EPSON

ROBOT CONTROLLER

SRC-320

Rev.7

EM01OC898F

ROBOT CONTROLLER

SRC-320

Rev. 7

WARRANTY

The robot and its optional parts are shipped to our customers only after being subjected to the strictest quality controls, tests and inspections to certify its compliance with our high performance standards.

Product malfunctions resulting from normal handling or operation will be repaired free of charge during the normal warranty period. (Please ask your Regional Sales Office for warranty period information.)

However, customers will be charged for repairs in the following cases (even if they occur during the warranty period):

1. Damage or malfunction caused by improper use which is not described in the manual, or careless use.
2. Malfunctions caused by customers' unauthorized disassembly.
3. Damage due to improper adjustments or unauthorized repair attempts.
4. Damage caused by natural disasters such as earthquake, flood, etc.

Warnings, Cautions, Usage:

1. If the robot or associated equipment is used outside of the usage conditions and product specifications described in the manuals, this warranty is void.
2. If you do not follow the WARNINGS and CAUTIONS in this manual, we cannot be responsible for any malfunction or accident, even if the result is injury or death.
3. We cannot foresee all possible dangers and consequences. Therefore, this manual cannot warn the user of all possible hazards.

SERVICE CENTER

Contact the following service center for robot repairs, inspections or adjustments.

Please have the model name, "Serial No." or "M.CODE", software version and a description of the problem ready when you call.

If service center information is not indicated here, please contact the supplier office for your region as listed in the following SUPPLIERS section.

SUPPLIERS

Japan & Others **SEIKO EPSON CORPORATION**
Okaya Plant No. 2
1-16-15, Daiei-cho
Okaya-shi, Nagano-ken, 394-0025
Japan

TEL: 81-266-23-0020 (switchboard)
81-266-24-2004 (direct)
FAX: 81-266-24-2017

North & South America **EPSON AMERICA, INC.**
Factory Automation/Robotics
18300 Central Avenue
Carson, CA 90746

TEL: (562) 290-5900
FAX: (562) 290-5999
E-MAIL: info@robots.epson.com

Europe **EPSON DEUTSCHLAND GmbH**
Factory Automation Division
Zuelpicher Str. 6 D-40546 Duesseldorf

TEL: (++) 49 - 211 - 5603 391 (Inside Sales)
FAX: (++) 49 - 211 - 5603 444
E-MAIL: robot.infos@epson.de

NOTICE

TRADEMARKS

Please direct any inquiries about the use of this manual to:

SRC-320 controller manual

SEIKO EPSON CORPORATION.
Sales Engineering Group
TEL : 81-266-24-2004
FAX : 81-266-24-2017

Safety Precautions

Please carefully read this manual and any other manuals before installing this robot system (and definitely before connecting cables). Keep this manual in a handy location for easy access at all times.

⚠ WARNING	This sign indicates that a danger of serious injury or death will exist if the instruction thereunder is not followed.
⚠ CAUTION	This sign indicates that ignoring the instruction there under may cause harm to people or physical damage to equipment and facilities.

⚠ WARNING

- The robot system manufacturer/supplier must design and construct robot systems in accordance with the principles described in "Safety section" of the User's manual. Please read user's manual first.
- This robot has been designed and manufactured strictly for use in a normal indoor environment. Do not use the robot in an environment that exceeds the conditions set forth in the manuals for the manipulator and controller.
- Do not use the robot outside of the usage conditions and product specifications described in the manuals. Doing so will not only adversely affect the life of the product, but may also present a serious safety problem.
- Only trained personnel should be allowed to design, install, operate, perform function testing, and maintain this robot and the robot system.
  Trained personnel are those who have taken a robot training course (held by the dealer on a regular basis) or those who have carefully read the manuals and have equivalent knowledge or skill.
- Be certain that the power has been turned off controller power before you plug or unplug any of the cables linking the manipulator and controller. Failure to do so could cause electric shock and malfunction.
- Do not touch the parts in the controller carelessly to avoid an electric shock and damage the controller. The controller has the high-voltage parts. When you maintenance the controller, refer to the maintenance volume and follow the description.
- Do not operate the robot system when either of the following symptoms appears; the light stays lit even after you take your hand off the CANCEL switch, or the light does not turn on when you push the CANCEL switch even though the robot is not in the emergency stop condition. Either of these conditions indicates the possibility that the emergency stop switch connected to TEACH port is inoperable.
- Use PC cable with the label "SRC-300" or PC cable with an enable switch. Cables without the label have a "normally open" emergency stop switch that does not function properly, exposing you to dangers.

⚠ CAUTION

- Connect the interlock switch circuit to the “normally closed” safety door input terminal of the REMOTE1 connector on the rear panel of the controller. Failure to do so will result in improper robot operation.
- Connect the cable firmly. Do not put a heavy thing on the cable or bend it extremely. This may damage the cable. If abnormality occurs in the signal cable, a robot may malfunction.
- When installing the cable between the manipulator and the controller, make sure the M. CODEs (matching codes) match. The M. CODEs are written on the yellow labels which appear on the back sides of both the manipulator and the controller. Also, make sure that the length of the power cable and signal cable correspond to the length which appear on the yellow labels mentioned above.

NOTE ☞ The appearance of the controller is the same for all, however, the various settings and the specifications are different depend on the manipulator models. Refer to the table on the page 2 for the details of the various combinations of controller settings and specification.

Manuals

1. User’s manual
   A manual that gives a general description of robots.
   It describes such things as safety precautions, operating methods, teaching methods, programming methods, and file management. Please read user's manual first.

2. Manipulator manual
   A manual for the manipulator itself.
   The basic volume describes safety tips to be observed by the user prior to/in setting up the equipment.
   The maintenance volume describes the maintenance procedure and part replacement.

3. Robot controller manual
   A manual that describes the robot controller who executes an operating software and controls I/O and the servo-mechanism.
   The functions volume describes connecting the robot to the peripheral equipment and basic robot settings.
   The maintenance volume describes the such things as a power supply circuit schematics, parts replacement, trouble shooting, etc.

4. Reference manual
   A manual that describes the commands for the SPEL III robot language.

5. Operating unit manual (option)
   A manual for the operating unit that describes such things as operating methods.

6. Programming support software manual (option)
   A manual for the program development support software. It describes such things as operating environment and operating methods of SPEL Editor or SPEL for Windows.
   We provide two kinds of software, SPEL Editor (for MS-DOS) and SPEL for Windows (for Microsoft Windows). We also provide Vision Guide, the integrated robot vision system, as an option of SPEL for Windows.

7. Teaching pendant manual (option)
   A manual for the teaching pendant. It describes such things as how to operate the teaching pendant.

FOREWORD

This manual specifies matters that you need to know to use the controller SRC-320. Please thoroughly read this and other related manuals before using the equipment.

In this manual for the controller, some of the functional features are listed separately according to each model of manipulator it may be connected to. Please refer to the description of the relevant model as specified with the initials as follows:

ES/EC	If your manipulator model is either ES or EC series, refer to this section.
EL/EH	If your manipulator model is either EL or EH series, refer to this section.
BN/BNA	If your manipulator model is either BN or BNA(-CL) type, refer to this section.
BL	If your manipulator model is either BL or BL(-CL) type, refer to this section.
XM3000	If your manipulator model is XM3000 series, refer to this section.
RT3300	If your manipulator model is RT3300 series, refer to this section.

The improvements at Rev.4:

- The MPU board facilitates easier installation of the Lithium battery.

The improvements at Rev.5:

- The mistakes of the circuit diagram on page 34 ware corrected.

The improvements at Rev.6:

- The wrong pin assignment of X12 in the circuit diagram on page 88 is corrected.

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Functions

The Functions volume describes the basic functions of the controller. Please refer to sections in this volume for safety features, connection to the other peripheral equipment and standard settings.

Various combinations of controller settings and specifications

The various settings and the specifications of the controller are different depend on the manipulator models. Therefore, be sure to connect the controller to the manipulator with the same M. CODE.

See the following table of the specifications and settings for each manipulator models.

		BN type	BNA(-CL) type	BL(-CL) type	XM3000 series	RT series
Controller name		SRC-320	SRC-320 ABS	SRC-320		
MPU board	device for absolute motor specification	not exist	exist	not exist		
	ROM name	MPUUas- MPULas- DSP@as-			MPUUax- MPULax- DSP@ax-	MPUUar- MPULar- DSP@ar-
	Setting of the jumper pins XP3	short				open
Driver capacity	axis #1	200W	200W (ABS)	400W	400W	400W
	axis #2	100W	100W (ABS)	200W	200W	400W
	axis #3	100W	100W (ABS)	200W	200W	400W
	axis #4	50W	50W (ABS)	100W	100W	50W
Regenerative brake unit		not exist	not exist	exist	exist	not exist
Setting of the jumper pins XP1 on the motor power unit		short	short	open	open	short

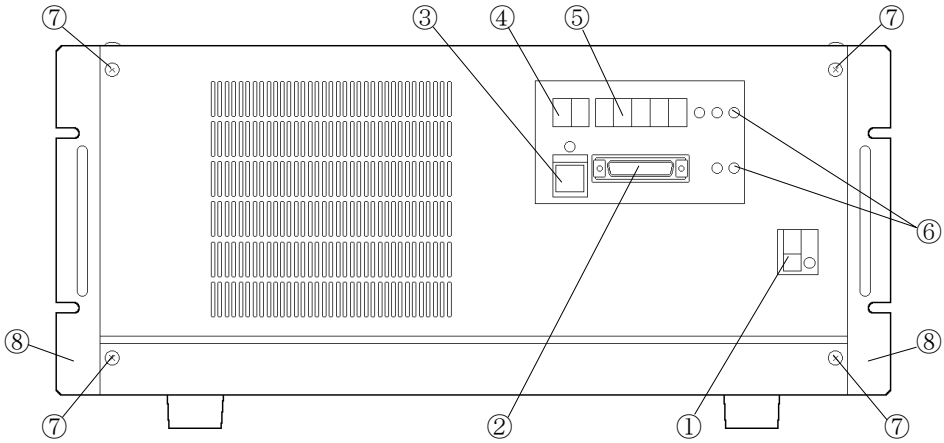
		ES series	EL series	EC series	EH series
Controller name		SRC-320 ABS			
MPU board	device for absolute motor specification	exist			
	ROM name	MPUUae- MPULae- DSP@as-			
	Setting of the jumper pins XP3	short			
Driver capacity	axis #1	200W (ABS)	400W (ABS)	100W (ABS)	400W (ABS)
	axis #2	100W (ABS)	200W (ABS)	100W (ABS)	200W (ABS)
	axis #3	100W (ABS)	100W (ABS)	100W (ABS)	200W (ABS)
	axis #4	100W (ABS)	100W (ABS)	50W (ABS)	100W (ABS)
Regenerative brake unit		not exist	exist	not exist	exist
Setting of the jumper pins XP1 on the motor power unit		short	open	short	open

NOTE ☞ The controller settings are different depend on the arm length or the stroke even if the manipulators are the same types or series. Refer to the settings of the dip switch SD1 written in the " Specifications" in the manipulator manual for details.

NOTE ☞ Also, the controller settings are different depend on the length of the power cable and signal cable. Be sure to connect the controller and the manipulator with the cables corresponds to the length appear on the M. CODE label.

1. Part Names and Functions

1.1 Front panel



① POWER switch

Controller power switch. There are a leakage indication button (yellow) and a test button (red) at right of the controller power switch.

② TEACH port

RS-232C connector for connecting a programming unit such as a personal computer. This can be used when in the TEACH Mode. The baud rate is 9600bps (bits per second). For safety, the robot stops functioning if this connector is disconnected. During operation, please connect any of the following devices:

TP-320 (option)

TEACH port connector (attached to the TEACH port when shipped)

PC cable for SPEL Editor or SPEL for Windows (option)

⚠ WARNING

- SPEL Editor and SPEL for Windows are designed so that the robot is operated from outside the safeguarded space for program development.
  Be sure to use the teaching pendant with an enable switch and emergency stop switch when performing the teaching operation within the safeguard space.
- Use PC cable with the label “SRC-300” or PC cable with an enable switch. Cables without the label have a “normally open” emergency stop switch that does not function properly, exposing you to dangers.

③ E. STOP CANCEL switch (with light)

Pushing the E. STOP CANCEL switch when replacing the TEACH port connector mentioned above, prevents emergency stop.

⚠ WARNING

It is dangerous to operate the robot when either of the following symptoms appears:

- The light stays lit even after you take your hand off the CANCEL switch.
- The light does not turn on when you push the CANCEL switch even though the robot is not in the emergency stop condition.

Either of these conditions indicates the possibility that the emergency stop switch connected to TEACH port is inoperable and needs repair.

④ PRG. No. LED

This is a 7-segment 2-digit LED that shows the program number under normal conditions. When an error occurs, the LED will alternately show the following information.

Error axis number	first digit (axis 0 to 4)*
Error task number	two digits

* 0 indicates that the error is not related to an axis.

⑤ LINE NO./STATUS LED

When a program is being executed, this shows the line number of the program being executed. When an error occurs, the error number is shown.

⑥ Indicator panel LED

The individual LEDs show the following information.

Symbol	Meaning	Function
E. STOP	Emergency stop	Lights under emergency stop
SAFE GUARD	Safeguard	Lights when safeguard is open
TEACH	Teach	Lights when in TEACH mode
AUTO	Automatic	Lights when in AUTO mode
S. ERR	System error	Lights when CPU is inoperable

NOTE ☞ When a system error has occurred, please be careful since LEDs other than S. ERR and E. STOP may not function properly.

⑦ Front panel mounting screws

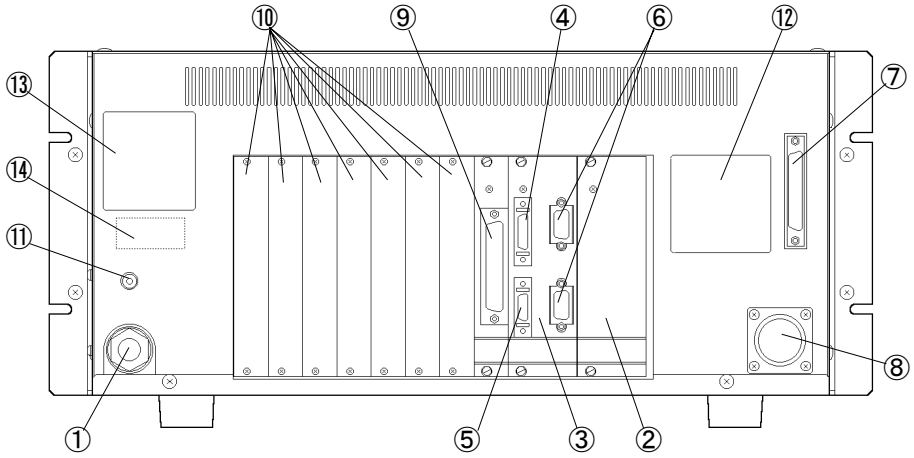
Removing these four screws allows front panel removal.

The front panel has a circuit board and cooling fan attached by cables. When removing the front panel, please do not pull hard.

⑧ Mounting bracket

These are brackets for mounting the controller. Use these brackets to mount the controller to a post of a base table, stand or other suitable location. The brackets alone cannot support the controller.

1.2 Rear panel



① POWER cable

Cable for controller AC power.
It is composed of two power leads (brown, blue) and a ground wire (green/yellow).

② PSU board

Circuit board for controller, manipulator, and peripheral units' power.

③ REMOTE board

Interface board having four connectors for REMOTE1&2 and RS-232C #20/#21.

④ REMOTE1

Connector for safeguard and emergency stop inputs. The safeguard input has safety features such as temporary program stop and low power mode.
The emergency stop input achieves robot emergency stop. This input terminal is "normally closed" so that if no cable is connected, the robot is in the emergency stop condition and will not operate.
Connect a "normally closed" emergency stop switch with the cable connector that came as a standard accessory.

⑤ REMOTE2

Connector specifically for the operating unit (option: OPU-300 or OPU-320). It can be used in the AUTO mode.
If there is no cable connected, the robot is in the emergency stop condition. If you do not use the operating unit, connect a "normally closed" emergency stop switch with the cable connector that came as a standard accessory. Further, it will be necessary to make a mode switching circuit or similar modification.

⑥ RS-232C #20, #21

Connector for the RS-232C serial interface. It is used for communication between robots, peripheral units, or host computers.

⑦ M/C SIGNAL

This is a connector for signals from such things as the robot motor encoder or calibration sensor. Connect the signal cable attached to the manipulator.

⑧ M/C POWER

Connector for robot power source. Connect the power cable attached to the manipulator.

⑨ I/O-1

50-pin D-sub input/output connector (16 inputs, 16 outputs). The cable connector is a standard attachment.

⑩ Option slot

Seven slots which can accommodate boards for such things as additional I/O and additional RS-232C boards. Any slot can be used.

⑪ PE(F-GND) terminal

A terminal for ground wire connection (frame ground). Please use this terminal if another ground wire is used in addition to the one included with the power cable.

⑫ M. CODE label

A label on which the M. CODE (matching code) with the manipulator is shown. Also, the length of the power cable and signal cable is shown on this label.

⚠ CAUTION

- The manipulator has the same M. CODE label affixed to it. When connecting the manipulator and the controller, make sure the M. CODEs correspond.
- When installing the cable between manipulator and controller, make sure that the length of the power cable and signal cable corresponds to the length written on the M. CODE label.

⑬ Serial No. label

A label on which the serial number is shown.

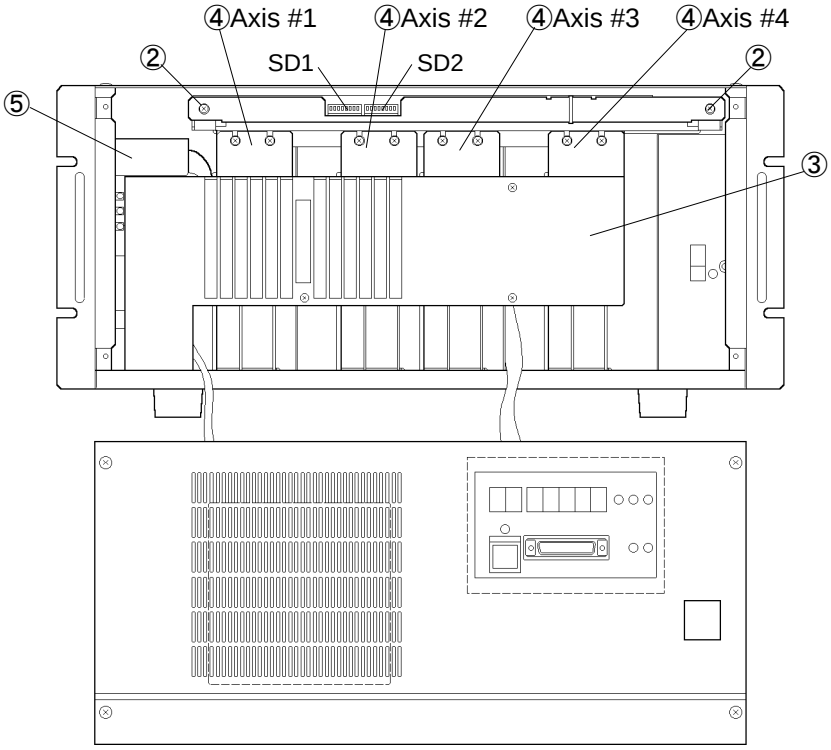
⑭ MT label

Labels that carry a special specification number. These are affixed to special specification robots. Robots having this label have special maintenance requirements. When performing maintenance, please confirm with us.

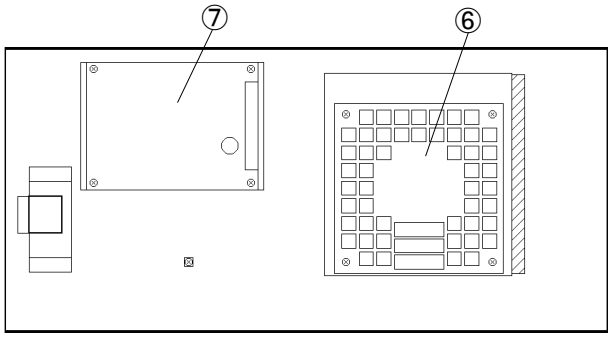
1.3 Controller interior

The interior of the controller as it appears after removal of the front panel is shown in the figure below.

Please do not pull hard when removing the front panel. A cooling fan and the indicator panel are attached to the front panel and connected to the interior by cables.



Back side of front panel ➔



① MPU board and mounting bracket

This board, containing the CPU, forms the nucleus of the controller and controls the various interfaces and executes the programs. It has DIP switches SD1 and SD2.

The MPU board and the mounting bracket are one piece, and the main body is fixed by the mounting bracket. You can remove the MPU board by pulling on the bracket.

② MPU board mounting screws

These screws affix the MPU board mounting bracket to the main body. To remove the MPU board, loosen the screws and then pull on the mounting bracket. Please do not pull the screws.

③ Safety cover

This safety cover prevents tools and such from being inserted or dropped into the interior of the controller.

④ AC servo driver

Unit to control the motors. Each servo-driver controls one motor.

⑤ Motor power unit

Contains the power circuit for the servo-drivers and motors as well as the dynamic brake circuit.

⑥ Cooling fan

The cooling fan is to fan out the heat generated from the servo-drivers to the outside the controller. Attached to the back of the front panel.

⑦ Front board

The board for indicator. Attached to the back of the front panel.

1.4 Safety features

The robot is equipped with safety features that protect it and peripheral equipment. However, these features are strictly to guard against unforeseen circumstances. To ensure safety, it is very important that you implement the maintenance inspections described in Maintenance volume of this manual and manipulator manual, and that you use the robot correctly.

The robot is equipped with the following safety features. If these features do not function properly, refer to “15. Trouble Shooting” in Maintenance volume herein and eliminate the cause of trouble.

- Emergency stop switch
  The optional PC cable (for SPEL Editor or SPEL for Windows), OPU-300/OPU-320, and TP-320 are all equipped with emergency stop switch.
  The REMOTE1 connector of the controller has an emergency stop input terminal that allows you to connect an add-on emergency stop switch.
  All the emergency stop switches are connected normally closed. When any of the emergency stop switches is pushed, the relay for the dynamic brake is activated to shut down the motor power for the robot (the emergency status).

- Temporary stop through input from the safeguard
  The robot temporarily stops operating when you open and close the safeguard. Be sure to connect the safeguard switch to the REMOTE1 connector of the controller.

- Low power mode
  This mode suppresses motor output. The robot automatically enters Low power mode and operates at a controlled, slower speed when it is in TEACH mode, a mode in which teaching and other operations are performed. When the safeguard is opened while the robot is in AUTO mode, the robot temporarily stops operating and enters Low power mode.

- Enable switch
  The optional PC cable (for SPEL Editor or SPEL for Windows) is equipped with enable switch. The robot temporarily stops operating when both the safeguard and the enable switch are open, making it safe to perform teaching operations.

- Mode switch with key
  The operating unit is equipped with a mode switch that can only be operated with the use of a key. Removing the key when the robot is in TEACH mode prevents the robot from switching to AUTO mode, making it safe to perform teaching operations. (See the operating unit manual.)

- Dynamic brake
  Dynamic brake circuit consists of a relay that switches the connection of motor power line to make a short-circuit on the motor side or to connect to the AC servo driver. When emergency stop is input, or the following malfunction is detected, the dynamic brake activates and stops the rotation of motor.

- Overheating detection
  A thermostat inside the controller detects overheating.

- Encoder discontinuity detection
  Detects discontinuity of the signal wire from the motor encoder to the controller.

- Overload detection
  Detects loads that exceed the capacity of the motor.

- Torque irregularity detection
  Detects irregular motor output.

- Speed irregularity detection
  Detects irregularities in motor speed.

- Servo overflow detection
  Detects the difference between the position reference and the current position of the manipulator.

- Motor lock detection
  Detects failure of the motor to respond to motion commands.

- Control power source irregularity detection
  Detects voltage irregularity of control power source of +5V, ±12V and +24V.

- Primary power source irregularity detection
  Detects dropped voltage of AC200V motor main power.

- CPU irregularity detection
  Detects CPU's irregularity that controls system with a watchdog timer. System controlling CPU and motor controlling CPU always watches over each other.

- Memory irregularity detection
  Detects check sum error of memory.

2. Installation

NOTE

The controller SRC-320 is not designed for the use in clean room environments. If you use the controller in the clean room, take an adequate countermeasure. As an example, place the controller in a box having a cooling or an exhausting mechanism.

2.1 Unpacking

⚠ CAUTION

- The controller weighs 24kg (standard). When moving the controller, use a hand cart. If unavoidable to move it by hand, be sure to hold by two persons.
- Do not hold the pulls on the front panel of the controller when moving.

Box contents

SRC-320 main unit	1 unit
50-pin D-sub I/O connector + clamp hood	1 set
Jumper socket	5 pieces
REMOTE1 connector	1 set
REMOTE2 connector	1 set
TEACH Port connector (attached to controller main unit)	1 piece

2.2 Environmental requirements

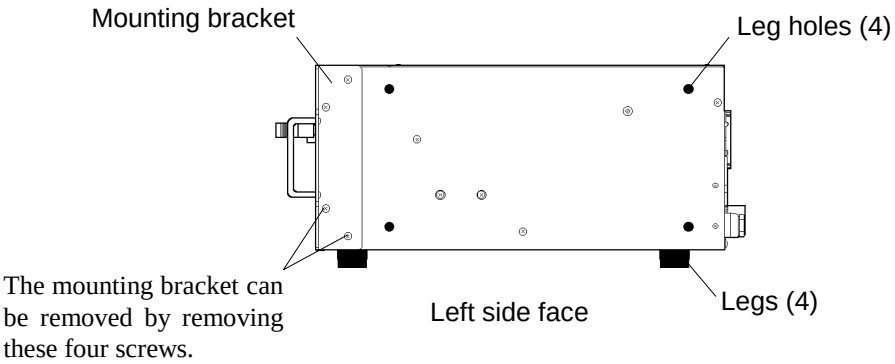
In order to maximize the functions of the SRC-320 controller and to use it in a safe manner, an appropriate environment is necessary. Please place the controller in an environment which satisfies the following conditions.

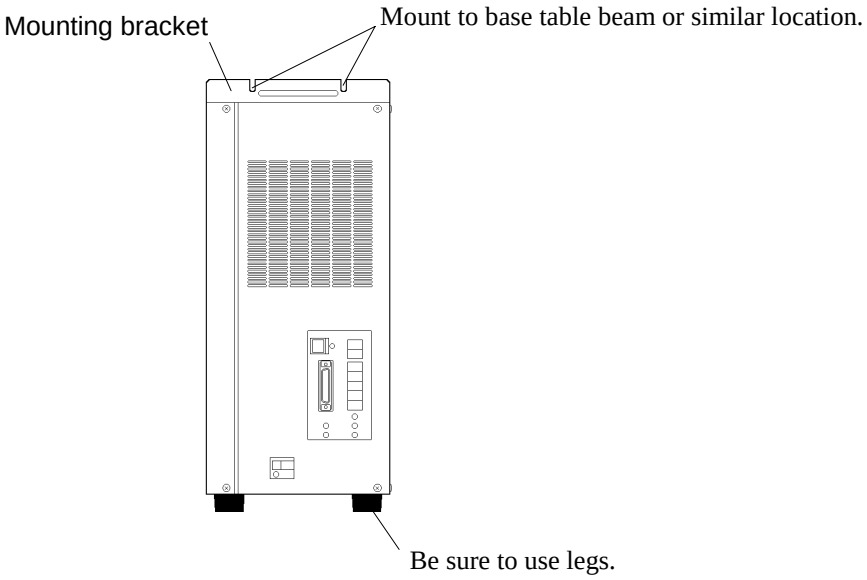
Ambient temperature	5 to 40°C (with minimal variation)
Ambient relative humidity	10 to 80% (with no condensation)
Fast transient burst noise	less than 2000V
Electrostatic noise	less than 6kV
Momentary power interrupt	10 ms (maximum)
Environment	● Install indoors. ● Place in a well-ventilated area. ● Keep away from direct sunlight. ● Keep away from dust, oil, salinity, metal powder or other contaminants. ● Keep away from flammable or corrosive solvents and gases. ● Keep away from water. ● Keep away from shocks or vibrations. ● Keep away from sources of electronic noise. If it's not avoidable to use the controller in the environment that does not fulfill the above mentioned conditions, take an adequate countermeasure for the actual environment. As an example, cover the controller with a box having a cooling mechanism. In addition, the controller is not designed for the use in clean room environments. If the controller is used in the clean room, place the controller in a box having a cooling or an exhausting mechanism.
Base table	Use a base table that is at least 100 mm off the floor. Placing the controller directly on the floor could allow dust penetration leading to malfunction.
Space	Allow at least 50 mm on each side. There must be room in front of the controller so that the entire controller can be pulled outward. There must also be room behind the controller so that one can attach and remove cables and boards.
Other	Do not remove the legs on the underside of the controller.

2.3 Vertical placement

Standard controller placement is horizontal. In the event that vertical placement is unavoidable, please do so following the points below.

1) Use the left side as the new bottom (see figure below).
2) Remove the four legs mounted on the original bottom. Remove them by inserting a flat screwdriver between the bottom and the legs.
3) Insert the legs into the four holes on the left side. Be sure to use the legs and not set the controller directly on the floor. You may remove the bottom-side mounting bracket if it is in the way.
4) The top surface (corresponding to the right side when the controller is placed horizontally) has two holes. Using some type of lid, be sure to cover the holes to prevent water or metal shaving penetration.
5) Placing the controller vertically is inherently unstable. Use the mounting bracket to mount the controller to prevent it from tipping over.





Vertical placement

2.4 Power

Power specifications

Please be sure available power meets the following specifications.

Voltage	AC 200 to 230V ±10%
Phase	Single phase
Frequency	50/60Hz
Power consumption	The controller itself consumes a maximum of approximately 200W, but actual consumption depends on the manipulator motors. Please refer to the manipulator manual for manipulator power consumption and then use the following equation to calculate total consumption: Rated consumption =200W+ total manipulator consumption ×1.5
Peak current	When power is turned on: approximately 130A (1msec.)
	When motor is on: approximately 90A (5msec.)
Leakage current	3mA typical
Earth leakage breaker in the controller	Rated current 10A
	Sensitivity 15mA
Ground	Be sure to use a grounded power source.

NOTE ☞ If you install an earth leakage breaker in the AC line, please use one that does not induce more than 10kHz (inverter type). If you install a circuit breaker, please select one that is bearable against the above mentioned peak current.

Power plug

⚠ WARNING

- To lockout the power supply, unplug the power plug. Never directly connect the robot to a factory power supply without using the power plug, as this will disable power lockout.
- Be sure to attach the ground wire (yellow/green) of AC power cable to the plug so that it shall be connected to the earth terminal of factory power supply.

The AC power cable is not equipped with a plug. Please attach a plug that is suitable for the power outlets in your area. The following table shows color of the wire of the power cable.

Wire	Color
AC power	Brown
Open	-
AC power	Blue
Ground wire	Green/yellow

For reference, specifications of the AC power cable included with the controller appear below.

Item		Specification
Conductor	Components	41 wires/ 0.26 mm (AWG #14)
	Outer diameter	1.9 mm (typical)
Insulator	Color	Brown, blue (AC power), green/yellow (ground)
	Outer diameter	3.5 mm (typical)
	UL. Style No.	1015
Braided shield	Braid density	70 %
Sheath	Color	Black
	Diameter	10.5 mm (typical)
Cable length		3.5 m

2.5 Cable connections

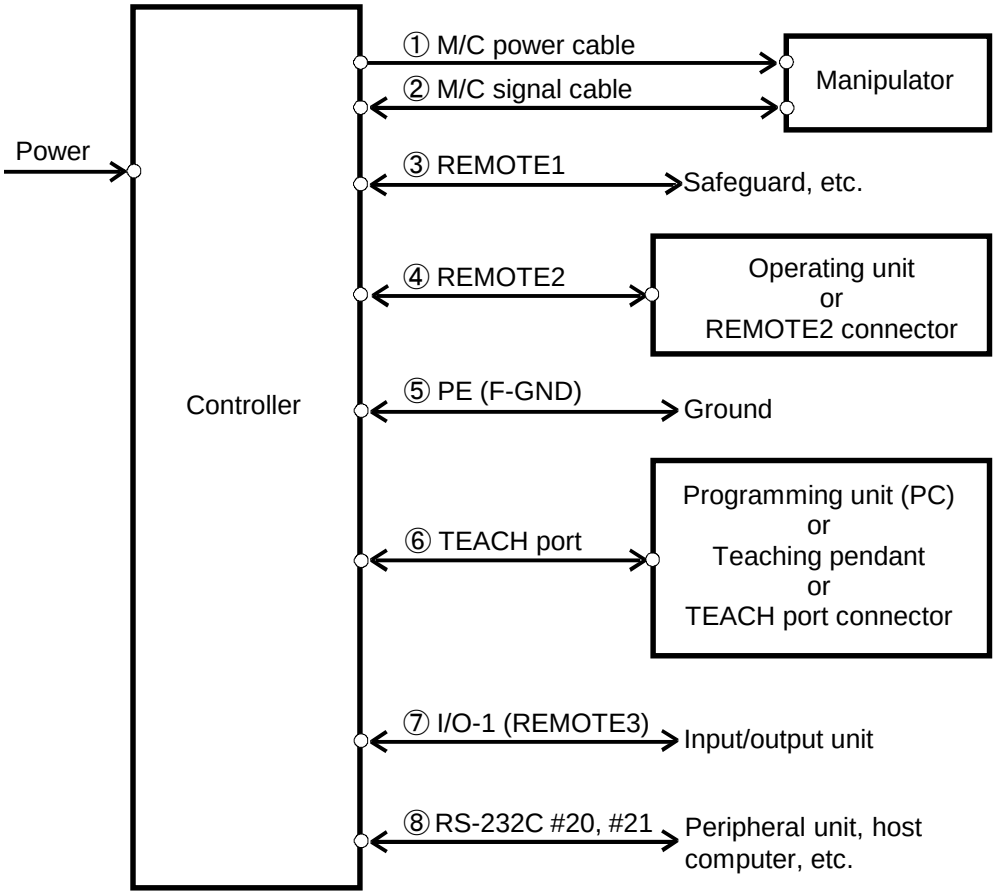
⚠ WARNING

- Be certain that the power has been turned off controller power before you plug or unplug any of the cables linking the manipulator and controller. Failure to do so could cause electrification and malfunction.

⚠ CAUTION

- When installing the cable between the manipulator and the controller, make sure the M. CODEs (matching codes) match. The M. CODEs are written on the yellow labels which appear on the back sides of both the manipulator and the controller. Also, make sure that the length of the power cable and signal cable correspond to the length which appear on the yellow labels mentioned above.

It is necessary to connect the various cables as shown in the figure below in order for the robot to operate.



① M/C power cable

Cables with 17-pin, round connectors on both ends.

Connect the female connector to the manipulator POWER connector and the male connector to the controller M/C POWER connector.

Insert the connectors and rotate clockwise until you hear a “click.”

② M/C signal cable

Cables with 68-pin, square connectors on both ends.

Connect the signal cable to the manipulator SIGNAL connector and controller M/C SIGNAL, respectively. Using the two fitting screws attached to the connectors, tighten down the connectors so that they will not come loose.

③ Safeguard switch connection (REMOTE1)

Please be absolutely certain to erect a safety enclosure around the robot area.

Connect that safeguard switch to the input terminal of the REMOTE1 safeguard. Since this input terminal is "normally closed," the robot will not operate normally if the safeguard switch is not installed.

Details of the connector are included in "4. REMOTE1" in this volume.

④ REMOTE2

Connect the optional operating unit (OPU-300 or OPU-320) to REMOTE2. Please refer to the separate manual for the operating unit for details.

If the operating unit is not being used, connect a "normally closed" emergency stop switch with the REMOTE2 connector that came as a standard accessory. If nothing is connected, the robot will be in the Emergency Stop mode and will not function. Details concerning necessary procedures when the operating unit is not being used appear in "5. When not using the operating unit" in this volume.

⑤ PE(F-GND) terminal connections

The PE terminal is for connection to the ground (frame ground).

We recommend connecting the PE terminal when several robots are used in a line or when a peripheral control unit such as a sequencer is used in the system. Use wiring having a diameter equal to or greater than AWG #16 to connect to the PE terminal.

⑥ TEACH port

Connect any one of the following units. If nothing is connected, the robot will be in the Emergency Stop mode and will not function. The details of these connectors are included in "3. Teach Port" in this volume.

- PC cable for SPEL Editor or SPEL for Windows (option)
- Teaching pendant TP-320 (option)
- TEACH port connector

⚠ WARNING

- SPEL Editor and SPEL for Windows are designed so that the robot is operated from outside the safeguarded space for program development.
  Be sure to use the teaching pendant with an enable switch and emergency stop switch when performing the teaching operation within the safeguard space.
- Use PC cable with the label "SRC-300" or PC cable with an enable switch. Cables without the label have a "normally open" emergency stop switch that does not function properly, exposing you to dangers.

⑦ I/O-1

If you have input/output units, connect them to this connector.

The details regarding I/Os appear in “6. I/Os” in this volume, and details regarding REMOTE3 appear in “7. I/O Remote Set Up” in this volume.

⑧ RS-232C #20/#21

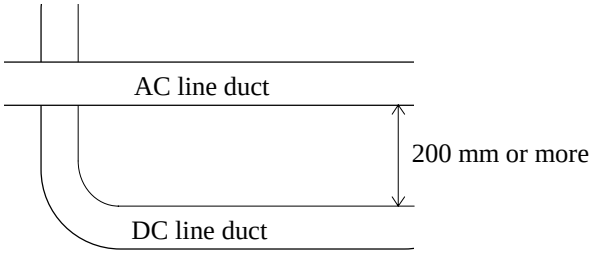
If you have communications units, connect them to this connector.

Details of this connector appear in “8. RS-232C” in this volume.

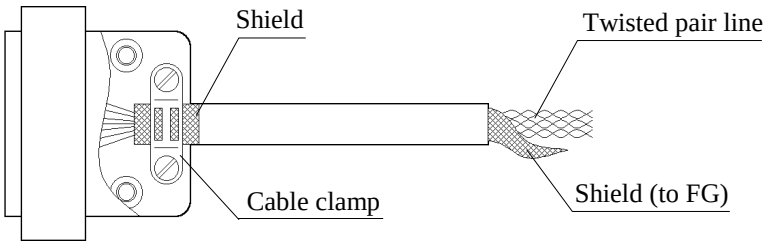
2.6 Noise countermeasures

Please pay attention to the following points when wiring the system.

- To ground the controller chassis is very important not only for prevention from electric shock, but also for reducing the electric noise influence around the controller. Therefore, be sure to connect the yellow/green wire in the power cable of the controller to the earth terminal of the factory power supply. (See the section “Power Plug” in “2.4 Power” in this chapter.)
- Do not tap into a power source which is supplying power to a piece of equipment which may cause noise.
- Use a twisted pair motor power line.
- Do not run AC power lines and DC power lines in the same wiring duct, and separate them by at least 200 mm.
  For example, separate the AC motor power line and the controller power line by at least 200 mm from the sensor or valve I/O lines; and do not bundle both sets of wiring with the same cable tie.
  Also, it is preferable to cross the different lines as shown below.

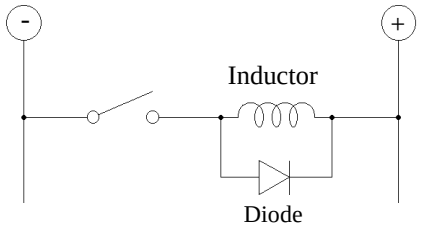


- For I/O lines, use a shield and clamp the shield to the attached I/O connector interior.



- Use a shielded wire for REMOTE1 and REMOTE2, and clamp the shield to the interior of the connectors.

- For such induction elements as relays and solenoid valves connected to an I/O, be sure to use elements which have surge suppressors. If surge suppressors are not used, insert an element such as a rectifying diode as close as possible to the inductors, as shown below. Choose rectifying diodes adequate to the inductors.



- For AC motors (induction motor, 3-phase induction units, etc.) in such things as conveyors which start, go forward and backwards regularly, install a spark killer between the lines.
  The spark killer is more efficient the closer it is to the motor.

3. TEACH Port

This port is used for such tasks as programming, teaching, and debugging, and is connected to a personal computer or teaching pendant TP-320 (option). This port becomes a console port when in the TEACH mode.

If nothing is connected to the TEACH port, the robot will enter the emergency stop condition. If you are not using a personal computer or TP-320, connect the TEACH port connector.
The TEACH port connector is connected to the TEACH port prior to shipping. When changing connectors, do so while pushing E. STOP CANCEL switch to the left of the TEACH port to avoid the emergency stop condition.

⚠ WARNING

It is dangerous to operate the robot when either of the following symptoms appears:

- The light stays lit even after you take your hand off the CANCEL switch.
- The light does not turn on when you push the CANCEL switch even though the robot is not in the emergency stop condition.

Either of these conditions indicates the possibility that the emergency stop switch connected to TEACH port is inoperable and needs repair.

3.1 Personal computer connection

WARNING

- SPEL Editor and SPEL for Windows are designed so that the robot is operated from outside the safeguarded space for program development.
  Be sure to use the teaching pendant with an enable switch and emergency stop switch when performing the teaching operation within the safeguard space.
- Use PC cable with the label “SRC-300” or PC cable with an enable switch. Cables without the label have a “normally open” emergency stop switch that does not function properly, exposing you to dangers.

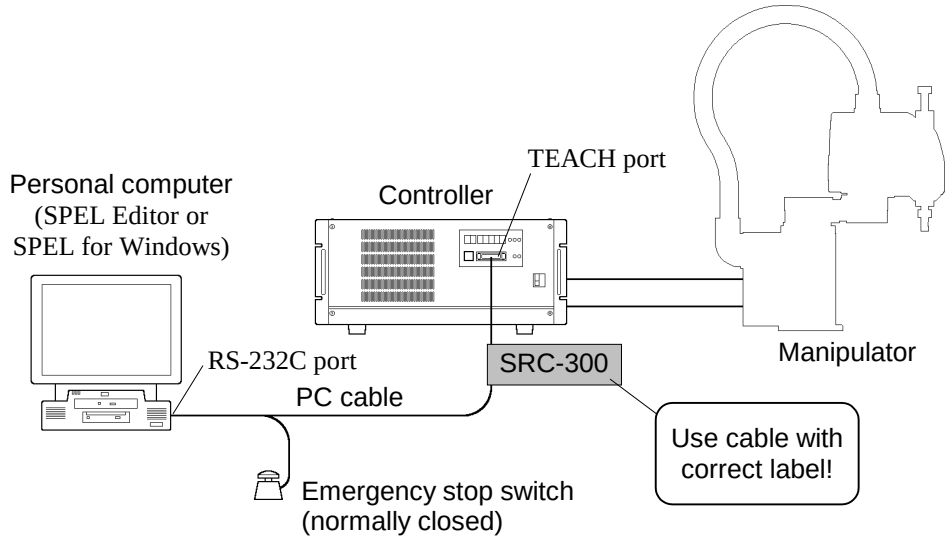
The following is information on connecting a personal computer.
Programming is done by a personal computer running the SPEL Editor or SPEL for Windows.

There is a special cable (PC cable) for use between the TEACH port and the personal computer attached to the SPEL Editor or SPEL for Windows. Connect it to the TEACH port.

This cable has a “normally closed” emergency stop switch.

Please set up the configuration of the personal computer’s RS-232C port to match the following protocol for the TEACH port:

9600bps, 8 bit, Even, 2 stop



3.2 Teaching pendant TP-320 connection

Teaching operation is possible to be done with a handy teaching pendant TP-320 instead with a personal computer. TP-320 is employing both of an emergency stop switch (normally closed) and an enable switch (normally open). The dedicated cable for the controller is attached to TP-320. Connect this cable to the TEACH port.

In TEACH mode, the enable switch has to be pressed for robot operation. If it is not pressed, pause condition will occur as soon as a program or motion command is executed. If the enable switch is set free during motion, the robot will quickly pause and a message will be issued.

To resume robot operation from the condition, press the enable switch and [RESUME] key. Refer to TP-320 manual for details.

In AUTO mode, a program or motion command can be executed even if the enable switch is not pressed.

The condition that a robot can be operated is called the enable condition. REMOTE1 and REMOTE3 have Enable condition output terminal.

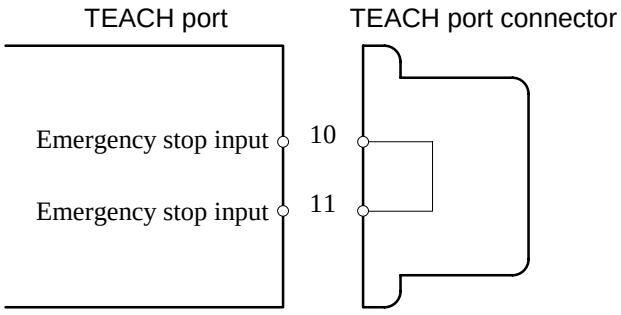
Make sure that the enable switch functions properly by the following procedure before a teaching operation.

1) Switch to TEACH mode.
2) Execute a program or motion command while pressing the enable switch.
3) Set the enable switch free during motion.
4) Make sure that the robot will quickly pause.

3.3 TEACH port connector (E. STOP CANCEL connector)

The TEACH port has “normally closed” emergency stop input terminals so that if the terminals are not closed, the unit will enter the emergency stop condition. If TP-320 or personal computer is not connected, install the TEACH port connector that came standard with the controller.

The internal wiring of the TEACH port connector is as shown below.



