

FANUC Robot series

RIA R15.06-1999 COMPLIANT

R-30iA Mate CONTROLLER

MAINTENANCE MANUAL

MARMTCTR06071E REV. F

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This manual can be used with controllers labeled R-30iA or R-J3iC. If you have a controller labeled R-J3iC, you should read R-30iA as R-J3iC throughout this manual.

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Conventions

WARNING

Information appearing under the "WARNING" caption concerns the protection of personnel. It is boxed and bolded to set it apart from the surrounding text.

CAUTION

Information appearing under the "CAUTION" caption concerns the protection of equipment, software, and data. It is boxed and bolded to set it apart from the surrounding text.

Note Information appearing next to NOTE concerns related information or useful hints.

• Original Instructions

Before using the Robot, be sure to read the "FANUC Robot Safety Manual (B-80687EN)" and understand the content.

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The products in this manual are manufactured under strict quality control. However, when using any of the products in a facility in which a serious accident or loss is predicted due to a failure of the product, install a safety device.

In this manual we have tried as much as possible to describe all the various matters. However, we cannot describe all the matters which must not be done, or which cannot be done, because there are so many possibilities.

Therefore, matters which are not especially described as possible in this manual should be regarded as "impossible".

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PREFACE

This manual describes the following models (R-30iA Mate controller).

| Model | Abbreviation | |
|--------------------------------|--------------------|----------------|
| FANUC Robot LR Mate 200iC | LR Mate 200iC | LR Mate 200iC |
| FANUC Robot LR Mate 200iC/5C | LR Mate 200iC/5C | |
| FANUC Robot LR Mate 200iC/5F | LR Mate 200iC/5F | |
| FANUC Robot LR Mate 200iC/5H | LR Mate 200iC/5H | |
| FANUC Robot LR Mate 200iC/5L | LR Mate 200iC/5L | |
| FANUC Robot LR Mate 200iC/5LC | LR Mate 200iC/5LC | |
| FANUC Robot LR Mate 200iC/5WP | LR Mate 200iC/5WP | |
| FANUC Robot ARC Mate 100iC | ARC Mate 100iC | ARC Mate 100iC |
| FANUC Robot ARC Mate 100iC/6L | ARC Mate 100iC/6L | |
| FANUC Robot ARC Mate 100iC/10S | ARC Mate 100iC/10S | |
| FANUC Robot M-10iA | M-10iA | M-10iA |
| FANUC Robot M-10iA/6L | M-10iA/6L | |
| FANUC Robot M-10iA/10S | M-10iA/10S | |
| FANUC Robot ARC Mate 120iC | ARC Mate 120iC | ARC Mate 120iC |
| FANUC Robot ARC Mate 120iC/10L | ARC Mate 120iC/10L | |
| FANUC Robot M-20iA | M-20iA | M-20iA |
| FANUC Robot M-20iA/10L | M-20iA/10L | |
| FANUC Robot ARC Mate 50iC | ARC Mate 50iC | ARC Mate 50iC |
| FANUC Robot ARC Mate 50iC/5L | ARC Mate 50iC/5L | |
| FANUC Robot M-1iA/0.5A | M-1iA/0.5A | M-1iA |
| FANUC Robot M-1iA/0.5S | M-1iA/0.5S | |

I. SAFETY PRECAUTIONS

Safety

FANUC Robotics is not and does not represent itself as an expert in safety systems, safety equipment, or the specific safety aspects of your company and/or its work force. It is the responsibility of the owner, employer, or user to take all necessary steps to guarantee the safety of all personnel in the workplace.

The appropriate level of safety for your application and installation can be best determined by safety system professionals. FANUC Robotics therefore, recommends that each customer consult with such professionals in order to provide a workplace that allows for the safe application, use, and operation of FANUC Robotics systems.

According to the industry standard ANSI/RIA R15-06, the owner or user is advised to consult the standards to ensure compliance with its requests for Robotics System design, usability, operation, maintenance, and service. Additionally, as the owner, employer, or user of a robotic system, it is your responsibility to arrange for the training of the operator of a robot system to recognize and respond to known hazards associated with your robotic system and to be aware of the recommended operating procedures for your particular application and robot installation.

Ensure that the robot being used is appropriate for the application. Robots used in classified (hazardous) locations must be certified for this use.

FANUC Robotics therefore, recommends that all personnel who intend to operate, program, repair, or otherwise use the robotics system be trained in an approved FANUC Robotics training course and become familiar with the proper operation of the system. Persons responsible for programming the system—including the design, implementation, and debugging of application programs—must be familiar with the recommended programming procedures for your application and robot installation.

The following guidelines are provided to emphasize the importance of safety in the workplace.

CONSIDERING SAFETY FOR YOUR ROBOT INSTALLATION

Safety is essential whenever robots are used. Keep in mind the following factors with regard to safety:

- The safety of people and equipment
- Use of safety enhancing devices
- Techniques for safe teaching and manual operation of the robot(s)
- Techniques for safe automatic operation of the robot(s)
- Regular scheduled inspection of the robot and workcell
- Proper maintenance of the robot

Keeping People and Equipment Safe

The safety of people is always of primary importance in any situation. However, equipment must be kept safe, too. When prioritizing how to apply safety to your robotic system, consider the following:

- People
- External devices
- Robot(s)
- Tooling
- Workpiece

Using Safety Enhancing Devices

Always give appropriate attention to the work area that surrounds the robot. The safety of the work area can be enhanced by the installation of some or all of the following devices:

- Safety fences, barriers, or chains
- Light curtains
- Interlocks
- Pressure mats
- Floor markings
- Warning lights
- Mechanical stops
- EMERGENCY STOP buttons
- DEADMAN switches

Setting Up a Safe Workcell

A safe workcell is essential to protect people and equipment. Observe the following guidelines to ensure that the workcell is set up safely. These suggestions are intended to supplement and not replace existing federal, state, and local laws, regulations, and guidelines that pertain to safety.

- Sponsor your personnel for training in approved FANUC Robotics training course(s) related to your application. Never permit untrained personnel to operate the robots.
- Install a lockout device that uses an access code to prevent unauthorized persons from operating the robot.
- Use anti-tie-down logic to prevent the operator from bypassing safety measures.
- Arrange the workcell so the operator faces the workcell and can see what is going on inside the cell.
- Clearly identify the work envelope of each robot in the system with floor markings, signs, and special barriers. The work envelope is the area defined by the maximum

motion range of the robot, including any tooling attached to the wrist flange that extend this range.

- Position all controllers outside the robot work envelope.
- Never rely on software or firmware based controllers as the primary safety element unless they comply with applicable current robot safety standards.
- Mount an adequate number of EMERGENCY STOP buttons or switches within easy reach of the operator and at critical points inside and around the outside of the workcell.
- Install flashing lights and/or audible warning devices that activate whenever the robot is operating, that is, whenever power is applied to the servo drive system. Audible warning devices shall exceed the ambient noise level at the end-use application.
- Wherever possible, install safety fences to protect against unauthorized entry by personnel into the work envelope.
- Install special guarding that prevents the operator from reaching into restricted areas of the work envelope.
- Use interlocks.
- Use presence or proximity sensing devices such as light curtains, mats, and capacitance and vision systems to enhance safety.
- Periodically check the safety joints or safety clutches that can be optionally installed between the robot wrist flange and tooling. If the tooling strikes an object, these devices dislodge, remove power from the system, and help to minimize damage to the tooling and robot.
- Make sure all external devices are properly filtered, grounded, shielded, and suppressed to prevent hazardous motion due to the effects of electro-magnetic interference (EMI), radio frequency interference (RFI), and electro-static discharge (ESD).
- Make provisions for power lockout/tagout at the controller.
- Eliminate *pinch points*. Pinch points are areas where personnel could get trapped between a moving robot and other equipment.
- Provide enough room inside the workcell to permit personnel to teach the robot and perform maintenance safely.
- Program the robot to load and unload material safely.
- If high voltage electrostatics are present, be sure to provide appropriate interlocks, warning, and beacons.
- If materials are being applied at dangerously high pressure, provide electrical interlocks for lockout of material flow and pressure.

Staying Safe While Teaching or Manually Operating the Robot

Advise all personnel who must teach the robot or otherwise manually operate the robot to observe the following rules:

- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.

Safety

- Know whether or not you are using an intrinsically safe teach pendant if you are working in a hazardous environment.
- Before teaching, visually inspect the robot and work envelope to make sure that no potentially hazardous conditions exist. The work envelope is the area defined by the maximum motion range of the robot. These include tooling attached to the wrist flange that extends this range.
- The area near the robot must be clean and free of oil, water, or debris. Immediately report unsafe working conditions to the supervisor or safety department.
- FANUC Robotics recommends that no one enter the work envelope of a robot that is on, except for robot teaching operations. However, if you must enter the work envelope, be sure all safeguards are in place, check the teach pendant DEADMAN switch for proper operation, and place the robot in teach mode. Take the teach pendant with you, turn it on, and be prepared to release the DEADMAN switch. Only the person with the teach pendant should be in the work envelope.

WARNING

Never bypass, strap, or otherwise deactivate a safety device, such as a limit switch, for any operational convenience. Deactivating a safety device is known to have resulted in serious injury and death.

- Know the path that can be used to escape from a moving robot; make sure the escape path is never blocked.
- Isolate the robot from all remote control signals that can cause motion while data is being taught.
- Test any program being run for the first time in the following manner:

WARNING

Stay outside the robot work envelope whenever a program is being run. Failure to do so can result in injury.

- Using a low motion speed, single step the program for at least one full cycle.
- Using a low motion speed, test run the program continuously for at least one full cycle.
- Using the programmed speed, test run the program continuously for at least one full cycle.
- Make sure all personnel are outside the work envelope before running production.

Staying Safe During Automatic Operation

Advise all personnel who operate the robot during production to observe the following rules:

- Make sure all safety provisions are present and active.
- Know the entire workcell area. The workcell includes the robot and its work envelope, plus the area occupied by all external devices and other equipment with which the robot interacts.
- Understand the complete task the robot is programmed to perform before initiating automatic operation.
- Make sure all personnel are outside the work envelope before operating the robot.
- Never enter or allow others to enter the work envelope during automatic operation of the robot.
- Know the location and status of all switches, sensors, and control signals that could cause the robot to move.
- Know where the EMERGENCY STOP buttons are located on both the robot control and external control devices. Be prepared to press these buttons in an emergency.
- Never assume that a program is complete if the robot is not moving. The robot could be waiting for an input signal that will permit it to continue its activity.
- If the robot is running in a pattern, do not assume it will continue to run in the same pattern.
- Never try to stop the robot, or break its motion, with your body. The only way to stop robot motion immediately is to press an EMERGENCY STOP button located on the controller panel, teach pendant, or emergency stop stations around the workcell.

Staying Safe During Inspection

When inspecting the robot, be sure to

- Turn off power at the controller.
- Lock out and tag out the power source at the controller according to the policies of your plant.
- Turn off the compressed air source and relieve the air pressure.
- If robot motion is not needed for inspecting the electrical circuits, press the EMERGENCY STOP button on the operator panel.
- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- If power is needed to check the robot motion or electrical circuits, be prepared to press the EMERGENCY STOP button, in an emergency.
- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.

Staying Safe During Maintenance

When performing maintenance on your robot system, observe the following rules:

- Never enter the work envelope while the robot or a program is in operation.
- Before entering the work envelope, visually inspect the workcell to make sure no potentially hazardous conditions exist.
- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- Consider all or any overlapping work envelopes of adjoining robots when standing in a work envelope.
- Test the teach pendant for proper operation before entering the work envelope.
- If it is necessary for you to enter the robot work envelope while power is turned on, you must be sure that you are in control of the robot. Be sure to take the teach pendant with you, press the DEADMAN switch, and turn the teach pendant on. Be prepared to release the DEADMAN switch to turn off servo power to the robot immediately.
- Whenever possible, perform maintenance with the power turned off. Before you open the controller front panel or enter the work envelope, turn off and lock out the 3-phase power source at the controller.
- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.
- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.

WARNING

Lethal voltage is present in the controller WHENEVER IT IS CONNECTED to a power source. Be extremely careful to avoid electrical shock. HIGH VOLTAGE IS PRESENT at the input side whenever the controller is connected to a power source. Turning the disconnect or circuit breaker to the OFF position removes power from the output side of the device only.

- Release or block all stored energy. Before working on the pneumatic system, shut off the system air supply and purge the air lines.
- Isolate the robot from all remote control signals. If maintenance must be done when the power is on, make sure the person inside the work envelope has sole control of the robot. The teach pendant must be held by this person.
- Make sure personnel cannot get trapped between the moving robot and other equipment. Know the path that can be used to escape from a moving robot. Make sure the escape route is never blocked.

- Use blocks, mechanical stops, and pins to prevent hazardous movement by the robot. Make sure that such devices do not create pinch points that could trap personnel.

WARNING

Do not try to remove any mechanical component from the robot before thoroughly reading and understanding the procedures in the appropriate manual. Doing so can result in serious personal injury and component destruction.

- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.
- When replacing or installing components, make sure dirt and debris do not enter the system.
- Use only specified parts for replacement. To avoid fires and damage to parts in the controller, never use nonspecified fuses.
- Before restarting a robot, make sure no one is inside the work envelope; be sure that the robot and all external devices are operating normally.

KEEPING MACHINE TOOLS AND EXTERNAL DEVICES SAFE

Certain programming and mechanical measures are useful in keeping the machine tools and other external devices safe. Some of these measures are outlined below. Make sure you know all associated measures for safe use of such devices.

Programming Safety Precautions

Implement the following programming safety measures to prevent damage to machine tools and other external devices.

- Back-check limit switches in the workcell to make sure they do not fail.
- Implement “failure routines” in programs that will provide appropriate robot actions if an external device or another robot in the workcell fails.
- Use *handshaking* protocol to synchronize robot and external device operations.
- Program the robot to check the condition of all external devices during an operating cycle.

Mechanical Safety Precautions

Implement the following mechanical safety measures to prevent damage to machine tools and other external devices.

- Make sure the workcell is clean and free of oil, water, and debris.
- Use software limits, limit switches, and mechanical hardstops to prevent undesired movement of the robot into the work area of machine tools and external devices.

KEEPING THE ROBOT SAFE

Observe the following operating and programming guidelines to prevent damage to the robot.

Operating Safety Precautions

The following measures are designed to prevent damage to the robot during operation.

- Use a low override speed to increase your control over the robot when jogging the robot.
- Visualize the movement the robot will make before you press the jog keys on the teach pendant.
- Make sure the work envelope is clean and free of oil, water, or debris.
- Use circuit breakers to guard against electrical overload.

Programming Safety Precautions

The following safety measures are designed to prevent damage to the robot during programming:

- Establish *interference zones* to prevent collisions when two or more robots share a work area.
- Make sure that the program ends with the robot near or at the home position.
- Be aware of signals or other operations that could trigger operation of tooling resulting in personal injury or equipment damage.
- In dispensing applications, be aware of all safety guidelines with respect to the dispensing materials.

NOTE: Any deviation from the methods and safety practices described in this manual must conform to the approved standards of your company. If you have questions, see your supervisor.

ADDITIONAL SAFETY CONSIDERATIONS FOR PAINT ROBOT INSTALLATIONS

Process technicians are sometimes required to enter the paint booth, for example, during daily or routine calibration or while teaching new paths to a robot. Maintenance personnel also must work inside the paint booth periodically.

Whenever personnel are working inside the paint booth, ventilation equipment must be used. Instruction on the proper use of ventilating equipment usually is provided by the paint shop supervisor.

Although paint booth hazards have been minimized, potential dangers still exist. Therefore, today's highly automated paint booth requires that process and maintenance personnel have full awareness of the system and its capabilities. They must understand

the interaction that occurs between the vehicle moving along the conveyor and the robot(s), hood/deck and door opening devices, and high-voltage electrostatic tools.



CAUTION

Ensure that all ground cables remain connected. Never operate the paint robot with ground provisions disconnected. Otherwise, you could injure personnel or damage equipment.

Paint robots are operated in three modes:

- Teach or manual mode
- Automatic mode, including automatic and exercise operation
- Diagnostic mode

During both teach and automatic modes, the robots in the paint booth will follow a predetermined pattern of movements. In teach mode, the process technician teaches (programs) paint paths using the teach pendant.

In automatic mode, robot operation is initiated at the System Operator Console (SOC) or Manual Control Panel (MCP), if available, and can be monitored from outside the paint booth. All personnel must remain outside of the booth or in a designated safe area within the booth whenever automatic mode is initiated at the SOC or MCP.

In automatic mode, the robots will execute the path movements they were taught during teach mode, but generally at production speeds.

When process and maintenance personnel run diagnostic routines that require them to remain in the paint booth, they must stay in a designated safe area.

Paint System Safety Features

Process technicians and maintenance personnel must become totally familiar with the equipment and its capabilities. To minimize the risk of injury when working near robots and related equipment, personnel must comply strictly with the procedures in the manuals.

This section provides information about the safety features that are included in the paint system and also explains the way the robot interacts with other equipment in the system.

The paint system includes the following safety features:

- Most paint booths have red warning beacons that illuminate when the robots are armed and ready to paint. Your booth might have other kinds of indicators. Learn what these are.
- Some paint booths have a blue beacon that, when illuminated, indicates that the electrostatic devices are enabled. Your booth might have other kinds of indicators. Learn what these are.
- EMERGENCY STOP buttons are located on the robot controller and teach pendant. Become familiar with the locations of all E-STOP buttons.

Safety

- An intrinsically safe teach pendant is used when teaching in hazardous paint atmospheres.
- A DEADMAN switch is located on each teach pendant. When this switch is held in, and the teach pendant is on, power is applied to the robot servo system. If the engaged DEADMAN switch is released or pressed harder during robot operation, power is removed from the servo system, all axis brakes are applied, and the robot comes to an EMERGENCY STOP. Safety interlocks within the system might also E-STOP other robots.

WARNING

An EMERGENCY STOP will occur if the DEADMAN switch is released on a bypassed robot.

- Overtravel by robot axes is prevented by software limits. All of the major and minor axes are governed by software limits. Limit switches and hardstops also limit travel by the major axes.
- EMERGENCY STOP limit switches and photoelectric eyes might be part of your system. Limit switches, located on the entrance/exit doors of each booth, will EMERGENCY STOP all equipment in the booth if a door is opened while the system is operating in automatic or manual mode. For some systems, signals to these switches are inactive when the switch on the SOC is in teach mode.
- When present, photoelectric eyes are sometimes used to monitor unauthorized intrusion through the entrance/exit silhouette openings.
- System status is monitored by computer. Severe conditions result in automatic system shutdown.

Staying Safe While Operating the Paint Robot

When you work in or near the paint booth, observe the following rules, in addition to all rules for safe operation that apply to all robot systems.

WARNING

Observe all safety rules and guidelines to avoid injury.

WARNING

Never bypass, strap, or otherwise deactivate a safety device, such as a limit switch, for any operational convenience. Deactivating a safety device is known to have resulted in serious injury and death.

⚠️ WARNING

Enclosures shall not be opened unless the area is known to be nonhazardous or all power has been removed from devices within the enclosure. Power shall not be restored after the enclosure has been opened until all combustible dusts have been removed from the interior of the enclosure and the enclosure purged. Refer to the Purge chapter for the required purge time.

- Know the work area of the entire paint station (workcell).
- Know the work envelope of the robot and hood/deck and door opening devices.
- Be aware of overlapping work envelopes of adjacent robots.
- Know where all red, mushroom-shaped EMERGENCY STOP buttons are located.
- Know the location and status of all switches, sensors, and/or control signals that might cause the robot, conveyor, and opening devices to move.
- Make sure that the work area near the robot is clean and free of water, oil, and debris. Report unsafe conditions to your supervisor.
- Become familiar with the complete task the robot will perform BEFORE starting automatic mode.
- Make sure all personnel are outside the paint booth before you turn on power to the robot servo system.
- Never enter the work envelope or paint booth before you turn off power to the robot servo system.
- Never enter the work envelope during automatic operation unless a safe area has been designated.
- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- Remove all metallic objects, such as rings, watches, and belts, before entering a booth when the electrostatic devices are enabled.
- Stay out of areas where you might get trapped between a moving robot, conveyor, or opening device and another object.
- Be aware of signals and/or operations that could result in the triggering of guns or bells.
- Be aware of all safety precautions when dispensing of paint is required.
- Follow the procedures described in this manual.

Special Precautions for Combustible Dusts (Powder Paint)

When the robot is used in a location where combustible dusts are found, such as the application of powder paint, the following special precautions are required to insure that there are no combustible dusts inside the robot.

- Purge maintenance air should be maintained at all times, even when the robot power is off. This will insure that dust can not enter the robot.
- A purge cycle will not remove accumulated dusts. Therefore, if the robot is exposed to dust when maintenance air is not present, it will be necessary to remove the covers

and clean out any accumulated dust. Do not energize the robot until you have performed the following steps.

1. Before covers are removed, the exterior of the robot should be cleaned to remove accumulated dust.
2. When cleaning and removing accumulated dust, either on the outside or inside of the robot, be sure to use methods appropriate for the type of dust that exists. Usually lint free rags dampened with water are acceptable. Do not use a vacuum cleaner to remove dust as it can generate static electricity and cause an explosion unless special precautions are taken.
3. Thoroughly clean the interior of the robot with a lint free rag to remove any accumulated dust.
4. When the dust has been removed, the covers must be replaced immediately.
5. Immediately after the covers are replaced, run a complete purge cycle. The robot can now be energized.

Staying Safe While Operating Paint Application Equipment

When you work with paint application equipment, observe the following rules, in addition to all rules for safe operation that apply to all robot systems.



WARNING

When working with electrostatic paint equipment, follow all national and local codes as well as all safety guidelines within your organization. Also reference the following standards: NFPA 33 Standards for Spray Application Using Flammable or Combustible Materials, and NFPA 70 National Electrical Code.

- **Grounding:** All electrically conductive objects in the spray area must be grounded. This includes the spray booth, robots, conveyors, workstations, part carriers, hooks, paint pressure pots, as well as solvent containers. Grounding is defined as the object or objects shall be electrically connected to ground with a resistance of not more than 1 megohms.
- **High Voltage:** High voltage should only be on during actual spray operations. Voltage should be off when the painting process is completed. Never leave high voltage on during a cap cleaning process.
- Avoid any accumulation of combustible vapors or coating matter.
- Follow all manufacturer recommended cleaning procedures.
- Make sure all interlocks are operational.
- No smoking.
- Post all warning signs regarding the electrostatic equipment and operation of electrostatic equipment according to NFPA 33 Standard for Spray Application Using Flammable or Combustible Material.
- Disable all air and paint pressure to bell.
- Verify that the lines are not under pressure.

Staying Safe During Maintenance

When you perform maintenance on the painter system, observe the following rules, and all other maintenance safety rules that apply to all robot installations. Only qualified, trained service or maintenance personnel should perform repair work on a robot.

- Paint robots operate in a potentially explosive environment. Use caution when working with electric tools.
- When a maintenance technician is repairing or adjusting a robot, the work area is under the control of that technician. All personnel not participating in the maintenance must stay out of the area.
- For some maintenance procedures, station a second person at the control panel within reach of the EMERGENCY STOP button. This person must understand the robot and associated potential hazards.
- Be sure all covers and inspection plates are in good repair and in place.
- Always return the robot to the “home” position before you disarm it.
- Never use machine power to aid in removing any component from the robot.
- During robot operations, be aware of the robot’s movements. Excess vibration, unusual sounds, and so forth, can alert you to potential problems.
- Whenever possible, turn off the main electrical disconnect before you clean the robot.
- When using vinyl resin observe the following:
 - Wear eye protection and protective gloves during application and removal.
 - Adequate ventilation is required. Overexposure could cause drowsiness or skin and eye irritation.
 - If there is contact with the skin, wash with water.
 - Follow the Original Equipment Manufacturer’s Material Safety Data Sheets.
- When using paint remover observe the following:
 - Eye protection, protective rubber gloves, boots, and apron are required during booth cleaning.
 - Adequate ventilation is required. Overexposure could cause drowsiness.
 - If there is contact with the skin or eyes, rinse with water for at least 15 minutes. Then seek medical attention as soon as possible.
 - Follow the Original Equipment Manufacturer’s Material Safety Data Sheets

1

SAFETY PRECAUTIONS

For the safety of the operator and the system, follow all safety precautions when operating a robot and its peripheral devices installed in a work cell.

In addition, refer to the “FANUC Robot SAFETY HANDBOOK (B-80687EN)”.

1.1 WORKING PERSON

The personnel can be classified as follows.

Operator:

- Power ON/OFF for robot controller
- Start of robot program with operator's panel

Programmer or teaching operator:

- Operate for Robot
- Teaching inside safety fence

Maintenance engineer:

- Operate for Robot
- Teaching inside safety fence
- Maintenance (adjustment, replacement)

- An operator cannot work inside the safety fence.
- A programmer, Teaching operator and maintenance engineer can work inside the safety fence. The workings inside safety fence are lifting, setting, teaching, adjusting, maintenance, etc..
- To work inside the fence, the person must be trained for the robot.

Table 1.1 lists the workings of outside the fence. In this table, the symbol “○” means the working allowed to be carried out by the personnel.

Table 1.1 List of workings outside the fence

| | Operator | Programmer or Teaching operator | Maintenance engineer |
|---|----------|---------------------------------------|-------------------------|
| Power ON/OFF for Robot controller | ○ | ○ | ○ |
| Select operating mode (AUTO, T1, T2) | | ○ | ○ |
| Select Remote/Local mode | | ○ | ○ |
| Select robot program with teach pendant | | ○ | ○ |
| Select robot program with external device | | ○ | ○ |
| Start robot program with operator's panel | ○ | ○ | ○ |
| Start robot program with teach pendant | | ○ | ○ |
| Reset alarm with operator's panel | | ○ | ○ |
| Reset alarm with teach pendant | | ○ | ○ |
| Set data on the teach pendant | ○ | ○ | |
| Teaching with teach pendant | ○ | ○ | |
| Emergency stop with operator's panel | | ○ | ○ |
| Emergency stop with teach pendant | | ○ | ○ |
| Emergency stop with safety fence open | | ○ | ○ |
| Maintain for operator's panel | | ○ | |
| Maintain for teach pendant | | | ○ |

In operating, programming and maintenance, the programmer, teaching operator and maintenance engineer take care of their safety using the following safety protectors, for example.

- Use adequate clothes, uniform, overall for operation
- Put on the safety shoes
- Use helmet

1.2 WORKING PERSON SAFETY

Working person safety is the primary safety consideration. Because it is very dangerous to enter the operating space of the robot during automatic operation, adequate safety precautions must be observed. The following lists the general safety precautions. Careful consideration must be made to ensure working person safety.

- (1) Have the robot system working person attend the training courses held by FANUC.

FANUC provides various training courses. Contact our sales office for details.

- (2) Even when the robot is stationary, it is possible that the robot is still in a ready to move state, and is waiting for a signal. In this state, the robot is regarded as still in motion. To ensure working person safety, provide the system with an alarm to indicate visually or aurally that the robot is in motion.
- (3) Install a safety fence with a gate so that no working person can enter the work area without passing through the gate. Install an interlock switch, a safety plug, and so forth in the safety gate so that the robot is stopped as the safety gate is opened.

The controller is designed to receive this interlock signal of the door switch. When the gate is opened and this signal received, the controller stops the robot in an emergency. For connection, see Fig.1.1.

- (4) Provide the peripheral devices with appropriate grounding (Class A, Class B, Class C, and Class D).
- (5) Try to install the peripheral devices outside the work area.
- (6) Draw an outline on the floor, clearly indicating the range of the robot motion, including the tools such as a hand.
- (7) Install a mat switch or photoelectric switch on the floor with an interlock to a visual or aural alarm that stops the robot when a working person enters the work area.
- (8) If necessary, install a safety lock so that no one except the working person in charge can turn on the power of the robot.

The circuit breaker installed in the controller is designed to disable anyone from turning it on when it is locked with a padlock.

- (9) When adjusting each peripheral device independently, be sure to turn off the power of the robot.

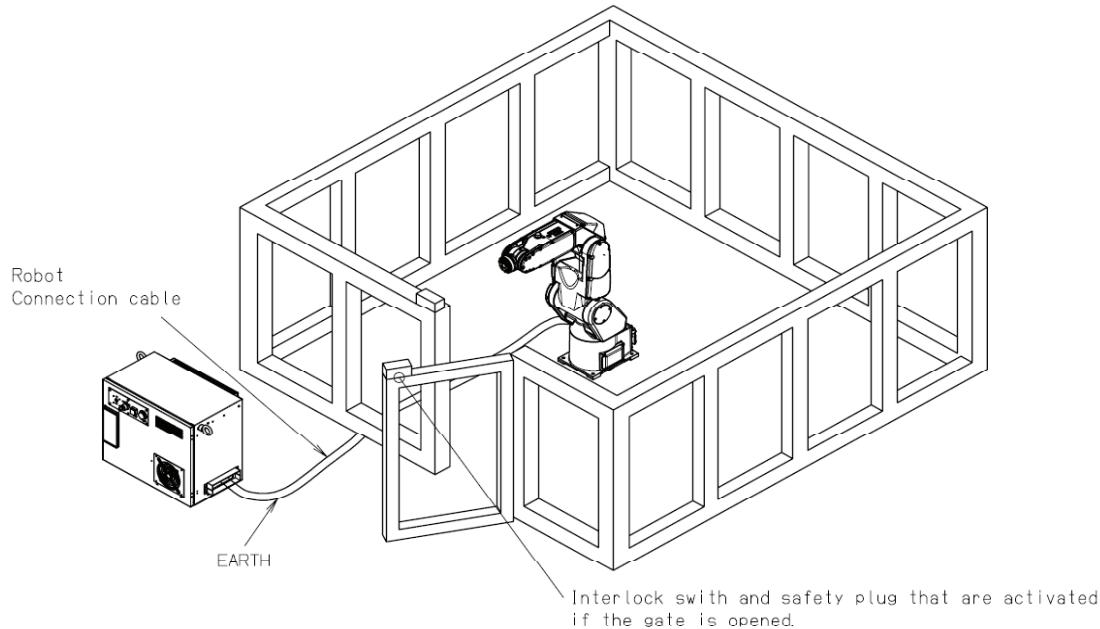
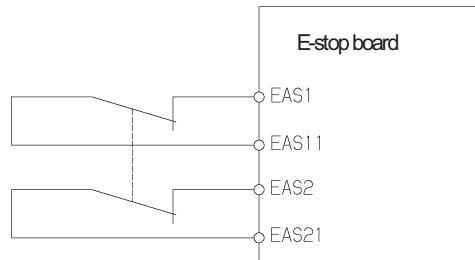


Fig.1.2 Safety fence and safety gate



NOTE

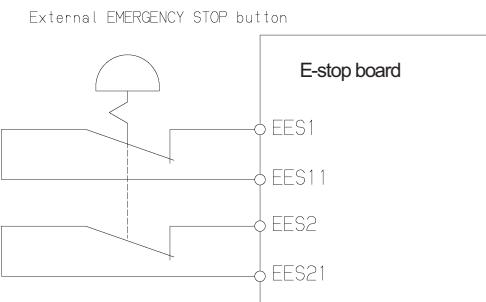
Terminals EAS1, EAS11, EAS2, and EAS21 are on emergency stop board in the E-stop unit.

1.2.1 General Person Safety

The general person is a person who operates the robot system. In this sense, a worker who operates the teach pendant is also a general person. However, this section does not apply to teaching operators.

- (1) If it is not necessary for the robot to operate, turn off the power of the robot controller or press the EMERGENCY STOP button, and then proceed with necessary work.
- (2) Operate the robot system at a location outside of the safety fence
- (3) Install a safety fence with a safety gate to prevent any worker other than the operator from entering the work area unexpectedly and to prevent the worker from entering a dangerous area.
- (4) Install an EMERGENCY STOP button within the general person's reach.

The robot controller is designed to be connected to an external EMERGENCY STOP button. With this connection, the controller stops the robot operation when the external EMERGENCY STOP button is pressed. See the diagram below for connection.

**NOTE**

Connect to EES1 and EES11, EES2 and EES21.

Fig.1.2.1 Connection diagram for external emergency stop button

1.2.2 Safety of the Teaching Operator

While teaching the robot, it is necessary for the operator to enter the work area of the robot. It is particularly necessary to ensure the safety of the teaching operator.

- (1) Unless it is specifically necessary to enter the robot work area, carry out all tasks outside the area.
- (2) Before teaching the robot, check that the robot and its peripheral devices are all in the normal operating condition.
- (3) When entering the robot work area and teaching the robot, be sure to check the location and condition of the safety devices (such as the EMERGENCY STOP button and the DEADMAN switch on the teach pendant).
- (4) The teaching operator should pay careful attention so that no other workers enter the robot work area.

Our operator panel is provided with an emergency stop button and a key switch (mode switch) for selecting the automatic operation mode (AUTO) and the teach modes (T1 and T2). Before entering the inside of the safety fence for the purpose of teaching, set the switch to a teach mode, remove the key from the mode switch to prevent other people from changing the operation mode carelessly, then open the safety gate. If the safety gate is opened with the automatic operation mode set, the robot enters the emergency stop state. After the switch is set to a teach mode, the safety gate is disabled. The programmer should understand that the safety gate is disabled and is responsible for keeping other people from entering the inside of the safety fence.

Our teach pendant is provided with a DEADMAN switch as well as an emergency stop button. These button and switch function as follows:

- (1) Emergency stop button: Causes an emergency stop when pressed.
- (2) DEADMAN switch: Functions differently depending on the mode switch setting status.
 - (a) Automatic operation mode: The DEADMAN switch is disabled.
 - (b) Teach mode: Causes an emergency stop when the operator releases the DEADMAN switch or when the operator presses the switch strongly.

Note) The DEADMAN switch is provided to place the robot in the emergency stop state when the operator releases the teach pendant or presses the pendant strongly in case of emergency. The R-30iA Mate employs a 3-position DEADMAN switch, which allows the robot to operate when the 3-position DEADMAN switch is pressed to its intermediate point. When the operator releases the DEADMAN switch or presses the switch strongly, the robot enters the emergency stop state.

The operator's intention of starting teaching is determined by the controller through the dual operation of setting the teach pendant enable/disable switch to the enable position and pressing the DEADMAN switch. The operator should make sure that the robot can operate in such conditions and be responsible in carrying out tasks safely.

The teach pendant, operator panel, and peripheral device interface send each robot start signal. However the validity of each signal changes as follows depending on the mode switch of the operator panel DEADMAN switch, the teach pendant enable switch and the remote condition on the software.

| Mode | Teach pendant enable switch | Software remote condition | Teach pendant | Operator panel | Peripheral device |
|-------------|-----------------------------|---------------------------|------------------|------------------|-------------------|
| AUTO mode | On | Local | Not allowed | Not allowed | Not allowed |
| | | Remote | Not allowed | Not allowed | Not allowed |
| | Off | Local | Not allowed | Allowed to start | Not allowed |
| | | Remote | Not allowed | Not allowed | Allowed to start |
| T1, T2 mode | On | Local | Allowed to start | Not allowed | Not allowed |
| | | Remote | Allowed to start | Not allowed | Not allowed |
| | Off | Local | Not allowed | Not allowed | Not allowed |
| | | Remote | Not allowed | Not allowed | Not allowed |

- (5) To start the system using the operator's panel, make certain that nobody is in the robot work area and that there are no abnormal conditions in the robot work area.
- (6) When a program is completed, be sure to carry out a test run according to the procedure below.
 - (a) Run the program for at least one operation cycle in the single step mode at low speed.
 - (b) Run the program for at least one operation cycle in the continuous operation mode at low speed.
 - (c) Run the program for one operation cycle in the continuous operation mode at the intermediate speed and check that no abnormalities occur due to a delay in timing.
 - (d) Run the program for one operation cycle in the continuous operation mode at the normal operating speed and check that the system operates automatically without trouble.
 - (e) After checking the completeness of the program through the test run above, execute it in the automatic operation mode.
- (7) While operating the system in the automatic operation mode, the teaching operator should leave the robot work area.

1.2.3 Safety during Maintenance

For the safety of maintenance engineer, pay utmost attention to the following.

- (1) During operation, never enter the robot work area.
- (2) Except when specifically necessary, turn off the power of the controller while carrying out maintenance. Lock the power switch, if necessary, so that no other person can turn it on.
- (3) If it becomes necessary to enter the robot operation range while the power is on, press the emergency stop button on the operator panel, or the teach pendant before entering the range. The maintenance engineer must indicate that maintenance work is in progress and be careful not to allow other people to operate the robot carelessly.
- (4) When disconnecting the pneumatic system, be sure to reduce the supply pressure.
- (5) Before the start of teaching, check that the robot and its peripheral devices are all in the normal operating condition.
- (6) Do not operate the robot in the automatic mode while anybody is in the robot work area.
- (7) When it is necessary to maintain the robot alongside a wall or instrument, or when multiple workers are working nearby, make certain that their escape path is not obstructed.
- (8) When a tool is mounted on the robot, or when any moving device other than the robot is installed, such as belt conveyor, pay careful attention to its motion.
- (9) If necessary, have a worker who is familiar with the robot system stand beside the operator panel and observe the work being performed. If any danger arises, the worker should be ready to press the EMERGENCY STOP button at any time.

- (10) When replacing or reinstalling components, take care to prevent foreign matter from entering the system.
- (11) When handling each unit or printed circuit board in the controller during inspection, turn off the circuit breaker to protect against electric shock.
- (12) When replacing parts, be sure to use those specified by FANUC.
In particular, never use fuses or other parts of non-specified ratings. They may cause a fire or result in damage to the components in the controller.
- (13) When restarting the robot system after completing maintenance work, make sure in advance that there is no person in the work area and that the robot and the peripheral devices are not abnormal.

1.3 SAFETY OF THE TOOLS AND PERIPHERAL DEVICES

1.3.1 Precautions in Programming

- (1) Use a limit switch or other sensor to detect a dangerous condition and, if necessary, design the program to stop the robot when the sensor signal is received.
- (2) Design the program to stop the robot when an abnormal condition occurs in any other robots or peripheral devices, even though the robot itself is normal.
- (3) For a system in which the robot and its peripheral devices are in synchronous motion, particular care must be taken in programming so that they do not interfere with each other.
- (4) Provide a suitable interface between the robot and its peripheral devices so that the robot can detect the states of all devices in the system and can be stopped according to the states.

1.3.2 Precautions for Mechanism

- (1) Keep the component cells of the robot system clean, and operate the robot in an environment free of grease, water, and dust.
- (2) Use mechanical unit cable that have required user interface.
Please do not obstruct the movement of the mechanical unit cable when cables are added. (Please never do the nylon band stop etc. of an external cable to the mechanical unit cable.) Moreover, please do not interfere with the mechanical unit cable when equipment is installed in the robot. If these precautions are not observed there is a possibility that the mechanical unit cable is disconnected and the trouble not anticipated occurs.
- (3) Employ a limit switch or mechanical stopper to limit the robot motion so that the robot or cable does not encounter its peripheral devices or tools.

1.4 SAFETY OF THE ROBOT MECHANISM

1.4.1 Precautions in Operation

- (1) When operating the robot in the jog mode, set it at an appropriate speed so that the operator can manage the robot in any eventuality.
- (2) Before pressing the jog key, be sure you know in advance what motion the robot will perform in the jog mode.

1.4.2 Precautions in Programming

- (1) When the work areas of robots overlap, make certain that the motions of the robots do not interfere with each other.
- (2) Be sure to specify the predetermined work origin in a motion program for the robot and program the motion so that it starts from the origin and terminates at the origin.

Make it possible for the operator to easily distinguish at a glance that the robot motion has terminated.

1.4.3 Precautions for Mechanisms

- (1) Keep the work areas of the robot clean, and operate the robot in an environment free of grease, water, and dust.

1.5 SAFETY OF THE END EFFECTOR

1.5.1 Precautions in Programming

- (1) To control the pneumatic, hydraulic and electric actuators, carefully consider the necessary time delay after issuing each control command up to actual motion and ensure safe control.
- (2) Provide the end effector with a limit switch, and control the robot system by monitoring the state of the end effector.

1.6 WARNING LABEL

- (1) Step-on prohibitive label



Fig.1.6 (a) Step-on prohibitive label

Description

Do not step on or climb the robot or controller as it may adversely affect the robot or controller and you may get hurt if you lose your footing as well.

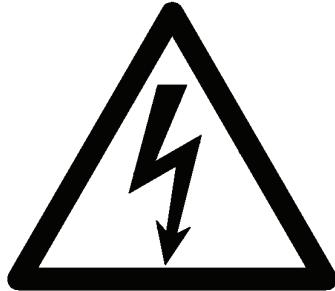
(2) High-temperature warning label

**Fig.1.6 (b) High-temperature warning label**

Description

Be cautious about a section where this label is affixed, as the section generates heat. If you have to inevitably touch such a section when it is hot, use a protective provision such as heat-resistant gloves.

(3) High-voltage warning label

**Fig.1.6 (c) High-voltage warning label**

Description

A high voltage is applied to the places where this label is attached.

Before starting maintenance, turn the power to the controller off, and then turn the circuit breaker off to avoid electric shock hazards. Be careful with servo amplifier and other units because high-voltage places in these units may remain in the high-voltage state for a fixed time.

II. MAINTENANCE

1 OVERVIEW

This manual describes the maintenance and connection of the R-30iA Mate robot controller (called the R-30iA Mate).

Maintenance Part:

Troubleshooting, and the setting, adjustment, and replacement of units

Connection Part:

Connection of the R-30iA Mate controller to the robot mechanical unit and peripheral devices, and installation of the controller

⚠ WARNING

Before you enter the robot working area, be sure to turn off the power to the controller or press the EMERGENCY STOP button on the operator's panel or teach pendant.

Otherwise, you could injure personnel or damage equipment.

- The RIA R15.06 -- 1999 compliant controller has safety circuit performance compliant with 4.5.4 control reliable.
- For information on third party approvals, contact your FANUC representative.
- The controller is designed to meet R15.06 -- 1999 American standard for industrial robots and robot systems -- safety requirements.

2 CONFIGURATION

2.1 EXTERNAL VIEW OF THE CONTROLLER

The appearance and components might slightly differ depending on the controlled robot, application, and options used.

Fig.2.1 (a) shows the view of R-30iA Mate.

Fig.2.1 (b) to (c) show the construction of the R-30iA Mate controller.

Fig.2.1 (d) to (f) show the external view of the operator's panel.

Fig.2.1 (g) to (h) show the block diagram of R-30iA Mate.

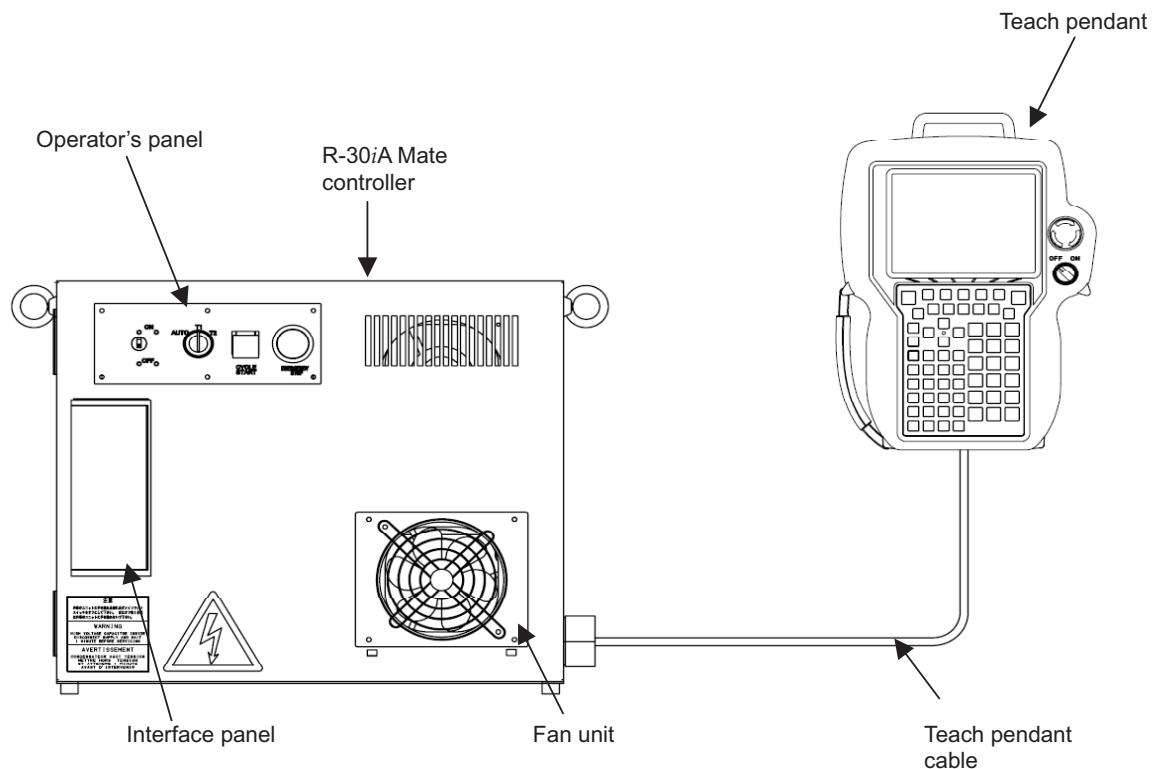


Fig.2.1 (a) External view of the R-30iA Mate controller

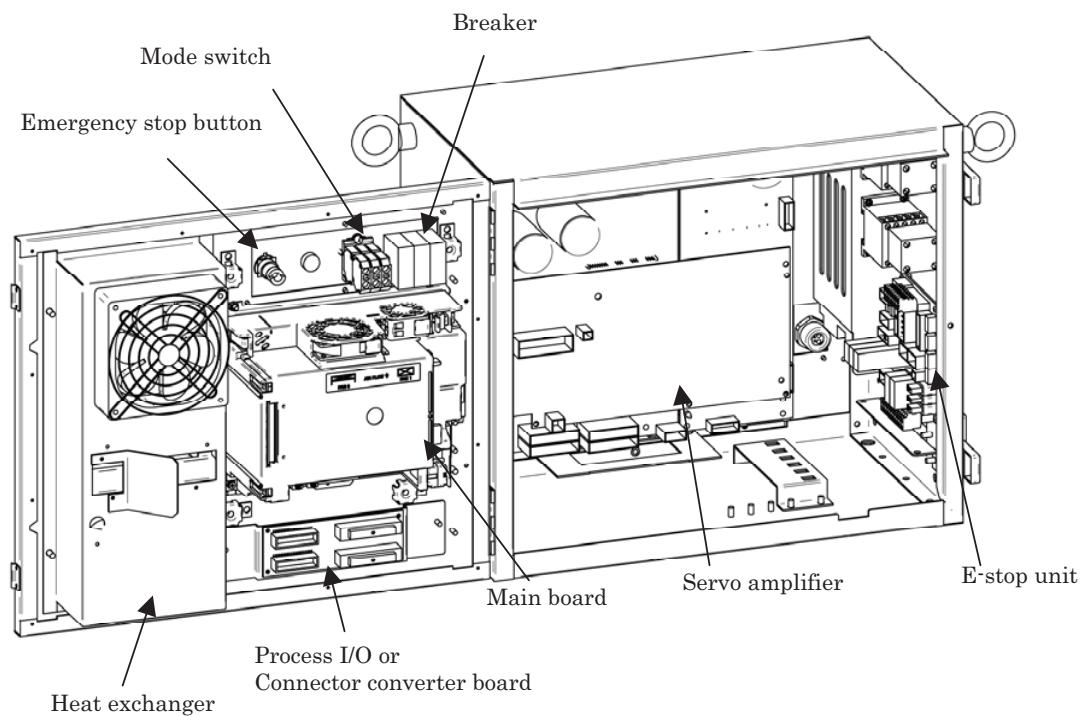
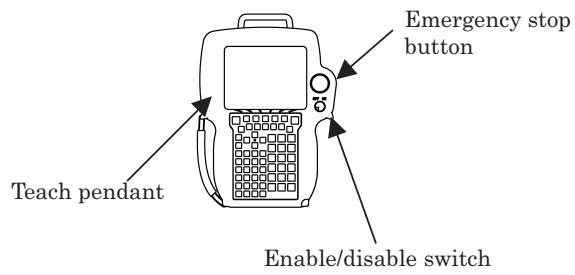


Fig.2.1 (b) R-30iA Mate interior (Front)

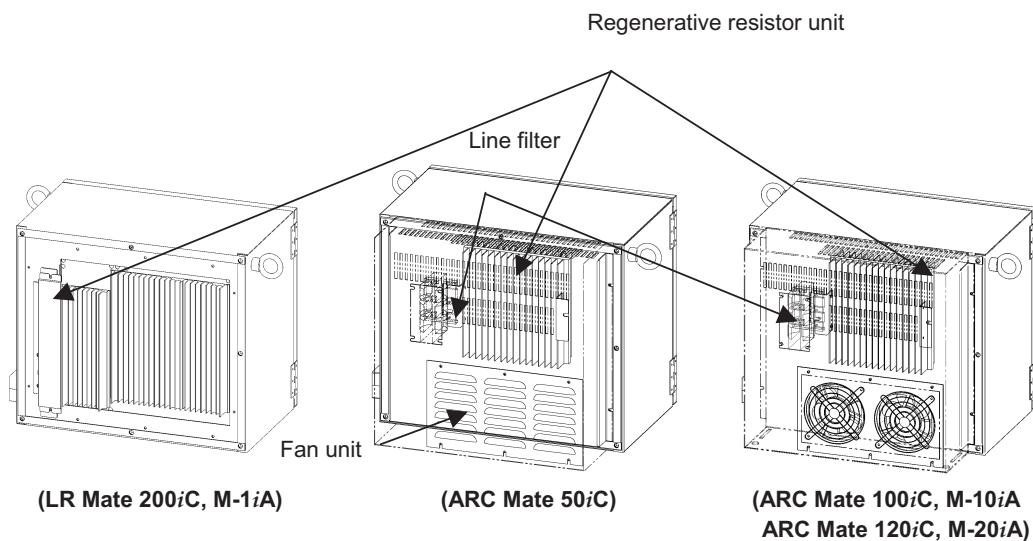


Fig.2.1 (c) R-30iA Mate interior

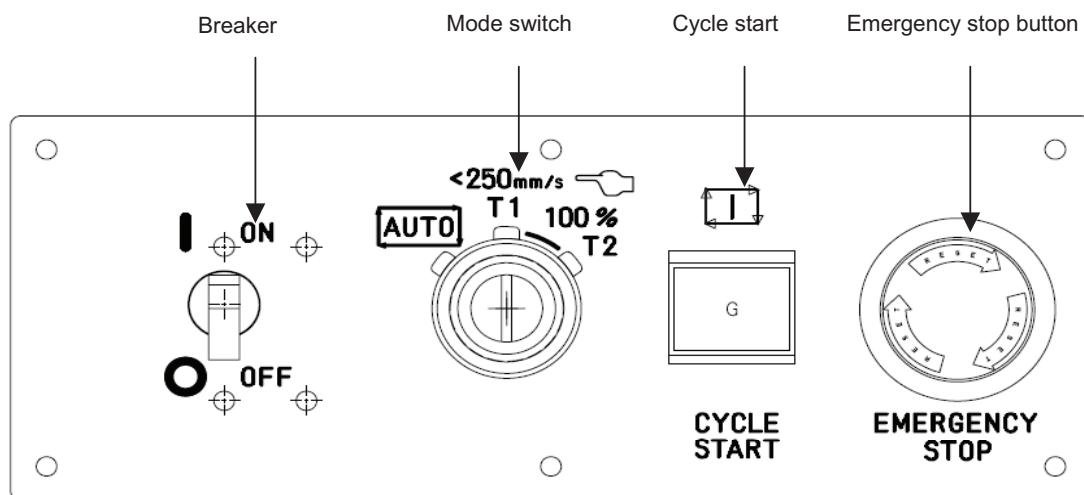


Fig.2.1 (d) R-30iA Mate panel overview

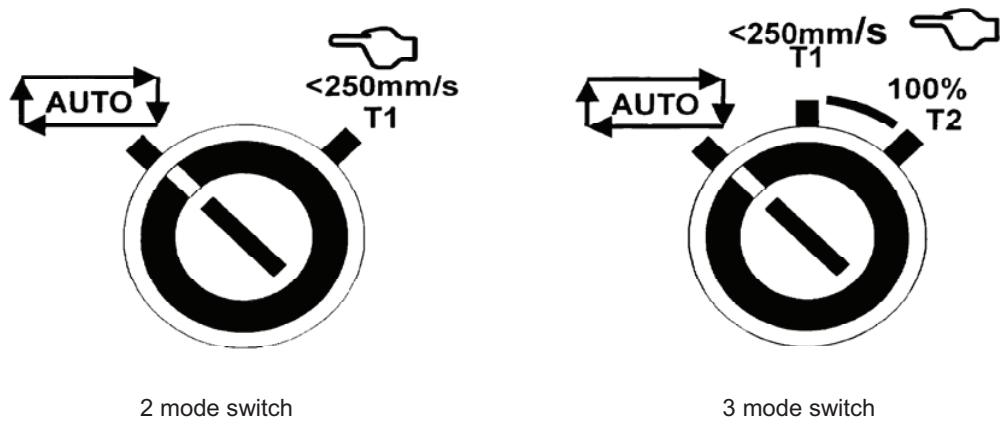


Fig.2.1 (e) Mode switch operation

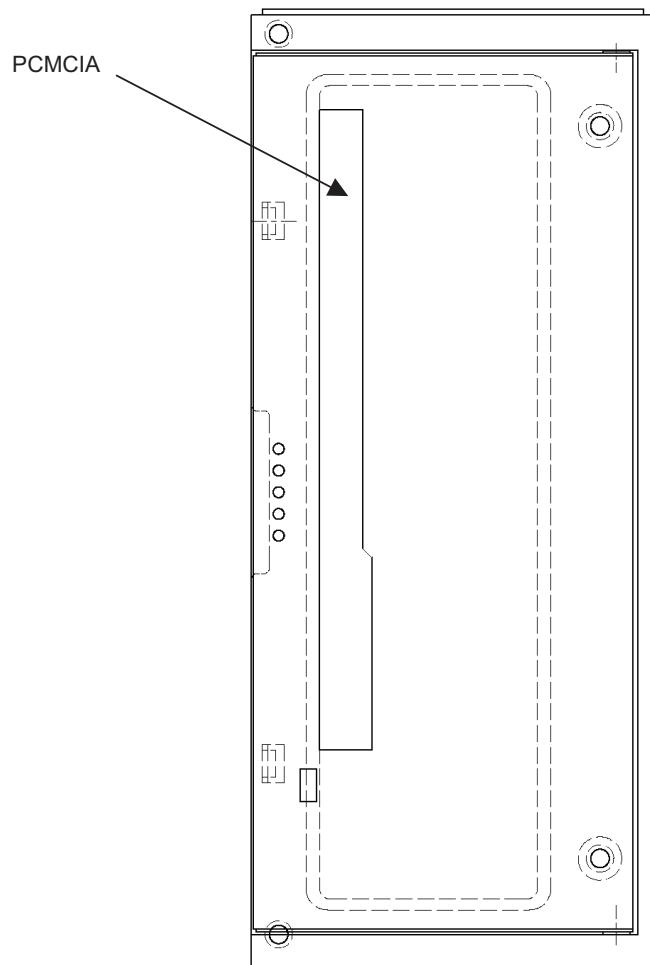


Fig.2.1 (f) interface overview

Table 2.1 Servo amplifier specifications

| ROBOT | SERVO AMPLIFIER | REGENERATIVE RESISTOR |
|------------------------|-----------------|-----------------------|
| LR Mate 200iC | A06B-6107-H005 | A05B-2550-C050 |
| M-1iA | A06B-6107-H005 | A05B-2550-C050 |
| ARC Mate 50iC | A06B-6107-H005 | A05B-2550-C051 |
| ARC Mate 100iC, M-10iA | A06B-6107-H004 | A05B-2550-C051 |
| ARC Mate 120iC, M-20iA | A06B-6107-H002 | A05B-2550-C052 |

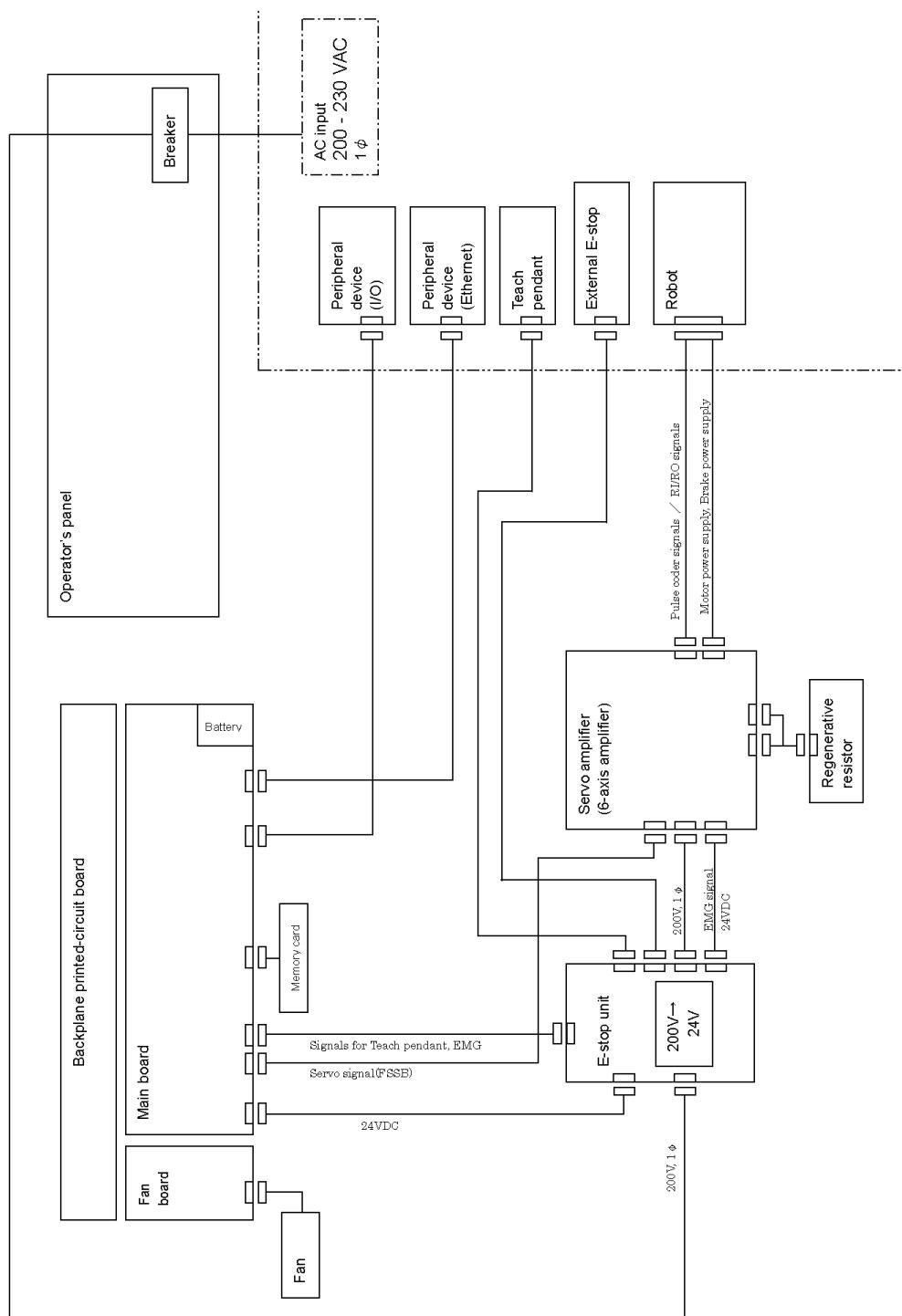
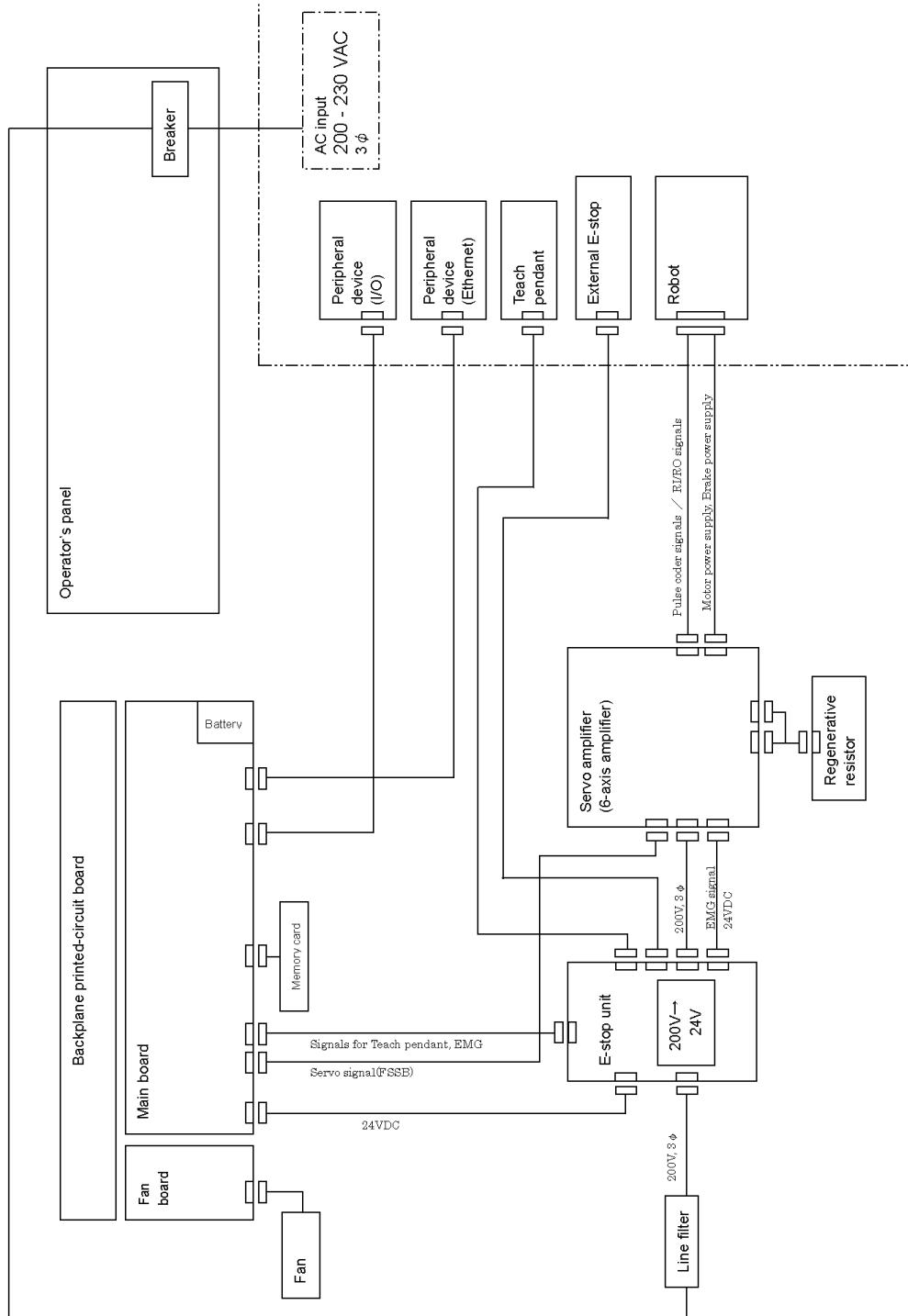


Fig.2.1 (g) Block diagram of the R-30iA Mate (LR Mate 200iC, M-1iA)



**Fig.2.1 (h) Block diagram of the R-30iA Mate
(ARC Mate 100iC, M-10iA, ARC Mate 120iC, M-20iA, ARC Mate 50iC)**

2.2 COMPONENT FUNCTIONS

- Main board
The main board contains a microprocessor, its peripheral circuits, memory, and operator's panel control circuit. The main CPU controls servo mechanism positioning.
- I/O printed circuit board
Various types of printed circuit boards are provided for applications including process I/O. When it is used, various I/O types can be selected. These are connected with FANUC I/O Link.
- E-stop unit and MCC unit
This unit controls the emergency stop system for both of the magnetic contactor and the precharge of the servo amplifier.
- Power supply unit
The power supply unit converts the AC power to various levels of DC power.
- Backplane printed circuit board
The various control printed circuit boards are mounted on the backplane printed circuit board.
- Teach pendant
All operations including robot programming are performed with this unit. The controller status and data are indicated on the liquid-crystal display (LCD) on the pendant.
- Servo amplifier
The servo amplifier controls servomotor, Pulsecoder signal, brake control, overtravel and hand broken.
- Operator's panel
Buttons and LEDs on the operator's panel are used to start the robot and to indicate the robot status. The panel has a port interface for the serial interface to an external device and an interface to connect the memory card for data backup.
- Fan unit, heat exchanger
These components cool the inside of the controller.
- Circuit breaker
If the electric system in the controller malfunctions, or if abnormal input power causes high current in the system, the input power is connected to the circuit breaker to protect the equipment.
- Regenerative resistor
To discharge the counter electromotive force from the servomotor, connect a regenerative resistor to the servo amplifier.

2.3 PREVENTIVE MAINTENANCE

Daily maintenance and periodic maintenance/inspection ensure reliable robot performance for extended periods of time.

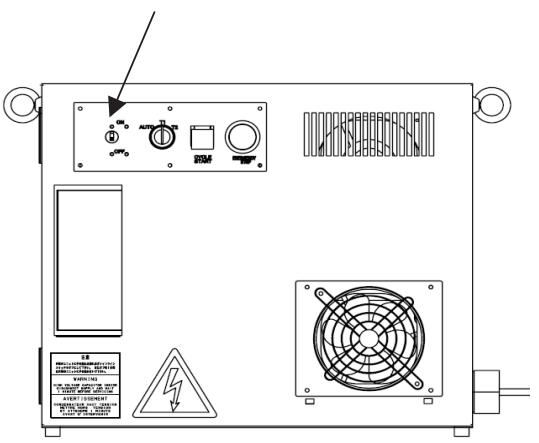
- (1) Daily maintenance
Before operating the system each day, clean each part of the system and check the system parts for any damage or cracks. Also, check the following:
 - (a) Before operation
Check the cable connected to the teach pendant for excessive twisting. Check the controller and peripheral devices for abnormalities.
 - (b) After operation
At the end of operation, return the robot to the specified position, and then turn off the controller. Clean each part, and check for any damage or cracks. If the ventilation port of the controller is dusty, clean it.
- (2) Check after one month
Check that the fan is rotating normally. If the fan has dirt and dust built up, clean the fan according to step (3) described below for inspection to be performed every 6 months.

- (3) Periodic inspection performed every six months
Remove any dirt and dust from the inside of the cabinet. Wipe off dirt and dust from the fan.
- (4) Battery daily check
Replace the battery on the front panel of the main board every 4 years. Please refer to the section 7.11.
- (5) Maintenance tools
The following maintenance tools are recommended:
 - (a) Measuring instruments
AC/DC voltmeter (A digital voltmeter is sometimes required.)
Oscilloscope with a frequency range of 5 MHz or higher, two channels
 - (b) Tools
Phillips screwdrivers: Large, medium, and small
Standard screwdrivers: Large, medium, and small
Nut driver set (Metric)
Pliers
Needle-nose pliers
Diagonal cutting pliers

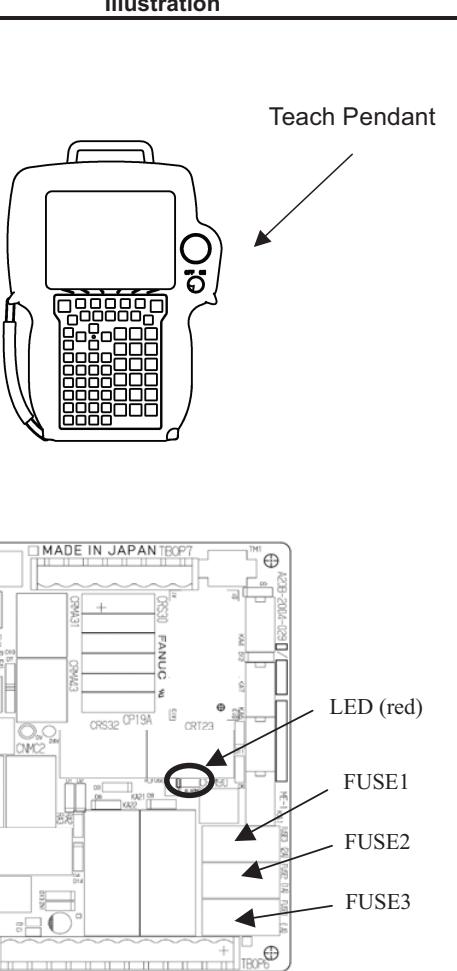
3 TROUBLESHOOTING

This chapter describes the checking method and corrective action for each error code indicated if a hardware alarm occurs. Refer to the operator's manual to release program alarms.

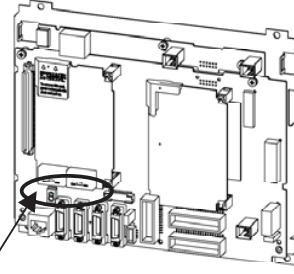
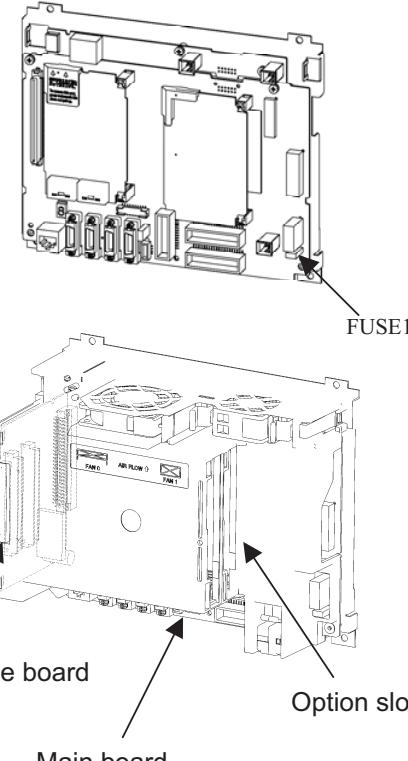
3.1 POWER CANNOT BE TURNED ON

| Check and Corrective action | | Figure |
|-----------------------------|--|--|
| (Check 1) | Check that the circuit breaker is on and has not tripped. (Corrective action) | <p>Circuit breaker</p>  |

3.1.1 When the Teach Pendant Cannot Be Powered on

| Inspection and action | Illustration |
|---|---|
| <p>(Inspection 1) Confirm that fuse FUSE2 on the emergency stop printed circuit board is not blown. When it is blown, the LED on the emergency stop printed circuit board lights in red. When FUSE2 is blown, carry out action 1 and replace the fuse.</p> <p>(Inspection 2) When FUSE2 is not blown, carry out action 2.</p> <p>(Action 1) (a) Check the cable of the teach pendant for failure and replace it as necessary. (b) Check the teach pendant for failure and replace it as necessary. (c) Replace the emergency stop printed circuit board.</p> <p>(Action 2) When the LED on the main board does not light, replace the emergency stop unit. When the LED on the main board lights, carry out action 1.</p> |  <p>The diagram shows the Teach Pendant's front panel with a screen and keypad, and a detailed cross-sectional view of the internal printed circuit board. In the board's layout, three fuses are labeled: FUSE1, FUSE2, and FUSE3. Arrows point from the labels to their respective locations on the board. A red LED is also indicated on the board.</p> |

3.1.2 When the Teach Pendant Does Not Change from the Initial Screen

| Inspection and action | Illustration |
|--|---|
| <p>(Inspection 1)</p> <p>Check that the status display LED and 7-segment LED on the main board operate normally.</p> <p>(Action)</p> <p>Carry out an action according to the LED status. For details, see "TROUBLESHOOTING USING THE LEDS ON THE MAIN BOARD".</p> |  <p>7-segment LED and status display LED (on the main board)</p> |
| <p>(Inspection 2)</p> <p>When the LED on the main board does not light in inspection 1, check if FUSE1 on the main board is blown.</p> <p>(a) When FUSE1 is blown See action 1.</p> <p>(b) When FUSE1 is not blown See action 2.</p> <p>(Action 1)</p> <p>(a) Replace the backplane board. (b) Replace the main board. (c) When an option board is installed in the option slot, replace the option board.</p> <p>(Action 2)</p> <p>(a) Replace the emergency stop unit. (b) Replace the cable between the main board and the emergency stop unit. (c) Replace the boards indicated in action 1.</p> |  <p>FUSE1</p> <p>Back plane board</p> <p>Main board</p> <p>Option slot</p> |

3.2 ALARM OCCURRENCE SCREEN

The alarm occurrence screen displays only the alarm conditions that are currently active. If an alarm reset signal is input to reset the alarm conditions, the alarm occurrence screen displays the message "PAUSE or more serious alarm has not occurred."

The alarm occurrence screen displays only the alarm conditions (if any) that occur after the most recently entered alarm reset signal. To erase all alarm displays from the alarm occurrence screen. Press the CLEAR key (+ shift) on the alarm history screen.

The alarm occurrence screen is intended to display PAUSE or alarms that are more serious. It will not display WARN, NONE, or a reset. It is possible to disable PAUSE and some of more serious alarms from being displayed by setting the \$ER_NOHIS system variable appropriately.

If two or more alarms have occurred, the display begins with the most recent alarm.

Up to 100 lines can be displayed.

If an alarm has a cause code, it is displayed below the line indicating the alarm.

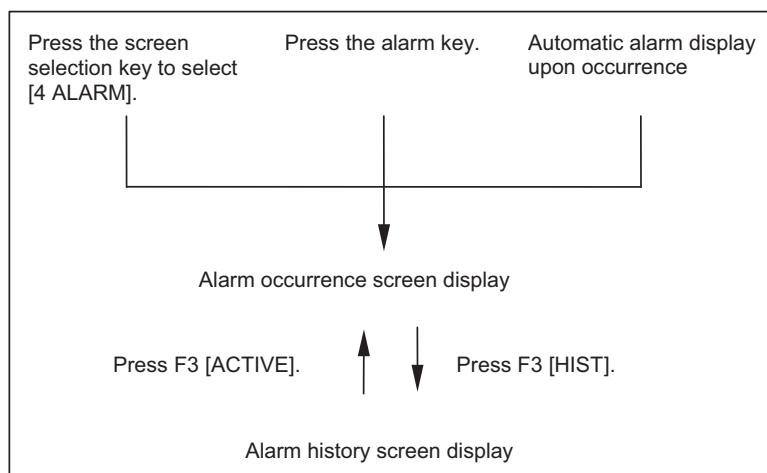
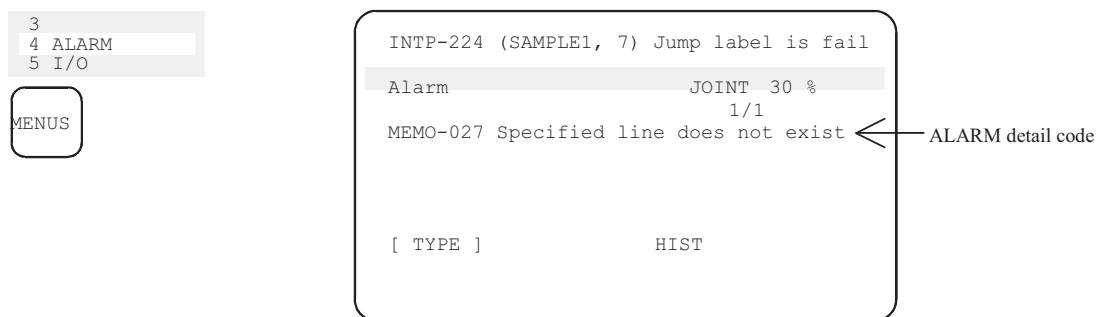


Fig.3.2 Alarm occurrence screen and alarm history screen display procedure

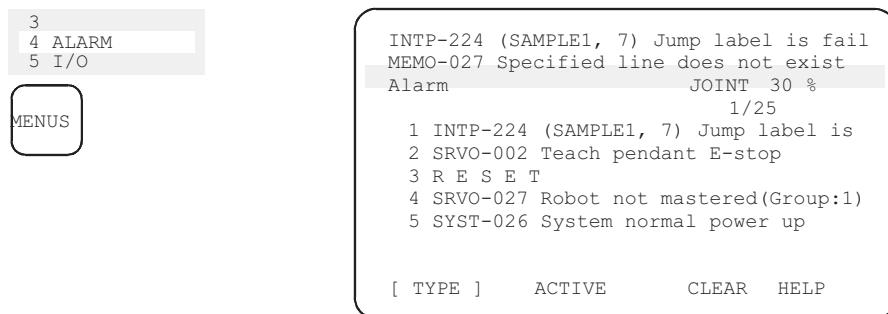
Displaying the alarm history/alarm detail information

Step

- (1) Press the MENUS key to display the screen menu.
- (2) Select [ALARM]. You will see a screen similar to the following
If an alarm has occurred, however, the alarm screen appears automatically.

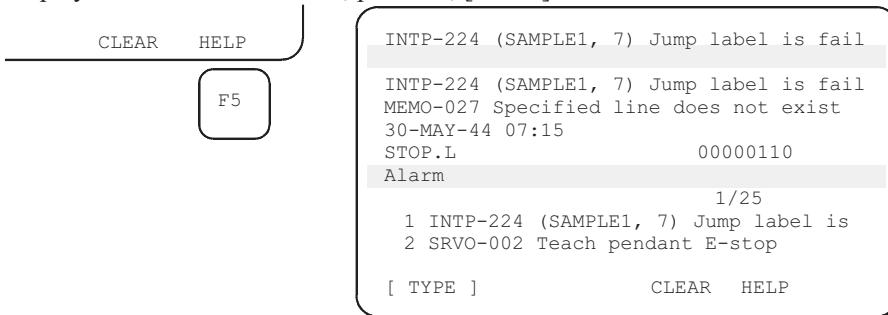


- (3) To display the alarm history screen, press F3, [HIST].
Press F3 [ACTIVE] again, the alarm screen appears.

**NOTE**

The latest alarm is assigned number 1. To view messages that are currently not on the screen, press the F5, HELP, and then press the right arrow key.

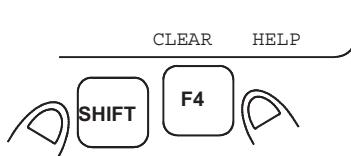
- (4) To display the alarm detail screen, press F5, [HELP].



- (5) To return to the alarm history screen, press the PREV key.

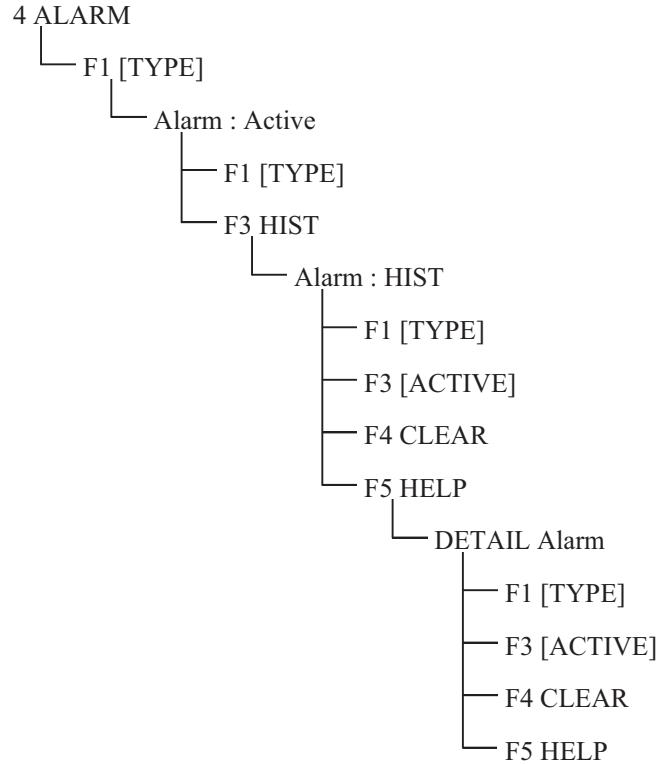


- (6) To delete all the alarm histories, press and hold down the SHIFT key, then press F4, [CLEAR].

**NOTE**

When system variable \$ER_NOHIS = 1, NONE alarms or WARN alarms are not recorded. When \$ER_NOHIS=2, resets are not recorded in the alarm history. When \$ER_NOHIS=3, resets, WARN alarms, and NONE alarms are not recorded.

The following map indicates teach pendant operations used to check an alarm.



3.3 SAFETY SIGNALS

The safety signal screen indicates the state of signals related to safety.

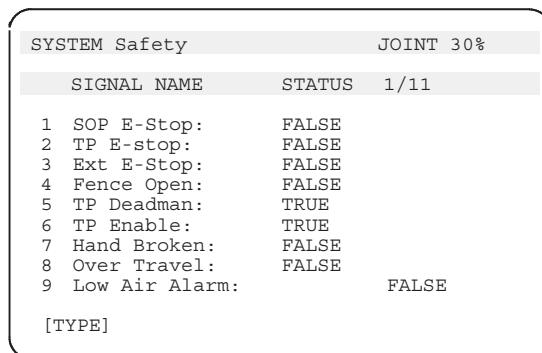
To be specific, the screen indicates whether each safety signal is currently on. On this screen, it is impossible to change the state of any safety signal.

Table 3.3 Safety signals

| Safety signal | Description |
|---------------------------------|---|
| Operator's panel emergency stop | This item indicates the state of the emergency stop button on the operator's panel. If the EMERGENCY STOP button is pressed, the state is indicated as "TRUE". |
| Teach pendant emergency stop | This item indicates the state of the emergency stop button on the teach pendant. If the EMERGENCY STOP button is pressed, the state is indicated as "TRUE". |
| External emergency stop | This item indicates the state of the external emergency stop signal. If the EMERGENCY STOP signal is asserted, the state is indicated as "TRUE". |
| Fence open | This item indicates the state of the safety fence. If the safety fence is open, the state is indicated as "TRUE". |
| DEADMAN switch | This item indicates whether the DEADMAN switch on the teach pendant is grasped. If the teach pendant is operable, and the DEADMAN switch is grasped correctly, the state is indicated as "TRUE". If the DEADMAN switch is released or is grasped tightly when the teach pendant is operable, an alarm occurs, causing the servo power to be switched off. |
| Teach pendant operable | This item indicates whether the teach pendant is operable. If the teach pendant is operable, the state is indicated as "TRUE". |
| Hand broken | This item indicates the state of the hand safety joint. If the hand interferes with a workpiece or anything like this, and the safety joint is opened, the state is indicated as "TRUE". In this case, an alarm occurs, causing the servo power to be switched off. |
| Robot overtravel | This item indicates whether the current position of the robot is out of the operation range. If any robot articulation goes out of the operation range beyond the overtravel switch, the state is indicated as "TRUE". In this case, an alarm occurs, causing the servo power to be switched off. |
| Abnormal air pressure | This item indicates the state of the air pressure. The abnormal air pressure signal is connected to the air pressure sensor. If the air pressure is not higher than the specified value, the state is indicated as "TRUE". |

Step

- (1) Press the MENUS key to display the screen menu.
- (2) Select STATUS on the next page.
- (3) Press F1, [TYPE] to display the screen switching menu.
- (4) Select Safety Signal. You will see a screen similar to the following.



3.4 MASTERING

Mastering is needed if:

- (1) The SRVO-062 BZAL or SRVO-038 pulse mismatch alarm occurs, or
- (2) The Pulsecoder is replaced.

Item (1) requires quick mastering, while item (2) requires zero-degree or fixture position mastering. (Zero-degree position mastering is just for quick-fix purposes. After zero-degree position mastering is used, fixture position mastering should be performed later.)

The mastering procedure is described below. For the procedure of mastering other than fixture position mastering, refer to the operator's manual of the mechanical unit.

For the procedure of fixture mastering, contact FANUC.

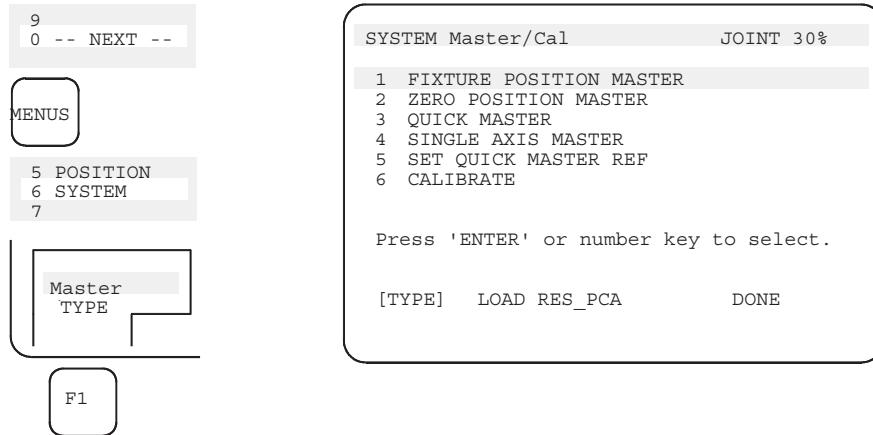
Condition

System variable \$MASTER_ENB must be set to 1 or 2.



Step

- (1) Press <MENUS>.
- (2) Select SYSTEM.
- (3) Press F1, TYPE.
- (4) Select Master/Cal you will see a screen similar to the following.

