE STOP commands.



Auto mode (Output)

3.2.3 Operation preparation completed (Output)

(1) Function

The signal output to the external device that the robot is in external mode and the motor power is ON.

(2) Terminal number

No50 of connector CN5

(3) Usage

Starting the program from the external device requires an EXTERNAL AUTO MODE input and a MOTOR ON input. The signal is used to confirm that the robot can be run in external mode.

(4) ON conditions

The signal will be turned ON under the external auto mode and motor ON.

Operation turned to External Auto Mode

- (a) When the external mode is selected on the teach pendant or mini pendant.
- (b) When the external mode is turned ON by the "Operation Preparation" command from the external device.

Operation turned to MOTOR ON

- (a) When the motor key is pushed on the teach pendant or mini pendant.
- (b) When the motor is turned ON by the "Operation Preparation" command from the external device.

(5) OFF conditions

The signal will be turned OFF under the following conditions;

- Out of the External Auto Mode
- Under the motor OFF.

Operation turned to out of the External Auto Mode

- (a) When internal mode is selected on the teach pendant or mini pendant.
- (b) When the mode selector switch of the teach pendant or mini pendant is set to MANUAL or TEACH CHECK in external mode.
- (c) When ROBOT STOP is input.
- (d) When ROBOT FAILURE is outputted. (Except level 2 error)
- (e) When an Enable Auto input is turned OFF.

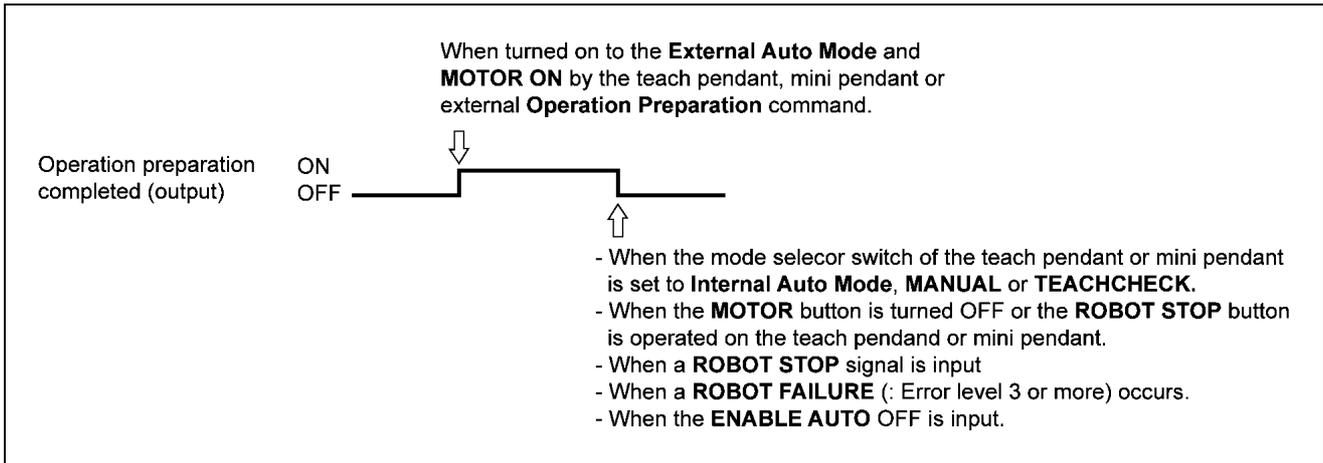
Operation turned to the motor OFF

- (a) When the Motor Key is turned OFF or the Robot Stop button is pushed on the teach pendant or mini pendant.
- (b) When the "Robot Failure" outputs.

Note: If ERROR 6071 to 607B, 6671 to 667B or 607F occurs in the MANUAL mode or TEACH CHECK mode, the motor power is not turned OFF.

(6) Note for software version 2.00 or later

To get the "Operation preparation completed" status using "SYSSTATE" command, AND Bit 2 "Servo ON" and Bit 5 "External mode" to use the result of the logical operation.



Operation preparation completed (Output)

3.2.4 Robot-in-operation (Output)

(1) Function

This signal outputs to the external device that the robot is in operation.

(2) Terminal number

No.46 of connector CN5

(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.

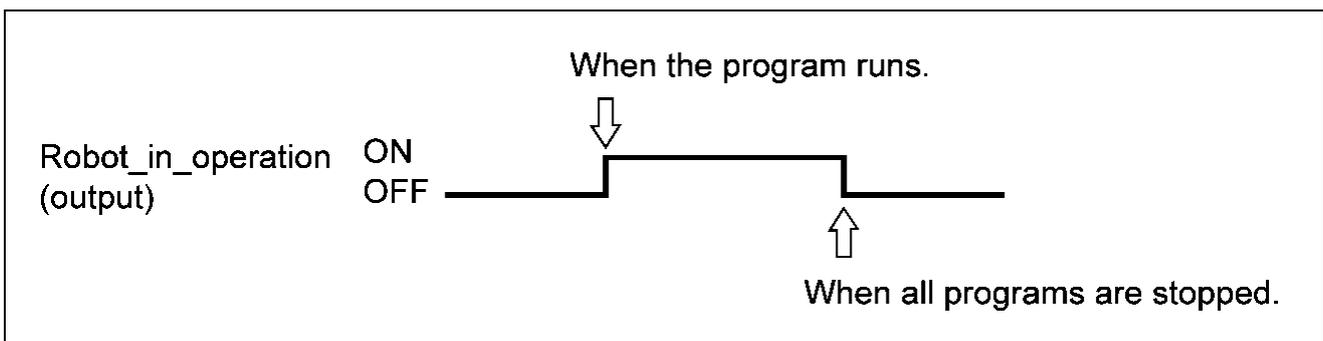
(4) ON conditions

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.

Caution: STOP ALL PROGRAMS means the operation of the ROBOT STOP or STOP button of the teach pendant or mini pendant and INSTANTANEOUS STOP (ALL TASKS), STEP STOP (ALL TASKS) and ROBOT STOP inputs.



Robot-in-operation (Output)

3.2.5 Normal CPU (Output)

(1) Function

The signal outputs to the external device that the Robot Controller CPU (hardware) is normal.

(2) Terminal number

No.45 of connector CN5

(3) Usage

- (a) The signal is used to light the Robot Controller external operating panel error indicator lamp.
- (b) The signal is used when a normal CPU SIGNAL is turned OFF because of an error and the PLC corrects it.

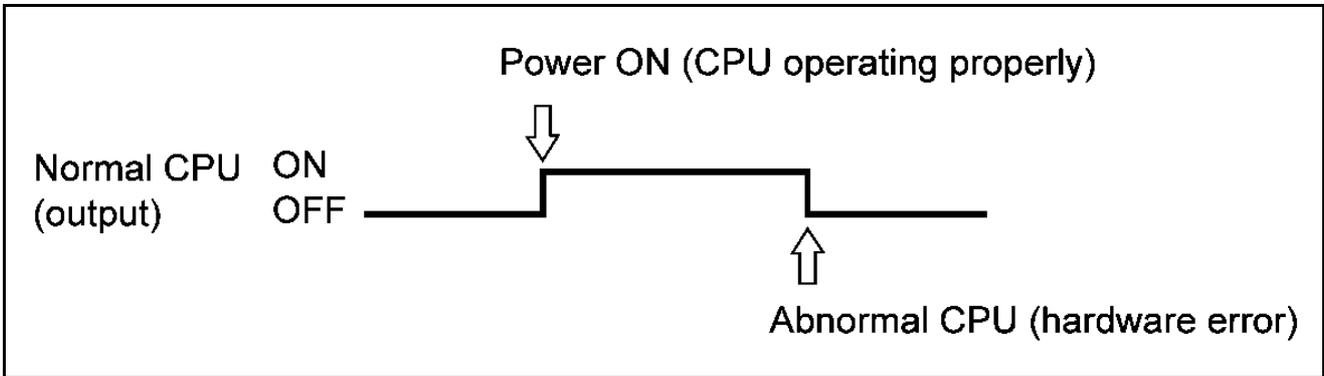
(4) ON conditions

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.



Normal CPU Output

3.2.6 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.47 of connector CN5

(3) Usage

- (a) The signal is used to light the robot external operating panel error indicator lamp of an.
- (b) The signal is used to help the PLC clear an error in response to a ROBOT FAILURE signal.

(4) ON conditions

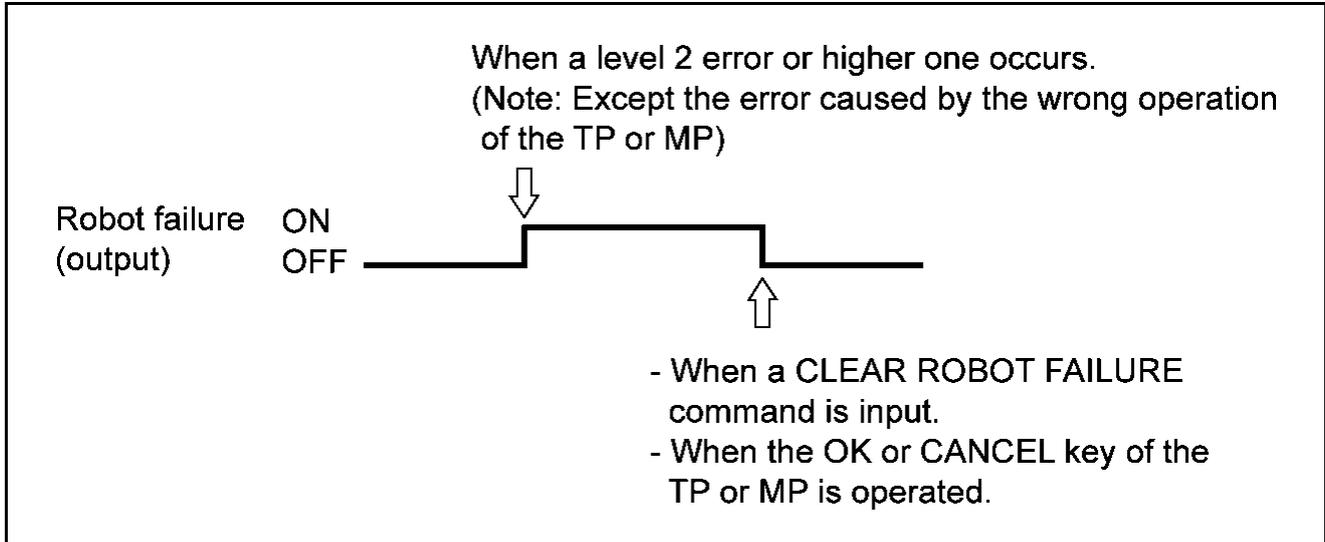
When a level 2 error or higher one occurs.

Note: Except the error caused by the wrong operation of the teach pendant or mini pendant.

(5) OFF conditions

As shown below, the signal will be turned OFF under the following conditions.

- (a) When a CLEAR ROBOT FAILURE command is inputted and the existing error is cleared.
- (b) When the existing error is cleared by operating the **OK** or **Cancel** key on the teach pendant or the mini pendant.



Robot Failure (Output)

3.2.7 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.51 of connector CN5

(3) Usage

The signal is used to check the timing battery replacement. For example, the battery voltage becomes lower than acceptable.

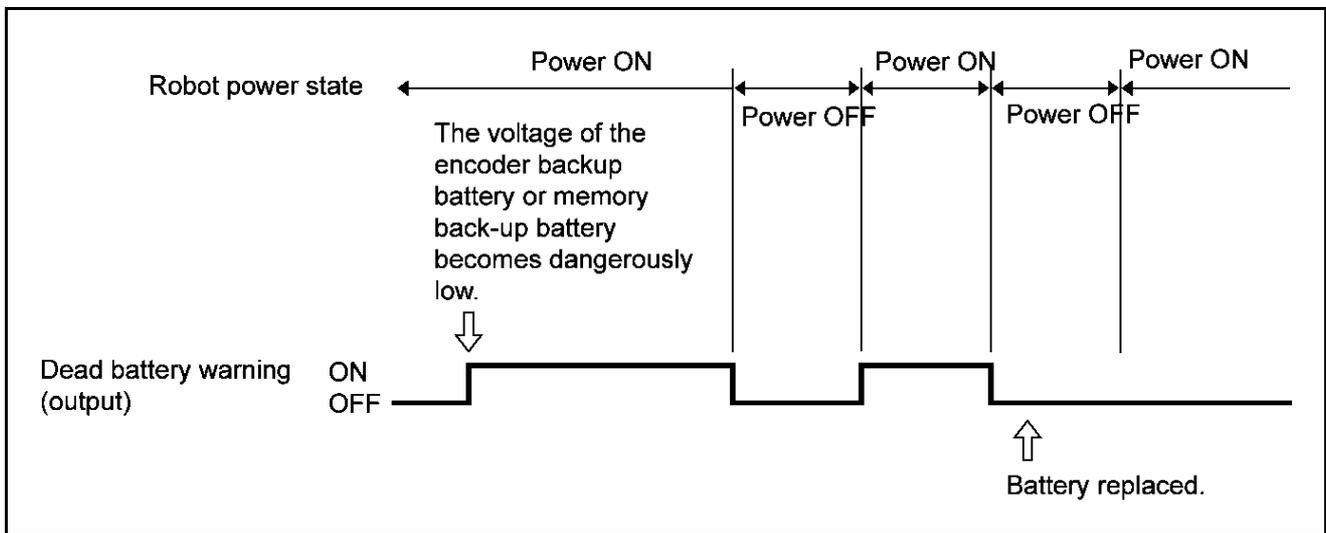
(4) ON condition

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.

(5) OFF condition

The signal will be turned OFF when the power is turned ON after the dead battery was replaced.



Dead Battery Warning Output

3.2.8 Continue Start Permitted (Output): Selectable by I/O hardware setting

The port No.24 output is selectable to "Continue Start Permitted" or "User output" by the I/O hardware setting. Default shipped from the factory is set to "User output".

When the "Continue Start Permitted" setting:

(1) Function

The controller will output this signal when the continue start is permitted.

(2) Terminal number

No.53 of connector CN5

(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."

3.2.9 Emergency Stop (1, 2) Output (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 teach pendant and on the mini pendant to be used as emergency stop buttons of the facilities. A 0.3A fuse is built in the controller.

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.

(2) Terminal number

Emergency Stop 1

No. 6 of connector CN5: Emergency stop (+)

No. 40 of connector CN5: Emergency stop (-)

Emergency Stop 2

No. 7 of connector CN5: Emergency stop (+)

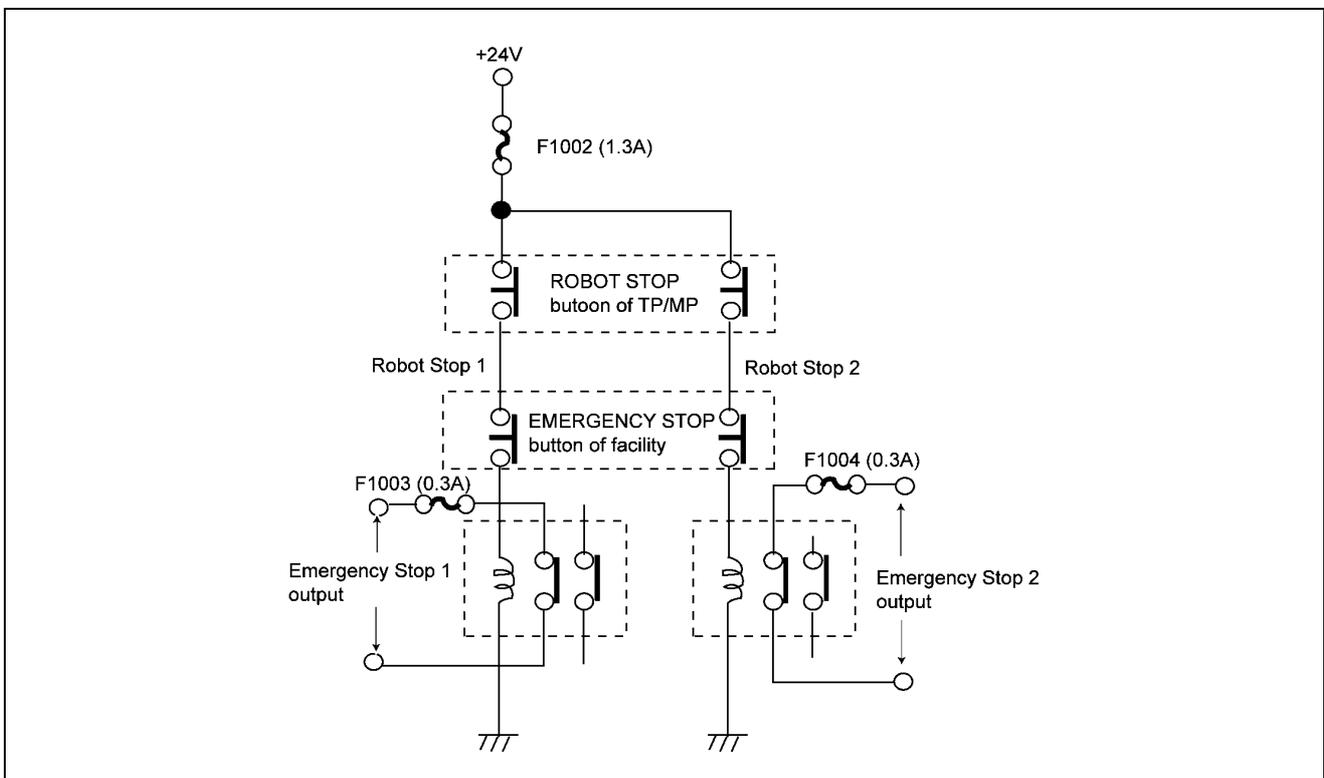
No. 41 of connector CN5: Emergency stop (-)

(3) Usage

This signal is used to stop the facilities or robot in an emergency. (Refer to Subsection 4.2.3 "Emergency Stop Circuit.")

(4) ON condition of Emergency Stop output (:OFF condition from contact) (B contact: Normal close type contact)

When the emergency stop button of the facility or teach pendant is pushed, the emergency stop signal turns ON.



Emergency Stop 1, 2 Output

3.2.10 Deadman (1, 2) Output (Output from a contact)

(1) Function

While the Deadman-switch on the teach pendant or mini pendant is pushed, the ON signal outputs from the contact.

