WARNING

THE INSTALLATION SHALL BE MADE BY QUALIFIED INSTALLATION PERSONNEL AND SHOULD CONFORM TO ALL NATIONAL AND LOCAL CODES

Hyundai Robot

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Hi4a Controller Operation Manual

HYUNDAI
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1

Safety

1.1. Introduction

The main purpose of this chapter is to describe the safety precautions for users and operators who repair and manipulate the industrial robot.

This manual describes safety precautions for robot manipulator and controller, in comply with the requirement of ANSI/RIA R15.06-1999, Standard for Safety, Industrial Robots, and qualified with safety regulations. The technical description and installation method of robot system is presented in detail at the specifications regarding installation of robot manipulator and controller.

Every operator, who installs, replaces, adjusts, manipulates, maintains, and repairs, must read thoroughly and fully understand the manipulation and maintenance manual, in particular, the special attention must be paid to the WARNING symbol, the most important marking related to the safety.

Installation, replacement, adjustment, manipulation, maintenance, and repair of robot system must be performed by the personnel who was duly trained for these purposes, following the indicated operating procedure.

This company is planning and carrying out the relevant training such as maintenance, repair, and manipulation for the above operations, so robot users make sure that robot operators should get the relevant training. And make sure that the robot handling work should be carried out only by the operators who completed this training course.

The Users of HR, HX and HA industrial robots have a responsibility under the safety relevant regulations enable in the country where the robot is installed, and a responsibility to properly design, install, and operate the safety devices to protect workers.

The dangerous zone of robot system, that is the working range in which the robot, tool, and peripheral equipment are operated, must be safeguarded to prevent workers or objects from entering the zone. If a person or object should nevertheless enters the dangerous zone, make sure that the robot system is immediately shut down by emergency stop system. The operators of robot system have a responsibility to take all necessary steps to make correct installation, examination and operation of the relevant safety devices.

This manual is provided for the utilization of HR, HX, HS and HA Series Manipulator models and Hi4a controller.
Enable application and disable environment of HR, HX, HS and HA Series robots are as follows.

Application

It is applied to the 6-axis industrial robot used by installing on the surface of wall or plane (axes addable). It is also appropriate for controlling operation in the dotted section or consecutive section.

Major application is

- Spot welding
- Arc welding
- Cutting
- Handling
- Assembly
- Application such as Sealing
- MIG/MAG welding
- Palletizing
- Grinding

For the other use than the above emergency application, make a contact with our company to consult on the robot use and possible applications.

Disable environment

Our robot must not be used in a highly explosive environment and the areas contaminated by oil, flammable materials or chemical materials. (Prohibited to be installed and manipulated.)

1.2. Relevant Safety Regulations

The robot is designed as per ISO 10218. Jan. 1992, safety standards for industrial robots, and furthermore in comply with ANSI/RIA 15.06-1999 regulations.

1.3. Safety Training

All the personnel who intend to teach, operate or inspect the robot must be trained in an approved robotic operation and safety training course before start-up. The safety training course includes the following details:

- Purpose and functions of safety devices
- Safety procedure to handle the robot
- Performance of robot or the robot system and possible hazards
- Tasks associated with any specific robot applications
- Safety concepts, etc.

1.4. Safety Related Nameplate

1.4.1. Safety Marking

For the purpose of effective safety instructions, the following safety symbols are used in this manual.

Table 1-1 Safety marking

Symbols		Descriptions
Warning		Indicate a potentially hazardous situation which, if not avoided, could result in death or serious injury to personnel and damage to equipment. The special attention must be paid to the operation and handling.
Mandatory		Indicate the compulsory measures that should be performed.
Prohibited		Indicate the prohibited actions and/or operations that should not be performed.

1.4.2. Safety Nameplate

Identification plates, warning label and safety symbols are attached to the robot and to the inside and outside of control panel. The designation labels and cable Mark for wire harness between the robot and control panel, and the cables inside/outside of control panel are provided.

All of these plates, labels, symbols and marks constitute safety-relevant parts of the robot and the control panel. They must remain attached to the robot manipulator and control panel at their clearly visible positions all the time for the safety and their full performance.

The painted markings on the floor and signs indicating dangerous zones must be clearly distinguished in form, color, and style from other markings on the machine near the robot system or inside the plant facilities where the robot system is installed.

It is forbidden to remove, cover, or paint over by way of spoiling the clearly visible identification plates, warning labels, safety symbols, designation labels and cable marks.

1.5. Definition of Safety Functions

Emergency Stop Function - IEC 204-1,10,7
There is one emergency stop button on the controller and teaching pendant respectively. If necessary, additional emergency buttons should be able to connected to the robot's safety chain circuit. The emergency stop function, which overrides all other robot controls, stops all moving parts by disconnecting power supply, and removes drive power to prevent the use of other dangerous functions controlled by the robot.

Safety Stop Function - ISO 10218(EN 775),6.4.3
When a safety stop circuit is provided, each robot must be delivered with the necessary connections for the safeguards and interlocks associated with this circuit. The robot should have a number of electrical input signals which can be used to connect external safety devices, such as safety gates, safety pads, and safety lamps. These signals allow the robot's safety functions to be activated by all equipment, including peripheral equipment and the robot itself.

Speed Limitation Function - ISO 10218(EN 775),3.2.17
In a manual mode, the speed of robot is strictly limited to 250 mm per second as maximum.
The speed limitation applies not only to the TCT(Tool Coordinate Time), but to all parts of manual mode robot. The speed of equipment mounted on the robot should be possibly monitored.

Restricting working Envelope - ANSI/RIA R15.06-1999
The working envelope of robot axes should be restricted using software limits.
Axis 1,2, and 3 can also be restricted by means of mechanical stopper.

Operation Mode Selection - ANSI/RIA R15.06-1999
The robot must be operated either manually or automatically. In a manual mode, the robot must be operated only by using the teach pendant..

1.6. Installation

1.6.1. Safety Fence

Install safety fence against the possible collision between the robot and workers, so that no worker may approach the robot .When operators or other personnel enter the robot's working envelope by accident, it may cause an accident. Install the safety fence to stop the robot when one, who intends to replace for TIP DRESSING or TIP replacement, or to inspect welding equipment, opens the fence gate and approaches the equipment during operation.

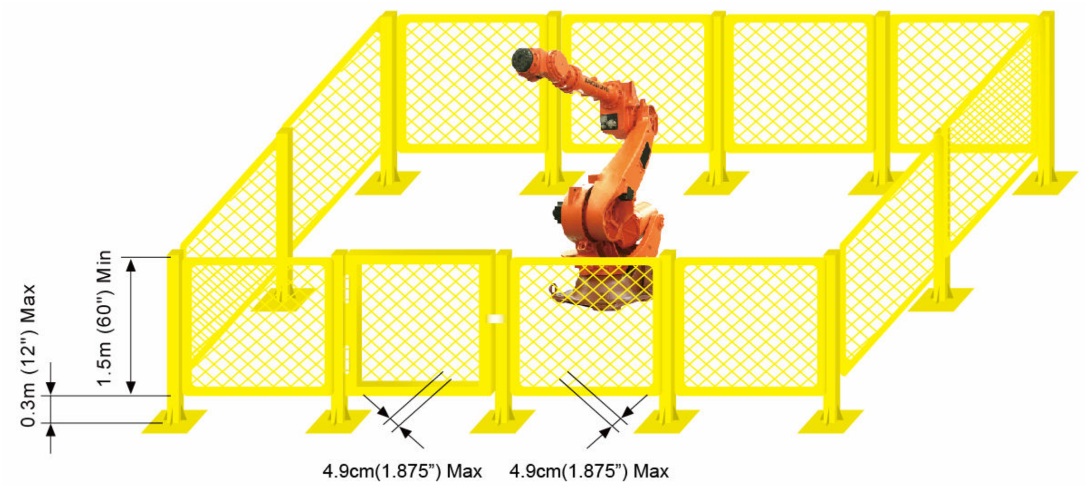


Fig 1.1 Recommended Size for Fence and Gate Hole (Square Gate)

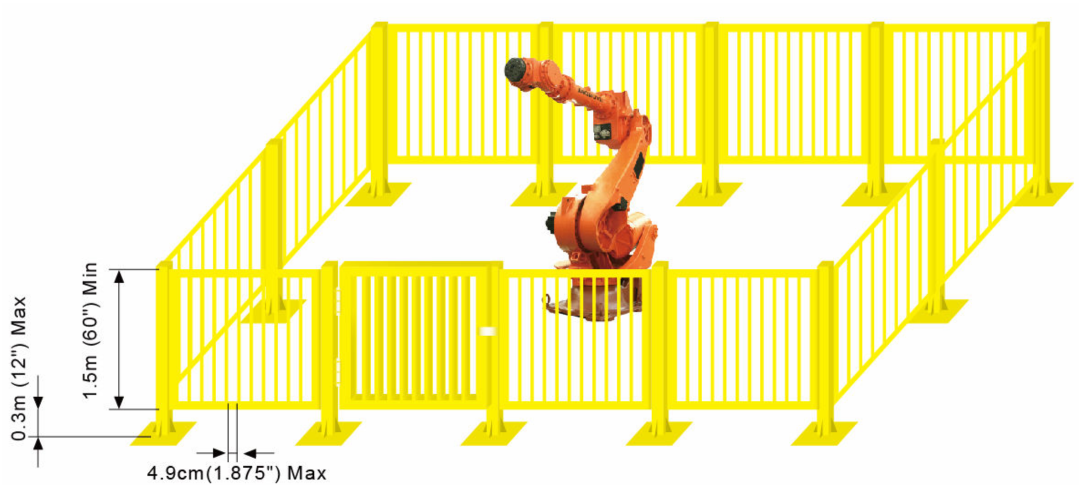


Fig 1.2 Recommended Size for Fence and Gate Hole (Slot Gate)

(1) Install the safety fence to cover the robot's working envelope and to secure enough space for teaching and maintenance working. The safety fence should also be firmly installed so that it is hardly accessible and removable.

(2) The safety fence should be a fixed type in principle, using harmless materials that do not have any broken surface or projecting part.

(3) Install the safety fence with an entrance gate, and register the safety plug at the gate so that it does not open unless pulling the plug out. Interlock the robot to be MOTOR OFF when the safety plug is pulled out., or wire the robot to be MOTOR OFF when the safety fence is open. (Refer to "11. Connecting the Other Signals", Hi4a Controller Manual)

(4) When intending to operate the robot with the safety plug pulled out, wire the robot as a low-speed play mode. (Refer to "11. Connecting the Other Signals", Hi4a Controller Manual)

(5) For immediate emergency stop, install emergency stop button within operator's easily accessible distance.

(6) If the safety fence is not installed, install other devices substituting for the safety plug in the whole place within the robot's working envelope, such as photoelectric switch and mat switch. These devices may stop the robot automatically when a person enters the working envelope.

(7) The robot's working envelope(dangerous zone) should be distinguished from other zones by painting its floor.

1.6.2. Placement of Robot & Peripheral Equipment

(1) Make sure that the power supply is off before operating, when connecting the primary power of controller or peripheral equipment. There is a possible danger of electric shock because the high voltage such as 220V and 440V is used as its primary power.

(2) Post a sign [No enter during operation] up the safety fence gate, and inform the operators of its purport.

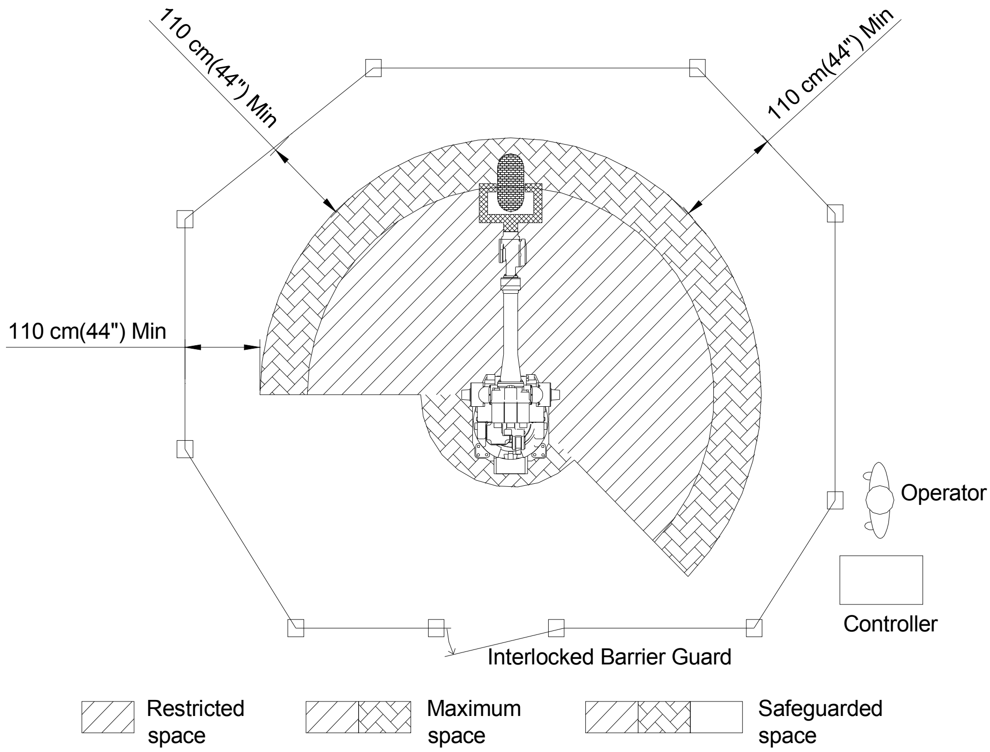


Fig 1.3 Placement of Peripheral Equipment and Operator

(3) Arrange such devices as controller, interlock panel, and other manipulation panels to be handled outside of the safety fence.

(4) When installing operation stand, install the emergency stop button on the stand. Make sure that the stand stops in an emergency wherever the robot is handled.

(5) Make sure that the robot manipulator and the wiring and piping of controller, interlock panel, and timer should not be placed in the way of operator's working range so that they would not be directly stepped on by FORK and LIFT. There is a possible danger of accident if the workers are affected by electricity or the wiring is down.

(6) Place the controller, interlock panel, and handling stand within the sight of robotic performance. It may cause a serious accident to operate the robot while the operator is working, or the robot is malfunctioning in an invisible sight.

(7) Restrict the robot's working envelope by using soft limits and mechanical stopper if the

necessary working envelope is narrower than the holding workable envelope. It is possible to stop the robot in advance when it moves beyond its normal working envelope due to an abnormal condition. (Refer to the 『Robot Manipulator Maintenance Manual』.)

(8) Welding spatters directly on the operator or around him may cause burning or fire. Install such devices as a glare shield or a cover in the full sight of robot's working envelope.

(9) Make sure that the device indicating the robot's running condition whether automatic or manual mode must be noticeable even in the far distance. In the case of automatic start-up, warning with a buzzer or warning lamp is also enable.

(10) Make sure that there is no projecting part in the robot's peripheral equipment. Cover it, if necessary. It usually may cause an accident if the operator comes in touch with it. And it may lead a serious accident if the operator is astonished at the sudden movement of robot, and conducts it.

(11) Don't make the system designed to allow the workers to carry the Work in and out using their hands through the safety fence. It could be a cause of accident associated with compressing or amputating.

1.6.3. Installing the Robot

Install the robot as per the planning and layout which has been previously reviewed and studied for its optimized performance and functionality. In case of poor conditions for robot installation, the serious problems can take place, including error of relative position between robot and workpiece during operation, bad performance quality of robot caused by vibration, shortening lifetime, and cause of serious accidents. Thus, pay attention to the following precautions when installing the robot.

General Safety Precautions

(1) Design and install the robot system properly in compliance with laws, regulations, and safety requirements enable in the country where the robot system is installed.

(2) All the workers for the robot system must have the complete knowledge on the information specified in the application and supplementary manual, and proficiently operate and handle the industrial robot.