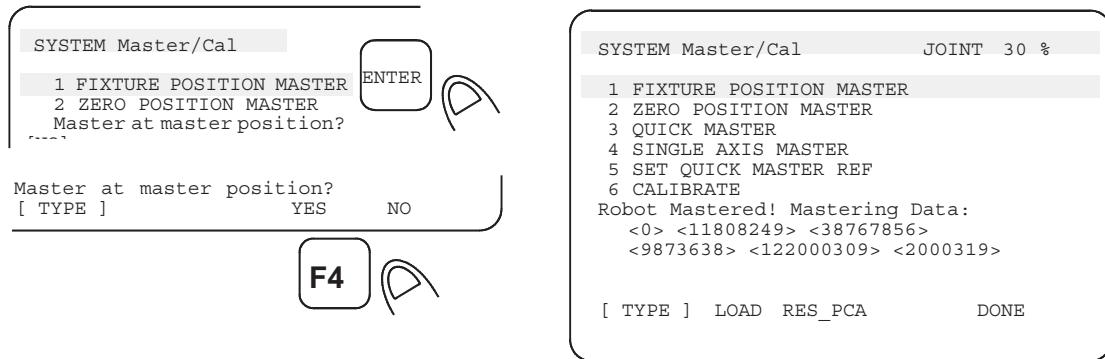


- (5) Move the robot by jog feed to the mastering position. Release the brake on the manual brake control screen if necessary.

NOTE

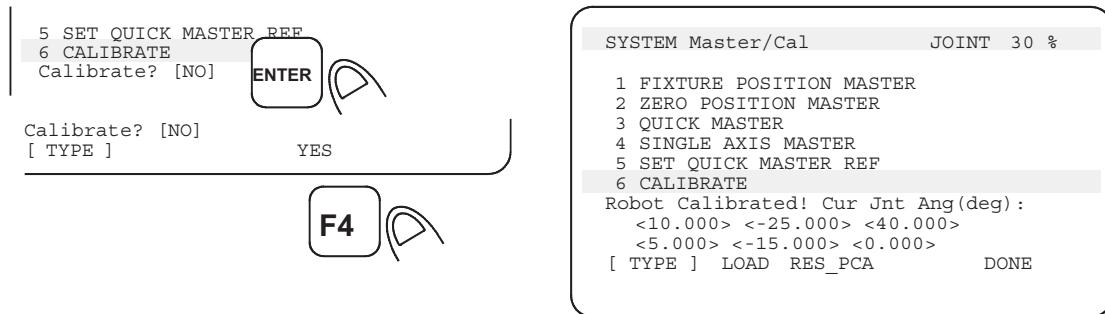
Mastering cannot be performed until axis is rotated enough to establish a pulse.

- (6) Select "1 FIXTURE POSITION MASTER" and press the F4 key (yes). Mastering data is set.



- (7) Select "6 CALIBRATE" and press the F4 key (yes). Calibration is performed.

Alternatively, to perform positioning, turn the power off, and then turn it on again. Calibration is performed whenever the power is turned on.



- (8) Press F5 "DONE", after mastering.

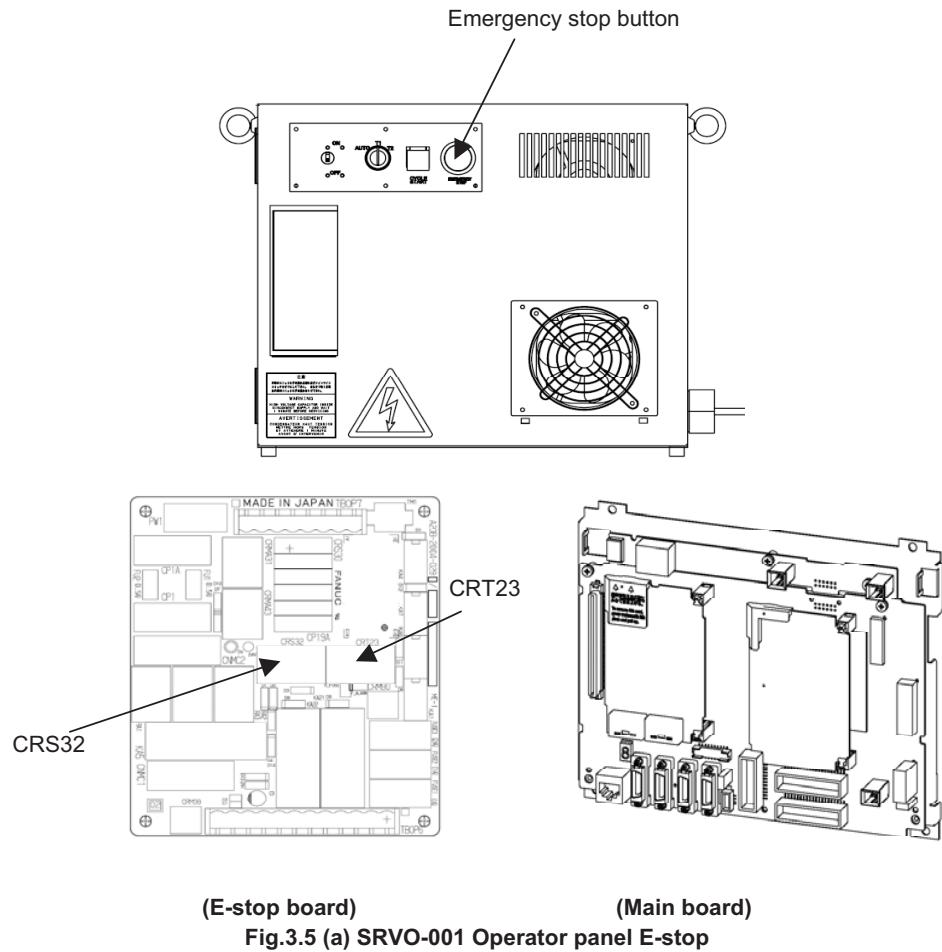


3.5 TROUBLESHOOTING USING THE ERROR CODE

- (1) SRVO-001 Operator panel E-stop
- (Explanation) The emergency stop button on the operator's panel is pressed.
- (Action 1) Release the emergency stop button pressed on the operator's panel.
- (Action 2) Check the wires connecting between the emergency stop button and the E-stop board (CRT23) for continuity. If an open wire is found, replace the entire harness.
- (Action 3) With the E-stop in the released position, check for continuity across the terminals of the switch. If continuity is not found, the emergency stop button is broken. Replace the switch unit or the operator's panel.
- (Action 4) Replace the E-stop board.
- (Action 5) Before executing the (Action 5), perform a complete controller back-up to save all your programs and settings.
Replace the main board.

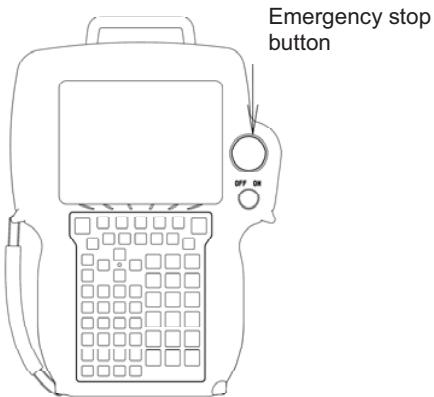
NOTE

If the LED (red) on the E-stop unit is lit, a fuse may have blown. Take the same actions described in (3) in Section 3.6.



(2) SRVO-002 Teach pendant E-stop

- (Explanation) The emergency stop button on the teach pendant was pressed.
 (Action 1) Release the emergency stop button on the teach pendant.
 (Action 2) Replace the teach pendant.

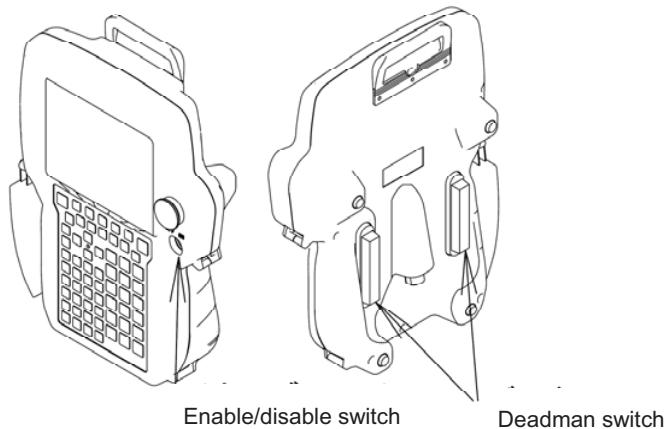
**Fig.3.5 (b) SRVO-002 Teach pendant E-stop**

(3) SRVO-003 DEADMAN switch released

- (Explanation) The teach pendant is enabled, but the DEADMAN switch is not pressed. Alternatively, the DEADMAN switch is pressed strongly.
 (Action 1) Check the intermediate position of the DEADMAN switch on the teach pendant.
 (Action 2) Check that the mode switch on the operator's panel and the enable switch on the teach pendant are at the correct positions.
 (Action 3) Replace the teach pendant.
 (Action 4) Check the mode switch connection and operation. If trouble is found, replace the mode switch.
 (Action 5) Replace the E-stop board.

Before executing the (Action 6), perform a complete controller back-up to save all your programs and settings.

- (Action 6) Replace the main board.

**Fig.3.5 (c) SRVO-003 DEADMAN switch released**

(4) SRVO-004 Fence open

(Explanation) In the automatic operation mode, the safety fence contact connected to EAS1-EAS11 or EAS2-EAS21 of TBOP7 is open.

(Action 1) When a safety fence is connected, close the safety fence.

(Action 2) Check the cables and switches connected between EAS1 and EAS11 and between EAS2 and EAS21 of the terminal block TBOP7 on the E-stop board.

(Action 3) If the safety fence signal is not used, make a connection between EAS1 and EAS11 and between EAS2 and EAS21 of the terminal block TBOP7 on the E-stop board.

(Action 4) Check the mode switch. If trouble is found, replace the mode switch.

(Action 5) Replace the E-stop board.

Before executing the (Action 6), perform a complete controller back-up to save all your programs and settings.

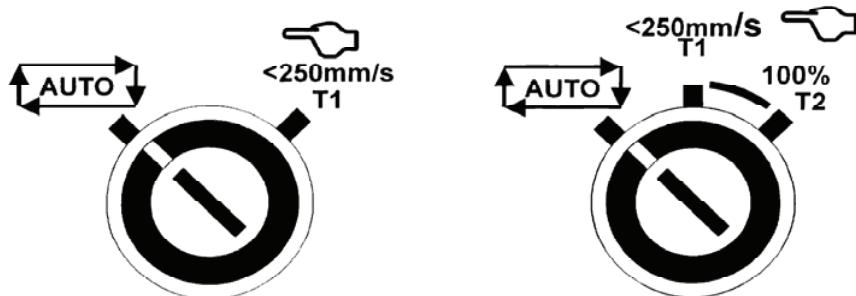
(Action 6) Replace the main board.

NOTE

If the LED (red) on the E-stop unit is lit, a fuse may have blown. Take the same actions described in (3) in Section 3.6.



(E-stop board)



2 mode switch

3 mode switch

(Mode switch)

Fig. 3.5 (d) SRVO-004 Fence open



In a system using the safety fence signal, it is very dangerous to disable the signal when a connection is made between EAS1 and EAS11 and between EAS2 and EAS21 of TBOP7. Never make such an attempt. If a temporary connection is needed for operation, separate safety measures must be taken.

(5) SRVO-005 Robot overtravel

(Explanation) The robot has moved beyond a hardware limit switch on the axes.

(Action 1)

1) Select [System OT release] on the overtravel release screen to release each robot axis from the overtravel state.

2) Hold down the shift key, and press the alarm release button to reset the alarm condition.

3) Still hold down the shift key, and jog to bring all axes into the movable range.

(Action 2)

Replace the limit switch.

(Action 3)

Check the FS2 fuse on the servo amplifier. If the SRVO-214 fuse blown alarm is also generated, the FS2 fuse has blown.

(Action 4)

Check the end effector connector.

(Action 5)

Replace the servo amplifier.

(Action 6)

Verify the following for connector RMP at the base of the robot:

1) There are no bent or dislocated pins in the male or female connectors.

2) The connector is securely connected.

Then verify that connectors CRF8 and CRM68 on the servo amplifier are securely connected. Also, verify that the RMP cable is in good condition, and there are no cuts or kinks visible. If no limit switch is in use, jumper connector must be attached in the mechanical unit. Check for the jumper connector.

NOTE

It is factory-placed in the overtravel state for packing purposes.

If the Overtravel signal is not in use, it may have been disabled by short-circuiting in the mechanical unit.

(6) SRVO-006 Hand broken

(Explanation) The safety joint (if in use) might have been broken. Alternatively, the HBK signal on the robot connection cable might be a ground fault or a cable disconnection.

(Action 1)

Hold down the shift key, and press the alarm release button to reset the alarm condition. Still hold down the shift key, and jog the tool to the work area.

1) Replace the safety joint.

2) Check the safety joint cable.

(Action 2)

Replace the servo amplifier.

(Action 3)

Verify the following for connector RMP at the base of the robot:

1) There are no bent or dislocated pins in the male or female connectors.

2) The connector is securely connected.

Then verify that connector CRF8 on the servo amplifier is securely connected.

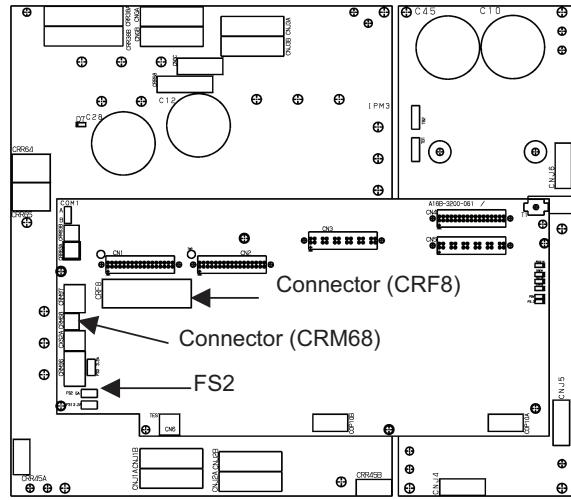
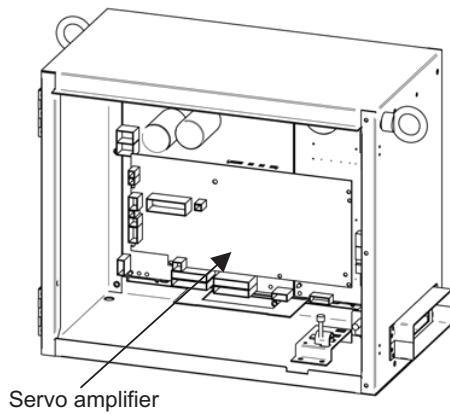
Also, verify that the RMP cable is in good condition, and there are no cuts or kinks visible. Check the robot connection cable (RMP) for a ground fault or a cable disconnection.

NOTE

If the Hand broken signal is not in use, it can be disabled by software setting.

Refer to Subsection 5.5.3 How to Disable/Enable HBK in Part III,

"CONNECTIONS" of "Maintenance Manual" to disable the Hand broken signal.



(Servo amplifier)

**Fig. 3.5 (e) SRVO-005 Robot over-travel
SRVO-006 Hand broken**

(7) SRVO-009 Pneumatic pressure abnormal

(Explanation) An abnormal air pressure was detected. The input signal is located on the end effector of the robot. Refer to the manual of your robot.

- (Action 1) If an abnormal air pressure is detected, check the cause.
- (Action 2) Check the end effector connector.
- (Action 3) Check the robot connection cable (RMP) for a ground fault or a cable disconnection. If a fault or a disconnection is detected, replace the cable.
- (Action 4) Replace the servo amplifier.
- (Action 5) Replace the internal cables of the robot.

NOTE

Pneumatic pressure alarm input is on the end effector. Please refer to the manual of your robot.

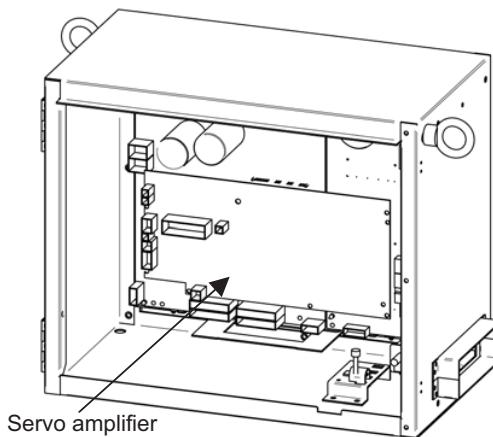


Fig.3.5 (f) SRVO-009 Pneumatic pressure alarm

(8) SRVO-014 Fan motor abnormal

(Explanation) A fan motor in the controller backplane unit is abnormal.

(Action 1) Replace a fan motor in the controller backplane unit.

(Action 2) Replace the fan board.

Before executing the (Action 3), perform a complete controller back-up to save all your programs and settings.

(Action 3) Replace the main board.

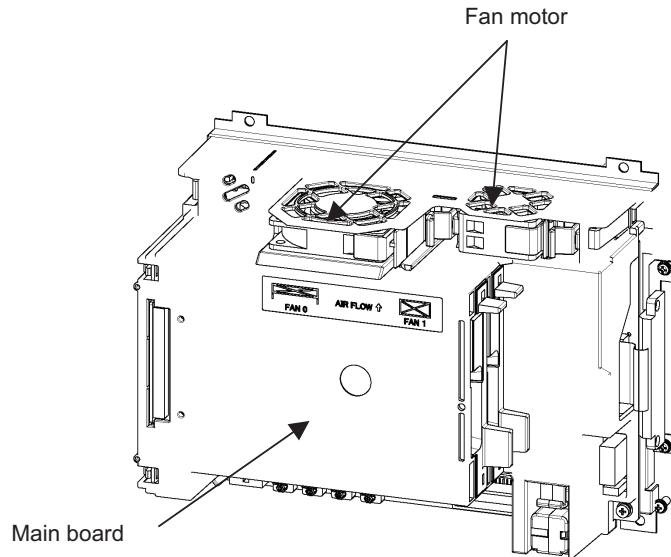


Fig. 3.5 (g) SRVO-014 Fan motor abnormal

(9) SRVO-015 SYSTEM OVER HEAT (Group: i Axis: j)

(Explanation) The temperature in the controller exceeds the specified value.

(Action 1) If the ambient temperature is higher than specified (45°C), cool down the ambient temperature.

(Action 2) If the fan motor is not running, check it and its cables. Replace them if necessary.

Before executing the (Action 3), perform a complete controller back-up to save all your programs and settings.

(Action 3) Replace the main board. (The thermostat on the main board may be faulty.)

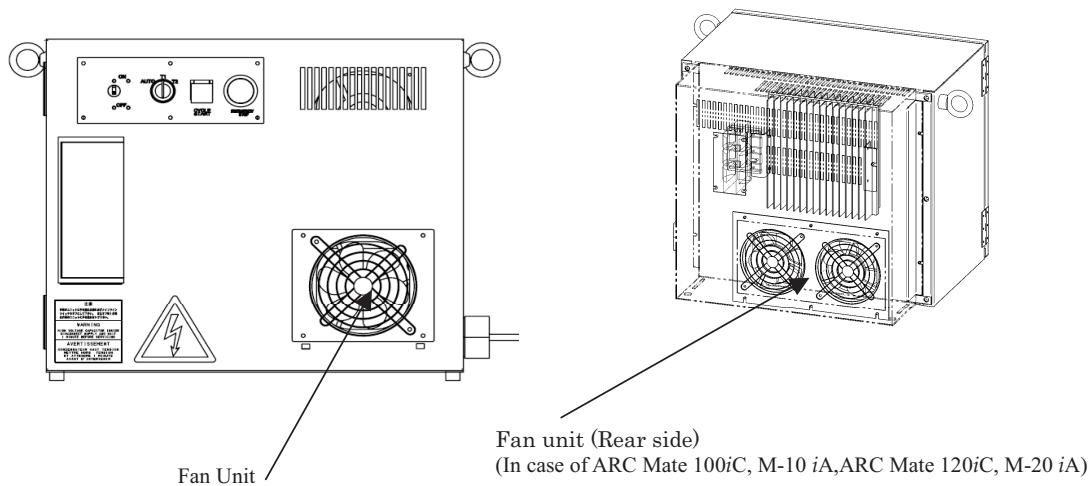
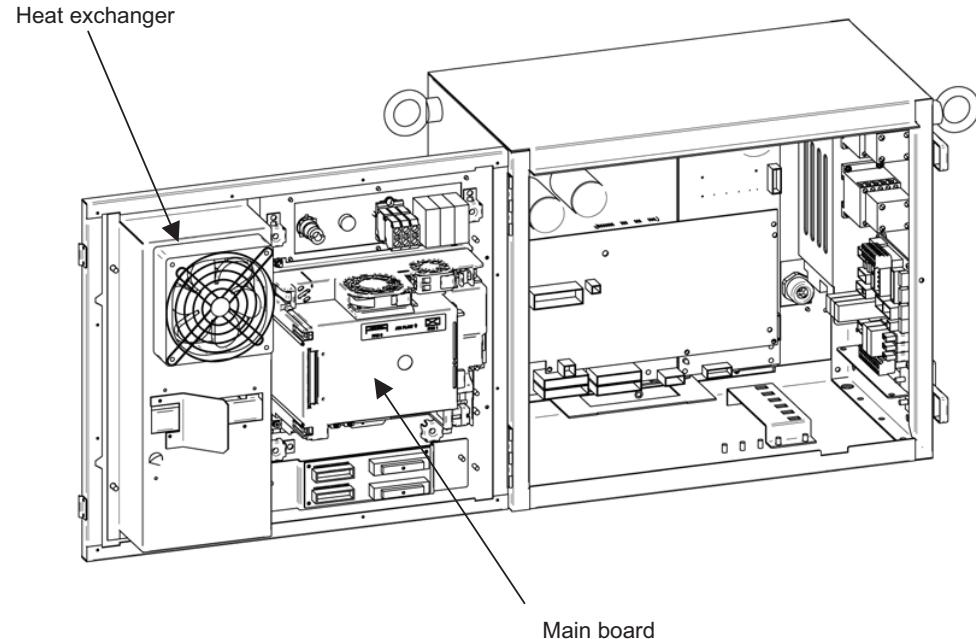


Fig.3.5 (h) SRVO-015 SYSTEM OVER HEAT

(10) SRVO-018 Brake abnormal

- (Explanation) An excessive brake current is detected. The ALM LED on the servo amplifier is lit.
- (Action 1) Check the cables and motor brakes connected to CRR88 connector on the servo amplifier. If a short-circuit or grounding fault is found, replace the failed part.
- (Action 2) Check the cables and motor brakes connected to CRR65A, CRR65B connector on the servo amplifier. If a short-circuit or grounding fault is found, replace the failed part.
- (Action 3) Replace the servo amplifier.

⚠ CAUTION

This error can be caused by the optional brake release unit if the on/off switch is left in on position while the operator attempts to jog the robot. To recover, turn the brake release unit off and cycle the controller power.

(11) SRVO-021 SRDY off (Group: i Axis: j)

- (Explanation) The HRDY is on and the SRDY is off, although there is no other cause of an alarm. (HRDY is a signal with which the host detects the servo system whether to turn on or off the servo amplifier magnetic contactor. SRDY is a signal with which the servo system informs the host whether the magnetic contactor is turned on.) If the servo amplifier magnetic contactor cannot be turned on when directed so, it is most likely that a servo amplifier alarm has occurred. If a servo amplifier alarm has been detected, the host will not issue this alarm (SRDY off). Therefore, this alarm indicates that the magnetic contactor cannot be turned on for an unknown reason.
- (Action 1) Make sure that the E-stop board connectors CRMA43, CRMA31 and servo amplifier SRMA43 are securely attached to the servo amplifier.
- (Action 2) It is possible that an instant disconnection of power source causes this alarm. Check whether an instant disconnection occurred.
- (Action 3) Replace the E-stop unit.
- (Action 4) Replace the servo amplifier.

(12) SRVO-022 SRDY on (Group: i Axis: j)

- (Explanation) When the HRDY is about to go on, the SRDY is already on. (HRDY is a signal with which the host directs the servo system whether to turn on or off the servo amplifier magnetic contactor. SRDY is a signal with which the servo system informs the host whether the magnetic contactor is turned on.)
- (Action 1) Replace the servo amplifier as the alarm message.

(13) SRVO-023 Stop error excess (Group: i Axis: j)

(Explanation) When the servo is at stop, the position error is abnormally large.
Check whether the brake is released through the clack sound of the brake or vibration.

In case that the brake is not released.

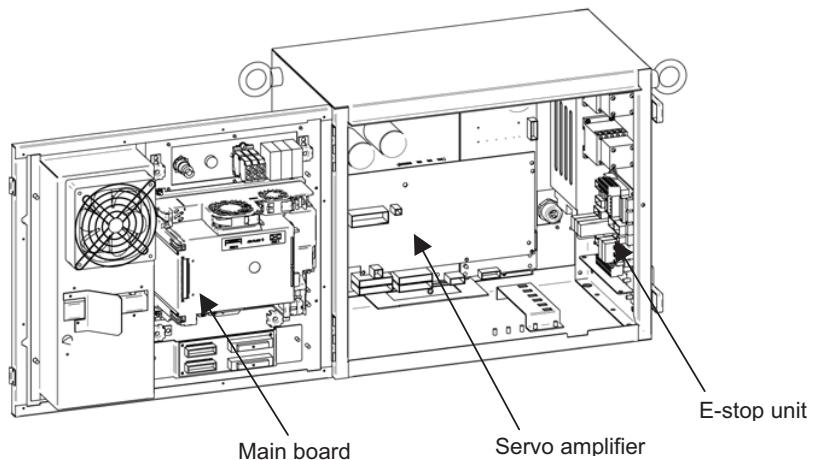
(Action 1) If the brake is not released, check the continuity of the brake line in the robot connection cable and the robot internal cable.
(Action 2) If the disconnection is not found, replace the servo amplifier or the servo motor.

In case that the brake is released.

(Action 1) Check whether the obstacle disturbs the robot motion.
(Action 2) Make sure that connectors CNJ1A-CNJ6 are securely attached to the servo amplifier.
(Action 3) Check the continuity of the robot connection cable and the internal robot power cable.
(Action 4) Check to see if the load is greater than the rating. If greater, reduce it to within the rating. (If the load is too great, the torque required for acceleration / deceleration becomes higher than the capacity of the motor.
As a result, the motor becomes unable to follow the command, and an alarm is issued.)
(Action 5) Check the input voltage to the controller is within the rated voltage and no phase is lack. In addition, check the setting of the transformer is correct.
Check each phase voltage of the CRR38A connector of the three-phase power (200 VAC) input to the servo amplifier. If it is 210 VAC or lower, check the line voltage. (If the voltage input to the servo amplifier becomes low, the torque output also becomes low. As a result, the motor may become unable to follow the command, hence possibly causing an alarm.).
(Action 6) Replace the servo amplifier.
(Action 7) Replace the motor of the alarm axis.

NOTE

Incorrect setting of the brake number causes this alarm.



**Fig.3.5 (i) SRVO-018 Brake abnormal
SRVO-021 SRDY off
SRVO-022 SRDY on
SRVO-023 Stop error excess**

(14) SRVO-024 Move error excess (Group: i Axis: j)

(Explanation) When the robot is running, its position error is greater than a specified value (\$PARAM _ GROUP. \$MOVER _ OFFST). It is likely that the robot cannot follow the speed specified by program.

(Action 1) Take the same actions as SRVO-023.

(15) SRVO-027 Robot not mastered (Group: i)

(Explanation) An attempt was made to calibrate the robot, but the necessary adjustment had not been completed.

(Action) Check whether the mastering is valid. If the mastering is invalid, master the robot.

⚠ WARNING

If the position data is incorrect, the robot or additional axis can operate abnormally, set the position data correctly. Otherwise, you could injure personnel or damage equipment.

(16) SRVO-030 Brake on hold (Group:i)

(Explanation) If the temporary halt alarm function is enabled (\$SCR.\$BRKHOLD ENB=1), SRVO-030 is issued when a temporary halt occurs. When this function is not used, disable the setting.

(Action) Disable [Servo-off in temporary halt] on the general item setting screen [6 General Setting Items].

(17) SRVO-033 Robot not calibrated (Group: i)

(Explanation) An attempt was made to set up a reference point for quick mastering, but the robot had not been calibrated.

(Action) Calibrate the robot.

1. Supply power.
2. Set up a quick mastering reference point using [Positioning] on the positioning menu.

(18) SRVO-034 Ref pos not set (Group: i)

(Explanation) An attempt was made to perform quick mastering, but the reference point had not been set up.

(Action) Set up a quick mastering reference point on the positioning menu.

(19) SRVO-036 Inpos time over (Group: i Axis: j)

(Explanation) The robot did not get to the effective area (\$PARAM _ GROUP.\$ STOPTOL) even after the position check monitoring time (\$PARAM _ GROUP. \$INPOS _ TIME) elapsed.

(Action) Take the same actions as for SRVO-023 (large position error at a stop).

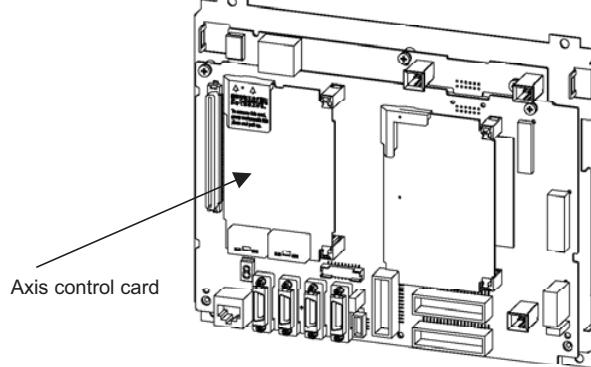
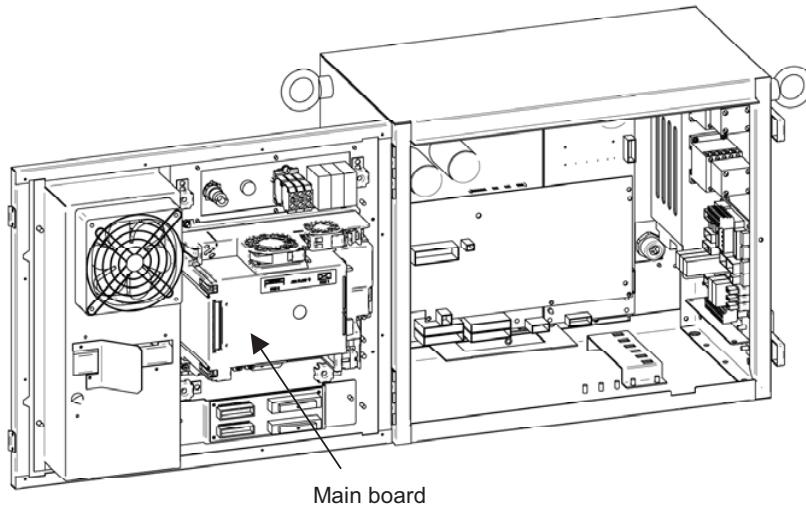
(20) SRVO-037 IMSTP input (Group: i)

(Explanation) The *IMSTP signal for a peripheral device interface was input.

(Action) Turn on the *IMSTP signal.

(21) SRVO-038 Pulse mismatch (Group: i Axis: j)

- (Explanation) The pulse count obtained when power is turned off does not match the pulse count obtained when power is applied. This alarm is asserted after exchange the Pulsecoder or battery for back up of the Pulsecoder data or loading back up data to the Main Board.
- (Action 1) Check the alarm history.
If the brake number is set to the non-brake motors, this alarm may occur. Check the software setting of the brake number.
- (Action 2) In case the robot has been moved by using the brake release unit while the power is off or when restoring the back-up data to the main board, this alarm may occur. Remaster the robot.
- (Action 3) If the robot has been moved because the brake failed, this alarm may occur. Check the cause of the brake trouble. Then remaster the robot.
- (Action 4) Replace the Pulsecoder and master the robot.



(Main board)

Fig.3.5 (j) SRVO-038 Pulse mismatch

(22) SRVO-042 MCAL alarm (Group: i Axis: j)

(Explanation) This alarm means that the contacts of the magnetic contactor have stuck to each other. The alarm condition occurs if the magnetic contactor turns out to be already on when an attempt is made to turn it on. The alarm condition is detected between the time contact sticking occurs and the time an attempt is made to turn on the magnetic contactor.

(Action 1) Replace the E-stop unit.

(Action 2) Replace the servo amplifier.

(23) SRVO-043 DCAL alarm (Group: i Axis: j)

(Explanation) The regenerative discharge energy was too high to be dissipated as heat. (To run the robot, the servo amplifier supplies energy to the robot. When going down the vertical axis, the robot operates from the potential energy. If a reduction in the potential energy is higher than the energy needed for acceleration, the servo amplifier receives energy from the motor. A similar phenomenon occurs even when no gravity is applied, for example, at deceleration on a horizontal axis. The energy that the servo amplifier receives from the motor is called the regenerative energy. The servo amplifier dissipates this energy as heat. If the regenerative energy is higher than the energy dissipated as heat, the difference is stored in the servo amplifier, causing an alarm.)

(Action 1) This alarm may occur if the axis is subjected to frequent acceleration/deceleration or if the axis is vertical and generates a large amount of regenerative energy.

If this alarm has occurred, relax the service conditions.

(Action 2) Check fuse FS3 in the servo amplifier. If it has blown, remove the cause, and replace the fuse. One of the probable causes of a blown fuse is a ground fault in the servo amplifier for the auxiliary axis.

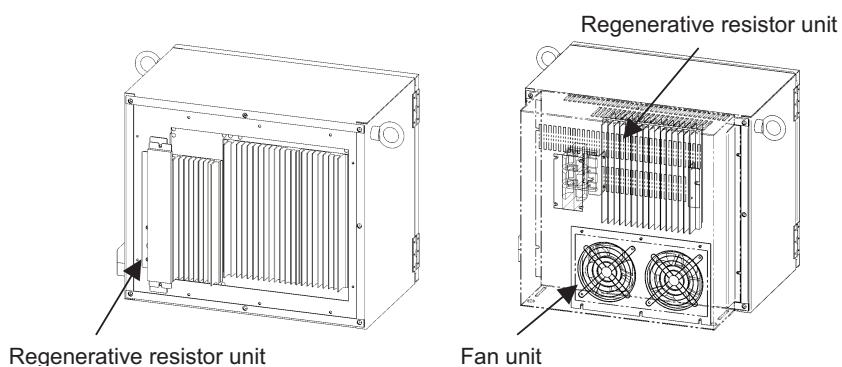
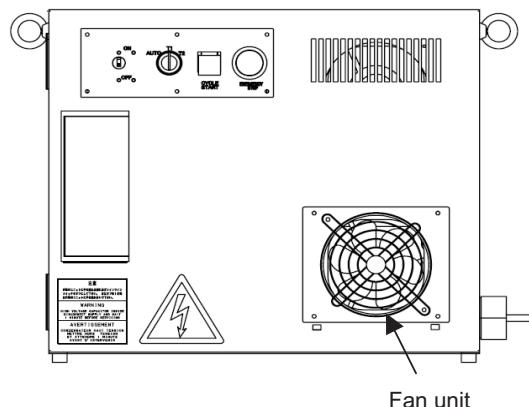
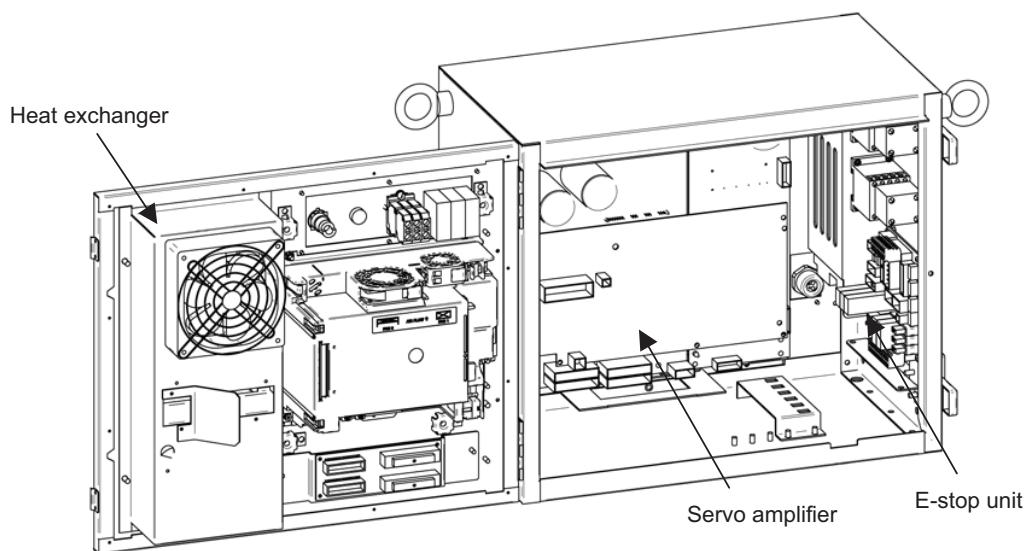
(Action 3) The ambient temperature is excessively high. Or the regenerative resistor can't be cooled effectively. Check the fan unit, and replace it if it stops. Clean up the fan unit, the regenerative resistor and the louver if they are dirty.

(Action 4) Make sure that the phase-to-phase voltages of input power fall within the specified range by measurement. If the voltages are out of the range, inspect the power equipment. When no failure is found, replace the E-stop unit.

(Action 5) Make sure that the servo amplifier CRR63A and CRR63B connectors are connected tightly. Then detach the cable from CRR63A and CRR63B connectors on the Servo amplifier, and check for continuity between pins 1 and 2 of the cable-end connector. If there is no continuity between the pins, replace the regenerative resistor.

(Action 6) Make sure that the servo amplifier CRR45A and CRR45B are connected tightly, then detach the cables from CRR45A and CRR45B on the servo amplifier and check the resistance between pins 1 and 2 of each cable end connector. If the resistance is not $9\text{--}16\Omega$, replace the regenerative resistor. CRR45B may not be used depending on the robot model.

(Action 7) Replace the servo amplifier.



(LR Mate 200iC, M-1iA)

(ARC Mate 100iC, M-10iA
ARC Mate 120iC, M-20iA)

**Fig.3.5 (k) SRVO-042 MCAL alarm
SRVO-043 DCAL alarm**

(24) SRVO-044 HVAL alarm (Group: i Axis: j)

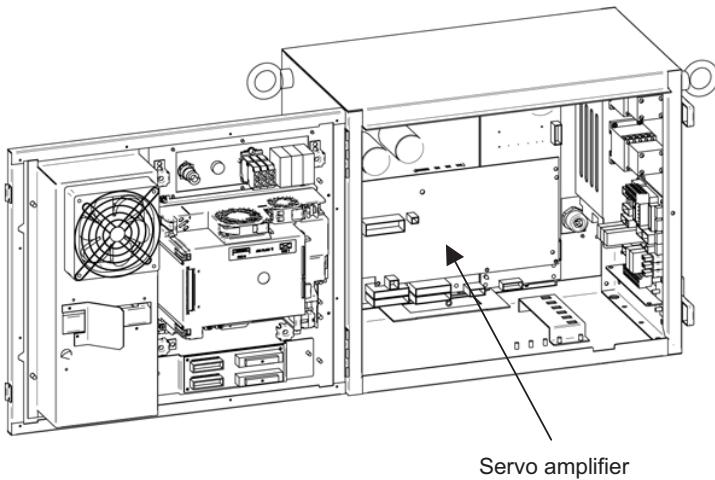
(Explanation) The DC voltage (DC link voltage) of the main circuit power supply is abnormally high.

(Action 1) Check the three-phase input voltage at the servo amplifier. If it is 230 VAC or higher, check the line voltage. (If the three-phase input voltage is higher than 230 VAC, high acceleration/deceleration can cause in this alarm.)

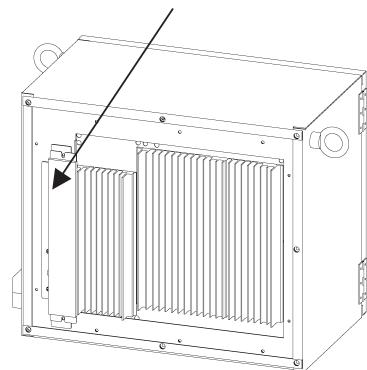
(Action 2) Check that the load weight is within the rating. If it is higher than the rating, reduce it to within the rating. (If the machine load is higher than the rating, the accumulation of regenerative energy might result in the HVAL alarm even when the three-phase input voltage is within the rating.)

(Action 3) Check that the CRR63A and CRR63B connectors of the servo amplifier are attached firmly. Next, detach the cables then check the continuity between pins 1 and 2 of the cable-side connectors. If a disconnection is found, replace the regenerative resistor.

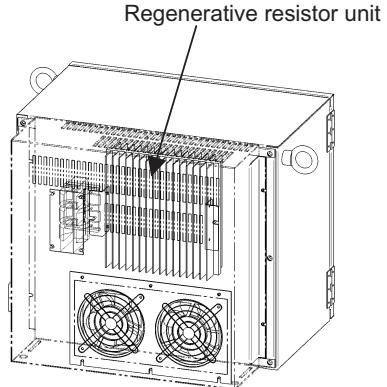
(Action 4) Replace the servo amplifier.



Regenerative resistor unit



(LR Mate 200iC, M-1iA)



(ARC Mate 100iC, M-10iA, ARC Mate 50iC, ARC Mate 120iC, M-20iA)

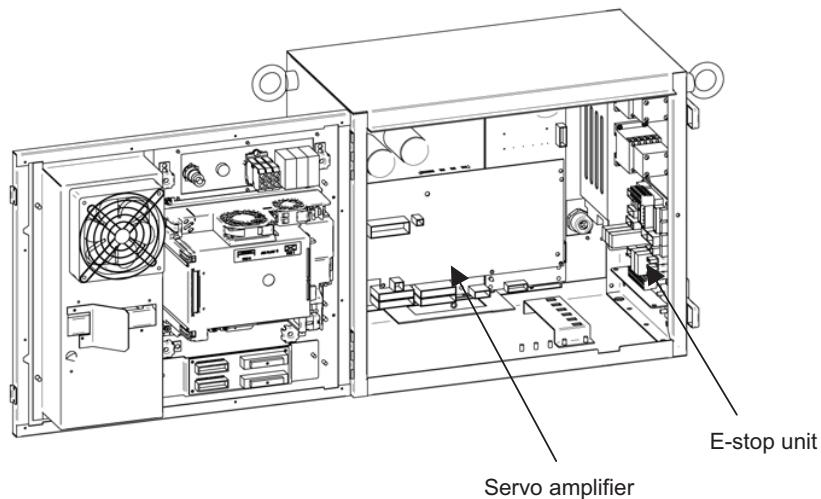
Fig.3.5 (I) SRVO-044 HVAL alarm

(25) SRVO-045 HCAL alarm (Group: i Axis: j)

- (Explanation) Abnormally high current flowed in the main circuit of the servo amplifier.
- (Action 1) Turn off the power, and disconnect the power cable from the servo amplifier indicated by the alarm message. (And disconnect the brake cable (CRR88 on the servo amplifier) to avoid the axis falling unexpectedly.) Supply power and see if the alarm occurs again. If the alarm occurs again, replace the servo amplifier.
- (Action 2) Turn off the power and disconnect the power cable from the servo amplifier indicated by the alarm message, and check the insulation of their U, V, W and the GND lines each other. If there is a short-circuit, replace the power cable.
- (Action 3) Turn off the power and disconnect the power cable from the servo amplifier by the alarm message, and measure the resistance between their U and V, V and W and W and U with an ohmmeter that has a very low resistance range. If the resistances at the three places are different from each other, the motor, the power cable is defective. Check each item in detail and replace it if necessary.

(26) SRVO-046 OVC alarm (Group: i Axis: j)

- (Explanation) This alarm is issued to prevent the motor from thermal damage that might occur when the root mean square current calculated within the servo system is out of the allowable range.
- (Action 1) Check the operating condition for the robot and relax the service condition if possible. If the load or operating condition has exceeded the rating, reduce the load or relax the operating condition to meet the rating.
- (Action 2) Check whether the voltage input to the controller is within the rated voltage and check whether the voltage set for the transformer of the controller is correct.
- (Action 3) Check whether the brake of the corresponding axis is released.
- (Action 4) Check whether there is a factor that has increased the mechanical load on the corresponding axis.
- (Action 5) Replace the servo amplifier.
- (Action 6) Replace the motor of the corresponding axis.
- (Action 7) Replace the E-stop unit
- (Action 8) Replace the motor power line (robot connection cable) of the corresponding axis.
- (Action 9) Replace the motor power line and brake line (inside the mechanical section) of the corresponding axis.



**Fig.3.5 (m) SRVO-045 HCAL alarm
SRVO-046 OVC alarm**

Reference

Relationships among the OVC, OHAL, and HC alarms

- Overview

This section points out the differences among the OVC, OHAL, and HC alarms and describes the purpose of each alarm.

- Alarm detection section

| Abbreviation | Designation | Detection section |
|--------------|--------------------|--|
| OVC | Overcurrent alarm | Servo software |
| OHAL | Overheat alarm | Thermal relay in the motor Thermal relay in the servo amplifier Thermal relay in the separate regenerative resistor unit |
| HC | High current alarm | Servo amplifier |

- Purpose of each alarm

- 1) HC alarm (high current alarm)
If high current flow in a power transistor momentarily due to abnormality or noise in the control circuit, the power transistor and rectifier diodes might be damaged, or the magnet of the motor might be degaussed. The HC alarm is intended to prevent such failures.
- 2) OVC and OHAL alarms (overcurrent and overload alarms)
The OVC and OHAL alarms are intended to prevent overheat that may lead to the burnout of the motor winding, the breakdown of the servo amplifier transistor, and the separate regenerative resistor.
The OHAL alarm occurs when each built-in thermal relay detects a temperature higher than the rated value. However, this method is not necessarily perfect to prevent these failures. For example, if the motor frequently repeats to start and stop, the thermal time constant of the motor, which has a large mass, becomes higher than the time constant of the thermal relay, because these two components are different in material, structure, and dimension. Therefore, if the motor continues to start and stop within a short time as shown in Fig. 3.5 (n), the temperature rise in the motor is steeper than that in the thermal relay, thus causing the motor to burn before the thermal relay detects an abnormally high temperature.

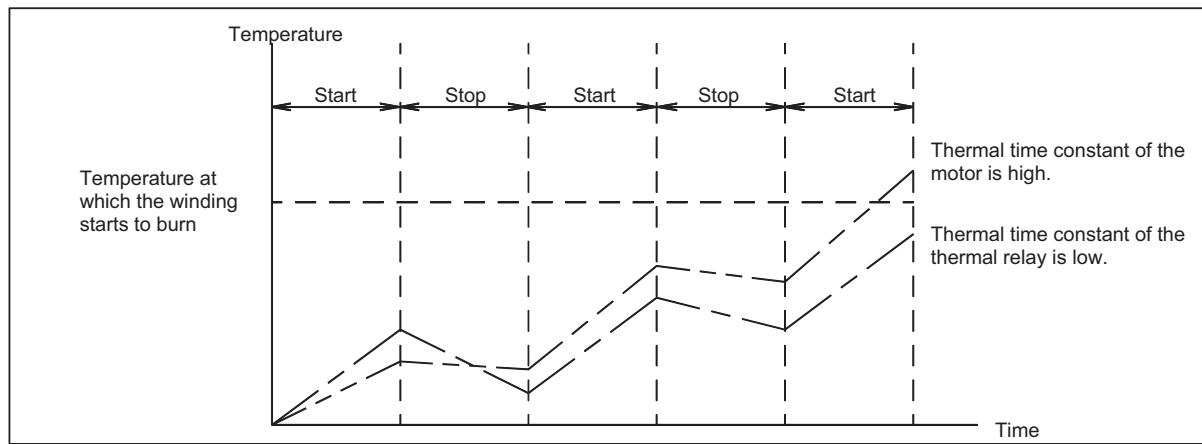


Fig.3.5 (n) Relationship between the temperatures of the motor and thermal relay on start/stop cycles

To prevent the above defects, software is used to monitor the current in the motor constantly in order to estimate the temperature of the motor. The OVC alarm is issued based on this estimated temperature. This method estimates the motor temperature with substantial accuracy, so it can prevent the failures described above.

To sum up, a double protection method is used; the OVC alarm is used for protection from a short-time overcurrent, and the OHAL alarm is used for protection from long-term overload. The relationship between the OVC and OHAL alarms is shown in Fig.3.5 (o).

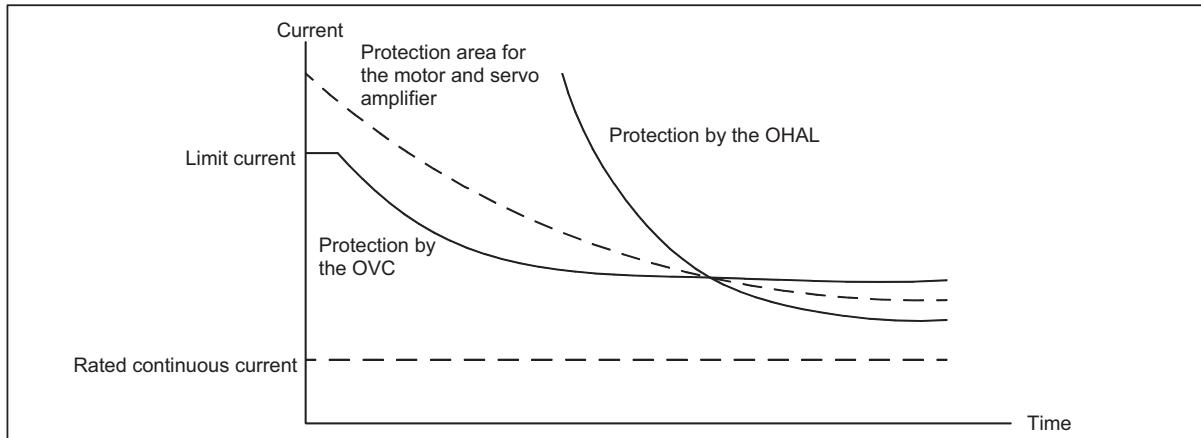


Fig.3.5 (o) Relationship between the OVC and OHAL alarms

NOTE

The relationship shown in Fig.3.5 (o) is taken into consideration for the OVC alarm. The motor might not be hot even if the OVC alarm has occurred. In this case, do not change the parameters to relax protection.

(27) SRVO-047 LVAL alarm (Group: i Axis: j)

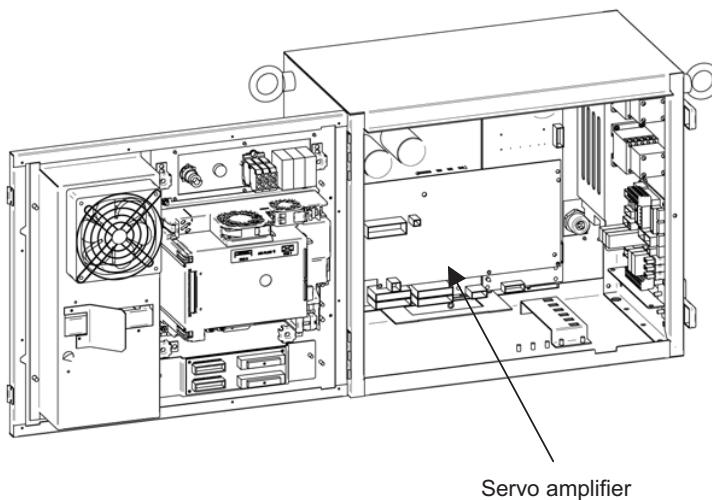
- (Explanation) The control power supply voltage (+5 V, etc.) supplied from the power supply circuit in the servo amplifier is abnormally low.
 (Action 1) Replace the servo amplifier.
 (Action 2) Replace the power supply unit.

(28) SRVO-050 CLALM alarm (Group: i Axis: j)

- (Explanation) The disturbance torque estimated by the servo software is abnormally high. (A collision has been detected.)
 (Action 1) Check whether the robot has collided and check whether there is a factor that has increased the mechanical load on the corresponding axis.
 (Action 2) Check whether the load settings are valid.
 (Action 3) Check whether the brake of the corresponding axis is released.
 (Action 4) If the load weight exceeds the rated range, decrease it to within the limit.
 (Action 5) Check whether the voltage input to the controller is within the rated voltage and check whether the voltage set for the transformer of the controller is correct.
 (Action 6) Replace the servo amplifier.
 (Action 7) Replace the motor of the corresponding axis.
 (Action 8) Replace the E-stop unit.
 (Action 9) Replace the motor power line (robot connection cable) of the corresponding axis.
 (Action 10) Replace the motor power line and brake line (inside the mechanical section) of the corresponding axis.

(29) SRVO-051 CUER alarm (Group: i Axis: j)

- (Explanation) The offset of the current feedback value is abnormally high.
 (Action) Replace the servo amplifier.



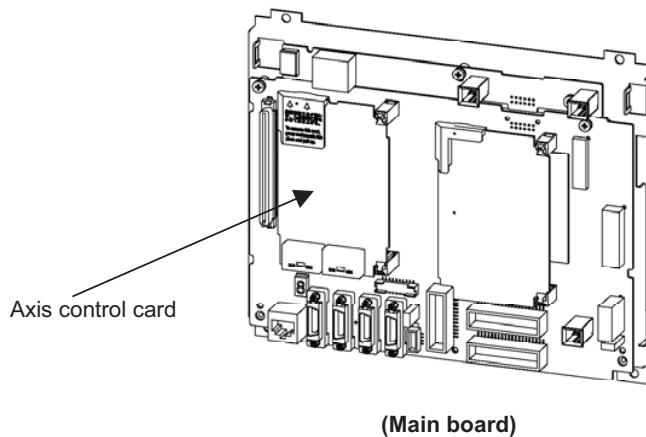
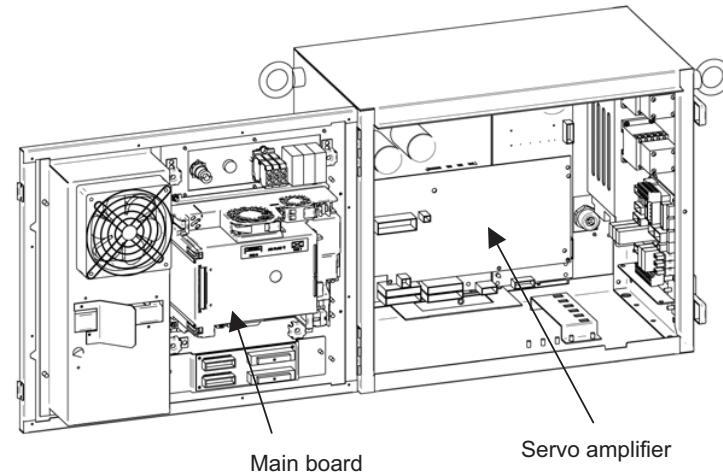
**Fig.3.5 (p) SRVO-047 LVAL alarm
SRVO-050 CLALM alarm
SRVO-051 CUER alarm**

- (30) SRVO-055 FSSB com error 1 (Group: i Axis : j)
 - (Explanation) A communication error has occurred between the main board and servo amplifier.
 - (Action 1) Check the communication cable (optical fiber) between the main board and servo amplifier. Replace it if it is faulty.
 - (Action 2) Replace the axis control card on the main board.
 - (Action 3) Replace the servo amplifier.
- (31) SRVO-056 FSSB COM error 2 (Group: i Axis : j)
 - (Explanation) A communication error has occurred between the main board and servo amplifier.
 - (Action 1) Check the communication cable (optical fiber) between the main board and servo amplifier. Replace it if it is faulty.
 - (Action 2) Replace the axis control card on the main board.
 - (Action 3) Replace the servo amplifier.
- (32) SRVO-057 FSSB disconnect (Group: i Axis : j)
 - (Explanation) Communication was interrupted between the main board and servo amplifier.
 - (Action 1) Check whether fuses FS1 and FS3 in the servo amplifier have blown. If the fuse has blown, replace the servo amplifier including the fuse.
 - (Action 2) Replace the optical cable between the axis control card and servo amplifier.
 - (Action 3) Replace the axis control card on the main board.
 - (Action 4) Replace the servo amplifier.
 - (Action 5) Check for a point where the robot connection cable or an internal cable running to each PulseCoder through the robot mechanical section is grounded.

Before executing the (Action 6), perform a complete controller back-up to save all your programs and settings.

 - (Action 6) Replace the main board.
- (33) SRVO-058 FSSB init error (Group: i Axis: j)
 - (Explanation) Communication was interrupted between the main board and servo amplifier.
 - (Action 1) Check whether fuse FS1 on the servo amplifier has blown. If the fuse has blown, replace the servo amplifier including the fuse.
 - (Action 2) Turn off the power and disconnect the CRF8 connector on the servo amplifier. Then check whether this alarm occurs again. (Ignore the alarm SRVO-068 because of disconnecting the CRF8 connector.)

- If this alarm does not occur, the RMP cable of the robot connection cable or the internal cable of the robot may be short-circuited to the ground. Check the cables and replace it if necessary.
- (Action 3) Check whether the LED (P5V and P3.3V) on the servo amplifier is lit. If they are not lit, the DC power is not supplied to the servo amplifier.
Make sure the connector CRP24 and CRM96 on the E-stop unit and the connector CRM96 on the servo amplifier are connected tightly. If they are connected tightly, replace the servo amplifier.
- (Action 4) Check the communication cable (optical fiber) between the axis control board and servo amplifier. Replace it if it is faulty.
- (Action 5) Replace the servo card on the main board.
- (Action 6) Replace the servo amplifier.
- (Action 7) If the other units (the servo amplifier for the auxiliary axis and the line tracking interface) are connected in the FSSB optical communication, disconnect these units and connect only servo amplifier for the robot. Then turn on the power. If this alarm does not occur, search the failed unit and replace it.
- Before executing the (Action 8), perform a complete controller back-up to save all your programs and settings.
- (Action 8) Replace the main board.



(Main board)

**Fig.3.5 (q) SRVO-055 FSSB com error 1
SRVO-056 FSSB com error 2
SRVO-057 FSSB disconnect
SRVO-058 FSSB init error**

(34) SRVO-059 Servo amp init error

- (Explanation) Servo amplifier initialization is failed.
(Action 1) Check the wiring of the servo amplifier.
(Action 2) Replace the servo amplifier.

(35) SRVO-062 BZAL alarm (Group: i Axis: j)

- (Explanation) This alarm occurs if battery for PulseCoder absolute-position backup is empty. A probable cause is a broken battery cable or no batteries in the robot.
(Action 1) Replace the battery in the battery box of the robot base.
(Action 2) Replace the PulseCoder with which an alarm has been issued.
(Action 3) Check whether the robot internal cable for feeding power from the battery to the PulseCoder is not disconnected and grounded. If an abnormality is found, replace the cable.

⚠ CAUTION

After correcting the cause of this alarm, set the system variable (\$MCR.\$SPC_RESET) to TRUE then turn on the power again. Mastering is needed.

(36) SRVO-064 PHAL alarm (Group: i Axis: j)

- (Explanation) This alarm occurs if the phase of the pulses generated in the PulseCoder is abnormal.
(Action) Replace the PulseCoder.

NOTE

This alarm might accompany the DTERR, CRCERR, or STBERR alarm. In this case, however, there is no actual condition for this alarm.

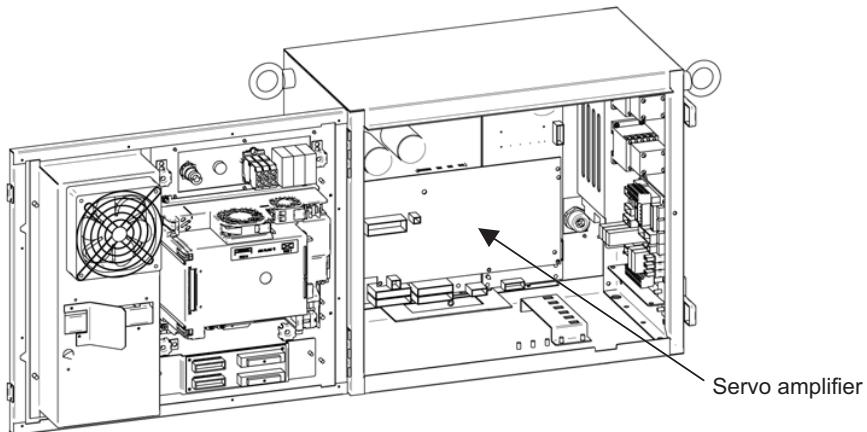
(37) SRVO-065 BLAL alarm (Group: i Axis: j)

- (Explanation) The battery voltage for the PulseCoder is lower than the rating.
(Action) Replace the battery.
(If this alarm occurs, turn on the power and replace the battery as soon as possible. A delay in battery replacement may result in the BZAL alarm being detected. In this case, the position data will be lost. Once the position data is lost, mastering will become necessary.)

(38) SRVO-067 OHAL2 alarm (Group: i Axis: j)

- (Explanation) The temperature inside the PulseCoder or motor is abnormally high, and the built-in thermostat has operated.
(Action 1) Check the robot operating conditions. If a condition such as the duty cycle and load weight has exceeded the rating, relax the robot load condition to meet the allowable range.
(Action 2) When power is supplied to the motor after it has become sufficiently cool, if the alarm still occurs, replace the motor.

- (39) SRVO-068 DTERR alarm (Group: i Axis: j)
- (Explanation) The serial Pulsecoder does not return serial data in response to a request signal.
- (Action 1) Make sure that the RMP connector of servo amplifier (motor side) is connected tightly.
- (Action 2) Check that the shielding of the RMP cable is grounded securely in the cabinet.
- (Action 3) Replace the Pulsecoder.
- (Action 4) Replace the servo amplifier.
- (Action 5) Replace the RMP cable.
- (Action 6) Replace the robot interconnection cable (for the Pulsecoder).
- (40) SRVO-069 CRCERR alarm (Group: i Axis: j)
- (Explanation) The serial data has disturbed during communication.
- (Action) See actions on SRVO-068.
- (41) SRVO-070 STBERR alarm (Group: i Axis: j)
- (Explanation) The start and stop bits of the serial data are abnormal.
- (Action) See actions on SRVO-068.



**Fig.3.5 (r) SRVO-059 Servo amp init error
SRVO-070 STBERR alarm**

- (42) SRVO-071 SPHAL alarm (Group: i Axis: j)
- (Explanation) The feedback speed is abnormally high.
- (Action) Action as same as the SRVO-068.

NOTE

If this alarm occurs together with the PHAL alarm (SRVO-064), this alarm does not correspond to the major cause of the failure.

- (43) SRVO-072 PMAL alarm (Group: i Axis: j)
- (Explanation) It is likely that the Pulsecoder is abnormal.
- (Action) Replace the Pulsecoder and remaster the robot.

(44) SRVO-073 CMAL alarm (Group: i Axis: j)

- (Explanation) It is likely that the Pulsecoder is abnormal or the Pulsecoder has malfunctioned due to noise.
- (Action 1) Check whether the connection of the controller earth is good. Check the earth cable connection between controller and robot. Check whether the shielding of the robot connection cables is connected securely to the grounding plate.
- (Action 2) Reinforce the earth of the motor flange. (In case of Auxiliary axis)
- (Action 3) Replace the Pulsecoder.

(45) SRVO-074 LDAL alarm (Group: i Axis: j)

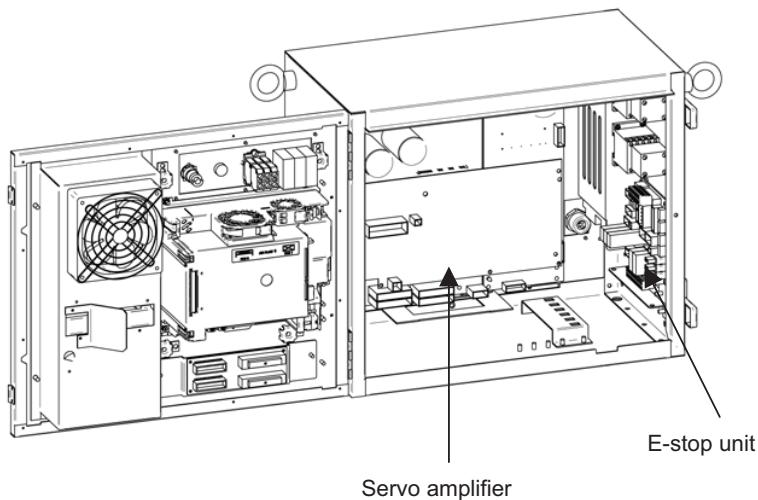
- (Explanation) The LED in the Pulsecoder is broken.
- (Action) Replace the Pulsecoder, and remaster the robot.

(46) SRVO-075 Pulse not established (Group: i Axis: j)

- (Explanation) The absolute position of the Pulsecoder cannot be established.
- (Action) Reset the alarm, and jog the axis on which the alarm has occurred until the same alarm will not occur again.

(47) SRVO-076 Tip Stick Detection (Group: i Axis: j)

- (Explanation) An excessive disturbance was assumed in servo software at the start of operation.
(An abnormal load was detected. The cause may be welding.)
- (Action 1) Check whether the robot has collided. Or check whether the machinery load of the corresponding axis is increased.
- (Action 2) Check whether the load settings are valid.
- (Action 3) Check whether the brake of the corresponding axis is released.
- (Action 4) Check whether the load weight is within the rated range. If the weight exceeds the upper limit, decrease it to the limit.
- (Action 5) Check whether the voltage input to the controller is within the rated voltage and check whether the voltage set for the transformer of the controller is correct.
- (Action 6) Replace the servo amplifier.
- (Action 7) Replace the corresponding servo motor.
- (Action 8) Replace the E-stop unit.
- (Action 9) Replace the power cable of the robot connection cable in which the corresponding axis is connected.
- (Action 10) Replace the power cable or brake cable of the robot interconnection cable in which the corresponding axis is connected.

**Fig.3.5 (s) SRVO-076 Tip Stick Detection**

- (48) SRVO-081 EROFL alarm (Track enc: i)
- (Explanation) The pulse counter for line tracking has overflowed.
- (Action 1) Check whether the condition of the line tracking exceeds the limitation.
- (Action 2) Replace the Pulsecoder.
- (Action 3) Replace the line tracking interface board.
- (49) SRVO-082 DAL alarm (Track ebc: i)
- (Explanation) The line tracking Pulsecoder has not been connected.
- (Action 1) Check the connection cable at each end (the line tracking interface board and the motor side)
- (Action 2) Check whether the shielding of the connection cable is connected securely to the grounding plate.
- (Action 3) Replace the line tracking cable.
- (Action 4) Replace the Pulsecoder.
- (Action 5) Replace the line tracking interface board.
- (50) SRVO-084 BZAL alarm (Track enc: i)
- (Explanation) This alarm occurs if the backup battery for the absolute position of the Pulsecoder has not been connected. See the description about the BZAL alarm (SRVO-062).
- (51) SRVO-087 BLAL alarm (Track enc: i)
- (Explanation) This alarm occurs if the voltage of the backup battery for the absolute position of the Pulsecoder is low. See the description about the BLAL alarm (SRVO-065).
- (52) SRVO-089 OHAL2 alarm (Track enc: i)
- (Explanation) The motor has overheated. When power is supplied to the Pulsecoder after it has become sufficiently cool, if the alarm still occurs. See the description about the OHAL2 alarm (SRVO-067).
- (53) SRVO-090 DTERR alarm (Track ebc: i)
- (Explanation) Communication between the Pulsecoder and line tracking interface board is abnormal. See the SRVO-068 DTERR alarm.
- (Action 1) Check the connection cable at each end (the line tracking interface board and the Pulsecoder)
- (Action 2) Check whether the shielding of the connection cable is connected securely to the grounding plate.
- (Action 3) Replace the Pulsecoder.
- (Action 4) Replace the line tracking cable.
- (Action 5) Replace the line tracking interface board.
- (54) SRVO-091 CRCERR alarm (Track enc: i)
- (Explanation) Communication between the Pulsecoder and line tracking interface board is abnormal.
- (Action) Action as same as the SRVO-090.
- (55) SRVO-092 STBERR alarm (Track enc: i)
- (Explanation) Communication between the Pulsecoder and line tracking interface board is abnormal.
- (Action) Action as same as the SRVO-090.
- (56) SRVO-093 SPHAL alarm (Track enc: i)
- (Explanation) This alarm occurs if the current position data from the Pulsecoder is higher than the previous position data.
- (Action) Action as same as the SRVO-090.

(57) SRVO-094 PMAL alarm (Track enc: i)

(Explanation) It is likely that the Pulsecoder is abnormal. See the description about the PMAL alarm (SRVO-072).

(58) SRVO-095 CMAL alarm (Track enc: i)

(Explanation) It is likely that the Pulsecoder is abnormal or the Pulsecoder has malfunctioned due to noise. See the description about the CMAL alarm (SRVO-073).

(Action 1) Reinforce the earth of the flange of the Pulsecoder.

(Action 2) Replace the Pulsecoder.

(59) SRVO-096 LDAL alarm (Track enc: i)

(Explanation) The LED in the Pulsecoder is broken. See the description about the LDAL alarm (SRVO-074).

(60) SRVO-097 Pulse not established (enc: i)

(Explanation) The absolute position of the Pulsecoder cannot be established. See the description about (SRVO-075). Pulse not established.

(Action 1) Reset the alarm, and jog the axis on which the alarm has occurred until the same alarm does not occur again. (Jog one motor revolution)

(61) SRVO-105 Door open or E-stop

(Explanation) The cabinet door is open.

- When the door switch is mounted.

(Action 1) When the door is open, close it.

(Action 2) Check the door switch and door switch connection cable. If the switch or cable is faulty, replace it.

- When the door switch is not mounted.

(Action 3) Check that the CRMA31, CRMA43, and CRM90 connectors on the E-STOP unit are connected securely.

(Action 4) Replace the E-stop unit.

(Action 5) Replace the servo amplifier.

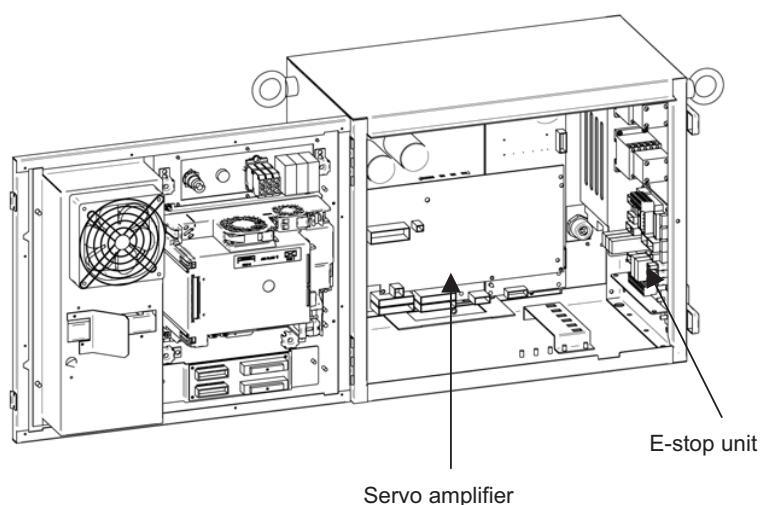


Fig.3.5 (t) SRVO-105 Door open or E-stop

(62) SRVO-136 DCLVAL alarm (Group: i Axis: j)

(Explanation) The servo the DC current of amplifier (DC link voltage) of the main power supply is abnormally low.

- This alarm occurred during robot operation.

(Action 1) Check the input voltage to the controller is within the rated voltage and no phase is lack. In addition, check the setting of the transformer is correct.

(Action 2) It is possible that an instant disconnection of power source causes this alarm. Check whether an instant disconnection occurred.

(Action 3) Modify the program in order that robot and the auxiliary axis do not accelerate simultaneously in the system with the auxiliary axis.

(Action 4) Replace the E-stop unit.

(Action 5) Replace the servo amplifier.

- If this alarm occurred before the magnetic contactor is turned on:

(Action 1) Check whether the circuit breaker in the E-stop unit is OFF. If it is OFF, check the servo amplifier and the wiring between the servo amplifier and the E-stop unit. If anything is abnormal, replace it. Else, turn on the breaker.

(Action 2) Check the input voltage to the controller is within the rated voltage and no phase is lack. In addition, check the setting of the transformer is correct.

(Action 3) Replace the E-stop unit.

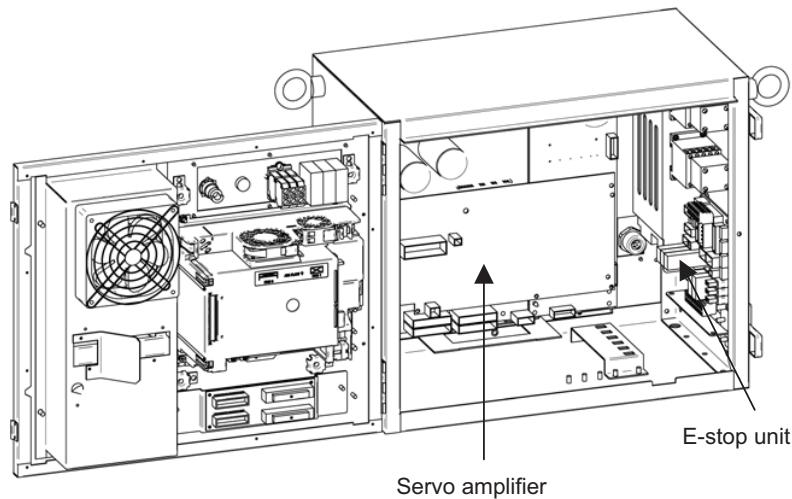
(Action 4) Replace the servo amplifier.

(63) SRVO-156 IPMAL alarm (Group: i Axis: j)

- (Explanation) Abnormally high current flowed through the main circuit of the servo amplifier.
- (Action 1) Turn off the power, and disconnect the power cable from the servo amplifier indicated by the alarm message. (And disconnect the brake cable (CRR88 on the servo amplifier) to avoid the axis falling unexpectedly.) Turn on the power, and if the alarm occurs again, replace the servo amplifier.
- (Action 2) Turn off the power and disconnect the power cable from the servo amplifier indicated by the alarm message, and check the insulation of their U, V, W and the GND lines each other. If there is a short-circuit, replace the power cable.
- (Action 3) Turn off the power and disconnect the power cable from the servo amplifier by the alarm message, and measure the resistance between their U and V, V and W and W and U with an ohmmeter that has a very low resistance range. If the resistances at the three places are different from each other, the motor, the power cable is defective. Check each item in detail and replace it if necessary.

(64) SRVO-157 CHGAL alarm (Group: i Axis: j)

- (Explanation) The capacitor for the condenser voltage of the servo amplifier was not charged within the specified time when the servo power is on.
- (Action 1) Replace the E-stop unit.
- (Action 2) Replace the servo amplifier.
- (Action 3) Replace the auxiliary amplifier for system of the auxiliary axis.

**Fig.3.5 (u) SRVO-136 DCLVAL alarm****SRVO-156 IPMAL alarm****SRVO-157 CHGAL alarm**

(65) SRVO-201 Panel E-stop or SVEMG abnormal

- (Explanation) The emergency stop button on the operator's panel was pressed, but the E-STOP line was not disconnected.
- (Action 1) With the E-stop in the released position, check for continuity across the terminals of the switch. If continuity is not found, the emergency stop button is broken. Replace the switch unit or the operator's panel.

Before executing the (Action 2), perform a complete controller back-up to save all your programs and settings.

- (Action 2) Replace the main board.
- (Action 3) Replace the Servo amplifier.
- (Action 4) Replace the E-stop board.

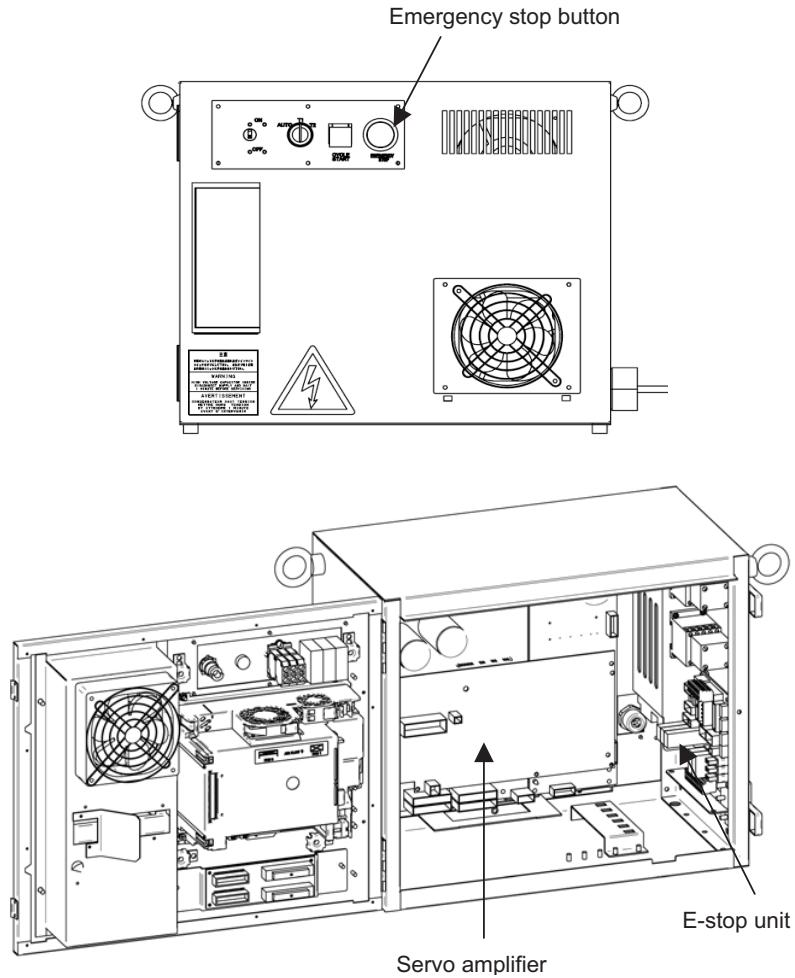


Fig.3.5 (v) SRVO-201 Panel E-stop or SVEMG abnormal

(66) SRVO-202 TP E-stop or SVEMG abnormal

(Explanation) The emergency stop button on the teach pendant was pressed, but the E-STOP line was not disconnected.

- (Action 1) Replace the teach pendant.
- (Action 2) Check the teach pendant cable. If this inferior, replace the cable.
- (Action 3) Replace the servo amplifier.
- (Action 4) Replace the E-stop unit.

NOTE

This alarm might occur if the emergency stop button is pressed slowly.

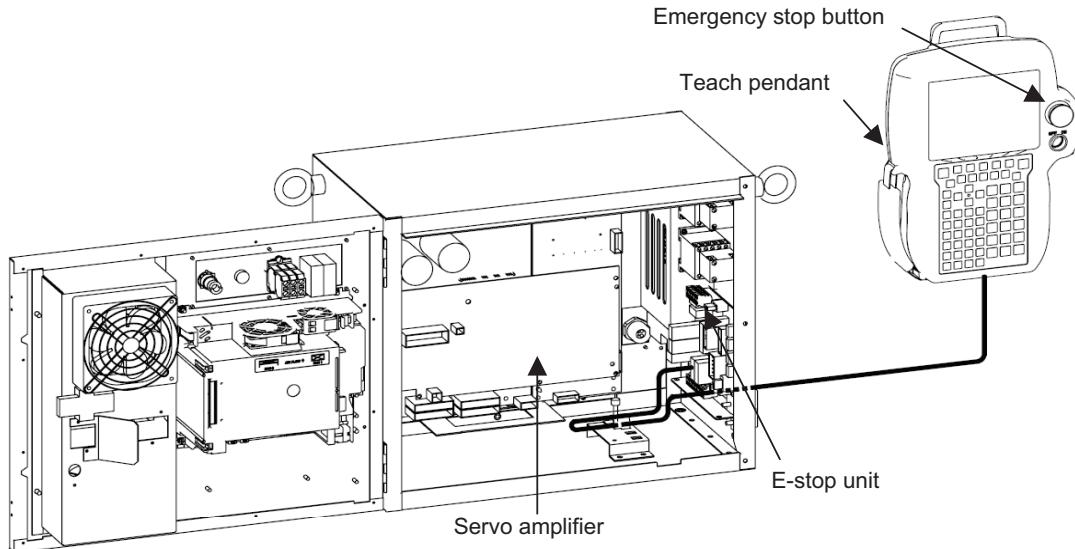


Fig.3.5 (w) SRVO-202 TP E-stop or SVEMG abnormal

(67) SRVO-204 External (SVEMG abnormal) E-stop

(Explanation) The E-stop line was not disconnected when the switch connected to the external E-stop contacts on the E-stop board was pressed.

Terminal connection: Between EES1 and EES11 and between EES2 and EES21 on the TBOP7 terminal board.

(Action 1)

Check the switches and cables connected between terminals on the E-stop board (between EES1 and EES11 and between EES2 and EES21 on TBOP7). If a defective cable or switch is found, replace it.

Before executing the (Action 2), perform a complete controller back-up to save all your programs and settings.

(Action 2)

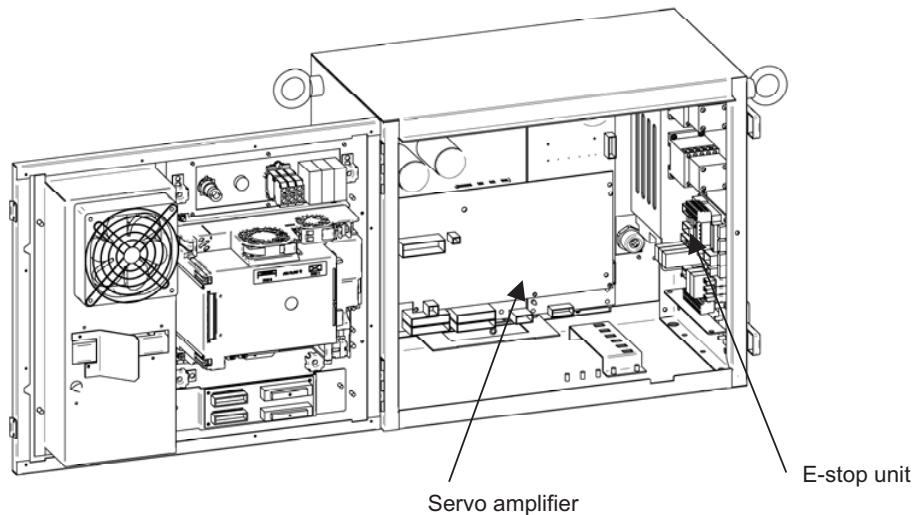
Replace the main board.

(Action 3)

Replace the servo amplifier.

(Action 4)

Replace the E-stop unit.



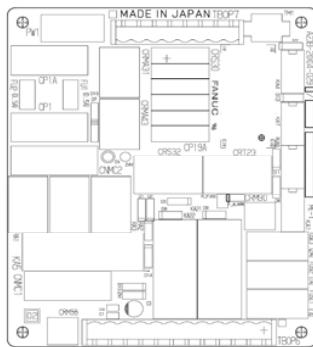


Fig.3.5 (x1) SRVO-204 External (SVEMG abnormal) E-stop

- (68) SRVO-205 Fence open (SVEMG abnormal)

(Explanation) The E-stop line was not disconnected when the switch connected to the safety fence contacts on the E-stop board was pressed.

Terminal connection: Between EAS1 and EAS11 and between EAS2 and EAS21 on the TBOP7 terminal board.

(Action 1)

Check the switches and cables connected between terminals on the E-stop board (between EAS1 and EAS11 and between EAS2 and EAS21 on TBOP7). If a defective cable or switch is found, replace it.

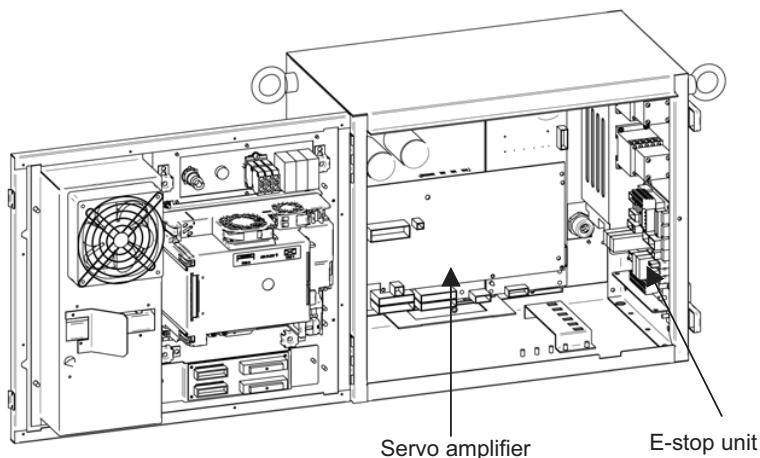
Before executing the (Action 2), perform a complete controller back-up to save all your programs and settings.

(Action 2)

Replace the main board.

(Action 3)

Replace the servo amplifier.



(E-stop board)

Fig.3.5 (x2) SRVO-205 Fence open (SVEMG abnormal)

(69) SRVO-206 DEADMAN switch (SVEMG abnormal)

(Explanation) When the teach pendant was enabled, the DEADMAN switch was released or pressed strongly, but the E-stop line was not disconnected.

(Action 1) Replace the teach pendant.

(Action 2) Check the teach pendant cable. If it is inferior, replace the cable.

Before executing the (Action 3), perform a complete controller back-up to save all your programs and settings.

(Action 3) Replace the main board.

(Action 4) Replace the servo amplifier.

(Action 5) Replace the E-stop unit.

