

MOVEMASTER

Industrial Robot

Specification Manual

Att. No.: 54637 – 961105 – BFP-A5618-C

**RV-E2/RV-E3J
MOVEMASTER SUPER**

NOTE TO THE USER

**TO ASSURE SAFETY IN DESIGN AND
CONSTRUCTION OF ROBOT SYSTEM,
READ 'SAFETY MANUAL' FIRST.**

- NO PART OF THIS PRINT MAY BE REPRODUCED IN ANY FORM WITHOUT PERMISSION.**
 - THIS PRINT IS SUBJECT TO CHANGE WITHOUT NOTICE.**
- COPYRIGHT (C) 1995 MITSUBISI ELECTRIC CORPORATION**

■ INTRODUCTION

The <MOVEMASTER Super E Series> was developed based on experience accumulated through the <MOVEMASTER> for personal needs and having a sales achievement of 20,000 units throughout the world. Focusing on "replacement for manual labor", the <MOVEMASTER> has been upgraded in terms of functions, performance, reliability and design, allowing this new series to be applied to various industrial applications. An AC servomotor and full absolute encoder have been incorporated for the robot arm, allowing the brush replacement and origin setting operations to be eliminated. A 32-bit CPU is used for the controller, allowing both the functions, performance and ease-of-use to be improved. With the "user-friendly concept" of the <MOVEMASTER> applied to the design, this new series can be used not only at manufacturing sites but also offices and laboratories.

- There are seven types of the <E Series> that can be selected according to the application and work. These specifications described these seven types.

- RV-E2 This is a 6-axis vertical articulated robot with a rated load of 2kgf.
As 6 axes are used, limits do not apply to the operation posture.
- RV-E3J This is a 5-axis vertical articulated robot with a rated load of 3kgf.
- RV-E2M This is an oil-mist specification 6-axis vertical articulated robot with a rated load of 2kgf.
- RV-E3JM This is an oil-mist specification 5-axis vertical articulated robot with a rated load of 3kgf.
- RV-E2-SR This is a 6-axis vertical articulated overhead robot with a rated load of 2kgf.
- RV-E3J-SR This is a 5-axis vertical articulated overhead robot with a rated load of 3kgf.
- RV-E2-SW This is a 6-axis vertical articulated wall-hanging robot with a rated load of 2kgf.

Caution:

- No part of this manual may be reproduced by any means or in any form, without prior consent from Mitsubishi.
- The details of this manual are subject to change without notice.
- The specifications values are based on Mitsubishi standard testing methods.
- An effort has been made to make full descriptions in this manual. However, if any discrepancies or unclear points are found, please contact your dealer.

■ CONTENTS

1. GENERAL CONFIGURATION

1.1 Configuration Devices	1. 1
1.2 Details of configuration devices	1. 1
1.3 Name of each robot arm part	1. 4

2. STANDARD SPECIFICATIONS

2.1 Robot arm	2. 1
2.2 Controller	2. 2
2.3 Standard color	2. 3
2.4 Operating environment	2. 3
2.5 Protection specifications	2. 4
2.6 Safety	2. 5
2.7 Precautions for handling	2. 5

3. DETAIL SPECIFICATIONS

3.1 Robot arm	3. 1
3.1.1 Robot coordinate systems	3. 1
3.1.2 Outline dimensions	3. 2
3.1.3 Motion range	3. 4
3.1.4 Wiring and piping for hand	3.11
3.2 Controller	3.15
3.2.1 Name of each part	3.15
3.2.2 Outline dimensions	3.17
3.2.3 External input/output	3.18
3.3 Software	3.25
3.3.1 Command list	3.25
3.3.2 Parameters	3.28

4. FACTORY SHIPMENT SPECIAL SPECIFICATIONS, OPTIONS AND MAINTENANCE PARTS

4.1 Factory shipment special specifications	4. 1
---	------

■ CONTENTS

4.2 Options	4. 2
(1) Pneumatic hand set	4. 4
(2) Motorized hand set	4. 8
(3) Solenoid valve set	4.11
(4) Hand input cable (Hand check cable)	4.14
(5) Hand output cable (Solenoid valve connection cable)	4.15
(6) Hand curl tube	4.16
(7) Calibration jig	4.17
(8) Teaching box (P6TB - T)	4.18
(9) Parallel I/O interface	4.21
(10) External I/O cable	4.24
(11) Rack adapter	4.2
(12) Personal computer cable	4.27
(13) Personal computer support s/w	4.28
(14) Expansion serial interface	4.30
(15) Additional axis interface	4.33
4.3 Maintenance parts	4.37

5. EXPLANATION OF SPECIFICATIONS

5.1 Definition of specification	5. 1
5.1.1 Position repeatability and positioning accuracy	5. 1
5.1.2 Rated load (load capacity)	5. 2
5.2 Working environment and protection specifications	5.
5.2.1 Robot arm (Basic type)	5. 4
5.2.2 Robot arm (Oil mist specification type)	5. 5
5.2.3 Controller and teaching box	5. 5

6. SAFETY

6.1 Safety	6. 1
6.1.1 Self - diagnosis stop functions	6. 1
6.1.2 External input/output signals for safety protection measures	6. 2
6.1.3 Precautions for robot application	6. 3
6.1.4 Safety measures for automatic operation	6. 3
6.1.5 Safety measures for teaching	6.
6.1.6 Safety measures for maintenance and inspections, etc.	6. 4

■ CONTENTS

6.1.7 Examples of safety measures	6. 5
-----------------------------------	------

APPENDIX

Standard devices and option devices	Appendix - 1 -
Operation range diagram. RV – E2 (Flange down)	Appendix - 3 -
Operation range diagram. RV – E2 (Flange front)	Appendix - 4 -
Operation range diagram. RV – E3J, RV – E3JM (Flange down)	Appendix - 5 -
Operation range diagram. RV – E3J, RV – E3JM (Flange front)	Appendix - 6 -
Documents for consultations of E Series robot specifications	Appendix - 7 -

1. GENERAL CONFIGURATION

1.1 Configuration Devices

The following devices are included in this system.

■ Standard configuration devices

- ① Robot arm
 - ② Controller
 - ③ Machine cables (Power cable and signal cable set)
- The following accessories and documents are enclosed with this system.
- ④ Robot arm installation bolts (with washers)
 - ⑤ Instruction manual
 - ⑥ Guarantee card

■ Factory shipment special specifications

Some standard devices are changed before shipment from the factory. Confirm the delivery of these specifications.

Changes in the specifications after shipment will require on-site work or for the system to be returned to Mitsubishi.

■ Options

The options can be installed after shipment. All installation must be done by the user.

■ Maintenance parts

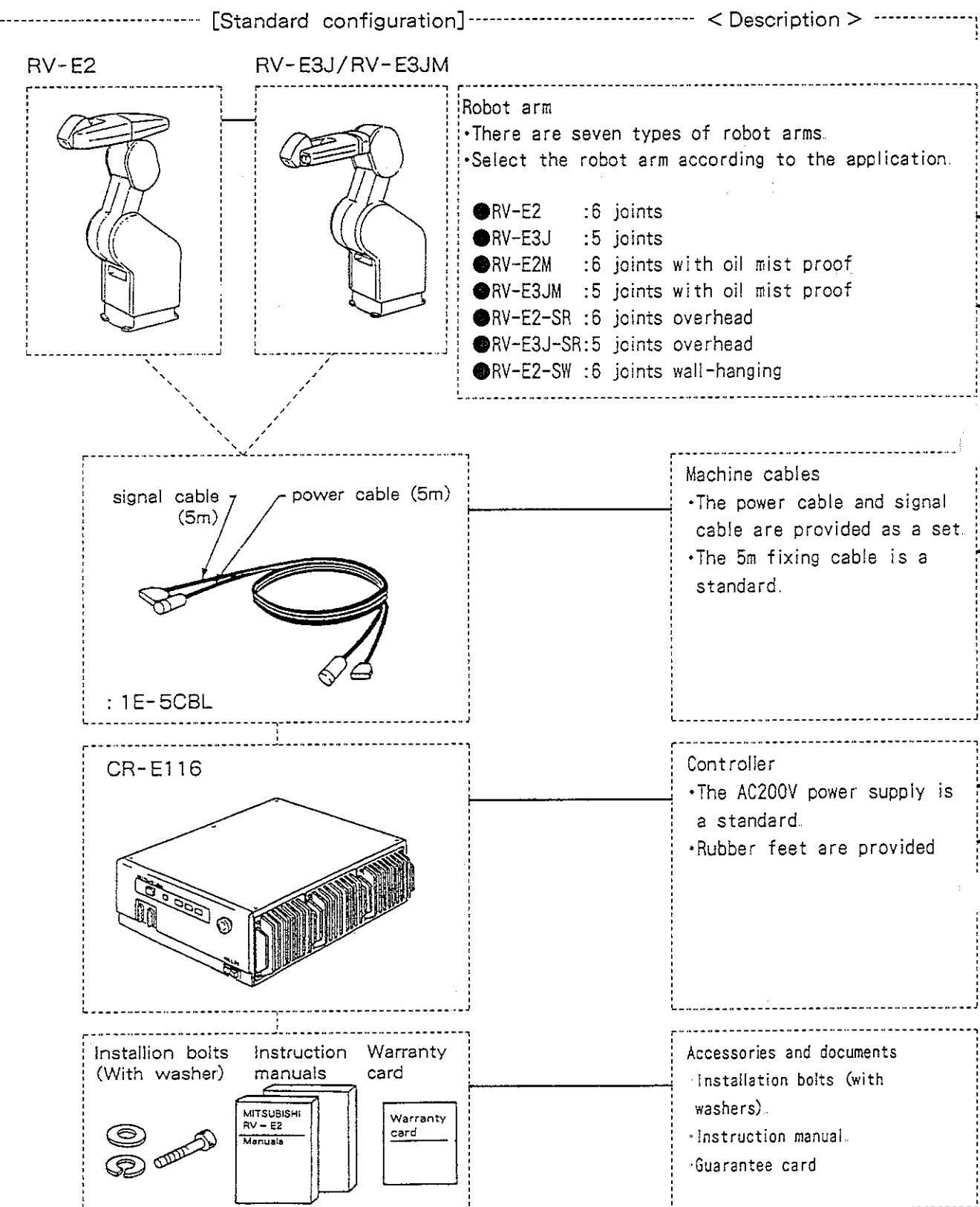
These are consumable parts and spare parts for maintenance.

Consult with your dealer or the Mitsubishi Electric Service Center for parts that are not listed.

1.2 Details of configuration devices

A list and details of the devices are given in Fig. 1.1.

• REVIEW



[Caution] The primary power supply cable is to be provided by the user.

Fig. 1.1 Configuration devices

• CONFIGURATION

△ : Option

□ : Factory shipment special specifications

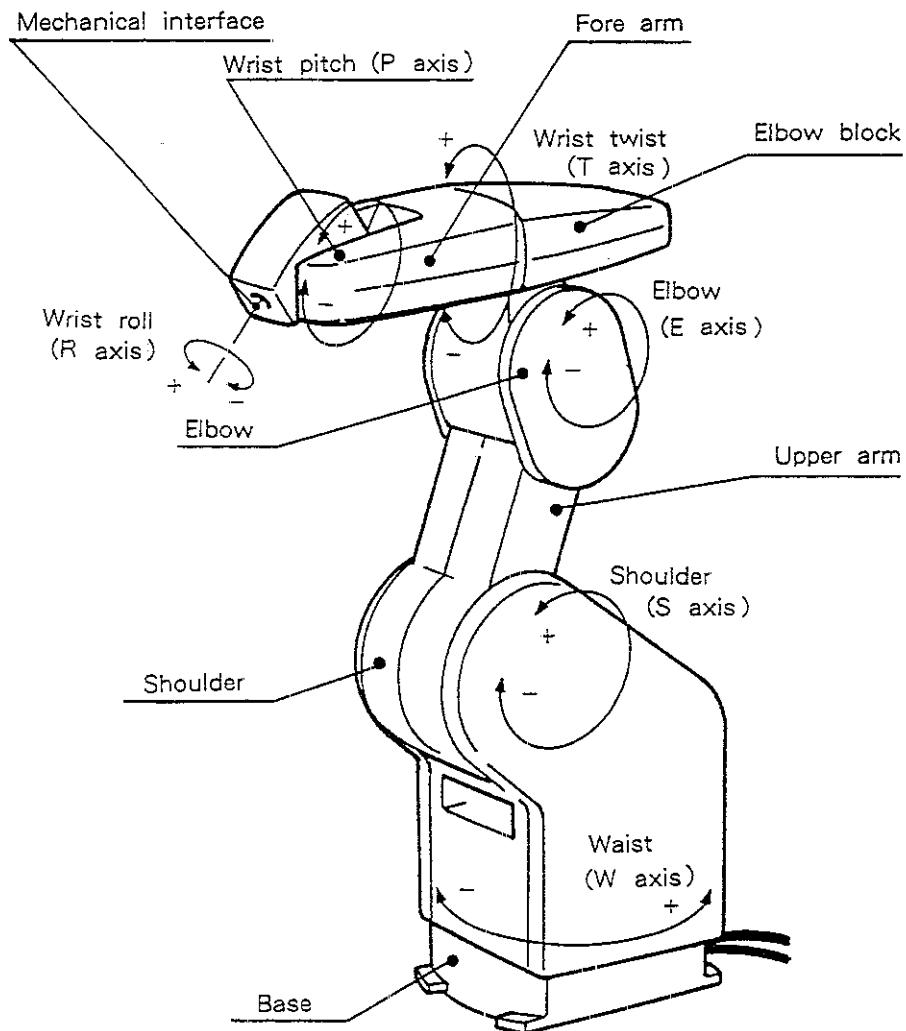
○ : Maintenance parts

Item	Type	Division	
Pneumatic hand set	4E-HP01 4E-HP01E	△ △	A hand interface board solenoid and hose are enclosed. (U.S.A., JAPAN)
Motorized hand set Modification of W axis operation range	4E-HM01 1E-DH***-000	△ □	A hand interface board solenoid and hose are enclosed. (EUROPE) A motorized hand interface board is enclosed. The W axis operation space has been changed. (Excluding RV-E2-SW)
Single solenoid valve set	1E-VD01 1E-VD01E	△ △	This is the solenoid valve set for the single pneumatic hand. (U.S.A., JAPAN)
Double solenoid valve set	1E-VD02 1E-VD02E	△ △	This is the solenoid valve set for the double pneumatic hand. (U.S.A., JAPAN)
			This is the solenoid valve set for the double pneumatic hand. (EUROPE)
Hand output cable	1E-GR35S	△	This is the cable connected to the hand output connector by the user.
Hand input cable	1E-HC15C	△	This is the cable connected to the hand sensor by the user.
Single hand curl tube	1E-ST0402C	△	This is the outer diameter φ4×2 pc curled air tube for the single hand.
Double hand curl tube	1E-ST0404C	△	This is the outer diameter φ4×4 pc curled air tube for the double hand.
Calibration jig	1E-INST	△	This is the adjustment jig used to improve the interpolation accuracy.
Machine cables(15m:fixing) Machine cables(15m:flexible)	1E-15CBL 1E-15LCBL	□ □	This is used to extend the distance between the controller and robot arm.
Teaching box	P6TB-TE	△	This is the pendant with cable for teaching and correcting the position, etc
Parallel I/O interface	2E-31IO	△	This is used to expand the external input/outputs. (U.S.A., JAPAN)
External I/O cable	2E-31I/OE I/O-CBL	△ △	This is used to expand the external input/outputs (EUROPE) This is the cable connected to peripheral devices such as the external sequencer
Rack adapters	2E-RACK	△	This is the installation clamp for storing the controller in a rack
Personal computer cable (PC98)	RS-PC-CBL	△	This is the RS-232-C connection cable for communication with a personal computer.
Personal computer cable (MAXY, PC/AT)	RS-MAXY-CBL	△	Select this according to the personal computer model.
Expansion serial interface	2E-31SIO	△	This is used to expand the RS-422 and RS-232-C interface.
Additional axis interface	2E-31AXS	△	This is the general-purpose servo amplifier control interface.
Personal computer support s/w (PC98)	SW-PC-3	△	This is used to simplify the robot start up using the personal computer functions.
Personal computer support s/w (MAXY)	SW-MAXY-3	△	Select this according to the personal computer model.
Personal computer support s/w (PC/AT DOS/V)	SW-AT-3	△	PC/AT compatible model Japanese DOS/V
Personal computer support s/w (PC/AT)	SW-ATE-3	△	PC/AT compatible model English version
Pneumatic hand interface	2E-31HND 2E-31HNE	△ △	This is mounted in the exclusive slot in the controller. (U.S.A., JAPAN)
			This is mounted in the exclusive slot in the controller. (EUROPE)
Controller (stationary: 100V)	CR-E116-1	□	This is a 100V specification controller with power capacity of 3KVA.
Battery for back up	A68AT	○	This is a spare backup battery used for the mechanics and controller.
Electric Fuse	MF60NR-8A-05	○	This is for protection of the controller.
Grease	SK-1A	○	This is for lubricating the robot arm's reduction gears and bearings.

• CONFIGURATION

1.3 Name of each robot arm part

The names of the external robot arm parts are shown in Fig. 1.2.



[Caution] The RV-E3J, RV-E3JM and RV-E3J-SR 5-axis specifications do not have the T axis.

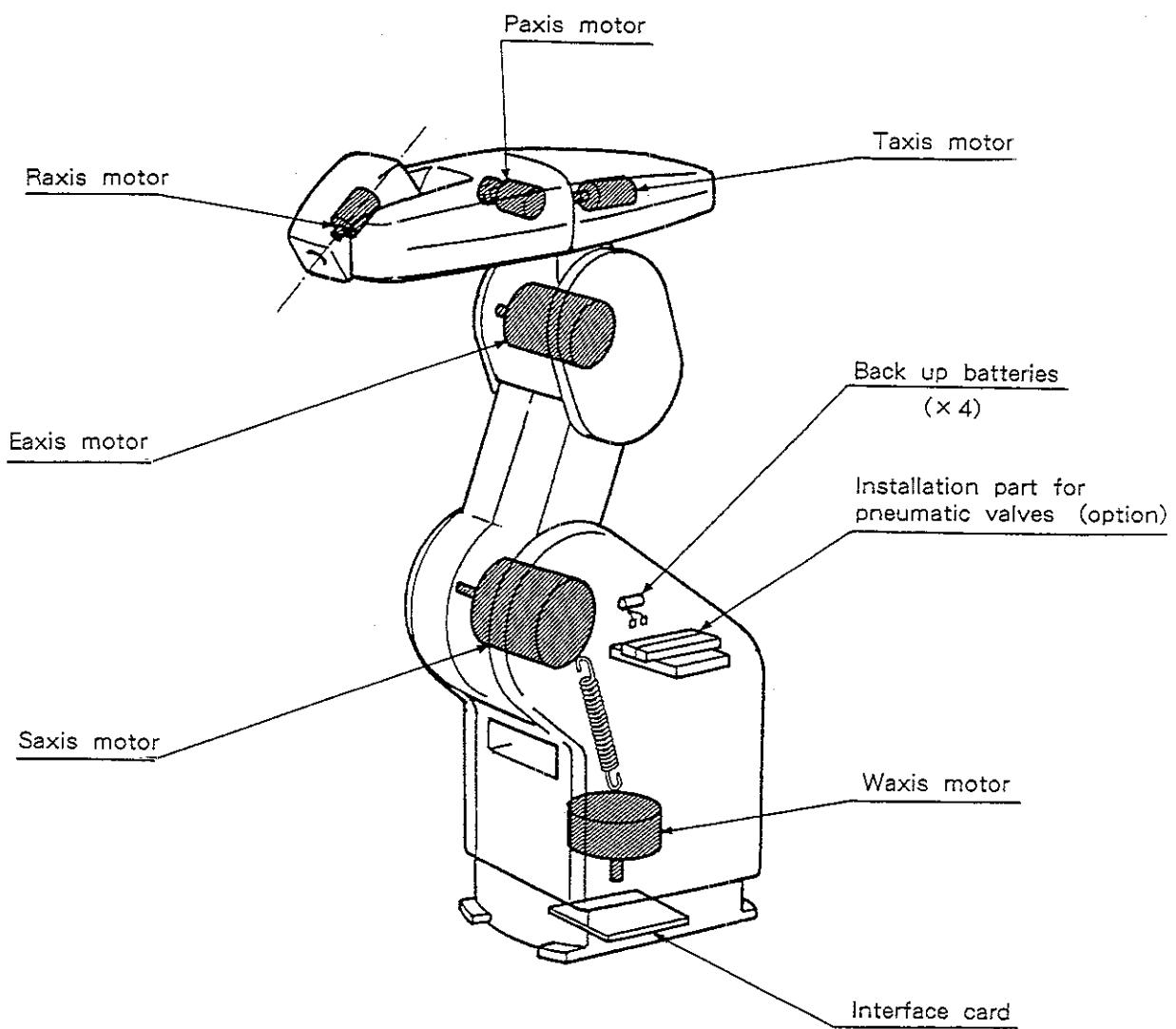
Fig. 1.2 Names of robot arm parts : External

[Reference] The name of each axis is defined as shown below.

- W axis : Waist Waist axis.
- S axis : Shoulder Shoulder axis
- E axis : Elbow Elbow axis
- T axis : Wrist twist Wrist twist axis
- P axis : Wrist Pitch Wrist pitch axis
- R axis : Wrist Roll Wrist roll axis

• CONFIGURATION

The names of each part in the robot arm are shown in Fig. 1.3.



[Caution] The RV-E3J, RV-E3JM and RV-E3J-SR 5-axis specifications do not have the T axis.

Fig. 1.3 Names of robot arm parts : Internal

2. STANDARD SPECIFICATIONS

2.1 Robot arm

The standard specifications of the robot arm are shown in Table 2.1.

Table 2.1. Robot arm standard specifications

Specification item	Unit	Standard specifications								
Type		RV-E2	RV-E2M	RV-E2-SR	RV-E2-SW	RV-E3J	RV-E3JM			
Installing posture		Floor mounted	Floor mounted	Ceiling mounted	Wall mounted	Floor mounted	Floor mounted			
Construction		Vertical articulated type								
Degree of freedom		6			5					
Drive method		AC servomotor								
Drive motor capacity		W, S, E joint:80W (With brakes) T P, R joint:40W (Without brakes)								
Position detection method		Absolute encoder								
Arm length	Shoulder shift	mm	100	100	100	100	100			
	Upper arm		250	250	250	250	250			
	Fore arm		250	250	280	280	280			
	Elbow shift		130	130	20	20	20			
	Wrist length		85	85	85	85	85			
Operation range (Max speed)	Waist W	Degree (Degree/s)	±160(150)	±160(150)	±30(150)	±160(150)	±160(150)			
	Shoulder S		180(150)	180(150)	180(150)	180(150)	180(150)			
	Elbow E		120(180)	120(180)	120(180)	135(180)	135(180)			
	Wrist twist T		±160(180)	±160(180)	±160(180)	—	—			
	Wrist pitch P		±120(180)	±120(180)	±120(180)	±120(180)	±120(180)			
	Wrist roll R		±200(250)	±200(250)	±200(250)	±200(250)	±200(250)			
Max. imum composite speed	mm/S	3500			3500					
Rated load	N(kgf)	19.6{2}			29.4{3}					
Position repeatability	mm	±0.04			±0.04					
Ambient temperature	°C	0~40			0~40					
Weight	N(kgf)	353{36}	363{37}	353{36}	324{33}	334{34}	324{33}			
Rated moment	Wrist twist T.	N·m {kgf·m}	3.6{0.37}	3.6{0.37}	—	—	—			
	Wrist pitch P		3.6{0.37}	3.6{0.37}	5.4{0.55}	5.4{0.55}	5.4{0.55}			
	Wrist roll R		2.6{0.27}	2.6{0.27}	3.9{0.40}	3.9{0.40}	3.9{0.40}			
Tolerable inertia	Wrist twist T.	kg·m ² {kgf·m ² }	1.1×10 ⁻² {11.0}	1.1×10 ⁻² {11.0}	—	—	—			
	Wrist pitch P		1.1×10 ⁻² {11.0}	1.1×10 ⁻² {11.0}	1.1×10 ⁻² {11.0}	1.1×10 ⁻² {11.0}	1.1×10 ⁻² {11.0}			
	Wrist roll R		4.1×10 ⁻³ {4.1}	4.1×10 ⁻³ {4.1}	4.1×10 ⁻³ {4.1}	4.1×10 ⁻³ {4.1}	4.1×10 ⁻³ {4.1}			
Reachable radius (Front P axis center point)	mm	621			630					
Tool wiring		6 lines hand check (including two for power supply used for four input points) 4 spare lines (stored from base to end of forearm: size 0 3SQ)								
Tool air piping		Primary side:φ6×2 Secondary side:φ4×4	Primary side:φ6×2 Secondary side:φ4×6	Primary side :φ6×2 Secondary side:φ4×4	Primary side:φ6×2 Secondary side:φ4×4	Primary side:φ6×2 Secondary side:φ4×6	Primary side:φ6×2 Secondary side:φ4×4			
air supply pressure	kgf/cm ²	5±10%								
Protection specification		IP30	IP54	IP30	IP30	IP54	IP30			

- Refer to section 2.5 for details on the protection specifications.
- Refer to chapter 3 for details on the changes in the motion range

• STANDARD SPECIFICATIONS

2.2 Controller

The controller specifications are shown in Table 2.2.

Table 2.2 Controller standard specifications

Item	Standard specifications		Remarks
Type	CR-E116		
Path control method	PTP control, CP control		
No. of controllable axes	5 or 6 simultaneous axes		
CPU	Main CPU (32-bit RISC), servo CPU (DSP)		
Main function	Joint interpolation, linear interpolation, 3D circular interpolation, palletizing, interrupt control, condition branching, subroutine		
Memory capacity	No. of teaching points	For teaching playback method: total 2000 steps Note 1) For command method: Max 999 teaching points/program Max 4000 programs steps/program	The memory capacity is 62k bytes. The specification values on the left are a guideline, and may differ according to the conditions. Note 1) The interpolation, speed input/output and timer condition settings are included in the steps.
	number of Programs	Max 31 programs	
Programming method	Personal computer or teaching box		
Programming language	MOVEMASTER commands (Automatically generated when using teaching playback method.)		
Position teaching method	Combination of teaching box, teaching playback method using personal computer or MDI method.		Teaching box and personal computer software are options.
External Input / output	General purpose	20 input points 16 output points	40 input points and 32 output points can be added.
	Exclusive	Assigned by user with general purpose input/output	
	Hand open/close	0 points (select either motorized or pneumatic hand with options.)	4 input points and 4 output points for hand open/close confirmation (For pneumatic hand interface)
	Emergency stop	1 point in controller (User wiring terminal block)	
Interface	1 RS-232-C port (for personal computer connection) 1 RS-422 port (for teaching box connection) 2 expansion slots 1 hand interface slot		
Ambient temperature	0 to 40 degrees.		
Ambient humidity	45 to 85 % without dew drop		With no dew condensation
Power source	Single-phase AC200V±10%, 50/60Hz, 3KVA [Caution]		[Caution]
Grounding	Class 3 grounding		
Construction	Independent standalone type		Rack installation is possible with rack installation adaptor option
Outline dimension	Approx. 422W × 512D × 202H mm		
Weight	Approx. 265N (Approx. 27kgf)		

- The personal computer must be provided by the user.
- The grounding work is to be done by the user.

[Caution] Note that the power capacity (3KVA) does not include the rush current when the power is turned on.

• STANDARD SPECIFICATIONS

2.3 Standard color

The standard colors of the devices are shown in Table 2.3.

Table 2.3 Standard equipment colors

Equipment name	Part	Color	Reference man cell color		Note
Robot arm	Arm part	Light gray	Munsell	7.65Y7.6/0.73	Resin
	Base part	Oyster gray	Munsell	4.94GYS.13/0.39	Painting
Controller	Robot arm	Light gray	Munsell	7.65Y7.6/0.73	Printing

The paint color is subject to change without notice.

Colors other than the above standard colors are available at the user's expense.

2.4 Operation environment

Avoid installation in the following places as the equipment's life and you should take precaution to use it under the following environment. When using in the following conditions, the user must pay special attention to the preventive measures.

(1) Power source

- Where the voltage fluctuation will exceed $\pm 10\%$ of the rated voltage.
- Where a momentary power failure exceeding 15ms may occur.
- Where the power capacity (3KVA) cannot be secured

(2) Noise

- Where a surge voltage exceeding 1000V, $1\mu s$ may be applied on the primary voltage. Near large inverters, high output frequency transmitters, large capacitors and welding machines.

Static noise may enter the lines when this product is used near radios or televisions. Keep the robot away from these items.

(3) Temperature and humidity

- Where the atmospheric temperature is 40°C or more, 0°C or less.
- Where the robot will be subject to direct sunlight or near heat generating sources such as heaters.
- Where the relative humidity is 45% or less, 85% or more, and where dew may condense.

(4) Atmosphere

- In an atmosphere containing dust or corrosive gases.
- Where cutting chips from metal machining or conductive substances may be scattered.

Refer to section 2.5 for the details on the oil mist environment.

• STANDARD SPECIFICATIONS

(5) Vibration

- Where excessive vibration or impact may be applied.

(Use in an environment of 3.5G during transportation and 0.5G or less during operation.)

(6) Installation environment

- Where strong electric fields or magnetic fields are generated.
- Where the installation surface is rough. (Avoid installing the robot on a bumpy or inclined floor.)

2.5 Protection specifications

The E Series robot arm and controller have a protection grade that follows IEC standards. Table 2.4 shows protection grade.

Table 2.4 Protection grade

Class	General environment specifications	Oil mist specifications	
Model	RV-E2 (6-axis) RV-E3J (5-axis)	RV-E2M (6-axis) RV-E3JM (5-axis)	
Robot arm	IP30 (fully closed type)	IP54 (waterproof type)	
Applicable fields	General assembly Environment with low levels of dust	Machining (cutting) Machine factories with high levels of oil mist Environment with high levels of dust	Take care to use of grinding machines that use abrasive agents as the life will be shortened.
Controller	IP20 (Protective-type)	IP20 (Protective-type)	The controller is common for CR-E116. Protective measures must be taken by the user.

The IEC IP symbols define the degree of protection against solids and fluids, and do not indicate a protective structure against the entry of oil or water. The evaluation regarding oil mist has been confirmed with Mitsubishi's standard testing methods. The RV-E2M and RV-E3JM robot arms have been evaluated with the cutting oils shown in Table 2.5.

Table 2.5 Tested cutting oil and the characteristics

Name	Maker	Relevant	Main	Application
Yushiron oil No.2	Yushiron Chemical Co. (Japan)	Class 2 No. 2	Fat oil :5.0 % Chlorine content :2.0 %	Cutting of nonferrous metal such as aluminum alloys, etc. Wide range of machining such as cutting of FC material.

The evaluation on the oil mist is limited to the confirmation made with the Mitsubishi standard testing methods. There are many types of cutting oils, and thus, not all have been tested. Thus, the life may be shortened and faults may occur depending on the applied cutting oil and work conditions.

Install the controller in a place where it will not be affected by oil mist.

Precautions regarding the protection functions and the application of each model are given in Chapter 5.

2.6 Safety

See the "Safety Manual", and Chapter 6 in this manual.

2.7 Precautions for handling

- (1) The robot arm has a molded cover. Parts cannot be installed and excessive force cannot be applied to the cover. A high grade of oil-proof resin is used for the molded cover.
- (2) The W, S and E axes of this robot have brakes. The precision of the robot may drop, looseness may occur and the reduction gears may be damaged if the robot is moved with force with the brakes applied.
- (3) Avoid moving the robot arm by hand. When unavoidable, gradually move the arm. If moved suddenly, the accuracy may drop due to an excessive backlash, or the back up data may be destroyed.
- (4) The wrist section may interfere with the base section even when in the motion range depending on the posture. Take care to prevent interference during jogging (JOG).
- (5) The robot arm is configured of precision parts such as bearings. Grease is used for lubricating these parts. When cold starting at low temperatures or starting operation after long-term stoppage, the position accuracy may drop or servo alarms may occur. If these types of phenomena occur, run the robot with idle operation for a short time.
- (6) The robot arm and controller must be grounded with Class 3 grounding to secure the noise resistance and to prevent electric shocks.
- (7) The items described in these specifications are conditions for carrying out the periodic maintenance and inspections described in the instruction manual.
- (8) When using the robot arm on a traveling axis or elevating table, the machine cables enclosed as standard devices may break due to the fixed installation specifications. In this case, use the "machine cable extension (for flexible)" factory shipment special specifications.
- (9) If the workpiece or peripheral devices are interfered with during speeds that exceed the "high-speed" jog speed for each axis, the position may deviate, etc. Take care to prevent interference with the workpiece or peripheral devices during operation.

3. DETAIL SPECIFICATIONS

3.1 Robot arm

3.1.1 Robot coordinate systems

The robot coordinate systems are shown in Fig. 3.1.

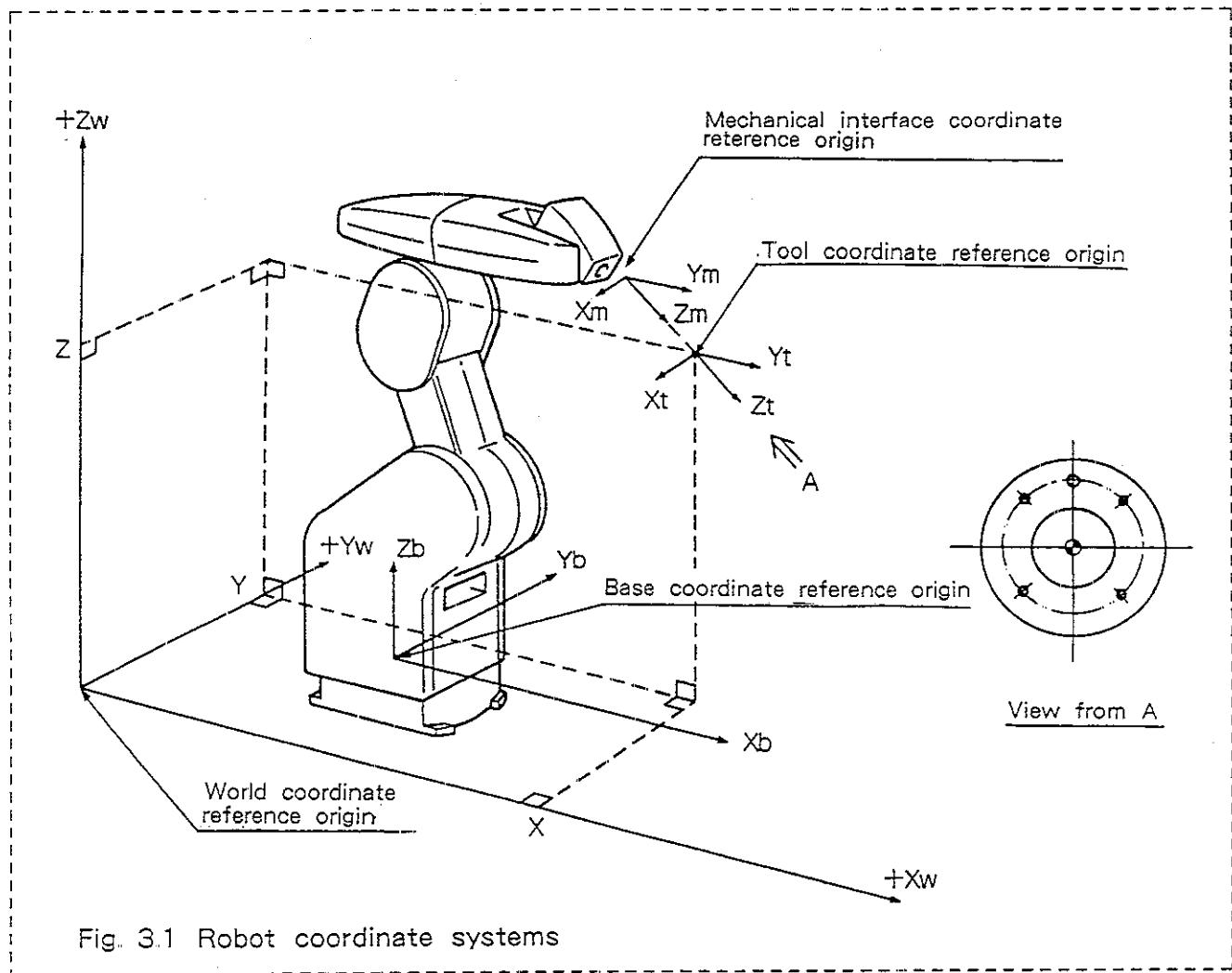


Fig. 3.1 Robot coordinate systems

[Explanation of coordinate system]

- **World coordinate system** This is the reference coordinate system that expresses the current position coordinates of the robot.
- **Base coordinate system** This is a coordinate system determined with using the robot's base installation surface as a reference. The relation to the work coordinate system is determined according to the "standard base coordinate parameter" (XBS).
- **Mechanical interface coordinate system** This is a coordinate system determined with using the robot's flange surface as a reference.
- **Tool coordinate system** This is a coordinate system tool installed on the robot flange surface as a reference. The relation with the mechanical interface coordinate system is determined according to the "standard tool coordinate parameter" (XTL).

