FANUC Robot series

R-30*i*A/R-30*i*A Mate/R-30*i*B/R-30*i*B Mate CONTROLLER FL-net Interface Function

OPERATOR'S MANUAL

MAROBFLNT10121E REV C

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FANUC America Corporation 3900 W. Hamlin Road Rochester Hills, Michigan 48309–3253

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FANUC conducts courses on its systems and products on a regularly scheduled basis at the company's world headquarters in Rochester Hills, Michigan. For additional information contact

FANUC America Corporation Training Department 3900 W. Hamlin Road Rochester Hills, Michigan 48309-3253 www.fanucrobotics.com

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Patents

One or more of the following U.S. patents might be related to the FANUC products described in this manual.

FANUC America Corporation Patent List

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Conventions

AWARNING

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

ACAUTION

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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Should you wish to export or re-export these products, please contact FANUC for advice.

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".

Safety

FANUC America Corporation 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 America Corporation 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 America Corporation 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 America Corporation therefore, recommends that all personnel who intend to operate, program, repair, or otherwise use the robotics system be trained in an approved FANUC America Corporation 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 Safe

The safety of people is always of primary importance in any situation. When applying safety measures to your robotic system, consider the following:

- 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 America Corporation 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.
- 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 America Corporation 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.

AWARNING

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:

AWARNING

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.

AWARNING

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.

AWARNING

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 DCS (Dual Check Safety), 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.

A 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.
- 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.



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. DCS (Dual Check Safety), 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.



Observe all safety rules and guidelines to avoid injury.

AWARNING

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.

A 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
- 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.



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.

SAFETY PRECAUTIONS

Thank you for purchasing FANUC Robot.

This chapter describes the precautions which must be observed to ensure the safe use of the robot. Before attempting to use the robot, be sure to read this chapter thoroughly.

Before using the functions related to robot operation, read the relevant operator's manual to become familiar with those functions.

If any description in this chapter differs from that in the other part of this manual, the description given in this chapter shall take precedence.

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 WORKING PERSON

The personnel can be classified as follows.

Operator:

- Turns robot controller power ON/OFF
- Starts robot program from operator's panel

Programmer or teaching operator:

- Operates the robot
- Teaches robot inside the safety fence

Maintenance engineer:

- Operates the robot
- · Teaches robot inside the 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 working activities inside the safety fence include lifting, setting, teaching, adjusting, maintenance, etc.
- To work inside the fence, the person must be trained on proper robot operation.

During the operation, programming, and maintenance of your robotic system, the programmer, teaching operator, and maintenance engineer should take additional care of their safety by using the following safety precautions.

- Use adequate clothing or uniforms during system operation
- Wear safety shoes
- Use helmet

2 DEFINITION OF WARNING, CAUTION AND NOTE

To ensure the safety of users and prevent damage to the machine, this manual indicates each precaution on safety with "Warning" or "Caution" according to its severity. Supplementary information is indicated by "Note". Read the contents of each "Warning", "Caution" and "Note" before attempting to use the robots.

WARNING

Applied when there is a danger of the user being injured or when there is a danger of both the user being injured and the equipment being damaged if the approved procedure is not observed.

!CAUTION

Applied when there is a danger of the equipment being damaged, if the approved procedure is not observed.

NOTE

Notes are used to indicate supplementary information other than Warnings and Cautions.

• Read this manual carefully, and store it in a sales place.

3 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 persons 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 interlocking device, 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 interlocking signal of the door switch. When the gate is opened and this signal received, the controller stops the robot (Please refer to "STOP TYPE OF ROBOT" in SAFETY PRECAUTIONS for detail of stop type). For connection, see Fig.3 (a) and Fig.3 (b).

(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
- (10) Operators should be ungloved while manipulating the operator's panel or teach pendant. Operation with gloved fingers could cause an operation error.
- (11) Programs, system variables, and other information can be saved on memory card or USB memories. Be sure to save the data periodically in case the data is lost in an accident.
- (12) The robot should be transported and installed by accurately following the procedures recommended by FANUC. Wrong transportation or installation may cause the robot to fall, resulting in severe injury to workers.
- (13) In the first operation of the robot after installation, the operation should be restricted to low speeds. Then, the speed should be gradually increased to check the operation of the robot.
- (14) Before the robot is started, it should be checked that no one is in the area of the safety fence. At the same time, a check must be made to ensure that there is no risk of hazardous situations. If detected, such a situation should be eliminated before the operation.
- (15) When the robot is used, the following precautions should be taken. Otherwise, the robot and peripheral equipment can be adversely affected, or workers can be severely injured.
 - Avoid using the robot in a flammable environment.
 - Avoid using the robot in an explosive environment.
 - Avoid using the robot in an environment full of radiation.
 - Avoid using the robot under water or at high humidity.
 - Avoid using the robot to carry a person or animal.
 - Avoid using the robot as a stepladder. (Never climb up on or hang from the robot.)
- (16) When connecting the peripheral devices related to stop(safety fence etc.) and each signal (external emergency, fence etc.) of robot. be sure to confirm the stop movement and do not take the wrong connection.
- (17) When preparing trestle, please consider security for installation and maintenance work in high place according to Fig.3 (c). Please consider footstep and safety bolt mounting position.

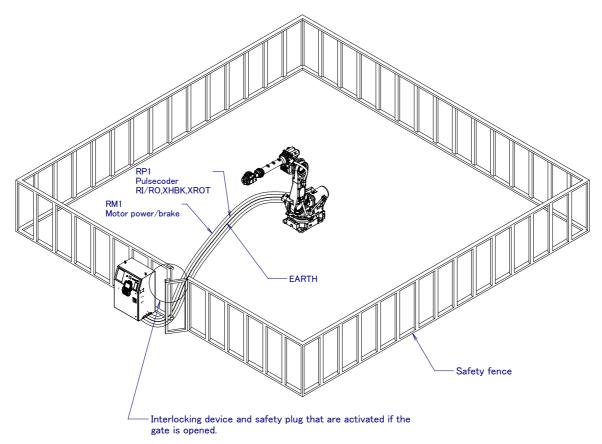


Fig. 3 (a) Safety fence and safety gate

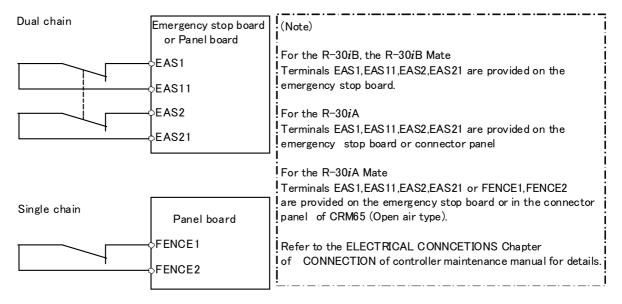


Fig. 3 (b) Limit switch circuit diagram of the safety fence

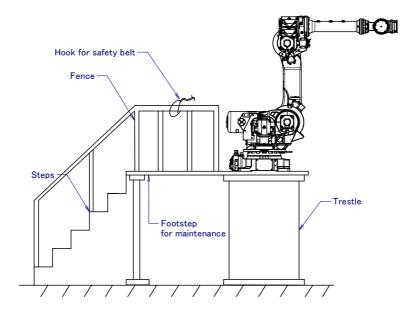


Fig.3 (c) Footstep for maintenance

3.1 OPERATOR SAFETY

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

- (1) If you do not have to operate the robot, 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 operator'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 (Please refer to "STOP TYPE OF ROBOT" in SAFETY PRECAUTIONS for detail of stop type), when the external EMERGENCY STOP button is pressed. See the diagram below for connection.

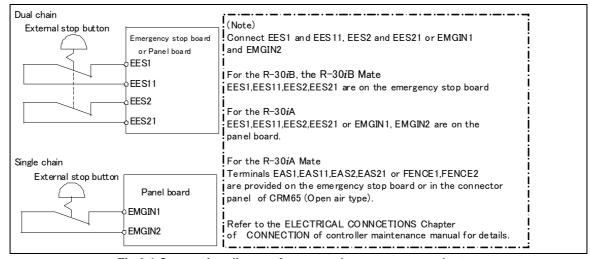


Fig.3.1 Connection diagram for external emergency stop button

3.2 SAFETY OF THE PROGRAMMER

While teaching the robot, the operator must enter the work area of the robot. The operator must ensure the safety of the teach pendant operator especially.

- (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) If it is inevitable to enter the robot work area to teach the robot, check the locations, settings, and other conditions of the safety devices (such as the EMERGENCY STOP button, the DEADMAN switch on the teach pendant) before entering the area.
- (4) The programmer must be extremely careful not to let anyone else enter the robot work area.
- (5) Programming should be done outside the area of the safety fence as far as possible. If programming needs to be done in the area of the safety fence, the programmer should take the following precautions:
 - Before entering the area of the safety fence, ensure that there is no risk of dangerous situations in the area.
 - Be prepared to press the emergency stop button whenever necessary.
 - Robot motions should be made at low speeds.
 - Before starting programming, check the entire system status to ensure that no remote instruction to the peripheral equipment or motion would be dangerous to the user.

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 stops (Please refer to "STOP TYPE OF ROBOT" in SAFETY PRECAUTIONS for detail of stop type). 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. (For the R-30*i*A Mate Controller standard specification, there is no mode switch. The automatic operation mode and the teach mode is selected by teach pendant enable switch.)

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 (Please refer to "STOP TYPE OF ROBOT" in SAFETY PRECAUTIONS for detail of stop type) when pressed.
- (2) DEADMAN switch: Functions differently depending on the teach pendant enable/disable switch setting status
 - (a) Disable: The DEADMAN switch is disabled.
 - (b) Enable: Servo power is turned off when the operator releases the DEADMAN switch or when the operator presses the switch strongly.
 - Note) The DEADMAN switch is provided to stop the robot when the operator releases the teach pendant or presses the pendant strongly in case of emergency. The R-30*i*B/R-30*i*B Mate/R-30*i*A/ R-30*i*A 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 stops immediately.

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 could operate in such conditions and be responsible in carrying out tasks safely.

Based on the risk assessment by FANUC, number of operation of DEADMAN SW should not exceed about 10000 times per year.

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 and the DEADMAN switch of the operator panel, the teach pendant enable switch and the remote condition on the software.

For the R-30*i*B/R-30*i*B Mate/R-30*i*A Controller or CE or RIA specification of the R-30*i*A Mate Controller

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

T1,T2 mode: DEADMAN switch is effective.

For the standard specification of R-30*i*A Mate Controller

Teach pendant enable switch	Software remote condition	Teach pendant	Peripheral device
On	Ignored	Allowed to start	Not allowed
Off	Local	Not allowed	Not allowed
	Remote	Not allowed	Allowed to start

- (6) (Only when R-30*i*B/R-30*i*B Mate /R-30*i*A Controller or CE or RIA specification of R-30*i*A Mate controller is selected.) To start the system using the operator's panel, make certain that nobody is the robot work area and that there are no abnormal conditions in the robot work area.
- (7) When a program is completed, be sure to carry out a test operation 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 operation above, execute it in the automatic operation mode.
- (8) While operating the system in the automatic operation mode, the teach pendant operator should leave the robot work area.

3.3 SAFETY OF THE MAINTENANCE ENGINEER

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

- (1) During operation, never enter the robot work area.
- (2) A hazardous situation may arise when the robot or the system, are kept with their power-on during maintenance operations. Therefore, for any maintenance operation, the robot and the system should be put into the power-off state. If necessary, a lock should be in place in order to prevent any other person from turning on the robot and/or the system. In case maintenance needs to be executed in the power-on state, the emergency stop button must be pressed.
- (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 personnel must indicate that maintenance work is in progress and be careful not to allow other people to operate the robot carelessly.
- (4) When entering the area enclosed by the safety fence, the maintenance worker must check the entire system in order to make sure no dangerous situations exist. In case the worker needs to enter the safety area whilst a dangerous situation exists, extreme care must be taken, and entire system status must be carefully monitored.
- (5) Before the maintenance of the pneumatic system is started, the supply pressure should be shut off and the pressure in the piping should be reduced to zero.
- (6) Before the start of teaching, check that the robot and its peripheral devices are all in the normal operating condition.
- (7) Do not operate the robot in the automatic mode while anybody is in the robot work area.
- (8) When you maintain the robot alongside a wall or instrument, or when multiple workers are working nearby, make certain that their escape path is not obstructed.
- (9) 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.
- (10) 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.
- (11) When replacing a part, please contact FANUC service center. If a wrong procedure is followed, an accident may occur, causing damage to the robot and injury to the worker.
- (12) When replacing or reinstalling components, take care to prevent foreign material from entering the system.
- (13) When handling each unit or printed circuit board in the controller during inspection, turn off the circuit breaker to protect against electric shock.

 If there are two cabinets, turn off the both circuit breaker.
- (14) A part should be replaced with a part recommended by FANUC. If other parts are used, malfunction or damage would occur. Especially, a fuse that is not recommended by FANUC should not be used. Such a fuse may cause a fire.
- (15) 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.
- (16) When a motor or brake is removed, the robot arm should be supported with a crane or other equipment beforehand so that the arm would not fall during the removal.
- (17) Whenever grease is spilled on the floor, it should be removed as quickly as possible to prevent dangerous falls.
- (18) The following parts are heated. If a maintenance worker needs to touch such a part in the heated state, the worker should wear heat-resistant gloves or use other protective tools.
 - Servo motor
 - Inside the controller
 - Reducer
 - Gearbox
 - Wrist unit
- (19) Maintenance should be done under suitable light. Care must be taken that the light would not cause any danger.
- (20) When a motor, reducer, or other heavy load is handled, a crane or other equipment should be used to protect maintenance workers from excessive load. Otherwise, the maintenance workers would be severely injured.
- (21) The robot should not be stepped on or climbed up during maintenance. If it is attempted, the robot would be adversely affected. In addition, a misstep can cause injury to the worker.
- (22) When performing maintenance work in high place, secure a footstep and wear safety belt.
- (23) After the maintenance is completed, spilled oil or water and metal chips should be removed from the floor around the robot and within the safety fence.
- (24) When a part is replaced, all bolts and other related components should put back into their original places. A careful check must be given to ensure that no components are missing or left not mounted.
- (25) In case robot motion is required during maintenance, the following precautions should be taken:

- Foresee an escape route. And during the maintenance motion itself, monitor continuously the whole system so that your escape route will not become blocked by the robot, or by peripheral equipment.
- Always pay attention to potentially dangerous situations, and be prepared to press the emergency stop button whenever necessary.
- (26) The robot should be periodically inspected. (Refer to the robot mechanical manual and controller maintenance manual.) A failure to do the periodical inspection can adversely affect the performance or service life of the robot and may cause an accident
- (27) After a part is replaced, a test operation should be given for the robot according to a predetermined method. (See TESTING section of "Controller operator's manual".) During the test operation, the maintenance staff should work outside the safety fence.

4 SAFETY OF THE TOOLS AND PERIPHERAL DEVICES

4.1 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.