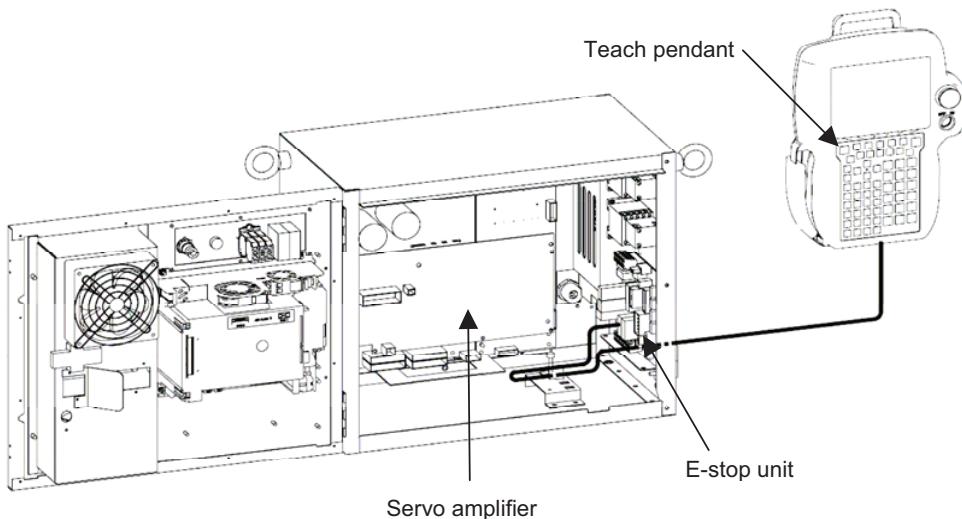


Fig.3.5 (y) SRVO-206 DEADMAN switch (SVEMG abnormal)

(70) SRVO-214 Fuse blown (Servo amplifier)

(Explanation) A fuse in the servo amplifier has blown.

In case that FS2 or FS3 is blown

(Action 1) A fuse is blown, eliminate the cause, and then replace the fuse. (See Section 3.6 in the Part II, "MAINTENANCE".)

(Action 2) Replace the servo amplifier.

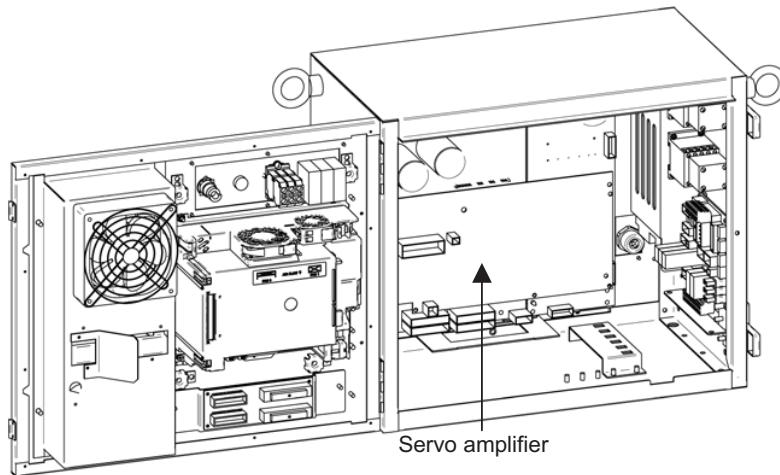
(71) SRVO-216 OVC (total) (Robot: i)

(Explanation) The current (total current for six axes) flowing through the motor is too large.

(Action 1) Slow the motion of the robot where possible. Check the robot operation conditions. If the robot is used with a condition exceeding the duty or load weight robot rating, reduce the load condition value to the specification range.

(Action 2) Check the input voltage to the controller is within the rated voltage and no phase is lack. In addition, check the setting of the transformer is correct.

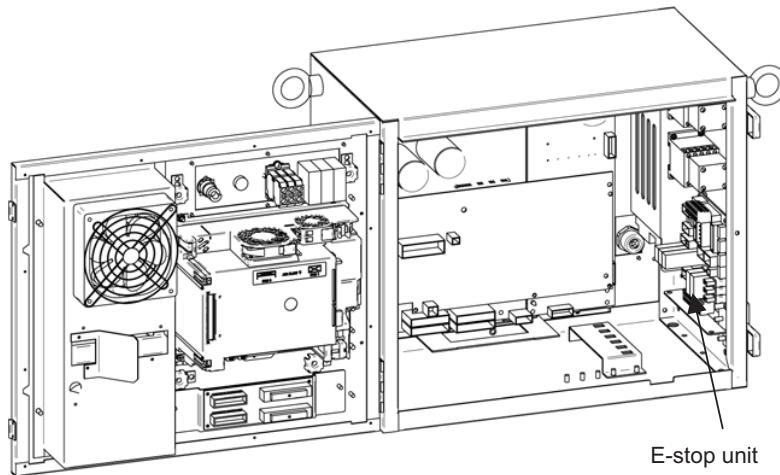
(Action 3) Replace the servo amplifier.



**Fig.3.5 (z) SRVO-214 Fuse blown (servo amplifier)
SRVO-216 OVC (total)**

(72) SRVO-218 Ext.E-stop/ServoDisconnect

- (Explanation) The switch connected across EES1 – EES11 and EES2 – EES21 on the TBOP7 terminal board on the E-stop board was pressed.
- (Action 1) When the external emergency stop button is connected, release the button.
- (Action 2) Check the switch and cable connected to EES1 – EES11 and EES2 – EES21 on TBOP7 terminal board. If the cable is abnormal, replace it.
- (Action 3) When this signal is not used, establish the short circuits between the contacts (between EES1 and EES11 and between EES2 and EES21) on the terminal block of the E-stop unit.
- (Action 4) Replace the teach pendant.
- (Action 5) Check the teach pendant cable. If this inferior, replace the cable.
- (Action 6) Replace the E-stop unit.





(E-stop board)

Fig.3.5 (aa) SRVO-218 Ext.E-stop/ServoDisconnect

(73) SRVO-220 SDI fuse blown

- (Explanation) A fuse (FUSE3) on the main board has blown.
 (Action 1) Check whether the fuse (FUSE3) on the main board has blown. If the fuse has blown, 24SDI may be short-circuited to 0V. Take Action 2.
 (Action 2) Remove the cause of the 24SDI ground-fault, and then check that FUSE3 does not blow. Disconnect the following on the main board, and then turn on the power.
 - CRMA15
 - CRMA16
 If FUSE3 does not blow in this state, 24SDI and 0V may be short-circuited at any of the above locations. Determine the faulty location, and then take appropriate action.
 If FUSE3 still blows after the above are disconnected, take Action 3.
 (Action 3) Disconnect CRS30. If FUSE3 still blows, replace the main board.
 (Action 4) Replace the cable between the E-stop unit and servo amplifier.
 (Action 5) Replace the cable between the main board and the E-stop unit.
 (Action 6) Replace the E-stop unit.
 (Action 7) Replace the servo amplifier

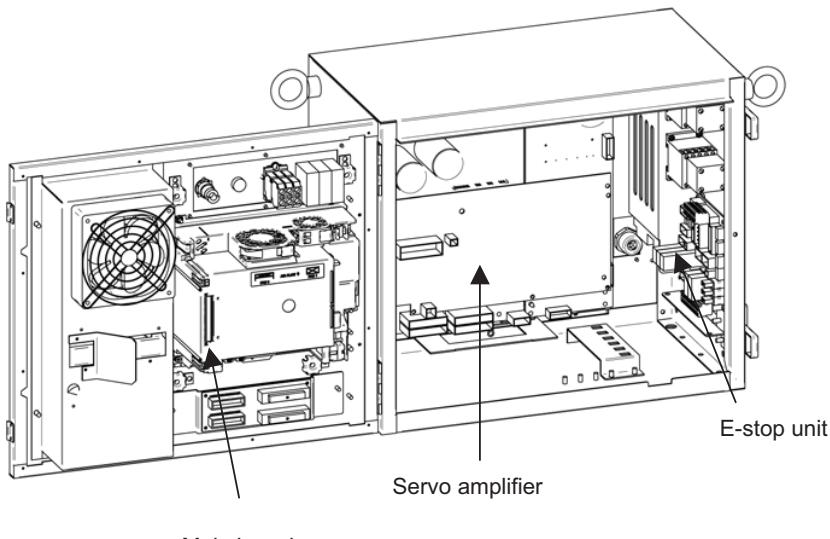


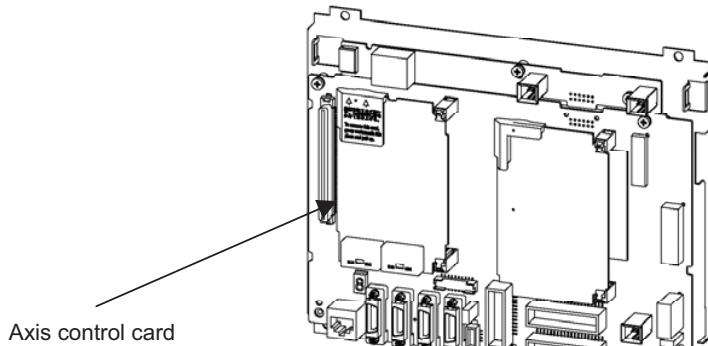
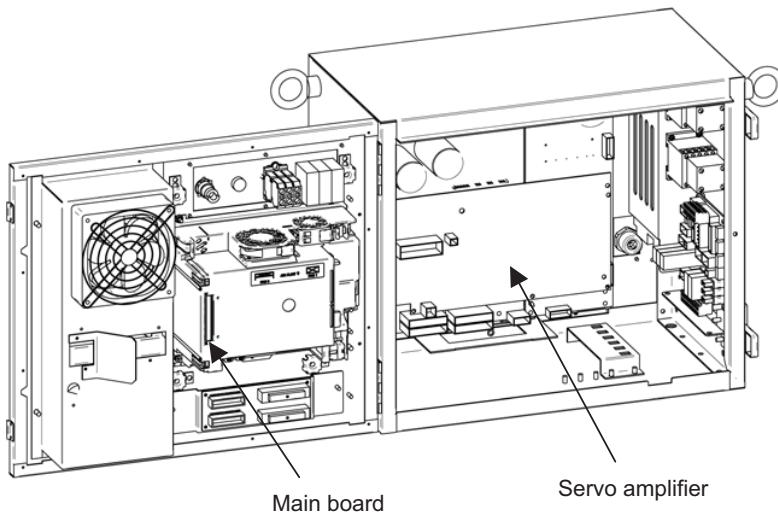
Fig.3.5 (ab) SRVO-220 SDI fuse blown

(74) SRVO-221 Lack of DSP (Group: i Axis: j)

- (Explanation) A controlled axis card corresponding to the set number of axes is not mounted.
- (Action 1) Check whether the set number of axes is valid. If the number is invalid, set the correct number.
- (Action 2) Replace the axis control card with a card corresponding to the set number of axes.

(75) SRVO-223 DSP dry run (a b)

- (Explanation) Servo system initialization was stopped because of a hardware failure or improper software setting. The controller has been started in the DSP dry run mode.
- (Action 1) When the value is 1, 5, or 6: An incorrect setting is made. Check whether the dry run mode is set and check whether the setting of the hard start axis is correct.
- (Action 2) When the value is 2, 3, 4, or 7: Replace the servo card.
- (Action 3) When the value is 8 or 10: Take action for an FSSB initialization error that has occurred at the same time.
- (Action 4) When the value is 9: Take the following action:
Check whether the servo amplifier is connected.
Replace the optical cable used for servo amplifier connection.
Replace the servo amplifier



(Main board)

**Fig.3.5 (ac) SRVO-221 Lack of DSP
SRVO-223 DSP dry run (a b)**

(76) SRVO-230 Chain 1 abnormal a,b

SRVO-231 Chain 2 abnormal a,b

(Explanation) A mismatch occurred between duplicate safety signals.

SRVO-230 is issued if such a mismatch that a contact connected on the chain 1 side (between EES1 and EES11, between EAS1 and EAS11, between SD4 and SD41, and so forth) is closed, and a contact on the chain 2 side (between EES2 and EES21, between EAS2 and EAS21, between SD5 and SD51, and so forth) is open occurs. SRVO-231 is issued if such a mismatch that a contact on the chain 1 side is open, and a contact on the chain 2 sides is closed occurs.

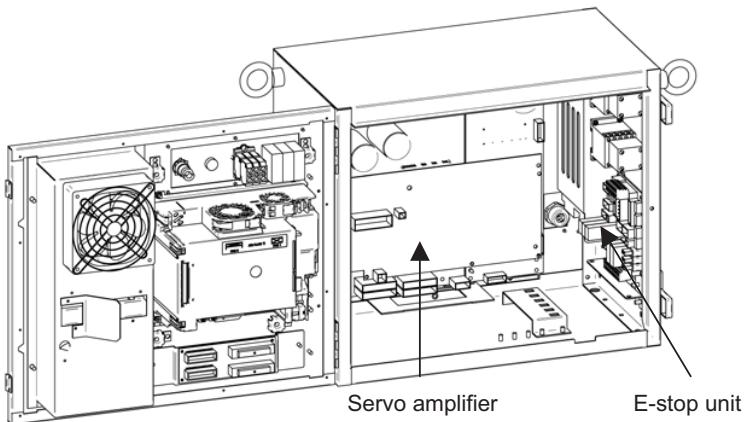
If a chain error is detected, correct the cause of the alarm then reset the alarm according to the method described later.

(Action) Check the alarms issued at the same time in order to identify with which signal the mismatch occurred.

SRVO-266 through SRVO-275 and SRVO-370 through SRVO-385 are issued at the same time. Take the action(s) described for each item.

⚠ WARNING

If this alarm is issued, do not reset the chain error alarm until the failure is identified and repaired. If robot use is continued with one of the duplicate circuits being faulty, safety may not be guaranteed when the other circuit fails.



**Fig.3.5 (ad) SRVO-230 Chain 1 (+24V) abnormal
SRVO-231 Chain 2 (0V) abnormal**

⚠ CAUTION

- 1 The state of this alarm is preserved by software. After correcting the cause of the alarm, reset the chain error alarm according to the chain error reset procedure described later.
- 2 Until a chain error is reset, no ordinary reset operation must be performed. If an ordinary reset operation is performed before chain error resetting, the message "SRVO-237 Chain error cannot be reset" is displayed on the teach pendant.

Alarm history display method

1. Press the screen selection key on the teach pendant.
2. Select [4 ALARM] on the teach pendant.
3. Press F3 [HIST] on the teach pendant.

Chain error reset procedure

 **CAUTION**

Do not perform this operation until the cause of the alarm is corrected.

<Method 1>

1. Press the emergency stop button.
2. Press the screen selection key on the teach pendant.
3. Select [0 NEXT PAGE] on the teach pendant.
4. Press [6 SYSTEM] on the teach pendant.
5. Press [7 SYSTEM SETTING] on the teach pendant.
6. Find "28" Chain Error Reset Execution.
7. Press F3 on the teach pendant to reset "Chain Error".

<Method 2>

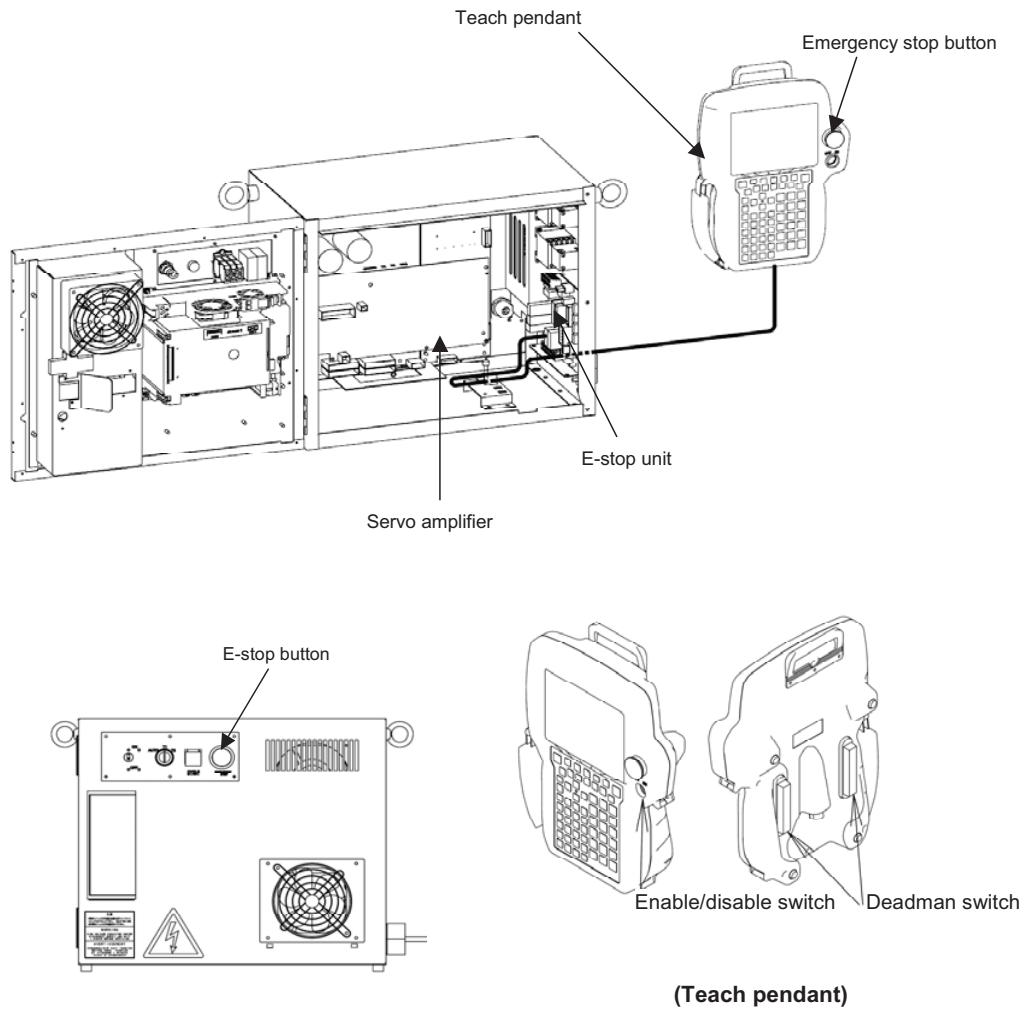
1. Press the screen selection key on the teach pendant.
2. Select [4 ALARM] on the teach pendant.
3. Press F4 [CHAIN RESET] on the teach pendant.

(77) SRVO-233 TP disabled in T1, T2/Door open

- (Explanation) Teach pendant is disabled when the mode switch is T1 or T2.
 (Action 1) Enable the teach pendant in teaching operation. In other case the mode switch should be AUTO mode.
 (Action 2) Replace the teach pendant.
 (Action 3) Replace the teach pendant cable.
 (Action 4) Replace the mode switch.
 (Action 5) Replace the E-stop unit.
 (Action 6) Replace the servo amplifier.

(78) SRVO-235 Short term Chain abnormal

- (Explanation) Short term single chain failure condition is detected.
- Cause of this alarm is;
 - Half release of DEADMAN switch
 - Half operation of E-stop switch.
- (Action 1) Cause the same error to occur again, and then perform resetting.
 (Action 2) Replace the E-stop unit.
 (Action 3) Replace the servo amplifier.



**Fig.3.5 (ae) SRVO-233 TP disabled in T1, T2/Door open
SRVO-235 Short term Chain abnormal**

- (79) SRVO-251 DB relay abnrl
 - (Explanation) An abnormality was detected in the internal relay (DB relay) of the servo amplifier.
 - (Action) Replace the servo amplifier.
- (80) SRVO-252 Current detect abnl
 - (Explanation) An abnormality was detected in the current detection circuit inside the servo amplifier.
 - (Action) Replace the servo amplifier.
- (81) SRVO-253 Amp internal over heat
 - (Explanation) An overheat was detected inside the servo amplifier.
 - (Action) Replace the servo amplifier.
- (82) SRVO-266 FENCE1 status abnormal
SRVO-267 FENCE2 status abnormal
 - (Explanation) A chain alarm was detected with the EAS (FENCE) signal.
 - (Action 1) Check whether the circuitry connected to the dual input signal (EAS) is faulty.

- (Action 2) Check whether the timing of the dual input signal (EAS) satisfies the timing specification (See Section 3.2.5, Table 3.2.5 of Part III CONNECTIONS).
Before executing the (Action 3), perform a complete controller back-up to save all your programs and settings.
- (Action 3) Replace the main board.
(Action 4) Replace the E-stop unit.

⚠ CAUTION

- 1 For the procedure of recovery from this alarm, see the descriptions of SRVO-230 and SRVO-231.
- 2 If this alarm is issued, do not reset the chain error alarm until the failure is checked and corrected. If robot use is continued with one of the duplicate circuits being faulty, safety may not be guaranteed when the other circuit fails.

(83) SRVO-270 EXEMG1 status abnormal

SRVO-271 EXEMG2 status abnormal

- (Explanation) A chain alarm was detected with the EES (EXEMG) signal.
- (Action 1) Check whether the circuitry connected to the dual input signal (EES) is faulty.
- (Action 2) Check whether the timing of the dual input signal (EES) satisfies the timing specification (See Section 3.2.5, Table 3.2.5 of Part III CONNECTIONS).
- (Action 3) Check the teach pendant cable. If this inferior, replace the cable.
- (Action 4) Replace the teach pendant.
- (Action 5) Check the emergency stop button connection and operation. If trouble is found, replace the emergency stop button.
- (Action 6) Replace the E-stop unit.
Before executing the (Action 7), perform a complete controller back-up to save all your programs and settings.
- (Action 7) Replace the main board.

⚠ CAUTION

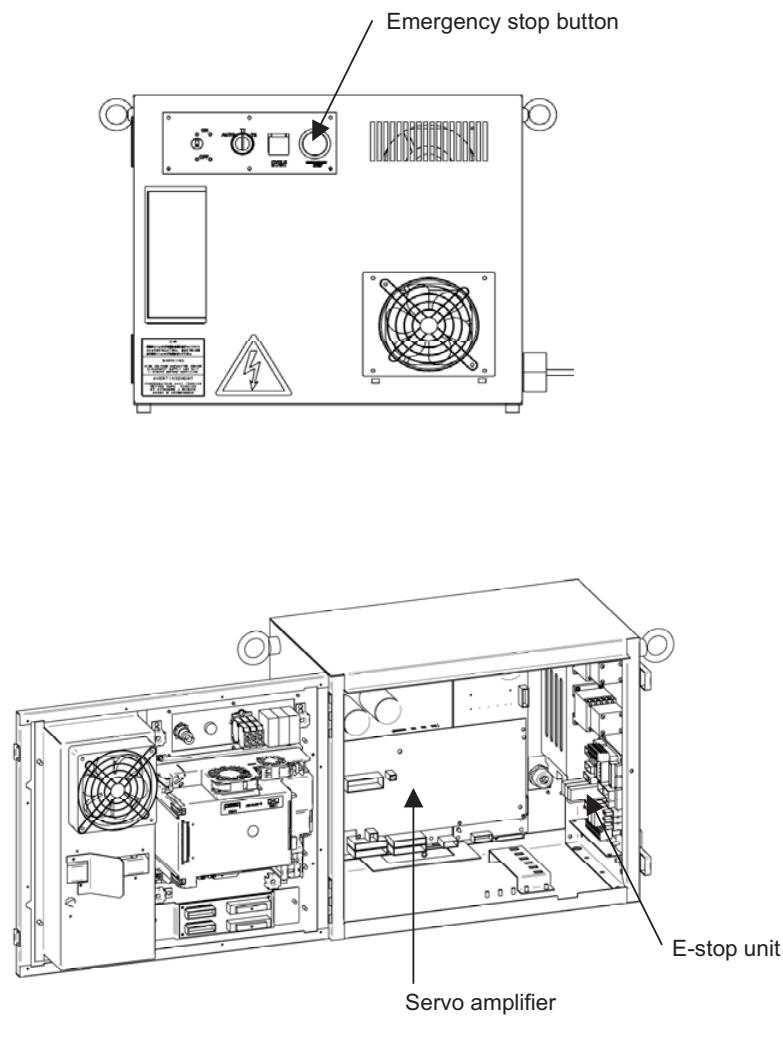
- 1 For the procedure of recovery from this alarm, see the descriptions of SRVO-230 and SRVO-231.
- 2 If this alarm is issued, do not reset the chain error alarm until the failure is checked and corrected. If robot use is continued with one of the duplicate circuits being faulty, safety may not be guaranteed when the other circuit fails.

(84) SRVO-277 Panel E-stop (SVEMG abnormal)

- (Explanation) The E-stop line was not disconnected although the emergency stop button on the operator's panel was pressed.

Before executing the (Action 1), perform a complete controller back-up to save all your programs and settings.

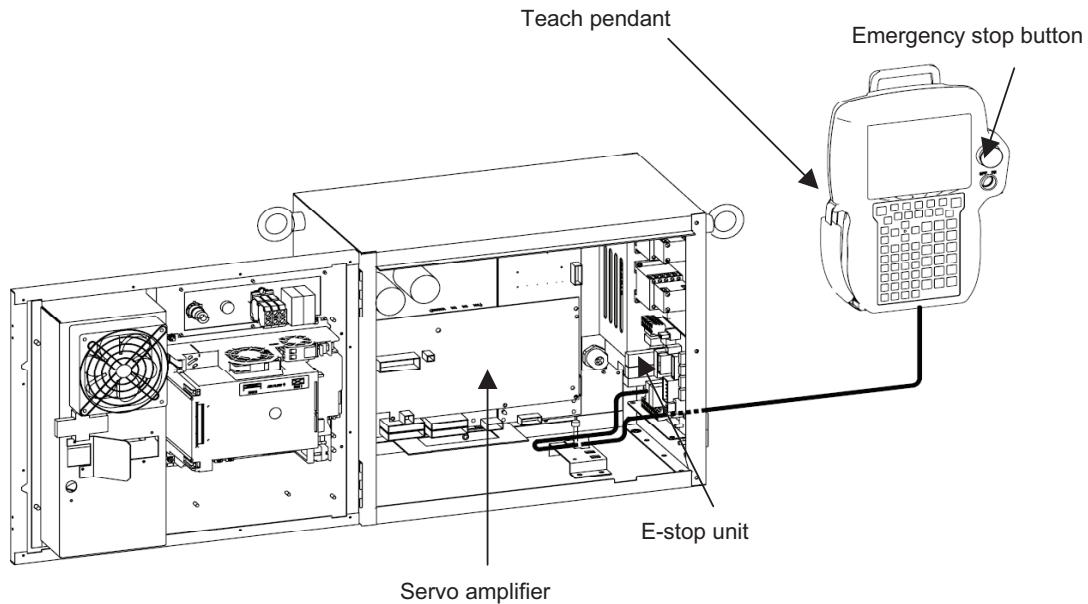
- (Action 1) Replace the main board.
(Action 2) Replace the E-stop unit
(Action 3) Replace the servo amplifier.



**Fig.3.5 (af) SRVO-251 DB relay abnormal
SRVO-252 Current detect abnl
SRVO-253 Amp internal over heat
SRVO-266 FENCE1 status abnormal
SRVO-267 FENCE2 status abnormal
SRVO-270 EXEMG1 status abnormal
SRVO-271 EXEMG2 status abnormal
SRVO-277 Panel E-stop (SVEMG abnormal)**

(85) SRVO-278 TP E-stop (SVEMG abnormal)

- (Explanation) The E-stop line was not disconnected although the emergency stop button on the teach pendant was pressed.
- (Action 1) Replace the teach pendant.
(Action 2) Replace the teach pendant cable.
(Action 3) Replace the E-stop unit.
(Action 4) Replace the servo amplifier.

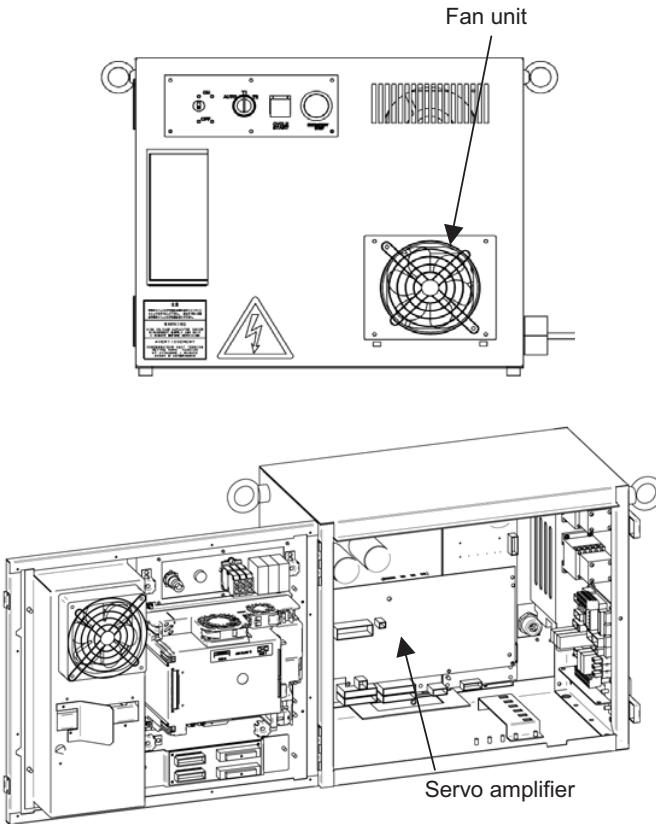
**NOTE**

This alarm may be issued if the emergency stop button is pressed very slowly.

Fig.3.5 (ag) SRVO-278 TP E-stop (SVEMG abnormal)

(86) SRVO-291 IPM over heat (G:i A:j)

- (Explanation) IPM on the servo amplifier is overheated.
- (Action 1) Check whether the fan for cabinet ventilation is stopped and check whether the vent hole is clogged. If necessary, clean or replace them.
- (Action 2) If SRVO-291 is issued when the robot operating condition is severe, check the robot operating condition then relax the condition when possible.
- (Action 3) If SRVO-291 is issued frequently, replace the servo amplifier.

**Fig.3.5 (ah) SRVO-291 IPM over heat**

(87) SRVO-300 Hand broken/HBK disabled

SRVO-302 Set Hand broken to ENABLE

- (Explanation) Although HBK was disabled, the HBK signal was input.
- (Action 1) Press RESET on the teach pendant to release the alarm.
- (Action 2) Check whether the hand broken signal is connected to the robot. When the hand broken signal circuit is connected, enable hand broken.
(See Subsection 5.5.3 in Part III, "CONNECTIONS".)

(88) SRVO-335 DCS OFFCHK alarm a, b

- (Explanation) A failure was detected in the safety signal input circuit.

Before executing the (Action 1), perform a complete controller back-up to save all your programs and settings.

- (Action 1) Replace the main board.

(89) SRVO-348 DCS MCC OFF alarm a, b

- (Explanation) A command was issued to turn off the magnetic contactor, but the magnetic contactor was not turned off.

- (Action 1) Replace the E-stop unit.

Before executing the (Action 2), perform a complete controller back-up to save all your programs and settings.

(Action 2) Replace the main board.

(90) SRVO-349 DCS MCC ON alarm a, b

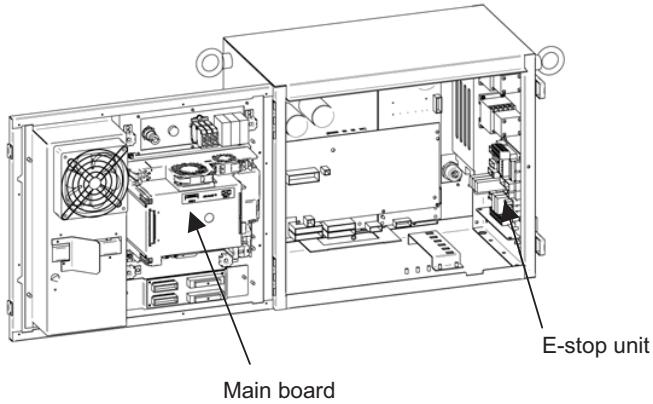
(Explanation) A command was issued to turn on the magnetic contactor, but the magnetic contactor was not turned on.

(Action 1) Replace the E-stop unit.

Before executing the (Action 2), perform a complete controller back-up to save all your programs and settings.

(Action 2) Replace the main board.

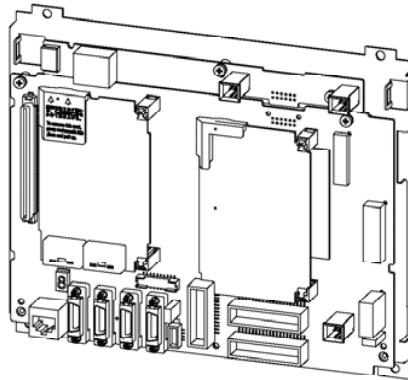
(Action 3) Replace the servo amplifier.



Main board



(E-stop board)



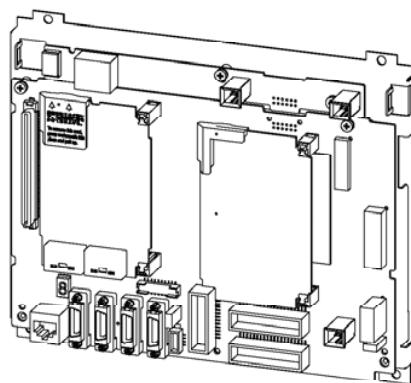
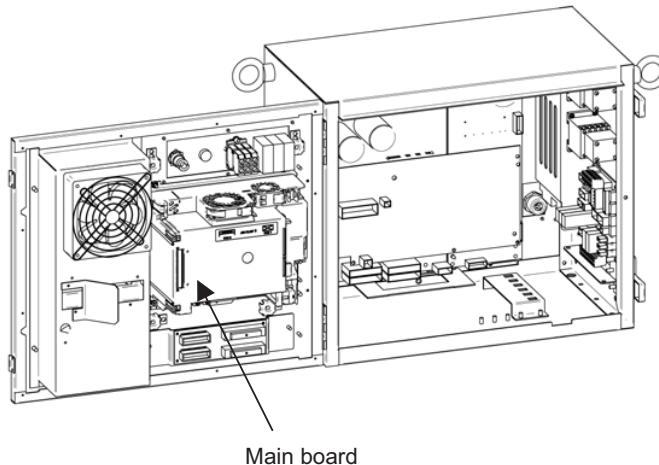
(Main board)

**Fig.3.5 (ai) SRVO-335 DCS OFFCHK alarm a, b
SRVO-348 DCS MCC OFF alarm a, b
SRVO-349 DCS MCC ON alarm a, b**

- (91) SRVO-370 SVON1 status abnormal a, b
SRVO-371 SVON2 status abnormal a, b
(Explanation) A chain alarm was detected with the main board internal signal (SVON).
(Action) Replace the main board.

⚠ CAUTION

- 1 For the procedure of recovery from this alarm, see the descriptions of SRVO-230 and SRVO-231.
- 2 If this alarm is issued, do not reset the chain error alarm until the failure is checked and corrected. If robot use is continued with one of the duplicate circuits being faulty, safety may not be guaranteed when the other circuit fails.



(Main board)

**Fig.3.5 (aj) SRVO-370 SVON1 status abnormal a, b
SRVO-371 SVON2 status abnormal a, b**

(92) SRVO-372 OPEMG1 status abnormal a, b

SRVO-373 OPEMG2 status abnormal a, b

(Explanation) A chain alarm was detected with the E-stop switch on the operator's panel.

(Action 1) Check the emergency stop button connection and operation. If trouble is found, replace the emergency stop button.

(Action 2) Replace the E-stop board.

Before executing the (Action 3), perform a complete controller back-up to save all your programs and settings.

(Action 3) Replace the main board.

CAUTION

- 1 For the procedure of recovery from this alarm, see the descriptions of SRVO-230 and SRVO-231.
- 2 If this alarm is issued, do not reset the chain error alarm until the failure is checked and corrected. If robot use is continued with one of the duplicate circuits being faulty, safety may not be guaranteed when the other circuit fails.

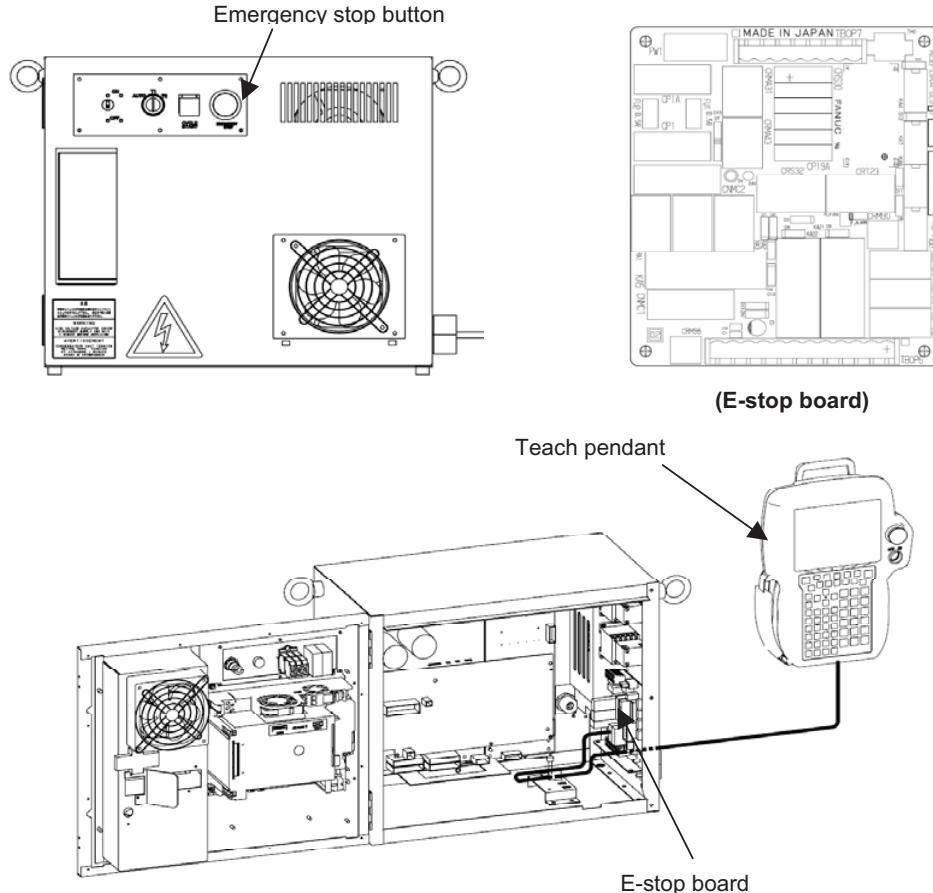


Fig.3.5 (ak) SRVO-372 OPEMG1 status abnormal a, b

(93) SRVO-374 MODE11 status abnormal a, b

SRVO-375 MODE12 status abnormal a, b

SRVO-376 MODE21 status abnormal a, b

SRVO-377 MODE22 status abnormal a, b

(Explanation) A chain alarm was detected with the mode switch signal.

(Action 1) Check the mode switch connection and operation. If trouble is found, replace the mode switch.

Before executing the (Action 2), perform a complete controller back-up to save all your programs and settings.

(Action 2) Replace the main board.

(Action 3) Replace the E-stop board.

⚠ CAUTION

- 1 For the procedure of recovery from this alarm, see the descriptions of SRVO-230 and SRVO-231.
- 2 If this alarm is issued, do not reset the chain error alarm until the failure is checked and corrected. If robot use is continued with one of the duplicate circuits being faulty, safety may not be guaranteed when the other circuit fails.

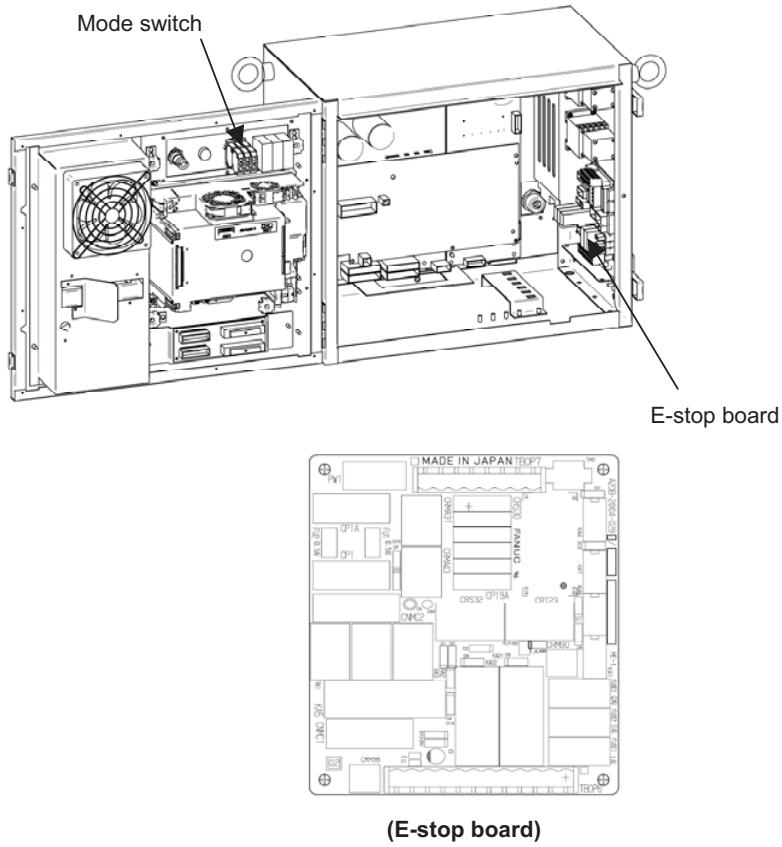


Fig.3.5 (a) SRVO-374 MODE11 status abnormal a, b
SRVO-375 MODE12 status abnormal a, b
SRVO-376 MODE21 status abnormal a, b
SRVO-377 MODE22 status abnormal a, b

3.6 FUSE-BASED TROUBLESHOOTING

This section describes the alarms and symptoms generated and actions required when the fuses installed on the printed circuit boards and units have blown.

(1) Fuses on the main board

FUSE1: For protecting the +24 V output

FUSE3: For protecting the +24 V output of the peripheral device interface

| Name | Symptom observed when fuse has blown | Action |
|-------|---|---|
| FUSE1 | The teach pendant becomes inoperative, and all LEDs on the main board go off. | <ol style="list-style-type: none"> 1. Replace the backplane board. 2. Replace the main board. |
| FUSE3 | An alarm (SRVO-220) is displayed on the teach pendant. | <ol style="list-style-type: none"> 1. 24SDI and 0 V may be short-circuited. Check the peripheral device cable for any abnormality, and replace it if necessary. 2. Disconnect CRS30. If FUSE3 still blows, replace the main board. 3. Replace the cable between the emergency stop unit and the servo amplifier. 4. Replace the cable between the main board and the emergency stop unit. 5. Replace the emergency stop unit. 6. Replace the servo amplifier. |

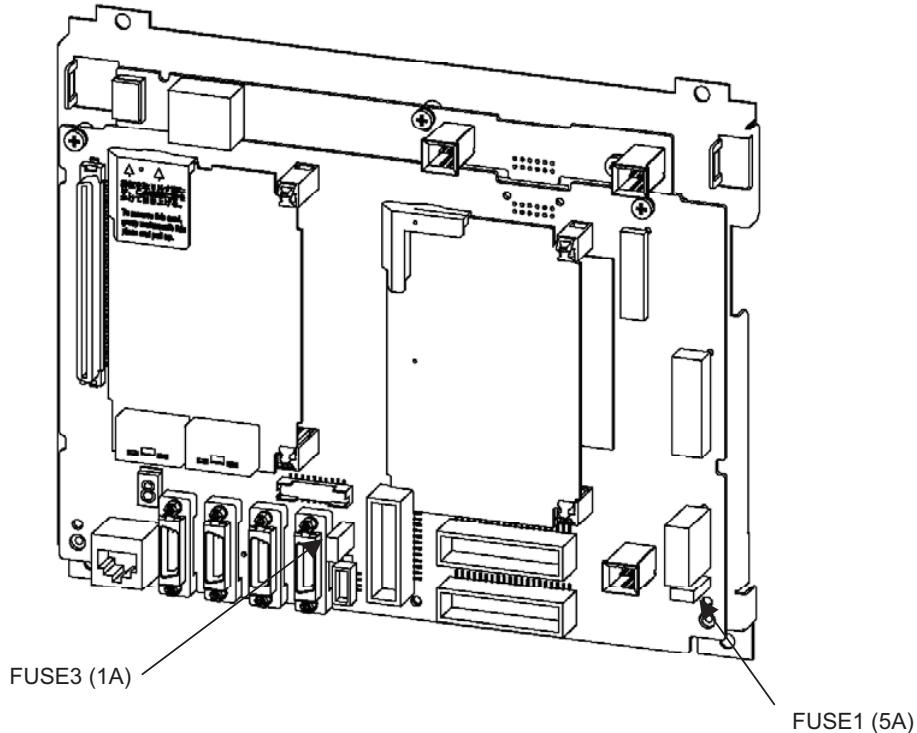


Fig.3.6 (a) Fuses on the main board

(2) Fuses on the servo amplifier

FS1: For generation of the power to the amplifier control circuit

FS2: For protection of the 24V output to the end effector, ROT, and HBK

FS3: For protection of the 24V output to the regenerative resistor and the additional axis amplifier

| Name | Symptom observed when fuse has blown | Action |
|------|---|---|
| FS1 | All LEDs on the servo amplifier go out. The FSSB disconnection or initialization alarm is displayed on the teach pendant. | Replace the servo amplifier. |
| FS2 | The Fuse Blown (Amp) alarm (SRVO-214), Hand broken (SRVO-006), and ROBOT OVER TRAVEL (SRVO-005) are displayed on the teach pendant. | <ol style="list-style-type: none"> Check +24VF used by the end effector for a ground fault. Check the robot connection cable and the robot's internal cable. Replace the servo amplifier. |
| FS3 | The Fuse Blown (Amp) alarm (SRVO-214) and DCAL (SRVO-043) are displayed on the teach pendant. | <ol style="list-style-type: none"> Check the regenerative resistor, and replace it if required. Check the additional axis amplifier and its wiring, and replace them if required. Replace the servo amplifier. |

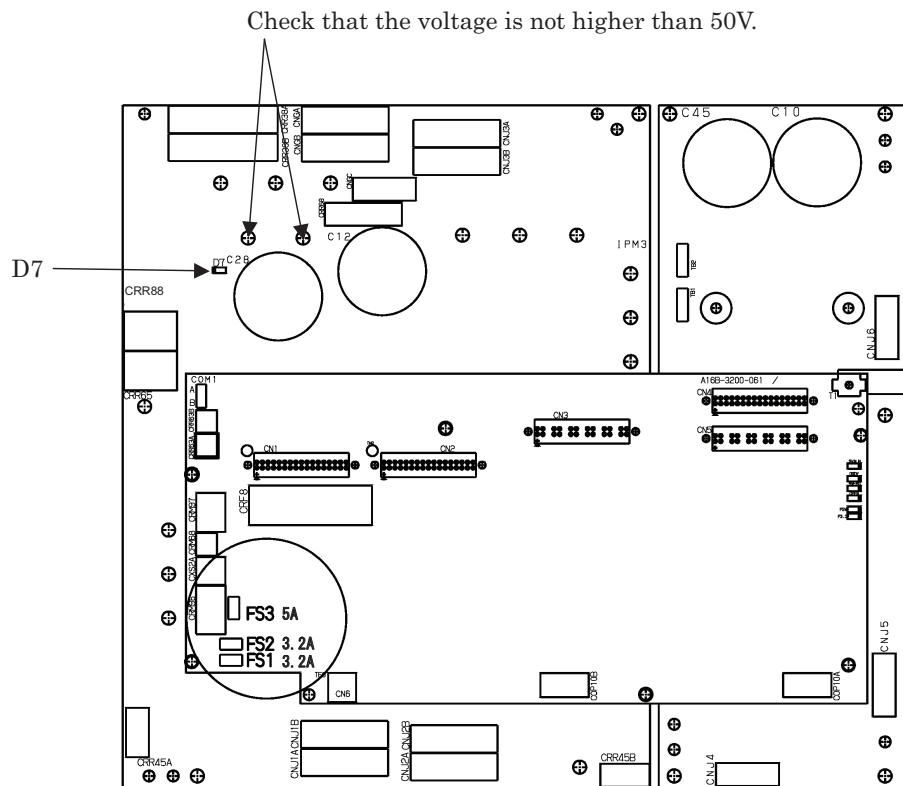


Fig.3.6 (b) Fuses on the servo amplifier

WARNING

Before touching the servo amplifier, check the DC link voltage with the screws located above the LED "D7". By using a DC voltage tester, check that the voltage is 50 V or less.

(3) Emergency stop board fuses

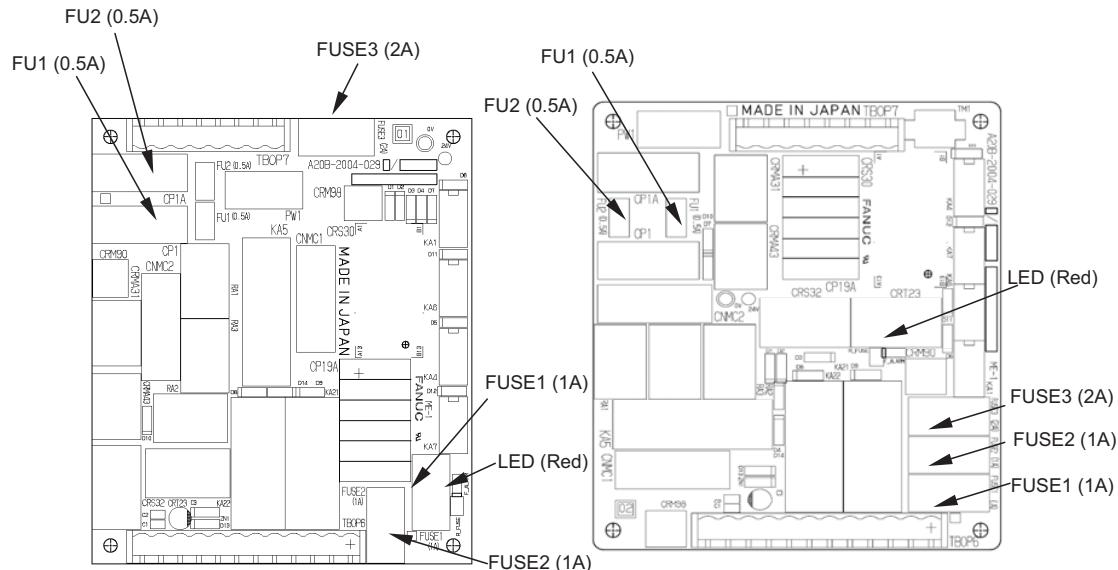
FUSE1: For protecting +24EXT for the emergency stop circuit

FUSE2: For protecting +24V for the teach pendant

FUSE3: For protecting +24V

FU1, FU2: For protecting input for the door fan

| Name | Symptom observed when fuse has blown | Action |
|----------|---|---|
| FUSE1 | Alarm (SRVO-218) is displayed on the teach pendant, and the LED (red) on the emergency stop board lights. | <ol style="list-style-type: none"> If an alarm is issued when the fuse has not blown, check the voltages of EXT24V and EXT0V (TBOP6). If external 24V or 0V is not used, check the jumper pin between EXT24V and INT24V or between EXT0V and INT0V. Check the +24EXT line (emergency stop line) for a short circuit or connection to ground. Replace the emergency stop board. |
| FUSE2 | The display on the teach pendant disappears, and the LED (red) on the emergency stop board lights. | <ol style="list-style-type: none"> Check teach pendant cable for any abnormality, and replace it if necessary. Check teach pendant for any abnormality, and replace it if necessary. Replace the emergency stop board. |
| FUSE3 | An alarm relating to an input signal that causes an emergency stop is issued, and the LED (red) on the emergency stop board lights. | <ol style="list-style-type: none"> Check the connections on TBOP7. Check the cable between the emergency stop board and the main board for any abnormality, and replace it if necessary. Replace the main board. Replace the emergency stop board. |
| FU1, FU2 | The fan stops. The teach pendant can not be operated. | <ol style="list-style-type: none"> Check the fan cable for any abnormality, and replace it if necessary. Replace the fan unit. Replace the emergency stop board. |



(Edition 01A)

(Edition 02B or later)

Fig.3.6 (c) Fuses on the E-stop board

(4) Fuse FUSE1 on the process I/O printed circuit board (for +24E)

| Name | Symptom observed when fuse has blown | Action |
|-------|---|---|
| FUSE1 | The LED (ALM1 or FALM) on the process I/O board lights. | <ol style="list-style-type: none"> 1. Check if the cables and peripheral devices connected to the process I/O board are normal. 2. Replace the process I/O board. |

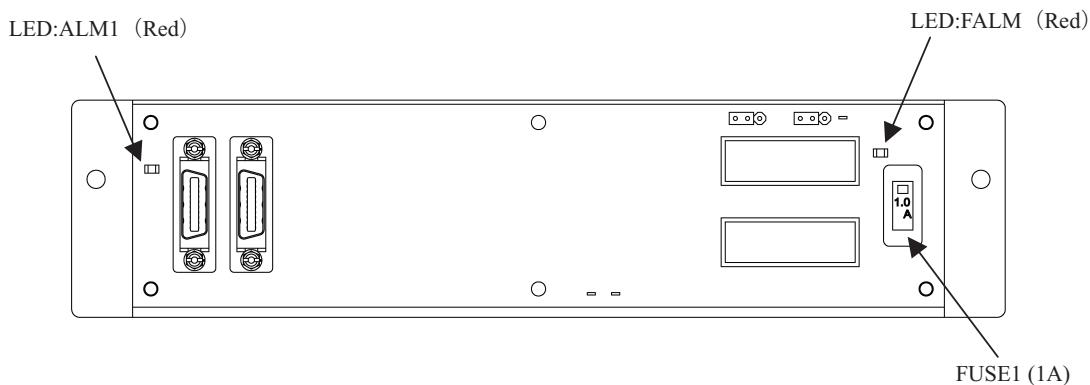


Fig.3.6 (d) Fuse on the process I/O board MA

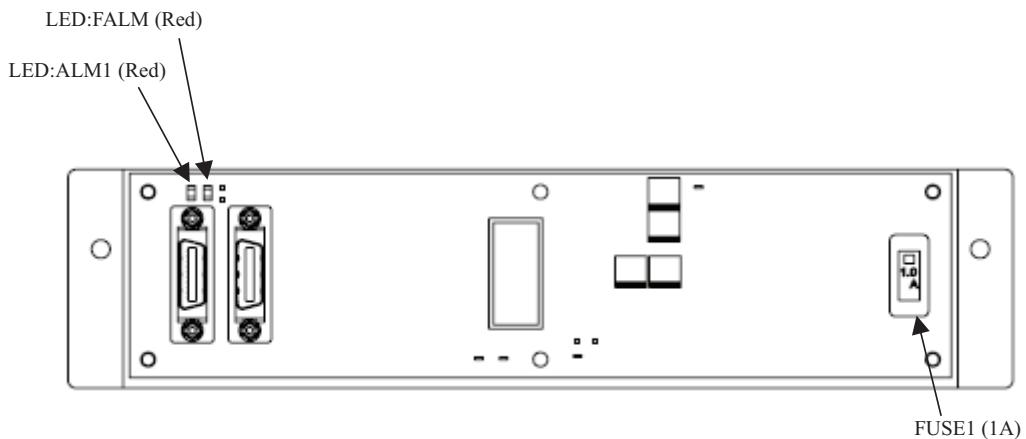


Fig.3.6 (e) Fuse on the process I/O board MB

3.7 TROUBLESHOOTING BASED ON LED INDICATIONS

The printed circuit boards and servo amplifier are provided with alarm LEDs and status LEDs. The LED status and corresponding troubleshooting procedures are described below.

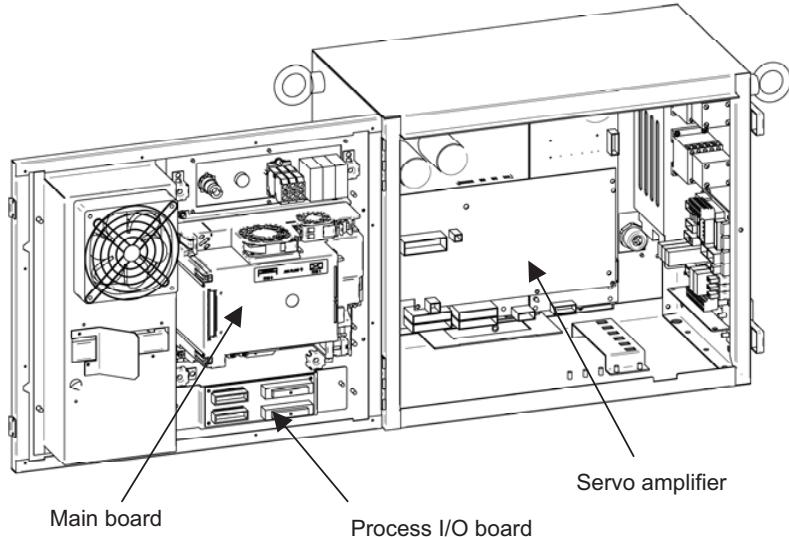


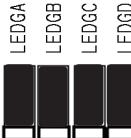
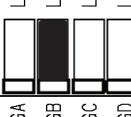
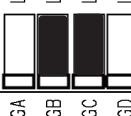
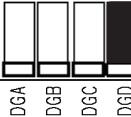
Fig.3.7 (a) Location of status LEDs

TROUBLESHOOTING USING THE LEDs ON THE MAIN BOARD

(1) Troubleshooting using the status display LED

To troubleshoot an alarm that arises before the teach pendant is ready to display, check the status LEDs (green) on the main board at power-on. After power-on, the LEDs light as described in steps 1 to end, in the order described. If an alarm is detected, the step in which the alarm occurred can be determined from which LEDs are lit.

- : On
- : Off
- ☆ : Blink

| Step | LED | Action to be taken |
|--|---|---|
| 1: After power-on, all LEDs are lit. |  | [Action1] Replace the CPU card. * [Action2] Replace the main board. |
| 2: Software operation start-up. |  | [Action1] Replace the CPU card. * [Action2] Replace the main board. |
| 3: The initialization of dram on the CPU card is completed. |  | [Action1] Replace the CPU card. * [Action2] Replace the main board. |
| 4: The initialization of DPRAM on the communication IC is completed. |  | [Action1] Replace the CPU card. * [Action2] Replace the main board. * [Action3] Replace the FROM/SRAM module. |
| 5: The initialization of the communication IC is completed. |  | [Action1] Replace the CPU card. * [Action2] Replace the main board. * [Action3] Replace the FROM/SRAM module. |
| 6: The loading of the basic software is completed. |  | * [Action1] Replace the main board. * [Action2] Replace the FROM/SRAM module. |
| 7: Basic software start-up. |  | * [Action1] Replace the main board. * [Action2] Replace the FROM/SRAM module. |
| 8: Start-up of communication with the teach pendant. |  | * [Action1] Replace the main board. * [Action2] Replace the FROM/SRAM module. |

| Step | LED | Action to be taken |
|--|-----|---|
| 9: The loading of optional software is completed. | | * [Action1] Replace the main board. [Action2] Replace the process I/O board. |
| 10: DI/DO initialization | | * [Action1] Replace the FROM/SRAM module. * [Action2] Replace the main board. |
| 11: The preparation of the SRAM module is completed. | | [Action1] Replace the axis control card. * [Action2] Replace the main board. [Action3] Replace the servo amplifier. |
| 12: Axis control card initialization | | [Action1] Replace the axis control card. * [Action2] Replace the main board. [Action3] Replace the servo amplifier. |
| 13: Calibration is completed. | | [Action1] Replace the axis control card. * [Action2] Replace the main board. [Action3] Replace the servo amplifier. |
| 14: Start-up of power application for the servo system | | * [Action1] Replace the main board. |
| 15: Program execution | | * [Action1] Replace the main board. [Action2] Replace the process I/O board. |
| 16: DI/DO output start-up. | | * [Action1] Replace the main board. |
| 17: Initialization is terminated. | | Initialization has ended normally. |
| 18: Normal status | | Status LEDs 1 and 2 blink when the system is operating normally. |

* If the main board or FROM/SRAM module is replaced, the contents of memory (parameters, specified data, etc.) will be lost. Before you replace the unit, therefore, make a backup copy of the data.

If an alarm is issued, data backup may be disabled. So, back up the contents of memory routinely.

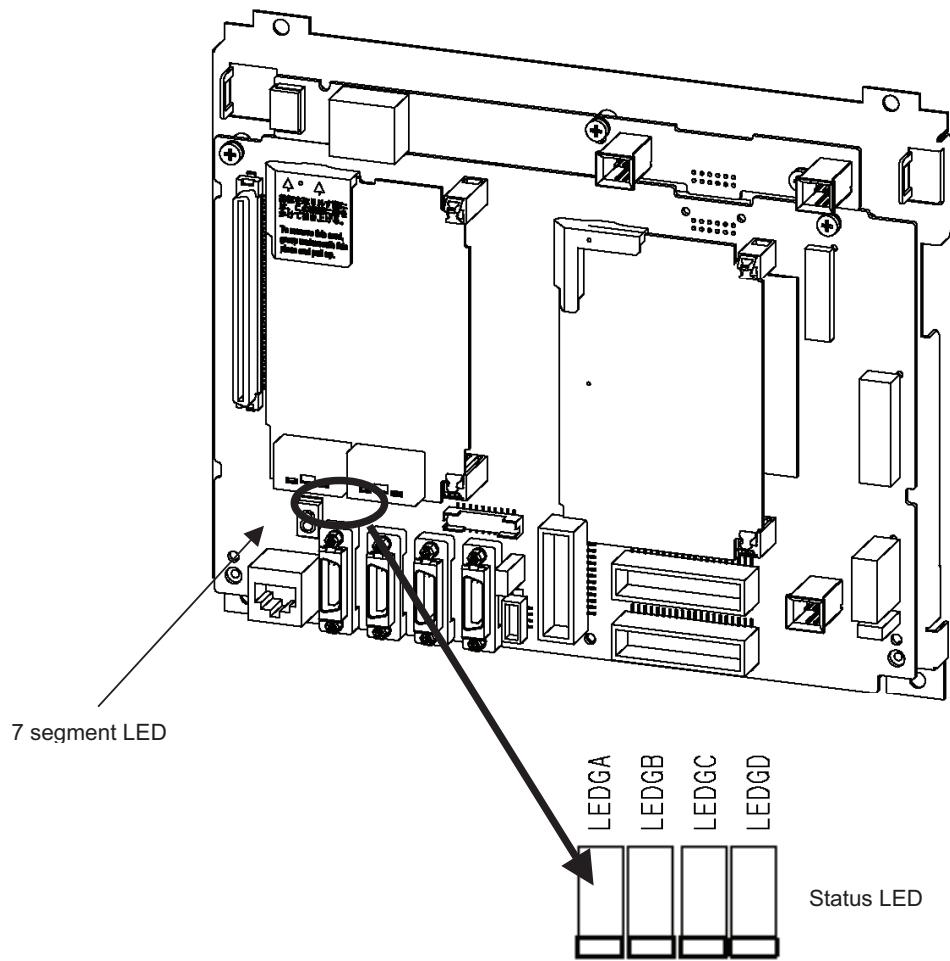


Fig.3.7 (b) LED status on the main board

(2) TROUBLESHOOTING BY 7-SEGMENT LED INDICATOR

| 7-segment LED indicator | Description |
|---|--|
|  | [Description] A parity alarm condition has occurred in DRAM on the CPU card installed on the main board. [Action1] Replace the CPU card. * [Action2] Replace the main board. |
|  | [Description] A parity alarm condition has occurred in SRAM on the FROM/SRAM module installed on the main board. [Action1] Replace the FROM/SRAM module. * [Action2] Replace the main board. |
|  | [Description] A bus error has occurred in the communication controller. * [Action] Replace the main board. |
|  | [Description] A parity alarm condition has occurred in DRAM controlled by the communication controller. * [Action] Replace the main board. |
|  | [Description] A servo alarm condition has occurred on the main board. [Action1] Replace the axis control card. * [Action2] Replace the main board. |
|  | [Description] The SYSEMG alarm has occurred. [Action1] Replace the axis control card. [Action2] Replace the CPU card. * [Action3] Replace the main board. |
|  | [Description] The SYSFAIL alarm has occurred. [Action1] Replace the axis control card. [Action2] Replace the CPU card. * [Action3] Replace the main board. |
|  | [Description] 5V is supplied to Main board. Above alarms do not occur. |

* If the main board or FROM/SRAM module is replaced, the contents of memory (parameters, specified data, etc.) will be lost. Before you replace the unit, therefore, make a backup copy of the data. If an alarm is issued, data backup may be disabled. So, back up the contents of memory routinely.

Troubleshooting by LEDs on servo amplifier

The servo amplifier has alarm LEDs. Troubleshoot the alarm indicated by the LEDs, referring also to the alarm indication on the teach pendant.

Check that the voltage is not higher than 50V.

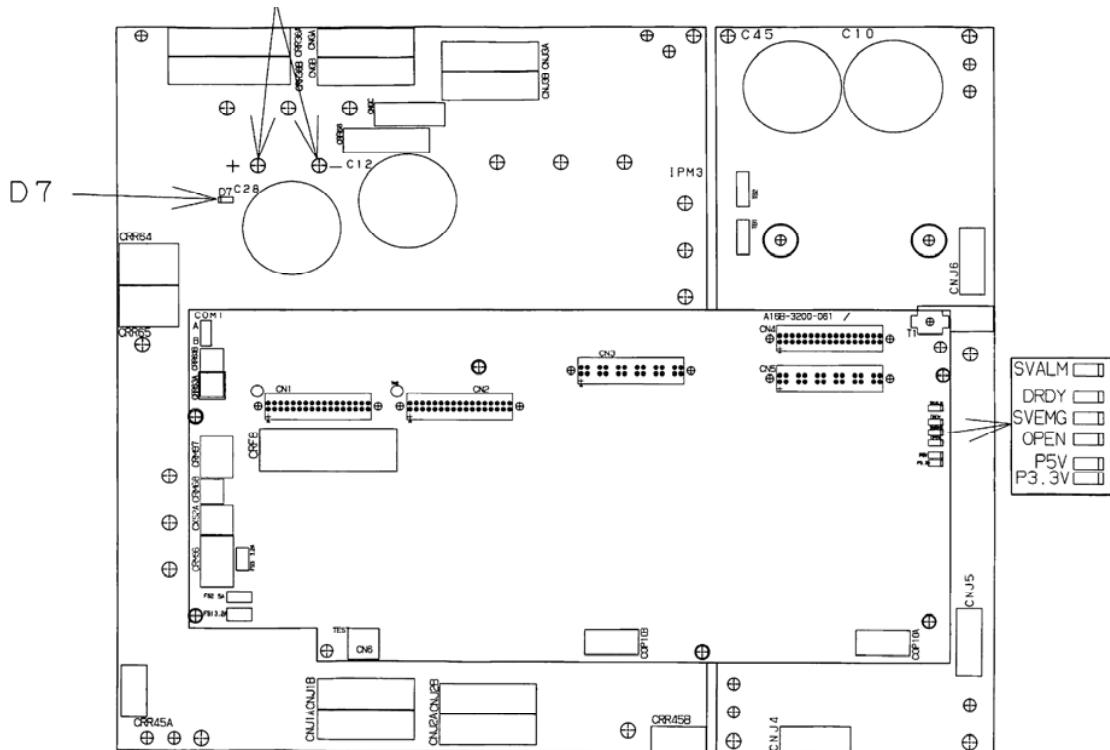


Fig.3.7 (c) LED status on the servo amplifier

⚠ WARNING

Before touching the servo amplifier, check the DC link voltage with the screws located above the LED "D7". By using a DC voltage tester, check that the voltage is 50 V or less.

| LED | Color | Description |
|-------|-------|--|
| P5V | Green | <p>Lights when the power supply circuit inside the servo amplifier outputs a voltage of +5 V normally.</p> <p><u>If the LED does not light:</u></p> <p>[Measure 1] Check the robot connection cable (RMP) to see if there is a ground fault in the +5V wire.</p> <p>[Measure 2] Replace the servo amplifier.</p> |
| P3.3V | Green | <p>Lights when the power supply circuit inside the servo amplifier outputs a voltage of +3.3 V normally.</p> <p><u>If the LED does not light:</u></p> <p>[Measure] Replace the servo amplifier.</p> |
| SVEMG | Red | <p>Lights when an emergency stop signal is input to the servo amplifier.</p> <p><u>If the LED lights when the machine is not at an emergency stop:</u></p> <p>[Measure] Replace the servo amplifier.</p> <p><u>If the LED does light when the machine is at an emergency stop:</u></p> <p>[Measure] Replace the servo amplifier.</p> |

| LED | Color | Description |
|------|-------|--|
| ALM | Red | <p>Lights when the servo amplifier detects an alarm.</p> <p><u>If the LED lights when there is no alarm condition in the machine:</u></p> <p>[Measure] Replace the servo amplifier.</p> <p><u>If the LED does not light when there is an alarm condition in the machine:</u></p> <p>[Measure] Replace the servo amplifier.</p> |
| DRDY | Green | <p>Lights when the servo amplifier is ready to drive the servo motor.</p> <p><u>If the LED does not light when the motor is activated:</u></p> <p>[Measure] Replace the servo amplifier.</p> |
| OPEN | Green | <p>Lights when the communication between the servo amplifier and the main board is normal.</p> <p><u>If the LED does not light:</u></p> <p>[Measure 1] Check for the connection of the FSSB optical cable.</p> <p>[Measure 2] Replace the servo card.</p> <p>[Measure 3] Replace the servo amplifier.</p> |
| D7 | Red | <p>Lights when the DCLINK circuit inside the servo amplifier is charged to reach the specified voltage.</p> <p><u>If the LED does not light after pre-charge is finished:</u></p> <p>[Measure 1] It is likely that the DC Link may be short-circuited. Check for connection.</p> <p>[Measure 2] It is likely that the charge current control resistor may be defective. Replace the emergency stop unit.</p> <p>[Measure 3] Replace the servo amplifier.</p> |

Troubleshooting by LEDs on Process I/O board

| LED | Color | Description |
|------|-------|--|
| ALM1 | Red | <p>[Explanation] An alarm was issued during communication between the main board and the process I/O board.</p> <p>[Measure 1] Replace the process I/O board.</p> <p>[Measure 2] Replace the I/O link connection cable.</p> <p>[Measure 3] Replace the main board.</p> |
| FALM | Red | <p>[Explanation] The fuse on the process I/O board was blown.</p> <p>[Measure 1] Replace the fuse on the process I/O board.</p> <p>[Measure 2] Check the cables and peripheral units connected to the process I/O board and replace the defective units.</p> <p>[Measure 3] Replace the process I/O board.</p> |

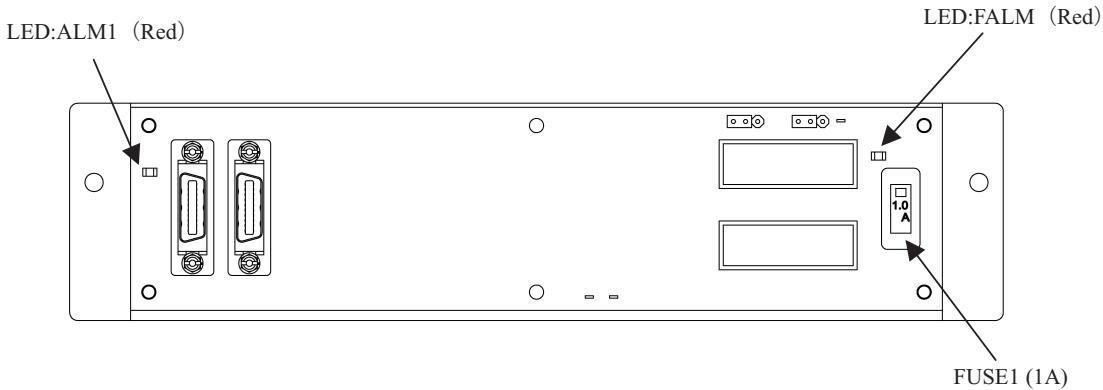


Fig.3.7 (d) LED status on the process I/O board MA

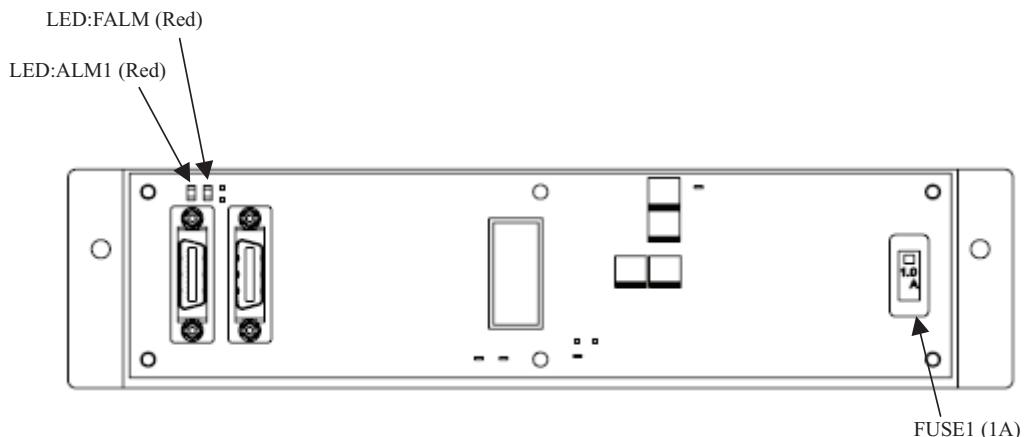


Fig.3.7 (e) Fuse on the process I/O board MB

3.8 POSITION DEVIATION FOUND IN RETURN TO THE REFERENCE POSITION (POSITIONING)

(Check 1) On the status screen, check the position deviation in the stopped state. To display the position deviation, press the screen selection key, and select STATUS from the menu. Press F1, [TYPE], select AXIS from the menu, then press the F4, PULSE.

(Corrective action)

Correct the parameters related to return to the reference position (positioning).

(Check 2) Check whether the motor axis can be positioned normally.

(Corrective action)

If the motor axis can be positioned normally, check the mechanical unit.

(Check 3) Check the mechanical unit for backlash.

(Corrective action)

Replace a faulty key of motor shaft or other faulty parts.

(Check 4) If checks 1 to 3 show normal results.

(Corrective action)

Replace the Pulsecoder and main board.

* If the main board or FROM/SRAM module is replaced, the contents of memory (parameters, specified data, etc.) will be lost. Before you replace the unit, therefore, make a backup copy of the data.

3.9 MANUAL OPERATION IMPOSSIBLE

The following explains checking and corrective action required if the robot cannot be operated manually after the controller is turned on:

(1) Check and corrective action to be made if manual operation is impossible

(Check 1) Check whether the mode switch is set to T1/T2 mode.

(Corrective action)

Change the mode switch to T1/T2 mode.

(Check 2) Check whether the teach pendant is enabled.

(Corrective action)

Turn on the teach pendant "enable".

(Check 3) Check whether the teach pendant is handled correctly.

(Corrective action)

To move an axis by manual operation, press the axis selection key and shift key at the same time.

Set the override for manual feed to a position other than the FINE and VFINE positions.

(Check 4) Check whether the ENBL signal of the peripheral device control interface is on.

(Corrective action)

Place the peripheral device control interface in the ENBL status.

(Check 5) Check whether the HOLD signal of the peripheral device control interface (hold status).

(Check whether the hold lamp on the teach pendant is on.)

(Corrective action)

Turn off the HOLD signal of the peripheral device control interface.

(Check 6) Check whether the previous manual operation has been completed.

(Corrective action)

If the robot cannot be placed in the effective area because of the offset of the speed command voltage preventing the previous operation from being completed, check the position deviation on the status screen, and change the setting.

(Check 7) Check whether the controller is in the alarm status.

(Corrective action)

Release the alarm.

(2) Check and corrective action to be taken if the program cannot be executed

(Check 1) Check whether the mode switch is set to AUTO mode when the program is started externally.

(Corrective action)

Change the mode switch to AUTO mode.

(Check 2) Check whether the mode switch is set to T1/T2 mode when the program is started from the teach pendant.

(Corrective action)

Change the mode switch to T1/T2 mode.

(Check 3) Check whether the start conditions are satisfied.

(Corrective action)

Check the start condition table given in the safety precautions.

(Check 4) Check whether the ENBL signal for the peripheral-device control interface is on.

(Corrective action)

Put the peripheral-device control interface in the ENBL state.

(Check 5) Check whether the HOLD signal for the peripheral-device control interface is on. Also check whether the HOLD lamp on the teach pendant is on.

(Corrective action)

If the HOLD signal of the peripheral device control interface is on, turn it off.

(Check 6) Check whether the previous manual operation has been completed.

(Corrective action)

If the robot cannot be placed in the effective area because of the offset of the speed command voltage, which prevents the previous operation from being completed, check the position deviation on the status screen, then change the setting.

(Check 7) Check whether the controller is in the alarm status.

(Corrective action)

Release the alarm.

4 PRINTED CIRCUIT BOARDS

The printed circuit boards are factory-set for operation. Usually, you do not need to set or adjust them. This chapter describes the standard settings and adjustment required if a defective printed circuit board is replaced. It also describes the test pins and the LED indications.

The controller printed circuit board includes the main unit printed circuit board and one or more cards or modules installed horizontally to the main-unit printed-circuit board.

These PC boards have interface connectors, LED indicators, and a plastic panel at the front. At the rear, there is a backplane connector.

4.1 MAIN BOARD

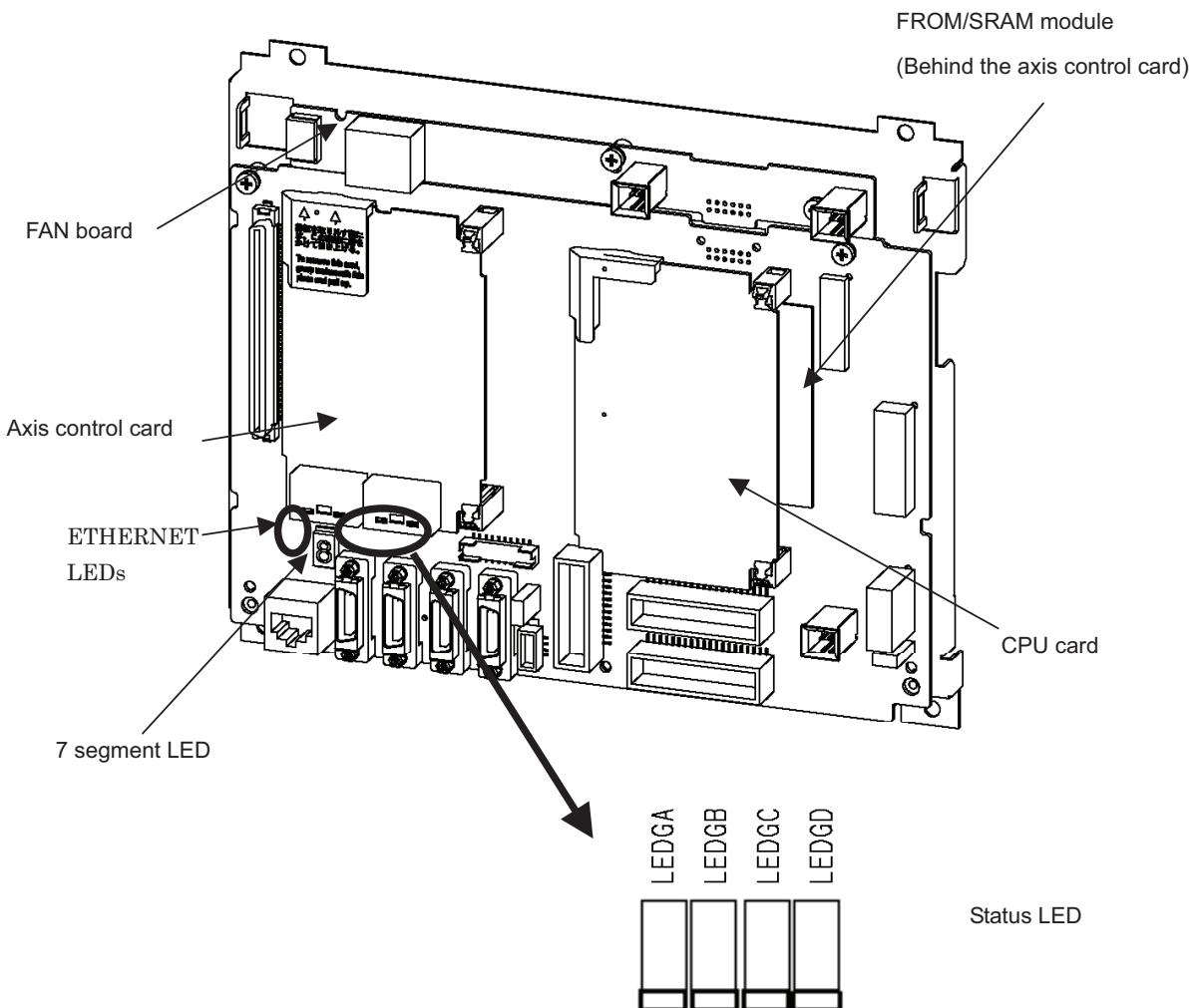
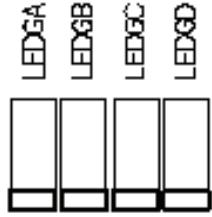


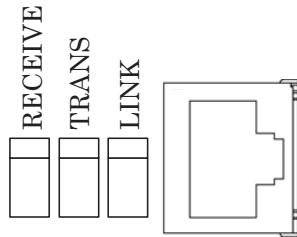
Fig.4.1 Main board

| Name | Ordering Specification | Board Specification | Note |
|-------------------|------------------------|---------------------|----------------------|
| Main board | A05B-2550-H001 | A20B-8200-0470 | Standard |
| | A05B-2550-H002 | A20B-8200-0471 | Vision |
| | A05B-2550-H003 | A20B-8200-0472 | Vision, Force sensor |
| CPU card | A05B-2550-H020 | A20B-3400-0020 | DRAM 32M |
| | A05B-2550-H021 | A20B-3400-0021 | DRAM 64M |
| Axis control card | A05B-2550-H040 | A20B-3300-0448 | 8-axis |
| | A05B-2550-H041 | A20B-3300-0447 | 12-axis |
| | A05B-2550-H042 | A20B-3300-0442 | 16-axis |
| FROM/SRAM module | A05B-2550-H060 | A20B-3900-0223 | FROM 32M/ SRAM 1M |
| | A05B-2550-H061 | A20B-3900-0224 | FROM 32M/ SRAM 2M |
| | A05B-2550-H062 | A20B-3900-0225 | FROM 32M/ SRAM 3M |
| | A05B-2550-H063 | A20B-3900-0226 | FROM 64M/ SRAM 1M |
| | A05B-2550-H064 | A20B-3900-0227 | FROM 64M/ SRAM 2M |
| | A05B-2550-H065 | A20B-3900-0228 | FROM 64M/ SRAM 3M |
| FAN board | A05B-2550-H001 | A20B-8002-0639 | |
| | A05B-2550-H002 | | |

(1) LEDs

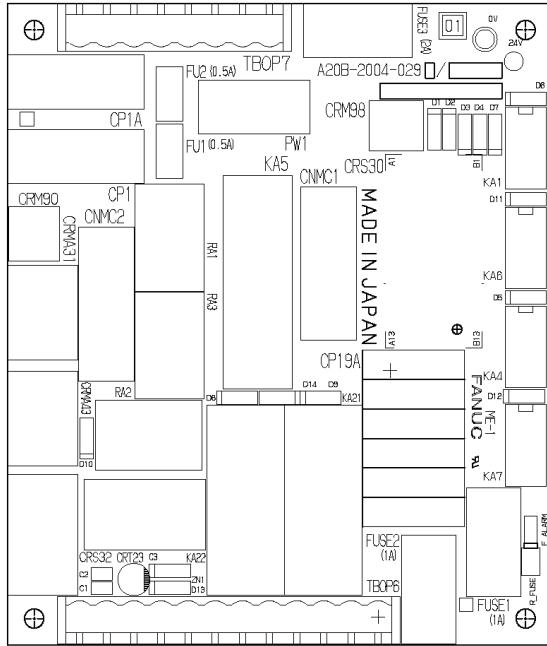
| Seven segment LED | Description |
|---|--|
|  | A parity alarm occurred in a DRAM of the CPU card on the main board. |
|  | A parity alarm occurred in a SRAM of the FROM/SRAM module on the main board. |
|  | Bus error occurred on the communication controller. |
|  | A parity alarm occurred in DRAM controlled by communication controller. |
|  | A servo alarm occurred on the main board. |
|  | SYSEMG occurred. |
|  | SYSFAIL occurred. |
|  | 5V is supplied to Main board. Above 0-7 alarms do not occur. |

| Status LED | Description |
|---|---------------------------------|
|  | Operating status of the system. |

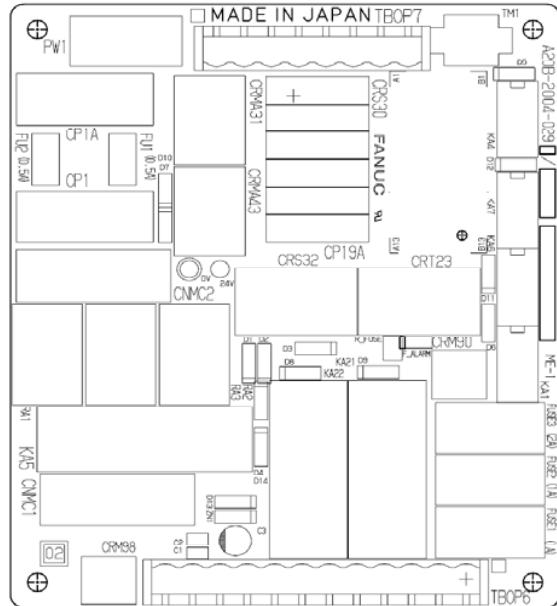


| ETHERNET LED | Color | Description |
|--------------|-------|------------------------------------|
| RECEIVE | Green | Blinks when data is received. |
| TRANS | Green | Flashes during data transmission. |
| LINK | Green | Lights when a link is established. |

4.2 EMERGENCY STOP BOARD (A20B-2004-0290)



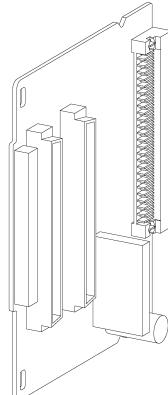
(Edition 01A)



(Edition 02B or later)

Fig.4.2 E-stop board

4.3 BACKPLANE BOARD (A20B-8101-0580)



(Backplane board)

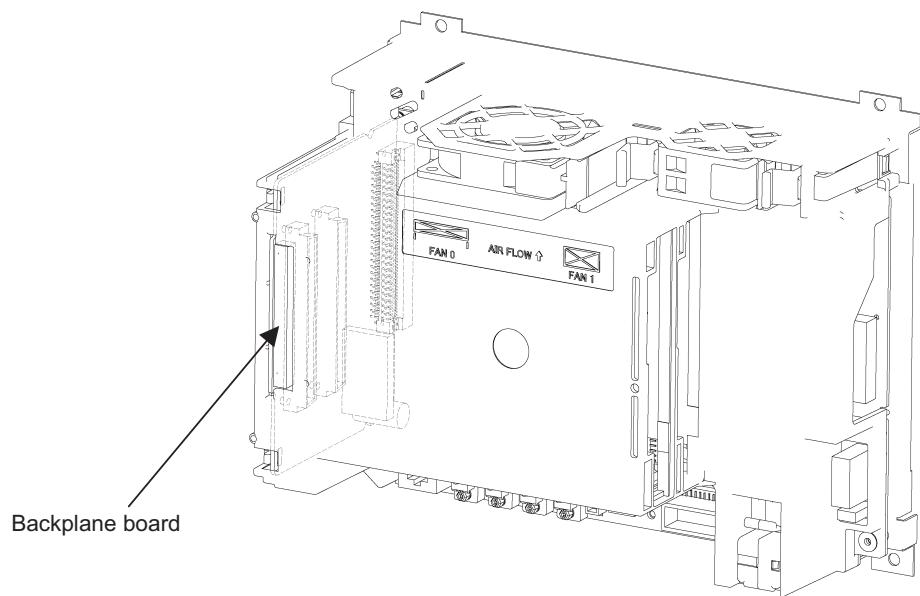


Fig.4.3 Backplane Board

4.4 PROCESS I/O BOARD MA (A20B-2004-0380)

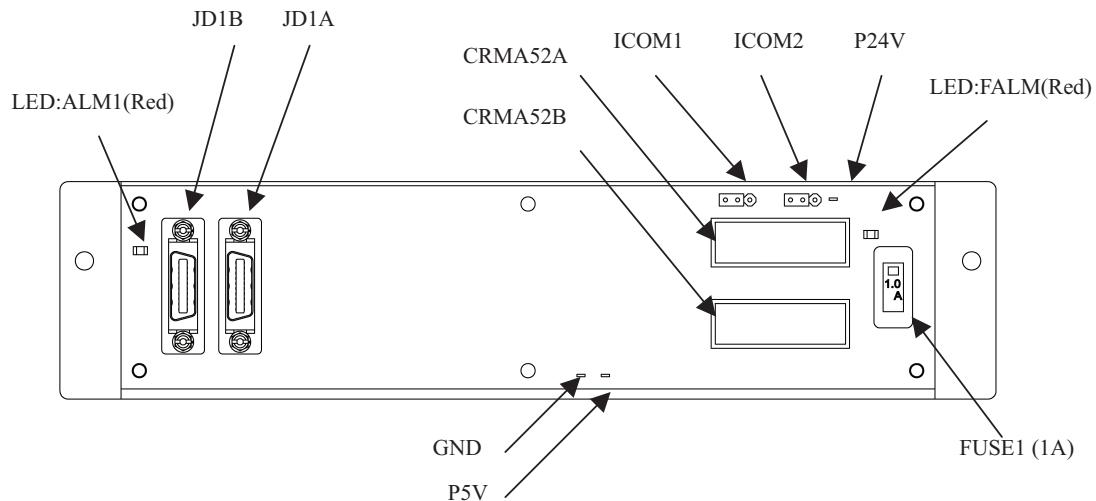


Fig.4.4 Process I/O board MA

(1) Test pins

| Name | Use |
|------|-------------------------------------|
| P24V | +24V |
| P5V | +5V |
| GND | GND |
| | For measuring the DC supply voltage |

(2) Settings

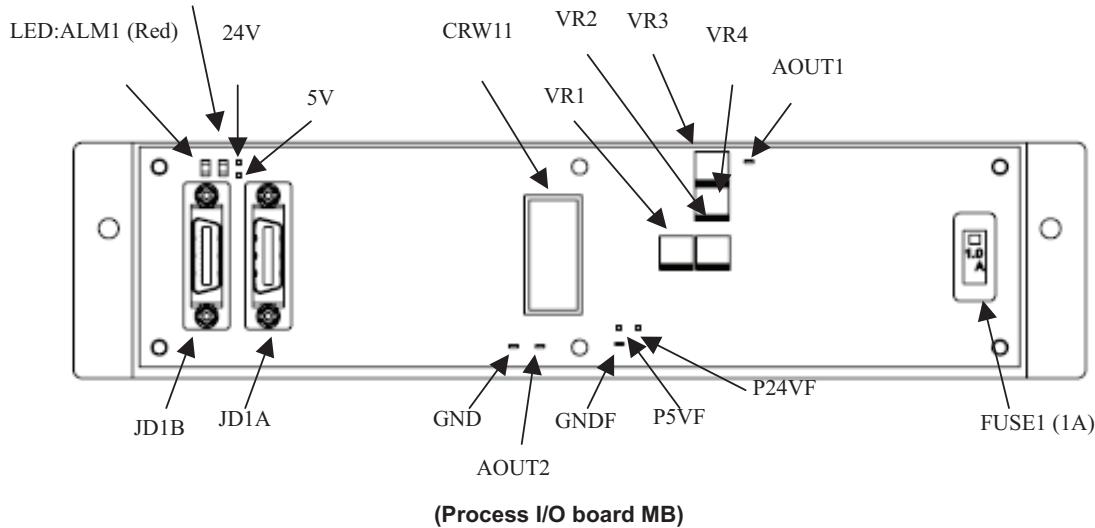
| Name | | Standard setting | Description |
|-------|----------------------------------|------------------|---|
| ICOM1 | UDI1- 10 (Connector CRMA52A) | Side A | For common voltage setting Side A: +24V common |
| ICOM2 | UDI11- 20 (Connector CRMA52B) | | Side B: 0V common |

(3) LEDs

| Name | Color | Description |
|------|-------|--|
| ALM1 | Red | A communication alarm occurred between the main CPU and process I/O board. |
| FALM | Red | The fuse (FUSE1) on the process I/O board has blown. |

4.5 PROCESS I/O BOARD MB (A20B-2101-0730)

LED:FALM (Red)



(1) Test pins and pads

| Name | | Use |
|-------|-----------|--|
| 24V | +24V | |
| 5V | +5V | |
| GND | GND | For measuring the DC supply voltage |
| P24VF | +24V | |
| P5VF | +5V | |
| GNDF | GND | D/A converter power supply |
| AOUT1 | Channel 1 | For analog output signal (D/A) voltage measurement |
| AOUT2 | Channel 2 | |

(2) Adjustment

VR1/VR2 Channel 1 gain and offset adjustment

Connect the "+" and "-" terminals of a digital voltmeter, respectively, to the AOUT1 check pin and the GNDF check pin (not a general ground point). From the teach pendant, execute AOUT [1]=3413, using a robot program. While observing the voltage at the AOUT1 check pin with the digital voltmeter, adjust potentiometers VR1 and VR2 for 15.0V.