• DETAIL SPECIFICATIONS

3.1.2 Outline dimensions

The outline dimensions of the RV-E2, RV-E2M, RV-E2-SR and RV-E2-SW robot arms are shown in Fig. 3.2. The outline dimensions of the RV-E2, RV-E2M, RV-E2-SR and RV-E2-SW are the same.

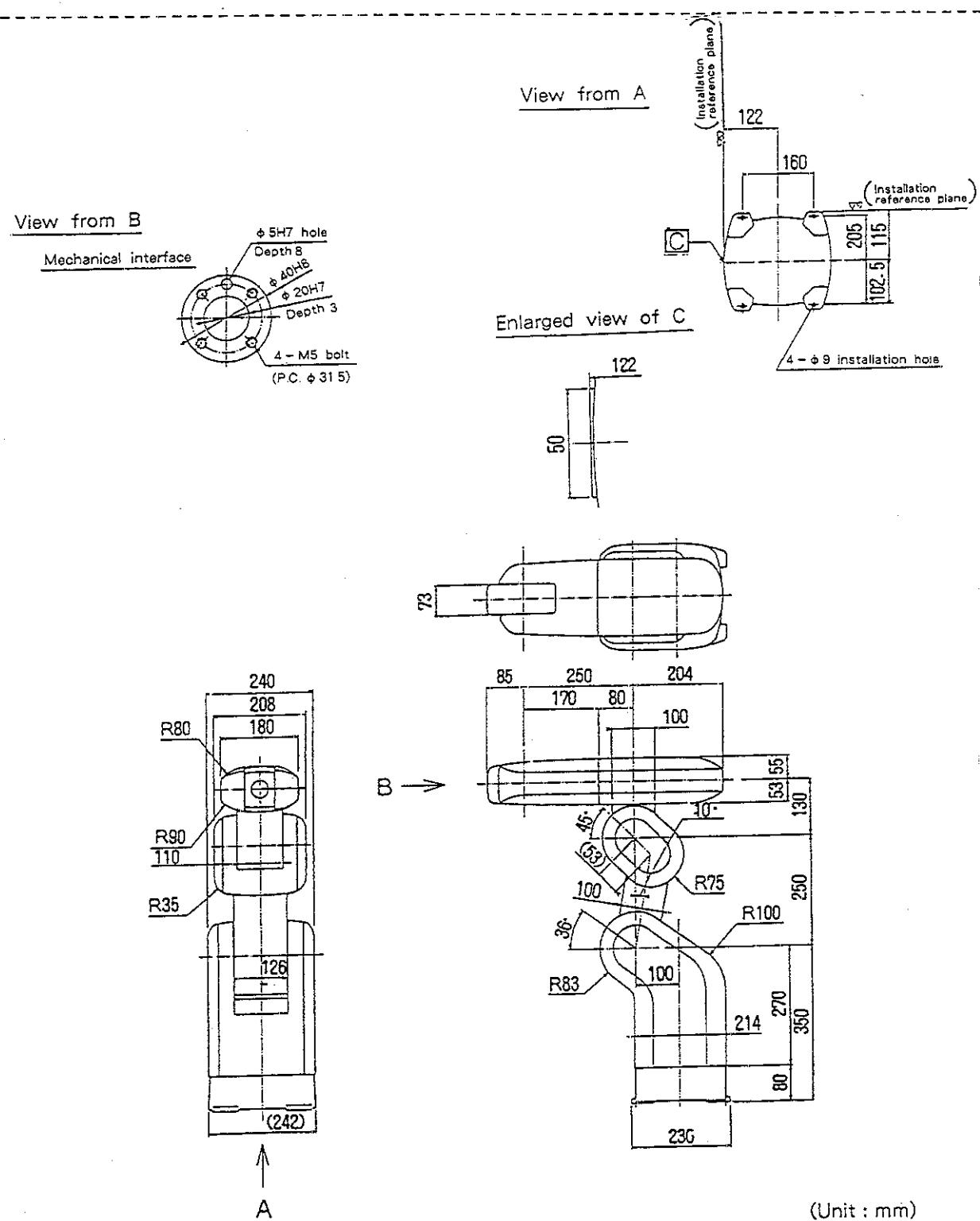


Fig. 3.2 Robot arm outline dimensions : RV-E2, RV-E2M,
RV-E2-SR, and RV-E2-SW

- DETAIL SPECIFICATIONS

The outline dimensions of the RV-E3J, RV-E3JM and RV-E3J-SR robot arms are shown in Fig.3.3. The outline dimensions of the RV-E3J, RV-E3JM and RV-E3J-SR are the same.

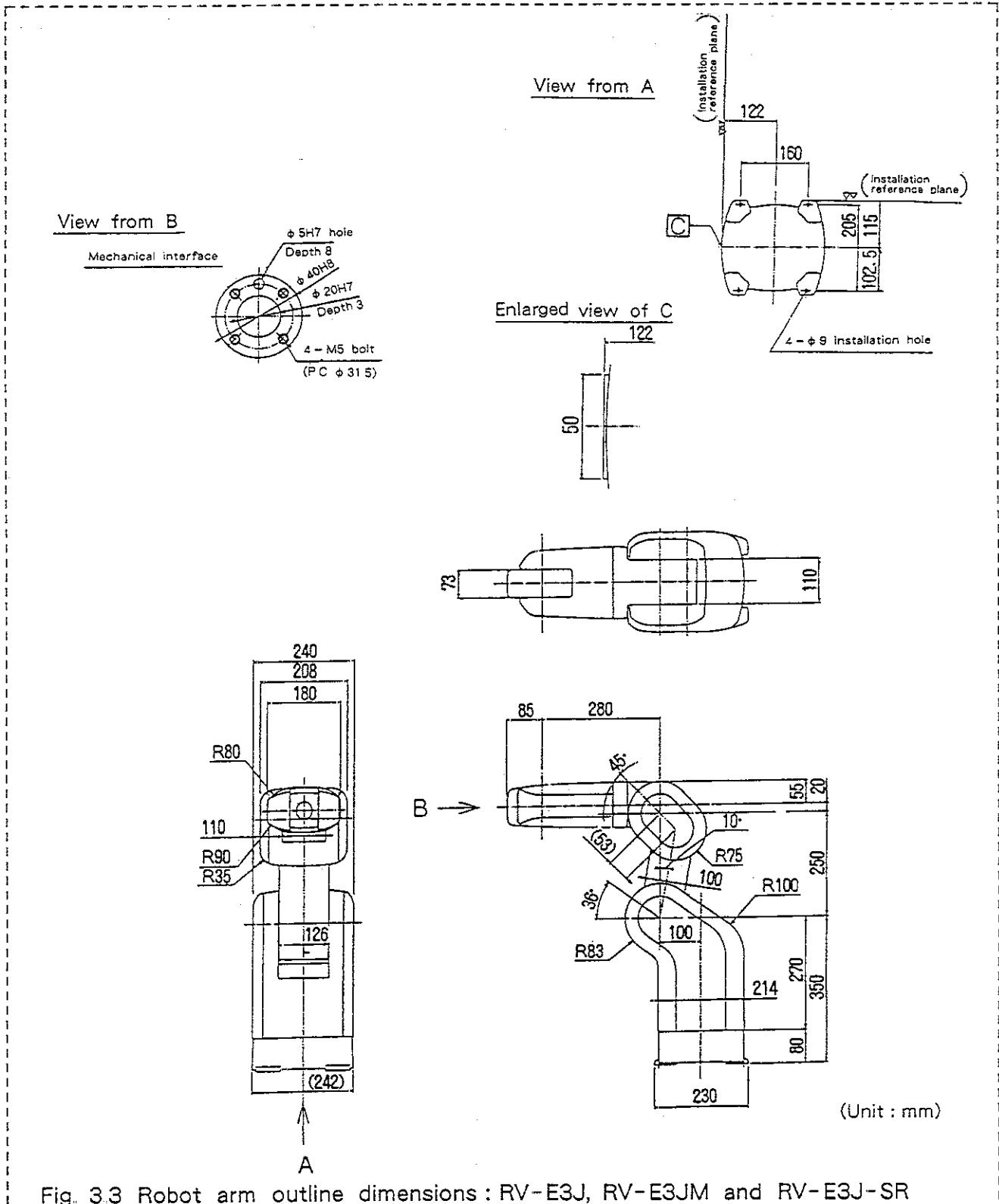


Fig. 3.3 Robot arm outline dimensions : RV-E3J, RV-E3JM and RV-E3J-SR

• DETAIL SPECIFICATIONS

3.1.3 Motion range

The motion ranges of the RV-E2 and RV-E2M are shown in Fig. 3.4.

The motion ranges of the RV-E2 and RV-E2M are the same.

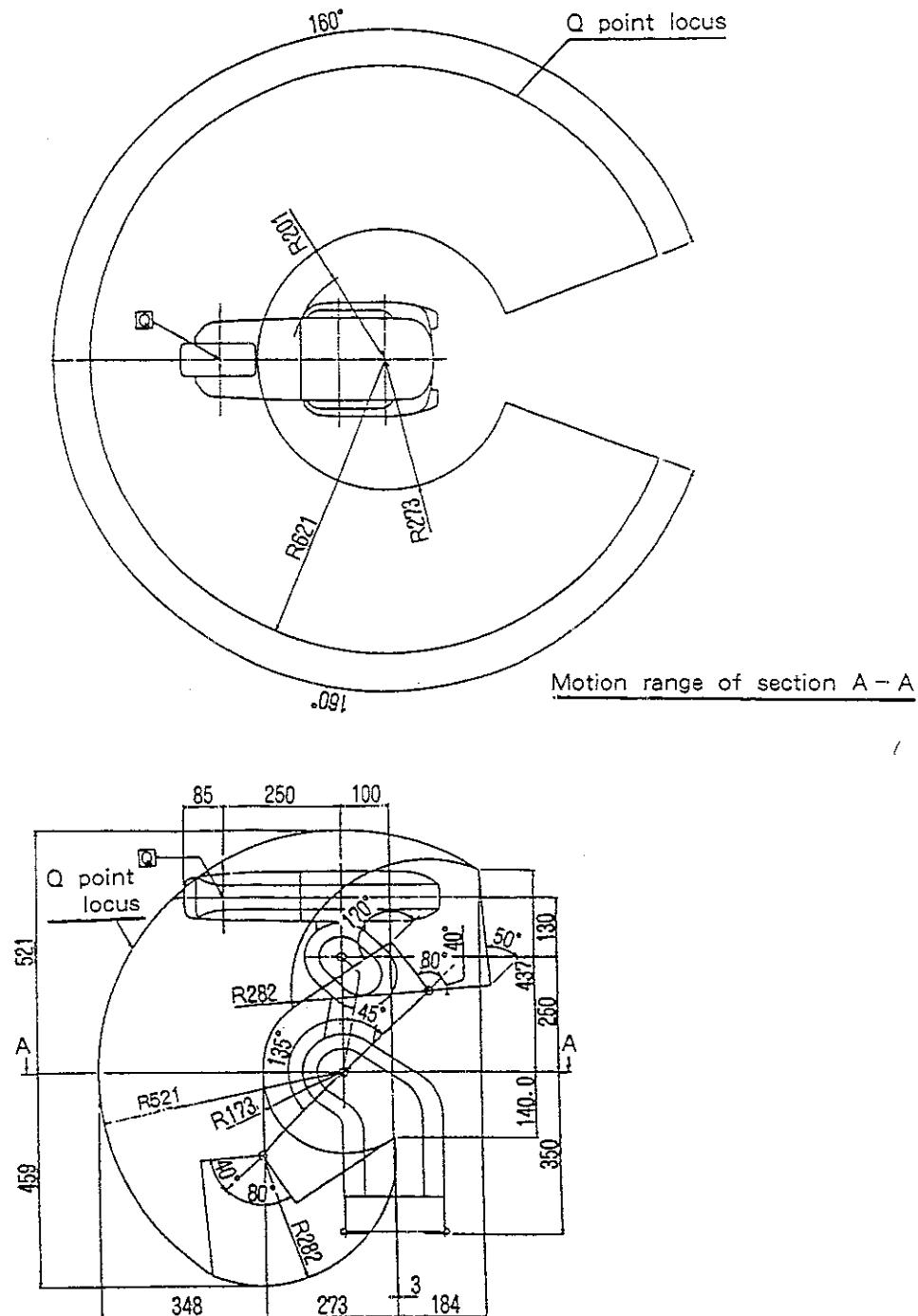


Fig.3.4 Motion range : RV-E2 and RV-E2M

[Caution] The motion range drawing does not show the state with the hand installed.
(Q point locus in the drawing.)

• DETAIL SPECIFICATIONS

The motion range of the RV-E2-SR is shown in Fig. 3.5.

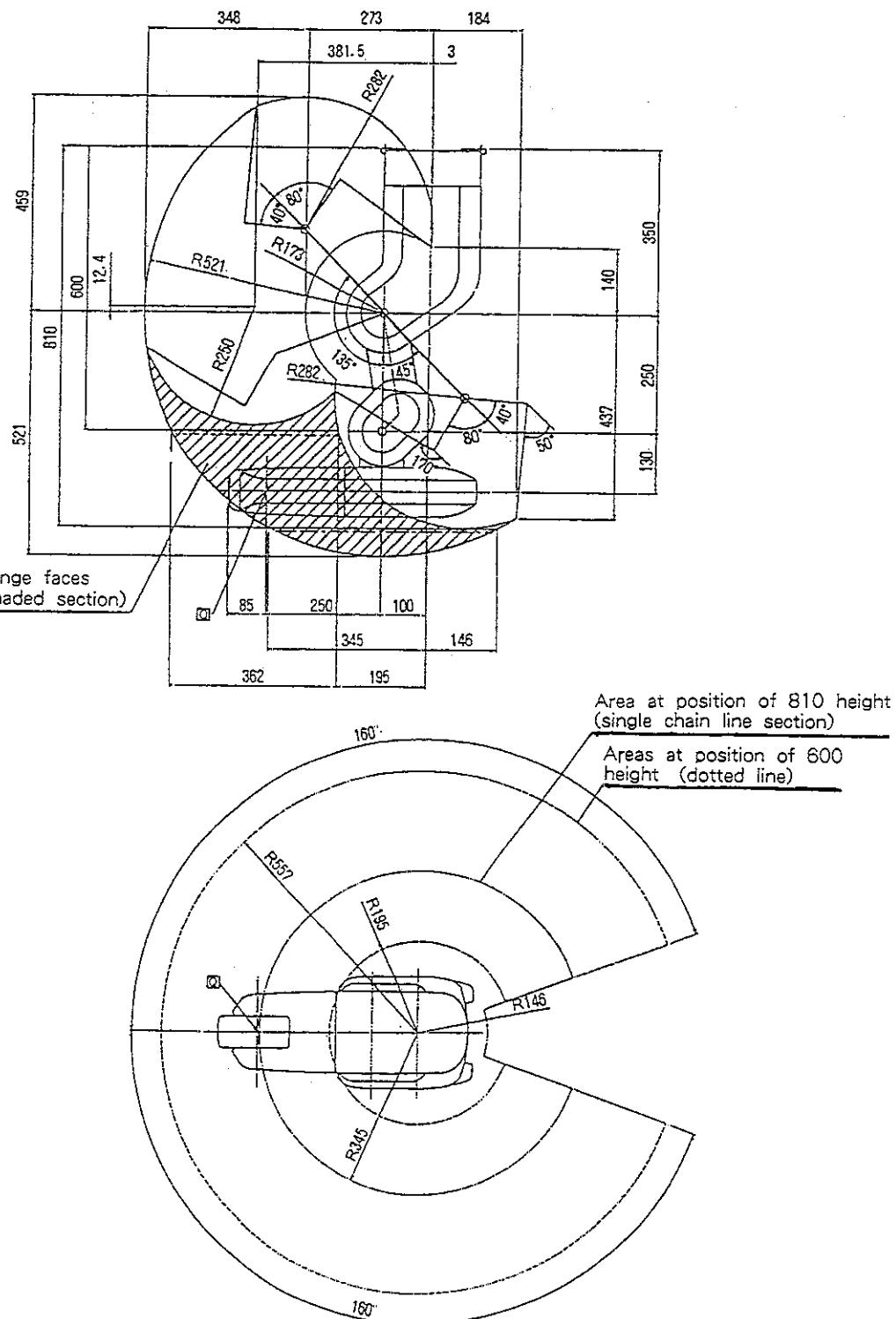


Fig 3.5 Motion range : RV-E2-SR

[Caution] The motion range drawing does not show the state with the hand installed.
(Q point locus in the drawing.)

• DETAIL SPECIFICATIONS

The motion range of the RV-E2-SW is shown in Fig. 3.6.

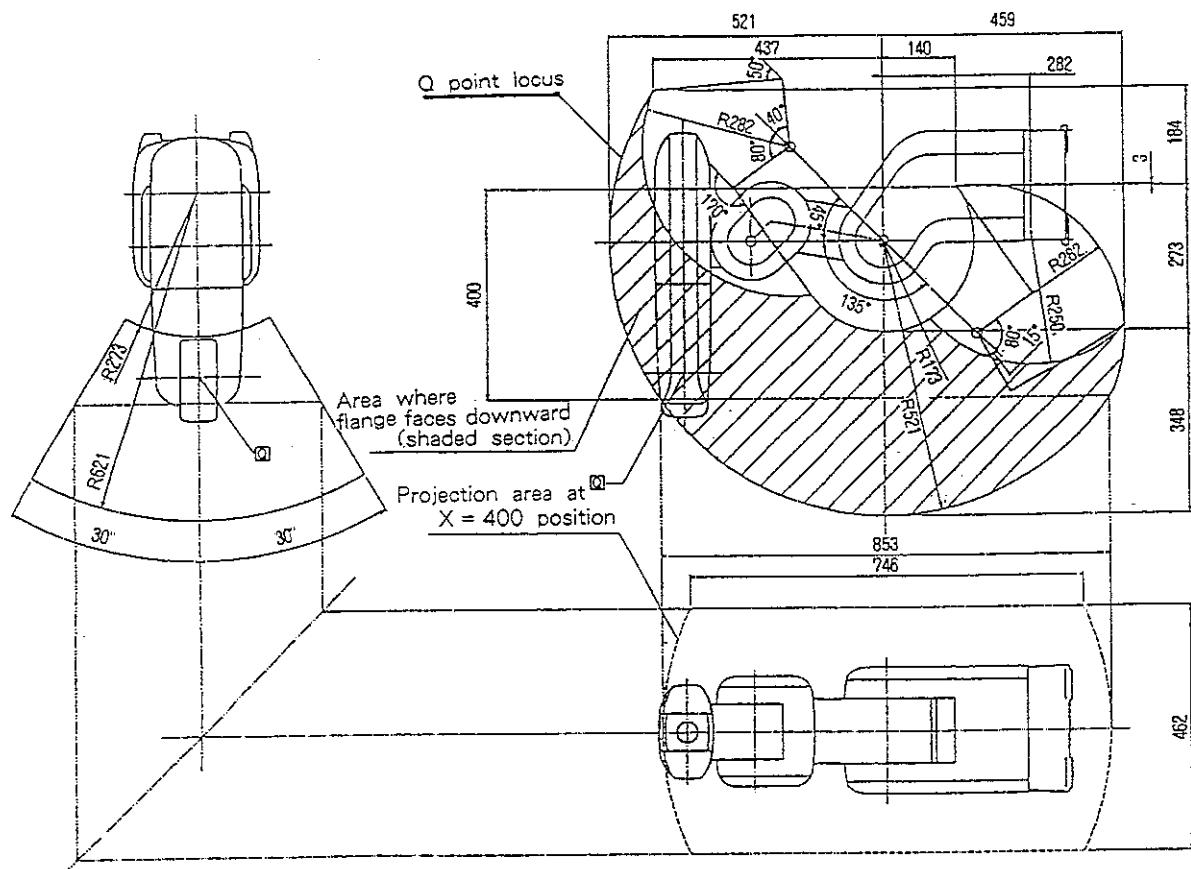


Fig 3.6 Motion range : RV-E2-SW

[Caution] The motion range drawing does not show the state with the hand installed
(Q point locus in the drawing.)

• DETAIL SPECIFICATIONS

The motion ranges of the RV-E3J and RV-E3JM are shown in Fig. 3.7.

The motion ranges of the RV-E3J and RV-E3JM are the same.

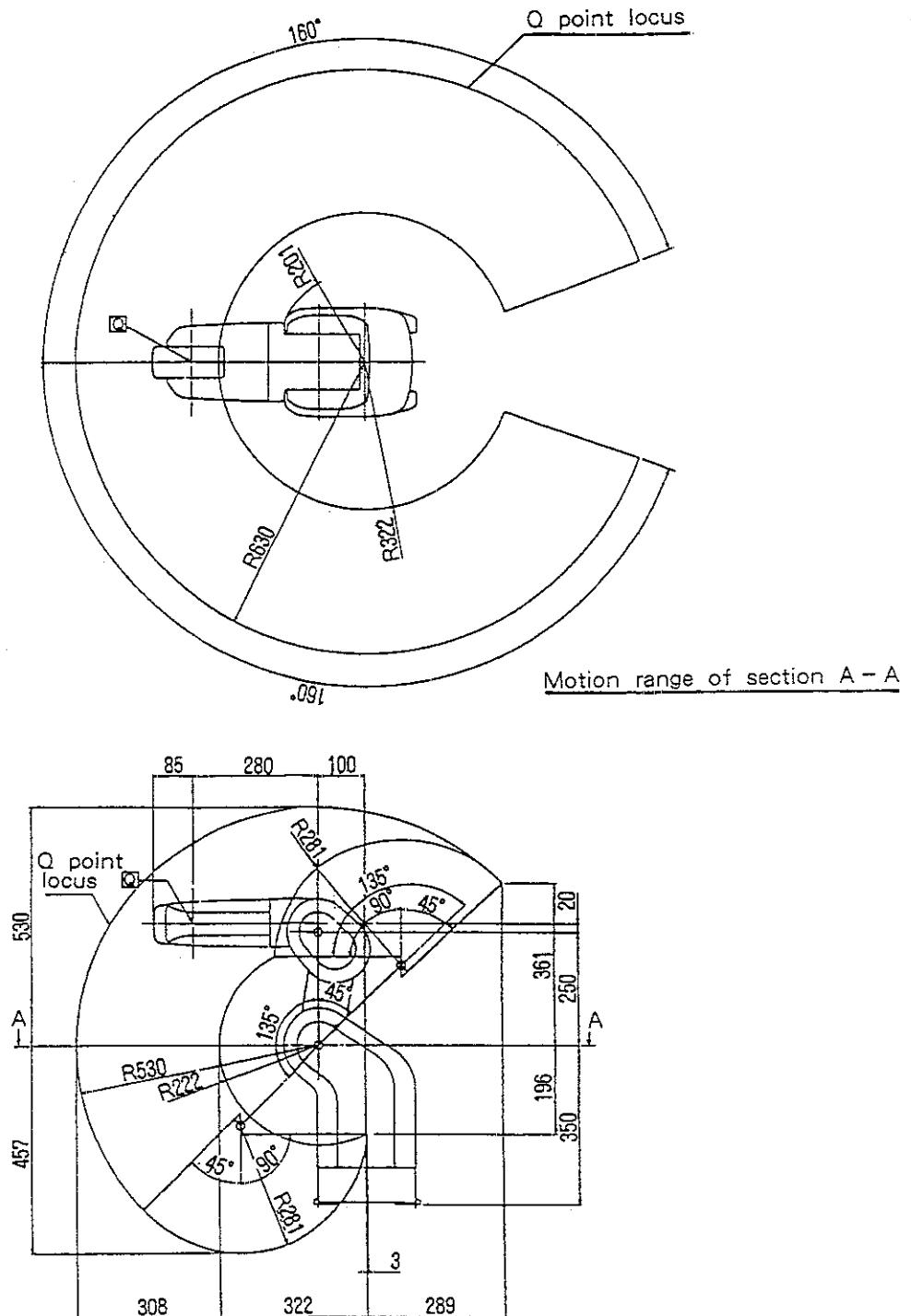


Fig. 3.7 Motion range : RV-E3J and RV-E3JM

[Caution] The motion range drawing does not show the state with the hand installed.
(Q point locus in the drawing.)

- DETAIL SPECIFICATIONS

The motion range of the RV-E3J-SR is shown in Fig. 3.8.

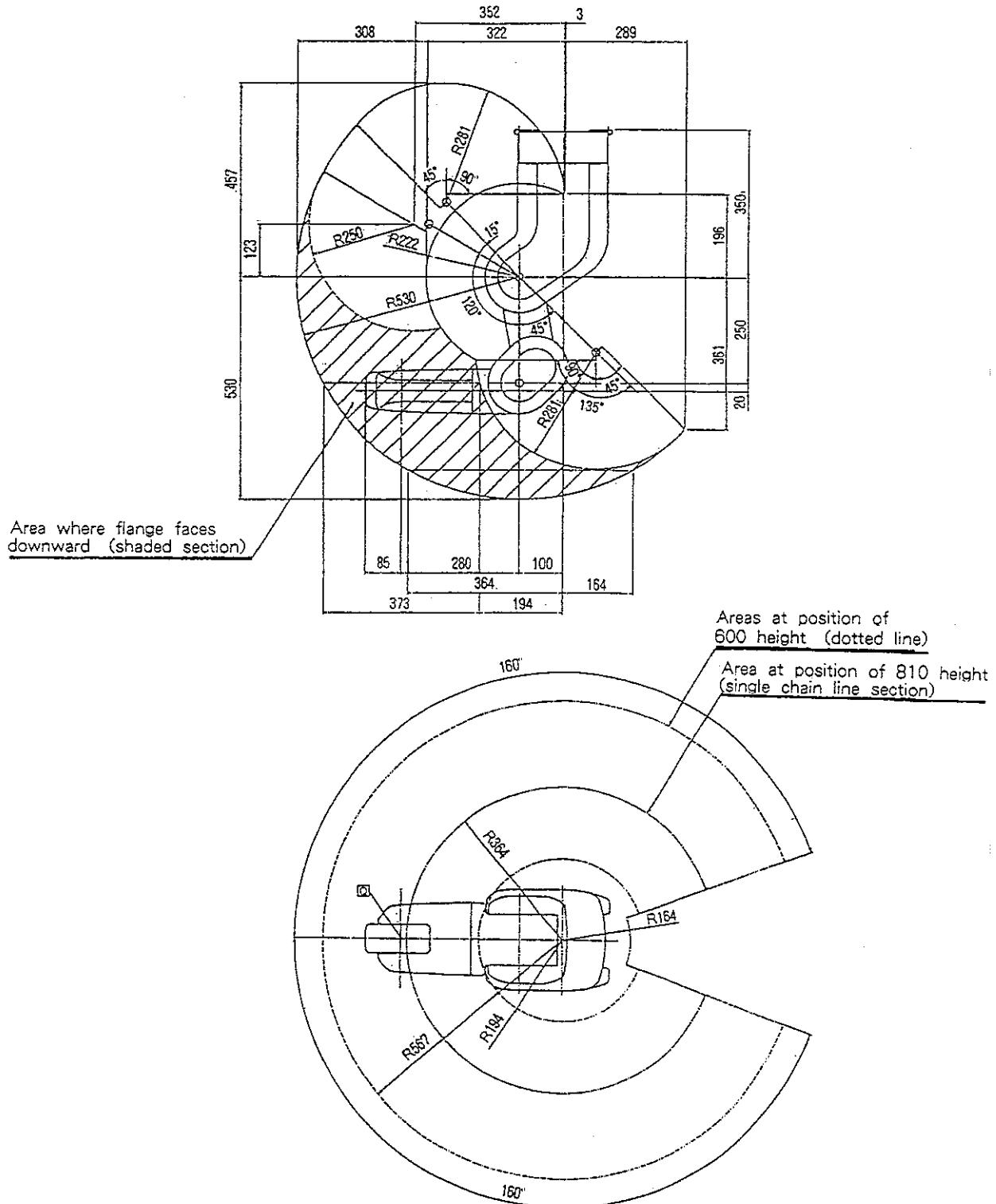


Fig. 3.8 Motion range : RV-E3J-SR

[Caution] The motion range drawing does not show the state with the hand installed.
(Q point locus in the drawing.)

• DETAIL SPECIFICATIONS

■ Changing of motion range

Of the motion ranges, only the W (waist) axis can be changed as a factory shipment special specification.

All models, excluding RV-E2-SW, are targeted for the changes.

Table 3.1 Robot arm motion range changeable angle: Only the W (waist) axis can be changed.

	Axis	Standard	Changeable angle	Type
J1	+ side	+160°	One point out of +120° +90° +60° or +30°	1E-DH *** - *** Plus side Minus side
	- side	-160°	One point out of -120° -90° -60° or -30°	The angle is described with *.

Note)

1. Each of the above motion range changes can be set independently. The counterclockwise direction looking from above is the + side.
2. The above details on the motion range changes control the mechanical stopper of the robot arm and the controller parameters before shipment from the factory. Always instruct changes when placing the order.
3. The above limit range indicates the motion range by the software. The limits by the mechanical stopper will be 5° outward from the above values, and must be considered when designing the layout.
4. There are ± 5 types of changeable angles for the W axis. When used in combination with the standard positions, a total of 24 types of motion ranges can be set. Refer to the following examples for the motion range change option types when placing the order.

Example of type

Plus side	Minus side	Type
+ 90°	-120°	1E-DH090-120
+120°	- 60°	1E-DH120-060

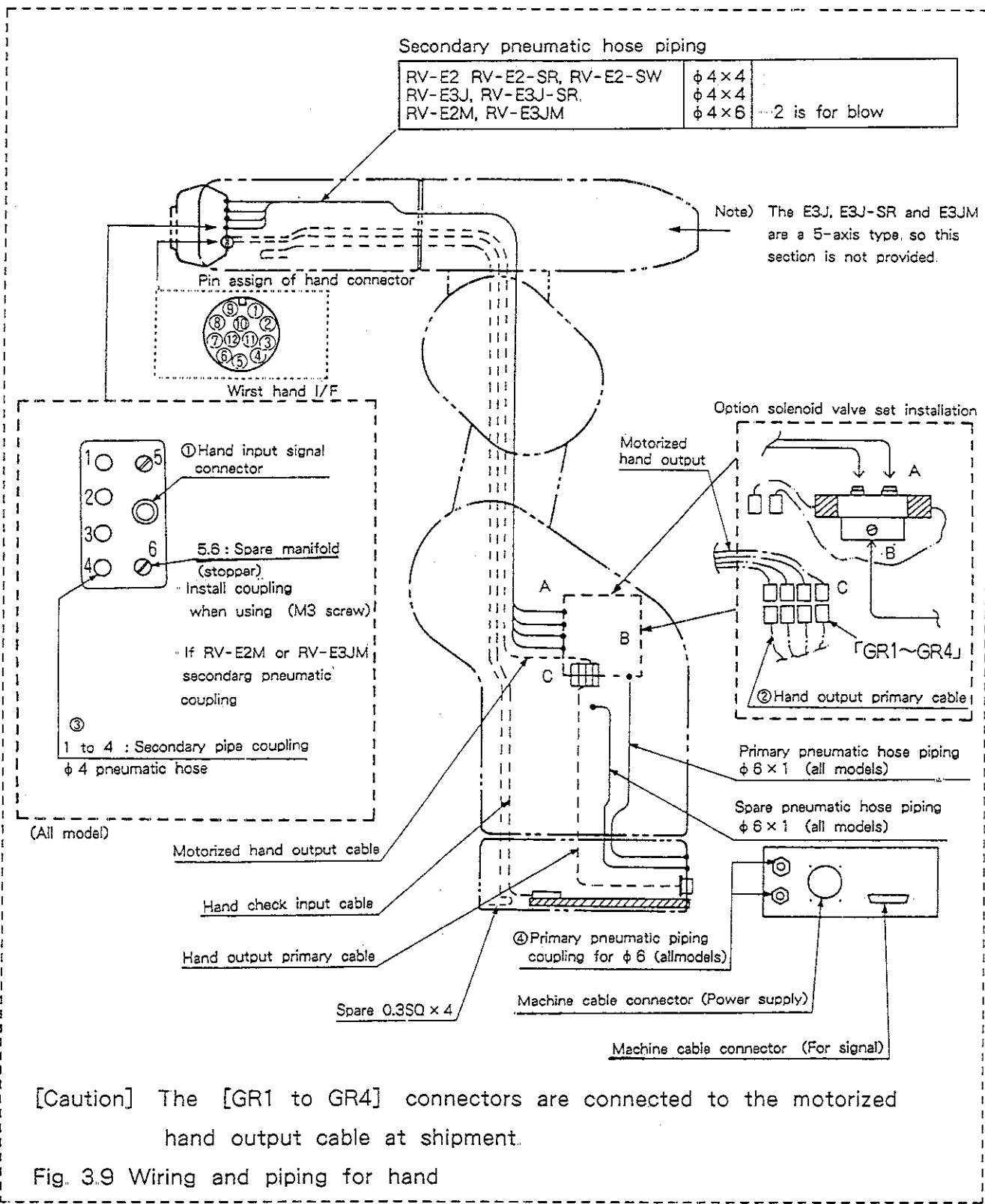
• DETAIL SPECIFICATIONS

MEMO

• DETAIL SPECIFICATIONS

3.1.4 Wiring and piping for hand

The wiring and piping format for the standard mounted hand is shown in Fig. 3.9.



[Caution] The [GR1 to GR4] connectors are connected to the motorized hand output cable at shipment.

Fig. 3.9 Wiring and piping for hand

[Caution] Each part No. corresponds to Table 3.2.

• DETAIL SPECIFICATIONS

(1) Pneumatic piping in robot

- Two $\phi 6 \times 4$ urethane hoses are provided from the pneumatic inlet to the shoulder cover for the primary piping.
- One hose is the primary piping for the pneumatic device. The other hose is spare piping for the air blowing, forced exhausting or the suction hand, etc.
- A $\phi 4 \times 2.5$ urethane hose is provided from inside the shoulder cover to the forearm side for the secondary piping. The mounted No. of hoses will differ according to the model as shown below.
 - RV-E2, RV-E2-SR RV-E2-SW 4 hoses
 - RV-E3J, RV-E3J-SR 4 hoses
 - RV-E2M, RV-E3JM 6 hoses. Two hoses are added for air blowing.
- All hose terminal sections are bridged in the shoulder base. On the forearm side, there are four air coupling bridges for the $\phi 4$ hose and two blind plug (M3 screws) for bridging. RV-E2M and RV-E3JM use 6 coupling bridges.
- The pneumatic inlet at the base section uses a $\phi 6$ size pneumatic coupling bridge.
- A maximum for two solenoid valve (option) sets can be installed in a row in the shoulder base.
- Refer to Chapter 4 for details on the solenoid valve set (option).