* Compatible connector : 25-pin D-sub connector

3.4 E. STOP CANCEL switch use

⚠ WARNING

- Never perform teaching or other operations while holding down the E. STOP CANCEL switch.
- Never use robot when the light is off while pushing E. STOP CANCEL switch and when not in the emergency stop condition. Do not use robot when the light does not return off though you release the E. STOP CANCEL switch, either.

The E. STOP CANCEL switch invalidates emergency stop input from the TEACH port. Pushing this switch when changing connectors on the TEACH port prevents the emergency stop condition. Release the switch after the connector is in place.

Never perform teaching or other operations while holding down the E. STOP CANCEL switch. It is very dangerous because Emergency stop input may not work in this case.
Before performing teaching operations, make certain that the E. STOP CANCEL switch and associated circuits are working properly. If they are not working properly, do not use the robot.

Please check them as follows.
This switch has an attached light. When not in the emergency stop condition (when E. STOP LED on the indicator panel of the controller is off), pushing the switch turns on the light. Removing your hand from the switch turns off the light. This is the normal operating condition of the switch, so please check that it acts accordingly before use. If it is not normal, the controller needs repair.

	Switch pressed	Switch released
In normal condition	Lit	Unlit

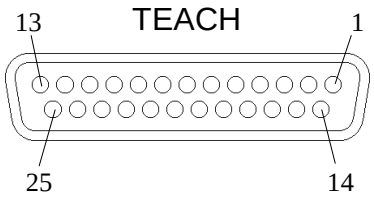
When in the emergency stop condition (when E. STOP LED on the indicator panel of the controller is on), there are cases in which pushing the switch turns on the light and does not turn on the light. When the light does turn on, the cause of the emergency stop is on the TEACH port side. When the light does not turn on, the cause of the emergency stop is in either REMOTE1 or REMOTE2 on the rear panel of the controller.

	Switch pressed	Switch released	Emergency stop cause
In emergency stop condition	Lit	Unlit	The emergency stop is pressed on the TEACH port side, or the connector is not connected properly.
	Unlit	Unlit	The emergency stop is pressed in either REMOTE1 or REMOTE2, or emergency stop input terminals are not wired.

3.5 Pin assignment of TEACH port

The pin assignment for the TEACH port is as shown below.

Pin number	Signal name
1	FG
2	SD
3	RD
4	RS
5	CS
6	-
7	SG
8	CD
10	E. STOP input (normally closed)
11	
14	DMSW input (normally open) (enable switch input)
15	
20	ER



If you prefer to use your own connection cable, please use a shielded cable and use the following example wiring diagram as a reference for wiring your cable.
Since the pin numbers on the personal computer side may differ depending on the type of computer, please refer to the computer manual.
Also, in order to ensure safe operation, be sure include an emergency stop switch and an enable switch.

Wiring example

[TEACH port] [RS-232C port of PC]

Signal name	Pin number	Pin number	Signal name
FG	1	1	FG
SD	2	2	SD
RD	3	3	RD
SG	7	7	SG
RS	4	4	RS
CS	5	5	CS
—	6	6	DR
CD	8	8	CD
ER	20	20	ER
E. STOP	10		E. STOP switch (normally closed)
E. STOP	11		
DMSW	14		Enable switch (normally open)
DMSW	15		

4. REMOTE1

WARNING

- Be sure to operate the system with a functional interlock switch on the safeguard. It is dangerous to operate the system with the switch wound in tape, or without the on/off conditions since the safeguard input functions will not operate.

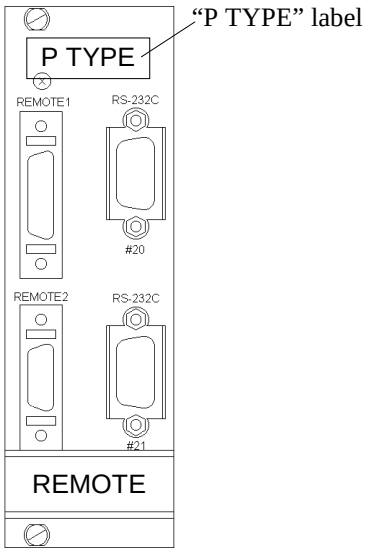
REMOTE1 has input terminals for the safeguard and the emergency stop.

In order to maintain a safe working zone, it is necessary to erect a safety enclosure around the manipulator. The interlock switch of this safeguard should be connected to REMOTE1. Safety functions such as momentary interruption of the program and switch to low power mode are activated when the safeguard is opened.

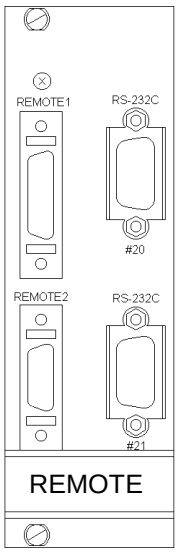
Further, the extended emergency stop input terminals are used when additional emergency stop switches are added or the operating unit is not used.

NOTE

PNP type or NPN type remote board is available. The pin assignments are different between each type remote boards. Confirm which type you select and refer to appropriate section of this manual when wiring.
Although NPN type remote board is not labeled, PNP type remote board is labeled as the drawing below.



PNP type REMOTE board
Refer to 4.3 - 4.4



NPN type REMOTE board
Refer to 4.5 - 4.6

4.1 Connecting to REMOTE1 the safeguard switch and emergency stop switch

⚠ CAUTION

- Use emergency stop switch conformed to the related safety standards (EN418, EN60204-1).
- The interlock switch must be designed and installed such as the contacts are opened by force when the safeguard opens, not by spring of the switch itself. (See EN1088 and EN954.)
- Wire the interlock switch dual-redundantly to the double safeguard inputs to prevent malfunction of the safeguard circuits.
- The safeguard must be designed and installed such as it does not close without operator's intention.
- The Latch release switch must be installed at a place where the hazardous area can be looked out.

Safeguard switch

An interlock switch of the safeguard, safeguard switch, should be connected with the cable connector that came as a standard accessory.
When wiring, in case of PNP type, refer to “4.3 Pin assignment of REMOTE1 (PNP type)” and “4.4 Circuit diagram and example wiring of REMOTE1 (PNP type).” In case of NPN type, refer to “4.5 Pin assignment of REMOTE1 (NPN type)” and “4.6 Circuit diagram and example wiring of REMOTE1 (NPN type).”

The safeguard input circuit is dual-redundant. An open safeguard is always detected even if one of the circuits fails. An error is displayed in the event of a failure. Therefore, we recommend dual-redundant wiring for the safety gate interlock switch.

If an open safeguard is detected by the safeguard input circuit, the signal will be latched, and even after the door is closed, it will not be recognized as such until the latch release signal is input. This has been provided as a means of preventing the kind of confusion that can easily arise during the construction of a robot system when operator and the robot system itself perceive the state of the safeguard differently; that is, when one believes the door is open, while the other perceives it as being closed. (For example, when faulty adjustment causes a difference in the state of the door and the state of the interlock switch; or when the door closes without the operator intending for it to be closed; etc.)

If the REMOTE board jumper pins XP4 and XP5 are set between “1 - 2,” the safeguard open signal will be latched. (This is the standard factory setting.) For releasing it, wire a normally open type switch between pin #9 and #22. If the jumper pins XP4 and XP5 are set between “2 - 3,” the signal will not be latched.

Use an interlock switch that opens when the safeguard opens. The safeguard input functions when the safeguard input terminals open, and activates the low power state.
A power source should be connected to pin #10 (or #11) and #23 (or #24) for the interlock switch.

Connect additional emergency stop switches between pin #6 and #19.
If you do not need additional emergency stop switches, shorten pin #6 and #19.

After connecting switches, make sure that each switch functions properly by the following procedure. For your safety these checks are recommended to be done at first of all.

1) Close the safeguard and push the latch release switch (when the REMOTE board jumper pins XP4 and XP5 are set between 1 and 2).
2) Open the safeguard.
3) Make sure that "SAFE GUARD" LED on the front panel will light.
   If a personal computer, on which SPEL Editor or SPEL for Windows is running, is connected to the TEACH port, the message to show the safeguard is open is displayed on the screen. (Refer to the SPEL Editor or SPEL for Windows manual for details.)
4) Close the safeguard.
   a) If the jumper pins XP4 and XP5 on remote board are set between 1 and 2 : "SAFE GUARD" LED still lights.
   b) If the jumper pins XP4 and XP5 on remote board are set between 2 and 3 : "SAFE GUARD" LED will go off.
5) In case of 4)-a), press a latch release switch, then "SAFE GUARD" LED will go off.

Emergency stop switch

When wiring, in case of PNP type, refer to "4.3 Pin assignment of REMOTE1 (PNP type)," "4.4 Circuit diagram and example wiring of REMOTE1 (PNP type)." In case of NPN type, refer to "4.5 Pin assignment of REMOTE1 (NPN type)," "4.6 Circuit diagram and example wiring of REMOTE1 (NPN type)."

1) Turn on the controller and press the emergency stop switch.
2) Make sure that "E. STOP" LED on the front panel will light.
3) Execute MOTOR ON command from a personal computer, or TP-320, or OPU-300/OPU-320 while "E. STOP" LED lights.
4) Error 121 will be issued.
5) Execute RESET command, then "E. STOP" LED will go off.

4.2 Safeguard input functions

The basic function of the safeguard input is to increase safety by stopping the robot and regulating the motor output when the safeguard is opened. When the safeguard is opened/closed while the robot is running a program or is in the direct command condition, it will quickly pause and turn into the Low Power state. It is not possible to operate the manipulator at high speeds in this state.

The methods to resume normal operation after quick pause are as follows.

- Push the start switch on operating unit.
- Press RESUME key if you use teaching pendant TP-320.
- Input a START signal to REMOTE3 when console is REMOTE3. See section "7. I/O Remote Set Up (REMOTE3)" in this volume.

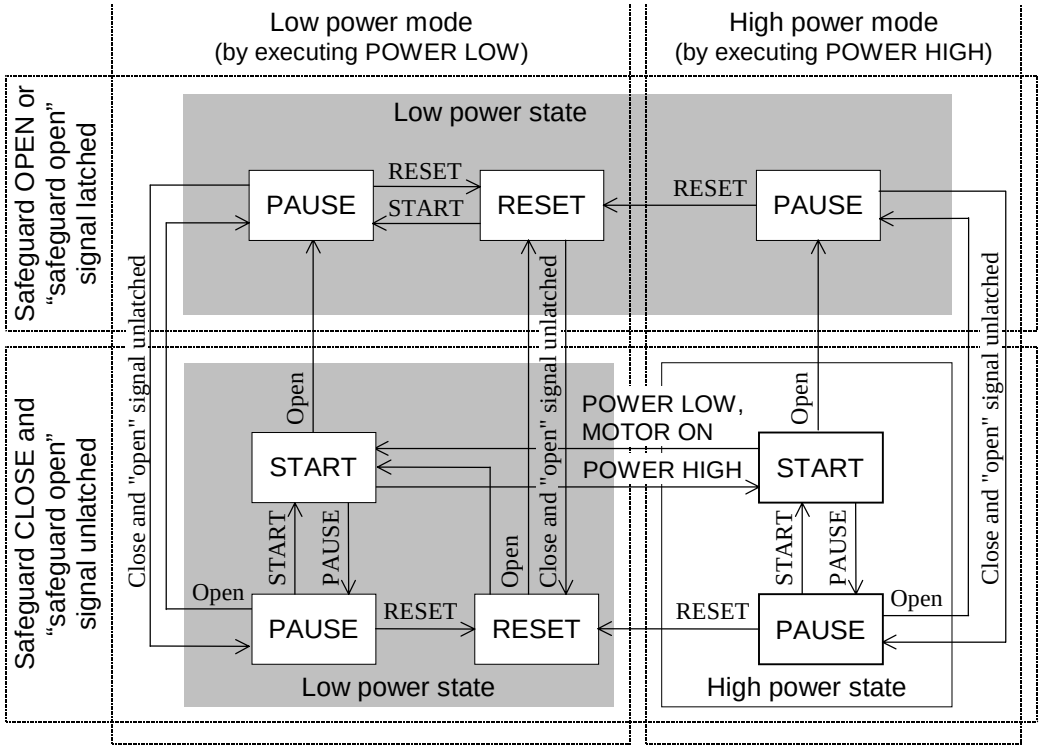
There are differences in robot operation when in the TEACH or AUTO modes. The safeguard input functions for each mode are explained below.
In addition, refer to the Operating unit, SPEL Editor or SPEL for Windows manuals for details on the operating methods.

AUTO mode

In AUTO mode the safeguard must be closed for the robot to operate. When the safeguard is opened during operation, there is a quick pause and the robot switches to Low Power state. Additionally, attempting to start a program with the safeguard open results in a quick pause, and the robot does not move.

To continue normal operation from the PAUSE condition, follow the procedure below.

1) Close the safeguard after confirming that there is no person in the safeguard.
2) Push the latch release switch.
3) Push the "START" switch. (Input a START signal when REMOTE3 is the console.)

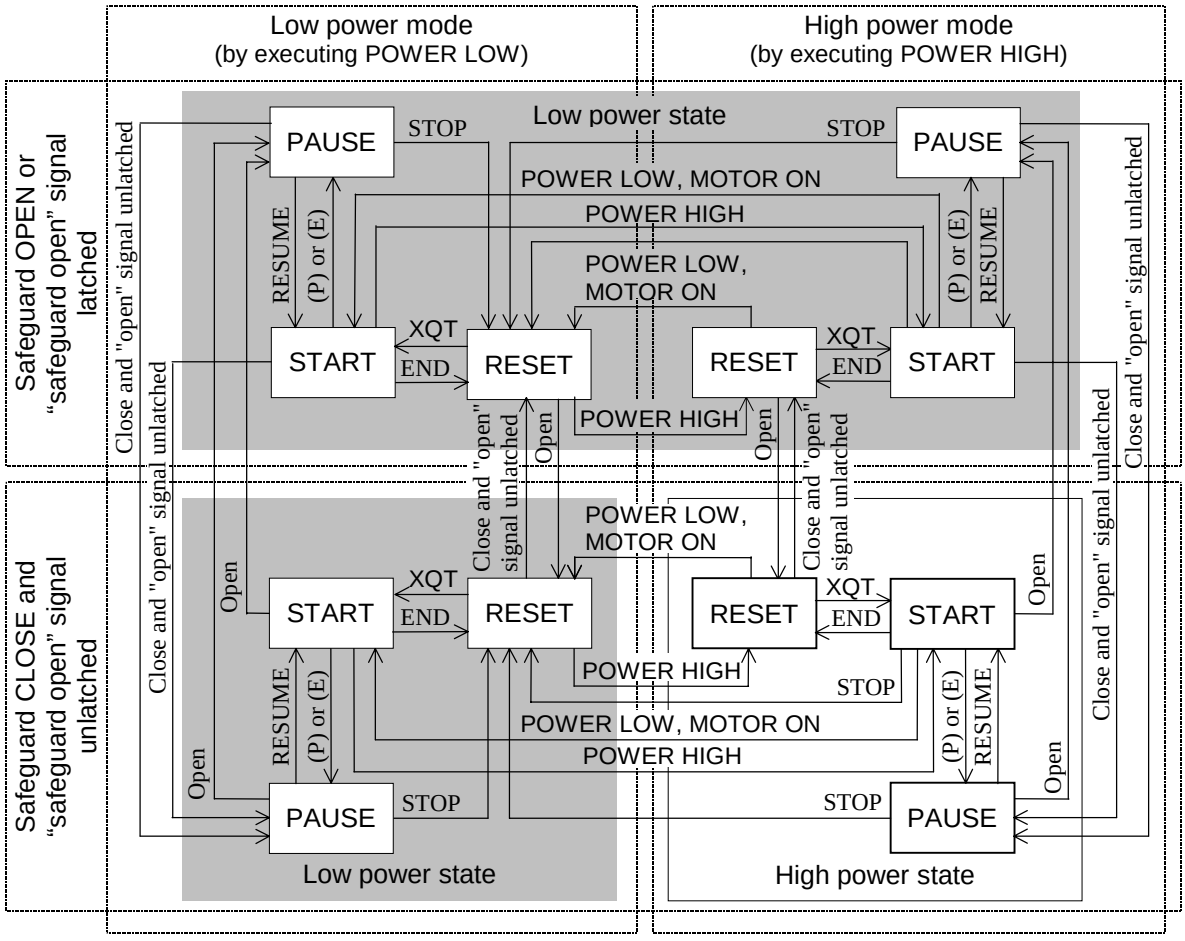


In case of S. NET mode, commands execution (direct commands) except for motion commands is not affected by the safeguard.

TEACH mode

In TEACH mode it is possible to operate the robot regardless of whether the safeguard is opened or closed. However, the robot operation speed and torque are limited when the safeguard is opened. The robot operation speed cannot be increased beyond the fixed value which depends on the type of robot when the safeguard is opened.
In addition, although the robot can operate by executing a program or command regardless of whether the safeguard is open or closed, it will quickly pause in either state if the safeguard is opened or closed during operation.

To operate the robot at high speed, close the safeguard and change the power mode to high by using POWER HIGH command. Refer to the SPEL III reference manual for details on POWER command. For your reference, POWER LOW equals LP ON, and POWER HIGH equals LP OFF.
When power is applied to the controller, the initial start up corresponds to POWER LOW so that the robot is always in low power state.



(P): PAUSE code input from TEACH port/PAUSE command
(E): ENABLE switch input from TEACH port

Command execution (direct commands) except for motion commands is not affected the enable switch and safeguard.

The Low Power/High Power state selection differs as shown below based on the combination of the safeguard status (open/closed) and power mode set by POWER command.

	POWER LOW (LP ON)	POWER HIGH (LP OFF)
Safeguard open	Low power state	Low power state
Safeguard closed		High power state

In order to achieve high power state, follow the procedure below.

1) Close the safeguard after confirming that there is no person in the safeguard.
2) Push the latch release switch. (In case that the jumper pins XP4 and XP5 on remote board are set between 1 and 2.)
3) Enter the POWER HIGH (or LP OFF) command.

Any of the following conditions causes cancellation of the POWER HIGH (LP OFF) command and selection of the low power state:

- Switching between TEACH and AUTO modes
- Execution of the POWER LOW (LP ON) command
- Execution of the RESET command (for an error requiring reset or turning on the power again)
- Execution of the MOTOR ON command
- Pushing the [STOP] key
- Pushing the [Ctrl] + [C] keys

4.3 Pin assignment of REMOTE1 (PNP type)

The pin assignment of the REMOTE1 connector for PNP type is as shown below.

⚠ CAUTION

- Pins #12, 13 and #25, 26 are for user's +24V power. This is the same as the power on I/O, so please be careful of the power capacity.
- The pins for an emergency stop circuit are both connected to the internal +24V power from the controller. Please follow the wiring examples to connect your emergency stop circuit. Any other wiring than sampled should be avoided.

Pin No.	Signal name	Function
1	Abnormal occurrence relay contact output *1	Relay contact output upon occurrence of system error
14	Abnormal occurrence relay contact output *1	
2	System error output	Output from system error (CPU inoperable)
15	Emergency stop output	Output from emergency stop condition
3	Safeguard output	Output from safeguard when open
16	Enable condition output	Output from enable condition
4	High power output	Output from high power condition
17	Motor power on output	Output from motor power condition
5	-	-
18	-	-
6	Emergency stop input	For connection to normally closed emergency stop switch
19	Emergency stop input	
7	Safeguard input 1 *2	For connection to safeguard input
20	Safeguard input 1 *2	
8	Safeguard input 2 *2	
21	Safeguard input 2 *2	
9	Latch release input	For connection to normally open switch that release the latch of "safeguard open"
22	Latch release input	
10	Common (GND)	For supply power for REMOTE1 internal circuit
23	Common (+DC)	
11	Common (GND)	For supply power for REMOTE1 internal circuit
24	Common (+DC)	
12	+24V output	+24V power output terminals for controller interior
25	+24V GND output	
13	+24V output	+24V power output terminals for controller interior
26	+24V GND output	

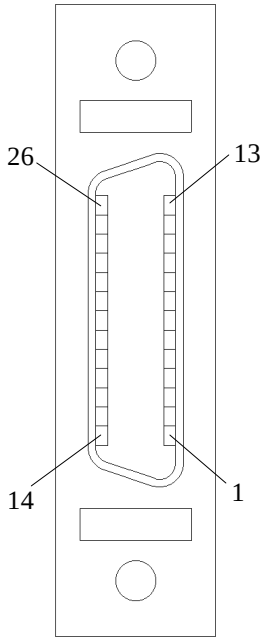
*1 These are “normally closed” contacts which open upon the occurrence of a system error. By using the jumper pins on the REMOTE board, it is possible to output other conditions.

Jumper pin	Function when shorted
XP2	outputs for emergency stop occurrence
XP3	also outputs for error occurrence

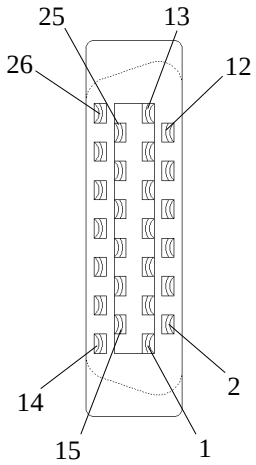
There is a possibility that there will be no output if the internal controller +24V power is abnormal.

*2 There are two safeguard inputs provided for REMOTE1. When the status of two inputs is different, CPU will take the safeguard input circuit as malfunction, and will issue an error. Therefore, it’s recommendable to use a two-contacts switch.

If it’s not avoidable to use a one-contact switch, be sure to short the jumper pin XP6 on the REMOTE board, so that the other input to which a switch is not connected will be connected internally.



REMOTE1 connector
Controller side



REMOTE1 connector
Cable side
(details for wiring)

4.4 Circuit diagram and example wiring of REMOTE1 (PNP type)

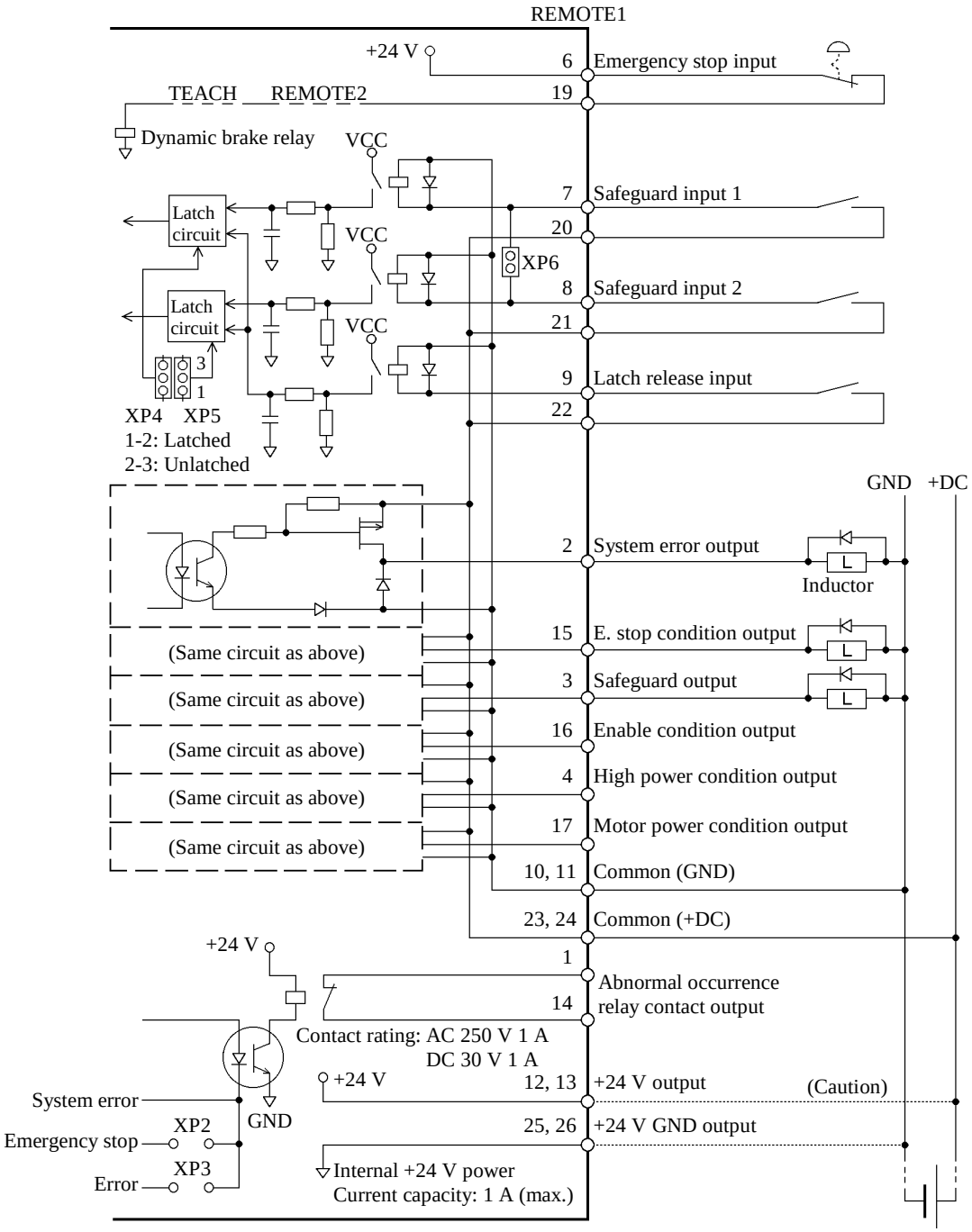
Input circuit

Emergency stop input current	100mA typical
Safeguard input current	2mA typical/for 24V input

Output circuit

Rated output voltage	DC 12 to 24V ±10%
Maximum output current	250mA/1 output
Output driver	Power MOS FET
Saturation voltage	1.0V

Example wiring



CAUTION

- Do not use internal controller power and external power simultaneously as it can result in damage.

4.5 Pin assignment of REMOTE1 (NPN type)

The pin assignment of the REMOTE1 connector for NPN type is as shown below.

⚠ CAUTION

- Pins #12, 13 and #25, 26 are for user's +24V power. This is the same as the power on I/O, so please be careful of the power capacity.
- The pins for an emergency stop circuit are both connected to the internal +24V power from the controller. Please follow the wiring examples to connect your emergency stop circuit. Any other wiring than sampled should be avoided.

Pin No.	Signal name	Function
1	Abnormal occurrence relay contact output *1	Relay contact output upon occurrence of system error
14	Abnormal occurrence relay contact output *1	
2	System error output	Output from system error (CPU inoperable)
15	Emergency stop output	Output from emergency stop condition
3	Safeguard output	Output from safeguard when open
16	Enable condition output	Output from enable condition
4	High power output	Output from high power condition
17	Motor power on output	Output from motor power condition
5	-	-
18	-	-
6	Emergency stop input	For connection to normally closed emergency stop switch
19	Emergency stop input	
7	Safeguard input 1 *2	For connection to safeguard input
20	Safeguard input 1 *2	
8	Safeguard input 2 *2	
21	Safeguard input 2 *2	
9	Latch release input	For connection to normally open switch that release the latch of "safeguard open"
22	Latch release input	
10	Common (+DC)	For supply power for REMOTE1 internal circuit
23	Common (GND)	
11	Common (+DC)	For supply power for REMOTE1 internal circuit
24	Common (GND)	
12	+24V output	+24V power output terminals for controller interior
25	+24V GND output	
13	+24V output	+24V power output terminals for controller interior
26	+24V GND output	

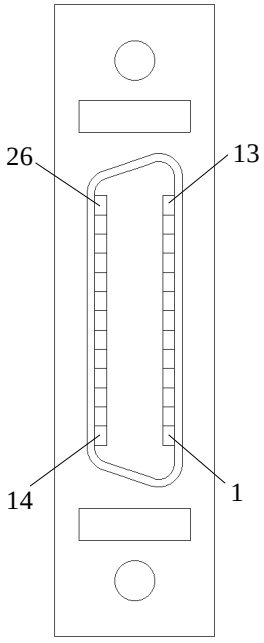
*1 These are “normally closed” contacts which open upon the occurrence of a system error. By using the jumper pins on the REMOTE board, it is possible to output other conditions.

Jumper pin	Function when shorted
XP2	outputs for emergency stop occurrence
XP3	also outputs for error occurrence

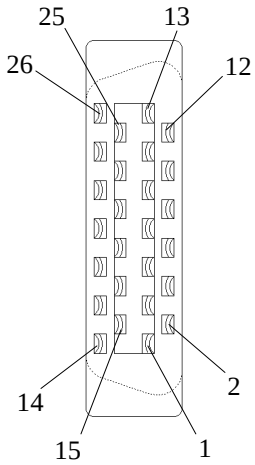
There is a possibility that there will be no output if the internal controller +24V power is abnormal.

*2 There are two safeguard inputs provided for REMOTE1. When the status of two inputs is different, CPU will take the safeguard input circuit as malfunction, and will issue an error. Therefore, it’s recommendable to use a two-contacts switch.

If it’s not avoidable to use a one-contact switch, be sure to short the jumper pin XP6 on the REMOTE board, so that the other input to which a switch is not connected will be connected internally.



REMOTE1 connector
Controller side



REMOTE1 connector
Cable side
(details for wiring)

4.6 Circuit diagram and example wiring of REMOTE1 (NPN type)

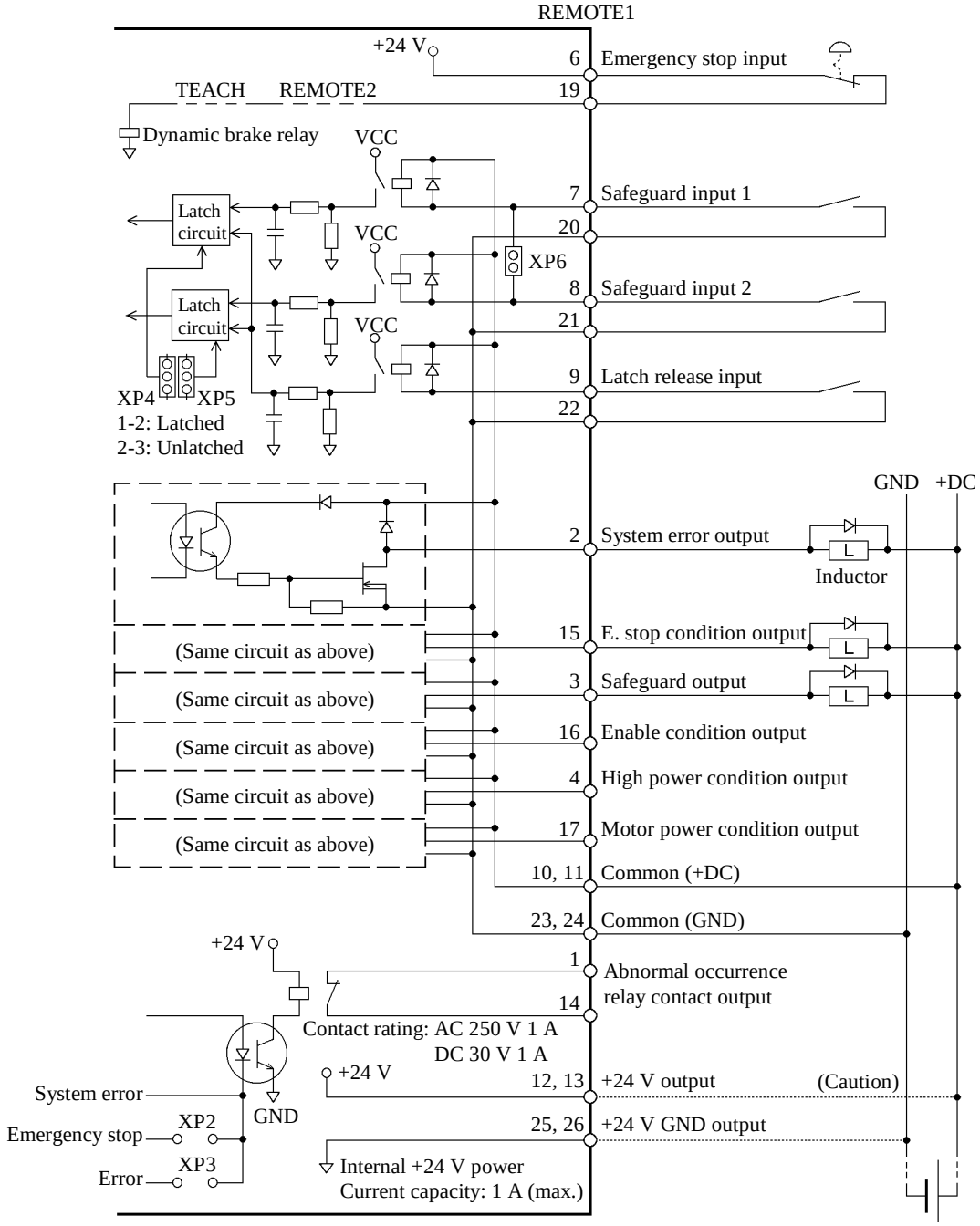
Input circuit

Emergency stop input current	100mA typical
Safeguard input current	2mA typical/for 24V input

Output circuit

Rated output voltage	DC12 to 24V ±10%
Maximum output current	250mA/1 output
Output driver	Power MOS FET
Saturation voltage	1.0V

Example wiring



CAUTION

- Do not use internal controller power and external power simultaneously as it can result in damage.

5. When Not Using the Operating Unit

Connect the optional operating unit OPU-300 or OPU-320 to the REMOTE2 connector. If you do not connect the operating unit, then you need to connect the REMOTE2 connector that came standard with the controller and take the following additional steps.

- Make a TEACH/AUTO mode switching circuit.
- Connect an emergency stop switch.

Or, if you connect the operating unit to the REMOTE2 connector but only use the output function (such as a display) rather than using it as a console, it is necessary to assign the console to another device.

5.1 Operating unit disconnected (REMOTE2)

Make a TEACH/AUTO mode switching circuit

Connector REMOTE2, to which you connect the operating unit, has a mode switching terminal. Switching of the TEACH/AUTO mode can only be done from the REMOTE2 connector. So, if you do not connect the operating unit, make a mode switching circuit using the pin assignment and wiring example for reference. For safety reasons, a key switch shall be used.

If nothing is connected to the mode switching terminal, TEACH mode will be assumed.

Connecting an emergency stop switch

Pins #5 and #15 of REMOTE2 are for an emergency stop input terminal. If operating unit is not connected to REMOTE2, connect emergency stop switch. Refer to the figures on the following page. Emergency stop input is normally closed. If nothing is connected, the emergency stop condition will be assumed.

Both REMOTE1 and REMOTE2 have an emergency stop input terminal.

Use an emergency stop switch conformed to the related safety standards (EN418, EN60204-1).

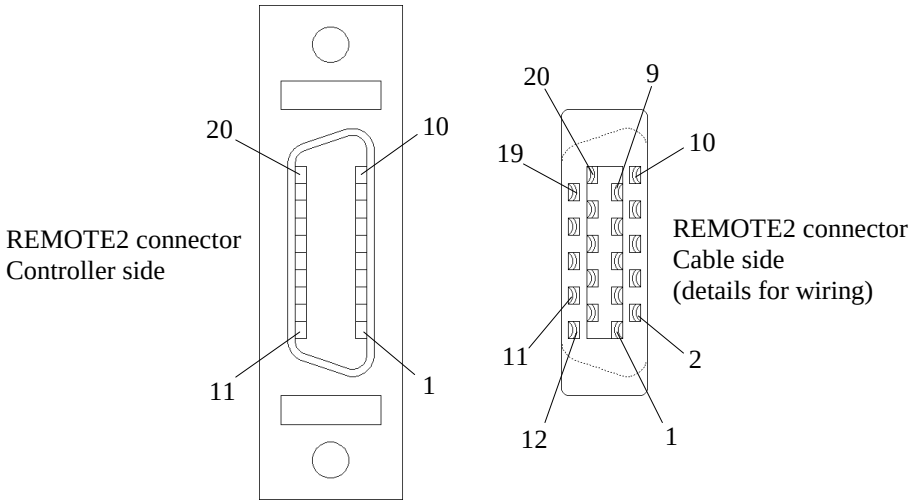
After connecting emergency stop switch, make sure that the switch functions properly by the following procedure.

1) Turn on the controller and press the emergency stop switch.
2) Make sure that “E. STOP” LED on the front panel will light.
3) Execute MOTOR ON command from a personal computer, or TP-320, or OPU-300/OPU-320 while “E. STOP” LED lights.
4) Error 121 will be issued.
5) Execute RESET command, then “E. STOP” LED will go off.

Pin assignment

REMOTE2 is a 20-pin connector, but only the pins in the table below can be used for wiring. Do not use any other pins under any circumstances, as they have not been freed for use.

Pin No.	Signal name	Pin. No.	Signal name
5	Emergency stop input	15	Emergency stop input
8	Teach mode input	18	Auto mode input
10	+24V GND	20	+24V GND

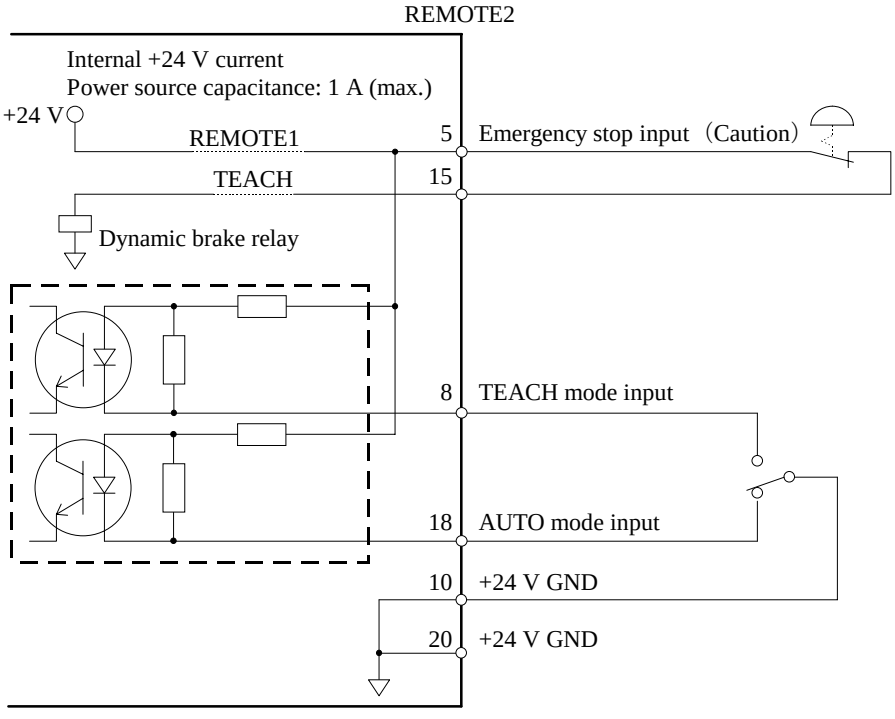


Wiring example

CAUTION

■ The controller has an internal power supply of +24V. Do not connect anything other than the emergency stop switch.

Emergency stop input current	100mA Typical
TEACH/AUTO mode input current	5mA Typical/for 24V input



5.2 When not using the operating unit as the console

The input port for controlling robot or the device connected to it is collectively referred to as the console. In many cases, operating unit is used as the console in AUTO mode. But when operating unit is not used, it is necessary to set up a console elsewhere. The input ports at which you can set up the console are as follows:

- I/O-1(REMOTE3)
- RS-232C #20/#21

I/O-1 (REMOTE3)

You can set up all functions except the display of operating unit at I/O-1 and use it as the console. The general procedures for doing so are explained below. For details, refer to "7. I/O Remote Set Up (REMOTE3)" in this volume.

1) Set up bits 1 & 2 of software switch SS1
2) Set up I/Os as the remote (REMOTE3)
3) Wire the REMOTE3 connector

RS-232C

When you assign RS-232C as the console, use the CONSOLE command. Refer to the SPEL III reference manual for details on the CONSOLE command.

In the case that RS-232C is assigned as the console a personal computer may be used and you will have to send all commands from it.

6. I/O

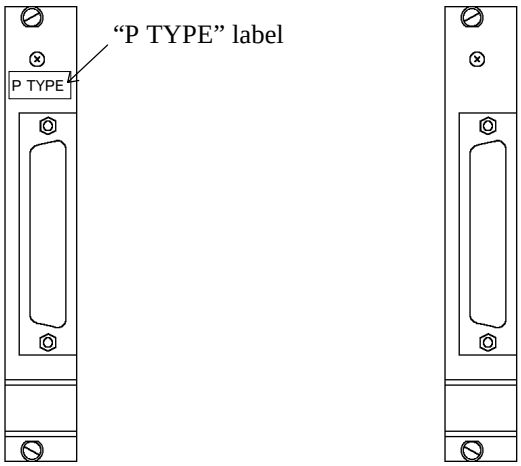
I/O links your input/output equipment. The controller comes standard with one I/O port on the rear panel, enabling you to use 16 inputs and 16 outputs. The cable connector for user cable is a standard accessory.

If you install additional I/O boards, you can use 16 inputs and 16 outputs multiplied by the number of I/O boards. The maximum number of input and output point is 128.

NOTE

When you are connecting wires, see “2.6 Noise countermeasures” in this volume.

PNP type or NPN type I/O board is available. The pin assignments are different between each type I/O boards. Confirm which type you select and refer to appropriate section of this manual when wiring.
Although NPN type I/O board is not labeled, PNP type I/O board is labeled as the drawing below.



PNP type I/O board
Refer to 6.1 - 6.4

NPN type I/O board
Refer to 6.5 - 6.8

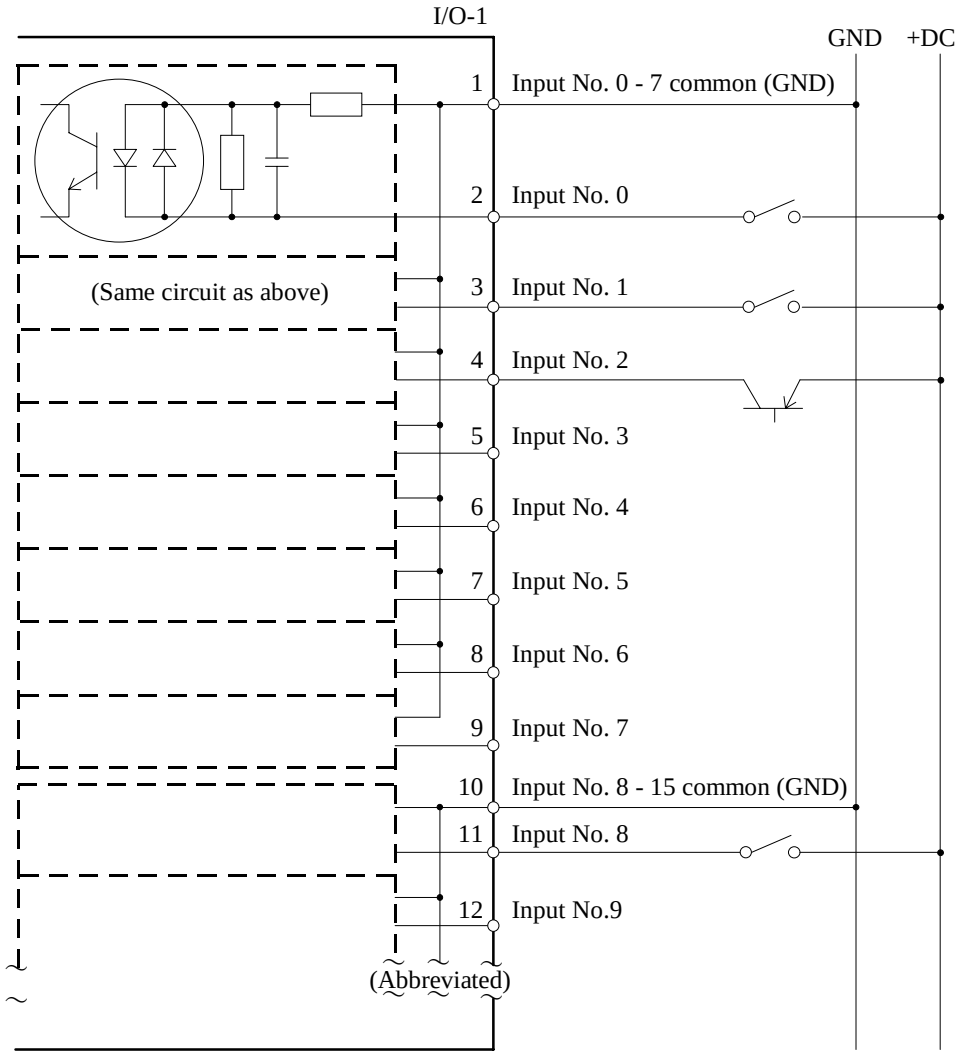
NOTE

All output bits will be turned off when an emergency stop switch is pressed and reset process such as by RESET command is done.
In case of emergency stop condition, output status can be held by the setting of software switch SS1. (Refer to “9.2 Software switches” in this volume.)