VR3/VR4 Channel 2 gain and offset adjustment

Connect the “+” and “-” terminals of a digital voltmeter, respectively, to the AOUT2 check pin and the GND check pin (not a general ground point). From the teach pendant, execute AOUT [2]=3413, using a robot program. While observing the voltage at the AOUT2 check pin with the digital voltmeter, adjust potentiometers VR3 and VR4 for 15.0V.

(3) LEDs

| Name | Color | Description |
|------|-------|--|
| ALM1 | Red | A communication alarm occurred between the main CPU and process I/O board. |
| FALM | Red | The fuse (FUSE1) on the process I/O board has blown. |

4.6 CONNECTOR CONVERTER BOARD (A20B-2004-0410)

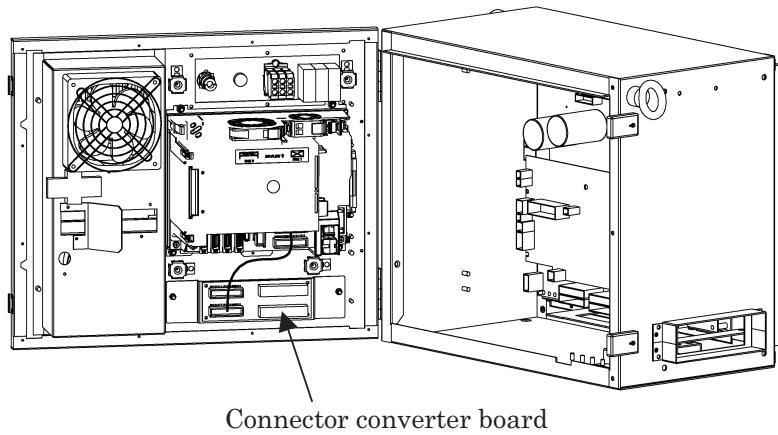
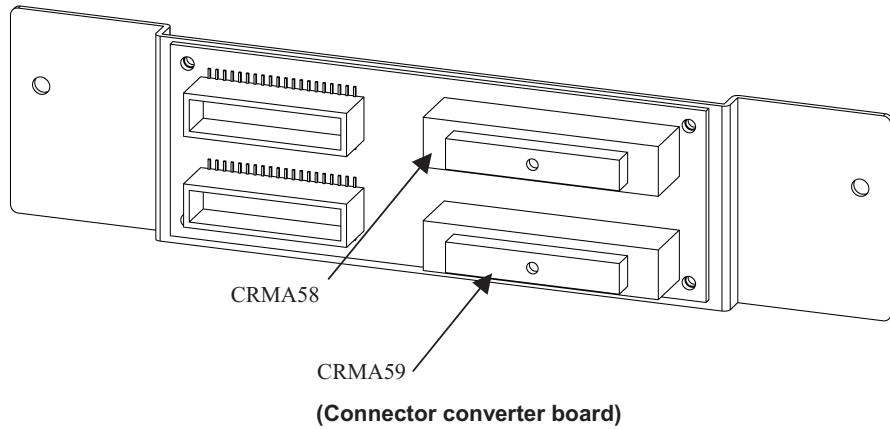


Fig.4.6 Location of the Connector converter board

5 SERVO AMPLIFIERS

The servo amplifiers are factory-set for operation. Usually, you do not need to set or adjust them. This chapter describes the standard settings and adjustment required if a defective servo amplifier is replaced. It also describes the use of test pins and meanings of the LED indications.

Table 5 Servo amplifier specifications

| Robot | Servo amplifier | Regenerative resistor |
|------------------------|------------------------|------------------------------|
| LR Mate 200iC | A06B-6107-H005 | A05B-2550-C050 |
| M-1iA | A06B-6107-H005 | A05B-2550-C050 |
| ARC Mate 50iC | A06B-6107-H005 | A05B-2550-C051 |
| ARC Mate 100iC, M-10iA | A06B-6107-H004 | A05B-2550-C051 |
| ARC Mate 120iC, M-20iA | A06B-6107-H002 | A05B-2550-C052 |

Check that the voltage is not higher than 50V.

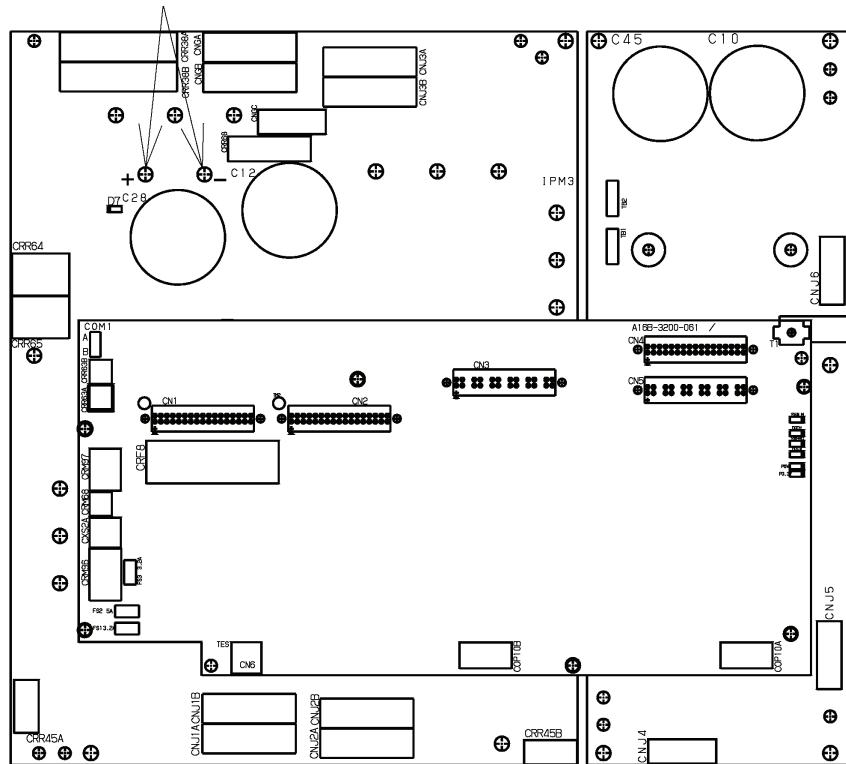


Fig.5 Servo amplifier

! WARNING

Before touching the servo amplifier, check the DC link voltage with the screws located above the LED "D7". By using a DC voltage tester, check that the voltage is 50 V or less.

5.1 LED OF SERVO AMPLIFIER

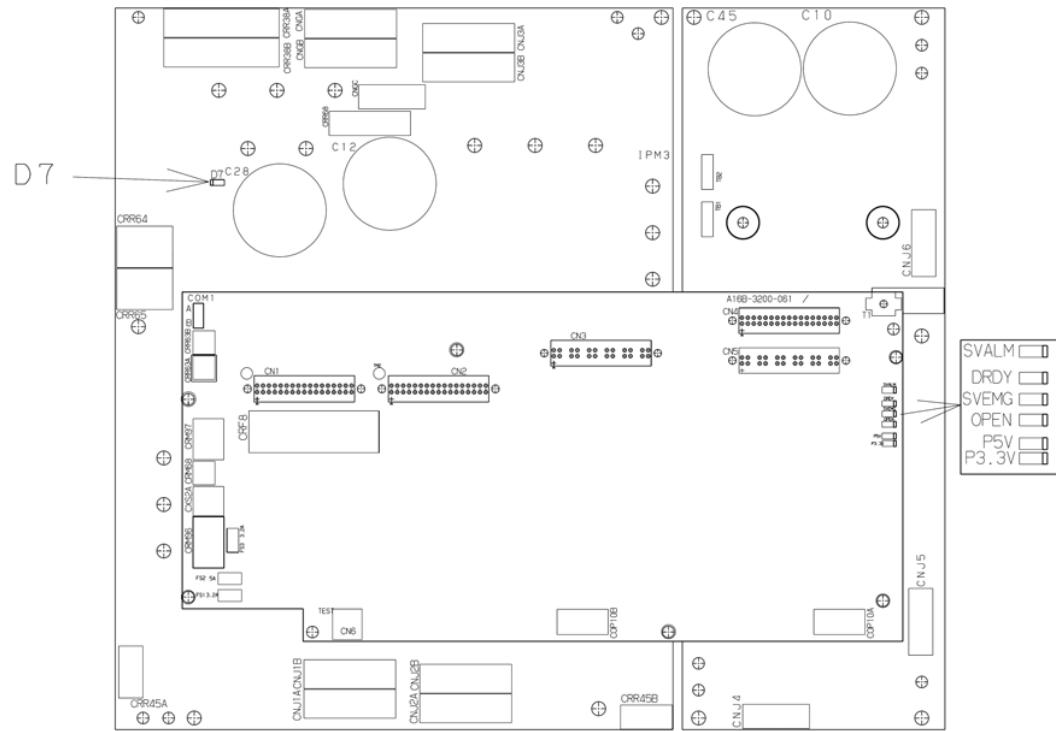


Fig.5.1 LED of servo amplifier

| LED | Color | Description |
|-------|-------|---|
| P5V | Green | Lights when the power supply circuit inside the servo amplifier outputs a voltage of +5 V normally. |
| P3.3V | Green | Lights when the power supply circuit inside the servo amplifier outputs a voltage of +3.3 V normally. |
| SVEMG | Red | Lights when an emergency stop signal is input to the servo amplifier. |
| SVALM | Red | Lights when the servo amplifier detects an alarm. |
| DRDY | Green | Lights when the servo amplifier is ready to drive the servo motor. |
| OPEN | Green | Lights when the communication between the servo amplifier and the main board is normal. |
| D7 | Red | Lights when the DCLINK circuit inside the servo amplifier is charged to reach a specific voltage. |

5.2 SETTING OF SERVO AMPLIFIER

Table 5.2 Settings

| Name | Standard setting | Description |
|------|------------------|---|
| COM1 | Side A | Robot Digital Input (RI) device common voltage. Side A: +24V common Side B: 0V common |

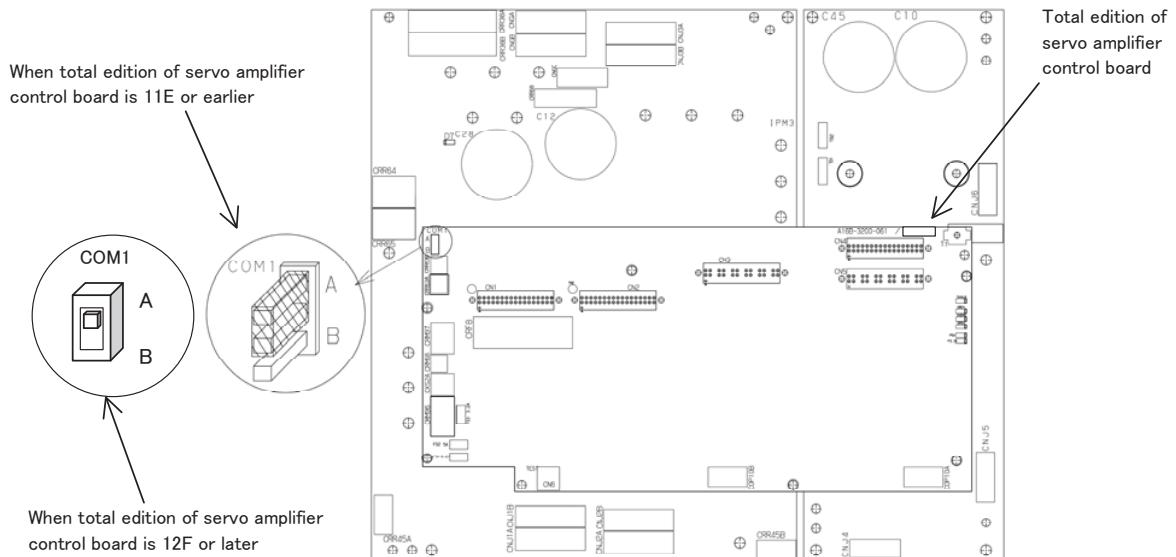


Fig.5.2 (a) Setting of servo amplifier

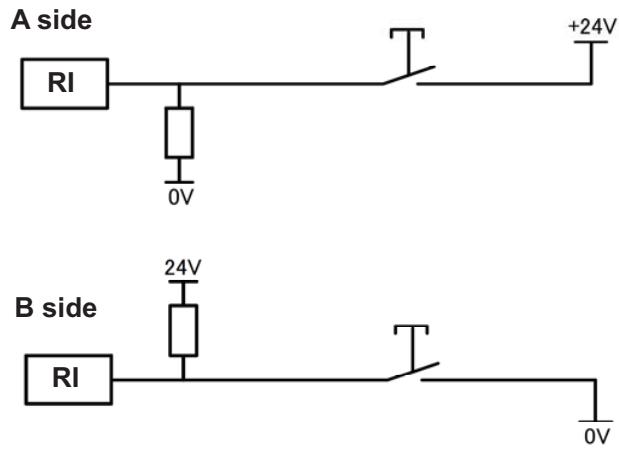


Fig.5.2 (b) Circuit based on jumper pin location or setting of switch

6

SETTING THE POWER SUPPLY

Setting and adjustment of the power supply is factory-set for operation. Usually, you do not need to set or adjust it.

6.1 BLOCK DIAGRAM OF THE POWER SUPPLY

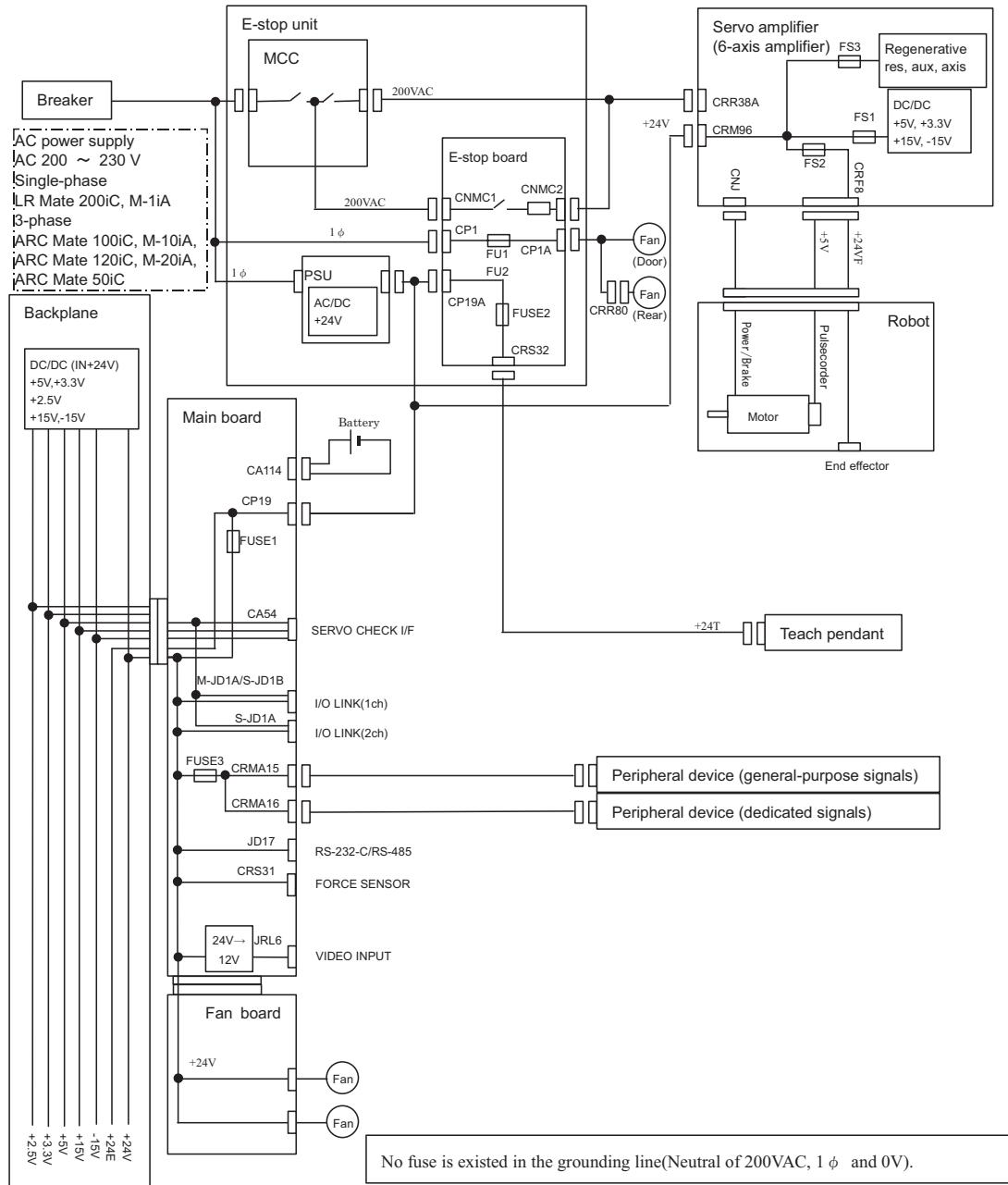


Fig. 6.1 Block diagram of the power supply

6.2 CHECKING THE POWER SUPPLY

The power supply need not be set or adjusted.

Table 6.2 Rating of the Power supply

| Output | Rated voltage | Tolerance |
|--------|---------------|-----------|
| +5V | +5.1V | ±3% |
| +3.3V | +3.3V | ±3% |
| +2.5V | +2.5V | ±3% |
| +24V | +24V | ±5% |
| +24E | +24V | ±5% |
| +15V | +15V | ±10% |
| -15V | -15V | ±10% |

7

REPLACING A UNIT

This section explains how to replace each unit in the control section.

⚠ WARNING

- 1 Before you start to replace a unit, turn off the controller main power. Also, keep all machines in the area of the controller switched. Otherwise, you could injure personnel or damage equipment.
- 2 Before replacing components, read the maintenance manual to understand the replacement procedure. Performing an incorrect replacement procedure can lead to an unpredictable accident, resulting in breakage in the robot or personal injury.
- 3 When a heavy component or unit is to be handled, support the workers with a crane or the like not to apply excessive loads to the workers. Note that incorrect handling can cause serious injury to the workers.

⚠ CAUTION

Components in the controller heat up, so care should be taken. When you have to touch a heated component, prepare a protector such as heat-resistant gloves.

7.1

REPLACING THE PRINTED-CIRCUIT BOARDS

⚠ CAUTION

When you replace printed-circuit boards, observe the following cautions:

- 1 Keep the controller power switched off.
- 2 When you remove a printed-circuit board, do not touch the semiconductor devices on the board with your hand or make them touch other components.
- 3 Make sure that the replacement printed-circuit board has been set up appropriately. (Setting plug etc.)
- 4 After replacing a printed-circuit board, make adjustments correctly if the board needs to be adjusted.
- 5 If the backplane board, power supply unit or main board (including cards and modules) is replaced, it is likely that robot parameters and taught data are lost. Before you start to replace these components, save a backup copy of the robot parameters and taught data to an external memory device.
- 6 Before you disconnect a cable, note its location. If a cable is detached for replacement, reconnect it exactly as before.

7.1.1 Replacing the Backplane Board (Unit)

Replace the backplane board together with the plastic case.

- (1) Remove the two screws fastening the case. (When cables are connected to option boards, detach the cables.)
- (2) Release the latches in the upper part on each side of the case from the base metal plate, and pull out the case. The case can be pulled out with the backplane board, fan, and battery installed in the case.

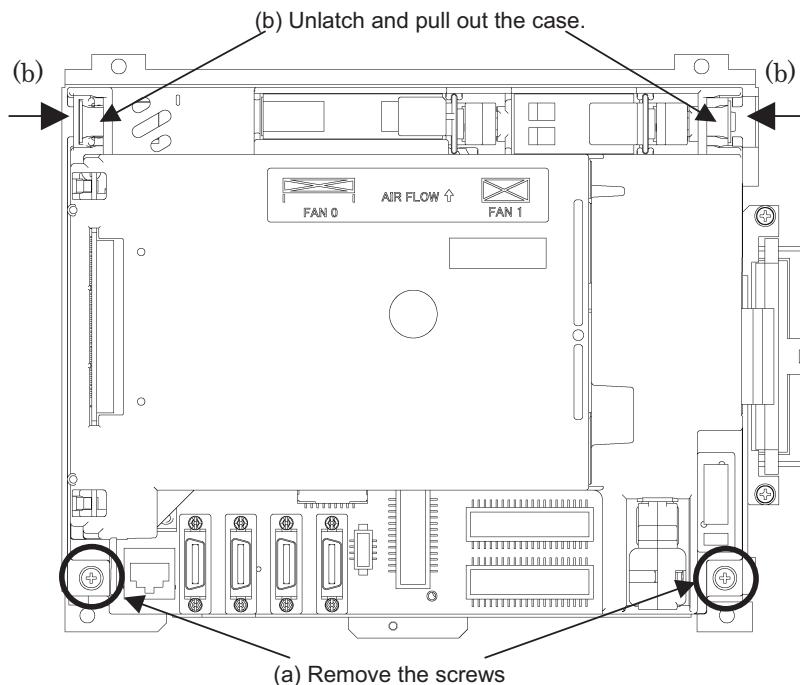


Fig.7.1.1 Replacing the backplane board

- (3) Replace the backplane unit with a new one.
- (4) Confirm that the screw and latch positions of the case are in place, and slowly set the case. When the case is attached, the backplane board installed in the case is connected to the main board with the connectors. When setting the case, check that the connectors are connected properly, and be careful not to apply excessive force.
- (5) After confirming that the case is surely latched, tighten the screws of the case. Lightly press the fan and battery, and make sure that the connectors are connected securely. (If the cables of option boards have been detached, connect the cables again.)

CAUTION

Be sure to back up all programs and a possibility of data loss when a backplane-mounted printed circuit board is replaced.

7.1.2 Replacing the Main board

The backplane unit incorporates the backplane board, main board, and option boards.

CAUTION

Before starting replacement, turn off the main power of the controller. The main board is equipped with battery-backed memory devices for holding robot parameters and taught data. When the main board is replaced, the memory contents are lost.

- (1) Remove the case. (See Subsection 7.1.1.)
- (2) Detach cables from the connectors on the main board, and remove the three screws fastening the main board. The main board and fan board are connected directly with connector CA115A. Detach the main board by sliding the main board downward.

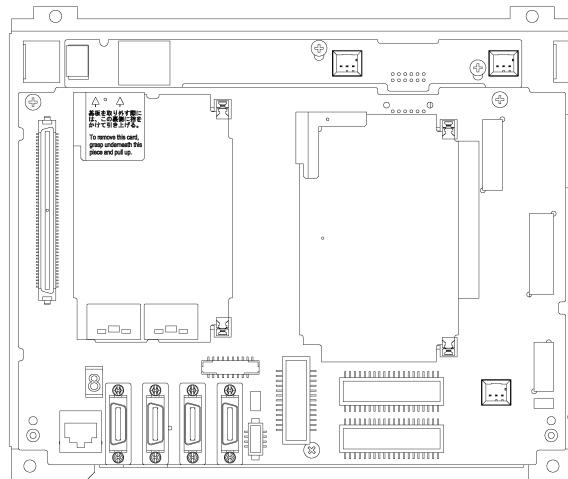


Fig.7.1.2 Replacing the main board

- (3) Replace the main board with a new one.
- (4) Install the case. (See Subsection 7.1.1.)

7.2 REPLACING CARDS AND MODULES ON THE MAIN BOARD

CAUTION

Before you start to replace a card or module, make a backup copy of robot parameters and taught data. If the FROM/SRAM module is replaced, SRAM memory contents are lost.

Demounting a Card

- (1) Pull up the spacer metal fitting.
- (2) A molded cover is attached to a corner of the servo card and CPU card although the shapes of the covers attached to the cards differ from each other. Insert a finger into the rear of the cover and pull up the cover slowly in the arrow direction shown in the figure below. (Note: At this time, hold the neighborhood of the main board on the opposite side with the other hand whenever possible. A force of 7 to 8 kgf is required for extraction. Be careful not to drop the card board due to the momentum of extraction.)

- (3) When one side of the card board is raised slightly by pulling up the cover, do not fully extract the card board, but push back the cover softly.
- (4) When the card board is pushed back to be parallel with the main board, pinch two sides of the card board and pull up the card board. This completes the extraction of the card board.

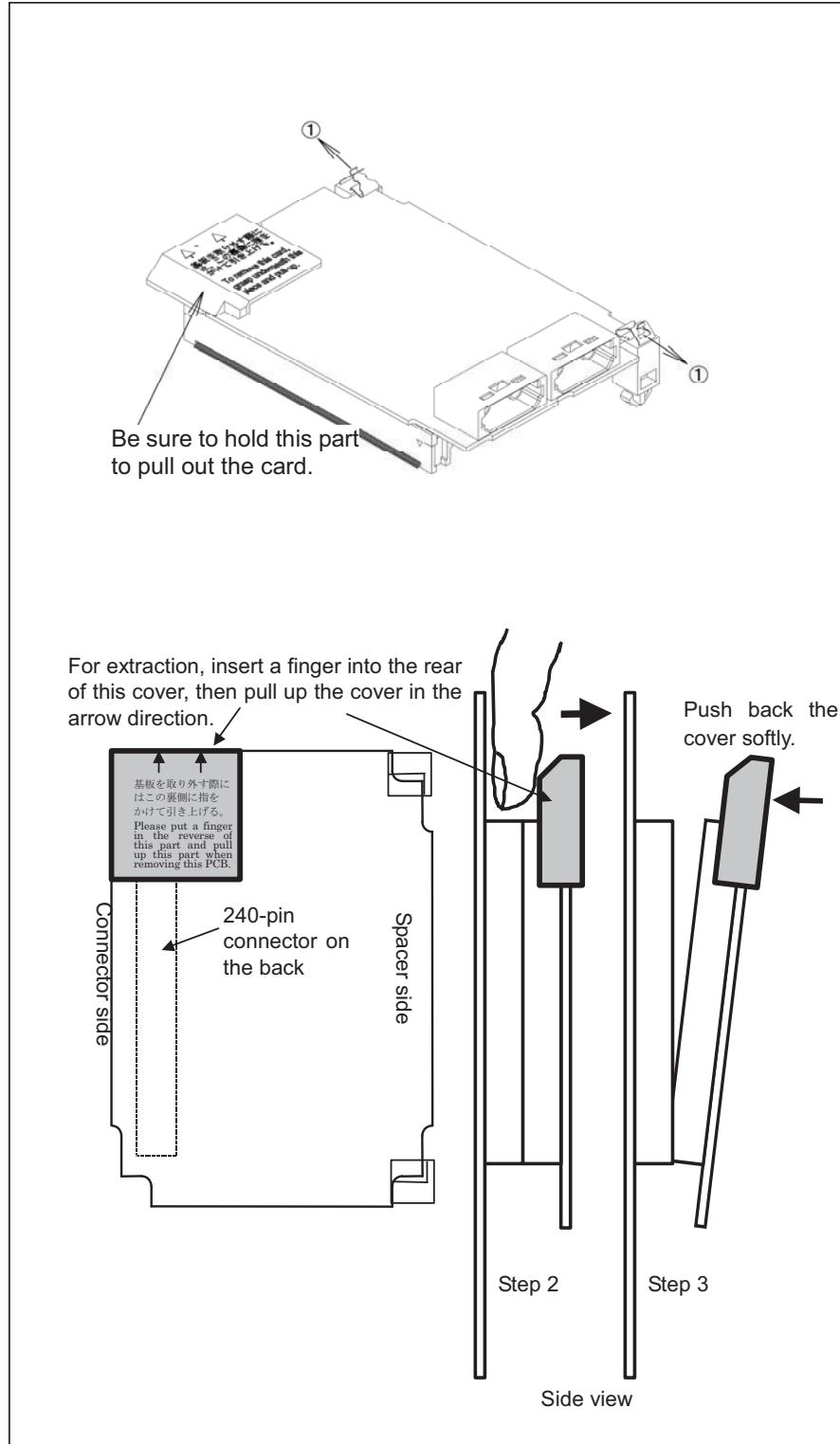


Fig. 7.2 (a) Demounting the card on the main board

Mounting a Card

- (1) Check that the metal fittings of the spacers are raised.
- (2) To align the card board insertion position, touch the spacer fixing end faces of the card board with the spacers as shown in the figure below. (At this time, the board can be touched with the spacers for easier position alignment by slightly holding up the connector side and lowering the spacer side only.)
- (3) While aligning the card board with the spacers, lower the connector side slowly then cause the connectors to touch each other.
- (4) The mating position can be determined more easily by moving the card board back and forth slightly in the arrow direction.
- (5) Push the connector side of the card board slowly. At this time, push the card board against the board on the rear side of the connector. The force required for connector insertion is about 10 kgf. If the connector cannot be mated by a force of about 10 kgf or more, the card board may be aligned incorrectly, and the connector can break. In this case, realign the card board. (Note: Do not press the radiation fin installed on a CPU and LSI chip. Otherwise, the radiation fin can break.)
- (6) Push in the spacer metal fittings.

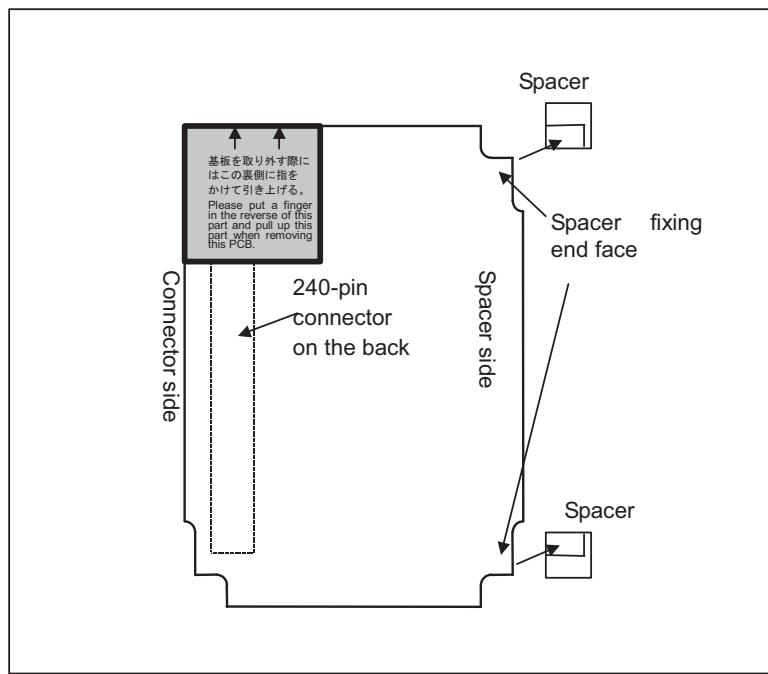


Fig. 7.2 (b) Mounting the card on the main board

Demounting a module

⚠ CAUTION

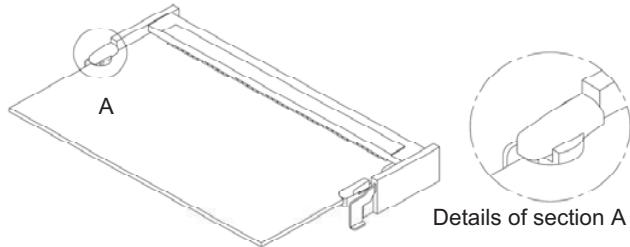
When replacing the module, be careful not to touch the module contact. If you touch the contact inadvertently, wipe out dirt on the contact with a clean cloth.

- (1) Move the clip of the socket outward. (a)
- (2) Extract the module by raising it at a 30-degree slant and pulling outward.

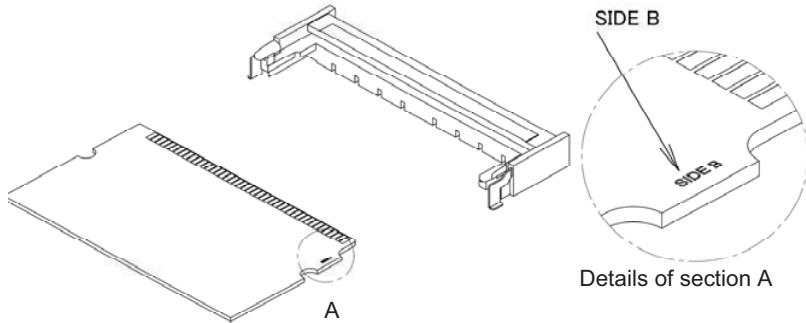
Mounting a module

- (1) Insert the module at a 30-degree slant into the module socket, with side B facing upward. (b)
- (2) Push the module inward and downward until it is locked. (c)

(a)



(b)



(c)

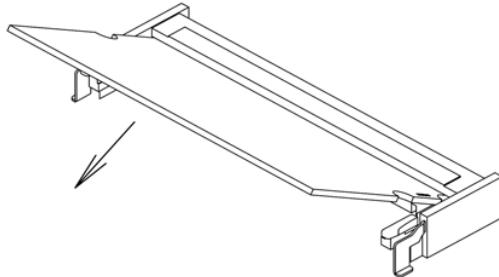


Fig.7.2 (c) Demounting/mounting a module

Fig.7.2 (d) shows the locations of the cards and modules.

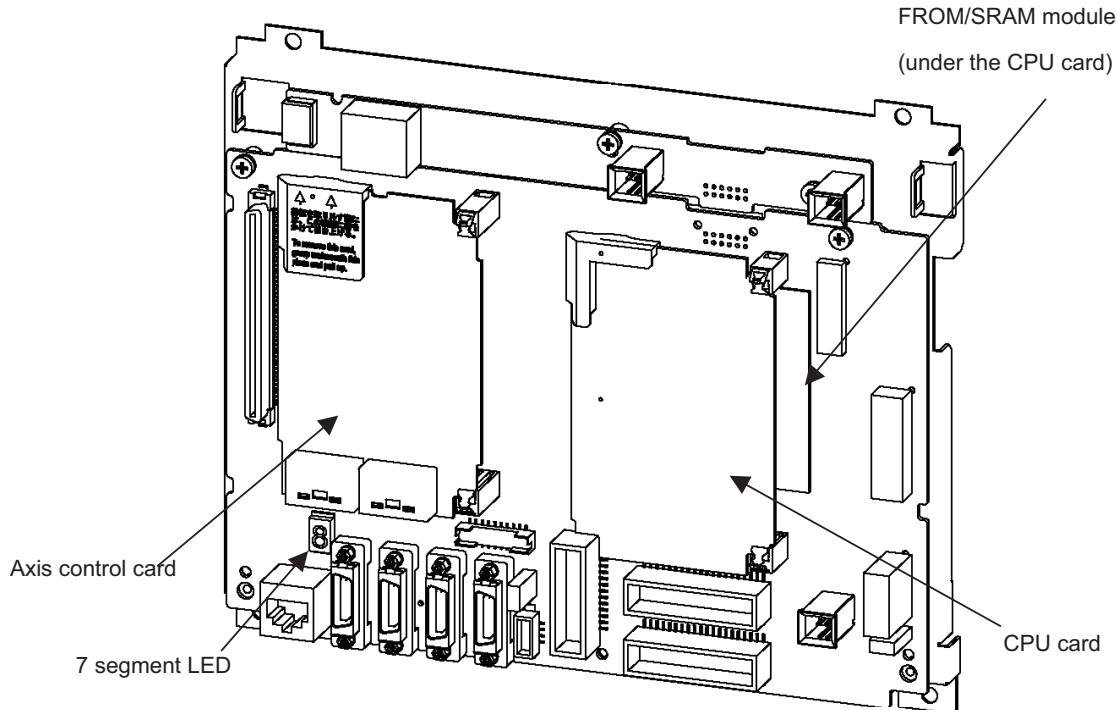


Fig.7.2 (d) Locations of cards and modules

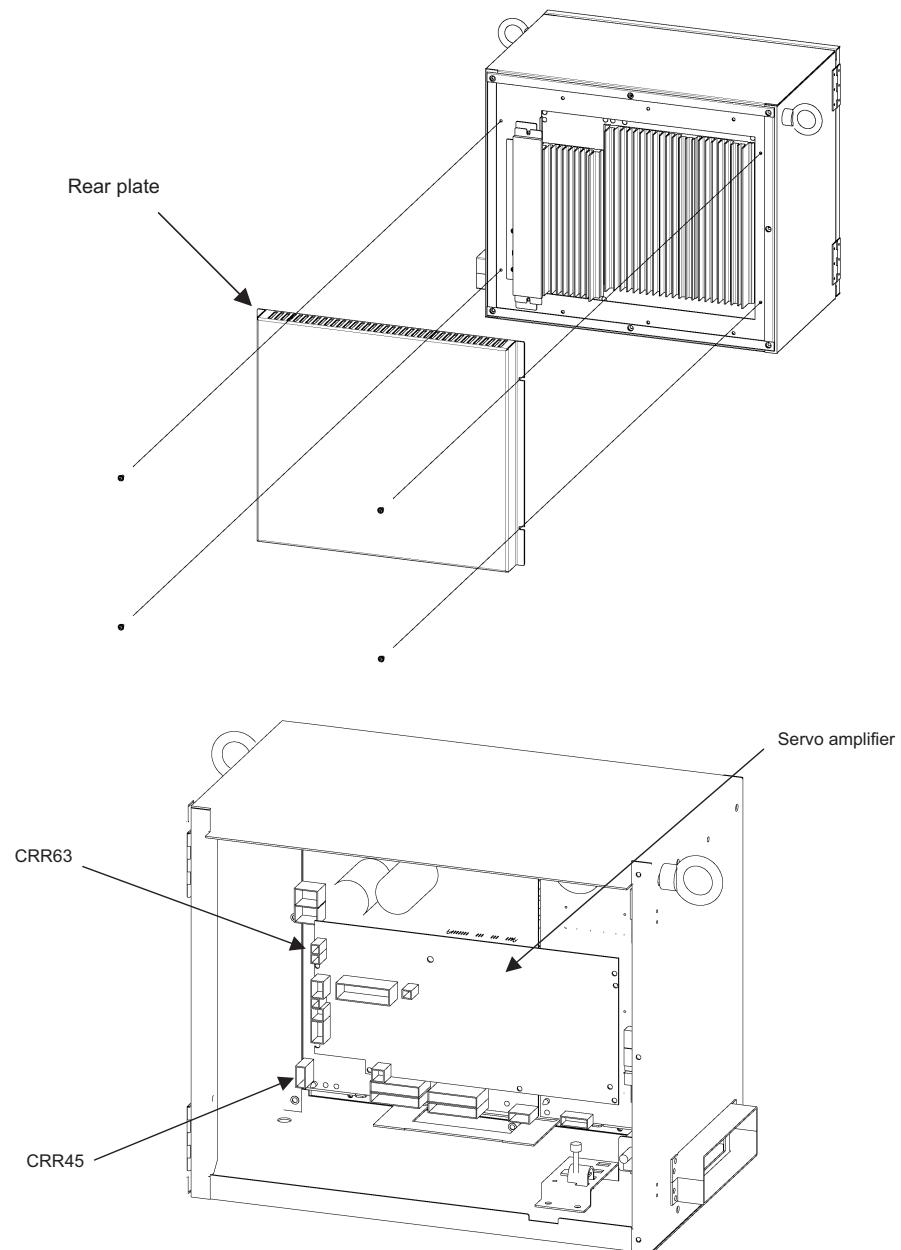
7.3 REPLACING THE REGENERATIVE RESISTOR UNIT

⚠ WARNING

Be careful not to be burned, because the regenerative resistor unit is very hot immediately after operation.

In case of LR Mate 200iC,M-1iA

- (1) Remove the four screws fastening the rear plate of the cabinet, and remove the rear plate.
- (2) Unplug connector CRR45 and CRR63 at the Servo amplifier.
- (3) Unscrew the retaining screws on the regenerative resistor unit and remove it.
- (4) Install the replacement unit by reversing this procedure (1) to (3).



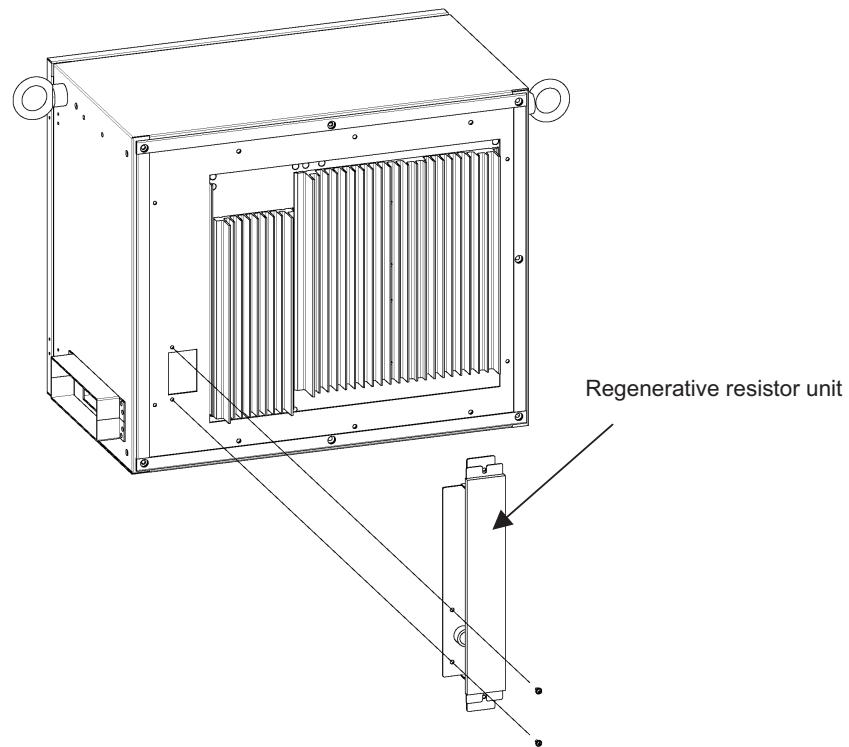
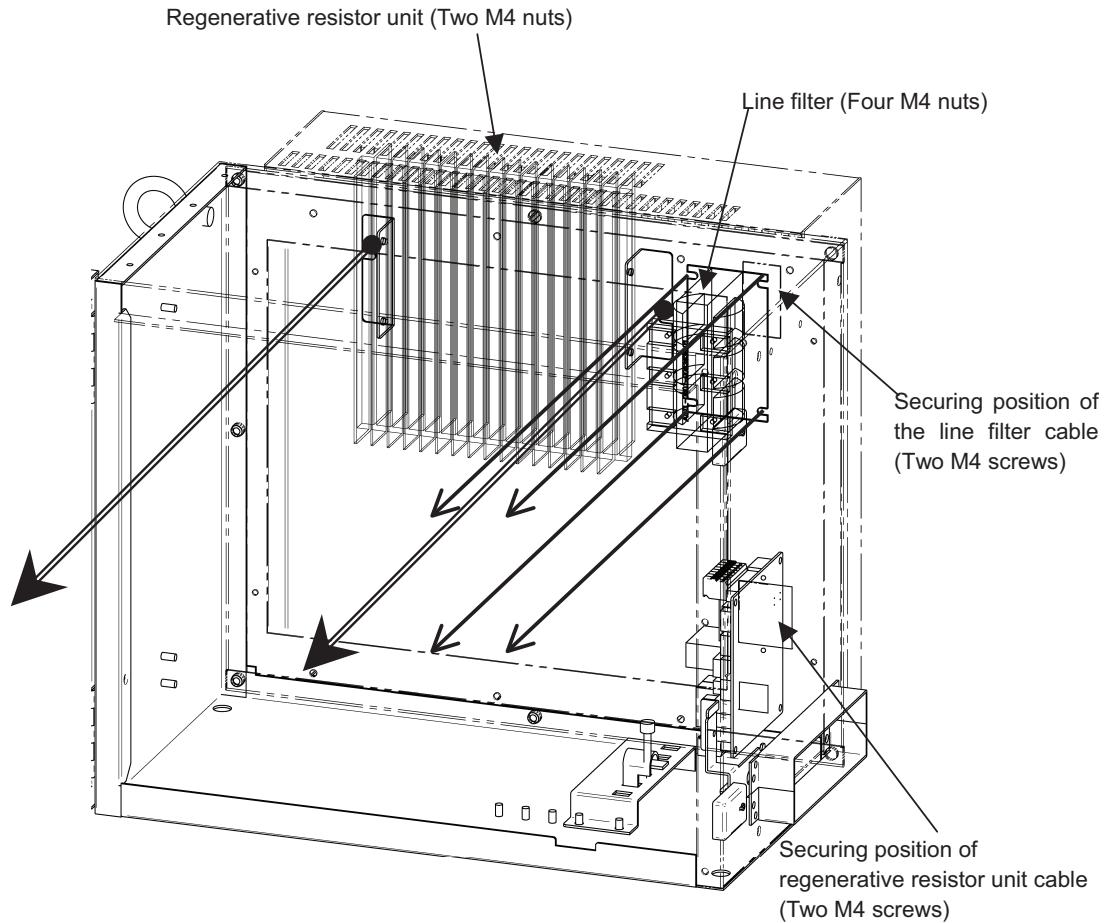


Fig. 7.3 (a) Regenerative resistor unit replacement (LR Mate 200iC, M-1iA)

In case of ARC Mate 100iC, M-10iA, ARC Mate 120iC, M-20iA, ARC Mate 50iC

- (1) Remove the servo amplifier from the front of the cabinet. For details, see Section 7.5.
- (2) Remove the metal plate securing the cable of the regenerative resistor unit. (This step is the same as in the line filter.)
- (3) Of the two nuts securing the regenerative resistor unit, remove the upper nut, loosen the lower nut, and remove the regenerative resistor unit. (The line filter is secured by the four nuts.)
- (4) Install a new regenerative resistor unit (or line filter) by reversing steps (1) to (3) above.



**Fig. 7.3 (b) Replacement of the regenerative resistor unit/line filter
(ARC Mate 100iC, M-10iA, ARC Mate 120iC, M-20iA ARC Mate 50iC)**

7.4 REPLACING THE E-STOP UNIT

- (1) Detach the cables from the emergency stop unit.
- (2) Remove the three nuts fastening the E-stop unit, and replace the E-stop unit.
- (3) Reconnect the cables.

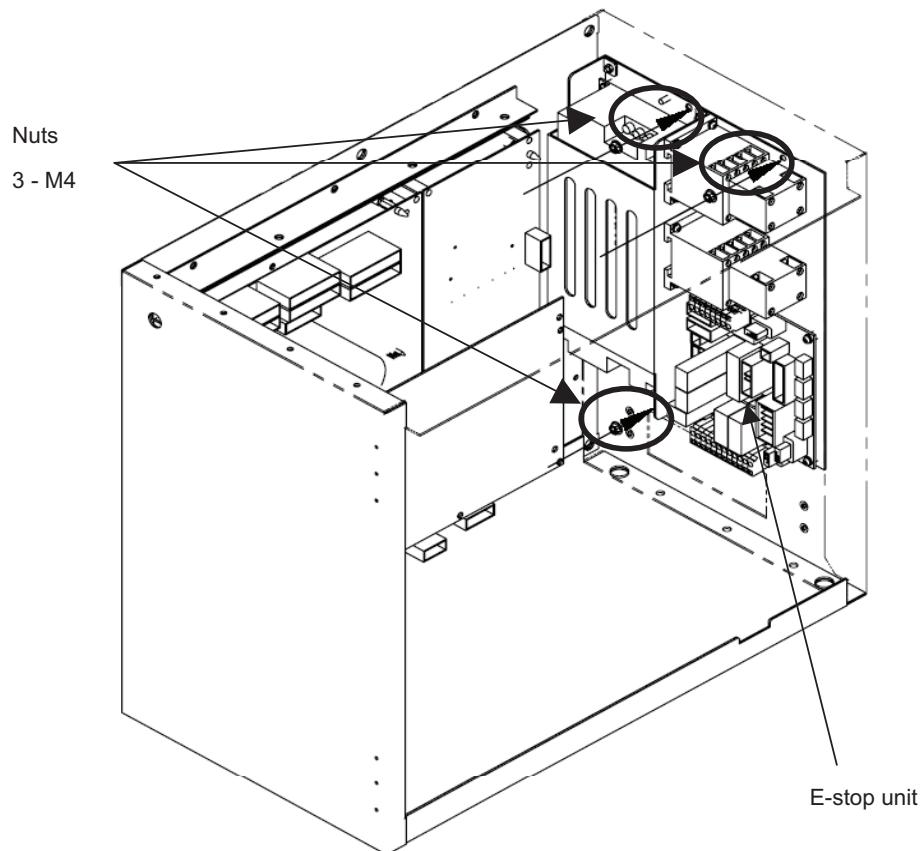


Fig.7.4 Replacing the emergency stop unit

7.5 REPLACING SERVO AMPLIFIERS

WARNING

Because the servo amplifier is heated immediately after operation, leave the servo amplifier until it cools down thoroughly, before replacing it.

- (1) Open the door, and check the DC link voltage at the screws above the LED "D7", using a DC power supply voltmeter. The voltage reading must be 50 V or lower.

Check that the voltage is not higher than 50V.

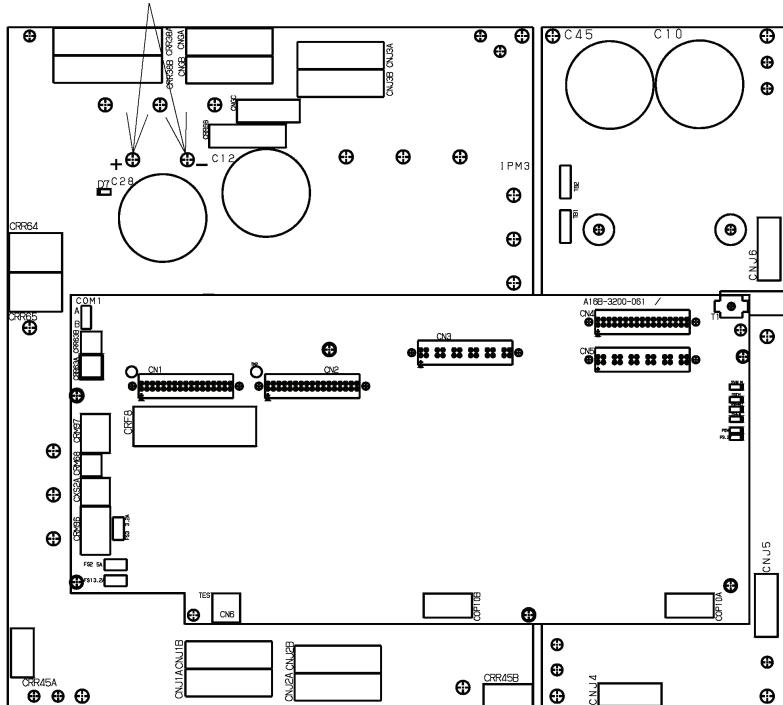


Fig.7.5 (a) Servo amplifier

- (2) Detach the cables from the servo amplifier.

WARNING

Before touching the servo amplifier, check the DC link voltage with the screws located above the LED "D7". By using a DC voltage tester, check that the voltage is 50 V or less.

- (3) Remove the two screws fastening the servo amplifier.

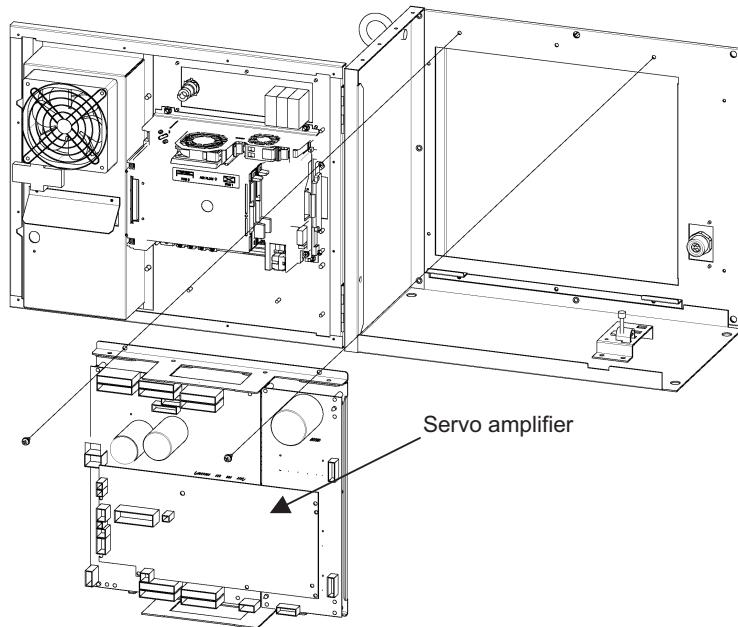


Fig.7.5 (b) Replacing the Servo amplifier

- (4) Hold the handles located in the upper and lower parts of the servo amplifier, and remove the servo amplifier.
(5) Reverse steps (2) to (4) above to install a new servo amplifier.

The servo amplifier can also be removed together with the metal plate of the rear of the cabinet.

- (6) Remove the eight screws fastening the metal plate, and remove the metal plate and the servo amplifier at a time.

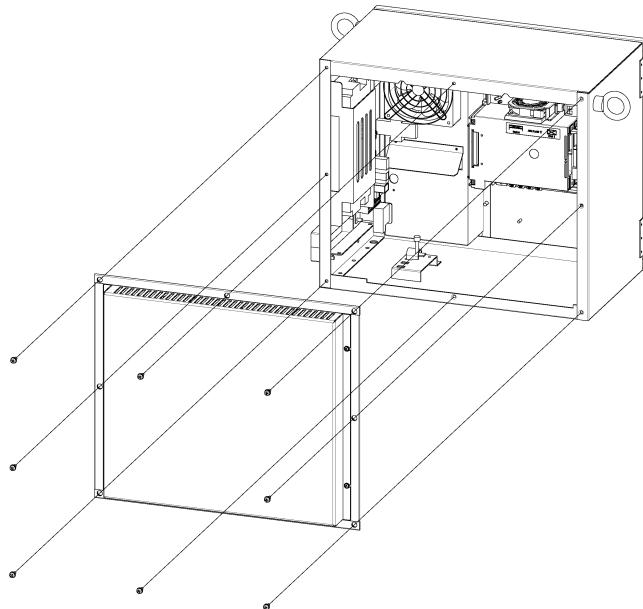


Fig.7.5 (c) Replacing the servo amplifier from rear side

7.6 REPLACING THE TEACH PENDANT and *i* PENDANT

The specifications of the teach pendant vary with its use. When you replace the teach pendant, check its specifications carefully.

- (1) Be sure that the power of a robot controller is off.
- (2) Detach the cable from the teach pendant.
- (3) Replace the teach pendant.

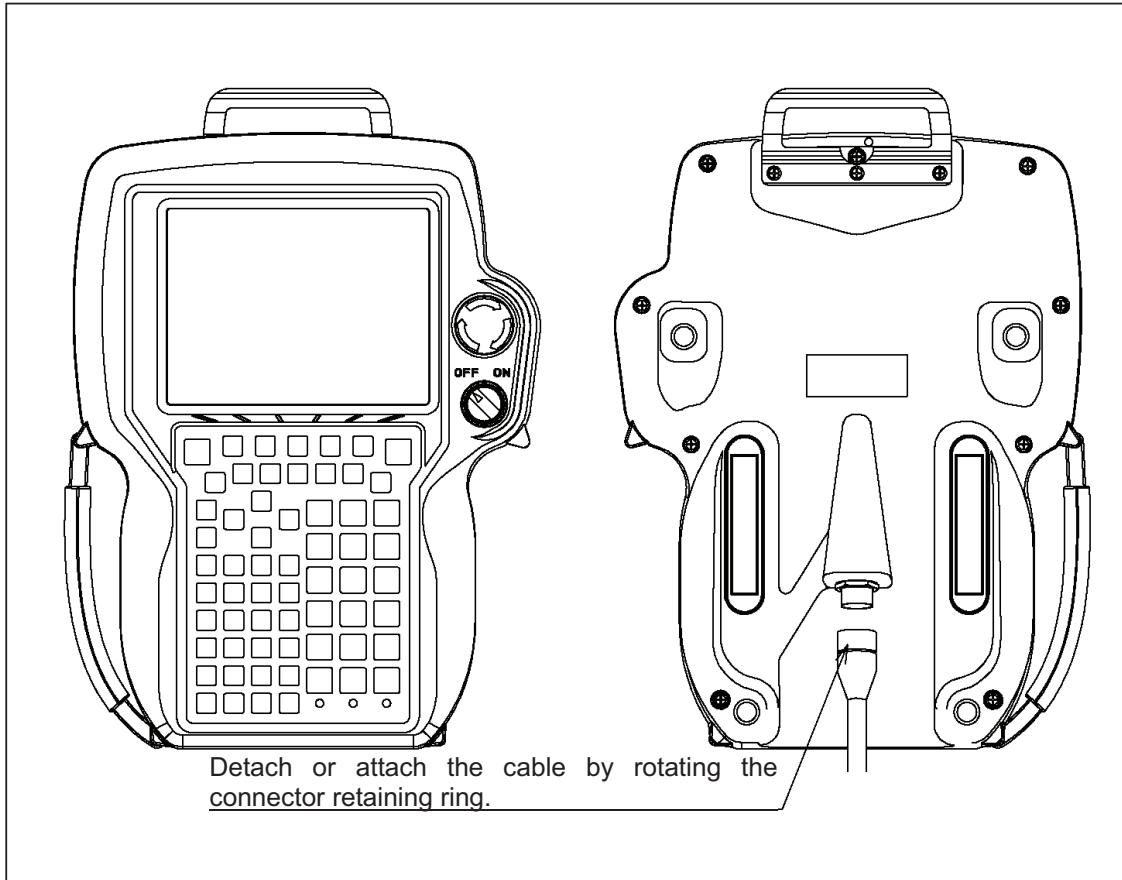
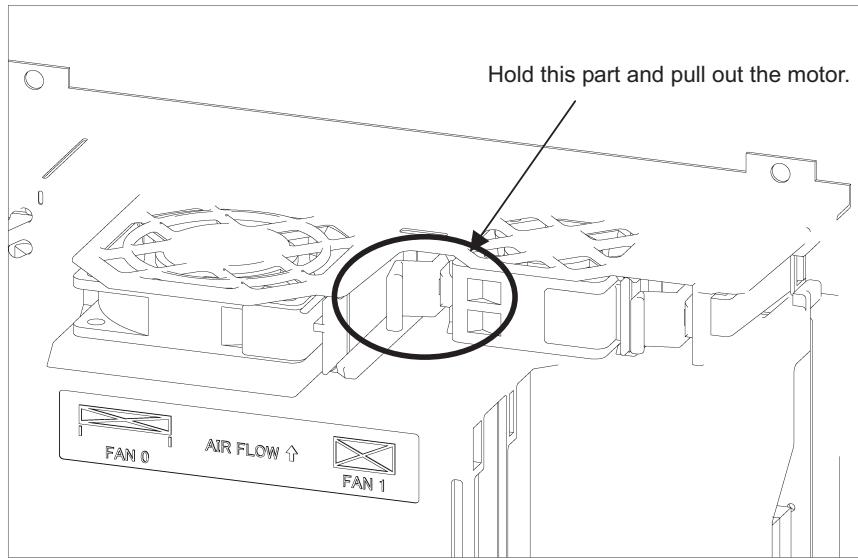


Fig.7.6 Replacing the teach pendant

7.7 REPLACING THE CONTROL SECTION FAN MOTOR

The control section fan motor can be replaced without using a tool. The fan motor is mounted on the fan unit rack.

- (1) Be sure that the power to the robot controller is turned off.
- (2) Pull out the fan motor to be replaced. (When pulling out the fan motor, hold the latch of the fan unit, and unlatch the unit from the case.)



- (3) Install a new fan unit. (Insert the unit until the latch of the unit snaps into the case.)

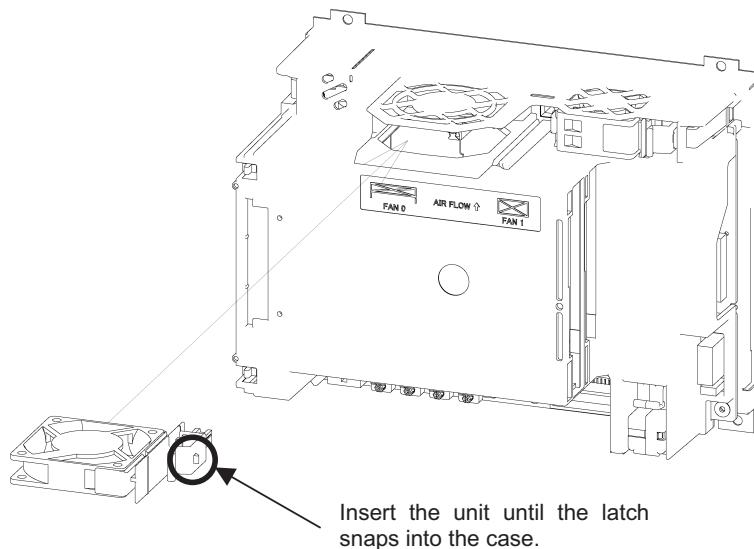


Fig.7.7 Replacing the control section fan motor

7.8 REPLACING THE AC FAN MOTOR

⚠ WARNING

Do not touch the fan motor when it is rotating, or you could be injured.

7.8.1 Replacing External Air Fan Unit and Door Fan

The cabinet has a heat exchanger inside the door.

Before replacing the heat exchanger, you must detach the door fan unit.

Door fan unit

- (1) Remove the four M4 retaining screws.
- (2) Remove the cables connected to the heat exchanger.
- (3) Mount a spare fan unit by reversing the removal procedure.

Heat exchanger

- (1) Remove the door fan unit (see the descriptions above).
- (2) Open the door of the cabinet, and remove the cables.
- (3) Remove the four M5 retaining nuts, and detach the heat exchanger.
- (4) Mount a spare heat exchanger by reversing the removal procedure.

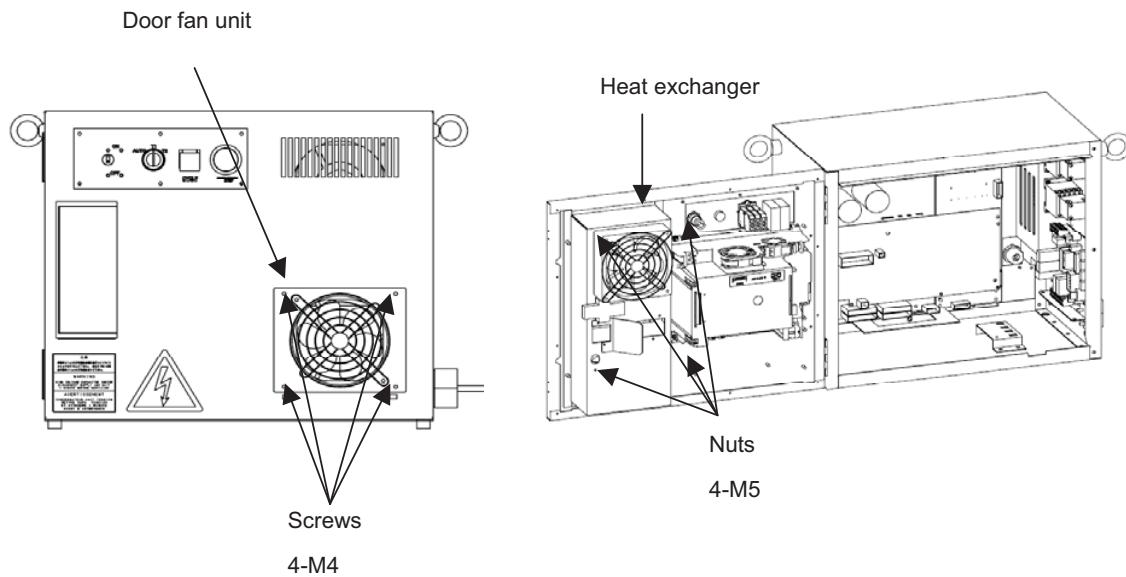


Fig.7.8.1 (a) Replacing the door fan unit

Fig.7.8.1 (b) Replacing the heat exchanger

Rear fan unit (for the ARC Mate 100iC/M-10iA, ARC Mate 120iC, M-20iA)

- (1) Remove the six securing screws (M4) and remove the unit.
- (2) Remove the connected cables.
- (3) Mount a spare fan unit by reversing the removal procedure.

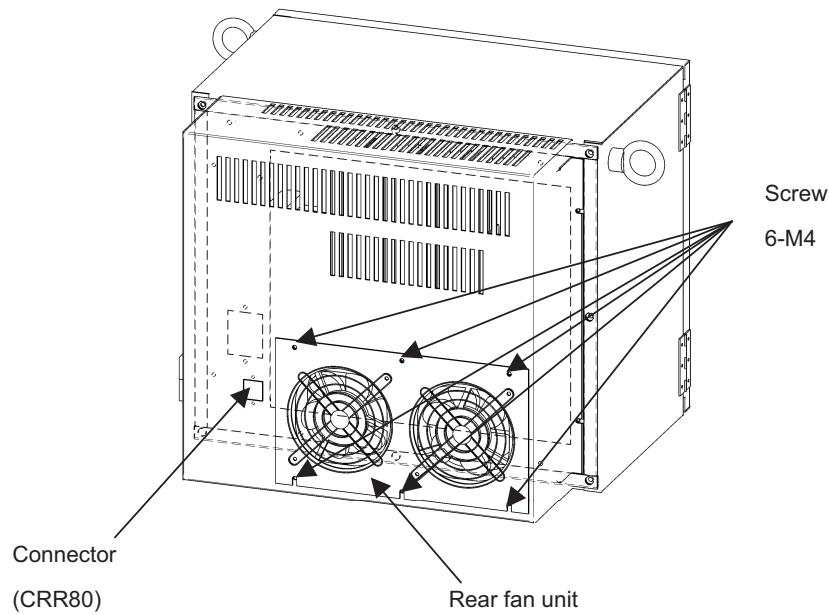


Fig.7.8.1 (c) Replacing the rear fan unit

7.9 REPLACING FUSES

If a fuse in the controller has blown, find the cause and take an appropriate measure before replacing the fuse.

7.9.1 Replacing Fuses in the Servo Amplifier

The following fuses are in the servo amplifier.

- FS1: For generation of the power to the amplifier control circuit (A60L-0001-0290#LM32C)
- FS2: For protection of the 24 V output to the end effector, ROT, and HBK (A60L-0001-0290#LM32C)
- FS3: For protection of the 24 V output to the regenerative resistor and the additional axis amplifier (A60L-0001-0290#LM50C)

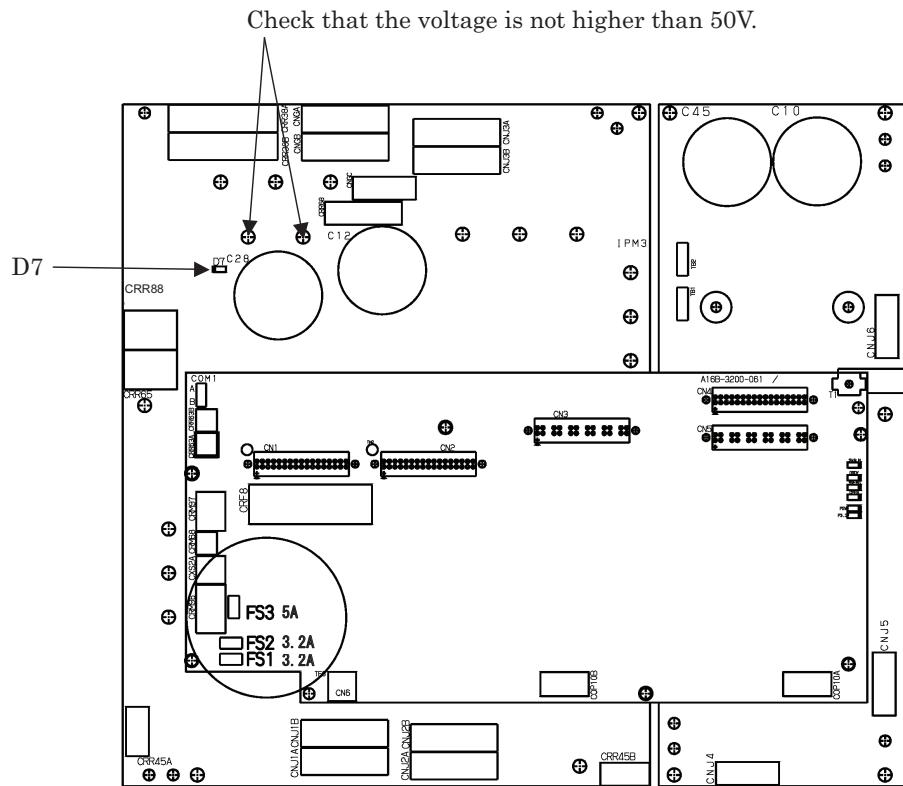


Fig.7.9.1 Replacing fuses in the servo amplifier

⚠ WARNING

Before touching the servo amplifier, check the DC link voltage with the screws located above the LED "D7". By using a DC voltage tester, check that the voltage is 50 V or less.

7.9.2 Replacing Fuses in the Main board

| | | |
|-------|---|----------------------|
| FUSE1 | Fuse for protecting the +24V output | A60L-0001-0290#LM50C |
| FUSE3 | Fuse for protecting the +24V output for peripheral equipment interfaces | A60L-0001-0290#LM10C |

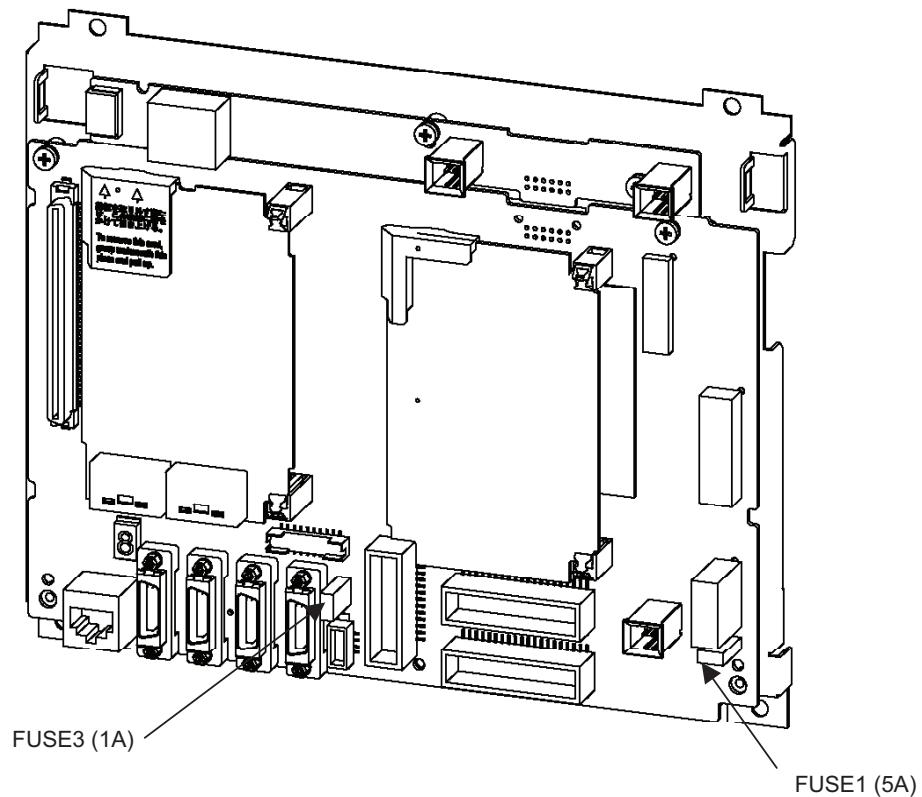
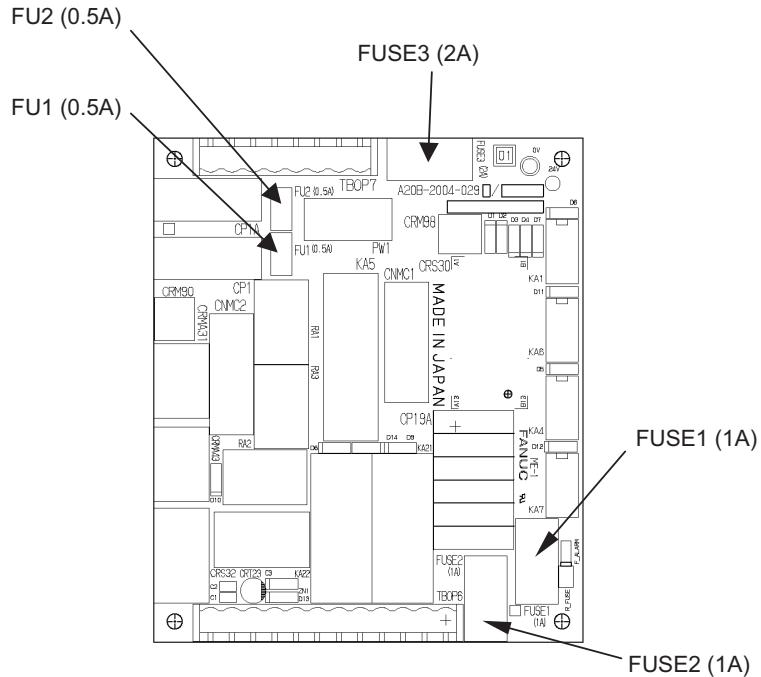


Fig.7.9.2 Replacing fuses in the main board

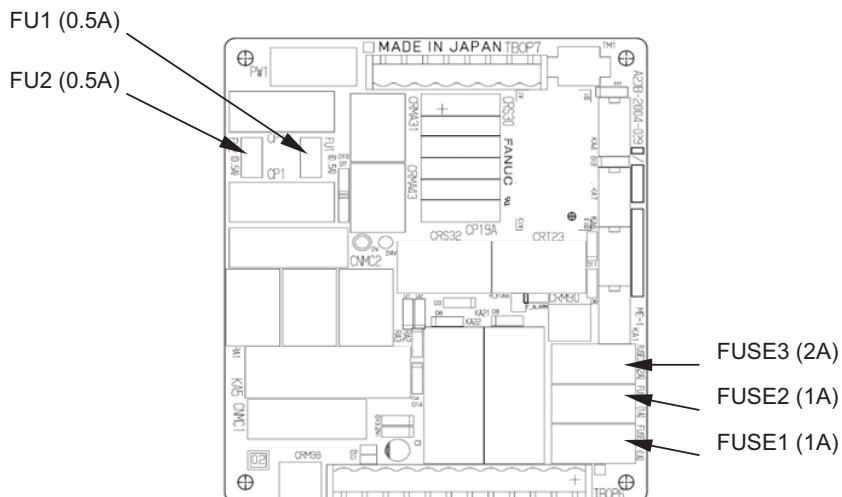
7.9.3 Replacing the Fuse on the E-stop Board

The emergency stop board has the following fuses:

| | | |
|-------------|---|---------------------|
| FUSE1 | For protecting +24EXT to the emergency stop circuit | A60L-0001-0046#1.0 |
| FUSE2 | For protecting +24V to the teach pendant | A60L-0001-0046#1.0 |
| FUSE3 | For protection of the +24V | A60L-0001-0046#2.0 |
| FU1 and FU2 | For door fan input protection | A60L-0001-0175#0.5A |



(Edition 01A)



(Edition 02B after)
Fig. 7.9.3 E-stop board

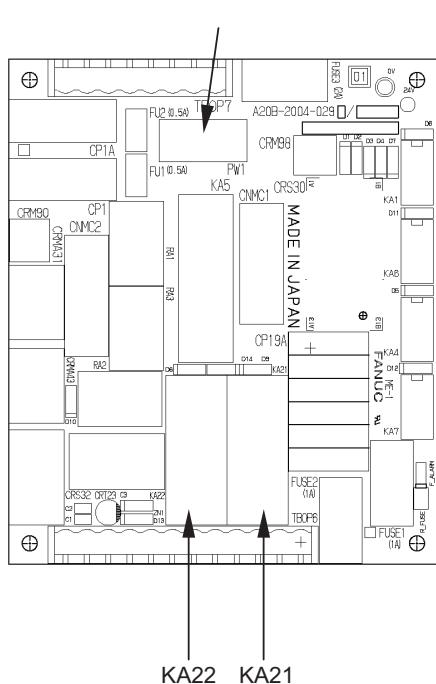
7.10 REPLACING RELAYS

Prolonged use of a relay might result in its contacts failing to make a secure connection or sticking to each other permanently. If such a failure occurs, replace the relay.

7.10.1 Replacing Relays on the E-stop Board

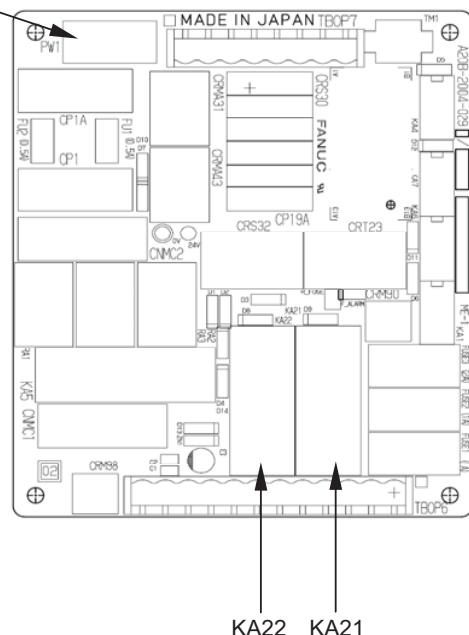
| | | |
|------------|--------------------------------|-----------------------|
| KA21, KA22 | For the emergency stop circuit | A58L-0001-0192#1997R |
| PW1 | For the 200-V power supply | A58L-0001-0548#AQC145 |

PW1



(Edition 01A)

PW1



(Edition 02B or later)

Fig.7.10.1 Replacing relays on the E-stop board

7.11 REPLACING BATTERY

7.11.1 Battery for Memory Backup (3 VDC)

The programs and system variables are stored in the SRAM in the main board. The power to the SRAM memory is backed up by a lithium battery mounted on the front panel of the main board. The above data is not lost even when the main power of controller is turned off. A new battery can maintain the contents of memory for about 4 years (Note).

When the voltage of the battery becomes low, the low-voltage battery alarm (system-035) is displayed on the teach pendant. When this alarm is displayed, replace the battery as soon as possible. In general, the battery can be replaced within one or two weeks, however, this depends on the system configuration.

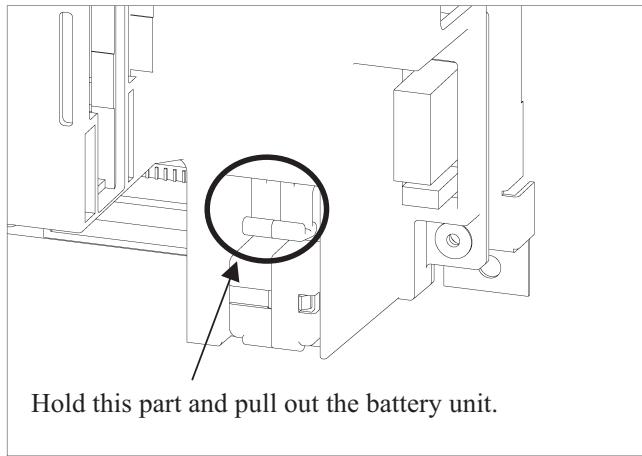
If the battery voltage gets lower, it becomes impossible to back up the content of the SRAM. Cycling power to the controller in this state causes system not to start, and LED located on the main board displays "1" because the contents of memory have been lost. Clear the entire SRAM memory and reenter data after replacing the battery. Important data should be saved to the memory card or other external device beforehand in case of emergency.