(2) Terminal number

Deadman 1 output

Note: The mini pendant is connected to the controller, the Deadman 1 output cannot be used.

No. 8 of connector CN5: Emergency stop (+)

No. 42 of connector CN5: Emergency stop (-)

Deadman 2 output

No. 9 of connector CN5: Emergency stop (+)

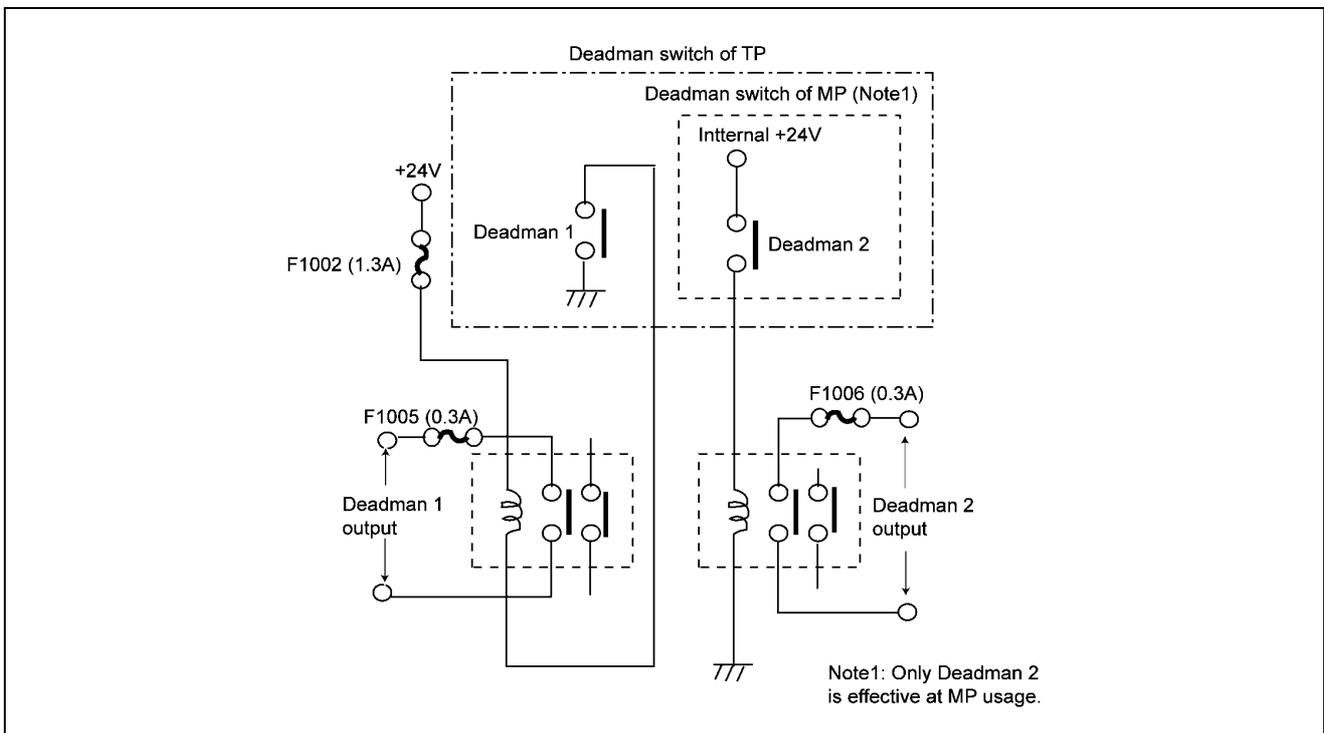
No. 43 of connector CN5: Emergency stop (-)

(3) Usage

Refer to Subsection 4.2.3 "Emergency Stop Circuit."

(4) ON condition of Deadman output (:ON condition from contact)

When the Deadman switch of the teach pendant or mini pendant is pushed, the Deadman output relay turns ON and ON signal outputs.



3.3 Types and Functions of System Input Signals

The table below lists the system input signals.

Types and Functions of System Input Signals

Application	Signal Name	Function
Start-up	Enable Auto	Enables switching to automatic operation.
Stop	Robot stop	Stops the robot with canceling signals.
	Step stop (all tasks)	Step-stops all programs being executed with canceling signals.

3.4 Usage of System Input Signals

The usage of each system input signal is described below.

3.4.1 Enable Auto (Input)

(1) Function

- (a) The signal enables switching of the robot mode to auto mode (shorted state).
- (b) The signal enables switching of the robot mode to manual mode or teach check mode (open state).

(2) Terminal number

No.35 of connector CN5.

(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

- (a) As shown below, the selectable operation mode depends on whether this input is shorted or open.
- (b) If the input becomes open during automatic operation, the mode will be switched to manual mode and ERROR21FC will be displayed.
- (c) If manual operation or a teach check is conducted with this input shorted, ERROR21F2 will be displayed.

- (d) 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 the table below, this error will remain displayed until the robot exits this state.
- (e) 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 ○.
- (f) When the input is turned OFF (open) in external mode, the external mode output will also be turned OFF.

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, 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:

- (a) Set the robot so that it will not start to operate when the Enable Auto input is open.
- (b) Enable Auto input open state and auto mode output (See Subsections 3.2.2 "Auto Mode".)
 Set the equipment to make an emergency stop in an AND state.
 Add (a) and (b) with the external sequence circuit.

3.4.2 Robot Stop 1, 2 (Input)

(1) Function

- (a) The signal stops the robot from the external device by opening the robot stop input.
- (b) The signal readies the power to the robot motor to be turned ON by shorting the robot stop input.

(2) Terminal number

Robot Stop 1: No.36 of connector CN5.

Robot Stop 1: No.37 of connector CN5.

(3) Input conditions and operation

- (a) The robot stops with this input OFF (open).
- (b) The power to the robot motor is made ready to be turned ON with this input ON (shorted).
- (c) 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.)
- (d) 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.)
- (e) Opening the ROBOT STOP input and pressing the **ROBOT STOP** button of the teach pendant or the mini pendant, function is the same.

(4) Timing of the input

This input will be processed prior to all commands and input signals.

3.4.3 Step Stop (All Tasks) (Input)

(1) Function

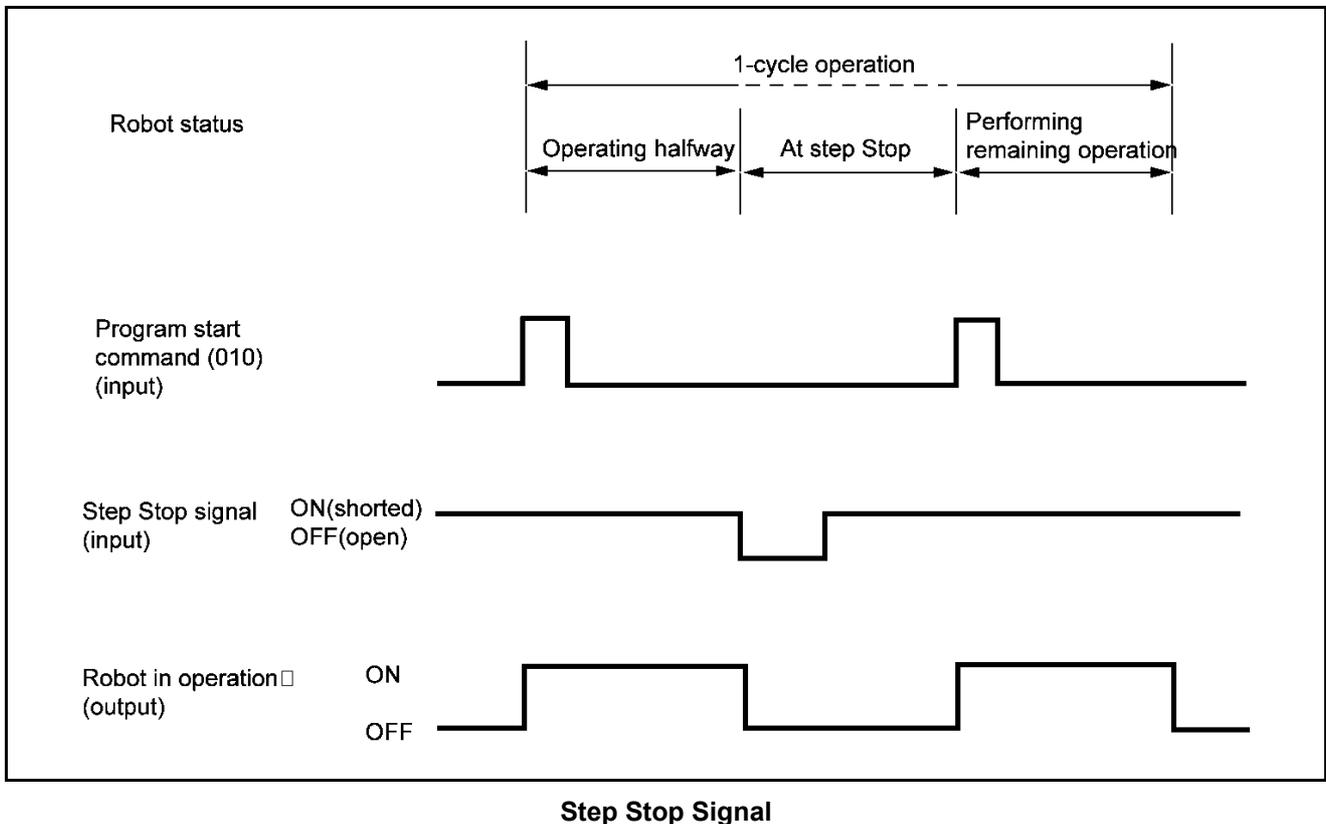
Input this signal to step-stop the program being executed from the external device. All tasks will be step-stopped.

(2) Terminal

No.11 of connector CN5.

(3) Input conditions and operation

- (a) 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 the figure given below.
- (b) For resuming the program after a step stop, see Chapter 3, Subsection 3.5.3.2 "Operation Preparation (000)".



3.5 Command Execution I/O Signals

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.
- Enable running the robot from the external device.
- Clear the robot failure.

3.5.1 General Information about Commands

The table below shows the I/O commands functions.

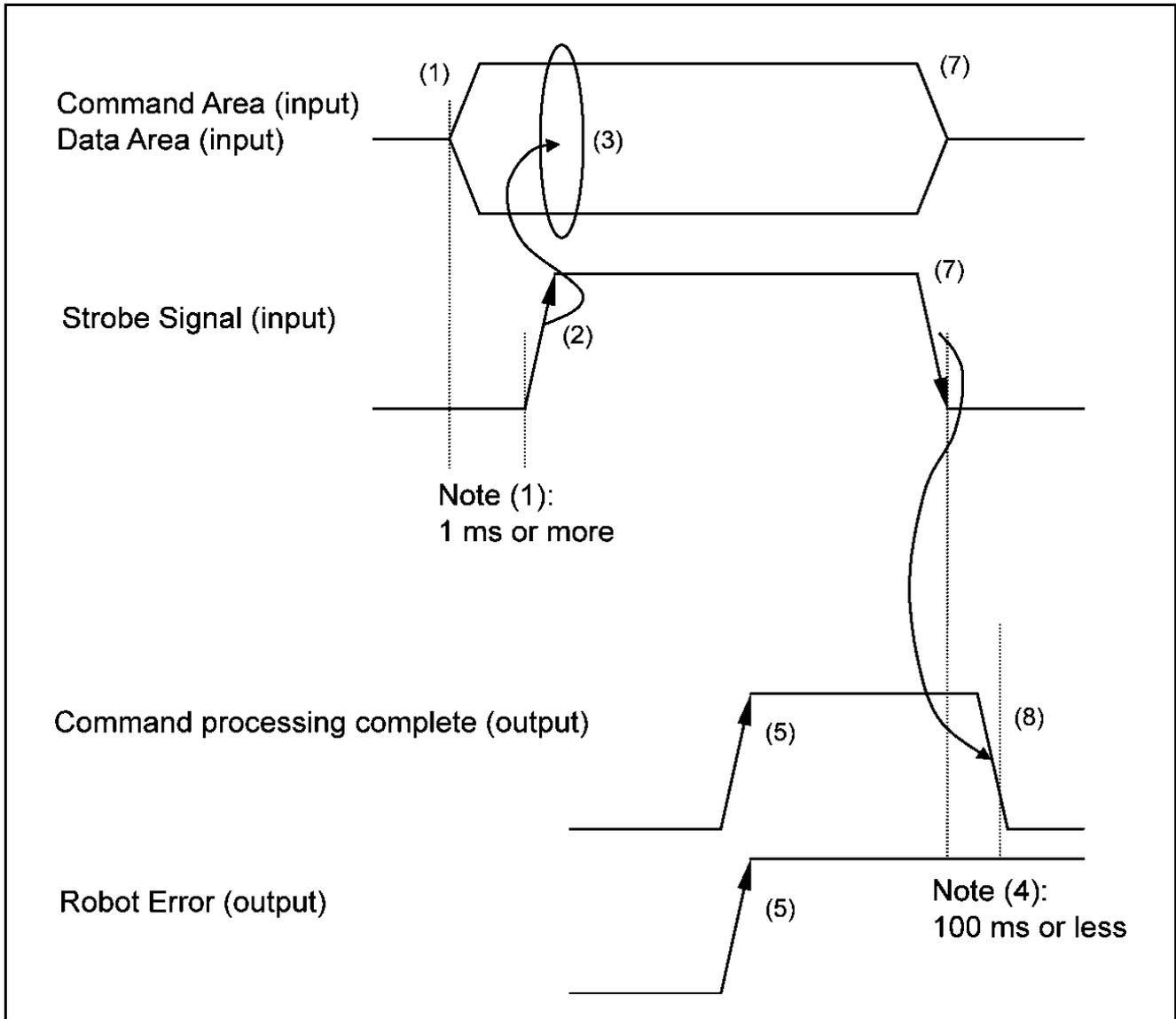
I/O Command Functions

Command	Description of function
Program operation	<ul style="list-style-type: none">· Starts the program cycle (specified program).· Step-stops the program (specified program/all programs).· Resets the program (specified program/all programs).
Operation preparation	<ul style="list-style-type: none">· Enables running the robot from the external device.
Clear robot failure	<ul style="list-style-type: none">· Clears a robot failure from the external device.

3.5.2 Processing I/O Commands

3.5.2.1 General Information about Processing

I/O commands to be executed are processed as shown below.



Outline of I/O Command Processing

- (1) Set a command area and a data area (if necessary) 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 ms before the strobe signal is turned ON.
(2) Perform command input with a strobe signal after the system output signal "Robot initialized" is output. But, if you execute the "Clear robot failure" command, the "Robot initialized" does not output. If the "Robot Error" is output, execute the "Clear robot failure" command.

- (3)The controller reads the command area and the data area as the strobe signal is input.
- (4)The controller starts processing based on the command it read.
- (5)After command processing has been completed, 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.
- (6)The PLC waits until the command processing complete signal is input. In this case, confirm that no error exists with the robot.
- (7)The PLC turns OFF the command and data areas and the strobe signal.
- (8)As soon as the strobe signal is turned OFF, the controller turns OFF 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 command processing complete signal are turned OFF, after the strobe signal is turned OFF in (7), is 100 ms.
(4)If the strobe signal is turned OFF before the command processing complete signal is turned ON in (5), the command processing complete signal will be output and then turned OFF within 100 ms.

3.5.2.2 Using Each Signal Line

[1] Command and Data Areas

This section describes the usage of the command area (3 bits, input) and data area (3 bits, input).

(1) Function

Specifies the commands to be executed by the Robot Controller.
Sets the command area at all times, and data area if necessary.

(2) Terminal numbers

Command area: No.16 to No.18 of connector CN5.
Data area: No.13 to No.15 of connector CN5.

(3) Input conditions and operation

- (a)Set the command area whenever I/O commands are to be executed. Set data for data area if commands require them.
- (b)"Shorted" represents the bit value = 1.
"Open" represents the bit value = 0.
- (c)Input the command area and data area before the strobe signal (1 ms or more). Retain the status until the command processing complete signal is output.

[2] Strobe Signal (Input)

(1) Function

This signal informs the Robot Controller that the command area and data area have been set. Additionally it directs the start of command processing.

Caution: Perform command (Except CLEAR ROBOT FAILURE) input with a strobe signal after the system output signal ROBOT INITIALIZATION COMPLETE is output.

(2) Terminal number

No.12 of connector CN5.

(3) Input conditions and operation

By turning ON this input in automatic or external mode, the robot controller reads the command area and data area, and starts processing.

[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.12 of connector CN5.

(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

- (a)The signal will be turned ON upon completion of processing the I/O command given.
- (b)If an error occurs as a result of executing an I/O command, the robot failure signal and the command processing complete signal will be turned simultaneously ON.

(5) OFF conditions

- (a)The signal will be turned OFF when the strobe signal is turned OFF.
- (b)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 ms.

3.5.3 I/O Commands Details

3.5.3.1 List of I/O Commands

The table below lists I/O commands.

List of I/O Commands

Command area	Data area
000 Operation Preparation	001 Motor ON, CAL execution 010 External speed 100 100 External mode switching 111 Execution of all above (Motor ON→CAL→SP100→External)
001 Clear robot failure	—
010 Program start	Program number
011 Continue start	—
100 Specified program reset	Program number
101 All programs reset	—

3.5.3.2 Operation Preparation (000)

(1) Function

Prepares to operate the robot by switching the operation mode from the external devices.

(2) Format

Command area (3 bits, input)

000

Data area (3 bits, input)

0 bit: Motor ON, CAL execution

1 bit: External speed 100

2 bit: External mode switching

These bits can be set at the same time and can be executed. If plural bits are set, the commands are executed in order.

For example: If the 0 bit, 1 bit and 2 bit are set, commands are executed as follows;

Motor ON, CAL execution, External speed 100 and External mode switching

(3) Explanation

This command can be executed in the auto mode. In other mode, an error occurs at execution. When executing this command, select the internal auto mode on the teach pendant or mini pendant.

3.5.3.3 Clear Robot Failure (001)

(1) Function

This command clears a robot failure that has been caused.