4.2 PRECAUTIONS FOR MECHANISM

- (1) Keep the components of the robot system clean, and operate the robot in an environment free of grease, water, and dust.
- (2) Only use approved cuttings fluids and cleaning fluids.
- (3) Use a limit switch or mechanical stopper to limit the robot motion to prevent the robot from collisions against peripheral devices or tools.
- (4) Observe the following precautions about the mechanical unit cables. Failure to follow these precautions may cause mechanical problems.
 - Use mechanical unit cable that meet user interface requirement.
 - Don not route additional cables or hoses inside the mechanical unit.
 - Do not obstruct the movement of the mechanical unit cables when additional cables are touted external to the mechanical unit.
 - For models that have exposed cables, do not modify the cable bundle construction (such as by adding on protective covers, tying on additional cables) that could change the behavior of the cable motion.
 - When installing user peripheral equipment on the robot mechanical unit, please pay attention that equipment does not interfere with the robot itself.
- (5) Frequent Power-Off stop of the robot during operation can cause mechanical problems of the robot. Avoid system designs that require routine or frequent Power-Off stop conditions. (Refer to bad example.) Please execute power-off stop after reducing the speed of the robot and stopping it by hold stop or cycle stop when it is not urgent. (Please refer to "STOP TYPE OF ROBOT" in SAFETY PRECAUTIONS for detail of stop type.)
 (Bad case example)

- Whenever a defective part is generated, the robot system is stopped by an emergency stop.
- The robot system is stopped by the operator opening the safety fence and forcing a servo off stop.
- The operator pushes the emergency stop button frequently to stop the robot system.
- Safety signals are triggered frequently by area sensors, light curtains, safety mats etc, causing the robot system to servo off stop excessively.
- (6) Robot stops urgently when collision detection alarm (SRVO-050) etc. occurs. Try to avoid unnecessary servo off stops as it may cause damage on the robot, too. If the collision detection alarm occurs repeatedly, investigate and remedy the cause for the collision alarm.

5 SAFETY OF THE ROBOT MECHANISM

5.1 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.

5.2 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

5.3 PRECAUTIONS FOR MECHANISMS

terminated.

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

5.4 PROCEDURE TO MOVE ARM WITHOUT DRIVE POWER IN EMERGENCY OR ABNORMAL SITUATIONS

For emergency or abnormal situations (e.g. persons trapped in or pinched by the robot), brake release unit can be used to move the robot axes without drive power.

Please refer to controller maintenance manual and mechanical unit operator's manual for using method of brake release unit and method of supporting robot.

6 SAFETY OF THE END EFFECTOR

6.1 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.

7 STOP TYPE OF ROBOT

The following three robot stop types exist:

Power-Off Stop (Category 0 following IEC 60204-1)

Servo power is turned off and the robot stops immediately. Servo power is turned off when the robot is moving, and the motion path of the deceleration is uncontrolled.

The following processing is performed at Power-Off stop.

- An alarm is generated and servo power is turned off.
- The robot operation is stopped immediately. Execution of the program is paused.

Frequent Power-Off stop of the robot during operation can cause mechanical problems of the robot.

Avoid system designs that require routine or frequent Power-Off stop conditions.

Controlled stop (Category 1 following IEC 60204-1)

The robot is decelerated until it stops, and servo power is turned off.

The following processing is performed at Controlled stop.

- The alarm "SRVO-199 Controlled stop" occurs along with a decelerated stop. Execution of the program is paused.
- An alarm is generated and servo power is turned off.

Hold (Category 2 following IEC 60204-1)

The robot is decelerated until it stops, and servo power remains on.

The following processing is performed at Hold.

- The robot operation is decelerated until it stops. Execution of the program is paused.

⚠ WARNING

The stopping distance and stopping time of Controlled stop are longer than the stopping distance and stopping time of Power-Off stop. A risk assessment for the whole robot system, which takes into consideration the increased stopping distance and stopping time, is necessary when Controlled stop is used.

When the emergency stop button is pressed or the FENCE is open, the stop type of robot is Power-Off stop or Controlled stop. The configuration of stop type for each situation is called *stop pattern*. The stop pattern is different according to the controller type or option configuration.

There are the following 3 Stop patterns.

Stop pattern	Mode	Emergency stop button	External Emergency stop	FENCE open	SVOFF input	Servo disconnect
	AUTO	P-Stop	P-Stop	C-Stop	C-Stop	P-Stop
Α	T1	P-Stop	P-Stop	-	C-Stop	P-Stop
	T2	P-Stop	P-Stop	-	C-Stop	P-Stop
	AUTO	P-Stop	P-Stop	P-Stop	P-Stop	P-Stop
В	T1	P-Stop	P-Stop	-	P-Stop	P-Stop
	T2	P-Stop	P-Stop	-	P-Stop	P-Stop
	AUTO	C-Stop	C-Stop	C-Stop	C-Stop	C-Stop
С	T1	P-Stop	P-Stop	-	C-Stop	P-Stop
	T2	P-Stop	P-Stop	-	C-Stop	P-Stop

P-Stop: Power-Off stop C-Stop: Controlled stop

-: Disable

The following table indicates the Stop pattern according to the controller type or option configuration.

Option	R-30 <i>i</i> B/R-30 <i>i</i> B Mate
Standard	A (*)
Controlled stop by E-Stop (A05B-2600-J570)	C (*)

(*) R-30*i*B/R-30*i*B Mate does not have servo disconnect. R-30*i*B Mate does not have SVOFF input.

		R-30 <i>i</i>	R-30iA Mate				
Option	Standard (Single)	Standard (Dual)	RIA type	CE type	Standard	RIA type	CE type
Standard	B (*)	Α	Α	Α	A (**)	Α	Α
Stop type set (Stop pattern C) (A05B-2500-J570)	N/A	N/A	С	С	N/A	С	С

^(*) R-30*i*A standard (single) does not have servo disconnect.

The stop pattern of the controller is displayed in "Stop pattern" line in software version screen. Please refer to "Software version" in operator's manual of controller for the detail of software version screen.

"Controlled stop by E-Stop" option

When "Controlled stop by E-Stop" (A05B-2600-J570) option (For the R-30*i*A/R-30*i*A Mate, it is Stop type set (Stop pattern C) (A05B-2500-J570)) is specified, the stop type of the following alarms becomes Controlled stop but only in AUTO mode. In T1 or T2 mode, the stop type is Power-Off stop which is the normal operation of the system.

^(**) R-30*i*A Mate Standard does not have servo disconnect, and the stop type of SVOFF input is Power-Off stop.

Alarm	Condition
SRVO-001 Operator panel E-stop	Operator panel emergency stop is pressed.
SRVO-002 Teach pendant E-stop	Teach pendant emergency stop is pressed.
SRVO-007 External emergency stops	External emergency stop input (EES1-EES11, EES2-EES21) is open. (R-30 <i>i</i> A/R-30 <i>i</i> B/R-30 <i>i</i> B Mate controller)
SRVO-194 Servo disconnect	Servo disconnect input (SD4-SD41, SD5-SD51) is open. (R-30 <i>i</i> A controller)
SRVO-218 Ext. E-stop/Servo Disconnect	External emergency stop input (EES1-EES11, EES2-EES21) is open. (R-30 <i>i</i> A Mate controller)
SRVO-408 DCS SSO Ext Emergency Stop	In DCS Safe I/O connect function, SSO[3] is OFF.
SRVO-409 DCS SSO Servo Disconnect	In DCS Safe I/O connect function, SSO[4] is OFF.

Controlled stop is different from Power-Off stop as follows:

- In Controlled stop, the robot is stopped on the program path. This function is effective for a system where the robot can interfere with other devices if it deviates from the program path.
- In Controlled stop, physical impact is less than Power-Off stop. This function is effective for systems where the physical impact to the mechanical unit or EOAT (End Of Arm Tool) should be minimized.
- The stopping distance and stopping time of Controlled stop is longer than the stopping distance and stopping time of Power-Off stop, depending on the robot model and axis. Please refer to the operator's manual of a particular robot model for the data of stopping distance and stopping time.

For the R-30*i*A or R-30*i*A Mate, this function is available only in CE or RIA type hardware.

When this option is loaded, this function cannot be disabled.

The stop type of DCS Position and Speed Check functions is not affected by the loading of this option.

⚠ WARNING

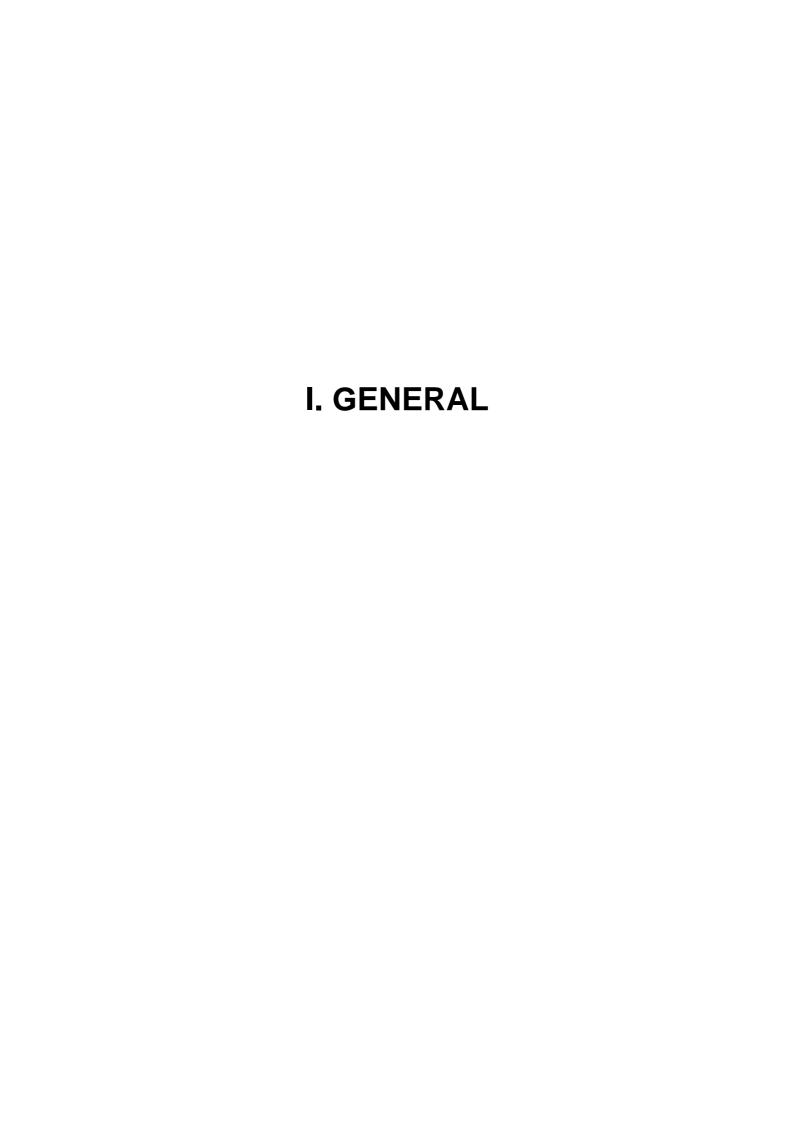
The stopping distance and stopping time of Controlled stop are longer than the stopping distance and stopping time of Power-Off stop. A risk assessment for the whole robot system, which takes into consideration the increased stopping distance and stopping time, is necessary when this option is loaded.

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1 GENERAL

This manual consists of the following parts:

About this manual

SAFETY PRECAUTIONS

This describes the precautions to be observed in reading this manual.

I. GENERAL

This part describes the organization of this manual.

II. DESCRIPTION

This part describes the general for using the FL-net function.

III. OPERATION

This part describes the settings and operation procedures for using the FL-net function.

IV. CONNECTION

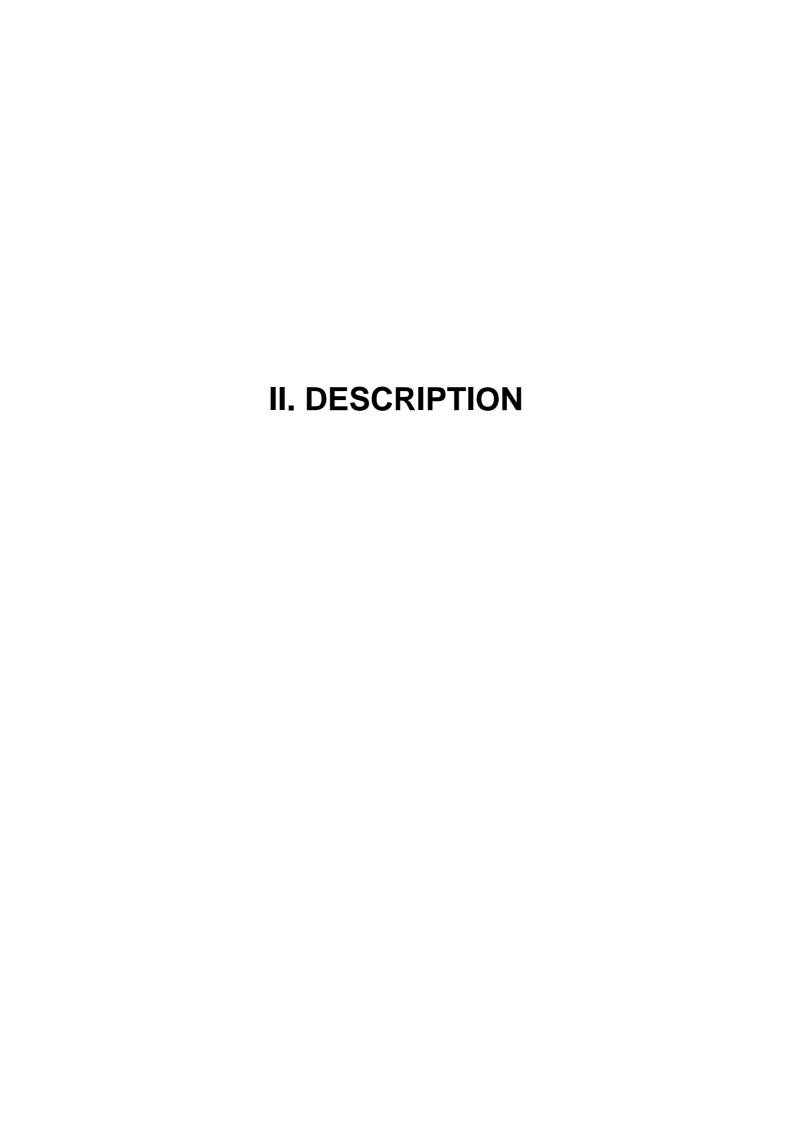
This part describes the method of connecting each device and notes on using the FL-net function.

V. MAINTENANCE

This part describes the drawing number of the FL-net board, the meanings of LED indications, and so forth.

APPENDIX

Error code output function.



1 OVERVIEW OF FL-net FUNCTION

The FL-net is an open FA network standardized by the FA Open Promotion Council (FAOP) in the Manufacture, Science, and Technology Center Incorporated Foundation.

1.1 FEATURES OF FL-net

- Masterless method
- Common memory function which uses cyclic transmission to allow the nodes to share the same data
- Communication between any given nodes that uses message transfer

1.2 SPECIFICATIONS OF FL-net FUNCTION

The following table gives an overview of specifications of the FL-net function.

Item	Description
Transmission rate	100Mbps (Internal port)
	10 Mbps (FL-net board)
Maximum number of devices which can be connected	254
Node number range	1 to 254 (250 to 254 for maintenance)
Maximum number of transfer data items per 1 variety	Digital signals (without safety signal): total 2048 points.
	Analog signals: 25 channels.
	(input and output for each)
	Registers: total 50 points.
Supported signals	Common memory area 1:
	Digital (DI/O), UOP, group I/O, WI/O, and WSTK
	Common memory area 2:
	Analog I/O and Registers
Supported variety	2 (Equal or after 7DC2/09), 1 (Before 7DC2/09)

NOTE

1 This function is optional. To use this function, FL-net interface function (software option) is required. FL-net board is required additionally for R-30*i*A/R-30*i*A Mate.

