FANUC Robot series

R-30*i*A/R-30*i*A Mate/R-30*i*B/R-30*i*B Mate/
R-30*i*B Plus/R-30*i*B Mate Plus CONTROLLER

FL-net Interface

OPERATOR'S MANUAL

B-82674EN/04

- **Original Instructions**

Thank you very much for purchasing FANUC Robot.
Before using the Robot, be sure to read the "FANUC Robot SAFETY HANDBOOK (B-80687EN)" and understand the content.

SAFETY PRECAUTIONS

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

For detailed functions of the robot operation, read the relevant operator's manual to understand fully its specification.
For the safety of the operator and the system, follow all safety precautions when operating a robot and its peripheral equipment installed in a work cell.
In addition, refer to the "FANUC Robot SAFETY HANDBOOK (**B-80687EN**)".

1 DEFINITION OF USER

The user can be defined as follows.

Operator:
- Turns ON/OFF power to the robot
- Starts the robot program from the operator's panel

Programmer:
- Operates the robot
- Teaches the robot inside the safety fence

Maintenance engineer:
- Operates the robot
- Teaches the robot inside the safety fence
- Performs maintenance (repair, adjustment, replacement)

- Operator is not allowed to work in the safety fence.
- Programmers and maintenance engineers are allowed to work in the safety fence. The work inside the safety fence includes lifting, setting, teaching, adjustment, maintenance, etc.
- To work inside the safety fence, the person must receive a professional training for the robot.

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

- Adequate clothes for the operation
- Safety shoes
- A helmet

2 DEFINITION OF SAFETY NOTATIONS

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 using the robot.

Symbol	Definitions
⚠**WARNING**	Used if hazard resulting in the death or serious injury of the user will be expected to occur if he or she fails to follow the approved procedure.
⚠**CAUTION**	Used if a hazard resulting in the minor or moderate injury of the user, or equipment damage may be expected to occur if he or she fails to follow the approved procedure.
NOTE	Used if a supplementary explanation not related to any of WARNING and CAUTION is to be indicated.

- Check this manual thoroughly, and keep it handy for the future reference.

3 SAFETY OF THE USER

User 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 user safety.

(1) Have the robot system users 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 user 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 user 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 (b).

(4) Provide the peripheral equipment with appropriate earth (Class A, Class B, Class C, and Class D).
(5) Try to install the peripheral equipment outside the robot operating space.
(6) Draw an outline on the floor, clearly indicating the range of the robot operating space, 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 user enters the work area.
(8) If necessary, install a safety lock so that no one except the user 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 equipment independently, be sure to turn off the power of the robot.
(10) Operators should be ungloved while manipulating the operator 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. (refer to Controller OPERATOR'S MANUAL.)
(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 inside 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.)
- Outdoor

(16) When connecting the peripheral equipment 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 footstep, please consider security for installation and maintenance work in high place according to Fig. 3 (c). Please consider footstep and safety belt mounting position.

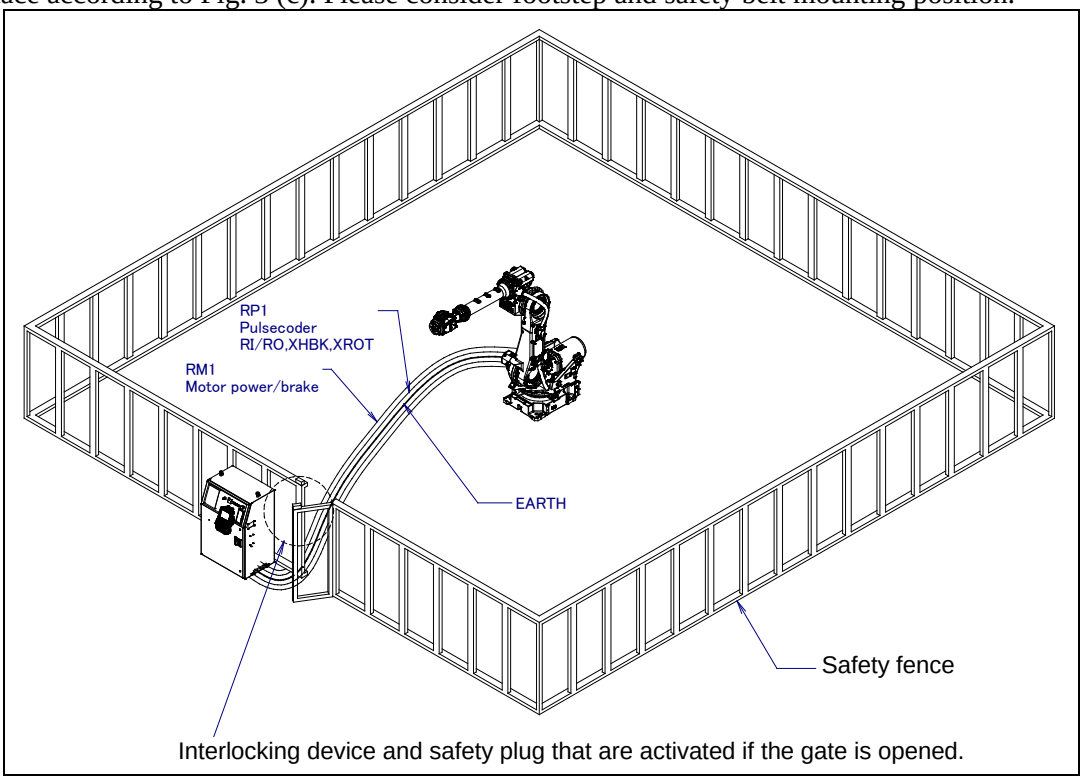

Fig. 3 (a) Safety fence and safety gate

⚠ WARNING
When you close a fence, please confirm that there is not a person from all directions of the robot.

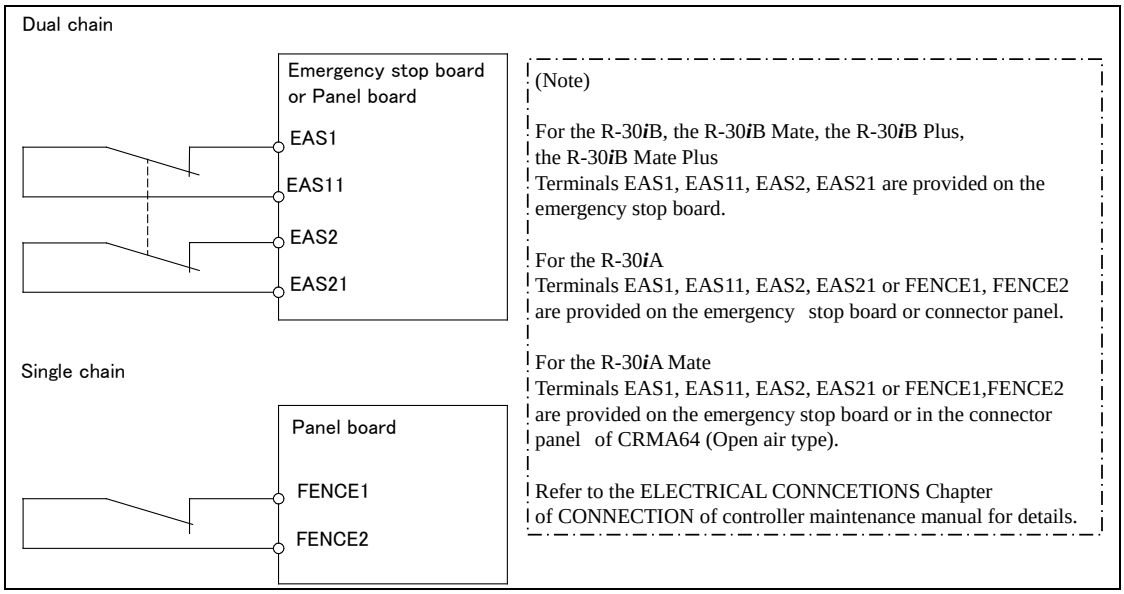

Fig. 3 (b) Connection diagram for the signal of safety fence

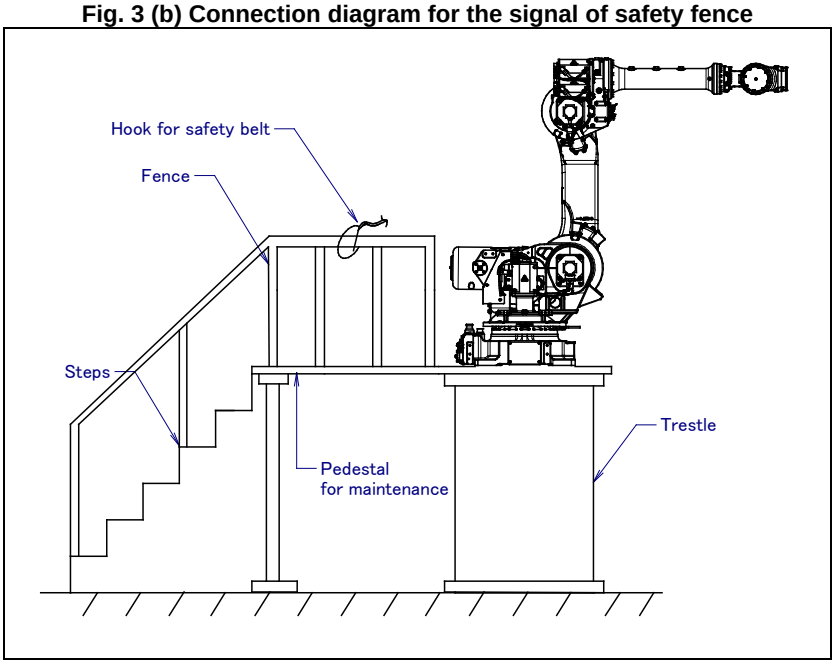

Fig. 3 (c) Pedestal for maintenance

3.1 SAFETY OF THE OPERATOR

An operator refers to a person who turns on and off the robot system and starts a robot program from, for example, the operator panel during daily operation.
Operators cannot work inside of the safety fence.

(1) If the robot does not need to be operated, turn off the robot controller power or press the EMERGENCY STOP button during working.
(2) Operate the robot system outside the operating space of the robot.
(3) Install a safety fence or safety door to avoid the accidental entry of a person other than an operator in charge or keep operator out from the hazardous place.

(4) Install the 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.

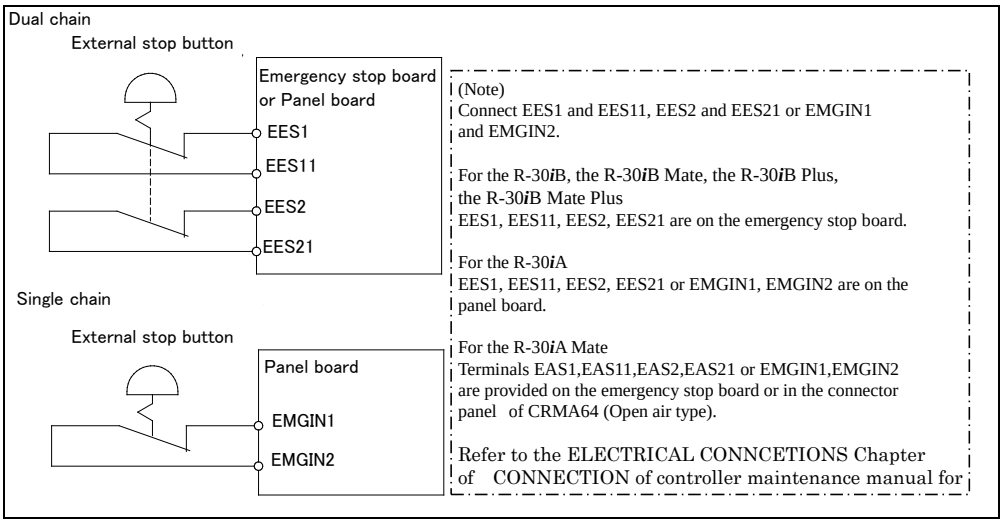

Fig. 3.1 Connection diagram for external emergency stop button

3.2 SAFETY OF THE PROGRAMMER

While teaching the robot, the operator may need to enter the robot operation area. The programmer must ensure the safety especially.

(1) Unless it is specifically necessary to enter the robot operating space, carry out all tasks outside the operating space.
(2) Before teaching the robot, check that the robot and its peripheral equipment are all in the normal operating condition.
(3) If it is inevitable to enter the robot operating space 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 operating space.
(5) Programming should be done outside the area of the safety fence as far as possible. If programming needs to be done inside 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 whole robot 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. (In case of 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.)

Teach pendant is provided with a switch to enable/disable robot operation from teach pendant and DEADMAN switch as well as emergency stop button. These button and switch function as follows:

(1) Emergency stop button: Causes the stop of the robot (Please refer to "STOP TYPE OF ROBOT" in SAFETY PRECAUTIONS for detail of stop type) when pressed.

(2) DEADMAN switch: Functions are different depending on the teach pendant enable/disable switch setting status.

(a) Enable: Servo power is turned off and robot stops when the operator releases the DEADMAN switch or when the operator presses the switch strongly.

(b) Disable: The DEADMAN switch is disabled.

(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 Plus/R-30*i*B Mate Plus /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 switch 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 Plus/R-30*i*B Mate Plus/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
AUTO mode	On	Local	Not allowed	Not allowed	Not allowed
		Remote	Not allowed	Not allowed	Not allowed
	Off	Local	Not allowed	Allowed to start	Not allowed
		Remote	Not allowed	Not allowed	Allowed to start
T1, T2 mode	On	Local	Allowed to start	Not allowed	Not allowed
		Remote	Allowed to start	Not allowed	Not allowed
	Off	Local	Not allowed	Not allowed	Not allowed
		Remote	Not allowed	Not allowed	Not allowed

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 Plus/R-30*i*B Mate Plus/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 panel, make certain that nobody is in the robot operating space and that there are no abnormal conditions in the robot operating space.