(2) Format

Command area (3 bits, input)
001

Data area (3 bits, input):
Nothing will be input.

(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 teach pendant or the mini pendant is operated will be performed.

3.5.3.4 Program start (010)

(1) Function

This command starts the specified program in the data area.

(2) Format

Command area (3 bits, input)
010

Data area (3 bits, input)
Program number: Program number to be started.
If the specified number is "n", PRO n starts.

(3) Description

This command is executable only in external mode. An error will occur in other modes. This command starts the program of the program number specified in data area. PRO 0 to PRO 7 can be started.

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 instantaneously stopped (Halt), 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.

3.5.3.5 Continue start (011)

(1) Function

This command starts the Continue start.

(2) Format

Command area (3 bits, input)
011

Data area (3 bits, input):
Nothing will be input.

(3) Description

This command is executable only in external mode. An error will occur in other modes.

If executing this command when the Continue Start Permitted signal is off, an error (ERROR 27A8) occurs.

3.5.3.6 Specified program reset (100)

(1) Function

This command immediately stops and also initializes the program of the program number specified in data area.

(2) Format

Command area (3 bits, input)
100

Data area (3 bits, input):
Program number: The program number to be reset.
If the number "n" is specified in data area, resets PRO n.

(3) Description

This command can reset the programs for PRO 0 to PRO 7.

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 (halt), it will be initialized. The initialized program will resume from the beginning.
- When the specified program is running, it will immediately stop (halt) and also be initialized. If started after the stop, the stopped program will resume from the beginning.

3.5.3.7 All programs reset (101)

(1) Function

This command immediately stops all programs and also initializes them.

(2) Format

Command area (3 bits, input)
101

Data area (3 bits, input):
Nothing will be input.

(3) Description

This command can reset all programs.

One of the following operations takes place according to the operating status of the program.

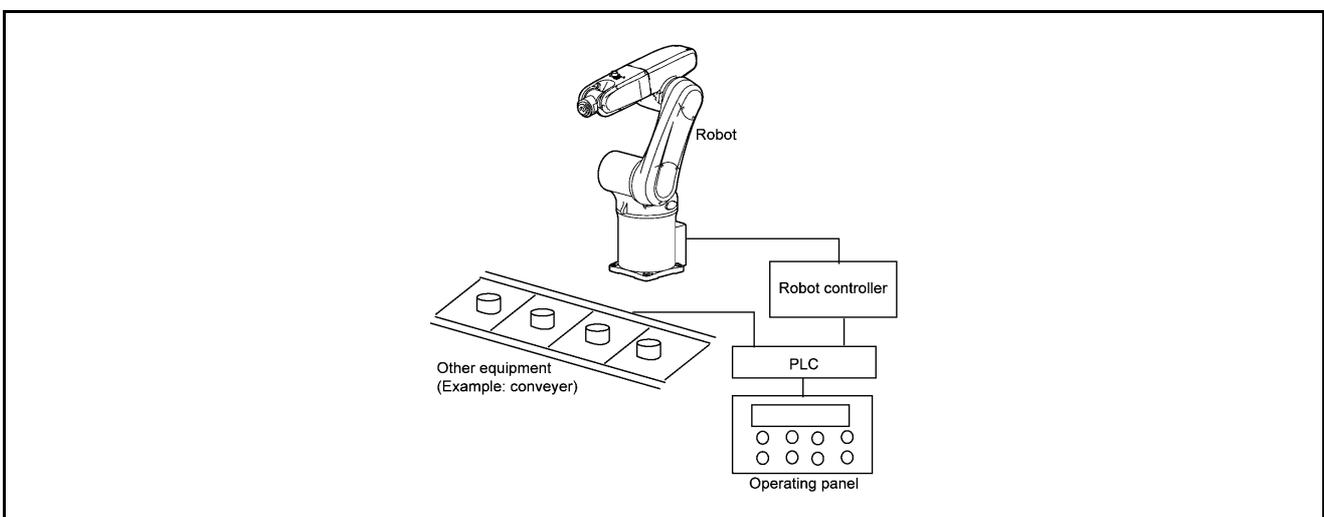
- When the specified program is terminated (stopped), nothing will happen.
- When the specified program is step-stopped or immediately stopped (halt), it will be initialized. The initialized program will resume from the beginning.
- When the specified program is running, it will immediately stop (halt) and also be initialized. If started after the stop, the stopped program will resume from the beginning.

3.6 Example of Using System I/O Signals

This section illustrates an example of starting and stopping the robot using system I/O signals.

(1) Equipment setup example

This example shown below assumes an equipment setup which allows you to run the robot by operating an external equipment's operation panel connected via the PLC to the robot controller. It is assumed that the operation panel has a display, lamps and switches listed on the next page.



Example of Equipment Setup Using a Robot

Function Example of Equipment Operating Panel

Classification	Part	Application
Display	Display	Displays messages, such as ROBOT PREPARATION OK.
Lamp	(1) Automatic operation indicator	- Lights during automatic operation. - Turned OFF when the robot is not in automatic operation.
	(2) Robot external running OK indicator	- Lights when the Operation Preparation Completed signal is ON. - Turned OFF when the Operation Preparation Completed signal is OFF.
	(3) Operation OK indicator	- Lights when the Enable Auto signal is ON. - Turned OFF when the Enable Auto signal is OFF.
	(4) Robot home position indicator	- Lights when the robot is in the home position for working. - Turned OFF when the robot is out of the home position for working. (By programming with an user-output)
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.
Caution: Actual equipment requires emergency stop, interlock and other functions; however, described here are the necessary functions.		

(2) Outline of procedure

Described below is the outline of the procedure when using the equipment taken as an example shown on the previous page.

Follow steps (a) to (d).

(a) Operation preparation

The Operation Preparation command brings to be able to operate the robot into external automatic operation mode. This operation will be completed when the Operation Preparation Completed signal is turned ON.

(b) Operation start area check

When the robot arm is in the home position for working, the robot home position indicator lights and "ROBOT PREPARATION OK" displays.

(c) Automatic operation

Start the program by which the robot starts from the home position for working, performs operations, and returns to the home position.

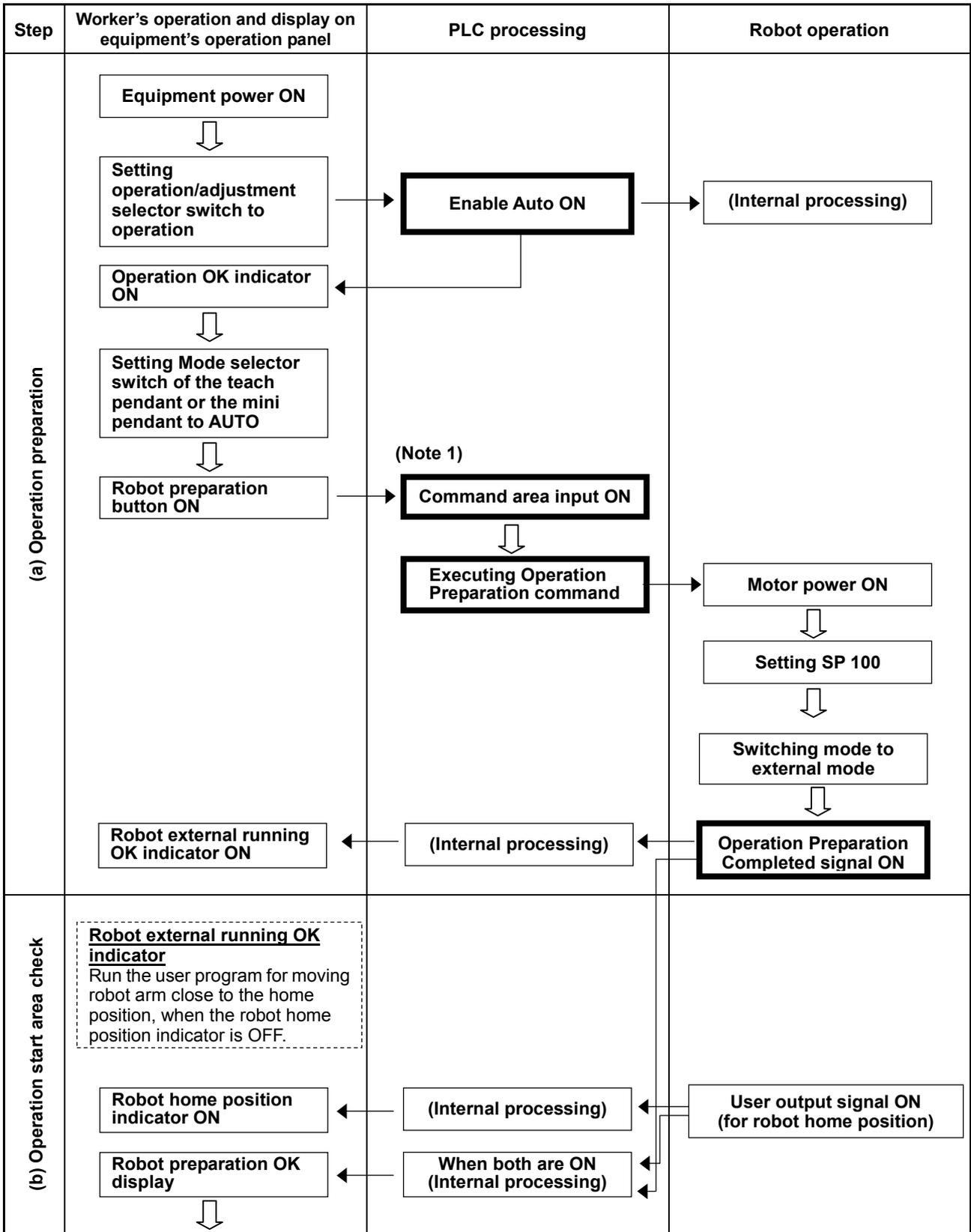
(d) Operation end

Terminate the day's operations with a cycle stop, and turn OFF the power.

(3) Start and stop procedure, and system I/O signals

The following pages show the relationship between the system I/O signals for start and stop, worker's operation, display on the equipment operation panel, PLC proceeding, and robot motion.

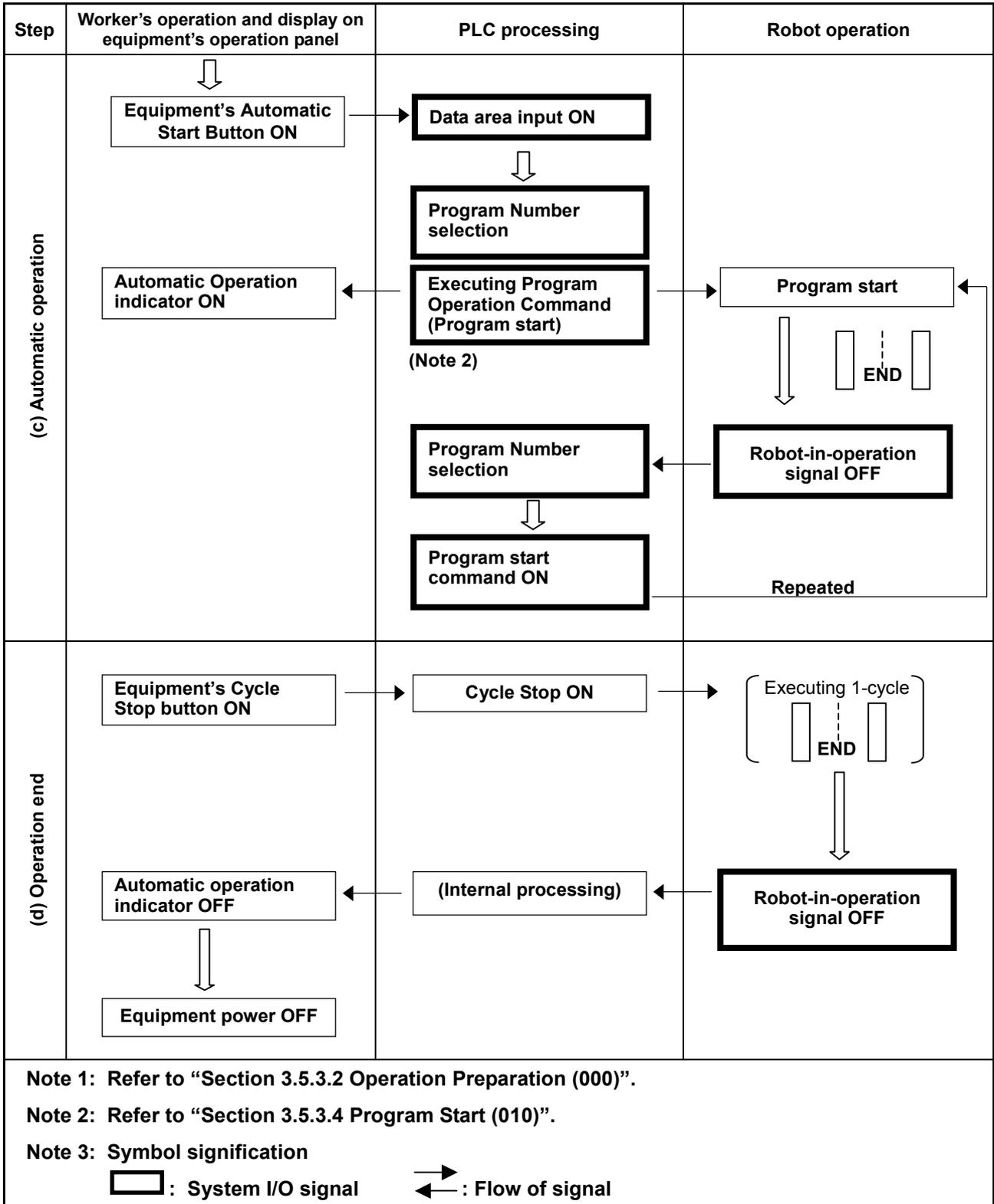
Start and Stop Procedure and System I/O Signals-1



(Continued on following page)

(Continued from preceding page)

Start and Stop Procedure and System I/O Signals-2



Chapter 4

Connector Pin Assignment and I/O Circuits (NPN type)

This chapter explains the connector pin assignment and circuits of NPN type (source input and sink output) on an I/O board. I/O boards designed for the use in Japan are of an NPN type.

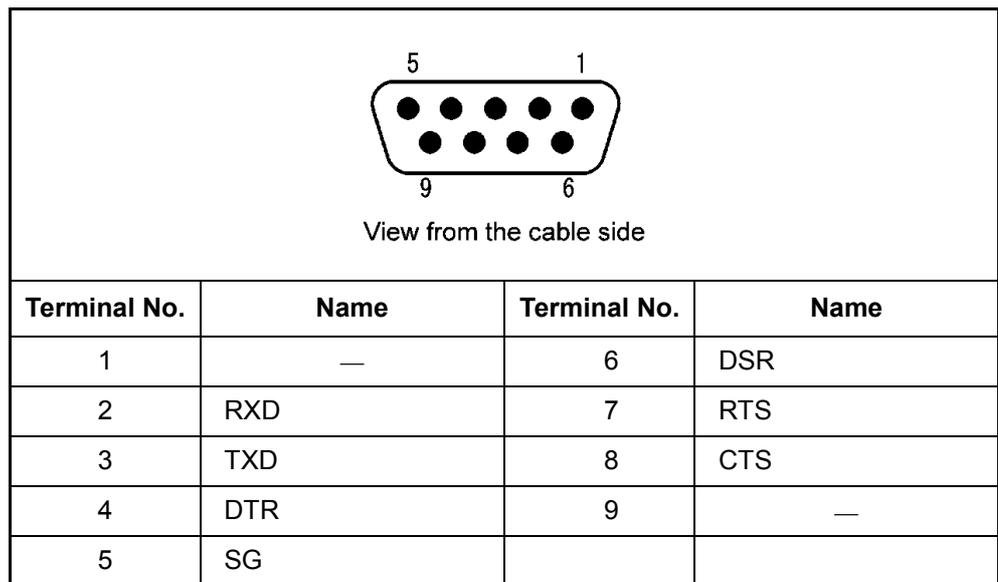
For a PNP type (sink input and source output), refer to Chapter 5, "Connector Pin Assignment and I/O Circuits (PNP type)."

4.1 Connector Pin Assignment (NPN type)

This section describes the pin assignment of I/O connectors on the robot controller.

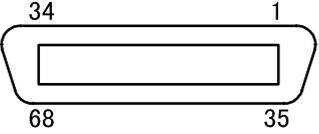
4.1.1 RS232C (CN1): RS232C connector

RS232C (CN1) Pin Assignment



4.1.2 Mini I/O (CN5): User-/System-I/O connector

Mini I/O (CN5) Pin Assignment

 <p>View from the cable side</p>							
Terminal number	Name	Port number	Wire color	Terminal number	Name	Port number	Wire color
1	Power supply for Enable Auto (internal +24V)	—	Black	35	Enable Auto	—	Pink
2	Power supply for Robot stop 1 (Internal +24V), 1b-1	—	Brown	36	Robot stop 1 input, 1b-2	—	Pink
3	Power supply for Robot stop 2 (Internal +24V), 2b-1	—	Red	37	Robot stop 2 input, 2b-2	—	Pink
*4	Reserved (Robot stop 3 input)	—	Orange	*38	Reserved (Robot stop 3 input)	—	Pink
*5	Reserved (Robot stop 4 input)	—	Yellow	*39	Reserved (Robot stop 4 input)	—	Pink
6	Emergency stop 1 output, 1-1	—	Black	40	Emergency stop 1 output, 1-2	—	White
7	Emergency stop 2 output, 2-1	—	Brown	41	Emergency stop 2 output, 2-2	—	White
8	Deadman 1 output, 1-1	—	Red	42	Deadman 1 output, 1-2	—	White
9	Deadman 2 output, 2-1	—	Orange	43	Deadman 2 output, 2-2	—	White
10	Reserved	—	Yellow	44	Reserved	—	White
11	Step-stop (all tasks)	0	Green	45	Normal CPU	16	White
12	Strobe signal	1	Blue	46	Robot in operation	17	White
13	Data area bit 0	2	Violet	47	Robot failure	18	White
14	Data area bit 1	3	Gray	48	Robot initialized	19	White
15	Data area bit 2	4	Pink	49	Auto mode	20	White
16	Command area bit 0	5	Black	50	Operation Preparation completed	21	Gray
17	Command area bit 1	6	Black	51	Dead battery warning	22	Violet
18	Command area bit 2	7	Brown	52	Command processing completed	23	Violet
19	User input	8	Red	53	User output / Continue start permitted	24	Violet
20	User input	9	Orange	54	User output	25	Violet
21	User input	10	Yellow	55	User output	26	Violet
22	User input	11	Green	56	User output	27	Violet
23	User input	12	Blue	57	User output	28	Violet
24	User input	13	Gray	58	User output	29	Violet
25	User input	14	Pink	59	User output	30	Violet
26	User input	15	Brown	60	User output	31	Gray
27	Reserved	—	Red	61	Reserved	—	Gray
28	Reserved	—	Orange	62	Reserved	—	Gray
29	Reserved	—	Yellow	63	Reserved	—	Gray
30	Reserved	—	Green	64	Reserved	—	Gray
31	Reserved	—	Blue	65	Reserved	—	Gray
32	External power input +24V (E24V)	—	Pink	66	External power input 0V (E0V)	—	Gray
33	External power input +24V (E24V)	—	Black	67	External power input 0V (E0V)	—	Blue
34	External power input +24V (E24V)	—	Brown	68	External power input 0V (E0V)	—	Blue

NOTE 1: The optional I/O cable for the above connector consists of twisted pair wires--pairs of #1 and #35, #2 and #36, #34 and #68.