6.1 Input circuit (PNP type)

Input voltage range	DC 12 to 24V ±10%
ON voltage	DC 10.8V (min.)
OFF voltage	DC 4V (max.)
Input current	5mA typical with input of DC 24V

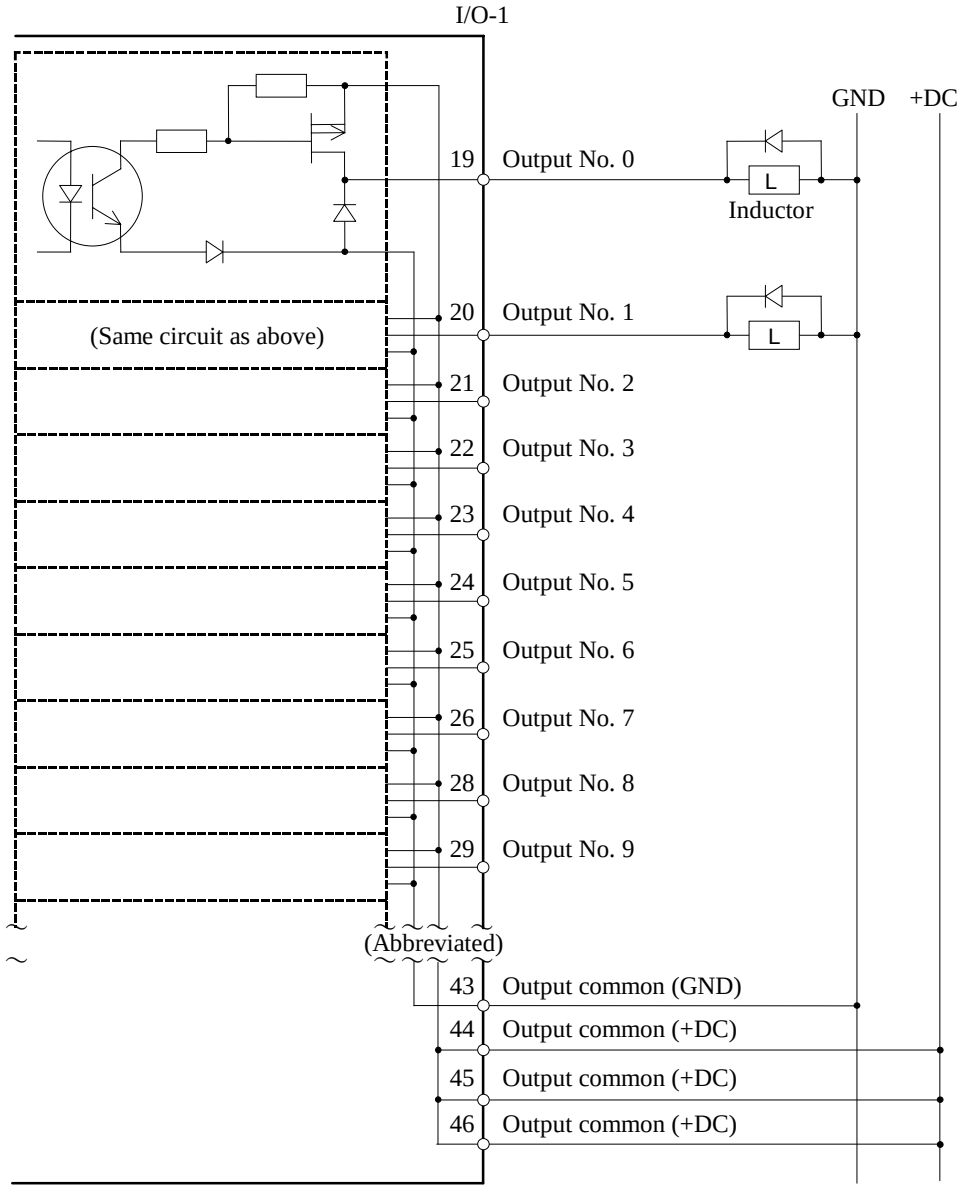
Input circuit diagram and wiring example



6.2 Output circuit (PNP type)

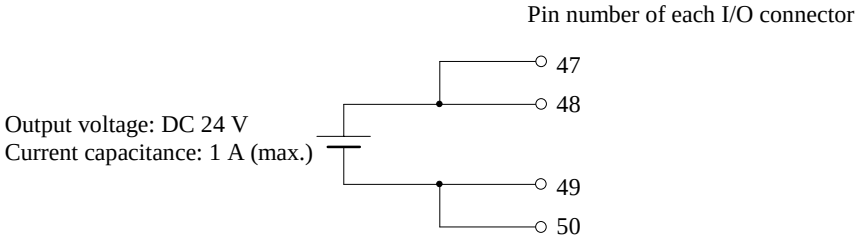
Rated output voltage	DC 12 to 24V ±10%
Maximum output current	250mA/1 output
Output driver	P channel power MOS FET
Saturation voltage	1.0V

Output circuit diagram and example of connections



6.3 Customer use power supply

A power supply for customer use is supplied to each I/O connector. This power supply is used for all I/Os as well as for REMOTE1 and REMOTE2. The current capacitance is 1A. Do not use this internal power supply together with an external power source, as doing so causes controller failure.



6.4 Pin assignment of I/O (PNP type)

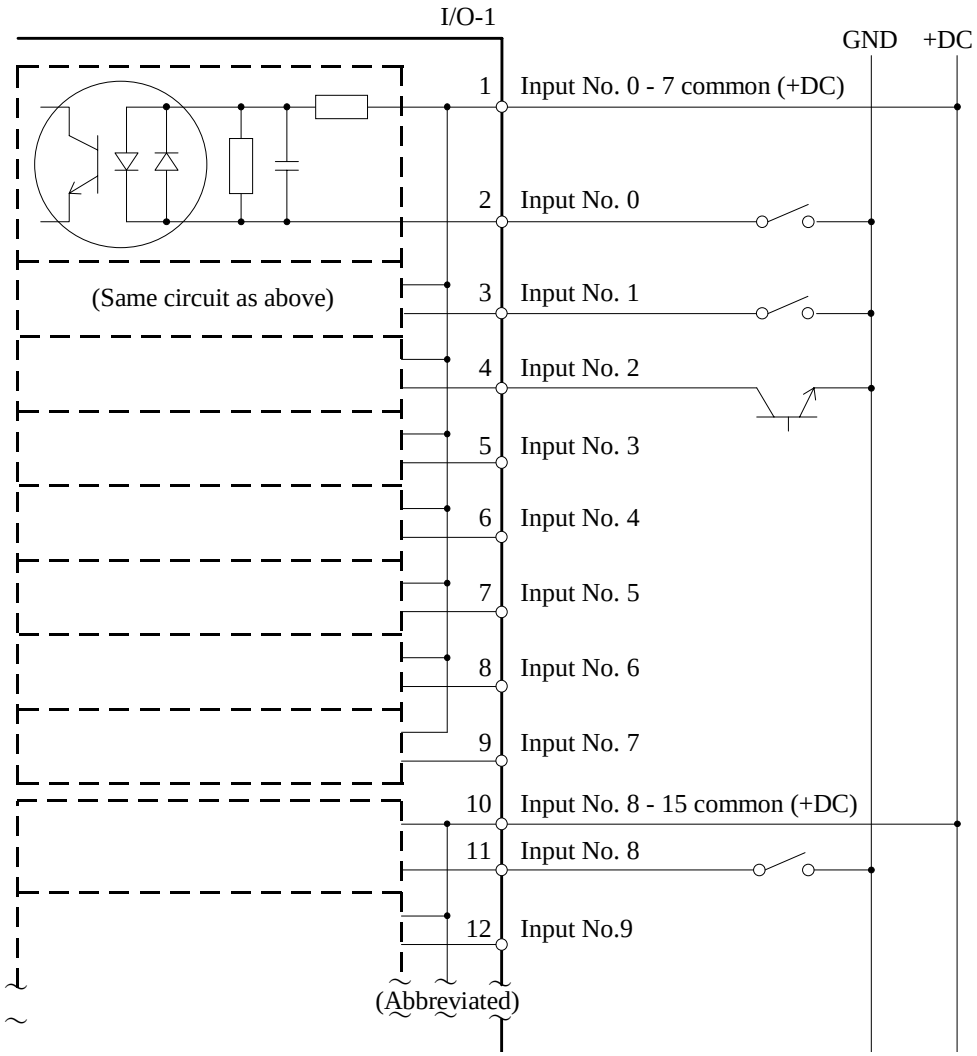
Only I/O-1 is standard, but the pin assignment of I/O-2 and other optional I/Os are shown in the table below. See “10.2 Additional I/O board” in this volume for information on how to install additional I/O ports.

Pin No.	Signal name								Pin No.	Signal name							
	I/O-1	2	3	4	5	6	7	8		I/O-1	2	3	4	5	6	7	8
1	Input common 0 to 7	16 to 23	32 to 39	48 to 55	64 to 71	80 to 87	96 to 103	112 to 119	26	Output 7	23	39	55	71	87	103	119
2	Input 0	16	32	48	64	80	96	112	27	-							
3	1	17	33	49	65	81	97	113	28	Output 8	24	40	56	72	88	104	120
4	2	18	34	50	66	82	98	114	29	Output 9	25	41	57	73	89	105	121
5	3	19	35	51	67	83	99	115	30	-							
6	4	20	36	52	68	84	100	116	31	Output 10	26	42	58	74	90	106	122
7	5	21	37	53	69	85	101	117	32	Output 11	27	43	59	75	91	107	123
8	6	22	38	54	70	86	102	118	33	-							
9	7	23	39	55	71	87	103	119	34	Output 12	28	44	60	76	92	108	124
10	Input common 8 to 15	24 to 31	40 to 47	56 to 63	72 to 79	88 to 95	104 to 111	120 to 127	35	-							
11	Input 8	24	40	56	72	88	104	120	36	Output 13	29	45	61	77	93	109	125
12	9	25	41	57	73	89	105	121	37	-							
13	10	26	42	58	74	90	106	122	38	Output 14	30	46	62	78	94	110	126
14	11	27	43	59	75	91	107	123	39	-							
15	12	28	44	60	76	92	108	124	40	-							
16	13	29	45	61	77	93	109	125	41	Output 15	31	47	63	79	95	111	125
17	14	30	46	62	78	94	110	126	42	-							
18	15	31	47	63	79	95	111	127	43	Output common (GND)							
19	Output 0	16	32	48	64	80	96	112	44	Output common (+DC)							
20	1	17	33	49	65	81	97	113	45	Output common (+DC)							
21	2	18	34	50	66	82	98	114	46	Output common (+DC)							
22	3	19	35	51	67	83	99	115	47	+24 V output							
23	4	20	36	52	68	84	100	116	48	+24 V output							
24	5	21	37	53	69	85	101	117	49	+24 V GND output							
25	6	22	38	54	70	86	102	118	50	+24 V GND output							

6.5 Input circuit (NPN type)

Input voltage range	DC 12 to 24V ±10%
ON voltage	DC 10.8V (min.)
OFF voltage	DC 4V (max.)
Input current	5mA typical with input of DC 24V

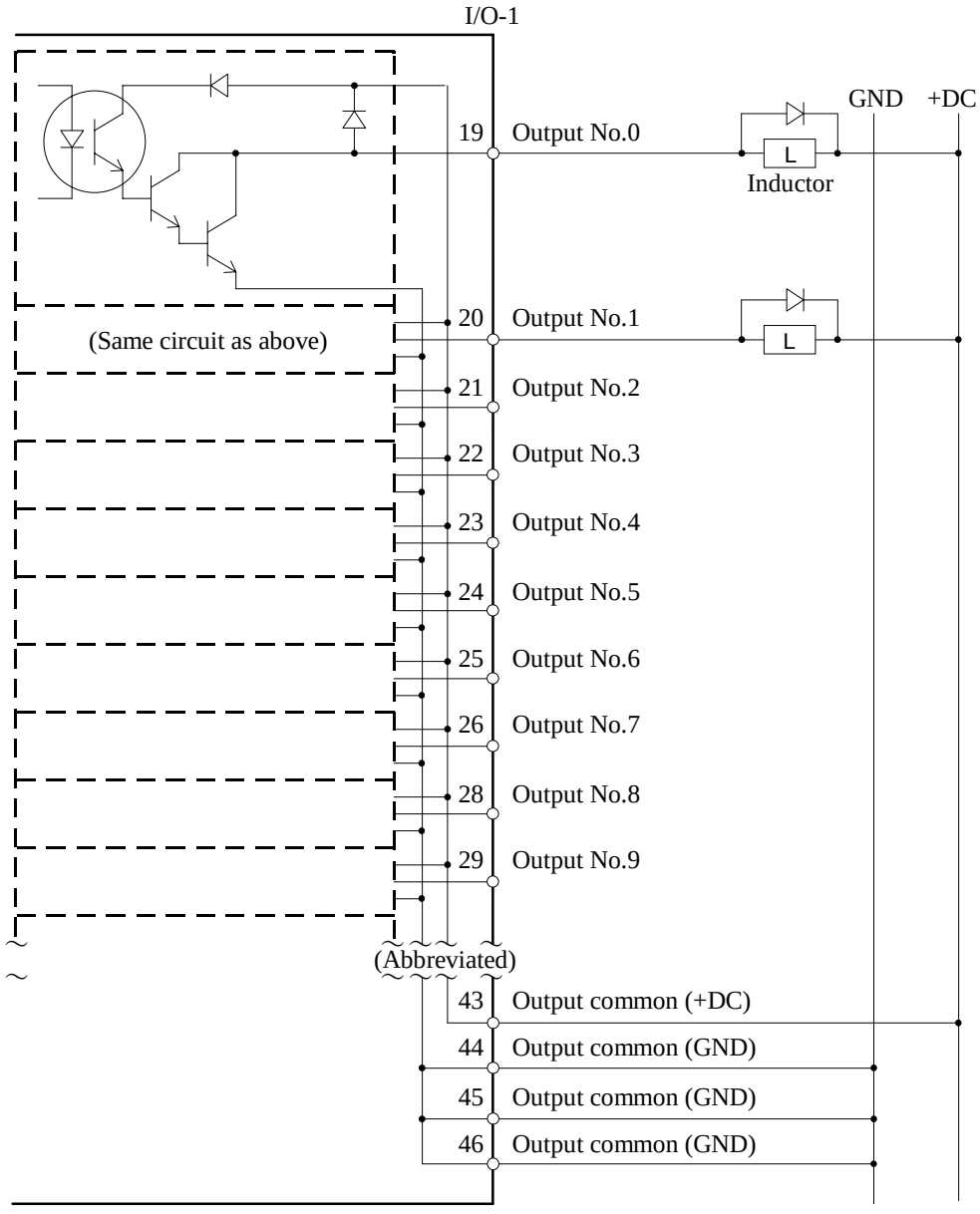
Input circuit diagram and wiring example



6.6 Output circuit (NPN type)

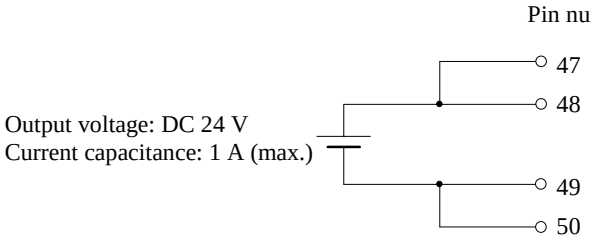
Rated output voltage	DC12 to 24V ±10%
Maximum output current	250mA/1 output
Output driver	N channel power MOS FET
Saturation voltage	1.0V

Output circuit diagram and example of connections



6.7 Customer use power supply

A power supply for customer use is supplied to each I/O connector. This power supply is used for all I/Os as well as for REMOTE1 and REMOTE2. The current capacitance is 1A. Do not use this internal power supply together with an external power source, as doing so causes controller failure.



6.8 Pin assignment of I/O (NPN type)

Only I/O-1 is standard, but the pin assignment of I/O-2 and other optional I/Os are shown in the table below. See “10.2 Additional I/O board” in this volume for information on how to install additional I/O ports.

Pin No.	Signal name								Pin No.	Signal name							
	I/O-1	2	3	4	5	6	7	8		I/O-1	2	3	4	5	6	7	8
1	Input common 0 to 7	16 to 23	32 to 39	48 to 55	64 to 71	80 to 87	96 to 103	112 to 119	26	Output 7	23	39	55	71	87	103	119
2	Input 0	16	32	48	64	80	96	112	27	-							
3	1	17	33	49	65	81	97	113	28	Output 8	24	40	56	72	88	104	120
4	2	18	34	50	66	82	98	114	29	Output 9	25	41	57	73	89	105	121
5	3	19	35	51	67	83	99	115	30	-							
6	4	20	36	52	68	84	100	116	31	Output 10	26	42	58	74	90	106	122
7	5	21	37	53	69	85	101	117	32	Output 11	27	43	59	75	91	107	123
8	6	22	38	54	70	86	102	118	33	-							
9	7	23	39	55	71	87	103	119	34	Output 12	28	44	60	76	92	108	124
10	Input common 8 to 15	24 to 31	40 to 47	56 to 63	72 to 79	88 to 95	104 to 111	120 to 127	35	-							
11	Input 8	24	40	56	72	88	104	120	36	Output 13	29	45	61	77	93	109	125
12	9	25	41	57	73	89	105	121	37	-							
13	10	26	42	58	74	90	106	122	38	Output 14	30	46	62	78	94	110	126
14	11	27	43	59	75	91	107	123	39	-							
15	12	28	44	60	76	92	108	124	40	-							
16	13	29	45	61	77	93	109	125	41	Output 15	31	47	63	79	95	111	125
17	14	30	46	62	78	94	110	126	42	-							
18	15	31	47	63	79	95	111	127	43	Output common (+DC)							
19	Output 0	16	32	48	64	80	96	112	44	Output common (GND)							
20	1	17	33	49	65	81	97	113	45	Output common (GND)							
21	2	18	34	50	66	82	98	114	46	Output common (GND)							
22	3	19	35	51	67	83	99	115	47	+24 V output							
23	4	20	36	52	68	84	100	116	48	+24 V output							
24	5	21	37	53	69	85	101	117	49	+24 V GND output							
25	6	22	38	54	70	86	102	118	50	+24 V GND output							

7. I/O Remote Set Up (REMOTE3)

You can set up a remote function in I/O-1 and use it as REMOTE3. You can use this as the console when in AUTO mode in place of operating unit OPU-300 or OPU-320 to implement various controls.

7.1 Remote set up

The input/output number and functions of I/O-1 that can be set up as REMOTE3 are as shown in the pin assignment chart on the next page. You can select and use functions individually. Input/output for which you have not set up a remote function can be used as a normal I/O.

You can easily set them up using the "Remote Set Up" of SPEL Editor or SPEL for Windows. See those manuals for details.

⚠ WARNING

- Before setting up a remote, always confirm that connections match remote functions. An output function at which you have set up a remote automatically outputs in accordance with the state of the controller. Connections that differ from the setting can lead to failure of peripheral equipment.

⚠ CAUTION

- After setting up the I/O remote, either keep a written record of the setup or use the MKVER command to keep the information as a file.
  If system initialization is performed using bit 1 of the MPU board's DIP switch SD1, the I/O remote setting is also canceled and it will revert to a normal I/O. It will be necessary to accurately reset the remote on the basis of the data you have kept on record.

Output performs its function with only the remote setup described above, but if an input function is desired, it is necessary to set up such that REMOTE3 is the console. Select the remote by using bit 1 of software switch SS1. See SPEL Editor or SPEL for Windows manual for instructions on setting the software switch.

The function of SS1 is as follows. Refer to "7.3 Valid/Invalid input signals" of this chapter for details.

Bit No.	Function	ON	OFF
SS1-1	Selection of the remote	REMOTE3 (I/O)	REMOTE2 (OPU-300/OPU-320)

:Factory settings (standard specification)

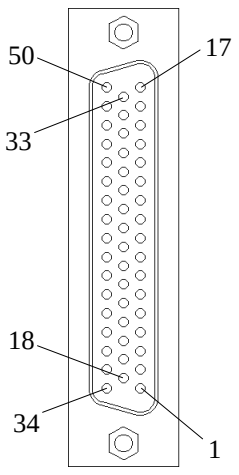
7.2 REMOTE3 input/output signals

The arrangement of signals that can be set up as REMOTE3 is shown in the table below. Input/output number has also been included in the table since you may also use them. Refer to the wiring examples in “6. I/O” in this volume when you connect wires.

Pin assignment

Pin No.	Signal	I/O No.	Pin No.	Signal	I/O No.
1	Input common 0 to 7		26	Program No. selection output 2^3	Output 7
2	RESET input	Input 0	27	-	
3	PAUSE input	1	28	MCAL output	Output 8
4	START input	2	29	Motor power on output	9
5	HOME input	3	30	-	
6	Program No. selection input 2^0	4	31	ERROR output	Output 10
7	Program No. selection input 2^1	5	32	Emergency stop output	11
8	Program No. selection input 2^2	6	33	-	
9	Program No. selection input 2^3	7	34	Safeguard output	Output 12
10	Input common 8 to 15		35	-	
11	MCAL input	Input 8	36	AUTO mode output	Output 13
12	Motor power on input	9	37	-	
13	Motor power off input	10	38	TEACH mode output	Output 14
14	-	11	39	-	
15	-	12	40	-	
16	-	13	41	Enable condition output	Output 15
17	-	14	42	-	
18	-	15	43	Output common (+DC) or (GND)*1	
19	RESET output	Output 0	44	Output common (GND) or (+DC) *1	
20	PAUSE output	1	45	Output common (GND) or (+DC) *1	
21	START output	2	46	Output common (GND) or (+DC) *1	
22	HOME output	3	47	+24V output	
23	Program No. selection output 2^0	4	48	+24V output	
24	Program No. selection output 2^1	5	49	+24V GND output	
25	Program No. selection output 2^2	6	50	+24V GND output	

*1: the case of PNP I/O



I/O connector
controller side

REMOTE3 Input Signal Functions

Signal Name	Functions
RESET	This signal is used for (1) initializing an error state; (2) interrupting a program. The robot controller will be reset at the input of this signal. If the robot controller needs to be reset during execution of a program, make sure that the signals are input as follows: 1) Input PAUSE. 2) Make sure that the PAUSE output signal is out. 3) Input RESET.
PAUSE	This signal is used to stop program for the moment. This signal temporarily stops the program from being executed. In order to resume the operation or to finish the program: 1) Wait to receive PAUSE output from the robot controller. 2) Input START（to resume operation） or RESET（to finish the program） signal.
START	This signal is used to (1) initiate execution of program; (2) resume operation from the pause state. In order to have the program executed from the very beginning, the robot controller must have been reset (in the state where RESET out is being output.)
HOME	Input of this signal moves the manipulator to the home position.
Program No. selection (2^0, 2^1, 2^2 and 2^3)	Input of this signal specifies the program to load at input of START (to execute a program). (For further details, refer to SPEL III Reference manual for “PRGNO command.”)
MCAL	Input of this signal executes calibration.
Motor Power ON	Input of this signal turns the motor power ON.
Motor Power OFF	Input of this signal turns the motor power OFF.

* The validity of the input signal depends on the console settings or the selected mode. Refer to “7.3 Valid/invalid input signals” in this chapter.

REMOTE3 Output Signal Functions

Signal name	Functions
RESET	This signal is output when the robot controller is in the reset state. Make sure that this signal is being output and that the START output signal is NOT being output when the following signals input to the REMOTE3: START, HOME, MOTOR ON, MOTOR OFF, MCAL and Program No.
PAUSE	This signal is output while execution of a program is on hold. Execution of a program will be put on hold at the input of PAUSE input signal and, the robot will stop operating. When the pause process completes, this PAUSE output signal will be output.
START	This signal is output when the robot controller is either executing a program or undertaking a command. Make sure that this signal is NOT being output and that the RESET output signal is being output when the following signals input to the REMOTE3: START, HOME, MOTOR ON, MOTOR OFF, MCAL and Program No.
HOME	This signal is output when the manipulator is in the home (standby) position.
Program No. selection (2^0, 2^1, 2^2, 2^3)	This signal outputs the program number loaded in the main memory.
MCAL	This signal is being output during calibration (while MCAL is being executed.)
Motor Power ON	This signal is output when the motor power is ON.
Error	This signal is output when an error occurs. This signal turns OFF at the input of RESET when the error is canceled.
Emergency Stop	This signal is output in the emergency stop state.
Safety Door	This signal is output when the Safety Door is open.
AUTO Mode	This signal is output when AUTO mode is selected.
TEACH Mode	This signal is output when TEACH mode is selected.

* The console settings or mode selection is irrelevant to output of any of the above output signals.

7.3 Valid/Invalid input signals

The validity of input from REMOTE3 and operating unit OPU-300 or OPU-320 in each mode changes as shown below depending on such conditions as the setup of software switch SS1 and the console selection.
In the case of REMOTE3, input is invalid if the remote has not been set up.

Functions of bits 1 and 2 of software switch SS1.

Bit No.	Function	ON	OFF
SS1-1	Selection of the remote	REMOTE3 (I/O)	REMOTE2 (OPU-300/OPU-320)

:Factory settings (standard specification)

TEACH mode
Console is TEACH port

In TEACH mode the console is the teaching pendant TP-320 or a personal computer connected to TEACH port. In this case all inputs from the remotes are invalid regardless of the setting of SS1.

		SS1-1 software switch setting	
		OFF	ON
Input from REMOTE3	RESET input	-	-
	PAUSE input	-	-
	START input	-	-
	HOME input	-	-
	Program number input	-	-
	MCAL input	-	-
	Motor power on input	-	-
	Motor power off input	-	-
Input from REMOTE2 (Input from OPU-300/OPU-320)	RESET input	-	-
	PAUSE input	-	-
	START input	-	-
	HOME input	-	-
	Program number input	-	-
	MCAL input	-	-
	Motor power on input	-	-
	Motor power off input	-	-

- : Invalid

AUTO mode
Console is REMOTE3 or operating unit

In AUTO mode, when you use the CONSOLE command to select “OP” as the console, the remote which was specified by software switch SS1-1 is the console. All input from the remote that was selected as the console is valid.

		SS1-1 software switch setting	
		OFF	ON
Input from REMOTE3	RESET input	-	V
	PAUSE input	-	V
	START input	-	V
	HOME input	-	V
	Program number input	-	V
	MCAL input	-	V
	Motor power on input	-	V
	Motor power off input	-	V
Input from REMOTE2 (Input from OPU-300/OPU-320)	RESET input	V	-
	PAUSE input	V	-
	START input	V	-
	HOME input	V	-
	Program number input	-	-
	MCAL input	V	-
	Motor power on input	V	-
	Motor power off input	V	-

V : Valid

* : Only restart after a pause is valid

- : Invalid

AUTO mode
Console is RS-232C

In AUTO mode, when you used the CONSOLE command to select either "#20" or "#21" of RS-232C as the console, the device connected to the port that you selected is the console. In this case nearly all input from the remote is invalid. Only PAUSE and START input signals can be made valid by software switch SS1.

		SS1-1 software switch setting	
		OFF	ON
Input from REMOTE3	RESET input	-	-
	PAUSE input	-	V
	START input	-	*
	HOME input	-	-
	Program number input	-	-
	MCAL input	-	-
	Motor power on input	-	-
	Motor power off input	-	-
Input from REMOTE2 (Input from OPU-300/OPU-320)	RESET input	-	-
	PAUSE input	V	-
	START input	*	-
	HOME input	-	-
	Program number input	-	-
	MCAL input	-	-
	Motor power on input	-	-
	Motor power off input	-	-

V : Valid
* : Only restart after a pause is valid except when the [Esc] key was used to initiate a pause.
- : Invalid

RESET, PAUSE and START input

RESET, PAUSE, and START input is possible as shown in the table below depending on the implementation of the program. Other signals can only be input when the program is not being executed.

	When program is not being executed	During execution of program	During pause
RESET input	○	×	○ (interrupt)
PAUSE input	×	○	×
START input	○	×	○ (continue)

7.4 Timing charts

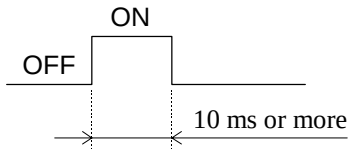
Response timing for REMOTE3 input signals is basically as follows. Signals input from REMOTE1 and REMOTE2 are also shown.

Input signal	Input remote
Safeguard input	REMOTE1
AUTO mode input	REMOTE2
TEACH mode input	REMOTE2

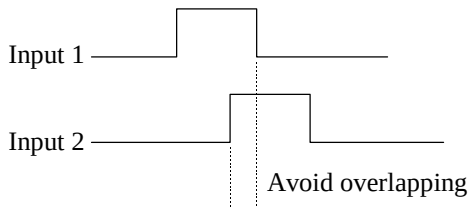
Notes regarding input signals

- The timing charts and the times referred to in the explanation of the timing charts should be considered guidelines. Actual times differ depending on such things as the number of tasks started up and the commands being executed.
  Do not input signals until after you have checked the output condition of the remotes and determined that the signals can be input.
  The time figures and wavelengths in the timing charts are not proportional.

- Use pulse input for all input signals except those using switches, such as the AUTO/TEACH mode switch, emergency stop input and safeguard input. The controller detects the rise of input signals. Set the pulse width of input signals to 10ms or more.



- Avoid overlapping remote input whenever possible.



- Avoid chattering input whenever possible.

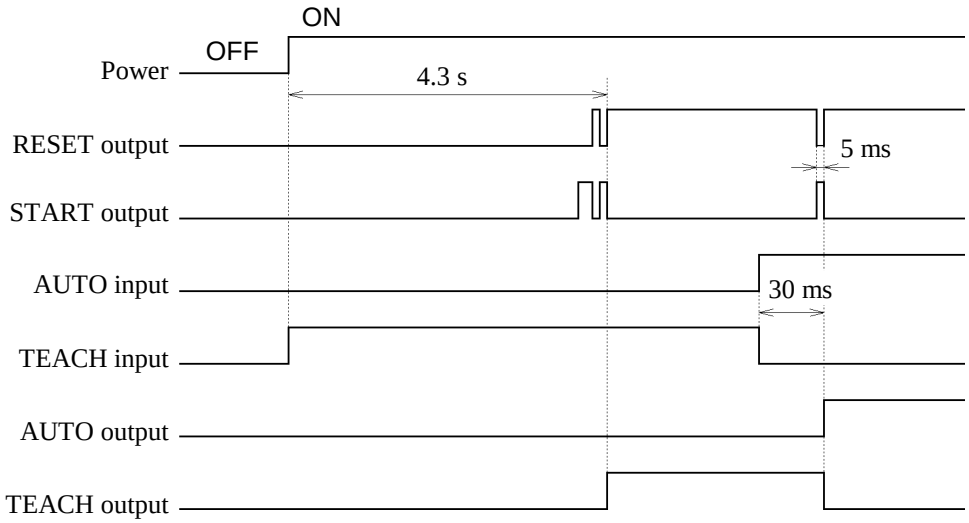
The timing chart when power is turned ON

Initialization inside the controller is finished and RESET output is turned ON 4.3 seconds after power is turned ON. From this point on, output from each remote is possible. Just before completion of initialization, RESET/START output turns ON/OFF momentarily.

When you switch modes in the RESET state, the new mode's output is turned ON and the earlier mode's output is turned OFF after 30ms. When mode output switches, START output turns ON momentarily.
In the example below is of switching from TEACH to AUTO.

The signals below can be input regardless of the mode, but other signals can be input only in AUTO mode. Input it only after you have confirmed that it is in AUTO mode.

- Mode switch
- Safeguard
- Emergency stop
- Restart from pause (except when pause was initiated by using the [Esc] key)



Timing chart for motor power ON, etc.

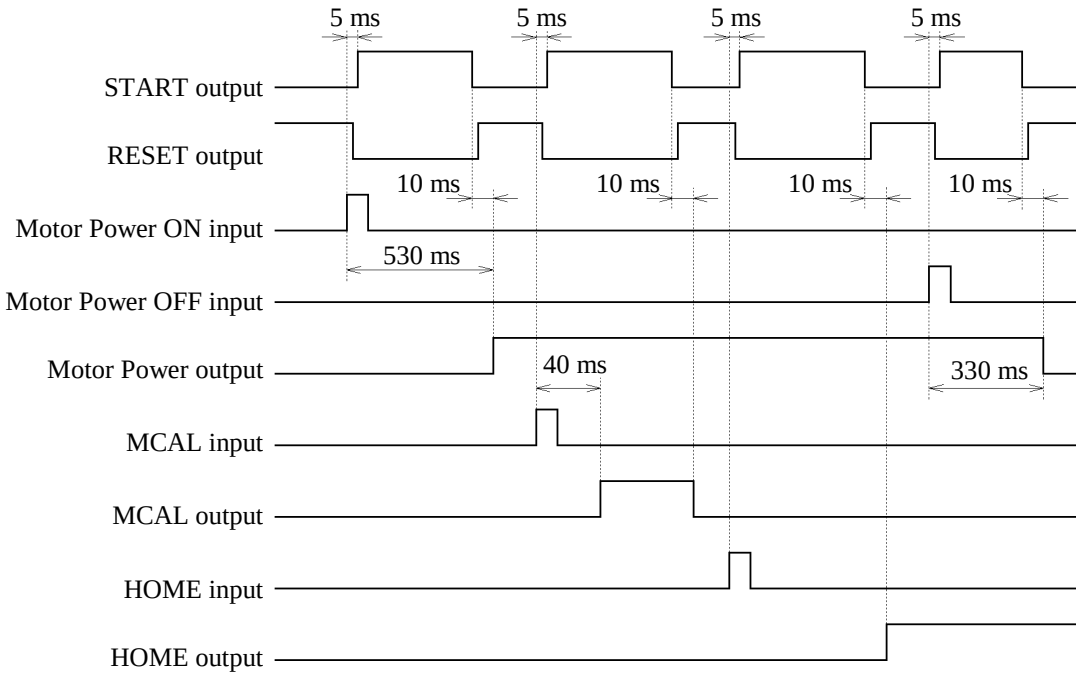
When RESET output is ON and the signals shown in the chart below are input, START output turns ON and RESET output turns OFF. After this input is executed, START output turns OFF and RESET output turns ON.

When Motor Power ON is input, Motor Power output turns ON after 530ms. After this it is possible to input MCAL and HOME, which command the robot to operate. If these are input when the motor power is OFF, an error occurs.

When MCAL is input, MCAL output turns ON in 40ms. After MCAL operations are completed, MCAL output turns OFF.

When HOME is input, the robot moves to the set standby position. While the robot is positioning itself in the standby position, HOME output is ON.

When Motor Power OFF is input, Motor Power output turns OFF in 330ms.



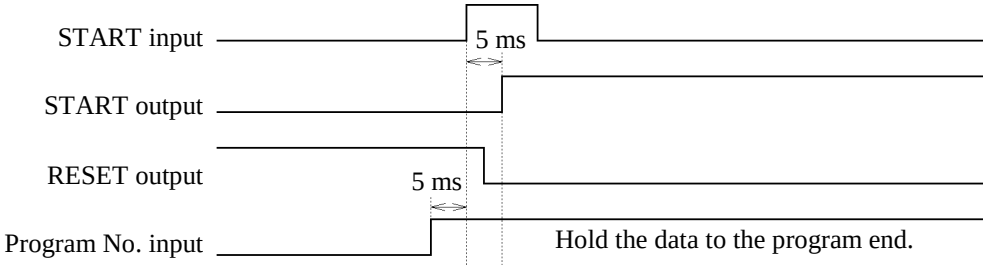
Timing chart for program execution

START input

RESET output turns OFF and START output turns ON 5ms after the input of START while at the RESET state.

In case of specifying the program No. by binary code:
Turn ON the Program No. within 5ms before START input and hold it while the program is executed. (The Controller must be at the RESET state.) The program No. input will be ignored if entered when the Controller is not at RESET state.

If the binary code specifies zero (0), that means to designate the program and the position data already in the main memory.



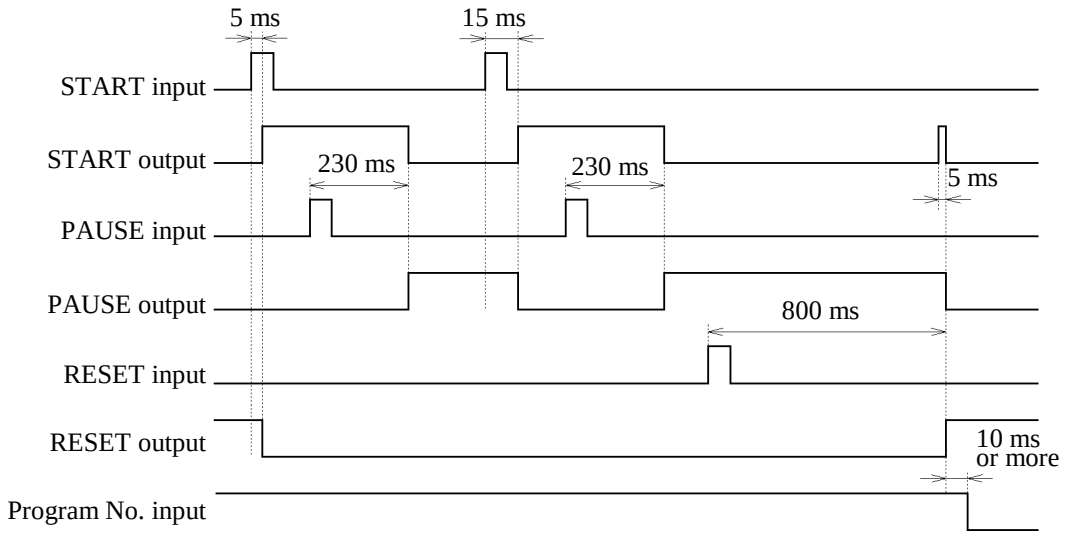
PAUSE input and RESET input

PAUSE output turns ON and START output turns OFF 230ms after input of PAUSE, but only when the QP command is ON. When the QP command is OFF, PAUSE output will not turn ON until the arms are stopped.

Once there is PAUSE input, it requires at least 230ms before input of START. START output will be ON 15ms after the START input (for restarting) and, the PAUSE output will turn OFF.

When RESET is input during the PAUSE state, it takes 800ms for RESET output to turn ON and PAUSE output to turn OFF. There is a brief output of START immediately before the RESET operations are to be completed.

In order to turn OFF the Program No. input, it would have to be at least 10ms past after RESET output is turned OFF.

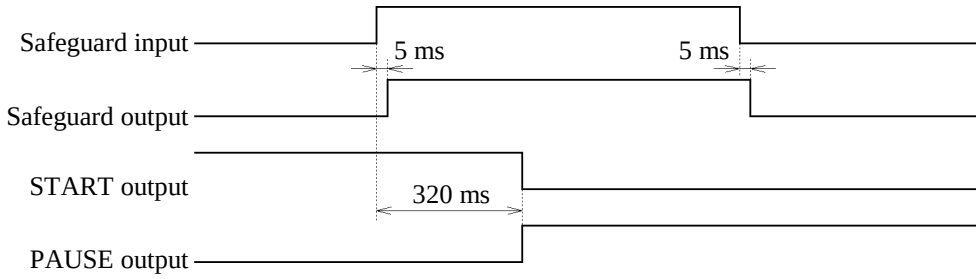


Timing chart for safeguard input

Safeguard output turns ON 5ms after the input of Safeguard while at the START state. After 320ms, PAUSE output turns ON and START output turns OFF.

The PAUSE state is maintained while the Safeguard input is ON (the “Safeguard open” is latched).
Safeguard output turns OFF 5ms after the Safeguard input turns OFF (when the safety door is closed). Close the safety door (to turn OFF the input of Safeguard) and turn ON the Latch Release input to restart.

While PAUSE output is ON, RESET can be input.

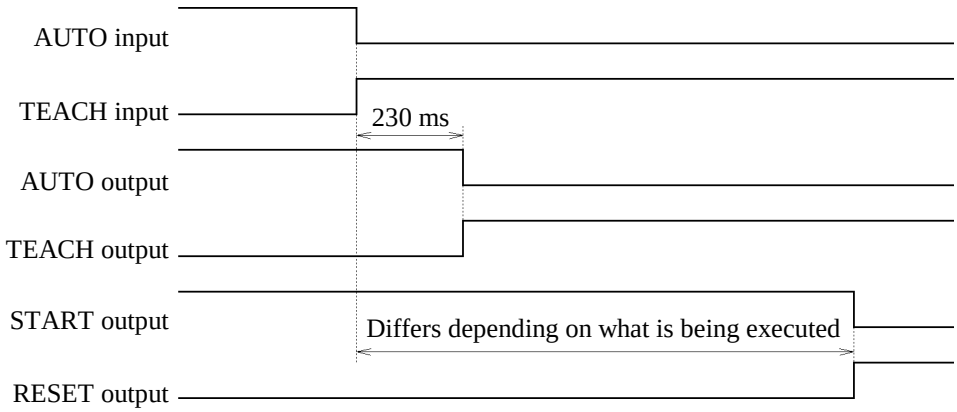


Timing chart for TEACH mode and AUTO mode

Regardless of whether operating in TEACH mode or AUTO mode, if you switch modes during execution, there will be a pause and then the controller will be reset. The charts below show a switch to TEACH mode when AUTO mode was operating.

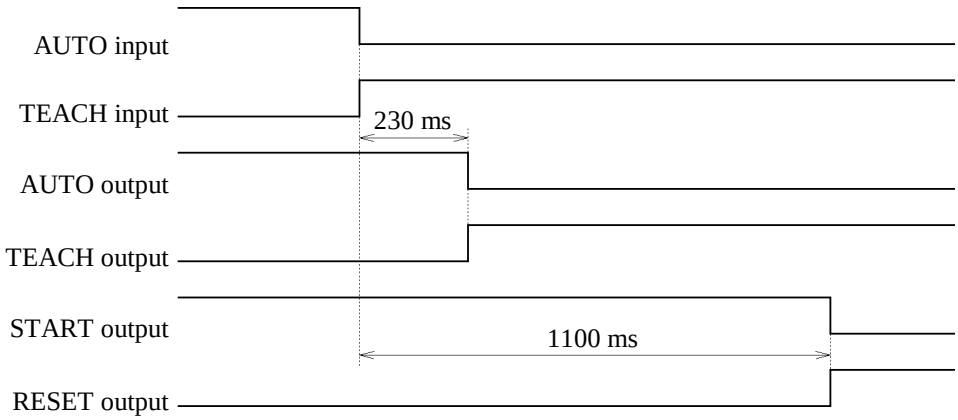
Switching modes in the START state

It takes 230ms for mode output to switch when you switch modes in the START state.
Timing for RESET output to come ON differs depending on what is being executed at the time.
Immediately prior to completion of RESET operations, START/RESET output turns ON/OFF momentarily.



Mode switching in the PAUSE condition

When there is a mode switch in the PAUSE state, mode output switches after 230ms and RESET output turns ON after 1100ms. Immediately prior to completion of RESET operations, START/RESET output turns ON/OFF momentarily.



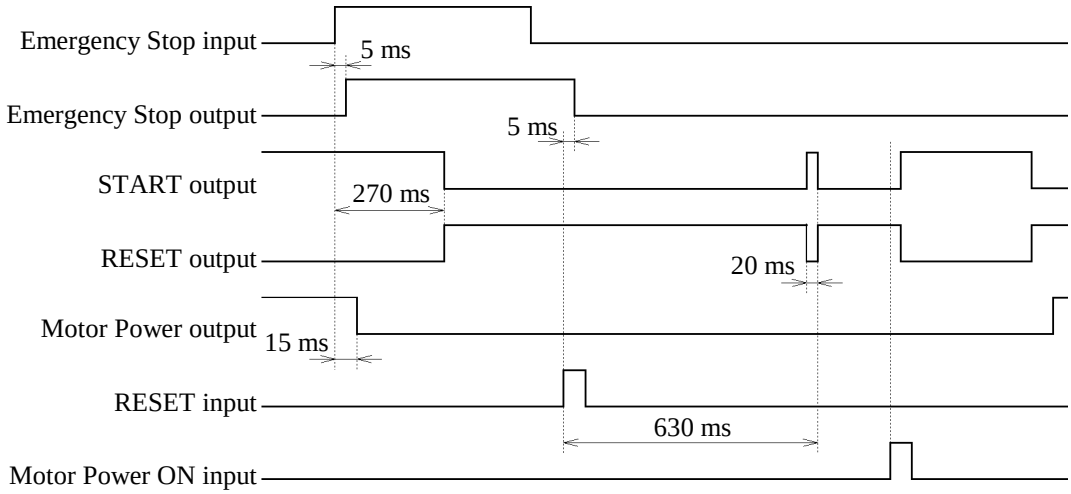
Timing chart for emergency stop

Emergency Stop input can be input at any time. During the emergency stop state only RESET input for canceling the emergency stop can be input.

Emergency Stop output turns ON 5ms after Emergency Stop is input. In 270ms, START output turns OFF and RESET output turns ON.

Emergency Stop output turns ON 5ms after RESET is input when in the emergency stop condition. START output turns ON momentarily just before completion of RESET operations.

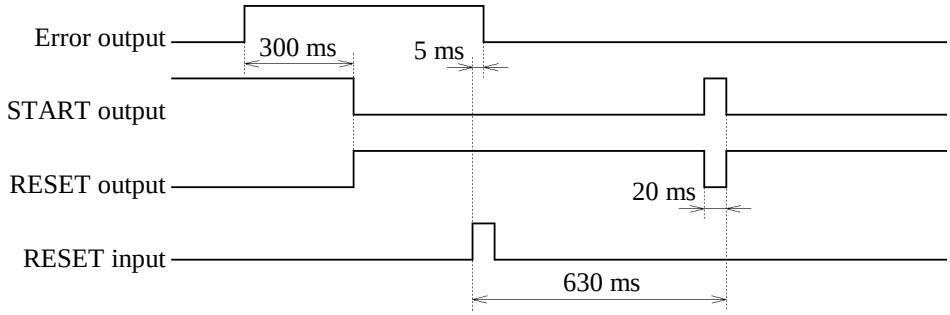
After RESET input, at least 630ms are necessary before other input can be made. In the chart below, Motor Power ON input is used as an example.



Timing chart for errors

RESET output turns ON and START output turns OFF 300ms after an error occurs in the START state. Relevant output also turns off depending on what is being executed and what kind of error occurred.

RESET input is sometimes necessary to cancel the error state. Error output turns OFF 5ms after RESET is input. START output turns ON momentarily just before completion of RESET operations. At least 630ms are necessary after PAUSE input before other input can be made.



8. RS-232C

The standard controller is equipped with 2-channel RS-232C so that you can connect peripheral equipment or a host computer to the robot and perform data communications and centralized control.