The internal Ethernet port on the R-30*i*A/R-30*i*A Mate main board cannot be used. Internal Ethernet port (CD38A or CD38B) on main board and/or the dedicated port on the FL-net board can be used for R-30*i*B, R-30*i*B Mate. In some R-30*i*B Mate, only 1 internal Ethernet port is supported.

Name	The number of internal Ethernet port	Order number for standard	Order number for open air		
Main board A	1	A05B-2650-H001	A05B-2655-H001		
Main board B	2	A05B-2650-H002	A05B-2655-H002		
Main board C	2	A05B-2650-H003	A05B-2655-H003		

- 2 The total size of digital input/output signals for the local and remote nodes that are allocated as robot I/O must not exceed 2048 (128 words) per 1 variety. With 70 safety signals, 2118 points can be used per 1 variety. But safety signal can be used only variety 1 and internal port.
 - Up to 50 registers are available per 1 variety. Larger than R[513] can't be used as sending register. Receive register doesn't have this limitation.
 - Up to 25 channels are available for each of input and output of analog signals per 1 variety.
- 3 When using 2 varieties, variety 1 is internal port only and variety 2 is FL-net board only.

NOTE

- 4 To reflect setting changes, turn the power off, then on again. After changing a setting such as area allocation, turn the power off, then on again for the new setting to take effect.
- 5 FL-net communication specifications have some versions: 1.00 and 2.00, which do not have compatibility to each another. Since the FANUC FL-net conforms to the FL-net communication specifications version 2.00, when using a FANUC FL-net device, the other devices must conform to the FL-net communication specifications without version 1.00.
- 6 When using internal port, FRAME INTERVAL can't be less than 20 (2ms).
- 7 Register update may delay than I/O.
 - Pay attention even when I/O is changed later than register change, I/O may be changed before register changing at receiving side.
 - If register update and I/O update should be synchronized, use group I/O, just before the flag DI/O. Analog I/O is synchronized than register but analog I/O update may delay than DI/O update.
 - Or regard invalid data when register is 0 etc., read after register value is changed (after valid value).
- 8 When using FL-net board, if digital I/O points are more than 1024, update interval between FL-net board and robot controller becomes 3 times. If internal port is used, this doesn't happen.
- 9 Error code output function doesn't prepared for 2 varieties.

1.3 I/O RACK NUMBER AND SLOT NUMBERS

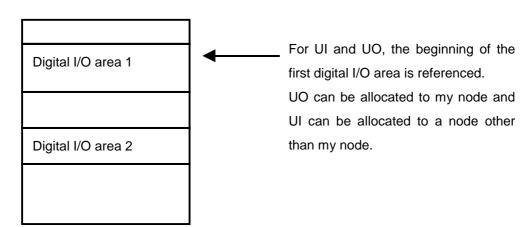
The rack number of I/O used by FL-net function is 68. The slot number of I/O is corresponds to the node number. For example, the slot number of I/O of my node (output signals) is the node number of my node. The slot number of I/O of other nodes (input signals), is the node number of the node. You can check the rack and slot numbers by selecting F2 [CONFIG] on a I/O list screen such as the digital I/O list screen.

1.4 DIGITAL I/O AND UOP

The start address (referred to as offset) and size of each I/O field is specified for each common memory area in FL-net function. Common memory area 1 is used for digital I/O and other signals. You can set two areas to be referenced as digital I/O in common memory area 1. The area specified with setting items DI or DO offset 1 and size 1 is used as the first digital I/O area and the area specified with DI or DO offset 2 and size 2 is used as the second area. You can set these areas without restraint unless they overlap with another area. In the following figure, the first area offset is smaller than the second area offset. You can also set the second area offset smaller than the first area offset.

You can allocate UOP to a node with digital I/O area. The UI signals are assigned from the top of the first digital area of the specified node. The required points are assigned to UI at first, and remaining points are assigned to DI. Similarly, a UO signals are assigned from the top of the first digital area of my node, and remaining points are allocated to DO. Be sure to allocate at least 3 bytes to the first digital I/O area where UI or UO is to be allocated. When you use UOP with the FL-net, be careful not to confuse the first digital I/O area with the second area.





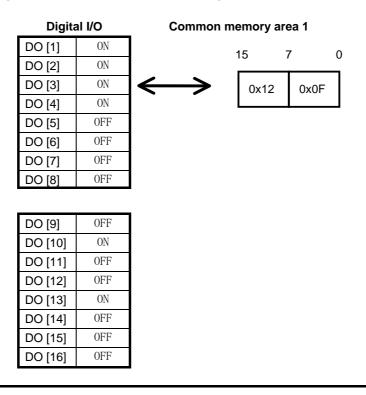
1.5 BYTE ORDERING OF DIGITAL I/O

When digital I/O is assumed to be data at least 8 bits long, the byte list is as follows:

Common memory ac	dres	3														
	DO 16	DO 15	DO 14	DO 13	DO 12	DO 11	DO 10	DO 9	DO 8	DO 7	DO 6	DO 5	DO 4	DO 3	DO 2	DO 1
			Hia	her b	vte d	ata					Lov	ver by	/te da	ata	3 2 1	

Example)

When the status of digital I/O is as shown in the following table:



NOTE

In an FL-net common memory area, the data width per address is 16 bits.

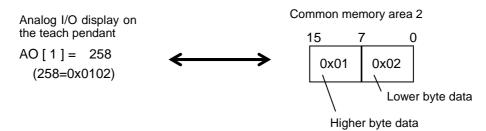
1.6 BYTE ORDERING OF ANALOG I/O AND REGISTER DATA

Common memory area 2 is used for analog I/O and register signals. When these signals are used for transmitting or receiving data at least 8 bits long, the byte lists are as follows.

Analog I/O

Example)

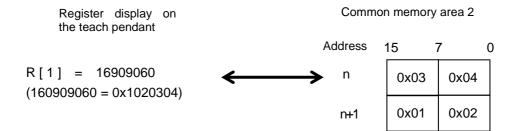
When AO[1] = 258 (0x102) (16 signals) is transmitted to common memory area 2: The bit image of common memory area 2 is 513 (0x201).



Register (32 bits)

Example)

When R[1] = 16909060 (0x1020304) is transmitted to common memory area 2: The bit image of common memory area 2 is 67305985 (0x4030201).



NOTE

In an FL-net common memory area, the data width per address is 16 bits.

1.7 REGISTER DATA FORMAT

An integer or real number can be set in a register of the robot.

When register data is input or output with the FL-net function, the register data is always treated as an integer, by default. If a real number is set in the register, the decimal fraction is truncated and the number is converted into an integer before being transferred (for a real number of 3.7, for example, the decimal fraction is truncated and the number is converted into an integer of 3).

To treat register data as a real number, make the following settings.

On the sending side, set the system variable \$FL_REG_TYP[] having the number of a register for which a real number is used to 1. For example, set \$FL_REG_TYP[5] to 1 to transfer data in R[5] as a real number.

On the receiving side, change the register data format for a node to which a real number is sent to [REAL] on the participating node detailed setting screen.

ACAUTION

- 1 If the register data format is changed to [REAL] on the participating node detailed setting screen, the register data received from the node is always treated as a real number.
- 2 If the register data format does not match between the sending and receiving sides, correct data cannot be received.

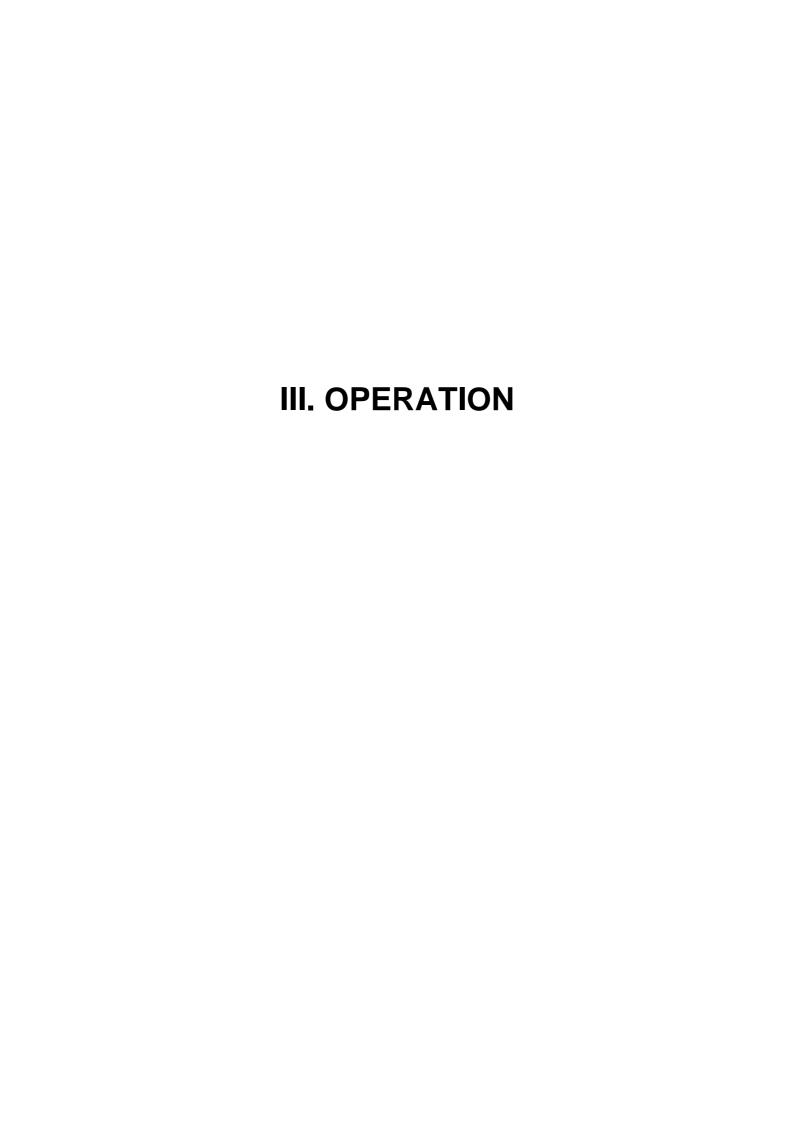
1.8 MULTICAST

Multicast can be used when using internal port on R-30*i*B, R-30*i*B Mate.

Usually, packet is sent to all nodes in same network because FL-net use broadcast, but by using multicast and switching hub having IGMP snooping function, packet can be sent only to the node which attend to the multicast address group. Multicast and IGMP snooping settings of each device should be set correctly to use multicast.

Robot isn't recognized correctly if IGMP query packet doesn't come at correct timing from L3 switch (router). In this case, robot is recognized after cycle power the robot.

IGMP V1 and V2 are supported. V3 is unsupported.



1 MY NODE SETUP

1.1 SETTING ITEMS

To display the FL-net setting screen, first press the [MENU] key and select "6.SETUP." Then, press [F1] "TYPE" and select FL-net from the displayed menu.

The following items are set to use this function.

Item	Description
DISPLAY VARIETY	Displayed variety. This setting affect to setting screen and status screen. Even
(Only after 7DC2/08)	when FL-net screen is displayed to other window, change is applied immediately.
TOTAL VARIETY	Total variety used in FL-net function.
(Only after 7DC2/08)	
ERROR ONE SHOT	The system can reset error related to this function even if the cause of the error
	has not been removed. Normally, set DISABLE. Set ENABLE only when the
	system must recover from the error (for example, at start-up).
	DISABLE: Cannot be reset.
	ENABLE: Can be reset.
	(Default: DISABLE)
MAX DIGITAL PORT NUM	Specifies the maximum total number of DI/DO signals.
	Use the default (1024) unless change is necessary.
USING PORT	BOARD: Using port on FL-net board.
(Only R-30 <i>i</i> B, R-30 <i>i</i> B Mate)	INTERNAL1: Using port on main board.(CD38A)
	INTERNAL2: Using port on main board.(CD38B)
IP ADDRESS	IP address of my node. The host address (last numeric value) in this IP address is
	used as the node number of my node.
	Only an IP address in class C can be specified.
	If INTERNAL port is selected as USING PORT, set IP address from [MENU] ->
	"6.SETUP." -> F1 key [TYPE] -> Host Comm -> TCP/IP. Change the IP address
	setting port by F3 key "PORT". In this case, set Subnet Mask to 255.255.255.0.
	Pay attention to network address (IP address AND operation Subnet MASK) of
	internal port 1 and internal port 2 should be different.
	There is no need to set Router IP address.
MULTICAST	DISABLE: Not using multicast.
	ENABLE: Using multicast.
MULTICAST ADDRESS	Set joining multicast address. Only an IP address in class D can be specified.
	Address to which administrator in organization can assign is 239.0.0.0/8. See
	RFC2365 for detail. RFC2365 isn't FANUC's document and RFC2365 exists in
	internet etc.
	See http://www.ietf.org/rfc.html
NODE NAME	Node name of my node. Up to 10 characters can be specified.

Item	Description
TOKEN WATCH TIME	Maximum time during which my node can hold a token (say later).
TOREIV WATON THE	Specify a value between 0 and 255 (ms). (Default: 50 ms)
	If my node doesn't send token to next node in this time, next node send token. If
	this happens 3 times, my node is assumed as disengaged from other node.
	TOKEN WATCH TIME should be larger than the time, which my node takes to
	-
	send data when token is coming to my node. Larger this value, less disengaged,
	but too large affect much time to detect disconnection.
	In FL-net board data can be sent about 0.7 millisecond if data is a few words.
	Larger the data size, longer the sending time.
	In internal port in R-30 <i>i</i> B, R-30 <i>i</i> B Mate, sending time is less than board basically.
	But if CPU load is high, the time becomes longer.
	Use default value unless problem exists. Even when changing this value, don't
	change this value less than FRAME INTERVAL + 9.
	- token
	Sending rights. Basically in FL-net, 1 node which has token can only send frame to
	line. Token is moved to small number node to large number node in number order.
FRAME INTERVAL	Specifies the time interval between transmission of a data frame by my node and
	that of the previous data frame.
	FRAME INTERVAL is set in each node, but the max value is applied to all nodes.
	Smaller this value, faster the data transmission, but the load for each device
	becomes larger. If this value is too small, specific node can't join the network.
	Specify a value between 0 and 50 in 100 μs.(Default 0 when board, 20(2ms) when
	internal port)
	When using internal port, this value must be equal or larger than 20. If this value is
	less than 20 when internal port is selected, this value is set to 20.
UOP ASSIGNMENT	Specifies whether to allocate UOP in common memory area 1 automatically.
	ENABLE: Allocates UO and UI in common memory area 1 automatically.
	DISABLE: Does not allocate UO and UI automatically.
	(Default: ENABLE)
	When ENABLE is selected, allocate larger size to after-mentioned DO BYTE SIZE
	and DI BYTE SIZE than UOP auto assignment size.
UI ALLOCATION NODE	Specifies the node number of node where UI is allocated.
OF ALLOCATION NODE	Specify a node other than my node.
AREA1 WORD OFFSET	Start address of my node transmission data in common memory area 1. Specify
AREAT WORD OFFSET	
	a value between 0 and 511 in words. (1 word = 2 bytes)
AREA1 WORD SIZE	Size of my node transmission data in common memory area 1. Specify a value
	between 0 and 512 in words. (1 word = 2 bytes)
DO BYTE OFFSET1	Start address of my node transmission data to be referenced as DO.
	Specifies a value between 0 and 1023 in bytes.
DO BYTE SIZE1	Size of my node transmission data to be referenced as DO.
	Specifies a value between 0 and 128 in bytes.
	If you want to set more than 128, use DO BYTE OFFSET2 and DO BYTE SIZE2.
	Example
	When DO BYTE OFFSET1 is 0 and you want to set 129 to DO BYTE SIZE1. Set
	128 to DO BYTE SIZE1 and set 128 to DO BYTE OFFSET2 and set 1 to DO
	BYTE SIZE2.
DO BYTE OFFSET2	Start address of my node transmission data to be referenced as DO.
	Specifies a value between 0 and 1023 in bytes.
DO BYTE SIZE2	Size of my node transmission data to be referenced as DO.
1	Specify a value between 0 and 128 in bytes.
WO BYTE OFFSET	Start address of my node transmission data to be referenced as WO.
	Specify a value between 0 and 1023 in bytes.
WO BYTE SIZE	
WO BYTE SIZE	Size of my node transmission data to be referenced as WO.
WOTK OUT DYTE OFFICE	Specify a value between 0 and 128 in bytes.
WSTK OUT BYTE OFFSET	Start address of my node transmission data to be referenced as WSTK OUT.
	Specify a value between 0 and 1023 in bytes.