(7) When a program is completed, be sure to carry out the test operation according to the following procedure.

(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 must leave the safety fence.

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 operating space.
(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 operating space while the power is on, press the emergency stop button on the operator box or operator panel, or the teach pendant before entering the range. The maintenance worker 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 worker must check the whole robot 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 whole robot 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 maintenance work, check that the robot and its peripheral equipment are all in the normal operating condition.
(7) Do not operate the robot in the automatic operation while anybody is in the robot operating space.
(8) When you maintain the robot alongside a wall or instrument, or when multiple users are working nearby, make certain that their escape path is not obstructed.
(9) When a tool is mounted on the robot, or when any movable device other than the robot is installed, such as belt conveyor, pay careful attention to its motion.
(10) If necessary, have a user who is familiar with the robot system stand beside the operator panel and observe the work being performed. If any danger arises, the user should be ready to press the EMERGENCY STOP button at any time.
(11) When replacing a part, please contact your local FANUC representative. If a wrong procedure is followed, an accident may occur, causing damage to the robot and injury to the user.
(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 operating space and that the robot and the peripheral equipment 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 user needs to touch such a part in the heated state, the user 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 robot 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 execution should be given for the robot according to a predetermined method. (See TESTING section of “Controller operator’s manual”.) During the test execution, the maintenance worker should work outside the safety fence.

4 SAFETY OF THE TOOLS AND PERIPHERAL EQUIPMENT

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 abnormality occurs in any other robots or peripheral equipment, even though the robot itself is normal.
(3) For a system in which the robot and its peripheral equipment 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 equipment 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 component cells of the robot system clean, operate the robot where insulated from the influence of oil, water, and dust.
(2) Don't use unconfirmed liquid for cutting fluid and cleaning fluid.
(3) Adopt limit switches or mechanical stoppers to limit the robot motion, and avoid the robot from collisions against peripheral equipment or tools.
(4) Observe the following precautions about the mechanical unit cables. Failure to follow precautions may cause problems.
- Use mechanical unit cable that have required user interface.
- Do not add user cable or hose to inside of the mechanical unit.
- Please do not obstruct the movement of the mechanical unit when cables are added to outside of mechanical unit.
- In the case of the model that a cable is exposed, please do not perform remodeling (Adding a protective cover and fix an outside cable more) obstructing the behavior of the outcrop of the cable.
- When installing user peripheral equipment on the robot mechanical unit, please pay attention that the device does not interfere with the robot itself.

(5) The frequent power-off stop for the robot during operation causes the trouble of the robot. Please avoid the system construction that power-off stop would be operated routinely. (Refer to bad case example.) Please perform 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 poor product is generated, a line stops by emergency stop and power-off of the robot is incurred.
- When alteration is necessary, safety switch is operated by opening safety fence and power-off stop is incurred for the robot during operation.
- An operator pushes the emergency stop button frequently, and a line stops.
- An area sensor or a mat switch connected to safety signal operates routinely and power-off stop is incurred for the robot.
- Power-off stop is regularly incurred due to an inappropriate setting for Dual Check Safety (DCS).

(6) Power-off stop of Robot is executed when collision detection alarm (SRVO-050) etc. occurs. Please try to avoid unnecessary power-off stops. It may cause the trouble of the robot, too. So remove the causes of the alarm.

5 SAFETY OF THE ROBOT MECHANICAL UNIT

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 operating spaces of robots overlap, make certain that the motions of the robots do not interfere with each other.
(2) Be sure to specify the predetermined work origin in a motion program for the robot and program the motion so that it starts from the origin and terminates at the origin. Make it possible for the operator to easily distinguish at a glance that the robot motion has terminated.

5.3 PRECAUTIONS FOR MECHANISMS

Keep the robot operation area 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 (R-30*i*A, R-30*i*A Mate)

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

1 The stopping distance and time of Controlled stop is longer than those 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. Please refer to the operator's manual of a particular robot model for the data of stopping distance and time.
2 In multi arm system, the longest stopping distance and time of Controlled Stop among each robot are adopted as those for the system. A risk assessment for the whole robot system which takes into consideration a possibility that the stopping distance and time increase, is necessary on the multi arm system.
3 In the system which has extended axis, the longer stopping distance and time of Controlled Stop among robot and extended axis are adopted as those for the system. A risk assessment for the whole robot system which takes into consideration a possibility that the stopping distance and time increase, is necessary on the system which has extended axis. Please refer to the extended axis setup procedure of the controller operator's manual for considering the stopping distance and time of the extended axis.
4 In case of Controlled stop, motor power shutdown is delayed for a maximum of 2 seconds. In this case, a risk assessment for the whole robot system is necessary, including the 2 seconds delay.

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
A	AUTO	P-Stop	P-Stop	C-Stop	C-Stop	P-Stop
	T1	P-Stop	P-Stop	-	C-Stop	P-Stop
	T2	P-Stop	P-Stop	-	C-Stop	P-Stop
B	AUTO	P-Stop	P-Stop	P-Stop	P-Stop	P-Stop
	T1	P-Stop	P-Stop	-	P-Stop	P-Stop
	T2	P-Stop	P-Stop	-	P-Stop	P-Stop
C	AUTO	C-Stop	C-Stop	C-Stop	C-Stop	C-Stop
	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*A				R-30*i*A Mate		
	Standard (Single)	Standard (Dual)	RIA type	CE type	Standard	RIA type	CE type
Standard	B (*)	A	A	A	A (**)	A	A
Stop type set (Stop pattern C) (A05B-2500-J570)	N/A	N/A	C	C	N/A	C	C

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

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

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 "Stop type set (Stop pattern C) (A05B-2500-J570) option 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.

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*A controller)
SRVO-194 Servo disconnect	Servo disconnect input (SD4-SD41, SD5-SD51) is open. (R-30*i*A controller)
SRVO-218 Ext.E-stop/Servo Disconnect	External emergency stop input (EES1-EES11, EES2-EES21) is open. (R-30*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.

8 STOP TYPE OF ROBOT (R-30*i*B, R-30*i*B Mate)

There are following four types of Stopping Robot.

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.

"**Power-Off stop**" performs following processing.

- An alarm is generated, and then the servo power turns off. Instantly the robot stops.
- 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.

"**Controlled stop**" performs following processing.

- The alarm "**SRVO-199 Controlled stop**" occurs along with a decelerated stop. The program execution is paused.
- An alarm is generated, and then the servo power turns off.

Smooth stop (Category 1 following IEC 60204-1)

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

"**Smooth stop**" performs following processing.

- The alarm "**SRVO-289 Smooth Stop**" occurs along with a decelerated stop. The program execution is paused.
- An alarm is generated, and then the servo power turns off.
- In Smooth stop, the robot decelerates until it stops with the deceleration time shorter than Controlled stop.

Hold (Category 2 following IEC 60204-1)

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

"**Hold**" performs following processing.

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

⚠ WARNING

1 The stopping distance and time of Controlled stop and Smooth stop are longer than those 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 or Smooth Stop is used. Please refer to the operator's manual of a particular robot model for the data of stopping distance and time.

2 In multi arm system, the longest stopping distance and time of Controlled Stop or Smooth Stop among each robot are adopted as those for the system. A risk assessment for the whole robot system which takes into consideration a possibility that the stopping distance and time increase, is necessary on the multi arm system.

3 In the system which has extended axis, the longer stopping distance and time of Controlled Stop or Smooth Stop among robot and extended axis are adopted as those for the system. A risk assessment for the whole robot system which takes into consideration a possibility that the stopping distance and time increase, is necessary on the system which has extended axis. Please refer to the extended axis setup procedure of the controller operator's manual for considering the stopping distance and time of the extended axis.

4 When Smooth stop occurs during deceleration by Controlled stop, the stop type of robot is changed to Power-Off Stop.
When Smooth stop occurs during deceleration by Hold, the stop type of robot is changed to Power-Off Stop.

5 In case of Controlled stop or Smooth Stop, motor power shutdown is delayed for a maximum of 2 seconds. In this case, a risk assessment for the whole robot system is necessary, including the 2 seconds delay.

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

There are the following 3 Stop patterns.

Stop pattern	Mode	Emergency stop button	External Emergency stop	FENCE open	SVOFF input	Deadman switch (*)
A	AUTO	P-Stop	P-Stop	C-Stop	C-Stop	-
	T1	P-Stop	P-Stop	-	C-Stop	P-Stop
	T2	P-Stop	P-Stop	-	C-Stop	P-Stop
C	AUTO	C-Stop	C-Stop	C-Stop	C-Stop	-
	T1	P-Stop	P-Stop	-	C-Stop	P-Stop
	T2	P-Stop	P-Stop	-	C-Stop	P-Stop
D	AUTO	S-Stop	S-Stop	C-Stop	C-Stop	-
	T1	S-Stop	S-Stop	-	C-Stop	S-Stop
	T2	S-Stop	S-Stop	-	C-Stop	S-Stop

P-Stop: Power-Off stop
C-Stop: Controlled stop
S-Stop: Smooth stop
-: Disable
(*) The stop pattern of NTED input is same as Deadman switch.

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

Option	R-30*i*B/ R-30*i*B Mate
Standard	A(**)
Controlled stop by E-Stop (A05B-2600-J570)	C(**)
Smooth E-Stop (A05B-2600-J651)	D(**)

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

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 is specified, the stop type of the following alarms become 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.

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.
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 time of Controlled stop is longer than those of Power-Off stop, depending on the robot model and axis.

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 time of Controlled stop are longer than those 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.

"Smooth E-Stop Function" option

When "**Smooth E-Stop Function**" (A05B-2600-J651) option is specified, the stop type of the following alarms becomes Smooth stop in all operation modes (AUTO, T1 and T2 mode).

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-003 Deadman switch released	Both deadman switches on Teach pendant are released.
SRVO-007 External emergency stops	External emergency stop input (EES1-EES11, EES2-EES21) is open.
SRVO-037 IMSTP input (Group: %d)	IMSTP input (*IMSTP signal for a peripheral device interface) is OFF.

Alarm	Condition
SRVO-232 NTED input	NTED input (NTED1-NTED11, NTED2-NTED21) is open.
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.
SRVO-410 DCS SSO NTED input	In DCS Safe I/O connect function, SSO[5] is OFF.
SRVO-419 DCS PROFIsafe comm. error	PROFINET Safety communication error occurs.

Smooth stop is different from **Power-Off stop** as follows:

- In Smooth stop, the robot is stopped along 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 Smooth 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 time of Smooth stop is longer than those of Power-Off stop, depending on the robot model and axis.

Smooth stop is different from **Controlled stop** as follows:

- The stopping distance and time of Smooth stop is normally shorter than those of Controlled stop, depending on the robot model and axis.

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 time of Smooth stop are longer than those 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.

9 STOP TYPE OF ROBOT (R-30*i*B Plus, R-30*i*B Mate Plus)

There are following three types of Stop Category.

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

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.

"**Stop Category 0**" performs following processing.

- An alarm is generated, and then the servo power turns off. Instantly the robot stops.
- Execution of the program is paused.

Frequent Category 0 Stop of the robot during operation can cause mechanical problems of the robot.
Avoid system designs that require routine or frequent Category 0 Stop conditions.

Stop Category 1 following IEC 60204-1 (Controlled Stop, Smooth Stop)

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

"**Stop Category 1**" performs following processing.

- The alarm "**SRVO-199 Controlled stop**" or "**SRVO-289 Smooth Stop**" occurs along with a decelerated stop. The program execution is paused.
- An alarm is generated, and then the servo power turns off.

In Smooth stop, the robot decelerates until it stops with the deceleration time shorter than Controlled stop. The stop type of Stop Category 1 is different according to the robot model or option configuration. Please refer to the operator's manual of a particular robot model.

Stop Category 2 following IEC 60204-1 (Hold)

The robot is decelerated until it stops, and servo power remains on.
"**Stop Category 2**" performs following processing.

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

> ⚠ **WARNING**
> 1 The stopping distance and time of Stop Category 1 are longer than those of Stop Category 0. A risk assessment for the whole robot system which takes into consideration the increased stopping distance and stopping time is necessary when Stop Category 1 is used. Please refer to the operator's manual of a particular robot model for the data of stopping distance and time.
> 2 In multi arm system, the longest stopping distance and time of Stop Category 1 among each robot are adopted as those for the system. A risk assessment for the whole robot system which takes into consideration a possibility that the stopping distance and time increase, is necessary on the multi arm system.
> 3 In the system which has extended axis, the longer stopping distance and time of Stop Category 1 among robot and extended axis are adopted as those for the system. A risk assessment for the whole robot system which takes into consideration a possibility that the stopping distance and time increase, is necessary on the system which has extended axis. Please refer to the extended axis setup procedure of the controller operator's manual for considering the stopping distance and time of the extended axis.
> 4 When Stop Category 1 occurs during deceleration by Stop Category 2, the stop type of robot is changed to Stop Category 0.
> 5 In case of Stop Category 1, motor power shutdown is delayed for a maximum of 2 seconds. In this case, a risk assessment for the whole robot system is necessary, including the 2 seconds delay.

When the emergency stop button is pressed or the FENCE is open, the stop type of robot is Stop Category 0 or Stop Category 1. The configuration of stop type for each situation is called *stop pattern*. The stop pattern is different according to the option configuration.

There are the following 3 Stop patterns.