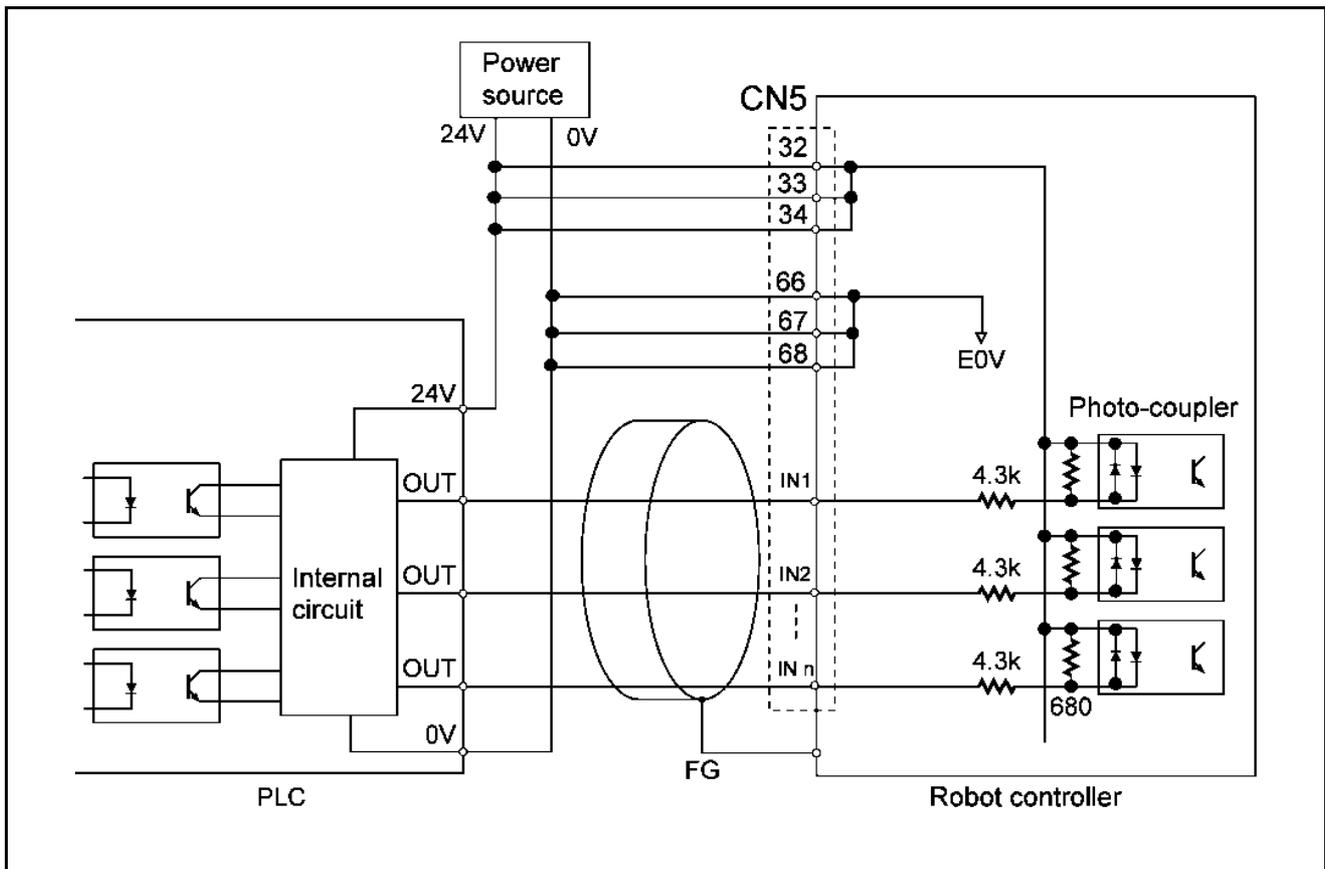
NOTE 2: The terminal number marked with (*) will be used in future.

4.2 Robot Controller I/O Circuits (NPN type)

4.2.1 User-Input and System-Input Circuits (NPN type)

The figure below shows examples of the user-input and system-input circuit configurations and connections of the robot controller.

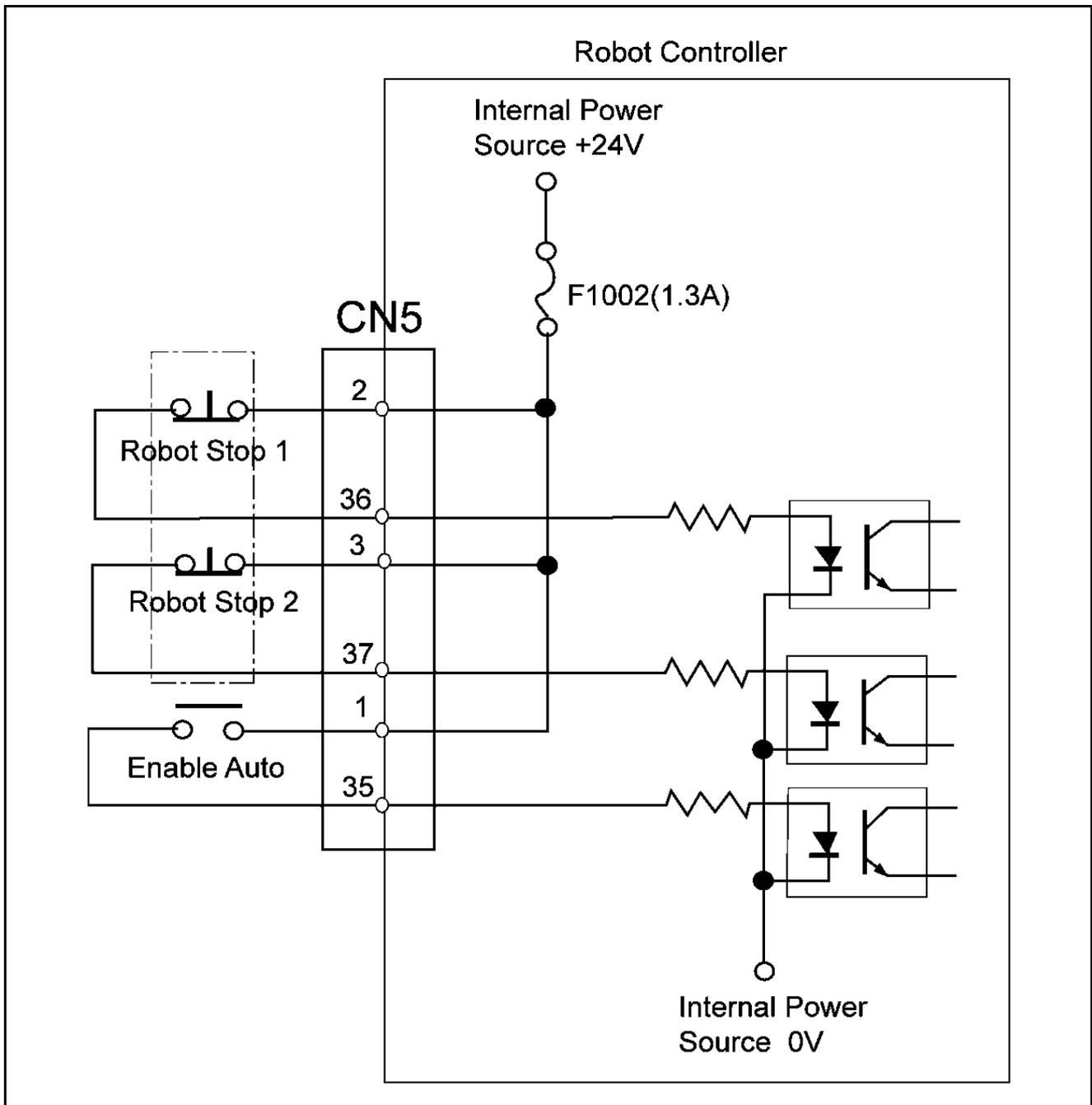
Caution: Use a multi-core shielding cable for the purpose of protecting the Robot Controller from noise. Ground it to the Robot Controller.



User-Input and System-Input Circuits (NPN type)

4.2.2 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 below.



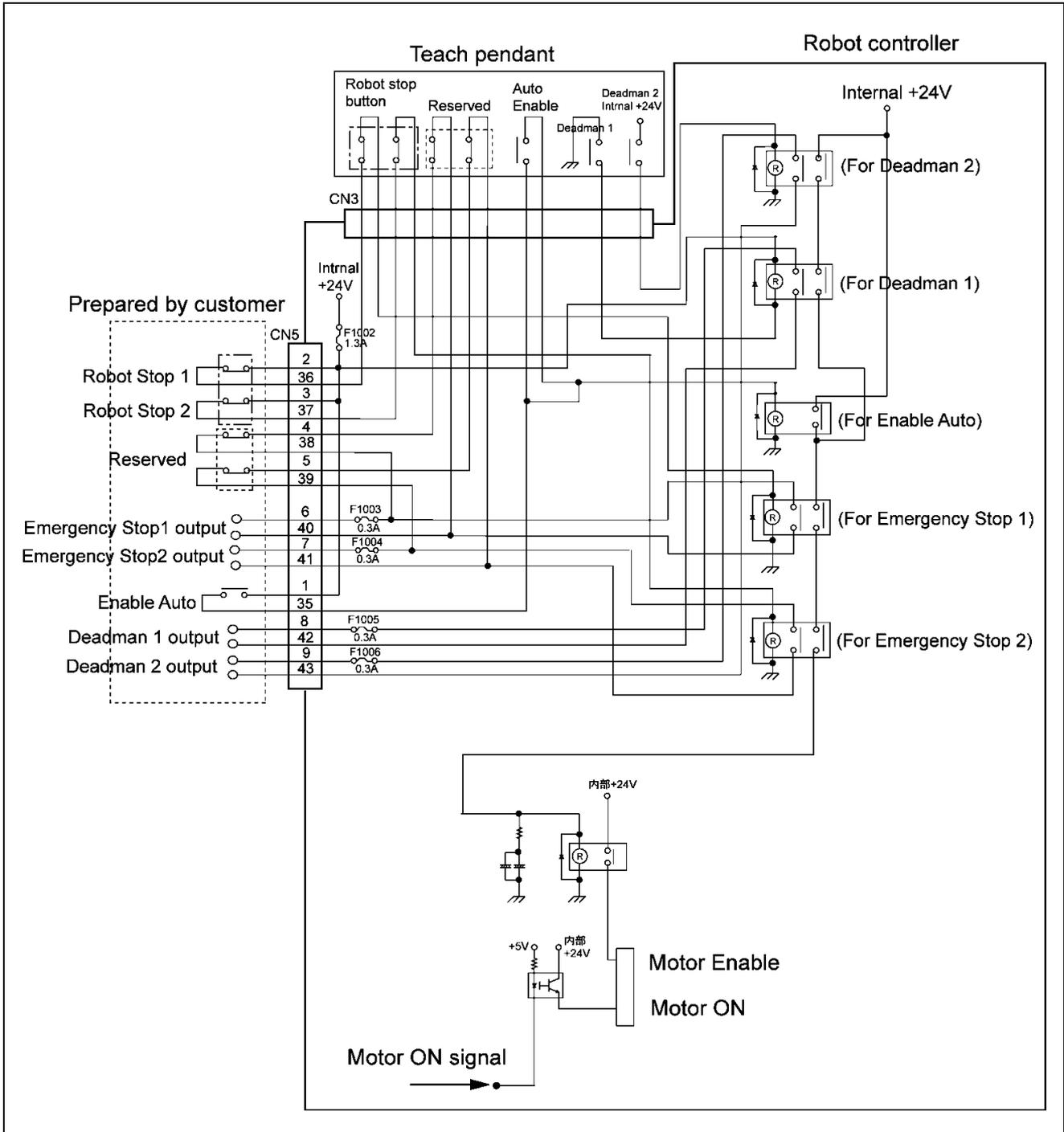
Robot Stop and Enable Auto Input Circuits

TIP: For the configuration sample of an emergency stop output circuitry, refer to Subsection 4.2.3 "Emergency Stop Circuit."

4.2.3 Emergency Stop Circuit

The following figures show the examples of configuration and connection of emergency stop circuit for the robot controller. In the RC7 controller, the emergency stop circuit consists of dual safety circuits.

The red mushroom-shaped switch provided on the robot controller front panel or on the teach pendant can be used as a switch for stopping the equipment in case of emergency.



Emergency Stop Circuit

4.2.4 User-Output, System-Output, and Hand-Output Circuits (NPN type)

The next page shows an example of the configuration and connection of the robot controller's user-input output, system-output and hand-output circuit.

(1) The User-Output and System-Output Circuit are open collector output circuits.

(2) The maximum allowable source current is 70 mA.

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.

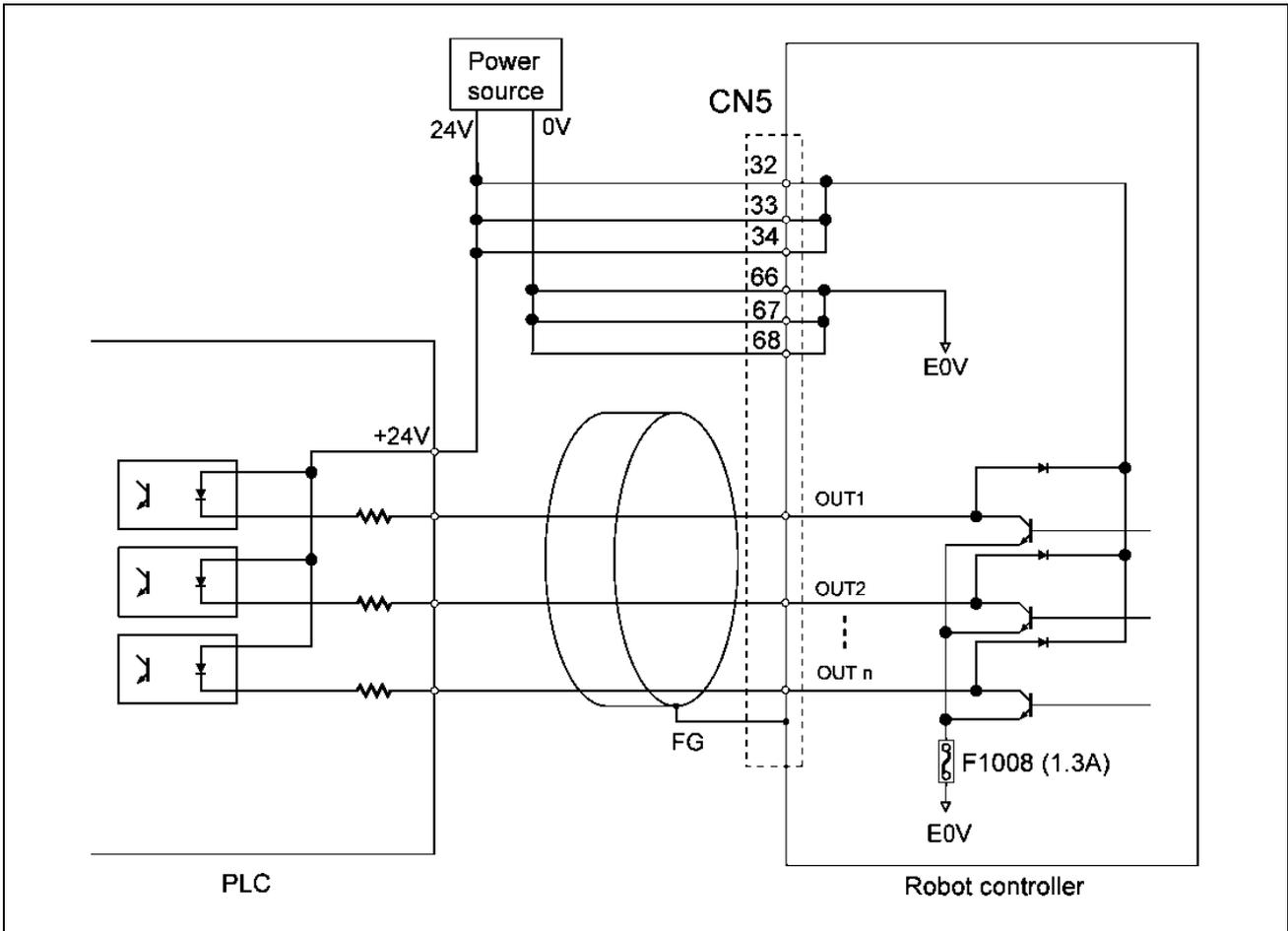
(4) Connecting a lamp requires a circuit through which dark current flows and use a lamp whose rating is 0.5W or less.

 **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. 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. Refer to next page.