Item	Description
WSTK OUT BYTE SIZE	Size of my node transmission data to be referenced as WSTK OUT.
	Specify a value between 0 and 128 in bytes.
AREA2 WORD OFFSET	Start address of my node transmission data in common memory area 2.
	Specify a value between 0 and 8191 in words.
AREA2 WORD SIZE	Size of my node transmission data in common memory area 2.
	Specify a value between 0 and 8192 in words.
AO BYTE OFFSET	Start address of my node transmission data to be referenced as AO.
	Specify a value between 0 and 16383 in words.
	NOTE) If an odd number is set, data may not be transferred correctly.
	Set an even number except in special circumstances.
AO CHANNEL NUMBER	Size of my node transmission data to be referenced as AO.
	Specify a value between 0 and 25. One channel is equivalent to one word.
AO SHIFT LEFT	Amount by which AO is to be shifted left. Each time AO is shifted left, a zero is
	inserted into the least significant bit. See NOTE2.
AO RANGE	Number of significant bits of the AO value shifted left.
	Specify a value between 0 and 16. The default is 16. See NOTE.
REGISTER BYTE OFFSET	Start address of my node transmission data to be referenced as registers.
	Specify a value between 0 and 16383 in bytes.
	NOTE) If a value, which is not a multiple of 4, is set, data may not be transferred
	correctly. Set the number, which is multiple of 4, except in special
	circumstances.
REGISTER START	Specifies the number of the first register of which data is to be allocated as my
	node transmission data. Specify a value between 0 and 150.
REGISTER NUMBER	Specifies the number of registers of which data is to be allocated as my node
	transmission data. Specify a value between 0 and 50. One register is 4 bytes long.

NOTE

The following procedure is used to output analog output data to common memory:

- 1. Shifts data left by the amount specified by AO SHIFT LEFT.
- 2. Outputs as many bits as the number of bits specified by AO RANGE from the left to common memory area 2.

CETUD EL NET	IOINT 400/
SETUP FL-NET	JOINT 10% 1/31
FL-NET OWN NODE SETUP	1/31
4 DICDLAY VADIETY	. 4
1 DISPLAY VARIETY	: 1 : 2
2 TOTAL VARIETY	
3 ERROR ONE SHOT	: DISABLE
4 MAX DIGITAL PORT NUM	
5 USING PORT	: INTERNAL2
IP ADDRESS	:[192.168.250. 96]
6 MULTICAST	: DISABLE
6 MULTICAST 7 MULTICAST ADDRESS 8 NODE NAME	:[239.255. 0. 0]
	.[
9 TOKEN WATCH TIME(msed	
10 FRAME INTERVAL(0.1msed	c) : 10
10 FRAME INTERVAL(0.1msed 11 UOP ASSIGNMENT	: ENABLE
12 UI ALLOCATION NODE	: 192
AREA1 SETUP	:
13 AREA1 WORD OFFSET	: 400
14 AREA1 WORD SIZE	: 112
15 DO BYTE OFFSET1	: 0
16 DO BYTE SIZE1	: 4
17 DO BYTE OFFSET2	: 4
18 DO BYTE SIZE2	: 34
19 WDO BYTE OFFSET	: 38
20 WDO BYTE SIZE	: 2
21 WSTK OUT BYTE OFFSET	: 40
22 WSTK OUT BYTE SIZE	: 2
AREA2 SETUP	:
23 AREA2 WORD OFFSET	: 0
24 AREA2 WORD SIZE	: 600
25 AO BYTE OFFSET	: 0
26 AO CHANNEL NUMBER	: 25
27 AO SHIFT LEFT	: 0
28 AO RANGE	: 16
29 REGISTER BYTE OFFSET	: 50
30 REGISTER START	: 1
31 REGISTER NUMBER	: 18
[TYPE] [OTHER]	ENABLE DISABLE >
[3111211]	

Pressing [F3] OTHER can change the displayed screen.

2 ATTENDING NODE SETUP

2.1 NODE LIST SCREEN

2.1.1 Settings Items

Set the following items on the node list screen.

Item	Description
NO	Node number
AREA1 ENB/DIS	Specifies whether to receive data in common memory area 1. DISABLE: Does not receive data in area 1. ENABLE: Receives data in area 1.
AREA2 ENB/DIS	Specifies whether to receive data in common memory area 2. DISABLE: Does not receive data in area 2. ENABLE: Receives data in area 2.
COMMENT	You can enter a comment (18 characters). This item can be omitted.

SETUP FL-NET	IOINT 10 W
	JOINT 10 %
FL-NET NODE LIST	192/254
NO AREA1 AREA2	Comment
190 DISABLE DISABLE	
191 DISABLE DISABLE	
192 ENABLE ENABLE	[ROBOT_192]
193 DISABLE DISABLE	[]
[TYPE] DETAIL [OTHER] ENABLE DISABLE >
	-

To set details of a node, position the cursor to the line on which information of a target node is displayed and press the [F2] "DETAIL" key. The detailed participating node setting screen is opened.

2.1.2 Automatic Setting of Common Memory Areas for Each Node

Though you can set the offset and size of each common memory area manually, you can also use an automatic setting function. This function obtains the common memory area setting information of other nodes from the current attending node management table and automatically sets the offsets and sizes of areas 1 and 2 for each node. To use this function, first open the node list screen. **Make sure all nodes including my node are connected to the network and each node has started up successfully with common memory setting completed.** Then, press the [NEXT] > key and select [F2] "AUTO_CFG". The settings of other nodes are cleared. Set these items on the detailed node setting screen.

2.2 ATTENDING NODE SETUP DETAIL SCREEN

2.2.1 Setting Items

For each node from which the robot receives data, set the items related to receive data.

Item	Description				
NODE NO.	Number of a node for which items are to be set. You can also select a desired				
	node by entering its number.				
DISCONNECTION ALARM	Specifies the severity for a disconnection error of this node.				
	WARN: Displays an alarm, but continues execution.				
	STOP: Displays an alarm and stops execution.				
	The default is STOP.				
I/O SAFETY VALUE	Specifies the I/O status of this node when disconnected.				
	LAST: Holds the last values.				
	CLEAR: Clears all values to 0. The default is CLEAR.				
AREA1 ALLOCATION	Specifies whether to enable the settings for the node transmission data in common				
	memory area 1.				
AREA1 WORD OFFSET	Start address of the node transmission data in common memory area1.				
, ii. (2) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1	Specify a value between 0 and 511 in words.				
AREA1 WORD SIZE	Size of the node transmission data in common memory area1.				
AINEAN WORLD GIZE	Specify a value between 0 and 512 in words.				
DI BYTE OFFSET1	Start address of transmission data to be referenced as DI of the node.				
BIBITE GITGETT	Specify a value between 0 and 1023 in bytes.				
DI BYTE SIZE1	Size of transmission data to be referenced as DI of the node.				
5.5112 5.221	Specify a value between 0 and 128 in bytes.				
DI BYTE OFFSET2	Start address of transmission data to be referenced as DI of the node.				
DIBITE OF ISETS	Specify a value between 0 and 1023 in bytes.				
DI BYTE SIZE2	Size of transmission data to be referenced as DI of the node.				
DIBITE SIZEZ					
WI BYTE OFFSET	Specify a value between 0 and 128 in bytes. Start address of transmission data to be referenced as WI of the node.				
WIBTIE OFFSET					
WI BYTE SIZE	Specify a value between 0 and 1023 in bytes. Size of transmission data to be referenced as WI of the node.				
WIBTIE SIZE					
WETK IN DVTE OFFEET	Specify a value between 0 and 128 in bytes. Start address of transmission data to be referenced as WSTK IN of the node.				
WSTK IN BYTE OFFSET					
WSTK IN BYTE SIZE	Specify a value between 0 and 1023 in bytes. Size of transmission data to be referenced as WSTK IN of the node.				
WSTR IN BYTE SIZE					
ADEA2 ALLOCATION	Specify a value between 0 and 128 in bytes.				
AREA2 ALLOCATION	Specifies whether to enable the settings for the node transmission data in common memory area 2.				
ADEAS WORD OFFCET	 				
AREA2 WORD OFFSET	Start address of the node transmission data in common memory area2.				
ADEAS WORD CIZE	Specify a value between 0 and 8191 in words.				
AREA2 WORD SIZE	Size of the node transmission data in common memory area2.				
ALDVIE OFFOFT	Specify a value between 0 and 8192 in words.				
AI BYTE OFFSET	Start address of transmission data to be referenced as AI of the node.				
ALCHANNEL NUMBER	Specify a value between 0 and 16383 in bytes.				
AI CHANNEL NUMBER	Size of transmission data to be referenced as Al of the node.				
ALOUET BLOUT	Specify a value between 0 and 25. One channel is equivalent to one word.				
AI SHIFT RIGHT	Amount by which AI is to be shifted right.				
	Al is shifted right with the most significant bit (sign bit) inserted. See NOTE.				
AI RANGE	Number of significant digits of the AI bits before shifting right. Specify a value				
	between 0 and 16. The default is 16. See NOTE.				
REGISTER BYTE OFFSET	Start address of transmission data to be referenced as registers in the node.				
	Specify a value between 0 and 16383 in bytes.				
REGISTER START	Specifies the number of the first register of which data is to be allocated as				
	transmission data of the node. Specify a value between 0 and 150.				
REGISTER NUMBER	Specifies the number of registers of which data is to be allocated as transmission				
	data of the node. Specify a value between 0 and 50.				
	One register is 2 words (4 bytes) long.				
REGISTER DATA	Specifies how to receive the register data of the node.				
FORMAT	integer: Register data is in integer format.				
	real: Register data is in real format.				

NOTE

The following procedure is used to receive analog input data:

- 1. Reads data from common memory area 2 with AI RANGE mask.
- 2. Shifts the data right for the amount specified by AI SHIFT RIGHT with considering the sign.
- 3. Receives the data as robot analog input data.

SETUP FL-NET	JOINT	10 %
FL-NET NODE 192 DETAIL		1/25
1 NODE NO.	:	192
2 DISCONNECTION ALARM	1 : [WAI	RN]
3 I/O SAFETY VALUE	: [LAS	т]
4 AREA1 ALLOCATION	: EN	IABLE
5 AREA1 WORD OFFSET	:	256
6 AREA1 WORD SIZE	:	100
7 DI BYTE OFFSET1	:	4
8 DI BYTE SIZE1	:	34
9 DI BYTE OFFSET2	:	0
10 DI BYTE SIZE2	:	4
11 WI BYTE OFFSET	:	38
12 WI BYTE SIZE	:	2
13 WSTK IN BYTE OFFSET	:	40
14 WSTK IN BYTE SIZE	:	2
15 AREA2 ALLOCATION	: EN	IABLE
16 AREA2 WORD OFFSET	:	4096
17 AREA2 WORD SIZE	:	600
18 AI BYTE OFFSET	:	0
19 AI CHANNEL NUMBER	:	25
20 AI SHIFT RIGHT	:	0
21 AI RANGE	:	16
22 REGISTER BYTE OFFSE	Γ :	50
23 REGISTER START	:	19
24 REGISTER NUMBER	:	18
25 REGISTER DATA FORMA	.T : [ii	nteger]
 ITVDE1 DDEV/ NEVT	[CHOICE]	
[TYPE] PREV NEXT	[CHOICE]	>

Pressing [F2] "PREV" or [F3] "NEXT" can change the node number to the previous or next one. You can also enter a node number to directly change the node for which items are to be set. To display the node list screen again, press the [PREV] key. To display a target screen selection menu, press [NEXT] > and select [F3] "OTHER".

2.3 SAMPLE NODE SETTINGS

2.3.1 Sample Digital I/O Settings

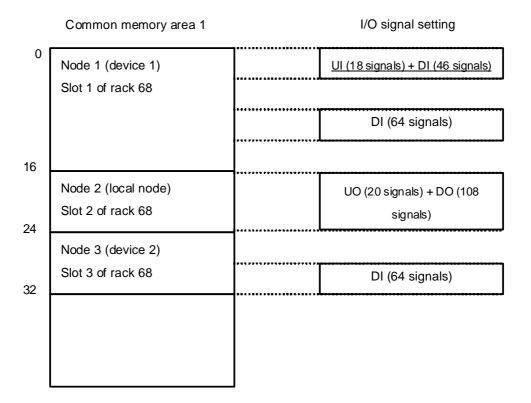
This subsection gives sample settings for a network which consists of the robot and two devices. These sample settings are for digital I/O in common memory area1 for simplicity.

Device Setting item	Robot (My node: Node number 2)	Device 1	Device 2
IP Address	192.168.250.2	-	-
Node number	-	1	3
UI ALLOCATION NODE	1	-	-
AREA1 WORD OFFSET	16	0	24
AREA1 WORD SIZE	8	16	8
DI/DO BYTE OFFSET1	0	0	8
DI/DO BYTE SIZE1	16	8	8
DI/DO BYTE OFFSET2	0	16	0
DI/DO BYTE SIZE2	0	8	0

III. OPERATION

(Caution: One word for the FL-net is equivalent to 2 bytes, that is, 16 bits.)

These settings specify the common memory area and I/O signals as shown in the following figure. Signals which are not to be used for data exchange with the robot may not be set in the common memory area. When UOP is set, 20 UO signals are allocated in the first DO area for my node and 18 UI signals are allocated in the first DI area for the node specified by UI ALLOCATION NODE.



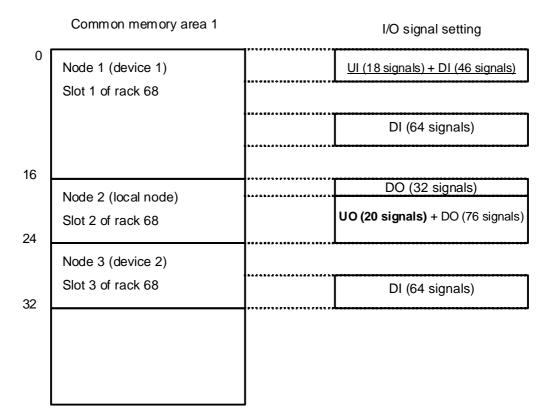
2.3.2 When the Offset or Size is Changed

As the offset is increased, the area is shifted in the direction in which the address increases. When the size is increased, the start address of the area does not change and the size of the area increases. Carefully change a setting so that the relevant area does not overlap with another area.