(2) Wiring for motorized hand and pneumatic hand output cable

- The primary cable for the hand output is used as the motorized hand output's primary side cable and the pneumatic hand output's primary side cable. When the motorized hand interface is installed in the controller, the cable will act as the motorized hand output cable, and when the pneumatic hand interface is installed in the controller, the cable will act as the pneumatic hand output cable.
- The hand output cable ($0.2SQ \times 2$ -core: 4 cables) are provided from the connector PCB in the base to the shoulder as the primary hand output cable. The terminals are connector bridged to correspond to the 4-point hand output. The connector names are "GR1" to "GR4".
- The motorized hand output cable ($0.2SQ \times 2$ -core: 1 cable) is wired from the shoulder to the forearm. The terminals are connected to the No 7 and 8 pins of the connector.
- The primary hand output cable is connected to the motorized hand output cable at shipment from the factory.

(3) Wiring of hand check input cable

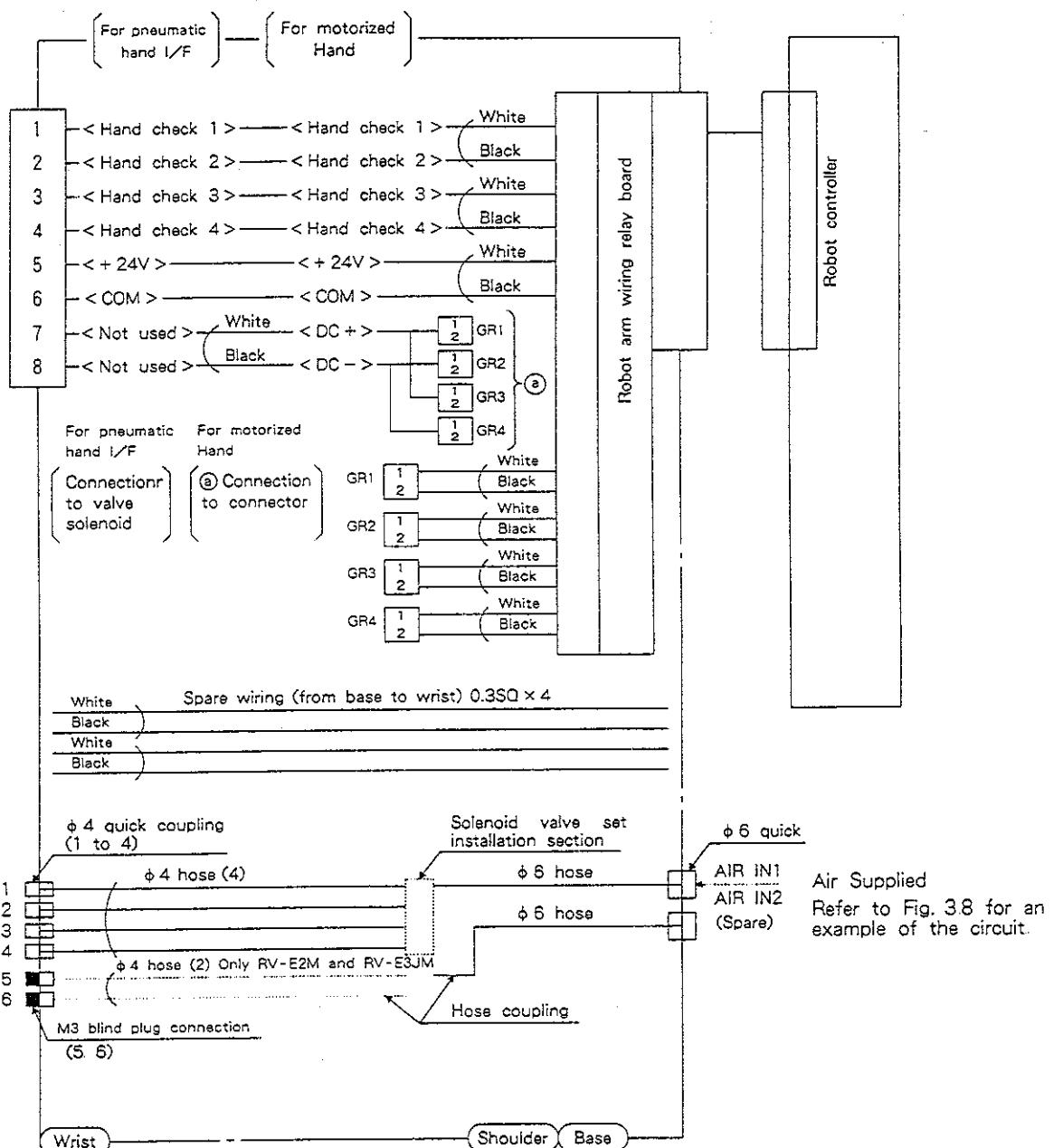
- The hand check input cable is directly wired from the base. The terminals are connected to the No 1 to 6 pins of the connector at the forearm.
- The pneumatic hand check signals are input to this connector.
- $0.3SQ \times 4$ spare wires are mounted from the base to the side of the forearm. The terminals are not treated on either end. Use these wires in the following cases.
 - To return the hand output cable when installing the solenoid value on the outside of the robot
 - When installing a sensor exceeding the No.4 of hand input/output points (four points) on the hand. (Connection to parallel I/O general purpose output.)

Table 3.2 Piping / wiring for hand

No	Name	Qty	Robot side(Arm side)		Mate side(Prepared by user)	
			Connector	Connector pin	Connector	Connector pin
①	Connector	1	HR-10A-10WTR-12S		HR10A-10WTP-12P	
②	Connector	4	SMP-02V-BC	BHF-001GU-0.8BS	SMR-02V-B	BYM-001T-0.6
③	Coupling	4	TSH4-M5M			
④	Coupling	2	UK6M			

• DETAIL SPECIFICATIONS

An example of the hand wiring and piping system diagram and solenoid valve installation is shown in Fig. 3.10.



[Caution] The connector② is connected at shipment from the factory

Fig. 3.10 Example of hand wiring and piping system diagram and valve installation

[Caution] Refer to Chapter 4 "Pneumatic hand set" for the wiring on the hand side.

• DETAIL SPECIFICATIONS

An example of the air supply circuit for the hand is shown in Fig. 3.11.

- (1) Always install a diode in parallel to the solenoid coil.
- (2) The actual work may be obstructed if the factory air pressure drops causing the hand's clamping force to drop. Use the circuit so that a pressure switch is installed on the air source and the robot stops when the pressure drops as shown in Fig. 3.11. If the operation is still obstructed with the pressure switch installed, use a mechanical lock-type hand or a hand that clamps with spring pressure.
- (3) The optional hand and solenoid valve are non-oiling types. When using these options, do not use an oiler.

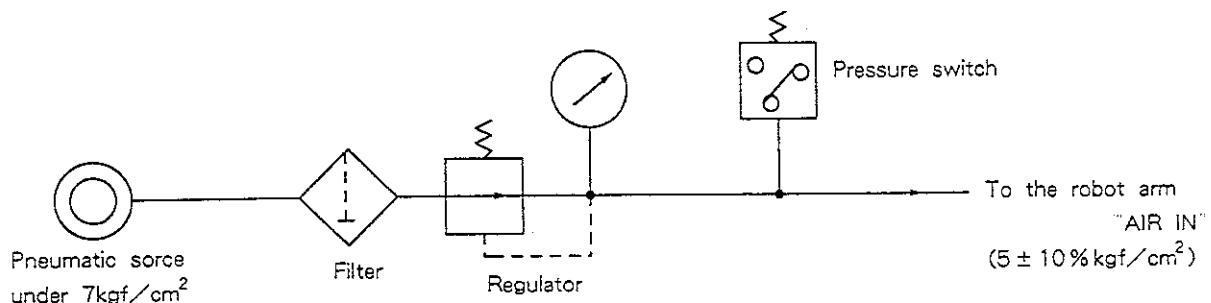


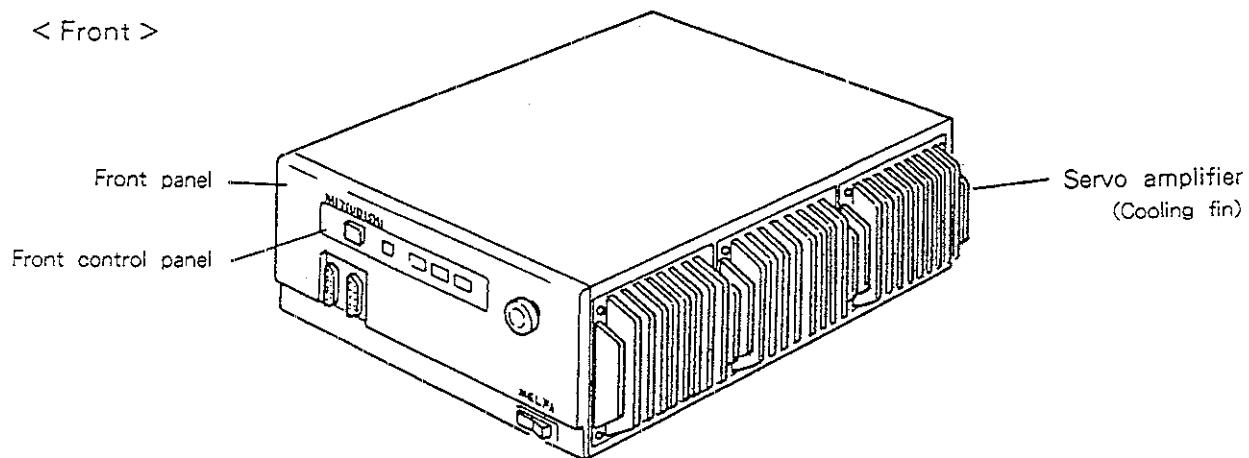
Fig. 3.11 Example of pneumatic supply circuit for hand

• DETAIL SPECIFICATIONS

3.2 Controller

3.2.1 Name of each part

< Front >



< Front control panel >

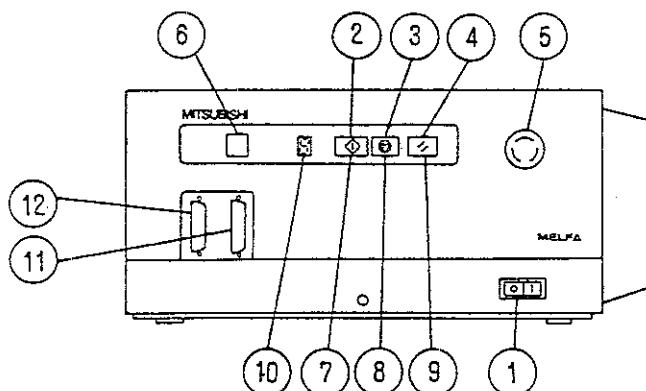


Fig. 3.12 Names of each controller part (Front)

- ① Power switch The power is turned ON/OFF.
- ② Start switch The program is executed and the robot started.
- ③ Stop switch The robot is stopped.
- ④ Alarm reset switch The alarm is canceled.
- ⑤ Emergency stop switch The robot is placed in the emergency stop state.
- ⑥ Teaching box emergency stop cancel switch This is used to attach/detach the teaching box without turning the power OFF.
- ⑦ Starting display lamp This lights while the program is being executed.
- ⑧ Stopping display lamp This lights when the program is being stopped.
- ⑨ Alarm display lamp This lights when an alarm occurs.
- ⑩ 8 – segment LED display lamp This indicates the alarm No. and program No., etc.
- ⑪ Teaching box connection connector This is a RS – 422 connector for connecting the teaching box.
- ⑫ Connector for the personal computer This is a RS – 232C connector for connecting the personal computer.

• DETAIL SPECIFICATIONS

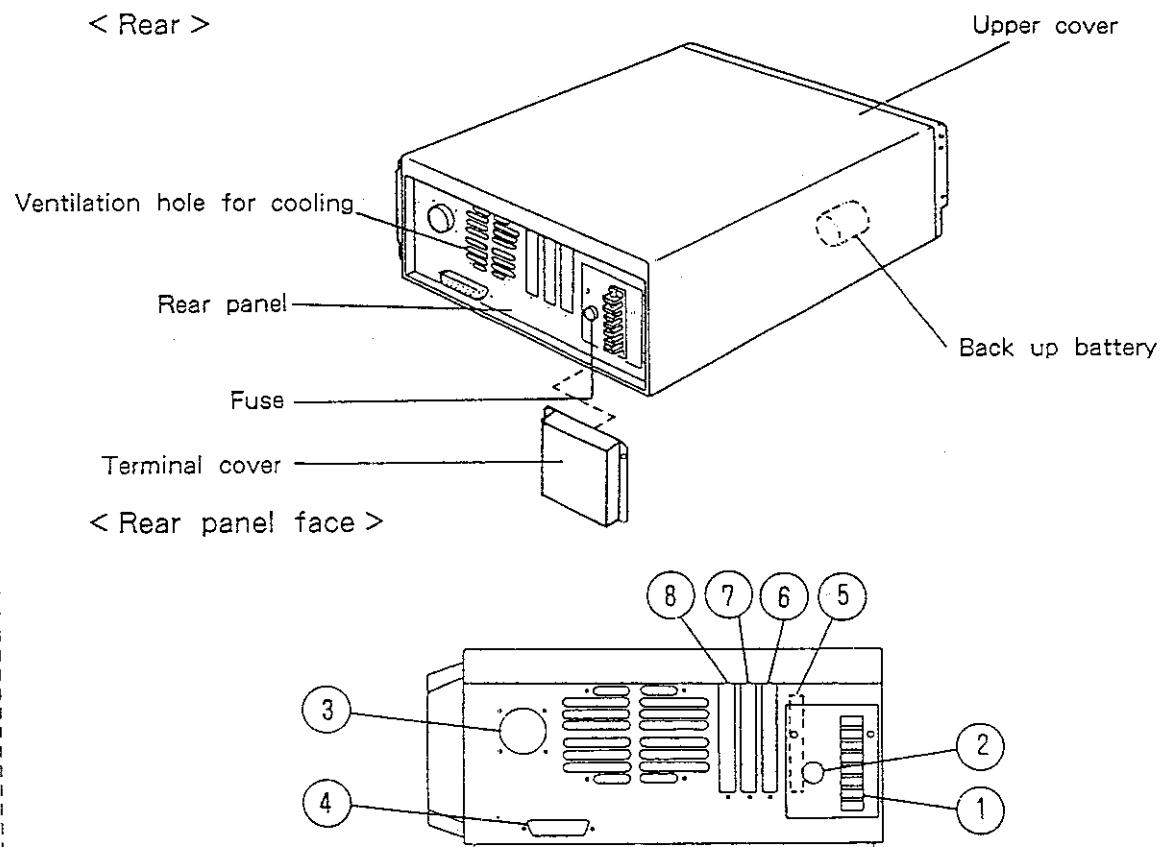


Fig 3.13 Names of each controller part (Back)

① User wiring terminal block

- (A) G terminal
- (B) AC INPUT terminal
- (C) EMG STOP terminal

This terminal block is opened to the user.
The following terminals are provided.

This is the grounding terminal.

This is the power supply terminal.

This is the external emergency stop input terminal.

The fuse is installed here.

② Fuse box

③ Machine cable (power supply cable) connector

The machine cable (power supply cable) is connected.

④ Machine cable (signal cable) connector

The machine cable (signal cable) is connected.

⑤ Hand interface board insertion slot

The hand interface board is installed here.

⑥ Standard slot (OPT1) : For standard I/O board.

The standard parallel I/O interface board is installed.

⑦ Option slot (OPT2) : For option board (1)

Each option board can be installed here. (1st board)

⑧ Option slot (OPT3) : For option board (2)

Each option board can be installed here. (2nd board)

• DETAIL SPECIFICATIONS

3.2.2 Outline dimensions

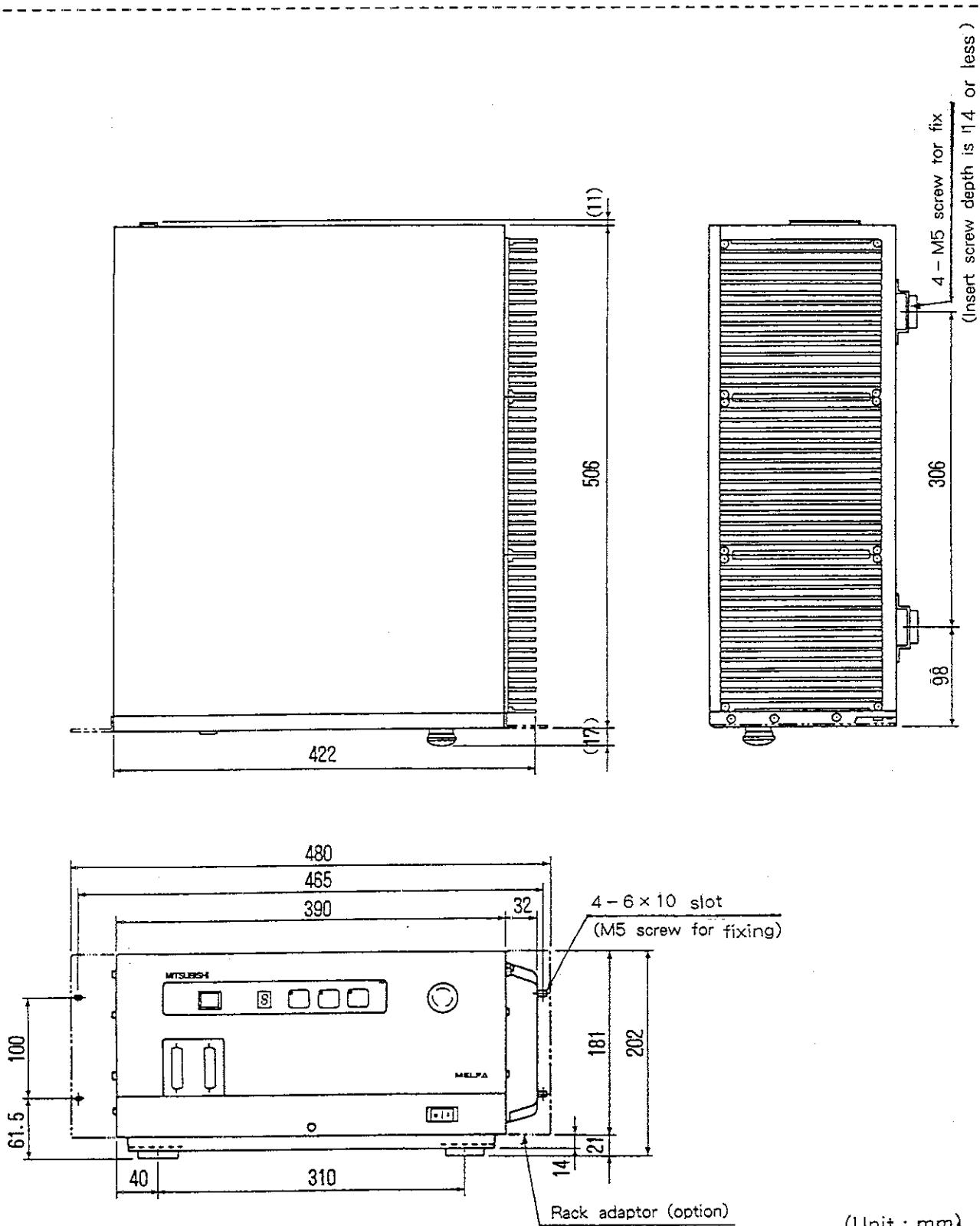


Fig. 3.14 Controller outline dimensions

[Caution] The values given in parentheses are the reference dimensions of the protrusions.

• DETAIL SPECIFICATIONS

3.2.3 External input output

- The following three types of external input/output are available for each function.

- (1) Exclusive input/output This input/output is used for remote operation of the robot and indicating the status.
- (2) General purpose input/output This is a user programmable input/output used for control of peripheral devices.
- (3) Hand input/output This is a user programmable input/output for the hand. (Optional)

Table 3.3 shows the standard external input/output.

Division	Name	No. of input/output points,		Connection form
		Input	Output	
Standard	Input/output terminal on the controller rear face.	Emergency stop	0	Terminal block
Standard	Parallel I/O interface	General purpose 20 /exclusive (11)	General purpose 16 /exclusive (3)	Connector

The parallel I/O interface (board) is connector bridged. When connecting with an external device, purchase the "external I/O cable".

The optional interface board for the hand input/output is selected according to whether a motorized hand or pneumatic hand is used. Refer to Chapter 4 Options for details.

< Hand input/output > : Option ... Chapter 4 Options item No. (1) and (2)

A maximum of two parallel I/O interfaces (boards) can be installed for the external input/output. In addition to the standard points, 40 input points and 32 output points can be added. Refer to Chapter 4 Options for details.

< Parallel I/O interface (2nd board) > ... Chapter 4 Options item No. (22)

< Parallel I/O interface (3rd board) > ... Chapter 4 Options item No. (22)

[Caution] There are three slots (one for standard slot and two option slots) for the function expansion. When using the expansion slot and adding or changing the functions, three boards including the standard mounted parallel I/O interface (board) will be used. When the standard mounted parallel I/O interface (board) is not being used, it can be removed, and replaced with another option board.

• DETAIL SPECIFICATIONS

Table 3.4 Exclusive input/output 1: These are assigned and set before shipment from the factory

Division	Name	Command	Description
Input	Starting Stop Program reset	STA STP RST	This executes the program and starts the robot. This suspend the program and stops the robot This cancels the suspended state. The alarm state is canceled.
	Numeric value input signal(0):4 bits	P10	This is used to designated numerical data suchas the program No., line No. and override.
	Numeric value input signal(1):4 bits	P11	(Default: 4-bit×2 signal assignment)
Output	Executing Waiting During alarm	RUN WAI ERR	This is output when a program is being executed. This is output when the program is temporarily stopped This is output when an alarm has occurred.

Table 3.5 Exclusive input/output 2: These are not assigned and set before shipment from the factory

Division	Name	Command	Description
Input	Alarm reset	ERS	This cancels the alarm.
	Servo on/off	SVO	This turns the servo ON/OFF.
	Brake on/off	BRK	This turns the brakes ON/OFF
	continue/cycle	CYC	This selects the continuous mode/cycle mode.
	Manual mode	TMD	This limits the max. speed during operation to the designated parameter value.
	Valid requirement apparatus	ORQ	This requests the priority rights for the external signal control.
	General output reset	ORS	This turns all general purpose output signal points OFF.
	Program number designation	PGN	This designates the value set with the numerical value input signal as the program No
	Program number output requirement	PGR	This requests an output of the program No being executed.
	Line number designation	LLN	This sets the value set with the numerical value input signal as the line No. of start.
	Line number output requirement	LLR	This requests an output of the line No. being executed.
	Override designation	OVR	This sets the value set with the numerical value input signal as the override.
	Override output requirement	ORR	This requests an output of the override being executed.
	Numeric value input signal(2):4 bits	P12	This is the additional 4-bit×2 signal for the numerical value input data.
	Numeric value input signal(3):4 bits	P13	
Output	Valid device	ATV	This outputs the operation rights of the external input/output.
	During servo on	SVA	This outputs the servo ON state.
	Continuous /cycle condition	CYS	This outputs the continuous mode state (OFF is output during cycle operation.)
	Manual mode condition	TMS	This outputs the manual mode state.
	In user specified area	UAR	This outputs the robot status to the parameter designated area.
	Ready	RDY	This outputs that the external input signals can be received after the controller power is turned ON.
	Numeric value output signal(0):4 bits	PO0	This outputs the numerical data such as the program No., line No. and override
	Numeric value output signal(1):4 bits	PO1	(None of the 4-bit×4 signals for the output are assigned before shipment.)
	Numeric value output signal(2):4 bits	PO2	
	Numeric value output signal(3):4 bits	PO3	

[Caution] The exclusive input/output can be assigned to the parallel I/O interface (standard, expansion 1, expansion 2) with parameters (IN1 to 3, OT1 to 3) according to the user applications.

If the No. of exclusive input and general purpose input points being used exceeds the standard No. of input/output points, install more the parallel I/O interface (2nd and 3rd board options).

• DETAIL SPECIFICATIONS

< Controller rear panel input >

- Signals are input from the terminal block in the rear of the controller.
- An emergency stop input terminal is provided on the rear.

Table 3.6 Exclusive input terminal on rear of controller.

Class	Name	Terminal size	Details
Input	Emergency stop	M4	The emergency stop state is entered (b contact)

▼ Note : A DC24V, 5mA to 300mA current will flow when the emergency stop input is short circuited. Install a switch that matches the current capacity.▼

< Parallel I/O interface >

■ Outline

- The interface is mounted as a standard in the input/output slot 1 of the controller.
- The external input/output circuit specifications are shown in Tables 3.7 and 3.8.
- The Nos. of the external input/output connector pins and the colors of the optional "external I/O cable" wires correspond as shown in Table 3.9.
- The same No. is assigned for the pins used for both the general purpose signals and exclusive signals.
- Non-assigned exclusive input/output signals can be assigned by the user as required for the general input/output pins during programming.
- Install the option card in slots 2 and 3 when there are not enough standard input/output points.
- Refer to the option specifications for the pin layout of the option cards.

Table 3.7 Electrical specifications of input circuit

Item	Specification		Internal circuitry
Type	DC input		E31IO type
No. of input points	20		
Insulation mode	Photocoupler insulation		
Rated input voltage	DC12V/DC24V		
Rated input current	Approx. 3mA(12V) / 7mA(24V)		
Working voltage range	DC10.2V to 26.4V (Ripple factor should be within 5%)		
ON voltage / ON current	DC8V/2mA or more		
OFF voltage / OFF current	DC4V/1mA or less		
Input resistance	Approx. 3.3kΩ		
Response time	OFF-ON	10ms(DC24V) or less	
	ON-OFF	10ms(DC24V) or less	
Common mode	8 points / 1 common (4 points/1 common portion)		
External wire connection	Connector		

• DETAIL SPECIFICATIONS

Table 3.8 Electric specifications of output circuit

Item		Specification	Internal circuitry
Type		Transistor output	2E31IO type
No. of output points		16	(24/12V)
Insulation method		Photocoupler insulation	
Rated load voltage		DC12V/DC24V	
Working load voltage range		DC 10.2V to 30V(Peak voltage DC30V)	
Max. load current		0.1A/1 points(100%)	
Current leak age during OFF		0.1mA or less	
Maximum voltage drop at N		DC0.9V(TYP.)	
Response time	OFF-ON	2ms or less(Hardware response)	
	ON-OFF	2ms or less(Resistor load) (Hardware response)	2E31OE type
Fuse rating		Fuse 3.2A(Per common) Not changeable	
Common method		4 points/common (Common terminal:4 points.)	
External wire connection		Connector	
External power	Voltage	DC12/24V(DC10.2~30V)	
	Current	60 mA(TYP. DC 24V/common) (Base drive current)	

◆ Important : The power (DC24V) for the input/output circuit must be prepared by the user.◆

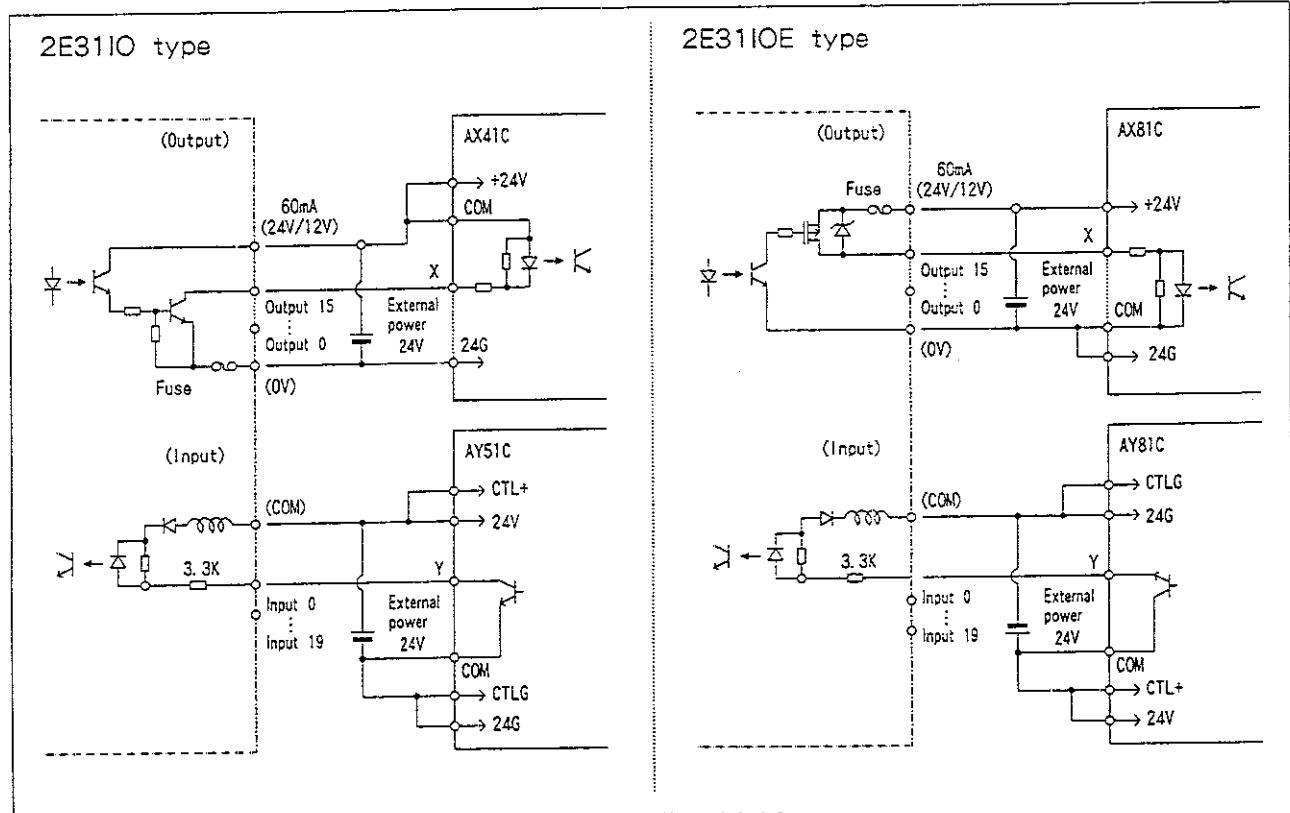


Fig. 3.15 Example of connection with Mitsubishi sequencer

• DETAIL SPECIFICATIONS

Table 39 Table 39 List of standard parallel I/O interface (board) pin Nos. and signal assignments
(External I/O cable colors)

Pin No.	Color	Function name		Pin No.	Color	Function name	
		General purpose	Exclusive/ power source, common			General purpose	Exclusive/ power source, common
1	White/black A		FG	26	White/black B		FG
2	Yellow/black A		0V:For pin 4-7	27	Yellow/black B		0V:For pin 29-32
3	Blue/black A		12V/24V:For pin 4-7	28	Blue/black B		12V/24V:For pin 29-32
4	Green/black A	General output 0		29	Green/black B	General output 4	
5	Orange/black A	General output 1		30	Orange/black B	General output 5	
6	Pink/black A	General output 2		31	Pink/black B	General output 6	
7	Gray/black A	General output 3		32	Gray/black B	General output 7	
8	Red/black A		0V:For pin 10-13	33	Red/black B		0V:For pin 35-38
9	Purple/black A		12V/24V:For pin 10-13	34	Purple/black B		12V/24V:For pin 35-38
10	Brown/black A	General output 8		35	Brown/black B	General output 12	
11	White/black C	General output 9		36	White/black D	General output 13	Executing(RUN)
12	Yellow/black C	General output 10		37	Yellow/black D	General output 14	Waiting(WAI)
13	Blue/black C	General output 11		38	Blue/black D	General output 15	Alarm(ERR)
14	Green/black C		COM0:For pin 15-22	39	Green/black D		COM1:For pin 40-47
15	Orange/black C	General input 0	Value input bit.0 (PIO)	40	Orange/black D	General input 8	
16	Pink/black C	General input 1	Value input bit.1 (PIO)	41	Pink/black D	General input 9	
17	Gray/black C	General input 2	Value input bit.2 (PIO)	42	Gray/black D	General input 10	
18	Red/black C	General input 3	Value input bit.3 (PIO)	43	Red/black D	General input 11	
19	Purple/black C	General input 4	Value input bit.4 (PI1)	44	Purple/black D	General input 12	
20	Brown/black C	General input 5	Value input bit.5 (PI1)	45	Brown/black D	General input 13	
21	White/Red A	General input 6	Value input bit.6 (PI1)	46	White/Red B	General input 14	
22	Yellow/Red A	General input 7	Value input bit.7 (PI1)	47	Yellow/Red B	General input 15	
23	Blue/Red A		Not used	48	Blue/Red B		CCM2:For 24 25 49 50
24	Green/Red A	General input 16		49	Green/Red B	General input 18	Stop(STP)
25	Orange/Red A	General input 17	Starting (STA)	50	Orange/Red B	General input 19	Reset(RST)

• The signals assigned as exclusive inputs can be used as general purpose inputs during program execution.

For safety purposes, do not use the exclusive inputs as general purpose inputs other than for numerical value inputting. The signals assigned as exclusive outputs cannot be used in the program. An alarm will occur when they are used.