Stop pattern	Mode	Emergency stop button	External Emergency stop	FENCE open	SVOFF input	Deadman switch (*)
A	AUTO	Category 0	Category 0	Category 1	Category 1	-
	T1	Category 0	Category 0	-	Category 1	Category 0
	T2	Category 0	Category 0	-	Category 1	Category 0
C	AUTO	Category 1	Category 1	Category 1	Category 1	-
	T1	Category 0	Category 0	-	Category 1	Category 0
	T2	Category 0	Category 0	-	Category 1	Category 0
D	AUTO	Category 1	Category 1	Category 1	Category 1	-
	T1	Category 1	Category 1	-	Category 1	Category 1
	T2	Category 1	Category 1	-	Category 1	Category 1

Category 0: Stop Category 0
Category 1: Stop Category 1
-: Disable

(*) The stop pattern of NTED input is same as Deadman switch.
The following table indicates the Stop pattern according to the controller type or option configuration.
The case R651 is specified.

Option	R-30*i*B Plus/ R-30*i*B Mate Plus
Standard	C(**)
Old Stop Function (A05B-2670-J680)	A(**)
All Smooth Stop Function (A05B-2670-J651)	D(**)

The case R650 is specified.

Option	R-30*i*B Plus/ R-30*i*B Mate Plus
Standard	A(**)
Stop Category 1 by E-Stop (A05B-2670-J521)	C(**)
All Smooth Stop Function (A05B-2670-J651)	D(**)

(**)R-30*i*B Mate Plus does not have SVOFF input.

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.

"Old Stop Function" option

When "**Old Stop Function**" (A05B-2670-J680) option is specified, the stop type of the following alarms becomes Stop Category 0 in AUTO mode.

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.
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.

Stop Category 0 is different from **Stop Category 1** as follows:

- In Stop Category 0, 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 stopping distance and time of Stop Category 0 is shorter than those of Stop Category 1, depending on the robot model and axis.

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.

"All Smooth Stop Function" option

When "**All Smooth Stop Function**" (A05B-2670-J651) option is specified, the stop type of the following alarms becomes Stop Category 1 in all operation modes (AUTO, T1 and T2 mode).

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-003 Deadman switch released	Both deadman switches on Teach pendant are released.
SRVO-007 External emergency stops	External emergency stop input (EES1-EES11, EES2-EES21) is open.
SRVO-037 IMSTP input (Group: %d)	IMSTP input (*IMSTP signal for a peripheral device interface) is ON.
SRVO-232 NTED input	NTED input (NTED1-NTED11, NTED2-NTED21) is open.
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.

Alarm	Condition
SRVO-410 DCS SSO Ext Emergency Stop	In DCS Safe I/O connect function, SSO[5] is OFF.
SRVO-419 DCS PROFIsafe comm. error	PROFINET Safety communication error occurs.

Stop Category 1 is different from **Stop Category 0** as follows:

- In Stop Category 1, the robot is stopped along 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 Stop Category 1, physical impact is less than Stop Category 0. 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 time of Stop Category 1 is longer than those of Stop Category 0, depending on the robot model and axis.

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 time of Stop Category 1 are longer than those of Stop Category 0. 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.

"Stop Category 1 by E-Stop" option

When "**Stop Category 1 by E-Stop**" (A05B-2670-J521) option is specified, the stop type of the following alarms become Category 1 Stop but only in AUTO mode. In T1 or T2 mode, the stop type is Category 0 Stop which is the normal operation of the system.

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.
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.

Stop Category 1 is different from **Stop Category 0** as follows:

- In Stop Category 1, the robot is stopped along 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 Stop Category 1, physical impact is less than Stop Category 0. 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 time of Stop Category 1 is longer than those of Stop Category 0, depending on the robot model and axis.

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 time of Stop Category 1 are longer than those of Stop Category 0. 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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TABLE OF CONTENTS

I. GENERAL

1 OVERVIEW

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.

II. DESCRIPTION

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: Sum of send and receive is 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 or later, R-30*i*B Mate or later. In some R-30*i*B Mate/R-30*i*B Mate Plus, only 1 internal Ethernet port is supported.**

R-30*i*B Mate

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

R-30*i*B Mate Plus

Name	The number of internal Ethernet port	Order number
Main board A	1	A05B-2680-H001
Main board B	2	A05B-2680-H002
Main board C	2	A05B-2680-H003

NOTE

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, which is sum of send and receive, 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.

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, version 1.00 devices can’t be used in the network. FL-net device of FANUC robot doesn’t support version 3.00, but mixed environments is supported. See manual of version 3.00 device etc. for detail.

6 When using internal port, FRAME INTERVAL (MINIMUM FRAME TIME) of robot can't be set the value less than 20 (2ms). When using internal port, FRAME INTERVAL in all node in network may have to be set to 20 (2m) or more. Max FRAME INTERVAL in all attending node is adopted to the behavior of all node. If node, which is set to 20 or more, isn’t attend to the network, the behavior becomes less than 20. When robot tries to attend the network, load of robot becomes too high, and robot may can’t attend the FL-net network, and may can’t ramp-up, or i-Pendant operation may get slow. So when using internal port, FRAME INTERVAL in all node may should have to be 20 or more. When using FL-net board, there is no that limitation.

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 instead of register, 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) Less max node number in own or attending node, CPU load and using memory volume get small a little.

(2) FL-net board is used when following situation.
  (a) Using 2 FL-net variety
  (b) All internal port are occupied or you want to save the used number of internal port.
  (c) You want to set FRAME INTERVAL less than 20.

(d) You want to save the load of robot communication function. (In this case, load for motion function gets high contrary.)

(3) Sometimes you should clear assignment written in section 2.5 before changing assignment or setting of size. Please try when you go wrong after changing setting or do wherever possible before changing.

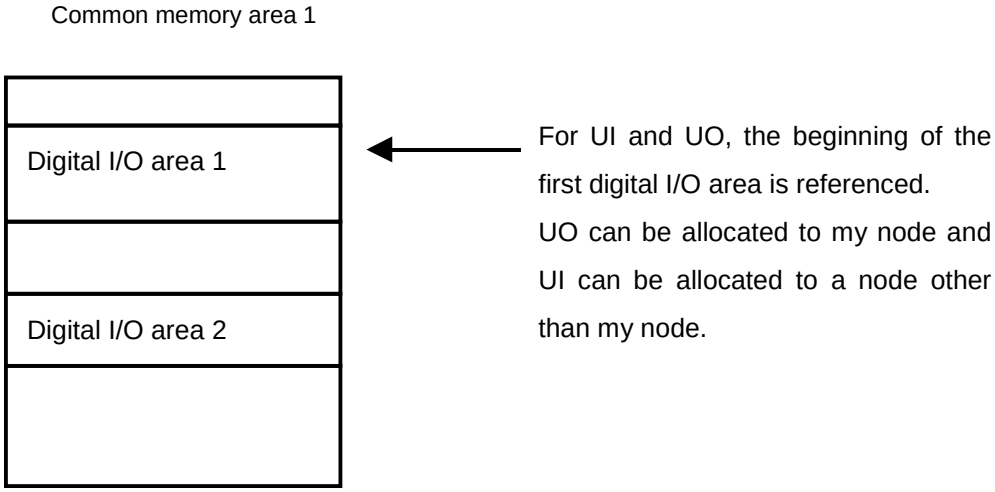
1.3 I/O RACK NUMBER AND SLOT NUMBERS

The rack number of I/O used by FL-net function is 68 in variety 1, 103 in variety 2. 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.



The area specified by “I/O Digital Out” screen etc. of “CONFIG” of “START” is following order.

Area specified by DO/DI BYTE OFFSET1 and DO/DI BYTE SIZE1 in AREA1
Area specified by DO/DI BYTE OFFSET2 and DO/DI BYTE SIZE2 in AREA1
Area specified by DO/DI BYTE OFFSET and DO/DI BYTE SIZE in AREA2

In following case, start in each area are following.

		value	START
AREA1	DO/DI BYTE OFFSET1	1	1
	DO/DI BYTE SIZE1	2	
	DO/DI BYTE OFFSET2	3	17
	DO/DI BYTE SIZE2	4	
AREA2	DO/DI BYTE OFFSET	5	49
	DO/DI BYTE SIZE	6	

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 address

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
Higher byte data								Lower byte data							

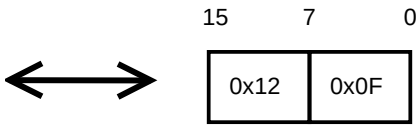
Example)
When the status of digital I/O is as shown in the following table:

Digital I/O

DO [1]	ON
DO [2]	ON
DO [3]	ON
DO [4]	ON
DO [5]	OFF
DO [6]	OFF
DO [7]	OFF
DO [8]	OFF

DO [9]	OFF
DO [10]	ON
DO [11]	OFF
DO [12]	OFF
DO [13]	ON
DO [14]	OFF
DO [15]	OFF
DO [16]	OFF

Common memory area 1

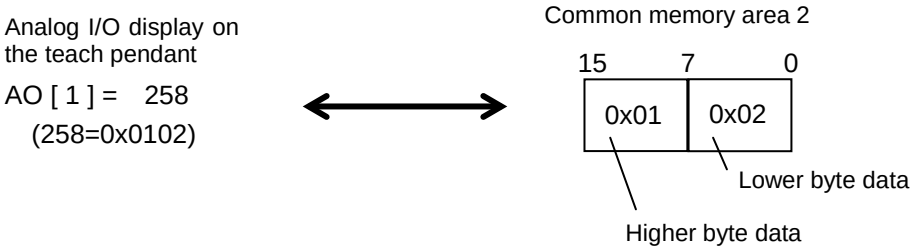


NOTE
In an FL-net common memory area, the data width per address is 16 bits.

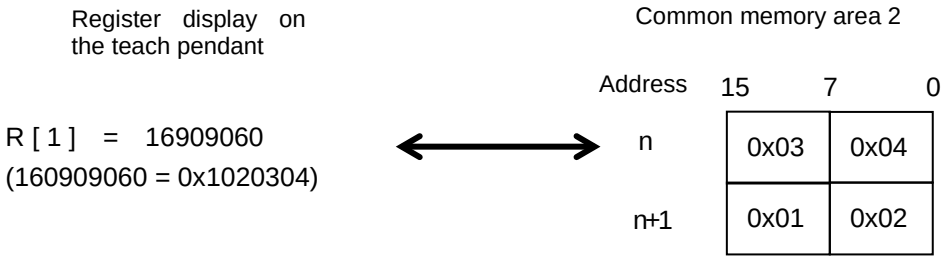
1.6 BYTE ORDERING OF ANALOG I/O AND REGISTER DATA

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).



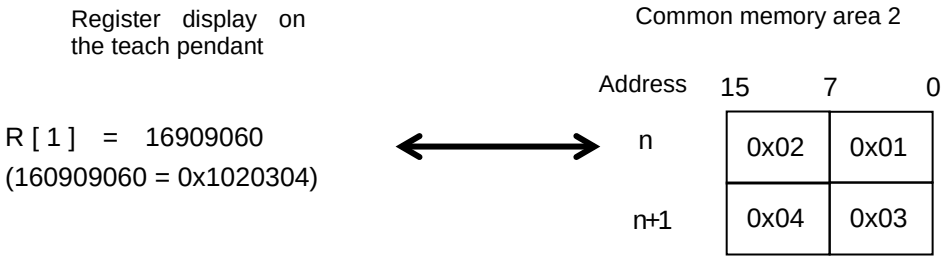
Register (32 bits)
Example)
When R[1] = 16909060 (0x1020304) is transmitted to common memory area 2:
The bit image of common memory area 2 is 67305985 (0x4030201).



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

In addition if $FLNODEVAR[x].$REG_EXCHG is set to 0, register is copied without exchange byte order for the node. In aforementioned formula, x=1 is own node and in the other case,
x = node number + 1.

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



1.7 REGISTER DATA FORMAT

Real number style is IEEE754 single precision.

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. In this case, byte order is exchanged when transmitting common memory area 2 as same with integer.

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.

⚠CAUTION
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 or later, R-30*i*B Mate or later.
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.

III. OPERATION

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 (Only after 7DC2/08)	Displayed variety. This setting affect to setting screen and status screen. Even when FL-net screen is displayed to other window, change is applied immediately.
TOTAL VARIETY (Only after 7DC2/08)	Total variety used in FL-net function.
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 (R-30*i*B or later, R-30 *i*B Mate or later)	BOARD: Using port on FL-net board. INTERNAL1: Using port on main board.(CD38A) INTERNAL2: Using port on main board.(CD38B) When TOTAL VARIETY is set to 2, variety 1 is fixed to internal port, variety 2 is fixed to FL-net board. INTERNAL2 is a little bit faster than INTERNAL1.
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). 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*B or later, R-30*i*B Mate or later, 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 [ms] + 9 [ms]. - 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. When using internal port, FRAME INTERVAL (MINIMUM FRAME TIME) setting of all node in network should be set to 20 (2ms) or more. Largest FRAME INTERVAL in all node, which participate to FL-net network, is adopted to behavior of all node. If node, which is set to 20 or more, doesn't participate, less than 20 is adopted and if robot tries to participate to the FL-net network, robot load may become too high and robot can't participate to FL-net network and robot can't start-up or i-Pendant operation becomes slow. So when using internal port, FRAME INTERVAL of all node should be set to 20 or more. If FL-net board is used, limitation like this doesn't exist.
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. Specify a node other than my node.
AREA1 WORD OFFSET	Start address of my node transmission data in common memory area 1. Specify 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.

Item	Description
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. 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	Size of my node transmission data to be referenced as WO. 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.
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 1 and 512.
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.
DO BYTE OFFSET	Start address of my node transmission data to be referenced as DO in area2. Specifies a value between 0 and 16383 in bytes.
DO BYTE SIZE	Size of my node transmission data to be referenced as DO in area 2. Specify a value between 0 and 256 in bytes.