2.3.3 To Allocate UO with Offset

When you want to allocate UO at an address other than the start address of the DO area for my node, set the address at which UO is to be allocated for the offset of digital I/O area1 for my node. For sample digital I/O settings in Subsection 2.3.1, to allocate UO at the address 4 bytes behind the start address of my node area in common memory area 1, set the items as follows.

Device Setting item	Robot (My node: Node number 2)	Device 1	Device 2
IP Address	192.168.250.2	-	-
NODE NUMBER	-	1	3
UI ALLOCATION NODE	1	-	-
AREA1 WORD OFFSET	16	0	24
AREA1 WORD SIZE	8	16	8
DI/DO BYTE OFFSET1	4	0	8
DI/DO BYTE SIZE1	12	8	8
DI/DO BYTE OFFSET2	0	16	0
DI/DO BYTE SIZE2	4	8	0



2.4 SAVE SETTINGS

To save settings of the FL-net, press [FCTN] key and select "SAVE" when displaying FL-net screen. You can select "BACKUP" to save the FL-net settings to a USB memory etc. as a file named FLNET.SV. To select a device for saving, press [F5] "UTIL" on the file screen and select "Set Device".

2.5 CLEARING ALLOCATION SETTINGS

To clear the current I/O allocation settings, press [NEXT] > and [F1] "CLR_ASG". A message appears, asking whether to clear the allocation settings. Press [F4] "YES" to clear the I/O allocation settings. Carefully perform this operation because all allocation settings are cleared.

3 SPECIAL FUNCTION

This function can be used to allocate signals having special meanings to DO or GO. If you do not want to use this function, you need not make any setting related to this function.

Signal name	Туре	Required signal count	Description
TP Disable	DO	1	DO turns on when the teach pendant is disabled or off when it is enabled
Robot Lock	DO	1	DO turns on when machine lock is enabled or off when it is disabled
STEP	DO	1	DO turns on in the step execution mode or off in other modes
PNS END	DO	1	DO turns on when the program reaches to [End] or END instruction is executed in a program named (PNS or RSR) + (4-digit number). Turns off when the program has not reached to [End] or END instruction is not executed or the next program is started. In this function, when other program is started by "RUN" command after PNS program is started, program which is started afterword is monitored. If the afterword started program's name isn't PNS**** or RSR**** system regard as out of monitoring and doesn't set this signal after program is finished. "CALL" command doesn't make these cases. This signal isn't changed to ON by "ABORT" command.
PNS Number	GO	8	When a program named (PNS or RSR) + (4-digit number) is started, the number obtained by subtracting the base number from the 4-digit number is output as binary data.
PNS Line	GO	8	The number of the line being executed in a program named (PNS or RSR) + (4-digit number) is output as binary data.
WAIT SDI[1-32]	DO	32	Each DO turns on when the corresponding SDI is in the wait state during execution of a program. Turns off when the SDI is released from the wait state or the program stops.

NOTE

- 1 Allocate the required number of signals to GO in advance when required.
- When WAIT DI[1] is set, a dialog for specifying whether to automatically set WAIT DI[2] to WAIT DI[32] is displayed. After WAIT DI[2] to WAIT DI[32] are automatically set, each WAIT DI setting can be changed by manual. Be careful not to set those DO signals used for other purpose by performing automatic setting of WAIT DI[2] to WAIT DI[32].
- 3 PNS End, PNS Number and PNS Line aren't output when running program, which is paused just after power-on. These signals are output after selecting other program or ending program.
- 4 The output of PNS Number and PNS LINE are cleared when a program which is not named (PNS or RSR) + (4-digit number) is started. If either overflows eight bits, the eight low-order bits are output. When another program is executed by a subprogram call during execution of a program, PNS Number and PNS Line of caller program are retained. When multiple programs are started in a multitasking environment, the program number and line number of the last started program are output. The output data is not updated by backward execution or cursor movement in EDIT screen, but it is updated at the next forward execution.

SETUP FL-NET			JOINT	10 %	
FL-NET FUNC	TIONS SET	UP		1/38	
No SIGNAL		#	SIM ST	ATUS	
1 TP Disable	DO[1]	U	OFF	
2 Robot Lock	DO[2]	U	OFF	
3 STEP	DO[3]	U	ON	
4 PNS END	DO[4]	U	OFF	
5 PNS Numbe	er GO[1]	U	0	
6 PNS Line	GO	2]	U	0	
7 WAIT DI[1]	DO[31]	U	OFF	
8 WAIT DI[2]	DO[32]	U	OFF	
	:				
38 W AIT DI[32]	DO[62]	U	OFF	
[TYPE]	[OTHER]				>
- -					

On the NO. 8 to 38 lines, the DI settings are listed in ascending order of number.

4

ERROR CODE OUTPUT FUNCTION

This function puts error code of robot alarm to FL-net I/O as digital output signals with a strobe signal. If you do not want to use this function, you need not make any setting related to this function. All alarms whose severity is not WARNING are output externally. This function uses 33 points of DO and 1 point of DI

Settings for this function are saved to sysvars.sv.

This function doesn't prepared for 2 varieties.

ltem	Description
OUTPUT DO TOP NO.	This function outputs error codes as 32-bit binary data with 1-bit strobe signal.
	This item specifies the first number of 33 consecutive DO signals used as 33 bits of
	output signals.
INPUT TIMING DI NO.	This function uses one DI signal as the timing signal for receiving the next error code if
	multiple alarms are issued.
	Use this item to set the number of this DI signal.

SETUP FL-NET	•	JOINT	10 %	
ERROR OUTF			1/2	
1 OUTPUT D 2 INPUT TIM	0			
2 II VI O I I IIVI	O			
[TYPE]	[OTHER]		>	

NOTE

For details of this function, refer to "APPENDIX A ERROR CODE OUTPUT FUNCTION".

5 MESSAGE TRANSFER FUNCTION

5.1 SERVER FUNCTIONS

The following server functions are supported. If a client requests an unsupported function, this function responds with "Uninstalled" to the client.

Server function	One-to-one communication	One-to-N communication
Byte block read	×	X
Byte block write	×	×
Word block read	×	×
Word block write	×	×
Network parameter read	0	×
Network parameter write	×	×
Stop command	×	×
Start command	×	×
Profile read	0	×
Log data read	0	×
Log data clear	0	0
Message loopback	0	×
Transparent message	×	×

5.2 CLIENT FUNCTIONS

No client functions are supported.

6 STATUS SCREEN

To display the FL-net status screen, first press the [MENU] key, then select "0. NEXT PAGE". Then, select "4.STATUS" and press [F1] "TYPE" and select "FL-net" from the displayed menu.

6.1 MY NODE INFORMATION SCREEN AND ATTENDING NODE INFORMATION SCREEN

You can check the status screen for the status of each node in this screen. In the attending node information screen, you can display any node by entering the node number to "NODE NO." field by manual.

Item	Description	
(OWN) NODE NO.	Number of the node for which node information is currently being displayed. On the attending node information screen, enter the node number to choose node.	
NODE NAME	Node name. This item is displayed only for my node or a node which has attended in the network after my node attended.	
VENDER NAME	Device vendor name. This item is displayed only for my node or a node which has attended in the network after my node attended.	
TYPE NAME	Manufacturer's model of the device. This item is displayed only for my node or a node which has attended in the network after my node attended.	
PROTOCOL VERSION	Protocol version. This item is displayed only on my node information screen. At present, this item is fixed at 80H.	
AREA1 ALLOCATION OFFSET	Start address of transmission data in common memory area 1 in words.	
AREA1 ALLOCATION SIZE	Size of transmission data in common memory area 1 in words.	
AREA2 ALLOCATION OFFSET	Start address of transmission data in common memory area 2 in words.	
AREA2 ALLOCATION SIZE	Size of transmission data in common memory area 2 in words.	
TOKEN WATCH	Maximum time during which a token can be held (in ms).	
FRAME INTERVAL	Time interval between transmission of a data frame and that of the previous data frame (in 100 μ s).	
REFRESH TOLERANCE	Allowable refresh cycle time (in ms).	
UPPER LINK STATUS	Status of the upper layer. Error information and error code of this device are not supported.	
RUN/STOP	ON: The "upper-layer program" is running. OFF: The "upper-layer program" is not running.	
U_ERR	Displays error information of the upper layer. (Not supported)	
U_ERR_CODE	Displays the error code in the upper-layer program. (Not supported)	
FA LINK STATUS	Status of the FA link layer	
ADDRESS CONFLICT	Indicates that a setting of common memory is duplicated among nodes connected to the network.	
COMMON MEM READY	Indicates that common memory setting is complete.	
COMMON MEM ENABLE	Indicates that cyclic data is valid.	
UPPER LAYER ERROR	Indicates that the updated alive signal for the upper layer cannot be checked.	
NODE ENTRY FLAG	Indicates whether the node attends in the network.	

	Item	Description
OWN NODE STATUS		Status of my node
		Displayed only on my node information screen.
	SETUP OK	Setting completion flag for my node
	NODE CONFLICT	Indicates that a node having the same node number as for my node is found in
		the network.
	WAIT STATUS	Indicates that the node enters the frame reception wait state without receiving
		any frame during network initialization.
	INITIALIZATION ERROR	Indicates that an error is found in an initialization parameter or a parameter set.
	TOKEN WATCH ERROR	Indicates an error happened when transmission does not terminate within the
		token monitoring time-out period set for my node.

STATUS FL-NET	JOINT 10 %
FL-NET OWN NODE STATUS	1/29
FL-NET OWN NODE STATOS	1/29
1 OWN NODE NO	96
1 OWN NODE NO. : 2 NODE NAME [ROBOT	
3 VENDER NAME [FANUC LTD 4 TYPE NAME [FL-NET8059	i
4 TYPE NAME FI -NET8059	i
5 FIRMWARE [656Z 0001]]]
6 PROTOCOL VERSION :	80H
7 AREA1 ALLOCATION OFFSET:	400
8 AREA1 ALLOCATION SIZE :	112
7 AREA1 ALLOCATION OFFSET: 8 AREA1 ALLOCATION SIZE: 9 AREA2 ALLOCATION OFFSET: 10 AREA2 ALLOCATION SIZE: 11 TOKEN WATCH (1msec): 12 FRAME INTERVAL (0. 1msec): 13 REFRESH TOLERANCE: 14 UPPER LINK STATUS: 15 RUN/STOP: 16 U_ERR: 17 U_ERROR_CODE: 18 FA LINK STATUS: 19 ADDRESS CONFLICT: 20 COMMON MEM READY: 21 COMMON MEM READY: 21 COMMON MEM ENABLE: 22 UPPER LAYER ERROR: 23 NODE ENTRY FLAG: 24 OWN NODE STATUS: 25 SETUP OK: 26 NODE CONFLICT: 27 WAIT STATUS: 28 INITIALIZATION ERR:	0
10 AREA2 ALLOCATION SIZE :	600
11 TOKEN WATCH(1msec) :	50
12 FRAME INTERVAL(0.1msec):	10
13 REFRESH TOLERANCE :	11
14 UPPER LINK STATUS :	0000H
15 RUN/STOP :	ON
16 U_ERR :	0FF
17 U_ERROR_CODE :	000H
18 FA LINK STATUS :	113H
19 ADDRESS CONFLICT :	0FF
20 COMMON MEM READY :	ON
21 COMMON MEM ENABLE :	ON
22 UPPER LAYER ERRUR :	UN
Z3 NUDE ENTRY FLAG :	UN
Z4 UWN NUDE STATUS :	UUH
20 SETUP UN	UFF
ZO NUDE CUNFLICE .	UFF
27 WAIT STATUS . 28 INITIALIZATION ERR :	OFF
28 INTITALIZATION ERR :	OFF
23 TONLIN WATOU ERROR .	UFF
[TYPE] [OTHER]	>
_	

Pressing [F3] "OTHER" can change the displayed screen.

6.2 NODE LIST SCREEN

On this screen, you can check a list of node information and communication status of each node.

ltem	Description
NO	Node number
STATUS	Network participation/disconnection information
	OFFLINE: Does not participate in the network.
	ONLINE: Participates in the network.
AREA1	Indicates whether the node transmits data to or receives it from my node via common memory area1.
	ENB: Transmits or receives data.
	DIS: Does not transmit or receive data.
AREA2	Indicates whether the node transmits data to or receives it from my node via common memory area2.
	ENB: Transmits or receives data.
	DIS: Does not transmit or receive data.
Comment	Displays a comment.

STATUS FL-NET FL-NET NODE LIST NO STATUS AREA1 2 190 OFFLINE DIS DIS 191 OFFLINE DIS DIS 192 ONLINE ENB ENB 193 OFFLINE DIS DIS	JOINT 10 % 192/254 Comment [
[TYPE] DETAIL [OTH	HER] >

Pressing the [F2] "DETAIL" key displays the information screen for the node on the line at the cursor. To display the node list screen again, press the [PREV] key. Pressing [F3] "OTHER" can change the displayed screen.

6.3 NETWORK MANAGEMENT TABLE

Item	Description
TOKEN NODE	Number of the node which currently holds the token
MIN FRAME	Maximum value of the allowable minimum frame intervals of all nodes participating in the network (in 100 $\mu\text{s})$
RCT	Allowable refresh cycle time of my node (in ms)
RCM	Refresh cycle measurement time of my node (in ms)
MAX RCM	Maximum refresh cycle measurement time of my node (in ms)
MIN RCM	Minimum refresh cycle measurement time of my node (in ms)

STATUS FL-NET FL-NET NETWORK INFO	JOINT 10 %
1 TOKEN NODE 2 FRAME INTERVAL (0. 1msec): 3 RCT (msec) 4 RCM (msec) 5 MAX RCM (msec) 6 MIN RCM (msec) :	5 20 10 8 10 6
[TYPE] [OTHER]	>

Pressing [F3] "OTHER" can change the displayed screen.

6.4 LOG INFORMATION MANAGEMENT TABLE

Item	Description
TOTAL SEND	Number of transmitted frames
SEND ERROR	Number of transmission errors
TOTAL RECEIVE	Total number of received packet
RECEIVE ERROR	Number of received errors. The reception of a packet other than an FL-net packet is also counted as a receive error.
CYCLIC DATA ERROR	Number of errors in cyclic transmission
MESSAGE RETRY	Number of retries for message transmission
MESSAGE RETRY OVER	Number of the message transmission retry over
MESSAGE RECEIVE ERROR	Number of message receive errors
ACK ERROR	Number of ACK errors
DUPLICATED TOKEN	Number of duplicate tokens detected
DESTROYED TOKEN	Number of discarded tokens
ISSUED TOKEN	Number of reissued tokens
FRAM WAIT	Number of times my node entered the frame wait state because there were no other nodes in the network
ENTRY	Number of times my node participated in the network
OWN DISCONNECT	Number of times my node was disconnected due to a token hold time-out
SKIP DISCONNECT	Number of times my node was disconnected from the network because the token did not come to my node
OTHER NODE DISCONNECT	Number of times my node recognized that another node was disconnected

STATUS FL-NET	JOINT	10 %
FL-NET LOG TABLE	1/17	
1 TOTAL SEND	: 2714992	
2 SEND ERROR	: 0	
3 TOTAL RECEIVE	2714969	
4 RECEIVE ERROR	: 0	
5 CYCLIC DATA ERROR	: 0	
6 MESSAGE RETRY	: 0	
7 MESSAGE RETRY OVER	: 0	
8 MESSAGE RECEIVE ERROR	: 0	
9 ACK ERROR	: 0	
8 MESSAGE RECEIVE ERROR	: 0	
9 ACK ERROR	: 0	
10 DUPLICATED TOKEN	: 0	
11 DESTROYED TOKEN	: 0	
12 ISSUED TOKEN	: 0	
13 FRAME WAIT	: 1	
14 ENTRY	: 0	
15 OWN DISCONNECT	: 0	
16 SKIP DISCONNECT	: 0	
17 OTHER NODE DISCONNECT	: 0	
[TYPE] [OTHER]	UPDATE CLEA	$R \rightarrow$

Press [F4] "UPDATE" to update network log information. Press [F5] "CLEAR" to clear network log information. To change the displayed screen, press [F3] "OTHER".