(3) Installation workers of robot must follow the safety instructions and apply them to the installation when they face any safety problems.

(4) System provider must ensure that all the circuits utilizing safety functions perfectly perform in a safe way.

(5) Install main power supply to be disconnected from outside of the robot’s working envelope.

(6) System provider must ensure that all the circuits utilizing emergency stop function perfectly perform in a safe way.

(7) For the immediate emergency stop, install emergency stop button within the accessible distance for the operator.

Technical Safety Precautions

(1) Eliminate any interference with peripheral equipment considering the dimension and working envelope.

(2) Avoid such places for installing which is directly exposed to the sun, extremely humid, contaminated by oil or chemicals, and containing a large amount of metal powder and explosive gas.

(3) Install at the ambient temperature ranged 0~45℃.

(4) Secure sufficient space for the easier disassembly and maintenance.

(5) Install safety fence with a gate, and prohibit any person from entering the robot's working envelope.

(6) Remove any obstacles out of the robot’s working envelope.

(7) Take a special measure, considering thermodynamics of controller, if the robot is installed near the heating elements or places exposed directly to the sun.

(8) Take a special measure if the robot is installed in a place of abundant dust such as metal powder in the air.

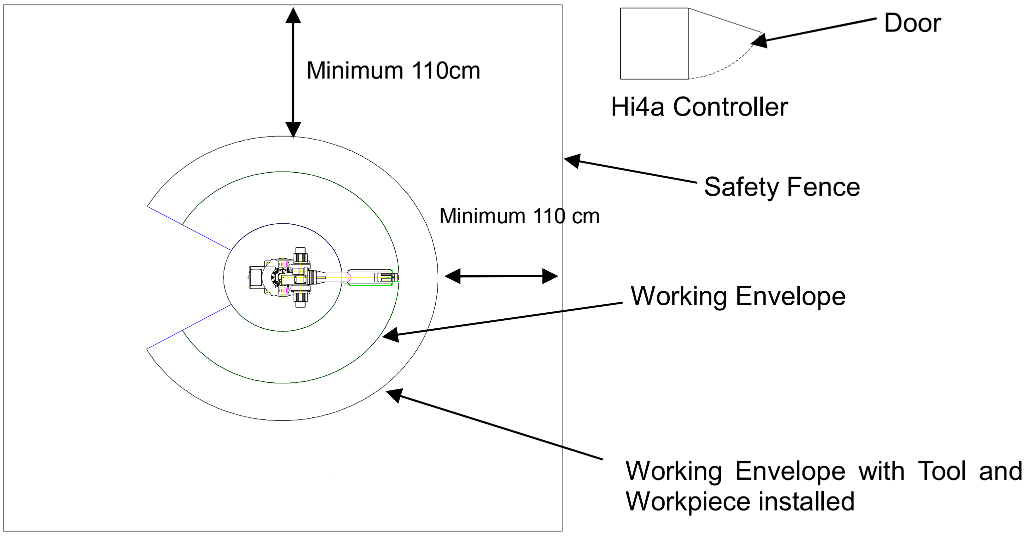
(9) Install the robot not to transmit welding electric current. (In other word, insulate SPOT GUN with/from the robot’s wrist.)

(10) Grounding is very critical in preventing electric shock and malfunction caused by noise, and thus install as following instructions.

① Install an exclusive grounding terminal using class 3 or higher. (For the input voltage of 400V of higher, use special class 3 or higher.)
② Connect grounding line into the grounding bus-bar inside of the control panel.
③ In case of direct grounding on the floor by anchoring, two-point grounding both by robot manipulator and by controller can produce a “ground loop” and contrariwise cause abnormal operation. In this case, connect the grounding line to the base of robot manipulator and disconnect the second grounding point to the controller. If the robot vibrates even after stopping, double-check the grounding status because the possible main causes could be an incomplete grounding or “ground loop” .
④ In the use of internal transgun(GUN), there is a possible danger of dropping because the primary power cable is directly connected to the spot gun. In this case, directly connect the grounding line to the base of robot manipulator in order to prevent any electric shock and protect the control panel, but do not connect it to the controller.

1.6.4. Space for Robot Installation

Install robot after securing sufficient space for maintaining the robot manipulator, Hi4a controller, and other peripheral equipment. Install the robot manipulator and controller, securing space for installation as per the guideline as described in the figure below. Install Hi4a controller outside of the safety fence in order to monitor the robot manipulator and to operate in a safe way.



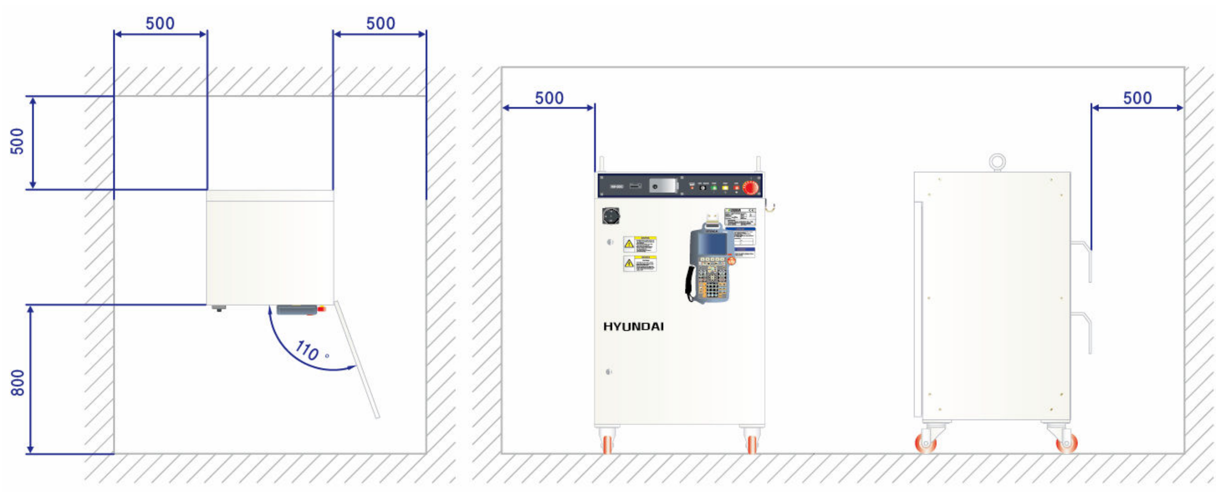


Fig 1.4 Space for robot installation

When installing, be sure to make it easier to perform the maintenance when opening the Hi4a Controller door. Secure the available space. The controller power in the above Figure could change depending on the kind of controller.

1.7. Safety Operation for Robot Handling

Follow the safety instructions to prevent any accidents. Don't modify nor ignore safety devices or circuits at any time, and be careful of electric shock.
All the normal operations in an automatic mode must be performed outside of the safety fence. Check the robot's working envelope if anyone is inside before operating.

1.7.1. Safety Precautions for Robot Handling

(1) Do not handle the robot other than such personnel as operators handling the robot and other possible operators and supervisors who were designated as whom duly trained in an approved robotic training course and become familiar enough with the proper operation of the safety and robotic functions.

(2) Be sure to wear helmets, goggles, and safety shoes.

(3) Perform the work in pairs. One person must be ready to press the emergency stop button in an emergency while the other must perform his work quickly but carefully within the robot's working envelope. Always check the escape route before working.

(4) Make sure that there is no one in the working envelope when the power source is on.

(5) Operations such as teaching must be performed outside of the robot's working envelope. However, if the operation is performed within the working envelope after stopping the robot, enter the envelope with safety plug or key switch for converting to automatic mode. Make sure that other operators do not change it into automatic mode by accident. Also, pay close attention to the specific direction of robotic movement in case of abnormal operation and malfunction.

(6) Supervisors should follow the instructions below.

① Be located at a place where you could take an entire view of robot, and commit yourself to monitoring.
② Press the emergency stop button immediately when abnormality is found.
③ Anyone is forbidden to be near the operating area other than those who are engaged in the operation.

(7) In a manual mode, the speed of teaching is limited to 250mm/sec

(8) In teaching, post a sign [Under Teaching].

(9) Operators must pull the safety plug out, and enter the safety fence with the plug.

(10) Do not use any devices causing noise in and around the teaching area.

(11) Handle the teaching pendant button, while checking the teaching point with your naked eyes, and do not handle it just relying on your sense.

(12) Do not work with your back against the robot, and always pay attention to the robot's movement.

(13) In teaching, check and examine carefully under your feet. In particular, in high teaching for more than 2M, secure a safe zone on which you may step before teaching.

(14) Instructions for any abnormal operations.

① Press immediately the emergency stop button when any abnormal operations are found.
② Be sure to check if the relevant equipment is stopped when checking the abnormality in an emergency stop.
③ In case that the robot stops automatically due to power failure, investigate possible causes and take actions after confirming that the robot completely stops.
④ In case of malfunction of emergency stop devices, immediately disconnect the main power and investigate possible causes to take necessary actions.
⑤ Investigation of the failure must be conducted only by a designated person. For the re-operation after emergency stop, operators must clarify the cause of failure and take necessary actions, and then operate the robot again following the proper procedure.

(15) Write out the operating rules proper to working details and installing location regarding the operation and handling method for the robot, and the necessary actions for robot's any failure. In addition, it is recommended to operate the robot in accordance with the operating rules.

(16) Instructions when the robot stops
Make sure not to approach the robot even when it seems to be stopped. Most accidents occur from a sudden movement of robot which seemed to be stopped when one approaches it. The conditions that the robot stops is as follows.

Table 1-2 State of Robot Stop

No.	State of Robot	Drive Power	Access
1	Pause (Minor failure, Pause switch)	ON	X
2	Emergency stop (Major failure, Emergency stop switch, Safety gate)	OFF	O
3	Input signal standby of peripheral equipment (START INTERLOCK)	ON	X
4	Playback Completion	ON	X
5	Standby	ON	X

Even in the accessible state of robot, be watchful against any possible sudden movement of robot. Make sure to avoid approaching the robot without precautions for emergency under all circumstances.

■ **Though the access during a pause is shown in the table as 『×』, allow the access to robot with the same precautions as teaching work if the entrance is open to take actions for minor failures(i.e. malfunction caused by failure in arc, nozzle contact and weldment detection).**

(17) Clean up any split oil, tools, and impurities in the safety fence after completing robotic operation. Accidents such as conduction may occur in the working envelope contaminated by oil, or scattered tools on its floor. Make a habit of organizing and cleaning things up.

1.7.2. Safety Precautions for Operating Test

In case of operating test, errors in design or teaching and inferiority in manufacturing are possibly seen in the entire system such as teaching program, jig, and sequence. Thus, be more careful and safe in case of operating test. Accidents may occur by these combined causes.

(1) Before handling, check the stop buttons and signal functions to stop the robot such as emergency stop button or stop button. And then, check the abnormality - detective movements. Above all, it is the most critical to check all the stop signals. It would be the most important to stop the robot when any possible accidents are predicted.

(2) In case of operating test, start the robot at low speed(approximately 20%~30%) in the variable speed function, and repeat it more than one cycle to check the movements. If any errors are found, immediately correct them. After then, increase in speed (50% → 75% → 100%) gradually, and repeat more than one cycle respectively to check the movements. Operating at high speed from the very beginning may cause a serious accident.

(3) In case of operating test, it is hard to predict what problems would happen. Do not enter the safety fence during operating test. Unexpected accidents are likely to occur because of its low reliability.

1.7.3. Safety Precautions for Automatic Operation

(1) While posting a sign [Do Not Enter During Operation] up the safety fence gate, ask the operators not to enter during operation. If the robot stops, you may enter the safety fence under your full understanding of the situation.

(2) Be sure to check if any operators are inside of the safety fence when starting the automatic operation. Operating without checking the presence of operators may cause a personal injury.

(3) Before starting the automatic operation, check and confirm that the program number, step number, mode, and starting selection are in the possible state for automatic operation. If starting with the other programs or steps selected, the robot could move in an unpredicted way, and lead to an accident.

(4) Before starting the automatic operation, check if the robot is properly located to get started. Check whether the program number or step number is identical with the location of robot. Even if it's all identical, accidents are still possible to occur due to an abnormal movement when the robot is differently located..

(5) Be prepared to immediately press the emergency stop button when starting the automatic operation. Immediately press the emergency stop button in case of robot's unexpected movements or emergency.

(6) Be sure to detect any abnormalities by checking the route, condition, or sound of robot movement. Sometimes the robot may be abnormally operated including a sudden break down. However, it will show(give) a certain indication before the break down. Understand the robot's normal condition well in order to catch the symptom in advance.

(7) When any abnormality is detected from the robot, immediately stop and take proper actions on it. Using the robot before any proper actions taken may cause an interruption of produce as well as serious failure leading to a very serious personal injury.

(8) When checking the robot’s movement after the proper actions taken for the abnormality, do not operate the robot with operators inside of the safety fence. Unexpected accidents are possibly to occur because its low reliability may cause another abnormality.

1.8. Safety Precautions for Access to Safety Fence

Robots are very powerful and heavy even at its low speed. When entering the safety fence, one must observe the relevant safety regulations of its pertinent country.
The operators always must be aware of the unexpected movements of robot. Robots are able to move fast shortly after being stopped. The operators should know that the robot is able to move in a different route, without any notice, by means of external signals. Thus, when trying to stop the robot during teaching or operating test, one should be able to stop the robot with a teaching pendant or control panel.
When entering the working envelope through the safety gate, take the teaching pendant with you so that other people may not operate the robot. Make sure to post up the control panel a sign indicating the state of robot handling.

Read carefully and be aware of the follows when entering the working envelope.

(1) Do not enter the working envelope other than teaching person.

(2) Operation set-up mode of controller must be a manual mode in the control panel.

(3) Always wear the approved working suite.(Do not wear a loose clothes as you please)

(4) Do not wear gloves when handling Hi4a controller.

(5) Do not leave innerwear such as underwear, shirts, or necktie out of the working suite.

(6) Do not wear personal accessories such as big earrings, rings, or necklaces.

(7) Make sure to wear safety shoes, helmet, and goggles and if necessary, wear other self-protective outfit such as safety gloves.

(8) Make sure that the emergency stop circuit is working correctly and in its proper function, turns MOTOR OFF when pressing the emergency stop button in the control panel and teaching pendant before handling the robot.

(9) Make your posture face-to-face with the robot manipulator when performing your work.

(10) Follow the predetermined working procedure.

(11) Be prepared for emergency exit or safe place considering that the robot may unexpectedly rush at you.

1.9. Safety Precautions for Maintenance and Repair

1.9.1. Safety Precautions for Hi4a Controller Maintenance and Repair

(1) Maintenance and repair of the robot must be performed by the personnel who was duly trained in the special maintenance training course and has a good knowledge of maintenance.

(2) Perform your work following the maintenance procedures for controller.

(3) Perform your maintenance and repair in a safe way by securing emergency exit or safe place.

(4) Before the daily maintenance, repair, or changing parts, be sure to power down. In addition, post a warning sign [Do Not Input Power] up the primary power so that other operators may not input power by accident.

(5) When changing parts, be sure to use the specified ones.

(6) Be sure to power down when opening the Hi4a controller door.

(7) Before performing, wait for three minutes after power down.

(8) Do not touch the heat sink and regeneration resistor of servo amp because they generate an intense heat.

(9) After completing maintenance, Be sure to close the door completely after checking if tools or other things are still remained in the Hi4a controller.

1.9.2. Safety Precautions for Robot System & Manipulator Maintenanace

(1) Refer to the safety precautions for Hi4a controller maintenance and repair.

(2) Perform your maintenance and repair for the robot system and manipulator, following the indicated procedures.

(3) Be sure to disconnect the primary power of controller. Post the warning sign [Do not input power] up the primary power to prevent other workers from connecting the power.

(4) Make sure that the Arm is fixed and immovable before maintenance and repair since dropping or moving of the robot's Arm may cause a danger during maintenance and repair. (Refer to the 『Robot manipulator maintenance manual』.)