NOTE

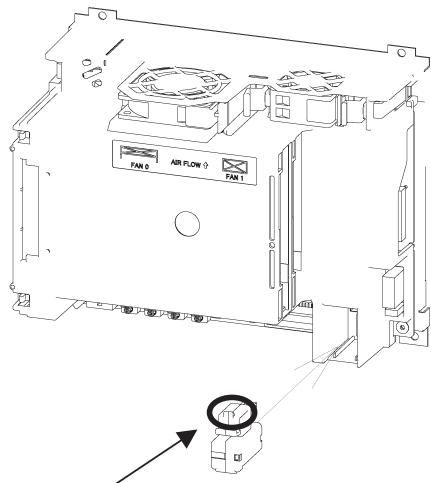
In a newly introduced robot, the battery is factory-installed. Battery replacement may, therefore, be needed within 4 years after the introduction of the robot.

Replacing the lithium battery

- (1) Prepare a new lithium battery (ordering drawing number: A05B-2550-K030).
- (2) Turn the robot controller on for about 30 seconds.
- (3) Turn the robot controller off.
- (4) Pull out the battery unit located in the lower right part of the backplane unit. (Hold the latch of the battery unit, unlatch the battery unit from the case, and pull out the unit.)



- (5) Install a new battery unit. (Insert the battery unit until the latch of the unit snaps into the case.) Check that the battery unit is latched securely.



Insert the unit until the latch snaps into the case.

Fig.7.11.1 Replacing the battery

⚠ CAUTION

Complete the steps (3) to (5) within 30 minutes.

If the battery is left disconnected for a long time, the contents of memory will be lost.

To prevent possible data loss, it is recommended that the robot data such as programs and system variables be backed up before battery replacement.

⚠ WARNING

Using other than the recommended battery may result in the battery explosion.

Replace the battery only with the specified battery (A05B-2550-K030).

Dispose of the replaced battery as an industrial waste, according to the laws and other rules in the country where the controller is installed and those established by the municipality and other organizations that have jurisdiction over the area where the controller is installed.

III. CONNECTIONS

1 GENERAL

This section describes the electrical interface connections in the R-30*i*A Mate. It also includes information about installation of the R-30*i*A Mate.

2 BLOCK DIAGRAM

Fig.2 is a block diagram of electrical interface connections with the R-30iA Mate.

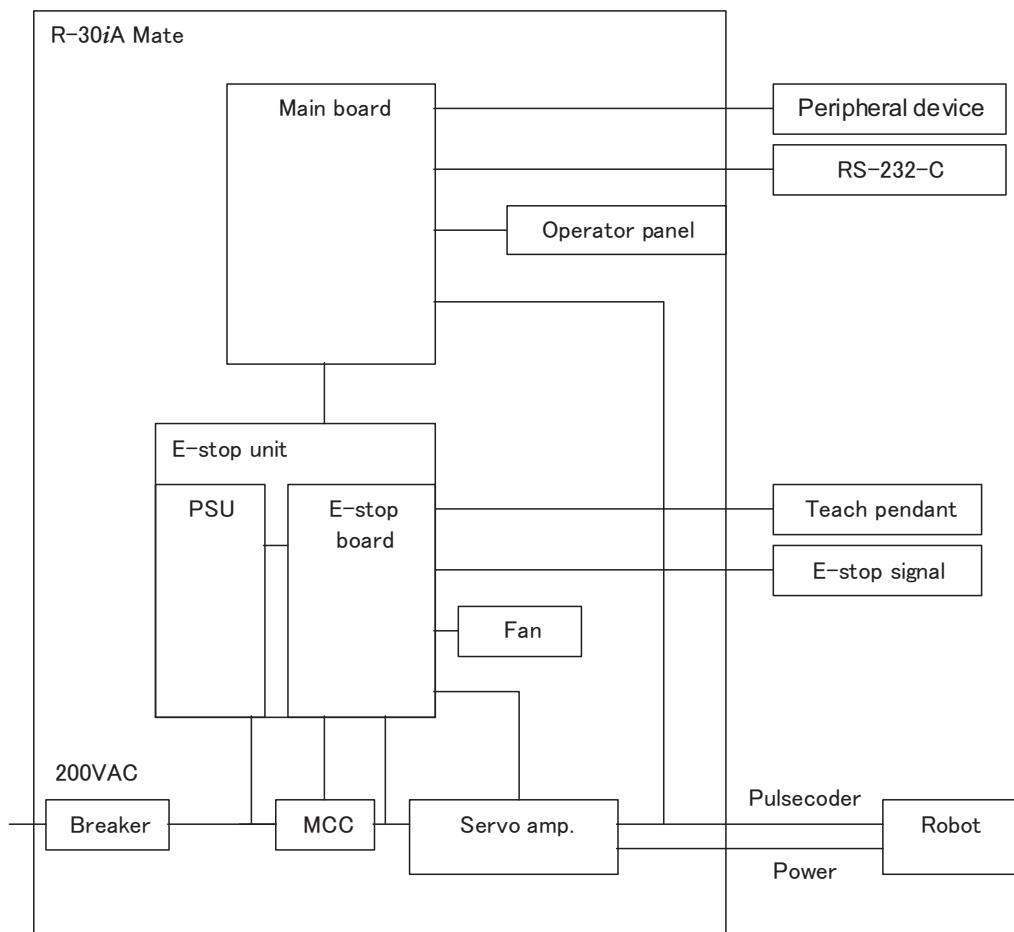


Fig.2 Block Diagram of Electrical Interface Connection

NOTE

- 1 — : Indicates electrical connection.
- 2 For more information, contact our service section.

3

ELECTRICAL CONNECTIONS

3.1

CONNECTION DIAGRAM BETWEEN MECHANICAL UNITS

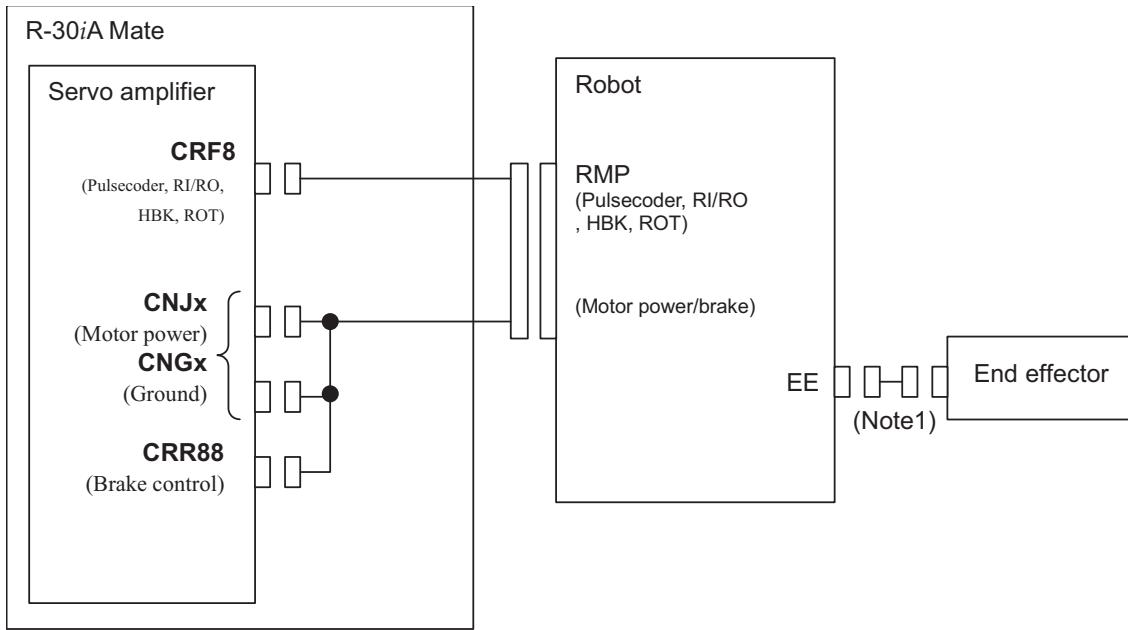


Fig.3.1 (a) Mechanical connection diagram

NOTE

- 1 This cable is not included. It must be supplied by the customer.

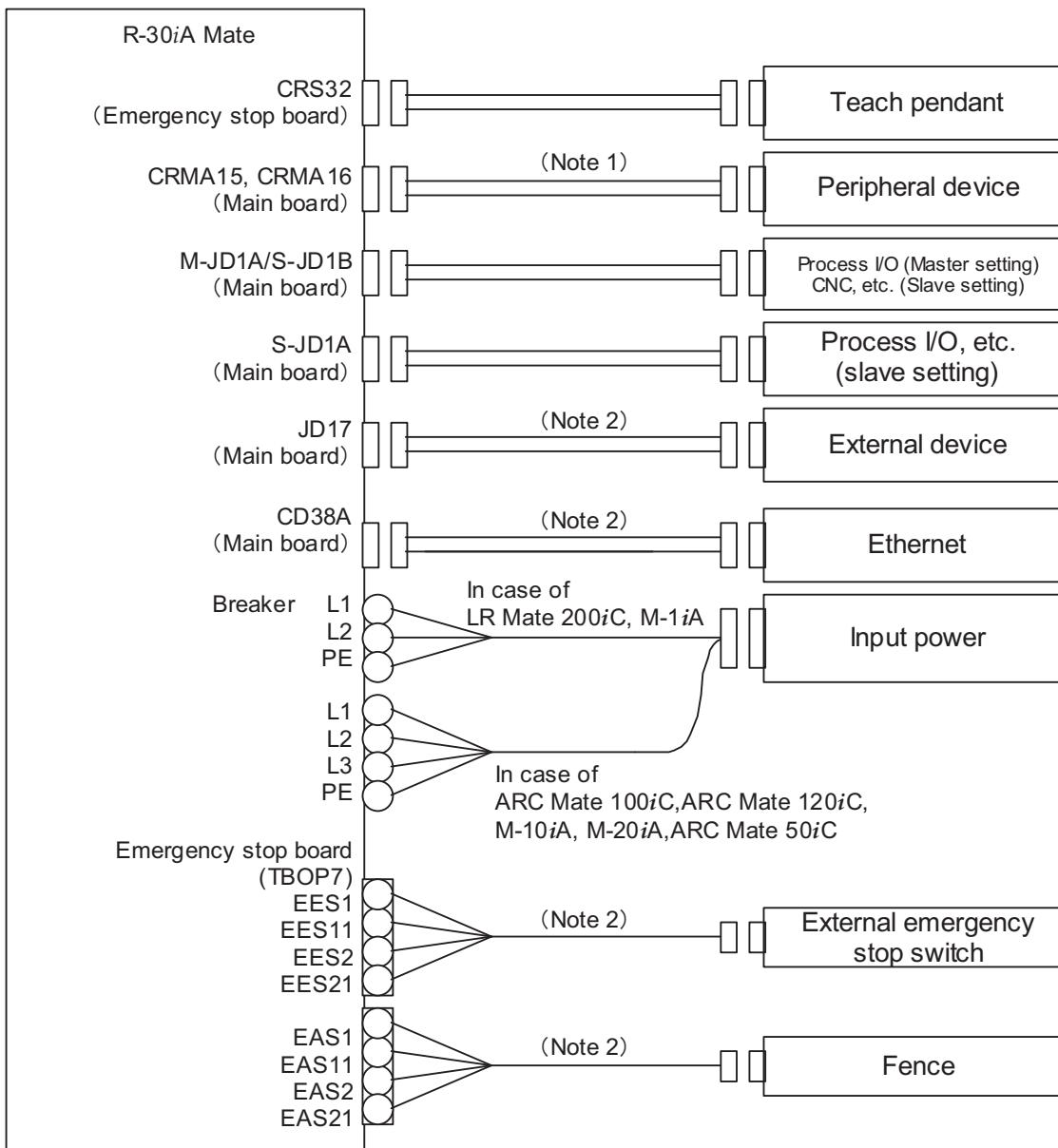


Fig.3.1 (b) Mechanical connection unit

NOTE

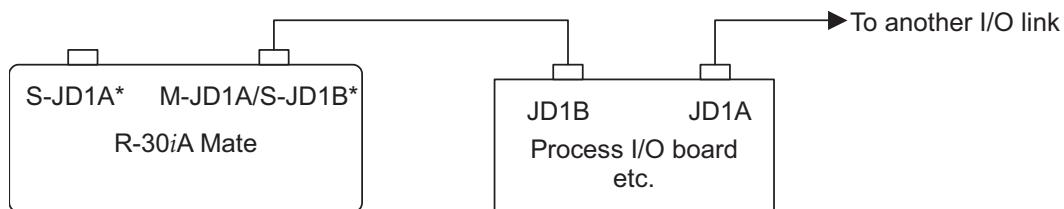
- 1 For detail of the peripheral device connection, see the section of Peripheral device interface.
- 2 This cable is not included. It must be supplied by the customer.

3.2 FANUC I/O LINK

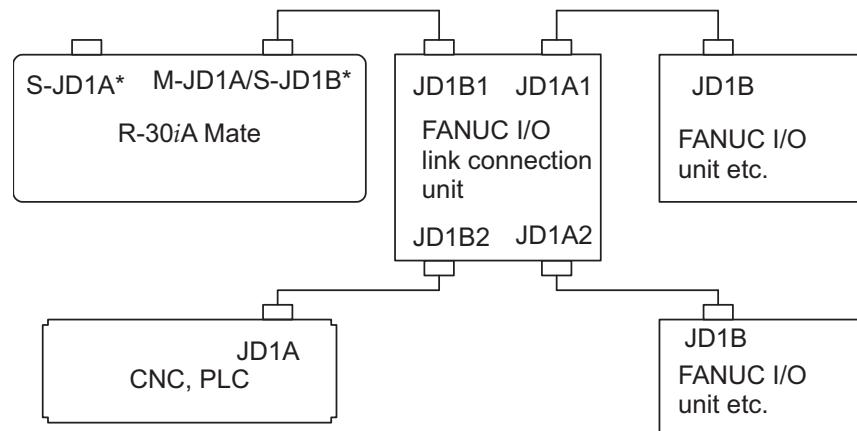
3.2.1 Connection of I/O Link

The connection of I/O links in the R-30iA Mate is shown below.

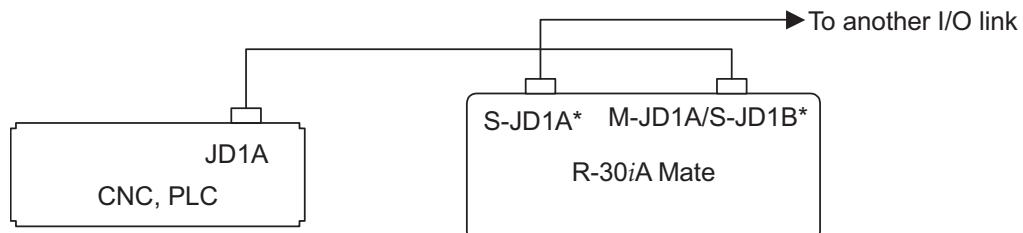
- When the R-30iA Mate controller is used as the I/O link master (default)
(When the R-30iA Mate controller controls the process I/O board etc.)



- When the R-30iA Mate controller is connected to a CNC etc. via the I/O link connection unit



- When the R-30iA Mate controller is used as an I/O link slave
(When a CNC or PLC is the I/O link master)



- * M-JD1A/S-JD1B: For main board general versions equal to or earlier than 04A, the connector name is JD1A.
- S-JD1A For main board general versions equal to or earlier than 04A, the connector name is JD1B.

Fig. 3.2.1 Connection of I/O links

3.2.2 Connection of I/O the Link Cable

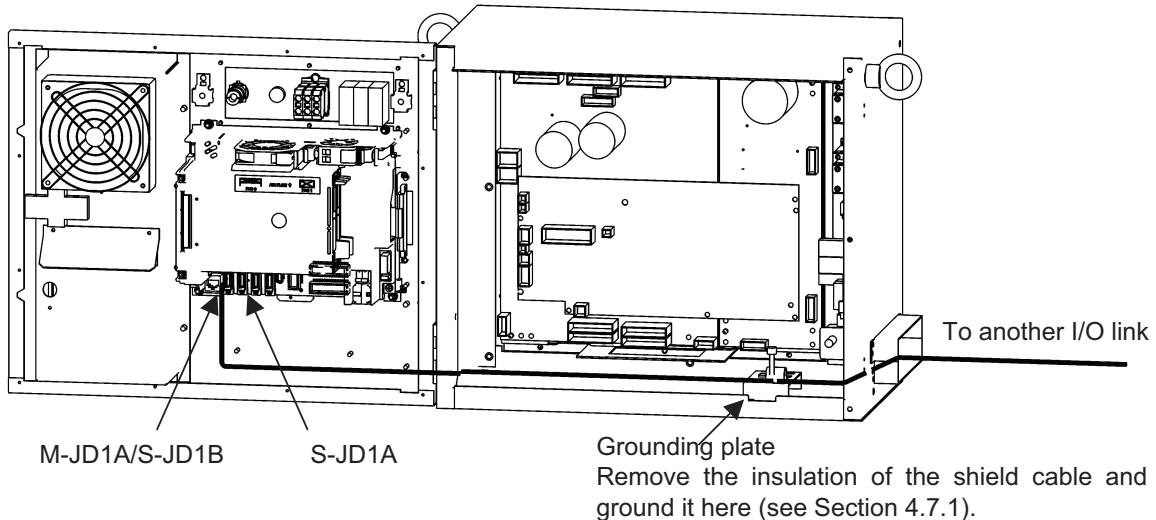


Fig. 3.2.2 (a) Path of the I/O link cable

1. Connect the cable according to the system. Be sure to perform shielding.
2. Before connection turn off the power.

NOTE

For connection with the CNC with I/O links, turn on or off the power of the CNC and the robot controller at the following timing.

- a) A slave unit must be powered on as soon as or before the master is powered on.
- b) If the CNC or robot controller is powered off after startup of the system, an I/O link error occurs. To successfully make connection with I/O links again, power off all of the units and then power them on at the timing indicated in a).

M-JD1A/S-JD1B interface

| | | | |
|----|-------|----|---------|
| 11 | 0V | 01 | RXSLC1 |
| 12 | 0V | 02 | XRXSLC1 |
| 13 | 0V | 03 | TXSLC1 |
| 14 | 0V | 04 | XTXSLC1 |
| 15 | 0V | 05 | |
| 16 | 0V | 06 | |
| 17 | | 07 | |
| 18 | (+5V) | 08 | |
| 19 | | 09 | (+5V) |
| 20 | (+5V) | 10 | |

Note: +5V is connected when the optical I/O link adapter is used.

- (1) Use a twisted-pair cable in which wires 1 and 2 are paired and wires 3 and 4 are paired.
- (2) Shield the cable collectively and ground the shield on the CNC side.

S-JD1A interface

| | | | |
|----|-------|----|---------|
| 11 | 0V | 01 | RXSLC2 |
| 12 | 0V | 02 | XRXSLC2 |
| 13 | 0V | 03 | TXSLC2 |
| 14 | 0V | 04 | XTXSLC2 |
| 15 | 0V | 05 | |
| 16 | 0V | 06 | |
| 17 | | 07 | |
| 18 | (+5V) | 08 | |
| 19 | | 09 | (+5V) |
| 20 | (+5V) | 10 | |

Note: +5V is connected when the optical I/O link adapter is used.

Cable connection diagram

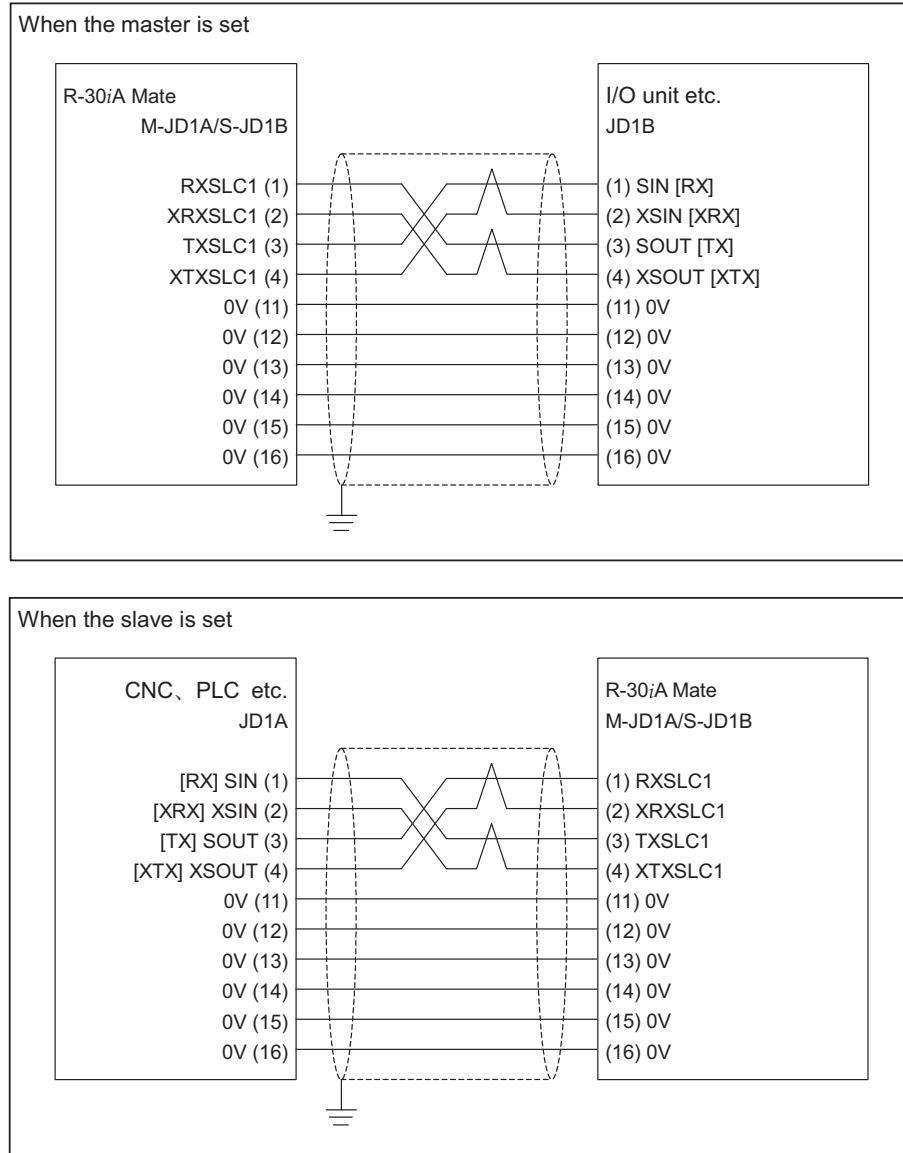


Fig. 3.2.2 (b) Connection diagram of I/O Link cable

3.3 EXTERNAL CABLE WIRING DIAGRAM

3.3.1 Robot Connection Cables

⚠ CAUTION

Before operating the robot, uncoil the interconnection cables from their shipping position to prevent excessive heat, which may damage the cables.
(Coiled part should be shorter than 10 meter.)

There are two types of the robot connection cable;

Non-flex type: usage is restricted to fixed laying

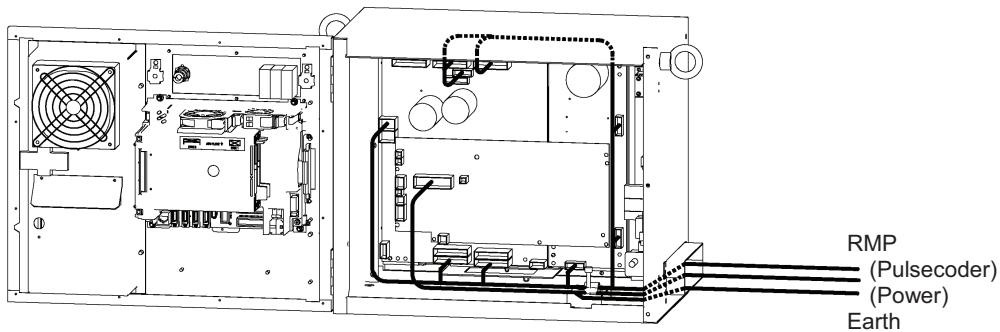
Flex type: possible to use in the cable track

Specification of cable

| | | Robot | Non-flex type | | | Flex type | | |
|------------------|------------------|--|--------------------------------------|------------------|------------------|--------------------------------------|-------|-----|
| Diameter (mm) | Weight (kg/m) | | Minimum bending radius (mm) | Diameter (mm) | Weight (kg/m) | Minimum bending radius (mm) | | |
| RMP | Signal | All models | 14.2 | 0.31 | 200 | 20.5 | 0.71 | 200 |
| | Power | ARC Mate 100iC ARC Mate 120iC M-10iA, M-20iA | 20.0 | 0.7 | 200 | - | - | - |
| | | LR Mate 200iC M-1iA ARC Mate 50iC | 15.5 | 0.3 | 200 | 15.5 | 0.49 | 200 |
| Earth | | All models | 4.7 | 0.065 | 200 | 4.7 | 0.065 | 200 |

Using condition of flex type cable

- (1) When routing cables in movable places, use a cable bearer.
- (2) The bending radius (R) of the cable track is more than 200mm.
- (3) The cable should be fixed to the cable track by using the clamp. (e.g. rubber packing)
- (4) The size of the hole to support a cable in the cable track should be more than 110% of the cable size and should have the gap more than 3mm.
- (5) When cables are laid in the cable track, pay attention for the cable not to be twisted.



- Detail of cable connection to servo amplifier.

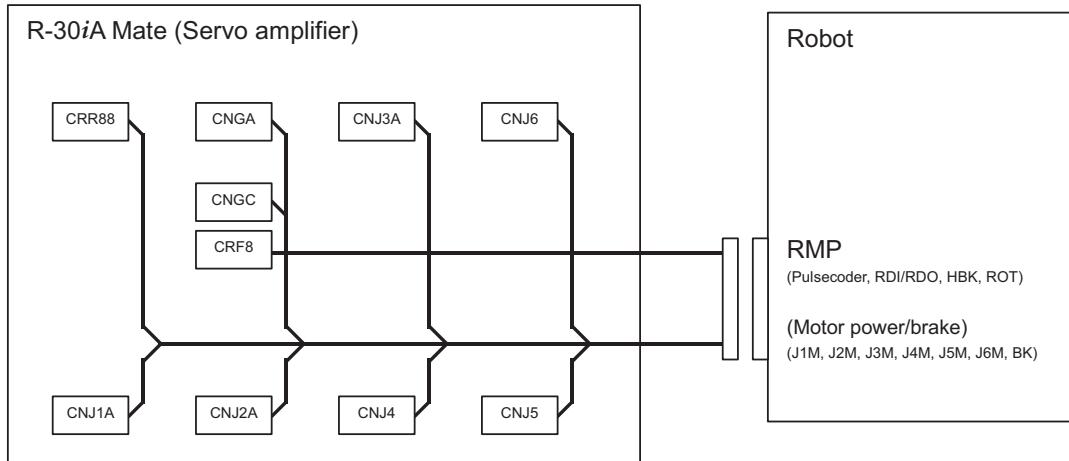


Fig. 3.3.1 Robot connection cable

3.3.2 Teach Pendant Cable

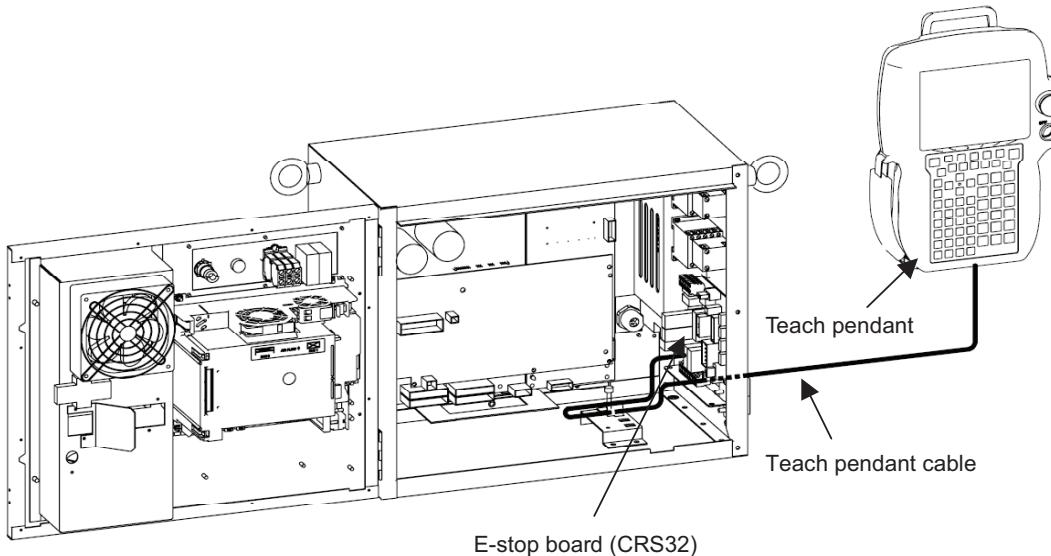


Fig.3.3.2 Teach pendant cable

3.3.3 Connecting the Input Power Supply

You can specify the power supply cables as the option.

Note) Be sure to install the supplied terminal cover.

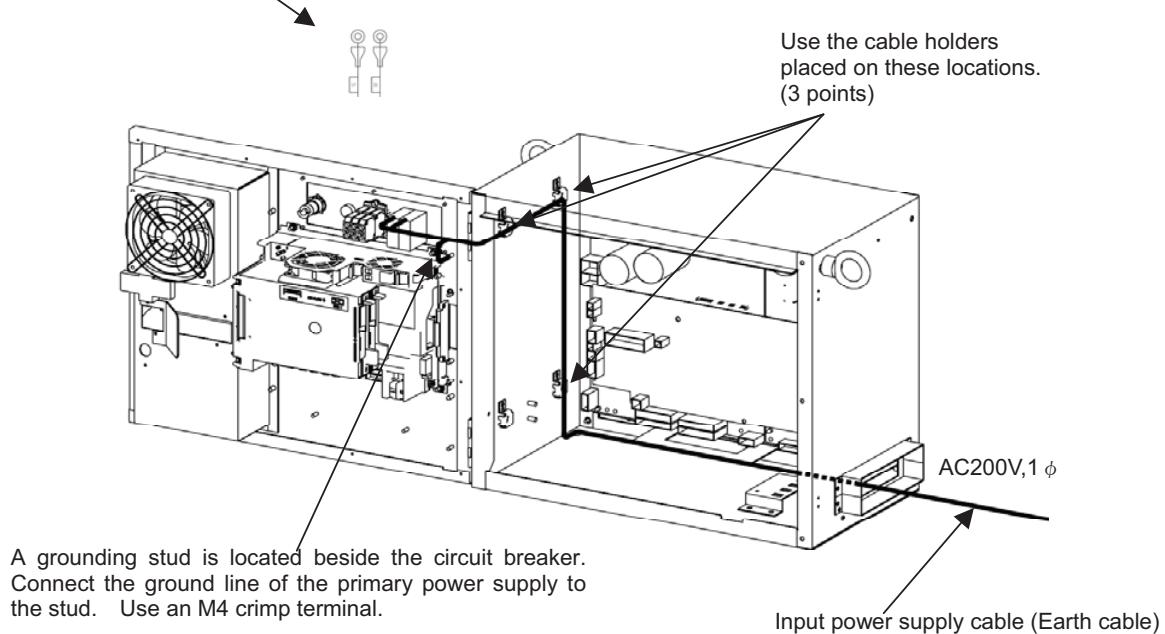


Fig.3.3.3 (a) Input power cable (LR Mate 200iC, M-1iA)

Note) Be sure to install the supplied terminal cover.

Use the cable holders
placed on these locations.
(3 points)

A grounding stud is located beside the circuit breaker. Connect the ground line of the primary power supply to the stud. Use an M4 crimp terminal.

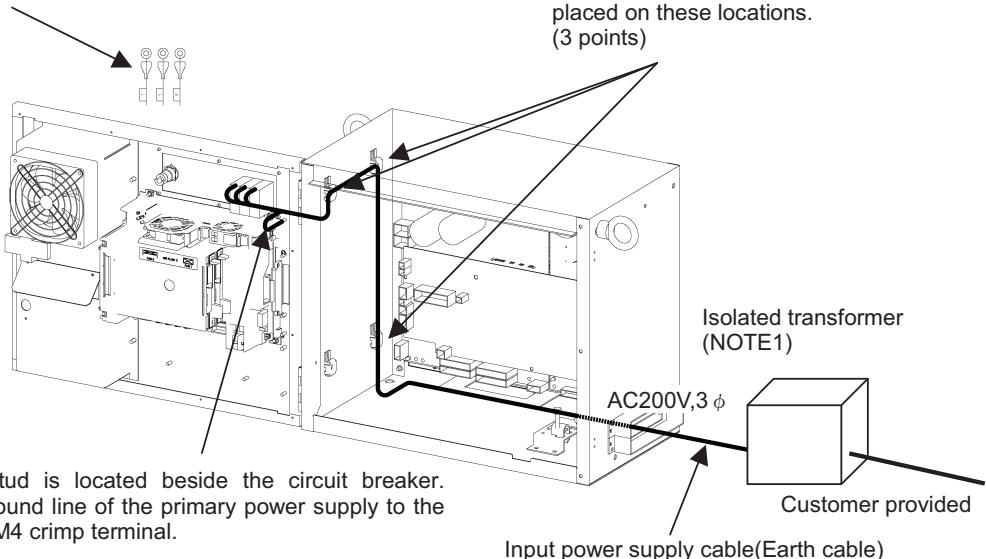


Fig.3.3.3 (b) Input power cable (ARC Mate 100iC, M-10iA, ARC Mate 120iC, M-20iA, ARC Mate 50iC)

NOTE1

Use the wire which size is from AWG14 to AWG10 for input power supply cable and earth cable.

3.3.4 Connecting the External Emergency Stop

After connecting the safety signals like external emergency stop signal and/or safety fence signal, verify that,

- All safety signals stop the robot as intended.
- There is no mistake in connection of safety signals.

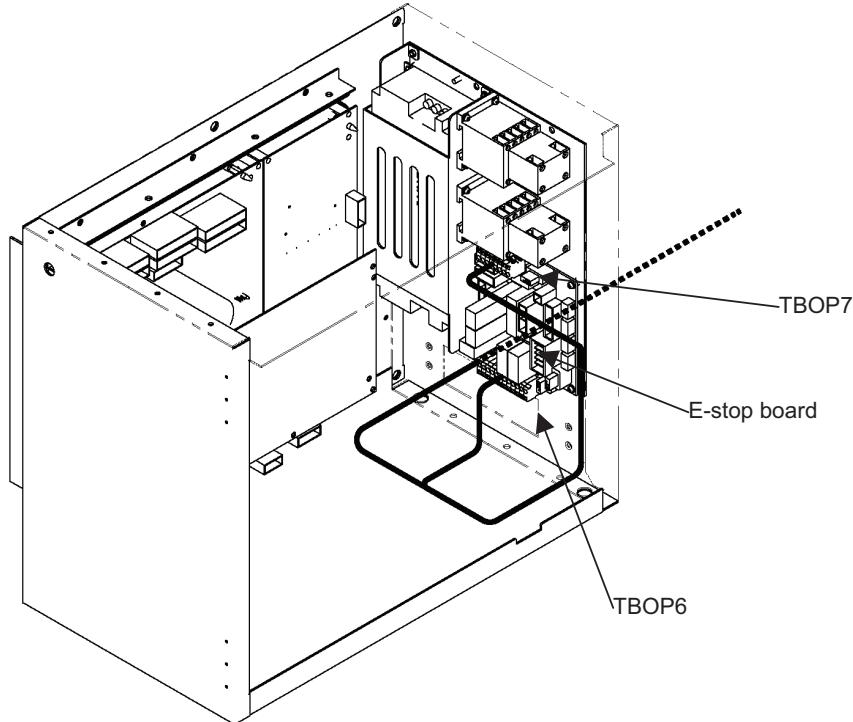


Fig.3.3.4 (a) Connection of the external emergency stop

External emergency stop output

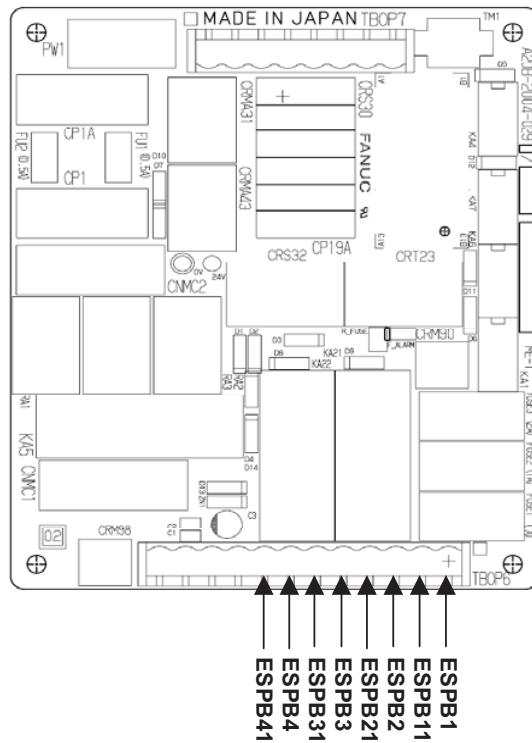
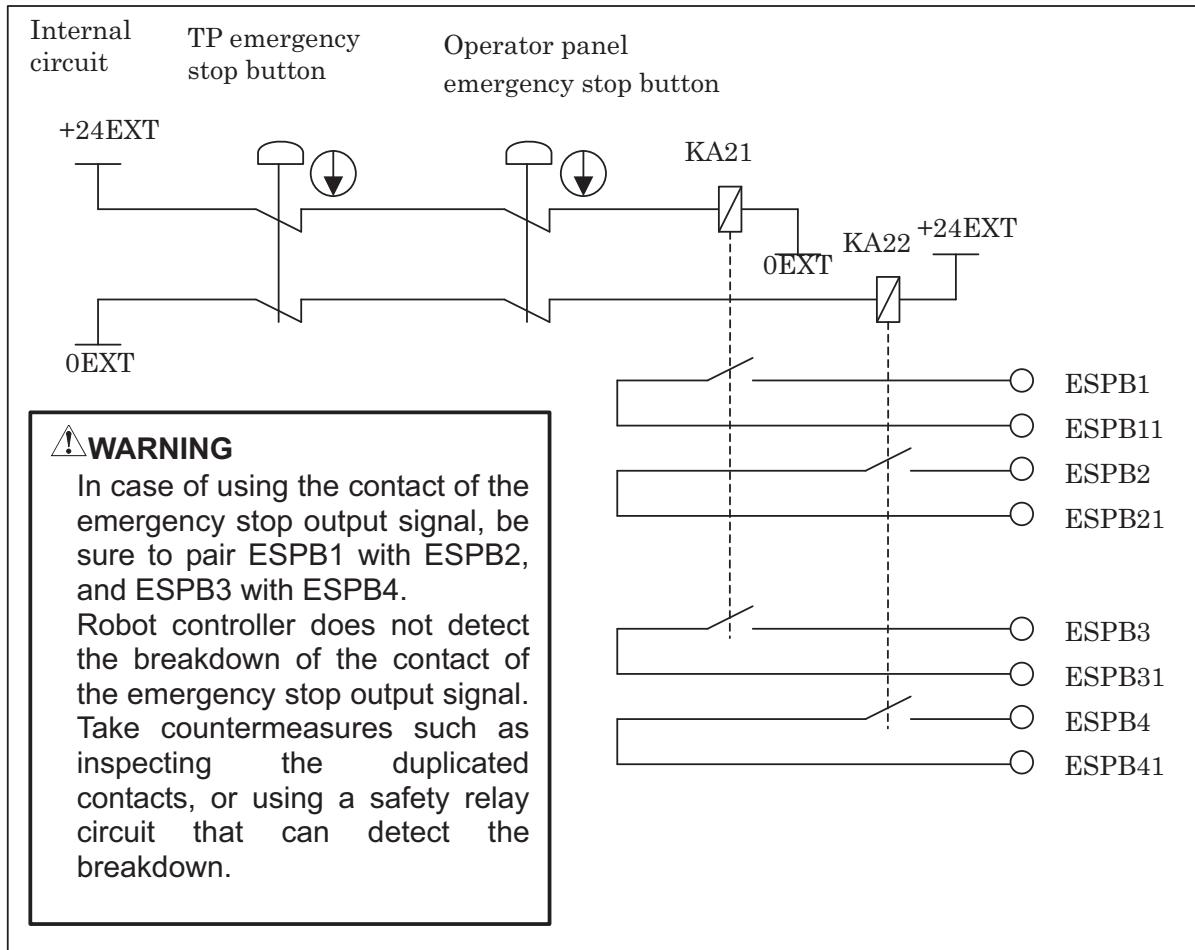


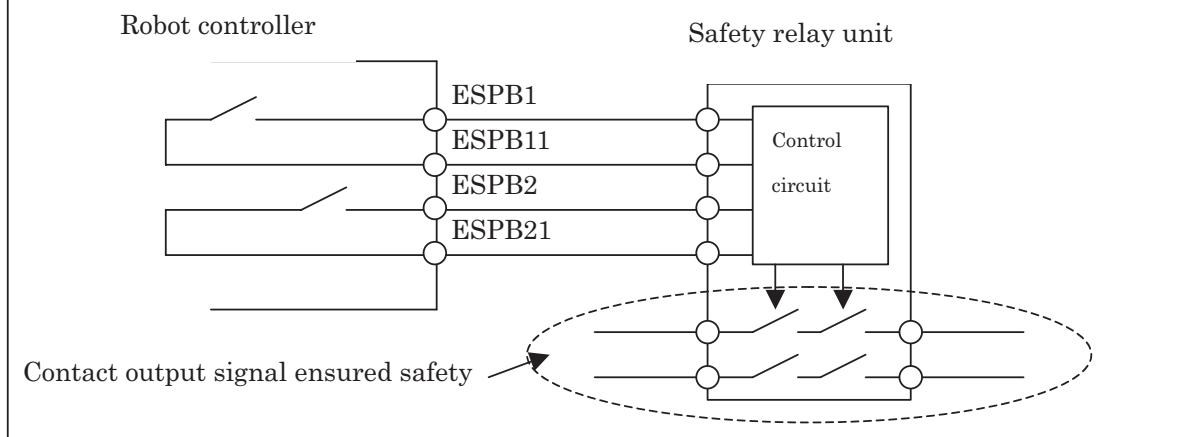
Fig.3.3.4 (b) E-stop board

For the circuit, see Fig. A (b) in Appendix A, "TOTAL CONNECTION DIAGRAM".

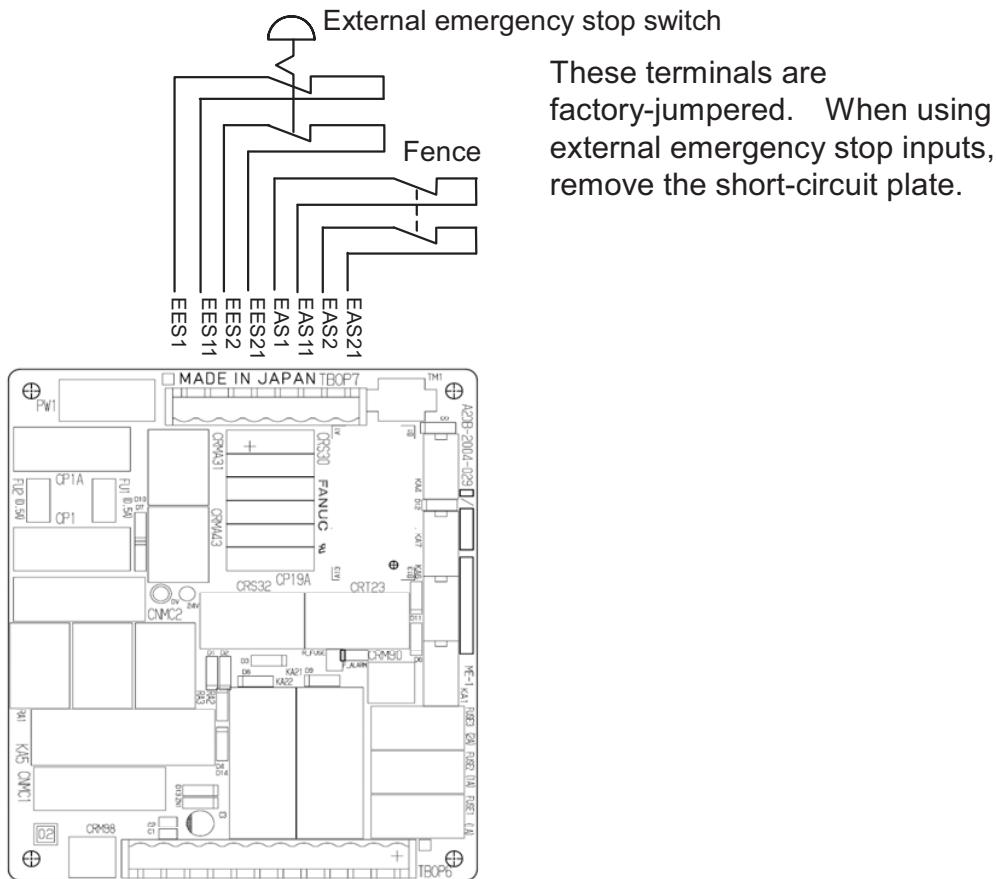
| Signal | Description | Current, voltage | Min. load |
|----------------|-------------|---|-------------------|
| ESPB1 — ESPB11 | | Rated contact: 250 VAC, 5-A resistor load | (Reference value) |
| ESPB2 — ESPB21 | | 300 VDC, 5-A resistor load | DC5V 10mA |
| ESPB3 — ESPB31 | | | |
| ESPB4 — ESPB41 | | | |



Example of the connection with the safety relay unit



External emergency stop input



These terminals are factory-jumpered. When using external emergency stop inputs, remove the short-circuit plate.

| Signal | Description | Current, voltage |
|--------------------------------|--|---------------------------------------|
| EES1 EES11 EES2 EES21 | Connect the contacts of the external emergency stop switch to these terminals. When a contact is open, the servo power supply is turned off, and the robot is immediately placed in the emergency stop state. When using the contacts of a relay or contactor instead of the switch, connect a spark killer to the coil of the relay or contactor, to suppress noise. When these terminals are not used, jumper them. | Open and close of 24VDC 0.1A (Note 1) |
| EAS1 EAS11 EAS2 EAS21 | These signals are used to stop the robot safely when the safety fence gate is opened during operation in the AUTO mode. When a contact is open, the robot decelerates then stops, and the servo power supply is turned off. In the T1 or T2 mode, the robot can be operated even when the safety fence gate is open. When using the contacts of a relay or contactor instead of the switch, connect a spark killer to the coil of the relay or contactor, to suppress noise. When these terminals are not used, jumper them. | Open and close of 24VDC 0.1A (Note 1) |

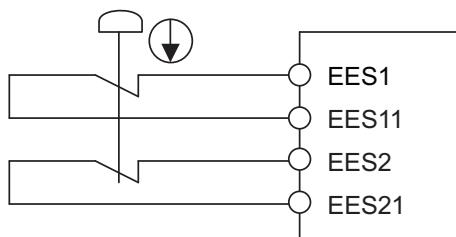
NOTE

Use a contact which minimum load is 5 mA less.

Examples of connection of duplicate safety signals

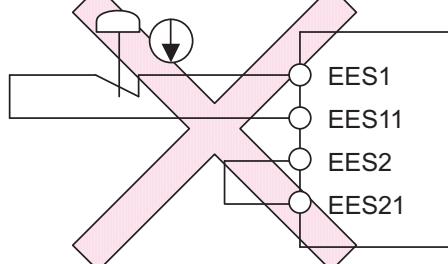
Correct connection

External emergency stop switch



Wrong connection

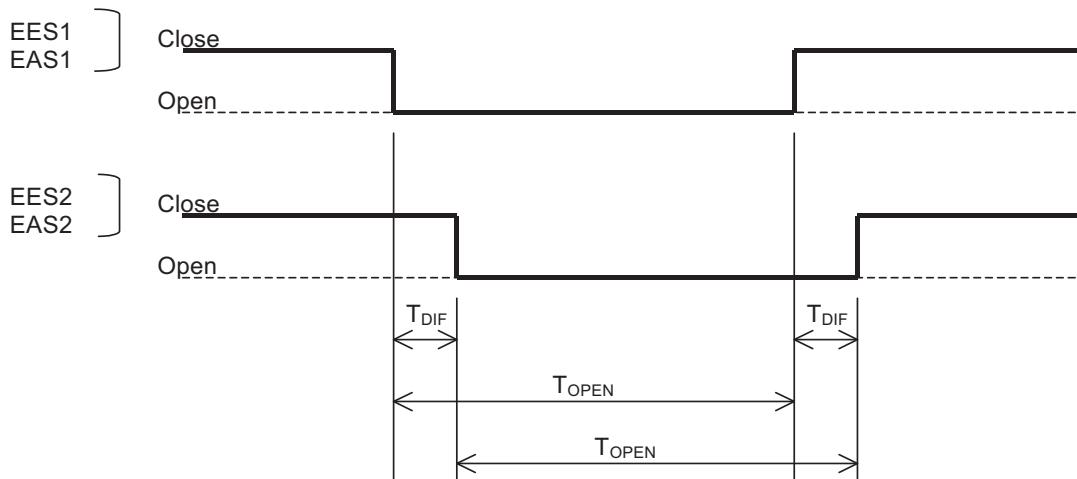
External emergency stop switch



Discrepancy in duplicate inputs results in an alarm.

Input timing of duplicate safety signals

Duplicate inputs are used for signals such as the external emergency stop signal, safety fence signal, and servo off signal so that a response is made even when a single failure occurs. The statuses of these duplicate input signals must always be changed at the same timing according to the timing specifications provided in this section. The robot controller always checks that the statuses of the duplicate inputs are the same, and if the controller finds a discrepancy, it issues an alarm. If the timing specifications are not satisfied, an alarm may be issued because of a signal discrepancy.

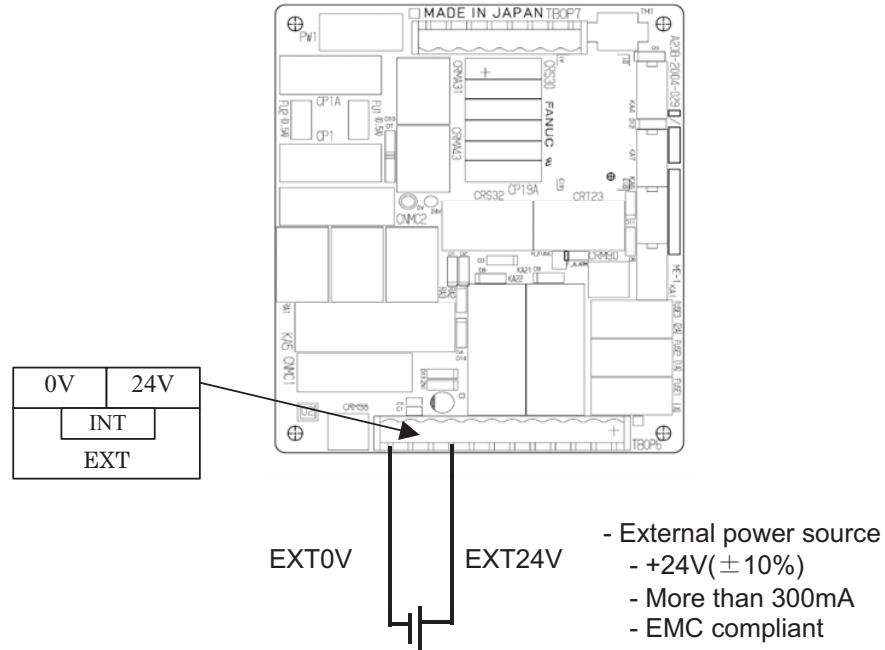


T_{DIF} (input time difference) < 200msec

T_{OPEN} (input hold period) > 2sec

Fig. 3.3.4(c) Input timing of duplicate safety signals

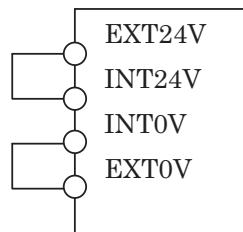
External power connection



The relays for emergency stop input and output can be separated from controller's power. Please connect external +24V instead of internal +24V, if emergency stop output must not be effected controller's power.

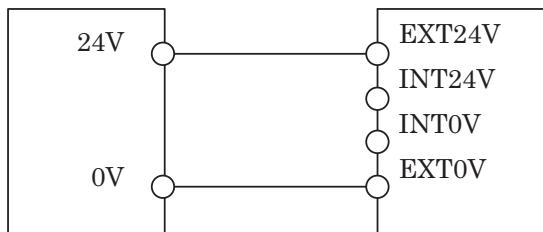
Example of the connection

In case of not using the external power source



In case of using the external power source

External power source



+24V($\pm 10\%$)
 More than 300mA
 EMC compliant

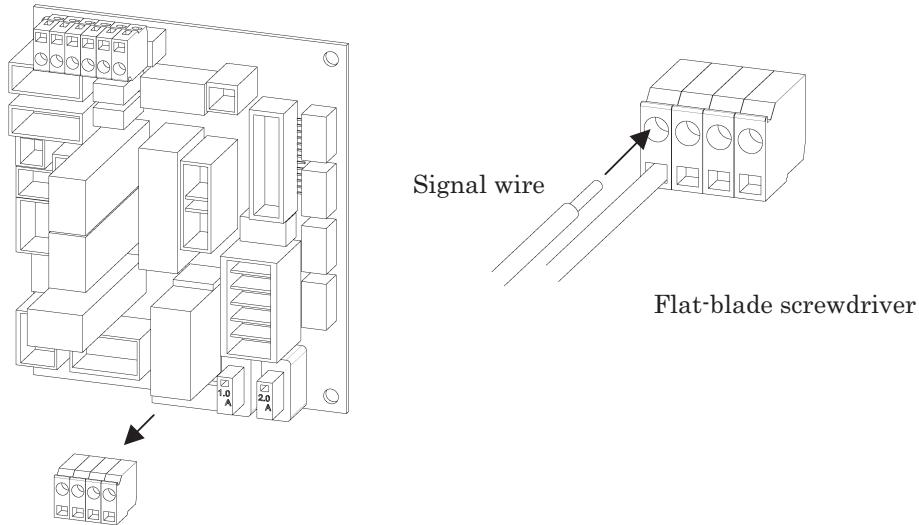
Connecting external on/off and external emergency stop signal input/output wires

| | FANUC's specification | Manufacturer's specification (WAGO) | Remark |
|--------------------------------|-----------------------|-------------------------------------|--|
| 8-pole terminal block (TBOP7) | A63L-0001-0783#308 | 231-311/026-000 | External emergency stop |
| 12-pole terminal block (TBOP6) | A63L-0001-0783#312 | 231-304/026-000 | External emergency stop |
| Jumper pin | A63L-0001-0783#902 | 231-902 | |
| Operation lever | A63L-0001-0783#131-M | 231-131 | 2 pieces of 231-131 and operation manual are included in FANUC's specification |

1. Detach the plug connector block from the panel board.
2. Insert the tip of a flat-blade screwdriver into the manipulation slot and push down its handle.
3. Insert the end of the signal wire into the wire slot.
4. Pull out the screwdriver.
5. Attach the plug connector block to the panel board.

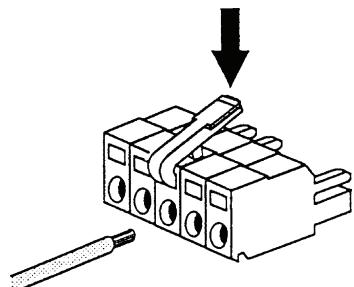
Do not insert a wire into the wire hole of a plug connector or pull it out with the plug connector block mounted on the panel board; otherwise, the panel board may be damaged.

FANUC recommends the lever (A05B-2400-K030) for connecting the signal wire to the plug connector block instead of Flat-blade screwdriver.

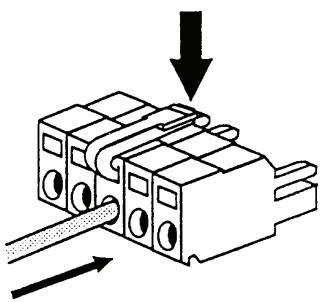


Wiring

(1) Pull down the lever.

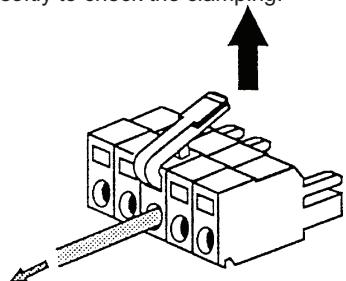


(2) Push in the conductor while holding the lever.



(3) Set the lever free.

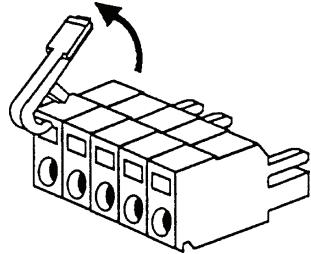
* In addition, pull the conductor softly to check the clamping.



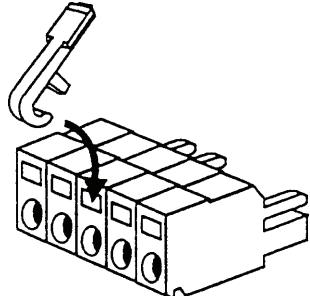
* Don't pull strongly.

Replace the lever

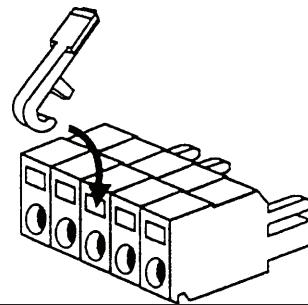
(1) Pull off the lever. Be careful not to lose the lever.



(2) Hook the lever to the rectangle hole.

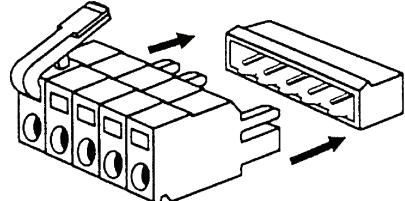


(3) Push down the lever until click in.

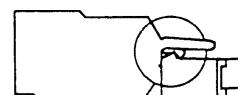


Fit to header

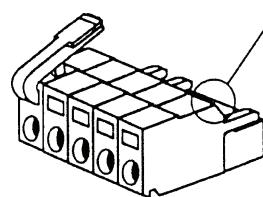
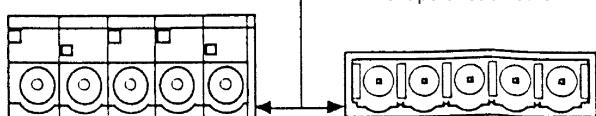
(1) Push in the connector to header.



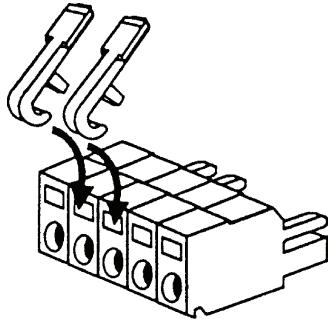
(2) Please check if the latch is hooked to header.



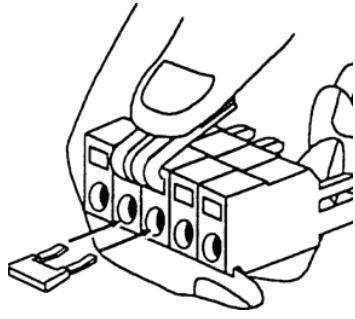
* Be careful to fit the shape of each other.



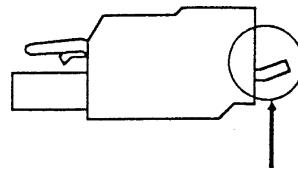
Installation of "Jumper"



(1) Attach levers to connector.



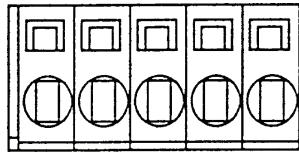
(2) Hold down levers at the same time, then put the jumper into connector.



* Please check the direction of the jumper.

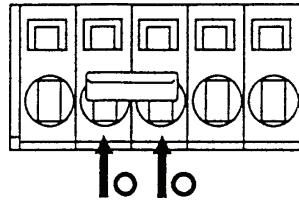
Availability of wires

- Without jumpers



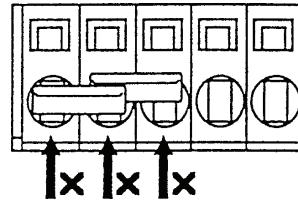
* Max wire size 0.2.0mm²
(AWG14) (with "Ferrule")

- With jumper



- Additional wire is available under the jumper.
* Max wire size 0.0.5mm² (AWG20)
(with "Ferrule")

- With two jumpers



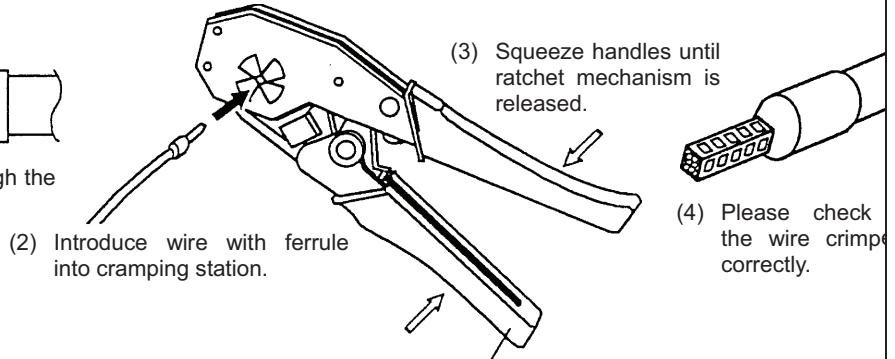
- Additional wire is not available under the jumper.

Installation of "Ferrules"



(1) Put the wire through the hole of ferrules.

(2) Introduce wire with ferrule into cramping station.



Crimping Tool (Specification : WAGO Item-No.206-204)

| Specifications of Ferrules | | WAGO Item-No. | Strand for mm ² (AWG) | Color | Stripped Length (m) | L | L1 | D (m) | D1 | D2 | Pack.-unit pcs |
|----------------------------|------|---------------|----------------------------------|--------------|---------------------|------|-----|-------|-----|-----|----------------|
| D2 | D1 | | | | | | | | | | |
| 0.21 | 0.08 | 216-301 | 0.25 | light yellow | 9.5 | 12.5 | 8.0 | 2.5 | 2.0 | 0.8 | 100 |
| 0.21 | 0.12 | 216-302 | 0.34 | light green | 9.5 | 12.5 | 8.0 | 2.5 | 2.0 | 0.8 | 100 |
| 0.21 | 0.18 | 216-201 | 0.5 | white | 9.5 | 14.0 | 8.0 | 3.1 | 2.6 | 1.0 | 100 |
| 0.21 | 0.25 | 216-202 | 0.75 | gray | 10.0 | 14.0 | 8.0 | 3.3 | 2.8 | 1.2 | 100 |
| 0.21 | 0.35 | 216-203 | 1.0 | red | 10.0 | 14.0 | 8.0 | 3.5 | 3.0 | 1.4 | 100 |
| 0.21 | 0.45 | 216-204 | 1.5 | black | 10.0 | 14.0 | 8.0 | 4.0 | 3.5 | 1.7 | 100 |
| 0.21 | 0.65 | 216-205 | 2.0 | black | 10.0 | 14.0 | 8.0 | 4.2 | 3.7 | 2.0 | 100 |

CAUTION Please make sure to use WAGO 206-204 to crimp the ferrules.

3.3.5 Connecting the Auxiliary Axis Brake (CRR65 A/B)

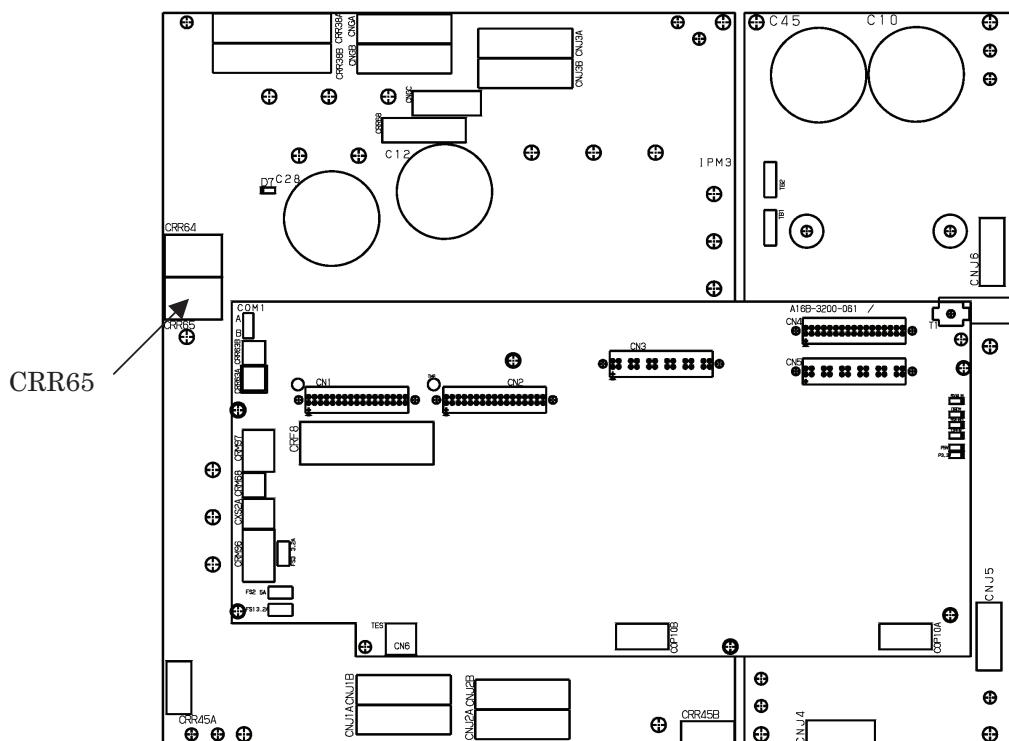


Fig.3.3.5 6-axis servo amplifier

Table 3.3.5 CRR65 A/B connector manufactured by Tyco Electronics AMP k.k.

| CRR65 A/B | | | |
|-----------|--------|----|--------|
| A1 | BKA1 | B1 | BKA2 |
| A2 | | B2 | |
| A3 | COMMON | B3 | COMMON |

Specification:

Rece-housing 1-178129-6: A63L-0001-0460#062KMXX

Rece-contact 175218-2: A63L-0001-0456#ASL

3.3.6 Connecting the Auxiliary Axis Over Travel (CRM68)

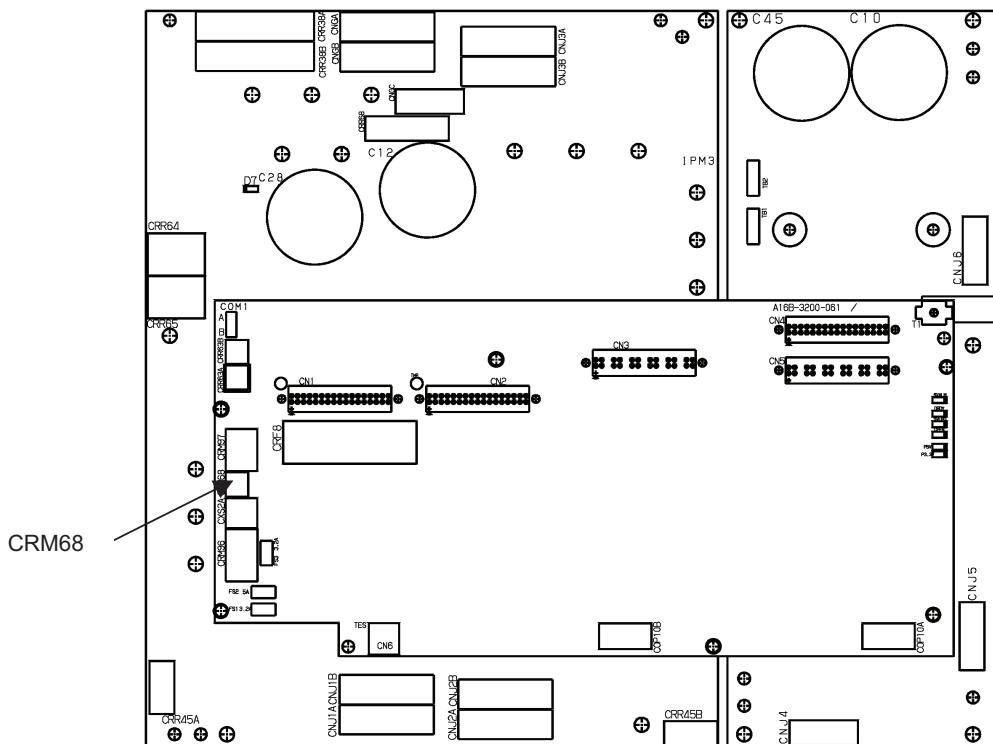


Fig.3.3.6 6-axis servo amplifier

Table 3.3.6 CRM68 connector manufactured by Tyco Electronics AMP k.k.

| CRM68 | |
|-------|--------|
| A1 | AUXOT1 |
| A2 | AUXOT2 |
| A3 | |

Specification:

Rece-housing 1-1318120-3: A63L-0001-0812#R03SX

Rece-contact 1318107-1: A63L-0001-0812#CRM

4 PERIPHERAL DEVICE AND END EFFECTOR INTERFACES

Table 4 lists the peripheral device interfaces of the R-30iA Mate.

Fig. 4 shows a peripheral device cable routing diagram.

Table 4 Peripheral device interface types

| No. | Name | Drawing number | Peripheral device interface | | | | Remarks | |
|-----|--------------|----------------|-----------------------------|----|--------|----|-----------------|--|
| | | | CRMA15 | | CRMA16 | | | |
| | | | DI | DO | DI | DO | | |
| 1a | Main board A | A20B-8200-0470 | 20 | 8 | 8 | 16 | Standard | |
| 1b | Main board B | A20B-8200-0471 | 20 | 8 | 8 | 16 | With Vision I/F | |

| No. | Name | Drawing number | Peripheral device interface | | | | Remarks | |
|-----|----------------------|----------------|-----------------------------|----|---------|----|---------|--|
| | | | CRMA52A | | CRMA52B | | | |
| | | | DI | DO | DI | DO | | |
| 2 | Process I/O board MA | A20B-2004-0380 | 10 | 8 | 10 | 8 | Option | |

| No. | Name | Drawing number | Peripheral device interface | | | | Remarks | |
|-----|----------------------|----------------|-----------------------------|----|-----|-----|---------|--|
| | | | CRW11 | | | | | |
| | | | WI | WO | D/A | A/D | | |
| 3 | Process I/O board MB | A20B-2101-0730 | 5 | 4 | 2 | 0 | Option | |

| No. | Name | Drawing number | Remarks |
|-----|---------------------------|----------------|---|
| 4 | Connector converter board | A20B-2004-0410 | This option board converts peripheral device interfaces CRMA15 and CRMA16 of the main board to the MR connector manufactured by Honda Tsushin Kogyo Co., LTD. |

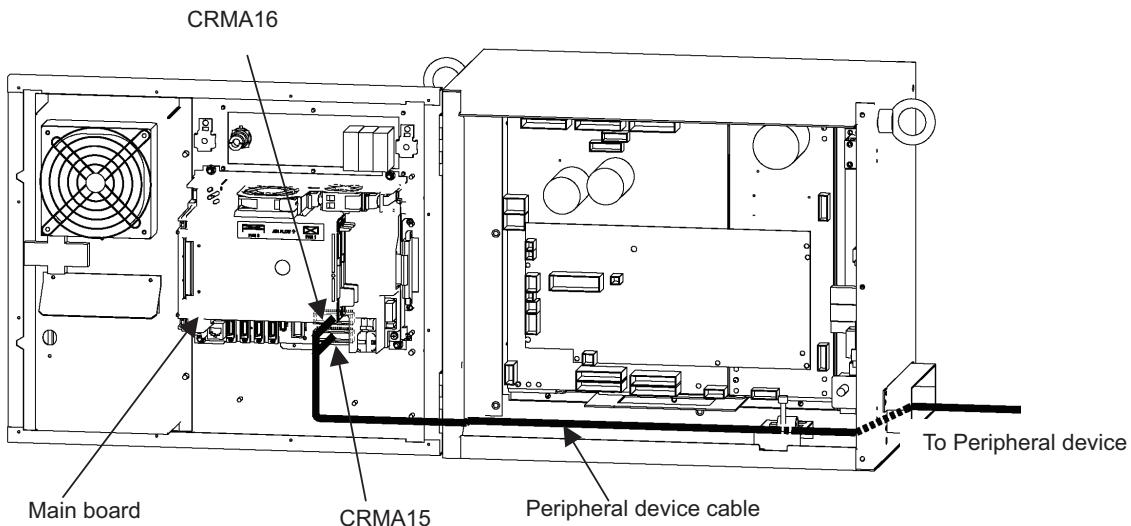


Fig. 4(a) Connecting the peripheral device cable (CRMA15, CRMA16)

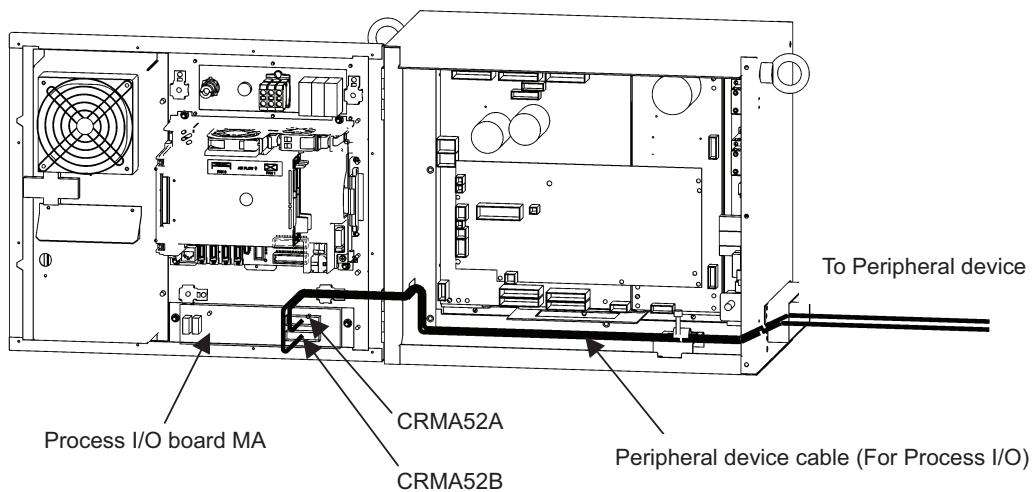


Fig. 4(b) Connecting the peripheral device cable (Process I/O board MA)

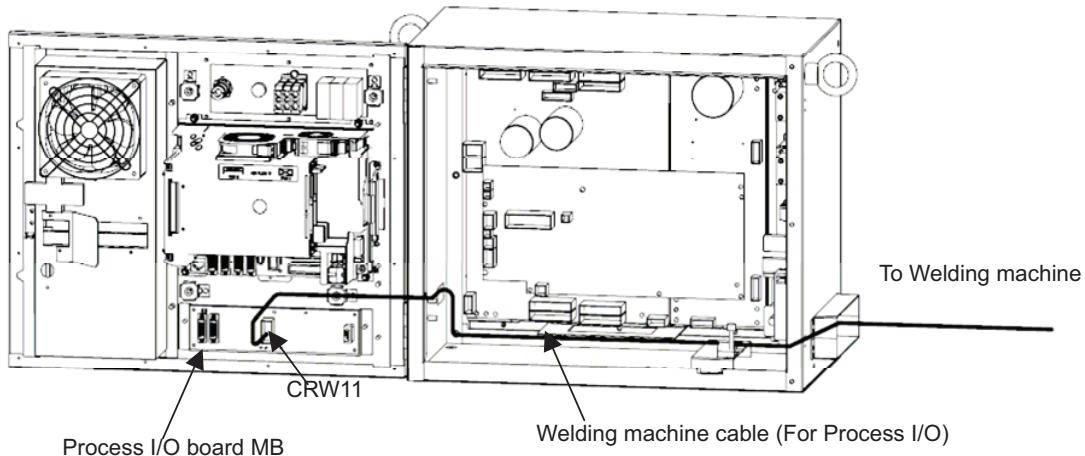


Fig. 4(c) Connecting the welding machine cable (Process I/O board MB)

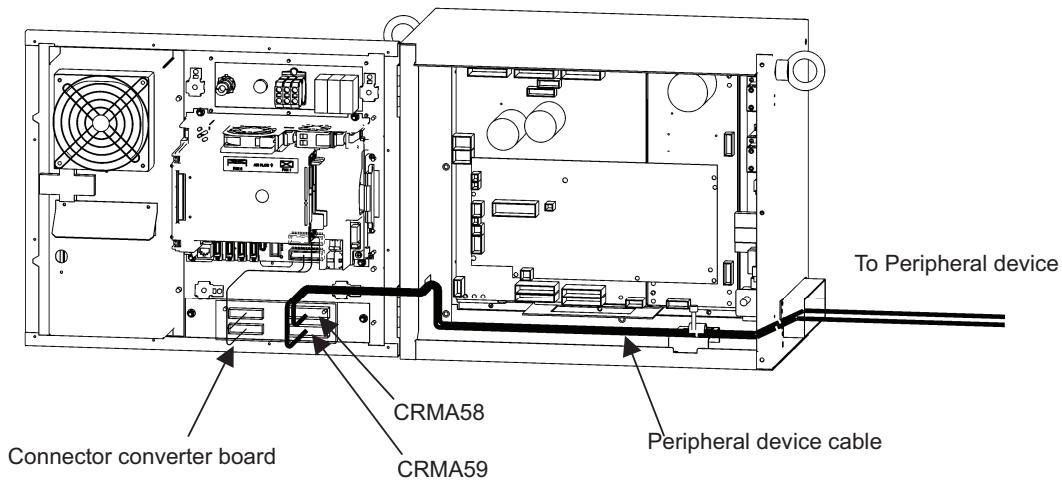


Fig. 4(d) Connecting the peripheral device cable (Connector converter board)

4.1 PERIPHERAL DEVICE INTERFACE BLOCK DIAGRAM

Following are a block diagram of the peripheral device interface and the specifications.

4.1.1 In case of Main board (CRMA15, CRMA16)

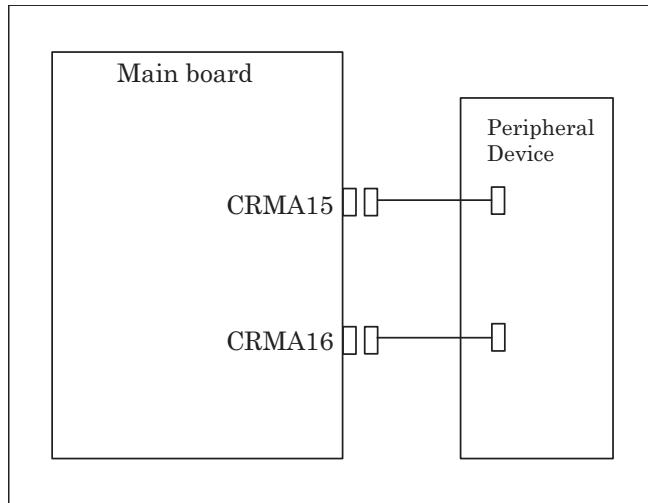
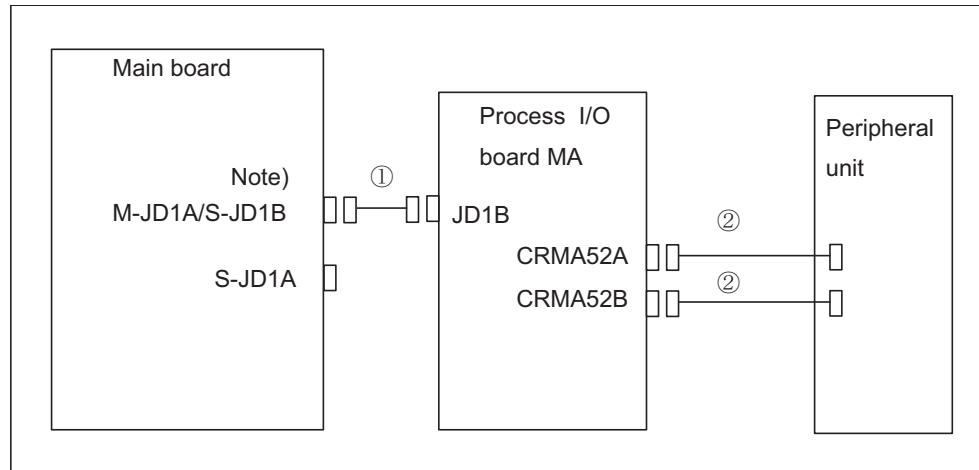


Fig.4.1.1 Block diagram of connecting peripheral device cable

| Name | Drawing number | Remarks |
|--|----------------|--|
| Peripheral device connection cable (For main board) | A05B-2550-J100 | Length: 10m (CRMA15) Length: 10m (CRMA16) |
| | A05B-2550-J101 | Length: 20m (CRMA15) Length: 20m (CRMA16) |

4.1.2 In the Case of the Process I/O Board MA

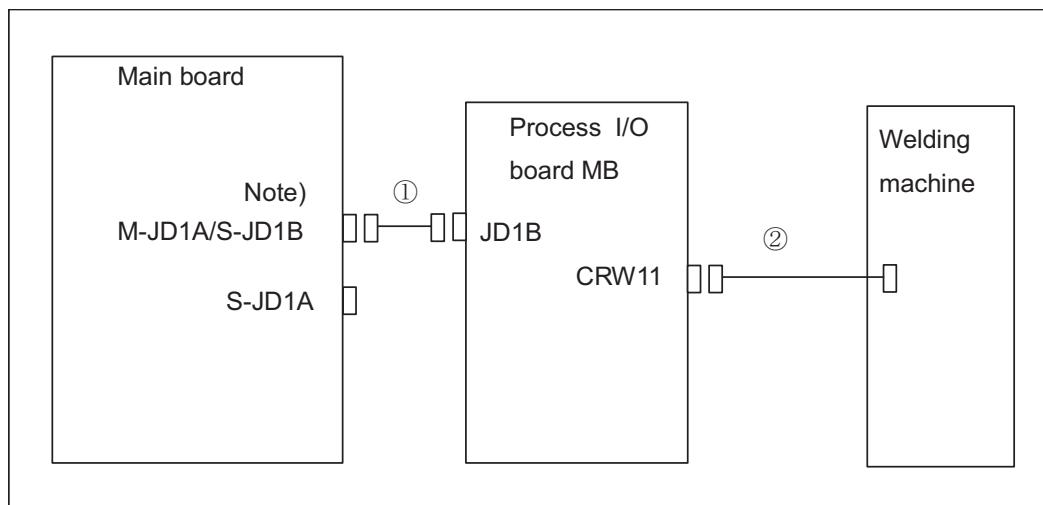


(Note) The connection depends on whether the R-30iA Mate is the I/O link master or an I/O link slave.
For details, see Section 3.2.1.

Fig. 4.1.2 Block diagram of the process I/O MA

| Component | Drawing number | Remark |
|---|----------------|--|
| <1> I/O link cable | - | Included in the process I/O board MA |
| <2> Peripheral device cable (For process I/O MA) | A05B-2550-J220 | Connection length 10m (one): CRMA52 |
| | A05B-2550-J221 | Connection length 20m (one): CRMA52 |

4.1.3 In the Case of the Process I/O Board MB

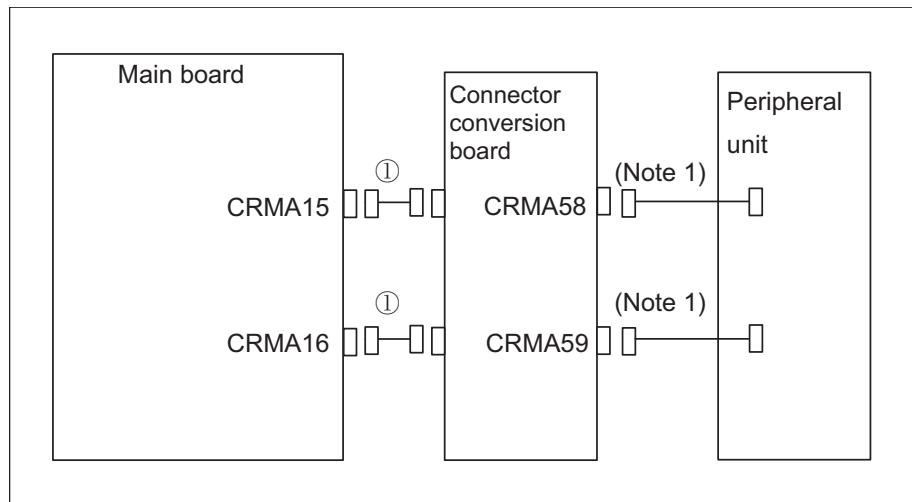


(Note) The connection depends on whether the R-30iA Mate is the I/O link master or an I/O link slave.
For details, see Section 3.2.1.