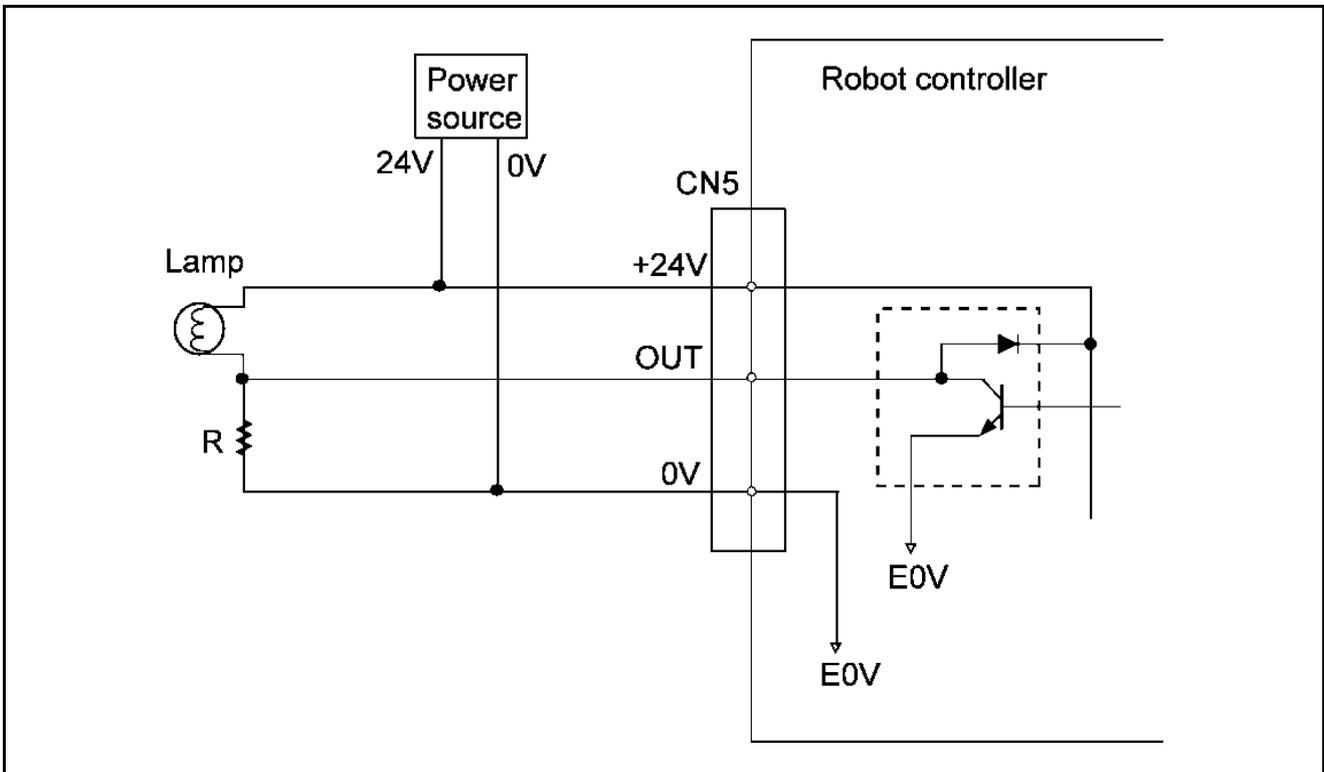
(5) Use a multi-core shielding cable for the purpose of protecting the devices from external noise. Ground it to the robot controller.

(6) +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.



User-Output and System-Output Circuits (NPN type)



Example of Circuit with Lamp (NPN type)

4.3 Wiring Notes for Controller I/O Connectors (NPN type)

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.

⚠ 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.

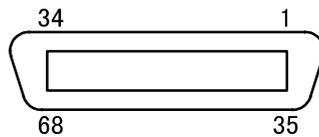
Check point (2)

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.

⚠ 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.

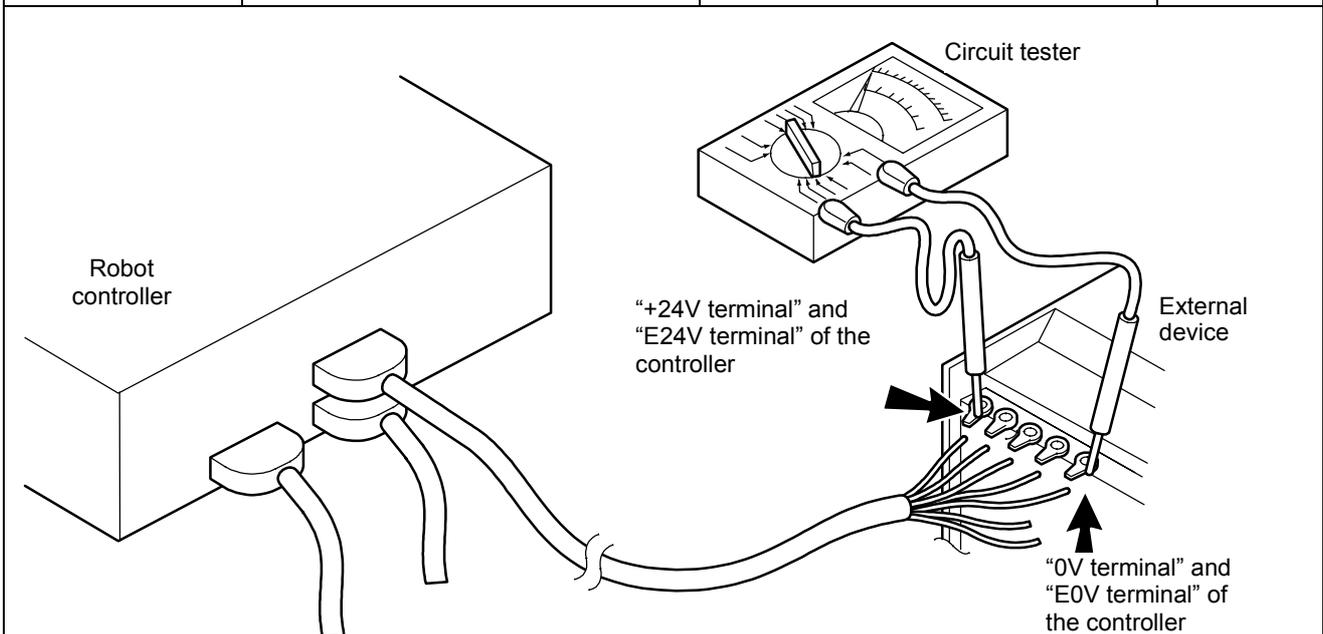
⚠ Caution: Wind adhesive vinyl tape around all ends of the unconnected wiring of each connector to prevent them from contacting other wiring and parts, which results in shorting.

Mini I/O connector (CN5)



View from cable side engaging face

Terminal Number	Name	Meaning	Check point
1, 2, 3	+24V internal power source terminal	+24V internal power source output	(1)
45 to 60	Signal output terminal	0V (GND) at output	(2)
32, 33, 34	E24V input terminal	24V power input	(1)
66, 67, 68	E0V (GND) input terminal	Power (GND) input	(1)



Chapter 5

Connector Pin Assignment and I/O Circuits (PNP type)

This chapter explains the connector pin assignment and circuits of PNP type (sink input and source output) on an I/O board.

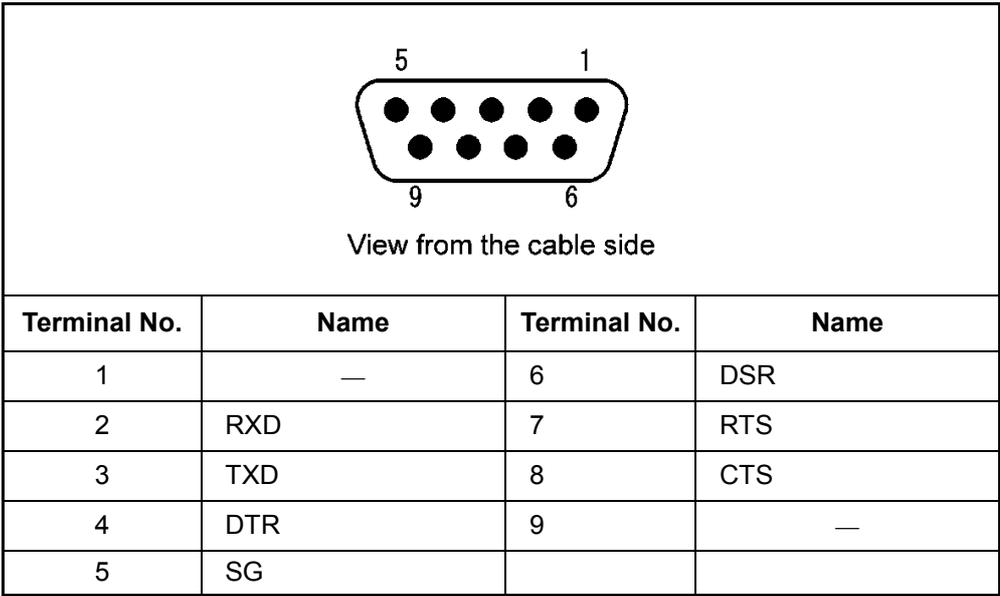
For an NPN type (source input and sink output), refer to Chapter 4, "Connector Pin Assignment and I/O Circuits (NPN type)."

5.1 Connector Pin Assignment (PNP type)

This section describes the pin assignment of I/O connectors on the robot controller.

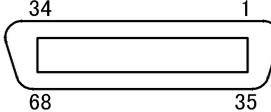
5.1.1 RS232C (CN1): RS232C connector

RS232C (CN1) Pin Assignment



5.1.2 Mini I/O (CN5): User-/System-I/O connector

Mini I/O (CN5) Pin Assignment

 <p>View from the cable side</p>							
Terminal number	Name	Port number	Wire color	Terminal number	Name	Port number	Wire color
1	Power supply for Enable Auto (internal +24V)	—	Black	35	Enable Auto	—	Pink
2	Power supply for Robot stop 1 (Internal +24V), 1b-1	—	Brown	36	Robot stop 1 input, 1b-2	—	Pink
3	Power supply for Robot stop 2 (Internal +24V), 2b-1	—	Red	37	Robot stop 2 input, 2b-2	—	Pink
*4	Reserved (Robot stop 3 input)	—	Orange	*38	Reserved (Robot stop 3 input)	—	Pink
*5	Reserved (Robot stop 4 input)	—	Yellow	*39	Reserved (Robot stop 4 input)	—	Pink
6	Emergency stop 1 output, 1-1	—	Black	40	Emergency stop 1 output, 1-2	—	White
7	Emergency stop 2 output, 2-1	—	Brown	41	Emergency stop 2 output, 2-2	—	White
8	Deadman 1 output, 1-1	—	Red	42	Deadman 1 output, 1-2	—	White
9	Deadman 2 output, 2-1	—	Orange	43	Deadman 2 output, 2-2	—	White
10	Reserved	—	Yellow	44	Reserved	—	White
11	Step-stop (all tasks)	0	Green	45	Normal CPU	16	White
12	Strobe signal	1	Blue	46	Robot in operation	17	White
13	Data area bit 0	2	Violet	47	Robot failure	18	White
14	Data area bit 1	3	Gray	48	Robot initialized	19	White
15	Data area bit 2	4	Pink	49	Auto mode	20	White
16	Command area bit 0	5	Black	50	Operation Preparation completed	21	Gray
17	Command area bit 1	6	Black	51	Dead battery warning	22	Violet
18	Command area bit 2	7	Brown	52	Command processing completed	23	Violet
19	User input	8	Red	53	User output / Continue start permitted	24	Violet
20	User input	9	Orange	54	User output	25	Violet
21	User input	10	Yellow	55	User output	26	Violet
22	User input	11	Green	56	User output	27	Violet
23	User input	12	Blue	57	User output	28	Violet
24	User input	13	Gray	58	User output	29	Violet
25	User input	14	Pink	59	User output	30	Violet
26	User input	15	Brown	60	User output	31	Gray
27	Reserved	—	Red	61	Reserved	—	Gray
28	Reserved	—	Orange	62	Reserved	—	Gray
29	Reserved	—	Yellow	63	Reserved	—	Gray
30	Reserved	—	Green	64	Reserved	—	Gray
31	Reserved	—	Blue	65	Reserved	—	Gray
32	External power input +24V (E24V)	—	Pink	66	External power input 0V (E0V)	—	Gray
33	External power input +24V (E24V)	—	Black	67	External power input 0V (E0V)	—	Blue
34	External power input +24V (E24V)	—	Brown	68	External power input 0V (E0V)	—	Blue

NOTE 1: The optional I/O cable for the above connector consists of twisted pair wires--pairs of #1 and #35, #2 and #36, #34 and #68.

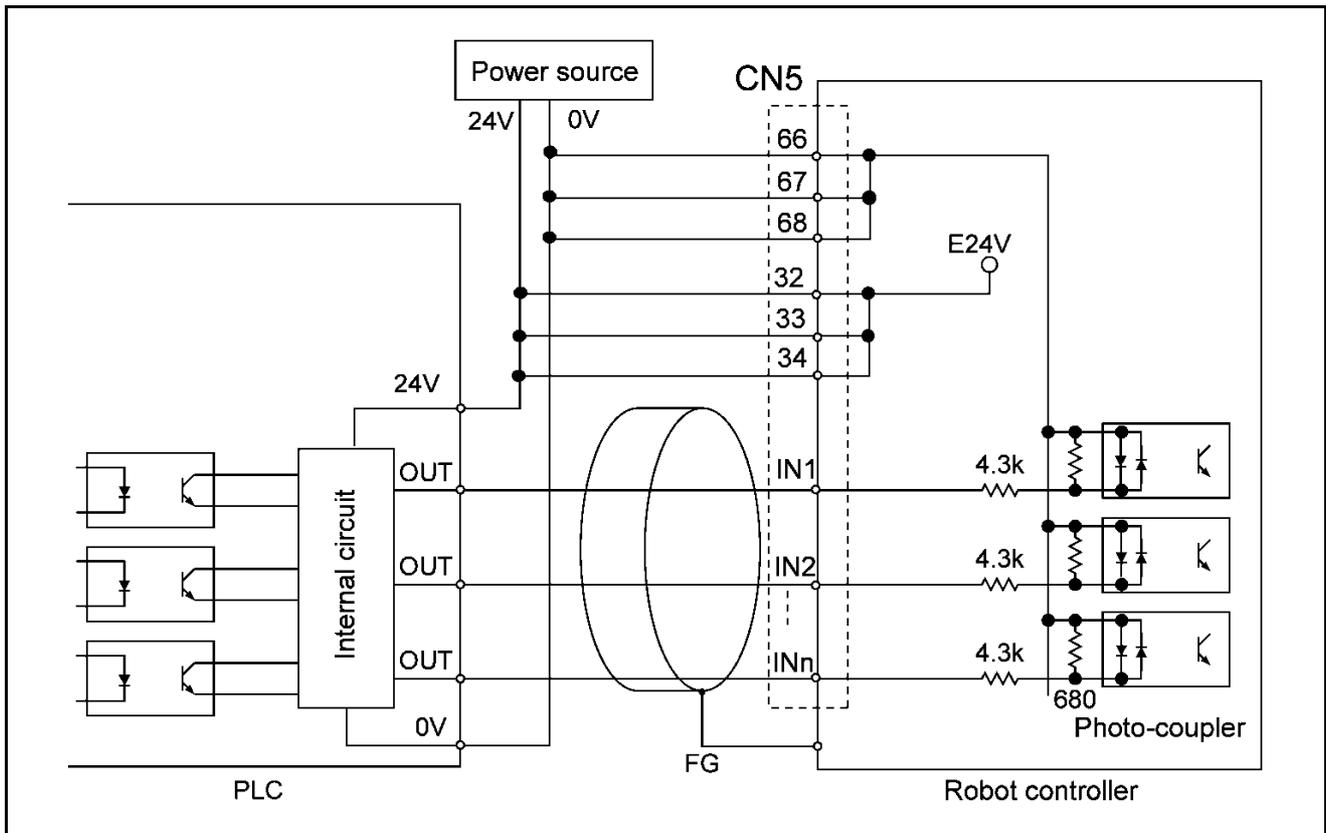
NOTE 2: The terminal number marked with (*) will be used in future.

5.2 Robot Controller I/O Circuits (PNP type)

5.2.1 User-Input and System-Input Circuits (PNP type)

The figure below shows examples of the user-input and system-input circuit configurations and connections of the robot controller.

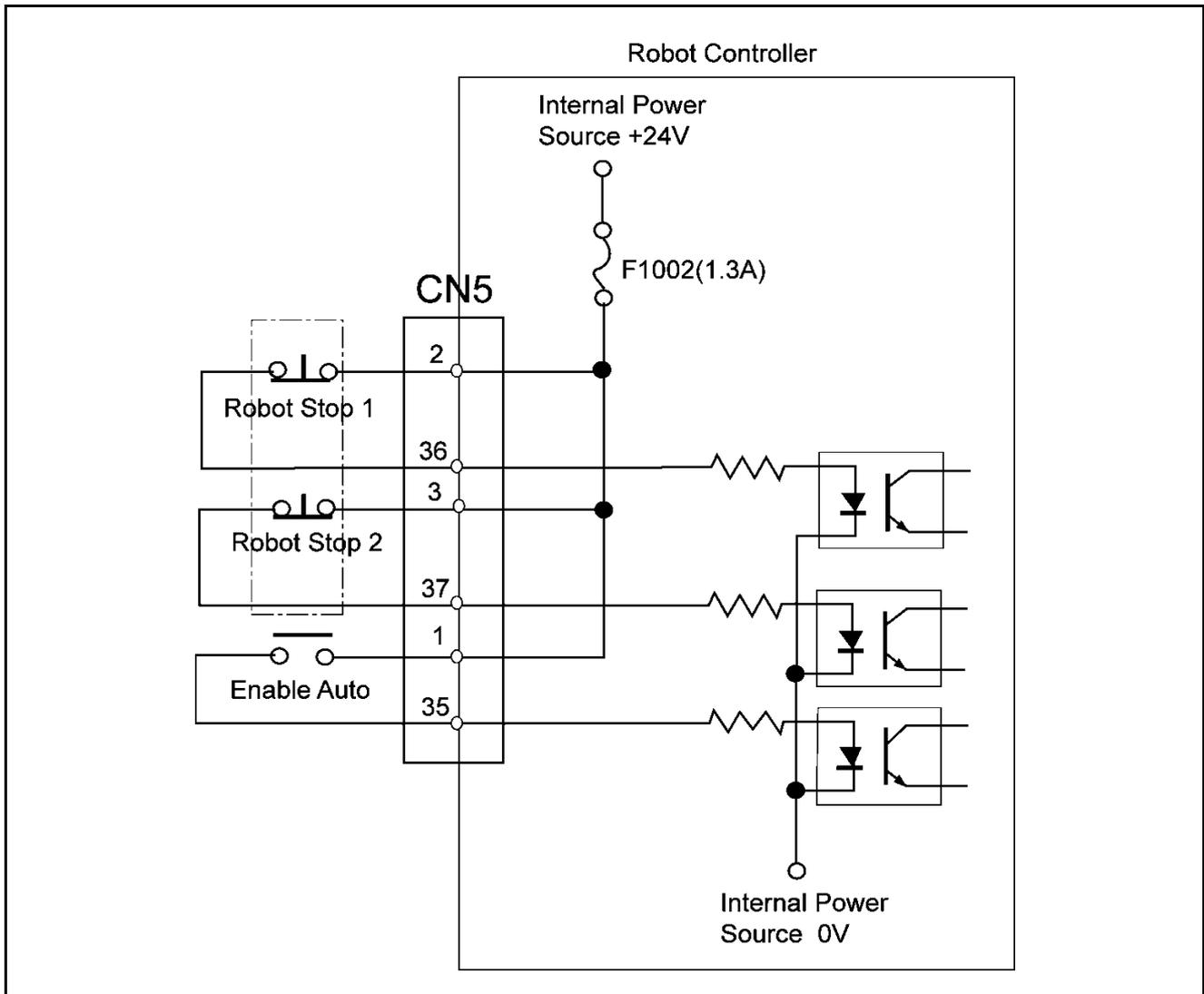
Caution: Use a multi-core shielding cable for the purpose of protecting the Robot Controller from noise. Ground it to the Robot Controller.