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.

```
SETUP FL-NET                        JOINT  10%
 FL-NET OWN NODE SETUP                 1/31

  1 DISPLAY VARIETY          :         1
  2 TOTAL VARIETY            :         2
  3 ERROR ONE SHOT           :   DISABLE
  4 MAX DIGITAL PORT NUM     :      1024
  5 USING PORT               :INTERNAL2
    IP ADDRESS         :[192.168.250. 96]
  6 MULTICAST                :   DISABLE
  7 MULTICAST ADDRESS    :[239.255.  0.  0]
  8 NODE NAME              :[ROBOT_96    ]
  9 TOKEN WATCH TIME(msec)   :        50
 10 FRAME INTERVAL(0.1msec)  :        10
 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 WO BYTE OFFSET           :        38
 20 WO 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
 32 DO BYTE OFFSET           :         0
 33 DO BYTE SIZE             :         0
```

Pressing [F3] OTHER can change the displayed screen.

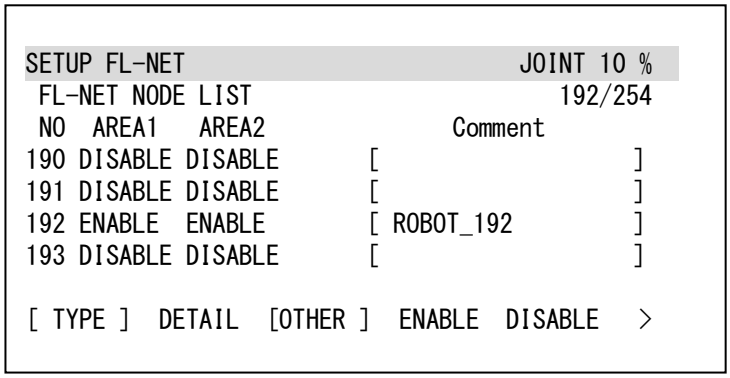
2 ATTENDING NODE SETUP

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.



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. Specify a value between 0 and 511 in words.
AREA1 WORD SIZE	Size of the node transmission data in common memory area1. 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. Specify a value between 0 and 1023 in bytes.
DI BYTE SIZE1	Size of transmission data to be referenced as DI of the node. 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. Specify a value between 0 and 1023 in bytes.
DI BYTE SIZE2	Size of transmission data to be referenced as DI of the node. Specify a value between 0 and 128 in bytes.
WI BYTE OFFSET	Start address of transmission data to be referenced as WI of the node. Specify a value between 0 and 1023 in bytes.
WI BYTE SIZE	Size of transmission data to be referenced as WI of the node. Specify a value between 0 and 128 in bytes.
WSTK IN BYTE OFFSET	Start address of transmission data to be referenced as WSTK IN of the node. Specify a value between 0 and 1023 in bytes.
WSTK IN BYTE SIZE	Size of transmission data to be referenced as WSTK IN of the node. 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.
AREA2 WORD OFFSET	Start address of the node transmission data in common memory area2. Specify a value between 0 and 8191 in words.
AREA2 WORD SIZE	Size of the node transmission data in common memory area2. 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. Specify a value between 0 and 16383 in bytes.
AI CHANNEL NUMBER	Size of transmission data to be referenced as AI of the node. 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. AI 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 1 and 5000.
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 FORMAT	Specifies how to receive the register data of the node. integer: Register data is in integer format. real: Register data is in real format.

Item	Description
DI BYTE OFFSET	Start address of transmission data to be referenced as DI of the node in area2. Specify a value between 0 and 16383 in bytes.
DI BYTE SIZE	Size of transmission data to be referenced as DI of the node in area2. Specify a value between 0 and 256 in bytes.

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       :    [WARN   ]
  3 I/O SAFETY VALUE          :    [LAST    ]
  4 AREA1 ALLOCATION          :      ENABLE
  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          :      ENABLE
 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 OFFSET      :          50
 23 REGISTER START            :          19
 24 REGISTER NUMBER           :          18
 25 REGISTER DATA FORMAT      :   [integer]
 26 DI BYTE OFFSET            :           0
 27 DI BYTE SIZE              :           0

[ 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

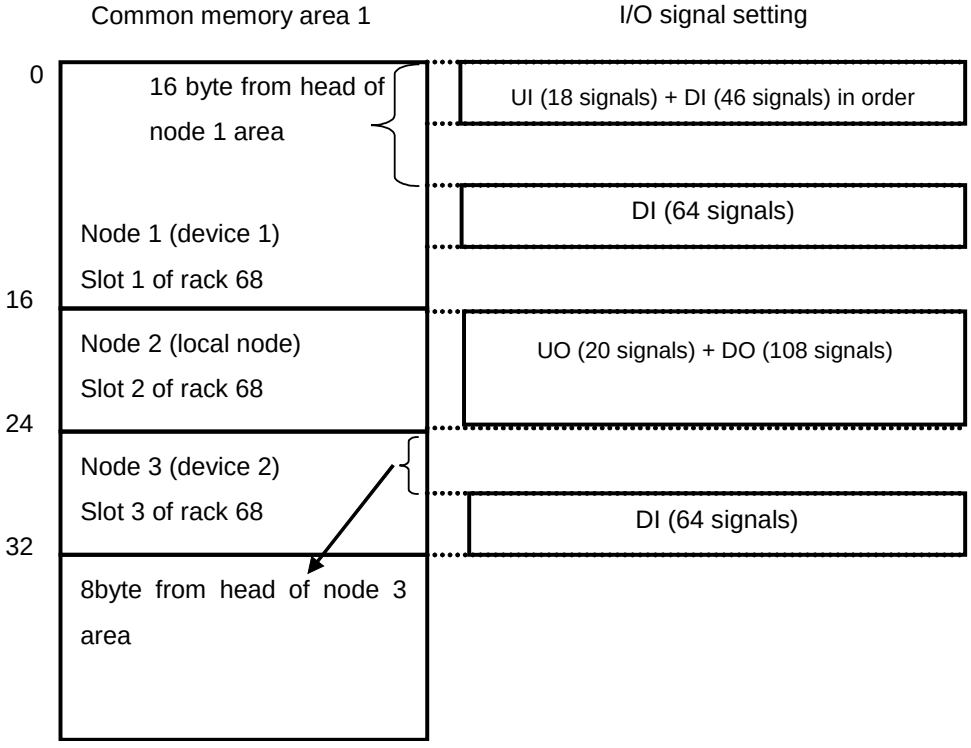
2.3.1 Sample Digital I/O Settings

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.

Setting item \ Device	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

(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.



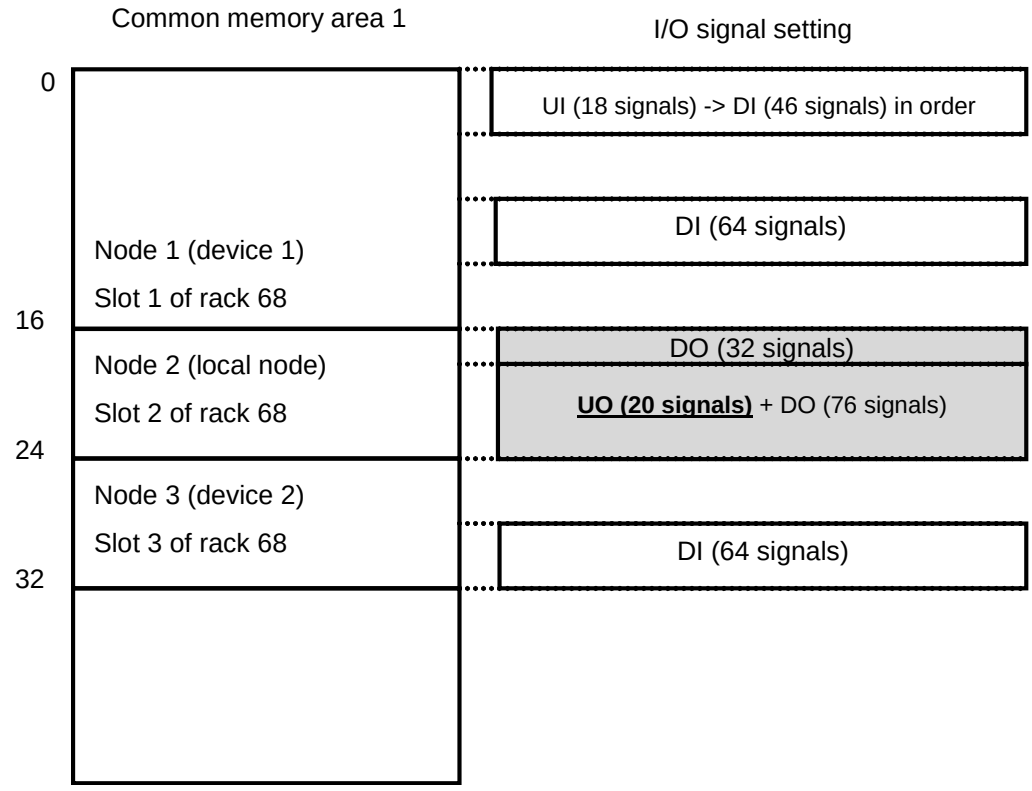
2.3.2 When the Offset or Size is Changed

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”.
Please check whether FLNET.SV is wrote because writing is missed when device is write protected even when prompt shows them as saved.

2.5 CLEARING ALLOCATION SETTINGS

Sometimes you should clear assignment before changing assignment or setting of size. Please try when you go wrong after changing setting or do wherever possible before changing.

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.

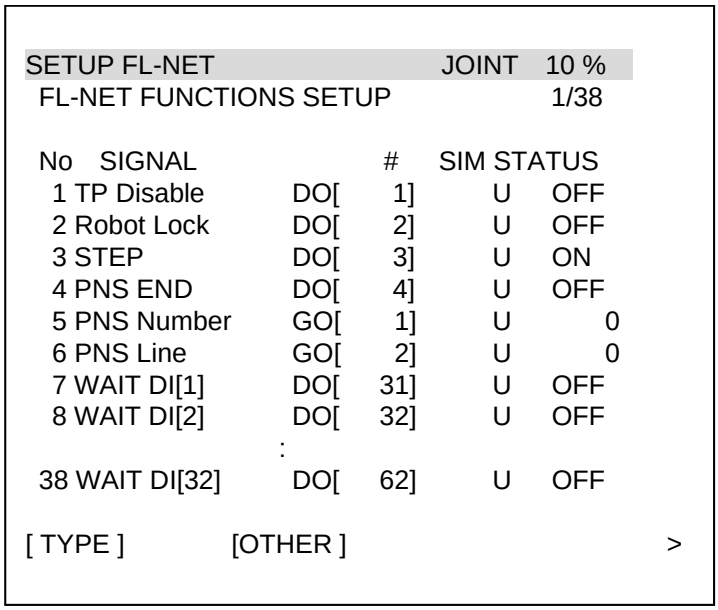
3 SPECIAL FUNCTION

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	Type	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	1-16	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	1-16	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.
2 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 set points, from 1st point to set point 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.

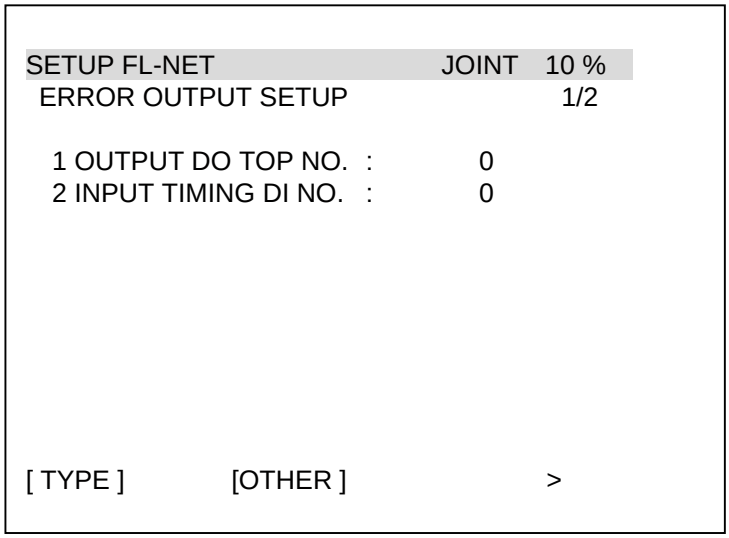


On the NO. 8 to 38 lines, the DI settings are listed in ascending order of number.

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.

Item	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.



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	not supported	not supported
Byte block write	not supported	not supported
Word block read	not supported	not supported
Word block write	not supported	not supported
Network parameter read	supported	not supported
Network parameter write	not supported	not supported
Stop command	not supported	not supported
Start command	not supported	not supported
Profile read	supported	not supported
Log data read	supported	not supported
Log data clear	supported	supported
Message loopback	supported	not supported
Transparent message	not supported	not supported

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 μs).
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

  1 OWN NODE NO.              :          96
  2 NODE NAME     [ROBOT                 ]
  3 VENDER NAME   [FANUC LTD             ]
  4 TYPE NAME     [FL-NET8059            ]
  5 FIRMWARE      [656Z 0001             ]
  6 PROTOCOL VERSION          :         80H
  7 AREA1 ALLOCATION OFFSET:            400
  8 AREA1 ALLOCATION SIZE     :         112
  9 AREA2 ALLOCATION OFFSET:              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                  :         OFF
 17    U_ERROR_CODE           :        000H
 18 FA LINK STATUS            :        113H
 19    ADDRESS CONFLICT       :         OFF
 20    COMMON MEM READY       :          ON
 21    COMMON MEM ENABLE      :          ON
 22    UPPER LAYER ERROR      :          ON
 23    NODE ENTRY FLAG        :          ON
 24 OWN NODE STATUS           :         00H
 25    SETUP OK               :         OFF
 26    NODE CONFLICT          :         OFF
 27    WAIT STATUS            :         OFF
 28    INITIALIZATION ERR     :         OFF
 29   TOKEN WATCH ERROR       :         OFF

[ 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.

Item	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.