8.1 Communications cable

A communications cable is not supplied.
Use 9-pin D-sub connector for the communications cable.
Use shielded twisted-pair leads for the cable. Clamp the shield to the hood as a noise countermeasure. (See “2.6 Noise countermeasures” in this volume.)

Pin assignments

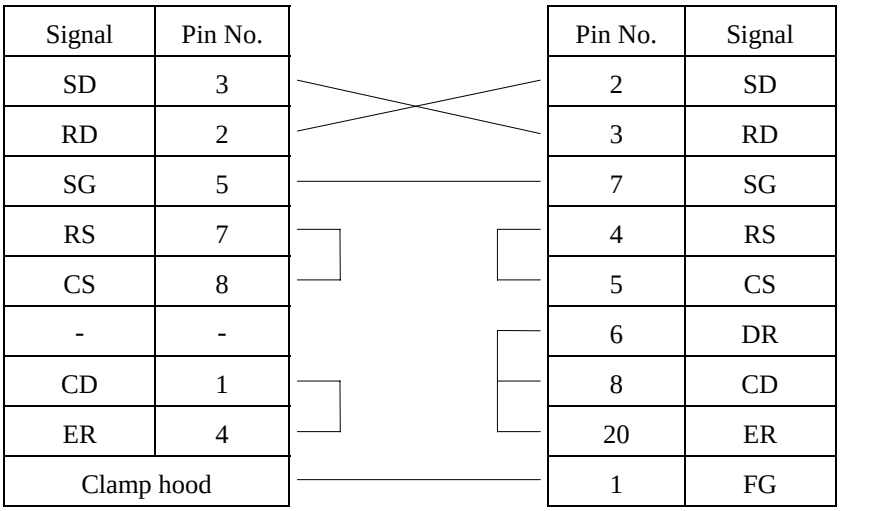
The pin assignments of the RS-232C connectors are as follows:

Pin No.	Notation	Signal	Signal direction
1	CD	Carrier detection	Input
2	RD	Receive data	Input
3	SD	Send data	Output
4	ER	Data terminal ready	Output
5	SG	Signal ground	
6	-		
7	RS	Required send	Output
8	CS	Clear to send	Input
9	-		

Wiring example

A common wiring example is shown below.

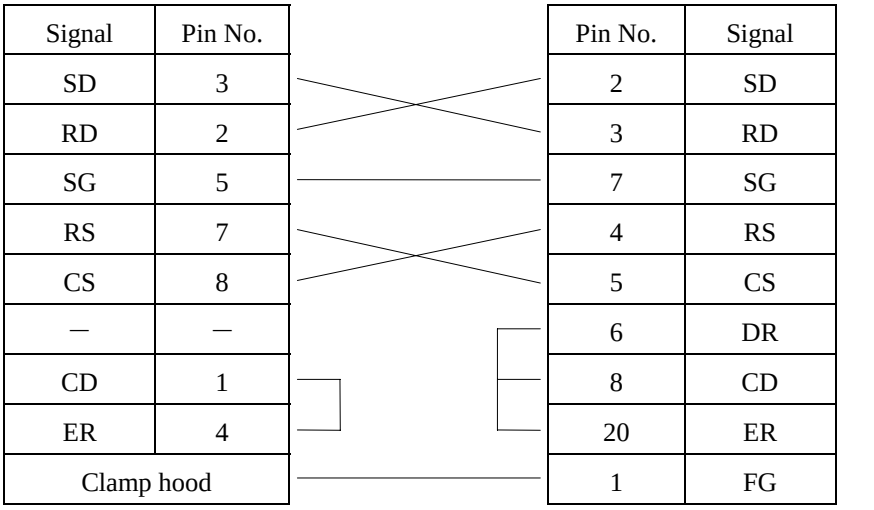
[Controller] [Connected equipment connector]



Signal	Pin No.		Pin No.	Signal
SD	3		2	SD
RD	2		3	RD
SG	5		7	SG
RS	7		4	RS
CS	8		5	CS
-	-		6	DR
CD	1		8	CD
ER	4		20	ER
Clamp hood			1	FG

The following example is for CS control.
Because the controller does not perform RS control, it cannot control transmissions from the connected equipment.

[Controller] [Connected equipment connector]



Signal	Pin No.		Pin No.	Signal
SD	3		2	SD
RD	2		3	RD
SG	5		7	SG
RS	7		4	RS
CS	8		5	CS
—	—		6	DR
CD	1		8	CD
ER	4		20	ER
Clamp hood			1	FG

* In this example, controller-side CS input uses RS output of the connected equipment. Wire as appropriate in accordance with the specifications of the connected equipment.

8.2 Communication preparations

To communicate using the controller and connected equipment, it is necessary to make the communication method (configuration) of both RS-232C ports the same. You must use the CONFIG command to set the following:

- Transmission speed (baud rate)
- Character bit number
- Parity
- Stop bit number
- Communication protocol
- XON/XOFF control
- CS control

The standard controller has two RS-232 ports, #20 and #21. You can determine the configuration of both ports. Which channel you use is determined by specifying that port number (#20 or #21). See the manuals that came with the equipment that you connect for information on configuration settings.

There are two basic commands that you use for communication: PRINT # and INPUT #.

PRINT #	data output from the controller
INPUT #	data input from the connected equipment

See the SPEL III reference manual for details about commands.

9. Switch Types and Jumper Pin Set Up

Many settings are necessary to use the robot's functions correctly. Here, we explain the settings of the MPU board's jumper pins and DIP switches as well as of software switches. You do not need to change the settings, as they have been correctly set at the factory on the basis of your specifications. Careless changes to these settings could cause system failure. Only when specification changes occur after the robot was delivered you should attempt to reset the switches, only in strict adherence to the instructions below.

After you set up the DIP switches and software switches, turn on the controller power. Turning on the controller power activates the settings.

You can display the current settings of the DIP switches and software switches using SPEL Editor or SPEL for Windows. See those manuals for details.

The shaded cells in the tables below are standard factory settings. Please be careful not to change the settings of bits which are shown as "(Reserved for system)."

9.1 MPU board DIP switches

DIP switches SD1 to 3 are located on the MPU board. Their functions are shown below.

SD1

Bit No.	Function	ON	OFF
1	System initialization	Initializes control data of CPU when power is turned on	Does not initialize
2	(Reserved for system)	-	(Always OFF)
3 to 8 (A to E)	Setting of model of manipulator	Please do not change these settings	

SD2

Bit No.	Function	ON	OFF
1(M)	Use of additional RAM	Exists	Does not exist
2(V)	Sets capacity of main memory and file memory when additional RAM is installed	Main memory : 374KB File memory : 900KB	Main memory: 174KB File memory : 1.1MB
3	(Reserved for system)	-	(Always OFF)
4	(Reserved for system)	-	(Always OFF)
5(X)	Use of axis #1	Yes	No
6(Y)	Use of axis #2	Yes	No
7(U)	Use of axis #3	Yes	No
8(Z)	Use of axis #4	Yes	No

SD3

Bit No.	Function	ON	OFF
1 to 4	(Reserved for system)	-	(Always OFF)

9.2 Software switches

SD1 to 3 are hardware switches. Switches that you set using software are called “software switches.” Controller has six such software switches, SS1 to 6. You set them from a personal computer. The functions of these software switches are shown below. See the programming support software manual for details on setting software switches.
The setting of bits that are labeled “(Reserved for system)” cannot be changed.

Software switch settings are saved even when power is turned off, but they are initialized at the system initialization by MPU board DIP switch SD1-1 and all assume the OFF state.

SS1

Bit No.	Function	ON	OFF
1	Selection of the remote	REMOTE3 (I/O)	REMOTE2 (operating unit)
2	(Reserved for system)	-	(Always OFF)
3	(Reserved for system)	-	(Always OFF)
4	(Reserved for system)	-	(Always OFF)
5	Execution of ON/OFF commands when safeguard is open in AUTO mode	Disabled	Enabled
6	Processing of output port during emergency stop	Save	Reset

7	Message language selection	OFF	Japanese	ON	English	OFF	German	ON	-
8		OFF		OFF		ON		ON	

SS2

Bit No.	Function	ON	OFF
1 to 8	(Reserved for system)		

SS3

Bit No.	Function	ON	OFF
1 to 8	(Reserved for system)		

SS4

Bit No.	Function	ON	OFF
1 to 8	(Reserved for system)		

SS5

Bit No.	Function	ON	OFF
1	Range check of HOFS value	Not performed	Performed
2	U coordinate conversion of LOCAL command	Teaching data dependent	XY coordinate value dependent
3	(Reserved for system)	-	(Always OFF)
4	(Reserved for system)	-	(Always OFF)
5	(Reserved for system)	-	(Always OFF)
6	CMOVE, CARC command operation	Passes near the specified point	Passes through the specified point
7	(Reserved for system)	-	(Always OFF)
8	(Reserved for system)	-	(Always OFF)

SS6

Bit No.	Function	ON	OFF
1	Execution of SFREE command to axis #4	Disabled	Enabled
2	Execution of SFREE command to axis #3	Disabled	Enabled
3	Execution of SFREE command to axis #2	Disabled	Enabled
4	Execution of SFREE command to axis #1	Disabled	Enabled
5	Execution of operation command when there is a non-excitation axis	Enabled	Disabled
6	(Reserved for system)	-	(Always OFF)
7	(Reserved for system)	-	(Always OFF)
8	(Reserved for system)	-	(Always OFF)

9.3 MPU board jumper pins

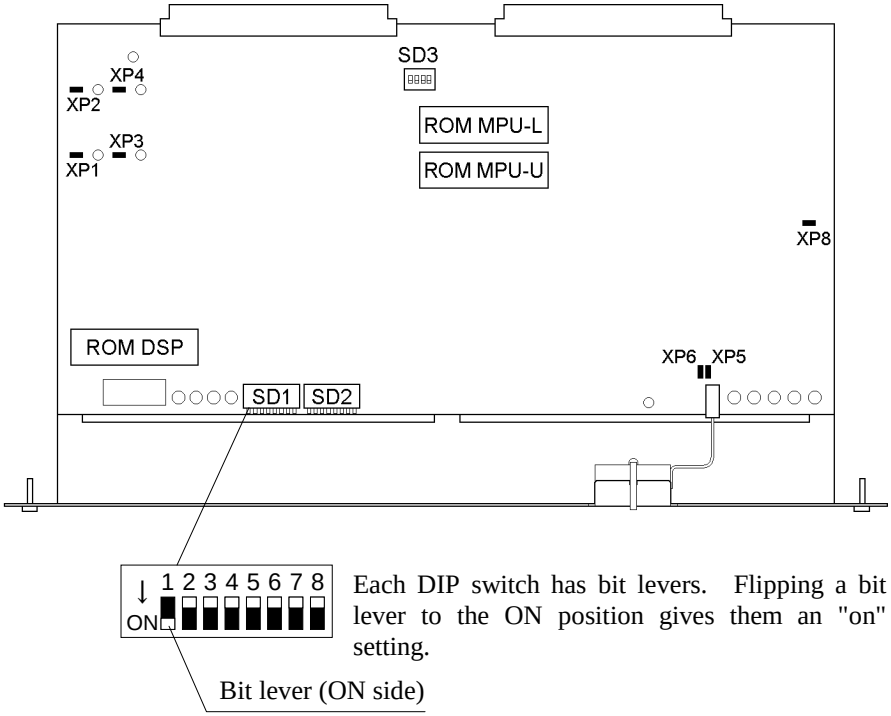
There are seven jumper pins on the MPU board. However, only XP6 can be set by such things as specification changes.

NOTE ☞ Never change the settings of other jumper pins, as doing so may interfere with the functions of the robot.

Pin No.	Function	Setting
XP1 to 4	(Reserved for system)	(Differs by model)
XP5	Backup power supply	Jump
XP6	Backup power supply for additional RAM	Jump when there is additional RAM
XP7	(Reserved for system)	Normally, jump between 2 - 3

9.4 Locations of DIP switches and jumper pins on MPU board

The position of the DIP switches and jumper pins (XP) on the MPU board are shown in the figure below.



Each DIP switch has bit levers. Flipping a bit lever to the ON position gives them an "on" setting.

Bit lever (ON side)

NOTE

Follow the steps described in “7. MPU board” in Maintenance volume herein when you pull out the MPU board.

10. Options

The following options have their own manuals. Please see the each manual for details.

- Operating unit : OPU-300 or OPU-320
- Teaching unit : TP-320
- Programming support software : SPEL Editor
  : SPEL for Windows
- Pulse generating board (be installed in controller)

Here, we explain the options that can be installed in the controller except above items. Please adhere closely to the following instructions and install options correctly if you want to change the specifications of your robot controller by yourself.

10.1 Option types and board current consumption

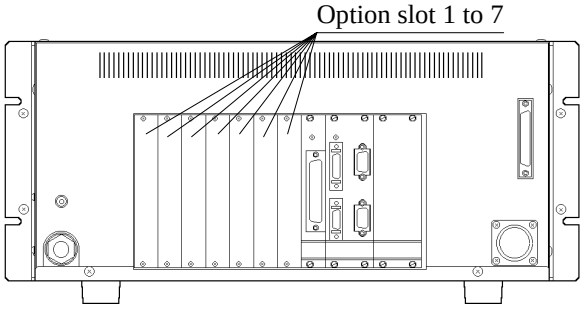
The table below lists the options that can be installed inside the controller. You can install any of the options, with the exception of additional RAM, by inserting a board into the option slot (OP slot) on the rear panel.

Option	Board current consumption
Additional I/O board	250mA
Additional RAM	-
Additional RS-232C board	250mA

The combined current capacitance of all option slots is approximately 3A (+5V).
The total board current consumption of options must not exceed this value. The required power supply at each input/output of I/Os is 24V. This is different from the board power supply of option slots.

The steps to install a board in option slot is as follows.

1) Turn the controller off.
2) Loosen the two fixing screw of a plate which covers option slot and remove the plate. You can use any board with any of the available option slots.
3) Firmly insert the option board until the mounting bracket touches the rear panel.
4) Fasten the mounting bracket with the two screws. Be sure to tighten the two screws.



10.2 Additional I/O board

The standard controller has 16 I/Os, but you can increase this number up to 128 I/Os. Additional I/Os come in units of 16 (16 inputs/16 outputs). The following parts are required for additional I/Os.

Please make certain that you get all parts at the time of purchase.

- I/O board 1
- 50-pin D-sub I/O connector 1 set
- Label sheet 1

Please follow the steps below to install additional I/Os.

1) Turn off the controller.
2) Peel the connector number label from the label sheet and affix it to the handle of the I/O board.
3) Set the I/O board's DIP switches.
   To identify I/O boards, set DIP switch SD1 on each board in accordance with the following table.

Connector No.	I/O number	ON bits
I/O-1	0 to 15	None
I/O-2	16 to 31	1
I/O-3	32 to 47	2
I/O-4	48 to 63	1,2
I/O-5	64 to 79	3
I/O-6	80 to 95	1,3
I/O-7	96 to 111	2,3
I/O-8	112 to 127	1,2,3

4) Insert the board into the option slot and secure it.
   See the "6.4 Pin assignment of I/O (PNP type)" or "6.8 Pin assignment of I/O (NPN type)" in this volume for information on setting up connector signals.

10.3 Additional RAM

Standard file memory is 100KByte. You can expand file memory to 1.1MByte by adding two RAM modules. You can also set DIP switches to expand main memory if you are unable to run a long program on the standard main memory alone.

Follow the steps below when installing additional RAM.

1) Before installation:
   Back up all files in file memory before attempting to install additional RAM. To use the additional RAM, you must perform a formatting operation which erases all files in the controller's file memory. Make backups of files from the personal computer. See SPEL Editor or SPEL for Windows manual for details.

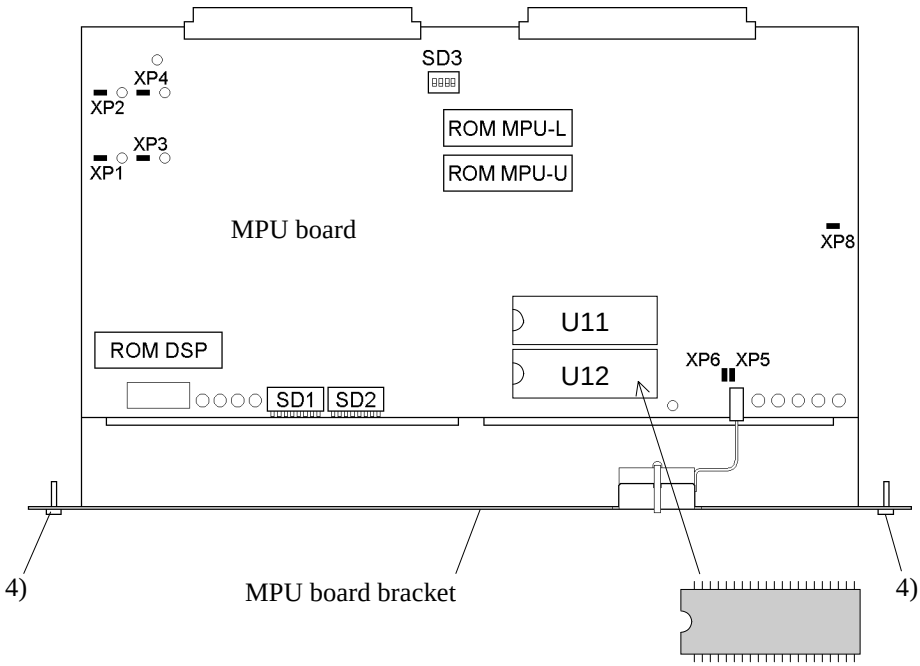
2) Turn off the controller power, and then unplug the power plug from power source so that the controller is locked out.

3) Remove the four front panel mounting screws and take off the front panel.
   On the inside of the front panel, there is a cooling fan. Do not pull hard when taking off the front panel, as it is connected to the inside by a cable.

4) The MPU board is fastened with a screw on the right and left. Loosen the two screws. Do not pull out the screws because it will drop the nuts into the controller.

5) Hook your finger on the board bracket and pull the board out.

6) Install two RAMs on the MPU board into sockets U11 and U12. Be careful to always try to keep from touching any of the components. Be careful with the direction of RAM. See the drawing below.



SRAM type × 2 pcs.

7) Plug the jumper socket into jumper pin XP6. (Use one of 5 jumper sockets which are shipped with controller.) By this jumper socket, the additional RAM module will be backed up by battery.

NOTE

Do not disassemble other jumper pins.

8) Setting DIP switches
Flip bit 1 of DIP switch SD2 on the MPU board to the ON position. Also flip bit 2 to the ON position when you want to expand main memory.

SD2

Bit No.	Function	ON	OFF
1	Use of additional RAM	Used	Not used
2	Sets capacity of main memory and file memory when additional RAM is installed	Main memory: 374KB File memory : 900KB	Main memory : 174KB File memory : 1.1MB

9) Once DIP switches are set, reinsert the MPU board to the controller.
Insert MPU board in the specified slot horizontally and push it in firmly. Tighten fixing screws of mounting bracket of MPU board.

10) Attach the front panel to the controller and turn the controller on.

11) Formatting
Execute FORMAT/A. The file memory is formatted without erasing the current file memory contents. When/A is specified, you will be prompted as follows.

```
>FORMAT/A
RAM disk size adjust OK (Y/N)?
?
```

Then, if Y is entered, the file memory is formatted and contents size increases.

NOTE

When FORMAT is executed, the message may be displayed “Memory error !! address $xxxxxxxx”. If the address number, which starts with $, is $00080003 or $00099001, it means the dip switch SD2 on MPU board is set so that additional RAM is installed while it is not installed actually. Check if RAMs are installed correctly and execute FORMAT/A again. If other address is displayed, please contact the authorized distributor of our robot.

When you want to increase the size of main memory (when you set the bit 1 and 2 of SD2 to the on position), initialize memory by SYSINIT command. Executing SYSINIT clears all data in main memory; object program, backup variables, point data, and source program. Restore all of backed up data to main memory.

```
>SYSINIT
Program,Point,Backup Variable,Object all clear -> Ok?
?Y
```

See the SPEL III reference manual for details on these commands.

12) Restoring files

Return the files that you backed up earlier to the controller. See SPEL Editor or SPEL for Windows manual for details.

10.4 Additional RS-232C board

Two channels of RS-232C are on one board. Install the RS-232C simply by plugging the board into an option slot. (Refer to “10.1 Option types and board current consumption” in this chapter.) The board has DIP switch SD1 and jumper pin XP1. These have been correctly set at the factory, so please do not change them.

The addresses of the additional RS-232C are #22/#23. Connector pin assignments and compatible connector are the same as those for #20/#21. See “8. RS-232C” in this volume for details.

The additional addresses, #22/#23, are for general communications. You cannot use the CONSOLE command to specify them as the console in AUTO mode.
Please use either #20 or #21 when you want to make the RS-232C the console.

For your reference, settings of DIP switch SD1 and jumper pin SP1 are shown

DIP switch SD1 : All bits off
Jumper pins XP1-A to H : see the table below

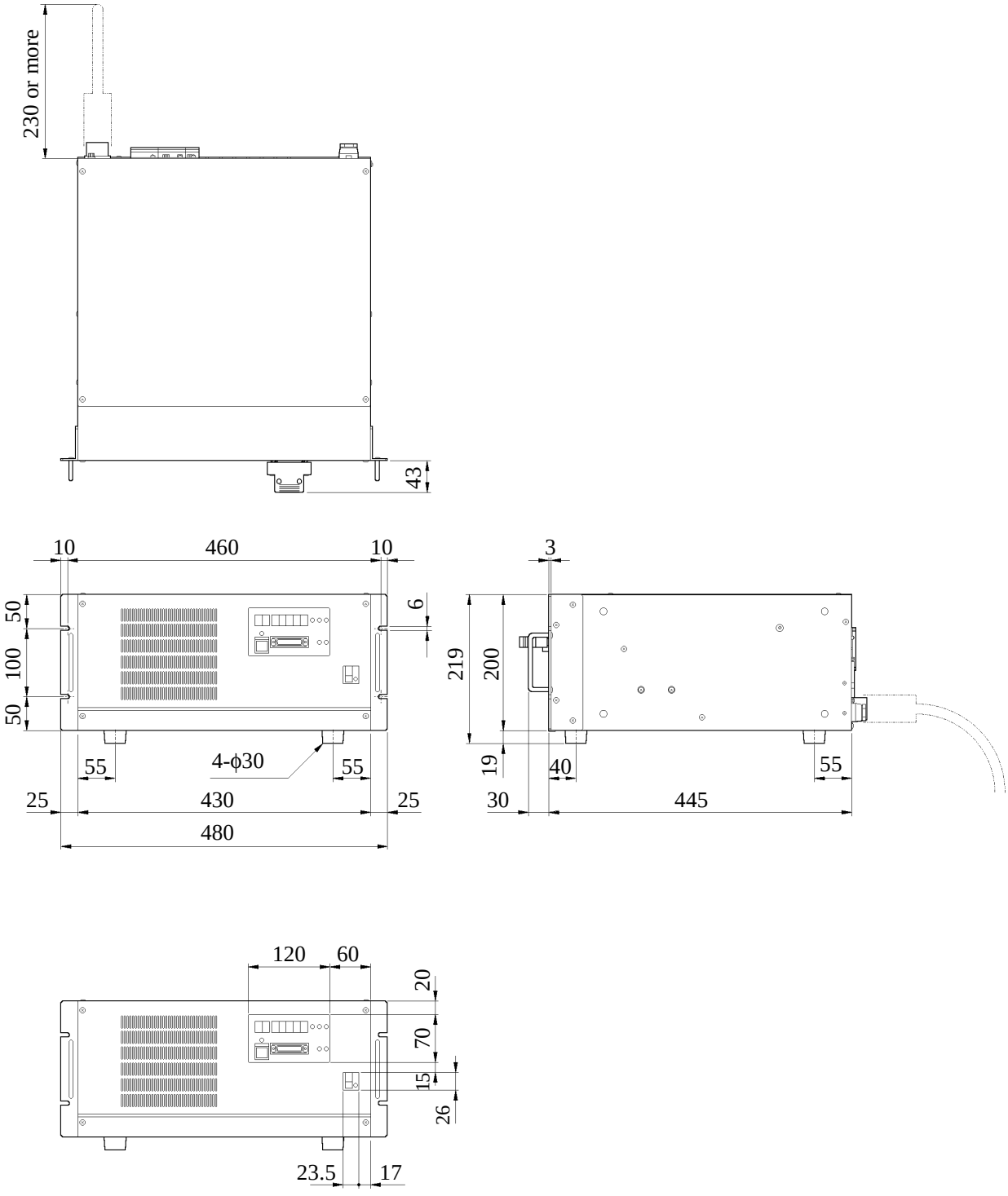
Number	Setting
XP1-A	Jump 2 and 3
XP1-B	Jump 2 and 3
XP1-C	Jump 2 and 3
XP1-D	Jump 2 and 3
XP1-E	Jump 2 and 3
XP1-F	Open
XP1-G	Open
XP1-H	Open

11. Specifications

11.1 Standard specifications

Model name	SRC-320		
Control method	4 axis simultaneous software, AC servo control		
	Speed control	1 to 100 % programmable	
	Accelera-tion/Decel-eration control	1 to 100 % programmable Automatic acceleration	
Positioning control	Point-to-point control, Continuous path control		
CPU	32 bits (68EC020)		
Memory media	RAM disk	(Backed up by lithium battery) (Battery life: 5 years in normal temperatures)	
Memory capacity	Program area	64KByte	
	Point data area	200 points	
	File memory	100KByte	
Programming language	Multi-task robot language SPEL III Ver. 6		
Teaching method	Remote teaching	Teaching by jog key	
	Direct teaching	Teaching by moving robot arm directly by operators	
	MDI (Manual Data Input) teaching	Teaching with numerical position data	
I/O	Input	16 inputs	(photo coupler)
	Output	16 outputs	(power MOS FET)
	Connector	50-pin D-Sub	1 pcs.
Interface	RS-232C	2 channels	(#20, #21)
Weight	24kg (standard)		
Dimensions	Refer to “11.2 Outer dimensions” on next page		
Power requirement	AC 200 to 230V ±10% Single phase, 50/60Hz		
Max. power consumption	1400W max. (differ with manipulator models)		
Safety functions	Emergency stop switch Enable switch Dynamic brake Overload detection Motor lock detection Mode switch with key Low power mode Control power source irregularity detection Primary power source irregularity detection Temporary stop through input form safeguard	CPU irregularity detection Servo overflow detection Overheating detection Encoder discontinuity detection Speed irregularity detection Torque irregularity detection Memory irregularity detection	
Insulation resistance	20MΩ or more (between line and ground)		
Environmental requirements	Momentary power interrupt	10 ms max.	
	Fast transient burst noise	less than 2000V	
	Electrostatic noise	less than 6kV	
	Temperature	5 to 40°C (with minimal variation)	
	Relative humidity	10 to 80 % (with no condensation)	

11.2 Outer dimensions (unit: mm)



Maintenance

The maintenance volume describes the maintenance procedure for each part in controller SRC-320.

1. Outline of Maintenance

1.1 Safety precautions on maintenance

Please carefully read this manual and other related manuals before performing any routine maintenance.

⚠ WARNING

- Only trained personnel should be allowed to operate, perform function testing, and maintain this robot and the robot system.
  Trained personnel are those who have taken a robot training course (held by the dealer on a regular basics) or those who have carefully read the manuals and have equivalent knowledge or skill.
- When you execute the maintenance work or the inspection of the controller, be sure to take the specified locking procedure for each robot system before starting the work. Do not touch the high voltage dangerous part to avoid an electric shock. Be sure to turn the power of the controller off, pull out the power plug from the power source and wait 2 minutes or more to discharge the capacitors before starting maintenance.
- Do not test the manipulator within the safeguard after replacing parts.
- Use proper maintenance parts for the robot controller. If incorrect parts such as for other controllers are used severe difficulties could be caused.
- All outer covers (panels) of the controller, the front panel, the rear panel and the upper cover, are connected to the protective bonding circuit with a yellow/green wire (grounding). If you need to open those covers (panels) and disconnect the wire to the protective bonding circuit during maintenance, be sure to reconnect it after the maintenance work.

⚠ CAUTION

- Temperature of AC servo driver unit and PSU (and regenerative brake unit) may rise depending on operation. Check the surface temperature before handling and use protective gloves if necessary.
- Do not take off any parts and units not described in this manual. Do not perform maintenance using different procedures that are described in this manual.

NOTE ☞ Backup all necessary programs, point data and robot system data before you start maintenance.

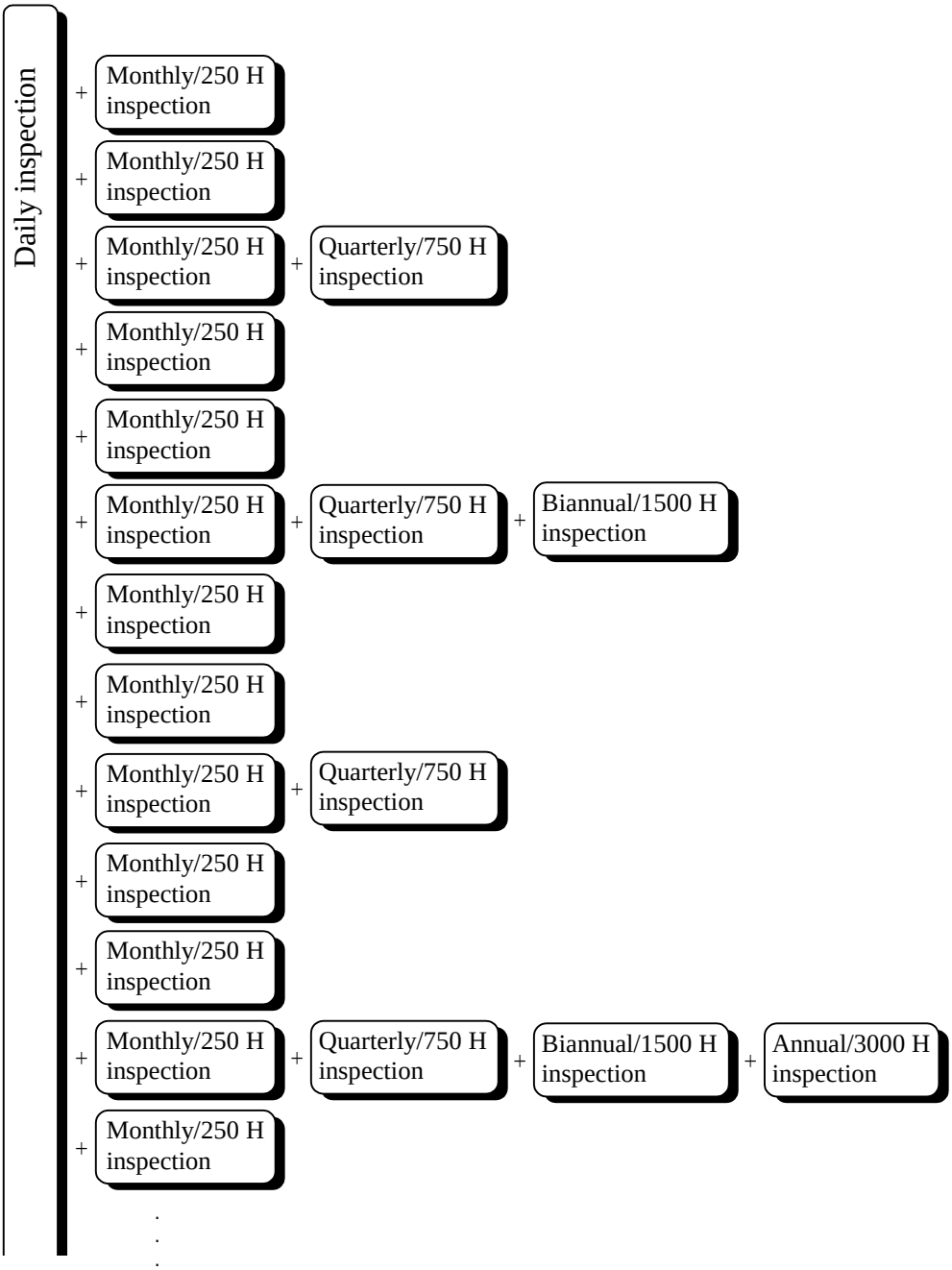
1.2 Maintenance schedule and inspections

Proper inspection steps are essential to prevent troubles and to maintain safety.
This section describes maintenance inspection schedule and procedure, so be sure to do inspection as follows:

Maintenance Inspection schedule

Inspection procedure is divided into such five stages as daily, monthly, quarterly, biannually and annually as each one is added.

However, if the robot is operated for 250 hours or longer per month, inspection schedule is different. In this case, each step of inspection should be added in every 250 hours, 750 hours, 1500 hours, and 3000 hours operation.



Inspections

Inspection while the power is OFF (Be sure to turn off the power.)

Inspection item	Point of inspection	Daily	Monthly	Quarterly	Biannual	Annual
Check looseness of connectors. If looseness is found, plug it in securely, or tighten.	External connectors on controller.			○	○	○
	Connectors on boards inside controller.					○
Visually check for external defect. Clean if necessary.	Boards inside controller.				○	○
Check clogging of controller filter.	Refer to “12. Cooling Fan” in this volume.		○	○	○	○
Storage condition of boards in controller.	Inside controller.				○	○

Inspection while the power is ON, or while manipulator is moving

Inspection item	Point of inspection	Daily	Monthly	Quarterly	Biannual	Annual
Check if each switch for stopping robot movement works properly or not.	Emergency stop switch on operating unit	○	○	○	○	○
	External emergency stop switch	○	○	○	○	○
	PAUSE switch on operating unit	○	○	○	○	○
	Expanded pause switch	○	○	○	○	○
Check if those switches function properly.	Other switches on operating unit				○	○
Check if interlock function properly.	Interlock with peripheral equipment	○	○	○	○	○
Check if safeguard switch functions properly.	Safeguard	○	○	○	○	○
Check motion range.	Motion range of each axis					○
Check disconnection by swinging cables.	External cables				○	○
Check if any malfunctions occur or not.	Strange sound and vibration during robot motion	○	○	○	○	○

2. Outline of Structure

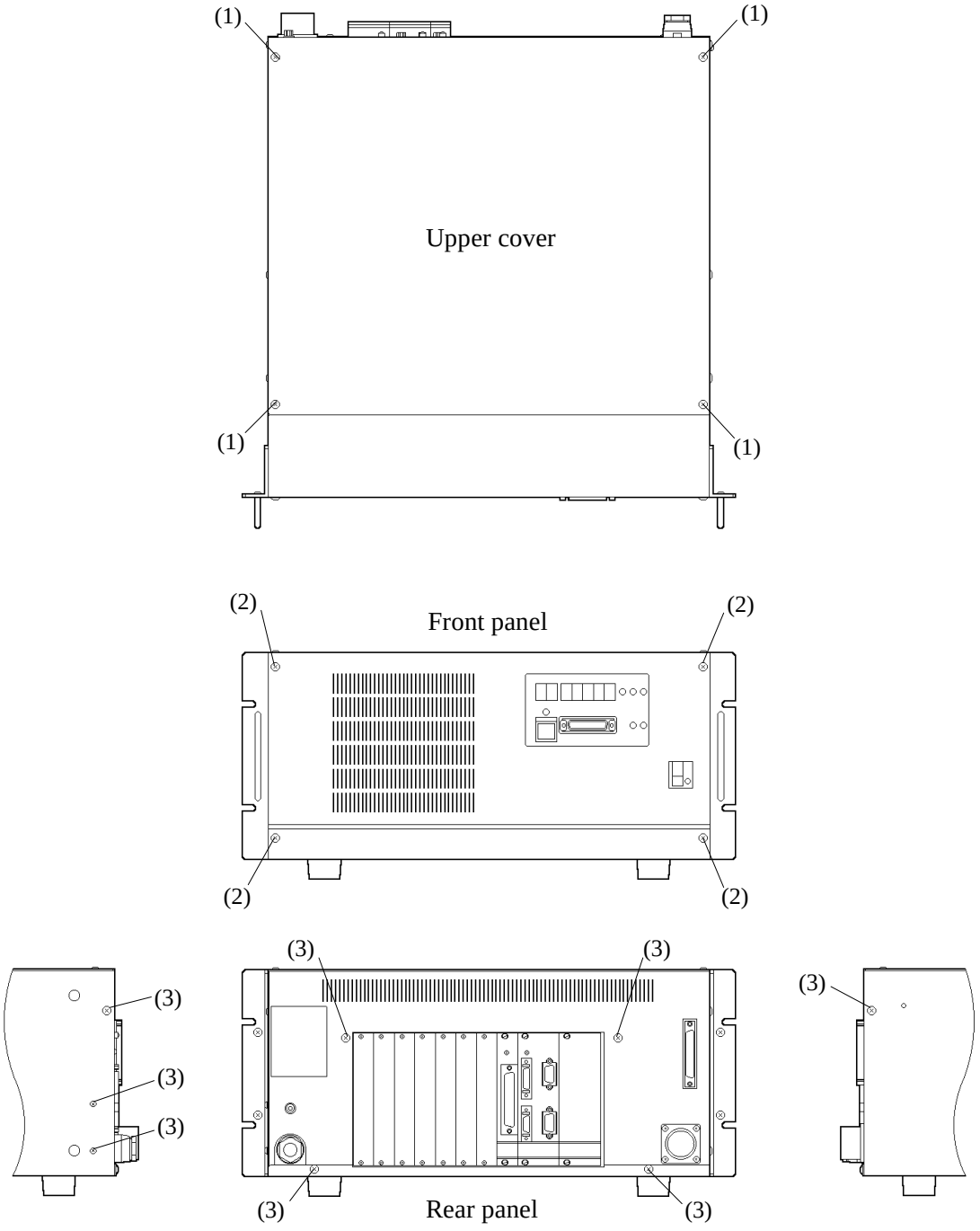
2.1 Fixing screws of panels

Covers of a controller can be taken off by loosening the following screws:

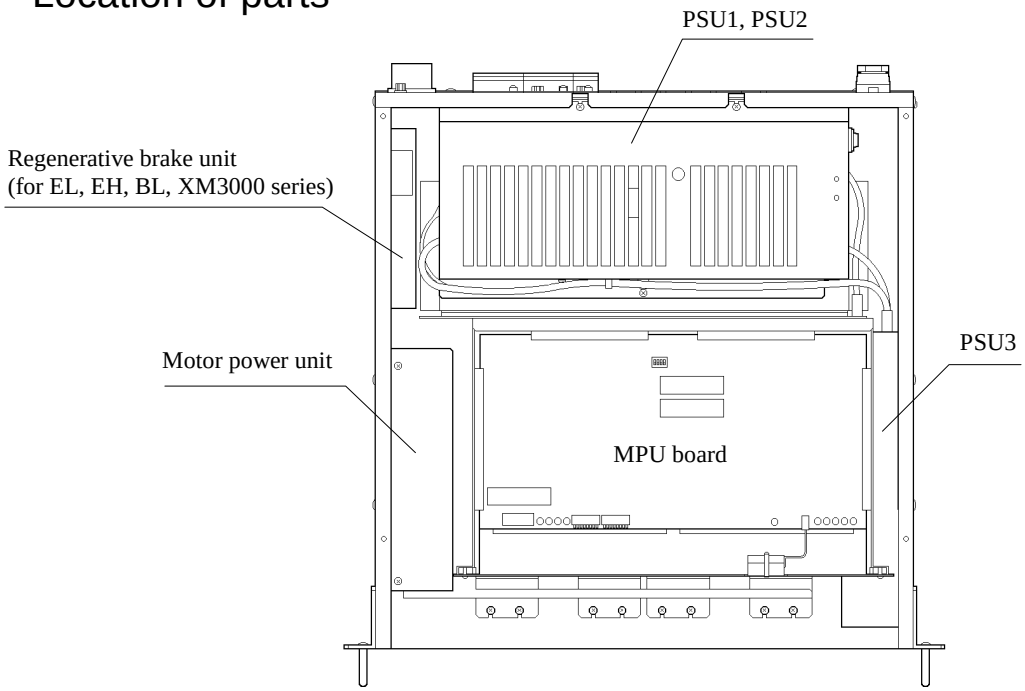
(1) Screws for upper cover : 4 pieces

(2) Screws for front panel : 4 pieces

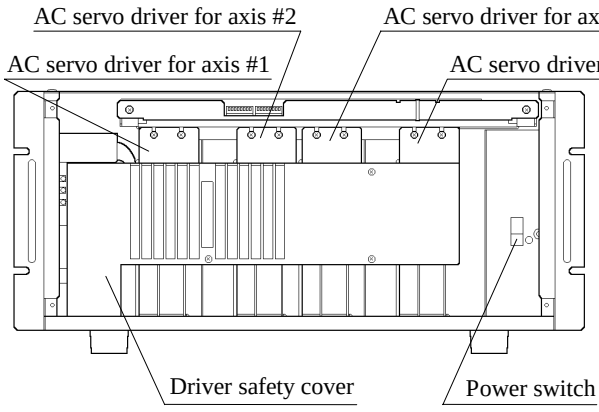
(3) Screws for rear panel : 8 pieces



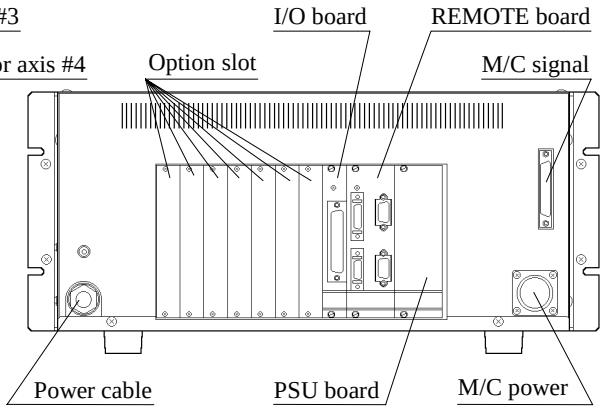
2.2 Location of parts



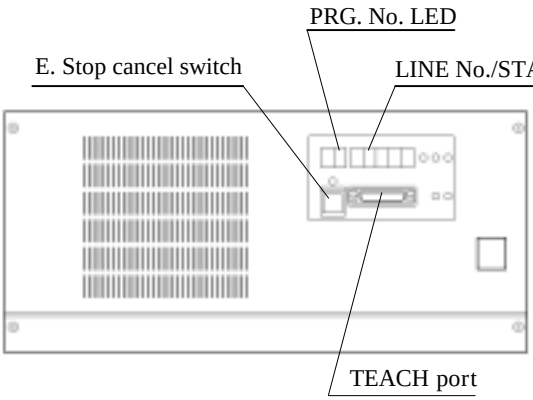
Top view of interior



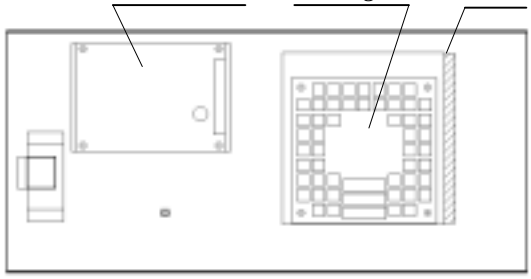
Front view of interior



Rear panel



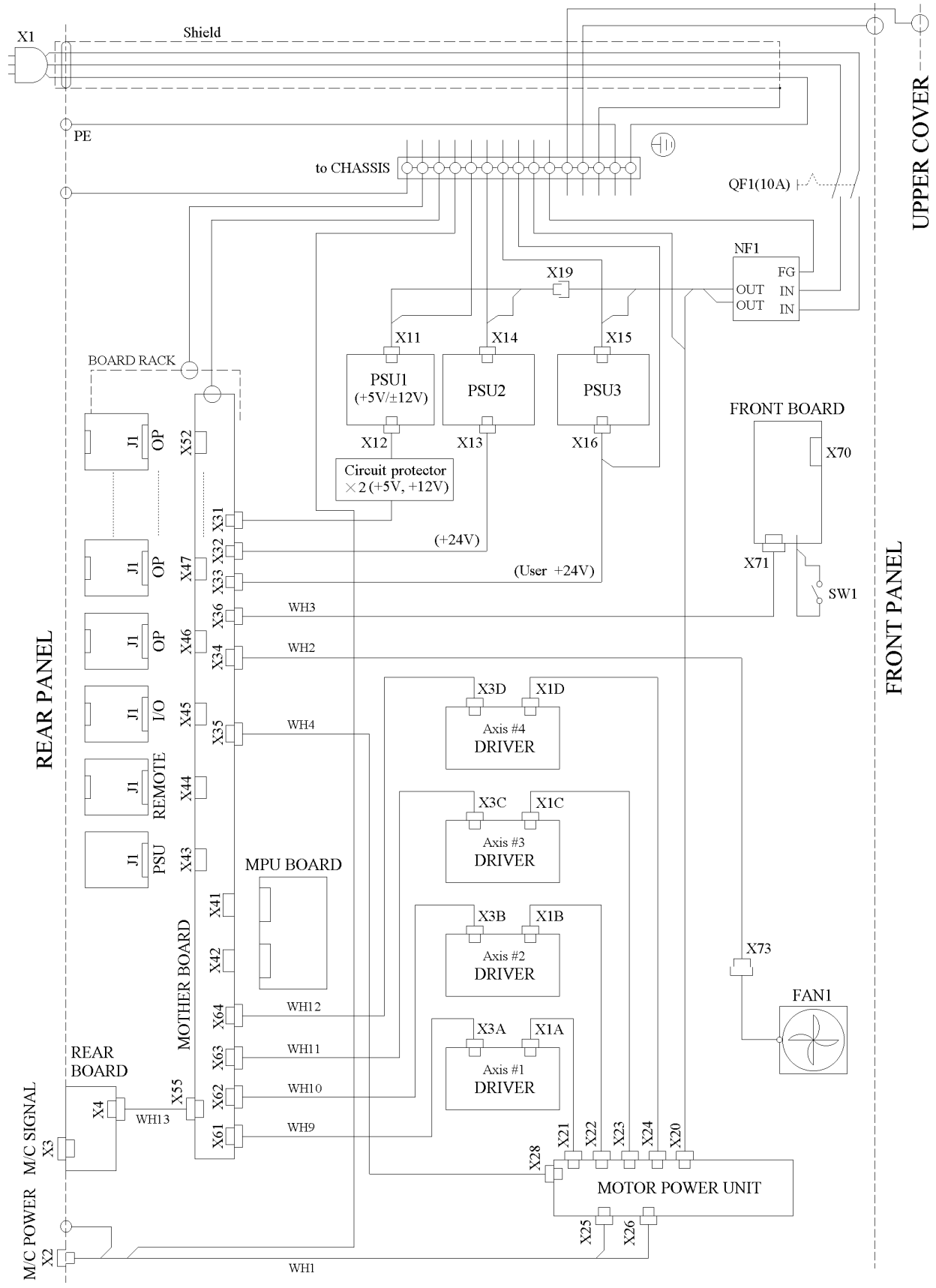
Front panel



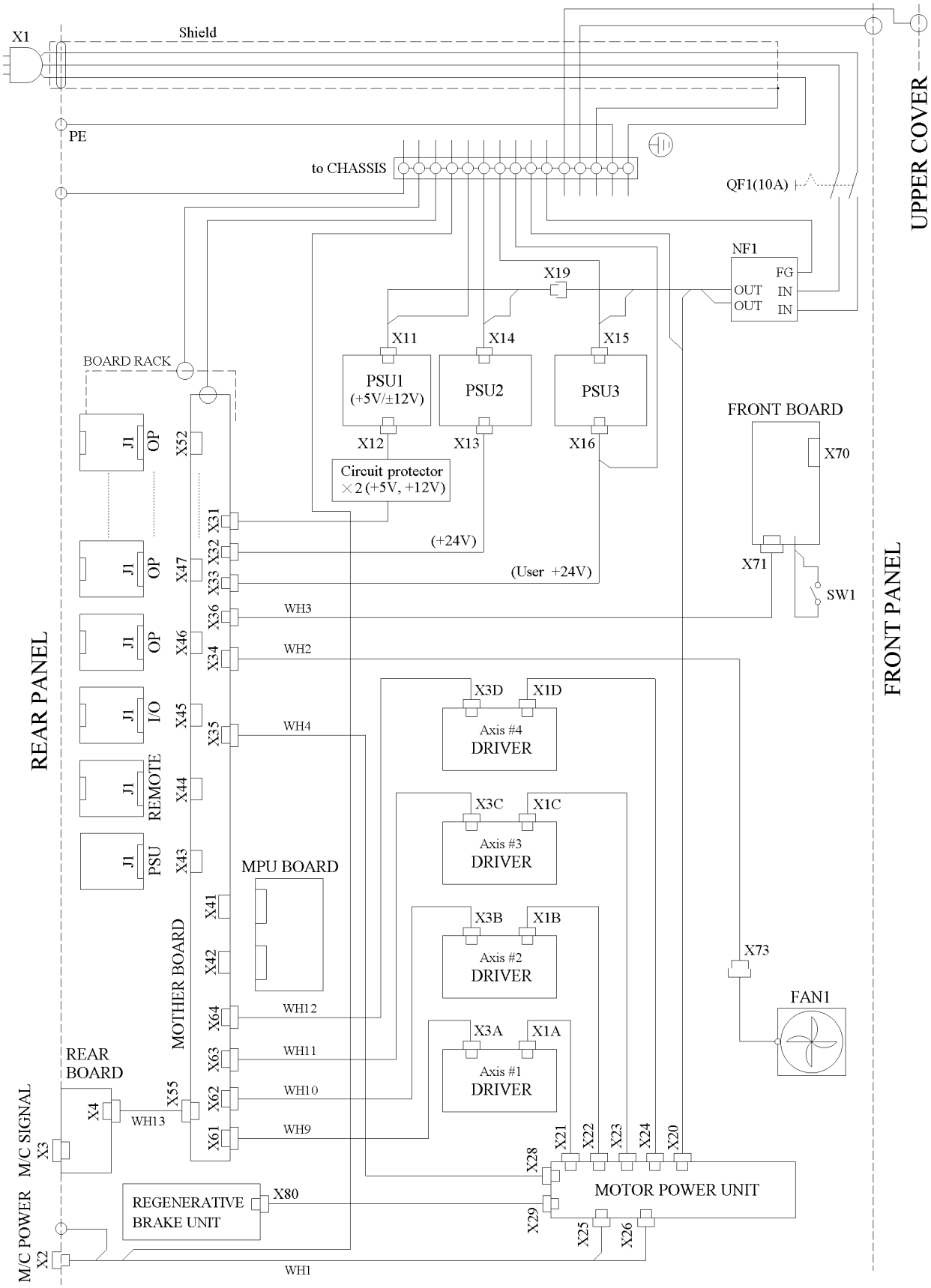
Back side of front panel

2.3 Diagram of cable connections

ES/EC BN/BNA RT3300



EL/EH BL XM3000



2.4 Connector pin assignment

	Rear panel						Front panel	
	M/C POWER (X2)		M/C SIGNAL (X3)				TEACH (X70)	
Cable side connector	JL05-6A20-29PC-A66F0		DX30A-68P				DB-25PF-N	
Controller side connector	JL05-2A20-29SC-F0		DX20A-68S				DB-25ST-N-S1	
Pin	1	1U	1	EG	35	2Z	1	FG
	2	4V	2	EG	36	$2\overline{Z}$	2	SD
	3	1V	3	4A	37	2S	3	RD
	4	4U	4	$4\overline{A}$	38	$2\overline{S}$	4	RS
	5	FG	5	4B	39	2HOME	5	CS
	6	1W	6	$4\overline{B}$	40	NC	6	NC
	7	4W	7	4Z	41	ENC+5V	7	SG
	8	NC	8	$4\overline{Z}$	42	ENC+5V	8	CD
	9	3W	9	4S	43	EG	9	NC
	10	2U	10	$4\overline{S}$	44	EG	10	E.STOP+
	11	NC	11	4HOME	45	1A	11	E.STOP-
	12	NC	12	NC	46	$1\overline{A}$	12	NC
	13	3V	13	ENC+5V	47	1B	13	DG
	14	2V	14	ENC+5V	48	$1\overline{B}$	14	DMSW+
	15	3U	15	EG	49	1Z	15	DMSW-
	16	2W	16	EG	50	$1\overline{Z}$	16	TP+
			17	3A	51	1S	17	TP-
			18	$3\overline{A}$	52	$1\overline{S}$	18	NC
			19	3B	53	1HOME	19	NC
			20	$3\overline{B}$	54	HCOM	20	ER
			21	3Z	55	ENC+5V	21	NC
			22	$3\overline{Z}$	56	ENC+5V	22	NC
			23	3S	57	NC	23	NC
			24	$3\overline{S}$	58	THS	24	NC
			25	3HOME	59	NC	25	+7V
			26	NC	60	NC		
			27	ENC+5V	61	NC		
			28	ENC+5V	62	$\overline{MP}$		
			29	EG	63	$\overline{EMB1}$		
			30	EG	64	$\overline{EMB2}$		
			31	2A	65	+24V		
			32	$2\overline{A}$	66	+24V		
			33	2B	67	RG		
			34	$2\overline{B}$	68	RG		

PNP type

	REMOTE board								I/O board			
	REMOTE1		REMOTE2		RS-232C #20		RS-232C #21		I/O-1			
Cable side connector	10126-3000VE		10120-3000VE		DE-9SF-N		DE-9SF-N		DB-50PF-N			
Controller side connector	10226-52A2JL		10220-52A2JL		DESP-JB9P		DESP-JB9P		DB-50ST-N-S1			
Pin	1	RLY	1	DG	1	CD	1	CD	1	IN COM 0	26	OUT 7
	2	S.ERR	2	+7V	2	RD	2	RD	2	IN 0	27	NC
	3	SAFE	3	SD	3	SD	3	SD	3	IN 1	28	OUT 8
	4	HP	4	NC	4	ER	4	ER	4	IN 2	29	OUT 9
	5	NC	5	E.STOP+	5	SG	5	SG	5	IN 3	30	NC
	6	E.STOP+	6	NC	6	NC	6	NC	6	IN 4	31	OUT 10
	7	SAFE11	7	$\overline{\text{S.ERR}}$	7	RS	7	RS	7	IN 5	32	OUT 11
	8	SAFE21	8	$\overline{\text{TEACH}}$	8	CS	8	CS	8	IN 6	33	NC
	9	CLR1	9	+24V	9	NC	9	NC	9	IN 7	34	OUT 12
	10	COM-	10	RG					10	IN COM 1	35	NC
	11	COM-	11	DG					11	IN 8	36	OUT 13
	12	+24V	12	+7V					12	IN 9	37	NC
	13	+24V	13	RD					13	IN 10	38	OUT 14
	14	RLY	14	NC					14	IN 11	39	NC
	15	E.STOP	15	E.STOP-					15	IN 12	40	NC
	16	DMSW	16	NC					16	IN 13	41	OUT 15
	17	MPON	17	$\overline{\text{E.STOP}}$					17	IN 14	42	NC
	18	NC	18	$\overline{\text{AUTO}}$					18	IN 15	43	OUT COM-
	19	E.STOP-	19	+24V					19	OUT 0	44	OUT COM+
	20	SAFE12	20	RG					20	OUT 1	45	OUT COM+
	21	SAFE22							21	OUT 2	46	OUT COM+
	22	CLR2							22	OUT 3	47	+24V
	23	COM+							23	OUT 4	48	+24V
	24	COM+							24	OUT 5	49	RG
	25	RGND							25	OUT 6	50	RG
	26	RGND										

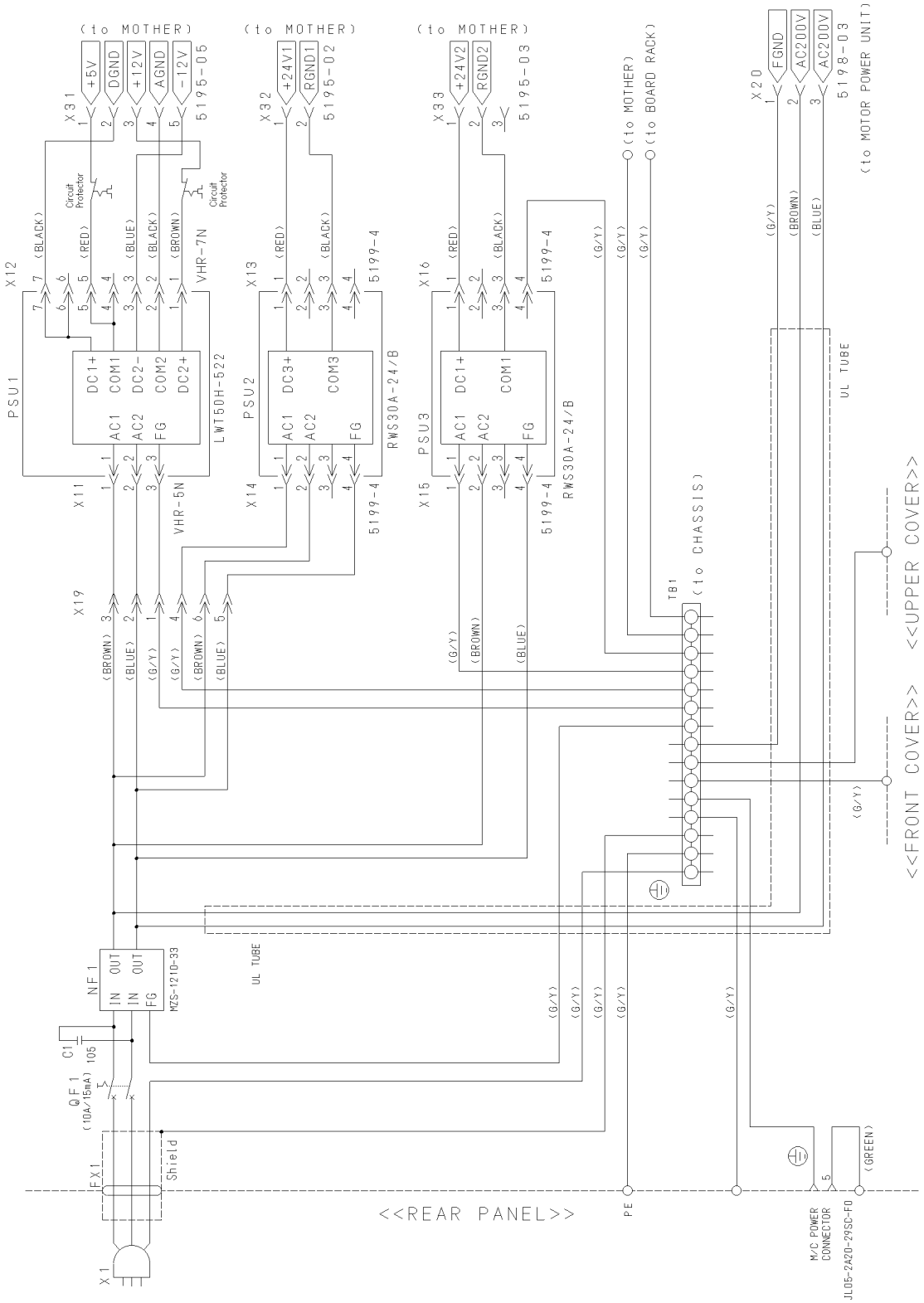
NPN type

	REMOTE board								I/O board			
	REMOTE1		REMOTE2		RS-232C #20		RS-232C #21		I/O-1			
Cable side connector	10126-3000VE		10120-3000VE		DE-9SF-N		DE-9SF-N		DB-50PF-N			
Controller side connector	10226-52A2JL		10220-52A2JL		DESP-JB9P		DESP-JB9P		DB-50ST-N-S1			
Pin	1	RLY	1	DG	1	CD	1	CD	1	IN COM 0	26	OUT 7
	2	S.ERR	2	+7V	2	RD	2	RD	2	IN 0	27	NC
	3	SAFE	3	SD	3	SD	3	SD	3	IN 1	28	OUT 8
	4	HP	4	NC	4	ER	4	ER	4	IN 2	29	OUT 9
	5	NC	5	E.STOP+	5	SG	5	SG	5	IN 3	30	NC
	6	E.STOP+	6	NC	6	NC	6	NC	6	IN 4	31	OUT 10
	7	SAFE11	7	$\overline{\text{S.ERR}}$	7	RS	7	RS	7	IN 5	32	OUT 11
	8	SAFE21	8	$\overline{\text{TEACH}}$	8	CS	8	CS	8	IN 6	33	NC
	9	CLR1	9	+24V	9	NC	9	NC	9	IN 7	34	OUT 12
	10	COM+	10	RG					10	IN COM 1	35	NC
	11	COM+	11	DG					11	IN 8	36	OUT 13
	12	+24V	12	+7V					12	IN 9	37	NC
	13	+24V	13	RD					13	IN 10	38	OUT 14
	14	RLY	14	NC					14	IN 11	39	NC
	15	E.STOP	15	E.STOP-					15	IN 12	40	NC
	16	DMSW	16	NC					16	IN 13	41	OUT 15
	17	MPON	17	$\overline{\text{E.STOP}}$					17	IN 14	42	NC
	18	NC	18	$\overline{\text{AUTO}}$					18	IN 15	43	OUT COM+
	19	E.STOP-	19	+24V					19	OUT 0	44	OUT COM-
	20	SAFE12	20	RG					20	OUT 1	45	OUT COM-
	21	SAFE22							21	OUT 2	46	OUT COM-
	22	CLR2							22	OUT 3	47	+24V
	23	COM-							23	OUT 4	48	+24V
	24	COM-							24	OUT 5	49	RG
	25	RGND							25	OUT 6	50	RG
	26	RGND										

2.5 Main power supply circuits

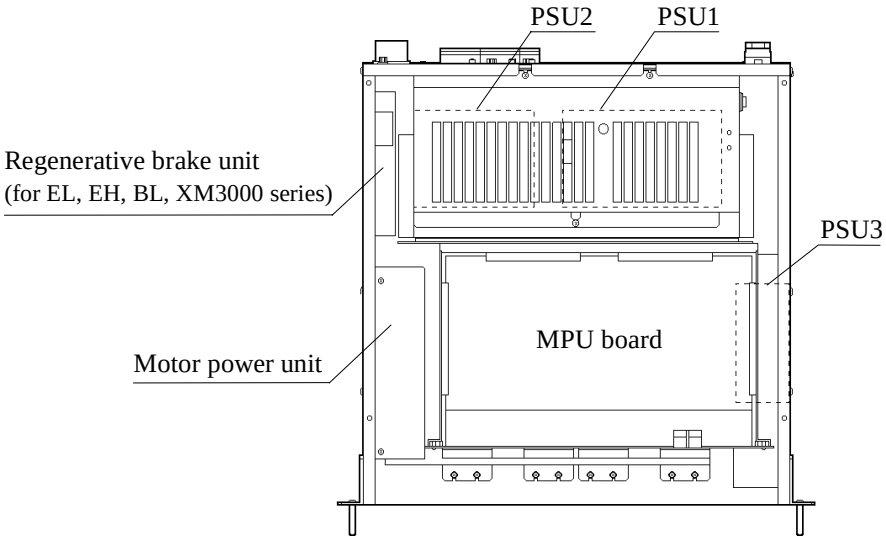
The main power supply circuit is comprised of an earth leakage circuit breaker, a noise filter, a circuit that supplies 200 volts AC to the motor power unit and three PSUs (switching power supply unit) that supply +5V/±12V, +24V and user +24V power to the mother board.

The controller's main power supply circuit



3. PSU

3.1 PSU layout



PSU comprises three switching power supplies (PSU1, PSU2, PSU3) that output the various voltages used inside the controller. The voltages output by each power supply are shown below.

	Model	Input voltage	Output voltage
PSU1	LWT50H-522	AC 200 to 230V (X11)	+5V/±12V (X12 to X31)
PSU2	RWS30A-24/B	AC 200 to 230V (X14)	Internal +24V (X13 to X32)
PSU3	RWS30A-24/B	AC 200 to 230V (X15)	+24V for user (X16 to X33)

3.2 Power supplies from PSU

		PSU1					PSU2	PSU3	To be disconnected at:
		5V VCC	±12V				Internal +24V	User +24V	
			+7V	ENC +5V	-5V	±12V			
Internal Parts	PSU board	○	○	○	○	○	○	○	Board
	MPU board	○				○	○		Board
	REMOTE board	○	○			○		○	Board
	I/O board	○						○	Board
	Additional RS-232C board	○				○			Board
	Front board	○	○			○			X71
	AC servo driver	○			○		○		Driver X3A~X3D
	Motor power unit						○		X28
	Cooling fan						○		X73
Connectors for External Equipment	M/C signals			○			○		Signal connector
	REMOTE1							○	REMOTE1 connector
	REMOTE2		○			○		○	REMOTE2 connector
	I/O							○	I/O connector
	TEACH		○			○			TEACH connector

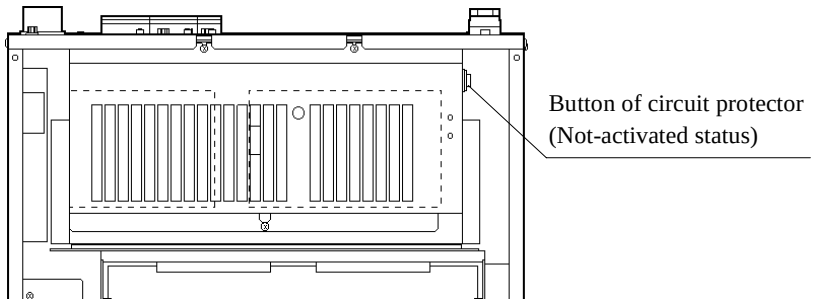
3.3 PSU inspection

WARNING

- Only trained personnel should be allowed to perform the following operations. Trained personnel are those who have taken a robot training course (held by the dealer) or those who have carefully read the manuals and have equivalent knowledge or skill.
- To avoid an electric shock, do not touch the dangerous high-voltage parts marked with the orange label.
- For safety, be sure to remove M/C POWER cable from the M/C POWER connector at the rear panel of controller so that the manipulator should not move accidentally.

1) Loosen the four screws that fasten the upper cover and remove the upper cover from the controller. As the earth line is connected to the upper cover, do not pull it unnecessarily.

2) Check the button of two circuit protectors on the side surface of PSU1. Proceed to the step 4) if both buttons have not come out.



3) If the button should come out, it means that the power supply circuit connected with PSU1 is short-circuited somewhere.
Turn OFF the power to the controller and depress the circuit protector button. Then turn ON the power again, and recheck whether the circuit protectors will activate or not.

NOTE

If the short-circuit current is small, a circuit protector may not activate immediately. Please watch the status for a while.

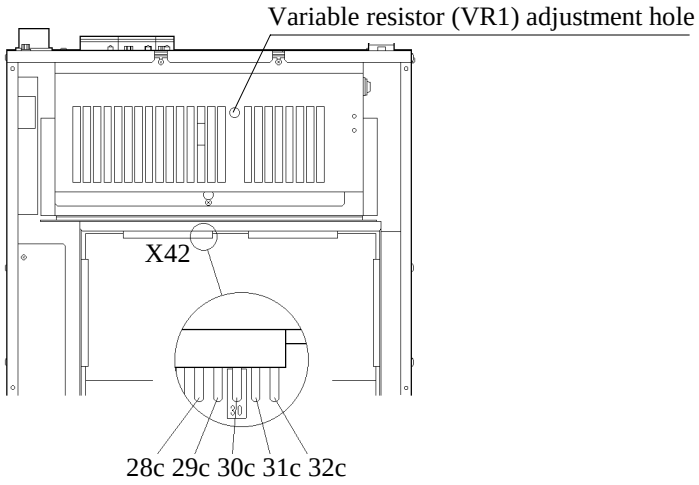
If the circuit protector is activated again, proceed to the next section “Check for PSU1 and the related devices.”

4) If the circuit protectors are not activated, check the output voltage from each PSU. Measure the DC voltage of each of the parts shown below. Check that they are within the specified normal voltage range.

WARNING

- Be careful not to touch the dangerous high-voltage parts marked with the orange label when checking the voltage.

Where measured :		+ side - side	standard (V)	name	from
MPU board	connector X42 (see drawing below)	at 31c and 32c	4.95 to 5.15	+5V	PSU1
		at 30c and 29c	11.4 to 12.6	+12V	
		at 28c and 29c	-11.4 to -12.6	-12V	
Fan	connector X73	at 1 (red) and 2 (black)	22.8 to 25.2	+24V	PSU2
I/O board	I/O connector	at 47 or 48 and 49 or 50	22.8 to 25.2	+24V	PSU3



You can adjust the +5V using the variable resistor VR1 on the PSU1. To make adjustments, insert a cross-head screwdriver through the variable resistor adjustment hole on the PSU cover.

⚠ WARNING

- PSU has the high-voltage parts. When you adjust the +5V, if a screwdriver touches around the variable resistor, you may get an electric shock. Insert the screwdriver straight to the variable resistor, and be careful not to touch anything else.

5) If all the tested data are within the proper range, inspection of PSU is now completed. Install the upper cover of the controller and connect the M/C POWER cable.

If the measured voltage of PSU1 is not proper, replace PSU1 referring “3.4 PSU unit replacement” in this chapter. Still, when the voltage does not return normally, proceed to the next section “Check for PSU1 and the related devices.”

If the measured voltage of PSU2 and/or PSU3 is not proper, proceed to the section “Check for PSU2, PSU3 and the related devices” below.

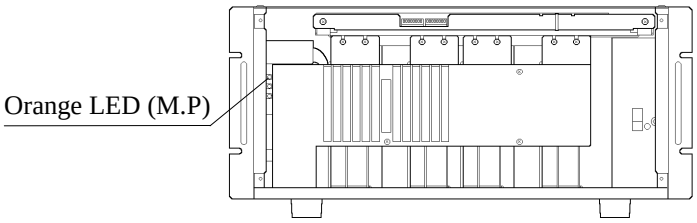
Check for PSU1 and the related devices

If there is malfunction (short-circuit) somewhere in the +5V power circuit that is output from PSU1, the upper circuit protector will activate, and the “8A” button should come out. If there is malfunction (short-circuit) somewhere in the +12V power circuit, the lower circuit protector will activate, and the “1A” button should come out.

1) Turn OFF power to the controller and check that the orange LED (M. P) on the front of the motor power unit is faded out completely.

⚠ WARNING

- Controller has the capacitors charged high voltage. To avoid an electric shock, do not touch the dangerous high-voltage parts marked with the orange label until the orange LED of motor power unit is faded out completely. When the orange LED is faded out, the high-voltage capacitors are discharged.



2) Detach one of the device whose power is supplied from PSU1 as shown in the previous table, “3.2 Power supplies from PSU.” Refer to the described method of disconnecting for replacing each part.

⚠ WARNING

- Temperature of PSU may rise depending on the operating condition. Check the surface temperature before handling and use the protective gloves if necessary.

3) Turn ON the controller’s power and check whether the circuit protector activates.

4) Measure the voltages from PSU1 listed in the previous table.

⚠ WARNING

- Do not touch the inside the controller while the controller power is ON.
- When connecting or disconnecting boards or connectors, be sure to turn OFF the power of controller.

5) Repeat step 2) to 4) for each device whose power is supplied by PSU1. Find and replace the device that the circuit protector does not activate or the voltage from PSU1 returns normally while the device is disconnected.

6) Turn ON the controller’s power. Confirm that the circuit protectors are not activated and the measured voltages are within the normal voltage range.

7) Install the upper cover of the controller and connect the M/C POWER cable. Now the procedure is completed.

Check for PSU2, PSU3 and the related devices

EL/EH BL XM3000

1) Disconnect the X80 connector on regenerative brake unit and remove the regenerative brake unit from the controller referring to "10. Regenerative Brake Unit" of this volume when the manipulator is EL, EH, BL or XM3000 series.

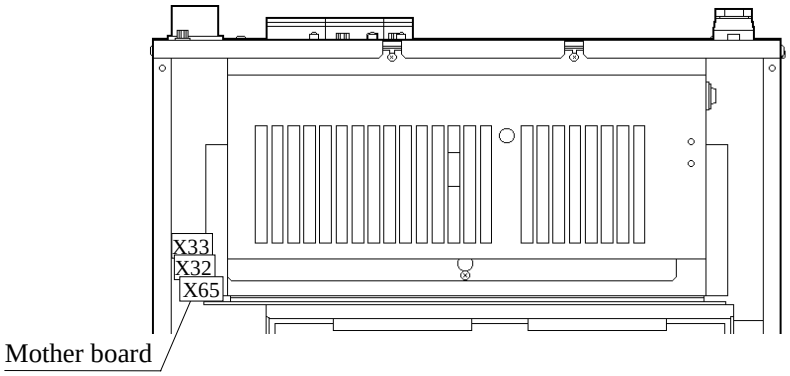
2) Remove the X32 and X33 connectors from the mother board. Disconnect the X65 connector first if these connectors are difficult to disconnect.

3) Turn ON the controller's power and measure the voltage listed in the table below.

⚠ WARNING

- Be careful not to touch the dangerous high-voltage parts marked with the orange label when checking the voltage.

Where measured :		+ side - side	standard (V)	name
PSU2	connector X32	at 1 (red) and 2 (black)	22.8 to 25.2	+24V
PSU3	connector X33	at 1 (red) and 2 (black)	22.8 to 25.2	+24V

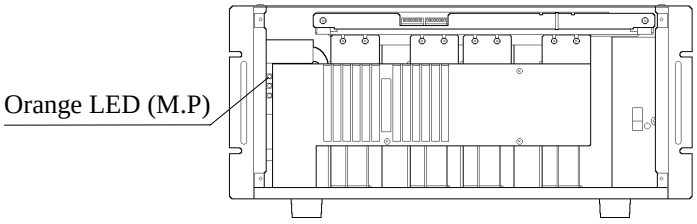


If the measured voltage from PSU2 or PSU3 is not proper, replace the PSU referring the replacement procedure in the next section 3.4.
If there is an error feedback despite the normal voltages at the PSUs, suspect the device connected to PSU2 or PSU3 for causing that error. Follow the steps below to define the device that is causing the error.

4) Turn OFF the power of controller and pull out the power plug from the power source. And check that the orange LED (M. P) on the front of the motor power unit is faded out completely.

⚠ WARNING

- Controller has the capacitors charged high voltage. To avoid an electric shock, do not touch the dangerous high-voltage parts marked with the orange label until the orange LED of motor power unit is faded out completely. When the orange LED is faded out, the high-voltage capacitors are discharged.



5) If the Error #110 (“the error at PSU2”) occurs, disconnect all the parts/equipment whose power is supplied from PSU2. The previous table, “Power supplies from PSU,” list all such parts. Refer to the described method of disconnecting for replacing each part.

⚠ WARNING

- Temperature of PSU may rise depending on the operating condition. Check the surface temperature before handling and use the protective gloves if necessary.

6) Once all the parts are disconnected, reconnect each part back to PSU2 one by one. Each time a part is reconnected, turn ON the Controller to measure the voltage at the +24V terminal using the X73 (cooling fan) connector. The problematic part can be defined by measuring this voltage each time the part is reconnected. (The problematic part should indicate the out-of-spec voltage when reconnected and measured.)

⚠ WARNING

- Do not touch the inside the controller while the controller power is ON.
- When connecting or disconnecting boards or connectors, be sure to turn OFF the power of controller.

7) If the Error #46 (“the error at PSU3”) occurs, disconnect the following connectors and boards one by one to determine the cause. Test by turning ON the Controller each time a connector/board is disconnected if the error will be canceled.: the REMOTE1 connector, REMOTE2 connector, I/O connectors and I/O boards.

8) If the error cannot be canceled in above 7), it is most likely that the PSU board or REMOTE board is causing the error. Replace each board one by one with a new board. The problematic board can be determined if the error state should disappear when replaced with the new board.

9) Once the problematic device is determined and replaced with the good one, reconnect all the parts. However, the M/C POWER connector must be left unconnected.

10) When all the parts (except for the M/C POWER connector) are reconnected, check and be sure that they are connected properly. Turn ON the Controller. Check that there should be no error indication.

EL/EH BL XM3000

11) Attach the regenerative brake unit to the controller and connect X80 referring to “10. Regenerative Brake Unit” of this volume when the manipulator is EL, EH, BL or XM3000 series.

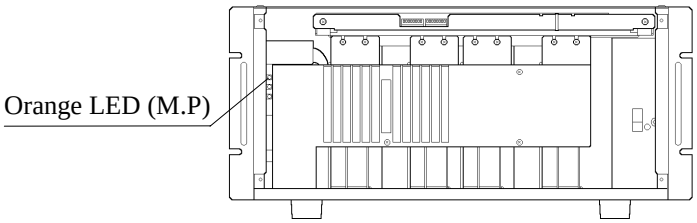
12) Install the upper cover of the controller and, connect the M/C POWER cable to the M/C POWER connector. Now the procedure is completed.

3.4 PSU replacement

If the AC input voltage is normal while the DC output voltage is out of the normal range, replace the PSU in question by following the steps below.

⚠ WARNING

- Only trained personnel should be allowed to perform the following operations. Trained personnel are those who have taken a robot training course (held by the dealer) or those who have carefully read the manuals and have equivalent knowledge or skill.
- Controller has the capacitors charged high voltage. To avoid an electric shock, do not touch the dangerous high-voltage parts marked with the orange label until the orange LED of motor power unit is faded out completely. When the orange LED is faded out, the high-voltage capacitors are discharged.



- For safety, be sure to remove M/C POWER cable from the M/C POWER connector at the rear panel of controller so that the manipulator should not move accidentally.

⚠ CAUTION

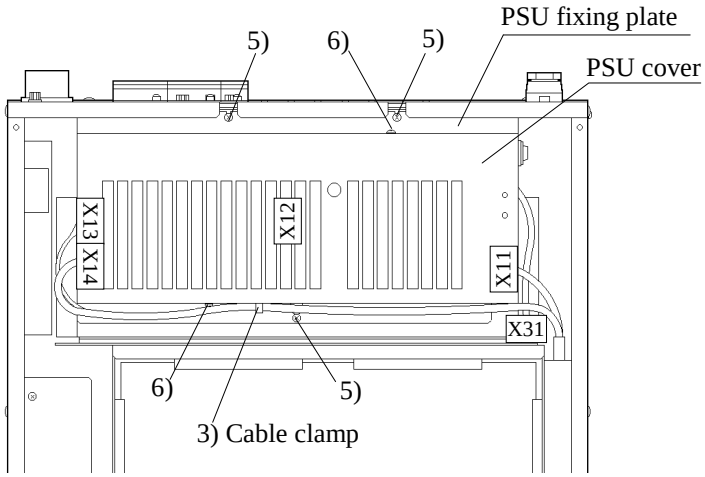
- Temperature of PSU may rise depending on the operating condition. Check the surface temperature before handling and use the protective gloves if necessary.

PSU1, PSU2 replacement

1) Turn OFF the controller, unplug the controller's power cord and wait about two minutes.

2) Remove the controller's upper cover. As the earth line is connected to the upper cover, do not pull the cover unnecessarily.

3) Cut off the cable clamp which fastens the cable to PSU cover.



4) Disconnect the four connectors (X11, X13, X14 and X31) from the PSU.

5) Loosen the three screws and remove the PSU fixing plate (with PSU1, PSU2 and PSU cover) from the board rack.

6) Loosen the two screws at the each side of PSU cover and remove the cover from the PSU fixing plate.

7) Remove the fixing screw of the PSU to be replaced. Each PSU1 and PSU2 is fixed to the fixing plate with two screws from underneath. If you loosen those screws, PSU1 or PSU2 can be removed. Then replace it with a new one.
If you replace PSU1, remove the X12 connector, and connect the cable of the X12 connector to a new PSU1.

8) Fix the new PSU and attach the PSU cover to the PSU fixing plate.

9) Connect X31 and mount the PSU fixing plate to the controller as it was before. Pay attention not to pinch the cable.

10) Connect X11, X13 and X14 to PSU.

11) Fasten the cables to the PSU cover with a cable clamp. Handle the cables carefully so that no load or weight is applied.

12) Fix the upper cover.

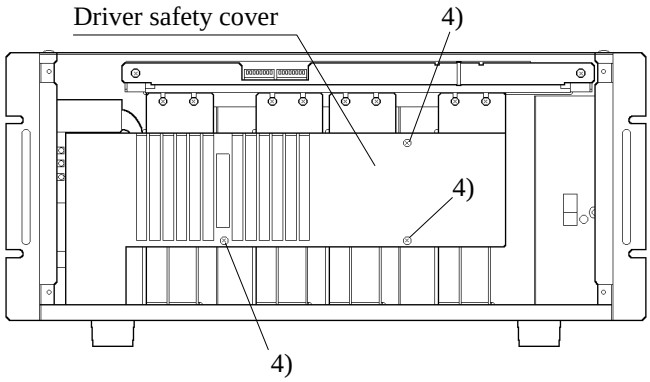
PSU3 replacement

1) Turn OFF the controller, unplug the controller's power cord and wait about two minutes.

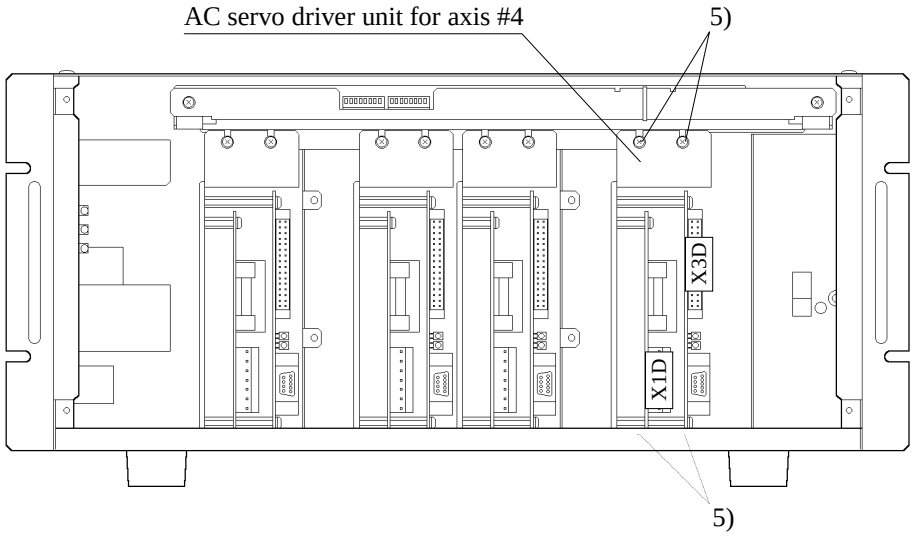
2) Remove the controller's front panel. As various cables are connected to the front panel, do not pull the panel unnecessarily.

3) Disconnect the earth line and the two connectors X71 and X73 from the back side of the front panel.

4) Remove the driver safety cover by taking out the three screws.

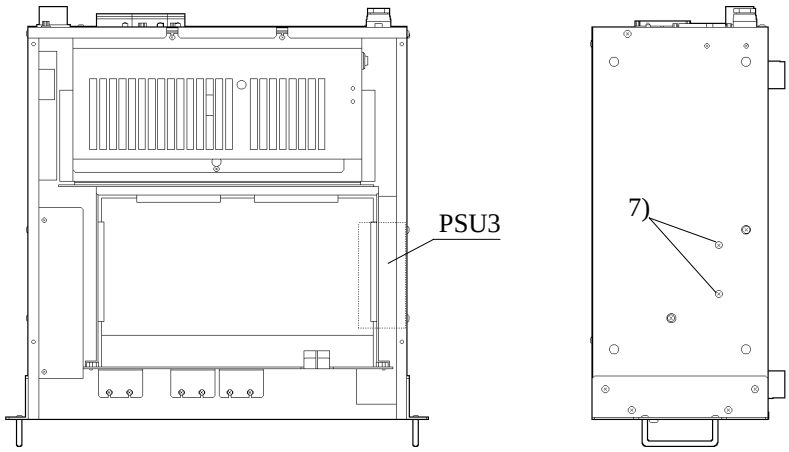


5) Remove the AC servo driver unit of axis #4.
   - Disconnect the connectors X1D and X3D from the AC servo driver for the axis #4.
   - Remove the four screws that hold the driver unit in place.
   - Pull the driver unit forward and out from the controller.



6) Disconnect the connectors X15 and X16 from PSU3.

7) Loosen two screws fixing PSU3 at the left panel of the controller and pull out PSU3 from the controller.

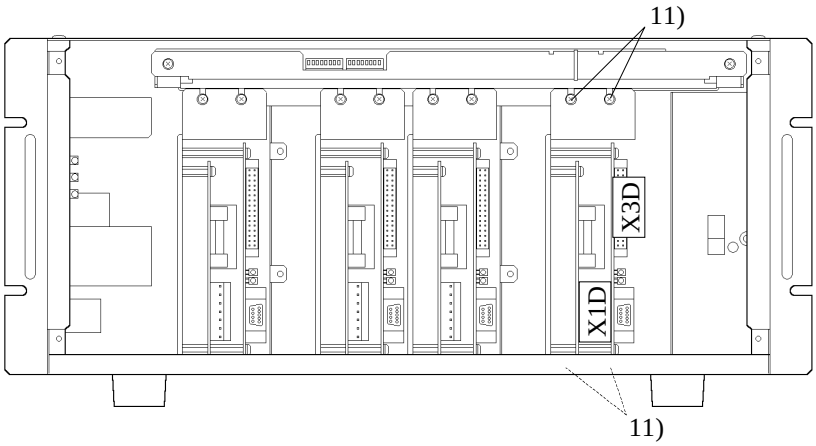


8) Insert a new PSU3 in the controller, and install it on the left panel of the controller.

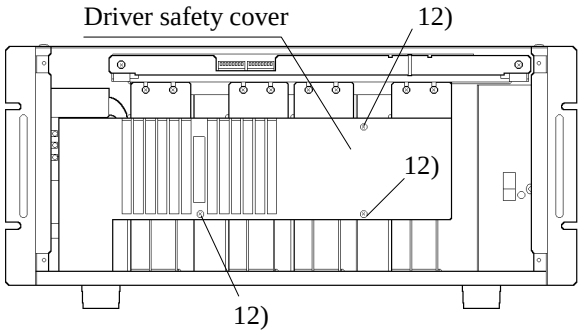
9) Connect the connector X15 and X16 to PSU3. The connector shape of X15 and X16 is same, so be careful not to misconnect.

10) Insert the AC servo driver for the axis #4 again, and secure it with four screws. Be sure not to bend the connected cables forcibly or not to pinch.

11) Connect the connectors X1D and X3D to the AC servo driver for the axis #4.



12) Fix the driver safety cover.



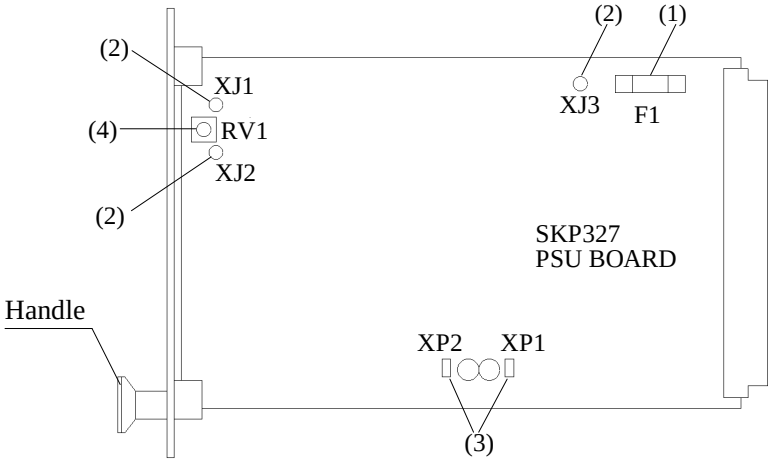
13) Reconnect the earth line, connectors X71 and X73 to the front panel and fix the front panel to the controller.

WARNING	■ Be sure to reconnect the earth line to front panel.

4. PSU board

4.1 Layout and function of PSU board parts

The PSU board outputs and monitors the power supplies that are used by the controller, manipulator and other peripheral equipment.



(1) Fuse (F1)

A 2A fuse for over-current protection and protection against abnormalities in the internal +24 voltage supplied to the servo driver and so on.

(2) Test pins (XJ1, XJ2, XJ3)

Test pins for measuring the power supply voltages.

Notation	Function
XJ1	DGND
XJ2	ENC +5V check
XJ3	-5V check

(3) Jumper pins (XP1, XP2)

Jumper pins are set in accordance with the specification for the manipulator's electromagnetic brake. Do not change the settings.

(4) Variable resistor (RV1)

Variable resistor RV1 is used to regulate the 5V power supply voltage of the servo motor's encoder. Voltage increases when you turn the variable resistor clockwise.

4.2 Errors related to the PSU board

PSU board error numbers and causes are shown in the following table.

Error No.	Cause
S.ERR	VCC power supply voltage deterioration
46	User's +24V power supply voltage deterioration
48	Momentary AC power service interruption
95	ENC +5V power supply voltage deterioration
102	+7V power supply voltage deterioration
104	±12V power supply voltage deterioration
118	-5V power supply voltage deterioration
110	+24V power supply voltage deterioration
115	Motor main power supply voltage deterioration

4.3 PSU board inspection and replacement

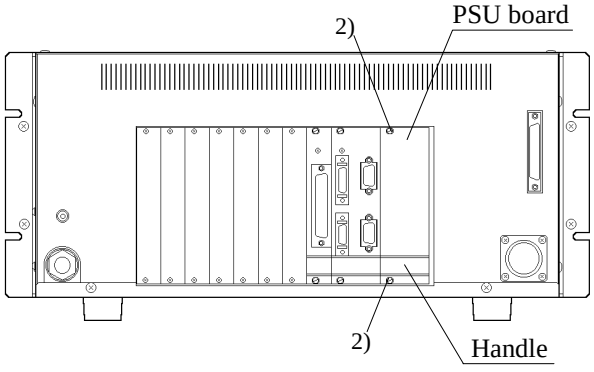
⚠ WARNING

- Make sure the power is turned OFF when connecting or disconnecting the PSU board to avoid an electric shock.

⚠ CAUTION

- Mount circuit boards of a controller in fixed slots.

1) Turn OFF the controller and position it so that you can remove the board.
2) After loosening the PSU board's upper and lower set screws, pull the board forward by the handle.



3) Check that the fuse (F1) is still good and that the wires inside the fuse are straight.
4) If PSU board has a malfunction, it is necessary to replace it. After replacing the board, set the new PSU board's jumper pins (XP1 and XP2) in the same way as the original board.
5) Firmly insert the new PSU board all the way into the designated slot (labeled "PSU") and re-tighten the screws.

4.4 ENC+5V (encoder 5V) power supply adjustment

⚠ WARNING

- Only trained personnel should be allowed to perform the following operations. Trained personnel are those who have taken a robot training course (held by the dealer) or those who have carefully read the manuals and have equivalent knowledge or skill.

1) Turn the controller OFF.
2) Disconnect the power connector X131 of the axis #3 motor of the manipulator. (Refer to the chapter of "Replacing the Motors" in the manipulator manual.)
3) For safety reasons, set the controller in TEACH mode, then turn ON the controller.
4) Pull the X31 connector closest to the servo-motor's encoder of the manipulator to the outside. Refer to the wiring schematics ("Outline of connection" and "Block diagram") in the manipulator manual. There is no need to disconnect the X31 connector.
5) Measure the voltage at "EGND" and "ENC+5V" of the X31 connector that you pulled out. (without disconnecting) Check that the voltage is between 4.80V and 5.05V.