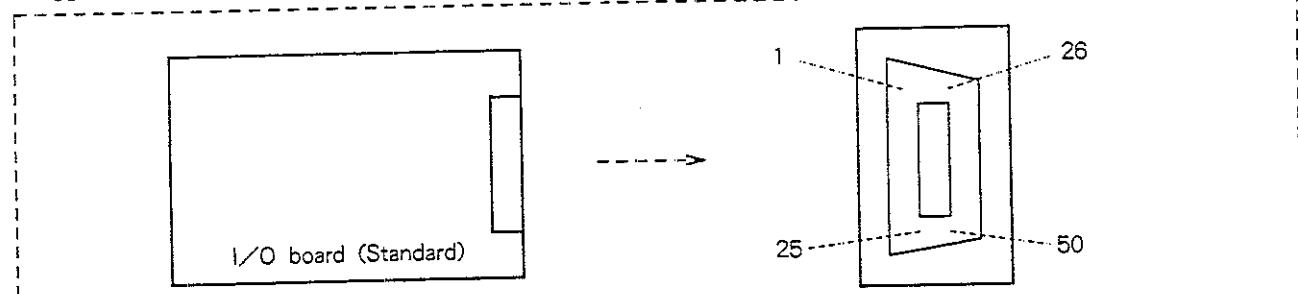
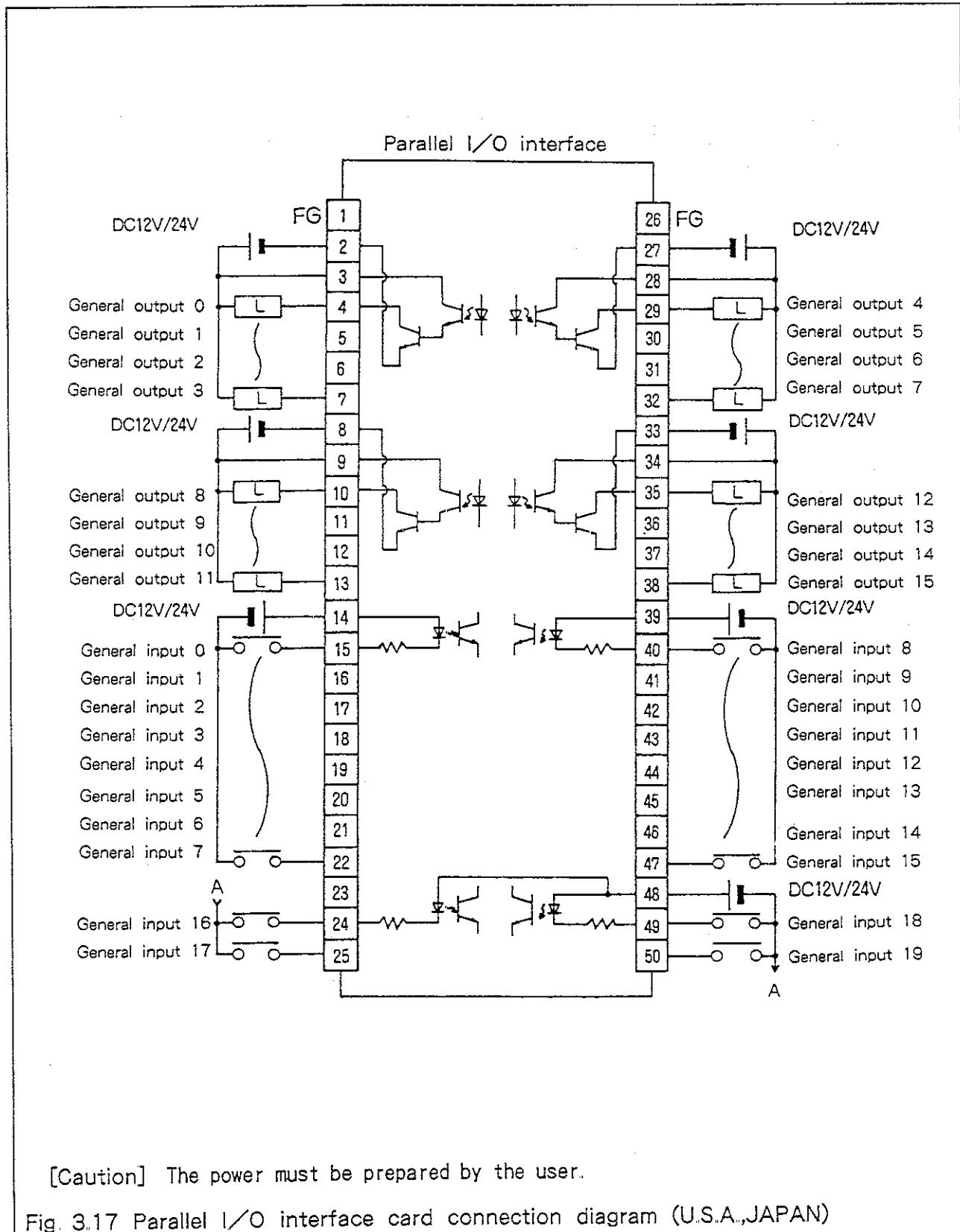


Fig. 3.16 Parallel I/O interface board connection and pin layout

• DETAIL SPECIFICATIONS

An example of the parallel I/O interface connection is shown in Fig. 3.17 - 2E31IO type



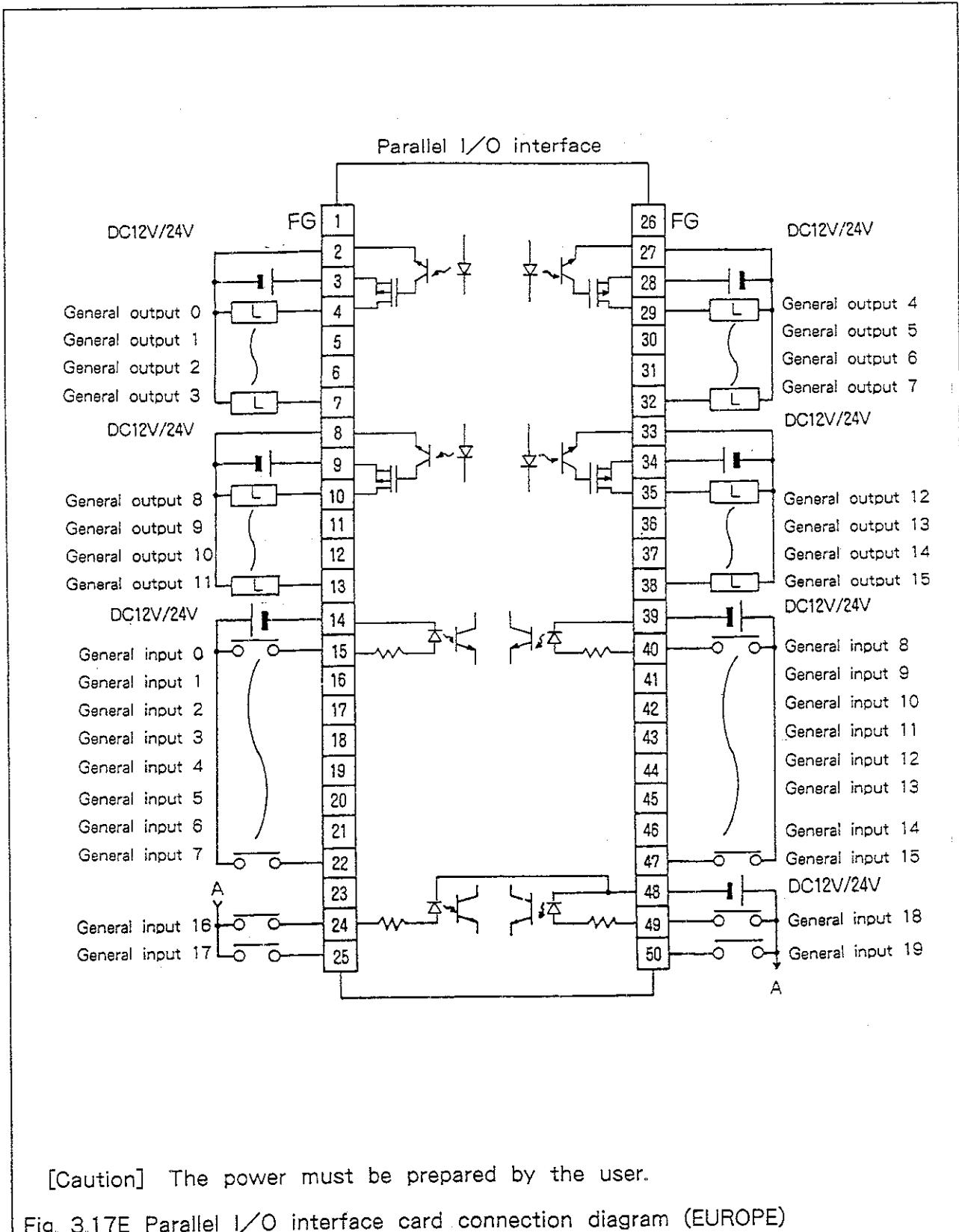
[Caution] The power must be prepared by the user.

Fig. 3.17 Parallel I/O interface card connection diagram (U.S.A., JAPAN)

• Refer to Tables 3.7 and 3.8 for the parallel I/O interface input/output specifications

• DETAIL SPECIFICATIONS

An example of the parallel I/O interface connection is shown in Fig. 3.17E--- 2E31IOE type



- Refer to Tables 3.7 and 3.8 for the parallel I/O interface input/output specifications

• DETAIL SPECIFICATIONS

3.3 Software.

3.3.1 Command list

Table 3.10 Command list (1)

No.	Command	Function
● Position / movement control commands.		
1	ADL	This sets the robot and addition axis acceleration/deceleration time when the additional axis is used.
2	CF	This changes the robot's posture data at the designated position.
3	DJ	This moves the designated axis by the designated amount from the current position.
4	DP	This moves to the position before the current position No. (Joint interpolation)
5	DS	This moves to a point separated by a designated distance in each direction from the current position. (Linear interpolation)
6	DW	This moves to a point separated by a designated distance in each direction from the current position. (Joint interpolation)
7	HE	This memorizes the current position coordinates as the point for the designated position No.
8	HO	This sets the current position as the origin posture.
9	IP	This moves to the position after the current position No. (Joint interpolation)
10	JRC	This adds ± 360 to the current R axis joint position and rewrites the current position, and allows shortcut control or endless control of the R axis.
11	MA	This moves to a point separated by the coordinate value of the designated point from the position No.
12	MC	This continuously moves from the position No. to the last registered position No. with linear interpolation.
13	MJ	This rotates each axis by the designated angle from the current position.
14	ML	When the additional axis issued, only the travel axis is moved by the designated distance.
15	MO	This moves with joint interpolation to the designated position No. point.
16	MP	This moves to the designated coordinate value point.
17	MPB	This moves to the designated position according to the designated speed, timer, hand state, input state, output state and interpolation method.
18	MPC	This moves to the designated position according to the designated interpolation method.
19	MR	This moves the circle determined with the position No. with circular interpolation.
20	MRA	This moves with circular interpolation using the two forward or backward MRA command position data.
21	MS	This moves to the designated position No. point with linear interpolation.
22	MT	This moves to a point in the tool direction from the designated position. (Joint interpolation).
23	MTS	This moves to a point in the tool direction from the designated position. (Linear interpolation).
24	NT	This returns to the machine system's origin position.
25	OG	This moves to the origin setting reference position.
26	OVR	This sets the program override.
27	PA	This sets the No. of grid points in the vertical and horizontal directions of the designated
28	PC	This clears the point of the designated position No.
29	PD	This sets the designated coordinate value as the designated position No. point.
30	PL	This substitutes the coordinate value of the designated point for the designated position No.

• DETAIL SPECIFICATIONS

Table 3.11 Command list.(2)

No.	Command	Function
○ (Continued)		
31	PT	This finds the coordinate value of the designated pallet's grid points, and sets the value for the corresponding position No. point.
32	PW	This waits to complete positioning until all axes have entered the designated pulse.
33	PX	This exchanges the designated position No. point with the point coordinate value.
34	SD	This sets the operation speed and primary delay time constant for linear interpolation.
35	SF	This shifts the coordinate value of the position No. by the coordinate value of the designated point and re-registers the position.
36	SL	This designates the motion range of the travel axis.
37	SP	This sets the operation speed and deceleration/acceleration.
38	TI	This stops the operation for the designated time (0.1 sec. unit)
39	TL	This sets the length from the hand installation section to the hand tip.
40	WRM	This designates whether to stop or execute the robot operation while the additional axis is operating.
● Program control commands		
41	CL	This sets the No. designated in the internal register value in the counter.
42	CP	This sets the designated No. counter value in the internal register.
43	DA	This disable the interrupt by the bit designated in the external input terminal.
44	DC	This subtracts 1 from the designated No. counter value.
45	DL	This deletes the program from line No. to line No.
46	EA	This enable the interrupt by the bit designated with the external input terminal, and sets the line No. branched to during interrupt.
47	ED	This indicates the end of a program.
48	EQ	This jumps to a line No. when the internal register and designated value are equal.
49	GS	This executes the line No. subroutine designated in the program No.
50	GT	This jumps unconditionally to a designated line No.
51	HLT	This interrupts the program.
52	IC	This adds 1 to the designated No. counter value.
53	LG	This jumps to a line No. when the internal register is larger than the designated value.
54	NE	This jumps to a line No. when the internal register and designated value are not equal.
55	NW	This erases all programs and positions in the RAM area.
56	NX	This sets the program loop range according to the "RC" command.
57	RC	This repeats the program the designated No. of times to the "NX" command.
58	RN	This executes the program between the designated line Nos.
59	RT	This ends the subroutine called with the "GS" command, and returns to the main program.
60	SC	This sets the designated value in the designated No. counter.
61	SM	This jumps to a line No. when the internal register is smaller than the designated value.

• DETAIL SPECIFICATIONS

Table 312 Command listing (3)

No.	Command	Function
● Hand control commands		
62	GC	This closes the hand's grip.
63	GF	This designates the grip's open/close state during execution of the "PD" command.
64	GO	This opens the hand's grip.
65	GP	This sets the motorized hand's gripping force or open/close time.
● I/O control commands		
66	AN	This logical ANDs the internal register and designated value.
67	ID	This unconditionally inputs a signal through the external input signal.
68	OB	This sets the output state of the designated bit in the external output terminal.
69	OC	This unconditionally outputs the designated No. counter value from the output port.
70	OD	This unconditionally outputs the designated data from the external output terminal.
71	OR	This logical ORs the internal register and designated value.
72	TB	This jumps to a line No. according to the state of the bit designated in the internal register.
73	TBD	This jumps to a line No. according to the state of the bit designated in the internal input terminal.
74	XO	This exclusive ORs the internal register and designated value.
● RS-232-C read commands		
75	CR	This reads the details of the designated No. counter.
76	DR	With the "ID" command, this reads the external input terminal data.
77	ER	This reads the alarm state.
78	LR	This reads the program of the designated line No.
79	PMR	This reads the details of the designated parameter.
80	PR	This reads the coordinate value of the designated position No.
81	QN	This reads the information of the selected program No. or designated program No.
82	STR	This reads the details of the designated step No.
83	VR	This reads the system ROM's software version name.
84	WH	This reads the coordinate value of the current position.
85	WT	This reads the current tool length.
● Other commands		
86	INP	This reads the counter No. or position No.
87	N	This selects the program with the designated No.
88	OPN	This opens the communication line and designates the input/output device.
89	PMW	This rewrites the details of the designated parameter with the designated details.
90	PRN	This transmits the designated counter setting value or position coordinate value.
91	RS	This cancels the alarm and resets the program.
92	'	This describes a 120-character or less (including line No. and '(apostrophe)) comment.

• DETAIL SPECIFICATIONS

3.3.2 Parameters

Table 3.13 Parameter list (Outline)

Parameter	Parameter	Contents
Standard tool coordinate	XTL	This sets the default value of the tool data. Unit: mm or deg.
Standard base coordinate	XBS	This sets the relation of the world coordinate system and robot coordinate system. Unit: mm or deg.
XYZ operation range	PAR	This designates the world coordinate system overrun limit value.
Joint operation range	JAR	This designates the overrun limit value of each joint axis.
User defined area	UAR	This designates the lower/upper limit values of the cartesian coordinates X, Y and Z axis.
Automatic execution program	ATP	This designates the program to be automatically executed when the power is turned ON.
Continuous function	CTN	This designates whether to use the previous execution environment (execution step, program variable, input/output state, etc.) when the power is turned ON.
Buzzer ON/OFF	BZR	This designates whether the buzzer is ON or OFF.
Automatic operation speed	SPI	This designates the initial level of the automatic operation speed.
Automatic operation override	EOV	This designates the initial override of the automatic operation (External override, program override)
Jog setting	JGJ	This designates the joint jog and step operation speeds. (Inching, low-speed, high-speed) ※ Cannot be changed.
	JGP	This designates the linear jog and step operation speeds (Inching, low-speed, high-speed) ※ Cannot be changed.
Continuous locus setting	CNT	This designates whether to omit the acceleration/deceleration at the teaching point and to execute continuous locus control.
Control time constant	TSR	This sets the time constant for control.
Positioning	PWI	This designates the range to complete positioning.
Stop input B contact designation	INB	This changes over the A contact and B contact for exclusive input/output.
Acceleration deceleration time	ADL	This designates the acceleration/deceleration time to the motor rating. (Both the acceleration and deceleration can be set.)
Hand control setting	GCD	This designates the forward or backward operation of the hand opening and closing.
User designated origin	UOG	This designates the user-specified origin position.
Origin positioning	UNG	This designates the operation order for origin setting.
Wrist angle (R) coordinate system selection	RCD	This changes over between the general angle method and joint angle method for the wrist angle (R) control and display
Parallel I/O input setting		The functions are set for the exclusive input.
	IN1	The 1st parallel I/O interface input is set.
	IN2	The 2nd parallel I/O interface input is set.
	IN3	The 3rd parallel I/O interface input is set.
Parallel I/O output setting		The functions are set for the exclusive output.
	OT1	The 1st parallel I/O interface output is set.
	OT2	The 2nd parallel I/O interface output is set.
	OT3	The 3rd parallel I/O interface output is set.
Program No. read start	PST	This sets whether to read the numerical value input when the program is started as the designated program or whether to ignore it and continue the current state.
Communication specifications	CMO	This designates the communications specifications (baud rate, data length, etc.) of the serial interface in the controller. Only RS-232-C is designated.

4. FACTORY SHIPMENT SPECIAL SPECIFICATIONS, OPTIONS AND MAINTENANCE PARTS

4.1 Factory shipment special specifications

■ What are factory shipment special specifications?

These are specifications created by partially changing the standard specifications before shipping. Confirm the delivery for these specifications.

Changes in the specifications after shipment will require on-site work or for the system to be returned to Mitsubishi.

■ Types

Table 4.1 Details of factory shipment special specifications

No.	Part name	Type	Details
1	Controller (stationary: 100V)	CR-E116-1	This is a 100V (3KVA) specification floor-installation type controller.
2	Machine cable extension (fixed)	1E-□□CBL	This cable is used to extend the distance between the controller and robot arm.
3	Machine cable extension (flexible)	1E-□□LCBL	This cable is used to extend the distance between the controller and robot arm.
4	Changes in motion range	1E-DH***-○○○	The motion range of the W axis is changed.

[Caution] No. 1 to 3 apply to all models.

No. 4 applies to all models excluding RV-E2-SW.

Refer to Section 39 for details on No. 4.

■ How to order

- (1) Note that the deliveries of special specifications may require extra time.
- (2) Designate the required special specifications before the system is shipped from Mitsubishi.
- (3) Designation method ... Indicate the part name, type and robot arm type.

Special specifications other than those listed in Table 4.1 are available. Contact the Sales Division for details.

■ Precautions for using controller (stationary : 100V) specifications

- (1) The AC100V power supply environment is often unstable. Thus, even if the acceleration/deceleration time or max. speed, etc., are set within the standard specifications range, an alarm may occur or the robot's max. performance may not be realized when the AC 100V specifications are used.
- (2) Confirm the power supply environment of the installation site before ordering the AC100V specifications.
- (3) Use the 200V standard specifications when using the product under severe tact time, load, speed or duty conditions, etc., such as in a production line.

• OPTION

■ Machine cable extension

- (1) Ordering format : ● Fixed type 1E - □□ - CBL
● Flexible type 1E - □□ - LCBL

Note) □□ indicates the cable length.

(2) Outline

This is a cable used to extend the distance between the controller and robot arm.
A fixed type and flexible type are available.

(3) Types

Table 4.2 Configuration devices and types

Part name	Type	Qty.	Remarks
Motor signal cable (for fixing)	1E-□□CBL(S)	One pc.	2m, 7m, 10m, or 15m
Motor power cable (for fixing)	1E-□□CBL(P)	One pc.	2m, 7m, 10m, or 15m
Motor signal cable (for flexible)	1E-□□LCBL(S)	One pc.	5m, 7m, 10m, or 15m
Motor power cable (for flexible)	1E-□□LCBL(P)	One pc.	5m, 7m, 10m, or 15m
Instruction manual	BFP-A5597	One book	
Nylon clamp	NK-24N	Two pcs.	
Nylon clamp	NK-14N	Two pcs.	
Silicon rubber		4 pcs.	

[Caution 1] The motor signal cable and motor power cable are either a fixed type or flexible type.

[Caution 2] The nylon clamp and silicon rubber are enclosed only with the flexible cable.

(4) Specifications

The specifications of the fixed cable are the same as the standard cable.

The usage states of the flexible cable are shown in Table 4.3.

Table 4.3 usage states of the flexible cable

Item	Specifications
Min. bending radius	100R or more
Cable bare, etc., occupation rate	Within 50%
Max. movement speed	Within 2000[mm/s]
Guaranteed life	7,500,000 times
Environment resistance	Oil-proof specification sheath(for silicon grease used for cable sliding lubrication)

4.2 Options

■ Options

Various options that meet the user's applications are prepared with the E Series robot to make setup easy.

The options can be installed by the user. The "set options" and "single part options" are available.

1. Set options These options are single part options and parts set according to the purpose. These include the pneumatic hand set and motorized hand set.
2. Single part options These options are configured with the min. required parts. These are selected according to the required purpose.

The details specifications are described in Section 4.4 and following.

• OPTION

■ Types and details

Table 4.4 Option configuration and installation type

Item No.	Name	Type	RV-E2	RV-E2M	RV-E2-SR	RV-E2-SW	RV-E3J	RV-E3JM	RV-E3JM-SR	Note
(1)	Pneumatic hand set	4E-HP01 4E-HP01E	○ ○							
(2)	Motorized hand set	4E-HM-01	○	* 1	○	○	○	* 1	○	* 1
(3)	Solenoid valve set(Single)	1E-VD01 1E-VD01E	○ ○							
	Solenoid valve set(Double)	1E-VD02 1E-VD02E	○ ○							
(4)	Hand input cable	1E-HC15C	○	○	○	○	○	○	○	
(5)	Hand output cable	1E-GR35S	○	○	○	○	○	○	○	
(6)	Hand curl tube(Single:2) Hand curl tube(Double:4)	1E-ST0402C 1E-ST0404C	○ ○							
(7)	Calibration jig	1E-INST	○	○	○	○	○	○	○	
(8)	Teaching box	P6TB-TE	○	○	○	○	○	○	○	
(9)	Parallel I/O interface	2E-3II0 2E-3II0E	○ ○							
(10)	External I/O cable	1/O-CBL	○	○	○	○	○	○	○	
(11)	Rack adapter	2E-RACK	○	○	○	○	○	○	○	
(12)	Personal computer cable (PC98) Personal computer cable (MAXY, PC/AT)	RS-PC-CBL RS-MAXY-CBL	○ ○							
(13)	Personal computer support S/W(PC98) Personal computer support S/W(MAXY) Personal computer support S/W(PC/AT DOS/V) Personal computer support S/W(PC/AT)	SW-PC-3 SW-MAXY-3 SW-AT-3 SW-ATE-3	○ ○ ○ ○							
(14)	Expansion serial interface	2E-31SIO	○	○	○	○	○	○	○	
(15)	Additional axis interface	2E-31AXS	○	○	○	○	○	○	○	
(1)	Pneumatic hand interface	2E-31HND 2E-31HNE	○ ○	* 2						

[Caution] The item Nos. correspond to the Nos. given in each option title on the following pages.

- [Caution]
- Note * 1) The motorized hand can be installed on the RV-E2M and RV-E3JM but as these do not have oil mist specifications, the quality cannot be guaranteed.
 - Note * 2) The pneumatic hand interface is required when using a user-manufactured hand.

(1) PNEUMATIC HAND SET

■ Ordering format: 4E - HP01 / 4E - HP01E

■ Features

- The set includes the pneumatic hand and required parts.
- The life of the hand is 10,000,000 times.
- A sensor is installed on the open/close end.

Table 4.5 Configuration devices

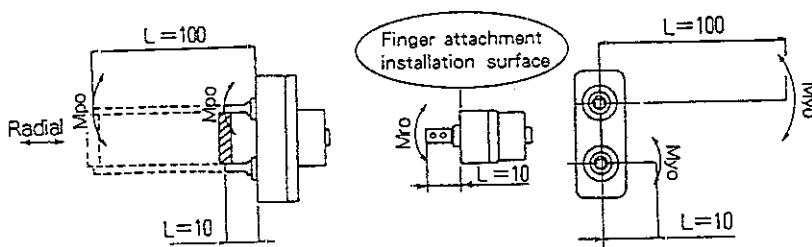
No.	Name	Type	Qty.	Remarks
①	Pneumatic hand	1E-HP01 / 1E-HP01E	1	Hand input cable with pneumatic coupling
②	Pneumatic hand interface	2E-31HND / 2E-31HNE	1	Interface board with installation screws
③	Solenoid valve set(Single)	1E-VD01 / 1E-VD01E	1	Refer to Section (3) Solenoid valve set
④	Hand curl tube(Single:2)	1E-ST0402C	1	Refer to Section (6) Hand curl tube
⑤	Installation bolts (with sockets)	M5×16	4	
⑥	Installation bolts (with sockets)	M3×12	4	
⑦	Adapter	BU144D697H01	1	Adaptor for installing item ① on the robot arm's mechanical interface.

■ Specification / outline dimensions

Table 4.6 Pneumatic hand specifications

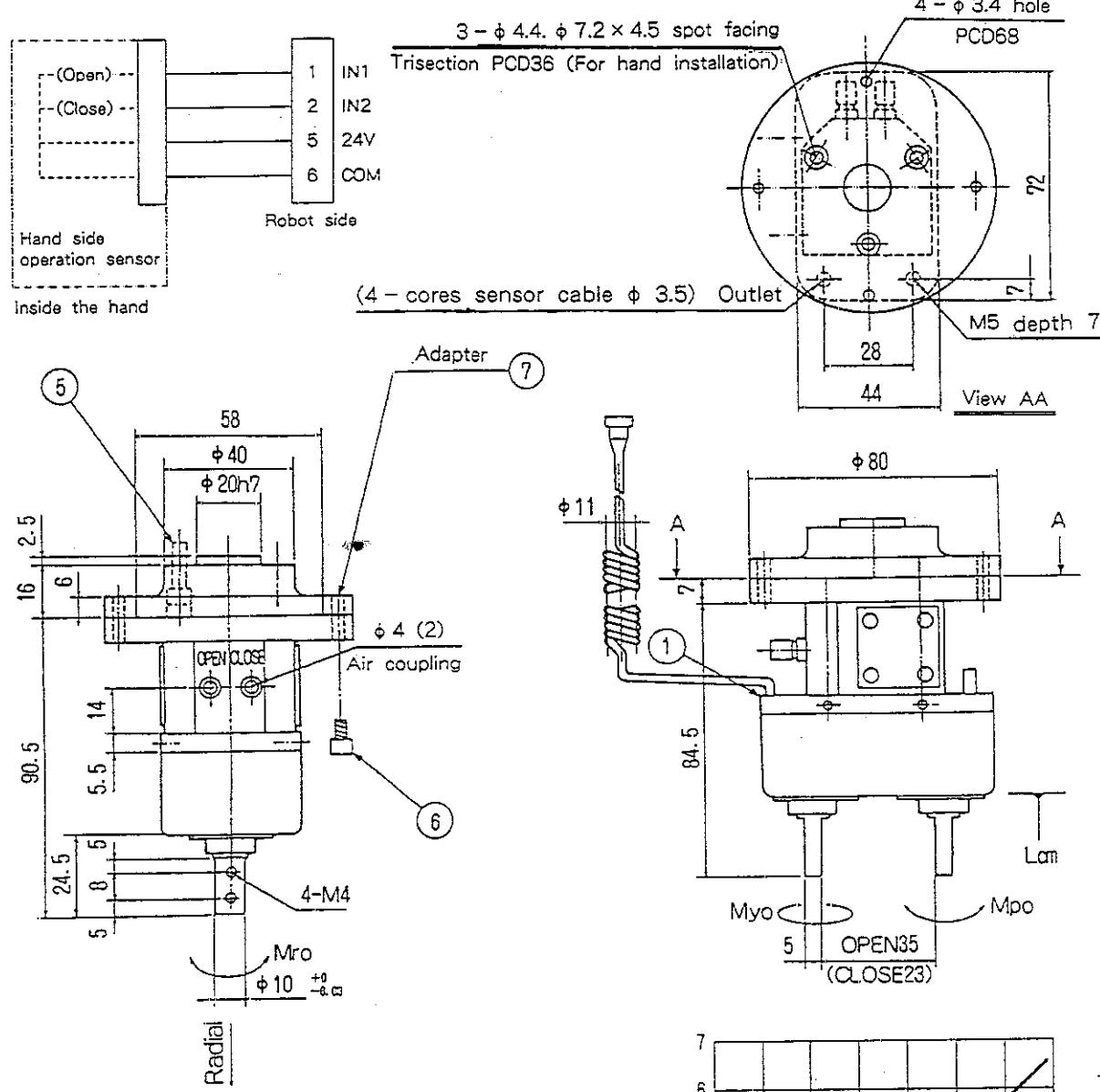
Item	Specification	Remarks
Operating fluid	Clean air	
Operating pressure limit	0.4~7kgf/cm ²	
Operating temperature limit	0~40°	
Operation stroke	12mm ²	
Life	10,000,000 cycles or more	
Action method	Double action	
Weight	0.45kgf	It contains the adapter⑦.
Operation confirmation sensors	Open end and close end	
Air coupling size	φ4(Quick coupling)	Connection hose diameter: φ4
Maximum load per finger.	Lmm(From finger center on Myo)	
Radial	70kgf	
Mpo moment	62kg·cm(6.2kg·10cm)	
Mro moment	108kg·cm(10.8kg·10cm)	
Myo moment	60kg·cm(6kg·10cm)	

Moment for the grip point L: Mpo, Mro, Myo

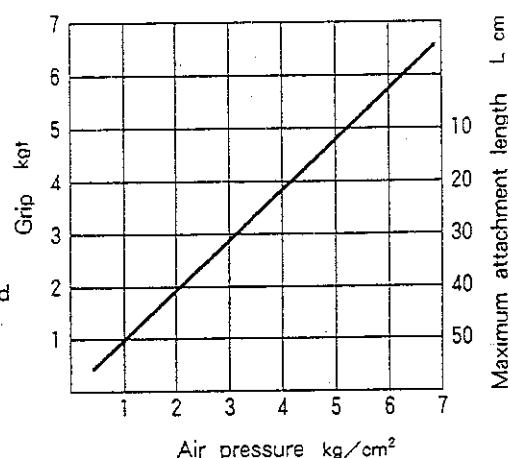


PNEUMATIC HAND SET

■ Wiring system diagram



Guideline for gripping force and
max. finger attachment length.



[Caution] Each part No. corresponds to the configuration
devices listed in Table 4.5.

Fig. 4.1 Outline dimension drawing of pneumatic hand

• PNEUMATIC HAND SET

■ Pneumatic hand I/F (Interface board)

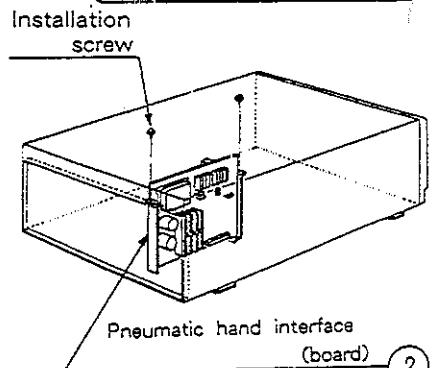
- The interface board is mounted in the hand interface board insertion slot in the controller.
- The board and installation screws are enclosed.

Installation method

- Turn the controller power OFF. Also turn OFF the main power supply.
- After turning the power OFF wait 3 minutes to discharge the charged section.
- Remove the upper cover of the controller
- Remove the two installation screws on the slot at the far right looking from the rear of the controller. Remove the dust-proof cover for the expansion slot connector (The user must save this cover)
- Insert the pneumatic hand interface board into the above slot connector.
- Tighten and fix with the two installation screws.
- Install the upper cover of the controller.
- Turn the controller power ON.
- If a hand is installed, confirm that the pneumatic hand opens and closes with jogging operation using the teaching box.

CAUTION

Wait at least 3 minutes after turning the power off before removing the top panel. Don't turn the power on until the top panel has been installed. Other methods of handling may lead to electric shocks.



[Caution] Each part No. corresponds to the configuration devices listed in Table 4.5.

Fig. 4.2 Pneumatic hand I/F (interface board) installation drawing

■ Examples of option selection for user - manufacturing of pneumatic hand

- Select the parts excluding the pneumatic hand for the parts used for the configuration devices shown in Table 4.5.
- Selection examples are given below.

Table 4.7 Example of option selections for user - manufacturing of pneumatic hand

No.	Name	Type	Single hand	Double hand	Vacuum hand	
1	Pneumatic hand	User makes it	×	×	×	
2	Pneumatic hand I/F	2E-31HND/ 2E-31HNE	○	○	○	
3	Solenoid valve set (Single)	1E-VD01/1E-VD01E	○	×	×	Valve interior
4	Solenoid valve set (Double)	1E-VD02/1E-VD02E	×	○	×	Valve interior
5	Hand output cable	1E-GR35S	○	○	○	
6	Hand input cable	1E-HC15C	○	○	○	Using sensor
7	Hand curl tube (Single:2)	1E-ST0402C	○	×	○:Single	
8	Hand curl tube (Double:4)	1E-ST0404C	×	○	×	
9	Adapter	BU144D697H01	×	×	×	

• PNEUMATIC HAND SET

■ Input/output circuit specifications for hand

When using a user-manufactured pneumatic hand, select the solenoids and sensors according to the following input/output circuit specifications.