1.9.3. Necessary Actions after Maintenance and Repair

(1) Check if the cables or parts of controller are properly connected.

(2) After maintenance is completed, carefully check that no tools are left around or inside of the controller and manipulator. Make sure that the door is firmly closed.

(3) Do not turn on the power if any problems or critical failures are detected.

(4) Be sure that there is no one within the working envelope, and that you are in a safe place before turning on the power

(5) Turn on the main circuit breaker on the control panel.

(6) Check the current position and status of robot.

(7) Operate the manipulator at low speed.

1.10. Safety Functions

1.10.1. Operating a Safety Circuit

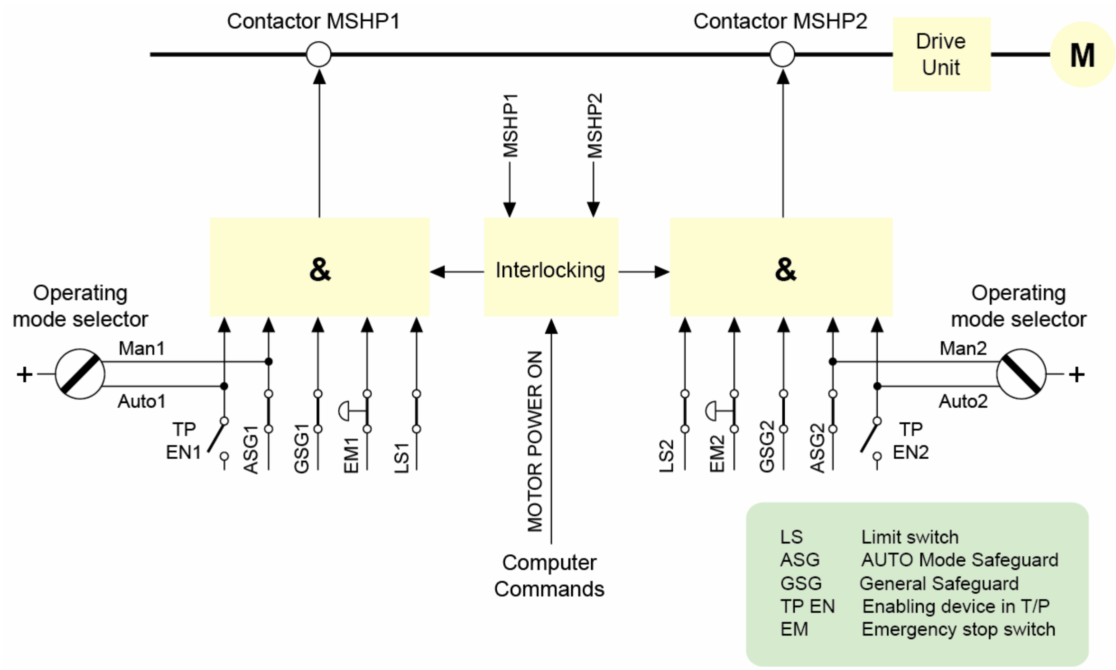


Fig 1.5 Robot's Safety Circuit

The robot's safety system is based on a two-channel safety circuit that is continuously monitored. If an error is detected, the power supply to the motors is disconnected and the motor brake is applied. To return the robot to MOTOR ON mode, the switches of two-channel circuit must be connected. If one of the two-channel circuit switches shorts, the contactor of motor will be disconnected leading to the application of brake, and finally the robot will be stopped. Furthermore, when safety circuit is disconnected, the interrupting call will be sent automatically to the controller to find out the possible reason for the interruption.

The safety control circuit of operation is based on dual safety electric circuit in which the controller and MOTOR ON mode are operated interactively. In order to be in MOTOR ON mode, the safety circuit consisted of several switches must be all connected. MOTOR ON mode indicates that drive power is supplied to the motors. If one of the contactors is disconnected, the robot will always return to MOTOR OFF mode.

MOTOR OFF mode indicates that drive power is removed from the robot's motors and the brakes are applied. The status of the switches is displayed on the teach pendant. (Refer to the I/O monitoring screen of "SERVICE" menu, 『Hi4a controller operation manual』.)

Safety circuit

The emergency stop buttons on the controller panel and on the teaching pendant and external emergency stop buttons are included in the safety circuit of operation. Users may install the safety devices (safety plug, safety stop device for safe place) which are operated in the AUTO mode. In a manual mode, the signals of these safety devices are ignored. You can connect the general safety stop devices that is active in all operating modes. No one can enter the working envelope in an automatic operation mode due to the unconditional operation of the safety devices (door, safety mat, safety plug etc.). These signals are also generated in a manual mode, but the controller will keep the robot operating while ignoring the robot's teaching. In this case, maximum speed of robot is restricted to 250mm/s. Thus, the purpose of this safety stop function is to secure the safe area around the manipulator while one approaches the robot for maintenance and teaching.
When the robot is stopped by a limit switch, it can be moved from the position by jogging it with the operation key on the teaching pendant. (Refer to “constant setting”, 『Hi4a controller operation manual』.)

The safety circuits must never be by-passed, modified or changed in any way.

1.10.2. Emergency stop

An emergency stop should be activated when people or equipment is located at the dangerous area. The emergency stop buttons are located both on the control panel and on the teaching pendant. All safety control devices such as emergency stop buttons on the control panel must be located outside the working envelope and easily accessible at any time.

Status of Emergency stop

When the button is pressed, the robot will operate as follows.
Robot stops immediately in any cases.

- Disconnect the servo system power.
- Motor brake is activated
- Emergency stop message is displayed on screen.

For the emergency stop, the following two methods can operated simultaneously. (Emergency stop for control panel and teach pendant is basic)

(1) Emergency stop for control panel and teach pendant (Basic)

The emergency stop switch is on the control panel and teach pendant of the controller.

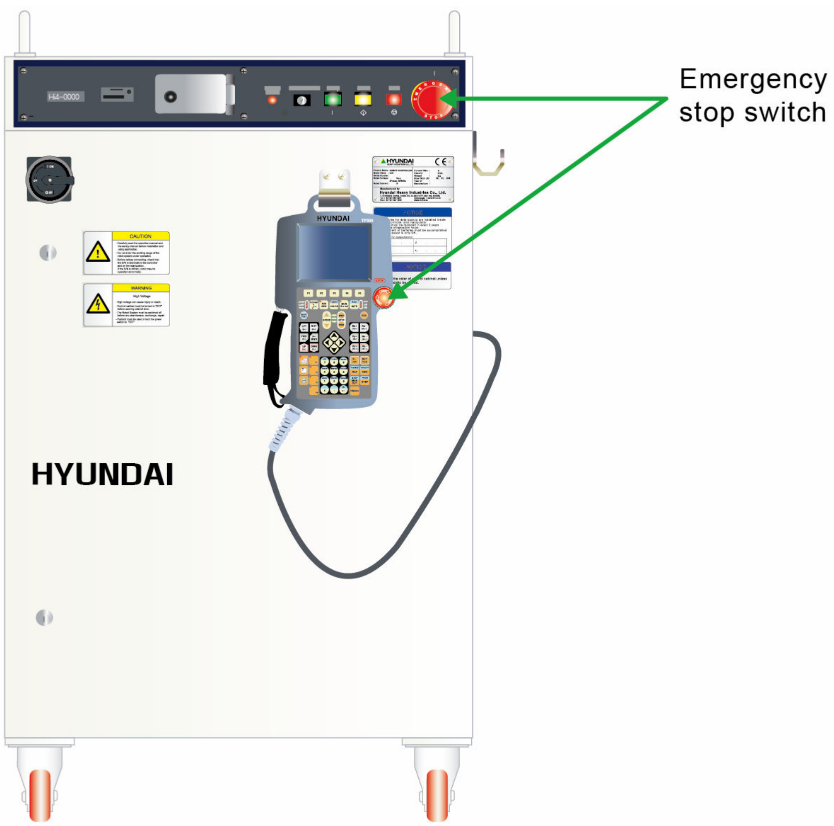


Fig 1.6 Emergency Stop

(2) Emergency stop of external system

External emergency stop device (button etc.) can be connected to the safety electric circuit in accordance with applied standard for the emergency stop circuit.

▶ Emergency stop connection of the external system

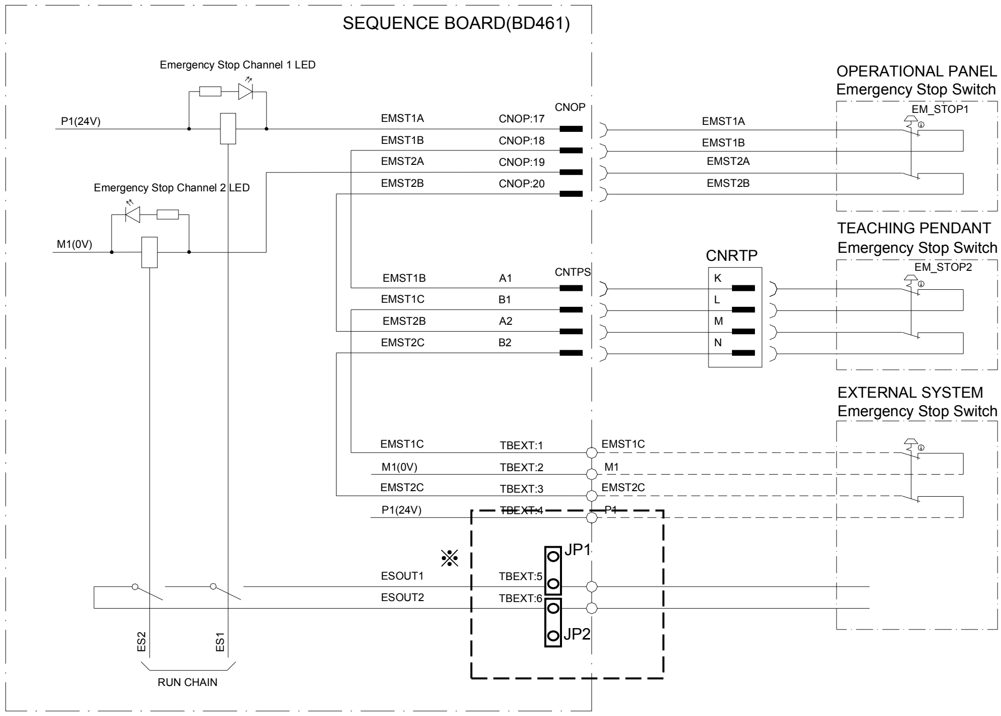


Fig 1.7 Emergency Stop Connection of External System

※ When using the emergency stop of the external system, connect the Terminal No. 1 (ES1) & No. 2 (M1,0V Common) or No. 3 (ES2) & No. 4 (P1,24V Common) of the terminal block of BD461 to the external emergency stop line, and you must open JP1 or JP2.

At this time, the emergency stop must be connected to be Normal On and it must be check for proper operation during test run.

1.10.3. Operating Speed

To teach the robot, the operating mode switch must be in a MANUAL mode. Then the maximum speed of robot is limited to 250mm/s.

1.10.4. Connecting the Safety Devices

External safety devices such as light beams, light curtains, safety plug, and safety mats which can be adapted by the system builder execute interlocking the controller by way of connecting with safety circuit within the controller. These devices are used for safety device during execution of normal program in an automatic mode.

1.10.5. Restricting the working Envelope

When the robot is not necessary to reach certain area for specific applications, working envelope of the robot can be limited to secure the sufficient safety working area. This will reduce the damage or loss in case of robot's collision with external safety devices such as safety fence, etc. The movement of axes 1, 2, and 3 of HR, HX, HS and HA can be limited by means of mechanical stopper or electrical limit switches. In this case, the corresponding software limitation parameters must be also changed. The movement of the three wrist axes, if necessary, can be also limited by the Main CPU. Limitation of working envelope for all the axes could be carried out by the user. The robot is delivered to customer as the status of full working envelope setting.

Manual mode: Maximum speed is 250mm/s.
In a manual mode, by means of worker's selection, workers may enter the safeguard area.

Auto mode: The robot can be operated via remote controller.
All safety devices such as safety door, safety mats, etc. are activated.
No one may enter the safety device area of robot.

1.10.6. Monitoring Function

(1) Motor monitoring function
Motors are protected against overload by means of onboard sensors.

(2) Voltage Monitoring Function
For the protection of, the servo amp module turns off the power switch when the voltage is too low or too high.

1.11. Safety Related to End Effectors

1.11.1. Gripper

(1) When a gripper is used to grip a workpiece, there should be safety precautions for unexpected dropping of the loaded workpiece.

(2) When any end effectors or devices are installed on the robot arm, use the required size and piece of bolt, and securely fasten as per the required torque using torque wrench. Do not use the bolt which has rust or dirt on its surface..

(3) End effector must be designed and manufactured not to exceed the maximum allowable load at the wrist of robot. Even though power or air supply stops, the gripped workpiece must not be dropped from the gripper. In order to remove any risks and problems which may cause personal injury and/or physical damage, the sharp edge and projecting part of end effector must be made dull and smooth.

1.11.2. Tool / Workpiece

(1) It must be possible to replace tools such as milling cutters in a safe manner. Make sure that safety devices are working correctly until the cutters stop rotating.

(2) Tool must be designed to keep in gripping workpiece securely even though a power failure or a control failure takes place. It must be possible to release workpiece from the gripper in a manual mode.

1.11.3. Pneumatic and Hydraulic Systems

(1) The special safety regulations will apply to pneumatic and hydraulic systems. .

(2) Since residual energy of pneumatic and hydraulic systems can be still remaining even after the robot stops, particular care and attention must be paid by users. Internal pressure of equipment must be removed whenever starting the repair work for pneumatic and hydraulic systems.

1.12. Liabilities

The robot system has been built in accordance with the latest technical standards and approved safety rules. Nevertheless, the serious accidents such as death or personal injury still may take place due to the collision between the robot system and peripheral equipment.

The robot system must be used by operator who has a full technical knowledge on its designated use and also pay his close attention to the possible dangers and risks involved in its operation. The use of robot system is subject to compliance with these operating instructions and the operation and maintenance manual supplied together with the robot system. The safety related functions of robot system must not be used for any purposes other than safety.

When you use the robot system for any other or additional purposes than its designated usage, you must review whether it is enable in accordance with design criteria. The manufacturers cannot take any responsibility for any damage or loss which resulted from such misuse or improper use. The users shall have the full responsibility for the risks caused by such misuse or improper use. When you use and operate the robot system for its designated use, you must have a good command of all the information contained at these operating instructions as well as the maintenance manual.

The robot system may not be put into operation until it is ensured that the functional machine or plant) into which the robot system has been integrated conforms to the specifications of the EC directives 89/392 EWG dated 14 June 1989 and 91/368 EWG dated 20 June 1991.

The following harmonized standards in particular were taken into account with regard to the safety of the robot system.

- IEC 204-1,10.7
- ISO 11161,3.4
- ISO 10218(EN 775),6.4.3
- ISO 10218(EN 775),3.2.17
- ISO 10218(EN 775),3.2.8
- ISO 10218(EN 775),3.2.7

Users must take the full responsibility for any accident caused by their negligence or non-observance of these instructions. The manufacturer will not take any liabilities and responsibilities for any damages or losses caused by the misuse or malfunction of such equipment which is not included in the contract between manufacturer and user and provided by user, or such equipment which is installed around the robot system arbitrarily by the user. User must take the full liabilities and responsibilities for any risks and damages caused by such equipment.

2

Basic Operation

2.1. Outline

This manual describes basic matters to handle and operate Robot.

This manual is divided into several chapters. Necessary various application functions for basic operation of Robot are included in each chapter.

Industrial Robot is 『a robot used in the industry that all types of work are executed by program by using manipulation function or movement operation function by AUTO control』.

Most of industrial Robot uses Manual operation method and AUTO operation method that are called as [Manual & AUTO operation method]. Manual operation is to instruct work contents to Robot and AUTO operation is to force that Robot repeats and executes instructed work contents.