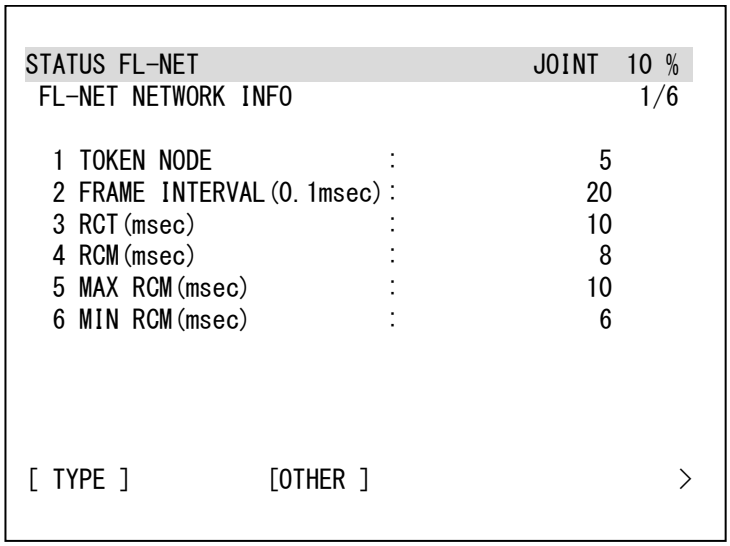
```
STATUS FL-NET                          JOINT    10 %
  FL-NET NODE LIST                          192/254
  NO STATUS AREA1 2        Comment
190 OFFLINE   DIS   DIS   [                          ]
191 OFFLINE   DIS DIS     [                          ]
192 ONLINE    ENB ENB     [ ROBOT_192                ]
193 OFFLINE   DIS DIS     [                          ]

[ TYPE ]    DETAIL    [OTHER ]                          >
```

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 μs)
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)