6.5 ERROR CODES OF FL-net FUNCTION

PRIO-178 WARN Blk scns lost; %d %d %d

Cause: A group of consecutive scans were lost; if n1 = 3 or 4, scans were lost on FL-net register on the main processor; if n1 = 5 or 6, scans were lost on FL-net register on the communications processor; n2 = number of lost scans; if n2 is less than 5, this may not be a serious problem; n3 = total scans since power-up. Generally indicates overloading of the indicated processor.

Action: Review software configuration and settings to determine how loading can be reduced.

PRIO-280 STOP FL-net System Error(%d)

Cause: An internal error occurred.

Action: Write down the parenthesized number in the message and contact the FANUC service representative.

PRIO-281 WARN FL-net PCB not installed

Cause: The FL-net board is not properly mounted on the control unit.

Action: If you want to use the FL-net function with FL-net board, insert the FL-net board properly.

If you do not want to use the FL-net function, clear the common memory and I/O settings for all nodes. This alarm is displayed when the FL-net setting is made for at least one node.

PRIO-282 STOP FL-net PCB Abnormal(%d)

Cause: The FL-net board does not function correctly.

Action: The FL-net board must be replaced. Write down the parenthesized number in the message and contact the FANUC service representative.

PRIO-283 STOP FL-net IP Address Incorrect

Cause: The IP address of my node is specified by the address that doesn't belong to the class C or host address (last number) is set to 0 or 255.

Action: Specify the IP address of my node by the address that is belong to the class C or set the host address to other than 0 and 255.

PRIO-284 STOP FL-net Token Interval Error

Cause: A time-out occurred in transmission from my node.

Action: Increase the value of the token monitoring time on the setting screen or decrease the amount of data to be transmitted from my node so that no time-out occurs in transmission from my node. Alternatively, a device may make a slow response to the network. Check whether my node is affected by such a device.

PRIO-285 STOP FL-net Init Error

Cause: An error was detected in FL-net connection sequence.

Action: Check whether all settings are correct. If this error occurs though all settings are correct, save setting data in FLNET.SV and send the file to the FANUC service representative.

PRIO-286 WARN FL-net Wait Frame Status

Cause: My node is in the frame reception wait state because there are no other nodes in the network or my node can recognize no other nodes.

Action: To start communication, make another node participate in the network. If my node does not recognize another node, check whether the robot and remote communication devices are connected to the network properly and are set correctly.

PRIO-287 STOP FL-net My Node Duplicate No.

Cause: Some node has the same node number to my node.

Action: Change the node number of my node or the node which has the same node number. To change the node number of my node, change the least significant digit of the IP address on my node setting screen. After changing the node number, turn the power off, then on again.

PRIO-288 STOP FL-net My Node Leave Network

Cause: My node was disconnected from the network. The cause may be disconnection of power or connection. My node may be disconnected from the network due to an error which has already occurred.

Action: Turn the power on and check whether my node can participate in the network and check whether the cables are connected properly. Also check whether another error message is issued. If another error message is issued, first remove the cause of the error.

PRIO-289 WARN FL-net My Node Enter Network

Cause: My node participated in the network.

Action: This alarm message calls an operator's attention.

PRIO-290 STOP FL-net My Node Duplicate Adr

Cause: The setting of common memory of a node overlaps the common memory area setting of my node.

Action: Change the common memory area setting for my node or the node whose common memory area overlaps with that of my node to terminate the overlapping status.

PRIO-291 WARN / STOP FL-net Node %d Leave Network

Cause: The node with the node number displayed in the message was disconnected from the network.

Action: Check the node disconnected from the network by confirming the device settings and cable connection. Also check whether another error message is issued. If another error message is issued, first remove the cause of the error.

Caution: You can set WARN or STOP for each node as the severity of this error in the item for the error severity on the detailed participating node setting screen.

PRIO-292 WARN FL-net Node %d Enter Network

Cause: The node having the node number displayed in the message participated in the network.

Action: This alarm message calls an operator's attention.

PRIO-293 STOP FL-net Duplicate Area Adr %d

Cause: The common memory area setting of a node overlaps that of the node with the node number displayed in the message.

Action: Change the setting of common memory area to terminate the overlapping status.

PRIO-294 STOP FL-net Multiple PCBs detected

Cause: Multiple FL-net boards are inserted into the control unit.

Action: Insert only one FL-net board.

PRIO-295 STOP FL-net register is too large

Cause: FL-net sending register is too large or too small to change to integer.

Action: Change the register to smaller (less than 2147483584) or larger (equal or larger than -2147483776) value or send the

register with float.

PRIO-296 WARN FL-net board can't use

Cause: Setting is to use internal port for FL-net. **Action:** Please use internal port or set to use board.

PRIO-297 WARN FL-net rcv reg is too large

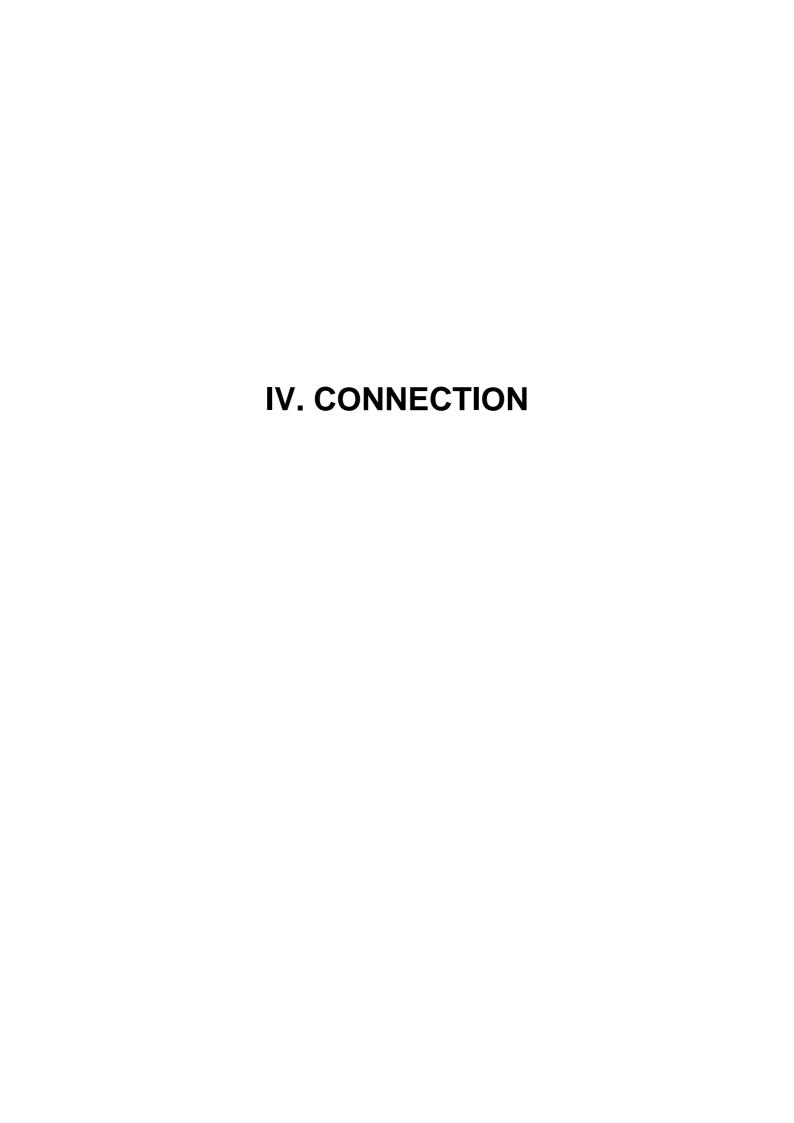
Cause: The number of FL-net receiving register is too large.

Action: Set the number of FL-net receiving register equal or under 50.

PRIO-298 WARN Var1=internal, var2=board only

Cause: When total variety is 2, variety 1 is internal port only, variety 2 is FL-net board only.

Action: This alarm message calls an operator's attention.



1 INSTALLATION

This chapter provides information required for installation of the FL-net board.

1.1 SPECIFICATIONS

The specifications of the FL-net board are described below.

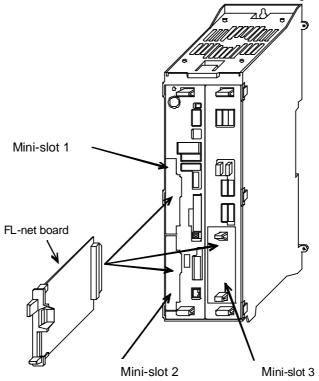
Name	FL-net board
Ordering code	A05B-2600-J105(R-30iB, R-30iB Mate)
-	A05B-2500-J105(R-30iA)
	A05B-2550-J040(R-30iA Mate)
Board drawing number	A20B-8101-0031

1.2 INSTALLATION

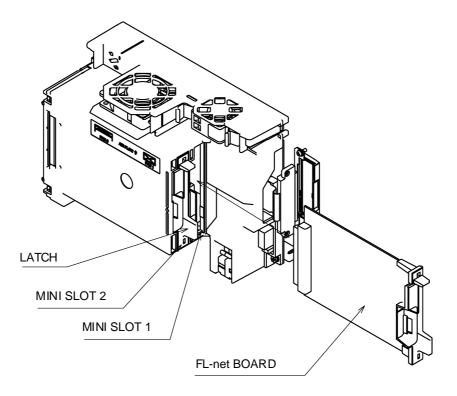
This section describes information about the installation of the FL-net board.

If multiple FL-net boards are inserted into the slots, error "PRIO - 294 STOP FL-net Multiple PCBs detected" occurs.

In the R-30*i*A or R-30*i*B controller, a FL-net board can be installed to an option slot like the figure below.



In the R-30*i*A Mate or R-30*i*B Mate controller, a FL-net board can be installed to an option slot like the figure below.



2 CONNECTION OF THE COMMUNICATION FUNCTION

This chapter provides information required for Ethernet connection of the FL-net board. See FANUC Robot series Ethernet Function OPERATOR'S MANUAL (B-82974EN) for internal port.

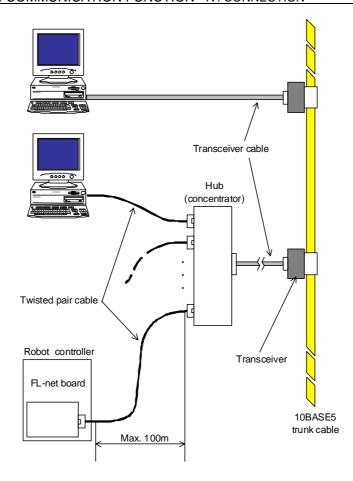
CAUTION

- 1 Do not connect to an FL-net network a communication data transfer device for use with a network that does not conform to FL-net. Otherwise, FL-net communication may not be performed correctly.
- 2 Before attaching or detaching a cable to the FL-net board, turn off the power of the robot controller, and confirm that the power is off.
- 3 For network building and the condition for using devices other than the FL-net board (such as hubs, transceivers, and cables), contact the supplier of each device. For network installation, care must be taken to protect the network from a noise source. Separate the network wiring sufficiently away from a noise source such as a power line and motor from an electrical viewpoint, and ground each device as required. If grounding is insufficient because of high impedance, a communication error may occur. Before going into actual operation after equipment installation, check the operation by conducting a communication test. FANUC cannot take responsibility for network trouble arising from a device other than the FL-net board.

2.1 CONNECTION TO ETHERNET

The FL-net board has a 10BASE-T interface. For connection to a 10BASE5 system, a hub (concentrator) is used.

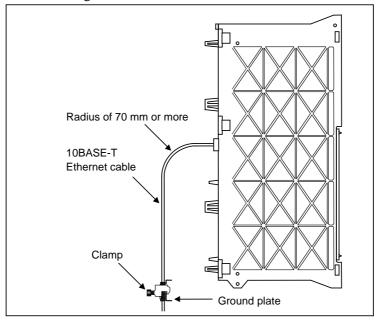
A typical example of connection is shown below.



Some devices (such as hubs and transceivers) used to build a network do not have a dust-proof structure. Using such devices in an atmosphere containing dust or oil mist can cause a communication error or failure. Be sure to house such devices in a dust-proof cabinet.

2.2 ROUTING OF THE ETHERNET CABLE

The Ethernet cable can be routed only from the front of the control unit. For connector location information, see the outside drawing of each board.



The Ethernet cable needs to be secured with a clamp so that no tension is applied to the connector (RJ-45) installed at the end of the cable even if the cable is pulled. This clamping also serves as the grounding of the cable shield.

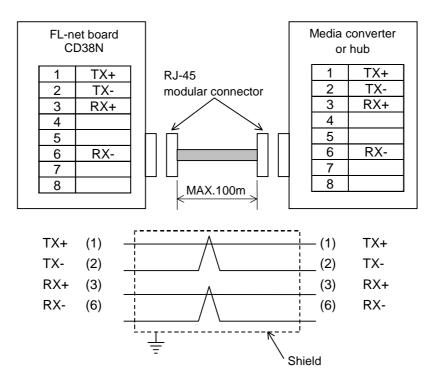
2.3 PIN ALLOCATION OF THE 10BASE-T CONNECTOR (CD38N)

CD38N				
Pin No.	Signal	Meaning		
1	TX+	Transmission +		
2	TX-	Transmission -		
3	RX+	Reception +		
4		Not used		
5		Not used		
6	RX-	Reception -		
7		Not used		
8		Not used		

2.4 TWISTED PAIR CABLE SPECIFICATIONS

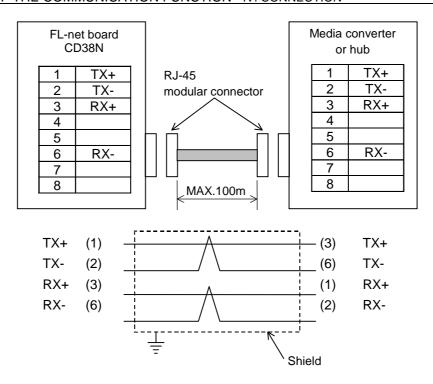
2.4.1 Cable Connection

Referring to the operator's manual of a device used, select an appropriate cable. An example of straight cable connection between the FL-net board 10BASE-T interface CD38N and a hub (or media converter) is given below.



The cable must not be longer than 100 m. Do not extend the cable unnecessarily.

An example of cross cable connection between the FL-net board 10BASE-T interface CD38N and a hub is given below.



The cable must not be longer than 100 m. Do not extend the cable unnecessarily.