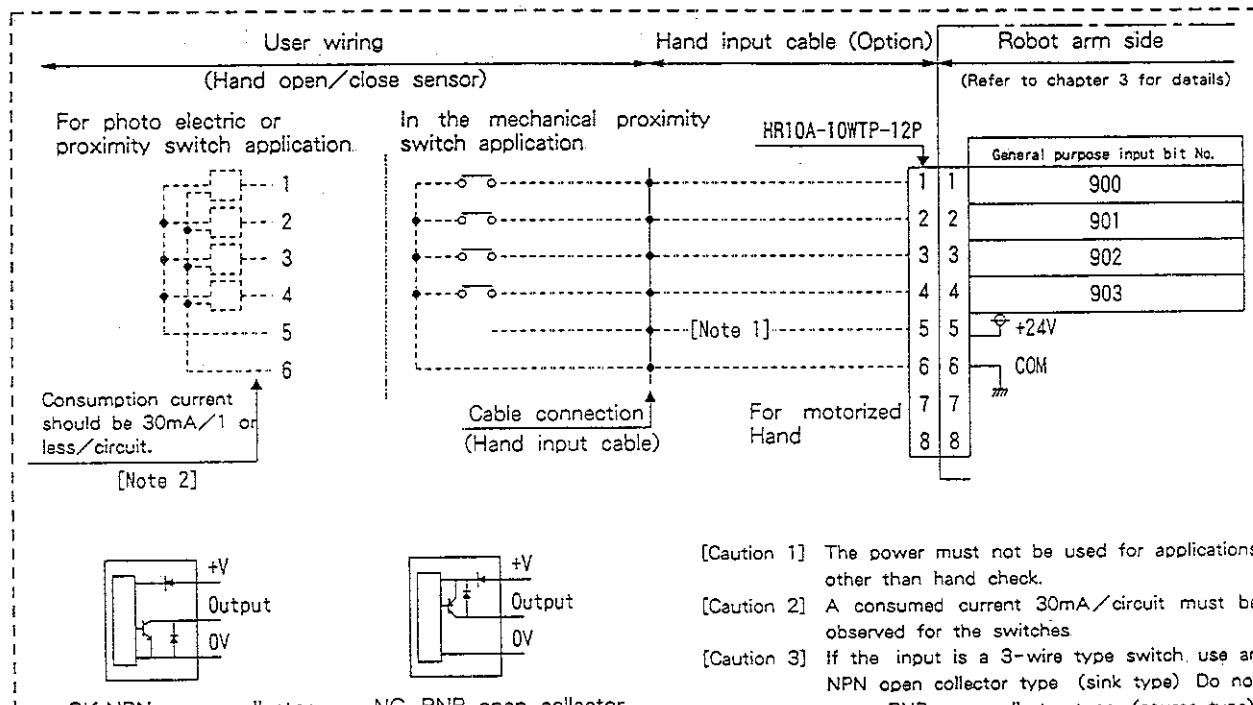


Fig. 4.3 Input circuit specifications for hand

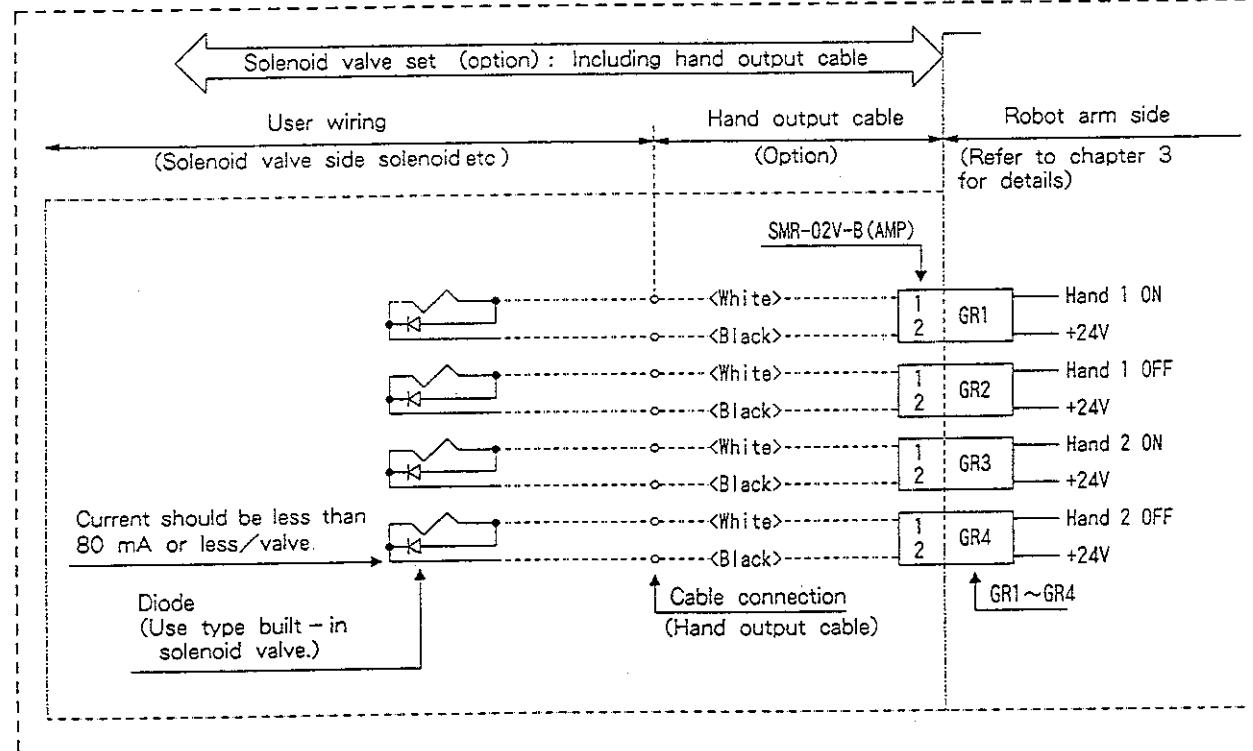


Fig. 4.4 Output circuit specifications for hand

(2) MOTORIZED HAND SET

■ Ordering format: 4E-HM01

■ Features

- The set includes the motorized hand and required parts.
- As air is not required, the hand can be used in laboratories.
- The gripping force can be adjusted.
- The life is 10,000,000 times at a 50% load. The 50% load refers to when the max load weights in Table 4.9 are all within 50%.
- Installation on RV-E2M and RV-E3JM is possible, but as these do not have oil mist specifications the quality cannot be guaranteed.

■ Configuration

Table 4.8 Configuration devices

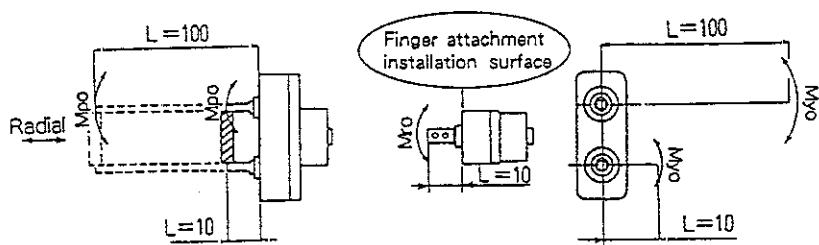
No.	Name	Type	Qty	Remarks
①	Motorized hand	1E-HM01	1	
②	Motorized hand curl cable	1E-GH14CD	1	
③	Motorized Hand interface	2E-32HND	1	
④	Installation bolts (with sockets)	M5×16	4	
⑤	Installation bolts (with sockets)	M3×12	2	
⑥	Adapter	BU144D697H01	1	Adaptor for installing item 1 on the robot arm's mechanical interface.

■ Specification / outline dimensions

Table 4.9 Motorized hand specifications

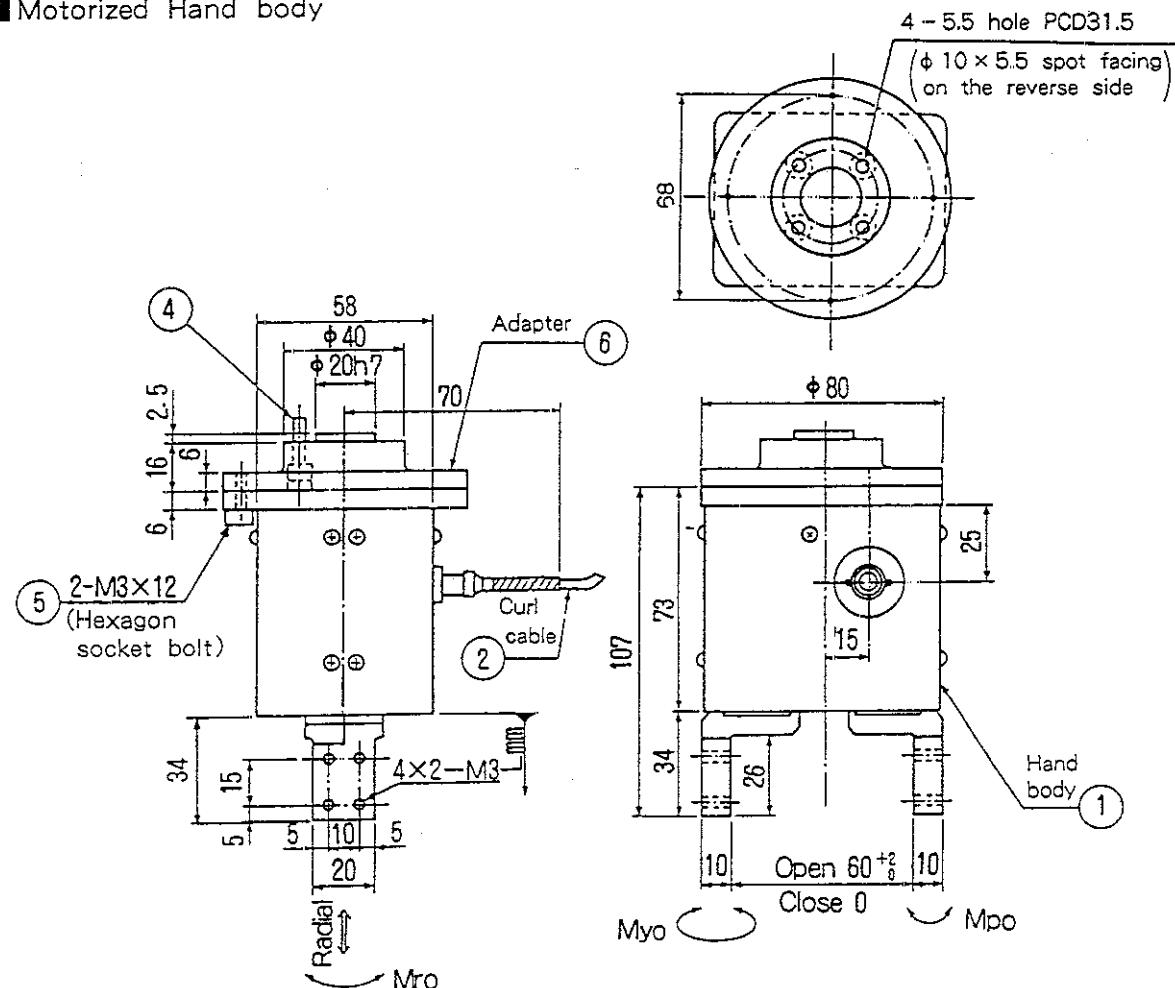
Item	Specification	Note
Drive method	DC servomotor	
Grip force	0.5~7kgf (Each side grip is 0.25 to 3.5kgf)	
Life	1,000,000 times cycle 100 % load 10,000,000 times cycle 50 % load.	
Repetition accuracy	0.03mm	
Ambient temperature	0~40°C	
Ambient humidity	45~85%	
Atmosphere	With no of oil mist, chip, powder dust.	
Operation confirmation sensors	None	
Body weight	0.59kgf	Including the adapter⑥.
Maximum load per finger	Lmm (From finger center on Myo)	
Radial	30kgf	
Mpo moment	62kg·cm (6.2kg·10cm)	
Mro moment	108kg·cm (10.8kg·10cm)	
Myo moment	60kg·cm (6kg·10cm)	Adaptor for installing item 1 on the robot arm's mechanical interface.

Moment for the grip point L : Mpo, Mro, Myo

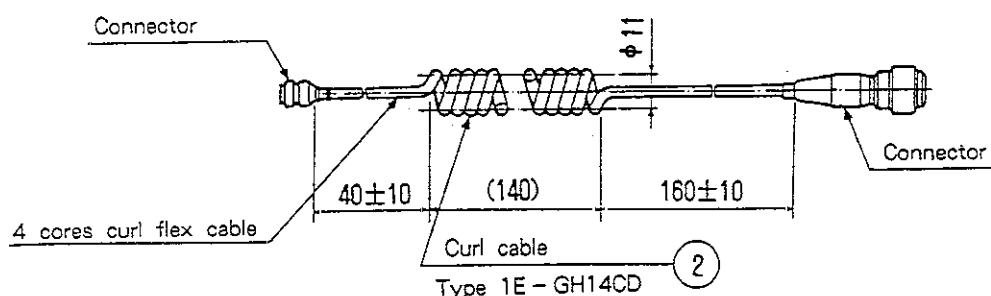


- MOTORIZED HAND SET

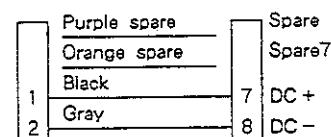
■ Motorized Hand body



■ Motorized Hand curl cable



[Wiring system diagram 1]



[Caution] Each part No. corresponds to the configuration devices listed in Table 4.8.

Fig. 4.5 Outline dimension drawing of motorized hand

• MOTORIZED HAND SET

■ Motorized hand I/F (interface board)

- The interface board is mounted in the hand interface board insertion slot in the controller.
- The board and installation screws are enclosed.

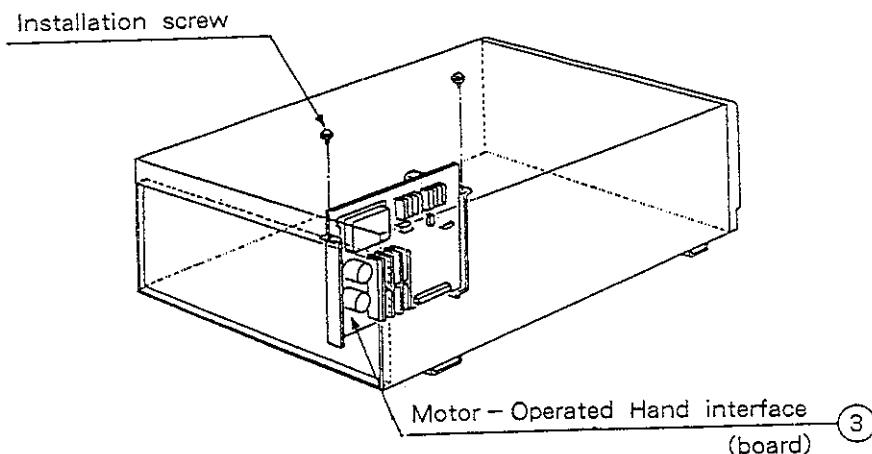
Installation method

- ① Turn the controller power OFF. Also turn OFF the main power supply
- ② After turning the power OFF, wait 3 minutes to discharge the charged section.
- ③ Remove the upper cover of the controller.
- ④ Remove the two installation screws on the slot at the far right looking from the rear of the controller. Remove the dust - proof cover for the expansion slot connector. (The user must save this cover)
- ⑤ Insert the motorized hand interface board into the above slot connector.
- ⑥ Tighten and fix with the two installation screws.
- ⑦ Install the upper cover of the controller.
- ⑧ Turn the controller power ON
- ⑨ If a hand is installed, confirm that the motorized hand opens and closes with jogging operation using the teaching box

CAUTION

Wait at least 3 minutes after turning off the power before removing the top panel. Don't turn the power on until the top panel has been installed. Other methods of handling may lead to electric shocks.

BANTOON-002



[Caution] Each part No. corresponds to the configuration devices listed in Table 4.8.

Fig. 4.6 Motorized hand I/F (interface board) installation drawing

■ Others

- The stroke cannot be adjusted so use the finger.
- The hand check signal is not included with the standard hand.
- The motorized hand (1E-HM01) can be used for RV-M1, RV-M2 and RH-M2, but the motorized hand curl cable (BU144D508G51) will be required.

(3) SOLENOID VALVE SET

- Ordering format:
 - One-row : 1E-VD01/1E-VD01E
 - Two-row : 1E-VD02/1E-VD02E

■ Outline

This is a solenoid valve option used to control the tooling when various tooling such as hands are installed on the end of the arm. All sets have double solenoid specifications, and a one-row or two-row type can be selected. This solenoid valve set has a solenoid valve connected to the (5) hand output cable. To make installation of this solenoid valve set onto the robot arm easily, a manifold, coupling and silencer, etc., are assembled into the set.

■ Type

Table 4.10 Configuration devices

Name	Type	Qty		Remarks
		Single	Double	
Solenoid valve set (Single)	1E-VD01/ 1E-VD01E	1	-	With 2 installation bolts M3 × 20.
Solenoid valve set (Double)	1E-VD02/ 1E-VD02E	-	1	

■ Specifications / outline dimensions

Table 4.11 Valve specifications

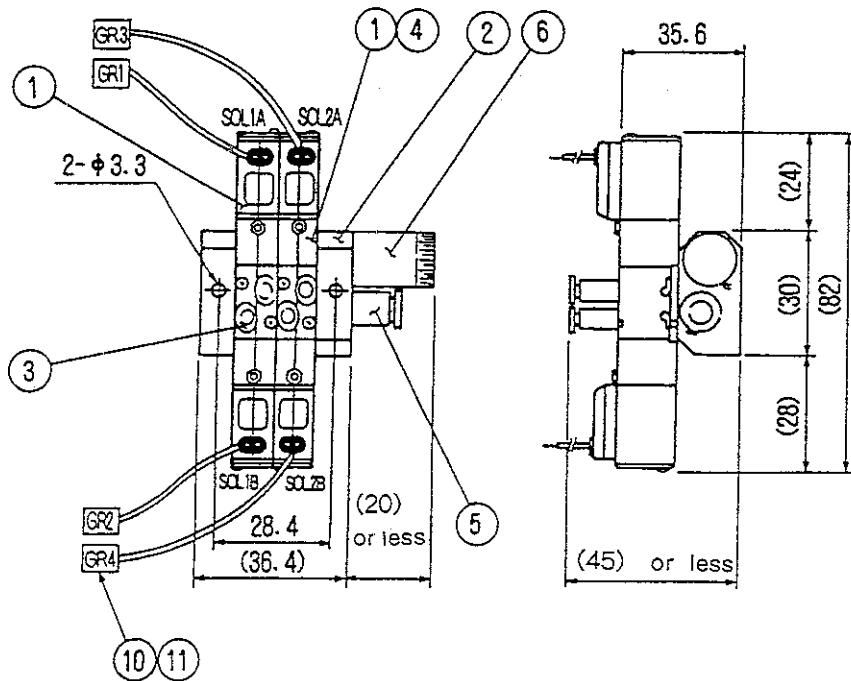
Item	Specification
No. of position	2
Port	5
Valve function	Double solenoid
Operating fluid	Clean air
Operation method	Pilot form
Effective cross section (CV value)	1.5mm (0.08)
Oil supply	No oil supply
Operating pressure range	0.2~0.7MPa {2.0~7.0kgf/cm ² }
Guaranteed/ pressure resistance	10MPa or more {10kgf/cm ² }
Response time	12ms or less (DC24V)
Max.operation frequency	5c/s
Ambient temperature	5~50°C

Table 4.12 Solenoid specifications

Item	Specification
Method	It has built-in surge measures fly-wheel diode.
Operation voltage	DC24V ± 10 %
Current value	40mA
Insulation	B type
Insulation resistance	100MΩ or more
Measures against surge	Fly-wheel diode

• SOLENOID VALVE SET

1E-VD01/1E-VD02 (U.S.A., JAPAN)



• Configuration

No.	Name	Single	Double	Specification
(1)	Valve	1	2	
(2)	Manifold block	1	1	
(3)	Quick coupling	2	4	φ 4
(4)	Block plate	1	0	
(5)	Quick coupling	1	1	φ 6
(6)	Silencer	1	1	
(10)	Connector	2	4	SMR-02V-B
(11)	Connector	4	8	SYM-001T-0.6
-	Installation bolt	2	2	M3 × 25

• Connection diagram

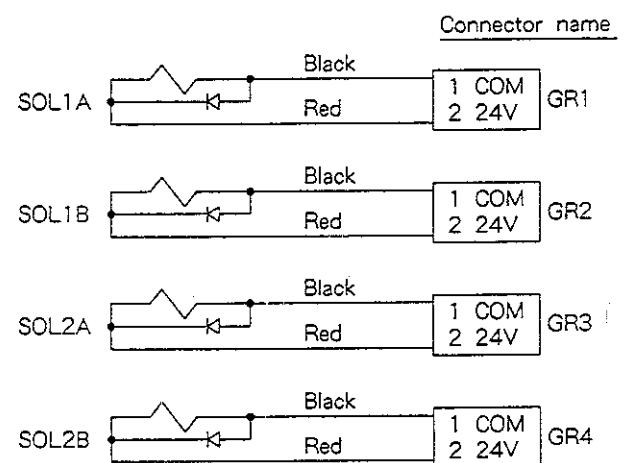
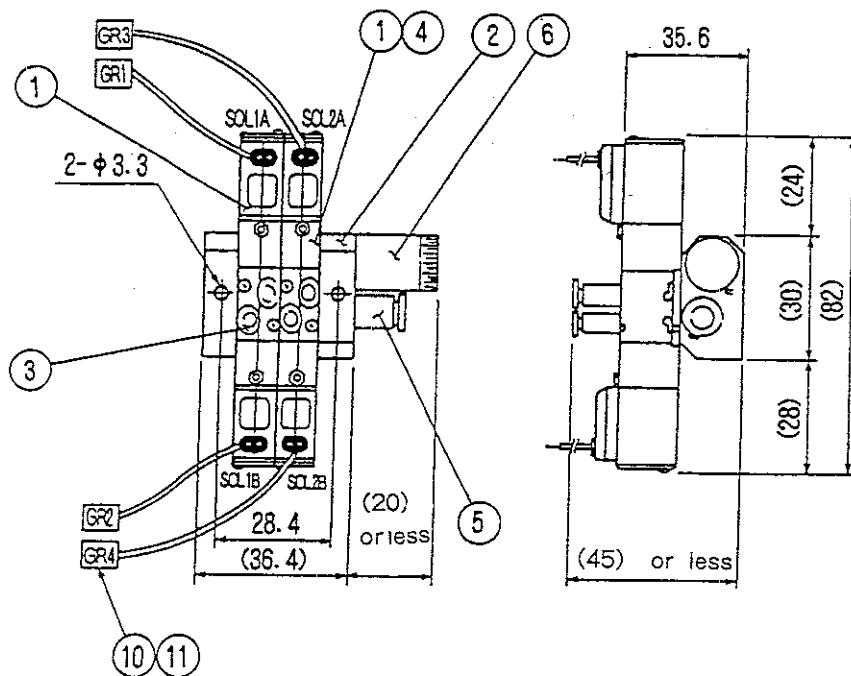


Fig. 4.7 Outline dimension drawing

• SOLENOID VALVE SET

1E-VD01E/1E-VD02E (EUROPE)



• Configuration

No.	Name	Single	Double	Specification
①	Valve	1	2	
②	Manifold block	1	1	
③	Quick coupling	2	4	φ 4
④	Block plate	1	0	
⑤	Quick coupling	1	1	φ 6
⑥	Silencer	1	1	
⑩	Connector	2	4	SMR-02V-B
⑪	Connector	4	8	SYM-001T-0.6
-	Installation bolt	2	2	M3 × 25

• Connection diagram

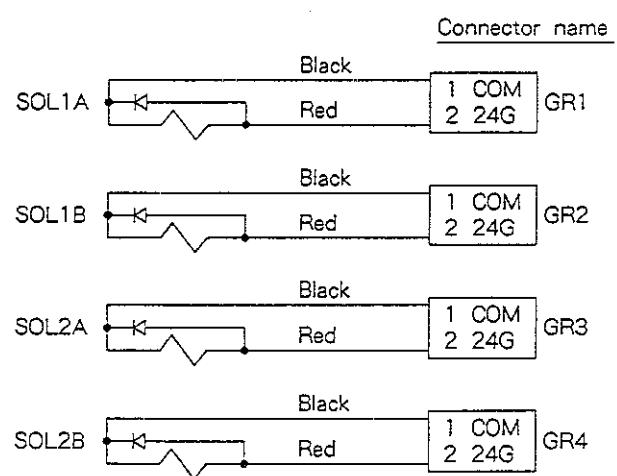


Fig. 4.7E Outline dimension drawing

(4) HAND INPUT CABLE (HAND CHECK CABLE)

■ Ordering format: IE-HC15C

■ Outline

- This option is used when the user manufactures the pneumatic hand.
- This cable is used to lead the hand open/close confirmation signals and grip confirmation signals to the controller.
- One end of this cable is connected to the hand signal input connector on the robot wrist. The other end is connected to the sensor in the user-manufactured hand.

■ Configuration

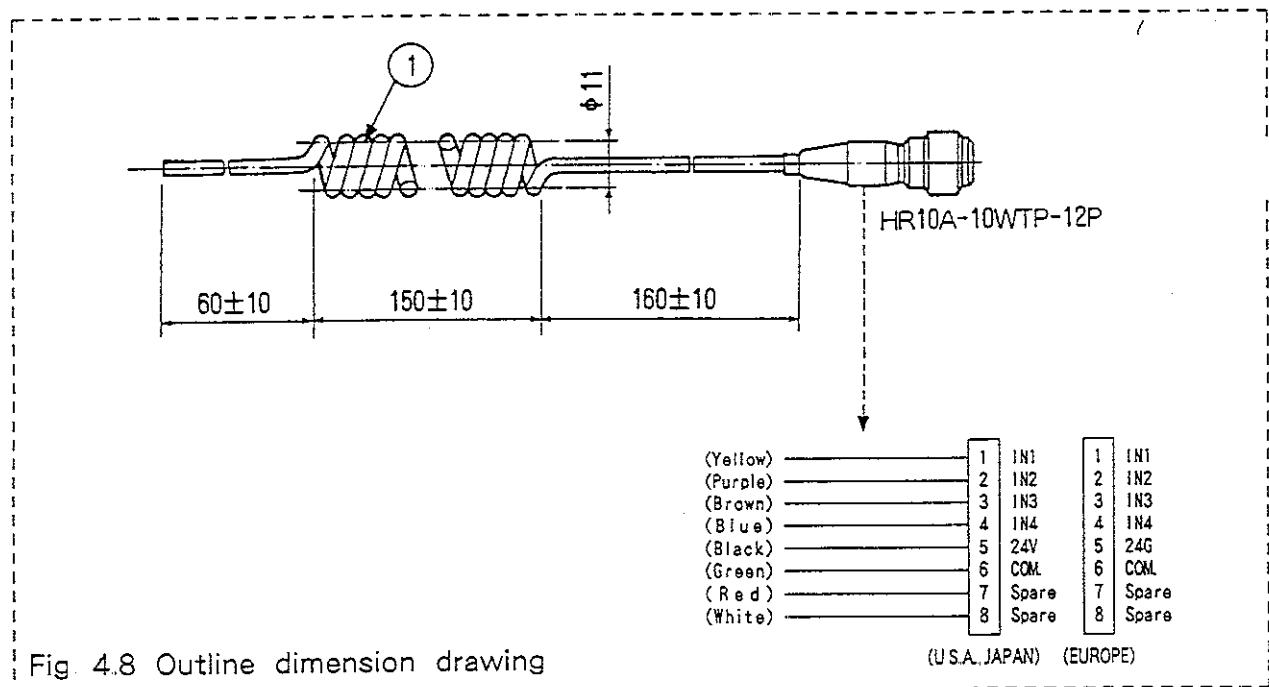
Table 4.13 Configuration devices

Name	Type	Qty.	Remarks
Hand input cable	IE-HC15C	1	

■ Specification / outside dimension

Table 4.14 Specification

Item	Specification	Remarks
Size × No. of cores	0.2SQ × 8 cores	
Total length	370mm	Including curl section 150mm



(5) HAND OUTPUT CABLE (SOLENOID VALVE CONNECTION CABLE)

■ Ordering format : IE - GR35S

■ Outline

- This option is used when a solenoid valve other than the option solenoid valve set is used.
- A connector connected to the input terminal in the robot is connected on one end, and the other end is a coupling bridge.

■ Configuration

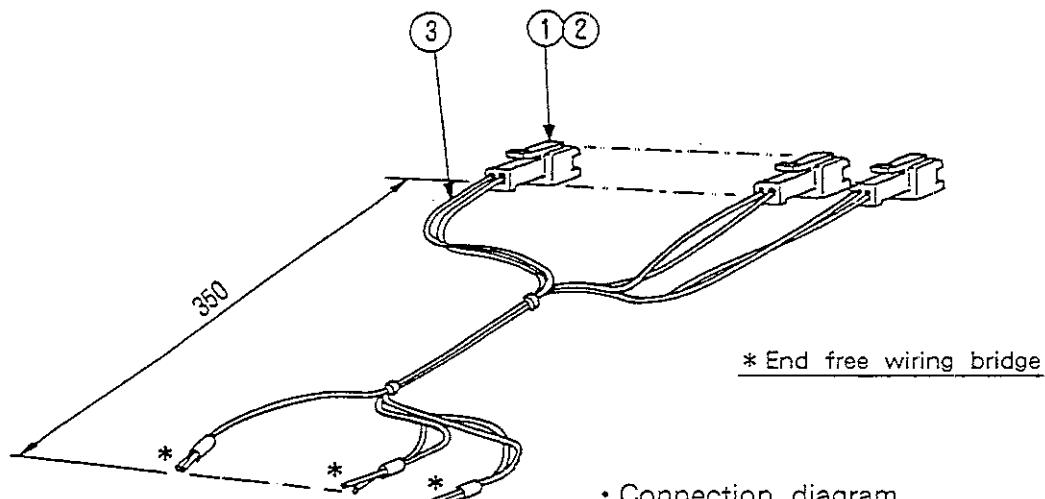
Table 4.15 Configuration devices

Name	Type	Qty.	Remarks
Hand output cable	IE - GR35S	1	

■ Specification / outside dimension

Table 4.16 Specification

Item	Specification	Remarks
No of cores	2 cores × 4	One end connector, one end cable bridge.
Size × No. of cores	0.3SQ × 2 core × 4 sets (Total 8 cores)	
Total length	350mm	



• Connection diagram

Connector name

White	1 COM	GR1
Black	2 24V	
White	1 COM	GR2
Black	2 24V	
White	1 COM	GR3
Black	2 24V	
White	1 COM	GR4
Black	2 24V	

• Configuration

No	Item	Qty.	Specification
①	Connector	4	SMR-02V-B
②	Connector	8	STM-001T-0.6
③	Twisted wire	4	0.3SQ × 2 core

Fig. 4.9 Outline dimension drawing

(6) HAND CURL TUBE

- Ordering format : ● Single : 1E-ST0402C
- Double : 1E-ST0404C

■ Outline

- This is the piping curl tube for the pneumatic hand.

■ Types

Table 4.17 Configuration devices

Name	Type	Qty.	Remarks
Curl tube (Single : 2)	1E-ST0402C	1	For single hand : $\phi 4$ tube 2
Curl tube (Double : 4)	1E-ST0404C	1	For double hand : $\phi 4$ tube 4

■ Specifications / outline dimensions

Table 4.18 Specifications

Item	Specification
Material	Urethane
Size	Outer diameter $\phi 4 \times$ inner diameter $\phi 2.5$

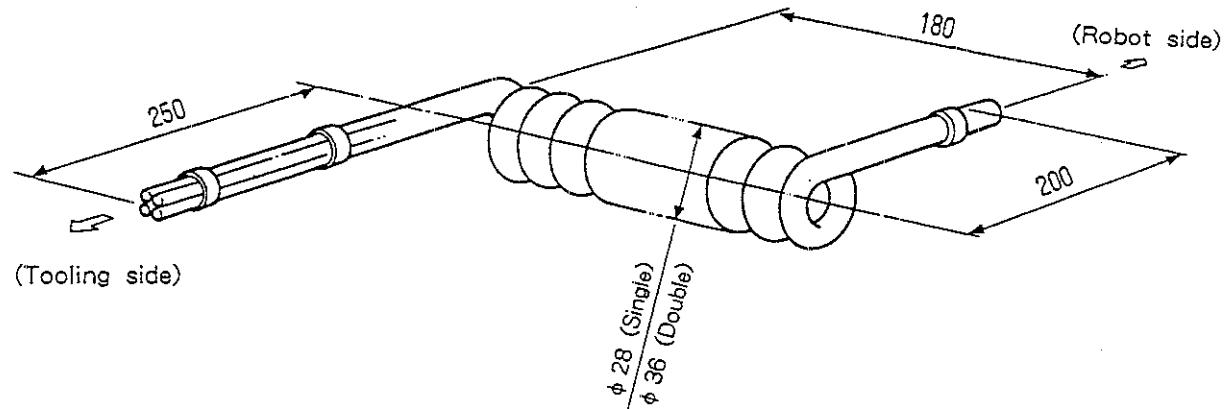


Fig. 4.10 Outline dimension drawing

(7) CALIBRATION JIG

■ Order format : 1E-INST

■ Outline

- This jig is used to calibrate the robot's coordinate origin to improve the deviation accuracy of the coordinates during palletizing or interpolation.

■ Configuration

Table 4.19 Construction equipment

Name	Type	Amount	Note
Calibration jig	1E-INST	1	
Installation bolts	M5 × 12	4	
Pin		1	

Table 4.20 Linear interpolation path accuracy anticipated with adjustment

Item	Using calibration jig	Mechanical stopper method : Standard	Remarks
Path accuracy	Approx. ± 0.5 mm	Approx. ± 20 mm	Speed 10% (50mm/s) value at robot face area 300 × 200mm

■ Calibration method

- ① Fix the robot on a base such as a table to be used as a reference.
- ② Install the calibration jig onto the robot flange.
- ③ Release the robot brakes.
- ④ Hold the handle on the jig, and align the jig reference plane to the table surface (Z direction reference) and the reference machining plane (XY direction reference).
- ⑤ Operate the controller and set the reference. (Set the reference coordinate parameter in the memory.)

For the standard method, the each axis is pushed against the mechanical stopper and the reference coordinate is set instead of step ②.

[Caution] Calibration must be done by the user. The standard method is the mechanical stopper method.

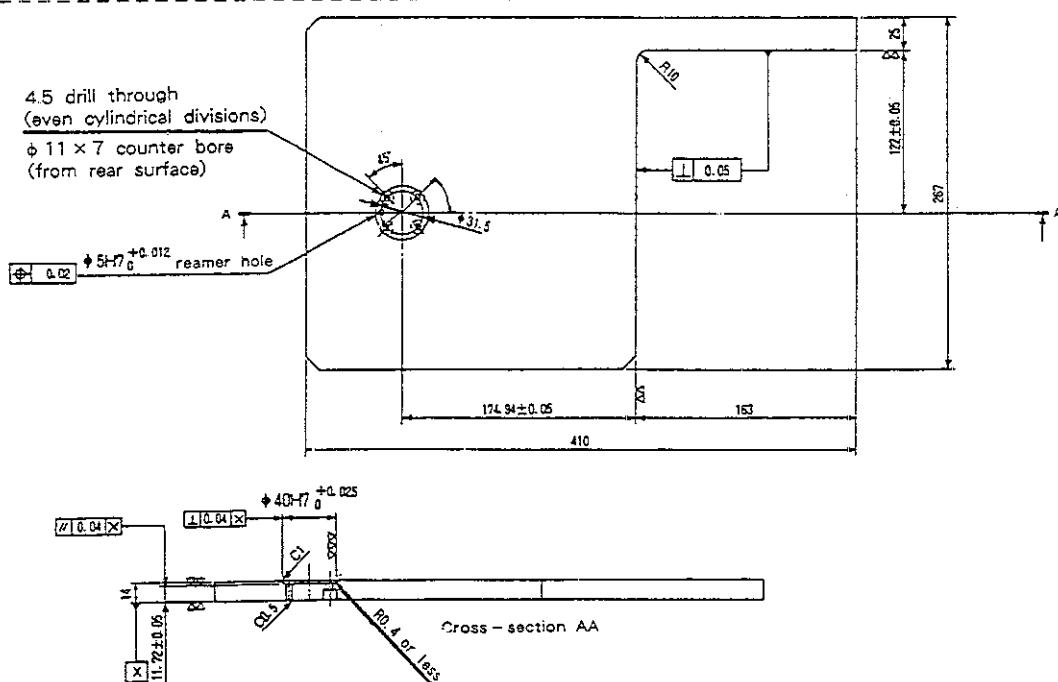


Fig. 4.11 Reference dimension drawing

(8) TEACHING BOX (P6TB - TE)

■ Order format : P6TB-TE

■ Outline

- This device creates a robot program by teaching (moving the robot and memorizing the positions). The jog feed and position display required for teaching can be done easily. With the large keys and 16-character × 4-line LCD display, simple programs can be created, edited and controller.