In this manual, application functions such as 『Arc welding function』, 『Palletize function』, 『Embedded PLC function』, 『Robot equalizer function』, 『Conveyor synchronization function』 and 『Servo gun function』 are not handled in detail. See functional manual about each function for detailed description of application function.

2.2. System overview

Robot is divided into Robot main body and controller for operating the main body.

2.2.1. General

Following Figure represents basic configuration drawing of the Robot system:

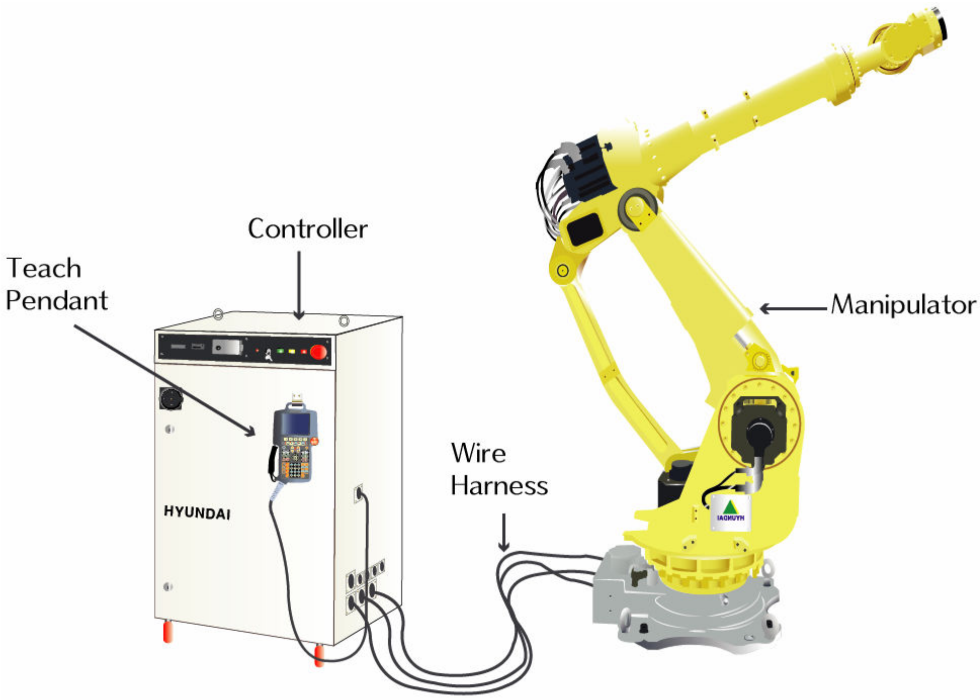


Figure 2.1 Basic configuration drawing of the Robot system

Robot can be moved by using the operation panel and teaching pendant attached to the controller.

Figure 2.2 TP and operation panel

2.2.2. Operation panel

2.2.2.1. External appearance of operation panel

The operation panel of the controller is composed of buttons and switches of automatically operating the Robot main body.

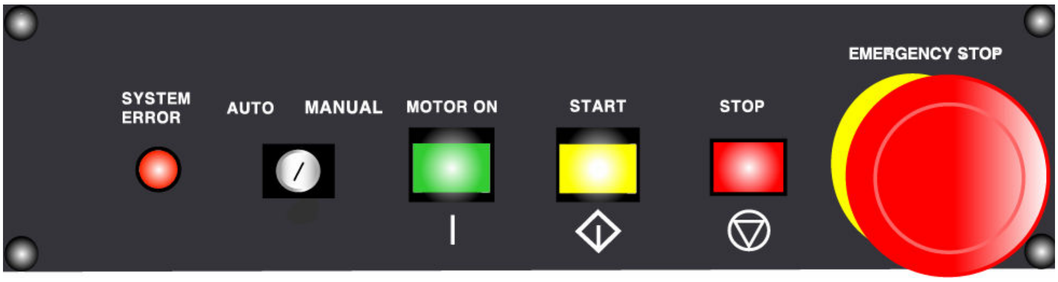
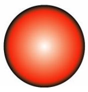
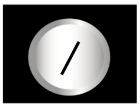
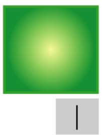
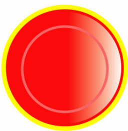
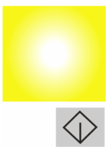
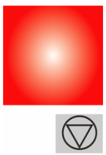


Figure 2.3 External appearance of operation panel

2.2.2.2. Button description

Table 2-1 Button description

Button	Descriptions
SYSTEM ERROR 	**[ERROR]** LED to display general failure error. Turns on in occurrence of system error such as Servo alarm, limit switch, arm interference, etc.
AUTO MANUAL 	**[AUTO/MANUAL]** Select switch for AUTO operation/Manual operation of Robot. Mode status of “Manual”, “AUTO” is displayed in the Title frame of teaching pendant depending on status of this switch.
MOTOR ON 	**[MOTOR ON]** Button used to supply Servo power to the motor in each axis of Robot. If becoming [MOTOR ON] status by pressing this button, the [MOTOR ON] lamp flickers in Manual mode, and the [MOTOR ON] lamp turns on in AUTO mode.
EMERGENCY STOP 	**[EMERGENCY STOP]** Used in emergent status where there is risk that Robot may collide against peripheral units during operation. This is button for Motor Off breaking Servo power to Robot motor and the [MOTOR ON] lamp turns Off.
START 	**[START]** Button used to automatically operate created program. If AUTO operation of Robot is started, the [START] lamp turns on and the [STOP] lamp turns off.
STOP 	**[STOP]** Used to temporarily stop Robot during AUTO operation. If Robot stop, the [STOP] lamp turns on and the [START] lamp turns off.

Reference

Determine whether operation preparation input is possible depending on JogEnable status of AUTO/MANUAL switch, safety plug and teaching pendant as shown in following table. Refer to following table:

Table 2-2 JogEnable status of AUTO/MANUAL switch, safety plug and TP

[AUTO/MANUAL] / Safety Plug	MANUAL		AUTO	
	JogEnable-ON	JogEnable-OFF	JogEnable -ON	JogEnable-OFF
Release	Motor ON Impossible	Motor ON Possible	Emergency (Motor Off)	Emergency (Motor Off)
	Jog operation Possible	Jog operation Impossible		
	Step forward/backward move Possible	Step forward/backward move Impossible		
Input	Motor ON Impossible	Motor ON Possible	Motor ON Impossible	Motor ON Possible Normal speed operation
	Jog operation Possible	Jog operation Impossible		
	Step forward/backward move Possible	Step forward/backward move Impossible		

2.2.3. Teach pendent

2.2.3.1. External appearance of teach pendent

The teaching pendant is composed of keys and buttons for manually operating the Robot main body and preparing work program.

Figure 2.4 External appearance of teach pendent

2.2.3.2. Teach Pendent Screen

Following figure represents the screen displayed on teaching pendant. The teaching pendant screen consists of 5 frames and the edit frame consists of a LCD with 11 rows/40 columns.

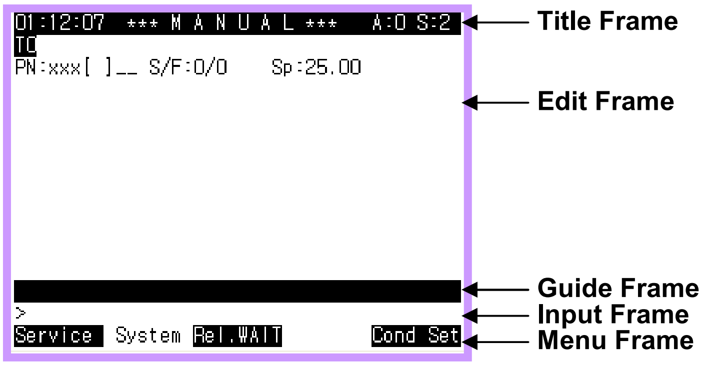


Figure 2.5 Teaching pendant screen

- **Contents of screen**

◆ **Title frame**

Displays current time (Hour: Minute: Second), mode status, accuracy level and manual speed.

```
01:18:37 *** M A N U A L ***   A:0 S:2
```

(1) Current time (Hour: Minute: Second)
Displays current time. To modify current time, see the 『[PF1]: Service』 → 『8: Date setting (Day, Time)』

(2) Mode status
Displayed as Manual or AUTO depending on status of the [AUTO/MANUAL] switch of the operation panel. In Manual mode, Robot work is instructed. In AUTO mode, Robot operates work according to instructed work pattern (Step, Cycle, Continuous).

(3) Accuracy level
Accuracy Level changes within scope of 0 ~ 5 if pressing the [SHIFT(high speed)]+[ACC/Interpolation] key of teaching pendant. Accuracy level value set when recording step is recorded as AUTO. See the 『[PF2]: system』 → 『3: Machine parameter』 → 『8: Accuracy』 for accuracy.

(4) Manual speed
Determines speed to manually operate Robot and there are 8 steps (1~8) in the level.

Speed level increases by a step if pressing the speed ⇧ key of teaching pendant, and decreases by a step if pressing the speed ⇩ key.

Speed level is set to 8 if pressing the [SHIFT(high speed)] + Speed ⇧ key, and is set to 2 if pressing the [SHIFT(high speed)] + Speed ⇩ key.

◆ **Edit frame**

Displays controller environment, program, file protection status, step number, function number, record speed and recorded command sentence. Step 0 is displayed as Robot type and axis number and total step numbers and the remaining displays contents of command sentence, position, condition file, etc.

```
T0 G1
PN:999[*]__ S/F=3/0    Sp:100.00
     Robot:H120, 6 axis, Total 4 stepd
S1  .MOVE L,S=50%,A=0,T=0
S2  .MOVE L,S=50%,A=0,T=0
    .WEAVON WEV#=1
    .ARCON ASF#=1
S3   MOVE L,S=40cm/min,A=0,T=0
     ARCOF AEF#=1
     WEAVOF
S4   MOVE L,S=50%,A=0,T=0
```

(1) Controller environment
Displays status of the controller currently set. Selected tool number, welding gun number, conveyor motion status, application status of servo hand, condition number of spot welding and sequence number, etc are displayed in status of the controller.

(2) Program
Displayed as PN:103[*]. 103 represents program number and XXX is displayed if there is no work program within the controller. A [ ] displays whether selected program exists in internal memory. If program exists, it is displayed as [*] and if not so, it is displayed as [ ].

(3) Protection status
Displays protection status of program where a __ near program is selected. See the 『[PF1]: Service』 → 『5: File manager』 → 『7: Protect』 for detailed description of protection.

(4) Step number/Function number
Displayed as S/F:3/0. Represents number of step or function currently selected. Function number is number of function recorded between steps, not number of total functions recorded in program.

(5) Speed display
Displays speed to be actually recorded in step depending on selected level in the Title frame. See the 『[PF2]: System』 → 『3: Machine parameter』 → 『9: speed』 for detailed description of speed.

(6) Robot type
Displays name of Robot main body to drive. See the 『[PF2]: System』 → 『5: Initialize』 → 『2: Robot type selection』 for detailed description of of Robot selection.

(7) Axis numbers
Displays numbers of total axis summing basic axis numbers (6axis) of Robot main body and additional axis numbers. See the 『[PF2]: System』 → 『5: Initialize』 → 『2: Robot type selection』 for setting of additional axis.

(8) Total step numbers
Displays total step numbers recorded in program currently selected.

Reference

- Reverse phase display of the screen S3 means that current step is No. 3. A '.' in front of commands before No. 3 step means commands executed. Commands after No. 3 step are those to be executed ahead.

◆ **Guide frame**

Guides and designates users' operation and displays error message when all types of error occur. This is area where output sentence is displayed when selecting output direction as TP in the output (PRINT) command sentence.

```
Select PF menu
```

◆ **Input frame**

Displays input value of contents to edit such as command language, character or function.

```
>[1 - 100] 70
```

◆ **Menu frame**

This is menu to set all types of parameter, control conditions, etc., which selects the PF ([PF1] ~ [PF5]) key of the teaching pendant.

Service	System	Rel.WAIT		Cond Set

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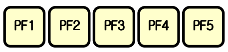
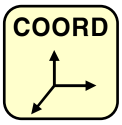
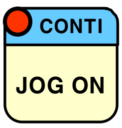
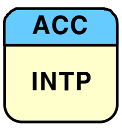
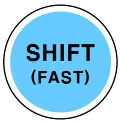
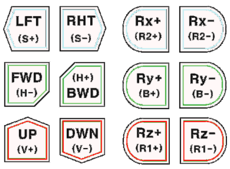
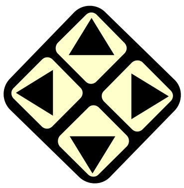
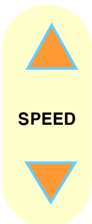
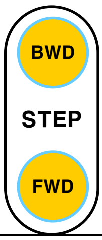
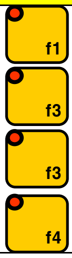
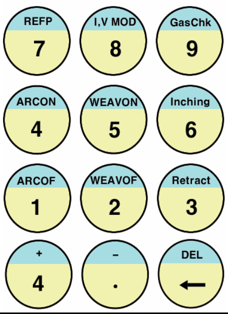
2.2.3.3. Key description

Table 2-3 Key description

Button	Descriptions
	**[E. STOP]** Used in emergent status where there is risk that Robot may collide against peripheral units during operation. This is button for Motor Off breaking Servo power to Robot motor and the [MOTOR ON] lamp turns Off.
	**[PF1], [PF2], [PF3], [PF4], [PF5]** Used when selecting every menu of menu frames on the screen. Press the [PF1] if selecting the first menu of menu frame.
	**[COORD]** Select coordinate system(axis, direct-cross, tool or user) that Robot will move if pressing the axis operation key. The coordinate system status currently selected is displayed in the left LED.
	**[AUX AXIS]** Used when selecting auxiliary axis operation. If pressing the [Left][Right]/[Front][Back]/[Top][Bottom] key with LED turned on, Robot operates additional axis 1/2/3 in forward/backward direction.
	**[CONTI/JOG ON]** Always selected when desiring to manually operating Robot. Status of this key can be checked in the [JOG ON] LED of teaching pendant. If pressing together with the [Shift(high speed)] key, you can select whether Robot will be performed step by step or consecutively be performed for forward/backward of step. Status currently selected is displayed in the left LED.
	**[GUN(Arc On)]** Determines whether GUN1 signal will be recorded together with step record. Function selection status is displayed in the left LED. GUN1 signal is manually output if pressing this key together with [Shift(high speed)] key. For arc welding, arc welding is actually performed if the LED turns on during AUTO operation, and only teaching trace is checked without performing arc welding if the LED turns off.
	**[ACC/INTP]** Key to determine type of interpolation(OFF, Straight, Arc) and Accuracy(0~5) as position decision level for recording MOVE sentence. For accuracy level, press this key with the [Shift(high speed)] key. Status of interpolation type is displayed in the right LED, while status of accuracy level is displayed in the right top end of the Title frame. See the 『[PF2]: System』 → 『3: Machine parameter』 → 『8: Accuracy』 for detailed descriptions.

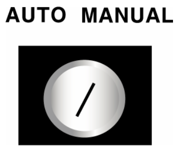
Button	Descriptions
	**[SHIFT(FAST)]** Used together when executing function in the top part (blue color) of key. Moves by 5 column if pressing this key together with the [⇐][⇒] key for inputting character string. Press and use this key together with the [⇐][⇒] key when editing or modifying parameter, numeric formula or character string. You can scroll the fixed screen by pressing this key together with the direction key in the monitoring screen. You can scroll this Edit screen by screen by present this key with the [⇑]/[⇓] key when entering in program during operation.
	**[ESC]** Used to cancel key inputs or various status process. This key has also function to convert the PF menu to the upper level.
	**[Axis operation key]** Used for operation of each axis of Robot.
	**[Direction Key]** Used when moving step or function by pressing the [⇑/⇓] key or when moving Parameters of recorded step or function by pressing the [⇑/⇓] key. You can select the previous/next [PF5] menu if pressing the [⇑/⇓] key when selecting and entering command sentence or when desiring to modify command sentence in the word cursor status or when '+' flickers in the light of the [PF5] menu. Move to word cursor of below or over command sentence where there is no '+' in the light of the [PF5] menu.
	**[SPEED]** Select speed when recording MOVE command by pressing and Robot movement speed in the Manual operation mode. Speed have total 8 steps of 1 through 8. See the 『[PF2]: System』 → 『3: Machine parameter』 → 『9: Speed』 for detailed description. Converted to Maximum high speed (S:8) / Maximum low speed (S:2) if pressing the [Shift(high speed)] key and the [⇑]/[⇓] key.
	**[STEP FWD/BWD]** Used when going forward or backward step by step from Manual mode. See the 『[PF5]: Cond Set』 → 『2: Step go/back max.speed』 for detailed description.