NOTE

A straight cable is usually used for connection between a communication device and hub. The cable required for connection may differ depending on the manufacturer of the hub or media converter, however. Check whether a straight or cross cable is required, then prepare a correct cable.

When connection is correct, the LED marked with "LIL" on the FL-net board lights up.

2.4.2 Cable Wire

As twisted pair cables for 10BASE-T, unshielded cables (UTP cables) are available on the market. For improved protection against noise in an FA environment, however, use a common shielded category-5 twisted pair cable (STP cable).

Recommended cables (For standard)

Manufacturer name	Specification	Remarks
The Furukawa Electric Co., Ltd.	DTS5087C-4P	Twisted wire
Nissei Electric Co., Ltd.	F-4PFWMF	Solid wire

Contact point

Manufacturer name Contact point		Contact point		
Sales Divisi	on, the Furukawa	2-6-1 Marunouchi Chiyoda Ward, Tokyo, 100-8233		
Electric Co.	, Ltd.	TEL: +81-3-3286-3126 FAX: 03-3286-3979		
Remarks				
Tamachi Office, Nissei Electric Co., Ltd.		MU Building 3F, 1-9-1 Minaminaruse, Machida City, Tokyo 194-0045 TEL: +81-427-29-2531 FAX: 0427-29-3375		
	Contact point for overseas sales	IWATANI International Corporation Tokyo Head Office 21-8 NISHI-SHINBASHI 3-CHOME, MINATO-KU, TOKYO, 105-8458, JAPAN TEL: +81-3-5405-5810 FAX: 03-5405-5666 Telex: 2524256 IWATYO J		
Remarks A processed cable with the both terminal connector is provided.		A processed cable with the both terminal connector is provided.		

NOTE

The recommended standard cables cannot be used with movable parts.

Recommended cable (For movable parts)

Manufacturer name	Specification	Remarks
Oki Electric Cable Co., Ltd.	AWG26 4P FANUC-specific cable	
	TPMC-C5-F(SB)	
SHINKO ELECTRIC INDUSTRIES CO., LTD	FNC-118	FANUC-specific cable

Specifications

- Electric characteristics: Conform to EIA/TIA 568A categories 3 and 5.

For reasons related to attenuation performance, the distance to the hub must be

50 m or shorter.

- Structure: Common shield cable (braided shield). Drain wire provided.

The conductor is AWG26 annealed copper stranded wire.

The sheath thickness is 0.8 mm.

The outside diameter is 6.7±0.3 mm.

• Flame resistance: UL1581 VW-1

• Oil resistance: Based on the FANUC standard.

(Equivalent to the conventional oil-resistant electric cables)

Flexing resistance: 1 million times or more with 50 mm of

a bend radius (U-shape flexing test)

• UL style No.: AWM 20276 $(80^{\circ}\text{C}/30 \text{ V/VW-1})$

NOTE

Always use connector TM21CP-88P(03) manufactured by Hirose Electric for this cable.

Contact point

Manufacturer name	Contact point		
Oki Electric Cable Co., Ltd.	Sales office; Nagano Sales office TEL: +81-266-27-1597		
SHINKO ELECTRIC INDUSTRIES Co., LTD	Sales office; Tokyo Sales office TEL: +81-3-3492-0073		

Cable assembly

Oki Electric Cable Co., Ltd. also supplies cable assemblies using above connector. Make arrangements directly with the manufacturer for the specifications (length, outgoing inspection, packing, and others) and purchase cable assemblies.

Contact point: Oki Electric Cable Co., Ltd.

Sales contact point)

Nagano Sales Office TEL: 0266-27-1597

2.4.3 Connector Specifications

As a connector used with a twisted pair cable for Ethernet, an 8-bit modular connector called RJ-45 is used. Use the following connector or equivalent:

	Specification	Manufacturer	Remarks
For solid wire	5-569530-3	Japan AMP	
For solid wire	MS8-RSZT-EMC	SK KOHKI Co., Ltd.	Special tool required
For twisted wire	5-569552-3	Japan AMP	
For twisted wire	TM11AP-88P	Hirose Electric Co., Ltd.	Special tool 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

TM21CP-88P(03)

Drawing number: A63L-0001-0823#P Manufacturer: Hirose Electric Co., Ltd.

Manufacturer catalog number: TM21CP-88P(03) Conforms to EIA/TIA 568A categories 3 and 5.

For how to assemble the connector and cable, contact Hirose Electric.

(Hirose Electric technical document "TM21CP-88P(03) Connection Procedure

Specifications" (technical specification No. ATAD-E2367) is available.)

2.4.4 Hub

Recommended hub

Manufacturer name	Specification	Remarks
Contec Co., Ltd.	RT-1008H	10BASE-T Eight ports
Phoenix Contact	FL-HUB 10BASE-T	10BASE-T Four ports

This hub is not for FA. Use the hub in a dust-proof cabinet.

Contact points

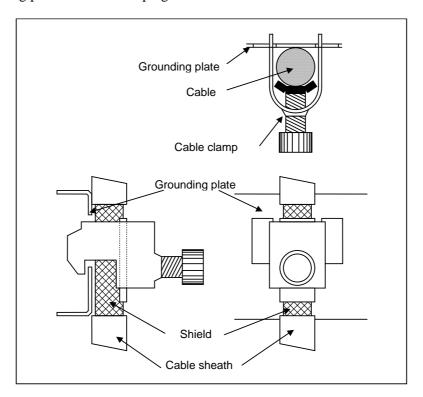
	Contact points
Manufacturer name	Contact point
Contec Co., Ltd.	Tachibana Annex Building, 2-25-14 Kameido, Koto Ward, Tokyo, 136-0071
East Branch	TEL: +81-3-5628-0211 (pilot number)
	FAX: +81-3-5628-0210
Remarks	http://www.contec.co.jp
Phoenix Contact	Yusen Shin-Yokohama 1-chome Building
Headquarters	1-7-9, Shin-Yokohama, Kohoku Ward, Yokohama-shi, Kanagawa Prefecture 222-0033, Japan
	TEL: +81-45-471-0030 (pilot number)
	FAX: +81-45-471-0031
Remarks	http://www.phoenixcontact.co.jp

2.5 ANTI-NOISE MEASURES

2.5.1 Clamping and Shielding of Cables

The Ethernet twisted pair cable needs to be clamped in the same way as the cables need to be shielded, as shown below. The clamping is required to shield and fix the cable. Be sure to perform the clamping to ensure the stable operation of the system.

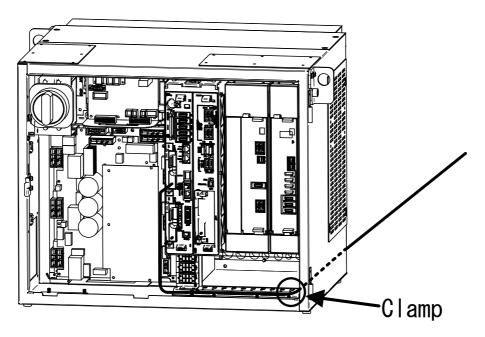
As shown in the figure, strip a part of the cable sheath to expose the metal shield and push the shield against the grounding plate with the clamping hardware.



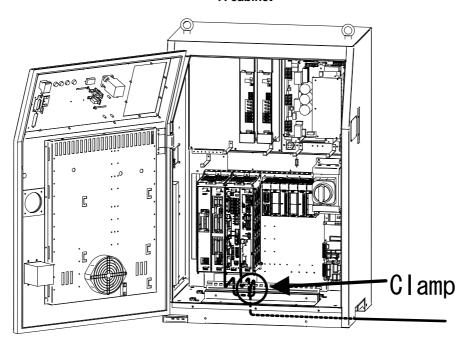
NOTE

- Be sure to clamp and shield the cable to ensure the stable operation of the system.
- 2 Unlike general Ethernet communication, FL-net communication does not perform retransmission at intervals of several seconds to achieve high responsibility. Accordingly, severer anti-noise measures must be taken as compared with general Ethernet wiring.
- 3 Upon completion of cabling, perform a communication test sufficiently not only before but also after system operation to ensure anti-noise measures.

R-30*i*B

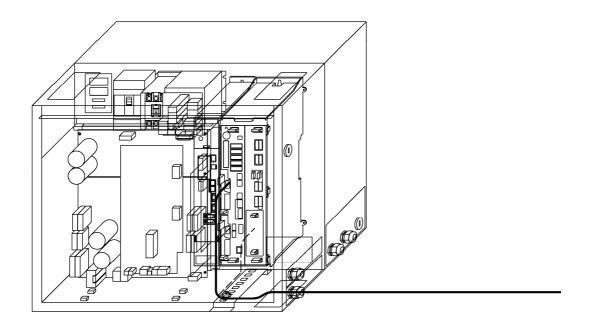


A-cabinet

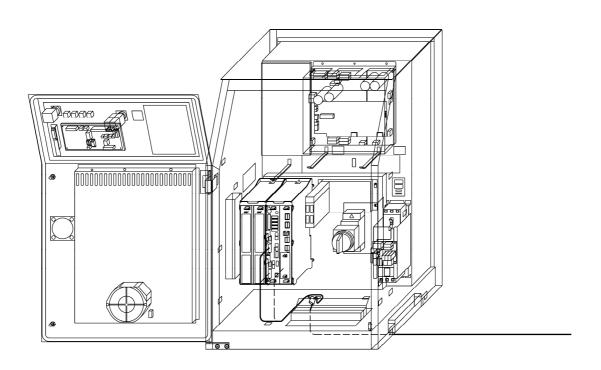


B-cabinet

R-30*i*A



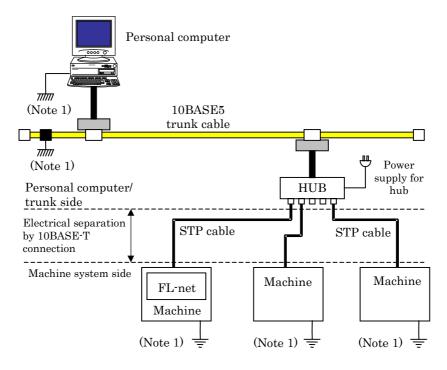
A-cabinet



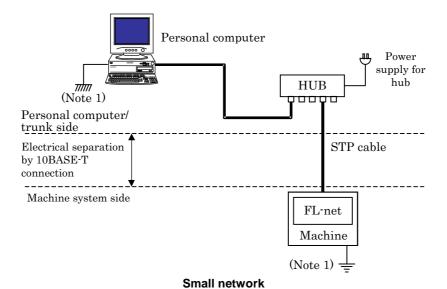
B-cabinet

2.5.2 Network Installation

Even when the grounding condition on the robot side is satisfied, noise generated by a robot may induce a communication error on the communication line, depending on the installation condition and environment of the robot. To prevent such trouble, the robot(s) should be separated and insulated from the Ethernet trunk cable and personal computer. Examples of connections are given below.



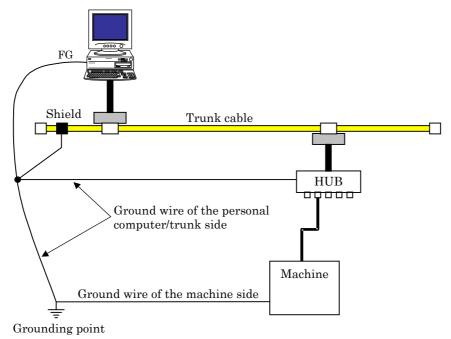
Large network



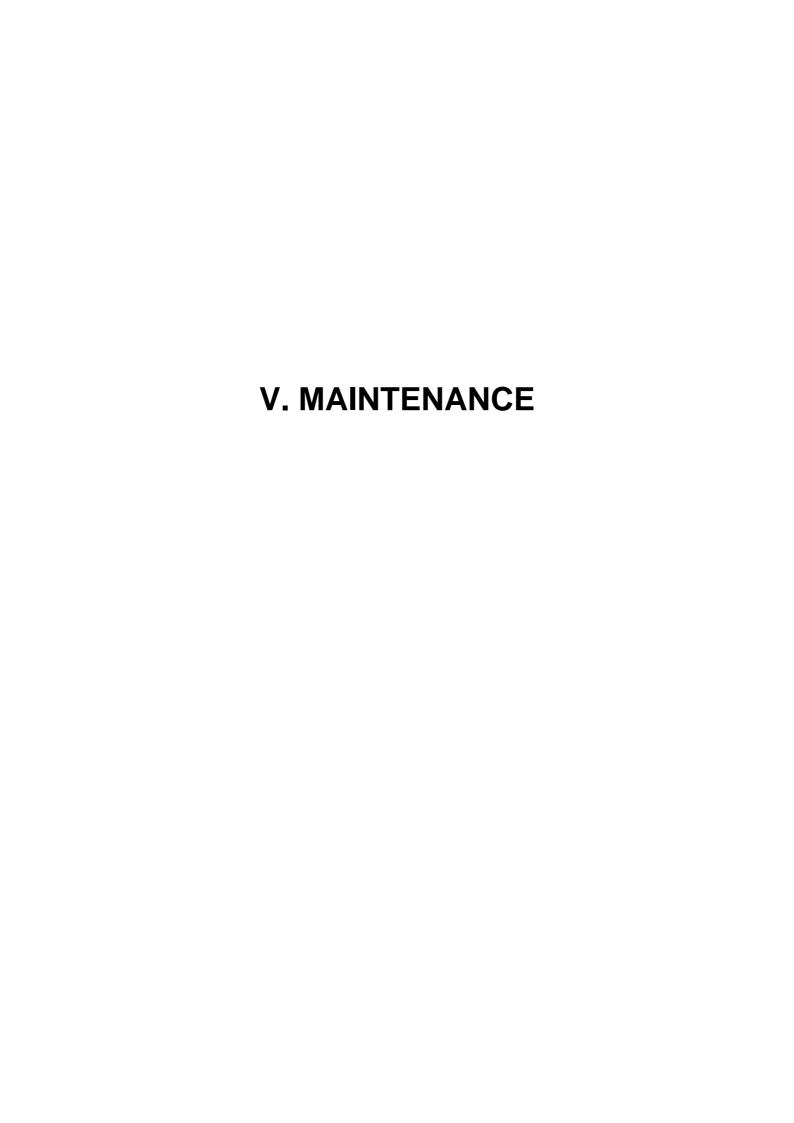
- 48 -

NOTE

- 1 Ensure that the ground system of the personal computer/trunk side is separated from the ground system of the robot system. If ground system separation is impossible because only one grounding point is available, run the personal computer/trunk side ground wire and the machine side ground wire separately to the grounding point. (See the figure below.) The ground resistance must be 100 ohms or less (class-3 grounding). The ground wire must not be thinner than the AC power line, and must be at least 5.5 mm² in diameter.
- 2 Note that the number of hubs that can be interconnected because the number depends on the type of hub.
- 3 Even when the insulation/separation method based on 10BASE-T is used as described above, noise can impede normal communication. When a network is used in such a very poor environment, consider the use of 10BASE-FLAG (optical fiber media) to completely separate the robot side from the personal computer side.



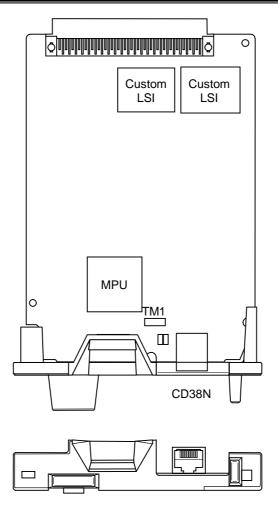
When only one grounding point is available



1 HARDWARE

This chapter provides hardware information required for the maintenance of the FL-net board.