■ Construction

Table 4.21 Configuration devices

Name	Type	Qty.	Remarks
Teaching box	P6TB-TE	1	Cable 5m, including hand strap

■ Specifications / outline dimensions

Table 4.22 Specifications

Item	Specifications
Outline dimension	95 (W) × 220 (H) × 25 (D) (Refer to outline drawing)
Body color	Light gray (Munsell color: 7.65Y7.64/0.73)
Weight	Approx. 0.45kgf (Only arm, excluding cable)
Connection method	Connect to controller with 25-core D-Sub connector: Cable length 5m
Interface	RS - 422
Display method	LCD method: 16 character × 4 line LCD illumination: Back light
Operation section	28 keys (Figs. 4.12 and 4.13)

• TEACHING BOX (P6TB - TE)

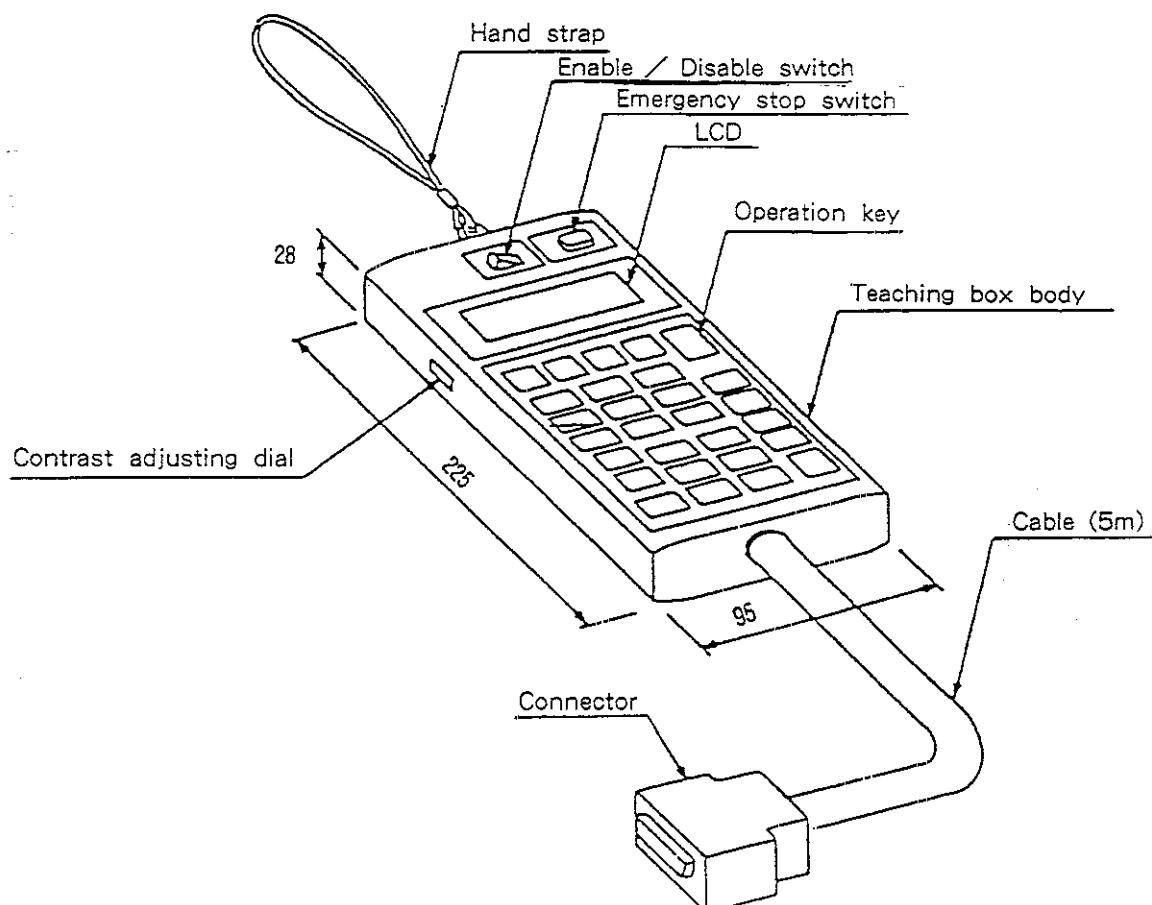


Fig. 4.12 Outline dimensions of teaching box

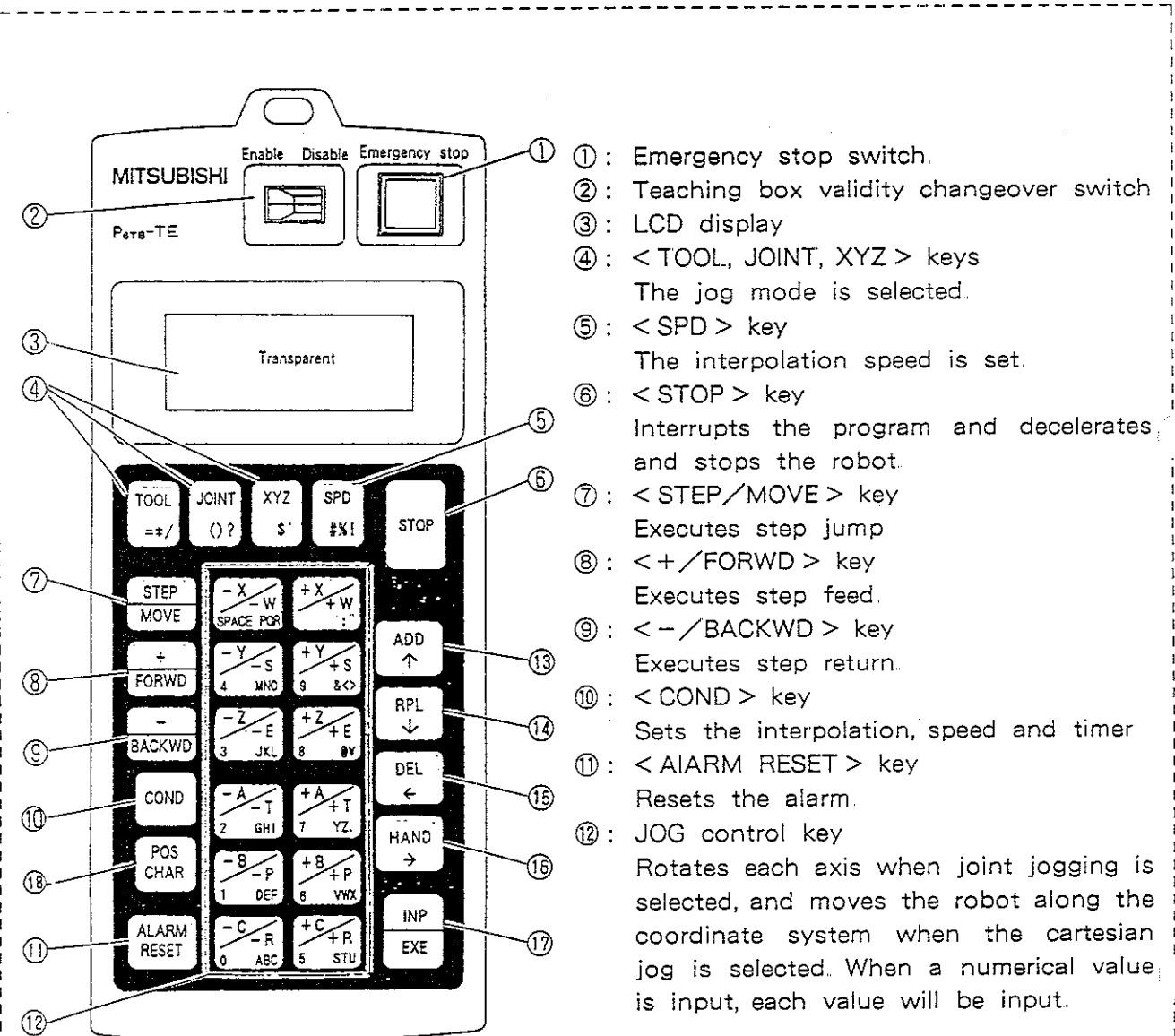
■ Installation method

Connect to the RS-422 connector on the front of the controller.

[Caution] The emergency stop state will be entered if the teaching box is disconnected during robot operation. Turn ON the "Emergency stop cancel switch" on the front operation panel of the controller before disconnecting the teaching box without stopping the robot operation.

• TEACHING BOX (P6TB - TE)

■ Key layout and main functions



- ① : Emergency stop switch.
- ② : Teaching box validity changeover switch
- ③ : LCD display
- ④ : < TOOL, JOINT, XYZ > keys
The jog mode is selected.
- ⑤ : < SPD > key
The interpolation speed is set.
- ⑥ : < STOP > key
Interrupts the program and decelerates and stops the robot.
- ⑦ : < STEP/MOVE > key
Executes step jump
- ⑧ : < + / FORWD > key
Executes step feed.
- ⑨ : < - / BACKWD > key
Executes step return.
- ⑩ : < COND > key
Sets the interpolation, speed and timer
- ⑪ : < AIARM RESET > key
Resets the alarm.
- ⑫ : JOG control key
Rotates each axis when joint jogging is selected, and moves the robot along the coordinate system when the cartesian jog is selected. When a numerical value is input, each value will be input.
- ⑬ < ADD / ↑ > key ... Adds and registers position data or condition data.
Moves the cursor upward (↑)
- ⑭ < RPL / ↓ > key ... Compensates the position data or condition data.
Moves the cursor downward (↓)
- ⑮ < DEL / ← → > key ... Deletes the position data or condition data.
Moves the cursor to the left (←)
Moves the cursor to the right (→)
- ⑯ < HAND / → > key ... Opens or closes the hand.
- ⑰ < INP / EXE > key ... Inputs condition data or executes step feed.
- ⑱ < POS / CHAR > key ... The changes the editing screen or changes between numerals and alphabetic characters.

Fig. 4.13 Teaching box key layout and main functions

(9) PARALLEL I/O INTERFACE

■ Ordering format : 2E-31IO/2E-31IOE

■ Outline

- This is used to expand the external input/output.

■ Configuration

Table 4.23 Configuration devices

Name	Type	Qty.	Remarks
Parallel I/O interface	2E-31IO	1	U.S.A., JAPAN
	2E-31IOE	1	EUROPE

■ Specifications

The input/output circuit specifications are the same as the standard mounted parallel I/O interface. Refer to Chapter 3 for details.

Table 4.24 Specifications

Item	Specification
Outline dimension	95 (W) × 220 (H) × 25 (D)
Connection method	Connect to option slot on rear of controller
No. of input/output points (per board)	General purpose input 20. General purpose output 16.

■ Installation method

Install in the option slot (OPT2) and (OPT3) on the rear of the controller, and connect the connector.

■ Others

- Use of the (10) external I/O cable for the connection cable is handy.
- Designate two boards when two are required.

• PARALLEL I/O INTERFACE

■ Parallel I/O interface (1st expansion board)

Table 4.25 List of 1st expansion board pin Nos. and signal assignments

Pin No.	Signal	Function name	Pin No.	Signal	Function name
		Exclusive / power source, common			Exclusive / power source, common
1		FG	26		FG
2		0V : For pin 4-7	27		0V : pin 29-32
3		12V/24V : For pin 4-7	28		12V/24V : pin 29-32
4	General output 100		29	General output 104	
5	General output 101		30	General output 105	
6	General output 102		31	General output 106	
7	General output 103		32	General output 107	
8		0V : For pin 10-13	33		0V : For pin 35-38
9		12V/24V : For pin 10-13	34		12V/24V : For pin 35-38
10	General output 108		35	General output 112	
11	General output 109		36	General output 113	
12	General output 110		37	General output 114	
13	General output 111		38	General output 115	
14		COM0 : pin 15-22	39		COM1 : pin 40-47
15	General input 100		40	General input 108	
16	General input 101		41	General input 109	
17	General input 102		42	General input 110	
18	General input 103		43	General input 111	
19	General input 104		44	General input 112	
20	General input 105		45	General input 113	
21	General input 106		46	General input 114	
22	General input 107		47	General input 115	
23		Not used	48		COM2 : 24, 25, 49, 50
24	General input 116		49	General input 118	
25	General input 117		50	General input 119	

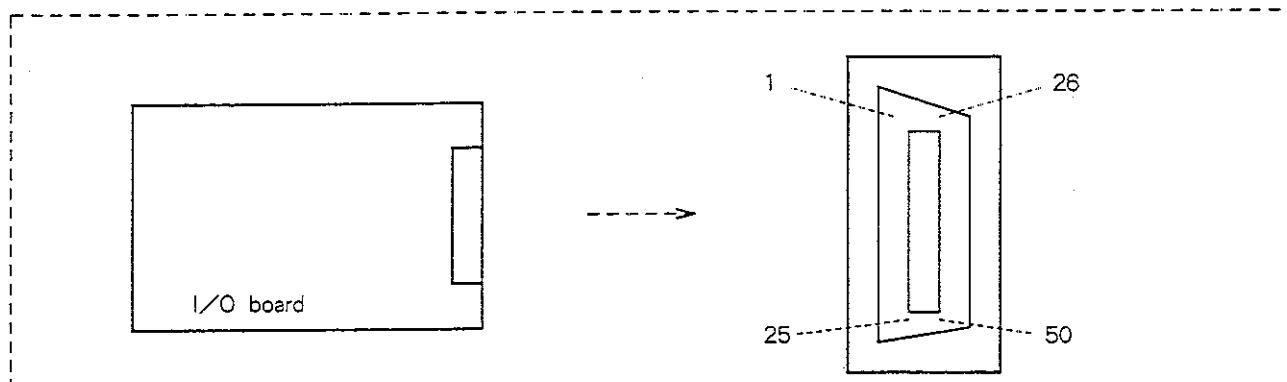


Fig. 4.14 Parallel I/O interface card connection and pin layout

• PARALLEL I/O INTERFACE

■ Parallel I/O interface (2nd expansion board)

Table 4.26 List of 2nd expansion board pin Nos. and signal assignments

Pin No.	Signal	Function name	Pin No.	Signal	Function name
		Exclusive / power source, common			Exclusive / power source, common
1		FG	26		FG
2		OV : For pin 4-7	27		OV : pin 29-32
3		12V/24V : For pin 4-7	28		12V/24V : pin 29-32
4	General output 200		29	General output 204	
5	General output 201		30	General output 205	
6	General output 202		31	General output 206	
7	General output 203		32	General output 207	
8		OV : For pin 10-13	33		OV : For pin 35-38
9		12V/24V : For pin 10-13	34		12V/24V : For pin 35-38
10	General output 208		35	General output 212	
11	General output 209		36	General output 213	
12	General output 210		37	General output 214	
13	General output 211		38	General output 215	
14		COM0 : pin 15-22	39		COM1 : pin 40-47
15	General input 200		40	General input 208	
16	General input 201		41	General input 209	
17	General input 202		42	General input 210	
18	General input 203		43	General input 211	
19	General input 204		44	General input 212	
20	General input 205		45	General input 213	
21	General input 206		46	General input 214	
22	General input 207		47	General input 215	
23		Not used	48		COM2 : 24 25, 49, 50
24	General input 216		49	General input 218	
25	General input 217		50	General input 219	

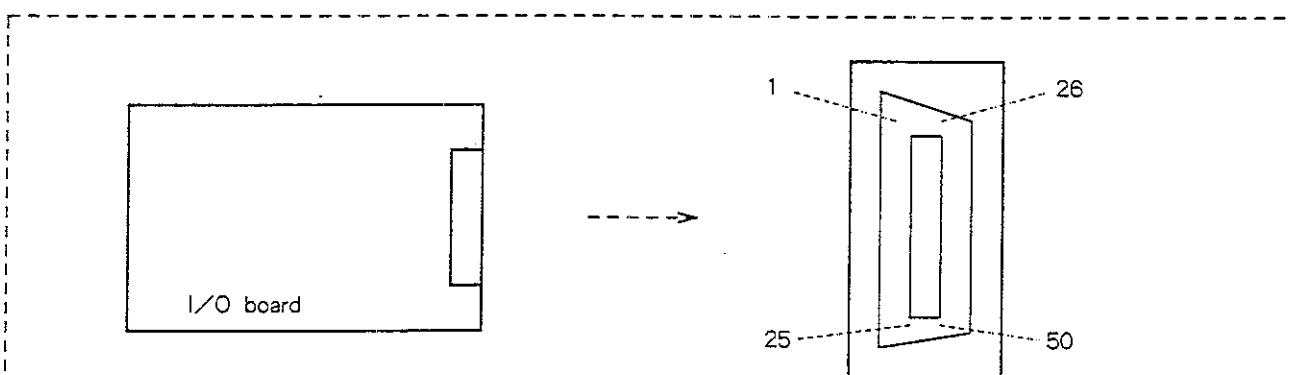


Fig. 4.15 Parallel I/O interface card connection and pin layout

(10) EXTERNAL I/O CABLE

■ Order format : I/O-CBL

■ Outline

- An exclusive cable is available to connect the parallel I/O interface connector to an external peripheral device. One end of this cable conforms to the parallel I/O interface connector and the other end is free. Connect the input/output signal on the peripheral device side to the free end.

■ Configuration

Table 4.27 Configuration devices

Name	Type	Qty.	Remarks
External I/O cable	I/O-CBL	1	

■ Specifications

Table 4.28 Specifications

Item	Specification
No. of cores × wire size	50 cores × 0.18 SQ
Total length	5m

■ Installation method

Table 4.29 Connector pin No. and wire color

Pin No.	wire color	Pin No.	wire color	Pin No.	wire color	Pin No.	wire color	Pin No.	wire color
1	White/black A	11	White/black C	21	White/red A	31	Pink/black B	41	Pink/black D
2	Yellow/black A	12	Yellow/black C	22	Yellow/red A	32	Gray/black B	42	Gray/black D
3	Blue/black A	13	Blue/black C	23	Blue/red A	33	Red/black B	43	Red/black D
4	Green/black A	14	Green/black C	24	Green/red A	34	Purple/black B	44	Purple/black D
5	Orange/black A	15	Orange/black C	25	Orange/red A	35	Brown/black B	45	Brown/black D
6	Pink/black A	16	Pink/black C	26	White/black B	36	White/black D	46	White/red B
7	Gray/black A	17	Gray/black C	27	Yellow/black B	37	Yellow/black D	47	Yellow/red B
8	Red/black A	18	Red/black C	28	Blue/black B	38	Blue/black D	48	Blue/red B
9	Purple/black A	19	Purple/black C	29	Green/black B	39	Green/black D	49	Green/red B
10	Brown/black A	20	Brown/black C	30	Orange/black B	40	Orange/black D	50	Orange/red B

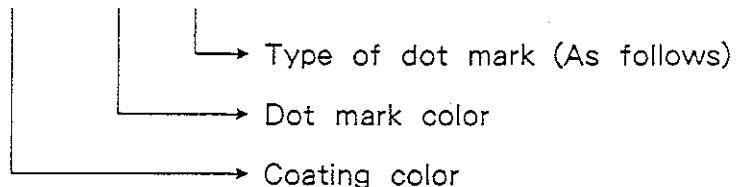
• EXTERNAL I/O CABLE

■ Connection and outer dimension

Each of the 50 signal wires has a color display and dot mark on the sheath for identification. Refer to the wire color designation given in the "parallel I/O interface connector pin layout" and connect them accordingly.

(Example) Pin No : Color display

21 : White/Red/A



Dot mark type

Type A

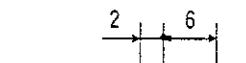
Dot pattern



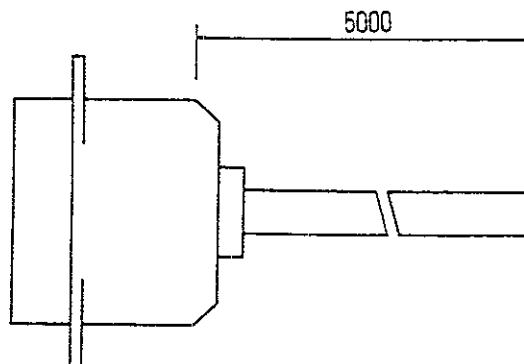
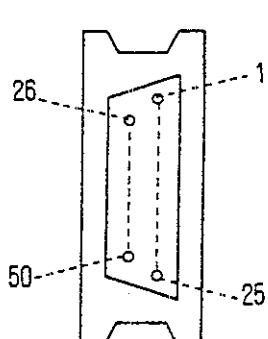
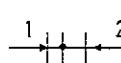
Type B



Type C



Type D



Receptacle type : 57AE-40500-21D (D8) DDK

Plug type : 57E-30500 DDK

Fig. 4.16 Connection / outline dimensions

(11) RACK ADAPTER

■ Ordering format : 2E-RACK

■ Outline

- This adaptor is used when installing the controller in a 19-inch standard rack.
- Tighten the rack adapters with the screws on the side of the controller.

■ Configuration

Table 4.30 Configuration devices

Name	Type	Qty.	Note
Rack adapter	1E-RACK	1 set (2pcs.)	The installation screws are enclosed with the controller.

■ Outline dimensions / installation section dimensions

- Dimensions for the 19 inches standard rack.

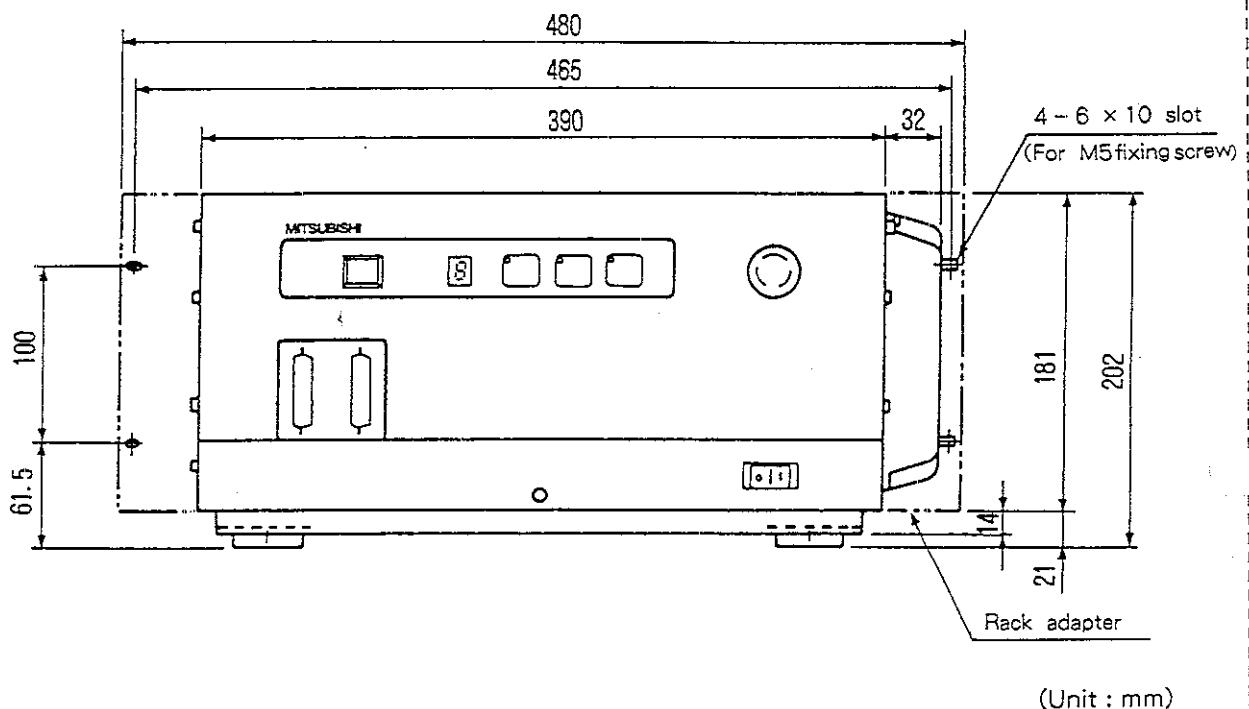


Fig. 4.17 Outline dimension drawing

■ Installation method

- Tighten the rack adapters with the screws on the side of the controller.

[Caution] The controller weighs approx. 28kgf. Make sure that the entire weight is not supported by only the rack adaptor.

(12) PERSONAL COMPUTER CABLE

- Ordering format:
 - For MAXY, PC/AT ... RS-MAXY-CBL
 - For PC98 ... RS-PC-CBL

■ Outline

This is an RS-232-C interface cable for connecting the controller and personal computer. Note that the above interface cable may be usable with the personal computer on hand. Confirm the connection specifications when ordering.

Personal computer cables for the Mitsubishi MAXY and for the NEC PC9801 are available.

■ Type

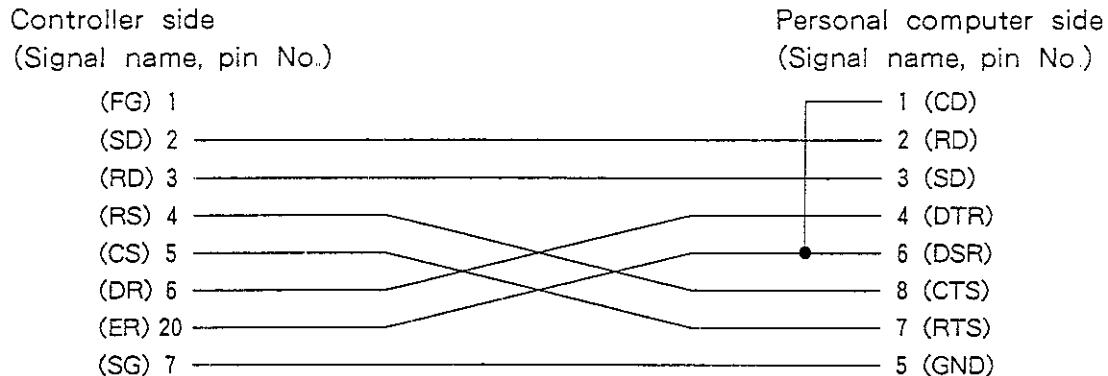
Table 4.31 Configuration devices and types

Name	Type	Qty.	Remarks
Personal computer cable(For MAXY & PC/AT)	RS-MAXY-CBL	1	3m
Personal computer cable(For PC9801)	RS-PC-CBL	1	3m

[Reference] The personal computer cable is the same as for the <MOVEMASTER>.

■ Connection specifications

(1) For MAXY & PC/AT



(2) For PC9801

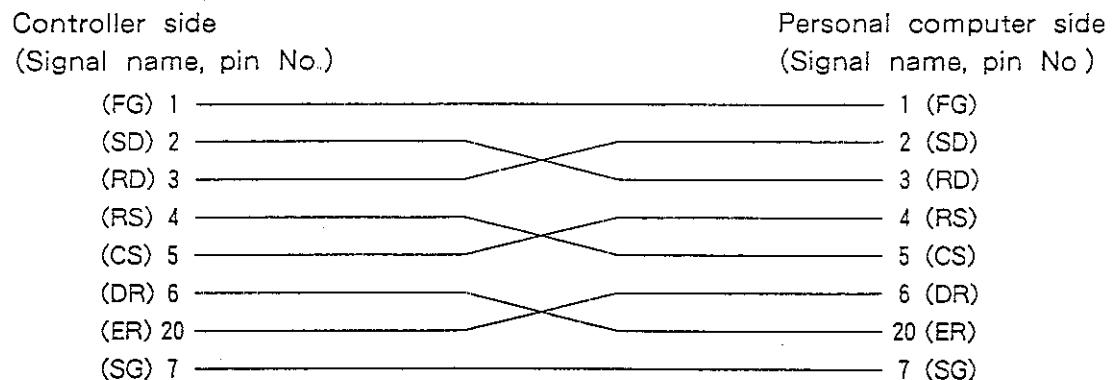


Fig 4.18 Connection specifications / (RS-232-C cable)

(13) PERSONAL COMPUTER SUPPORT S/W

- Ordering format:
 - For PC98 SW-PC-3
 - For MAXY SW-MAXY-3
 - For PC/AT SW-AT-3 (Japanese version)
SW-ATE-3 (English version)

■ Outline

This handy software fully uses the personal computer functions, and is used for the initial start up of the robot to the creation, editing, execution and control of the program.

■ Features

- (1) Operation is easy with the guidance method and menu method

Initial setting of the controller and starting operations can be done easily following the instructions on the screen. Even a beginner can easily do the work required to create and execute a program.

- (2) Improved work efficiency with ample support functions

With the multi-window method that allows multiple work and displays to done simultaneously, the work efficiency can be greatly improved. The renumbering, copying, searching, grammar check and step execution functions have been strengthened making program editing and debugging work easy.

■ Type

Table 4.32 types

Part name	Type	Qty.	Remarks
Personal computer support software (for PC9801)	SW-PC-3	1 set	With one instruction manual
Personal computer support software (for MAXY)	SW-MAXY-3	1 set	With one instruction manual
Personal computer support software (for PC/AT DOS/V)	SW-AT-3	1 set	With one instruction manual
Personal computer support software (for PC/AT)	SW-ATE-3	1 set	With one instruction manual (English specifications)

[Caution] This product comes on 3.5 inch floppy disks.

• PERSONAL COMPUTER SUPPORT S/W

■ Functions

Table 4.33 Functions

Functions	Details
Applicable model	PC98 PC9801 Series and compatible models that are VM and higher (excluding XL/XL2/XA/LT)
	MAXY MAXY Series
	PC/AT PC/AT compatible models Japanese DOS/V compatible
Editing functions	<ul style="list-style-type: none"> • Command input (syntax check selection possible), comment description • Program registration and deletion, position registration and deletion • File operation (read/write to floppy disk, read/write to controller) edit/delete end • Call and search (line No., character) • Copy, cut paste (range designated) • Coordinate data addition/subtraction • Line No. automatic generation, renumbering, syntax batch check
Execution functions	<ul style="list-style-type: none"> • Program selection • Program execution (head, range designated step) • Direct execution (menu selection, command input) • Current position jog mode selection • Program and error reset • Jog operation (mode speed, movement amount selection)
Monitor functions	<ul style="list-style-type: none"> • Hand open/close state • Counter details • Input signal and output signal status (binary, decimal, hexadecimal)
Management functions	<ul style="list-style-type: none"> • File management (list, copy, name change, delete, initialization, back up, restore) • Print (file list, program list, detail, counter)
Auxiliary functions	<ul style="list-style-type: none"> • Initialize start-up (switch operation etc.) • System ROM version read • Environment setting (robot type selection, communication parameter, printing style, drive directory, etc.) • MS-DOS command execution

- The execution functions, monitor functions and some other functions are valid only when the controller is connected.
- The program being executed or the robot movement cannot be stopped with the personal computer.
- The above jog operations are substituted in part with the actual teaching box functions, but not all functions are replaced.

[Caution] The (12) personal computer cable is required.

(14) EXPANSION SERIAL INTERFACE

■ Ordering format : 2E-31S1O

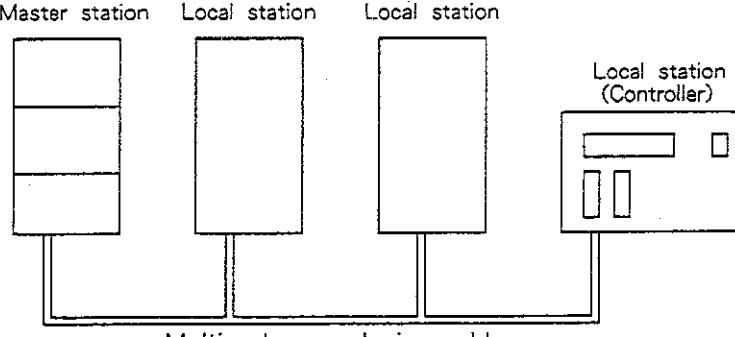
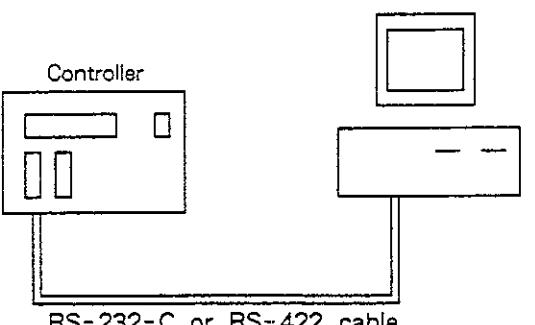
■ Outline

This is used to expand an interface having the same functions as the RS-422 interface and RS-232-C interface on the front of the controller to allow multi-drop link communication and serial communication.

■ Functions

The expansion serial interface has the following two communication functions. One of the functions can be selected and used. A maximum of two interface boards can be mounted.

Table 4.34 Communication functions

No.	Communication functions	Description
1	Multi-drop link functions	<p>This has the functions as the local station that is one of the Mitsubishi sequencer communication networks. The multi-drop link unit is connected using the RS-422 interface to create a link system. With this I/O (96 points each) is possible through communication. The system can also be constructed with less wiring. Refer to the sequencer manual for details on the multi-drop link.</p> <p>Master station Local station Local station  Multi - drop exclusive cable</p>
2	Serial communication functions	<p>This function allows connectors having the same functions as the RS-422 connector and RS-232-C connector on the front of the panel to be used with one board. Both connectors can be used simultaneously. When connected with an external device (personal computer, etc.), the robot programs can be up/downloaded and the robot can be operated.</p> <p>Controller  RS-232-C or RS-422 cable</p>

• EXPANSION SERIAL INTERFAC

■ Transmission specifications

Table 4.35 Transmission specifications

Item	Specifications	
	Communication with multi-drop link	Serial communication
Interface	According to RS-422, RS-485	According to RS-232, RS-422
Transmission method	Half-duplex communication (no procedure)	Full-duplex communication (no procedure)
Synchronization method	Asynchronous	Asynchronous
Baud rate	19200, 38400BPS	600, 1200, 2400, 4800, 9600, 19200BPS
Data form	Start bit Data bit Parity bit Stop bit	1 7 or 8 1 or none 1 or 2
Error detection	With parity check (even)	With parity check (odd/even) or none
DTR/DSR (ER/DR) control	Not provided	Provided
X ON/OFF control	Not provided	Not provided
Data format	Start bit + data bit + parity bit + stop bit	Start bit + data bit + parity bit + stop bit
No. of possessed I/O points	192 points (96 input points/96 output points)	—

■ Standard configuration

Table 4.36 Standard configuration

No.	Item	Product name	Qty.
1	Expansion serial interface board	E31SIO	1
2	Multi-drop exclusive cable	EC05LNK	1
3	Instruction manual	BFP-A5628	1

The external devices such as the personal computer and connection cables such as RS-232-C and RS-422 must be prepared by the user.

• EXPANSION SERIAL INTERFAC

■ RS-232-C connector specifications

• RS-232-C connector pin layout

The correspondence of the RS-232-C connector in Nos. and signal names is as shown below.

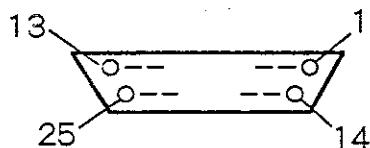


Fig.4.19 Pin layout (front of RS-232-C connector)

• The function of each signal wire in the RS-232-C connector is shown below

Table 4.37 Signal names and functions (RS-232-C)

Pin No.	Signal name	Input/output	Functions
1	FG	—	This is the frame ground. Connect the G terminal on the controller.
2	SD (TXD)	Output	This is transmission data sent from the controller to the external device.
3	RD (RXD)	Input	This is the reception data sent from the external device to the controller.
4	RS (RTS)	Output	This is the data transmission request signal sent to the external device.
5	CS (CTS)	Input	This is the data transmission permit signal to the controller.
6	DR (DSR)	Input	This is the external device's transmission/reception preparation ready signal.
7	SG	—	This is the ground for the signal wire.
20	ER (DTR)	Output	This is the controller's transmission/reception preparation ready signal.

Compatible connector: DB-25P (plug side (pin side) or equivalent (Japan Aviation Electronics)

■ RS-422 connector specifications

• RS-422 connector pin layout

The correspondence of the RS-422 connector in Nos. and signal names is as shown below.

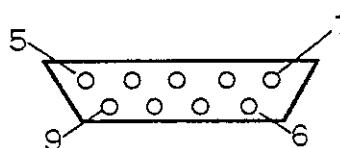


Fig.4.20 Pin layout (front of RS-422 connector)

• The function of each signal wire in the RS-422 connector is shown below.

Table 4.38 Signal names and functions (RS-422)

Pin No.	Signal name	Input/output	Functions
1	CB	Input	This is the external device's transmission/reception preparation ready signal.
2	CA	Output	This is the controller's transmission/reception preparation ready signal.
3	SG	—	This is the ground for the signal wire.
4	BB	Input	This is the reception data sent from the external device to the controller.
5	BA	Output	This is transmission data sent from the controller to the external device.
6	CBL	Input	This is the external device's transmission/reception preparation ready signal.
7	CAL	Output	This is the controller's transmission/reception preparation ready signal.
8	BBL	Input	This is the reception data sent from the external device to the controller.
9	BAL	Output	This is transmission data sent from the controller to the external device.