Button	Descriptions
	**[f-Key]** Performs function allocated as User key setting. See the 『[PF2]: System』 → 『2: Controller parameter』 → 『11: f-key setting』 for detailed description.
	**[QuickOpen]** QuickOpen function is performed if pressing this key in the specific command sentence. See the Quick Open for detailed description.
	**[Help]** Displays relevant Help defending on each status. Grammar form for command sentence is shown if pressing this key when the cursor exists in command sentence. Displays function for each code number when the cursor is located at M-, I-, T-code or when inputting. Description for R-code function is shown if pressing this key after pressing the [R..(NO)] key when desiring to use function registered as R-code. You can view contents, measures or diagnosis methods for error pressing this key in occurrence of error.
	**[LCD]** Adjust brightness of the LCD screen by pressing this key with the direction Key [⇑]/[⇓] key.
	**[Number key]** Inputs numbers. A [←] is a BackSpace key to delete character by character backward. Current value is displayed in reverse phase if firstly selecting Parameters when editing command sentence. In this case, all Parameter values are deleted if pressing this key. You can enter +, - symbol of shortkey or numbers for arc application function, or delete command sentence or Parameter if pressing this key with the [Shift (high speed)] key.
	**[R..(NO)]** Used when performing function registered as R-code or when reset function is required. Press the [SET] key after pressing the [R..(NO)]. Reset function is same function as R0: step counter reset of the R-code. See function of R-code for detailed description. This key is used when selecting refuse (No) for response of Permit/Refuse (Yes/No).

Button	Descriptions
SET (Yes)	**[SET(Yes)]** Contents of Input frame is reflected on Edit frame if using this key for completing number input. This key is used when selecting permit (Yes) for response of Permit/Refuse (Yes/No). This key is used when modifying command sentence in the Manual mode. This key is changed to a word cursor if pressing this key once more in sentence cursor and Parameter is converted to editable status.
Pos MOD / REC	**[Pos MOD/REC]** This key is used when recording step in program, namely when adding MOVE command. MOVE command entered in this time is command consisted of hidden pose. You can input step when the cursor is located at the middle between steps. This key is used when modifying position of selected step if pressing this key with the [SHIFT] key.
Ch/Var/Fn / CMD	**[Ch/Var/Fn/CMD]** Used when inputting command sentence. This key is converted to status to input character, variable or function.
STOP / MAN OUT	**[STOP/MAN OUT]** Manually outputs Output(DO) signal. Robot during operation stops if pressing this key with the [SHIFT] key.
PROG / STEP	**[PROG/STEP]** Used when selecting step. This key is selected when selecting program if pressing this key with the [SHIFT] key.
History	**[History]** This screen displays performance status of step or function recorded in program when executing recorded program. This screen also displays error numbers and error contents when various error occurs.

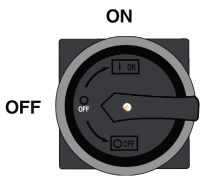
2.3. Manual operation

This means behavior to direct work contents to Robot and check the contents.

	To perform manual operation, firstly convert the [AUTO/MANUAL] switch of the operation panel to [MANUAL] direction as shown in left figure.

2.3.1. Power input

To operate a Robot, power must be firstly supplied to the Robot controller.

	To supply main power of the controller, convert power switch on the left top of the controller to [ON] direction as shown in left figure.

2.3.2. Initial setting

Initial setting is executed only when firstly installing Robot or when the Robot controller does not properly operate and the procedure is as follow:

(1) Checks that Title frame of teaching pendant is manual mode. If AUTO mode, converts the [AUTO/MANUAL] switch on the operation panel to [MANUAL] direction.

(2) Select the『[PF2]: System』 → 『5: Initialize』 → 『1: System format』. Do not use this function except for when initially installing system since all programs are deleted as well as integer file, machine integer file if initializing system.

(3) Select the type of Robot which the controller is attached to.

(4) Input axis number if additional axis exists, and select whether Robot will be used in link with a conveyor whether anti-vibration controller will be applied. And then press the『[PF5]: Execute』 key.

(5) Turn power of the controller from Off to On by using the main power switch in the left top end in the front of the controller.

(6) Execute encoder offset calibration from the 『[PF2]: System』 → 『5: Machine parameter』.

(7) Turn power of the controller from Off to On.

(8) Supply power to the motor. (Motor ON)

(9) Move Robot as standard posture with Manual operation and then execute encoder offset calibration once again. These values are used as position to reset the encoder when replacing the motor.

(10) Select program No. 999 by pressing the [Shift (high speed)]+[Prog/STEP] key of the teaching pendant and then record a point. This position is used as standard position of Robot.

2.3.3. Manual operation

Means all behaviors such as instructing work contents to Robot by using the Jog key and checking work contents so instructed and the procedures are as follow:

(1) Check whether there is a person within a safety fence or there is obstacles within operation scope of Robot.

(2) Check that Title frame of teaching pendant is manual mode. If AUTO mode, convert the [AUTO/MANUAL] switch of the operation panel to [MANUAL] direction.

(3) Select desired program by pressing the [Shift (SPEED)]+[Prog/STEP] key. (1-999)

- Method to confirm program list
  - 『[PF1]: Service』 → 『5: File Manager』 → 『1: Show file names in memory』 → Select 『Yes or No』.
  - Initial screen : R17 SET

(4) Press the [Motor ON] button of the operation panel and then check flickering status of the [MOTOR ON] lamp on the operation panel. And then check On status of the [MOTOR ON] LED of teaching pendant. This operation is ready status for supplying SERVO power to the motor in the every excess of Robot.

(5) Check the [JOG ON] LED turns on by pressing the [JOG ON] key of teaching pendant. This operation is required for executing the axis operation key of teaching pendant.

(6) Press the [ENABLE] switch in the rear of teaching pendant and check flickering status of the [MOTOR ON] lamp on the operation panel. And then check On status of the [MOTOR ON] LED of teaching pendant. The MSPR, MSHP relay operates by this operation and brake of the motor is released and becomes Servo On status. Namely, it becomes status to operate Robot.

(7) Operation to move the Robot is available depending on movement condition of speed level or coordinate system.

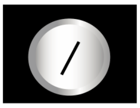
(8) Press the [Posi MOD/REC] key at a position to memorize current position of Robot.

(9) Record function.

(10) Check working contents by using the STEP FWD/BWD] key. Robot moves while the [STEP FWD/BWD] key is pressed. If Robot arrives at the target step, a 『.』 as mark of completing performance is displayed in front of relevant commands.

2.4. AUTO operation

After checking contents that Robot works, operation to actually force Robot to work is referred to as AUTO operation.

AUTO MANUAL 	To execute AUTO operation, firstly convert the [AUTO/MANUAL] switch of the operation panel to [AUTO] direction.

2.4.1. AUTO operation

Procedure of AUTO operation is as follow:

(1) Press the [JOG ON] Key of teaching pendant and then check OFF status of the [JOG ON] LED.

(2) Check Title frame of teaching pendant is AUTO mode after converting the [AUTO/MANUAL] switch of the operation panel to [AUTO] direction.

(3) Set condition of the desired operation cycle from the 『[PF5]: Condition setting』 → 『1: Cycle type = <1 step, 1 cycle, Continu>』.

(4) Set operation speed of Robot from the 『[PF5]: Condition setting』 → 『4: Speed rate』. If set to 100, Robot moves at recorded speed. If set to 50, Robot moves at 50% rate of recorded speed.

(5) Press the [Operation] button of the operation panel and check On status of the [Operation]. And then check that Robot performs work according to instructions by worker.

2.4.2. Power release

This means all operations of stopping Robot and turning off power switches after the operator performed all desired works. The procedure is as follow:

(1) Check On status of the [Stop] lamp by pressing the [STOP] button of the operation panel or pressing the [SHIFT(SPEED)] + [STOP/MAN OUT] key of teaching pendant and then check that Robot stops.

(2) Select number 999 program by pressing the [Shift(SPEED)]+[PROG/STEP] key of teaching pendant. This program is program preset as standard position when installing Robot.

(3) Convert the [AUTO/MANUAL] switch of the operation panel to [MANUAL] direction and then check that Title frame of teaching pendant is Manual mode.

(4) Check that the [JOG ON] LED turns on by pressing the [JOG ON] key of teaching pendant.

(5) Check that Robot moves to standard position after executing program preset as standard position by using the [STEP FWD] key.

(6) Press the [Emergency Stop] button of operation panel or teaching pendant. It becomes motor Off status by this operation.

(7) Turn the main power switch in the left top end in front of the controller main body to Off direction and release power of the controller. (Encoder data may be extinguished depending on status of battery.)

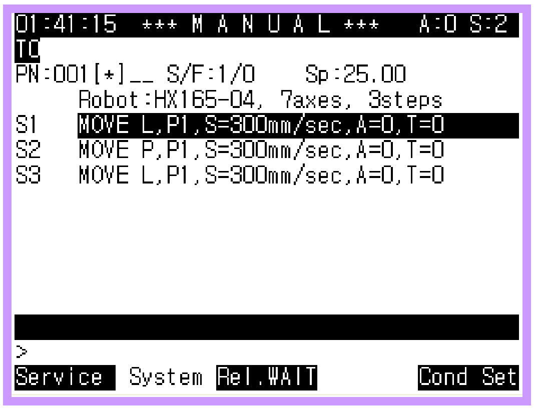
2.5. Step

Step is terms to display specific statute (or position of tool end) of recorded Robot. Namely step is referred to every position where Robot will arrive at.

2.5.1. Basic matters for step

Robot also performs other different functions while it moves from optional step to other step.

The movement command, MOVE is command language to instruct movement of the Robot main body, which is most basical of Robot programming. Position of the tool end or encoder value by axis is recorded and various items including speed, interpolation, etc are designated.



2.5.2. Parameter of step command sentence

Move conditions are required as well as Move, as movement command in order that the Robot moves from optional step to other step. Such movement conditions are referred to as parameter of step command sentence and are divided into basic parameter and selective parameter. The basic parameter is parameter essential for step, while selective parameter is parameter that operator can add if necessary. Step command sentence consists of follows:

```
          ( Basic Parameter )                ( Selective Parameter )
MOVE   L,   P1,   S=100%,   A=0,   T=0,   G1,   MX1,   UNTIL I4,   V6
      (1)   (2)    (3)      (4)    (5)    (6)          (7)         (8)
```

(1) Interpolation
P(Interpolation Off), L(Linear interpolation), C(Circular interpolation), SP(Stationary tool interpolation Off), SL(Stationary tool linear interpolation), SC(Stationary tool arc interpolation)

(2) Pose(X,Y,Z, Rx,Ry,Rz, Cfg) {coordinate system} + Shift(X,Y,Z, Rx,Ry,Rz) {coordinate system}

(3) Speed (Unit : mm/sec, cm/min, %, sec)

(4) Accuracy : 0 ~ 5

(5) Tool number : 0 ~ 9

(6) Output option (for spot), BM(block mark)

(7) Stop condition

(8) Stop status parameter

2.5.2.1. Interpolation

Refers to trace pattern between steps and interpolation method of [step N] determines trace pattern between [step N-1] and [step N].

■ **P - Interpolation off(point to point)**

This is used in the zone irrespective of that tool end (control point) of Robot moves to any trace to the destination.

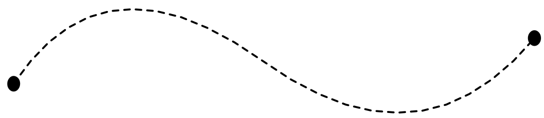


Figure 2.6 P – Example of interpolation off (point to point)

■ **L – Linear interpolation**

Moves to linear trace between both steps. It is used in the case that requires linear trace such as welding zone. It moves while automatically changing wrist posture as in following figure.

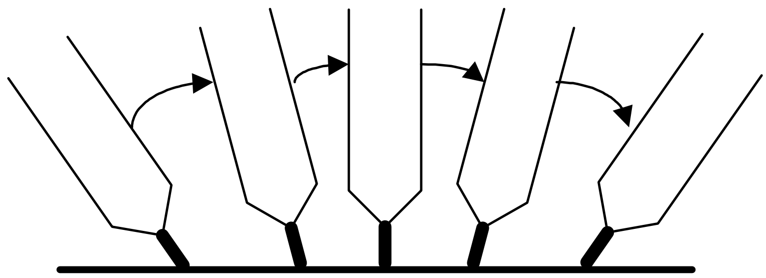


Figure 2.7 L – Example of linear interpolation

Linear interpolation moves while automatically changing wrist posture of the Robot and fails to automatically change wrist posture in specific condition. This condition is referred to as impossible conditions of posture interpolation.

Reference

Robot cannot perform posture interpolation in following cases.

- Where B-axis is located at near the dead zone. See the『[PF2]: System』→ 『3: Machine parameter』→『7: B axis dead zone』for for dead zone setting.
- Where symbol is changed. Namely, where symbol of B-axis angle is change from 『-』to『+』or from 『+』to『-』.
- Where change of the R2, R1-axis angle exceeds 180 degree.
- Where the B-axis center or tool end passes by center of S-axis rotation. Trace error or other error as well as posture may occur.
- Where change of the S-axis angle exceeds 180 degree. Error unconditionally occurs.

■ **C – Circular interpolation**

Moves between both steps to circular trace. To determine a circle, 3 points are needed. Standard to select it is as follow:

The next step [step n+2] is viewed if interpolation method of the [step n+1] is arc interpolation C. Determine a circle with the [step n] [step n+1] or [step n+2] if interpolation method of the [step n+2] is also arc interpolation C, and move along with arc of the [step n]~[step n+1] zone of them. If interpolation method of the [step n+2] is not circular interpolation, determine a circle with the [step n-1] [step n] or [step n+1] be referring to the previous step of the [step n-1], and move along with arch of the [step n]~ [step n+1] zone.

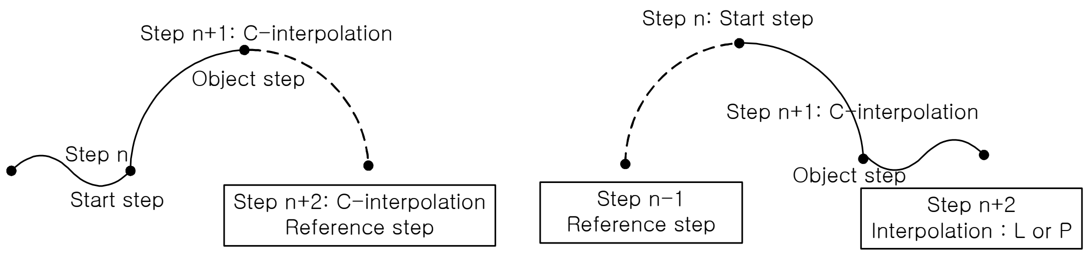


Figure 2.8 C – Example 1 of circular interpolation

You can create program by using double registration of same point even for consecutive arc if using standard as above described.
Considering trace to move to like this, you can create program as you want if determining interpolation method of step and using double registration of the same point.