Fig. 4.1.3 Block diagram of the process I/O MB

| Component | Drawing number | Remark |
|--|----------------|--------------------------------------|
| <1> I/O link cable | - | Included in the process I/O board MB |
| <2> Welding machine connection cable (For process I/O MB) (FANUC interface/elbow type) | A05B-2552-J204 | Connection length 7m (one): CRW11 |

4.1.4 In the Case of the Connector Conversion Board



NOTE

This component is not provided by FANUC. The customer needs to obtain it. For details on the connection method, see "Connection between the peripheral devices and the controller".

Fig. 4.1.4 Connection diagram of the connector conversion board

| Component | Drawing number | Remark |
|----------------------|----------------|---|
| <1> Connection cable | - | Included in the I/O connector conversion board. |

4.2 I/O SIGNALS OF MAIN BOARD

There are 28 data inputs (DI) and 24 data outputs (DO) on main board.
Table 4.2 shows I/O signals of main board.

Table 4.2 I/O Signals of main board

| Connector number | Signal name | Description | Remarks |
|------------------|-------------|--------------------------|----------------|
| (DI signals) | | | |
| CRMA15-A5 | DI101 | Peripheral device status | General signal |
| CRMA15-B5 | DI102 | | |
| CRMA15-A6 | DI103 | | |
| CRMA15-B6 | DI104 | | |
| CRMA15-A7 | DI105 | | |
| CRMA15-B7 | DI106 | | |
| CRMA15-A8 | DI107 | | |
| CRMA15-B8 | DI108 | | |

| Connector number | Signal name | Description | Remarks |
|---------------------|-------------|----------------------------------|----------------|
| CRMA15-A9 | DI109 | | |
| CRMA15-B9 | DI110 | | |
| CRMA15-A10 | DI111 | | |
| CRMA15-B10 | DI112 | | |
| CRMA15-A11 | DI113 | | |
| CRMA15-B11 | DI114 | | |
| CRMA15-A12 | DI115 | | |
| CRMA15-B12 | DI116 | | |
| CRMA15-A13 | DI117 | | |
| CRMA15-B13 | DI118 | | |
| CRMA15-A14 | DI119 | | |
| CRMA15-B14 | DI120 | | |
| CRMA16-A5 | XHOLD | Temporary stop | |
| CRMA16-B5 | FAULT RESET | External reset | |
| CRMA16-A6 | START | Start | |
| CRMA16-B6 | ENBL | Operation enabled | |
| CRMA16-A7 | PNS1 | Robot service request | |
| CRMA16-B7 | PNS2 | | |
| CRMA16-A8 | PNS3 | | |
| CRMA16-B8 | PNS4 | | |
| (DO signals) | | | |
| CRMA15-A15 | DO101 | Peripheral device control signal | General signal |
| CRMA15-B15 | DO102 | | |
| CRMA15-A16 | DO103 | | |
| CRMA15-B16 | DO104 | | |
| CRMA15-A17 | DO105 | | |
| CRMA15-B17 | DO106 | | |
| CRMA15-A18 | DO107 | | |
| CRMA15-B18 | DO108 | | |
| CRMA16-A10 | DO109 | | |
| CRMA16-B10 | DO110 | | |
| CRMA16-A11 | DO111 | | |
| CRMA16-B11 | DO112 | | |
| CRMA16-A12 | DO113 | | |
| CRMA16-B12 | DO114 | | |
| CRMA16-A13 | DO115 | | |
| CRMA16-B13 | DO116 | | |
| CRMA16-A14 | DO117 | | |
| CRMA16-B14 | DO118 | | |
| CRMA16-A15 | DO119 | | |
| CRMA16-B15 | DO120 | | |
| CRMA16-A16 | CMDENBL | During automatic operation | |
| CRMA16-B16 | FAULT | Alarm | |
| CRMA16-A17 | BATALM | Battery voltage drop | |
| CRMA16-B17 | BUSY | During operation | |

4.3 INTERFACE FOR PERIPHERAL DEVICES

4.3.1 Connection between the Main board (CRMA15, CRMA16) and Peripheral Devices

| Peripheral device control interface A1 (source type DO) | | |
|---|----------|----------|
| CRMA15 | | |
| 01 | A 24F | B 24F |
| 02 | A 24F | B 24F |
| 03 | SDICOM1 | SDICOM2 |
| 04 | 0V | 0V |
| 05 | DI101 | DI102 |
| 06 | DI103 | DI104 |
| 07 | DI105 | DI106 |
| 08 | DI107 | DI108 |
| 09 | DI109 | DI110 |
| 10 | DI111 | DI112 |
| 11 | DI113 | DI114 |
| 12 | DI115 | DI116 |
| 13 | DI117 | DI118 |
| 14 | DI119 | DI120 |
| 15 | DO101 | DO102 |
| 16 | DO103 | DO104 |
| 17 | DO105 | DO106 |
| 18 | DO107 | DO108 |
| 19 | 0V | 0V |
| 20 | DOSRC1 | DOSRC1 |

| Peripheral device control interface A2 (source type DO) | | |
|---|----------|----------|
| CRMA16 | | |
| 01 | A 24F | B 24F |
| 02 | A 24F | B 24F |
| 03 | SDICOM3 | |
| 04 | 0V | 0V |
| 05 | XHOLD | RESET |
| 06 | START | ENBL |
| 07 | PNS1 | PNS2 |
| 08 | PNS3 | PNS4 |
| 09 | | |
| 10 | DO109 | DO110 |
| 11 | DO111 | DO112 |
| 12 | DO113 | DO114 |
| 13 | DO115 | DO116 |
| 14 | DO117 | DO118 |
| 15 | DO119 | DO120 |
| 16 | CMDENBL | FAULT |
| 17 | BATALM | BUSY |
| 18 | | |
| 19 | 0V | 0V |
| 20 | DOSRC2 | DOSRC2 |

SDICOM1~3 signal are common selection signal for SDI.

When +24F common is used, connect to 0V.

When 0V common is used, connect to +24F.

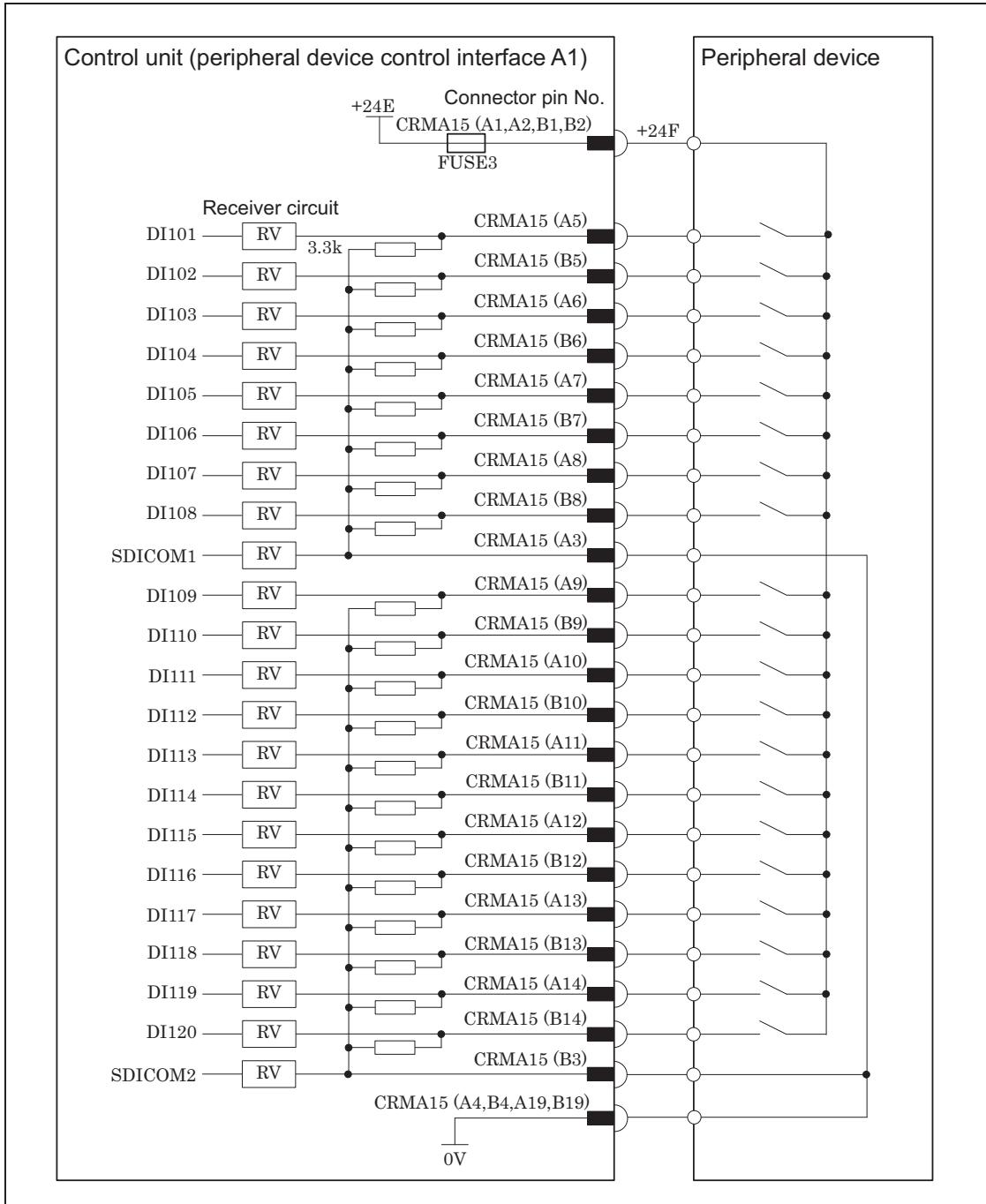
SDICOM1 → Selects a common for DI101~DI108.

SDICOM2 → Selects a common for DI109~DI120.

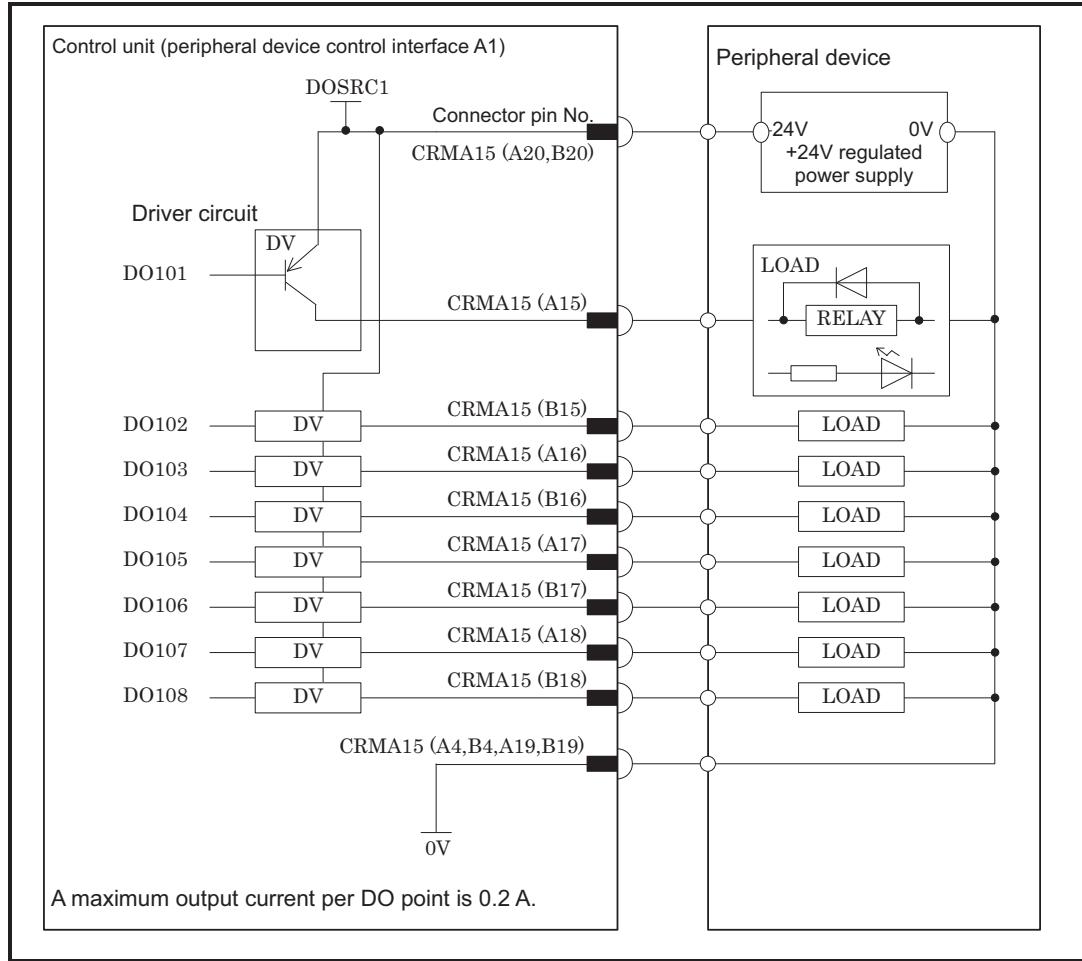
SDICOM3 → Selects a common for XHOLD、RESET、START、ENBL、PNS1～PNS4.

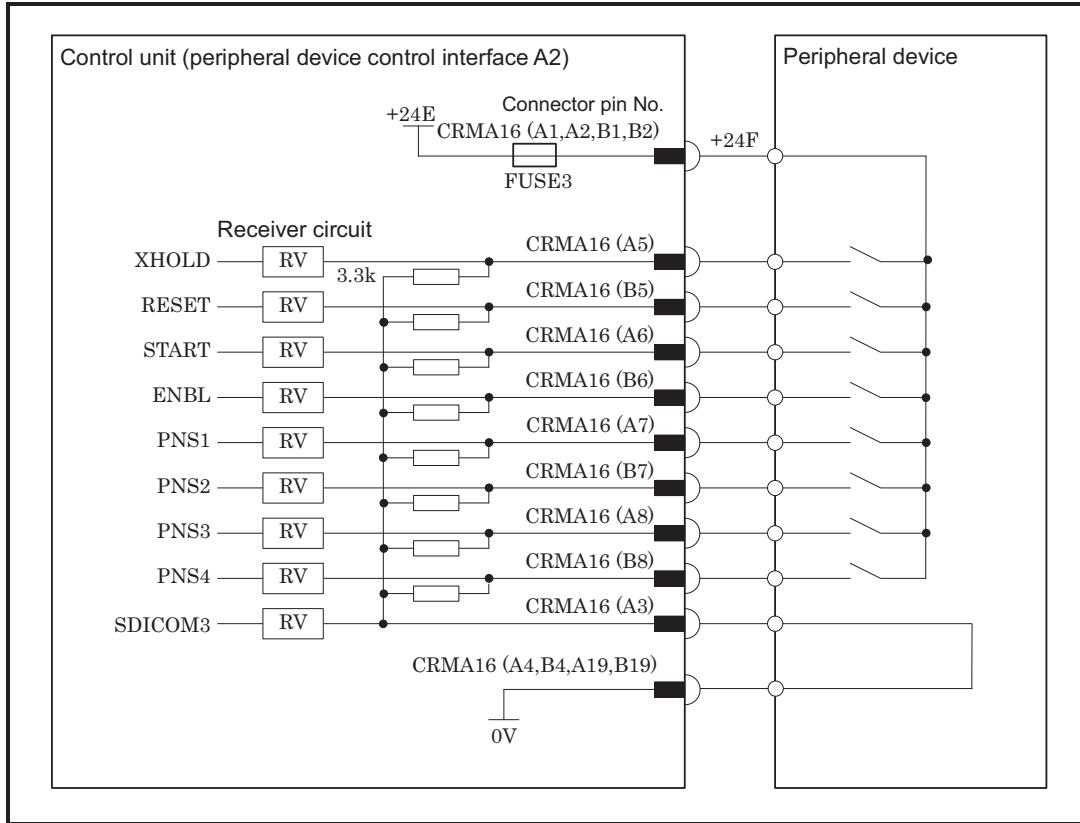
NOTE

- 1 The peripheral device connection cables are optional.
- 2 The DOSRC1 and DOSRC2 pins of the CRMA15 and CRMA16 are pins for supplying power to drivers. (None of these pins can be left open.)

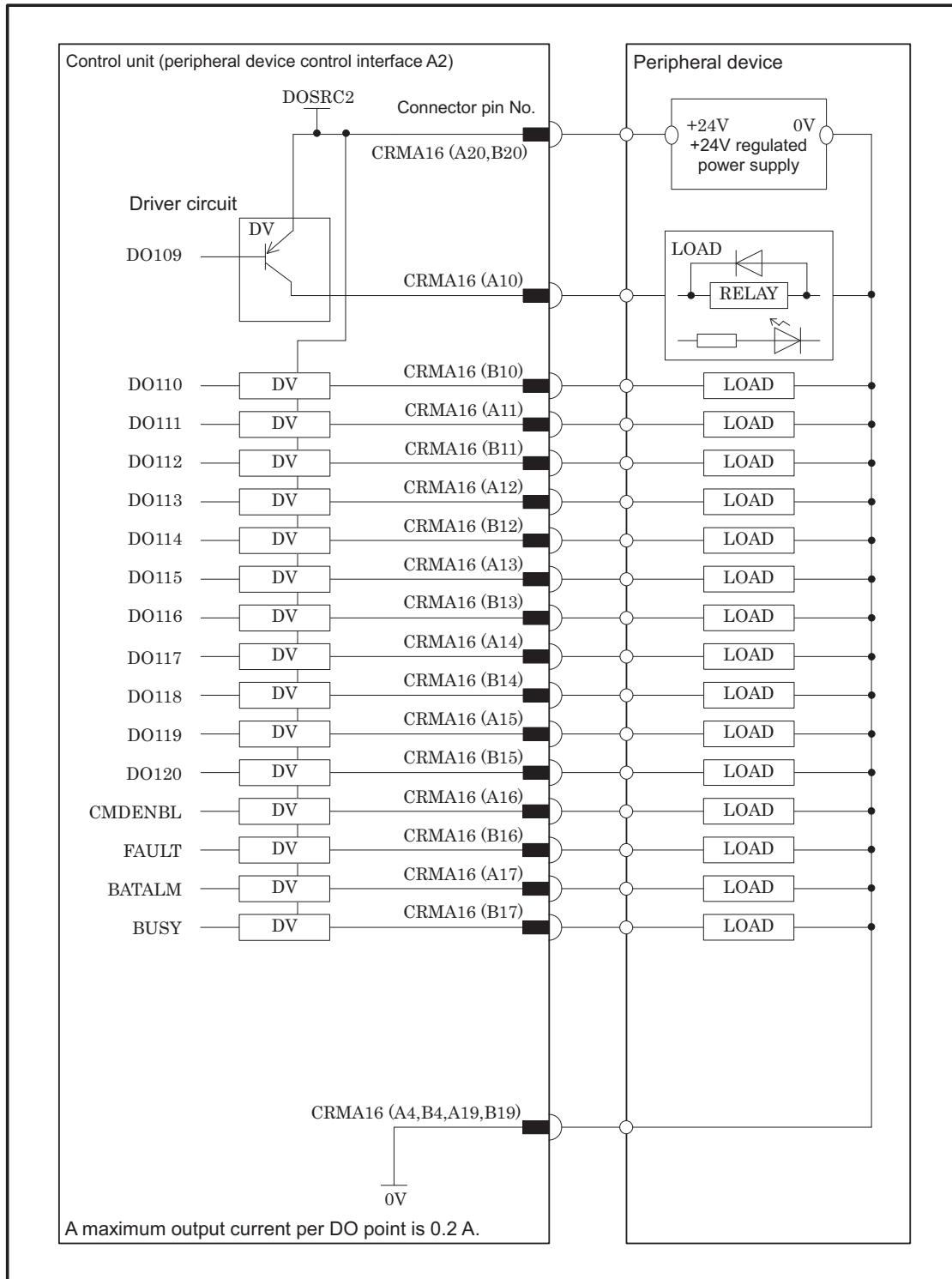

NOTE

In this diagram, common voltage of input devices is +24V.

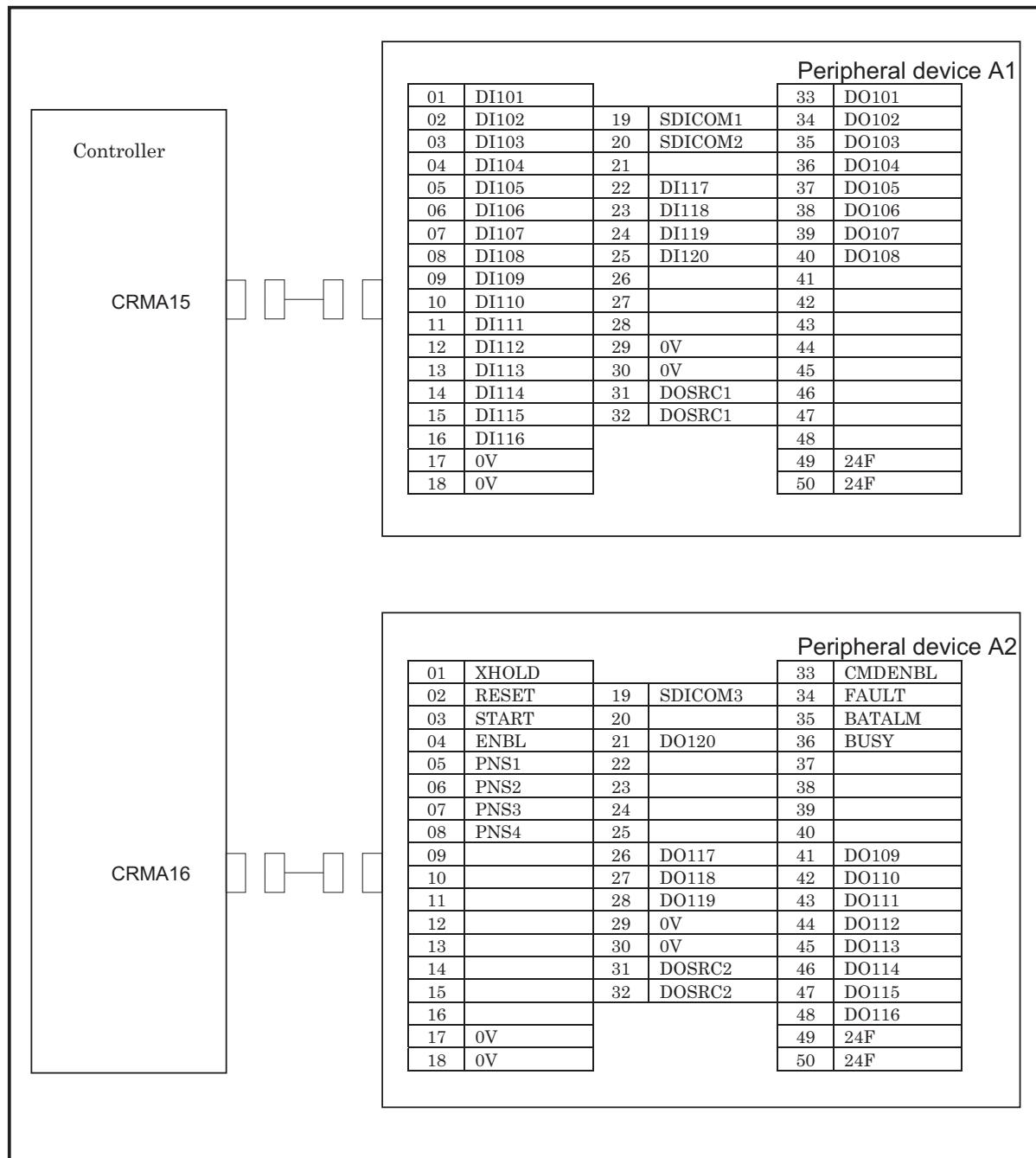


**NOTE**

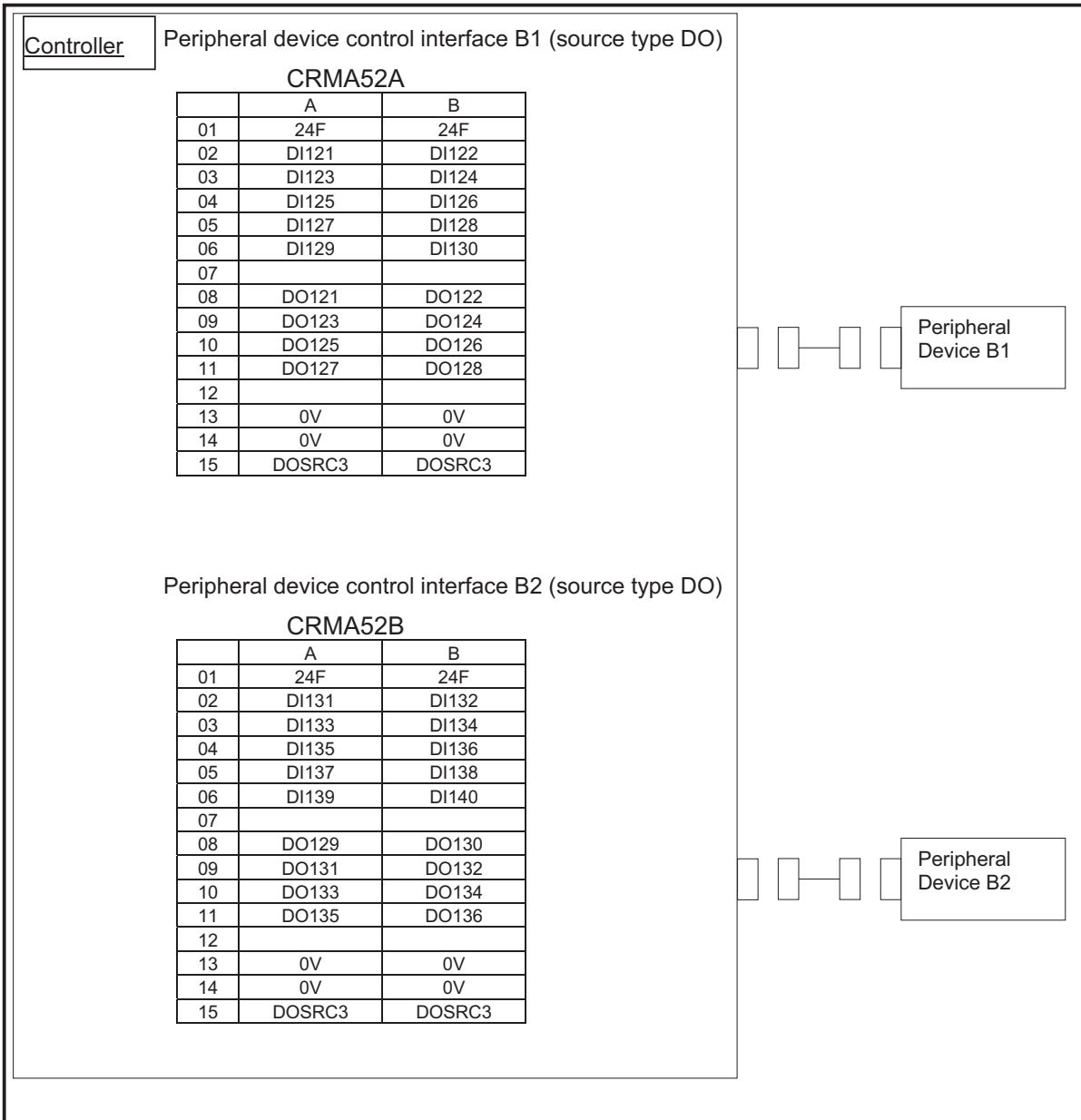
In this diagram, common voltage of input devices is +24V.



The following shows the connector interface of the optional peripheral device cables on the peripheral device side.

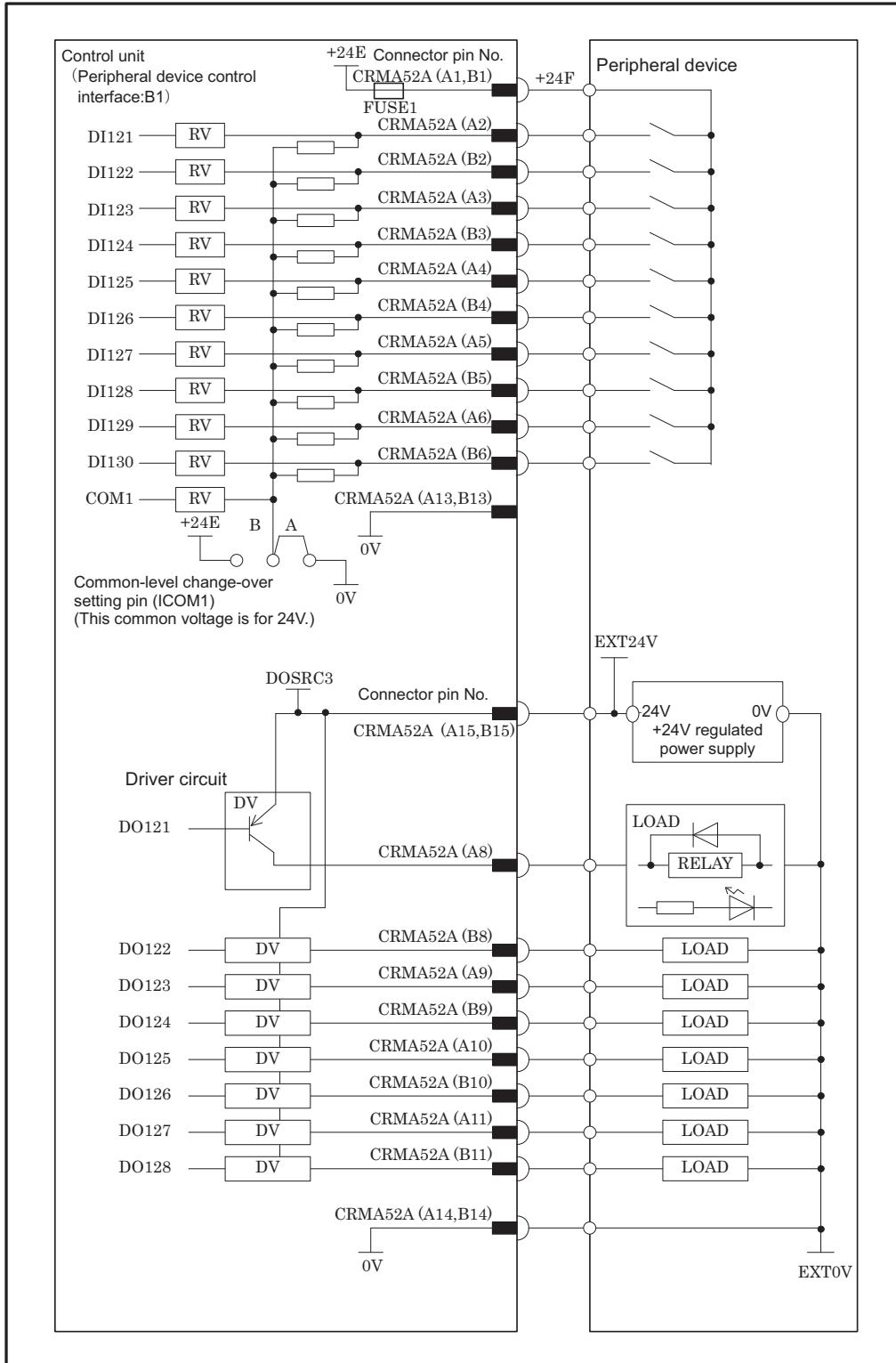


4.3.2 Connection between the Process I/O Board MA and Peripheral Devices

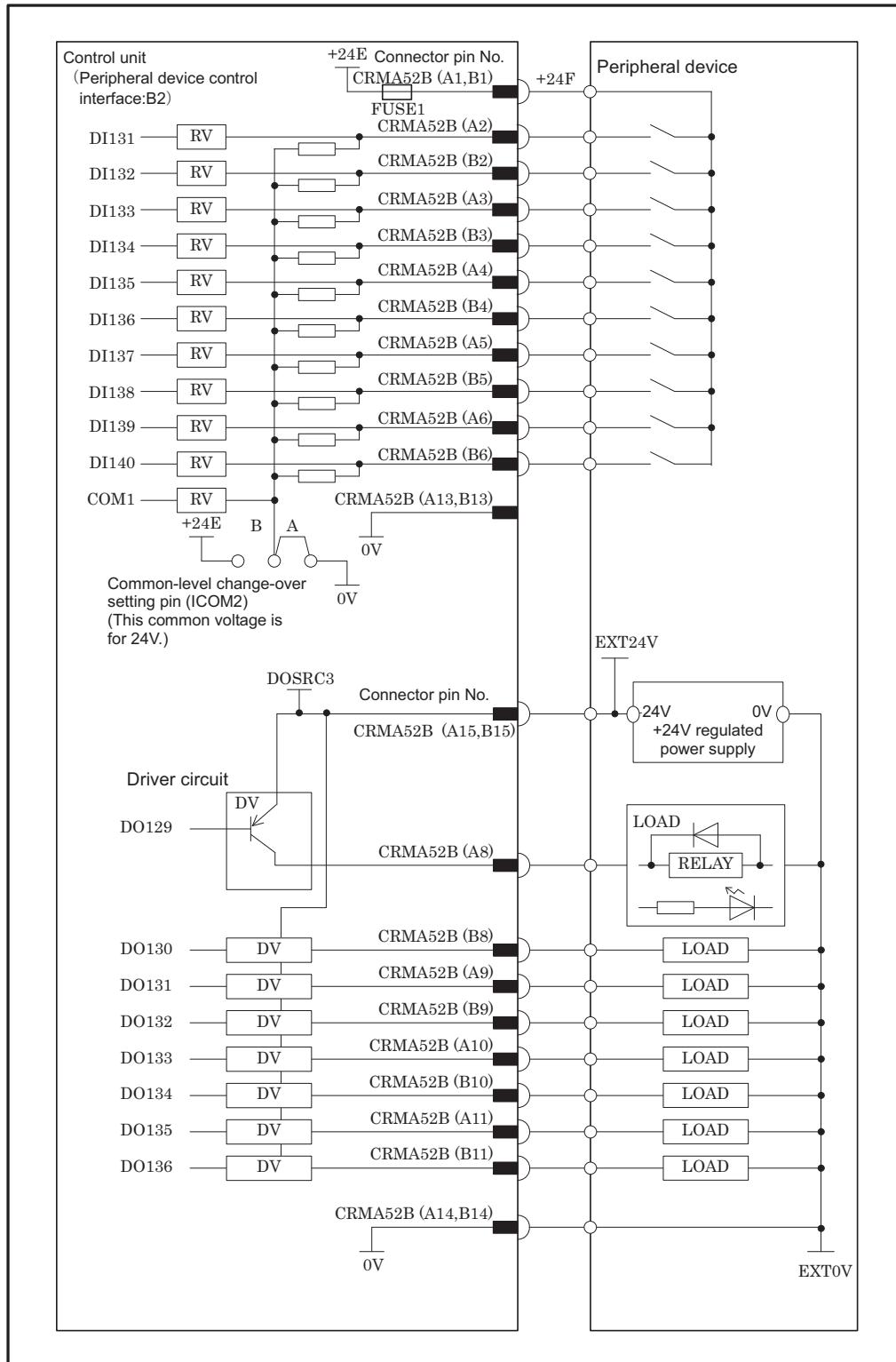


NOTE

- 1 The peripheral device connection cable is optional.
- 2 The DOSRC3 pin of CRMA52A and CRMA52B supply power to the drivers (connect all pins).

**NOTE**

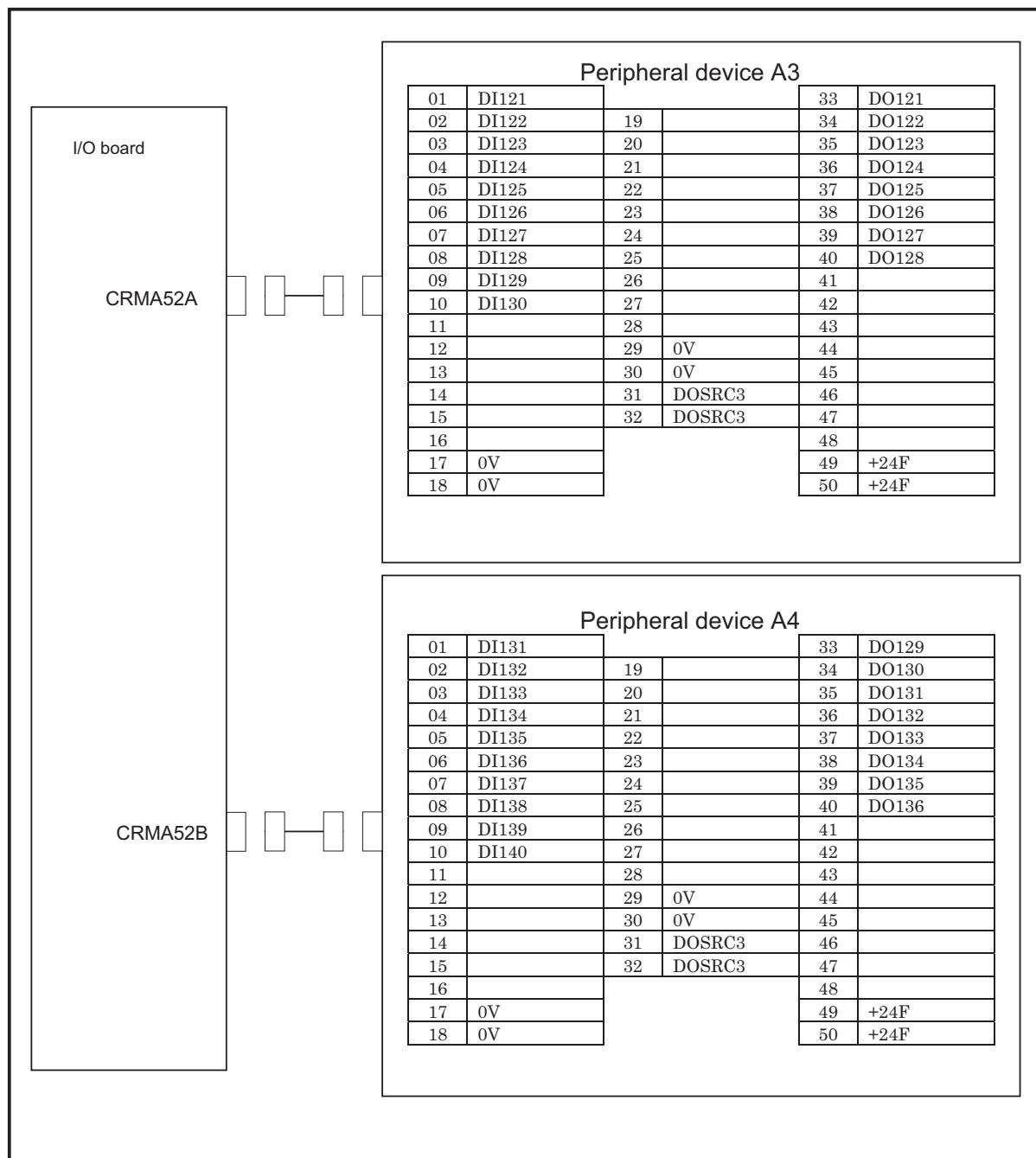
In this diagram, common voltage of input device is 24V.



NOTE

In this diagram, common voltage of input device is 24V.

The following shows the connector interface of the optional peripheral device cables on the peripheral device side.



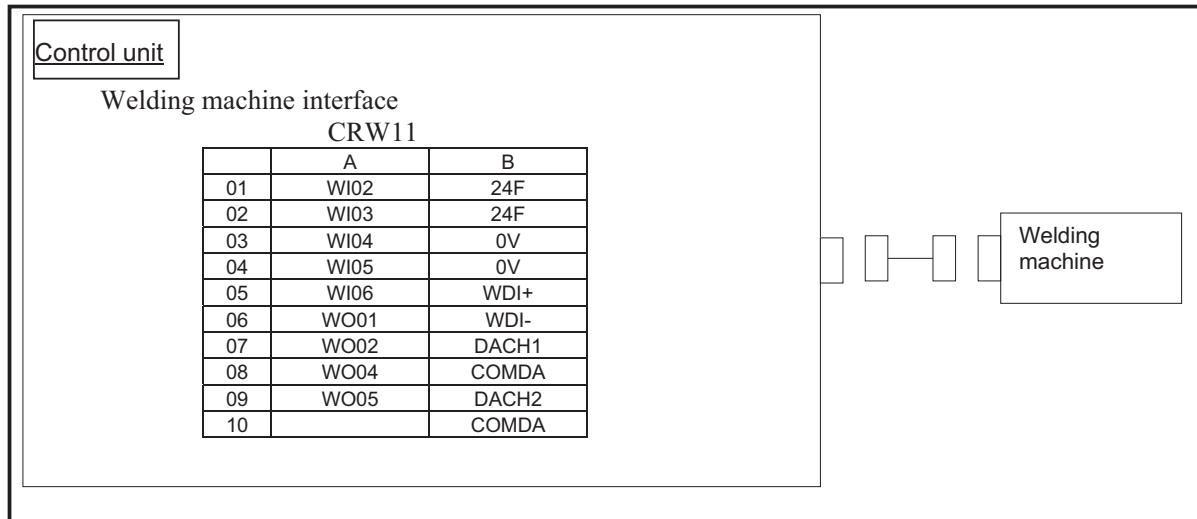
4.3.3 Connection between the Connector Conversion Board and Peripheral Devices

The connector interface of the optional connector conversion board is shown below. For electrical connection, see Section 4.3.1.

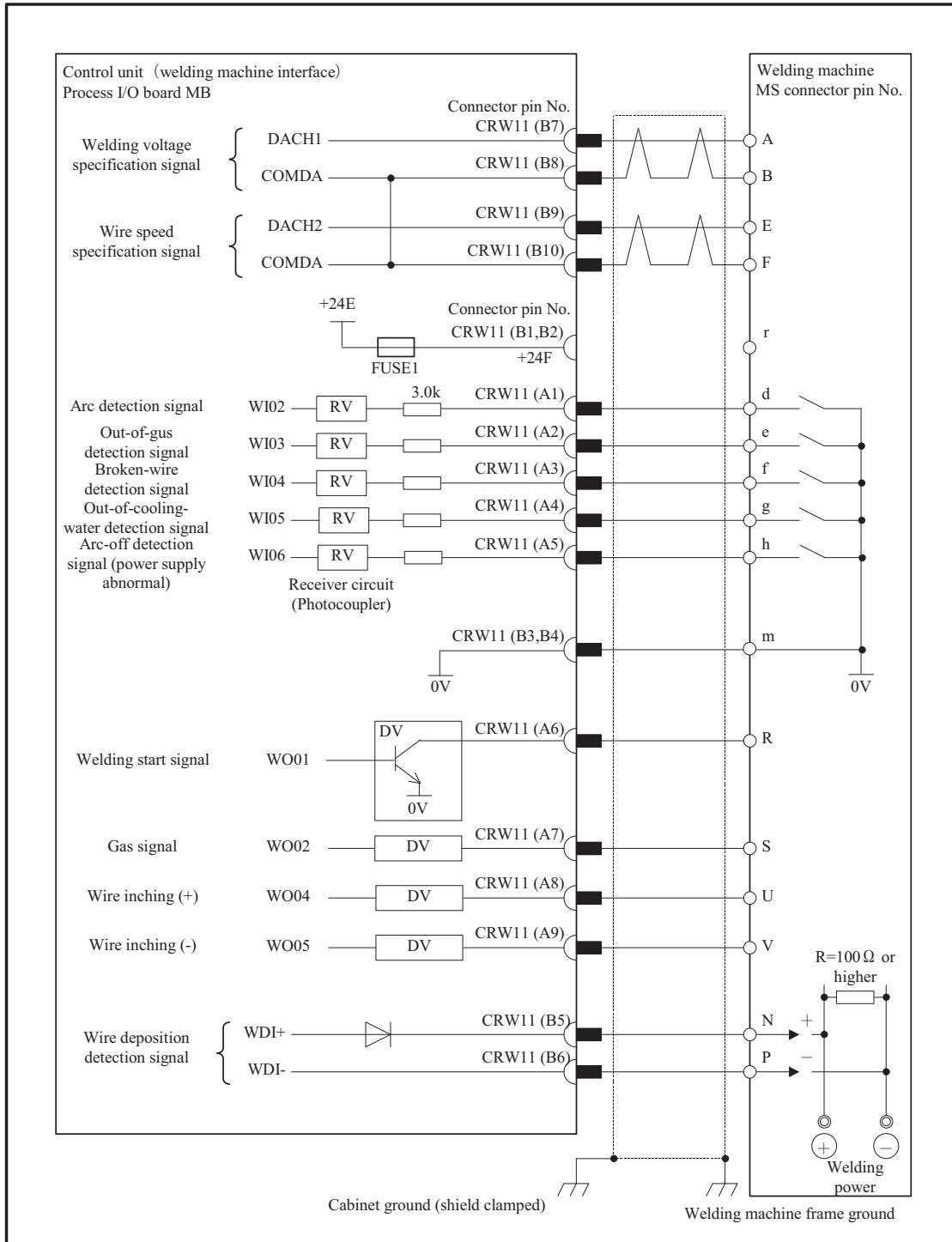
| Controller | | Peripheral device control interface C1 (Honda Tsushin Kogyo MR-50RFD) CRMA58 | | | |
|------------|-------|--|---------|----|-------|
| | | | | | |
| 01 | DI101 | | | 33 | DO101 |
| 02 | DI102 | 19 | SDICOM1 | 34 | DO102 |
| 03 | DI103 | 20 | SDICOM2 | 35 | DO103 |
| 04 | DI104 | 21 | | 36 | DO104 |
| 05 | DI105 | 22 | DI117 | 37 | DO105 |
| 06 | DI106 | 23 | DI118 | 38 | DO106 |
| 07 | DI107 | 24 | DI119 | 39 | DO107 |
| 08 | DI108 | 25 | DI120 | 40 | DO108 |
| 09 | DI109 | 26 | | 41 | |
| 10 | DI110 | 27 | | 42 | |
| 11 | DI111 | 28 | | 43 | |
| 12 | DI112 | 29 | 0V | 44 | |
| 13 | DI113 | 30 | 0V | 45 | |
| 14 | DI114 | 31 | DOSRC1 | 46 | |
| 15 | DI115 | 32 | DOSRC1 | 47 | |
| 16 | DI116 | | | 48 | |
| 17 | 0V | | | 49 | 24F |
| 18 | 0V | | | 50 | 24F |

| Peripheral device control interface C2 (Honda Tsushin Kogyo MR-50RFD) CRMA59 | | | | | |
|--|-------|----|---------|----|---------|
| | | | | | |
| 01 | XHOLD | | | 33 | CMDENBL |
| 02 | RESET | 19 | SDICOM3 | 34 | FAULT |
| 03 | START | 20 | | 35 | BATALM |
| 04 | ENBL | 21 | DO120 | 36 | BUSY |
| 05 | PNS1 | 22 | | 37 | |
| 06 | PNS2 | 23 | | 38 | |
| 07 | PNS3 | 24 | | 39 | |
| 08 | PNS4 | 25 | | 40 | |
| 09 | | 26 | DO117 | 41 | DO109 |
| 10 | | 27 | DO118 | 42 | DO110 |
| 11 | | 28 | DO119 | 43 | DO111 |
| 12 | | 29 | 0V | 44 | DO112 |
| 13 | | 30 | 0V | 45 | DO113 |
| 14 | | 31 | DOSRC2 | 46 | DO114 |
| 15 | | 32 | DOSRC2 | 47 | DO115 |
| 16 | | | | 48 | DO116 |
| 17 | 0V | | | 49 | 24F |
| 18 | 0V | | | 50 | 24F |

4.3.4 Connection between the Process I/O Board MB and Welding Machines

**NOTE**

- 1 The welding machine connection cable is optional.



**Pin-to-pin connection between CRW11 connector and welding machine connector (FANUC interface)
(analog output, welding wire deposition detection, WI/WO connection)**

4.4 INTERFACE FOR END EFFECTOR

4.4.1 Connection between the LR Mate 200iC, ARC Mate 50iC, M-1iA and End Effector

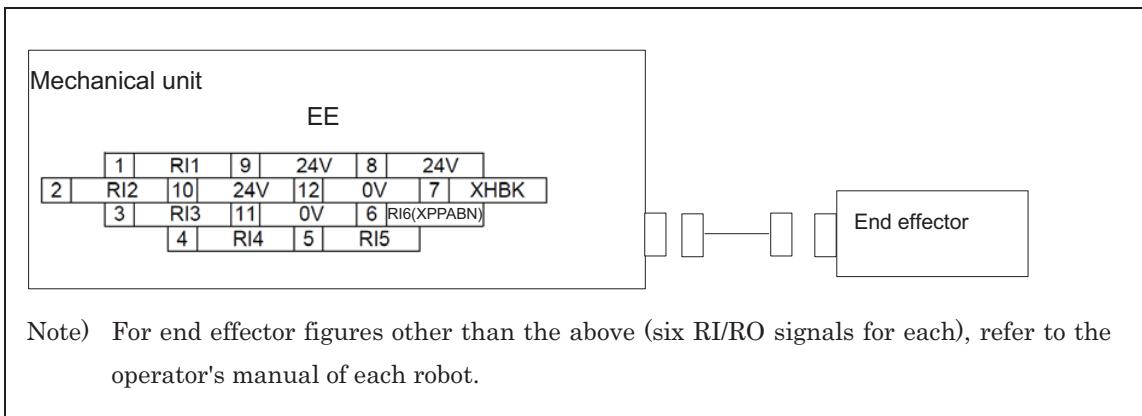


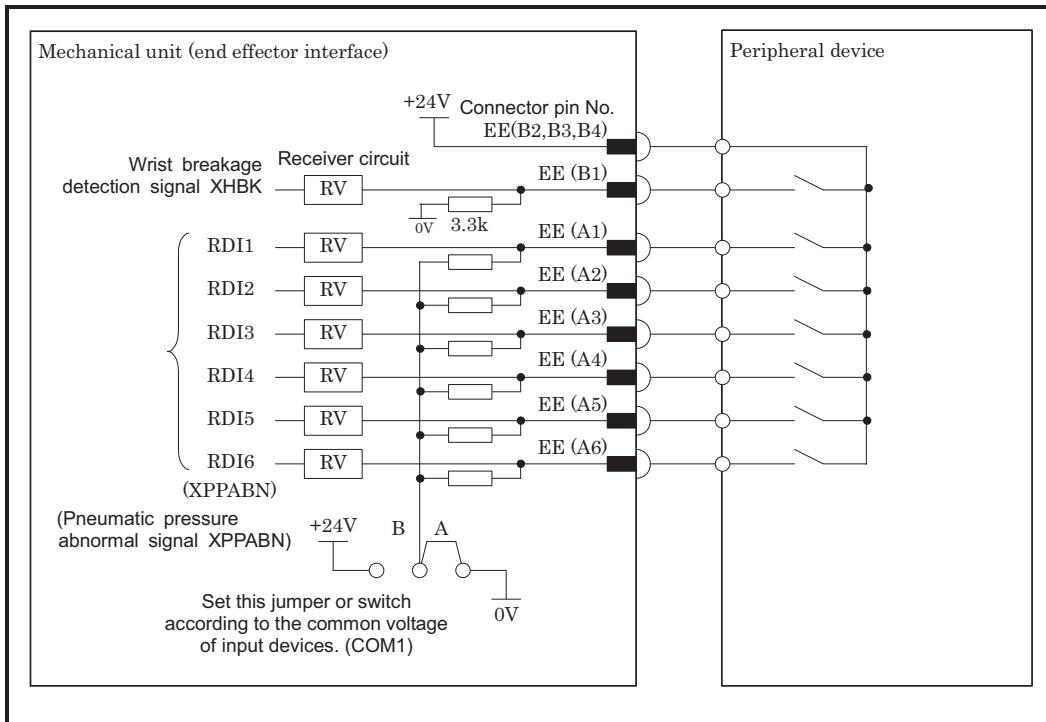
Fig.4.4.1 End effector interface

NOTE

RDO1 to RDO6 are used as the on/off signals of the solenoid valve option.

The RDI and XHBK signals can be used for the end effector.

For RDO, refer to the maintenance manual of the mechanical unit.



NOTE

- 1 In this diagram, common voltage of input devices is +24V.
- 2 The common-level change-over setting pin or switch (COM1) is in the 6-axis servo amplifier.

4.4.2 Connection between the ARC Mate 100iC/M-10iA ARC Mate, 120iC/M-20iA and End Effector

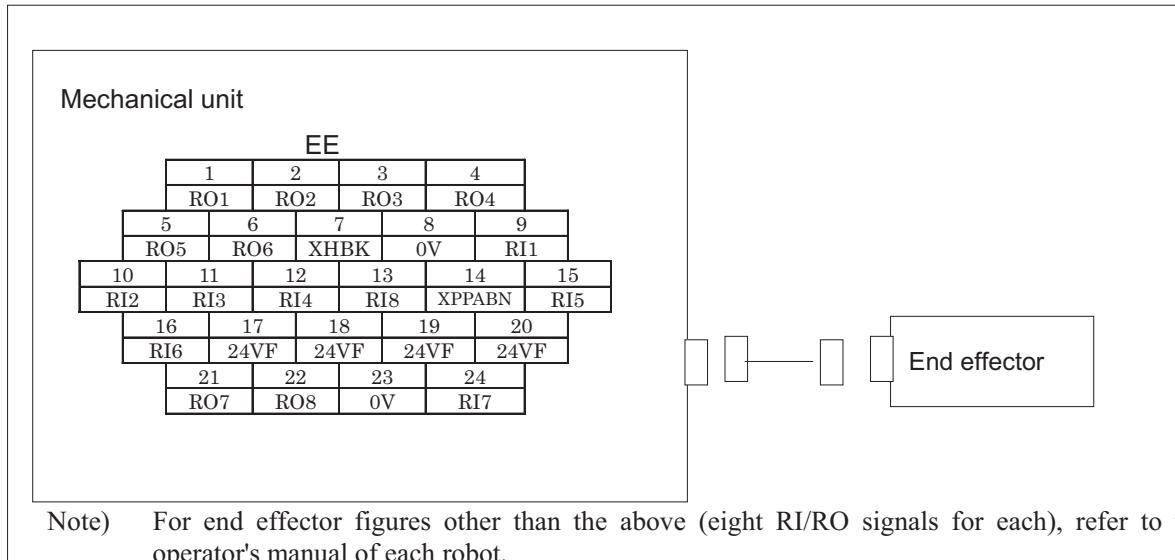
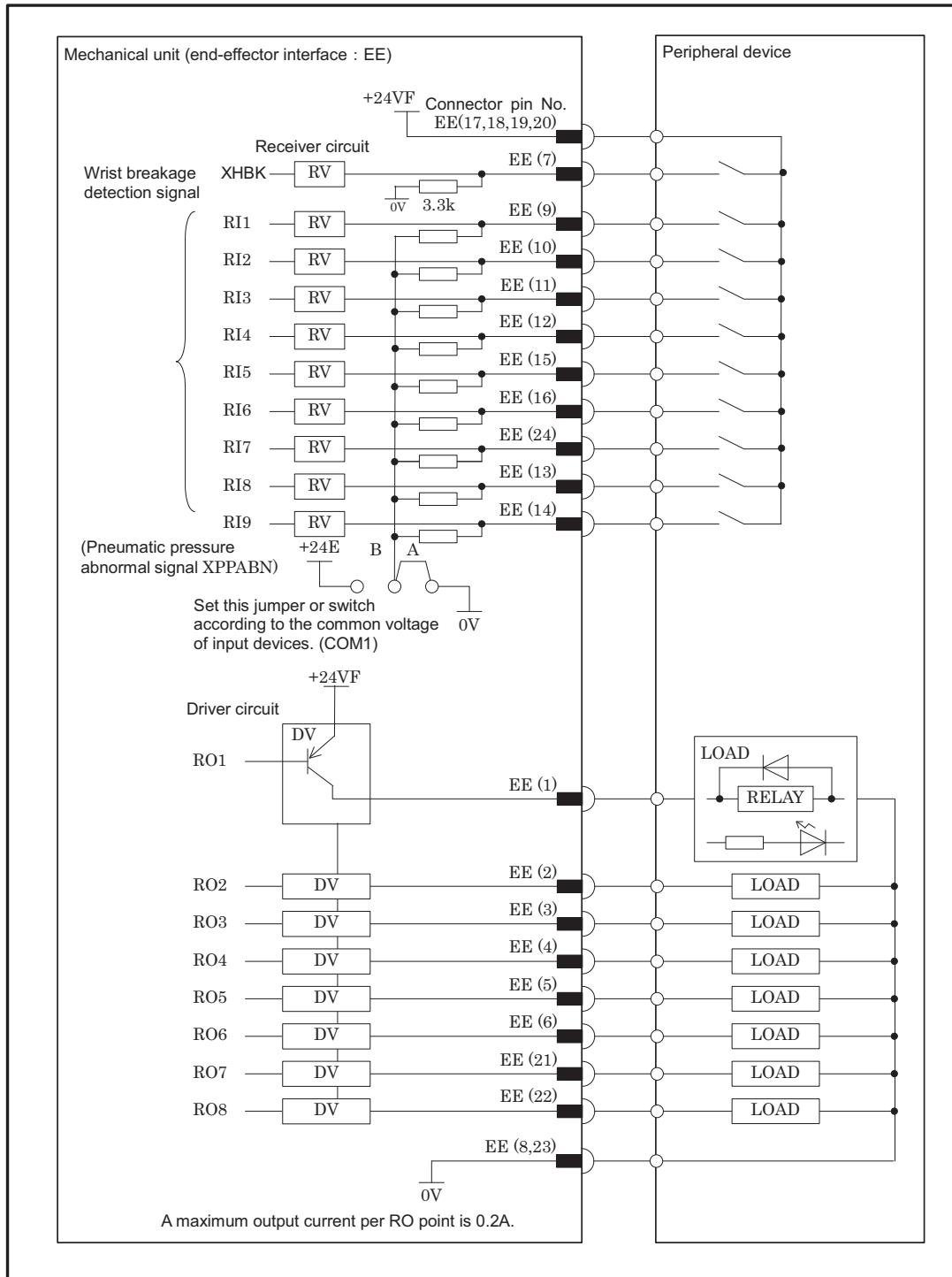


Fig. 4.4.2 Connection between the ARC Mate 100iC/M-10iA, ARC Mate 120iC/M-20iA and end effector

**NOTE**

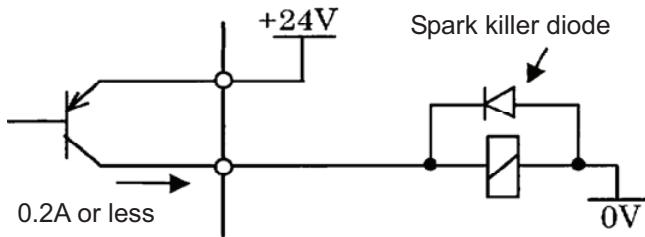
- 1 In this diagram, common voltage of input device is +24V.
- 2 The common-level change-over setting pin or switch (COM1) is in the 6-axis servo amplifier.

4.5 DIGITAL I/O SIGNAL SPECIFICATIONS

This section describes the specifications of the digital I/O signals interfaced with the peripheral device, end effector, and arc welder.

4.5.1 Peripheral Device Interface

- (1) Output signals in peripheral device interface A (Source type DO)
 - (a) Example of connection



- (b) Electrical specifications
 - Maximum load current when driver is on: 200 mA (including momentary level)
 - Saturation voltage when driver is on: 1.0 V max.
 - Dielectric strength: 24 V \pm 20% (including momentary level)
 - Leakage current when driver is off: 100 μ A
- (c) The external power supply to output signals must satisfy the following:
 - Power supply voltage: +24 V \pm 10%
 - Power supply current:
 - For each printed circuit board of this type
 - (Total sum of maximum load currents including momentary levels + 100 mA or more)
 - Power-on timing:
 - At the same time when the controller is turned on or earlier
 - Power-off timing:
 - At the same time when the controller is turned off or later
- (d) Spark killer diode
 - Rated peak reverse voltage: 100 V or more
 - Rated effective forward current: 1 A or more
- (e) Driver for output signals
 - In the driver device, the current of each output signal is monitored, and when an overcurrent is detected, the relevant output is turned off. After an output has been turned off by overcurrent, the overcurrent state is released because the output is off, so the output on state is restored. Therefore, in the ground fault or overcurrent state, the output is turned on and off repeatedly. Such a condition is found also when a load with a high surge current is connected.
 - The driver device also includes an overheat detection circuit, which turns off all outputs of the device when the internal temperature of the device has increased as a result of a continued overcurrent state due to a ground fault of an output and so on. The outputs are held off, but their normal states can be restored by turning the power to the controller on and off after the internal temperature of the device has lowered.
- (f) Note on use
 - When adding a relay, solenoid, or the like directly to the circuit, connect a diode for counter electromotive voltage protection in parallel to the load.

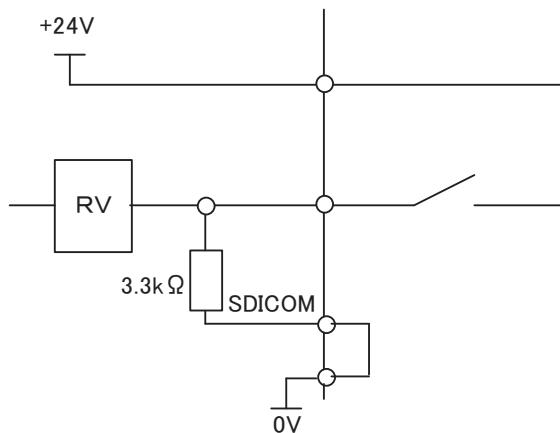
(g) Applicable signals

Output signals of main board I/O board CRMA15 and CRMA16
 CMDENBL, FAULT, BATALM, BUSY,
 DO101 to DO120

Output signals of Process I/O board CRMA52A and CRMA52B
 DO121 to DO136

(2) Input signals in peripheral device interface A

(a) Example of connection



(b) Electrical specifications of the receiver

Type: Grounded voltage receiver

Rated input voltage: Contact close

+20V to +28V

Contact open

0V to +4V

Maximum applied input voltage: +28VDC

Input impedance: 3.3kΩ (approx.)

Response time: 5ms to 20ms

(c) Specifications of the peripheral device contact

Voltage and Current: DC24V, 0.1A

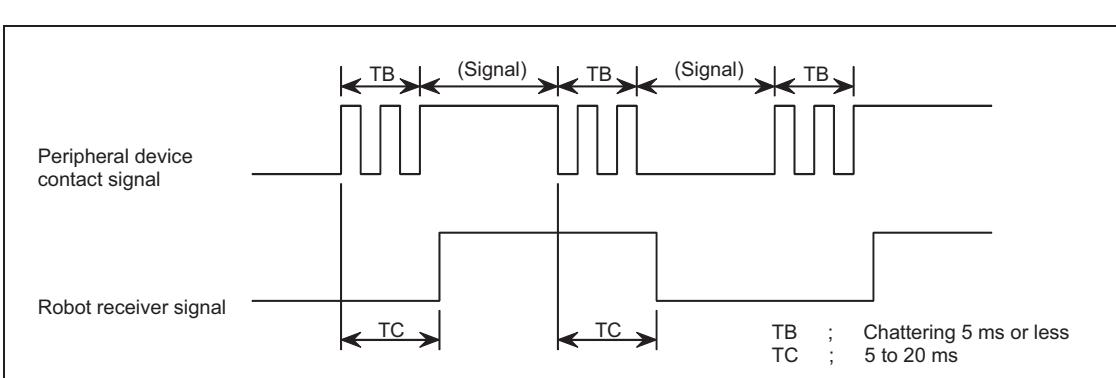
(Use a contact which minimum load is 5mA less.)

Input signal width: 200ms or more (on/off)

Chattering time: 5ms or less

Closed circuit resistance: 100Ω or less

Opened circuit resistance: 100kΩ or more



(d) Note on use

Apply the +24 V power at the robot to the receiver.

However, the above signal specifications must be satisfied at the robot receiver.

(e) Applicable signals

Input signals of main board CRMA15 and CRMA16

XHOLD, FAULT RESET, START, HOME, ENBL

DI101 to DI120

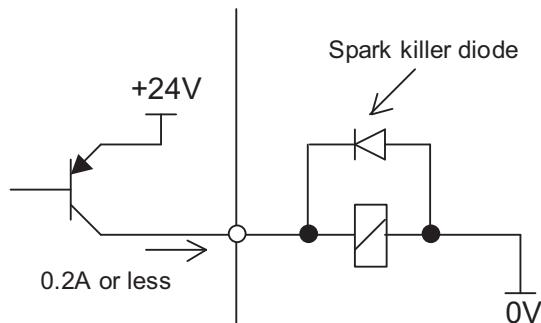
Input signals of Process I/O board CRMA52A and CRMA52B

DI121 to DI140

4.5.2 End Effector Control Interface

(1) Output signals in end effector interface

(a) Example of connection



(b) Electrical specifications

Maximum load current when driver is on: 200 mA (including momentary level)

Saturation voltage when driver is on: 1.0 V max.

Dielectric strength: 24 V \pm 20% (including momentary level)

Leakage current when driver is off: 100 μ A

(c) Power supply to output signals

The +24 V power supply on the robot side can be used if the total current level, including the current of the welding interface, is 0.7 A or less.

(d) Driver for output signals

In the driver device, the current of each output signal is monitored, and when an overcurrent is detected, the relevant output is turned off. After an output has been turned off by overcurrent, the overcurrent state is released because the output is off, so the output on state is restored. Therefore, in the ground fault or overcurrent state, the output is turned on and off repeatedly. Such a condition is found also when a load with a high surge current is connected.

The driver device also includes an overheat detection circuit, which turns off all outputs of the device when the internal temperature of the device has increased as a result of a continued overcurrent state due to a ground fault of an output and so on. The outputs are held off, but their normal states can be restored by turning the power to the controller on and off after the internal temperature of the device has lowered.

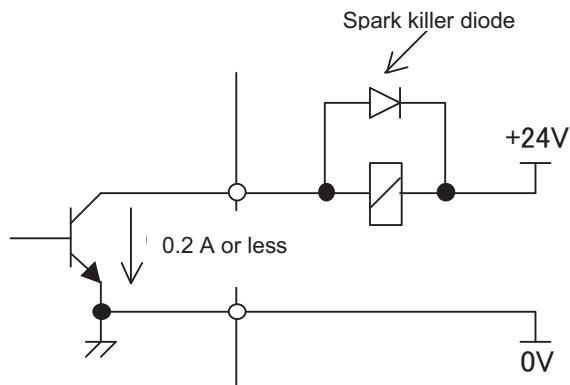
(e) Note on use

When adding a relay, solenoid, or the like directly to the circuit, connect a diode for counter electromotive voltage protection in parallel to the load.

- (f) Applicable signals
RO1 to RO8
- (2) Input signal in peripheral device interface
The input signals are the same as those of other I/O boards. (Refer to Subsection 4.5.1 in CONNECTIONS.)
(a) Applicable signals
RI1 to RI8, XHBN, XPPABN

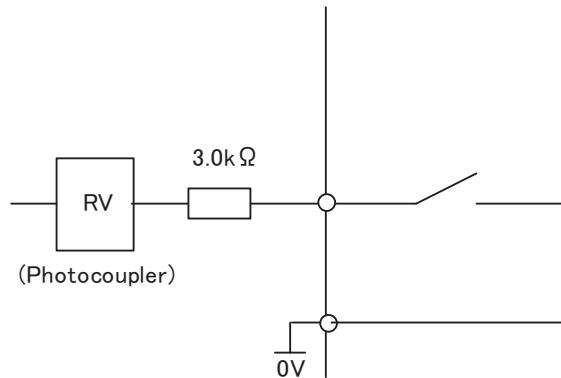
4.5.3 Specification for Arc Welding Machine interface Input/Output signals

- (1) Specification for arc welding machine interface digital output signals
(a) Example of connection



- (b) Electrical specifications
Rated voltage: 24VDC
Maximum applicable voltage: 30VDC
Maximum load current: 0.2A
Transistor type: Open-collector NPN
Saturation voltage when the circuit is on: Approximately 1.0V
- (c) Spark killer diode
Rated peak-to-peak reverse withstand voltage: 100 V or higher
Rated effective forward current: 1 A or more
- (d) Caution for use
The arc welding machine interface can use the +24V power supply of the robot unless the sum of its sink current and that of the end effector control interface exceeds 0.7A. When using a relay or solenoid directly as a load, connect the load and a back electromotive force voltage prevention diode in parallel.
When using a load, such as a lamp, that generates surge current when it is turned on, install a protection resistor.
- (e) Applicable signals
Arc welding machine interface output signals
[WO1,2,4,5]

- (2) Specification for arc welding machine interface digital input signals
 (a) Example of connection

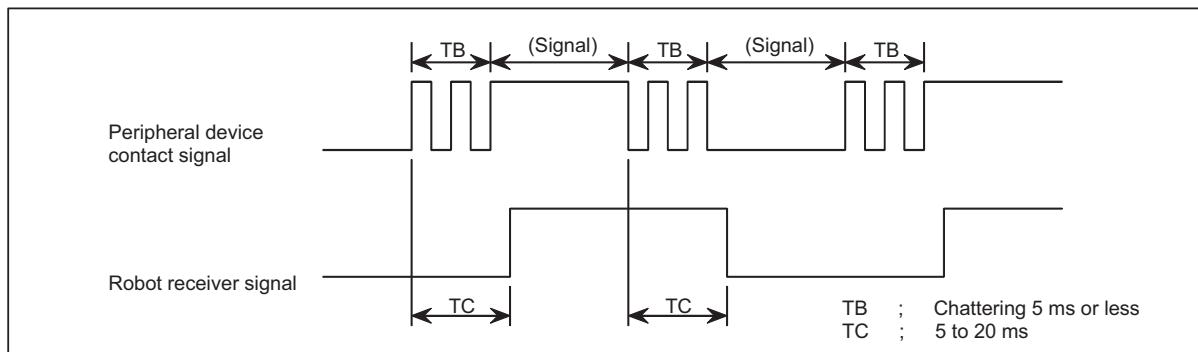


- (b) Electrical specifications of the receiver

| | |
|--------------------------------|--|
| Type: | Grounded voltage receiver |
| Rated input voltage: | Contact close +20V to +28V Contact open 0V to +4V |
| Maximum applied input voltage: | +28VDC |
| Input impedance: | 3.0kΩ (approx.) |
| Response time: | 5ms to 20ms |

- (c) Specifications of the peripheral device contact

| | |
|---|------------------------|
| Voltage and Current: | DC24V, 0.1A |
| (Use a contact which minimum load is 5mA less.) | |
| Input signal width: | 200ms or more (on/off) |
| Chattering time: | 5ms or less |
| Closed circuit resistance: | 100Ω or less |
| Opened circuit resistance: | 100kΩ or more |



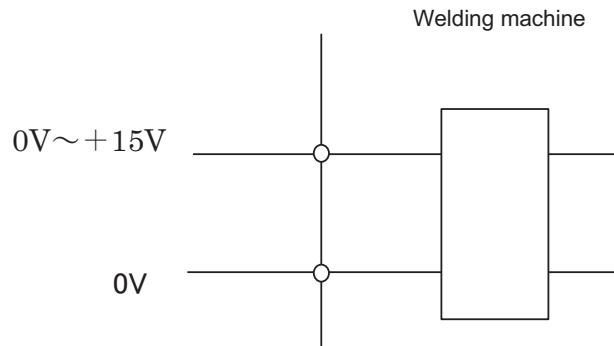
- (d) Note on use

Apply the +24 V power at the robot to the receiver.
 However, the above signal specifications must be satisfied at the robot receiver.

- (e) Applicable signals

Arc welding machine interface input signals
 [WI2~6]

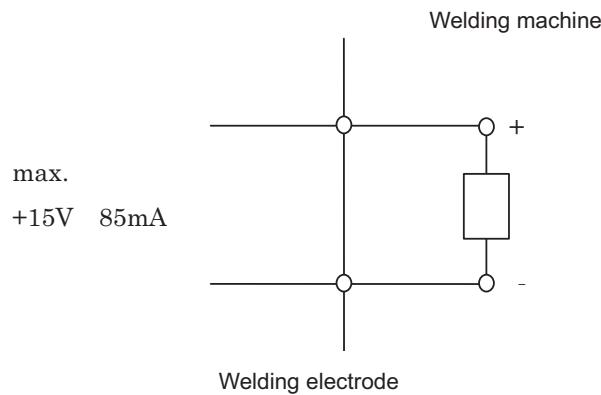
- (3) Specification for arc welding machine interface analog output signals(welding voltage and wire feed speed specification signals)
- (a) Example of connection



- (b) Caution for use
- Input impedance: $3.3 \text{ k}\Omega$ or higher
Install a high-frequency filter.

(Wire deposit detection: WDI+ and WDI-)

- (a) Example of connection



(Wire deposition detection: WDI+, WDI-)

- (b) Caution for use

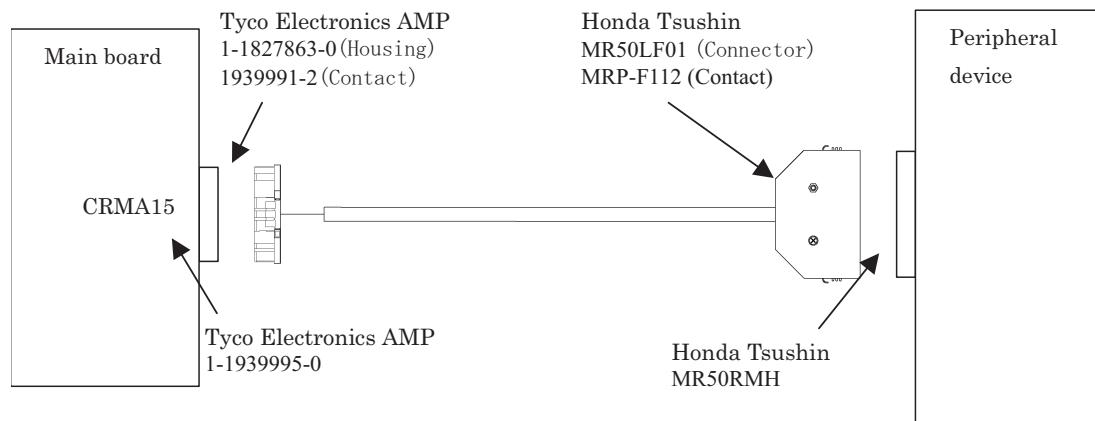
The resistance between the + and - terminals of the welding machine must be 100Ω or higher.
The TIG welding deposition detection circuit must be isolated from the welding circuit (high frequency).
This circuit can withstand up to 80 V.

4.6 SPECIFICATIONS OF THE CABLES USED FOR PERIPHERAL DEVICES AND WELDERS

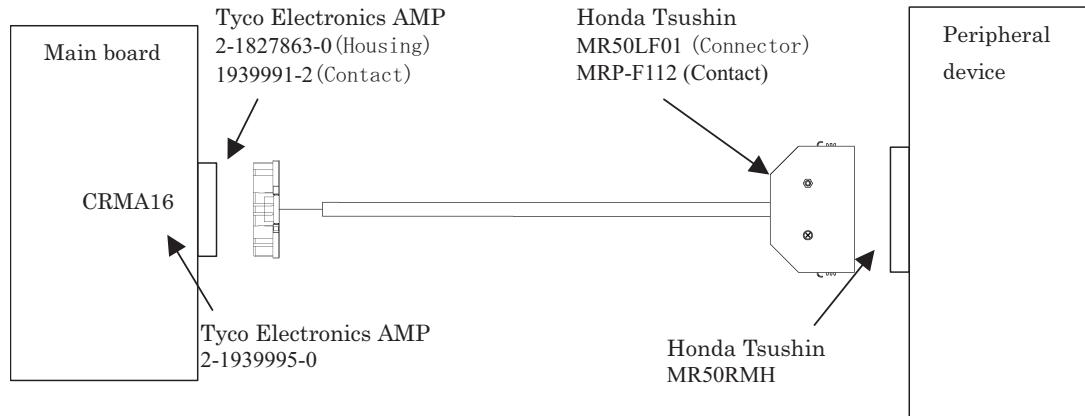
If the customer manufactures cables, make sure they conform to the FANUC standard cables described in this section.

(See the description in "Peripheral Device Interface" in this manual for the specifications of the FANUC standard cables.)

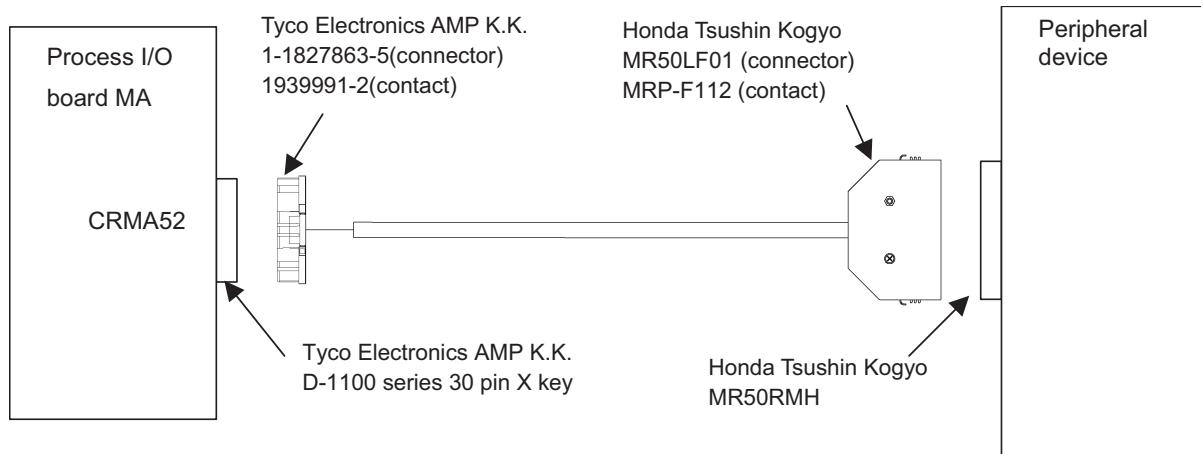
4.6.1 Peripheral Device Interface A1 Cable (CRMA15: Tyco Electronics AMP, D-1000 series, 40 pins)



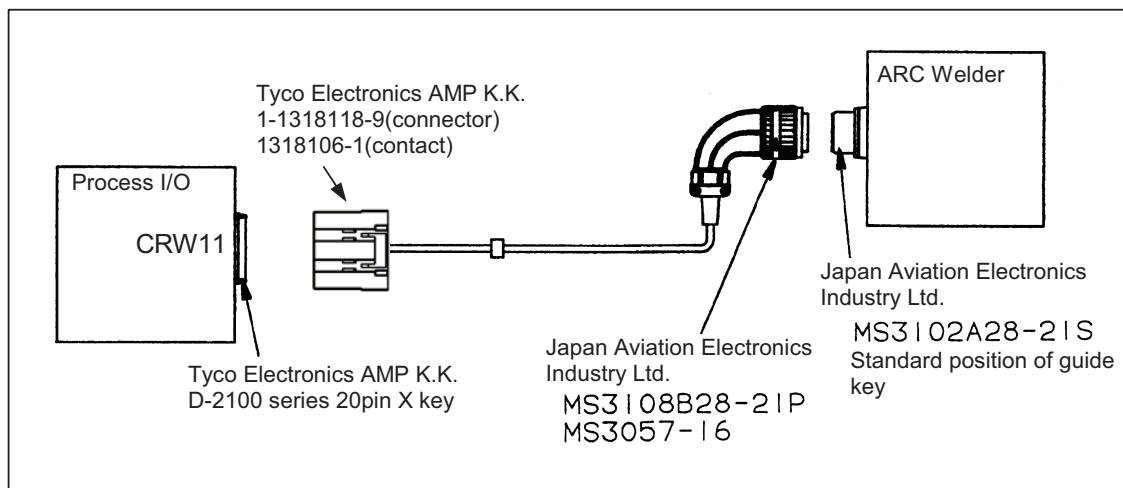
4.6.2 Peripheral Device Interface A2 Cable (CRMA16: Tyco Electronics AMP, D-1000 series, 40 pins)



4.6.3 Peripheral Device Interface B1 and B2 Cables (CRMA52; Tyco Electronics AMP K.K. 30 pin)



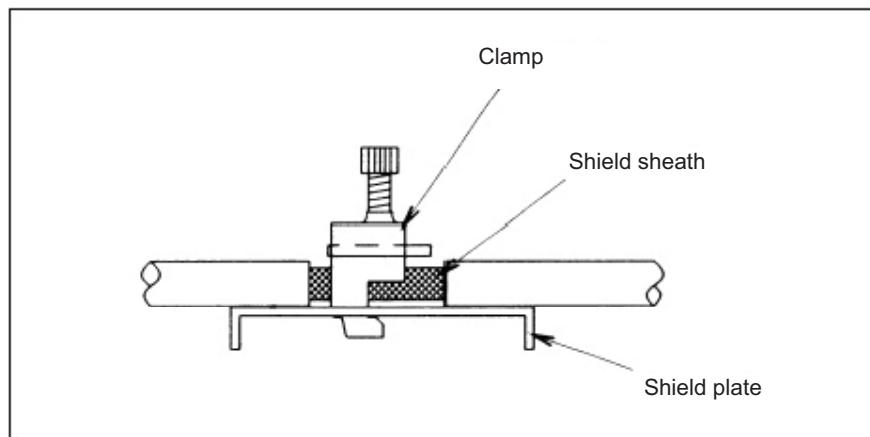
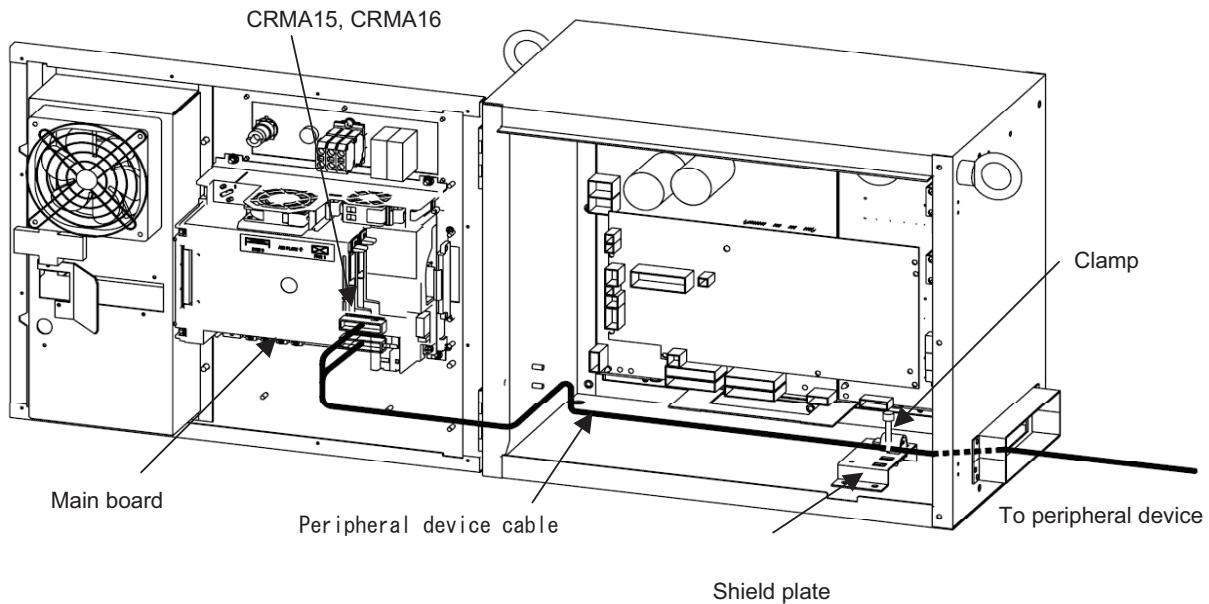
4.6.4 ARC Weld Connection Cables (CRW11; Tyco Electronics AMP K.K. 20 pin)



4.7 CABLE CONNECTION FOR THE PERIPHERAL DEVICES

4.7.1 Peripheral Device Connection Cable

Fig.4.7.1 shows the connection of the peripheral device cable in the cabinet.

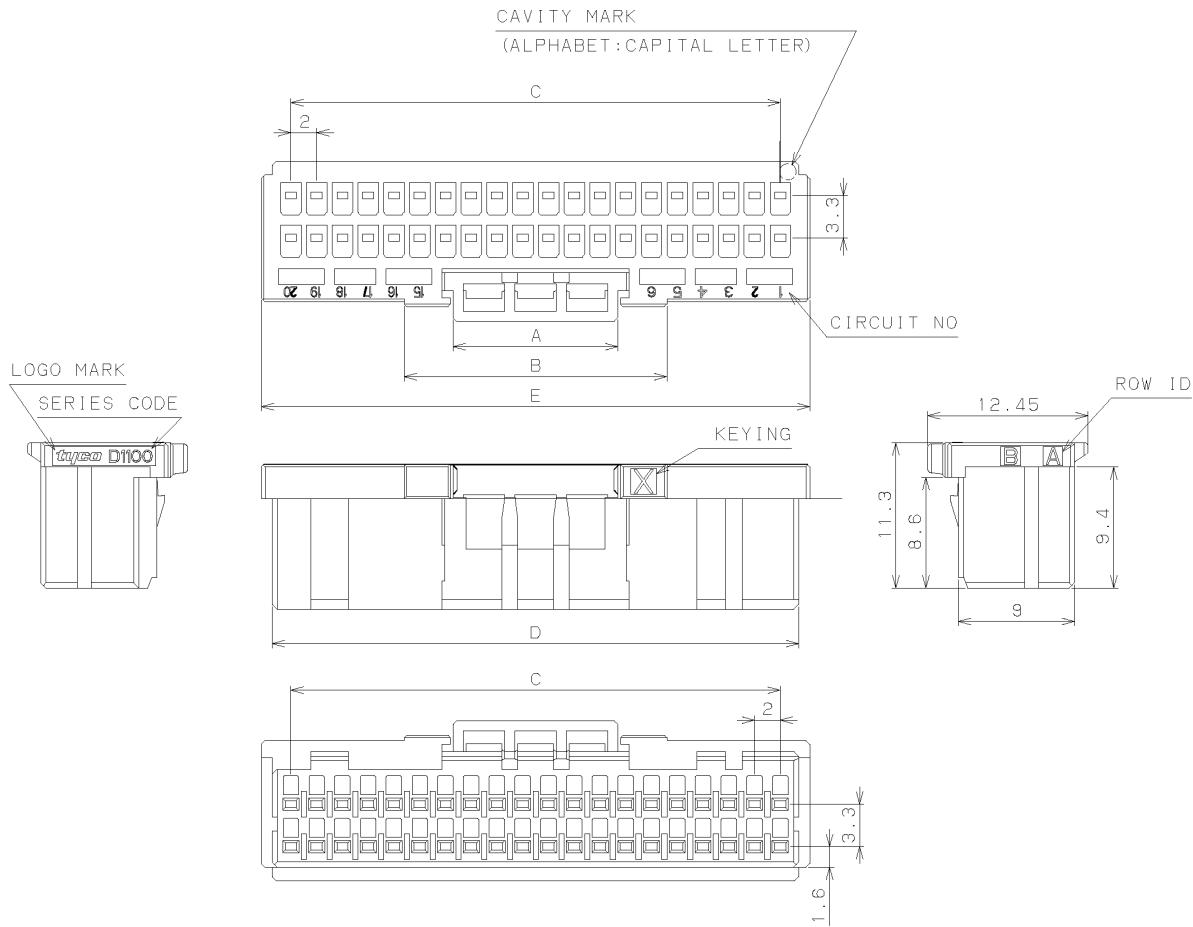


For noise protection, cut part of the jacket of the peripheral device cable to expose the shield sheath, and fasten this part to the shield plate with the clamp.