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  CLEAR    >
```

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

%d in “FL-net%d” at head of the alarm message shows the variety of FL-net.

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%d 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%d 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%d 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%d 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%d 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%d 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%d 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%d 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%d 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%d 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%d 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%d 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%d 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%d 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%d 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%d 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%d 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%d 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.

IV. CONNECTION

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.

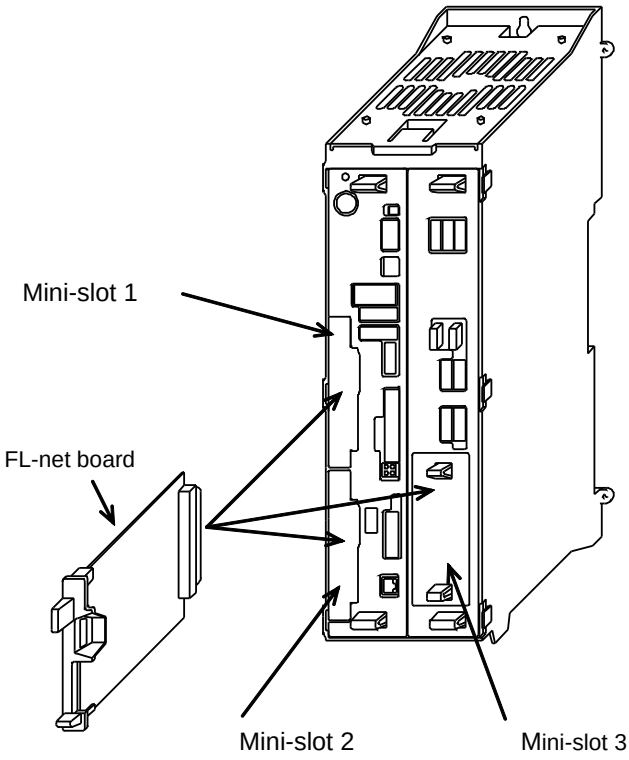
Name	FL-net board
Ordering code	A05B-2600-J105(R-30*i*B, R-30*i*B Mate, R-30*i*B Plus, R-30*i*B Mate Plus) A05B-2660-J105(R-30*i*B Mate Open Air) A05B-2500-J105(R-30*i*A) A05B-2550-J040(R-30*i*A Mate) A05B-2560-J040(R-30*i*A Mate Open Air)
Board drawing number	A20B-8101-0031

1.2 INSTALLATION

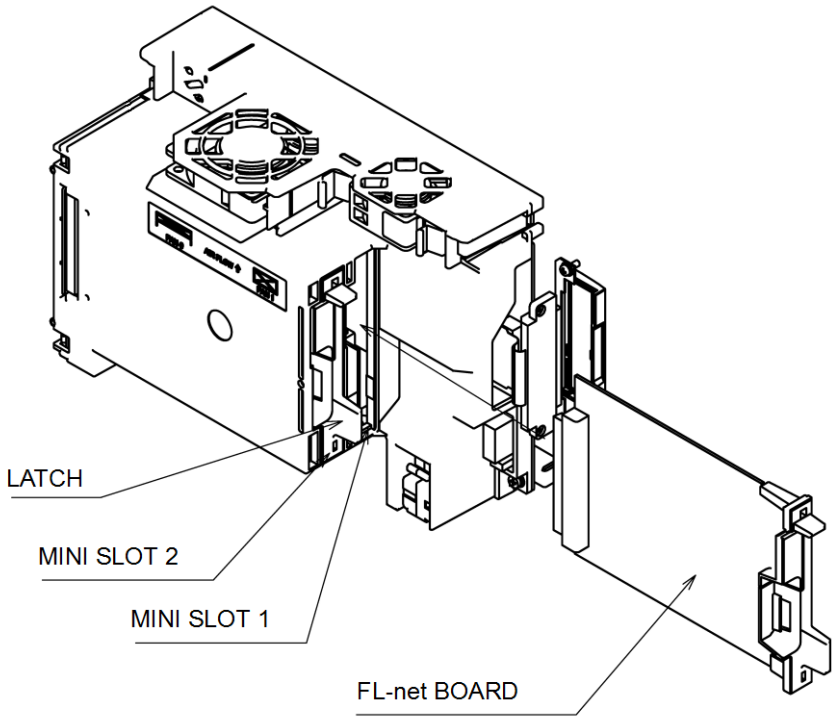
This section describes information about the installation of the FL-net board.

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

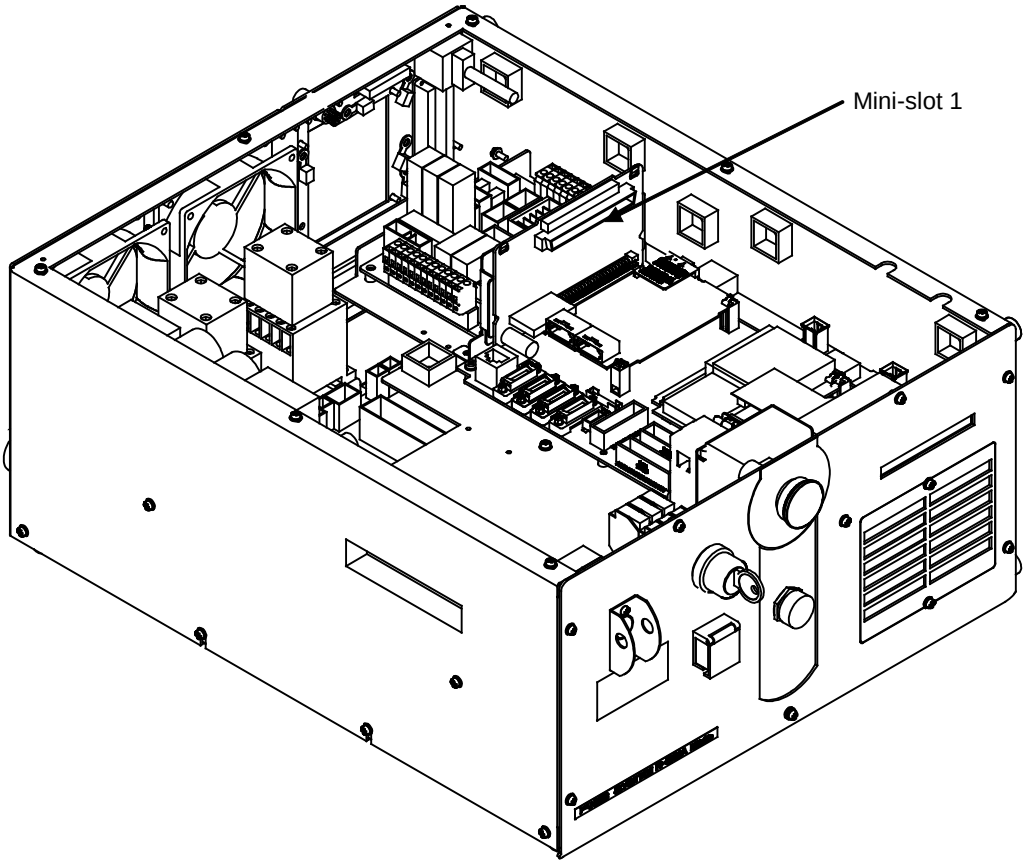
In the R-30*i*A or R-30*i*B/R-30*i*B Plus controller, a FL-net board can be installed to an option slot like the figure below.



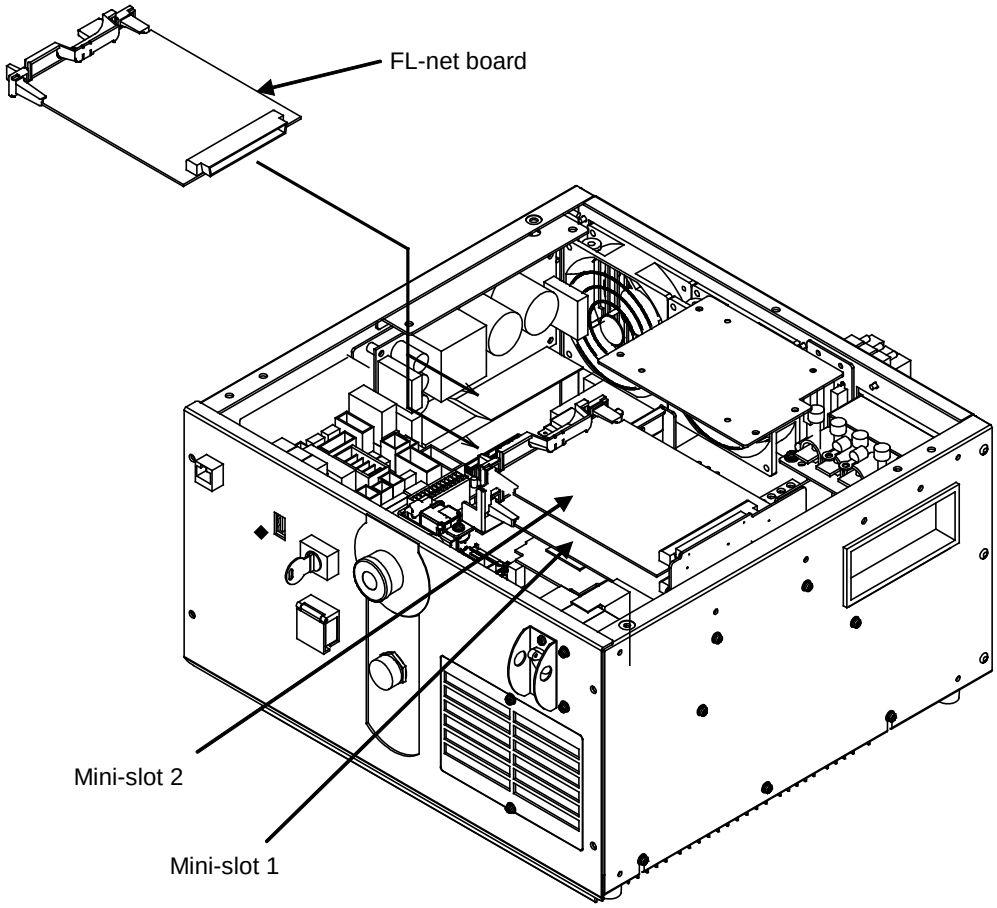
In the R-30*i*A Mate or R-30*i*B Mate/R-30*i*B Mate Plus controller, a FL-net board can be installed to an option slot like the figure below.



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



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



2 CONNECTION OF THE COMMUNICATION FUNCTION

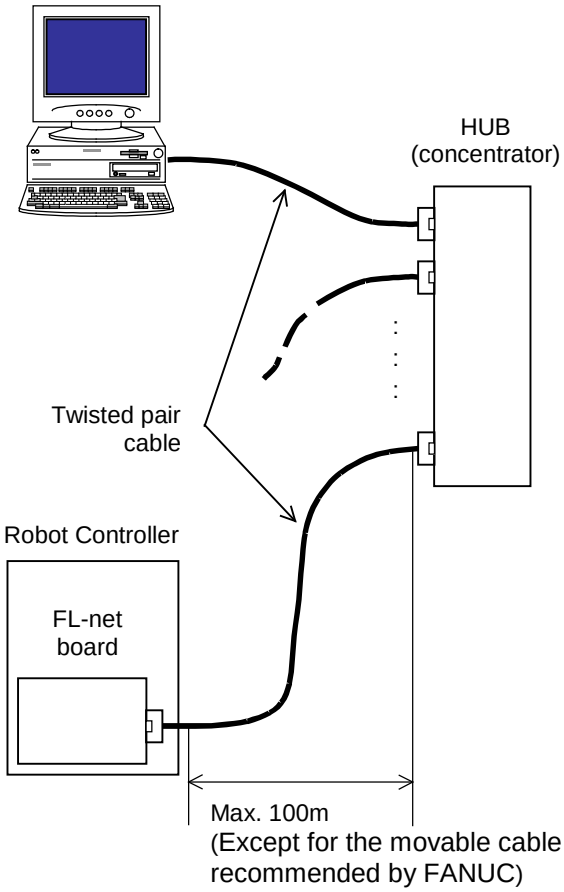
This chapter provides information required for Ethernet connection of the FL-net board.
See FANUC Robot series Ethernet Function OPERATOR'S MANUAL (B-82974EN) for internal port.

⚠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

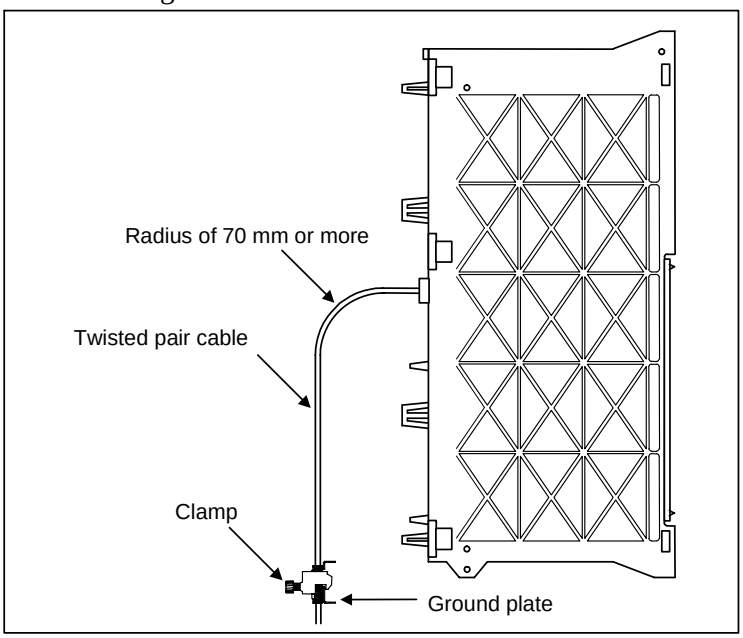
The FL-net board is provided with a 100BASE-TX interface.
Prepare a HUB for connecting the FL-net to the Ethernet trunk. The following shows an example of a general connection.



NOTE
1 The cable can be up to 100 m long (for the FANUC- recommended cable for movable sections, up to 50 m). Do not make the cable longer than necessary.
2 An Ethernet cable needs clamping to make system operation stable. For details of clamping, see Subsection 2.5.1, “Clamping and Shielding of Cables”. The clamp for grounding the shield of the cable can also fix the cable.
3 Some of the units (hub, transceiver, etc.) required to build a network are not dust-proof. They should be enclosed in a dust-proof cabinet. Using them in an atmosphere with dust or oil mist may lead to a communication error or failure.

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 RJ-45 CONNECTOR PIN ASSIGNMENTS

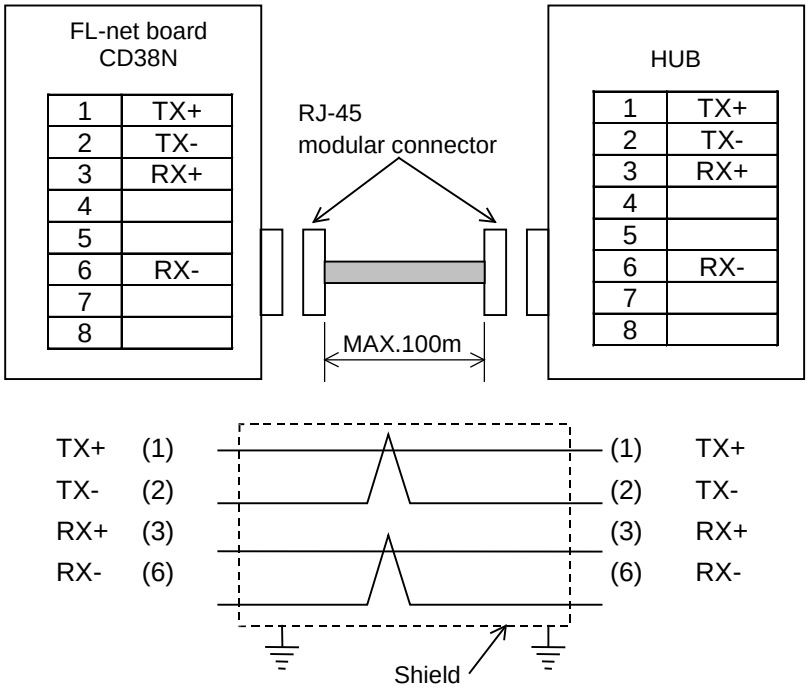
CD38N

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 100BASE-TX 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.