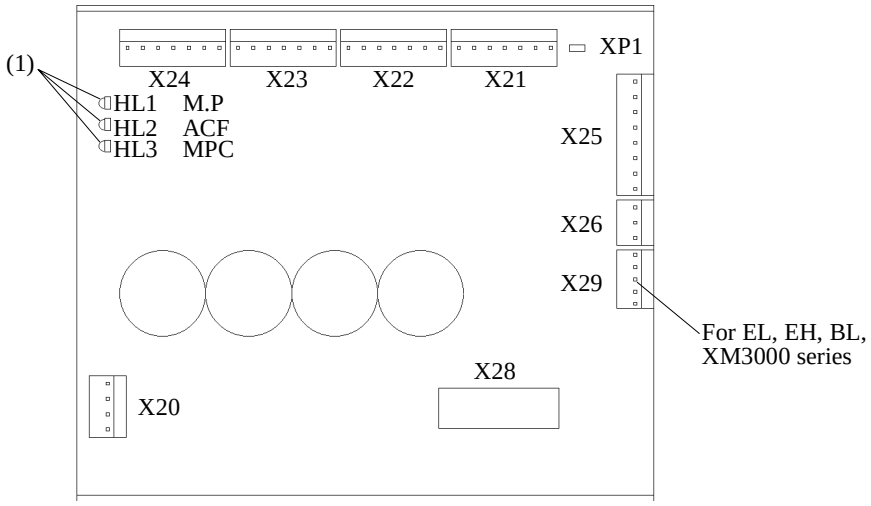
Manipulator	EGND	ENC+5V	Standard
BN, BL(-CL), XM3000, RT3300	pin No. 8	pin No. 7	4.80V to 5.05V
ES, EL, EC, EH, BNA(-CL)	pin No. 13	pin No. 12	

6) If the voltage is not within the specified range, turn the controller OFF, then pull out the PSU board and adjust its variable resistor (RV1) as follows:
   When the voltage is low : turn "RV1" clockwise 1/2 graduation.
   When the voltage is high : turn "RV1" counterclockwise 1/2 graduation.
   After adjusting the variable resistor, firmly insert the PSU board back into the designated slot (labeled "PSU") and repeat steps 4) to 6).
7) If the voltage value is within the specified range, turn the controller OFF and attach the X131 connector to the axis #3 motor.
8) Return the connectors X31 and X131 to its original position referring the chapter of "Replacing the Motors" in the manipulator manual.
9) If you pulled out the PSU board, be sure to re-tighten its upper and lower set-screws.

5. Motor Power Unit

5.1 Layout and function of motor power unit parts

The motor power unit consists of the motor main power supply circuit to the AC servo driver and the dynamic brake circuit.



(1) LED (HL1, HL2, HL3)

A description of the monitoring performed by the LED in the motor power unit is shown in table.

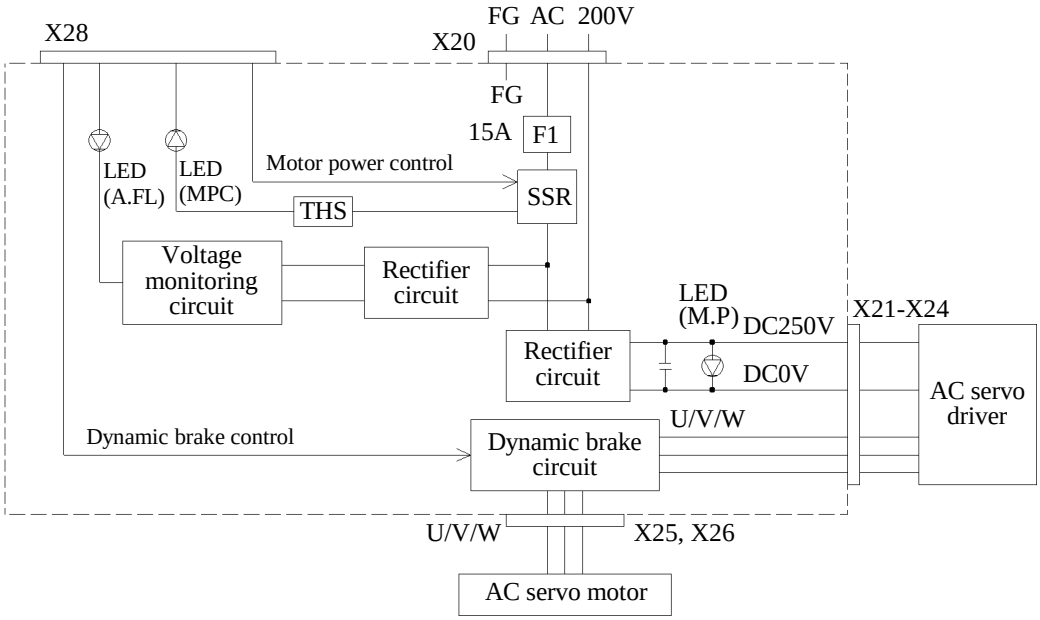
Notation	Name	Color	Description of display when on
HL1	M.P	Orange	Motor main power supply is being output
HL2	ACF	Green	AC power supply is being input
HL3	MPC	Green	Motor is on

(2) Jumper pins (XP1)

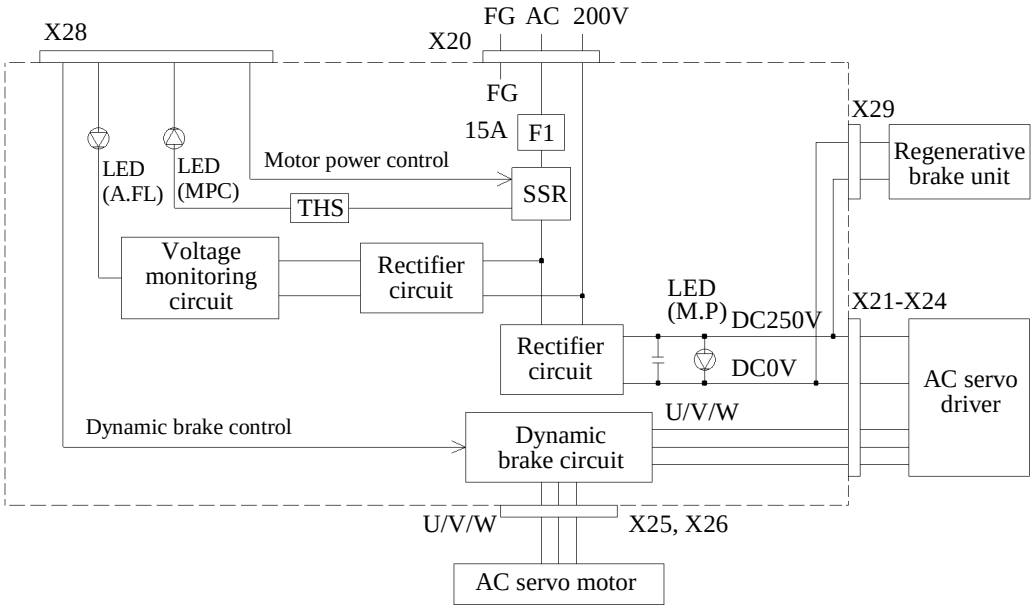
Manipulator	Setting
ES, EC, BN, BNA(-CL), RT3300	Short
EL, EH, BL(-CL), XM3000	Open

Block diagram

ES/EC
BN/BNA
RT3300



EL/EH
BL
XM3000



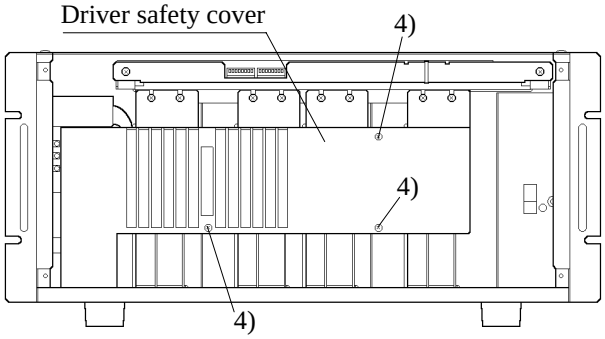
5.2 Motor power unit inspection

Inspect the motor power unit by following the steps below.

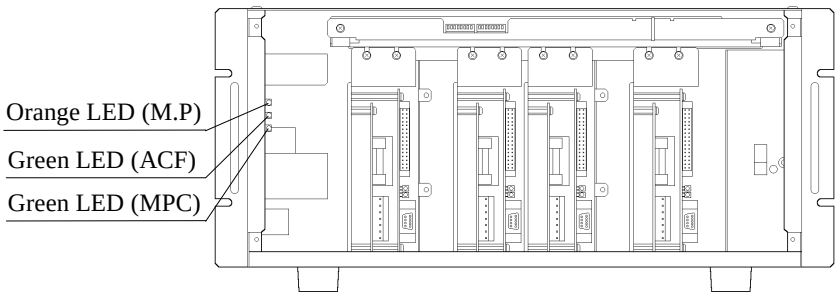
⚠ WARNING

- Only trained personnel should be allowed to perform the following operations. Trained personnel are those who have taken a robot training course (held by the dealer) or those who have carefully read the manuals and have equivalent knowledge or skill.
- To avoid an electric shock, do not touch the dangerous high-voltage parts marked with the orange label when the power is ON.

1) Turn the controller OFF and pull out the power plug from the power source.
2) Remove the front panel. Do not disconnect the connectors that are attached to the back of the front panel.
3) Wait until the orange LED (M. P) on the front of the motor power unit is faded out completely.
4) Remove the driver safety cover by taking out the three screws.



5) Check that the connectors X20 to 26 and X28 (, X29) attached to the motor power unit are securely attached. If the connection is loose, reconnect it securely.
6) With the front panel off, plug the power cord and turn the controller ON.
7) Check that the green LED (ACF) on the front of the motor power unit is lit. (The orange LED is dimly lit.)



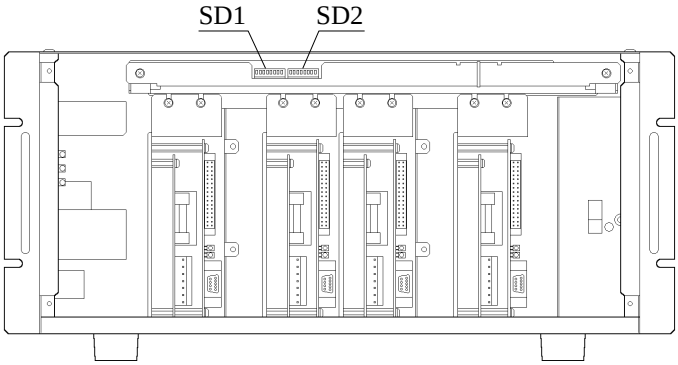
8) Execute the MOTOR ON command. If the motor power unit's LEDs are all on and no error code is issued, inspection is completed. Attach the driver safety cover and the front panel.

NOTE

If all LEDs of the motor power unit are not on, there is a possibility of malfunction of the motor power unit or PSU board.
If an error code is issued, take corrective action by following the troubleshooting steps. (Refer to "15.1 Error code table" in this volume.) However, if a driver error (error 180 to 189) occurs, cause of the problem will be found by taking the following steps. Refer to these.

1) Turn the controller OFF.

2) Make a note of the setting of the DIP switch SD2 on the MPU board, and set bits 5 to 8 of the SD2 to the off position which means the setting of a non-use of axis.



Note : When a driver error occurs, the motor main power supply is shut down and you cannot check the voltage in step 4). That is the reason you have to switch to the non-use of axis setting.

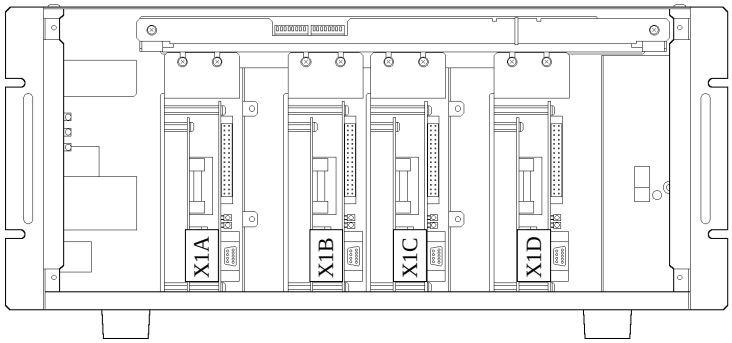
3) Turn ON the controller and execute the MOTOR ON command.

4) Use a tester to check that the motor power unit is outputting correctly to each AC servo driver. This cannot be checked at the motor power unit; it must be checked at the AC servo driver's power connector (X1A, X1B, X1C and X1D; see the figure below). In this case, be sure not to make a short-circuit. The voltage is as follows:

⚠ WARNING

- In order to avoid electric shock, use an insulating glove when you measure the voltage.

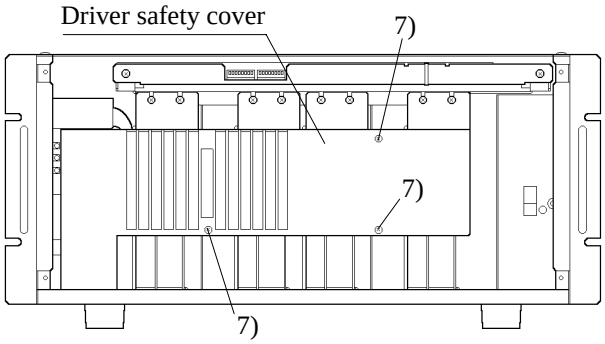
Measuring point (connector)	Pin number + side - side	Standard (V)
X1A X1B X1C X1D	at 6 and 5 (yellow) (black)	AC source power voltage $\sqrt{2}$ ±10 % (In case of AC 230 V: approx. DC 320 V)



5) If the above voltage is not outputted, there is a possibility of malfunction of the motor power unit or the PSU board.

6) After checking the voltage, turn off the controller, and set bits 5 ~ 8 of the MPU board's DIP switch SD2 as they were before.

7) Fix the driver safety cover.



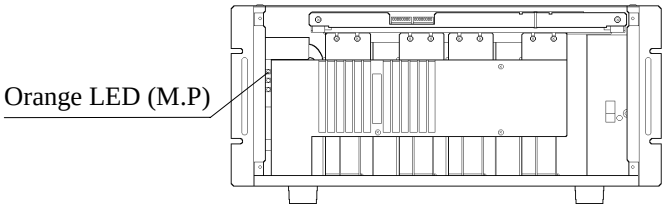
8) Attach the front panel.

5.3 Motor power unit replacement

When there is something wrong with the motor power unit, replace it by following the steps below.

⚠ WARNING

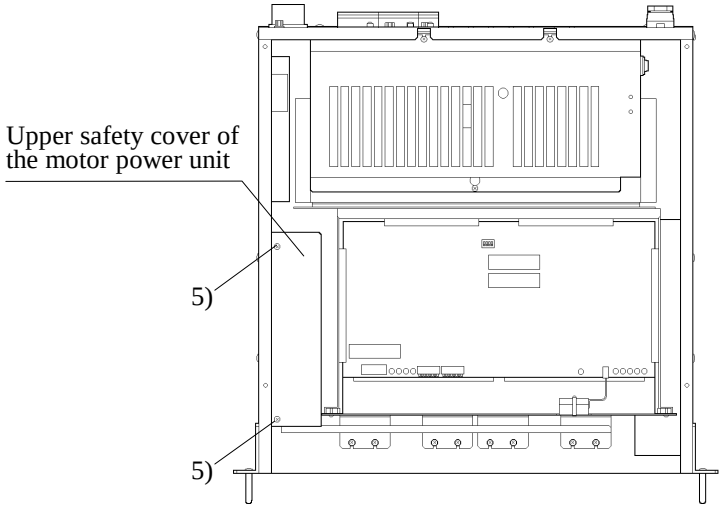
- Only trained personnel should be allowed to perform the following operations. Trained personnel are those who have taken a robot training course (held by the dealer) or those who have carefully read the manuals and have equivalent knowledge or skill.
- Controller has the capacitors charged high voltage. To avoid an electric shock, do not touch the dangerous high-voltage parts marked with the orange label until the orange LED of motor power unit is faded out completely. When the orange LED is faded out, the high-voltage capacitors are discharged.



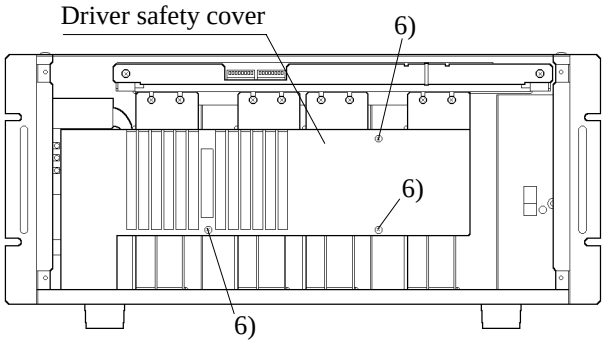
⚠ CAUTION

- Temperature of the AC servo driver, PSU and regenerative brake unit may rise depending on the operating condition. Check the surface temperature before handling and use the protective gloves if necessary.

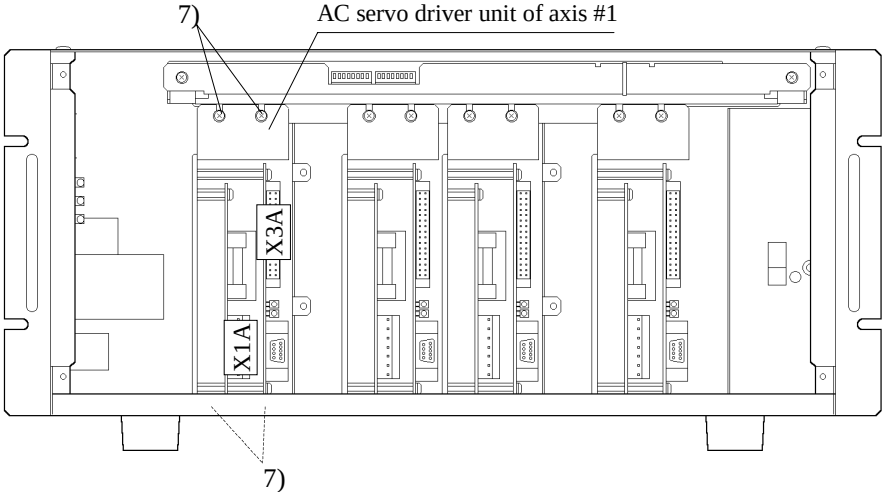
1) Turn the controller OFF and pull out the power plug from the power source.
2) Remove the front panel.
3) Disconnect the earth line and connectors X71 and X73 from the back side of front panel.
4) Remove the upper cover from the controller. As the earth line is connected to the upper cover, do not pull the cover unnecessarily.
5) Remove the upper safety cover of the motor power unit by taking out the two set-screws.



6) Remove the driver safety cover by taking out the three screws.

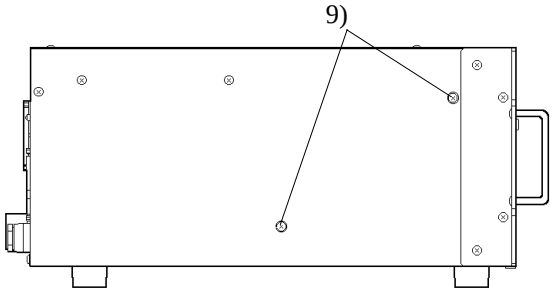


7) Remove the AC servo driver unit of axis #1 (to facilitate replacement of the motor power unit.)
   - Remove the connectors X1A and X3A.
   - Remove the four screws that hold the driver unit in place.
   - Pull the driver unit forward and out from the controller.



8) Remove the connectors X20 to X26 (and X29) of the motor power unit.

9) Remove the screws from two places on the right side of the controller.



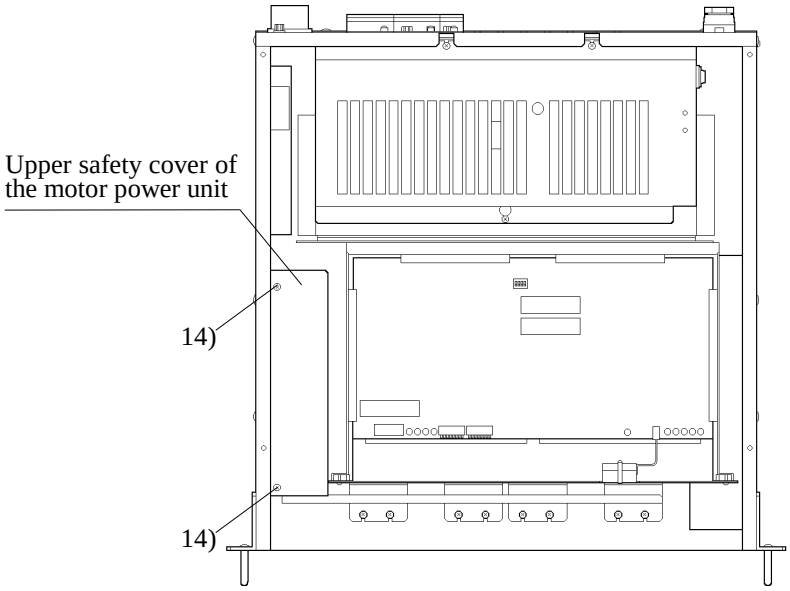
10) Gently pull the motor power unit forward and disconnect the X28 connector.

11) Attach the X28 connector to a new motor power unit.

12) Be careful not to pinch the X73 connector cable while mounting the motor power unit in the controller, and connect the connectors X20 to X26 (and X29).

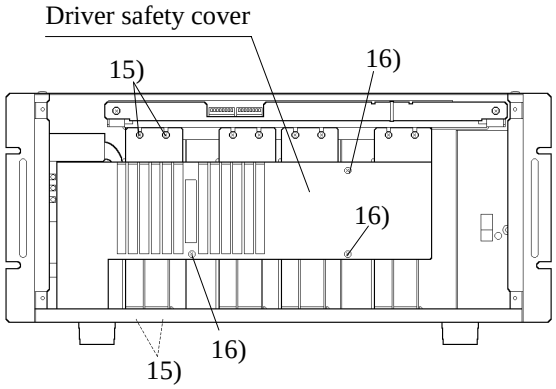
13) Tighten the motor power unit with two screws. (Refer to the figure above.) Be sure not to bend the connected cables forcibly or not to pinch.

14) Attach the upper safety cover of the motor power unit.



15) Return the AC servo driver unit of axis #1. Mount it with the four screws and attach the connectors X1A and X3A. Be sure not to bend the connected cables forcibly or not to pinch.

16) Attach the driver safety cover.



17) Attach the upper cover of the controller.

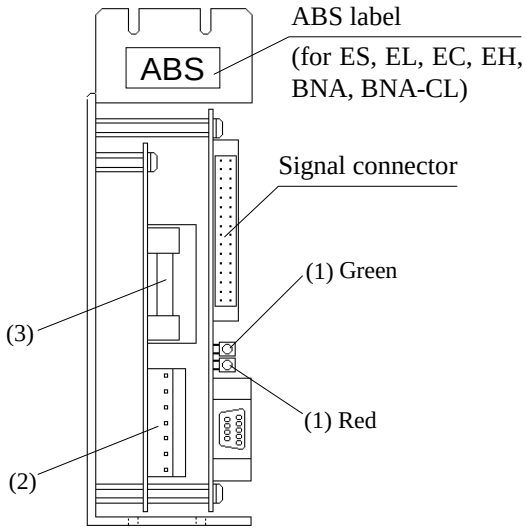
18) After connecting the earth line, connectors X71 and X73 to the front panel, attach the panel to the controller.

WARNING ■ Be sure to reconnect the earth line (yellow/green) to front panel.

19) Refer to “11. Manipulator operation check” in this volume for the remaining steps.

6. AC Servo Driver

6.1 Layout and function of AC servo driver parts



(1) LED

The LED on the front of the AC servo driver shows the following conditions.

Name	Color	Display when lit
POWER	Green	5V power supply being input
ALARM	Red	Being in error condition

(2) Power connectors (X1A ~ X1D)

Pin assignments for the power connectors are shown below.

Pin No.	Wire color	Signal name	Content
1	Brown	Motor; W-phase	Connect to W-phase of motor
2	Red	Motor; V-phase	Connect to V-phase of motor
3	Orange	Motor; U-phase	Connect to U-phase of motor
4	-	-	N. C.
5	Black	DC0V	Main circuit power supply common (0 volts DC)
6	Yellow	DC300V	Motor main circuit power supply
7	Green/yellow	F. GND	Frame ground

(3) Fuse

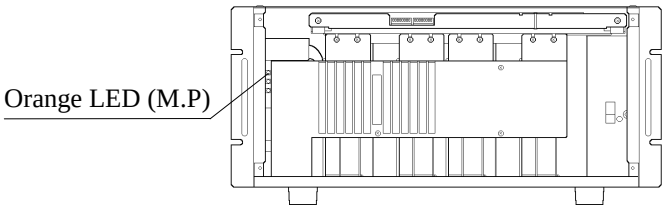
The AC servo driver is equipped with a fuse to protect against over-current from the motor main power supply.

6.2 AC servo driver inspection

Inspect the AC servo driver by following the steps below.

⚠ WARNING

- Only trained personnel should be allowed to perform the following operations. Trained personnel are those who have taken a robot training course (held by the dealer) or those who have carefully read the manuals and have equivalent knowledge or skill.
- Controller has the capacitors charged high voltage. To avoid an electric shock, do not touch the dangerous high-voltage parts marked with the orange label until the orange LED of motor power unit is faded out completely. When the orange LED is faded out, the high-voltage capacitors are discharged.



⚠ CAUTION

- Temperature of AC servo driver unit may rise depending on the operating condition. Check the surface temperature before handling and use the protective gloves if necessary.

1) Turn OFF the controller and remove the front panel. (Do not disconnect the connectors from the back of front panel.)
2) Check that the connectors attached to the AC servo driver units are securely attached. If the connection is loose, reconnect it securely.
3) With the front panel off, turn the controller ON and execute the MOTOR ON command. If the state of the LED lamps located on the front of the AC servo drivers is as shown below, the AC servo drivers have no problem.

   The green LED is lit.
   The red LED is off.

   If the green LED is off, power is not supplied to the AC servo driver. There are possibilities that power connector's connection is not correct, or the AC servo driver's malfunction.
   If the red LED is lit, control power supply (±5V, +24V) is improper. Find the part of malfunction referring the section of PSU inspection, and eliminate the cause.
4) If the state of the LED lamps has no problem, execute the MOTOR ON command and the motion command. If the robot moves properly, the inspection is now completed.

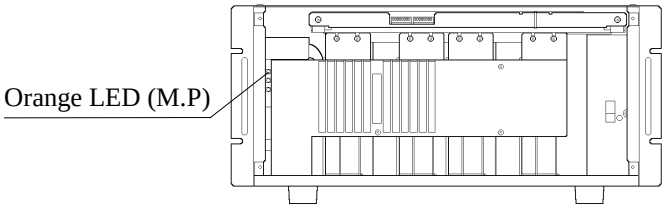
   If an error occurs and the red LED on the AC servo driver turns ON when using the MOTOR ON or motion command, refer to "15. Error Code Table" in this volume and eliminate the cause of error.

6.3 AC servo driver replacement

If the AC servo driver is not functioning properly, replace it by following the steps below. The steps are same for each driver.

⚠ WARNING

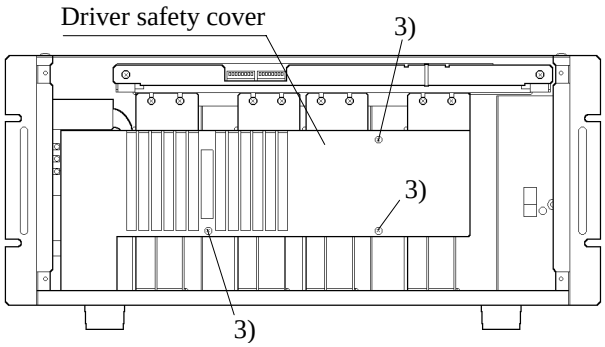
- Only trained personnel should be allowed to perform the following operations. Trained personnel are those who have taken a robot training course (held by the dealer) or those who have carefully read the manuals and have equivalent knowledge or skill.
- Controller has the capacitors charged high voltage. To avoid an electric shock, do not touch the dangerous high-voltage parts marked with the orange label until the orange LED of motor power unit is faded out completely. When the orange LED is faded out, the high-voltage capacitors are discharged.



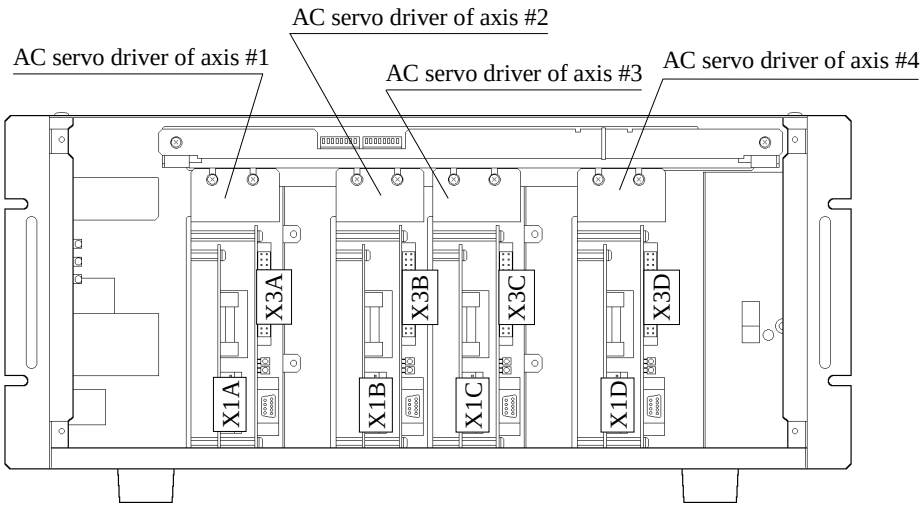
⚠ CAUTION

- Temperature of AC servo driver unit may rise depending on the operating condition. Check the surface temperature before handling and use the protective gloves if necessary.
- Check the model name and mount it on proper location when replace the AC servo driver.

1) Turn OFF the controller, pull out the power plug from the power source.
2) Remove the front panel and disconnect the earth line, the connectors X71 and X73 from the back side of the front panel.
3) Remove the driver's safety cover by taking out the three set-screws.

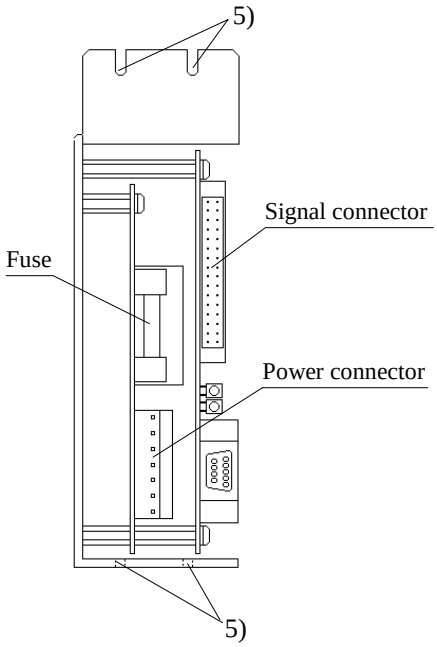


4) Disconnect the driver's power connector (X1A, X1B, X1C or X1D) and signal connector (X3A, X3B, X3C or X3D).



5) Remove the four upper and lower screws that hold the driver in place, then pull the driver out.

6) Use a tester to check whether the fuse of the driver that you removed is blown. A blown fuse may indicate a short-circuited motor power line. Therefore, before replacing the driver, inspect the motor and the motor power line.



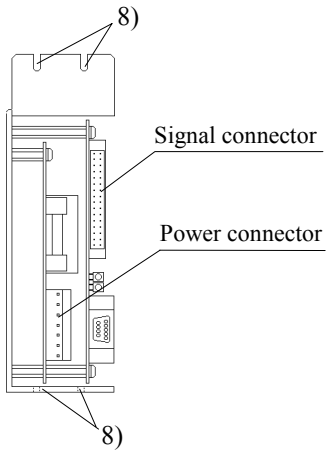
7) Attach the power connector and signal connector to a new driver.
The capacitance is different depending on the manipulator model and the axis. Make sure of the driver model which is indicated on the label attached to the side surface.
The corresponding driver to each manipulator is listed in the following table.

Manipulator	Axis	Capacitance	Old code	New code	Driver model
EC	1, 2, 3	100 W	ZA007109	R13ZA00710900	CACR-01-SU23GC ABS
	4	50 W	ZA007108	R13ZA00710800	CACR-A5-SU23GC ABS
ES	1	200 W	ZA007110	R13ZA00711000	CACR-02-SU23GC ABS
	2, 3, 4	100 W	ZA007109	R13ZA00710900	CACR-01-SU23GC ABS
EL	1	400 W	ZA007111	R13ZA00711100	CACR-04-SU23GC ABS
	2	200 W	ZA007110	R13ZA00711000	CACR-02-SU23GC ABS
	3, 4	100 W	ZA007109	R13ZA00710900	CACR-01-SU23GC ABS
EH	1	400 W	ZA007111	R13ZA00711100	CACR-04-SU23GC ABS
	2, 3	200 W	ZA007110	R13ZA00711000	CACR-02-SU23GC ABS
	4	100 W	ZA007109	R13ZA00710900	CACR-01-SU23GC ABS
BN	1	200 W	ZA007104	R13ZA00710400	CACR-02-SU23GC
	2, 3	100 W	ZA007103	R13ZA00710300	CACR-01-SU23GC
	4	50 W	ZA007102	R13ZA00710200	CACR-A5-SU23GC
BNA(-CL)	1	200 W	ZA007110	R13ZA00711000	CACR-02-SU23GC ABS
	2, 3	100 W	ZA007109	R13ZA00710900	CACR-01-SU23GC ABS
	4	50 W	ZA007108	R13ZA00710800	CACR-A5-SU23GC ABS
BL(-CL)	1	400 W	ZA007105	R13ZA00710500	CACR-04-SU23GC
	2, 3	200 W	ZA007104	R13ZA00710400	CACR-02-SU23GC
	4	100 W	ZA007103	R13ZA00710300	CACR-01-SU23GC
XM3000	J1	700 W	ZA007106	R13ZA00710600	CACR-08-SU23GC
	J2	400 W	ZA007105	R13ZA00710500	CACR-04-SU23GC
	J3	100 W	ZA007103	R13ZA00710300	CACR-01-SU23GC
	J4	50 W	ZA007102	R13ZA00710200	CACR-A5-SU23GC
RT3300	1, 2, 3	400 W	ZA007105	R13ZA00710500	CACR-04-SU23GC
	4	50 W	ZA007102	R13ZA00710200	CACR-A5-SU23GC

NOTE

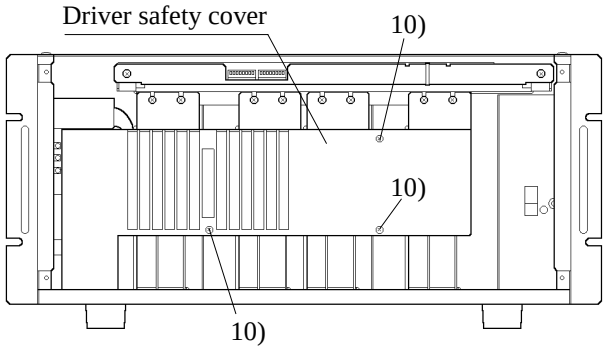
Attach the power connector correctly. If connected pins are in different position, the earth leakage breaker of your factory may trip, and the controller may be damaged.

8) Mount the driver to the controller and secure it with the four set-screws. Be sure not to bend the connected cables forcibly or not to pinch.



9) Connect the power connector and the signal connector to the driver.

10) Attach the driver safety cover.



11) After connecting the earth line, the connectors X71 and X73 to the front panel, install the front panel to the controller.

WARNING

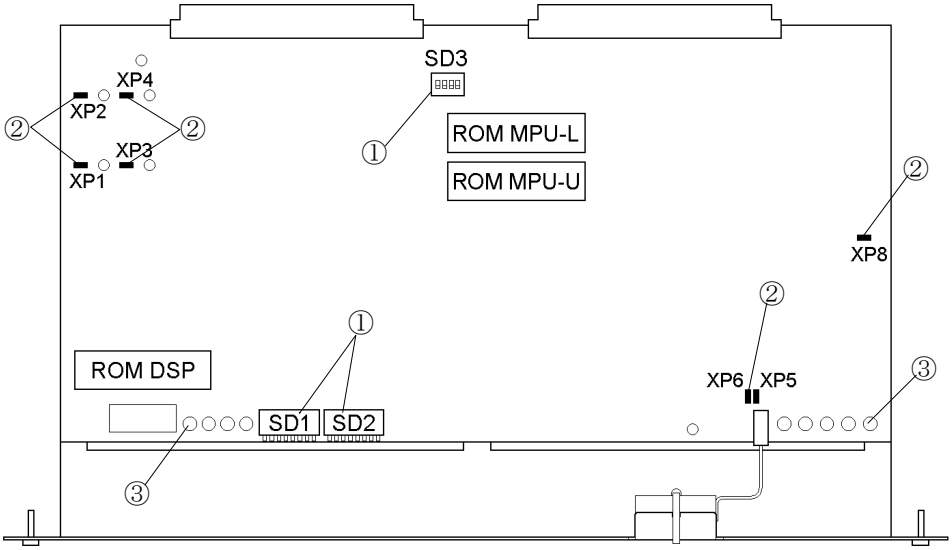
- Be sure to reconnect the earth line (yellow/green) to front panel.

12) Refer to “11. Manipulator operation check” in this volume for the remaining steps.

7. MPU board

7.1 Layout and function of MPU board parts

The MPU board executes programs and controls the manipulator.



① DIP switches

The DIP switches are used to set various software functions. The functions are as follows.

SD1

Bit No.	Function	ON	OFF
1	System initialization	Initializes CPU control data when power is turned on	Does not initialize
2	(Reserved for system)	-	(Always off)
3 to 8 (A~E)	Setting of manipulator model	(Do not change these settings)	

SD2

Bit No.	Function	ON	OFF
1 (M)	Use of additional RAM	Yes	No
2 (V)	Sets capacity of main memory and file memory when you add additional RAM	Main memory : 374KB File memory : 900KB	Main memory : 174KB File memory : 1.1MB
3	(Reserved for system)	-	(Always off)
4	(Reserved for system)	-	(Always off)
5 (X)	Use of axis #1	Yes	No
6 (Y)	Use of axis #2	Yes	No
7 (Z)	Use of axis #3	Yes	No
8 (U)	Use of axis #4	Yes	No

SD3

Bit No.	Function	ON	OFF
1 to 4	(Reserved for system)	-	(Always off)

DIP switches have been correctly set at the factory on the basis of your specifications. Careless changes to these settings could cause system failure. Please be careful not to change the setting of bits which are shown as "(Reserved for system)."

When replacing the MPU board, DIP switches of a new board have to be set the same way as the current board. You can display the current settings of the DIP switches using the SPEL Editor or SPEL for Windows. Before replacement, it is better to display and record the current settings just in case. See the SPEL Editor manual or SPEL for Windows manual for information on how to display the settings. The shaded cells in the tables above are standard factory settings.

② Jumper pins

Jumper pins are used to set various hardware functions.

Notation	Function	Setting
XP1 to 4	(Reserved for system)	(Differs by model)
XP5	Backup power supply	Jump
XP6	Backup power supply for additional RAM	Jump when there is additional RAM
XP8	(Reserved for system)	(Differs by model)

Jumper pins have been correctly set at the factory on the basis of your specification. Careless changes to these settings could cause system failure. Be careful not to change the setting of jumper pins which are shown as "(Reserved for system)."
When replacing the MPU board, jumper pins of a new board have to be set as same as the current board.

③ LED

The functions of the LED on the MPU board are shown below.

Notation	Name	Color	Functions
HL1	RES	Red	Comes on when the CPU is reset
HL2	HALT	Red	Comes on when the CPU is the halt state
HL3	WDT	Red	Comes on when the watchdog timer is operating
HL4	-	Yellow	Displays the status of CPU operations
HL5	-	Yellow	Blinks at regular intervals when MPU is operating normally

You can change the functions of HL 6 ~ 9 as follows by resetting SD3-1.
(SD3-1 is set to the off position at the factory.)

Notation	Name	Color	Functions	
			Bit 1 of SD3 is Off	Bit 1 of SD3 is On
HL6	X	Green	Comes on in low power mode	Axis #1 servo end
HL7	Y	Green	Comes on when manipulator stops	Axis #2 servo end
HL8	Z	Green	Comes on when MCAL and MCORG commands are executed	Axis #3 servo end
HL9	U	Green	Comes on when a servo-related error occurs	Axis #4 servo end

7.2 Lithium battery inspection and replacement

The data such as programs, point data, and settings are stored in RAM on the MPU board. Lithium battery supplies DC power to the RAM to maintain this data when controller power off.

NOTE

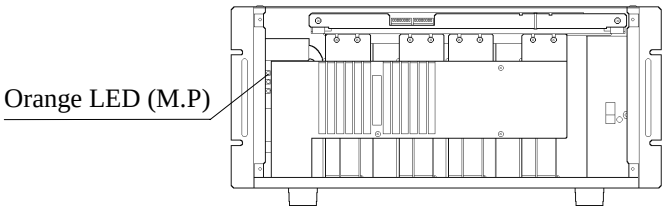
When the voltage of the lithium battery on the MPU board falls, error 49 occurs. When the error occurs, back up all of the data immediately before it is lost.
Refer to SPEL Editor manual or SPEL for Windows manual for how to back up .

NOTE

When replacing lithium battery, follow the steps below after backing up data.

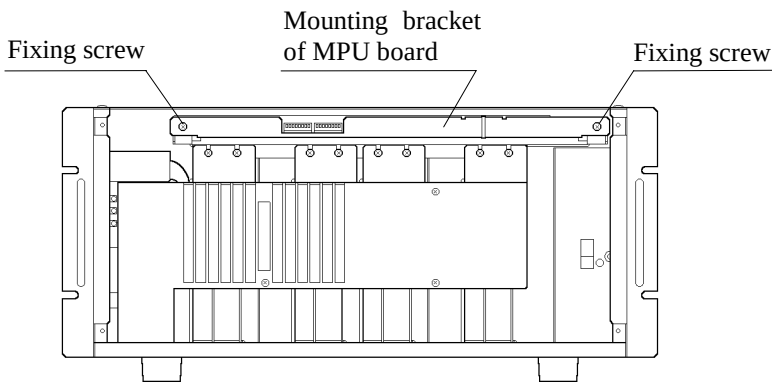
⚠ WARNING

- Only trained personnel should be allowed to perform the following operations. Trained personnel are those who have taken a robot training course (held by the dealer) or those who have carefully read the manuals and have equivalent knowledge or skill.
- Controller has the capacitors charged high voltage. To avoid an electric shock, do not touch the dangerous high-voltage parts marked with the orange label until the orange LED of motor power unit is faded out completely. When the orange LED is faded out, the high-voltage capacitors are discharged.



1) Turn OFF the controller and remove the front panel. (Do not disconnect the connectors from the back side of front panel.)

2) Loosen the two screws that fasten the MPU board's mounting bracket, then pull out the mounting bracket forward horizontally. Be careful not to pull the screws, or they will be removed from the mounting bracket.

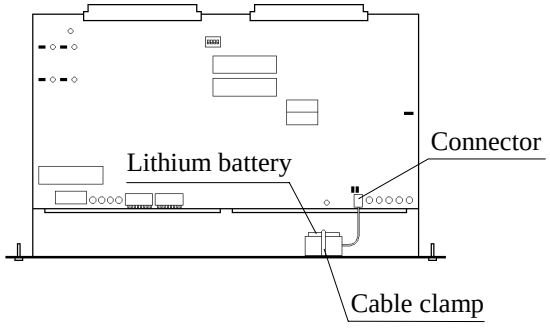


NOTE

MPU board should be placed on an insulator.

3) Use a tester to measure the voltage between the pins of the lithium battery's connector

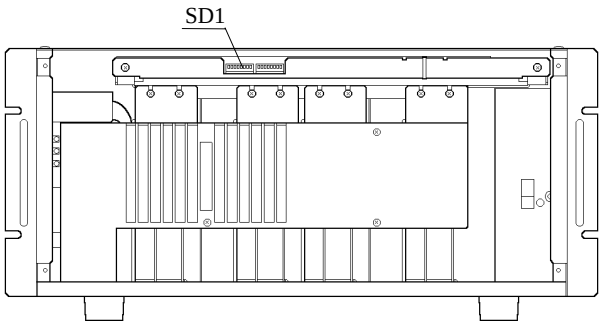
on the board. If the measured voltage is below 3.4V*, the battery is dead or flat. Replace it with a new one. When removing the old battery, cut off the clamp that is holding the battery and, disconnect the connector. Connect the new battery to the connector and, secure it with clamp.



* When the error 49 (low battery voltage) is issued, if a voltage is 3.4V or more, it could mean a failure of the voltage detection circuit. Mount the MPU board in the controller, fix it securely, and turn on the power, then check again whether an error is displayed. If an error occurs, replace the MPU board. See the next section to replace the MPU board.

4) Insert the MPU board in the specified slot and push it in firmly. Tighten fixing screws of mounting bracket of MPU board.

5) Turn on bit 1 of the MPU board's DIP switch (SD1), then turn ON the controller. The controller is initialized by this step.



Look at the controller's front panel and check that:

- The E.STOP LED and S.ERR LED are off.
- Error No. is not displayed.
- The TEACH LED or AUTO LED is lit.