Fig.4.7.1 Peripheral Device Cable Connection

4.7.2 Peripheral Device Cable Connector

- (1) Fig.4.7.2 shows the connector for peripheral device cables A1 and A2.



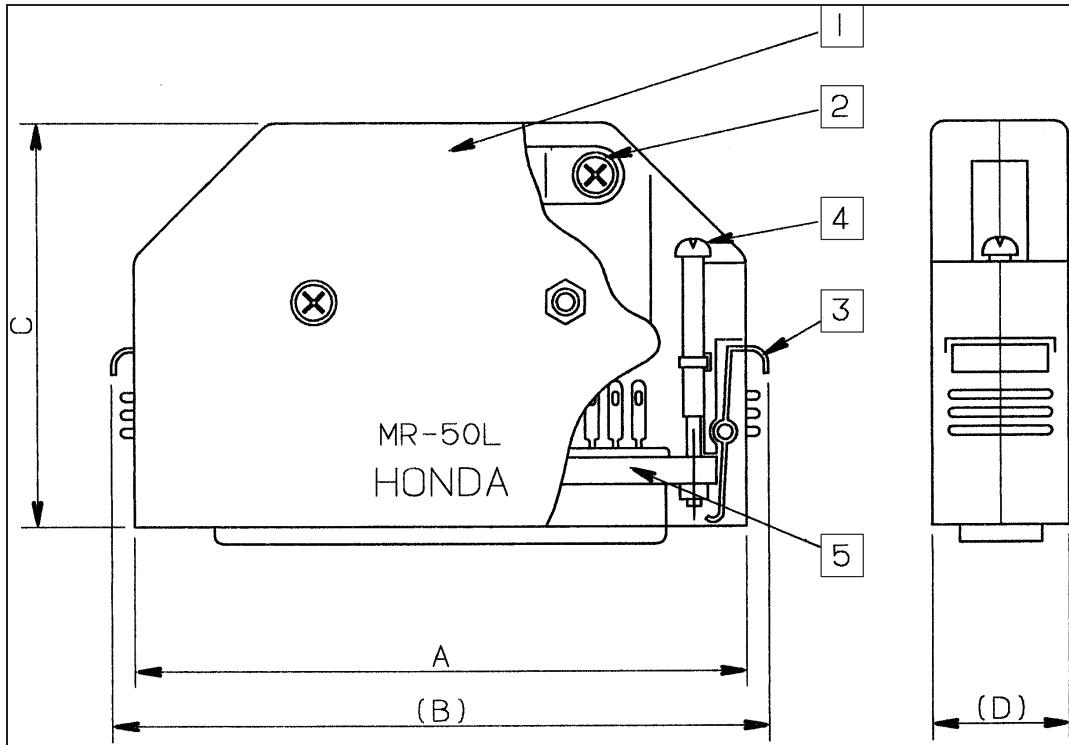
| Connector specifications | Applicable interface | Dimensions | | | | | Remark |
|--------------------------|----------------------|------------|------|------|------|------|---|
| | | A | B | C | D | E | |
| 1-1827863-0 (Housing) | CRMA15 | 12.8 | 20.4 | 38.0 | 40.9 | 42.6 | Tyco Electronics AMP D-1000 series 40pin (X-key) |
| 2-1827863-0 (Housing) | CRMA16 | | | | | | Tyco Electronics AMP D-1000 series 40pin (Y-key) |
| 1-1827863-5 (Housing) | CRMA52 | 12.8 | 20.4 | 28.0 | 30.9 | 32.6 | Tyco Electronics AMP D-1000 series 30pin (X-key) |
| 1939991-2 (Contact) | CRMA15 CRMA16 | / | / | / | / | / | Tyco Electronics AMP D-1000 series |

Maintenance tool

Hand tool (for crimping contact) 1762846-1:A05B-2550-K060

Extraction tool 1891526-1:A05B-2550-K061

Fig.4.7.2 (a) Peripheral device cable connector (Tyco Electronics AMP)

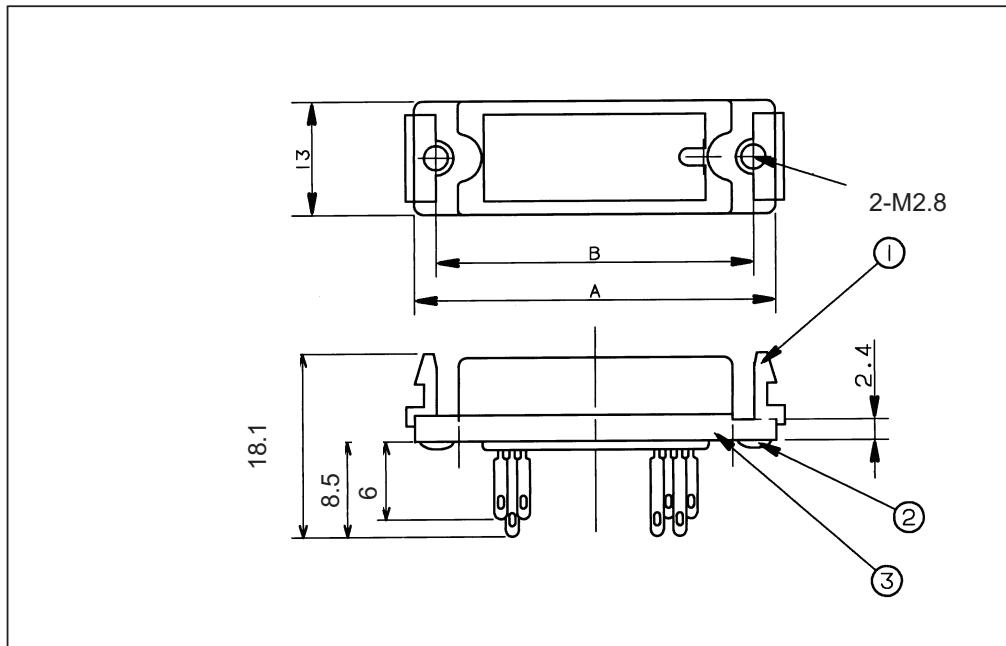


| Connector specifications | Applicable interface | Dimensions | | | | Remark |
|--------------------------|----------------------|------------|------|------|-----|---|
| | | A | (B) | C | (D) | |
| MR50LF (Connector) | CRMA15 CRMA16 | 67.9 | 73.5 | 44.8 | 18 | Honda Tsushin Kogyo, 50 pins, female |
| MR50LM (Connector) | CRMA58 CRMA59 | 67.9 | 73.5 | 44.8 | 18 | Honda Tsushin Kogyo, 50 pins, male |
| MRP-F112 (Contact) | CRMA15 CRMA16 | / | / | / | / | Honda Tsushin Kogyo |

| Symbol | Name |
|--------|----------------------------------|
| 1 | Connector cover |
| 2 | Cable clamp screw |
| 3 | Connector clamp spring |
| 4 | Connector clamp screw |
| 5 | Connector 50 pins (female) MR50F |

Fig.4.7.2 (b) Peripheral device cable connector (Honda Tsushin Kogyo)

(2) Peripheral device connector



| Connector specifications | Applicable interface | Dimensions | | Remark |
|--------------------------|----------------------|------------|------|------------------------------|
| | | A | B | |
| MR50RM | (CRMA15) (CRMA16) | 61.4 | 56.4 | Honda Tsushin Kogyo, 50 pins |

| Symbol | Name |
|--------|-----------------------|
| ① | Connector clamp screw |
| ② | Screw M2.8×8 |
| ③ | Connector (MR50RM) |

Fig.4.7.2 (c) Peripheral device connector (Honda Tsushin Kogyo)

4.7.3 Recommended Cables

(1) Peripheral device connection cable

Connect a peripheral device using a completely shielded, heavily protected cable conforming to the specifications in Table 4.7.3 (a).

Allow an extra 50 cm for routing the cable in the controller.

The maximum cable length is 30 m.

Table 4.7.3 (a) Recommended Cable (for Peripheral Device Connection)

| Number of wires | Wire specifications (FANUC specifications) | Conductor | | Sheath thickness (mm) | Effective outside diameter (mm) | Electrical characteristics | |
|-----------------|---|---------------|---------------|-----------------------|---------------------------------|-----------------------------|-----------------------|
| | | Diameter (mm) | Configuration | | | Conductor resistance (Ω/km) | Allowable current (A) |
| 50 | A66L-0001-0042 | φ1.05 | 7/0.18 AWG24 | 1.5 | φ12.5 | 106 | 1.6A |

(2) End effector connection cable

Connect an end effector using a heavily protected cable with a movable wire conforming to the specifications in Table 4.7.3(b).

The cable length is determined so that the cable will not interfere with the end effector and the wrist can move through its full stroke.

Table 4.7.3 (b) Recommended Cable (for End Effector Connection)

| Number of wires | Wire specifications (FANUC specifications) | Conductor | | Sheath thicknes s (mm) | Effective outside diameter (mm) | Electrical characteristics | |
|-----------------|--|------------------|------------------|------------------------------|--|-----------------------------------|--------------------------|
| | | Diameter (mm) | Configuration | | | Conductor resistance (Ω/km) | Allowable current (A) |
| 6 | A66L-0001-0143 | φ 1.1 | 40/0.08 AWG24 | 1.0 | φ 5.3 | 91 | 3.7 |
| 20 | A66L-0001-0144 | φ 1.1 | 40/0.08 AWG24 | 1.0 | φ 8.6 | 91 | 2.3 |
| 24 | A66L-0001-0459 | φ 0.58 | 40/0.08 AWG24 | 1.0 | φ 8.3 | 93 | 2.3 |

4.8 CONNECTING THE COMMUNICATION UNIT

4.8.1 RS-232-C Interface

4.8.1.1 Interface

This interface can be connected to a communication unit from FANUC.

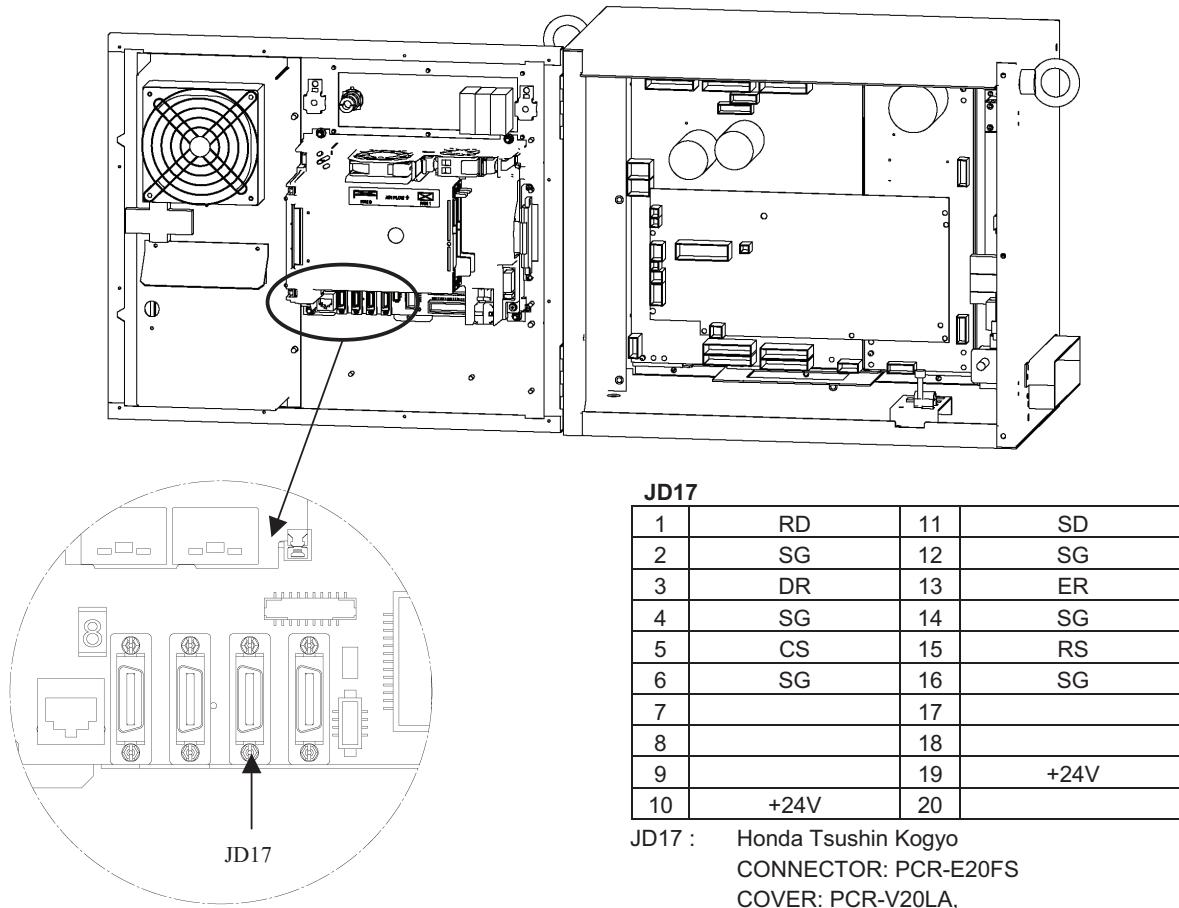


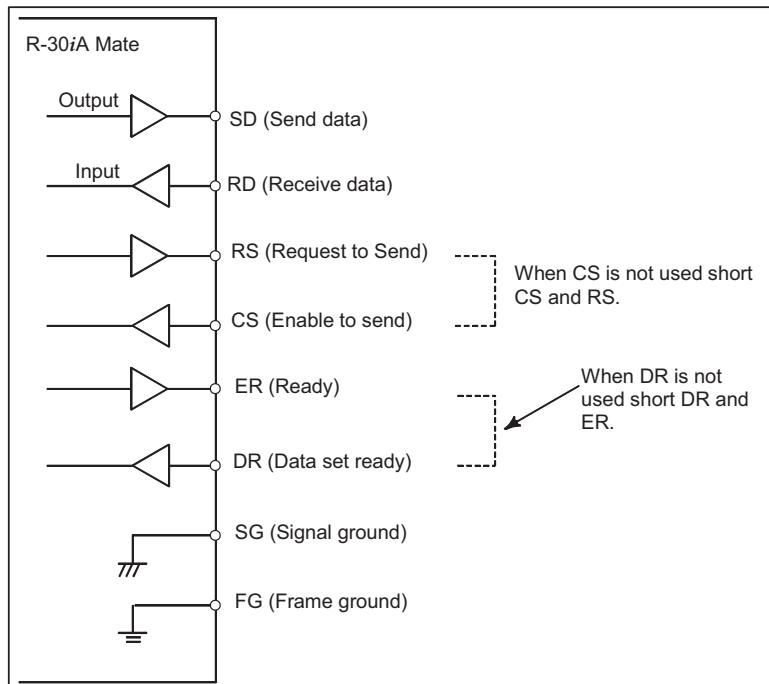
Fig.4.8.1.1 RS-232-C interface

NOTE

- 1 +24V can be used as the power supply for FANUC RS-232-C equipment.
- 2 Do not connect anything to those pins for which signal names are not indicated.

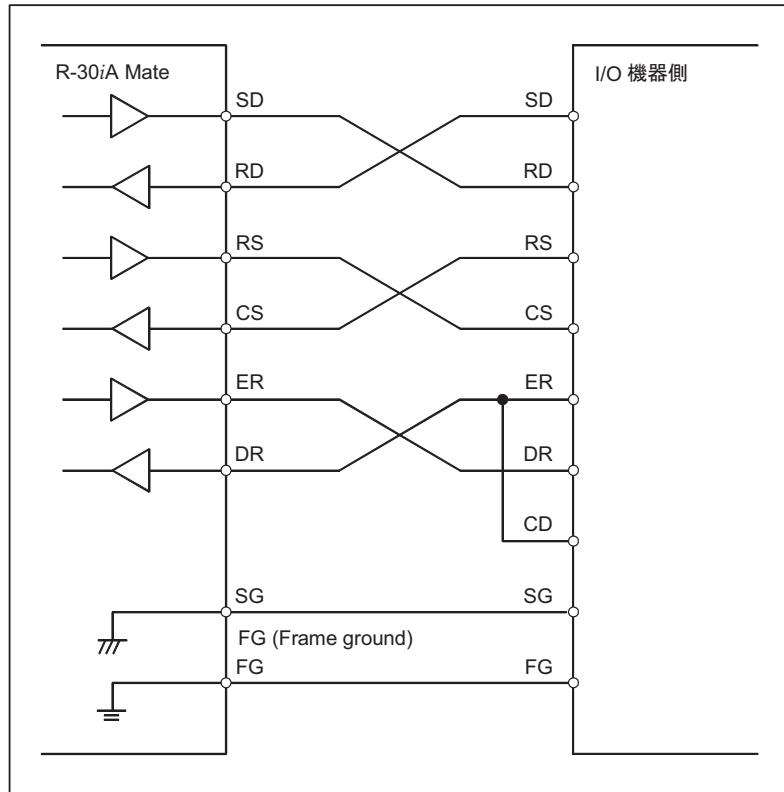
4.8.1.2 RS-232-C interface signals

Generally signals as follows are used in RS-232-C interface.

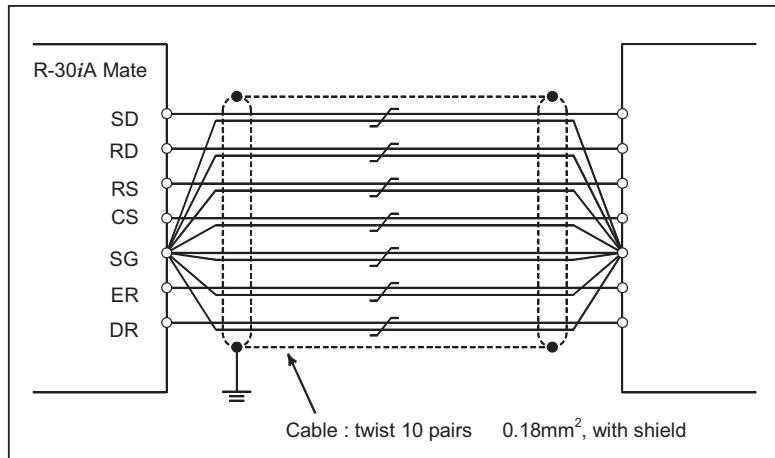
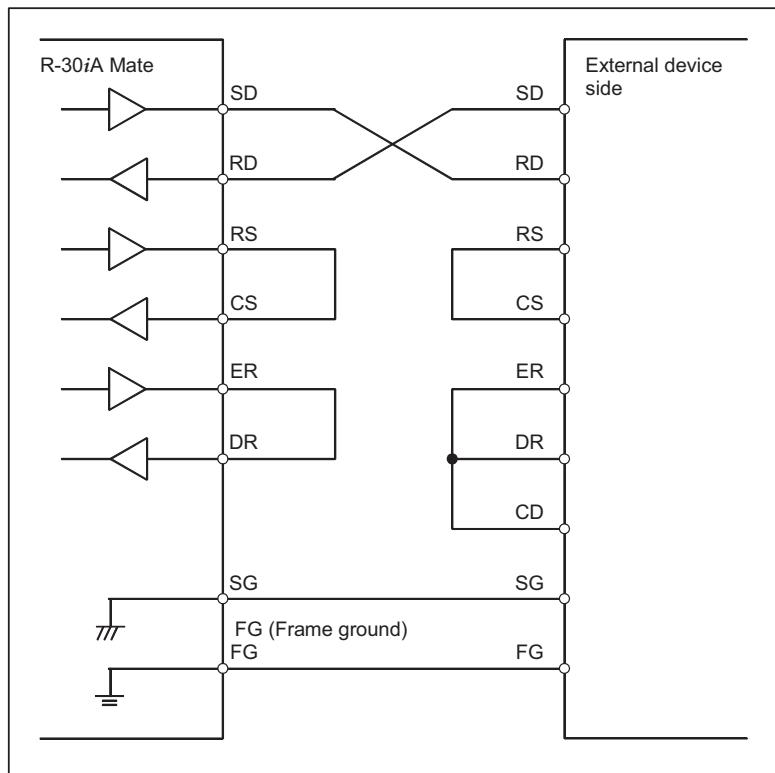


4.8.1.3 Connection between RS-232-C interface and I/O device

The figure below shows a connection with the handshaking of the ER/DR, RS/CS signals.



- The figure below shows a connection without the handshaking of the RS/CS, ER/DR signals.



Cable connection

Pair each signal with SG.

4.8.2 Ethernet Interface

This section describes information relating to the physical Ethernet connection.

⚠ CAUTION

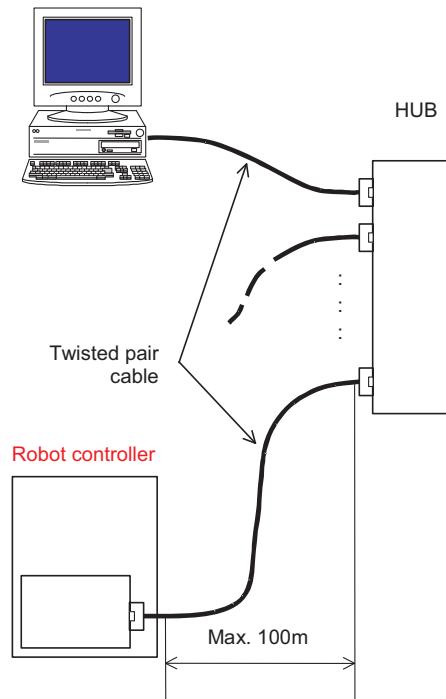
- 1 Before connecting or disconnecting the Ethernet cable, make sure that the power to the robot controller is turned off.
- 2 Please inquire of each manufacturer (of hub, transceiver, cable etc.) about the construction of network or the condition of using the equipment. When configuring your network, you must take other sources of electrical noise into consideration to prevent your network from being influenced by electrical noise. Make sure that network wiring is sufficiently separated from power lines and other sources of electrical noise such as motors, and ground each of the devices as necessary. In addition, high and insufficient ground impedance may cause interference during communications. After installing the robot, conduct a communications test before you actually start operating the robot.
We cannot ensure operation that is influenced by network trouble caused by a device other than the robot controller.

4.8.2.1 Connection to Ethernet

The robot controller is provided with a 100BASE-TX interface.

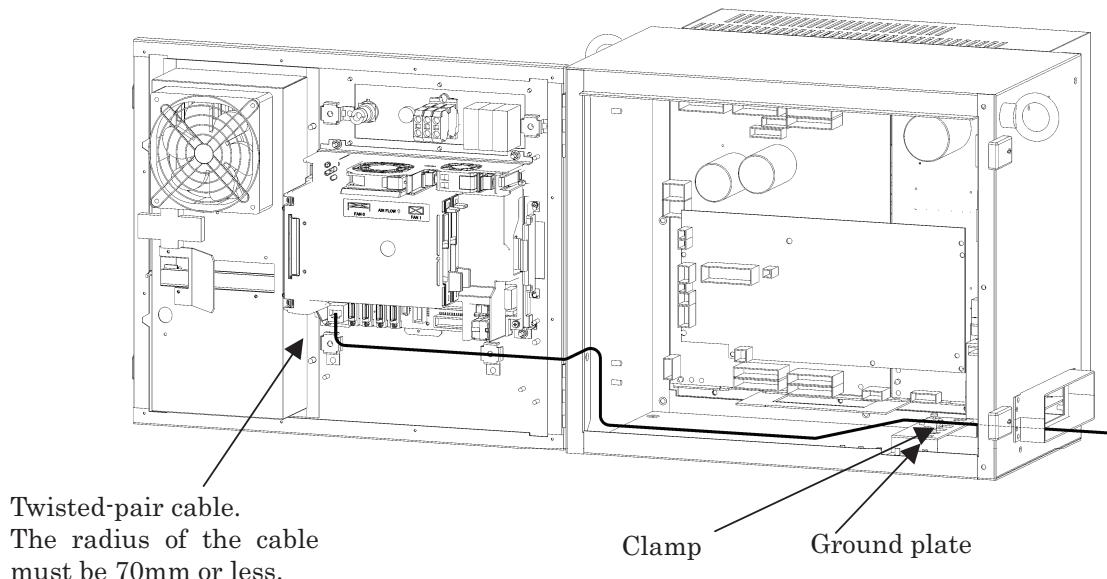
Prepare a hub for connecting the controller to the Ethernet trunk. The following shows an example of a general connection.

Some devices (hub, transceiver, etc.) that are needed for building a network do not come in a dust-proof construction. Using such devices in an atmosphere where they are subjected to dust or oil mist will interfere with communications or damage the robot controller. Be sure to install such devices in a dust-proof cabinet.



4.8.2.2 Leading out the Ethernet Cable

For this type of controller, the cable is drawn out only from the front of the controller. See the outline drawing of each type of board for the location of the connector.



The Ethernet cable must be fastened by a cable clamp to prevent tension being applied to the modular connector (RJ-45) that connects the cable to the controller even if the Ethernet cable is pulled directly. This clamp is also used to ground the cable shield.

4.8.2.3 100BASE-TX Connector (CD38R) Pin Assignments

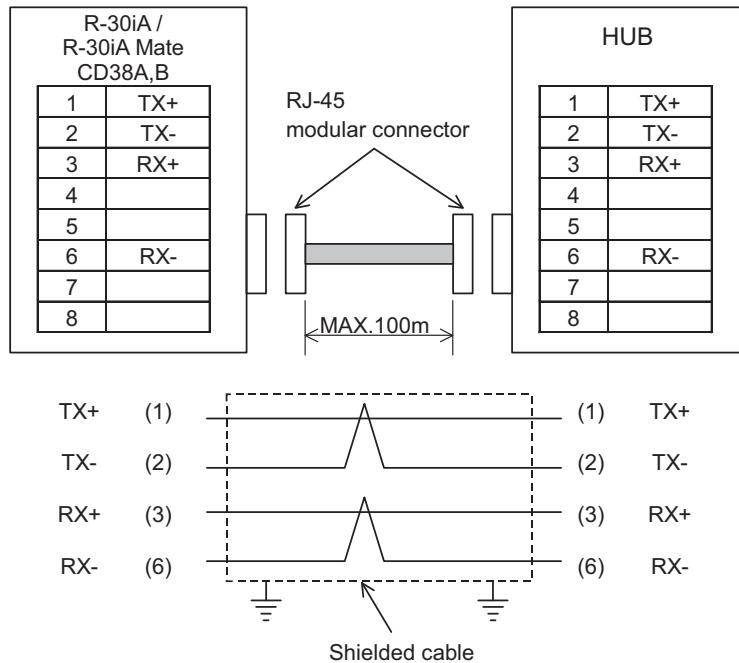
Table 4.8.2.3 CD38R

| Pin No. | Signal name | Description |
|---------|-------------|-------------|
| 1 | TX+ | Send + |
| 2 | TX- | Send - |
| 3 | RX+ | Receive + |
| 4 | | Not used |
| 5 | | Not used |
| 6 | RX- | Receive - |
| 7 | | Not used |
| 8 | | Not used |

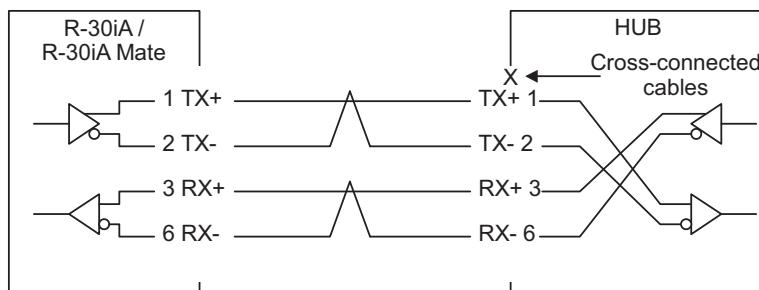
4.8.2.4 Twisted-pair Cable Specification

(1) Cable Connection

The cable used for connection between the 100BASE-TX interface, CD38R, of the controller and the hub is connected as follows:



- Keep the total cable length within 100 m.
Do not extend the cable more than is necessary.
- The figure above shows the cable connection when cables are crossed in the hub.
"X" is usually indicated at the port of the hub to signify that cables are crossed in the hub.



(2) Cable Materials

⚠ CAUTION

Unshielded cable (UTP cable) is commercially available as 100BASE-TX twisted-pair cable: You should, however, use shielded Category 5 twisted-pair cable (STP cable) to improve the resistance to electrical noise in an FA environment.

Table 4.8.2.4 (a) Recommended Cables

| Manufacturer | Specification | Remarks |
|-----------------------------|---------------|------------------------|
| FURUKAWA ELECTRIC CO., LTD. | DTS5087C-4P | Twisted-pair cable |
| NISSEI ELECTRIC CO., LTD. | F-4PFWMF | Single-conductor cable |

Table 4.8.2.4 (b) Inquiries

| Manufacturer | Contact address |
|--|--|
| FURUKAWA ELECTRIC CO., LTD. Sales Headquarters | 2-6-1 Marunouchi, Chiyoda-ku, Tokyo 100-8322 TEL: 03-3286-3126 FAX: 03-3286-3979 |
| Remarks | |
| NISSEI ELECTRIC CO., LTD. Machida Branch Overseas Sales Office | 3F MU Bldg., 1-9-1 Minami-narise, Machida City, Tokyo 194-0045 TEL: 0427-29-2531 FAX: 0427-29-3375 |
| | IWATANI International Corporation Tokyo Head Office 21-8 Nishi-shinbashi 3-chome, Minato-ku, TOKYO, 105-8458, JAPAN TEL: 03-5405-5810 FAX: 03-5405-5666 Telex: 2524256 IWATYO J |
| Remarks | A finished cable with connectors at both ends can be offered. |

NOTE

The recommended cables cannot be connected to moving parts.

Table 4.8.2.4 (c) Recommended cable (for movable parts)

| Manufacturer | Specification | Remarks |
|--------------------------------------|-------------------------|--------------|
| Oki Electric Cable Co., Ltd. | AWG26 4P TPMC-C5-F (SB) | Dedicated to |
| Shinko Electric Industrial Co., Ltd. | FNC-118 | FANUC |

Specification

- Electric characteristics:
Conforms to EIA/TIA 568A Category 3 and Category 5.
From the viewpoint of attenuation performance, ensure that the length to the hub is 50 m or less.
- Structure:
Group shielded (braided shield). A drain wire is available.
The conductor is an AWG26 annealed copper twisted wire, with a sheath thickness of 0.8 mm and an outer diameter of 6.7 mm ± 0.3 mm.
- Fire retardancy
UL1581 VW-1
- Oil resistance
Conforms to the FANUC internal standards (equivalent to the conventional oil-resistant electric cables).
- Flexing resistance:
1,000,000 times or more with a bending radius of 50 mm (U-shaped flex test)
- UL style No.
AWM 20276 (80°C/30V/VW-1)

NOTE

Be sure to use the connector TM21CP-88P (03) manufactured by HIROSE ELECTRIC CO., LTD. for this cable.

Table 4.8.2.4 (d) Inquiries

| Manufacturer | Contact address |
|--------------------------------------|--------------------------------------|
| Oki Electric Cable Co., Ltd. | Nagano Sales Office TEL:0266-27-1597 |
| Remarks | |
| Shinko Electric Industrial Co., Ltd. | Tokyo Sales Office TEL:03-3492-0073 |
| Remarks | |

Cable assembly

Oki Electric Cable Co., Ltd. can also supply the cable assembly mentioned above.

Contact Oki Electric directly to determine the specifications (length, factory test, packing, and so forth) for purchase.

(3) Connector Specification

Use an 8-pin modular connector (RJ-45) with the twisted-pair cable for the Ethernet connection. The following connectors or equivalents must be used.

| For general use | Specification | Manufacturer | Remarks |
|--------------------|---------------|----------------------------|------------------------|
| Solid wire | 5-569530-3 | Tyco Electronics AMP K.K.. | |
| Solid wire | MS8-RS2T-EMC | SK KOHKI CO., LTD. | Special tools required |
| Twisted-pair cable | 5-569552-3 | Tyco Electronics AMP K.K.. | |
| Twisted-pair cable | TM11AP-88P | HIROSE ELECTRIC CO., LTD. | Special tools required |

| For movable parts | Specification | Manufacturer | Remarks |
|--|-----------------|---------------------------|---------|
| For cable AWG26 4P TPMC-C5-F (SB) or FNC-118 | TM21CP-88P (03) | HIROSE ELECTRIC CO., LTD. | Note |

NOTE

Information about TM21CP-88P (03):

Connector (standard product of the manufacturer)

Drawing number: A63L-0001-0823#P

Manufacturer: HIROSE ELECTRIC CO., LTD.

Manufacturer type number: TM21CP-88P (03)

Conforms to EIA/TIA 568A Category 3 and Category 5.

For assembly with a cable, contact HIROSE ELECTRIC CO., LTD. directly.

(From HIROSE ELECTRIC CO., LTD., "TM21CP-88P (03) Connection

Procedure Manual (Technical Specification No. ATAD-E2367)" is available as a technical document.)

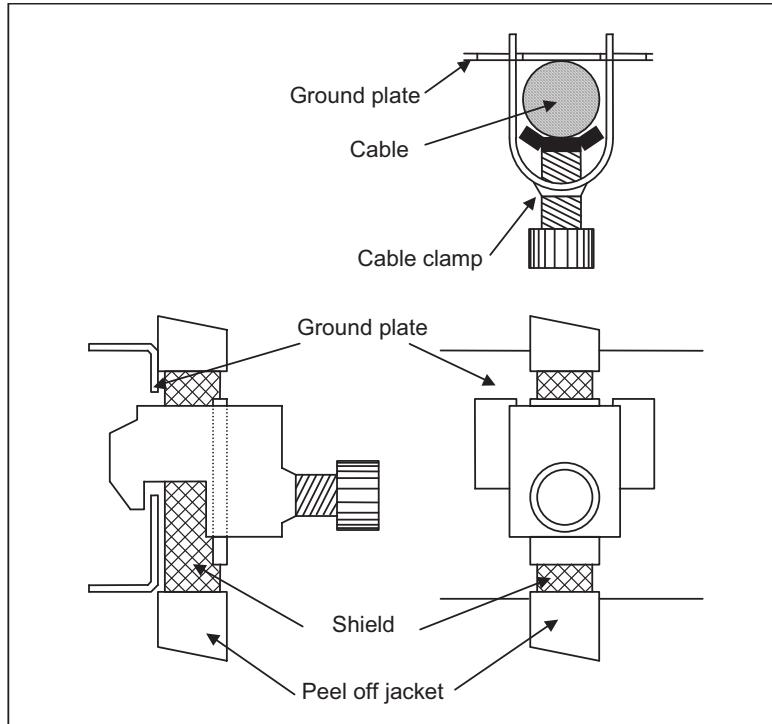
4.8.2.5 Electrical Noise Countermeasures

(1) Clamping and Shielding Cables

Clamp an Ethernet twisted pair cable according to the method described below, as with cables that need to be shielded. Clamping cables provides support and shielding and is extremely important to the safe operation of the system. Never overlook cable clamping.

Peel off part of the jacket as shown in the figure to expose the outer coating of the shield, and press this outer coating against the ground plate with the clamp fixture.

The machine manufacturer must prepare the ground plate and install it as follows:



NOTE

To ensure the safe operation of the system, clamp and shield the cables.

Connect the Ethernet board and hub with a twisted-pair cable. Shield the cable with clamp fixtures.

(2) Grounding the Network

Even if the grounding condition on the machine side is satisfied, the communication line can pick up noise from the machine, depending on the machine installation condition and environment, thus resulting in a communication error. To protect against such noise, the machine should be separated and insulated from the Ethernet trunk cable and personal computer. Examples of connection are given below.

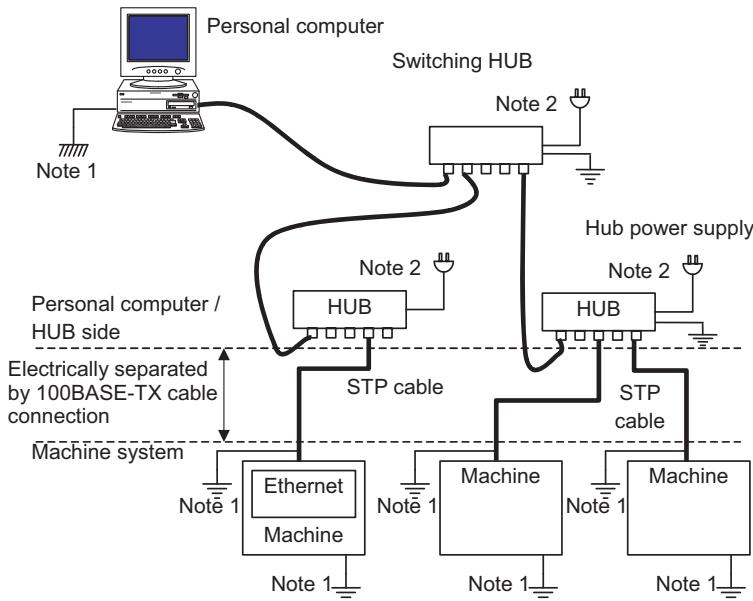


Fig. 4.8.2.5 (a) Large-Scale Network

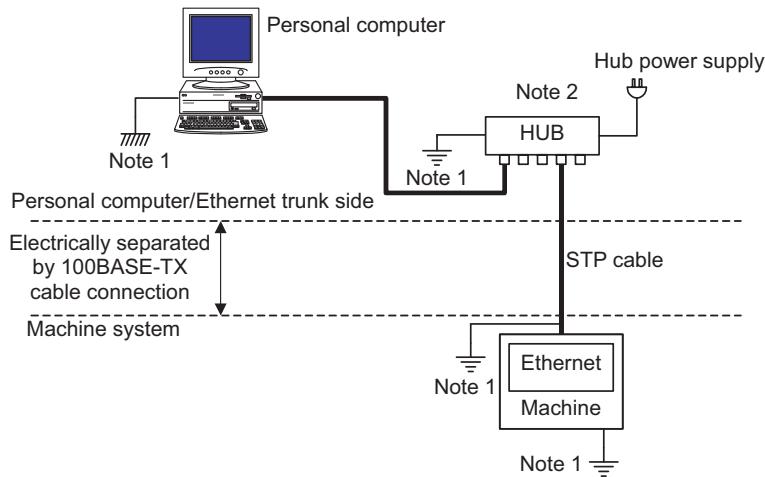
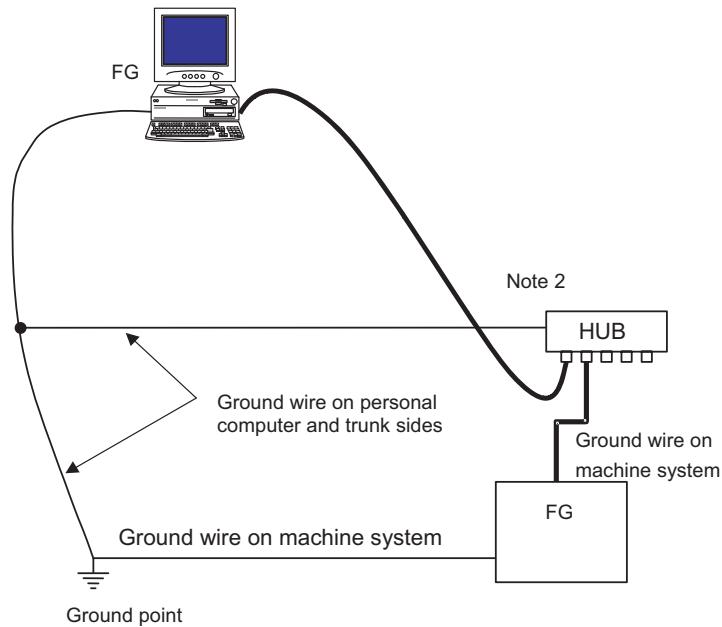


Fig. 4.8.2.5 (b) Small-Scale Network

NOTE

- 1 The ground between PC/HUB side and machine system side must be separated. If it is impossible to separate the ground because there is only one grounding point, connect the ground cable for each system to the grounding point independently. (See figure below.)
The resistance for grounding must be less than 100-ohm (Class D). The thickness of the ground cable is the same as the thickness of AC power cable or more. At least thickness of 5.5mm² is necessary.
- 2 Note that the number of allowable hub-to-hub connections depends on the type of hub.
- 3 There is possibility that noise makes the obstacle of communication even if the ground is separated using the 100BASE-TX. In the case of using the FAST Ethernet/FAST Data Server under the worst environment, please separate between the PC/Trunk line side and machine system side completely using the 100BASE-FX (Optical fiber media).

**Fig. 4.8.2.5 (c) Wiring on a single ground point**

4.8.2.6 Check Items at Installation

The following table lists check items at installation.

| Check item | Description | Check |
|------------------|--|-------|
| Ethernet cable | | |
| Type | Use cables which satisfies all the following conditions: 1) With shielding 2) Twisted-pair cable 3) Category 5 | |
| Length | The cable length shall be within 100 m (50 m for a movable cable recommended by FANUC). | |
| Connection | For a twisted-pair cable, the following pins shall be paired: 1) Pin No. 1 (TX+) – pin No. 2 (TX-) 2) Pin No. 3 (RX+) – pin No. 6 (RX-) | |
| Separation | The Ethernet cables shall be bound separately from the following cables or covered with an electromagnetic shield: 1) Group A: AC power lines, power lines for motors, and others 2) Group B: Current DC (24 VDC) and others | |
| Shielding | For a shielded cable, the part of which outer coating is peeled off and exposed shall be fixed to the ground plate with a clamp fixture. | |
| Clamping | The ground plate shall be located as nearest to the CNC as possible (to make the cable between the ground plate and CNC hard to be affected by noise). | |
| Connectors | Any cable connector shall not be pulled (to prevent poor contact of the connector). | |
| Wiring | No cable shall be laid under a heavy object. | |
| Bending radius | The bending radius shall be at least four times as long as the diameter of the cable. | |
| For movable part | For a movable part, a cable for a movable part shall be used. | |
| HUB | | |
| Use conditions | The "cautions on use" of the hub shall be observed (A terminating resistor shall be mounted properly if required). | |
| Grounding | The hub shall be grounded. | |
| Cabinet | The hub shall be installed in an enclosed cabinet. | |
| Vibration | The hub shall be installed so that it is not affected by vibration. | |
| Bending radius | The bending radius shall be at least four times as long as the diameter of the cable. | |

5

TRANSPORTATION AND INSTALLATION

This chapter describes the transportation and installation for the controller.

5.1 TRANSPORTATION

The controller is transported by a crane. Attach a strap to eyebolts at the top of the controller.

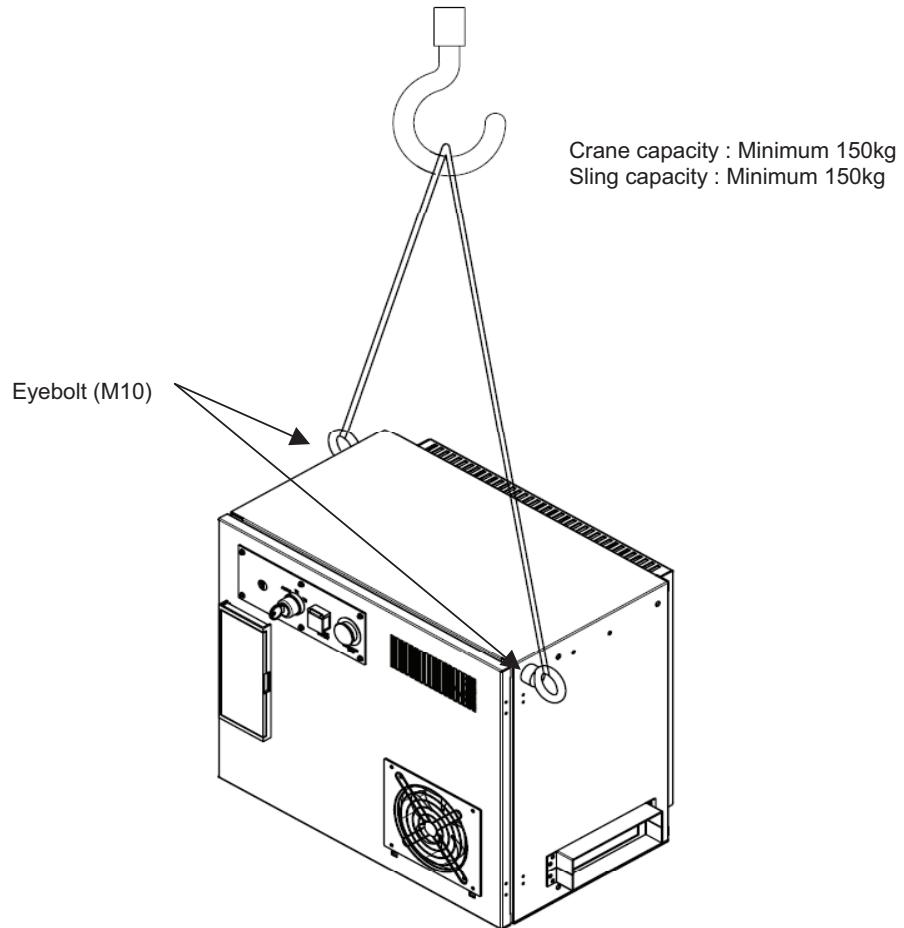


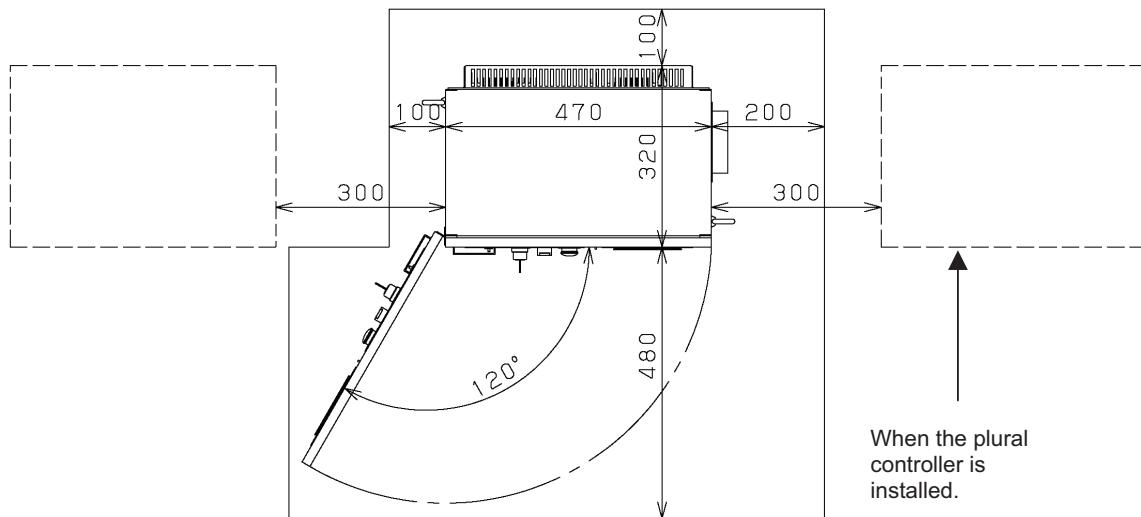
Fig. 5.1 Transportation

5.2 INSTALLATION

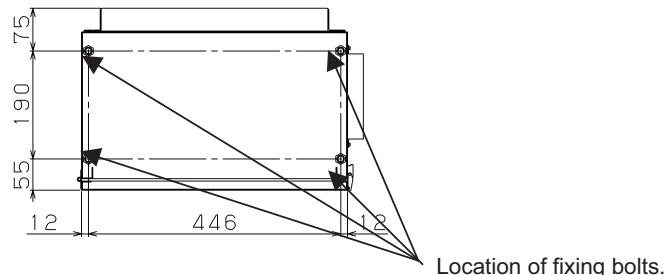
5.2.1 Installation Method

Following is the installation method for cabinet.

When installing the controller, allow the space for maintenance shown in the following figure.



When the plural
controller is
installed.



(Top View)

Location of fixing bolts.

(M10: 4 places)

Fig. 5.2.1 (a) Installation dimension (LR Mate 200iC, M-1iA)

NOTE

Keep this area for maintenance and the radiation of heat.

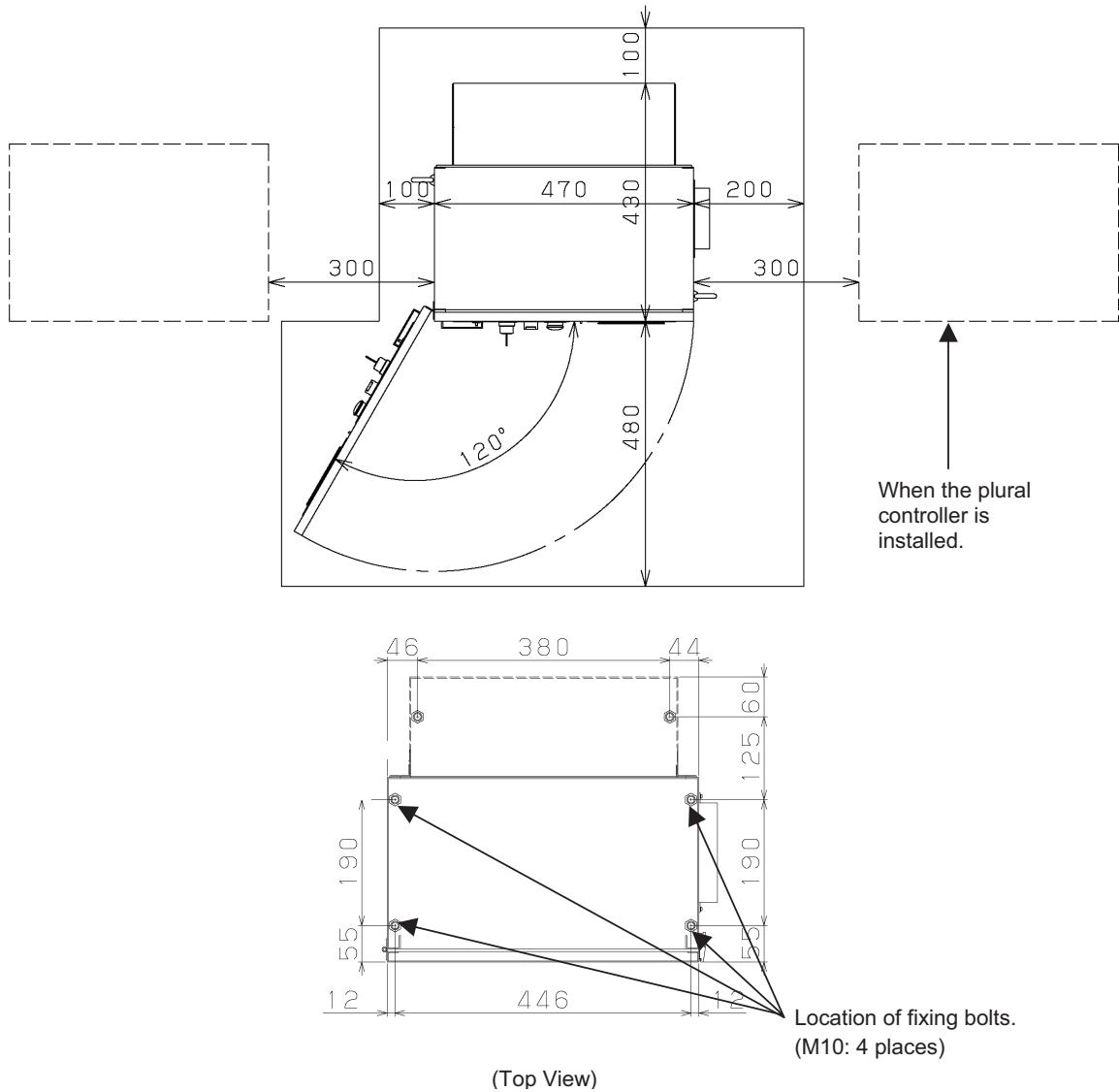


Fig. 5.2.1 (b) Installation dimension (ARC Mate 100iC, M-10iA, ARC Mate 120iC, M-20iA, ARC Mate 50iC)

NOTE

Keep this area for maintenance and the radiation of heat.

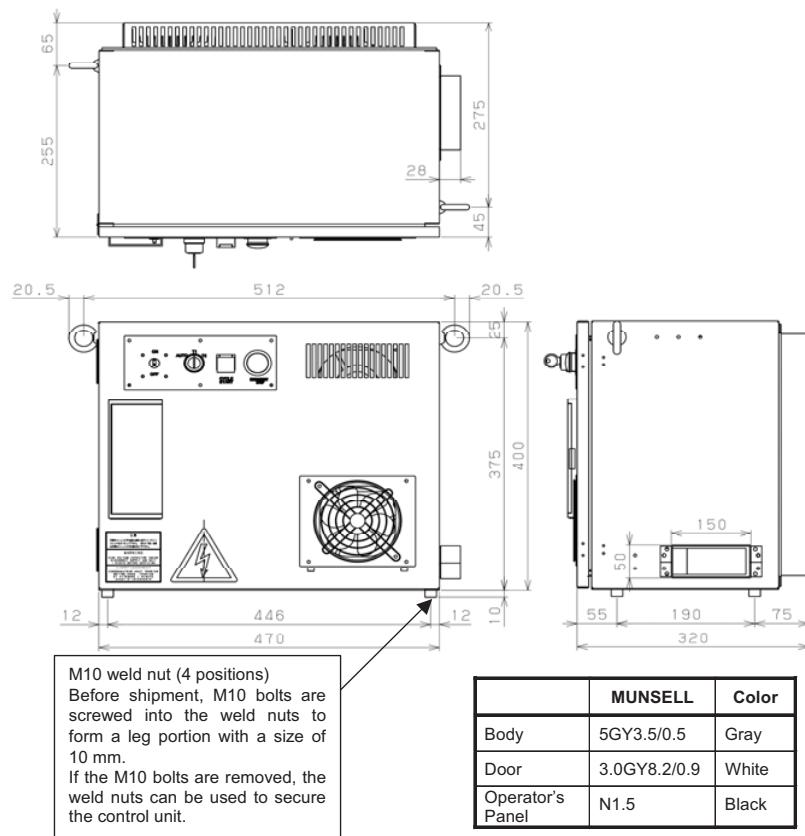


Fig. 5.2.1(c) External dimension (LR Mate 200iC, M-1iA)

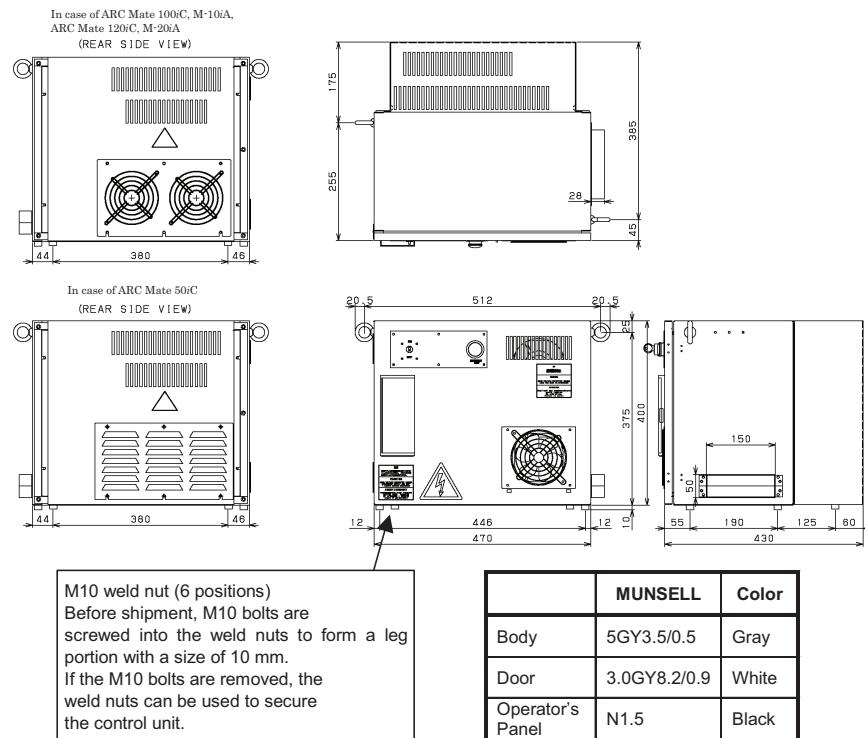


Fig. 5.2.1(d) External dimension (ARC Mate 100iC, M-10iA, ARC Mate 120iC, M-20iA, ARC Mate 50iC)

5.3

MOUNTING METHOD OF TEACH PENDANT HOOK

Following is external dimension for Teach Pendant HOOK (Ordering specification: A05B-2550-K050).

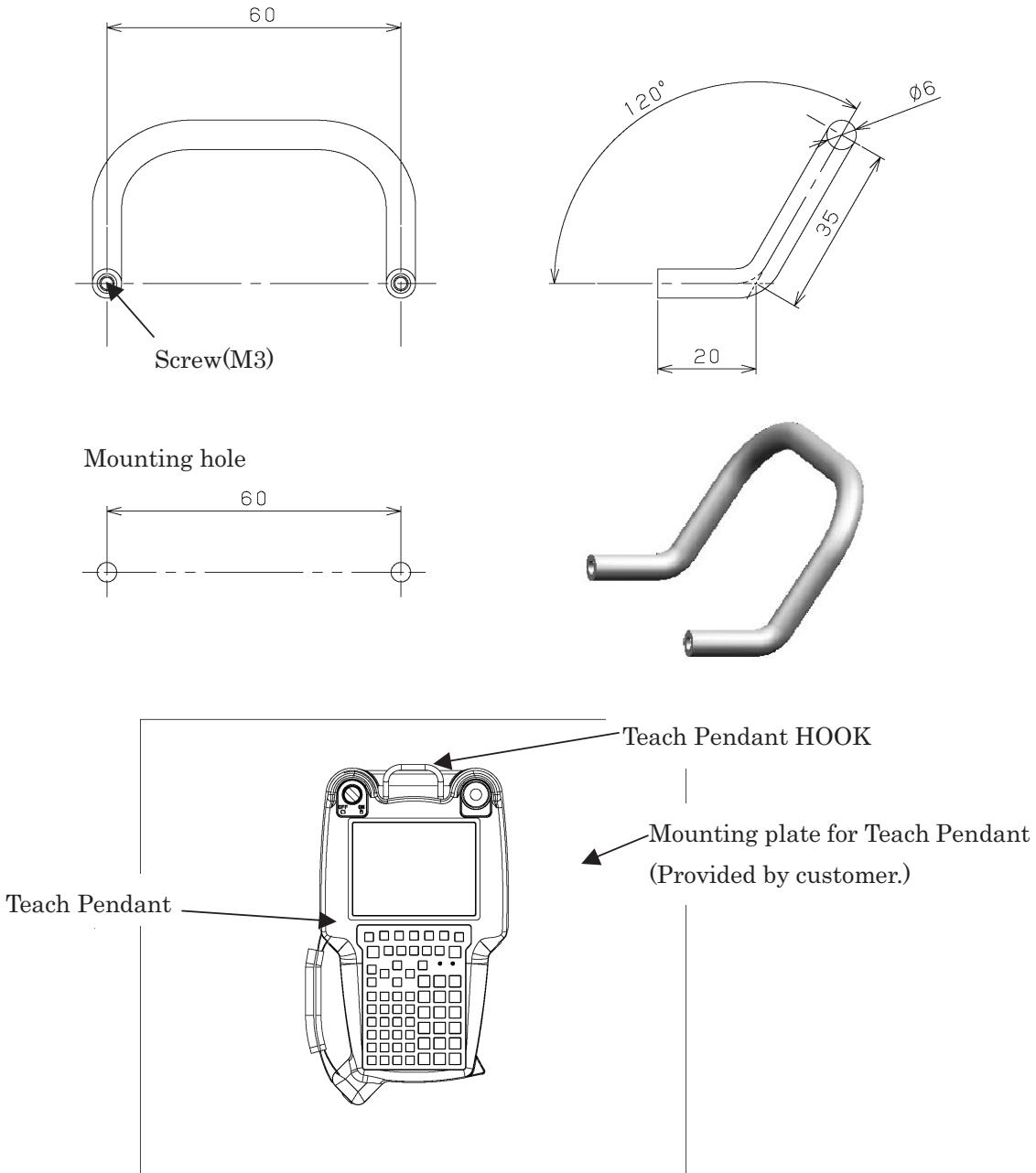


Fig. 5.3 External dimension of Teach Pendant HOOK

5.4 INSTALLATION CONDITION

| Item | Model | Specification/condition |
|-----------------------------------|--|---|
| Rated Voltage | LR Mate 200iC M-1iA | 200-230VAC +10% -15% 50/60Hz ±1Hz Single phase |
| | ARC Mate 100iC, ARC Mate 120iC, M-10iA, M-20iA, ARC Mate 50iC | 200-230VAC +10% -15% 50/60Hz ±1Hz 3 phase |
| Tolerant fluctuation | All models | Tolerant voltage fluctuation: +10% -15% Tolerant frequency fluctuation: ±1Hz |
| Input power source capacity | M-1iA, | 1.0KVA |
| | LR Mate 200iC, ARC Mate 50iC | 1.2KVA |
| | ARC Mate 100iC,M-10iA | 2.0KVA |
| | ARC Mate 120iC,M-20iA | 3.0KVA |
| Average power consumption | M-1iA, | 0.2KW |
| | LR Mate 200iC, ARC Mate 50iC | 0.5KW |
| | ARC Mate 100iC,M-10iA ARC Mate 120iC,M-20iA | 1.0KW |
| Permissible ambient temperature | All models | Operating 0°C to 45°C Storage, Transport -20°C to 60°C Temperature change 0.3°C/minute or less |
| Permissible ambient humidity | All models | Normal: 75%RH or less, no condensation Short period (less than 1 month): 95%RH or less, no condensation |
| Surrounding gas | All models | An additional protective provision is necessary if the machine is installed in an environment in which there are relatively large amounts of contaminants (dust, dielectric fluid, organic solvent, acid, corrosive gas, salt, etc.). |
| Installation Category | LR Mate 200iC M-1iA | Installation Category III, Pollution Degree 3, IEC60664-1 and IEC61010-1 |
| | ARC Mate 100iC, ARC Mate 120iC, M-10iA, M-20iA, ARC Mate 50iC | Installation Category II, Pollution Degree 3, IEC60664-1 and IEC61010-1 (NOTE2) |
| Vibration | All models | 0.5G or less When using the robot in a location subject to serious vibration, consult with your FANUC sales representative. |
| Altitude | All models | Operating: Up to 1000m Non-operating: Up to 12000m |
| Ionized and non-ionized radiation | All models | A shielding provision is necessary if the machine is installed in an environment in which it is exposed to radiation (microwave, ultraviolet rays, laser beams, and/or X-rays). |
| Mass of controller | All models | 50kg |

NOTE

- 1 The power rating indicated above is sufficient as the continuous rating. However, when the robot is rapidly accelerating, the instantaneous requirement may increase to several times the continuous rating.
If the acceleration/deceleration override (ACC) greater than 100% is set in the robot program, the extreme current may flow to the robot controller instantaneously and the input voltage of robot controller will drop.
In this case, if the supply voltage is decreased 10% or more per rated voltage, Power supply alarm, Move error excess alarm, DCLV alarm of servo amplifier may occur.
- 2 In case of connected with Input power source of Installation category III, set up isolated transformer between Input power source and controller.

5.5 ADJUSTMENT AND CHECKS AT INSTALLATION

Adjust the robot according to the following procedure at installation.

| No. | Description |
|-----|---|
| 1 | Visually check the inside and outside of the controller. |
| 2 | Check the screw terminals for proper connection. |
| 3 | Check that the connectors and printed circuit boards are firmly connected. |
| 4 | Connect controller and mechanical unit cables. |
| 5 | The breaker off and connect the input power cable. |
| 6 | Check the input power voltage. |
| 7 | Press the EMERGENCY STOP button on the operator panel and turn on the controller. |
| 8 | Check the interface signals between controller and robot mechanical unit. |
| 9 | Check the parameters. If necessary, set them. |
| 10 | Release the EMERGENCY STOP button on the operator panel. Turn on the controller. |
| 11 | Check the movement along each axis in manual jog mode. |
| 12 | Check the end effector interface signals. |
| 13 | Check the peripheral device control interface signals. |

5.6 RESETTING OVERTRAVEL AND EMERGENCY STOP AT INSTALLATION

An overtravel and emergency stop occur when the robot is operated for the first time after it is installed and the mechanical and controller are wired. This section describes how to reset the overtravel and emergency stop.

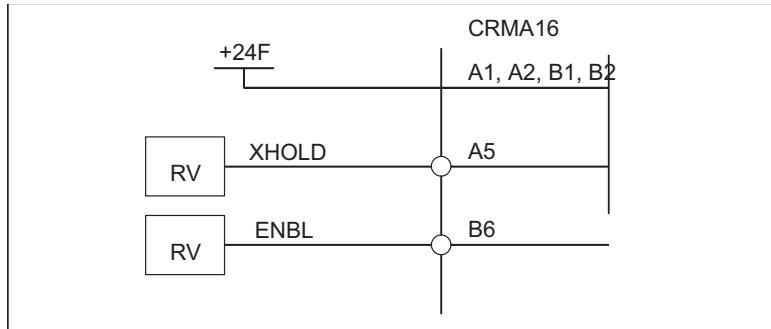
Remove the red plate fastening the swiveling axis beforehand.

The J2 and J3 axes are pressed against the hard stops at shipment. Therefore, an overtravel alarm occurs when the power is turned on after installation.

The robot can also be in an emergency stop state if the peripheral device control interface is not connected.

5.6.1 Peripheral Device Interface Processing

Take the following actions if signals *HOLD and ENBL are not used.



5.6.2 Resetting Overtravel

- (1) Select [OT release] on the overtravel release screen to release each robot axis from the overtravel state.
- (2) Hold down the shift key, and press the alarm release button to reset the alarm condition.
- (3) Still hold down the shift key, and jog to bring all axes into the movable range.

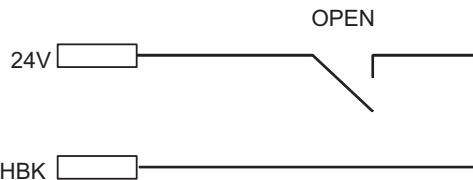
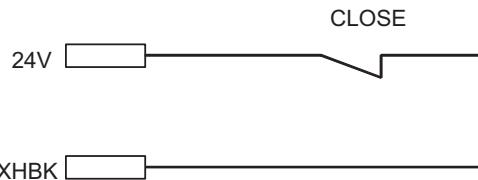
5.6.3 How to Disable/Enable HBK

- (1) Press [MENUS] on the teach pendant.
- (2) Select [NEXT].
- (3) Select [SYSTEM].
- (4) Press "F1" (TYPE) on the teach pendant.
- (5) Select "Config" to disable/enable HBK.

| Status | Hand Broken enable/disable setting | HBK (*1) | HBK detection | Robot operation | Message |
|--------|------------------------------------|----------|---------------|-----------------|-------------------------|
| 1 | Enable | CLOSE | Yes | Possible | None |
| 2 | Enable | OPEN | Yes | Impossible | SRVO-006 |
| 3 | Disable | CLOSE | Yes (*2) | Possible | None |
| 4 | Disable | OPEN | No | Possible | At cold start, SRVO-300 |

NOTE

- 1 Robot end effector connector



- 2 The moment the HBK circuit is closed, HBK detection becomes enabled. When the HBK circuit is opened again, alarm "Servo 300" or "Servo 302" occurs, causing the robot to stop.
- 3 If the power is turned off and on again under the condition stated in *2, status 4 is entered, so the alarm condition is removed.

5.6.4 How to Disable/Enable Pneumatic Pressure Alarm (PPABN)

- (1) Press [MENUS] on the teach pendant.
- (2) Select [NEXT].
- (3) Select [SYSTEM].
- (4) Press "F1" (TYPE) on the teach pendant.
- (5) Select "Config" to disable/enable PPABN.

APPENDIX

A

TOTAL CONNECTION DIAGRAM

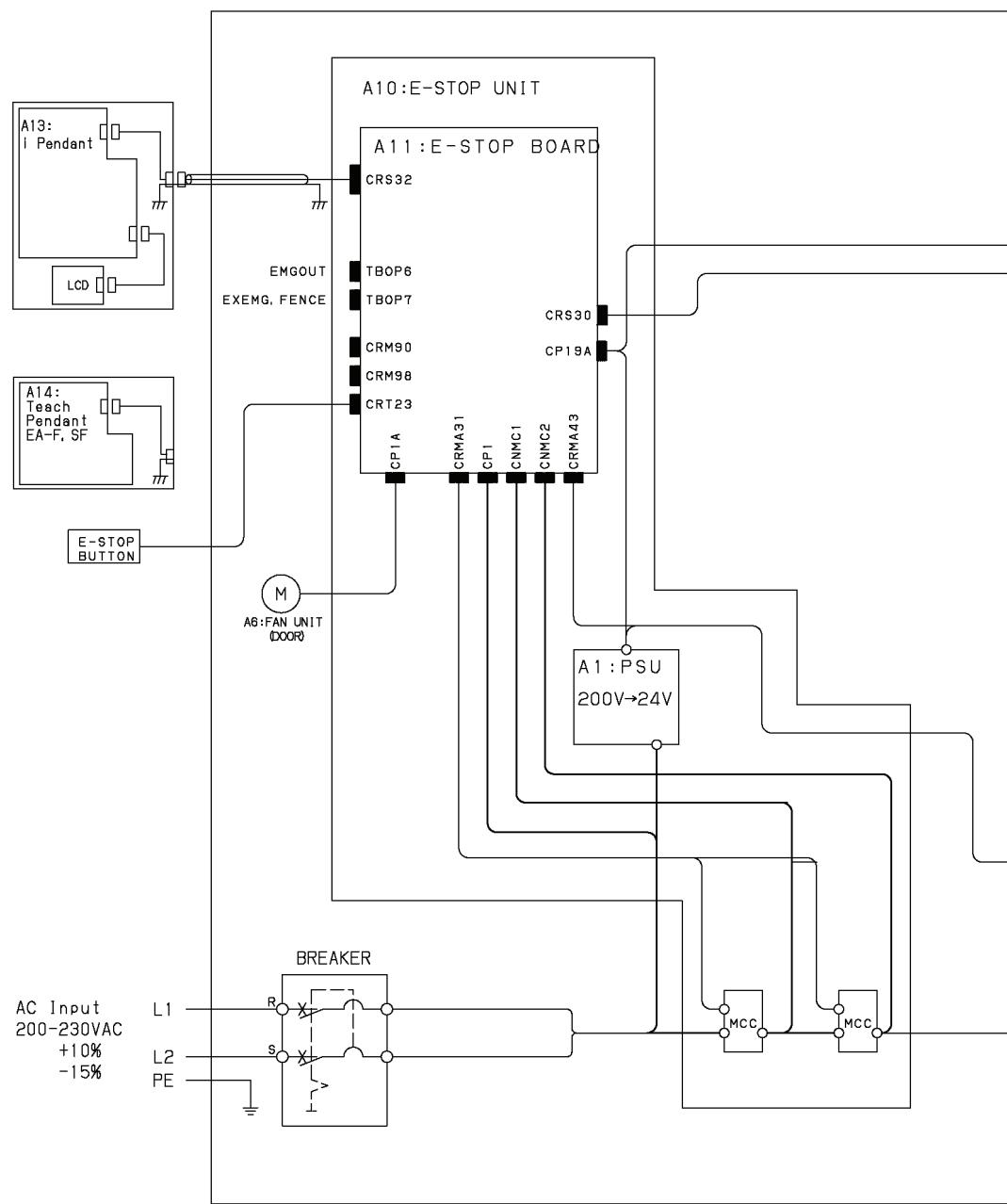
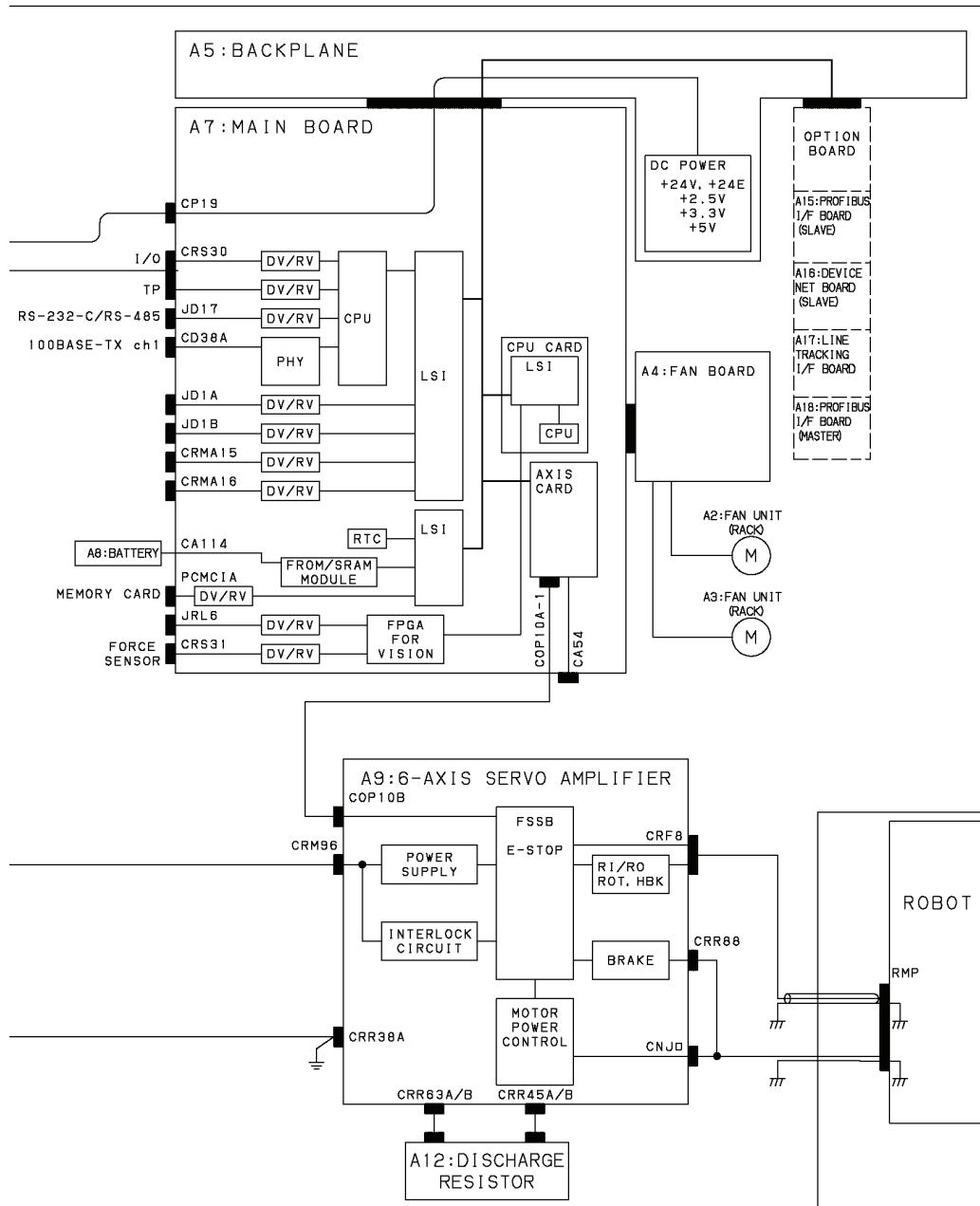


Fig. A (a) System block diagram (M-1iA, LR Mate 200iC)

A.TOTAL CONNECTION DIAGRAM



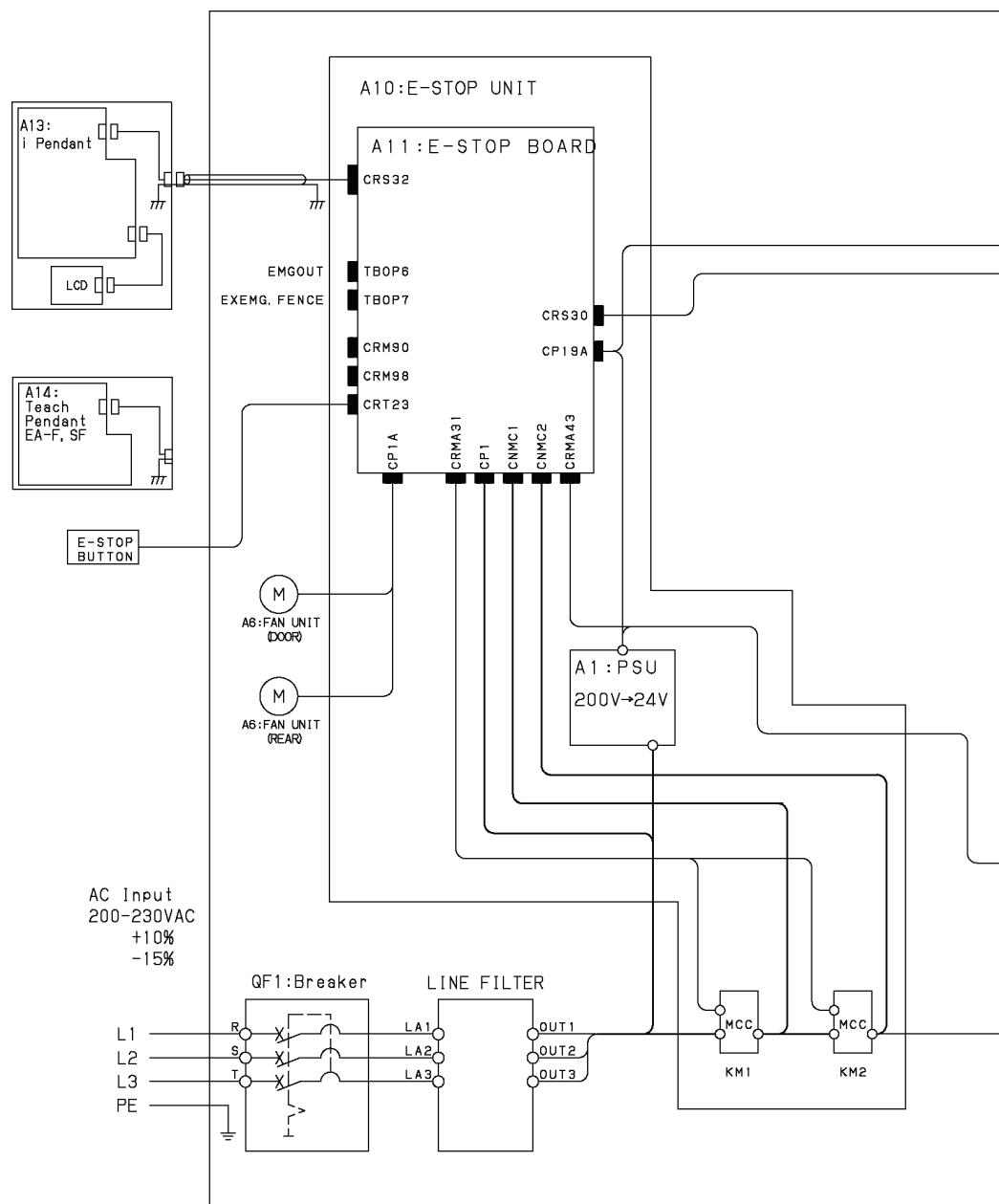
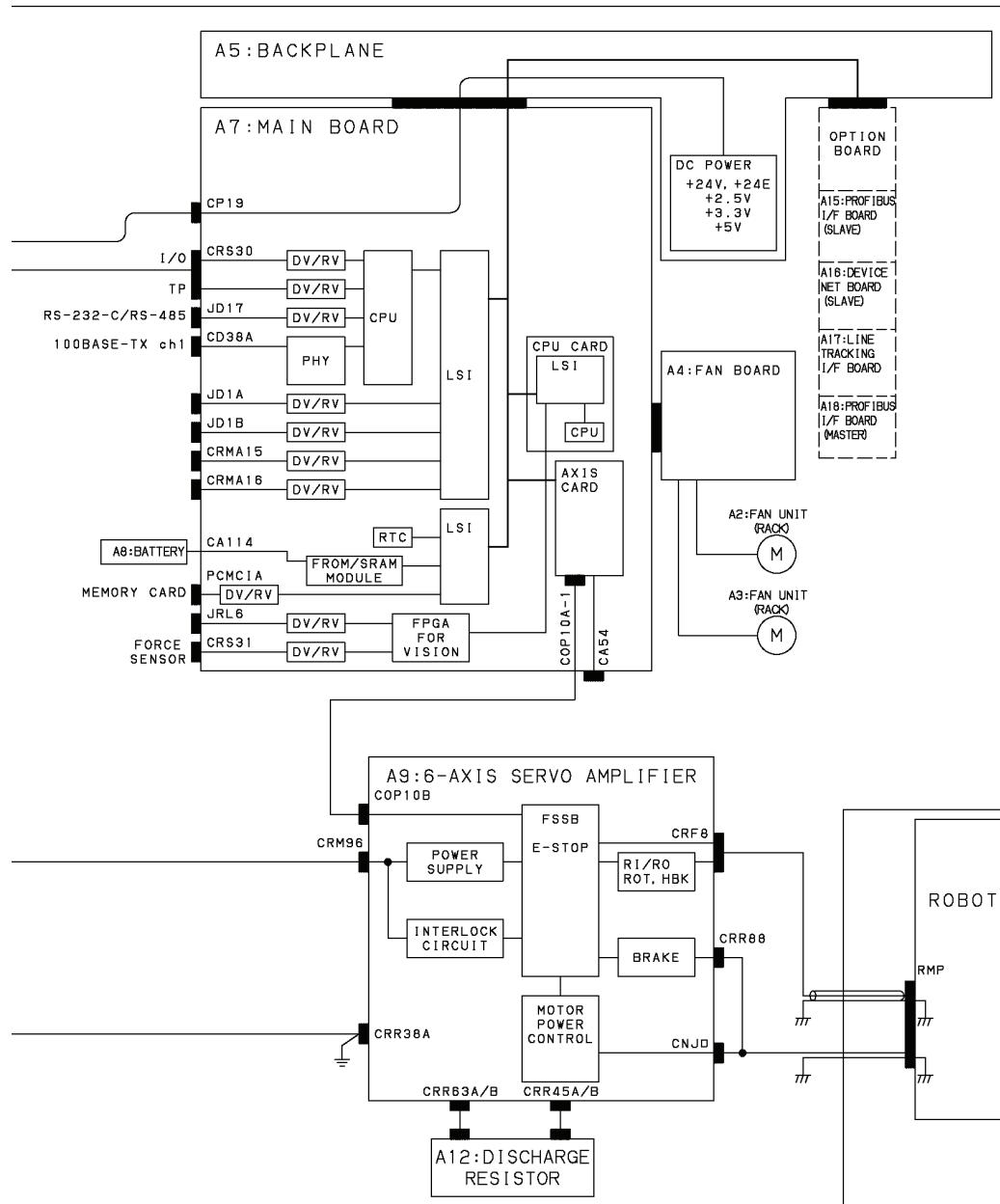


Fig. A (b) System block diagram
(ARC Mate 120iC, M-20iA, ARC Mate 100iC, M-10iA, ARC Mate 50iC)



E-STOP CIRCUIT <R-301A Mate>
Dual check safety

DI:Simple DI
PI:Photo coupler DI
Not showing the diodes to protect from reverse electric power.