Compatible connector: DE-9P-N (plug side (pin side) or equivalent (Japan Aviation Electronics)

(15) ADDITIONAL AXIS INTERFACE

■ Ordering format: 2E-31AXS

■ Outline

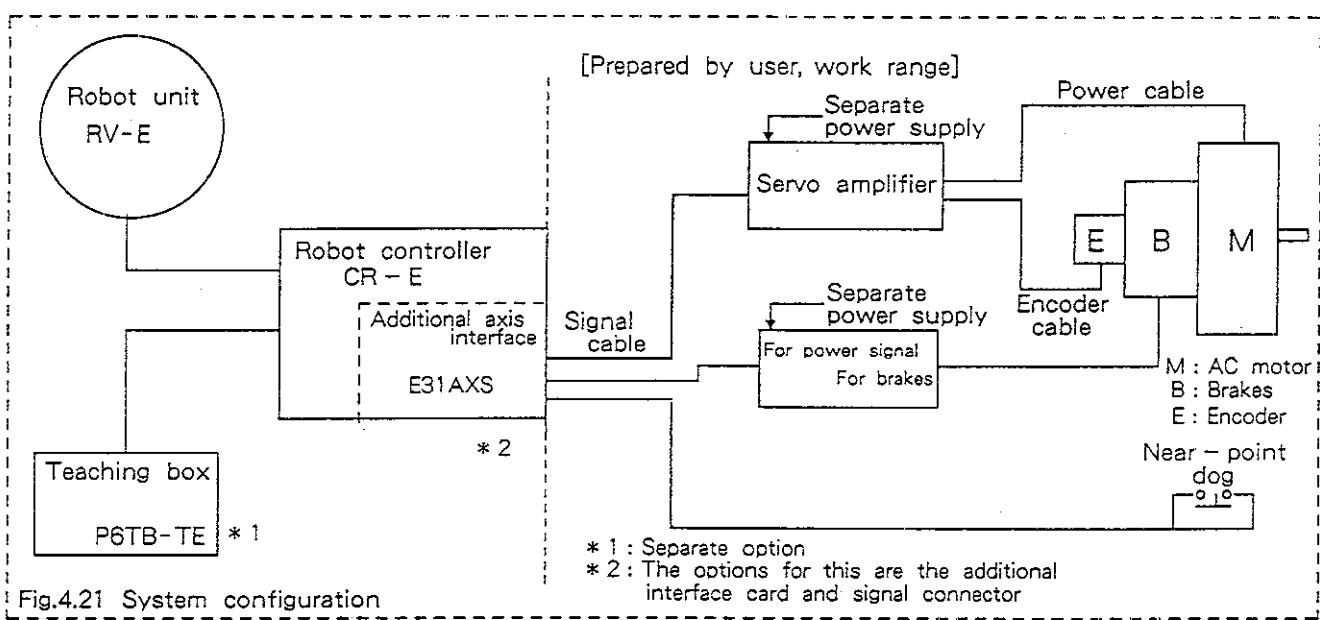
This is the general-purpose servo amplifier control axis used together with the E Series controller.

■ Function

The additional axis interface has the following functions.

- (1) Using the additional axis interface and the general purpose servo system as a set, one axis such as the travel axis can be controlled with the controller. A maximum of two additional axis interface boards can be installed allowing a maximum of two axes to be controlled.
- (2) Various general purpose servo amplifiers (Refer to Table 1.6) and servomotors can be used.
- (3) Jog operation of the additional axis is possible from the teaching box.
- (4) Programming and teaching play back of the additional axis using MOVEMASTER commands is possible.
- (5) Simultaneous start interpolation of the robot and additional axis is possible.

■ System configuration



[Caution] The above drawing shows only one additional axis.

■ Usable servo systems

Table 4.39 Usable servo systems

Marker	Type
IMITSUBISHI ELECTRIC CO.	MR-H, MR-J (Encoder output line driver type)
YASUKAWA ELECTRIC CO.	SGD
NIKKI DENSO	NPSA-G
MATSUSHITA ELECTRIC	MSD

[Caution] Refer to catalogs issued by each maker for the servo system details.

• ADDITIONAL AXIS INTERFACE

■ Additional axis interface specifications

Table 4.40 Specifications

Item	Specifications
Type	2E-31AXS
No. of controllable axes	1
Compatible amplifiers	MR - H (ABS, INC method) MR - J encoder output line driver type (INC method) Other maker general purpose amplifiers (INC method)
Output pulse rate	Max. 400kHz
Tolerable input pulse	Max. 250kHz
Input signal	Positioning completion, brake interlock, servo alarm, operation ready, encoder A, B and Z, origin dog ABS (preparing transmission data, bit 0, bit 1)
Output signal	Emergency stop, servo ON Alarm reset, forward/reverse command pulse Counter clear, brake signal ABS (operation mode, request, data store)
Connector	PCR - S50FS (case: PCR - LS50LA) : Honda Tsushin
Program method	MOVEMASTER command method and teaching playback method
Control functions	Simultaneous start interpolation control (Only starting is matched. The interpolation path cannot be regulated.)
Origin positioning	Setting of operation direction for return and origin position is possible (Note that origin setting is not required for the ABS method.)
Acceleration/	Plateau type, acceleration/deceleration time setting possible
Position control	Distance control/angle control selection possible Real value control using pitch and reduction ratio setting
Min. command value	0.01 [mm or deg] (The unit is set with parameters)
Max. operation range	- 80000.00 to + 80000.00 [mm or deg] (Operation limit can be set at random position.)
Max. No. of mountable	Two boards (two axes)

[Caution 1] ABS and INC refer to the absolute value encoder and incremental encoder respectively.

[Caution 2] If a position containing additional axis position data is registered with the additional axis system, the No. of registerable position points will decrease by the size of the additional axis position data.
If additional axis position data is included in all positions, the No. of registerable position points will be approx 1600 points.

■ Standard configuration

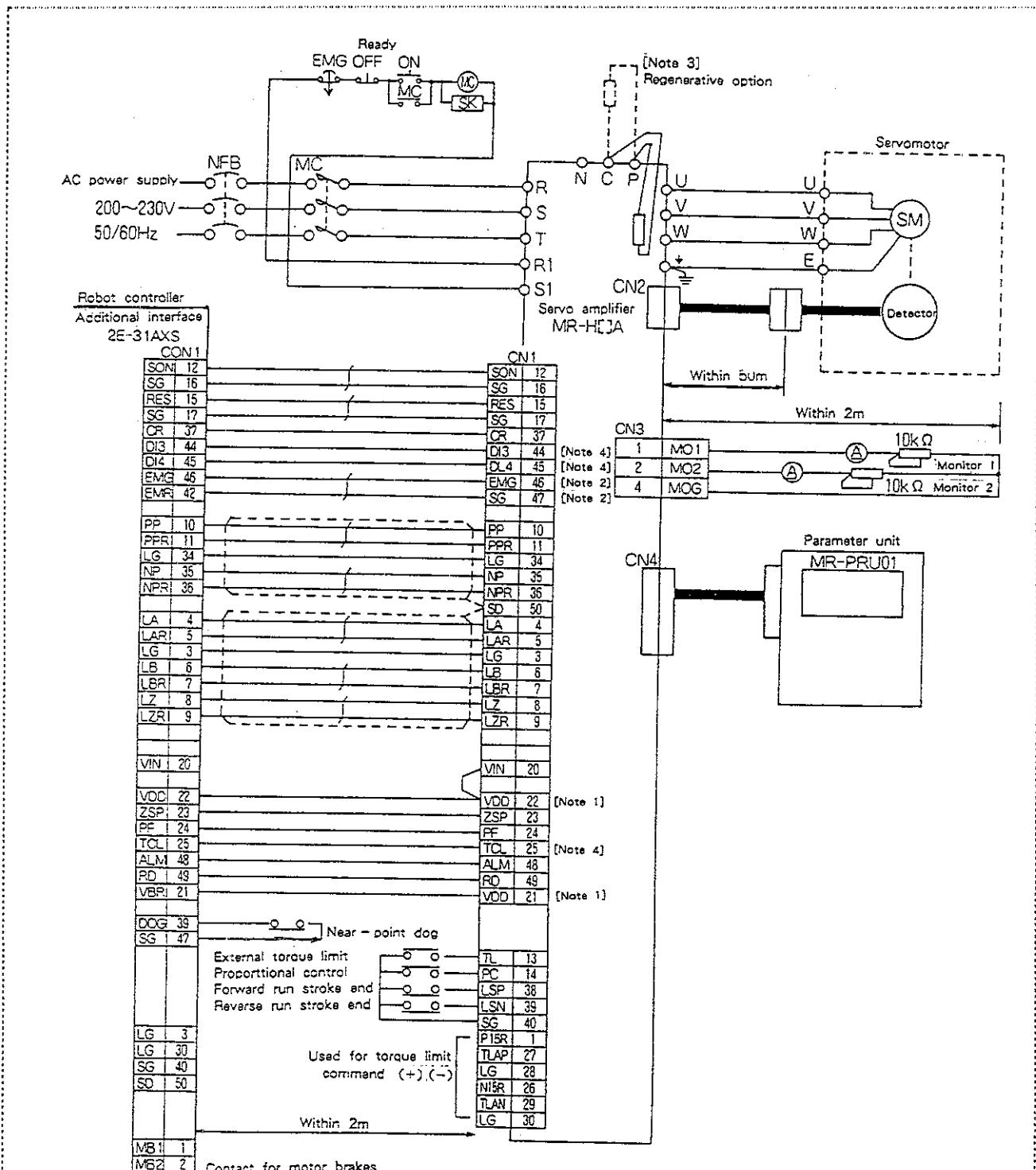
Table 4.41 Standard configuration

No.	Part name	Type	Qty.
1	additional axis interface board	E31AXS	1
2	Connector	PCR-S50FS	1
3	Connector case	PCR-LS50LA	1
4	Instruction manual	BFP-A5627	1

The servo amplifier and connection cable must be prepared by the user.

• ADDITIONAL AXIS INTERFACE

■ Connection of MR-H type (Mitsubishi)



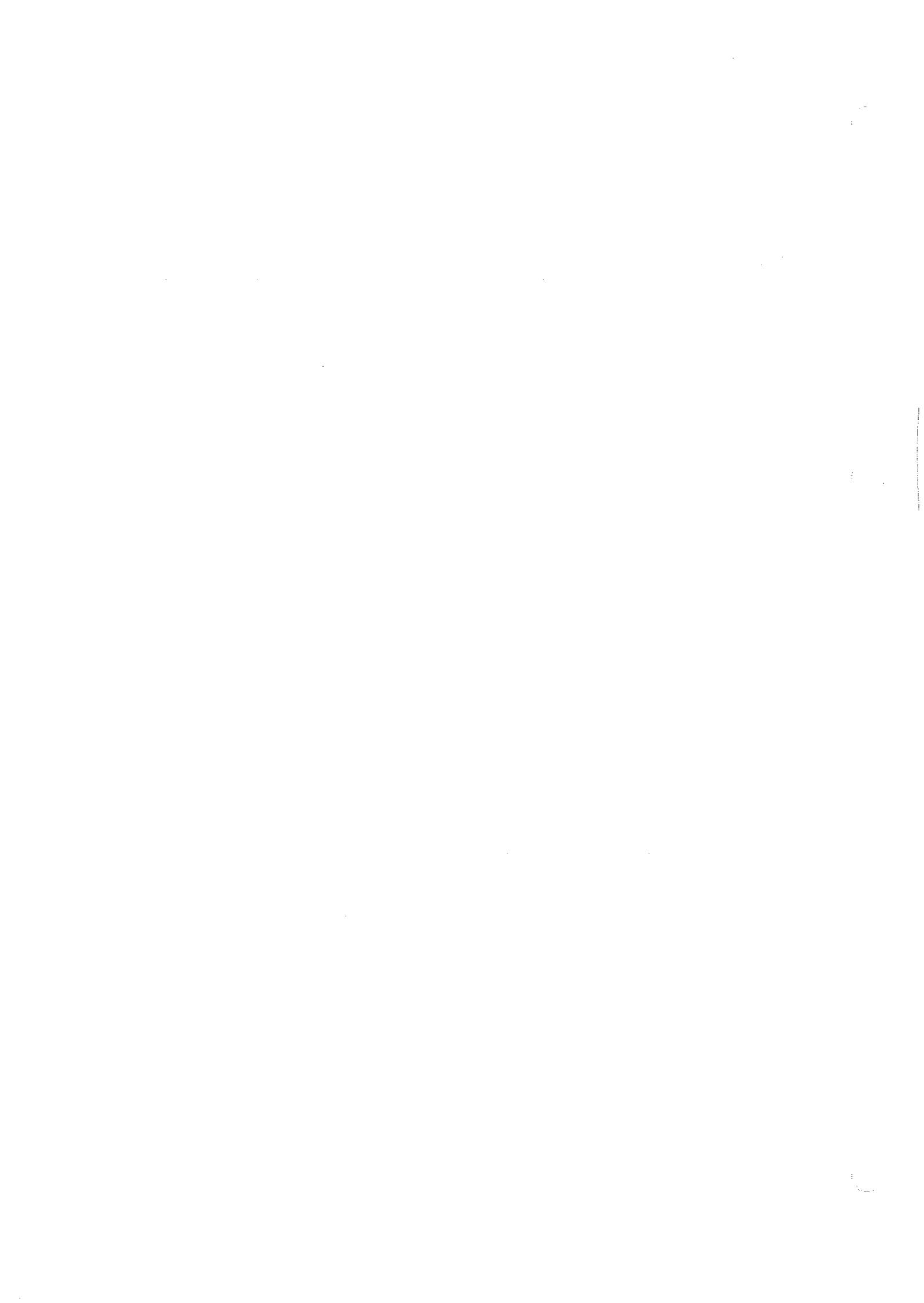
[Caution 1] The 24V power tolerable power from the VDD terminal is 200mA or less.

[Caution 2] Always connect the emergency stop EMG.

[Caution 3] When using the regenerative option, disconnect the connection to the internal regenerative resistor P and C, and connect the option between P and C.

[Caution 4] The connection is not required when using the absolute position detection system.

Fig.4.22 Example of connection with servo amplifier MR-H



5. EXPLANATION OF SPECIFICATIONS

This chapter clarifies the range of the guarantee, including the definition of specifications, so that the robot may be introduced smoothly, and trouble prevented beforehand. Safety measures that must be observed when selecting the robot, designing the tooling and studying the system are also explained.

5.1 Definition of specifications

5.1.1 Position repeatability and positioning accuracy

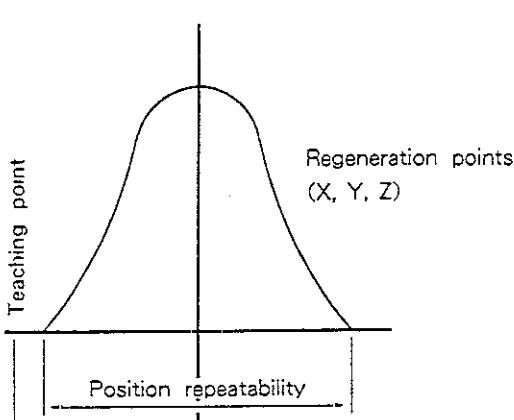
The position repeatability listed in catalogs and specifications is defined as follows.

- (1) Position accuracy is the space coordinates (X, Y, Z) that are used as the reference when the robot is repeated moved over an operation path under the same conditions.
- (2) The reference point is the intersection of the P axis core and tooling installation flange surface.

For the E Series robot, the positioning repeatability and positioning accuracy are assumed and measured as shown in Table 5.1.

Table 5.1 Specified accuracy value

Item	Specified value	Specification conditions
Position repeatability	X Y Z ... ± 0.04mm	Repeatability is a value obtained by averaging the max. value and min. value of the regeneration positions and adding ± .
Position accuracy	X Y Z 0.1mm	The positioning accuracy is the distance obtained by averaging the max value and min. value of the regeneration points from the teaching point.



- Measurement conditions
 - Load during measurement The rated load is applied to the load weight reference point shown in Fig. 5.2.
 - Repetition movement 10 times at 20% speed.
10 times at 100% speed
 - Measuring instrument Non-contact displacement meter.

Fig. 5.1 Accuracy specifications

[Caution] The positioning accuracy listed in the specifications were obtained by accuracy measurement under the same conditions, and does not include the robot working environment or conditions. The accuracy may also drop slightly even over the same path depending on if there is a workpiece or due to the arm slackening or expanding during repetition when the temperature changes. These specifications also do not apply if the speed during teaching and the actual speed differ, and do not apply to the coordinates or position accuracy obtained by numerical setting.

SPECIFICATIONS

5.1.2 Rated load (load capacity)

Generally only the weight is indicated for the robot load capacity. However, restrictions will apply when the load is largely deviated even when the same tools or workpiece weight is used. Confirm the following points when designing of the tooling or selecting the robot.

- (1) The tooling must have the smaller of the tolerable moment and tolerable inertia values listed in Table 2.1 Robot arm standard specifications.
- (2) The distribution dimensions of the weight position when the load volume is relatively small are shown in Fig. 2.1. Refer to the drawing when designing the tooling.
- (3) Even if the load is force instead of weight, the tooling must be designed so that the tolerable movement value listed in Table 2.1 Robot arm standard specifications

[Caution] The load capacity is greatly affected by the robot's operation speed and operation posture. Even if the above tolerable range is entered, overloads or overcurrent alarms may occur. In this case, the acceleration/deceleration time setting, operation speed and operation posture must be changed.

[Caution] The load overhand amount such as the movement or inertia specified in this chapter is the dynamic limit value determined according to the capacity of the motor that drives each axis and the reduction gears. Thus, these values do not guarantee the accuracy in all areas of the tooling. The accuracy is guaranteed at the center point of the mechanical interface. Thus, if the work point is separated from the flange when using long and low-rigidity tooling, the position accuracy will drop and vibration may occur.

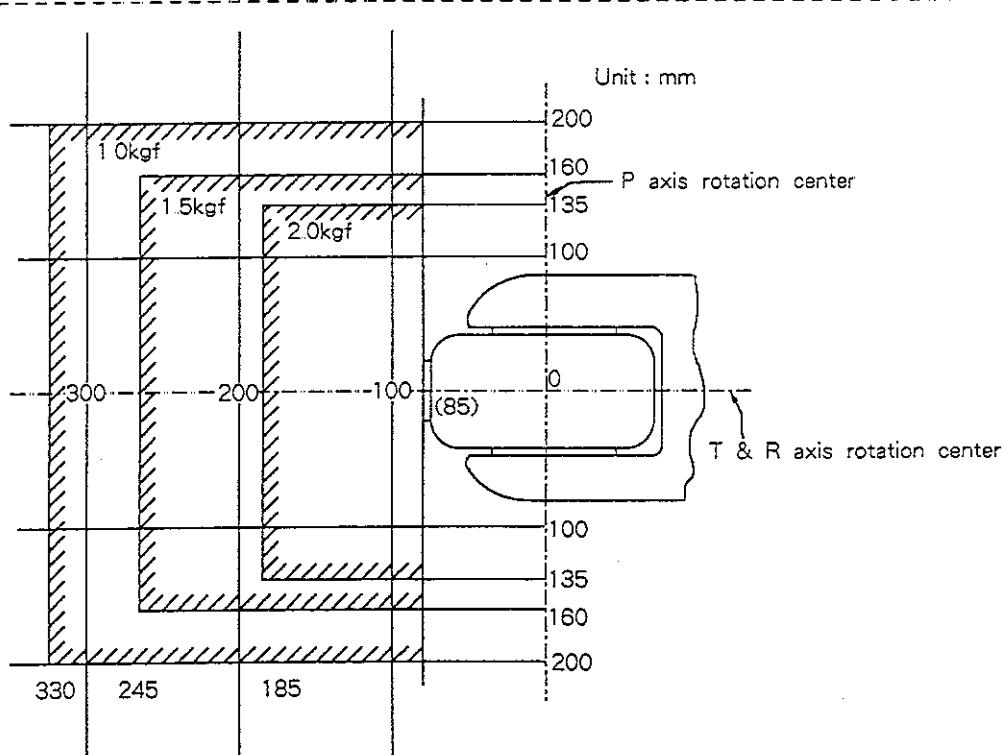


Fig. 5.2 Load center of gravity

(when load volume is relatively small) : RV-E2, RV-E2M, RV-E2-SR, RV-E2-SW

SPECIFICATIONS

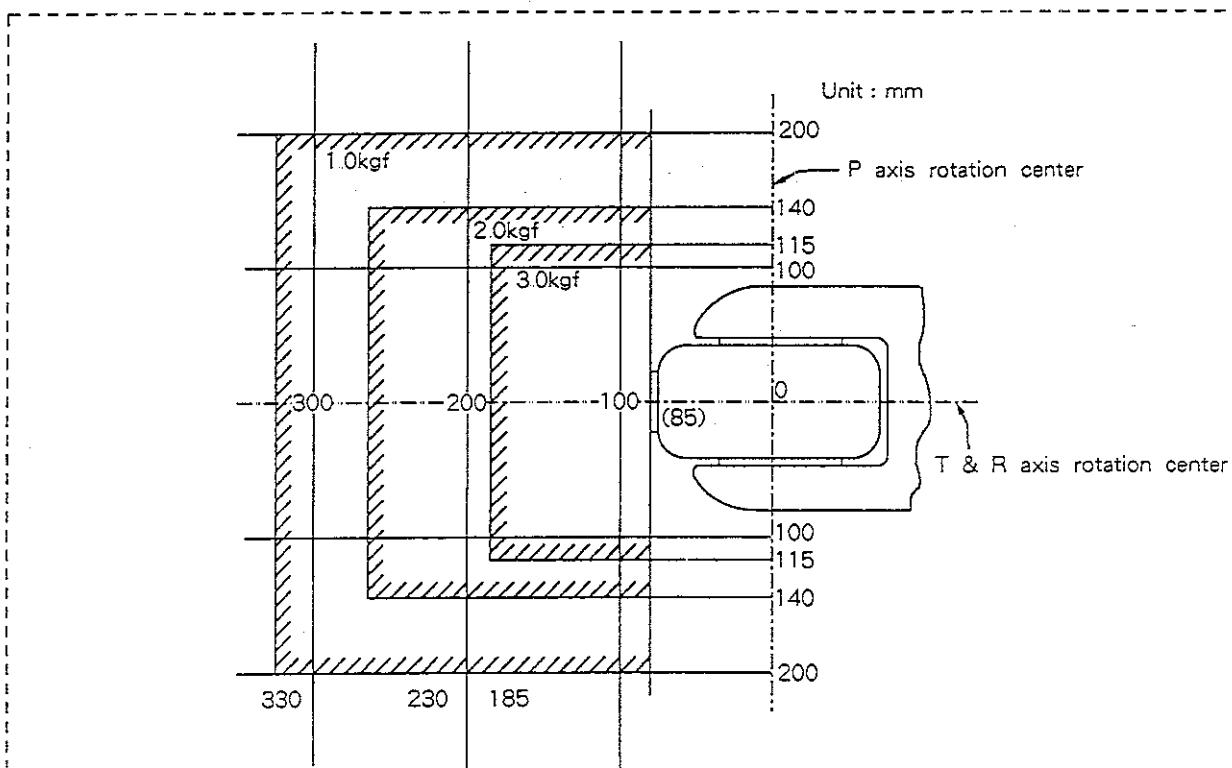


Fig. 5.3 Load center of gravity

(when load volume is relatively small) : RV-E3J, RV-E3JM, RV-E3J-SR

5.2 Working environment and protection specifications

5.2.1 Robot arm (Basic type)

This robot arm incorporates a protection method that conforms to the IEC Standards IP30 (fully closed type). The robot has a protection structure in which a tool or wire exceeding $\phi 2.5\text{mm}$ will not contact the conductive parts in the outer sheath or the rotary sections. Note that special protection measures are not taken against the entry of water or oil, and thus the guarantee will not cover trouble occurring in the following types of atmospheres.

- (1) Atmosphere where inflammable gases or corrosive gases are generated.
- (2) Atmosphere where water or oil directly drop onto the robot arm.
- (3) Atmosphere where water or oil splash on robot.
- (4) Atmosphere where dust or oil mist is generated.

When using the robot in an oil mist atmospheres such as when used with a machining tool, the RV-E2M (6-axis specifications) or RV-E3JM (5-axis specifications) with enhanced protection functions should be used.

[Reference] IEC Standard IP30 is a protective structure that does not allow a $\phi 2.5^{+0.05}\text{mm}$ straight steel wire or bar cut at a right angle and deburred to enter an opening on the outer sheath of a prototype device when pressed with a force of $3N \pm 10\% \{0.31kg \pm 10\%\}$.

• SPECIFICATIONS

5.2.2 Robot arm (Oil mist specifications type)

This robot arm incorporates a protection method that conforms to the IEC Standards IP54 (waterproof type). The robot arm operation will not be harmfully affected due to the splattering of water from any direction.

Recommended working conditions

- (1) This robot arm has been designed for use with a machine tool device.
- (2) The following recommended cutting oil has been used for the Mitsubishi standard tests.
 - Mitsubishi standard test cutting oil : Yushiron Oil No. 2 (Non-water soluble Class 2 : JIS Class 2 No. 2 or equivalent.)
- (3) Take measures to prevent water, oil, or cutting chips mist from dropping onto the robot arm.

Trouble occurring in the robot when used in the following atmospheres is not covered by the guarantee.

- (1) Use with grinding work.
- (2) Atmosphere using non-evaluated cutting oil.
- (3) Atmosphere where water or oil may directly contact the robot arm.
- (4) Atmosphere where cutting chips will directly contact the robot arm
- (5) Atmosphere where the min. diameter of the cutting chips is 0.5mm or less.
- (6) Atmosphere where large quantities of dust or oil mist are generated.
- (7) Atmosphere where inflammable gases or corrosive gases are generated.

[Reference] The IEC Standard IP54 is a protective structure defined as not causing a harmful effect when $10 \pm 0.5 \text{ l/min}$ of water is sprayed at a water pressure of 80 to 100kPa {0.82 to 1.0kgf/cm²} over the entire 180° range of the prototype from a position separated by 300 to 500mm. The water is sprayed for 1 min. per 1m² of the prototype device surface area for a total of five minutes.

5.2.3 Controller and teaching box

This controller and teaching box incorporate a protection method that conforms to the IEC Standards IP20 (protective type). Thus, the structure will not let solid foreign objects exceeding a diameter of 12mm into the robot. Note that special protection measures are not taken against the entry of water or oil, and thus the guarantee will not cover trouble occurring in the following types of atmospheres.

- (1) Atmosphere where inflammable gases or corrosive gases are generated.
- (2) Atmosphere where water or oil directly drop onto the robot arm.
- (3) Atmosphere where water or oil splash on robot.
- (4) Atmosphere where dust or oil mist is generated.

[Reference] IEC Standard IP20 is a protective structure that does not allow a $12^{+0.05} \text{ mm}$ steel probe enter an opening on a prototype device when pressed at a force of $30N \pm 10\%$ { $3.1kg \pm 10\%$ }.

6. SAFETY

6.1 Safety

See the "Safety Manual".

6.1.1 Self-diagnosis stop functions

The E Series robot has the self-diagnosis stop functions listed in Table 6.1 to provide safety.

Table 6.1 Self-diagnosis stop functions

No.	Function		Details	Remarks
1	Overload protection function		This functions when the total motor current time exceeds the specified value.	The drive circuit is shut off. The robot will stop and an alarm will display.
2	Overcurrent diagnostic function		This functions when an overcurrent has flowed to the motor circuit	The drive circuit is shut off. The robot will stop and an alarm will display.
3	Encoder wire breakage diagnosis function		This functions when the encoder cable breaks or a wire breaks.	The drive circuit is shut off. The robot will stop and an alarm will display.
4	Over-deviation diagnosis function		This functions when a difference occurs in the actual position in regard to the commanded value and the specified pulse is exceeded.	The drive circuit is shut off. The robot will stop and an alarm will display.
5	AC power voltage drop diagnosis function		This functions when the AC power voltage drops below the specified value	The drive circuit is shut off. The robot will stop and an alarm will display.
6	CPU error detection function		This functions when an error occurs in the CPU.	The drive circuit is shut off. The robot will stop and an alarm will display.
7	Overrun prevention function	Software limit detection	This limit is set by the software so that operation is possible only in the motion range.	The drive circuit is shut off. The robot will stop and an alarm will display
		Mechanical stopper	This is a mechanical stopper set outside the software	The robot stops mechanically and function No. 1 or 2 is activated.

Table 6.2 List of stop functions

Stop function	Operation panel	Teaching box	External input	Details
Emergency stop	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	This is the stopping action with the highest degree of emergency. The servo power is shut off, and the mechanical brakes (W, S and E axes) function to stop the robot. The servo power turns ON when the alarm has been reset.
Stop	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	This is the stopping action with a high degree of emergency. The robot will immediately decelerate and stop, but the servo power will not be shut off. Use this when incorporating a collision evasion sensor.

• SAFETY

6.1.2 External input/output signals for safety protection measures

Table 6.3 External input/output signals for safety protection measures

Signal	Command	Fnction	Usage method
Input	External emergency stop (Input signal)	The servo power is turned OFF, and the robot stops immediately.	Externally installed emergency stop switch Door switch on safety protection fence Stops when a high-level error occurs.
	Stop STP	The program execution is immediately stopped, and the robot stops. The servo power is not turned OFF.	The robot is stopped when trouble occurs in a peripheral device. The servo power is not turned OFF.
	Servo ON/OFF SVO	The servo power can be turned ON/OFF with external signals.	The robot is stopped when trouble occurs in a peripheral device. The servo power is turned OFF.
Output	During servo ON SVA	The servo power ON/OFF state is output.	The servo power ON state is indicated with the display lamp
	During stopping WAI	This is output when the robot is temporarily stopped.	The temporary stop state is indicated with the display lamp.
	During alarm ERR	This is output when an alarm occurs in the robot.	The alarm (error) occurrence is indicated with the display lamp.

[Caution] The external emergency stop input uses a b contact as a standard for safety purposes. If the emergency stop input circuit is open when the robot is started up, the robot will not function. Refer to the Fig. 6.1 Examples of safety

• SAFETY

6.1.3 Precautions for robot application

The safety measures for using the robot are specified in the "Labor Safety and Sanitation Rules" in Japan. An outline of the rules is given below.

(1) Robot installation

- Secure sufficient work space required to safely perform work such as teaching and maintenance related to the robot.
- Install the controller outside the robot's movement range. (If a safety fence is provided, install outside the fence.)
- Install the controller where the entire robot operation can be viewed.
- Install display lamps, etc., to indicate the robot's operation state.
- Securely fix the robot arm onto the fixing table with the designated bolts.

(2) Prevention of contact with operator

- Install a safety fence or enclosure so that the operator cannot easily enter the robot's movement range.
- Install an interlock function that will stop the robot if the safety fence or enclosure door is opened.

(3) Work procedures

- Create and observe work procedures for the robot display, operation, inspection and emergencies
- Create hand signals to be followed when several operators are working together.
- Create displays such as "Teaching" and "Inspecting" to be put up when an operator is in the robot's movement range so that other operators will not operate the operation panel (controller, control panel).

(4) Training

- Train the operators about the operations, maintenance and safety required for the robot work.
- Only trained and registered operators must operate the robot. (Special training following the Ministry of Labor Report No. 49.)

Participation in the "Special training for industrial robots" sponsored by the Labor Safety and Sanitation Committee, etc., is recommended for safety training.

(5) Daily inspection and periodic inspection

- Always inspect the robot before starting daily operations and confirm that there are no abnormalities.
- Set the periodic inspection standards in view of the robot's ambient environment and operation frequency, and perform periodic inspections.
- Make records when periodic inspections and repairs have been done, and store the records for three or more years.

6.1.4 Safety measures for automatic operation

- (1) Install safety fences so that operators will not enter the operation area during operation and indicate that automatic operation is being done with lamps, etc.
- (2) Create signals to be given when starting operation, assign a person to give the signal, and make sure that the operator follows the signals.

• SAFETY

6.1.5 Safety measures for teaching

Observe the following measures when teaching, etc., in the robot's motion range

- (1) Specify and follow items such as procedures related to teaching work, etc.
- (2) Take measures so that operation can be stopped immediately in case of trouble, and measures so that operation can be restarted.
- (3) Take measures on the robot start switch, etc., to indicate that teaching work is being done.
- (4) Always inspect that functions such as the emergency stop device function before starting the work.
- (5) Immediately stop the work when trouble occurs, and correct the trouble.
- (6) Take measures so that the work supervisor can immediately stop the robot operation when trouble occurs.
- (7) The teaching operator must have completed special training regarding safety. (Training regarding industrial robots and work methods, etc.)
- (8) Create signals to be used when several operators are working together.

6.1.6 Safety measures for maintenance and inspections, etc.

Turn the power OFF and take measures to prevent operators other than the relevant operator from pressing the start switch when performing inspections, repairs, adjustments, cleaning or oiling.

If operation is required, take measures to prevent hazards caused by unintentional or mistaken operations.

- (1) Specified and follow items such as procedures related to maintenance work, etc.
- (2) Take measures so that operation can be stopped immediately in case of trouble, and measures so that operation can be restarted.
- (3) Take measures on the robot start switch, etc., to indicate that work is being done.
- (4) Take measures so that the work supervisor can immediately stop the robot operation when trouble occurs.
- (5) The operator must have completed special training regarding safety. (Training regarding industrial robots and work methods, etc.)
- (6) Create signals to be used when several operators are working together.

• SAFETY

6.1.7 Examples of safety measures

One emergency stop input circuit is prepared on the user wiring terminal block at the rear of the controller. Create a circuit as shown below for safety purposes.

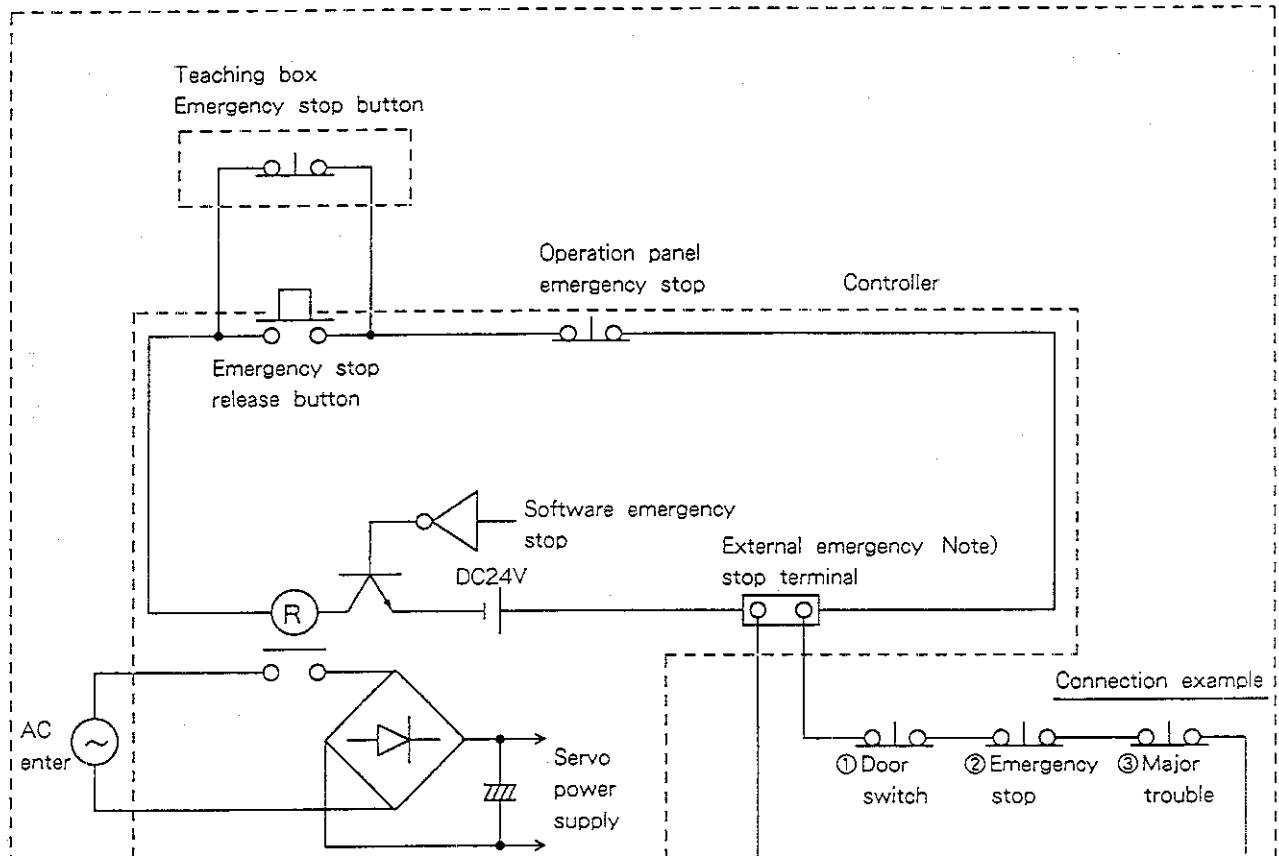


Fig. 6.1 Example of safety measures

Note) Short circuit with a short bar when not using this terminal.