User-Input and System-Input Circuits (PNP type)

5.2.2 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 below.



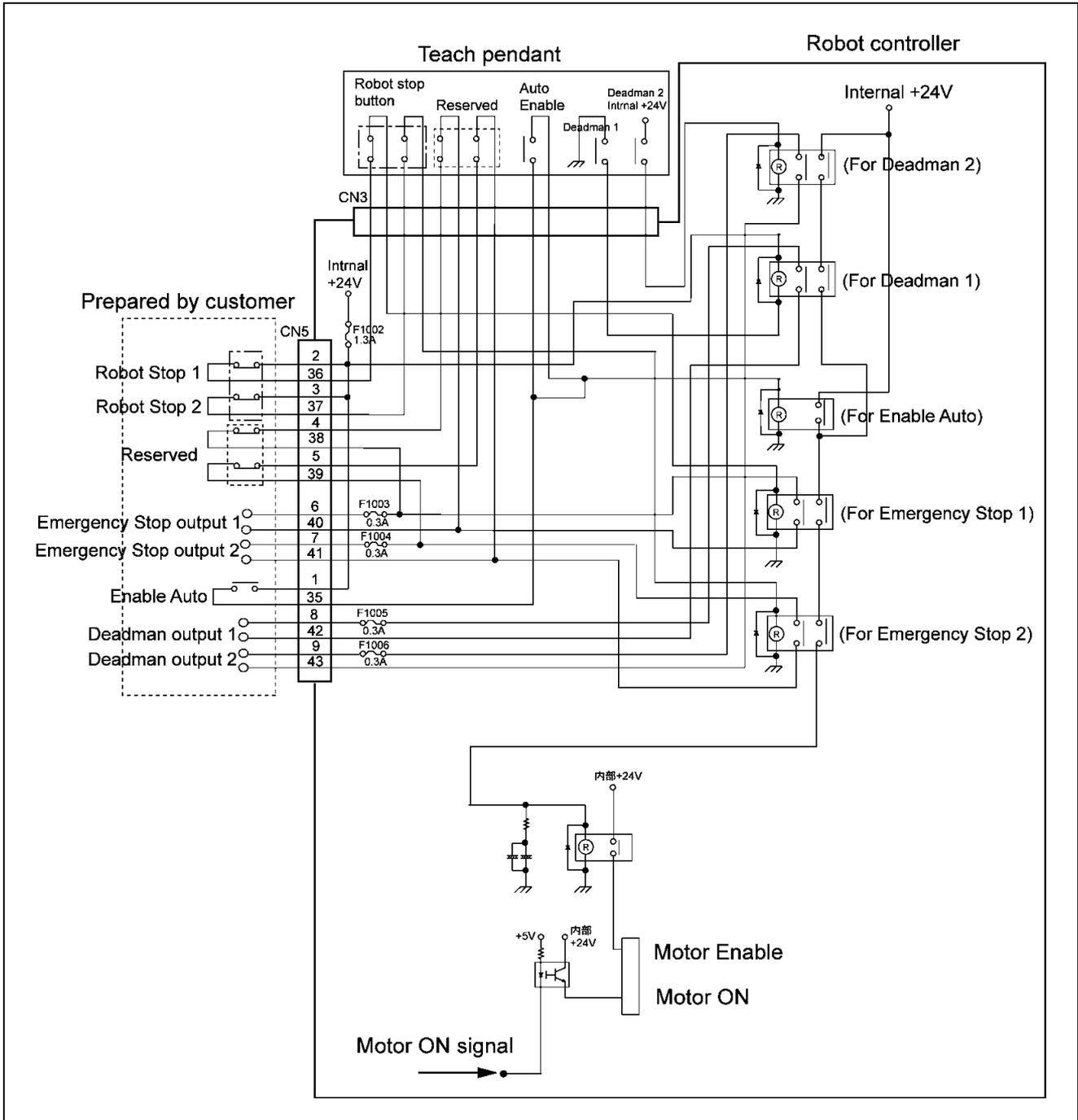
Robot Stop and Enable Auto Input Circuits

TIP: For the configuration sample of an emergency stop output circuitry, refer to Subsection 4.2.3 "Emergency Stop Circuit."

5.2.3 Emergency Stop Circuit

The following figures show the examples of configuration and connection of emergency stop circuit for the robot controller. In the RC7 controller, the emergency stop circuit consists of dual safety circuits.

The red mushroom-shaped switch provided on the robot controller front panel or on the teach pendant can be used as a switch for stopping the equipment in case of emergency.



Emergency Stop Circuit

5.2.4 User-Output, System-Output, and Hand-Output Circuits (PNP type)

The next page shows an example of the configuration and connection of the Robot Controller's user-input output, system-output and hand-output circuit.

(1) **The User-Output and System-Output Circuit are open collector output circuits.**

(2) **The maximum allowable sink current is 70 mA.**

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.

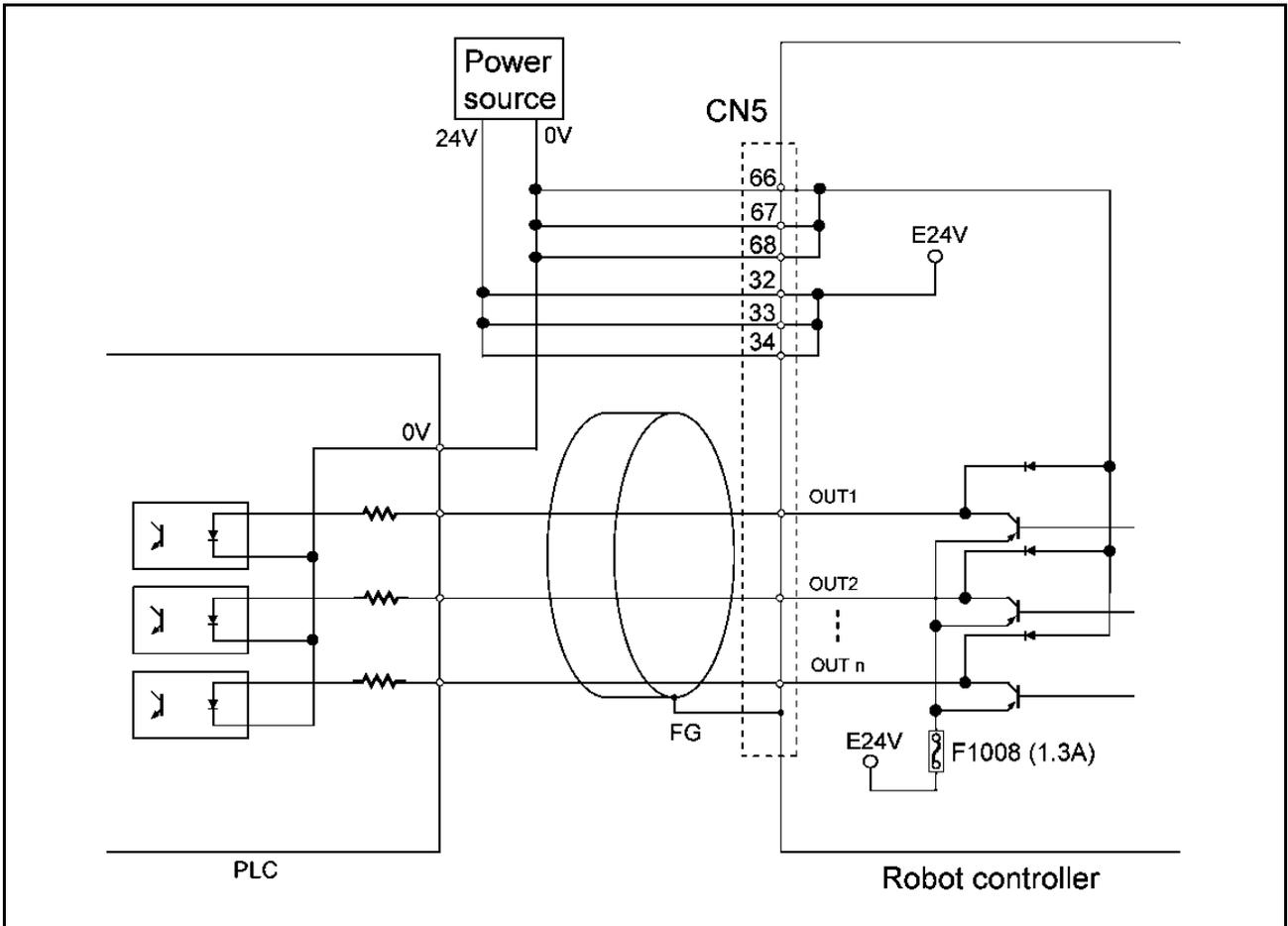
(4) **Connecting a lamp requires a circuit through which dark current flows and use a lamp whose rating is 0.5W or less.**

⚠ 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. 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. Refer to next page.

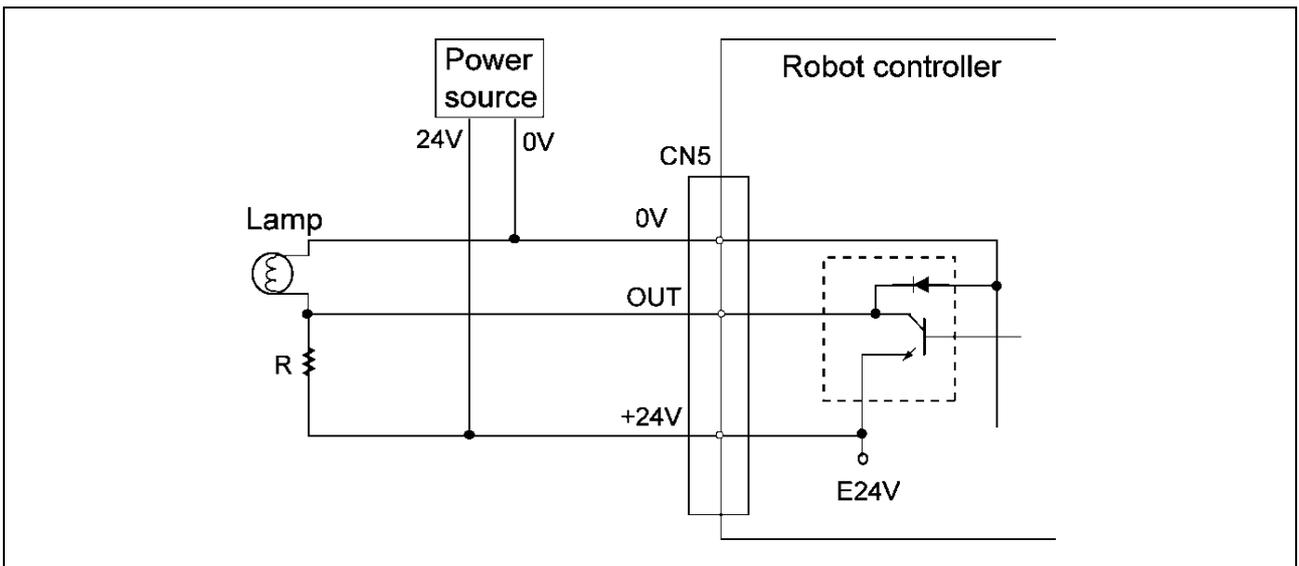
(5) **Use a multi-core shielding cable for the purpose of protecting the devices from external noise. Ground it to the robot controller.**

(6) **+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.



User-Output and System-Output Circuits (PNP type)



Example of Circuit with Lamp (PNP type)

5.3 Wiring Notes for Controller I/O Connectors (PNP type)

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.

⚠ 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.

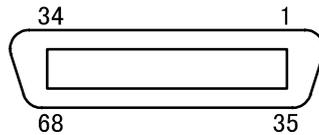
Check point (2)

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.

⚠ 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.

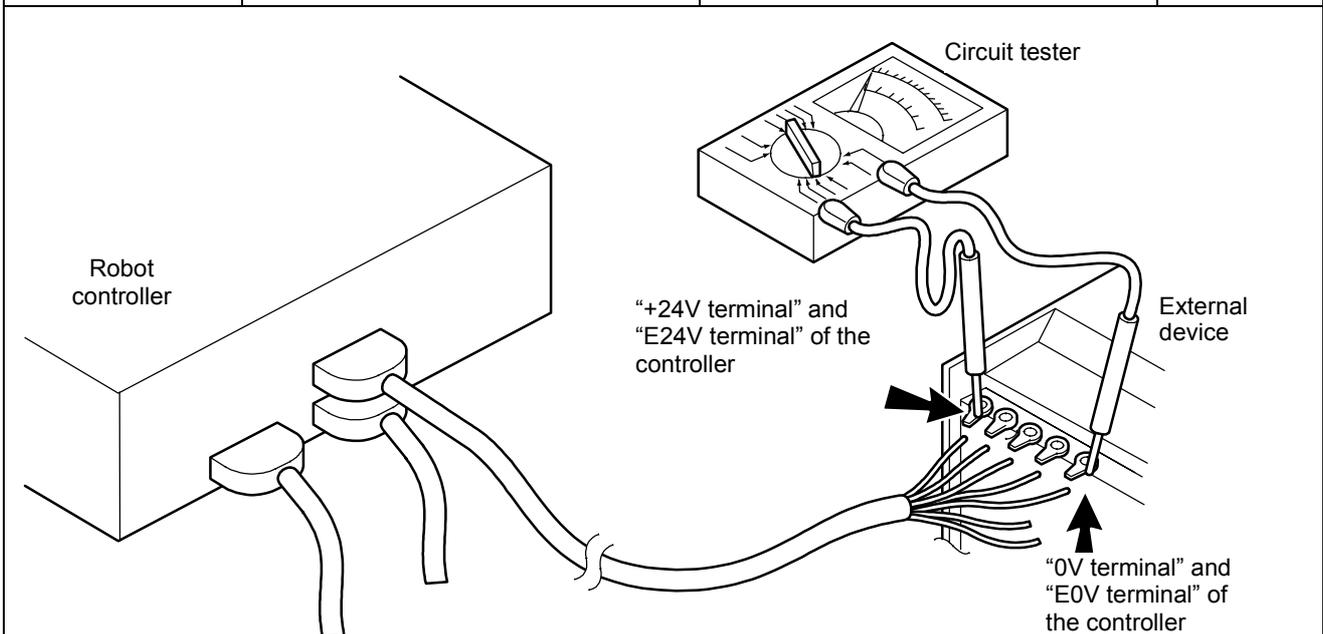
⚠ Caution: Wind adhesive vinyl tape around all ends of the unconnected wiring of each connector to prevent them from contacting other wiring and parts, which results in shorting.

Mini I/O connector (CN5)



View from cable side engaging face

Terminal Number	Name	Meaning	Check point
1, 2, 3	+24V internal power source terminal	+24V internal power source output	(1)
45 to 60	Signal output terminal	24V at output	(2)
32, 33, 34	E24V input terminal	24V power input	(1)
66, 67, 68	E0V (GND) input terminal	Power (GND) input	(1)



Chapter 6 Installation and Maintenance of the RC7J controller

6.1 Supplies for the RC7J controller

The table below lists the supplies for the RC7 controller.

List of Supplies for the RC7 Controller

No.	Name	Part Number	Remarks
1	Air inlet filter	410041-4730	Cooling fan filter for the RC7 controller
2	Memory backup battery	410076-0260	
3	Fuse (1.3A)	410054-0230	Fuse (LM13) for controller I/O
4	Fuse (0.3A)	410054-0240	Fuse (LM03) for controller I/O
5	IC for output (NPN)	410077-0010	IC (M54522P) for controller output
6	IC for output (PNP)	410077-0020	IC (M54564P) for controller output

6.2 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.