6) Turn OFF the controller. Then, after setting bit 1 of the DIP switch (SD1) to the off position, install the front panel on the controller.

7) Turn ON the controller again, execute the following commands:

NEW	Deletes the source program
CLEAR	Clears the position data
VERINIT	Initializes the system parameters
FORMAT	Formats the file memory

8) Restore all of backed-up data. Refer to the SPEL Editor manual or SPEL for Windows for how to restore.

7.3 MPU board and/or ROM replacement

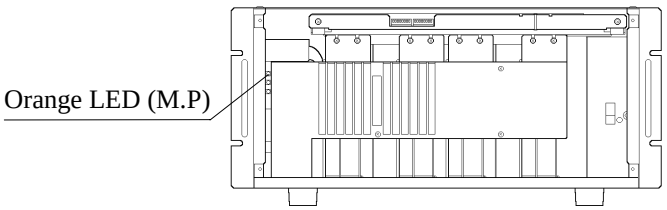
The data such as programs, point data and settings are stored in RAM on the MPU board. When replace ROM chips or MPU board the data have to be backed up before replacement.

NOTE ☞ Before replacing ROM chips or MPU board, back up all of the data.
Refer to SPEL Editor manual or SPEL for Windows manual for how to back up.

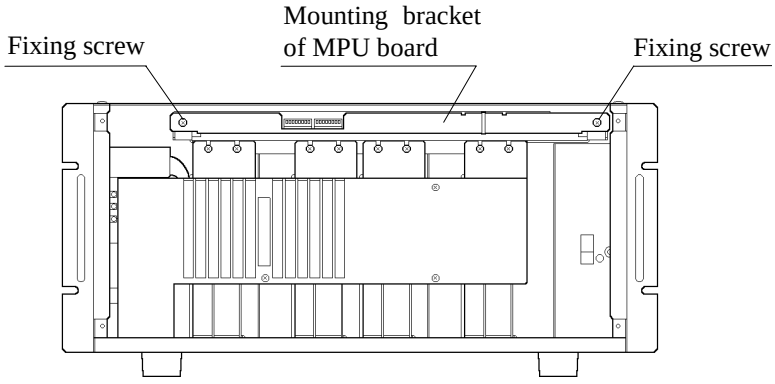
Replace MPU board or the parts in question by following the steps below.

⚠ WARNING

- Only trained personnel should be allowed to perform the following operations. Trained personnel are those who have taken a robot training course (held by the dealer) or those who have carefully read the manuals and have equivalent knowledge or skill.
- Controller has the capacitors charged high voltage. To avoid an electric shock, do not touch the dangerous high-voltage parts marked with the orange label until the orange LED of motor power unit is faded out completely. When the orange LED is faded out, the high-voltage capacitors are discharged.

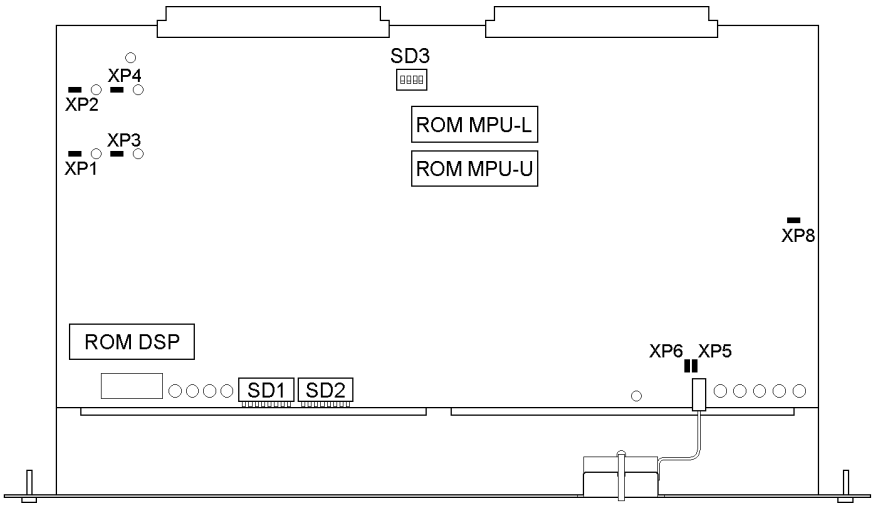


1) Turn OFF the controller and remove the front panel. (Do not disconnect the connectors from the back side of front panel.)
2) Loosen the two screws that fasten the MPU board's mounting bracket, then pull out the mounting bracket forward horizontally. Be careful not to pull the screws, or they will be removed from the mounting bracket.



NOTE ☞ MPU board should be placed on an insulator.

3) ROM replacement:
When replacing the ROM, be careful not to touch any other devices on the board and not to damage the board.
The MPU board has three ROM chips. Names of ROM such as MPU-L, MPU-U and DSP are printed beside ROM sockets. ROM chips have labels on which ROM names and versions are written. Refer to the following.

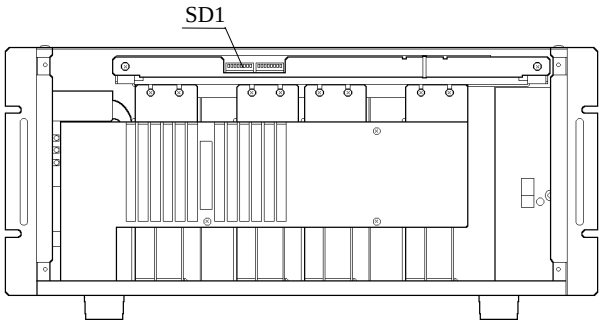


Check the version of the new ROM chips and the position to which it is to be mounted, then mount it on to the board. Be certain to attach the ROM chips in the correct direction by aligning the hollows of the ROM chips and sockets.

When replacing the MPU board:
Transfer the ROM from the old board to the new. Set the new board's DIP switches and jumper pins to the same position as those on the old board.

4) Insert MPU board in the specified slot and push it in firmly. Tighten fixing screws of mounting bracket of MPU board.

5) Turn on bit 1 of the MPU board's DIP switch (SD1), then turn ON the controller. The controller is initialized by this step.



Look at the controller's front panel and check that:
- The E.STOP LED and S.ERR LED are off.
- Error No. is not displayed.
- The TEACH LED or AUTO LED is lit.

6) Turn OFF the controller. Then, after setting bit 1 of the DIP switch (SD1) to the off position, install the front panel on the controller.

7) Turn ON the controller again, execute the following commands:

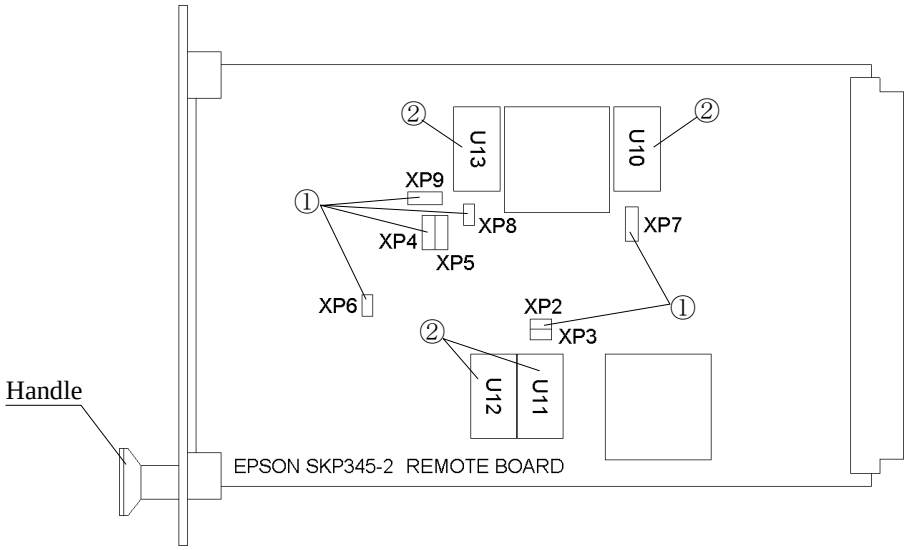
NEW	Deletes the source program
CLEAR	Clears the position data
VERINIT	Initializes the system parameters
FORMAT	Formats the file memory

8) Restore all of backed-up data. Refer to the SPEL Editor manual or SPEL for Windows for how to restore.

8. REMOTE Board

8.1 Layout and function of REMOTE board parts

The REMOTE board controls 7-segment display of the front panel as well as REMOTE1, REMOTE2 and RS-232C #20 and #21.



① Jumper pins (XP2 to 8)

The functions of the jumper pins are described in the table below. Do not change the setting of XP1.

Pin No.	Function when shorted	Setting
XP2	Also outputs for emergency stop occurrence	Open
XP3	Also outputs for error occurrence	Open
XP4	1 - 2 : Latches the state of “safeguard open”	Jump 1 and 2
XP5	2 - 3 : Does not latch the state of “safeguard open”	
XP6	Uses one-contact safeguard switch	Open
XP7	1 - 2 : Outputs the safeguard status that CPU recognized 2 - 3 : Outputs the actual safeguard status	Jump 1 and 2
XP8	(Reserved for system)	Open
XP9	Factory-set and fixed	Jump 2 and 3

② RS-232C driver IC (U10 to 13)

IC No.	Name	Used for
U10	MC145406P	TEACH interface
U11		RS-232C #21 interface
U12		RS-232C #20 interface
U13		REMOTE2 (OPU) interface

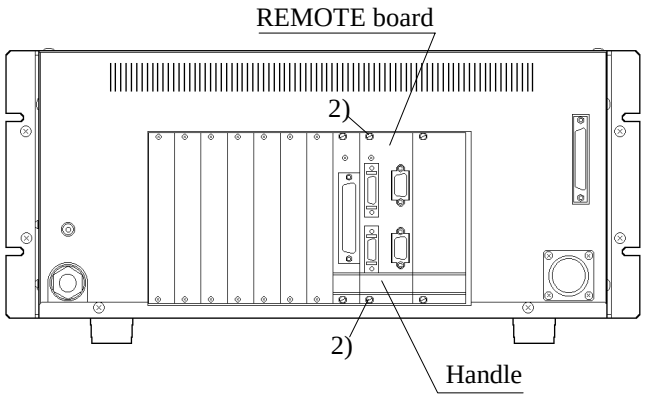
8.2 REMOTE board and parts replacement

⚠ CAUTION

- When connecting or disconnecting the REMOTE board make sure the power is turned OFF.
- Mount REMOTE board in fixed slot (labeled “REMOTE”).

If the REMOTE board is not functioning properly, replace it or the parts in question by following the steps below.

1) Turn OFF the controller and disconnect all the connectors that are attached to the REMOTE board.
2) After loosening the remote board’s upper and lower set-screws, pull the board out by the handle.

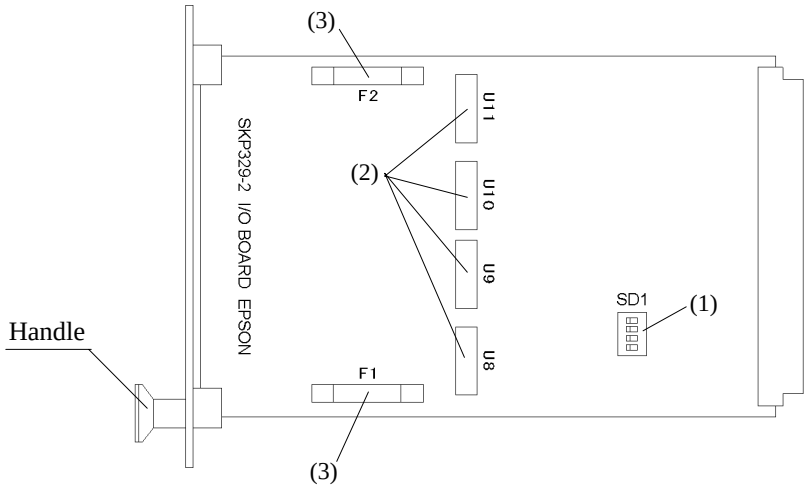


3) If you are replacing the entire board, set the jumper pins of the new board in the same way as those on the old board.
   If you are replacing the RS-232C driver, pull it out of the IC socket, being careful not to touch the surrounding devices. Mount the new IC, being sure to place it in the proper direction.
4) Insert the REMOTE board in the specified slot (labeled “REMOTE”) and push it in firmly. Tighten the upper and lower set-screws.
5) Reconnect the connectors.

9. I/O Board

9.1 Layout and functions of I/O board parts

Each I/O board controls 16 inputs and 16 outputs.



(1) DIP switch (SD1)

Assign the bit numbers of each I/O board by setting the bits of DIP switch SD1 as shown in the table below.

	I/O No.	Bit No.	DIP switch	Slot assignment
Board 1	I/O-1	0 to 15	Turn all off	I/O slot
Board 2	I/O-2	16 to 31	Turn 1 on	OP1 slot
Board 3	I/O-3	32 to 47	Turn 2 on	OP2 slot
Board 4	I/O-4	48 to 63	Turn 1 & 2 on	OP3 slot
Board 5	I/O-5	64 to 79	Turn 3 on	OP4 slot
Board 6	I/O-6	80 to 95	Turn 1 & 3 on	OP5 slot
Board 7	I/O-7	96 to 111	Turn 2 & 3 on	OP6 slot
Board 8	I/O-8	112 to 127	Turn 1, 2 & 3 on	OP7 slot

(2) Output transistor array (U8 to 11)

A transistor array that drives output ports. The transistor array is replaceable since it is mounted in the IC socket. Table below shows the I/O bit numbers and their correspondence to the IC No.

	U8	U9	U10	U11
Board 1	0 to 3	4 to 7	8 to 11	12 to 15
Board 2	16 to 19	20 to 23	24 to 27	28 to 31
Board 3	32 to 35	36 to 39	40 to 43	44 to 47
Board 4	48 to 51	52 to 55	56 to 59	60 to 63
Board 5	64 to 67	68 to 71	72 to 75	76 to 79
Board 6	80 to 83	84 to 87	88 to 91	92 to 95
Board 7	96 to 99	100 to 103	104 to 107	108 to 111
Board 8	112 to 115	116 to 119	120 to 123	124 to 127

(3) Fuses (F1, F2)

The fuses protect the internal circuitry from output port misconnections.

Please use the following fuse.

Standard: ULCS-61M-2 (2A)

The following table shows I/O bit numbers which the fuses protect.

	F1	F2
Board 1	0 to 7	8 to 15
Board 2	16 to 23	24 to 31
Board 3	32 to 39	40 to 47
Board 4	48 to 55	56 to 63
Board 5	64 to 71	72 to 79
Board 6	80 to 87	88 to 95
Board 7	96 to 103	104 to 111
Board 8	112 to 119	120 to 127

9.2 I/O board and parts replacement

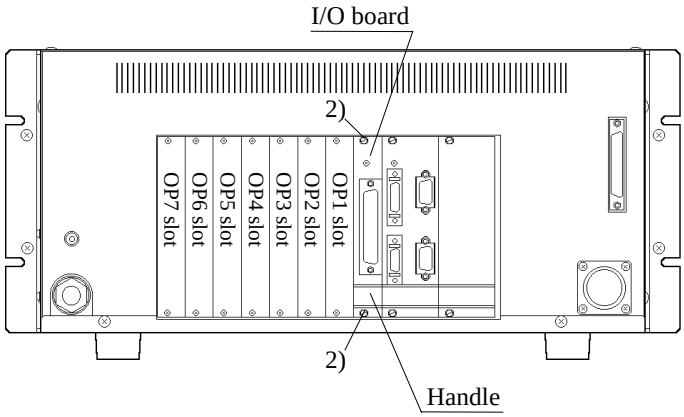
CAUTION

- When connecting or disconnecting the I/O board make sure the power is turned OFF.
- Mount I/O boards in fixed slots.

If the I/O board is not functioning properly, replace it or its parts by following the steps below.

1) Turn OFF the controller and disconnect the I/O connectors that are attached to the I/O board.

2) After loosening the I/O board's upper and lower set-screws, pull the board out by the handle.



3) If you are replacing the entire board, set the DIP switch (SD1) in the same way as on the original board and affix the attached I/O number label to the designated spot on the handle.
When you are replacing a fuse or the transistor array, simply replace the part in question without changing the settings on the DIP switch.

4) Firmly insert the I/O board into the original slot and tighten the upper and lower set-screws.

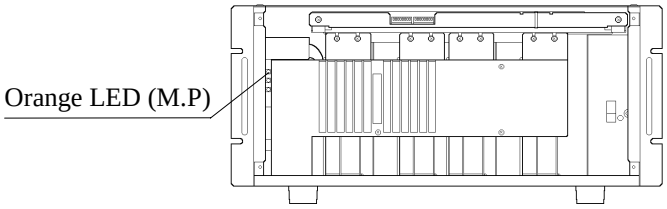
5) Connect the I/O connectors.

10. Regenerative Brake Unit (for EL, EH, BL, XM3000 series)

The controller for EL, EH, BL and XM3000 series has a regenerative brake unit.
If the regenerative brake unit is not operating properly, replace it by following the steps below.

⚠ WARNING

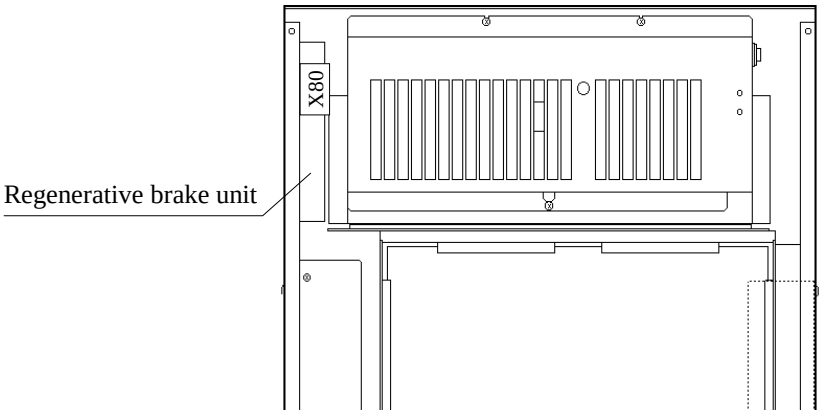
- Only trained personnel should be allowed to perform the following operations. Trained personnel are those who have taken a robot training course (held by the dealer) or those who have carefully read the manuals and have equivalent knowledge or skill.
- Controller has the capacitors charged high voltage. To avoid an electric shock, do not touch the dangerous high-voltage parts marked with the orange label until the orange LED of motor power unit is faded out completely. When the orange LED is faded out, the high-voltage capacitors are discharged.



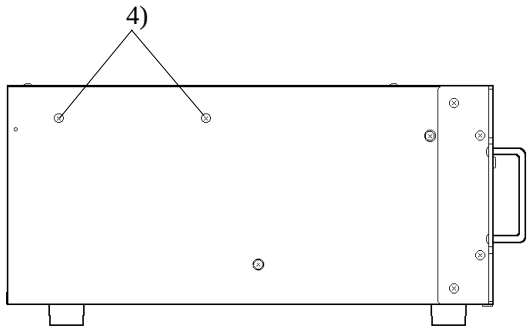
⚠ CAUTION

- Temperature of the regenerative brake unit, PSU unit and AC servo driver may rise depending on the operating condition. Check the surface temperature before handling and use the protective gloves if necessary.

1) Remove the controller's upper cover and rear panel. As the ground wire is connected to the upper cover and rear panel, do not pull them unnecessary.
2) Turn OFF power to the controller and check the orange LED (M. P) on the front of the motor power unit is faded out completely.
3) Disconnect the X80 connector on the regenerative brake unit.



4) Remove the two screws that fasten the regenerative brake unit on the right side of the controller, and take out the regenerative brake unit backward.



5) Mount the new regenerative brake unit in the controller with the two screws. Be sure not to bend the cables forcibly or not to pinch.

6) Connect the X80 connector to the regenerative brake unit.

7) Attach the upper cover and rear panel of the controller.

8) For the operation confirmation after replacement, see the following chapter “11. Manipulator Operation Check.”

11. Manipulator Operation Check

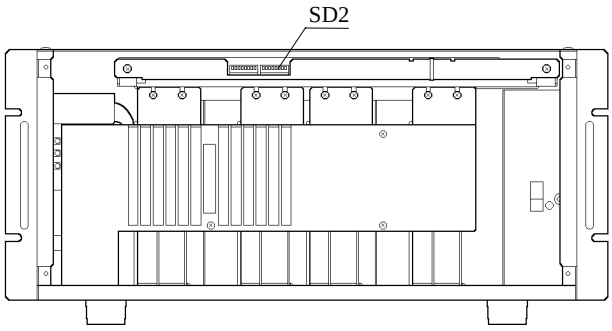
⚠ WARNING

■ Only trained personnel should be allowed to perform the following operations. Trained personnel are those who have taken a robot training course (held by the dealer) or those who have carefully read the manuals and have equivalent knowledge or skill.

Here we explain how to check the operation of the manipulator after you have replaced boards, units or other items. If an abnormality occurs during the check, reinspect the part that was replaced.

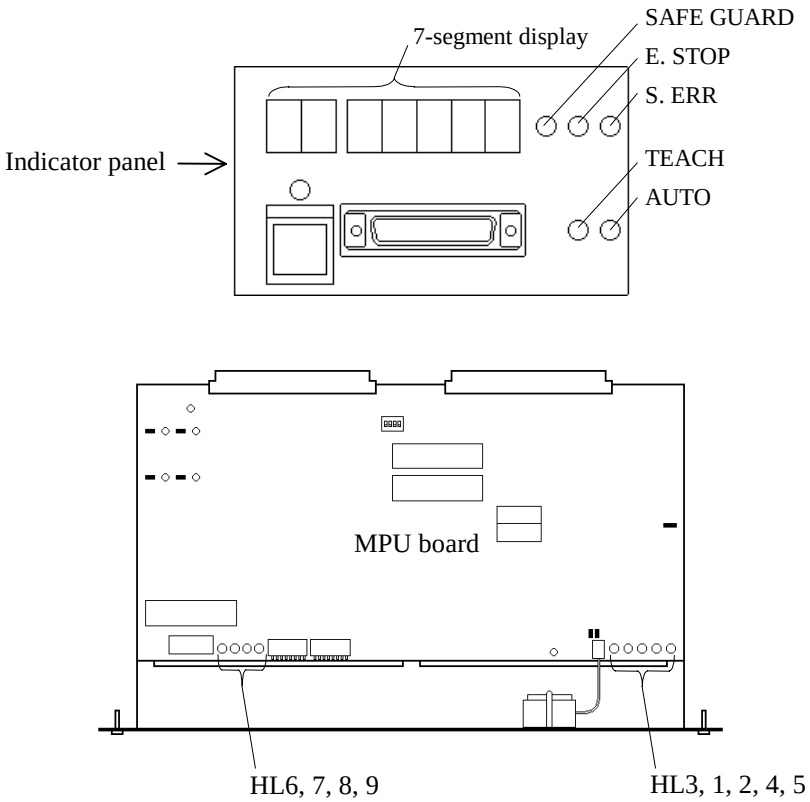
1) Recheck the cables and connectors to or in the vicinity of the parts that you replaced. Turn off the controller and remove the front panel.

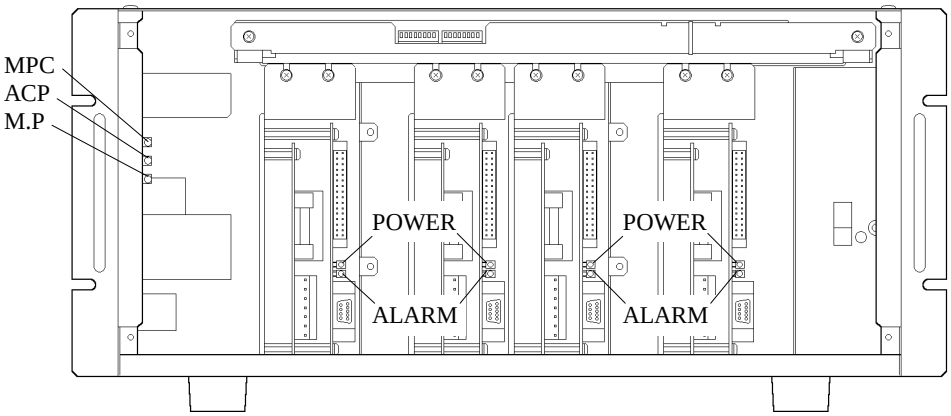
2) Turn off bits 5 to 8 of the MPU board's DIP switch SD2. (Nonuse of axis setting. Refer to the table of step 5.)



3) Turn on the controller and check the LED status in the following table.

Check point		Color	Status
Front panel (Indicator panel)	S.ERR	Red	Off
	E.STOP	Red	Off (when E. STOP is not input)
	SAFE GUARD	Orange	Off（when SAFE is not input）
	TEACH/AUTO	Green	Either TEACH or AUTO is lit
	7-segment display	Green	All display "0"
MPU board	HL1(RES)	Red	Off
	HL2(HALT)	Red	Off
	HL3(WDT)	Red	Off
	HL4	Yellow	lit
	HL5	Yellow	Blinking
	HL6(X)	Green	lit
	HL7(Y)	Green	lit
	HL8(Z)	Green	Off
	HL9(U)	Green	Off
AC servo driver	POWER	Green	lit
	ALARM	Red	Off
Motor power unit	M.P	Orange	Dimly lit
	ACF	Green	lit
	MPC	Green	Off





4) Turn OFF the controller.

5) Use bits 5 to 8 of the MPU board's DIP switch (SD2) to set only the axis whose operation you are to check to "exists." The setting of "exists" of each axis is shown below.

bit	5	6	7	8
Axis #1 only "exists"	**ON**	OFF	OFF	OFF
Axis #2 only "exists"	OFF	**ON**	OFF	OFF
Axis #3 only "exists" *	OFF	OFF	**ON**	**ON**
Axis #4 only "exists" *	OFF	OFF	**ON**	**ON**

* Always set as both axis #3 and axis #4 exist even if you only check the operation of one of them.

NOTE Perform the following check steps from a position in which you can immediately press the emergency stop button.

6) Turn ON the controller.
   Execute the MOTOR ON command and check that:
   - No error is displayed.
   - Click sound (when it's relayed) of the motor power unit in the controller is heard.
   - No unexpected motion occurs. Manipulator is excited normally.

7) Perform the steps 4) to 6) for the other axes and check that they magnetize normally.

8) After confirming that all axes excite normally, set all the bits 5 to 8 of the DIP switch (SD2) to on and install the front panel on the controller.

9) Input TSPEED to confirm the specified value. For the safety reasons, set TSPEED 1.

10) For BN, BL, BL-CL, XM3000 and RT3300 series, execute MCAL command and check the robot operates normally. If the error 237 occur when you execute the MCAL command, turn the controller off, turn the axis #4 between 180° and 360° and perform steps 6) to 9) again.

11) Execute JUMP and other operation commands to check whether the manipulator stops in the correct position.

12) If the position is correct, set TSPEED as you confirmed in the step 9).

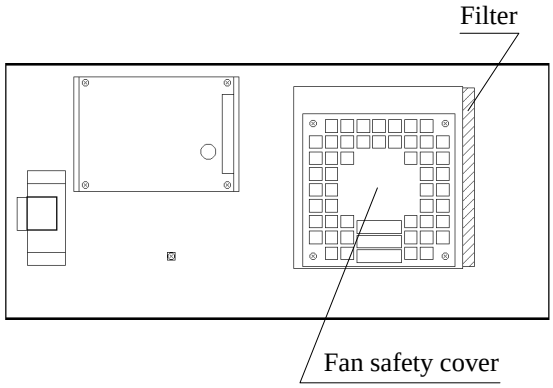
12. Cooling Fan

12.1 Fan inspection

Inspect the fan (clean the filter) by following the steps below.

1) Turn OFF the controller and remove the front panel. Do not disconnect the cables from the back side of the front panel.

2) Pull out the fan's filter. It is attached to the back of the front panel. Clean it by vacuum cleaner or wash and dry.



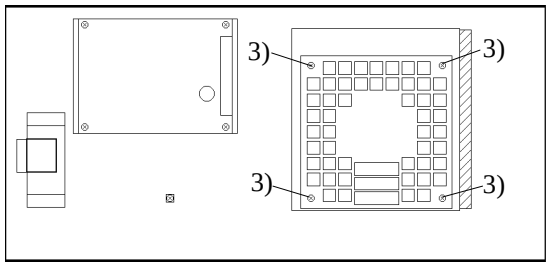
3) Turn ON the controller, with the front panel off. Check that the fan runs properly.

4) Install fan's filter to its original position, and install the front panel on the controller.

12.2 Fan replacement

If the fan is not operating properly, replace it by following the steps below.

1) Turn OFF the controller and remove the front panel.
2) Disconnect the X73 connector from the fan. Do not disconnect the earth line and X71 connector.
3) Unscrew the four screws that hold the fan in place. Remove the fan and fan safety cover. Spring washer and flat washer are used with the screw, do not lose them.



4) Install a new fan together with the fan safety cover. Attach the fan safety cover to the side of the fan's motor cable, and connect the X73 connector.
5) With the front panel off, turn ON the controller and check to see that the fan runs properly.
6) Reattach the front panel.

13. Front board

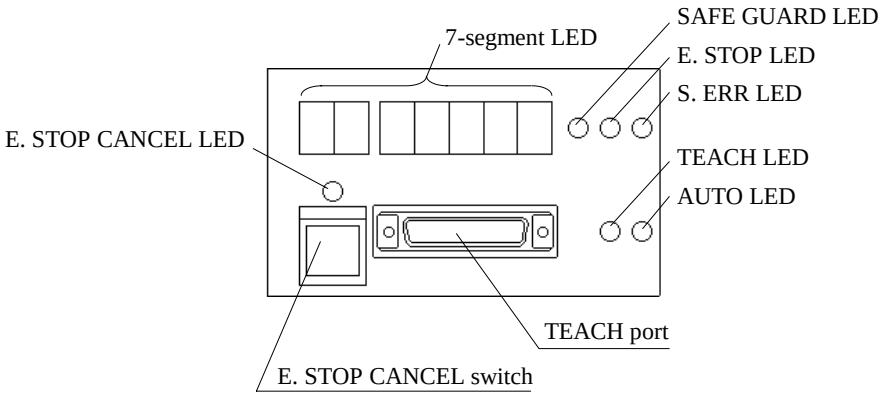
13.1 Front board inspection

1) Check that the following displays on the front panel function properly.

Checkpoint	Notation	Color	What to check
7-segment display	HL1 to 7	Green	The line numbers are correctly displayed when the program is executed.
S.ERR LED	HL8	Red	Off
AUTO LED	HL 9	Green	The LED is lit during AUTO mode.
TEACH LED	HL10	Green	The LED is lit during TEACH mode.
E.STOP LED	HL11	Red	The LED is lit by the emergency stop input from either the REMOTE1, REMOTE2 or TEACH connectors.
SAFE GUARD LED	HL12	Orange	The LED is lit by the safeguard open signal input.

2) Check whether the E. STOP CANCEL switch works by checking the following:

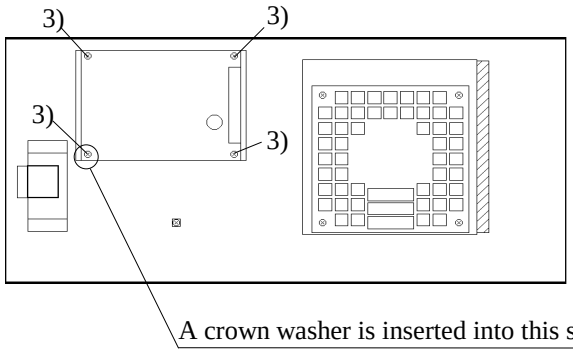
- While pressing the E. STOP CANCEL switch when the manipulator is not in the emergency stop state, unplug the connector from the TEACH port. The manipulator should not enter the emergency stop state. The E. STOP CANCEL LED should come on.
- In this state, when you remove your finger from the E. STOP CANCEL switch, it should be in the emergency stop state.



13.2 Front board replacement

If the front board is not operating properly, replace it by following the steps below.

1) Turn the controller OFF and remove the front panel.
2) Disconnect the connectors X71 and X72 from the front board. (Do not disconnect the ground wire attached to the front panel and the X73 connector.)
3) Unscrew the four screws that hold the board in place, then the acrylic plate and mounting bracket come off at the same time. One of the four screws has a crown washer together, do not lose it.

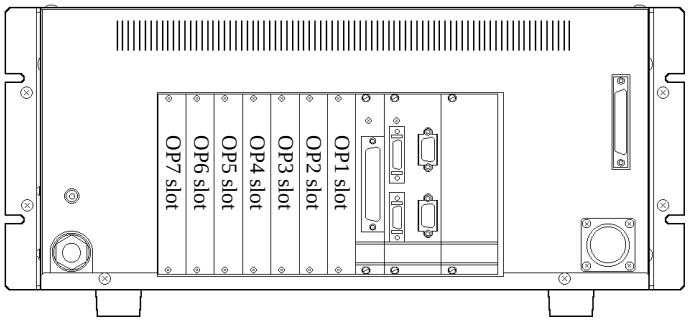


4) Make sure that HL8 to 12 LED lamps on a new board are not bent. If they are bent, return to the straight position.
5) Install the acrylic plate, mounting bracket and the new front board to the front panel in this order and fix them with screws. Be sure to insert the crown washer into the marked screw in above figure. This screw connects the to the frame ground to avoid the noise. The crown washer makes this connection securely.
6) Attach the connectors X71 and X72 to the new front board.
7) Attach the front panel to the controller.

14. Option Boards

CAUTION

- When connecting or disconnecting the option boards make sure the power is turned OFF.
- Mount the option boards in the fixed slots (OP1 to 7).

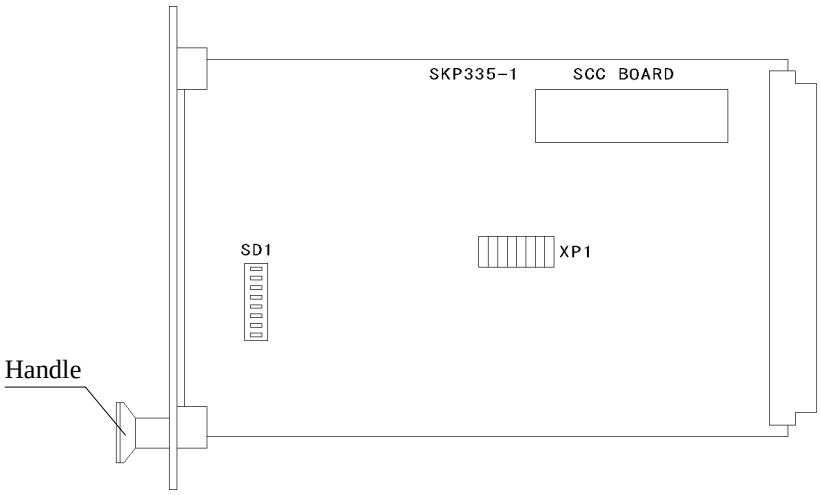


NOTE

See the pulse generating board manual for detail of the pulse generating board.

14.1 Additional RS-232C board replacement

1) Turn OFF the controller.
2) Loosen the additional RS-232C board's upper and lower set screws and pull the board out by the handle. (The handle is labeled "RS-232C.")
3) Set the DIP switch (SD1) and jumper pins (XP1-A ~ H) of the new board to the same settings as those of the old board.



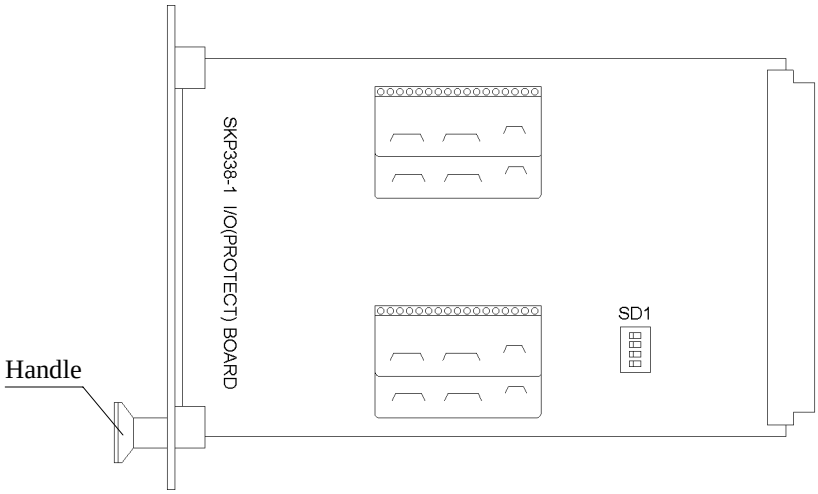
4) Insert the board firmly into the original slot and tighten the upper and lower set-screws.

14.2 Protected I/O board replacement

The protected I/O board is an I/O board that is equipped with a function that protects the internal circuitry from output port misconnections. Replace the protected I/O board or its parts by following the steps described below.

1) Turn off the controller.

2) Loosen the upper and lower set-screws of the protected I/O board and pull the board out by its handle.



3) If you are replacing the entire board, set the DIP switch (SD1) to the same settings as the original board and affix the attached I/O number label to the handle. (DIP switch settings are the same as for a standard I/O board.)

I/O board	I/O No.	Bit No.	DIP switch	Slot assignment
Board 1	I/O-1	0 to 15	Turn all off	I/O slot
Board 2	I/O-2	16 to 31	Turn 1 on	OP1 slot
Board 3	I/O-3	32 to 47	Turn 2 on	OP2 slot
Board 4	I/O-4	48 to 63	Turn 1 & 2 on	OP3 slot
Board 5	I/O-5	64 to 79	Turn 3 on	OP4 slot
Board 6	I/O-6	80 to 95	Turn 1 & 3 on	OP5 slot
Board 7	I/O-7	96 to 111	Turn 2 & 3 on	OP6 slot
Board 8	I/O-8	112 to 127	Turn 1, 2 & 3 on	OP7 slot

To replace the hybrid IC (SEP007 for NPN, SEP008 for PNP), lift it straight upward and insert a new IC into the socket, making sure to place it in the correct direction.
After inserting the IC, push it down diagonally like the original.

4) Insert the board firmly into the original slot and tighten the upper and lower set-screws.

15. Trouble Shooting

This chapter describes causes and remedies of trouble.
Refer to section 15.1 when error code is displayed.
Refer to section 15.2 for troubles which error code is not displayed.
When a trouble occurs, refer to this chapter and find the cause and remedy. If the trouble is not described in this chapter, contact the service center with the Communication list for failure and trouble described in section 15.3.

15.1 Error code table

There are three major categories of errors. In this table, they are indicated as follows:

123 : Errors that do not require RESET to be executed to recover.

123 (italic) : Errors that RESET command should be executed to recover.

123 (italic with underline) : Errors that the power should be turned off once and on again to recover.

Code	Meaning	Remedy
0	No errors.	
1	1) FOR statement corresponding to NEXT statement is missing. 2) WHILE statement corresponding to WEND statement is missing. 3) SELECT statement corresponding to SEND statement is missing. 4) IF statement corresponding to ELSE, ENDIF statement is missing.	1) Make FOR statement. 2) Make WHILE statement. 3) Make SELECT statement. 4) Make IF statement.
2	1) Syntax error. 2) Undefined variable is used in command. 3) Undefined array is used as an array. 4) Batch file is attempted to execute without specifying path.	1) Correct syntax. 2) Use the variables which were already compiled and registered. 3) Use the variables which were already compiled and registered. 4) Make path for the batch file.
3	GOSUB statement is absent, while RETURN statement is present.	Make GOSUB statement or delete RETURN statement.
4	1) Program contains 851 or more GOTO and GOSUB statements in total. 2) Program contains 410 or more labels.	1) Reduce GOTO or GOSUB statement. 2) Reduce label.
5	1) Too large parameter is entered. 2) Numeral beyond specified range is entered. 3) Argument is abnormal. 4) Undefined parameter is used. 5) Undefined PALET is used. 6) Null string is specified.	
6	1) Numeral or variable is overflowed. 2) Undefined address is specified.	1) Reduce numeral or variable.

Code	Meaning	Remedy
7	1) GOSUB...RETURN program has too many nesting levels. 2) Too large source program is saved.	1) Reduce nesting levels. Maximum number of GOSUB...RETURN nesting levels is 10. 2) Correct program. (Refer to PRGSIZE command of reference manual.)
8	Line called by GOTO or GOSUB does not exist.	
9	Subscription of array variable is beyond specified size.	
10	1) Same names of variable, label or function exist. 2) Reserved words are used for variable, label or function. 3) Name of variable, label or function starts with P.	1) Do not specify the same name. 2) Reserved words are not allowed to use. 3) First letter should be other than P.
11	1) Division by 0 (zero) is attempted. 2) Undefined PALET function is used.	Correct program.
12	Command is used as a statement, or statement is used as a command.	
13	Number of parentheses on the left " (" and on the right ") " are not equal.	Correct program.
14	Number of parameters does not match.	Correct the number of parameters of executed command.
15		
16	Program line is not within FUNCTION...FEND.	Include program lines between FUNCTION ... FEND.
17	FUNCTION declaration exists between FUNCTION ... FEND.	Describe FEND so that FUNCTION corresponds to FEND.
18	Variable declaration is not at a head of statement line.	Variable declaration is not allowed after multi-statements. When variable type is different, be sure to change statement line.
19	Number of characters on one line is 80 and over.	Number of characters on one line is up to 79.
20	Structured program has too many nesting loops.	Reduce nesting loops. Maximum total number of nesting loops is 40.
21	Overflow occurred in converting variable.	Change the value to allowable variable type.
22	Parameter specification table exceeds allowable range.	Subscription of PALET is 0 to 15.
23	Too many characters are on one line. (intermediate code)	
24	1) Mixed operation of character and numerical value is attempted. 2) Data tag error of object program.	
25	1) Numerical variable error. Entry of too many digits is attempted. 2) ASCII character in INPUT statement cannot be converted to numeral.	
26	1) Specified address does not exist. 2) Robot operation command is executed as Task 2 to 16, without SELRB declaration.	1) Maximum address is 19. 2) Set robot operation task with SELRB command.
27	1) Specified I/O bit number does not exist. 2) File not opened is attempted to access.	1) Confirm I/O board address setting. 2) Open the file. Confirm the file name.

Code	Meaning	Remedy
28	1) NEXT statement corresponding to FOR statement is missing. 2) WEND statement corresponding to WHILE statement is missing. 3) SEND statement corresponding to SELECT statement is missing. 4) ENDIF statement corresponding to IF statement is missing. 5) #endif statement corresponding to #ifdef is missing.	1) Make NEXT statement. 2) Make WEND statement. 3) Make SEND statement. 4) Make ENDIF statement. 5) Make #endif statement.
29	DMERGE, DLOAD commands are executed as Task 2 to 16.	Execute DMERGE and/or DLOAD commands as Task 1.
30	Number of received data and that of variable for INPUT is not equal	
31	1) Communication from a personal computer connected to TEACH port is not possible. 2) Devices connected to RS-232C port cannot communicate.	1) Check the cable connection, and change to TEACH mode. 2) Check the cable connection, and configuration of RS-232C.
32		
33	Buffer memory overflow (receiving buffer is filled up and data continues to be transferred to RS-232C.)	
34	Parity, overrun, or framing error due to RS-232C communication.	
35		
36	Data over 80 characters is transferred to RS-232C port.	Number of characters per line is up to 79.
37	Overtime error of RS-232C communication.	
38		
39	The number of FUNCTION...FEND is more than 70.	Reduce the number of FUNCTION... FEND up to 70.
40	Specified task does not exist.	
41	Cannot begin a task that has already begun.	
42	Command cannot be executed due to either insufficient memory, or memory malfunction.	
43		
44		
45	1) Prohibited command is executed during task execution. 2) Edit mode is selected.	1) Press [BREAK (or STOP)] key or RESET switch. 2) Exit Edit mode. (Refer to EDIT command in the reference manual.)
46	Improper voltage of DC24V for customer use.	Check +24V output at PSU. (Refer to the section 3.3 in the maintenance volume.)
47		
48	Instantaneous power loss or power failure.	
49	Warning - Low battery voltage.	Backup all of the data immediately before they are lost. Then, replace the lithium battery on MPU board with new one. (Refer to the section 7.2 in the maintenance volume.)

Code	Meaning	Remedy
50	Optional designation of command is invalid.	
51		
52		
53	Specified file does not exist.	1) Check the file name. 2) Check whether the specified file exists or not in file memory.
54		
55		
56		
57	File with same name already exists.	Change file name, or delete existed file in file memory, and save it.
58	1) Filename is incorrect. 2) Filename cannot be changed by NAME command. (Same name already exists.)	
59		
60	No available space in file memory.	Backup the files on disk if necessary, delete the unnecessary files. (Refer to the SPEL for Windows manual or SPEL Editor manual for detail of backup operation.)
61		
62	1) Filename is more than 8 characters. 2) File cannot be opened.	
63		
64		
65	Disk reading error.	The file cannot be loaded. Delete (DEL) the erroneous file. If same error occurs in other files reformat the file memory by FORMAT command.
66	Disk writing error.	The file cannot be saved. Reformat the file memory with FORMAT command.
67	Improper disk drive is selected.	Omit the drive name or specify drive “A:”.
68		
69		
70	Invalid file format.	
71		
72	Check sum error of position data.	
73	Check sum error of source program.	
74	Check sum error of object program.	
75	1) Undeclared or undefined Function or variable is used. 2) Specified function is not supported.	
76	Invalid commands executed.	