- The figure above shows the cable connection when cables are crossed in the HUB.

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 100BASE-TX, 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
Nissei Electric Co., Ltd.	F-4PWWWMF	Solid wire

Contact point

Manufacturer name	Contact point
Machida Sales Department, Nissei Electric Co., Ltd.	TEL: +81-427-29-2531 FAX: +81-427-29-3375
Remarks	A processed cable with the both terminal connector is provided.

NOTE
The aforementioned recommended cables cannot be used with movable parts.

Recommended cable (For movable parts)

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

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℃/30 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: +81-266-27-1597

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:

Specification	Manufacturer	Remarks
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

FL-net device supports the two transmission speed (10Mbps, 100Mbps). Please use the Recommended HUB as shown below.

Recommended HUB 10BASE-T/100BASE-TX

Manufacturer	Specification	Remarks
Phoenix Contact	FL SWITCH SFN 5TX	10BASE-T/100BASE-TX, 5 ports
Phoenix Contact	FL SWITCH SFN 8TX	10BASE-T/100BASE-TX, 8 ports

NOTE
1 Before using the HUB, refer to the operation manual supplied by the manufacturer.
2 The use of a switching hub causes a delay time in data transmission for reasons of device characteristics. For this reason, use as small number of switching hubs as possible when required and fully consider the data delay time when designing the system.

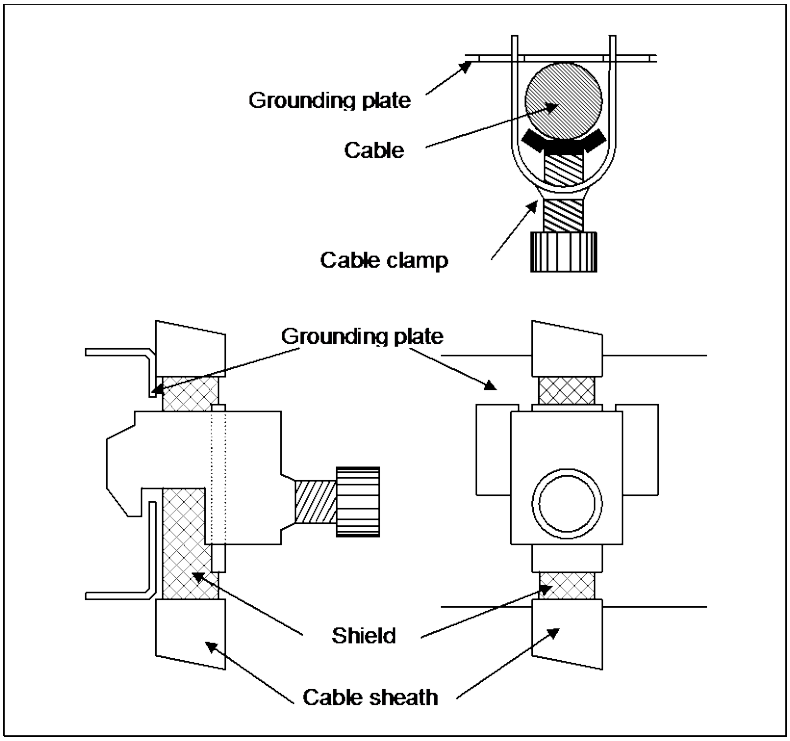
Contact points

Manufacturer name	Contact point
Phoenix Contact Yokohama branch	Yusen Shin-Yokohama 1-chome Building 1-7-9, Shin-Yokohama, Kohoku Ward, Yokohama-shi, Kanagawa Prefecture 222-0033, Japan TEL: +81-45-471-0030 FAX: +81-45-471-0031
Remarks	http://www.phoenixcontact.co.jp

2.5 ANTI-NOISE MEASURES

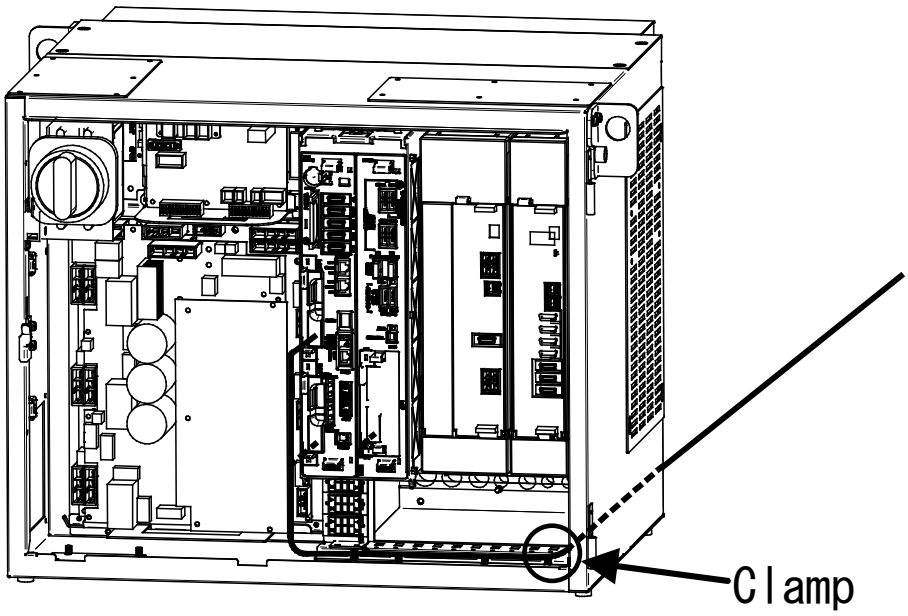
2.5.1 Clamping and Shielding of Cables

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.

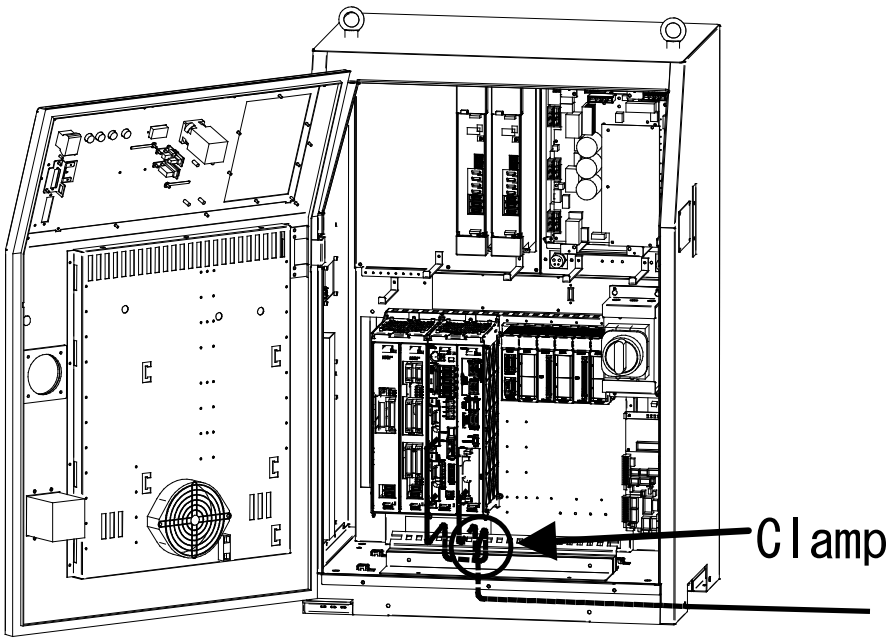


NOTE
1 Be sure to clamp and shield the cable to ensure the stable operation of the system.
2 Unlike general Ethernet communication, FL-net communication does not perform retransmission at intervals of several seconds to achieve high responsibility. Accordingly, severer anti-noise measures must be taken 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/ R-30*i*B Plus

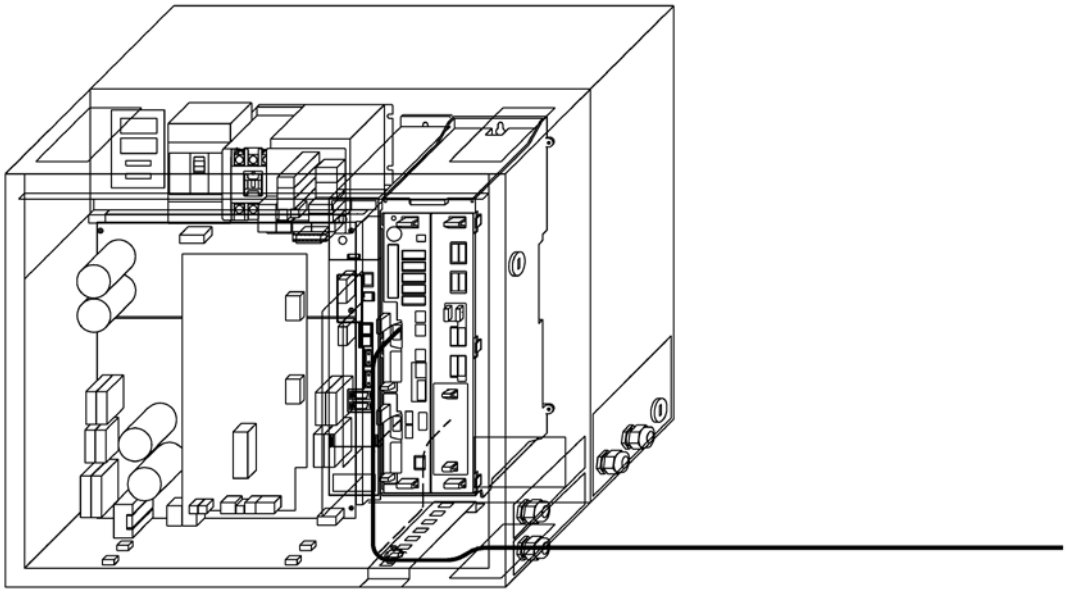


A-cabinet

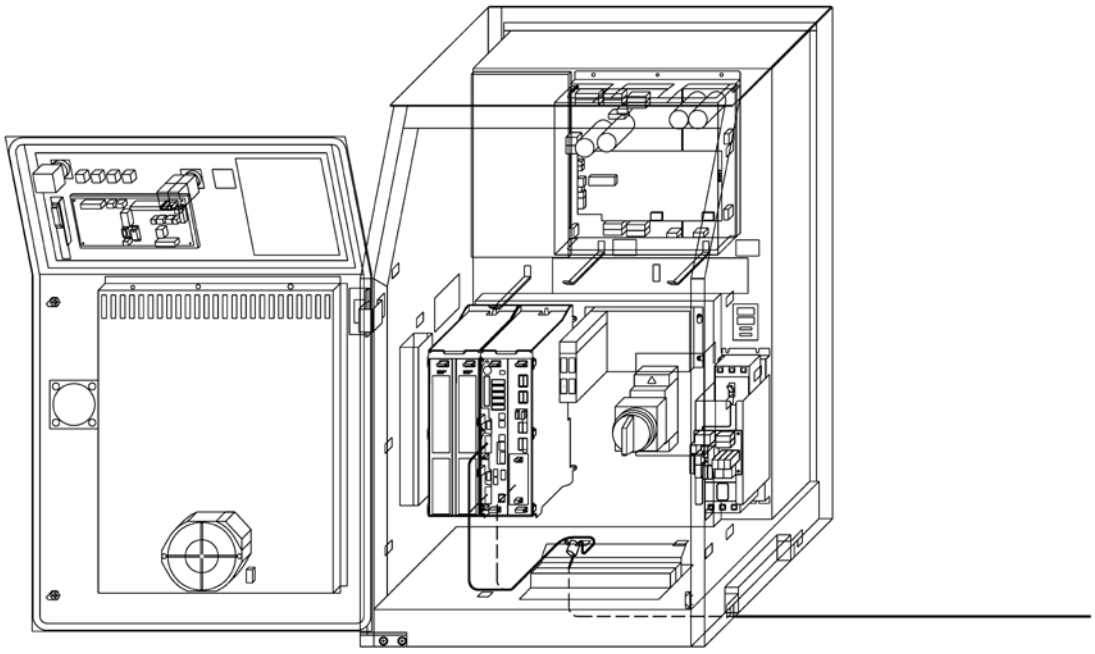


B-cabinet

R-30*i*A

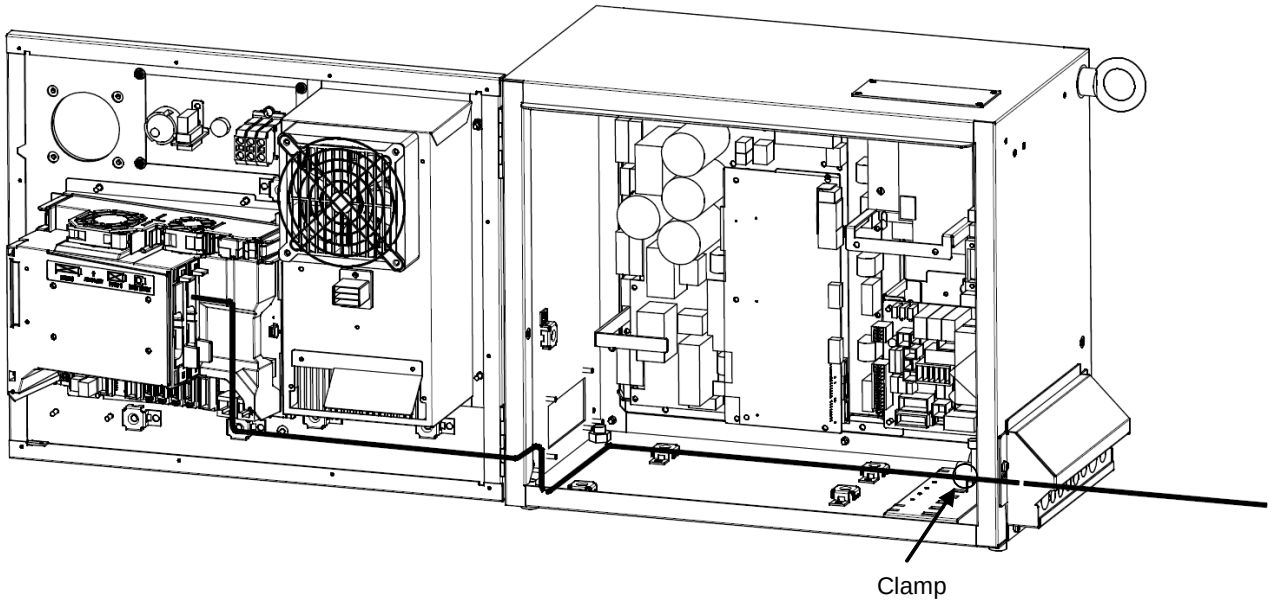


A-cabinet

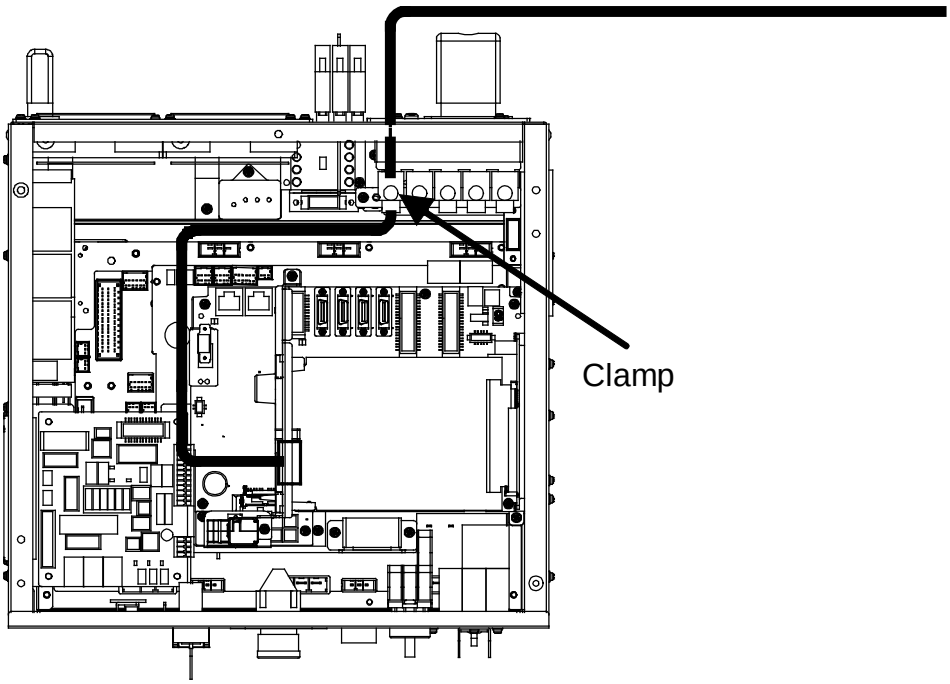


B-cabinet

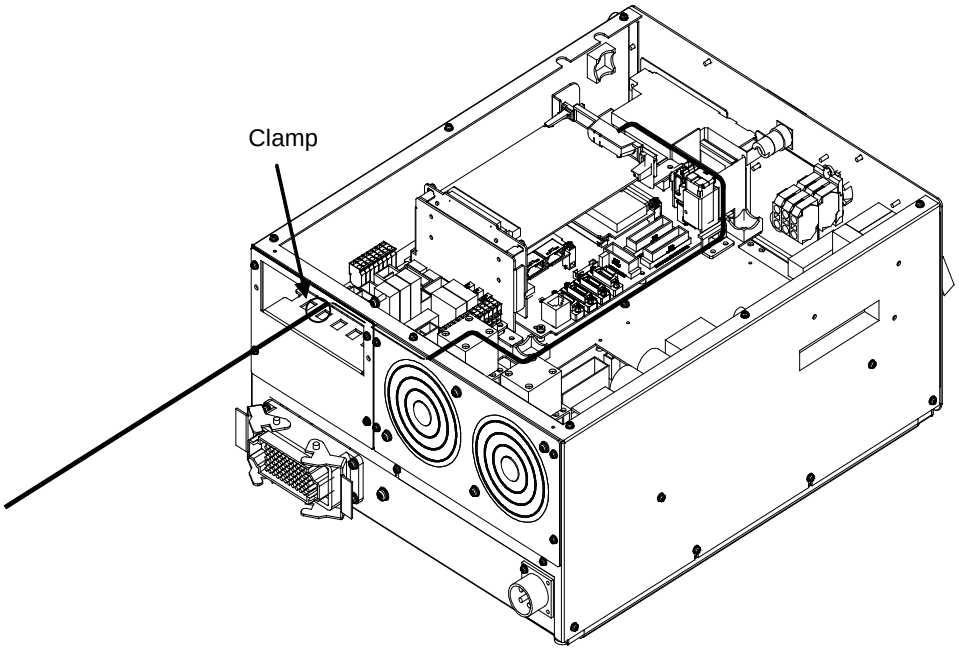
R-30*i*A Mate/R-30*i*B Mate/R-30*i*B Mate Plus



R-30*i*B Mate Open Air

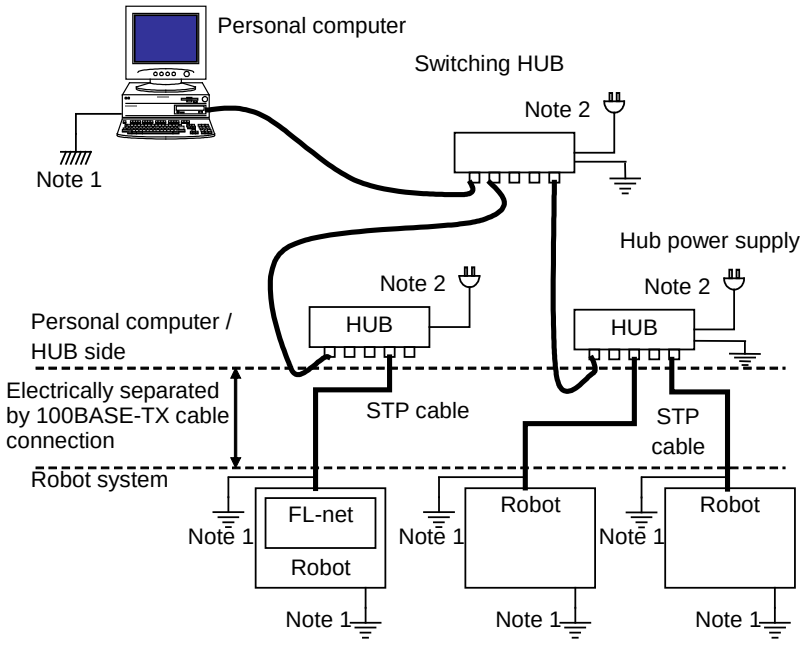


R-30*i*A Mate Open Air

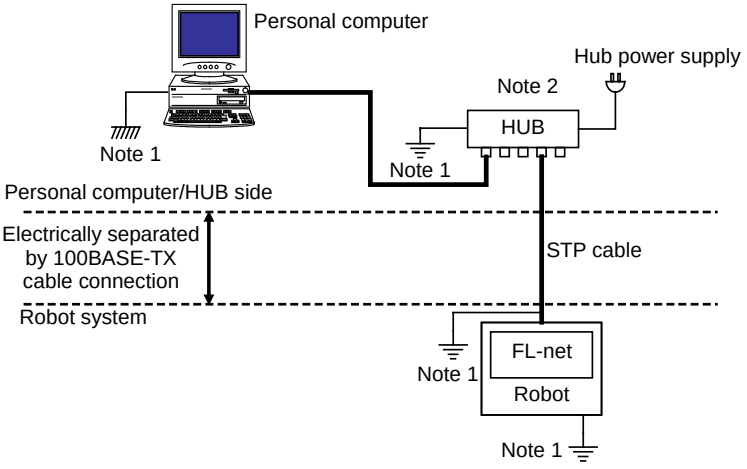


2.5.2 Network Installation

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) / HUB / personal computer should be separated and insulated. Examples of connections are given below.



Large network



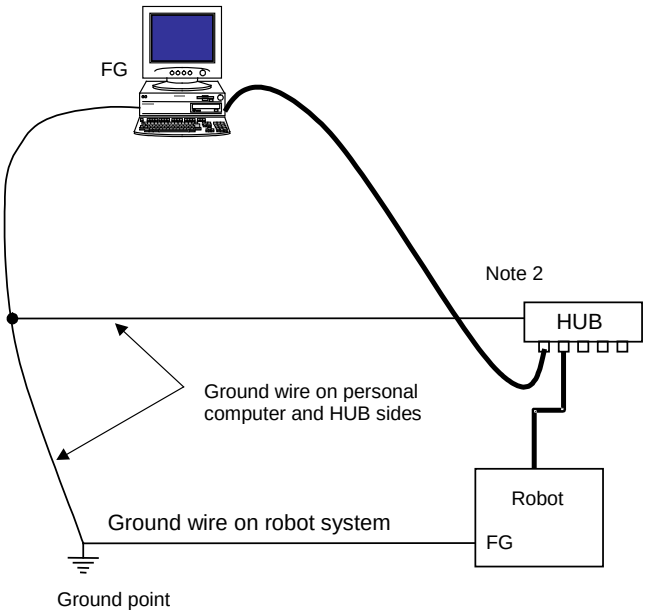
Small network

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-D grounding). The ground wire must not be thinner than the AC power line, and must be at least 5.5 mm^2 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 100BASE-TX 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 100BASE-FX (optical fiber media) to completely separate the robot side from the personal computer side.



When only one grounding point is available

2.6 CHECK ITEMS AT INSTALLATION

The following table lists check items at installation.

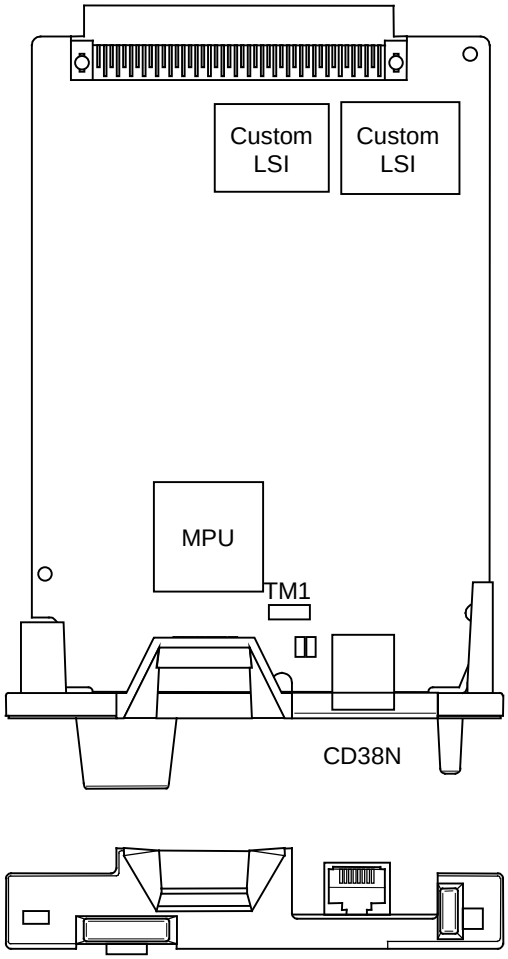
Check item		Description	Check
Ethernet cable			