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

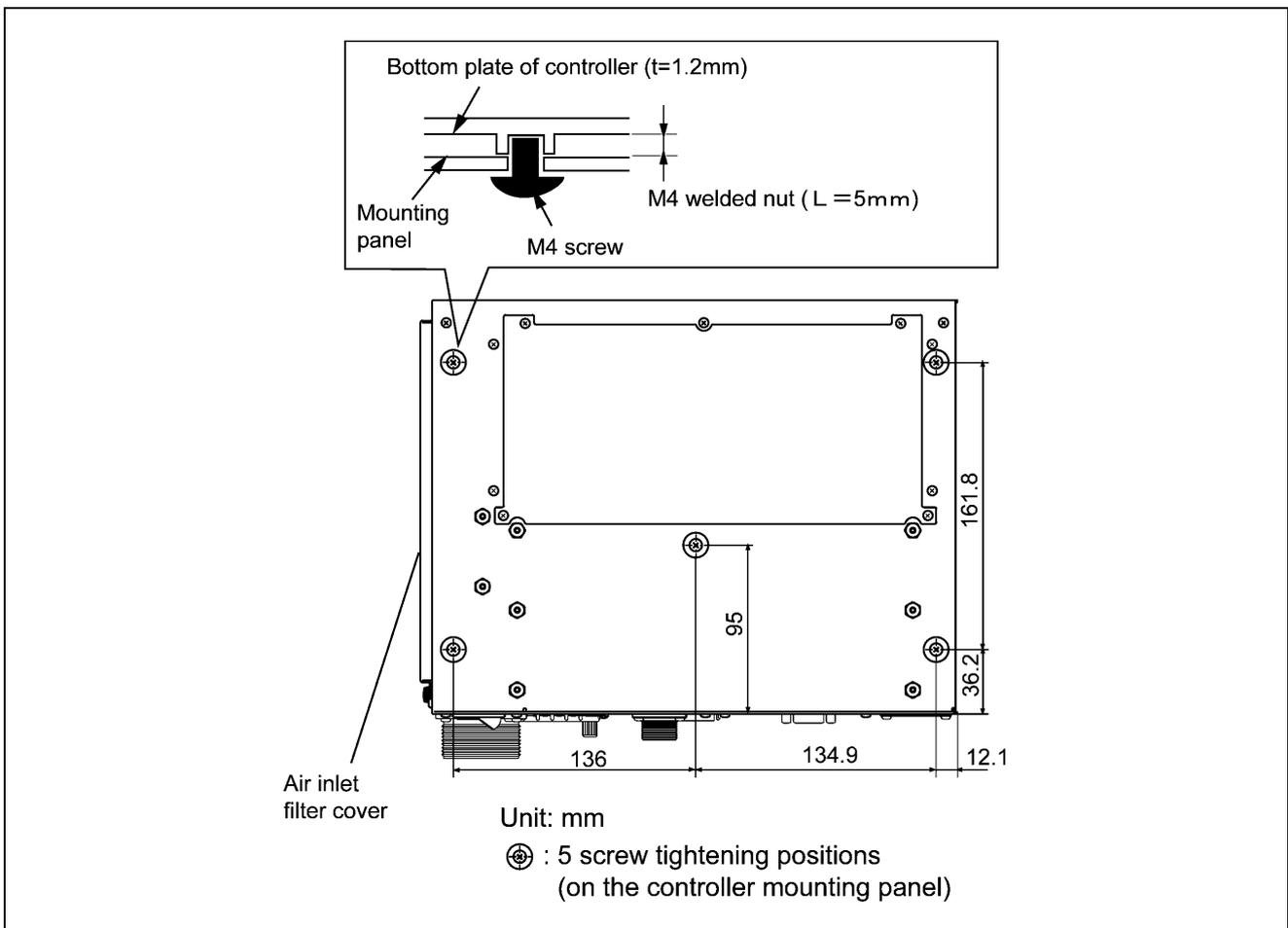
⚠ Caution: When using the robot controller in any environment where there is mist, put the controller in an optional robot controller protective box. The robot controller is not dust-proof, splash-proof, or explosion-proof.

6.2.1 Securing the Robot Controller to the Controller Mounting Panel

- (1) The figure below shows the bottom view of the robot controller. Five M4-nut welded holes may be used for securing the robot controller to the mounting panel.
- (2) Prepare a mounting panel large enough for mounting the robot controller and secure the robot controller onto the mounting panel using five 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 five nut-welded holes.



Location of Mounting Screw Holes (on the bottom of the robot controller)

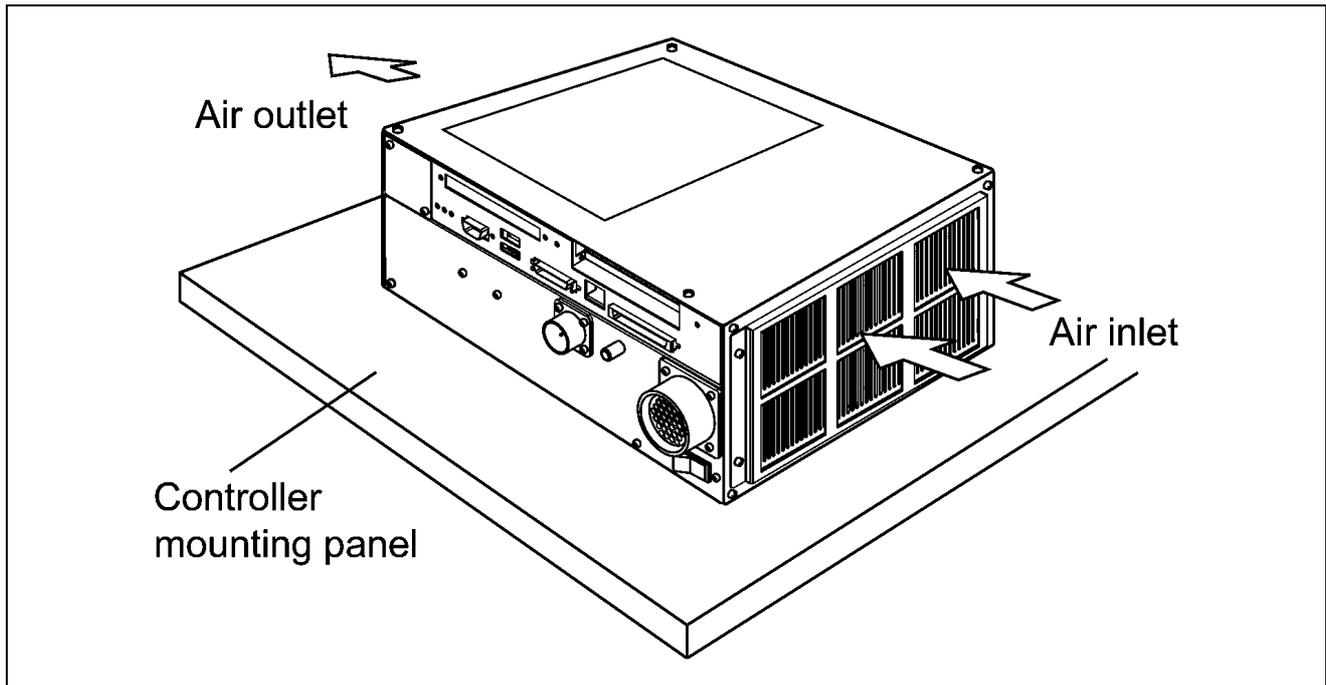
6.2.2 Installing the Robot Controller

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

[1] Stand-alone

Install the robot controller as shown in the figure below.

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

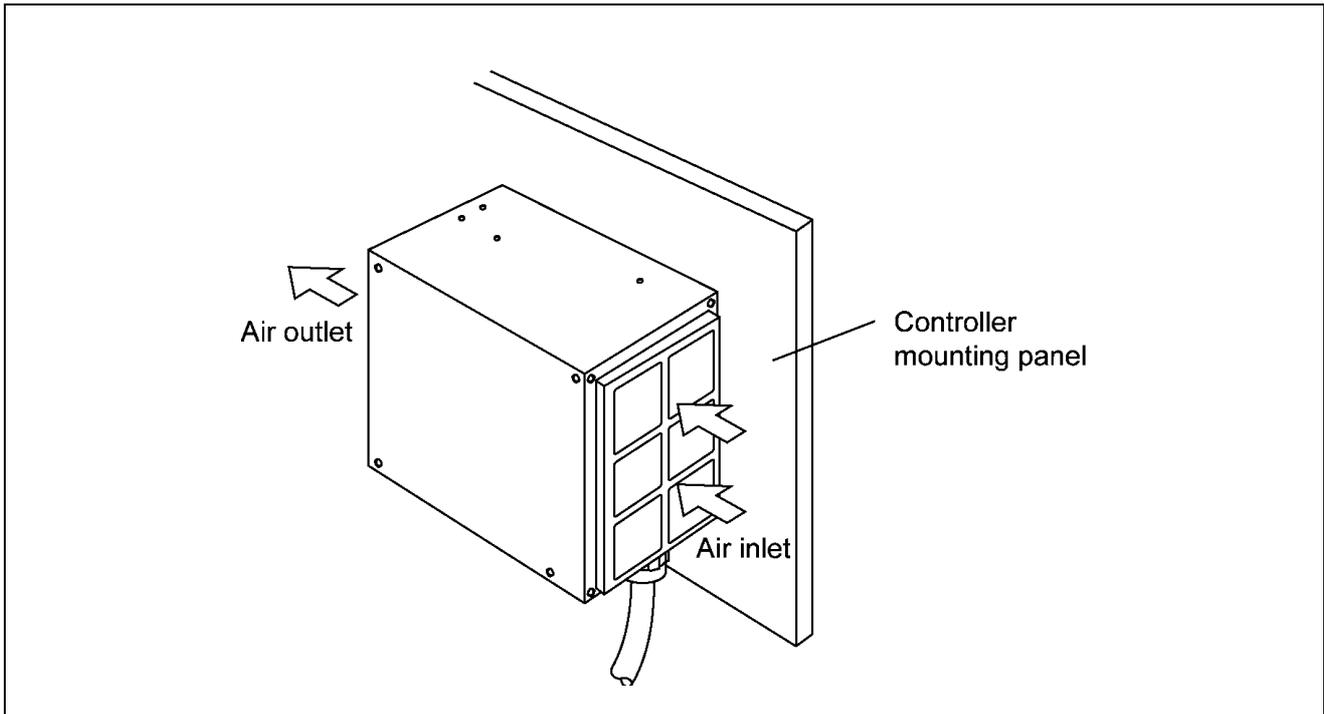


Stand-alone Installation

[2] Wall-mounted

Install the robot controller as shown in the figure below.

- ⚠ **Caution:** Do not place anything within 200 mm from the air inlet and air outlet on the robot controller.
- ⚠ **Caution:** The RC7 controller has not the air filter on the side of air outlet. Therefore, install the controller as shown in the figure (: Example A) below.



Wall-mounted Installation

6.3 I/O and AC Input Wiring

6.3.1 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 the table given below if necessary.

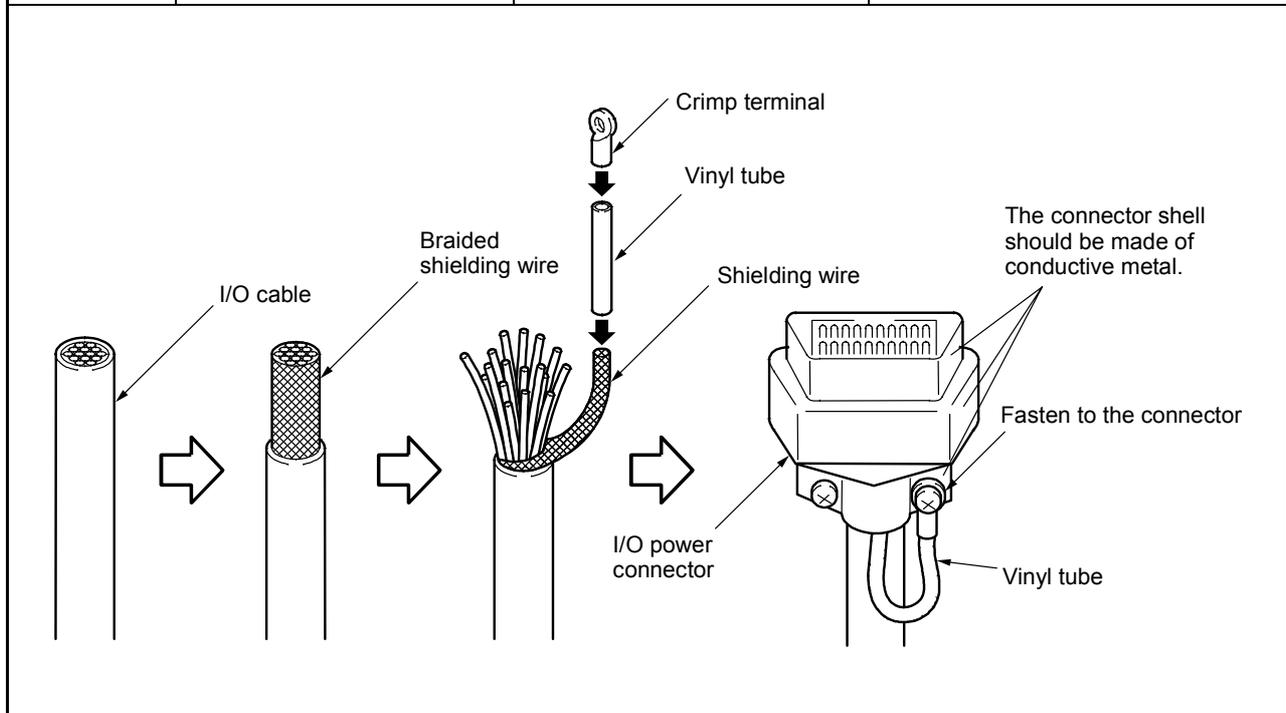
I/O Cables (Optional items)

Name	Part Number	Remarks
I/O cable	41041-2700	8m
I/O cable	41041-2710	15m

If you do not use optional cables listed on the previous page, use the recommended connectors and cables listed below.

Recommended Connectors for I/O Cables and Cable Standards

Connector name	Connector model/manufacturer	Cable Standards	Remarks
Mini I/O	PCR-E68FS connector PCS-E68LPA-1E cover (HONDA TSUSHIN KOGYO Co., LTD)	UL2789 - With shield Equivalent to AWG28x34P	Caution: Be sure to modify the shielding wire at the end of the cable to be used, as shown below. Without this modification, the robot may malfunction due to noise.



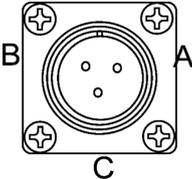
Modifying the Shielding Wire (Example)

6.3.2 Wiring of Primary Power Source

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 mm² 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 200/100 VAC main line and other cables according to the tables given below.

Robot Controller Power Supply Specifications

Item	Specifications	Pin assignment on power connector (CN6) (View from the pin face of cable)
Power supply (RC7J all models)	Single-phase, 200 VAC -10% to 230 VAC + 10%, 50/60 Hz, 1KVA	 <p>A: 200/100 VAC, phase R B: 200/100 VAC, phase S C: Ground</p>
	Single-phase, 100 VAC -10% to 110 VAC + 10%, 50/60 Hz, 500VA	
Max. rush current when the power is turned ON	40 A (for 1/50 or 1/60 second)	

Caution: If ERROR6102 (power voltage drop) occurs when the robot is in operation, then it may be due to an insufficient capacity of the primary power source.

- (7) Do not bundle the teach pendant cables, I/O cables or motor cables together with high power lines such as 200/100 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.
- (9) Use the correct power source (200 VAC or 100 VAC) for the controller specification.

6.4 Cleaning the Air Intake Filter

The robot controller has an air intake filter.

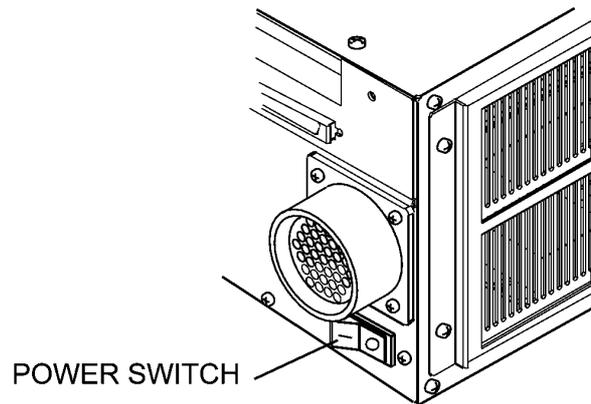
If the filter is clogged, the robot controller becomes badly ventilated to overheat so that the internal electronic devices may fail due to heat.

If a power module error appears, it may be caused by clogged filter, so clean the filter.

<Cleaning Procedures>

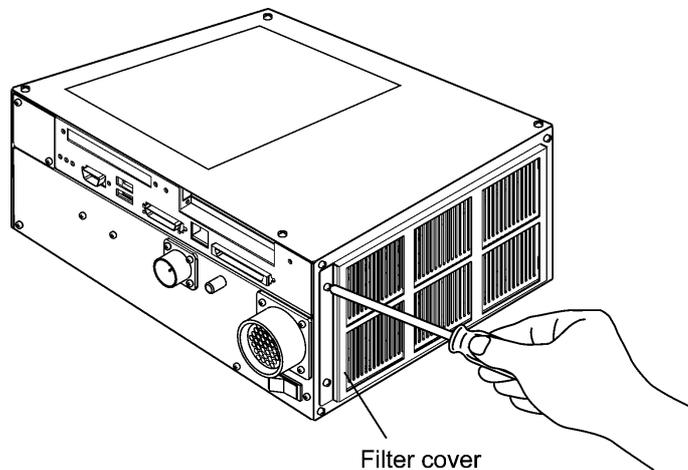
► STEP 1

Turn the controller power OFF.



► STEP 2

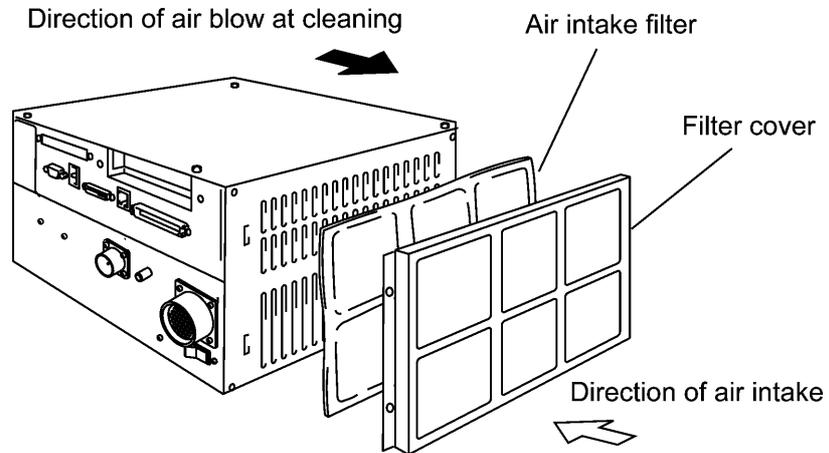
Remove the filter cover from the controller by unscrewing two screws.