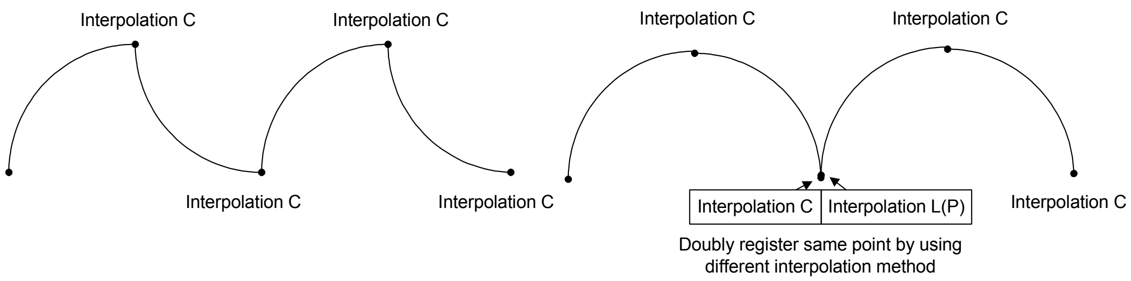


Figure 2.9 C – Example 2 of arc interpolation

Reference

- Stationary tool interpolation is function used Robot holds works and performs work on the works by using outside fixed tool. In this case, interpolation operation is done based on works that Robot owns.

- See 『7.3.12.2.1 Stationary tool interpolation function』 for description concerning the type of stationary tool interpolation.

2.5.2.2. Pose

Parameter to record position is referred to as pose, and pose parameter must be always used in case of inputting MOVE, movement command by using the [CMD] key. No pose formular appears in case of inputting MOVE sentence by pressing the [Posi MOD/REC] key (Hidden pose). At that time, position and posture of Robot is recorded as possible as the [Posi MOD/REC] key is pressed.

Input Method

- [CMD] key → 『[PF1]: MOVE, I/O』 →『PF1: MOVE』 → Yes → SET
- [QuickOpen] key → Pose number selection → 『 [PF1]: Cur.Pose』 → 『[PF5]: Save』

(1) Pose : (X, Y, Z, Rx, Ry, Rz, Cfg) {Coordinate system}
{Coordinate system} : ' ' = Base coordinate system
R = Robot coordinate system
U = User coordinate system
E = Encoder

(2) Shift : (X, Y, Z, Rx, Ry, Rz) {Coordinate system}*) R1 ~ R8 is same as Online Shift Register.
{Coordinate system} : ' ' = Base coordinate system
R = Robot coordinate system
T = Tool coordinate system
U = User coordinate system

2.5.2.3. Speed

Designates movement speed of tool end. Units are mm/sec, cm/min, sec and %.
A Sec designates speed as movement time, and a % is rate on maximum speed.

2.5.2.4. Accuracy

Determines precision level (approaching level for recording position) passing through the step when Robot proceeds the target step. Robot moves to the next step if difference between current position and recording position is less than fixed level (accuracy OK) when the main body (tool end) moves to the target step, where the difference is accuracy. Accuracy 0 is most precise and accuracy 5 represents a case where difference is largest. This value can be defined as distance or beat number. See 『[PF2]: system』 → 『3: Machine parameter』 → 『8: Accuracy』 for detailed description.

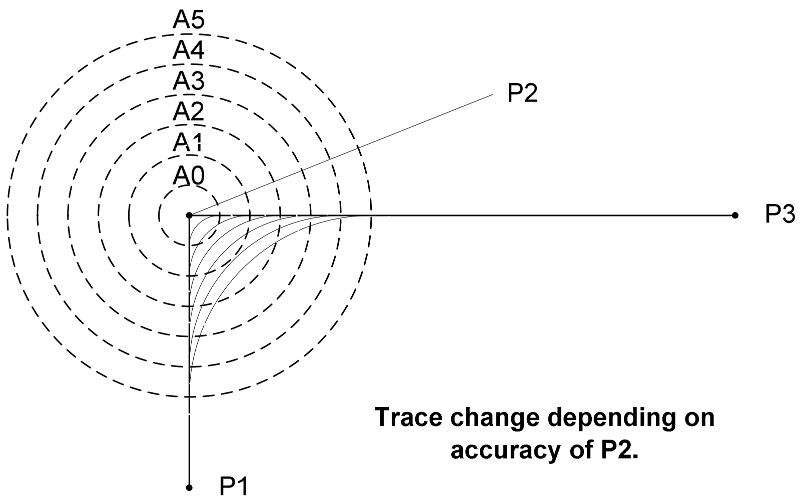


Figure 2.10 Trace change depending on accuracy of P2

2.5.2.5. Tool number

Robot position is determined by position and posture of the tool end. Designate number of the tool used.

2.5.2.6. Output option

G1, G2 - GUN signal. – For spot
This is output command for spot welding.

MX1, MX2 – Large open, Small open – For spot
This is output command to determine stroke of the spot welding gun.

BM - Block Mark
5% increase/decrease of speed can be designated for use. In this case, movement speed between steps for which BM is designated can be increased or decreased by 5% of speed recorded in current step.

2.5.2.7. Stop condition

If conditions formula after UNTIL is met, Robot stops to move and performs following command (step or function).

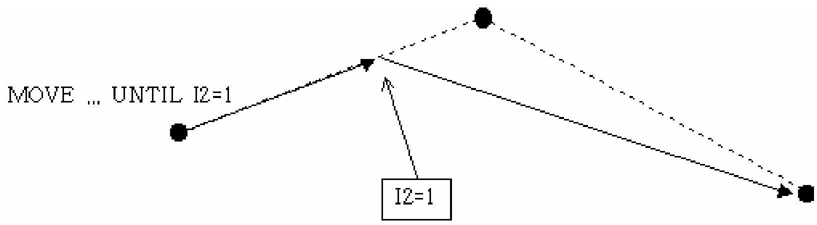


Figure 2.11 Example of stop condition

2.5.2.8. Stop status parameter

Resulting value of stop condition formula (condition formula after UNTIL) is kept. You can know whether MOVE operation is terminated by condition formula.

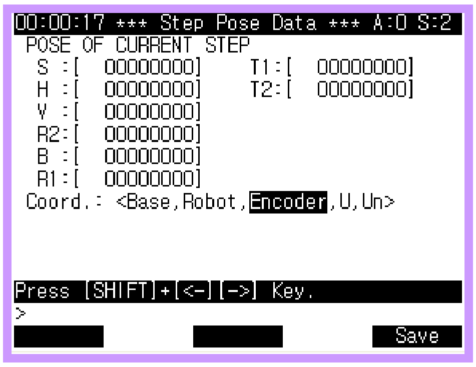
2.5.3. Confirm/Modify of step position

Confirm/Modify Robot position and posture of recorded step by pressing [Posi MOD/REC] key.

2.5.3.1. Encoder recording coordinate

Following screen is displayed if pressing the [QuickOpen] key in the MOVE command sentence selected and recorded as 『[PF2]: System』 → 『1: User parameter』 → 『2: Pose REC type =<Base,Robot,Enco,U,Un>』 in the Manual Mode.

For position of Robot recorded as encoder, only position can be identified and you cannot modify position data.



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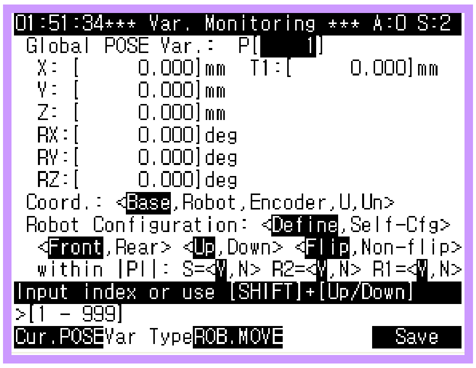
2.5.3.2. Base or Robot recording coordinate

Following screen is displayed if pressing the [QuickOpen] key in the MOVE command sentence selected and recorded as 『[PF2]: System』 → 『1: User parameter』 → 『2: POSE REC type =<Base> or <Robot>』.

Following screen is a case of selecting Pose recording pattern as <Base>, Robot configuration pattern as <Define>.



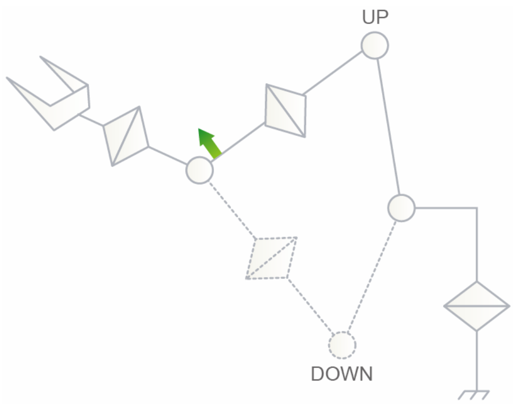
Reference

- Designation of Robot pattern is required if only describing pattern of coordinate since there are multiple of coordinate types in respect of features of tool when describing position of Robot. These values represent coordinate system but are only for reference, not reflected in calculation.

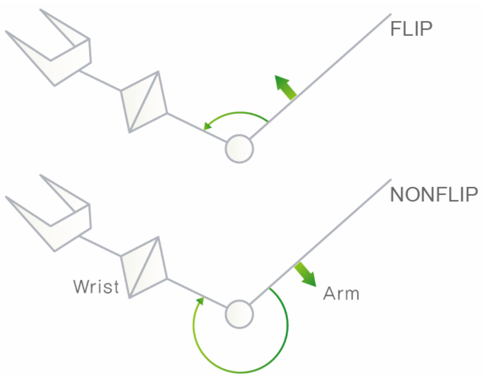
  bit0 : (0: Define, 1: Self-Cfg)
  Determines whether or not configuration pattern will be designated for posture that Robot currently poses.

  bit1 : (0: Front, 1: Rear)
  Select Front if tool end of Robot is at left and select Back if at back, when checking it in the X-axis of the Robot coordinate system.

  bit2 : (0: Up, 1: Down)
  Represents relation between H-axis and V-axis, and our all mass production models are of Up pattern.



  bit3 : (0: Flip, 1: Non-flip)
  Select Flip pattern if a coordinate is located at |R2|<90 against standard coordinate of the R2-axis, and select non-flip pattern if |R2|>=90.



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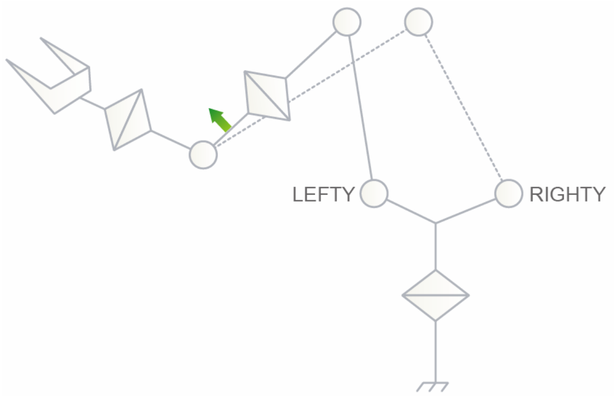
bit4 : (0: Left, 1: Right)
Select where angle of the S-axis is located at.



bit5 : (0: |R2|<180, 1: |R2|>=180)
Select where angle of the R2-axis is located at.

bit6 : (0: |R1|<180, 1:|R1|>=180)
Select where angle of the R1-axis is located at.

Hereafter, values represent coordinate system but are only for reference, not reflected in calculation.
bit 7~9 : Represents coordinate system.
(0: Base, 1: Robot, 2: Reserved, 3: Encoder,4:User)

bit 10~13 : User coordinate system number. (1~10)

- Designation of coordinate system is separated by additional character in the last for convenience of user as follow:

Base coordinate system = ((X,Y,Z,Rx,Ry,Rz,cfg)
Robot coordinate system = (X,Y,Z,Rx,Ry,Rz,cfg)R
Encoder coordinate system = (S,H,V,R2,B,R1)E
User coordinate system =(X,Y,Z,Rx,Ry,Rz,cfg)U ➔ Number non-define method
User coordinate system =(X,Y,Z,Rx,Ry,Rz,cfg)Un ➔ Number define method (1~10)

2.6. Help key

Minutely describes function performed when pressing the [Help] key of the teaching pendant.

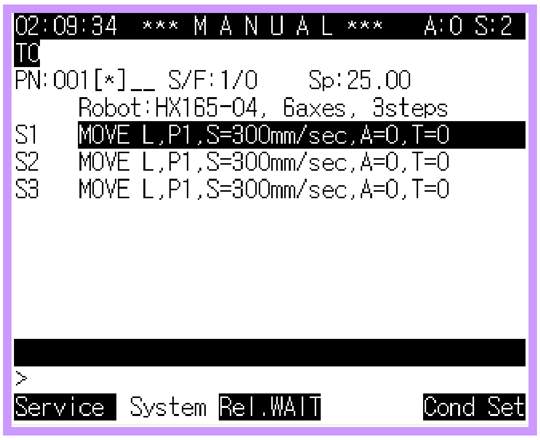
2.6.1. Command sentence

You can know Parameter and related information selected in relevant command sentence by using the [Help] key.

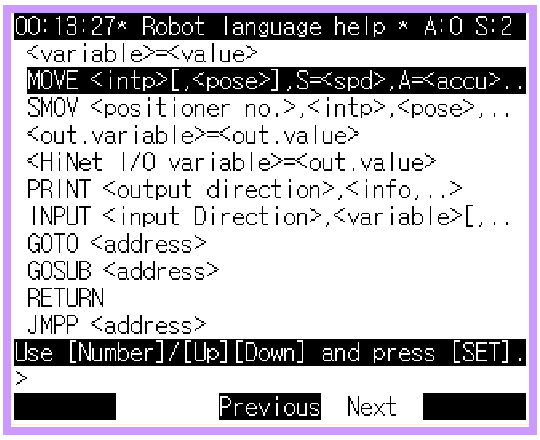
There are very much command sentences used in the Hi4a controller. Here, you can find only method of using the [Help] key for MOVE command sentence which is most basic.

See 『Chapter 10, Robot Language』 for command language used in the Hi4a controller.

(1) Moves the cursor to MOVE sentence as following screen:



(2) The Robot Language Help screen appears if pressing the [Help] key as follow:



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(3) Detailed description appears for selected command sentence as below screen if pressing the [SET(Yes)] key after moving the cursor to the [MOVE] command

```
00:14:38* Robot language help * A:0 S:2
MOVE <interp.>,[<pose>],S=<speed>,A=<acc
u.>,T=<tool>[,<out.options>][ UNTIL <con
dition>[,<interrupt status variable>]]
________________________________________
Moves tool end of robot to pose position
________________________________________
interpolation: robot tool(P-PTP,L-Linear
,C-Circular), stationary tool(SP,SL,SC)
pose: Pose expr. Target pose to move. If
     there is hidden pose, it is omitted
    or only the shift expr. is specified
Press [ESC] for exit help.
>
                Previous  Next
```

Reference

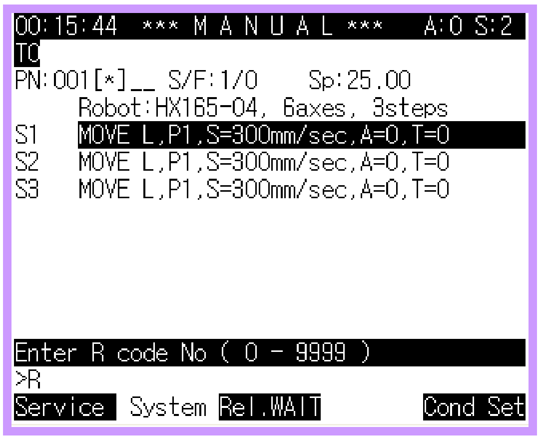
- Parameter of < > is basic Parameter basically used, while Parameter of [,] is selective Parameter usable after selecting either of both Parameters.

- Detailed descriptions are provided about Parameters used in selected commands as above figure. Where Help function exceeds a page, you can view desired page by using the 『[PF3]: Previous』, 『[PF4]: Next』 key.