Code	Meaning	Remedy
77	Point number is improper.	
78	Use of undefined position data is attempted.	Define point. (Refer to PNTSIZE command in reference manual.)
79		
80		
81		
82	System error of internal process.	1) Eliminate external noise source. (Refer to the section 2.6 in the functions volume.) 2) Check storage condition of the MPU board and looseness of connectors on the board. If this error frequently occurs, replace or repair the MPU board. (Refer to the section 7.3 in the maintenance volume.)
83	1) Program contains 400 or more variables. 2) Registration of backup variables is too many.	1) Number of variables is up to 399. 2) Refer to LIBSIZE command in the reference manual.
84	Compiled object program is too long.	Reduce size of program.
85	Restored file by RESTORE command is too long.	
86	Memory check error in system work area.	Initialize MPU board by SYSINIT commend.
87	Check sum error of file.	Delete (DEL) the erroneous file. If this error frequently occurs, replace or repair the MPU board. (Refer to the section 7.3 in the maintenance volume.)
88	The I/O bit is assigned as REMOTE3.	
89	I/O board communication error.	Input RESET command.
90	Use of invalid statements in parallel processing is attempted.	
91	No D parameter is returned from internal process.	
92	Safeguard circuit malfunction.	
93	Number of parameters for command is improper.	D parameters should be 5 or less.
94	In WAIT SW command, specified condition is not satisfied within specified period of time.	
95	5V for encoder is improper.	Check the +12V output at PSU. (Refer to the section 3.3 in the maintenance volume.)
96	I/F board communication error.	
97	Memory error of system control parameter.	1) Eliminate external noise source and execute VERINIT command. (Refer to the section 2.6 in the functions volume.) 2) Check the voltage of the lithium battery on MPU board. Replace it if the voltage is less than 3.4V. (Refer to the section 7.2 in the maintenance volume.) 3) If this error frequently occurs, replace or repair the MPU board. (Refer to the section 7.3 in the maintenance volume.)

Code	Meaning	Remedy
98	Parameter check sum error of RAIOC.	
99	Memory check error of ROM.	Replace the ROM chips on the MPU board.
100	Device communication error.	Check device address, connections, or MAX-DEV setting.
101	MPU error by malfunction of hardware.	1) Eliminate external noise source and execute VERINIT command. (Refer to the section 2.6 in the functions volume.) 2) If this error frequently occurs, replace or repair MPU board. (Refer to the section 7.3 in the maintenance volume.)
102	Incorrect voltage of the DC7V or DC12V.	Check the ±12V output at PSU. (Refer to the section 3.3 in the maintenance volume.)
103	Malfunction of robot control.	Same as error 101.
104	Improper voltage of the DC12V.	Check the ±12V output at PSU. (Refer to the section 3.3 in the maintenance volume.)
105	Communication error in internal process.	Same as error 101.
106	Communication buffer overflow of internal process.	Same as error 101.
107	Check sum error of robot model data.	1) Check the setting of the DIP switch SD1 on the MPU board. (Refer to the specifications table in the manipulator manual.) 2) If the setting is correct, replace the MPU board. (Refer to the section 7.3 in the maintenance volume.)
108	Memory check error of internal process.	1) If you replaced the ROM, initialize the MPU board. (Refer to the section 7.3 in the maintenance volume.) 2) Check the voltage of the lithium battery on the MPU board. Replace it if the voltage is less than 3.4V. (Refer to the section 7.2 in the maintenance volume.) 3) Replace or repair the MPU board. (Refer to the section 7.3 in the maintenance volume.)
109	Parameter is abnormal, cannot display.	1) Turn off and on the controller, execute VERINIT command. 2) If this error still exists, replace the MPU board. (Refer to the section 7.3 in the maintenance volume.)
110	Improper voltage of the DC24V.	Check the +24V output at PSU. (Refer to the section 3.3 in the maintenance volume.)
111	Coprocessor error. (code error)	Same as error 109.
112	Coprocessor error. (overflow)	Same as error 109.
113	Coprocessor error. (underflow)	Same as error 109.
114	Coprocessor error. (division by zero)	Same as error 109.

Code	Meaning	Remedy
115	Improper voltage or temperature of motor power supply unit.	1) Clean the filter of cooling fan and inspect the cooling fan, replace it if necessary. (Refer to the chapter 12 of the maintenance volume.) 2) If ambient temperature of the controller is over 40°C, cool the place where the controller is. 3) Check the motor power unit and replace if necessary. (Refer to the section 5.3 in the maintenance volume.)
116	Malfunction of Servo CPU dual port RAM.	1) Eliminate external noise source and execute VERINIT command. (Refer to the section 2.6 in the functions volume.) 2) If this error frequently occurs, replace or repair MPU board. (Refer to the section 7.3 in the maintenance volume.)
117		
118	Improper voltage of DC5V.	Check the -12V output at PSU. (Refer to the section 3.3 in the maintenance volume.)
119	Arm is moved too much after switching off the power of controller.	1) If you moved the arm manually after switching off the power, turn off and on the controller or input RESET. 2) Check arm position data. Move the arms to a taught point manually and display the numbers of pulse of this point. If the values of current are different too much from the numbers of pulse of taught point, calibrate the manipulator. (Refer to the section "Calibration" in manipulator manual.)
120	Invalid commands is executed.	
121	Executed invalid command under emergency stop condition.	Release emergency stop status. (One of TEACH, REMOTE1 or REMOTE2.)
122	Improper type of data is used.	
123	Specified command is not supported.	
124	Numeric value is out of allowable range.	
125	Arm reached the limit of motion range.	
126	Arm reached the limit of motion range specified by XYLIM command.	
127	Specified ARM is not defined.	1) Use already defined arm number. 2) Define Arm by ARMSET.
128	Specified TOOL is not defined.	1) Use already defined tool number. 2) Define Tool by TLSET.
129	LIMZ error. 1) Z axis value of target position with JUMP command is higher than specified LIMZ value. 2) Z axis value of current position with JUMP command is higher than specified LIMZ value.	1) Set Z axis value of target position lower than LIMZ value or set LIMZ value higher than Z axis value of target position. 2) Set Z axis value of current position lower than LIMZ value or set LIMZ value higher than Z axis value of current position.

Code	Meaning	Remedy
130	Different LOCAL attribute is specified.	Define LOCAL by LOCAL command.
131	Specified LOCAL is not defined.	1) Specify already defined LOCAL number. 2) Define LOCAL by LOCAL command.
132	HOFS value is out of allowable range.	HOFS should be in the range of -40960 to 40960.
133	HOME command is attempted even though certain axes are not engaged.	Engage all axes by SLOCK command before HOME operation.
134	Change of arm attribute in CP control.	Arm attribute cannot be changed in CP control.
135	SFREE is attempted for axis that cannot be disengaged by SFREE.	Check the setting of software switch SS6. (Refer to the section 9.2 of the functions volume.)
136	Improper number (many or few) of point data is specified by CURVE.	Refer to CURVE command of the reference manual.
137	Point data specified by CURVE contain point which has different arm attribute.	Refer to CURVE command of the reference manual.
138	Free curve cannot be made by CURVE.	Verify that no two successive points overlap one another.
139	Restart of CVMOVE motion after quick pause is attempted.	Restarting CVMOVE motion after quick pause is impossible.
140	Only axis #4 movement is attempted in CP control.	
141	Improper point data for ARC command.	In ARC command, specified points are too close, or points are on straight line. (Refer to ARC command in reference manual.)
142		
143	HOME position is not defined.	Define home position by HOMESET command.
144	Improper number of parameters for command.	
145	Malfunction of CVMOVE command file.	
146	Motion command is executed under SFREE condition.	Engage all axes by SLOCK.
147	The value of 4th and 6th parameter in BASE 0 command is different.	Refer to BASE 0 command in reference manual.
148	Function not supported for this manipulator.	
149	The command can not be used in MOTOR ON condition.	
150	Motion command is executed under MOTOR OFF condition.	

Code	Meaning	Remedy
151	Positioning cannot be completed by specified FINE.	1) Check disconnection of motor power circuit, or loose connection. Then, check the motor power unit and the voltage of AC servo driver. (Refer to the section 5.2 of the maintenance volume.) 2) Eliminate binding factor such as an obstacle if arm is bound. 3) Check each axis motion moving by hand. Secure the arm locking bolts tightly if looseness of them are found. Also, check each reduction gear. Verify appropriate lubrication or replace if necessary. (Refer to the manipulator manual.) 4) In other case than the above, replace motor, AC servo driver and/or MPU board. (Refer to the section "Motor replacement" of the manipulator manual, the section 6.3 and/or 7.3 in the maintenance volume of this manual.)
152	Arm motion exceeds maximum speed or acceleration.	
153	CP motion cannot decelerate and stop in specified distance.	1) Prepare enough deceleration distance. 2) Don't finish operation with CP motion without deceleration.
154	The axis #4 movement exceeds limit of its movement.	There is limit for axis #4 movement of the robot which has ball-screw spline unit.
155	Communication error with Servo CPU at internal process.	
156	Malfunction of Servo CPU.	
157	Robot moved in improper speed.	1) Turn off and on the controller. 2) Check arm position data. Move the arms to a taught point manually and display the numbers of pulse of this point. If the values of current are different too much from the numbers of pulse of taught point, calibrate the manipulator. (Refer to the section "Calibration" in manipulator manual.) 3) If this error frequently occurs, replace or repair the MPU board. (Refer to the section 7.3 in the maintenance volume.)
158		

Code	Meaning	Remedy
159	Reading error of encoder revolution data.	
	1) External noise exists.	1) Eliminate external noise source. (Refer to the section 2.6 in the functions volume.)
	2) Disconnection of encoder signal line.	2) Check disconnection or miscontact of the signal line between the controller's rear panel and mother board, and AC servo driver. (Refer to "2.3 Diagram of cable connection" in the maintenance volume.) If the red ALARM LED on AC servo driver is lit, check signal line shown below also. • in manipulator. • signal cable.
	3) Voltage of encoder power source is abnormal.	3) Check the ENC+5V voltage at signal connector of motor. If voltage is not proper, inspect PSU board and wiring. (Refer to the section 4.4 of the maintenance volume.) If the green POWER LED on AC servo driver is off, check the connection of signal connector of the servo driver. (Refer to the section 6.2 of the maintenance volume.)
	4) Other than the above.	4) Consider the following. • Connection of the MPU board. • Replace U15 and U16 (SCC) on the MPU board. • Replace the MPU board. • Replace the AC servo driver. • Replace the motor.
160	Encoder signal disconnection of A phase.	Same as error 159.
161	Encoder signal disconnection of B phase.	Same as error 159.
162	Encoder signal disconnection of Z phase.	Same as error 159.
163	Encoder signal disconnection of S phase.	Same as error 159.
164	Character error of absolute encoder.	
165	< NOTICE > Encoder is initialized.	1) This error is displayed when encoder is initialized and controller power is switched on. Repeat turning the power off and on twice. 2) In other case than the above, check whether RES wire of encoder shorted with other line or not.
166	Servo calculation overflow.	
167	Malfunction of Servo CPU hardware.	Replace or repair the MPU board. (Refer to the section 7.3 in the maintenance volume.)
168	Servo CPU's communication error with Sub CPU.	

Code	Meaning	Remedy
169	Servo overspeed.	1) Check whether the M/C signal cable is surely connected. 2) Check disconnection or miscontact of the encoder line in manipulator. (Refer to the manipulator manual.) 3) Check cable damage or loose connection between the controller's rear panel and mother board, and AC servo driver. (Refer to "2.3 Diagram of cable connection" in the maintenance volume.) 4) Eliminate external noise source. (Refer to the section 2.6 in the functions volume.) 5) In other case than the above, replace the MPU board. (Refer to the section 7.3 in the maintenance volume.)
170	Servo overflow. 1) Motor power line has problem. 2) Encoder signal line has problem. 3) Motor power unit is not outputting correctly to servo driver. 4) Mechanical load is added on axis. 5) Tension of timing belt is not proper. 6) Arm is bound. 7) Axis #3 brake cannot be released. 8) Arm hit an obstacle. 9) Manipulator moved unexpectedly. 10) External noise source exists. 11) Other than the above.	Try the following remedies 1) to 11). 1) Check disconnection of the motor power line in manipulator and controller. (Refer to the manipulator manual and "2.3 Diagram of cable connection" in the maintenance volume of this manual.) 2) If the red ALARM LED on AC servo driver is lit, check disconnection or miscontact of signal line in the following : • in manipulator. • signal cable. • between the controller's rear panel and mother board, and AC servo driver. 3) Inspect the motor power unit. (Refer to the section 5.2 in the maintenance volume.) 4) Check each axis motion moving by the hand. Verify appropriate lubrication or replace the reduction gear. (Refer to the manipulator manual.) 5) Check tension of the timing belt. Tighten or replace if necessary. (Refer to the section "Replacing the timing belt" of manipulator manual.) 6) Eliminate binding factor such as an obstacle. 7) If the brake cannot be released with the brake release button at MOTOR OFF, check the wire of brake. If the brake does not release at MOTOR ON, inspect the brake control signal circuit. (Refer to the section "Re-placing the brake" of manipulator manual.) 8) Prevent arm from hitting. 9) Take the same remedy as 2). If there is no problem in 2), replace AC servo driver and/or MPU board. (Refer to the section 6.3 and/or 7.3 of the maintenance volume.) 10) Eliminate external noise source. (Refer to the section 2.6 in the functions volume.) 11) Replace the AC servo driver and/or MPU board. (Refer to the section 6.3 and/or 7.3 of the maintenance volume.)

Code	Meaning	Remedy
171	Communication check sum error of Servo CPU.	1) Eliminate external noise source and execute VERINIT command. (Refer to the section 2.6 in the functions volume.) 2) If this error frequently occurs, replace or repair the MPU board. (Refer to the section 7.3 in the maintenance volume.)
172	Instructive motor torque is abnormal.	Check disconnection of the motor power line in manipulator and controller. (Refer to the manipulator manual and "2.3 Diagram of cable connections" in the maintenance volume of this manual.)
173	Robot is in low power state. Motor output power is limited.	
174	Motor torque overload.	
175	Hardware malfunction related Servo CPU.	
176		
177		
178		
179	Servo adjustment mode is selected.	
180	Driver overheat/overcurrent. • When the red LED on the front of the AC servo driver is off. 1) External noise source exists. • When the red LED on the front of the AC servo driver is lit. 2) Weight of the end effector and work piece exceeds rated payload. 3) Motion duty of manipulator is too much. 4) Mechanical load is added on axis. 5) Tension of the timing belt is not proper. 6) The cooling fan is not functioning. 7) The filter is clogged. 8) Ambient temperature around controller is over 40°C. 9) The motor power line is shorted or grounded. 10) Other than the above.	1) Eliminate external noise source and execute VERINIT command. (Refer to the section 2.6 in the functions volume.) If no external noise source exists, replace MPU board. (Refer to the section 7.3 in the maintenance volume.) 2) Check actual weight, and set proper WEIGHT. (Refer to the section "Load weight and the WEIGHT setting" of manipulator manual.) 3) Reduce operation speed of robot. (Refer to ACCEL, SPEED and WEIGHT command of the reference manual.) 4) Check each axis motion moving by the hand. Verify appropriate lubrication or replace reduction gear. (Refer to the manipulator manual.) 5) Check the tension of timing belt. Tighten or replace if necessary. (Refer to the section "Replacing the timing belt" of manipulator manual.) 6) Inspect the cooling fan. Replace it if necessary. (Refer to the section 12.2 of the maintenance volume.) 7) Clean the filter of cooling fan. (Refer to the section 12.1 of the maintenance volume.) 8) Cool the place where the controller is. 9) Check disconnection of the motor power line in manipulator and controller. (Refer to the manipulator manual and "2.3 Diagram of cable connection" in the maintenance volume of this manual.) 10) Replace the AC servo driver. (Refer to the section 6.3 of the maintenance volume.)

Code	Meaning	Remedy
181	Driver overload. • When the red LED on the front of the AC servo driver is off.	
	1) External noise source exists.	1) Eliminate external noise source and execute VER-INIT command. (Refer to the section 2.6 in the functions volume.) If no external noise source exists, replace the MPU board. (Refer to the section 7.3 in the maintenance volume.)
	• When the red LED on the front of the AC servo driver is lit.	
	2) Weight of the end effector and work piece exceeds rated payload.	2) Check actual weight, and set proper WEIGHT. (Refer to the section "Load weight and the WEIGHT setting" of manipulator manual.)
	3) Motion duty of manipulator is too much.	3) Reduce operation speed of the robot. (Refer to ACCEL, SPEED and WEIGHT command of the reference manual.)
	4) Mechanical load is added on axis.	4) Check each axis motion moving by the hand. Verify appropriate lubrication or replace the reduction gear. (Refer to the manipulator manual.)
	5) Tension of the timing belt is not proper.	5) Check tension of the timing belt. Tighten or replace if necessary. (Refer to the section "Replacing the timing belt" of manipulator manual.)
	6) Arm is bound.	6) Eliminate binding factor such as an obstacle.
	7) Arm hit an obstacle.	7) Prevent arm from hitting.
	8) Axis #3 brake cannot be released.	8) If the brake cannot be released with the brake release button at MOTOR OFF, check the wire of brake. If brake does not release at MOTOR ON, inspect the brake control signal circuit. (Refer to the section "Re-placing the brake" of manipulator manual.)
	9) The motor power line is shorted or grounded.	9) Check disconnection of the motor power line in manipulator and controller. (Refer to the manipulator manual and "2.3 Diagram of cable connection" in the maintenance volume of this manual.)
	10) Other than the above.	10) Replace the AC servo driver. (Refer to the section 6.3 of the maintenance volume.)
182	Driver detected overspeed.	

Code	Meaning	Remedy
183	Driver detected locked motor. • When the red LED on the front of the AC servo driver is off.	
	1) External noise source exists.	1) Eliminate external noise source and execute VERINIT command. (Refer to the section 2.6 in the functions volume.) If no external noise source exists, replace the MPU board. (Refer to the section 7.3 in the maintenance volume.)
	• When the red LED on the front of the AC servo driver is lit.	
	2) The motor power line is shorted or grounded.	2) Check disconnection of the motor power line in manipulator and controller. (Refer to the manipulator manual and "2.3 Diagram of cable connection" in the maintenance volume of this manual.)
	3) Mechanical load is added on axis.	3) Check each axis motion moving by the hand. Verify appropriate lubrication or replace the reduction gear. (Refer to the manipulator manual.)
	4) Tension of the timing belt is not proper.	4) Check tension of the timing belt. Tighten or replace if necessary. (Refer to the section "Replacing the timing belt" of manipulator manual.)
	5) Arm is bound.	5) Eliminate binding factor such as an obstacle.
	6) Axis #3 brake cannot be released.	6) If the brake cannot be released with the brake release button at MOTOR OFF, check the wire of brake. If brake does not release at MOTOR ON, inspect the brake control signal circuit. (Refer to the section "Replacing the brake" of manipulator manual.)
	7) Arm hit an obstacle.	7) Prevent arm from hitting.
	8) Other than the above.	8) Replace the AC servo driver. (Refer to the section 6.3 of the maintenance volume.)
184	Driver detected improper motion. • When the red LED on the front of the AC servo driver is off.	
	1) External noise source exists.	1) Eliminate external noise source and execute VERINIT command. (Refer to the section 2.6 in the functions volume.) If no external noise source exists, replace MPU board. (Refer to the section 7.3 in the maintenance volume.)
	• When the red LED on the front of the AC servo driver is lit.	
	2) Encoder signal line has problem.	2) Check disconnection or miscontact of the signal line in the following : • in manipulator. • signal cable. • between the controller's rear panel and mother board, and AC servo driver.
	3) Other than the above.	3) Replace the motor and/or AC servo driver. (Refer to the section "Motor replacement" of the manipulator manual and/or the section 6.3 in the maintenance volume of this manual.)

Code	Meaning	Remedy
185	Encoder signal disconnection.	Same as error 184.
186	Malfunction of driver's CPU. • When the red LED on the front of the AC servo driver is off. 1) External noise source exists. • When the red LED on the front of the AC servo driver is lit. 2) The cable between AC servo driver and mother board has problem. 3) +24V output at PSU is improper. 4) Other than the above.	1) Eliminate external noise source and execute VERINIT command. (Refer to the section 2.6 in the functions volume.) If no external noise source exists, replace the MPU board. (Refer to the section 7.3 in the maintenance volume.) 2) Check disconnection of line or looseness of the connectors between AC servo driver and mother board. (Refer to the section 2.3 in the maintenance manual.) 3) Check whether POWER LED (green) on the front of AC servo driver is lit or not. If the LED is off, check the +24V output at PSU. (Refer to the section 3.3 in the maintenance volume.) 4) Replace the AC servo driver. (Refer to the section 6.3 in the maintenance volume.)
187		
188	Driver detected improper torque/speed.	
189	Encoder S phase signal is not transmitted within pre-determined period of time.	
190	Encoder overheat.	
191	Encoder overspeed.	Confirm whether any axis moved at power on. If axis #3 moved, inspect the axis #3 brake. (Refer to the section "Replacing the brake" of manipulator manual.)
192	Encoder data error.	
193	Encoder battery error.	1) Check the voltage of the battery on the signal relay board. Replace it if the voltage is less than 2.8V. (Refer to the section "Replacing the signal relay board" of the manipulator manual.) 2) Check disconnection of line between the motor encoder and signal relay board. (Refer to the manipulator manual.)
194	Encoder check sum error.	Calibrate the axis. (Refer to the section "Calibration" of manipulator manual.) If this problem still exists, replace the motor. (Refer to the section "Motor replacement" of manipulator manual.)

Code	Meaning	Remedy
195	Encoder backup error. 1) This is the error shown after replacing motor with absolute encoder. 2) The battery voltage on signal relay board is improper. 3) The voltage of encoder power (ENC+5V) is improper. 4) Other than the above.	 1) Refer to the section "Calibration" of the manipulator manual. 2) Check the voltage of the battery on signal relay board. If the voltage is less than 2.8 V, replace the battery. 3) Check the ENC+5V voltage at signal connector of motor. If voltage is not proper, inspect PSU board and wiring. (Refer to the section 4.4 of the maintenance volume.) 4) Replace the motor. (Refer to the section "Motor replacement" of the manipulator manual.)
196		
197	Framing error of encoder data. 1) This is the error shown after replacing motor with absolute encoder. 2) Strong external noise source exists. 3) Other than the above.	 1) Refer to the section "Calibration" of the manipulator manual. 2) Eliminate external noise source and execute VERINIT command. (Refer to the section 2.6 in the functions volume.) 3) In other case than the above, take the following procedures: • Check inserted condition of MPU board. • Replace the MPU board. (Refer to the section 7.3 in the maintenance volume.) • Replace the motor. (Refer to the section "Motor replacement" of the manipulator manual.)
198	Overrun error of encoder data.	Same as error 197.
199	Parity error of encoder data.	Same as error 197.
200		
⋮		
230	MCORG command has not executed.	
231	MCAL command has not executed.	
232	Home sensor detection error.	Check whether home sensor LED of manipulator lights or not while moving the arm by hand. If the LED does not light, execute MCORG command. If the LED lights, check disconnection of signal cable.
233	Encoder Z phase signal detection error.	1) Check signal line of Z phase. 2) If the line has no problem, replace motor. (Refer to the section "Motor replacement" of the manipulator manual.)
234	Quick pause interrupted MCORG execution.	
235	Incorrect ball-screw spline axis setting.	Set the bit 7 and 8 of SD2 on the MPU board to ON. (Refer to the section 9.1 of the functions volume.)

Code	Meaning	Remedy
236	Current position calculated by the sensor and encoder Z phase is out of the default RANGE value.	1) Connect the manipulator and the controller with the same M. CODE. 2) If the arm has been hit an obstacle, there is a possibility of mechanical position deviation. Execute MCORG command. (Refer to MCORG command in reference manual.) 3) Other than the above, contact authorized dealer with its VER data.
237	HTEST data is improper.	1) Confirm the M. CODE of manipulator and controller. If they are different, connect the ones with same M. CODE. 2) If axis #4 has rotated more than 180° while the power is off, turn off the controller power once, and return axis #4 around the previous position. 3) If the arm has been hit an obstacle, there is a possibility of mechanical position deviation. Execute MCORG command. (Refer to MCORG command in reference manual.)
238		
239		
240		
⋮		
300	Specified directory does not exist.	
301	1) Cannot delete specified directory because does not exist. 2) Cannot delete specified directory because includes files.	
302	Unable to create directory.	1) Specified directory already exist. Change the name. 2) The disk is full.
303	Specified file or directory does not exist.	
304	Date designation method is incorrect.	
305	Time designation method is incorrect.	
306	Specified drive does not exist.	
307	Memory shortage for environment string.	Maximum memory for environment string is 512 bytes.
308	Batch file is too large.	Maximum memory for batch file is 4KB.
309	File cannot be copied onto itself.	
310		

15.2 Troubles whose error codes are not displayed

The troubles whose error codes are not displayed are as described below.
Send the communication list in the following section 15.3 to the service center when these troubles cannot be restored even if they are diagnosed and treated by the methods described in this section.

The power cannot be turned on even if the power switch is turned on.

The SYS. ERROR lamp lights, but no error code is displayed.

The emergency stop cannot be canceled.

The system does not operate at a set speed.

The operation speed is low.

The motor is turned on (excited), but it does not operate.

No precision is obtained (during installation and operation).

The arm vibrates (during positioning completion and low-speed operation).

An abnormal sound is generated (during operation and stop).

There is an axis that does not operate.

The I/O port does not operate or another I/O port operates.

The operating unit does not operate.

The REMOTE3 connector does not operate.

The power cannot be turned on even if the power switch is turned on.

Diagnosis	Correction	See
1) Is the power plug not disconnected?	1) Check that the power plug is inserted properly.	
2) Is the switching power (PSU1) output normally?	2) Check that PSU1 is output normally.	Section 3.3 in Maintenance volume

The SYS. ERROR lamp lights, but no error code is displayed.

Diagnosis	Correction	See
1) Turn on the power again and confirm that the system operates normally.	1) If the system operates normally, the trouble is caused by an instantaneously power failure.	
2) Do the three red LEDs (RES, HSLT, WDT) on the MPU board light?	2) Check that the ROM on the MPU board is mounted properly and insert the MPU board securely. If the three LEDs (red) often light, replace the MPU board.	Section 7.3 in Maintenance volume
3) Check that a switching power (PSU1) of 5V is output properly.	3) If the output value does not satisfy the specifications, adjust VR2 to satisfy the required specifications. If the adjustment is impossible, replace the PSU.	Section 3.3 and 3.4 in Maintenance volume

The emergency stop cannot be canceled.

Diagnosis	Correction	See
1) Is the REMOTE1 connector not disconnected?	1) Insert the connector securely and tighten it with two fixing screws.	Chapter 4 in Functions volume
2) Is the emergency stop input pin of the REMOTE1 connector not open?	2) Connect the normally closed emergency stop switch.	Section 4.1 in Functions volume
3) Is the REMOTE2 connector not disconnected?	3) Connect the supplied REMOTE2 connector when an operating unit is not connected.	Chapter 5 in Functions volume
4) Is the TEACH port not open?	4) Connect the supplied TEACH port connector when a PC cable (personal computer) or teaching pendant is not connected to the TEACH port.	Section 3.3 in Functions volume
5) Is the emergency stop switch of the connected equipment not pressed? • PC cable • Operating unit • Teaching pendant • Equipment to be connected to REMOTE1	5) For a supplied emergency stop switch, turn the switch clockwise and unlock it.	
6) Was the resetting performed?	6)-1 For TEACH mode, execute the RESET command. 6)-2 If the operating unit is in the AUTO mode of the console, press the RESET switch. 6)-3 If the REMOTE3 connector is in the AUTO mode of the console, input a RESET signal. 6)-4 For S. NET mode, execute the RESET command.	
7) Is the emergency stop circuit not disconnected?	7) If the circuit is disconnected, repair it.	

The system does not operate at a set speed.

Diagnosis	Correction	See
1) Does the SAFEGUARD LED on indicator panel not light?	1)-1 Close the safeguard. 1)-2 Check that the safeguard switch circuit is not disconnected and adjust so that the safeguard input terminal is closed.	
2) Is the POWER command set to HIGH? (Is the LP command set to OFF?)	2) Change the power mode to high by using POWER HIGH (or LP OFF) command.	POWER (LP) com-mand in Reference manual
3) Are TSPEED and/or TSPEEDS not set to low speed?	3) Set them to high speed as required. The operation speed is low.	TSPEED and/or TSPEEDS command in Reference manual

The operation speed is low.

Diagnosis	Correction	See
1) Is the WEIGHT parameter set corresponding to the load?	1) Measure the weight of the end effector and conveyed object and set the measured value in the parameter of a WEIGHT command.	"The end effector and operation acceleration/deceleration speed" section in Manipulator manual
2) Is LIMZ set to less than -150 mm in the model with an axis #3 stroke of more than 150 mm?	2) When the axis #3 stroke is lower than -150 mm during horizontal movement, the automatic acceleration function is activated and the operation speed becomes low.	

The motor is turned on (excited), but it does not operate.

Diagnosis	Correction	See
1) Does the SAFEGUARD LED on the indicator panel not light?	1)-1 Connect the normally closed safeguard switch to the safeguard input terminal of the REMOTE1 connector. 1)-2 Close the safeguard. 1)-3 Check that the safeguard switch circuit is not disconnected and adjust so that the safeguard input terminal is closed.	Chapter 4 in Functions volume
2) Does the PAUSE LED not light?	2) Cancel the PAUSE input of the REMOTE3 (I/O-1) connector.	

No precision is obtained (during installation).

Diagnosis	Correction	See
1) Is the bolt that installs a manipulator tightened firmly?	1) Confirm that the manipulator is firmly fixed to the frame.	"Installation method" section in the Manipulator manual
2) Does the arm not touch the peripheral equipment?	2) Take care that the arm does not touch the peripheral equipment.	
3) Does no play exist in the base table (frame)?	3) Check the rigidity and horizontally of the base table (frame) and reinforce it as required.	"Base table" section in the Manipulator manual
4) Is vibration not propagated from peripheral equipment?	4) Install the manipulator away from the vibration source or take vibration isolating measures against the base table (frame).	"Base table" section in the Manipulator manual
5) Does no overload occur?	5) Set the weight, speed, and acceleration corresponding to the load.	"The end effector and operation acceleration/deceleration speed" section in Manipulator manual
6) Is the fixing screw of the end effector not loosened?	6) Confirm the fixing screw of the end effector.	
7) Is the tension of a timing belt proper?	7) Push the timing belt and tighten the belt again or replace if it is loose.	"Replacing the timing belt" section in Manipulator manual

No precision is obtained (during operation), the position is shifted, and the shifted position cannot be corrected.

Diagnosis	Correction	See
1) Is the bolt that installs a manipulator tightened firmly?	1) Confirm that the manipulator is firmly fixed to the base table (frame).	"Base table" section in Manipulator manual
2) Is the tension of a timing belt proper?	2) Push the timing belt and tighten the belt again or replace if it is loosen.	"Replacing the timing belt" section in Manipulator manual
3) Does a remarkable play occur when the power is turned off and when the arm is moved manually?	3) Check the main fastening bolt of the arm and confirm that the bolt is not loosened.	
4) Does the operating time of a robot exceed 8,000 hours in all?	4) Examine the replacement of reduction gears in each axis.	
5) Does the operating time of a robot exceed 15,000 hours in all?	5) Examine the replacement of an axis #3 ball-screw spline unit.	
6) Is there no strong noise source in the neighborhood?	6) Take measures against the noise.	Section 2.6 in Functions volume
7) For except the above.	7)-1 Replace the MPU board.	Section 7.3 in Maintenance volume
	7)-2 Replace the AC servo driver.	Section 6.3 in Maintenance volume
	7)-3 Replace the motor.	"Motor replacement" section in Manipulator manual

The positioning point is shifted, but the shifted point can be corrected.

Diagnosis	Correction	See
1) Is the position of peripheral equipment not shifted?	1) Confirm the fixing screws of the peripheral equipment.	
2) Do a play and catch occur when the power is turned off and when the arm is moved manually?	2) Check the main fastening bolt of the arm and confirm that the bolt is not loosened.	

The arm vibrates. (The residual vibration during positioning completion is high.)

Diagnosis	Correction	See
1) Does no overload occur?	1) Set the weight, speed, and acceleration corresponding to the load.	"The end effector and operation acceleration/deceleration speed" section in Manipulator manual
2) Is the bolt that install a manipulator tightened firmly?	2) Confirm that the manipulator is firmly fixed to the base plate (frame).	"Base table" section in Manipulator manual
3) Is the tension of a timing belt proper?	3) Push the timing belt and tighten the belt again or replace if it is loose.	"Replacing the timing belt" section in Manipulator manual
4) Does a remarkable play occur when the power is turned off and when the arm is moved manually?	4) Check the main fastening bolt of the arm and confirm that the bolt is not loosened.	
5) Does the operating time of a robot exceed 8,000 hours in all?	5) Examine the replacement of reduction gears in each axis.	
6) Does the operating time of a robot exceed 15,000 hours in all?	6) Examine the replacement of an axis #3 ball-screw spline unit.	
7) Does vibration occur in subtle movement (within 10 mm) with the arm spread?	7) Decrease the acceleration value.	ACCEL command in Reference manual
8) Is the operation that coincides with the characteristic vibration frequency of the arm not performed?	8) Change the speed and acceleration slightly.	SPEED, ACCEL command in Reference manual

The arm vibrates (during low-speed operation).

Diagnosis	Correction	See
1) Does vibration occur in only a low-speed area?	1) If vibration occurs in a high-speed area, see "No precision cannot be obtained (during installation)" and "The arm vibrates (The residual vibration during positioning completion is high)" described previously.	
2) Does the vibration level vary with the arm position?	2) This phenomenon is not abnormal because the input rotation of reduction gears resonates with respect to the characteristic vibration frequency determined by the arm position. Change the speed before use.	

An abnormal sound is generated (during operation).

Diagnosis	Correction	See
Assign the generation source by operating the system via a single shaft or operating it manually.		
1) Is the tension of a timing belt proper?	1) Push the timing belt and tighten the belt again or replace if it is loose.	"Replacing the timing belt" section in Manipulator manual
2) Does the axis #3 brake operate normally?	2) Press the axis #3 brake release button in the MOTOR OFF condition and confirm that the axis #3 operates normally. Confirm that the brake works when the button is not pressed. If abnormality is found, replace the brake.	"Replacing the brake" section in Manipulator manual
3) Does the cover or cable not strike against anything else?	3) Be careful not to touch anything else.	
4) Is the fixing screw of the cover not loose?	4) Check the fixing screw of the cover and tighten the screw again if it is loose.	"Cover removal" section in Manipulator manual
5) Is an abnormal sound generated from reduction gears?	5) Replace the grease on the reduction gears. If the abnormal sound is generated still more, replace the reduction gears.	
6) Is an abnormal sound generated from around the ball-screw spline shaft of axis #3?	6) Apply grease to the ball-screw spline shaft. If the abnormal sound is generated still more, replace the ball-screw spline unit.	"Lubrication" section in Manipulator manual

An abnormal sound is generated (during stop).

Diagnosis	Correction	See
The abnormal sound generated during stop is almost the oscillation of a motor owing to the play in a mechanical system.		
1) Is the tension of a timing belt proper?	1) Push the timing belt and tighten the belt again or replace if it is loose.	"Replacing the timing belt" section in Manipulator manual
2) Does the operating time of a robot exceed 8,000 hours in all?	2) Examine the replacement of reduction gears in each axis.	
3) Does the operating time of a robot exceed 15,000 hours in all?	3) Examine the replacement of an axis #3 ball-screw spline unit.	

There is an axis that does not operate.

Diagnosis	Correction	See
1) Are DIP switches SD2 bit 5 to bit 8 on the MPU board set properly?	1) Confirm that DIP switches SD2 on the MPU board are set properly.	Section 9.1 in Functions volume

The I/O port does not operate or another I/O port operates.

Diagnosis	Correction	See
1) Is the I/O port wired properly?	1) Check the wiring on the I/O connector and load sides.	Section 6 in Functions volume
2) Is the I/O connector connected properly?	2) Check the position of the connector to be connected, the disconnection, and the slackness.	Section 6 in Functions volume
3) Is the board inserted properly?	3) Insert the board as far as it will go and tighten it with two upper and lower screws.	Section 9.2 in Maintenance volume
4) Is the power supplied?	4) Check the wiring in which +24V is input to the common terminal of the I/O connector and confirm that the power is supplied.	Section 6 in Functions volume
5) Are DIP switches on the I/O board set properly?	5) Confirm that DIP switches SD1 on the I/O board are set properly.	Section 9.1 in Maintenance volume

The REMOTE3 connector does not operate.

Diagnosis	Correction	See
1) Is the REMOTE3 connector set properly?	1) Set the I/O remote connector properly from the SPEL Editor or SPEL for Windows.	SPEL Editor or SPEL for Windows manual
2) Is the REMOTE3 connector wired properly?	2) Check the wiring on the REMOTE3 connector and load sides.	Section 7 in Functions volume
3) Is the REMOTE3 (I/O-1) connector connected properly?	3) Check the disconnection and slackness of the connector and cable and connect them firmly.	Section 6 in Functions volume
4) Is the board inserted properly?	4) Insert the board as far as it will go and tighten it with two upper and lower screws.	Section 9.2 in Maintenance volume
5) Is the power supplied?	5) Check the wiring in which +24V is input to the common terminal of the REMOTE3 (I/O-1) connector and confirm that the power is supplied.	Section 6 in Functions volume

The operating unit does not operate.

Diagnosis	Correction	See
1) Is the cable connected properly?	1) Check the connection cable of the operating unit.	
2) Does the operating unit switch operate normally?	2) Turn off the power of the controller, then turn on the power of the controller again while pressing the three keys ([←], [↑], and [→]) of the operating unit at the same time. The switch state is displayed on the screen. Confirm that the display changes every time each switch is pressed. If the display does not change, the operating unit is considered to be defective.	
3) Is the operation mode of operating unit selected properly?	3) Check the parameter of OPUNIT command. Some of the functions of operating unit are restricted depend on the parameter of OPUNIT.	OPUNIT command in Reference manual

15.3 Communication list for failure and trouble

If a trouble that does not apply to the description on the preceding pages occurs, please copy the communication list on next page, enter necessary items, and send it to service center by facsimile. Send the version data, program list, and position data simultaneously as required. After confirming the contents of the trouble, we examine the countermeasures to be taken and contact you.

Communication list for failure and trouble

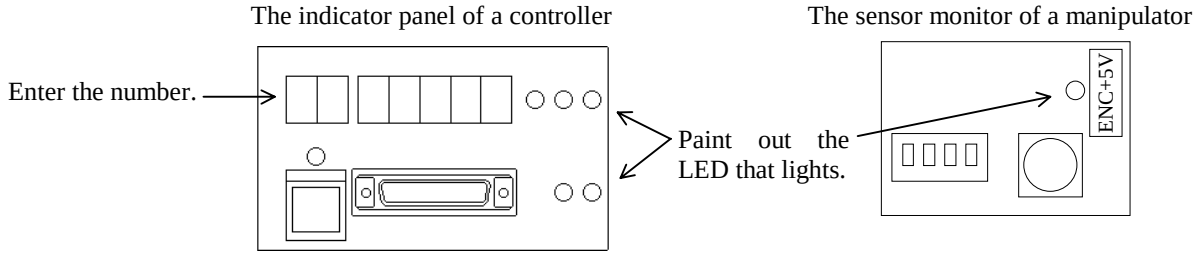
Company name:	
Name:	Department name:
Phone:	Facsimile:
Manipulator name: (Described in the signature/serial No. label of a manipulator.)	Controller name: SRC-320
M. CODE : (Described in the M. CODE label of a manipulator or controller.)	Total current conduction duration: (Displayed when the HOUR command is executed.)
Trouble occurrence date:	

Contents (Enter in full detail as far as possible.)

1. Which type is the trouble? (Error code, abnormal sound, vibration, generation frequency, reproducibility, etc.)

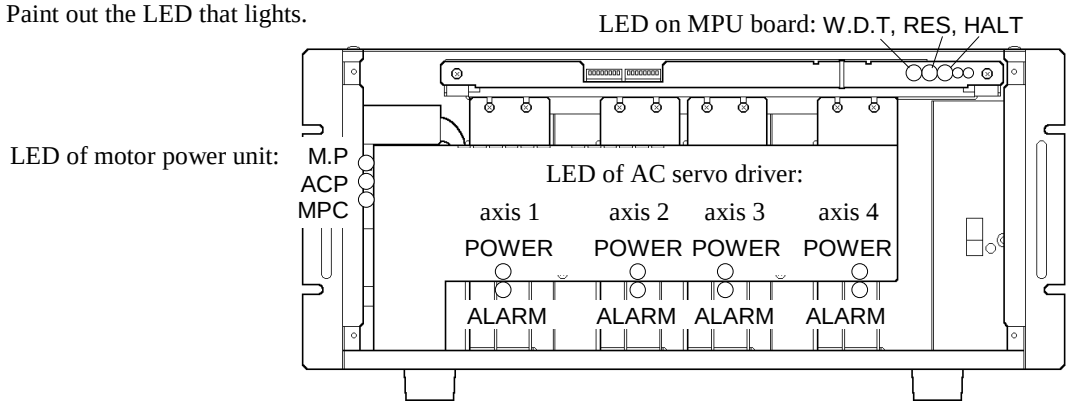
2. When does the trouble occur? (When the power is turned on, during MOTOR ON, MCAL, and during operation, etc.)

3. Display on the panels



4. LED displays inside controller (Remove the front panel.)

Paint out the LED that lights.



16. Maintenance Parts List

Parts name	Old code	New Code	Specification	Notes
MPU board for ABS	ZA004014	R13ZA00401400	SKP326-3	attached a ABS label : for ES, EL, EC, EH, BNA and BNA-CL
MPU board for INC	ZA004004	R13ZA00400400	SKP326-3	for BN, BL, BL-CL, XM3000 and RT3300
PSU board	ZA004400	R13ZA00440000	SKP327	
REMOTE board (NPN)	ZA004602	R13ZA00460200	SKP345-2 NPN	
REMOTE board (PNP)	ZA004604	R13ZA00460400	SKP345-2 PNP	
Standard I/O board (NPN)	ZA004301	R13ZA00430100	SKP329-2	
Protected I/O board (NPN)	ZA004310	R13ZA00431000	SKP338-1 NPN	
Protected I/O board (PNP)	ZA004320	R13ZA00432000	SKP338-1 PNP	
Additional RS-232C board	ZA004711	R13ZA00471100	SKP335-1	
Pulse generating board	ZA004800	R13ZA00480000		
Front board	ZA004B02	R13ZA004B0200	SKP343-2	with an E. STOP CANCEL switch
PSU1	ZA006607	R13ZA00660700		+5V/±12V
PSU2, PSU3	ZA006606	R13ZA00660600		+24V
Motor power unit	ZA007C01	R13ZA007C0100	SKP334-2	
Regenerative brake unit	ZA007A01	R13ZA007A0100	SKP342-2	
AC servo driver for ABS (50 W)	ZA007108	R13ZA00710800	CACR-A5-SU23 GC ABS	attached an ABS label
AC servo driver for ABS (100 W)	ZA007109	R13ZA00710900	CACR-01-SU23 GC ABS	attached an ABS label
AC servo driver for ABS (200 W)	ZA007110	R13ZA00711000	CACR-02-SU23 GC ABS	attached an ABS label
AC servo driver for ABS (400 W)	ZA007111	R13ZA00711100	CACR-04-SU23 GC ABS	attached an ABS label
AC servo driver for INC (50 W)	ZA007102	R13ZA00710200	CACR-A5-SU23 GC	
AC servo driver for INC (100 W)	ZA007103	R13ZA00710300	CACR-01-SU23 GC	
AC servo driver for INC (200 W)	ZA007104	R13ZA00710400	CACR-02-SU23 GC	
AC servo driver for INC (400 W)	ZA007105	R13ZA00710500	CACR-04-SU23 GC	
AC servo driver for INC (750 W)	ZA007106	R13ZA00710600	CACR-08-SU23 GC	
Lithium battery (solder type)	ZI526001	R13ZI52600100		for MPU board
Lithium battery (connector type)	ZA006002	R13ZA00600200		for MPU board

Parts name	Old Code	New Code	Specification	Notes
RS-232C driver	ZI526301	R13ZI52630100		for REMOTE board
Cooling fan	ZA006501	R13ZA00650100		
Hybrid IC for input	ZI526303	R13ZI52630300	SEP005A	for I/O and REMOTE board
Hybrid IC for output (NPN)	ZI526304	R13ZI52630400	SEP007	for protected I/O board or REMOTE board
Hybrid IC for output (PNP)	ZI526305	R13ZI52630500	SEP008	
Transistor array	ZI062620	R13ZI06262000		for standard I/O board
Fuse	ZA006401	R13ZA00640100		
PC cable with emergency stop switch	ZA002102	R13ZA00210200	with E. STOP switch	
PC cable with enable switch	ZA002101	R13ZA00210100	with enable switch	
PC cable adaptor (25-25 pins)	ZA002103	R13ZA00210300		
PC cable adaptor (25-9 pins)	ZA002104	R13ZA00210400		
M/C power cable (3 m)	ZA002002	R13ZA00200200	Standard	
M/C power cable (5 m)	ZA002033	R13ZA00203300		
M/C power cable (10 m)	ZA002034	R13ZA00203400		
M/C power cable L type (3m)	ZA002037	R13ZA00203700		
M/C power cable L type (5m)	ZA002038	R13ZA00203800		
M/C power cable L type (10m)	ZA002039	R13ZA00203900		
M/C signal cable (3m)	ZA002003	R13ZA00200300	Standard	
M/C signal cable (5m)	ZA002035	R13ZA00203500		
M/C signal cable (10m)	ZA002036	R13ZA00203600		
OPU-320	ZA007905	R13ZA00790500		
TP-320	ZA007B04	R13ZA007B0400		