	Type	Use cables which satisfies all the following conditions:	
		1) With shielding	
		2) Twisted-pair cable	
		3) Category 5 or more	
	Length	The cable length shall be within 100 m (50 m for a movable cable recommended by FANUC).	
	Connection	For a twisted-pair cable, the following pins shall be paired:	
		1) Pin No. 1 (TX+) – pin No. 2 (TX-)	
		2) Pin No. 3 (RX+) – pin No. 6 (RX-)	
	Separation	The Ethernet cables shall be bound separately from the following cables or covered with an electromagnetic shield:	
		1) Group A: AC power lines, power lines for motors, and others	
		2) Group B: Current DC (24 VDC) and others	
	Shielding	For a shielded cable, the part of which outer coating is peeled off and exposed shall be fixed to the ground plate with a clamp fixture.	
	Connectors	Any cable connector shall not be pulled (to prevent poor contact of the connector).	
	Wiring	No cable shall be laid under a heavy object.	
	Bending radius	Please confirm the specification of the cable.	
	For movable part	For a movable part, a cable for a movable part shall be used.	
Robot and cabinet			
	Robot grounding	The robot ground shall be connected properly.	
	Mounting	When the optional board is used, it shall be inserted in a robot slot properly.	
HUB			
	Use conditions	The "cautions on use" of the hub shall be observed (A terminating resistor shall be mounted properly if required).	
	Grounding	The hub shall be grounded.	
	Cabinet	The hub shall be installed in an enclosed cabinet.	
	Vibration	The hub shall be installed so that it is not affected by vibration.	

V. MAINTENANCE

1 HARDWARE

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

1.1 LAYOUT OF COMPONENTS

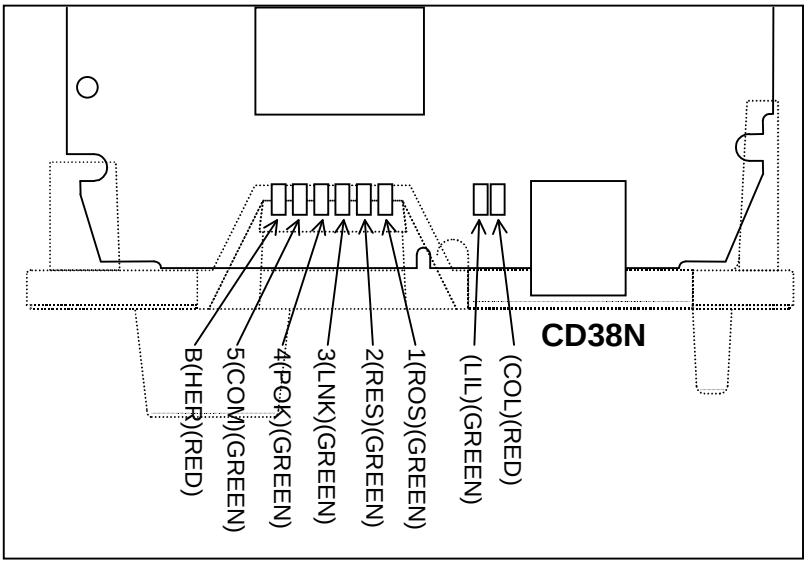


Name	PCB drawing number
FL-net board	A20B-8101-0031

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 indication 4 POK	3 LNK	2 RES	1 ROS	FL-net board state
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	◇	◇	◇	☆	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.

No.	LED indication		Board state
	LONG 4 3 2 1	SHORT 4 3 2 1	
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.

APPENDIX

A 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 / Severity	25	26	27	28	29	30	31	32
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

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

Other alarm IDs

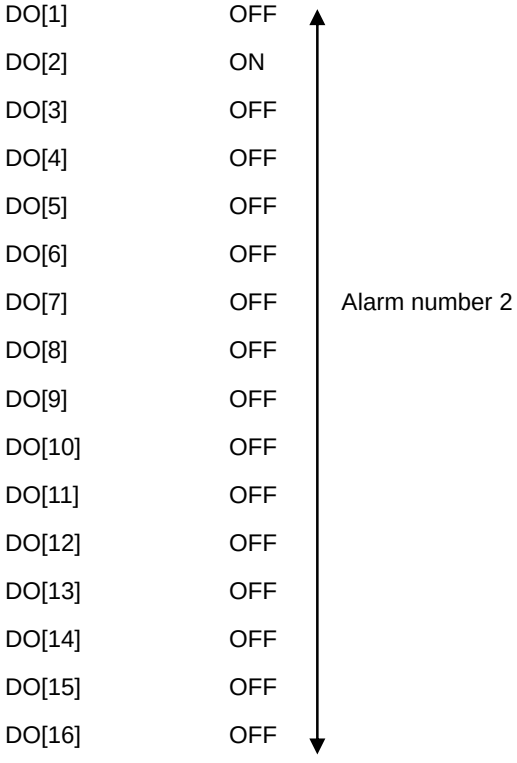
Numeric value	Alarm ID	Numeric value	Alarm ID
1	SRIO	36	TKSP
2	FILE	37	KT
4	COND	38	APSH
5	ELOG	42	CMND
6	MCTL	43	RPSM
8	OPIF	44	LNTK
10	FLPY	45	WEAV
13	PRIO	46	TCPP
14	TPAX	47	TAST
16	VARS	48	MUPS
17	ROUT	49	MIGE
18	WNDW	50	LSR
21	LANG	51	SEAL
25	SCIO	52	PANE
27	UAPL	54	TRAK
33	DICT	55	CMCC
34	KCLI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

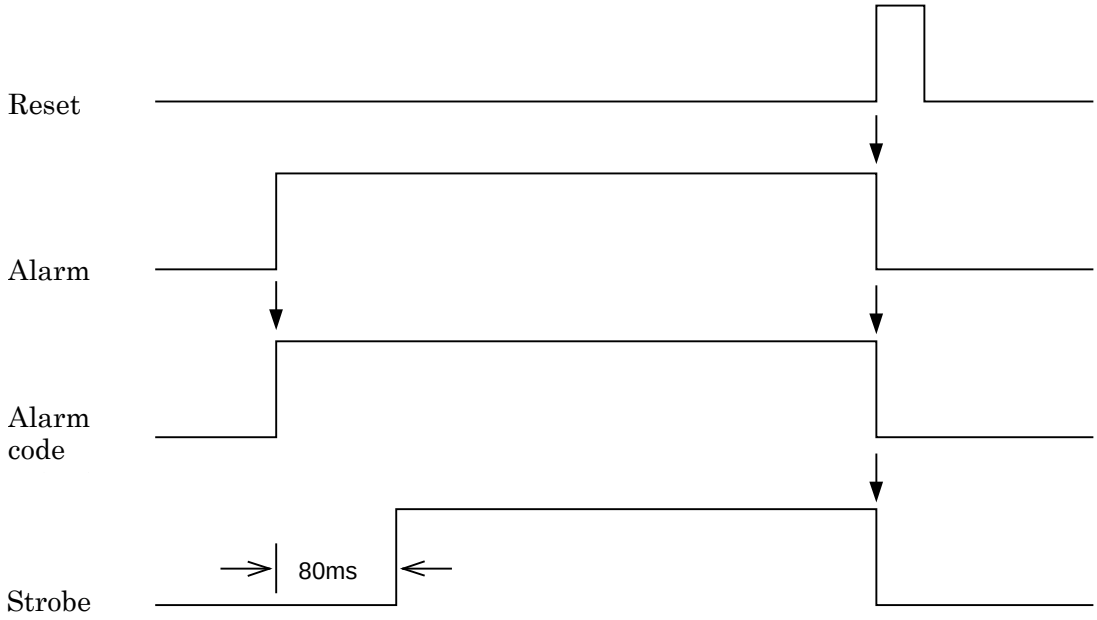
(Example) For "servo - 002 (severity: SERVO)," the alarm number is 2 and the alarm ID of "servo..." is 11.
The DOs are as follows:



DO[17]	ON	
DO[18]	ON	
DO[19]	OFF	
DO[20]	ON	Alarm ID 11
DO[21]	OFF	
DO[22]	OFF	
DO[23]	OFF	
DO[24]	OFF	
DO[25]	OFF	
DO[26]	ON	
DO[27]	ON	
DO[28]	OFF	Alarm severity SERVO
DO[29]	ON	
DO[30]	ON	
DO[31]	OFF	
DO[32]	OFF	

A.3 SIGNAL TIMING CHARTS

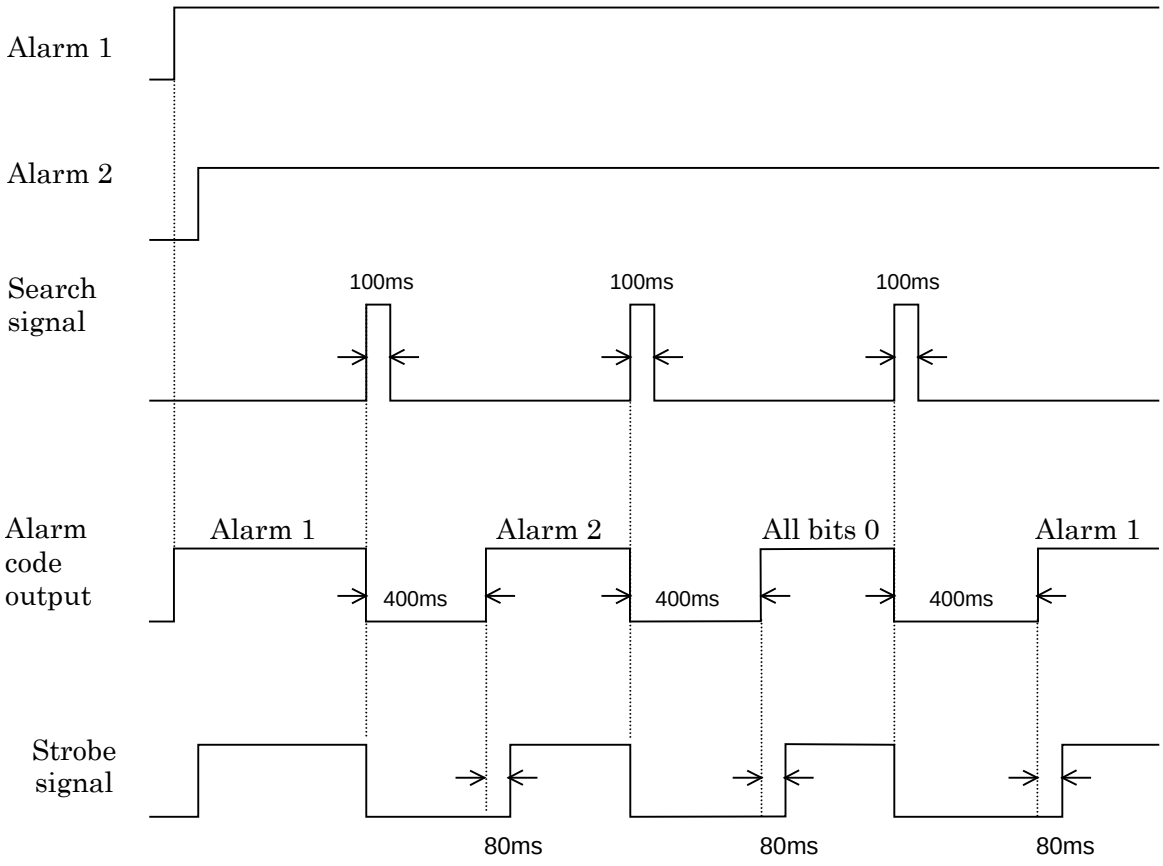
A.3.1 If a Single Alarm is Generated



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.



INDEX

REVISION RECORD

Edition	Date	Contents
04	Sep., 2017	• Supported R-30*i*B Plus, R-30*i*B Mate Plus • Misentry is fixed • Supported function expansion • Attention for frame interval etc.
03	Feb., 2014	• 2 variety and 2048 point per 1 variety are supported. • R-30*i*B Mate is supported.
02	Oct., 2012	• Supported R-30*i*A Mate and R-30*i*B controller. (Internal port and multicast)
01	Mar., 2007	

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