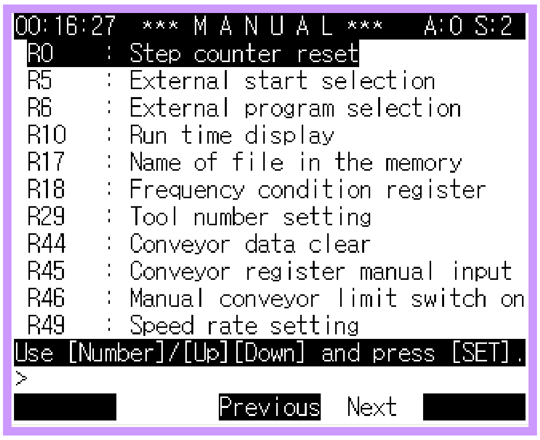
2.6.2. R-code

A R-code is a code used for overall manage program without being used for recording step. Namely, it is function to set various conditions for controller status. You can represent contents about every R-code number by using the [Help] key.

(1) Following message is displayed in the Guide frame if pressing the [R..(NO)] key:



(2) Following screen is displayed if pressing the [Help] key:

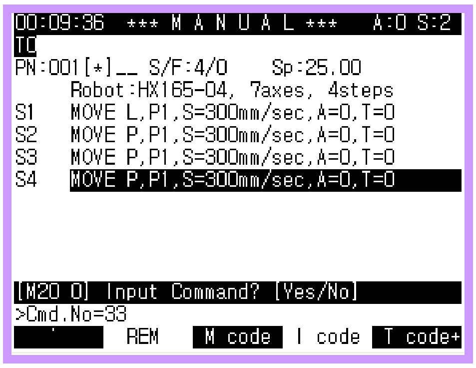


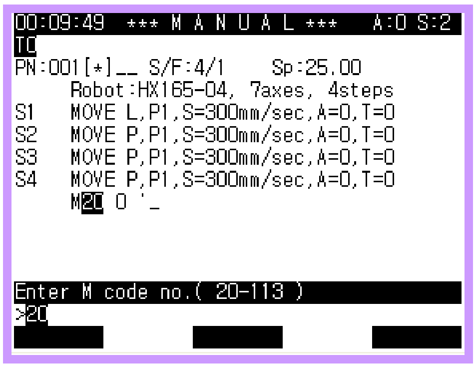
(3) See『Chapter 8, R-code』for detailed description about every R-code.

2.6.3. M, I code

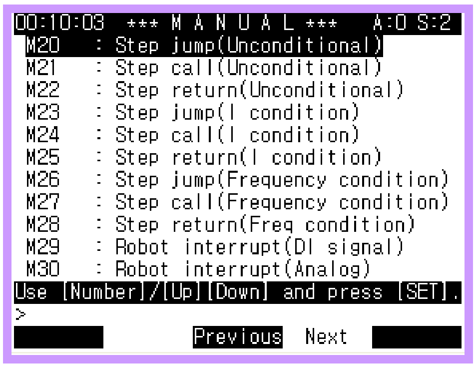
You can display message for code number of M-code or I-code by using the [Help] key when preparing program in the pattern of command sentence with M-code or I-code.

(1) Following screen is displayed if selecting M-code or I-code by using the [CMD] key.





(2) Following screen is displayed if pressing the [Help] key.



(3) M code Command sentence of relevant M-code is selected if pressing the [SET(YES)] key after moving item with number or direction key. See the Robot language for detailed contents about every M-code or I-code.

2.6.4. Error information

You can know contents and measure method about error occurred by pressing the [Help] key when all types of error such as system error or operation error.

Error occurred is displayed in following method if error occurs in the Hi4a controller.

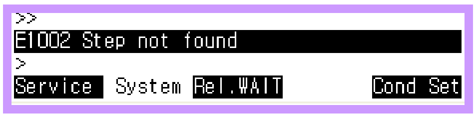
(1) Up to 100 errors recently occurred are recorded in『[PF1]: Service』 →『7: System checking』 → 『4: Error logging』.

(2) Numbers and messages about errors occurred are displayed when pressing the [History] key of teaching pendant.

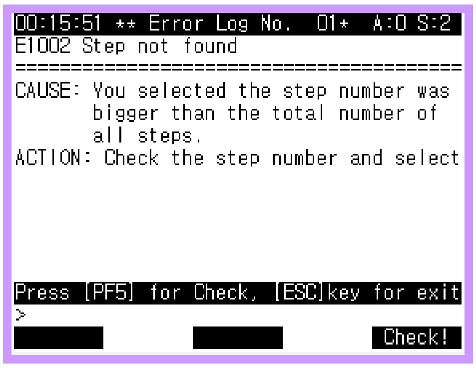
(3) Numbers and messages about errors occurred are displayed in the Guide frame of teaching pendant when error occurs.

You can know contents and measure method about error occurred by pressing the [Help] key when error is displayed in the Guide frame in above time (3).

(4) Numbers and messages about errors are displayed when all types of error occur in the Guide frame as below screen:



(5) You can know contents and measure methods about error occurred by pressing the [Help] key of teaching pendant as in following screen:



(6) Press the『[PF5]: Check!』key to diagnose error occurred and press the [ESC] key to exit.

2.7. Coordinate system

A coordinate in space is required to determine direction that Robot moves on space. In this case, a coordinate system is referred to define coordinate that Robot will moves on. Coordinate system that the Hi4a controller provides includes axis coordinate system, Robot coordinate system, user coordinate system and tool coordinate system.

2.7.1. JOG operation key

Following table represents direction that Robot actually moves in axis coordinate system, Robot coordinate system, user coordinate system and tool coordinate system when pressing the [axis operation] key of teaching pendant.
You must understand operation pattern of Robot in every coordinate system based on following table:

Table 2-4 Operation pattern of Robot in every coordinate system

Operation / OperationKey	[Coordinate system]			
	Axis-Coord	**Robot (Robot-Coord)**	**Robot (User-Coord)**	**Tool-Coord**
Left(S+)	S [Left]	Xr (-)	Xu (-)	Xt (-)
Right(S-)	S [Right]	Xr (+)	Xu (+)	Xt (+)
Front(H-)	H [Front]	Yr (+)	Yu (+)	Yt (+)
Rear(H+)	H [Back]	Yr (-)	Yu (-)	Yt (-)
Top(V+)	V [Top]	Zr (+)	Zu (+)	Zt (+)
Bottom(V-)	V [Bottom]	Zr (-)	Zu (-)	Zt (-)
Rx+(R2+)	R2 [Forward]	Rxr (+)	Rxu (+)	Rxt (+)
Rx-(R2-)	R2 [Backward]	Rxr (-)	Rxu (-)	Rxt (-)
Ry+(B+)	B [Forward]	Ryr (+)	Ryu (+)	Ryt (+)
Ry-(B-)	B [Backwardd]	Ryr (-)	Ryu (-)	Ryt (-)
Rz+(R1+)	R1 [Forward]	Rzr (+)	Rzu (+)	Rzt (+)
Rz-(R1-)	R1 [Backward]	Rzr (-)	Rzu (-)	Rzt (-)

2.7.2. Axis coordinate system

Check that Jon On LED turns on pressing the [JOG ON] key in the motor ON status in Manual mode, and then press the [ENABLE] switch at the rear side of teaching pendant.
Turn on the LED at direct-cross position by pressing the coordinate system key of teaching pendant. Robot operates as in following figure if pressing the axis operation key.
Axis coordinate system Robot Key Robot axis.
See the JOG operation key for progress direction about Robot about the axis operation key:

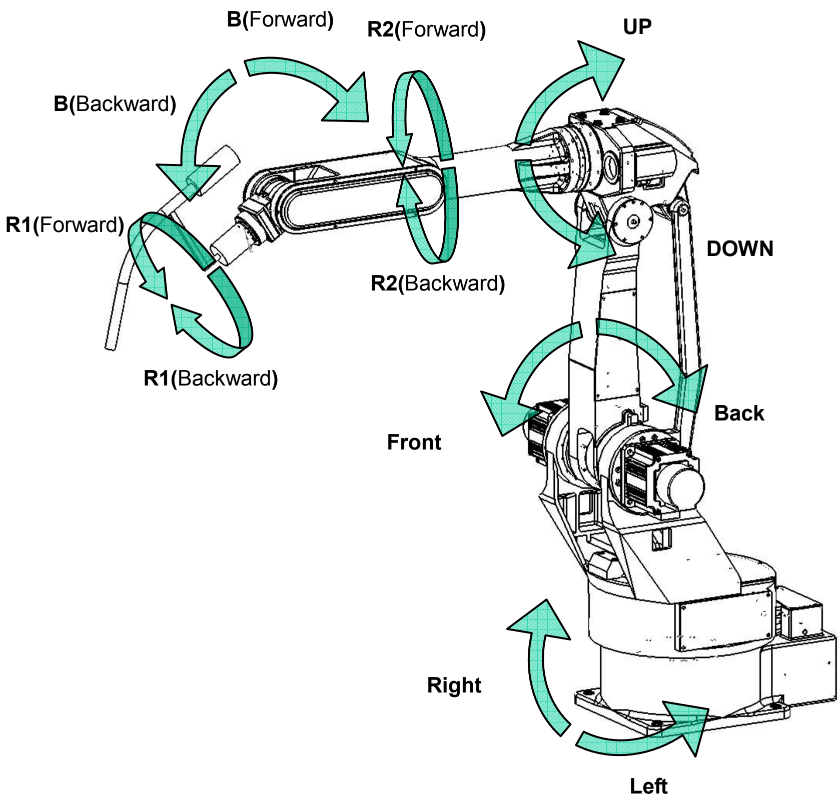


Figure 2.12 Axis Coordinate System

2.7.3. Robot coordinate system

Check that Jon On LED turns on pressing the [JOG ON] key in the motor ON status in Manual mode, and then press the [ENABLE] switch at the rear side of teaching pendant.
Turn on the LED at direct-cross position by pressing the coordinate system key of teaching pendant. Robot operates as in following figure if pressing the axis operation key.
See the JOG operation key for progress direction about Robot about the axis operation key.

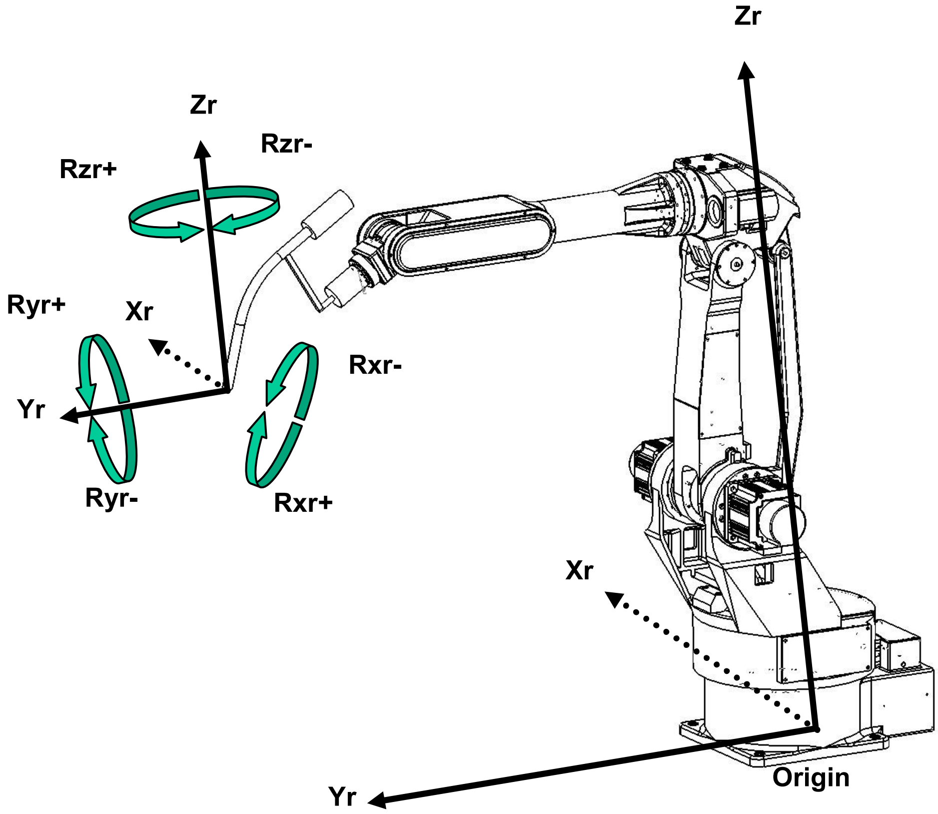


Figure 2.13 Robot coordinate system

Reference

- Following figure shows method to conveniently determine direction that the Robot progresses when spreading thumb, second finger, middle finger at a right angle. When laying progress direction of the left finger at the rear of Robot to Y-direction of the Robot coordinate system, progress direction of the thumb finger becomes Z-direction, and progress direction of the middle finger becomes X-direction. If utilizing such principle, you can conveniently understand operation of Robot in the Robot coordinate system.

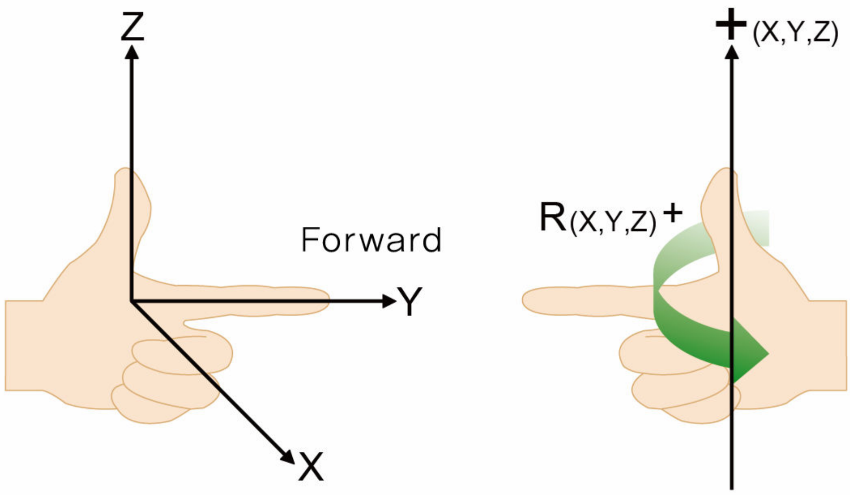


Figure 2.14 Direction and rotation direction of coordinate system

2.7.4. User coordinate system

Register the user coordinate system by selecting the『[PF2]: System』→『2: Controller parameter』→『12: Coordinate setting』→『1: User coordinate』.
Robot operates as following figure if reproducing program after selecting the『[PF5]: Cond Set』→『8: Select user coordinate』.

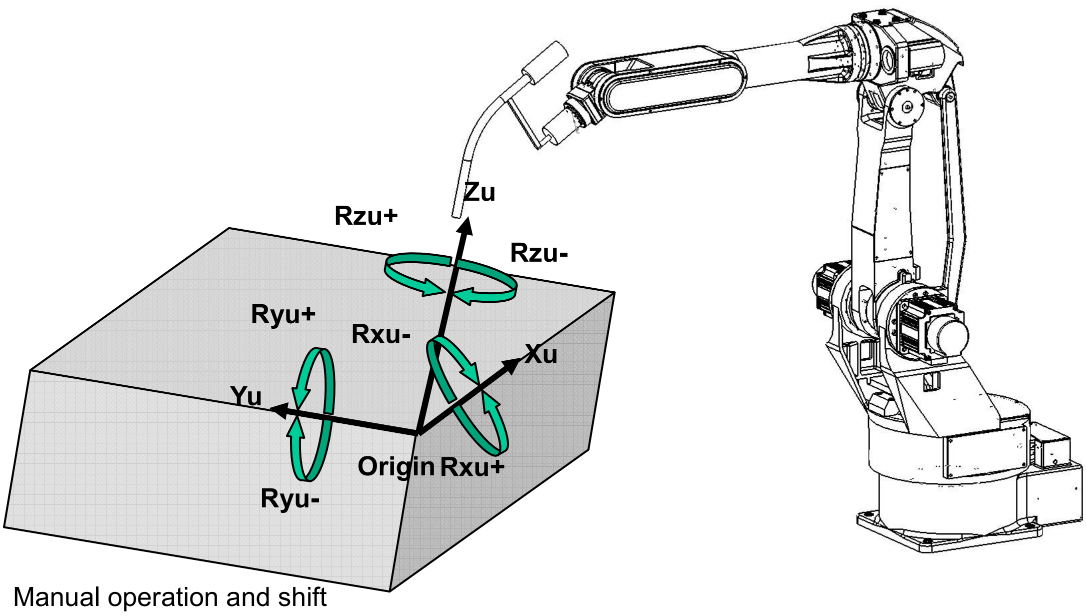


Figure 2.15 User coordinate system

2.7.5. Tool coordinate system

Check that Jon On LED turns on pressing the [JOG ON] key in the motor ON status in Manual mode, and then press the [ENABLE] switch at the rear of teaching pendant.
Turn on the LED at tool position by pressing the coordinate system key of teaching pendant. Robot operates as in following figure if pressing the axis operation key.
See the JOG operation key for progress direction of Robot about the axis operation key.