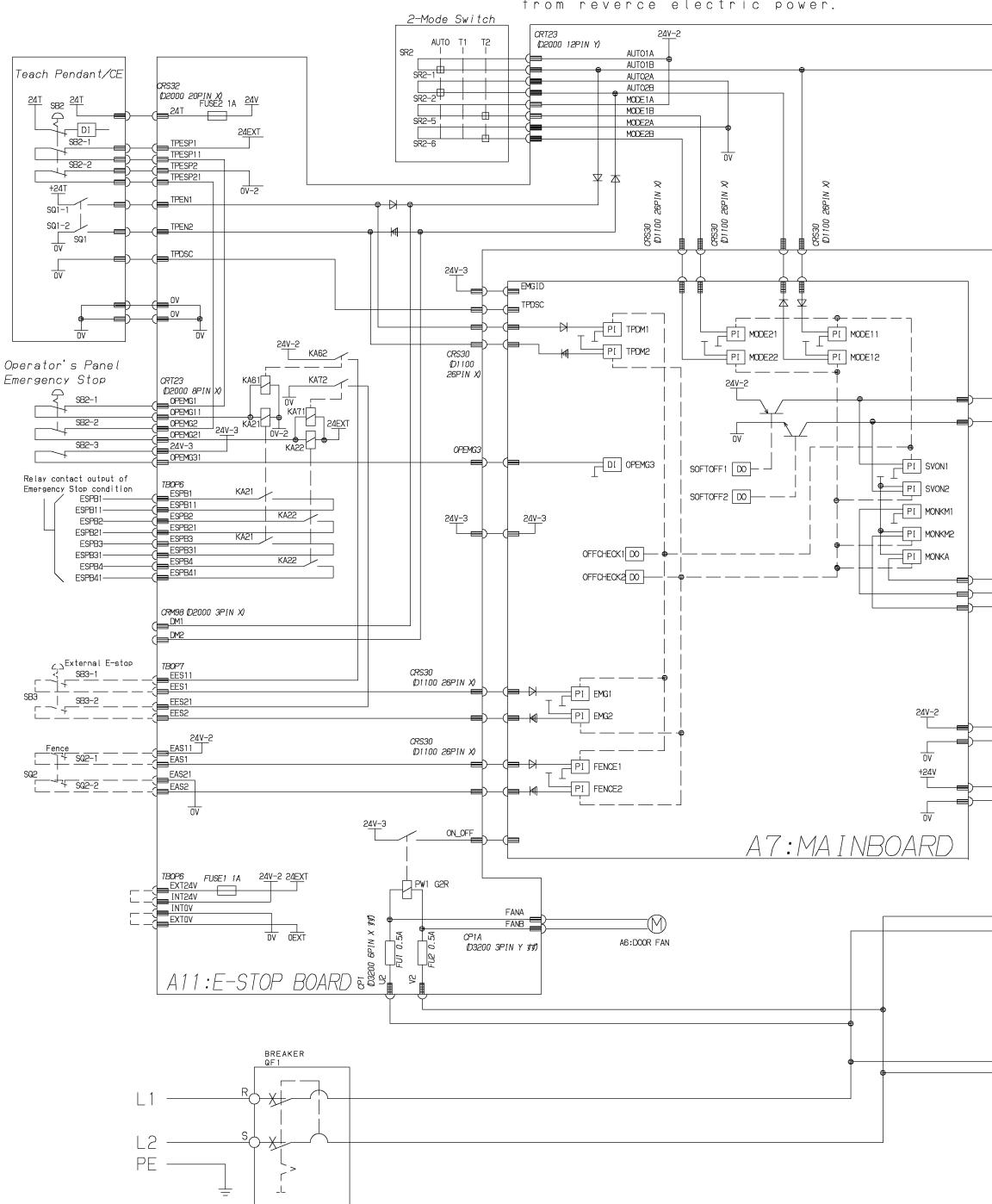
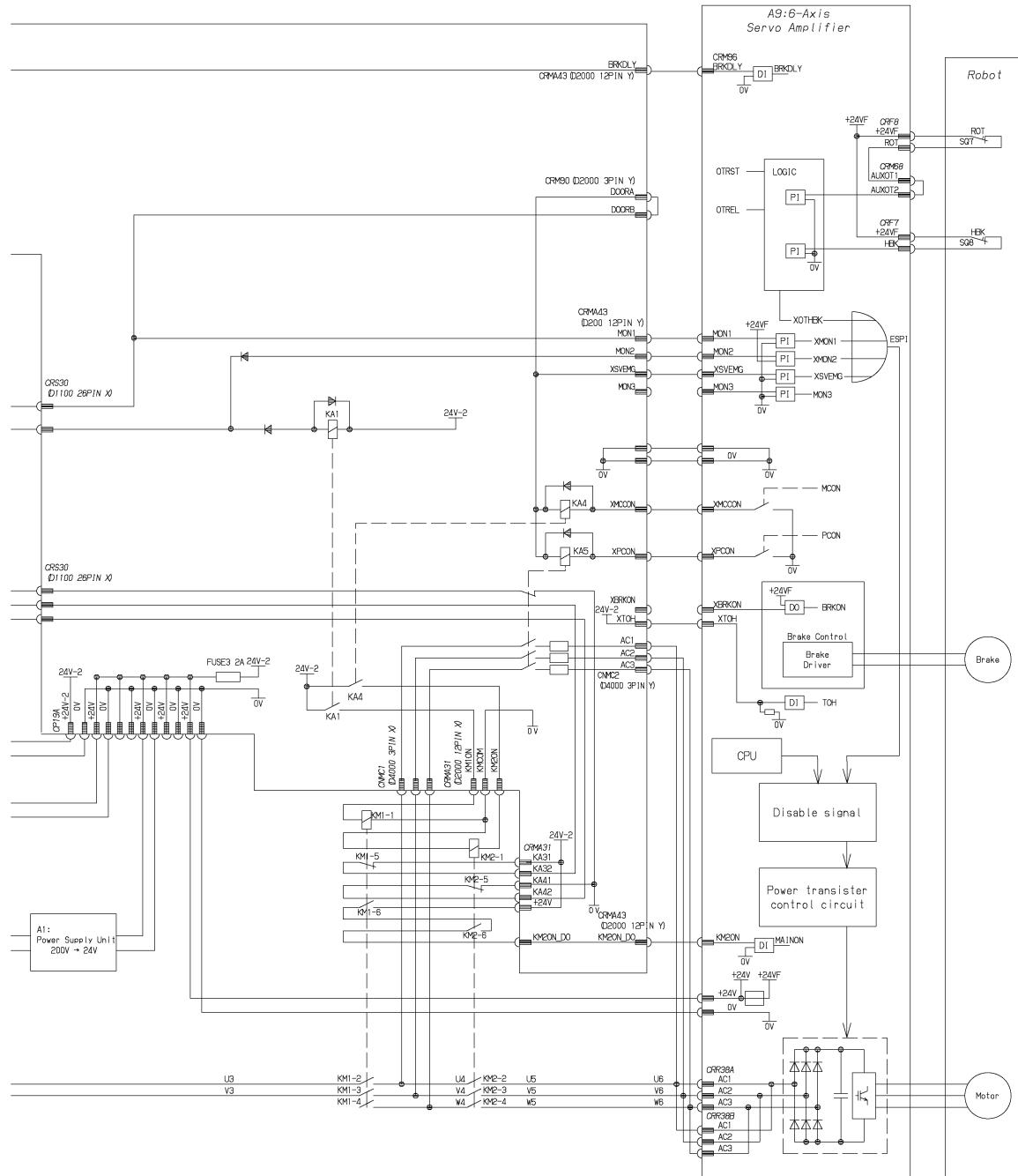


Fig. A (c) Emergency stop circuit diagram (M-1iA, LR Mate 200iC)

A.TOTAL CONNECTION DIAGRAM



E-STOP CIRCUIT <R-30iA Mate>
Dual check safety

DI : Simple DI

PI:Photo coupler DI

Not showing the diodes to protect from reverse electric power.

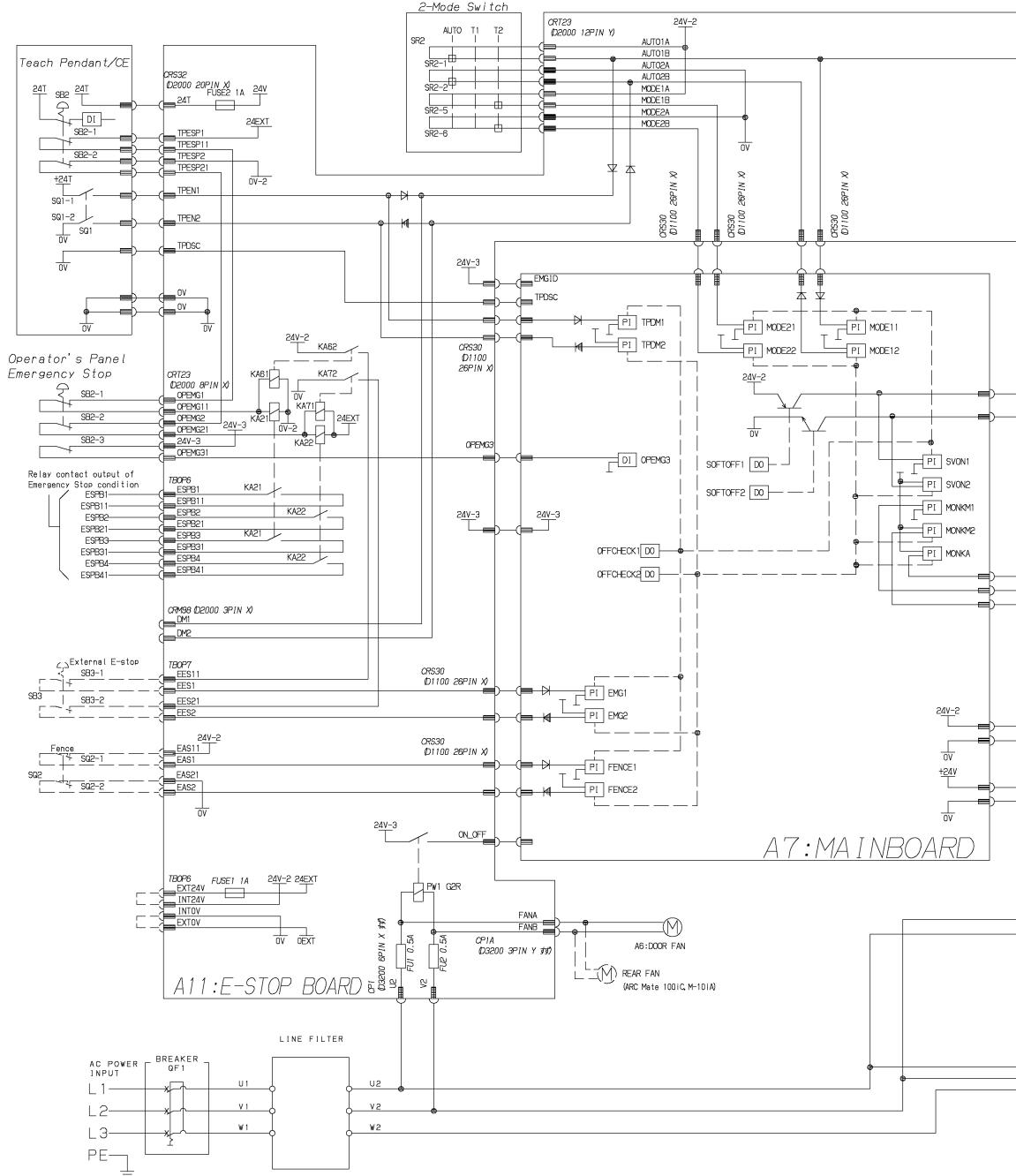
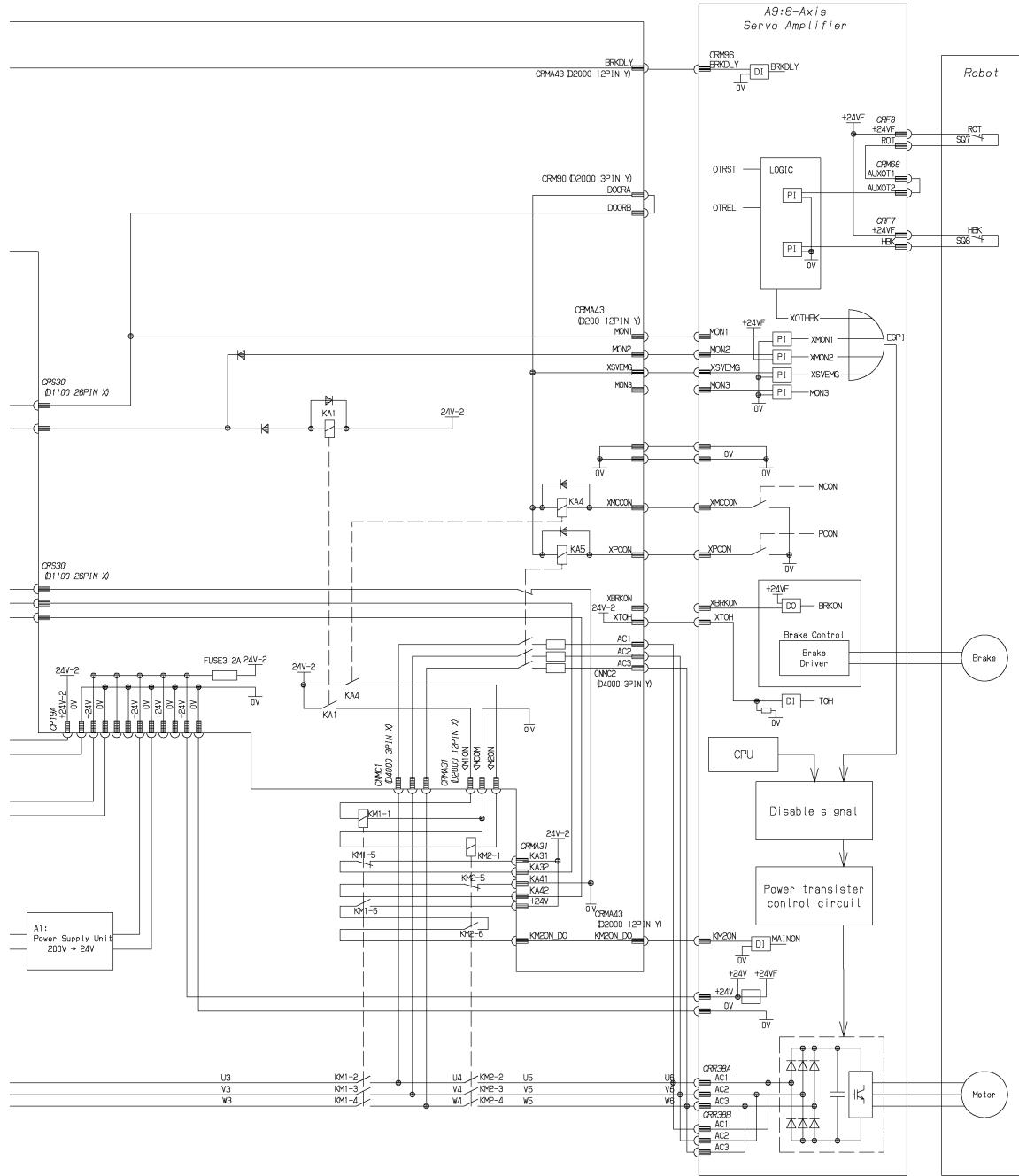


Fig. A (d) Emergency stop circuit diagram
(ARC Mate 120iC, M-20iA, ARC Mate 100iC, M-10iA, ARC Mate 50iC)



| CRS32 D2000 (X-k _e y) | | CRMA43 D2000 (Y-k _e y) | | CRMA31 D2000 (X-k _e y) | | CRMA31 D2000 (Y-k _e y) | |
|-------------------------------------|--------|--------------------------------------|--|--------------------------------------|---------|--------------------------------------|--|
| 1 | A | B | | 1 | A | B | |
| 1 | TXTP | XTXTP | | 1 | KA31 | KA32 | |
| 2 | RXTF | XRXTP | | 2 | KA41 | KA42 | |
| 3 | TPESP1 | TPESP1 | | 3 | MONK1 | MONK1 | |
| 4 | TPESP2 | TPESP2 | | 4 | MODE12 | MONK2 | |
| 5 | TPEN1 | TPEN2 | | 5 | MODE21 | MONKA | |
| 6 | TPDSC | | | 6 | MODE22 | TPDSC | |
| 5 | 24T | 0V | | 7 | TPDM1 | START | |
| 6 | 24T | 0V | | 8 | TPDM2 | EMGID | |
| | | | | 9 | FENCE1 | SVON1 | |
| | | | | 10 | FENCE2 | SVON2 | |
| | | | | 11 | EXENG1 | BUSY | |
| | | | | 12 | EXENG2 | OPEMG31 | |
| | | | | 13 | 2AV-3 | ON-OFF | |
| | | | | | | | |
| CRT23 D2100 (Y-k _e y) | | CP1 D3200 (X-k _e y) | | CP1 D3200 (Y-k _e y) | | CP1A D3200 (Y-k _e y) | |
| 1 | A | B | | 3 | 2 | 1 | |
| 1 | AUTO1A | AUTO1B | | 3 | v2 | U2 | |
| 2 | AUTO2A | AUTO2B | | | | | |
| 3 | MODE1A | MODE1B | | | | | |
| 4 | MODE2A | MODE2B | | | | | |
| 5 | OPENG1 | OPENG1 | | | | | |
| 6 | OPENG2 | OPENG2 | | | | | |
| 7 | START | 2AV-3 | | 1 | 24V-2 | 0V | |
| 8 | BUSY | OPGMG31 | | 2 | 24V | 0V | |
| | | | | 3 | | | |
| | | | | 4 | 24V | 0V | |
| | | | | 5 | 24V | 0V | |
| | | | | 6 | 24V | 0V | |
| CRM98 D2100 (X-k _e y) | | TBOP6 TBOP7 | | TBOP6 TBOP7 | | TBOP6 TBOP7 | |
| 3 | 2 | 1 | | 1 | EES1 | | |
| | DM2 | DM1 | | 2 | EES11 | | |
| | | | | 3 | EES2 | | |
| | | | | 4 | EES21 | | |
| | | | | 5 | EAS1 | | |
| | | | | 6 | EAS11 | | |
| | | | | 7 | EAS2 | | |
| | | | | 8 | EAS21 | | |
| CRMS0 D2100 (Y-k _e y) | | CNMC1 D4000 (X-k _e y) | | CNMC1 D4000 (X-k _e y) | | CNMC2 D4000 (Y-k _e y) | |
| 3 | 2 | 1 | | 3 | 2 | 1 | |
| | DOORB | DOORA | | 200T | 200S | 200R | |
| | | | | | | | |
| CNMC2 D4000 (Y-k _e y) | | CONNECTOR ON THE TEACH PENDANT | | CONNECTOR ON THE TEACH PENDANT | | CONNECTOR ON THE TEACH PENDANT | |
| 3 | 2 | 1 | | 4 | XRXTP | XTXTP | |
| AC3 | AC2 | AC1 | | 9 | 8 | 7 | |
| | | | | | | | |
| | | | | 10 | 24T | 0V | |
| | | | | 16 | TPESP21 | TPESP2 | |
| | | | | 20 | 0V | 0V | |
| | | | | | | | |
| | | | | 13 | TPESP11 | TPESP11 | |
| | | | | 18 | TPEN2 | TPDSC | |
| | | | | 17 | TPDSC | | |

All:
E-STOP Board
Connector Table

Fig. A (e) Emergency stop board connector table

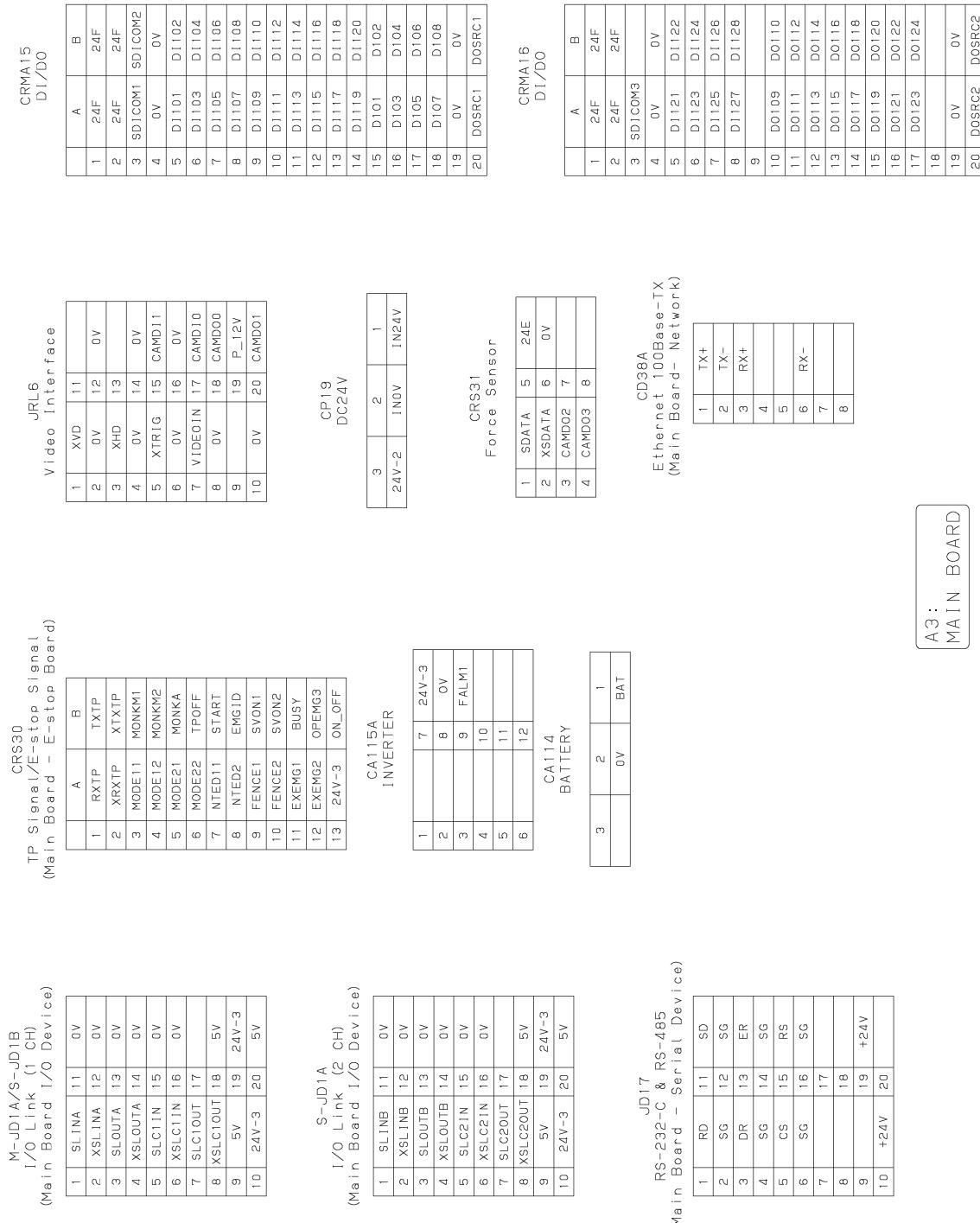


Fig. A (f) Main board connector table

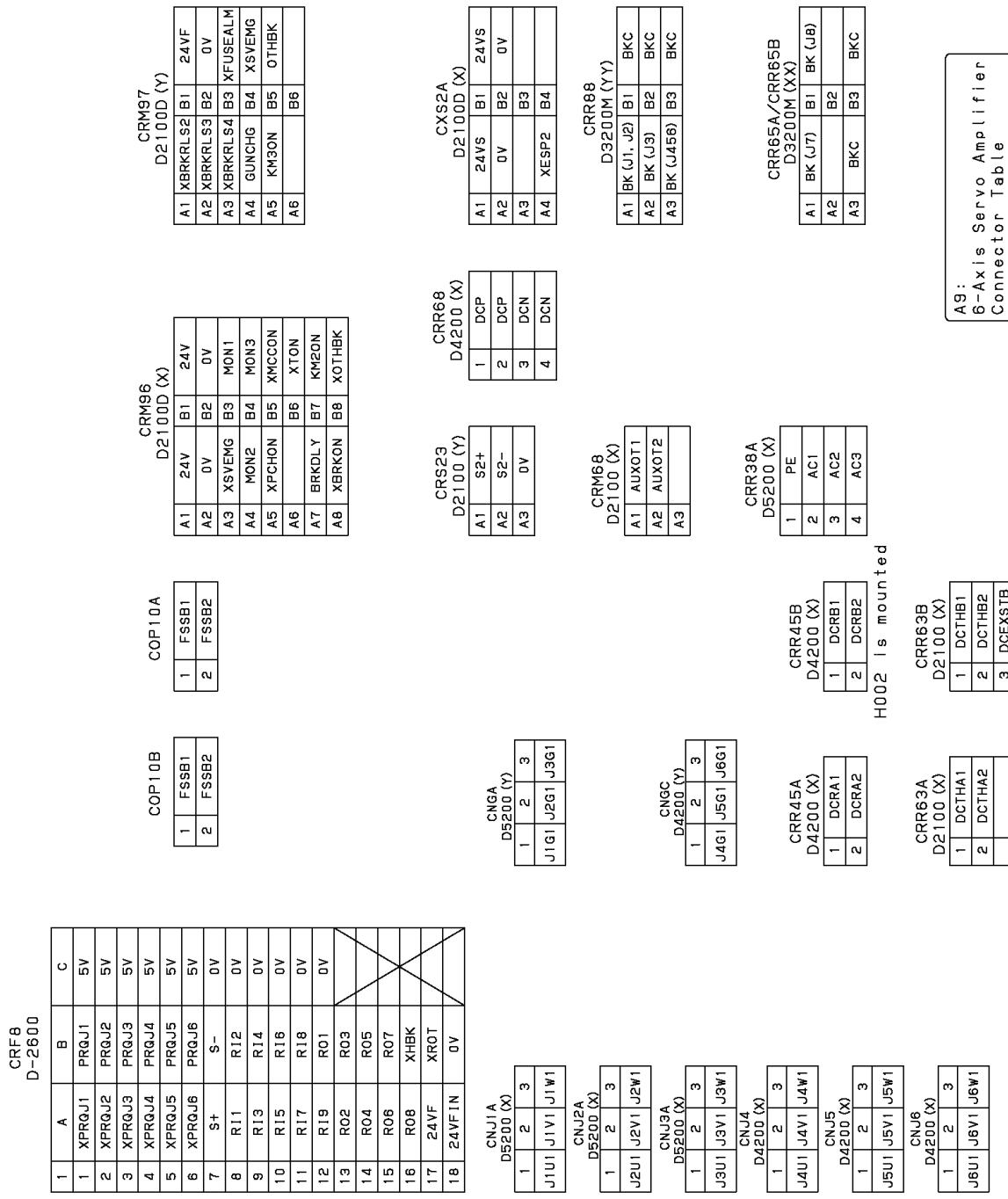


Fig. A (g) Servo amplifier connector table

Ag:
6-Axis Servo Amplifier
Connector Table

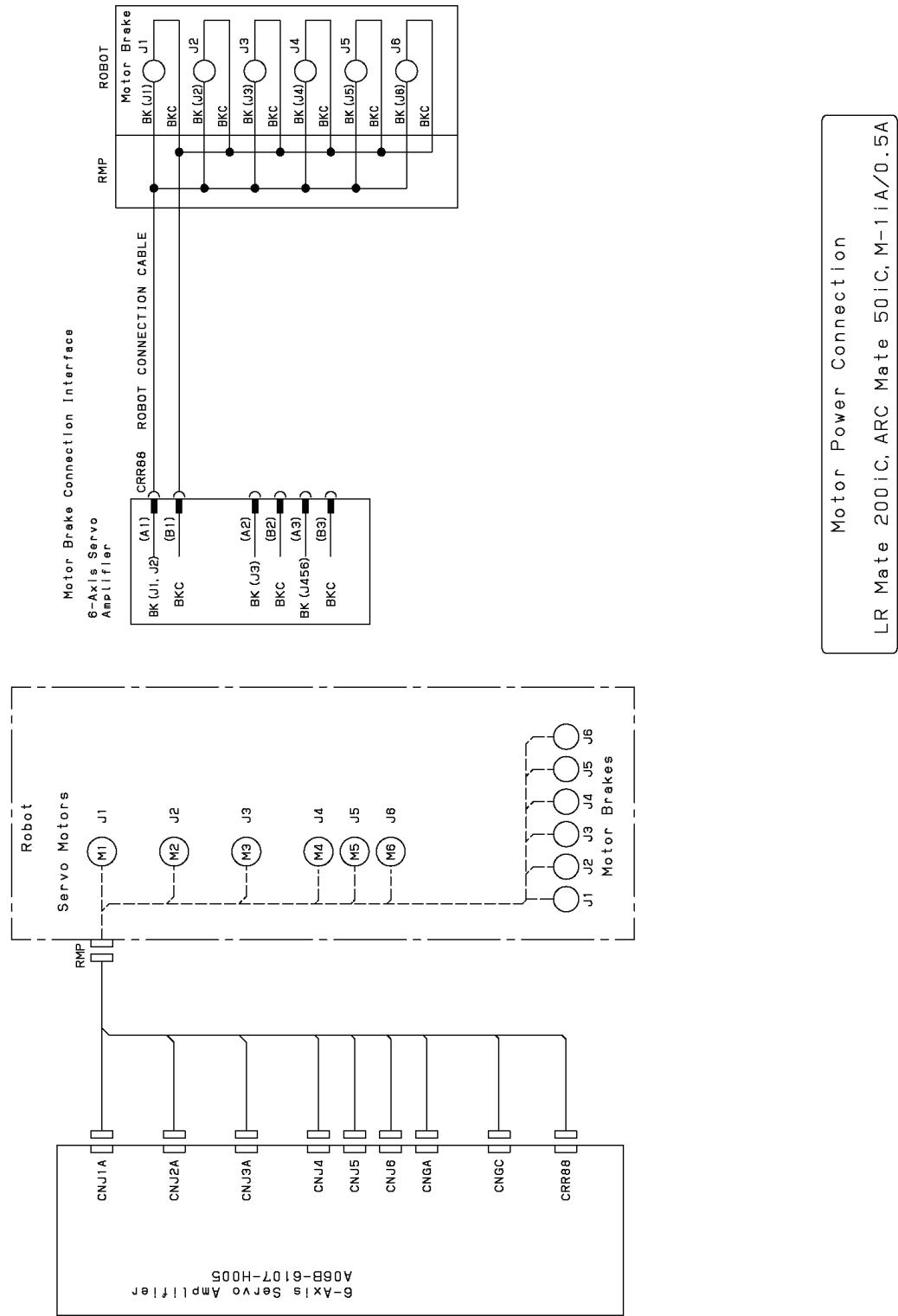


Fig. A (h) Motor power connection (LR Mate 200iC(6-Axis), ARC Mate 50iC, M-1iA/0.5A)

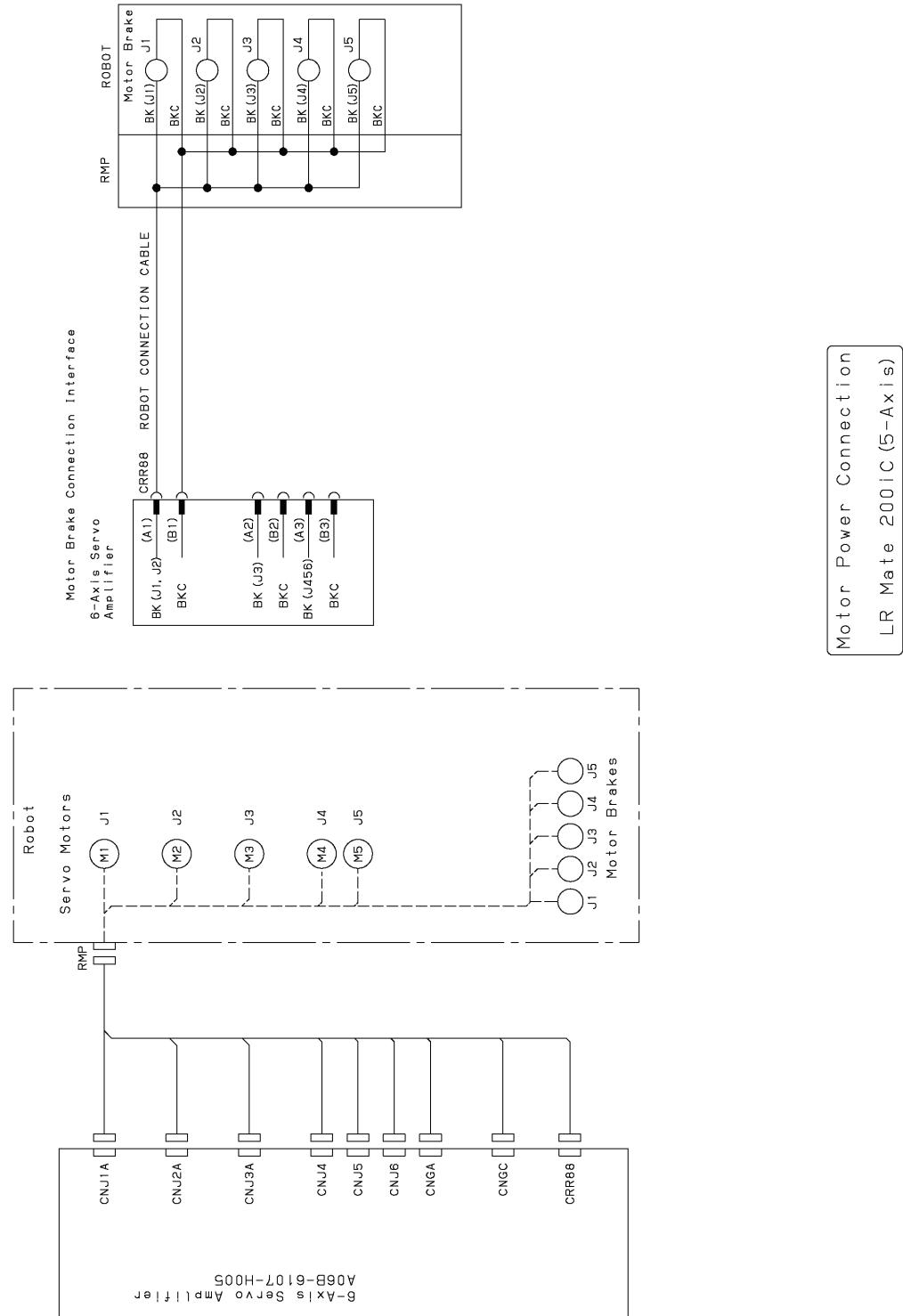


Fig. A (i) Motor power connection (LR Mate 200iC(5-Axis))

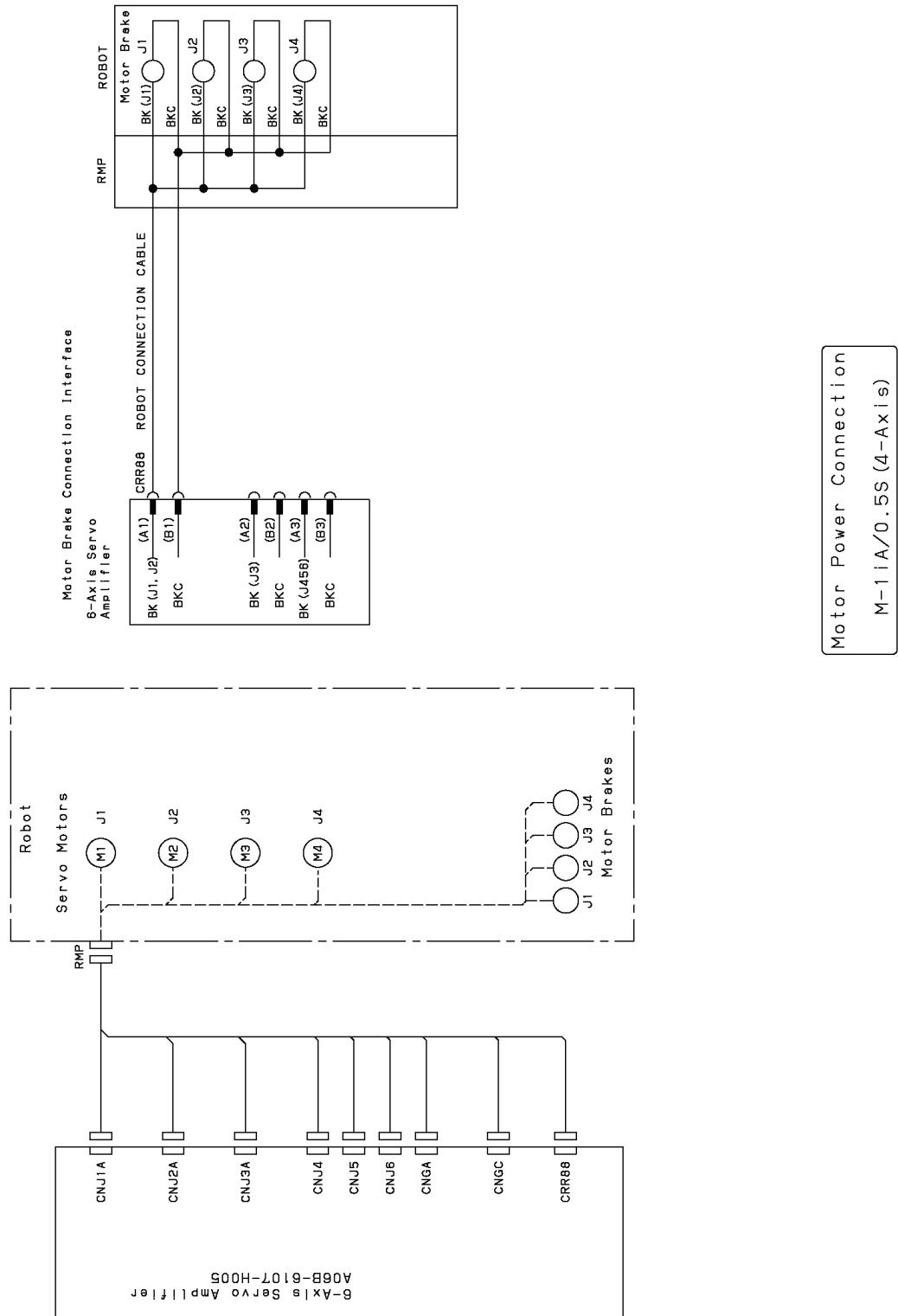


Fig. A (j) Motor power connection (M-1iA/0.5S(4-Axis))

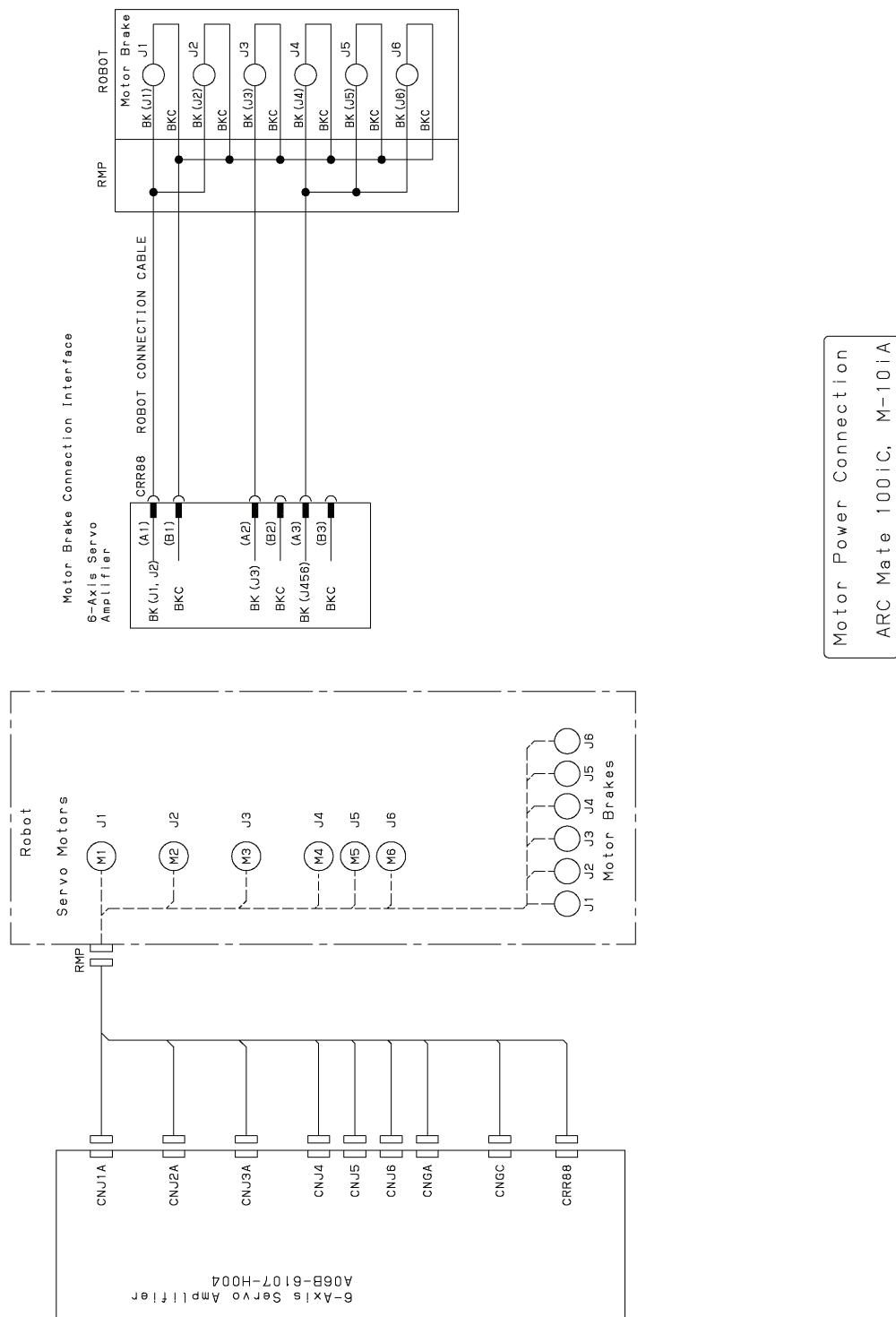


Fig. A (k) Motor power connection (ARC Mate 100iC, M-10iA)

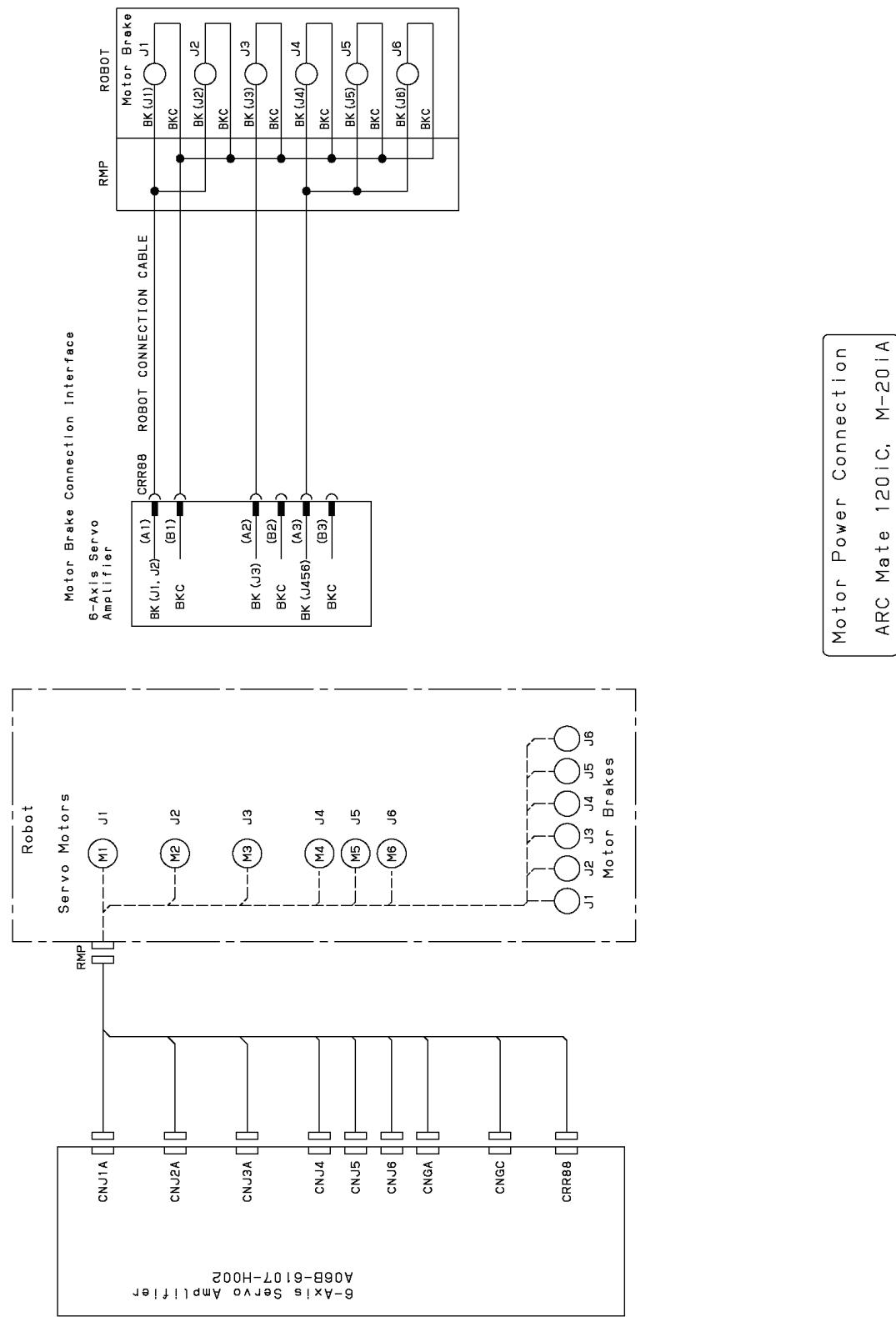


Fig. A (I) Motor power connection (ARC Mate 120iC, M-20iA)

| RMP | (FOR LR Matte 2001C, M-1 i A, ARC Matte 501C) | RMP | (FOR ARC Matte 1001C, M-10 i A, ARC Matte 1201C, M-201A) |
|------------|---|----------------|--|
| 1 BK (J1) | 13 BK (J2) | 25 BK (J3) | 37 BK (J4) |
| 2 BKc | 14 BKc | 26 BKc | 38 BKc |
| 3 J1U1 | 15 J2U1 | 27 J3U1 | 39 J4U1 |
| 4 JV1 | 16 J2V1 | 28 J3V1 | 40 J4V1 |
| 5 J1W1 | 17 J2W1 | 29 J3W1 | 41 J4W1 |
| 6 J1G1 | 18 J2G1 | 30 J3G1 | 42 J4G1 |
| 7 XROT | 19 X2VF (OT) | 43 24VF | 43 R15 |
| 8 R11 | 20 R12 | 32 R13 | 44 R14 |
| 9 R01 | 21 R02 | 33 R03 | 45 R04 |
| 10 SV (J1) | 22 SV (J2, J3) | 34 SV (J2, J3) | 46 DV (J1) |
| 11 PRQJ1 | 23 PRQJ2 | 35 PRQJ3 | 47 PRQJ4 |
| 12 XPRQJ1 | 24 XPRQJ2 | 36 XPRQJ3 | 48 XPRQJ4 |
| 56 R15 | 57 R05 | 69 R06 | 71 R16 |
| 58 R16 | 59 R07 | 70 R08 | 72 R09 |
| 59 R08 | 60 R09 | 71 R10 | 73 R11 |
| 60 R09 | 61 R11 | 72 R12 | 74 R13 |
| 61 R10 | 62 R12 | 73 R13 | 75 R14 |
| 62 R11 | 63 R13 | 74 R14 | 76 R15 |
| 63 R12 | 64 R14 | 75 R15 | 77 R16 |
| 64 R13 | 65 R15 | 76 R16 | 78 R17 |
| 65 R14 | 66 R16 | 77 R17 | 79 R18 |
| 66 R15 | 67 R17 | 78 R18 | 80 R19 |
| 67 R16 | 68 R18 | 79 R19 | 81 R20 |
| 68 R17 | 69 R19 | 80 R20 | 82 R21 |
| 69 R18 | 70 R20 | 81 R21 | 83 R22 |
| 70 R19 | 71 R21 | 82 R22 | 84 R23 |
| 71 R20 | 72 R22 | 83 R23 | 85 R24 |
| 72 R21 | 73 R23 | 84 R24 | 86 R25 |
| 73 R22 | 74 R24 | 85 R25 | 87 R26 |
| 74 R23 | 75 R25 | 86 R26 | 88 R27 |
| 75 R24 | 76 R26 | 87 R27 | 89 R28 |
| 76 R25 | 77 R27 | 88 R28 | 90 R29 |
| 77 R26 | 78 R28 | 89 R29 | 91 R30 |
| 78 R27 | 79 R29 | 90 R30 | 92 R31 |
| 79 R28 | 80 R30 | 91 R31 | 93 R32 |
| 80 R29 | 81 R31 | 92 R32 | 94 R33 |
| 81 R30 | 82 R32 | 93 R33 | 95 R34 |
| 82 R31 | 83 R33 | 94 R34 | 96 R35 |
| 83 R32 | 84 R34 | 95 R35 | 97 R36 |
| 84 R33 | 85 R35 | 96 R36 | 98 R37 |
| 85 R34 | 86 R36 | 97 R37 | 99 R38 |
| 86 R35 | 87 R37 | 98 R38 | 100 R39 |
| 87 R36 | 88 R38 | 99 R39 | 101 R40 |
| 88 R37 | 89 R39 | 100 R40 | 102 R41 |
| 89 R38 | 90 R40 | 101 R41 | 103 R42 |
| 90 R39 | 91 R41 | 102 R42 | 104 R43 |
| 91 R40 | 92 R42 | 103 R43 | 105 R44 |
| 92 R41 | 93 R43 | 104 R44 | 106 R45 |
| 93 R42 | 94 R44 | 105 R45 | 107 R46 |
| 94 R43 | 95 R45 | 106 R46 | 108 R47 |
| 95 R44 | 96 R46 | 107 R47 | 109 R48 |
| 96 R45 | 97 R47 | 108 R48 | 110 R49 |
| 97 R46 | 98 R48 | 109 R49 | 111 R50 |
| 98 R47 | 99 R49 | 110 R50 | 112 R51 |
| 99 R48 | 100 R50 | 111 R51 | 113 R52 |
| 100 R49 | 101 R51 | 112 R52 | 114 R53 |
| 101 R50 | 102 R52 | 113 R53 | 115 R54 |
| 102 R51 | 103 R53 | 114 R54 | 116 R55 |
| 103 R52 | 104 R54 | 115 R55 | 117 R56 |
| 104 R53 | 105 R55 | 116 R56 | 118 R57 |
| 105 R54 | 106 R56 | 117 R57 | 119 R58 |
| 106 R55 | 107 R57 | 118 R58 | 120 R59 |
| 107 R56 | 108 R58 | 119 R59 | 121 R60 |
| 108 R57 | 109 R59 | 120 R60 | 122 R61 |
| 109 R58 | 110 R60 | 121 R61 | 123 R62 |
| 110 R59 | 111 R61 | 122 R62 | 124 R63 |
| 111 R60 | 112 R62 | 123 R63 | 125 R64 |
| 112 R61 | 113 R63 | 124 R64 | 126 R65 |
| 113 R62 | 114 R64 | 125 R65 | 127 R66 |
| 114 R63 | 115 R65 | 126 R66 | 128 R67 |
| 115 R64 | 116 R66 | 127 R67 | 129 R68 |
| 116 R65 | 117 R67 | 128 R68 | 130 R69 |
| 117 R66 | 118 R68 | 129 R69 | 131 R70 |
| 118 R67 | 119 R69 | 130 R70 | 132 R71 |
| 119 R68 | 120 R70 | 131 R71 | 133 R72 |
| 120 R69 | 121 R71 | 132 R72 | 134 R73 |
| 121 R70 | 122 R72 | 133 R73 | 135 R74 |
| 122 R71 | 123 R73 | 134 R74 | 136 R75 |
| 123 R72 | 124 R74 | 135 R75 | 137 R76 |
| 124 R73 | 125 R75 | 136 R76 | 138 R77 |
| 125 R74 | 126 R76 | 137 R77 | 139 R78 |
| 126 R75 | 127 R77 | 138 R78 | 140 R79 |
| 127 R76 | 128 R78 | 139 R79 | 141 R80 |
| 128 R77 | 129 R79 | 140 R80 | 142 R81 |
| 129 R78 | 130 R80 | 141 R81 | 143 R82 |
| 130 R79 | 131 R81 | 142 R82 | 144 R83 |
| 131 R80 | 132 R82 | 143 R83 | 145 R84 |
| 132 R81 | 133 R83 | 144 R84 | 146 R85 |
| 133 R82 | 134 R84 | 145 R85 | 147 R86 |
| 134 R83 | 135 R85 | 146 R86 | 148 R87 |
| 135 R84 | 136 R86 | 147 R87 | 149 R88 |
| 136 R85 | 137 R87 | 148 R88 | 150 R89 |
| 137 R86 | 138 R88 | 149 R89 | 151 R90 |
| 138 R87 | 139 R89 | 150 R90 | 152 R91 |
| 139 R88 | 140 R90 | 151 R91 | 153 R92 |
| 140 R89 | 141 R91 | 152 R92 | 154 R93 |
| 141 R90 | 142 R92 | 153 R93 | 155 R94 |
| 142 R91 | 143 R93 | 154 R94 | 156 R95 |
| 143 R92 | 144 R94 | 155 R95 | 157 R96 |
| 144 R93 | 145 R95 | 156 R96 | 158 R97 |
| 145 R94 | 146 R96 | 157 R97 | 159 R98 |
| 146 R95 | 147 R97 | 158 R98 | 160 R99 |
| 147 R96 | 148 R98 | 159 R99 | 161 R100 |
| 148 R97 | 149 R99 | 160 R100 | 162 R101 |
| 149 R98 | 150 R100 | 161 R101 | 163 R102 |
| 150 R99 | 151 R101 | 162 R102 | 164 R103 |
| 151 R100 | 152 R102 | 163 R103 | 165 R104 |
| 152 R101 | 153 R103 | 164 R104 | 166 R105 |
| 153 R102 | 154 R104 | 165 R105 | 167 R106 |
| 154 R103 | 155 R105 | 166 R106 | 168 R107 |
| 155 R104 | 156 R106 | 167 R107 | 169 R108 |
| 156 R105 | 157 R107 | 168 R108 | 170 R109 |
| 157 R106 | 158 R108 | 169 R109 | 171 R110 |
| 158 R107 | 159 R109 | 170 R110 | 172 R111 |
| 159 R108 | 160 R110 | 171 R111 | 173 R112 |
| 160 R109 | 161 R111 | 172 R112 | 174 R113 |
| 161 R110 | 162 R112 | 173 R113 | 175 R114 |
| 162 R111 | 163 R113 | 174 R114 | 176 R115 |
| 163 R112 | 164 R114 | 175 R115 | 177 R116 |
| 164 R113 | 165 R115 | 176 R116 | 178 R117 |
| 165 R114 | 166 R116 | 177 R117 | 179 R118 |
| 166 R115 | 167 R117 | 178 R118 | 180 R119 |
| 167 R116 | 168 R118 | 179 R119 | 181 R120 |
| 168 R117 | 169 R119 | 180 R120 | 182 R121 |
| 169 R118 | 170 R120 | 181 R121 | 183 R122 |
| 170 R119 | 171 R121 | 182 R122 | 184 R123 |
| 171 R120 | 172 R122 | 183 R123 | 185 R124 |
| 172 R121 | 173 R123 | 184 R124 | 186 R125 |
| 173 R122 | 174 R124 | 185 R125 | 187 R126 |
| 174 R123 | 175 R125 | 186 R126 | 188 R127 |
| 175 R124 | 176 R126 | 187 R127 | 189 R128 |
| 176 R125 | 177 R127 | 188 R128 | 190 R129 |
| 177 R126 | 178 R128 | 189 R129 | 191 R130 |
| 178 R127 | 179 R129 | 190 R130 | 192 R131 |
| 179 R128 | 180 R130 | 191 R131 | 193 R132 |
| 180 R129 | 181 R131 | 192 R132 | 194 R133 |
| 181 R130 | 182 R132 | 193 R133 | 195 R134 |
| 182 R131 | 183 R133 | 194 R134 | 196 R135 |
| 183 R132 | 184 R134 | 195 R135 | 197 R136 |
| 184 R133 | 185 R135 | 196 R136 | 198 R137 |
| 185 R134 | 186 R136 | 197 R137 | 199 R138 |
| 186 R135 | 187 R137 | 198 R138 | 200 R139 |
| 187 R136 | 188 R138 | 199 R139 | 201 R140 |
| 188 R137 | 189 R139 | 200 R140 | 202 R141 |
| 189 R138 | 190 R140 | 201 R141 | 203 R142 |
| 190 R139 | 191 R141 | 202 R142 | 204 R143 |
| 191 R140 | 192 R142 | 203 R143 | 205 R144 |
| 192 R141 | 193 R143 | 204 R144 | 206 R145 |
| 193 R142 | 194 R144 | 205 R145 | 207 R146 |
| 194 R143 | 195 R145 | 206 R146 | 208 R147 |
| 195 R144 | 196 R146 | 207 R147 | 209 R148 |
| 196 R145 | 197 R147 | 208 R148 | 210 R149 |
| 197 R146 | 198 R148 | 209 R149 | 211 R150 |
| 198 R147 | 199 R149 | 210 R150 | 212 R151 |
| 199 R148 | 200 R150 | 211 R151 | 213 R152 |
| 200 R149 | 201 R151 | 212 R152 | 214 R153 |
| 201 R150 | 202 R152 | 213 R153 | 215 R154 |
| 202 R151 | 203 R153 | 214 R154 | 216 R155 |
| 203 R152 | 204 R154 | 215 R155 | 217 R156 |
| 204 R153 | 205 R155 | 216 R156 | 218 R157 |
| 205 R154 | 206 R156 | 217 R157 | 219 R158 |
| 206 R155 | 207 R157 | 218 R158 | 220 R159 |
| 207 R156 | 208 R158 | 219 R159 | 221 R160 |
| 208 R157 | 209 R159 | 220 R160 | 222 R161 |
| 209 R158 | 210 R160 | 221 R161 | 223 R162 |
| 210 R159 | 211 R161 | 222 R162 | 224 R163 |
| 211 R160 | 212 R162 | 223 R163 | 225 R164 |
| 212 R161 | 213 R163 | 224 R164 | 226 R165 |
| 213 R162 | 214 R164 | 225 R165 | 227 R166 |
| 214 R163 | 215 R165 | 226 R166 | 228 R167 |
| 215 R164 | 216 R166 | 227 R167 | 229 R168 |
| 216 R165 | 217 R167 | 228 R168 | 230 R169 |
| 217 R166 | 218 R168 | 229 R169 | 231 R170 |
| 218 R167 | 219 R169 | 230 R170 | 232 R171 |
| 219 R168 | 220 R170 | 231 R171 | 233 R172 |
| 220 R169 | 221 R171 | 232 R172 | 234 R173 |
| 221 R170 | 222 R172 | 233 R173 | 235 R174 |
| 222 R171 | 223 R173 | 234 R174 | 236 R175 |
| 223 R172 | 224 R174 | 235 R175 | 237 R176 |
| 224 R173 | 225 R175 | 236 R176 | 238 R177 |
| 225 R174 | 226 R176 | 237 R177 | 239 R178 |
| 226 R175 | 227 R177 | 238 R178 | 240 R179 |
| 227 R176 | 228 R178 | 239 R179 | 241 R180 |
| 228 R177 | 229 R179 | 240 R180 | 242 R181 |
| 229 R178 | 230 R180 | 241 R181 | 243 R182 |
| 230 R179 | 231 R181 | 242 R182 | 244 R183 |
| 231 R180 | 232 R182 | 243 R183 | 245 R184 |
| 232 R181 | 233 R183 | 244 R184 | 246 R185 |
| 233 R182 | 234 R184 | 245 R185 | 247 R186 |
| 234 R183 | 235 R185 | 246 R186 | 248 R187 |
| 235 R184 | 236 R186 | 247 R187 | 249 R188 |
| 236 R185 | 237 R187 | 248 R188 | 250 R189 |
| 237 R186 | 238 R188 | 249 R189 | 251 R190 |
| 238 R187 | 239 R189 | 250 R190 | 252 R191 |
| 239 R188 | 240 R190 | 251 R191 | 253 R192 |
| 240 R189 | 241 R191 | 252 R192 | 254 R193 |
| 241 R190 | 242 R192 | 253 R193 | 255 R194 |
| 242 R191 | 243 R193 | 254 R194 | 256 R195 |
| 243 R192 | 244 R194 | 255 R195 | 257 R196 |
| 244 R193 | 245 R195 | 256 R196 | 258 R197 |
| 245 R194 | 246 R196 | 257 R197 | 259 R198 |
| 246 R195 | 247 R197 | 258 R198 | 260 R199 |
| 247 R196 | 248 R198 | 259 R199 | 261 R200 |
| 248 R197 | 249 R199 | 260 R200 | 262 R201 |
| 249 R198 | 250 R200 | 261 R201 | 263 R202 |
| 250 R199 | 251 R201 | 262 R202 | 264 R203 |
| 251 R200 | 252 R202 | 263 R203 | 265 R204 |
| 252 R201 | 253 R203 | 264 R204 | 266 R205 |
| 253 R202 | 254 R204 | 265 R205 | 267 R206 |
| 254 R203 | 255 R205 | 266 R206 | 268 R207 |
| 255 R204 | 256 R206 | 267 R207 | 269 R208 |
| 256 R205 | 257 R207 | 268 R208 | 270 R209 |
| 257 R206 | 258 R208 | 269 R209 | 271 R210 |
| 258 R207 | 259 R209 | 270 R210 | 272 R211 |
| 259 R208 | 260 R210 | 271 R211 | 273 R212 |
| 260 R209 | 261 R211 | 272 R212 | 274 R213 |
| 261 R210 | 262 R212 | 273 R213 | 275 R214 |
| 262 R211 | 263 R213 | 274 R214 | 276 R215 |
| 263 R212 | 264 R214 | 275 R215 | 277 R216 |
| 264 R213 | 265 R215 | 276 R216 | 278 R217 |
| 265 R214 | 266 R216 | 277 R217 | |

B BRAKE RELEASE UNIT

B.1 SAFETY PRECAUTIONS

⚠ WARNING

Support the robot arm by mechanical means to prevent it from falling down or rising up when brake is released. Before using the brake release unit, read the Operator's manual of the robot that tries to release the brake.

Confirm that the robot is fixed tightly to the floor to prevent the falling down and unexpected movement of robot.

Confirm that the outlet with earth is used for the power supply of brake release unit and earth of brake release unit is surely connected to earth of power supply. There is danger of getting an electric shock if earth is not connected.

B.2 CONFIRMATIONS BEFORE OPERATION

Confirm the followings before operation.

- (1) Confirm the exterior of the brake release unit and the power cable. Do not use it when there are damages in the unit and the cable.
- (2) Confirm that the power supply of the robot controller is disconnected.
- (3) There are two types of brake release units according to the input voltage as shown in Table B.2 (a). Confirm the input voltage of the unit to refer to the input voltage label put to the unit (Fig. B.5 (a)).
- (4) Confirm that the voltage of power supply before connecting the power supply to the brake release unit. There is possibility to give the damaging to the brake or the brake release unit when the incorrect power supply is connected to the unit.

Table B.2 (a) Specification of Brake release unit

| Brake release unit | Remarks |
|------------------------------|--|
| Brake release unit (AC 100V) | Input voltage AC100-115V, single phase |
| Brake release unit (AC 200V) | Input voltage AC200-240V, single phase |

- (5) The brake release unit connection cable is different in each robot. Confirm the cable specification corresponding to the robot referring to Table B.2 (b).

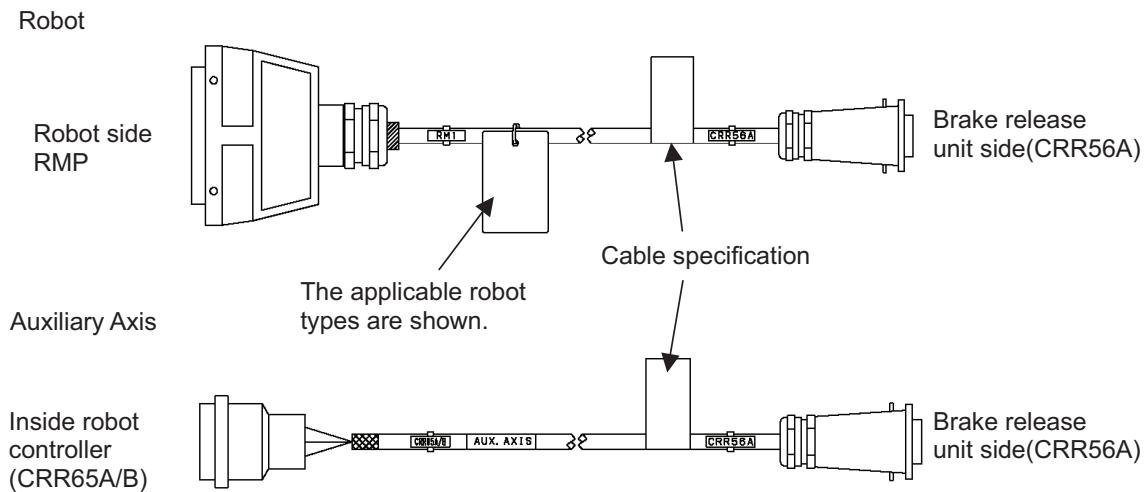


Fig.B.2 Brake release unit connection cable

Table B.2 (b) Specification of brake release unit connection cable

| Applicable robot types | Specification of cable |
|--|------------------------|
| LR Mate 200iC, ARC Mate 50iC, M-1iA | A660-2006-T474 |
| ARC Mate 100iC, M-10iA, ARC Mate 120iC, M-20iA | A660-2006-T881 |
| Auxiliary AXIS | A660-2005-T711 |

B.3 OPERATION

In case of operating to the robot

Operate the brake release unit according to the following procedures.

- (1) Support the robot arm by mechanical means to prevent it from falling down or rising up when brake is released. Refer to the Operator's manual for each robot.
- (2) Connect the Brake Release Unit connection cable to Brake Release Unit.
- (3) Disconnect the RMP connector from Robot, and connect the Brake Release Unit connection cable to the Robot. Keep the connection of Robot connection cable except RMP cable.
- (4) Connect the power cable of Brake release unit to power supply.
- (5) Press and hold the deadman switch in the middle position.
- (6) Press the brake switch '1'..'6' according to the axis that tries to release the brake, then brake will be released. (Refer to Table B.3) Two axes or more cannot be operated at the same time.

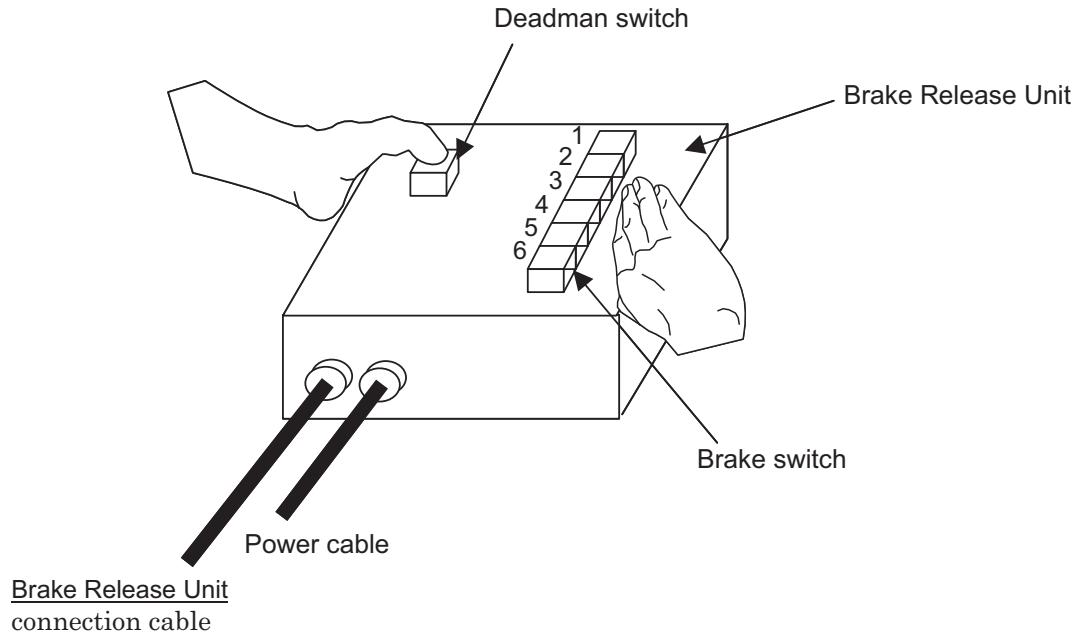


Fig.B.3 (a) Brake Release Unit

Table B.3 The relation between brake switch and robot axis

| Robot | Brake switch | | | | | |
|---|--------------|----|----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| LR Mate 200iC(6 axes), ARC Mate 100iC, M-10iA, ARC Mate 50iC ARC Mate 120iC, M-20iA, M-1iA/0.5A(6 axes) | J1 | J2 | J3 | J4 | J5 | J6 |
| LR Mate 200iC(5 axes) | J1 | J2 | J3 | - | J4 | J5 |
| M-1iA/0.5S(4 axes) | J1 | J2 | J3 | J4 | - | - |

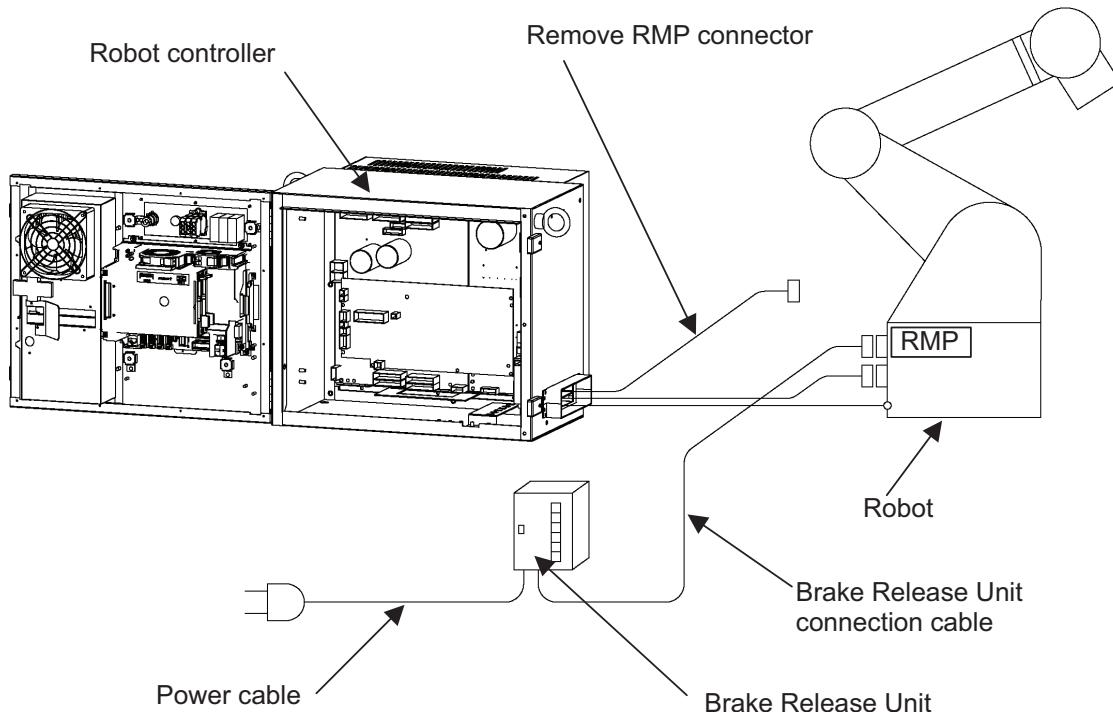


Fig.B.3 (b) How to connect Brake Release Unit (In case of operating the Robot)

In case of operating to the auxiliary Axis

Operate the brake release unit according to the following procedures.

- (1) Support the auxiliary Axis by mechanical means to prevent it from falling down or rising up when the brake is released.
- (2) Connect the Brake Release Unit connection cable to Brake Release Unit.
- (3) Disconnect the aux. axis brake connector (CRR65A/B), and connect the CRR65A/B connector to the Brake Release Unit connection cable. Keep the connection of all cables of aux. axis motor (power, Pulsecoder, brake).
- (4) Connect the power cable of Brake release unit to power supply.
- (5) Press and hold the deadman switch in the middle position.
- (6) Press the brake switch '1', then brake will be released.

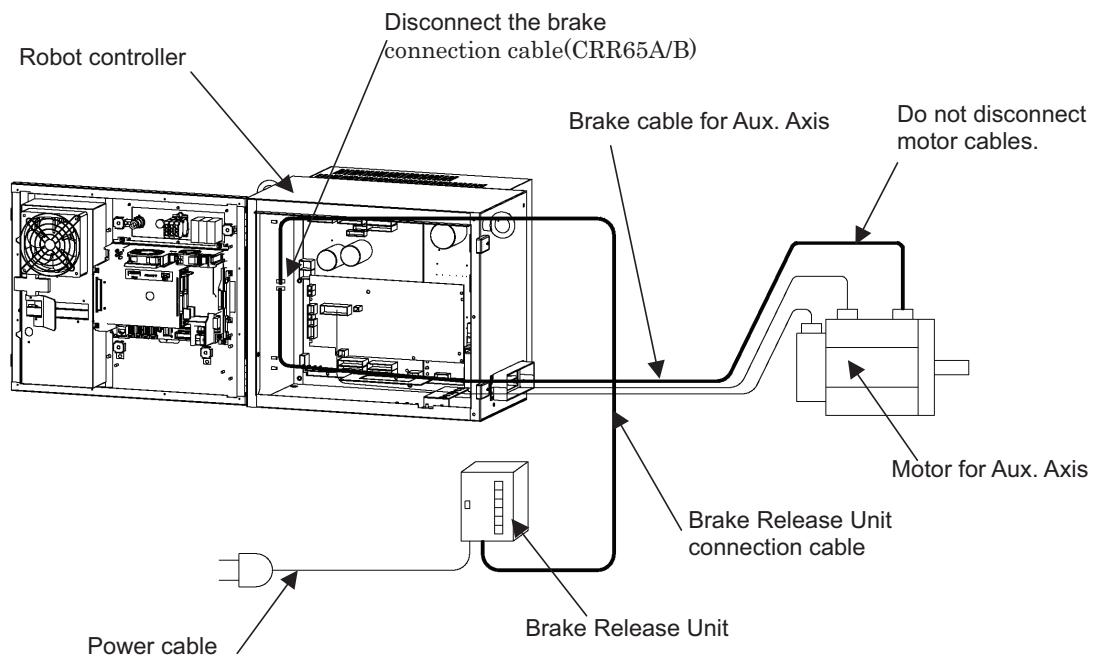


Fig.B.3 (c) How to connect Brake Release Unit (In case of operating the Aux. Axis)

B.4 HOW TO CONNECT THE PLUG TO THE POWER CABLE (IN CASE OF NO POWER PLUG)

Connect the plug to the power cable as follows. This plug is provided by customer.

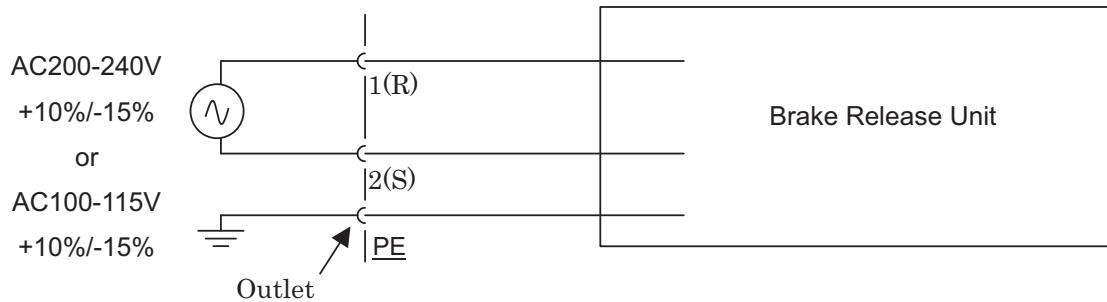
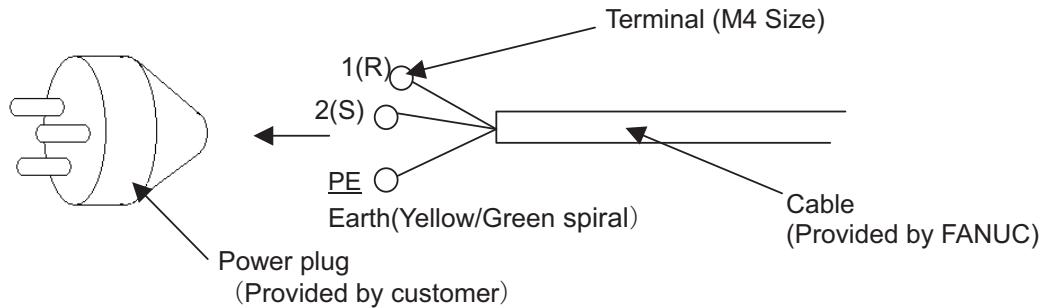


Fig.B.4 How to connect the plug to the power cable

⚠ WARNING

Only a specialist having the relevant expertise knowledge is permitted to connect the plug to the power cable.

In the EU area, only plug complying with the relevant European product standard can be used.

Do not install the plugs without protective earth pin.

B.5 DIMENSION

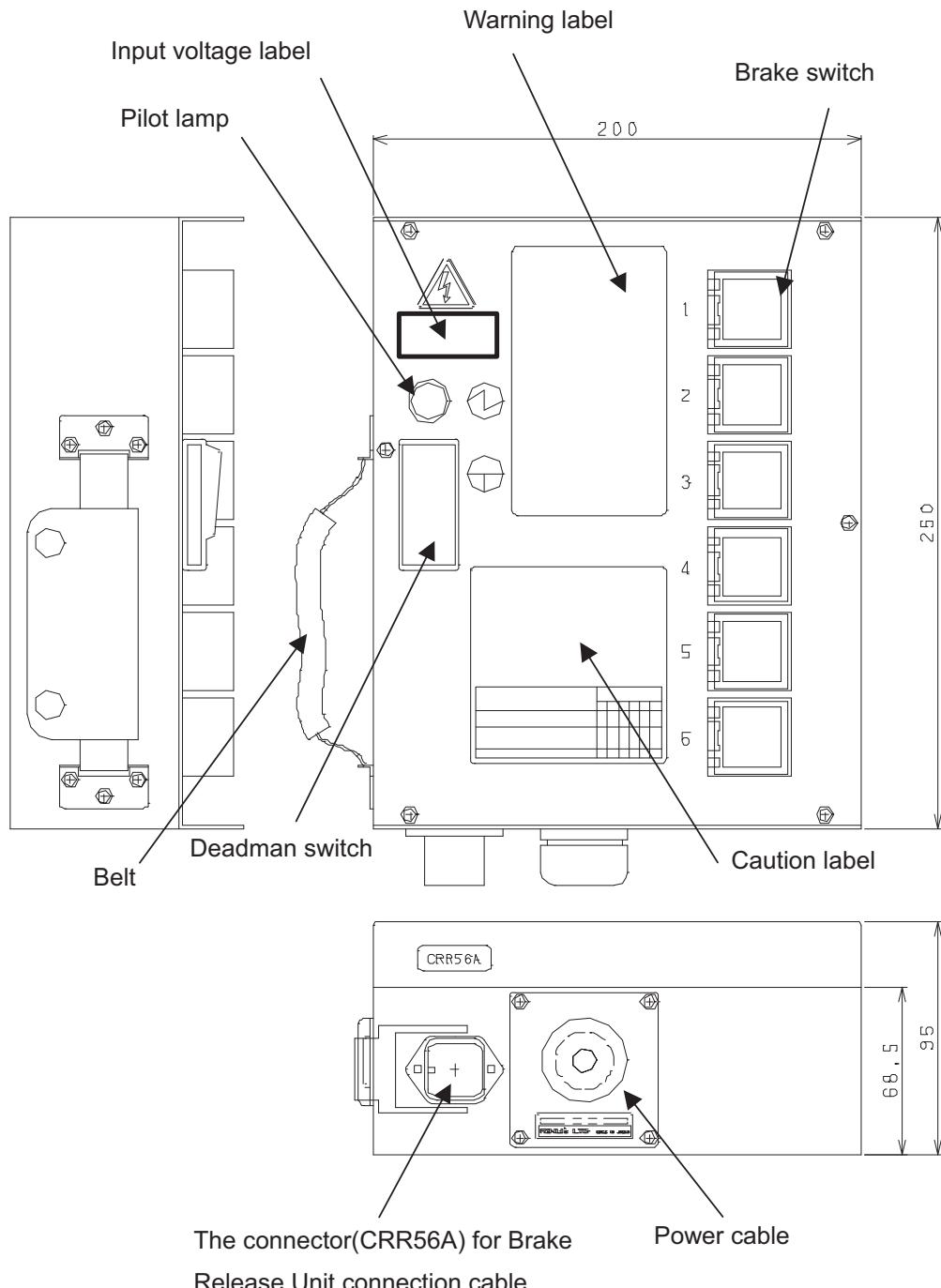
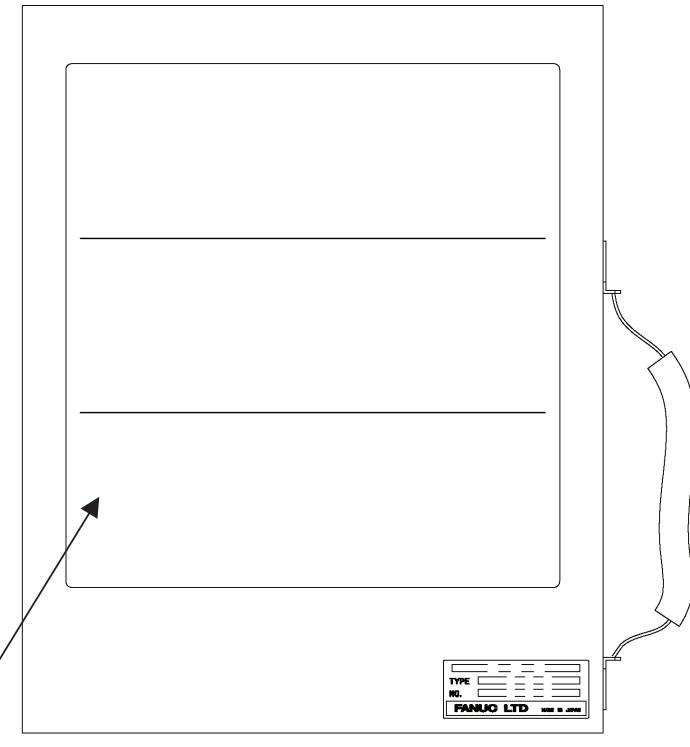


Fig.B.5 (a) Dimension of Brake Release Unit (Front view)



Instructions for use

Fig.B.5 (b) Dimension of Brake Release Unit (Rear view)

B.6 FUSE

The fuses are mounted inside this unit. Please check the fuse when the pilot lamp doesn't light even if deadman switch is pressed. When the fuse is blown, exchange the fuse after finding the root cause of failure, and taking the appropriate countermeasures.

Manufacturer: Daito Communication Co.

Specification: P420H

Rating: 2A

⚠ WARNING

When the fuse is replaced, the power cable of brake release unit must be disconnected.

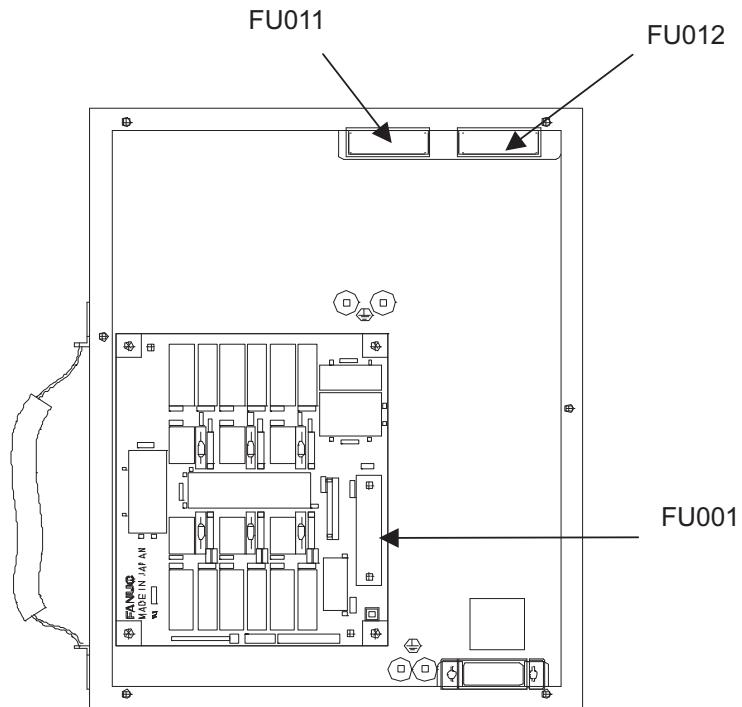


Fig.B.6 The location of fuses

B.7 SPECIFICATIONS

Input power supply

AC100-115V, 50/60Hz±1Hz, single phase, +10%/-15%, 1A

AC200-240V, 50/60Hz±1Hz, single phase, +10%/-15%, 1A

Weight

Brake Release Unit (AC 100V); 2.3 kg

Brake Release Unit (AC 200V); 3.5 kg

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Revision Record

FANUC Robot series (RIA R15.06-1999 COMPLIANT) R-30iA Mate CONTROLLER MAINTENANCE MANUAL (B-82725EN-2)

| Edition | Date | Contents | Edition | Date | Contents |
|---------|------------|---|---------|------|----------|
| 06 | May, 2010 | <ul style="list-style-type: none">• Addition of I/O cable interface | | | |
| 05 | May, 2009 | <ul style="list-style-type: none">• Addition of ARC Mate 120iC, M-20iA, M-1iA | | | |
| 04 | Nov., 2008 | <ul style="list-style-type: none">• Addition of ARC Mate 50iC | | | |
| 03 | Jun., 2008 | <ul style="list-style-type: none">• Addition of ARC Mate 100iC | | | |
| 02 | Dec., 2007 | <ul style="list-style-type: none">• Addition of I/O Link and Process I/O | | | |
| 01 | Jun., 2007 | _____ | | | |

B-82725EN-2/06



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