► STEP 3

Blow compressed air to the filter in the direction opposite to the regular air-flow.

NOTE: Use dehumidified, oil-free, pure compressed air for cleaning.



If the filter is excessively dirty, wash it with water or warm water (40°C or lower). A neutral detergent is most effective.

Notes: (1) Dry the washed filter completely before replacing it.
(2) If the filter is still dirty after air blowing or washing, replace it with new one.

► STEP 4

Reinstall the filter in the reverse order of removal.

6.5 Replacing the Memory Backup Battery

Programs, parameters, CAL data, etc. are stored in the internal memory of the robot controller.

The memory backup battery retains the above data while the power to the robot controller is turned OFF. However, the battery has a limited lifetime and must, therefore, be replaced regularly.

NOTE: If two years elapse from replacement of backup battery, the "Time to change controller backup battery" message will appear on the teach pendant.

⚠ Caution: Without replacing the memory backup battery, important robot-specific data stored in the memory will be lost.

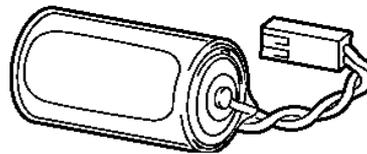
6.5.1 Replacing procedures

This section gives an example of replacing the memory backup battery.

Caution: Before replacing the memory backup battery, be sure to save the memory data of the robot controller using WINCAPSII.

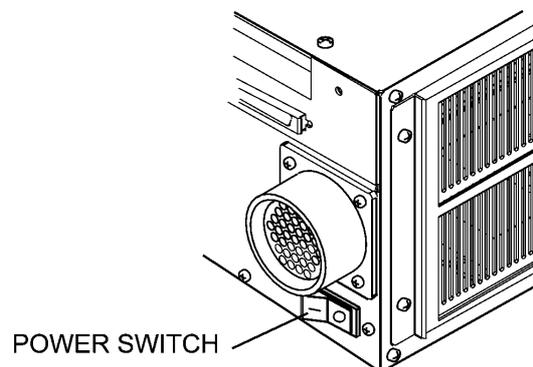
► STEP 1

Prepare a new memory backup battery.



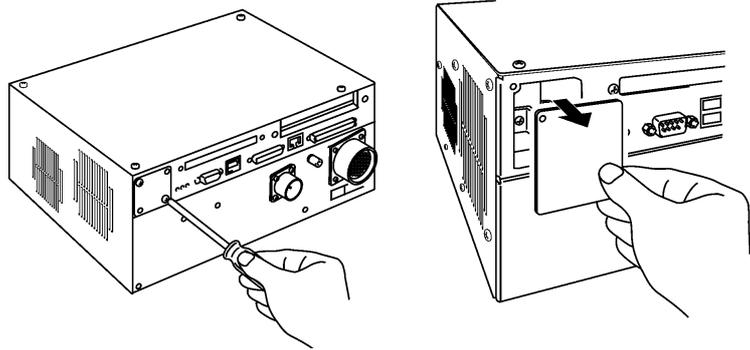
► STEP 2

Turn the controller power ON, wait at least one minute, and then turn it OFF again.



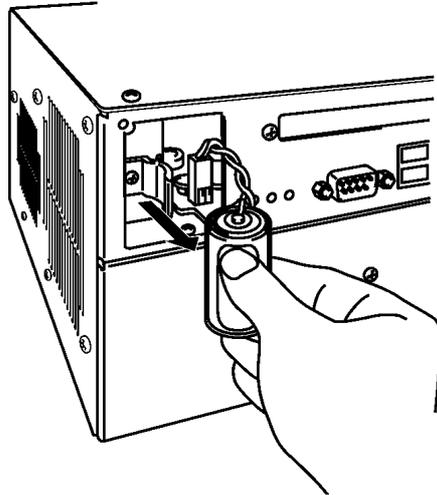
► STEP 3

Remove the backup battery cover by unscrewing two screws.



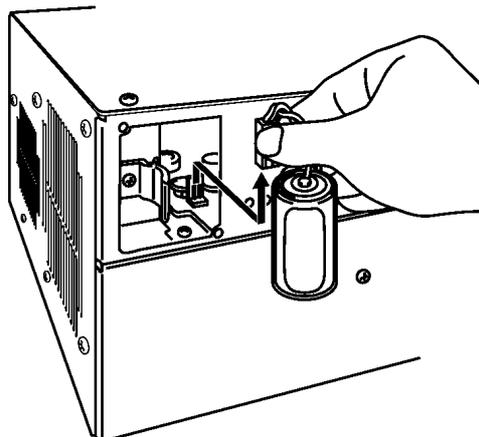
► STEP 4

Pull out the backup battery from the controller.



► STEP 5

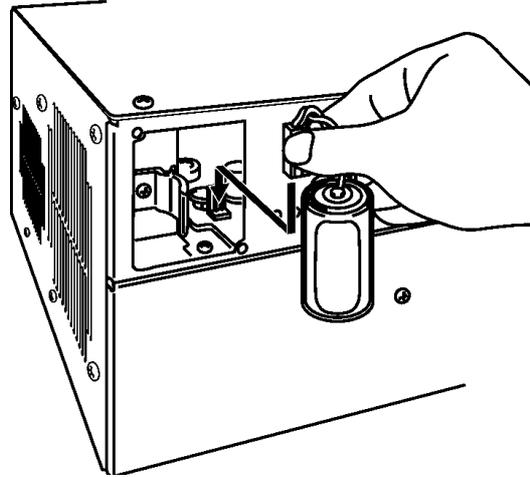
Disconnect the backup battery connector.



⚠ Caution: Complete the operations in STEP 5 and 6 within three minutes. If the battery is disconnected for over three minutes, the memory data will be lost.

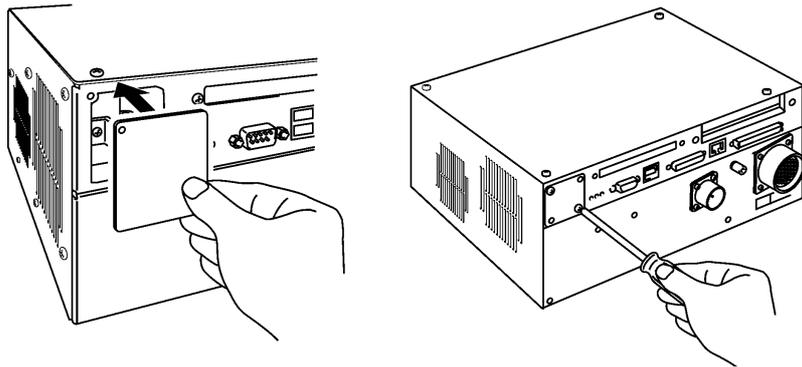
▶ STEP 6

Connect the new memory backup battery prepared in Step 1, to the robot controller.



▶ STEP 7

Insert the backup battery into the robot controller.
Reinstall the battery cover onto the controller.



⚠ Caution: Take care not to pinch the battery lead wires between covers or internal parts. Shorting may occur, resulting in an unexpected failure.

6.5.2 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 mini pendant.

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 Replacing Fuses and Output ICs

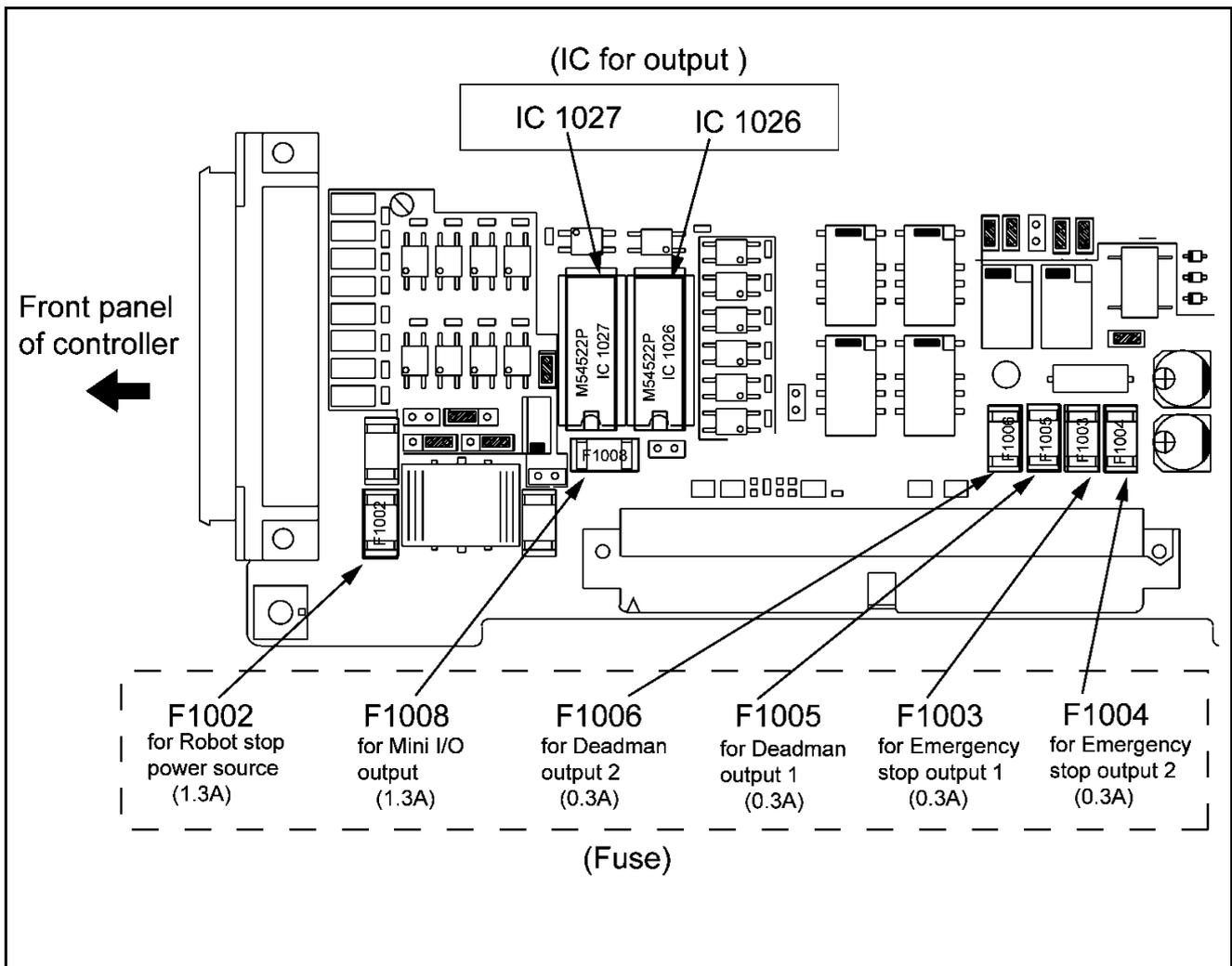
6.6.1 Positions of Fuses and Output ICs

The robot controller is equipped with fuses to protect it from external wiring shorted.

If any fuse is blown, replace it according to the following procedure

If an output signal error persists even after replacement of the output fuse, the related output IC needs to be replaced.

Fuses and output ICs are located in the robot controller as shown in the figure below.



Positions of Fuses and Output ICs

The table below shows the output signals and related IC numbers and fuses.
 If an output signal error occurs, check the corresponding fuse.

Output ICs and Fuses

Connector No.	Connector terminal No.	I/O Port No.	Output IC No.	Fuse No.		
Mini I/O CN5	1	-	-	F1002 (1.3A)		
	35	-				
	2	-				
	36	-				
	3	-				
	37	-				
	6	-			-	F1003 (0.3A)
	40	-			-	F1004 (0.3A)
	7	-			-	F1005 (0.3A)
	41	-	-	F1006 (0.3A)		
	8	-	-	-		
	42	-	-	-		
	9	-	-	-		
	43	-	-	-		
	45	16	IC1026	F1008 (1.3A)		
	46	17				
	47	18				
	48	19				
	49	20				
	50	21				
	51	22				
	52	23				
	53	24				
	54	25			IC1027	
	55	26				
	56	27				
	57	28				
	58	29				
	59	30				
	60	31				

6.6.2 Replacing procedures

Replace fuses and output ICs according to the following procedure:

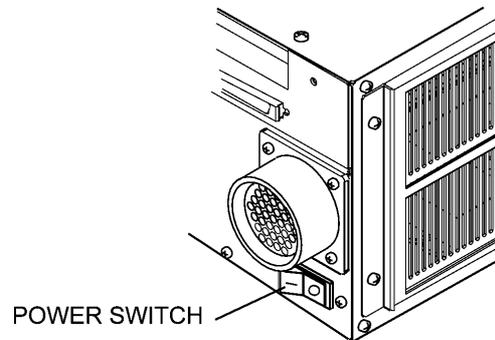
⚠Warning Do not touch the inside of controller before turning off the power switch and waiting 3 minutes or more, or you can easily receive an electric shock.

⚠Caution (1) Wear a wristband and connect its terminal to a grounded portion before starting work.
(2) Do not touch elements or their terminals on any printed circuit board with bare hand (elements could be destroyed by static electricity).

<Replacing fuses>

▶ STEP 1

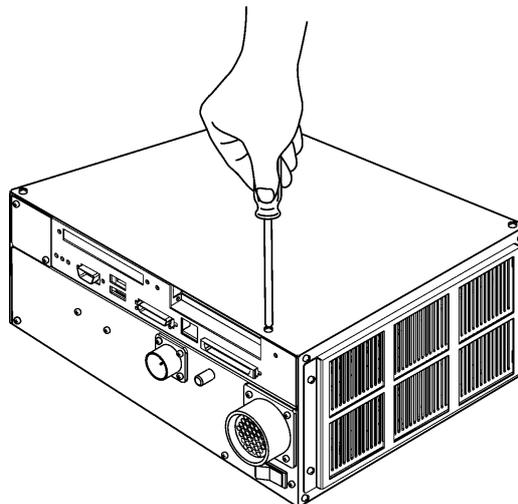
Turn the controller power OFF.



▶ STEP 2

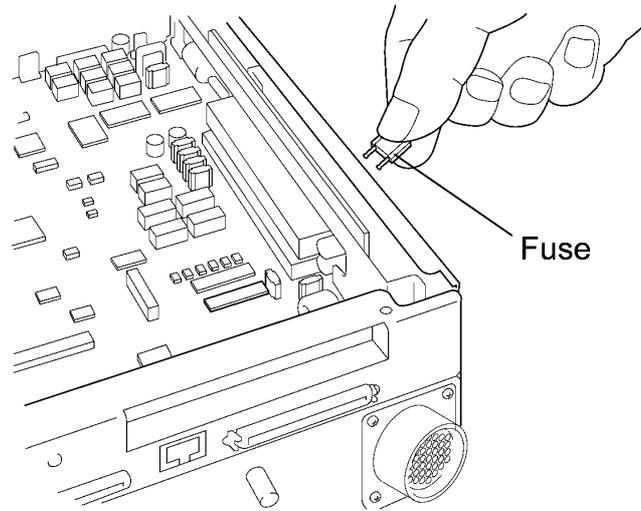
Remove the controller upper cover by unscrewing four screws.

⚠Warning Do not touch the inside of controller before turning off the power switch and waiting 3 minutes or more, or you can easily receive an electric shock.



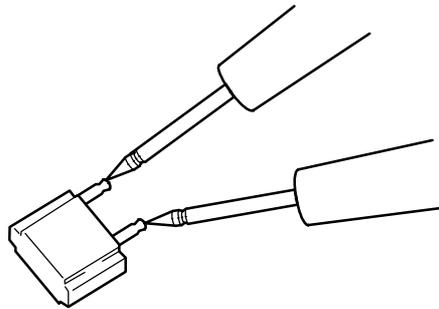
▶ STEP 3

Pull out the fuse to be checked.



▶ STEP 4

Using a circuit tester, check the removed fuse for continuity.



▶ STEP 5

If no continuity is observed with the fuse in Step 4:

- (1) Check the wiring of the corresponding output connector and remove the cause of the blown fuse.
- (2) Insert a new fuse into place in the controller.

If continuity is observed with the fuse in Step 4, set the removed fuse back into place in the controller.

▶ STEP 6

Reinstall the controller upper cover.

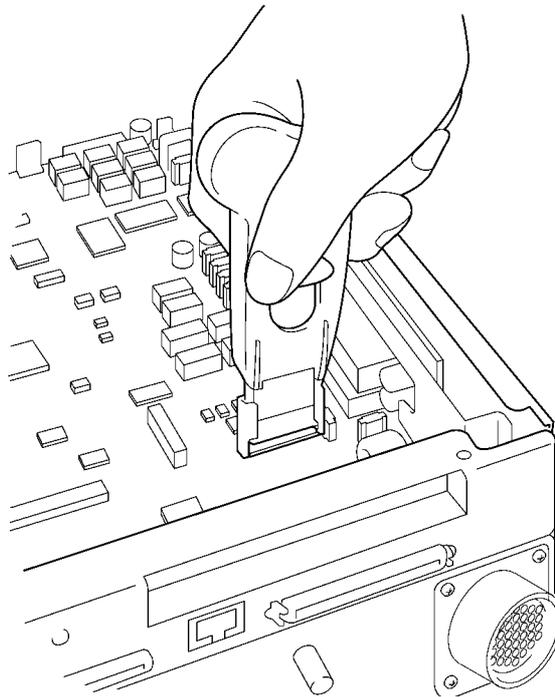
<Additional procedures when replacing output ICs>

► **STEP 7**

If an output signal error persists even after replacement of the output fuse in STEP 3, the related output IC needs to be replaced.

Check the IC marked with "IC1026" or "IC1027" on the PC board, and remove the defective output IC with an IC pull-out jig and replace the IC.

⚠ 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.



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RC7J CONTROLLER

INTERFACE MANUAL

First Edition January 2004

Second Edition November 2004

DENSO WAVE INCORPORATED
Factory Automation Division

11F**C

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.

In no event will DENSO WAVE INCORPORATED be liable for any direct or indirect damages resulting from the application of the information in this manual.