- (1) Install a limit switch on the safety fence's door. With a constantly open contact (a contact) wire so that the switch turns ON (is conducted) when the door is closed, and turns OFF (is opened) when the door is open
- (2) Use a b contact manual - return type operator emergency stop switch.
- (3) Create a contact signal that switches when a fault is detected in the peripheral device.
- (4) Classify the faults into minor faults (faults that are easily restored and that do not have a great effect) and major faults (faults that cause the entire system to stop immediately, and that require care in restoration), and wire accordingly.

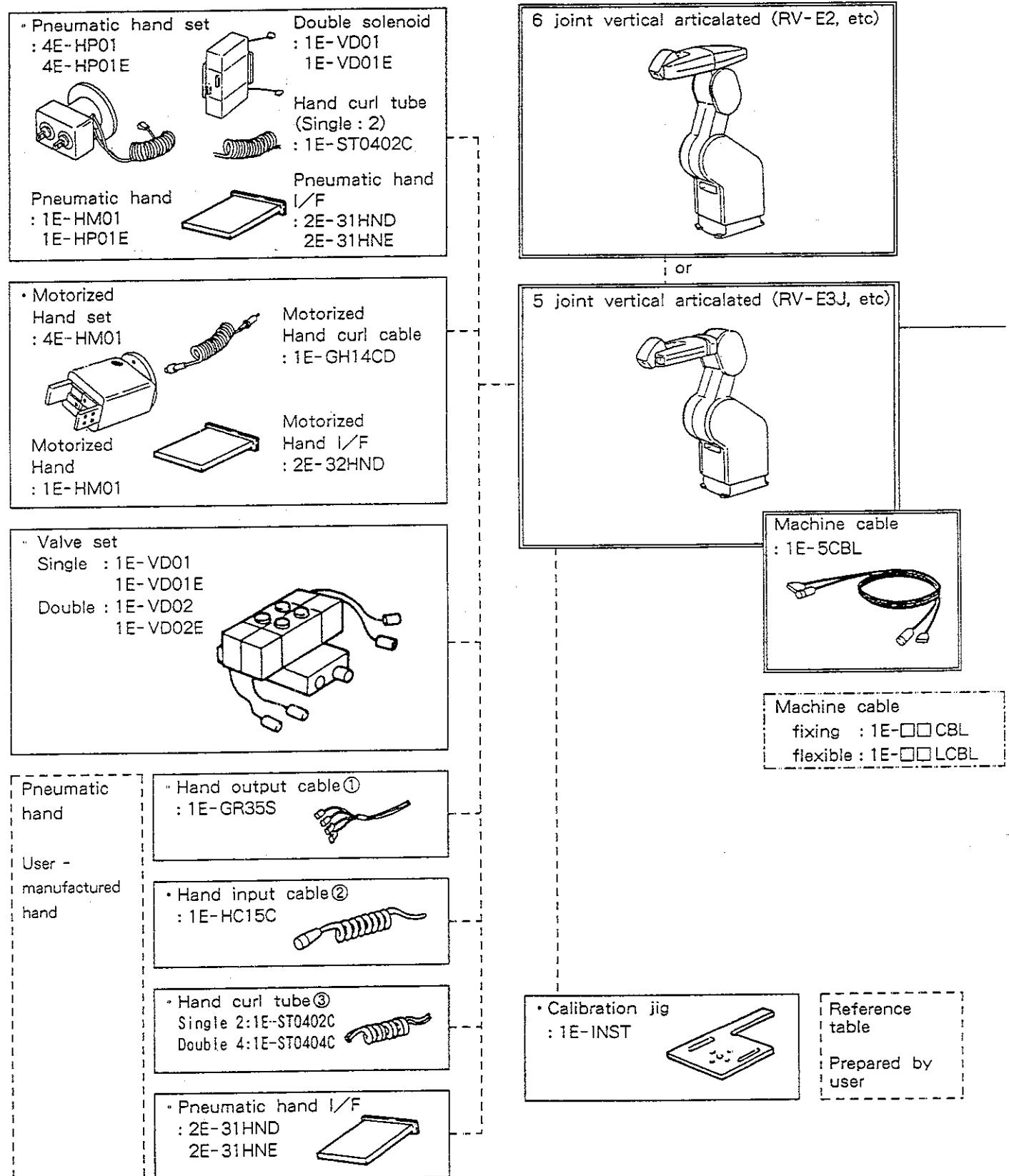
[Caution] The emergency stop input on the user wiring terminal block at the rear of the controller can be used for safety measures as shown above. Note that there are limits to the switch contact capacity and cable length, so refer to the following and install.

- Use a contact that operates with a switch contact capacity of approx. 5 to 300mA.
- The length of the wire between the switch and terminal block must be max. 15m or less.

APPENDIX

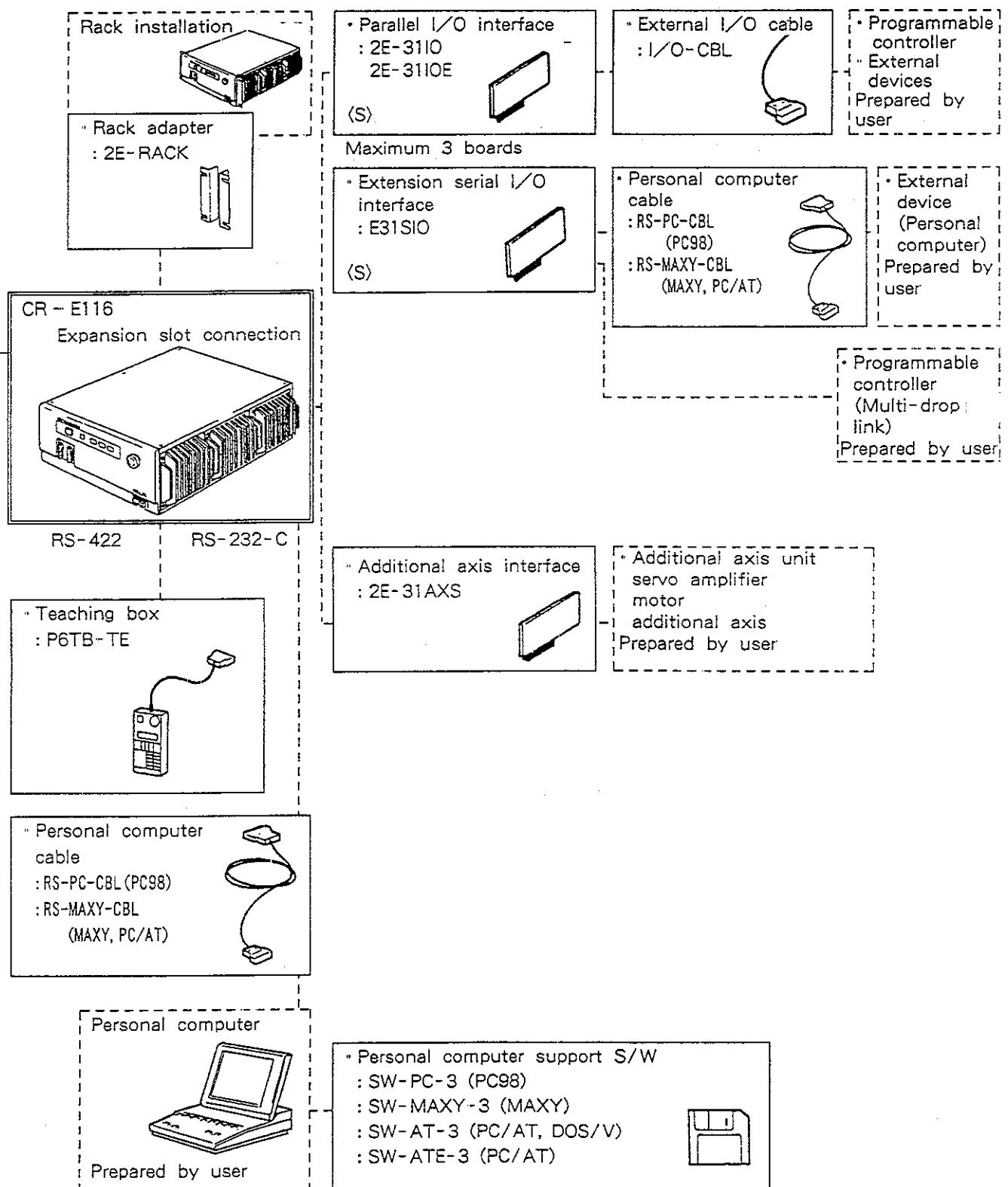
Standard devices and option devices	appendix - 1 -
Operation range diagram. RV-E2, RV-E2M (With flange facing downward)	appendix - 3 -
Operation range diagram. RV-E2, RV-E2M (With flange facing front)	appendix - 4 -
Operation range diagram. RV-E3J, RV-E3JM (With flange facing downward)	appendix - 5 -
Operation range diagram. RV-E3J, RV-E3JM (With flange facing front)	appendix - 6 -
Documents for consultation for E Series robot	appendix - 7 -

APPENDIX : STANDARD DEVICES AND OPTION DEVICES



Appendix Fig. 1 Standard devices and option devices

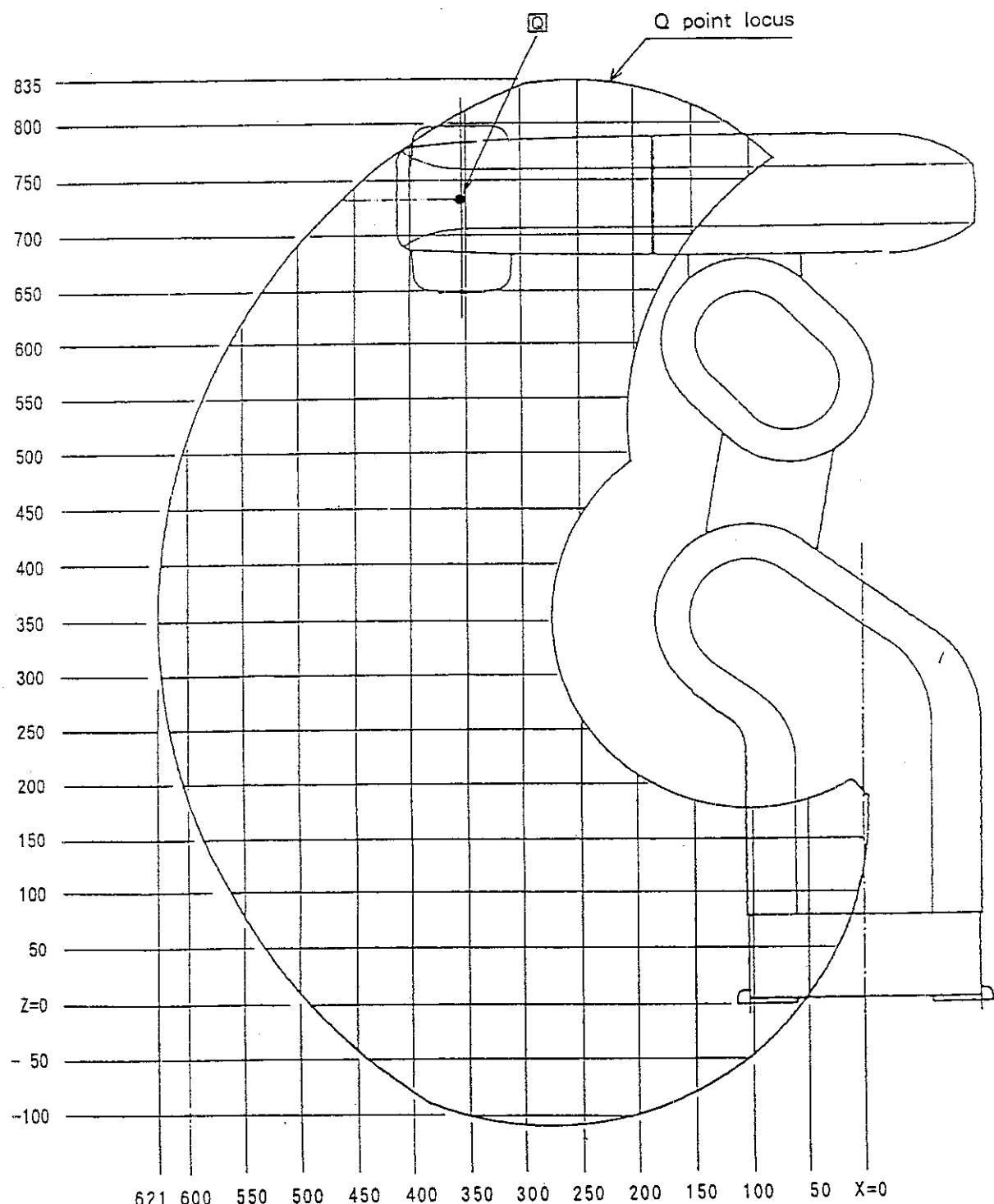
APPENDIX : STANDARD DEVICES AND OPTION DEVICES



[Caution] Standard device Special specifications Option Prepared by user

(S) : Use controller expansion slot

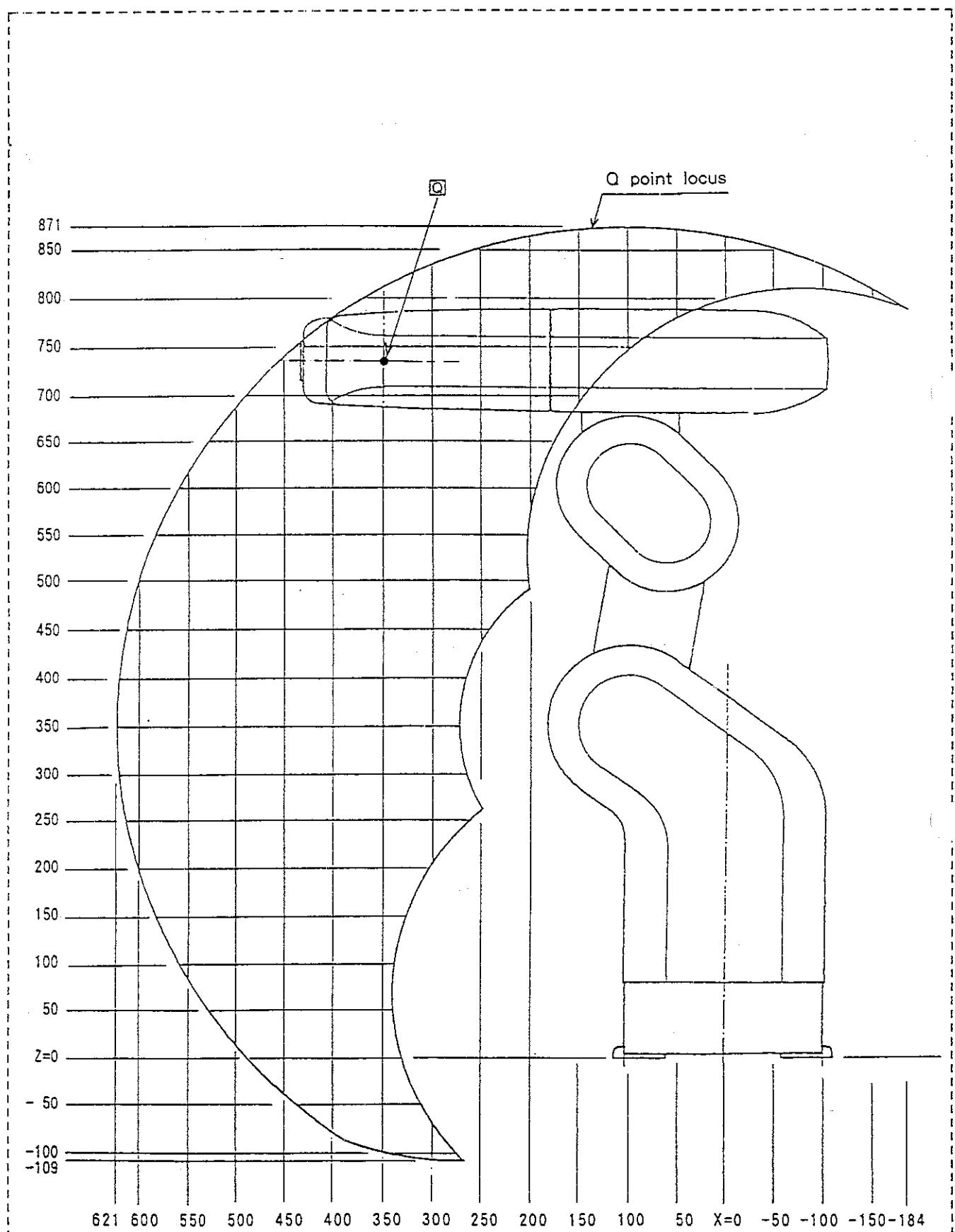
APPENDIX : OPERATION RANGE DIAGRAM



Appendix Fig. 2 Operation range diagram. RV-E2, RV-E2M

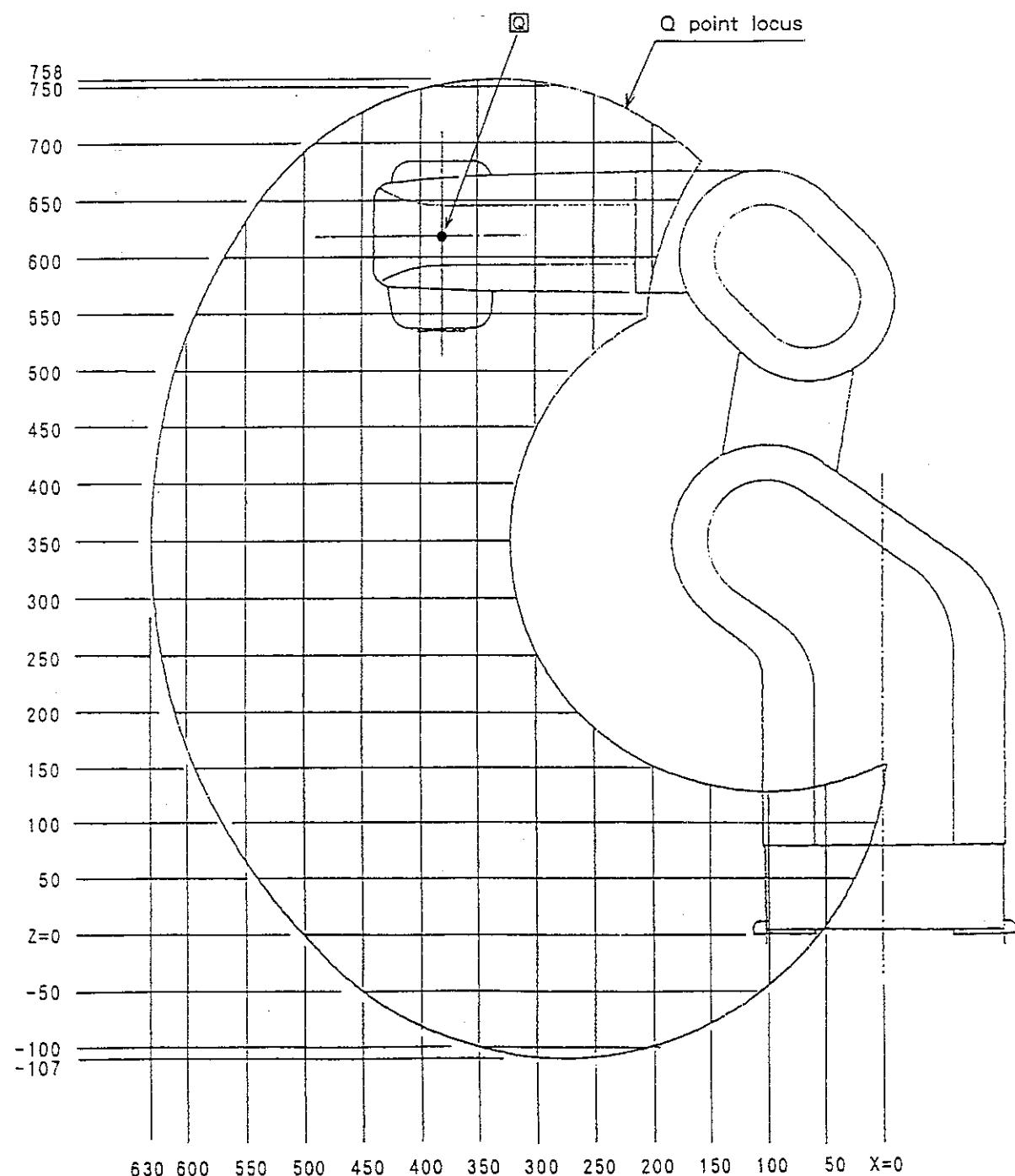
(With flange facing downward)

APPENDIX : OPERATION RANGE DIAGRAM



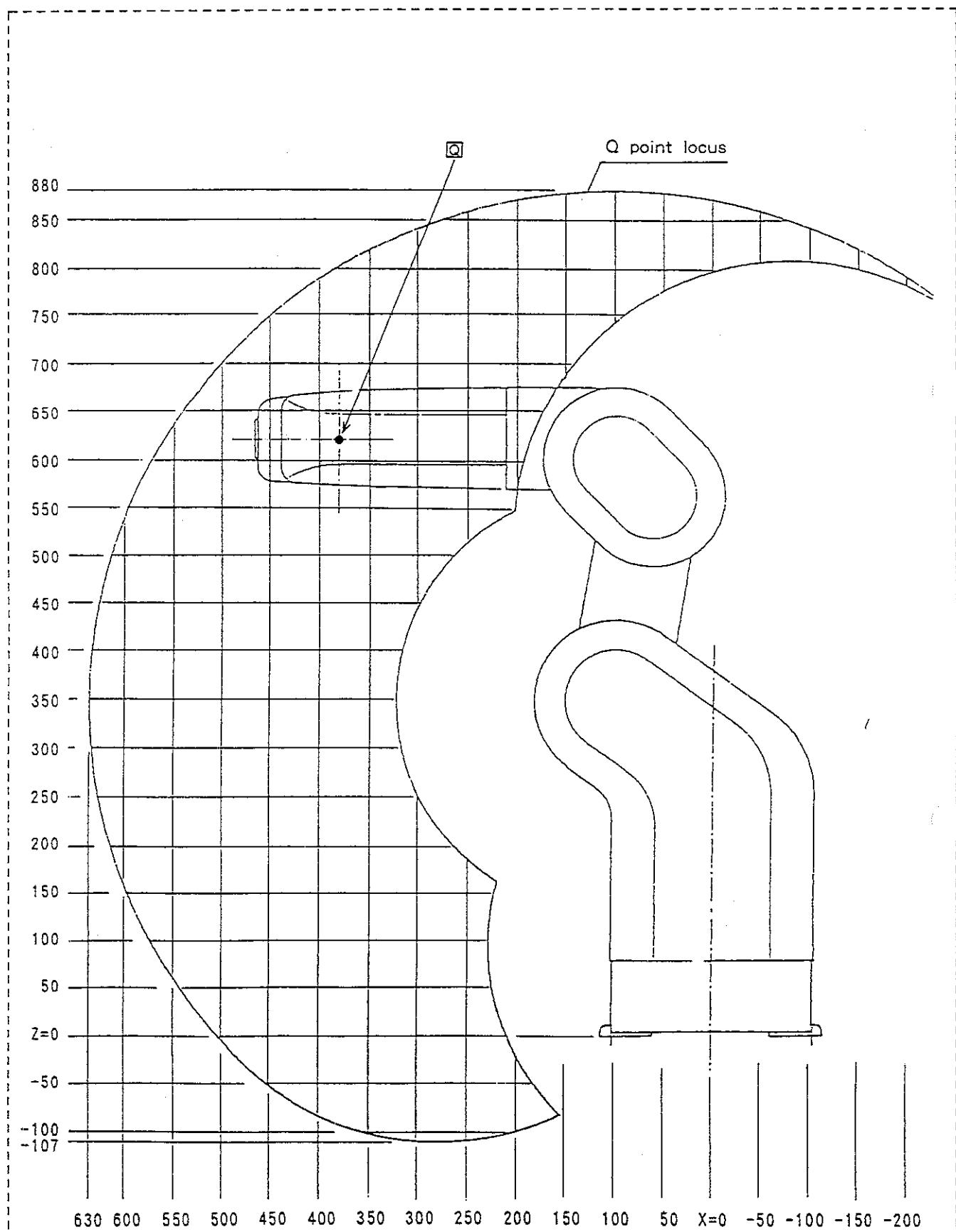
Appendix Fig. 3 Operation range diagram. RV-E2, RV-E2M (With flange facing front)

APPENDIX : OPERATION RANGE DIAGRAM



Appendix Fig. 4 Operation range diagram. RV-E3J, RV-E3JM
(With flange facing downward)

APPENDIX : OPERATION RANGE DIAGRAM



Appendix Fig. 5 Operation range diagram. RV-E3J, RV-E3JM (With flange facing front)

APPENDIX : DOCUMENTS FOR CONSULTATION FOR E SERIES ROBOT —

■ User

Company name		Person in charge	Section
Address		Tel. () - () -	

■ Model to be purchased

Model	<input type="checkbox"/> RV-E2 <input type="checkbox"/> RV-E3J	<input type="checkbox"/> RV-E2M <input type="checkbox"/> RV-E3JM	<input type="checkbox"/> RV-E2-SR <input type="checkbox"/> RV-E3J-SR	<input type="checkbox"/> RV-E2-SW
-------	---	---	---	-----------------------------------

■ Factory shipment special specifications (These can only be set when the unit is shipped)

Item	Standard	Factory shipment special specifications
Robot arm	Operation range W axis +	<input type="checkbox"/> + 160° <input type="checkbox"/> + 120° <input type="checkbox"/> + 90° <input type="checkbox"/> + 60° <input type="checkbox"/> + 30°
	W axis -	<input type="checkbox"/> - 160° <input type="checkbox"/> - 120° <input type="checkbox"/> - 90° <input type="checkbox"/> - 60° <input type="checkbox"/> - 30°
Controller	Machine cable	<input type="checkbox"/> 5m for fixing <input type="checkbox"/> 2m for fixing <input type="checkbox"/> 7m for fixing <input type="checkbox"/> 10m for fixing <input type="checkbox"/> 15m for fixing <input type="checkbox"/> 5m for flexible <input type="checkbox"/> 7m for flexible <input type="checkbox"/> 10m for flexible <input type="checkbox"/> 15m for flexible
	Power voltage	<input type="checkbox"/> AC200V <input type="checkbox"/> AC100V
	Controller structure	<input type="checkbox"/> Standalone type

■ Options (These can be installed after shipment)

Item < S >	Max. three cards in the expansion slots	Provision and specifications when provided
Robot arm	Hand set	<input type="checkbox"/> None <input type="checkbox"/> Motorized <input type="checkbox"/> Air <input type="checkbox"/> Only air hand interface
	Solenoid valve set	<input type="checkbox"/> None <input type="checkbox"/> One-row <input type="checkbox"/> Two-row
	Hand output cable	<input type="checkbox"/> None <input type="checkbox"/> Provided
	Hand input cable	<input type="checkbox"/> None <input type="checkbox"/> Provided
	Curled hand tube	<input type="checkbox"/> None <input type="checkbox"/> One-row <input type="checkbox"/> Two-row
	Calibration jig	<input type="checkbox"/> None <input type="checkbox"/> Provided
Controller	Teaching box	<input type="checkbox"/> None <input type="checkbox"/> Provided
	Parallel I/O interface < S >	<input type="checkbox"/> None <input type="checkbox"/> 1 card <input type="checkbox"/> 2 cards [Note] As a standard, only 1 card < S > is mounted.
	External I/O cable	<input type="checkbox"/> None <input type="checkbox"/> 1 cable <input type="checkbox"/> 2 cables <input type="checkbox"/> 3 cables
	Lack adaptor	<input type="checkbox"/> None <input type="checkbox"/> Provided
	Personal computer	<input type="checkbox"/> None <input type="checkbox"/> PC98 <input type="checkbox"/> MAXY, PC/AT
	Peasonal computer support software	<input type="checkbox"/> None <input type="checkbox"/> PC98 3.5inch <input type="checkbox"/> MAXY 3.5inch <input type="checkbox"/> PC/AT DOS/V 3.5inch (Japanese specifications) <input type="checkbox"/> PC/AT 3.5inch (English specifications)
	Expansion serial interface	<input type="checkbox"/> None <input type="checkbox"/> 1 card <input type="checkbox"/> 2 cards
	Additional axis interface	<input type="checkbox"/> None <input type="checkbox"/> 1 card <input type="checkbox"/> 2 cards

■ Maintenance parts (consumable parts)

Maintenance parts	<input type="checkbox"/> Backup battery () pcs	<input type="checkbox"/> Fuse () pcs	<input type="checkbox"/> Grease () cans
-------------------	---	---------------------------------------	--

■ Robot selection check items

Work details	<input type="checkbox"/> Material handling <input type="checkbox"/> Assembly <input type="checkbox"/> Machining L/UL <input type="checkbox"/> Sealing <input type="checkbox"/> Tests and inspections <input type="checkbox"/> Others ()
Work weight	<input type="checkbox"/> 0.5kgf or less <input type="checkbox"/> 1.0~1.5kgf <input type="checkbox"/> 1.5~2.0kgf <input type="checkbox"/> 2.0~2.5kgf
Hand weight	<input type="checkbox"/> 0.5kgf or less <input type="checkbox"/> 1.0~1.5kgf <input type="checkbox"/> 1.5~2.0kgf <input type="checkbox"/> 2.0~2.5kgf
Atmosphere	<input type="checkbox"/> General environment <input type="checkbox"/> With oil mist <input type="checkbox"/> With dust <input type="checkbox"/> Clean <input type="checkbox"/> Others ()
Remarks	

< Copy this page before using >



FA Center

MITSUBISHI ELECTRIC CORPORATION
Marunouchi
Tokyo 100
JAPAN
Phone: (03) 3218-3176
Fax: (03) 3218-2422

JAPAN

MITSUBISHI ELECTRIC EUROPE
Gothaer Str. 8
D-40880 Ratingen
GERMANY
Phone: (0 21 02) 486 - 0
Fax: (0 21 02) 486 - 112

EUROPE

MITSUBISHI ELECTRIC EUROPE
Travellers Lane
GB-Hatfield Herts. AL10 8 XB
UK
Phone: (07 07) 27 61 00
Fax: (07 07) 27 86 95

UK

MITSUBISHI ELECTRONICS AMERICA INC
800 Biermann Court
Mt. Prospect, IL 60056
USA
Phone: (708) 298-9223
Fax: (708) 298-1834

USA

Ryden (Holdings) Ltd
10th Fl., Manulife T 169 Electric Rd. N Point
Hong Kong
HONG KONG
Phone: 2887-8870
Fax: 2578-2461

HONG KONG

P.T. SAHABAT INDONESIA
Blok A/Utara No. 1 Kaw. No. 11
Jakarta 11050
INDONESIA
Phone: 6610651
Fax: 6603700

INDONESIA

SETSUZO ENTERPRISE Co.,Ltd.
3rd Fl., No.122, Wu Kung 2nd Road
Wu-Ku Hsiang Taipei Hsien
TAIWAN
Phone: (02) 298 - 17 95
Fax: (02) 298 - 18 25

TAIWAN

MITSUBISHI ELECTRIC SALES SINGAPORE Pte Ltd
No. 6, Commonwealth Lane #01 - 01
149547 Singapore
SINGAPORE
Phone: 476 - 72 35
Fax: 476 - 74 39

SINGAPORE

European Representatives

GEVA
Wiener Straße 89
A-2500 Baden
Phone: (0 22 52) 8 55 52-0
Fax: (0 22 52) 4 88 60

AUSTRIA

GETRONICS NV/SA
Pontbeeklaan 43
B-1731 Zellik
Phone: (02) 4 67 17 49
Fax: (02) 4 67 17 45

BELGIUM

ELPEFA A/S
Geminivej 32
DK-2670 Greve
Phone: (0 43) 95 95 95
Fax: (0 43) 95 95 90

DENMARK

Beijer Electronics OY
PL 13
SF-00621 Helsinki
Phone: (0) 615 20 11
Fax: (0) 615 20 500

FINLAND

APA
19, Rue Forlen
F-67112 Geispolsheim
Phone: (0 88) 66 10 11
Fax: (0 88) 66 11 12

FRANCE

MITSUBISHI ELECTRIC EUROPE
Gothaer Str. 8
D-40880 Ratingen
Phone: (0 21 02) 486 - 0
Fax: (0 21 02) 486 - 112

GERMANY

IMATECH Ltd
34 Vassilisis Olgas Avenue
GR-54641 Thessaloniki
Phone: (0 31) 84 33 45
Fax: (0 31) 81 51 59

GREECE

GEVA Kft.
Tamási Áron u. 34
H-1124 Budapest
Phone: (01) 175 0688
Fax: (01) 175 0688

HUNGARY

CARPANETO & C. S.p.A.
Via Ferrero 10
I-10090 Cascine Vica-Rivoli (TO)
Phone: (0 11) 95 90 111
Fax: (0 11) 95 90 250

ITALY

Geveke Electronics bv
Donauweg 10
NL-1043 AJ-Amsterdam
Phone: (0 20) 5 86 15 92
Fax: (0 20) 5 86 19 27

NETHERLANDS

Beijer Electronics A/S
Tegiverksveien 1
N-3002 Drammen
Phone: (32) 84 85 70
Fax: (32) 84 85 77

NORWAY

MPL Technology Sp. Z.o.o
ul. Wroclawska 53
PL-30011 Kraków
Phone: (0 12) 32 28 85
Fax: (0 12) 32 47 82

POLAND

F. Fonseca Lda.
Estrada de Taboeira 87/89 Esgueira
P-3800 Aveiro
Phone: (0 34) 31 58 00
Fax: (0 34) 31 58 04

PORTUGAL

INEA
Ljubljanska 80
SLO-61230 Domžale
Phone: (0 61) 71 25 63
Fax: (0 61) 72 16 72

SLOVENIA

Medición y Control, S. A.
Gran Via de les Corts Catalanes 133, 4
E-08014 Barcelona
Phone: (03) 4 22 77 00
Fax: (03) 4 32 28 47 / 2 96 63 32

SPAIN

Beijer Electronics AB
Box 325
S-20123 Malmö
Phone: (0 40) 35 86 00
Fax: (0 40) 93 23 01

SWEDEN

ECONOTEC AG
Postfach 282
CH-8309 Nürensdorf
Phone: (01) 838 48 11
Fax: (01) 838 48 12

SWITZERLAND

MITSUBISHI ELECTRIC EUROPE
Travellers Lane
GB-Hatfield Herts. AL10 8 XB
Phone: (07 07) 27 61 00
Fax: (07 07) 27 86 95

UK