1.1 LAYOUT OF COMPONENTS

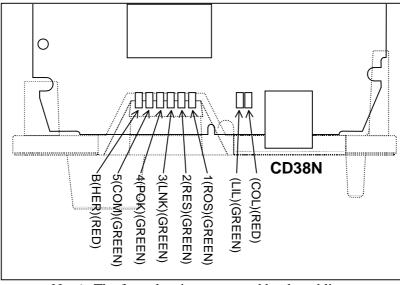


Name	PCB drawing number		
FL-net board	A20B-8101-0031		

1.2 LED INDICATIONS AND MEANINGS

The FL-net board has four green LEDs (ROS, RES, LNK, and POK) and one red LED (HER) for state indication, and two green LEDs (COM and LIL) and one LED (COL) for communication status indication. The locations and meanings of the LEDs are described below. In the description below, the following marks are used to represent the display states of each LED:

□: Turned off □: Turned on ☆: Blinking ◇: Don't care



Note) The face plate is represented by dotted lines.

LED indication transition at power-on (ROS, RES, LNK, POK)

No.		LED in	dication		Ethernet board state
	4	3	2	1	
	POK	LNK	RES	ROS	
1					Power off
2					Initial state immediately after power-on
3					Completion of MPU initialization
4					Completion of downloading of firmware
5					Transfer of control to the OS
6					OS PHASE1
7					OS PHASE2
8					OS PHASE3
9					OS PHASE4
10	\Diamond	\Diamond	\Diamond	☆	Completion of activation

When the board is activated normally, the state of No. 10 is set. This state continues until an error occurs.

LED indication during normal operation

No.	LED indication	Communication status
1	ROS ☆	Blinks at 1-second intervals when the communication software on the FL-net board
		operates normally.
2	RES □	Normally, off
3	LNK ■	Turned on when the node participates in the FL-net network
4	POK ■	Turned on when all FL-net parameters are valid.

LED indication for communication status

No.	LED indication	Communication status			
1	COM ■	Turned on when data is transmitted or received			
2	LIL ■	Turned on when the connection with the hub is normal			
3	COL ■	Turned on when a data collision occurs			

NOTE

COL: The FL-net manages the token-based transmission right so that no collision occurs. If this LED is turned on frequently, a communication error has occurred due to noise, or an Ethernet compliant product other than the FL-net is connected.

LED indication when an error occurs (ROS, RES, LNK, POK)

The LEDs repeat the indications of the LONG pattern and SHORT pattern. In this case, the LONG pattern is turned on for a longer time, and the SHORT pattern is turned on for a shorter time.

	LED inc	dication		
No.	LONG	SHORT	Board state	
	4321	4321		
1			Reset exception	
2			General machine check exception	
3			Data Storage	
4			Instruction Storage	
5			Alignment	
6			Program	
7			Floating Point Unavailable	
8			Decrementer	
9			Trace	
10			Floating Point Assist	
11			Implementation Dependent Software Emulation	
12			Implementation Dependent Instruction TLB Miss	
13			Implementation Dependent Data TLB Miss	
14			Implementation Dependent Instruction TLB Error	
15			Implementation Dependent Data TLB Error	
16			Implementation Dependent Data Breakpoint	
17			Implementation Dependent Instruction Breakpoint	
18			Implementation Dependent Peripheral Breakpoint	
19			Implementation Dependent Non Maskable Development	
20			DRAM Parity Alarm	
21			Other NMI	
22			Invalid interrupt	

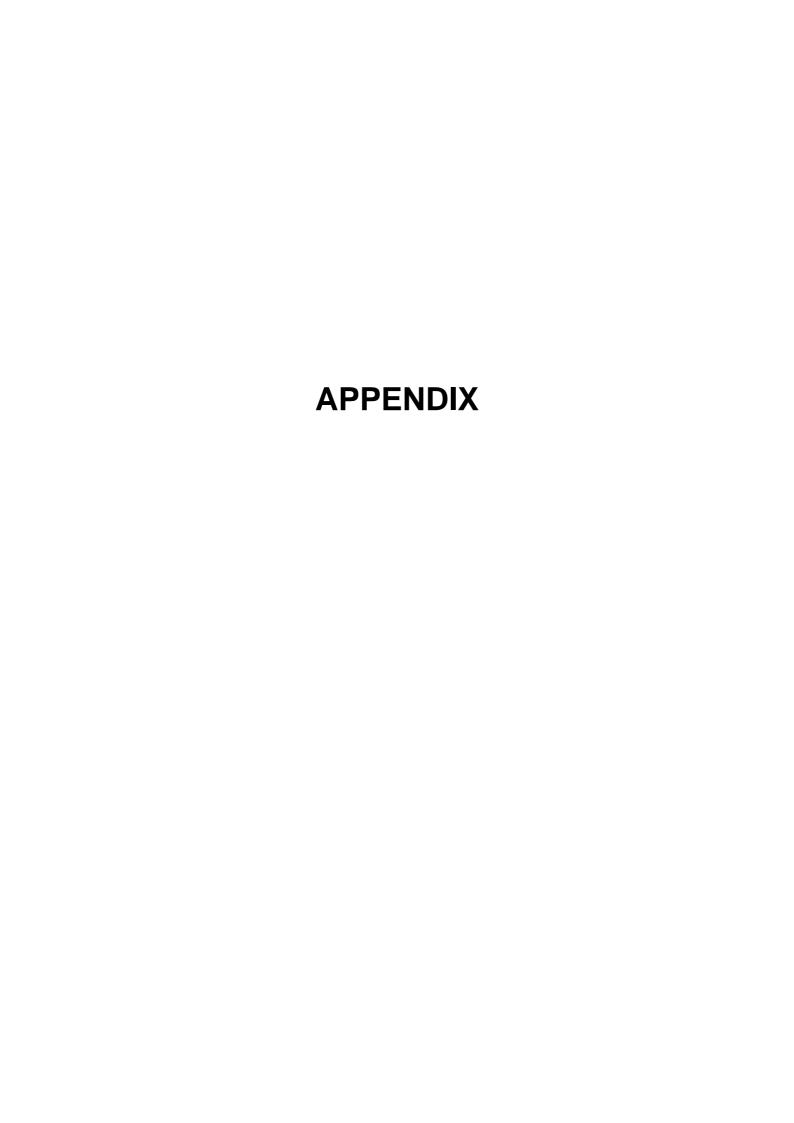
Note) If any of these errors occurs, contact FANUC.

LED indication when an error occurs (HER)

No.	LED indication		Board state
1	HER		A parity error occurred in the main memory.

1.3 **SETTING PIN**

The FL-net board has a setting pin (TM1) installed. The B side is connected with a jumper plug (factory setting). If the plug is removed, or the setting is changed, the FL-net board does not operate normally.





ERROR CODE OUTPUT FUNCTION

This function outputs the code of the alarm generated in the robot as a digital output signal with a strobe. This is an optional function but this option is ordered automatically by ordering FL-net.

The codes subject to the external output by this function are those of the alarms with alarm severities other than WARN. For the external output of alarm codes, 33 DOs (32 bits for the error code plus 1 bit for the strobe signal) are used. For an input signal, one DI is used.

A.1 SETTING METHOD

Use the following system variables to specify which I/O numbers to use:

\$ER_OUTPUT.\$OUT_NUM : Output signal number \$ER OUTPUT.\$IN NUM : Input signal number

This can be performed on the "FL-net error code output setting screen."

(See Operation 4, ERROR CODE OUTPUT FUNCTION.)

33 DOs starting from the DO number specified as the output signal number are used.

If \$ER_OUTPUT.\$OUT_NUM is equal to 1, the following DOs are used:

DO	Signal type				
1-32	Used to output an alarm code as binary data (32 bits). For the format of the error code, see the next section.				
33	Used for a strobe signal.				

The DI specified with \$ER_OUTPUT.\$IN_NUM is used as a timing signal for receiving the next alarm code if two or more alarms are generated. For details, see A.3, "Signal Timing Charts."

A.2 ALARM CODE FORMAT

The alarm code output by this function is 32 bits in length.

If \$ER_OUTPUT.\$OUT_NUM is equal to 1, the respective DOs have the meanings given in the table below.

DO	Signal type
1-16	Used to output a 16-bit alarm number.
17-24	Used to output an 8-bit alarm ID.
25-32	Used to output an 8-bit alarm severity.
33	Used for a strobe signal. This bit has no meaning for the alarm code.

A.2.1 Alarm Severities

This function does not output alarm codes whose severities are less than WARN.

DO	25	26	27	28	29	30	31	32
Severity								
PAUSE.L	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF
PAUSE.G	OFF	ON	OFF	OFF	OFF	ON	OFF	OFF
STOP.L	OFF	ON	ON	OFF	OFF	OFF	OFF	OFF
STOP.G	OFF	ON	ON	OFF	OFF	ON	OFF	OFF
SERVO	OFF	ON	ON	OFF	ON	ON	OFF	OFF
SERVO2	ON	ON	OFF	ON	ON	ON	OFF	OFF
SYSTEM	ON	ON	OFF	ON	ON	ON	ON	OFF

- DO[25] and DO[26] together indicate the severity of program execution.

DO[25]	DO[26]	Program execution
OFF	OFF	Continues to run.
OFF	ON	Interrupted.
ON	ON	Forcibly terminated.

- DO[27] and DO[28] together indicate the severity of robot operation.

DO[27]	DO[28]	Robot operation		
OFF	OFF	Continues to operate.		
ON	OFF	Decelerates and stops.		
OFF	ON	Stops instantaneously.		

- DO[29] indicates the severity of the servo power supply.

DO[29]	Servo power supply
OFF	Not turned off.
ON	Turned off.

- DO[30] specifies the range in which the alarm is applicable if multiple programs are running at the same time (multitasking).

DO[30]	Range
OFF	Program that caused the alarm to be generated
ON	All programs

-DO[31] indicates whether a cold start is required for a return from the alarm.

DO[31]	Return from the alarm
OFF	Does not require the power be turned off.
ON	Requires a cold start.

-DO[32] indicates whether the alarm must be indicated on the teach pendant.

DO[32]	Indication
OFF	The alarm need not be indicated on the teach pendant.
ON	The alarm must be indicated on the teach pendant.

A.2.2 Alarm IDs

The alarm IDs and their corresponding output numeric values are given as below.

Typical alarm IDs

Typical alaith ibs					
Numeric value	Alarm ID	Numeric value	Alarm ID		
0	OS	20	APPL		
3	PROG	23	SPOT		
7	MEMO	24	SYST		
9	TPIF	26	PALT		
11	SRVO	53	ARC		
12	INTP	57	MACR		
15	MOTN	58	SENS		
19	JOG	59	COMP		

Ot	her	al	arm	IDs

Numeric value	Alarm ID	Numeric value	Alarm ID
1	SRIO	36	TKSP
2	FILE	37	KT
4	COND	38	APSH
5	ELOG	42	CMND
6	MCTL	43	RPSM
8	OPIF	44	LNTK
10	FLPY	45	WEAV
13	PRIO	46	TCPP
14	TPAX	47	TAST
16	VARS	48	MUPS
17	ROUT	49	MIGE
18	WNDW	50	LSR
21	LANG	51	SEAL
25	SCIO	52	PANE
27	UAPL	54	TRAK
33	DICT	55	CMCC
34	KCLI	56	SP
35	TRAN	60	THSR

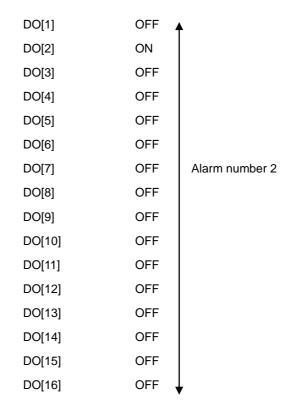
For an explanation of the codes not listed above, refer to the Alarm code List OPERATOR'S MANUAL.

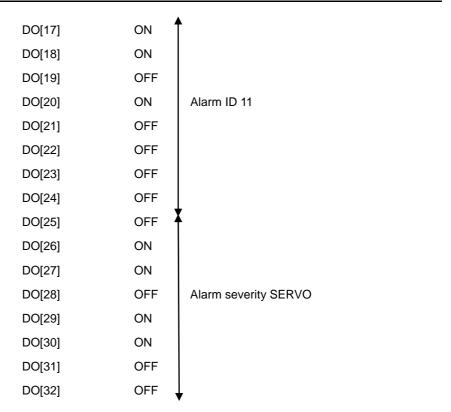
A.2.3 Alarm Numbers

Alarm numbers are output directly as binary representations.

((Example) For "servo - 002 (severity: SERVO)," the alarm number is 2 and the alarm ID of "servo..." is 11.

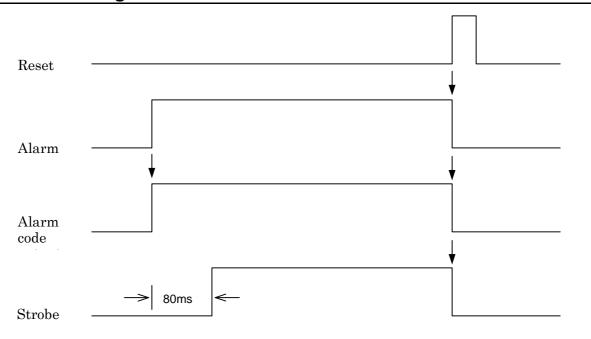
The DOs are as follows:





A.3 SIGNAL TIMING CHARTS

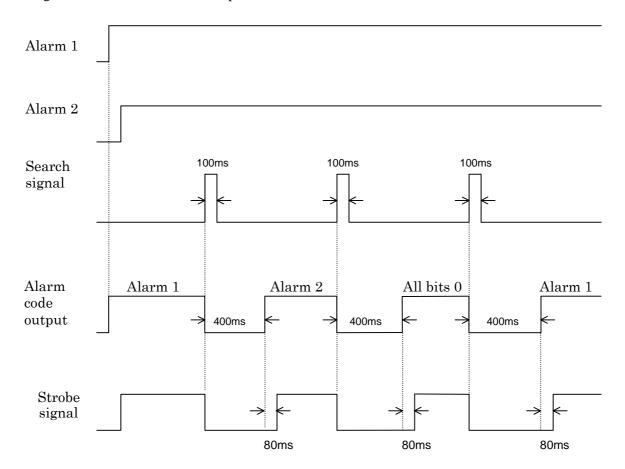
A.3.1 If a Single Alarm is Generated



If an alarm is generated, alarm code output is started. In about 80 msec, the strobe signal turns ON. Canceling the alarm with the reset key causes the strobe signal to turn OFF.

A.3.2 If Multiple Alarms are Generated

If multiple errors occur at the same time, the first alarm is output first. Then, as the DI specified with \$ER_OUTPUT.\$IN_NUM is input, alarm codes and strobe signals are output in the order in which the alarms are generated. Thus, this DI plays a role as an alarm search signal. After all the alarms have been output, an alarm code with all of its bits being 0 is output together with the strobe signal to indicate that all the generated alarms have been output.



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REVISION RECORD

REVISION RECORD

Edition	Date	Contents
03	Feb., 2014	 2 variety and 2048 point per 1 variety are supported. R-30iB Mate is supported.
02	Oct., 2012	Supported R-30iA Mate and R-30iB controller. (Internal port and multicast)
01	Mar., 2007	

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