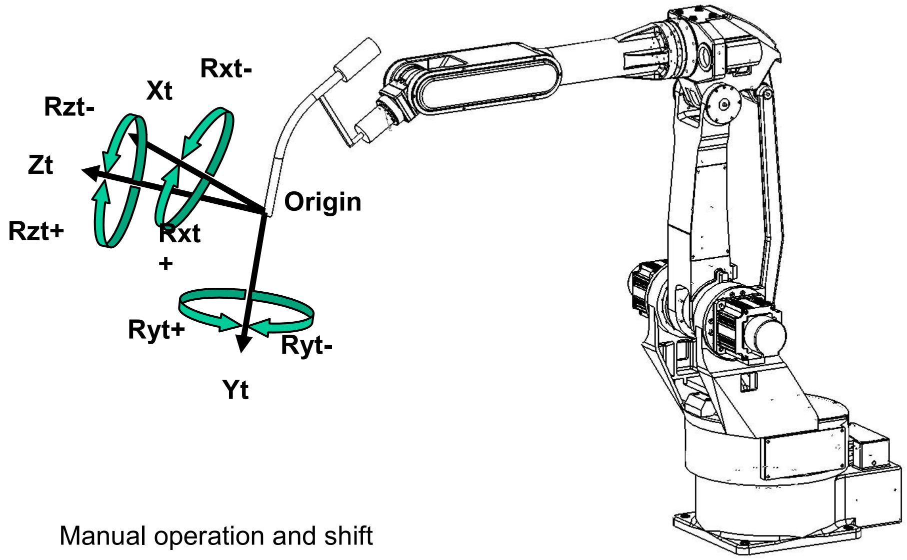


Figure 2.16 Tool coordinate system (for torch adhesion)

Following figure represents case that a torch is not adhered to Robot:

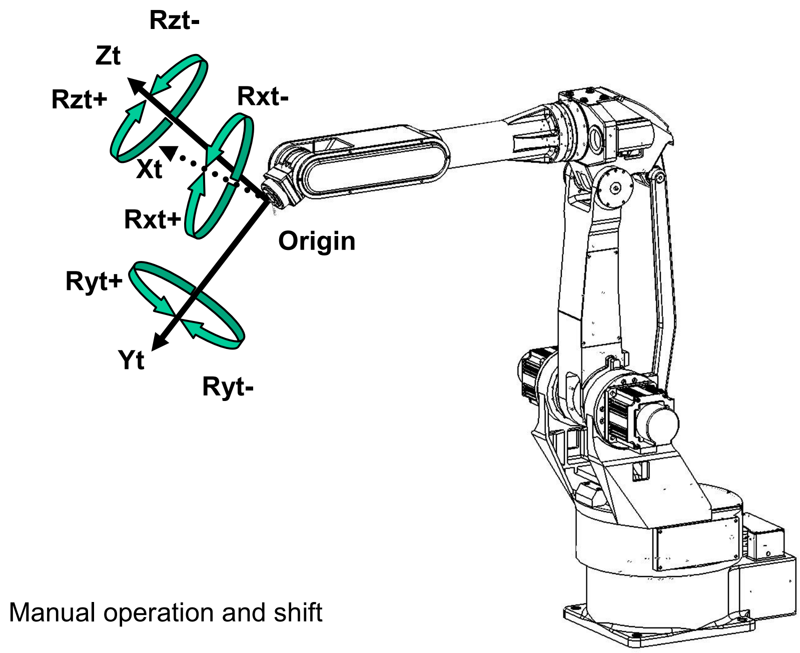


Figure 2.17 Tool coordinate system (without tool)

2.8. Robot automatic constant Setting

Off integer data of linear interpolation and then set Robot to AUTO. This is function to obtain linear interpolation integer offset from encoder data in each step of program recording same point in various posture to improve conversion level of linear interpolation trace and coordinate. You can set the distance to tool end to AUTO difficult to measure on 3-D by execution of this function. Linear interpolation integer offset is length of H, V, R2, B-axis axis integer and X, Y, Z-direction tool.

(1) Check Title frame of teaching pendant is Manual status after converting the [Mode] switch of the operation panel to Manual.

(2) Press the both [SHIFT] key and the [Program] key of teaching pendant and select optional program.

(3) Press the [MOTOR ON] button of the operation panel and check that the MOTOR ON lamp flickers.

(4) Check ON status of the JOG ON LED by pressing the [JOG ON] key of teaching pendant.

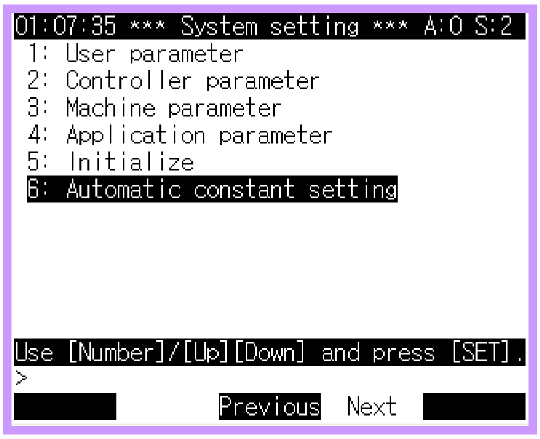
(5) Press the [ENABLE] switch in the rear of teaching pendant and then check Robot manually operates by the [axis operation] key.

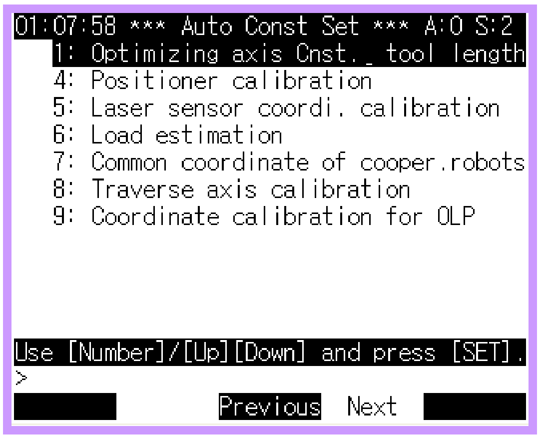
(6) Place optional pointed point within operation scope of Robot and correspond tool end of Robot.

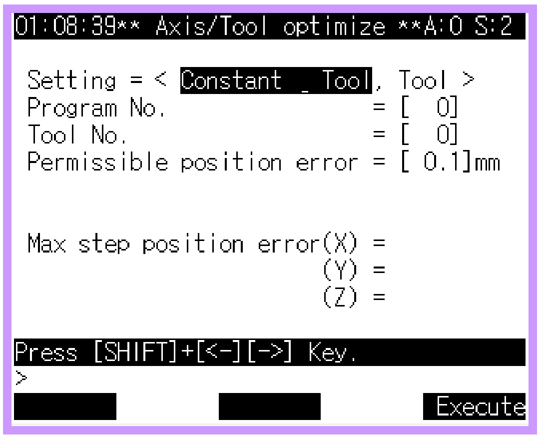
(7) Record step by pressing the [REC] key of teaching pendant.

(8) Largely change posture of Robot (posture of 3-axis of possible wrist) and then repeat and perform No. (6), (7) by more than 4 times.

(9) Following screen is displayed if selecting the [PF2]: System』→『6: Automatic constant setting』→『1: Optimizing axis Cnst.& tool length』







(10) Axis integer and tool integer selected are set if pressing the 『[PF5]: Execute』 key selected if pressing the 『[PF5]: Execute』 key after setting allowance scope of program number, tool number and step prepared for AUTO integer setting.

(11) Convert multiple tools to "tool" in the "setting =<Constant and tool, tool>" on the screen when setting tool integer from the second when using multiple of tool.

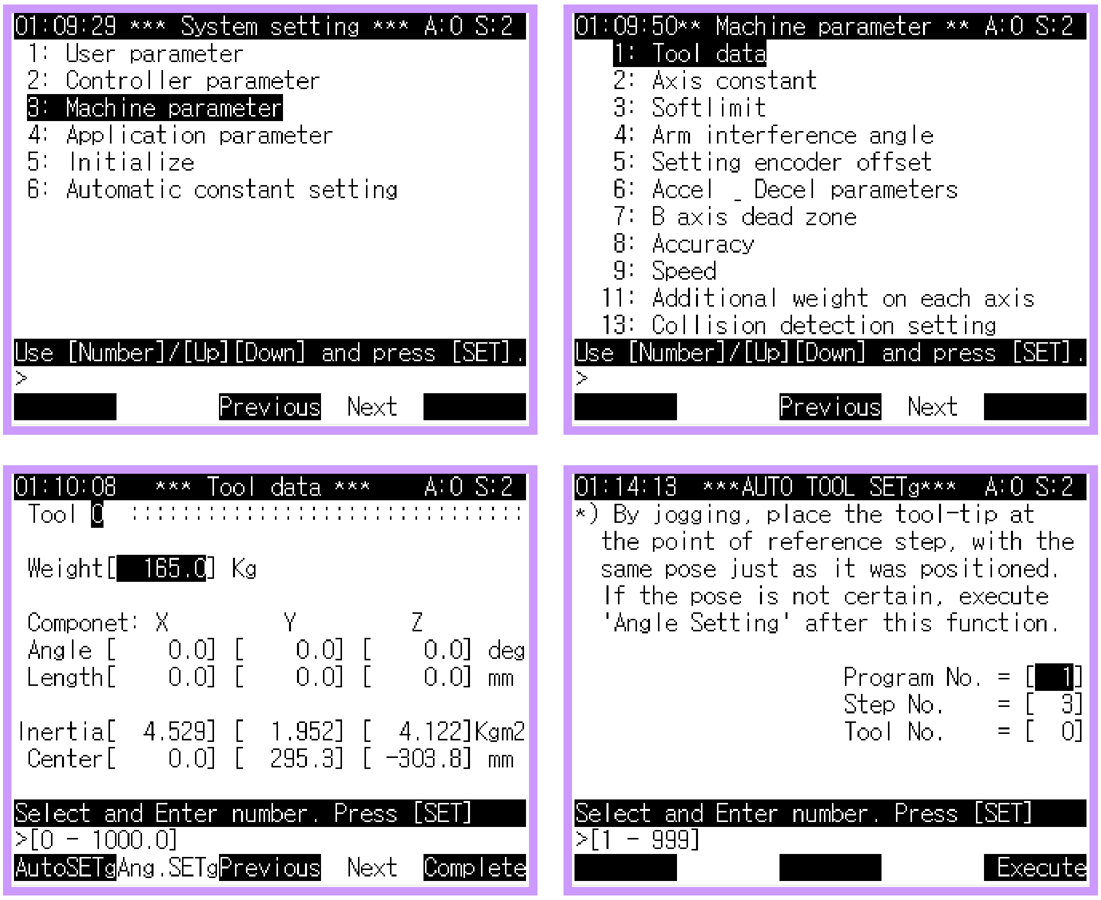
Reference

- See the 『[PF2]: System』 → 『6: Auto constant setting』 → 『1: Optimizing axis Cnst.& tool length』.

2.9. AUTO TOOL SETg

This is method to simply determine new tool integer when deformity or change occurs in tool by various Parameters after determining axis/tool integer to AUTO integer setting function, etc. However, axis integer (Axis Constant) must be determined on presumption that it is continuingly maintained. If tool deformity occurs, perform such process after placing tool on a standard point designated before deformity.

Following figure is displayed if pressing the『[PF1]: AUTO TOOL SETg』in the『[PF2]: System』 → 『3: Machine parameter』 → 『1: Tool data』 setting screen. Moves to the changed tool end to the position by using the [Axis operation] key. Therefore, to use this function, previously designate and mark the standard position. Set [PF5]: Execute』 after confirming program number, step number and tool number to set.



Reference

- See the『[PF2]: System』 → 『3: Machine parameter』 → 『1: Tool data』.

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3 Program preparation

3.1. Program selection

This explains the method on how to select a program to prepare or already prepared.

(1) If you press the [SHIFT]+[Program] key when the robot is stopped, you will see the following screen.

```
Enter program No ( 1 - 999 )
>Program =
Service  System Rel.WAIT        Cond Set
```

(2) Enter the program number using the [Number] key and press the [SET] to see the following screen. Program 10 is a program not prepared. If it is a program that has been prepared you will see PN:010[*] and the program content in the screen.

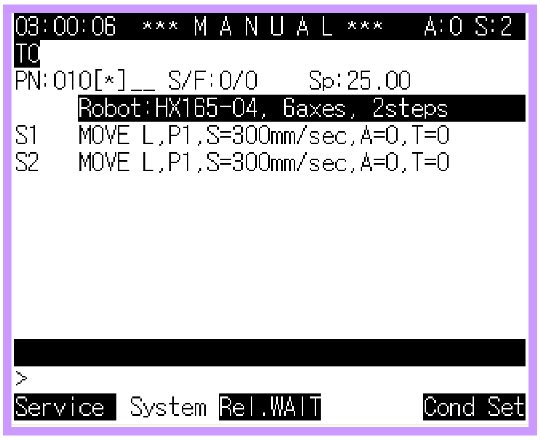
```
02:35:38  *** M A N U A L ***   A:0 S:2
TO
PN:010[ ]__ S/F:0/0     Sp:25.00







The program selected
>
Service  System Rel.WAIT        Cond Set
```

3.2. Program deletion

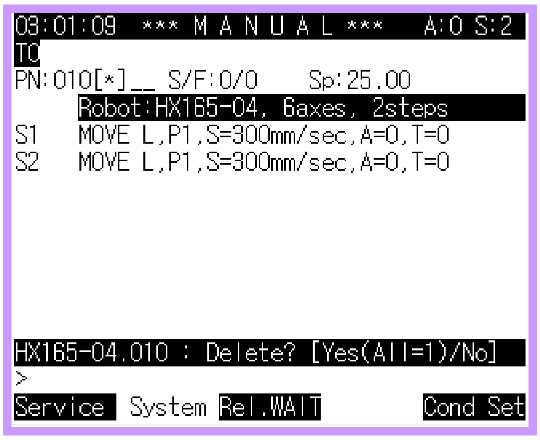
There are 3 ways to delete a program. It is possible only when the robot is stopped.

- Refer to 『[PF1] Service』 → 『5: File manager』 → 『6: Delete』.
- Refer to R117 of 『Chapter 8. R Code』.
- When deleting a program with cursor in step 0

(1) Use the [Arrow] key or [SHIFT]+[⇑] key to move the cursor to the step 0 as shown below.



(2) If you press the [SHIFT] +[Delete] key in teach pendant, you will see the following screen.



(3) If you press [YES], the program will be deleted sending you to the same screen as when you have selected a program not prepared.

3.3. Program preparation

Preparing a robot program is for the user to compose a program by using commands to move and work in a way to achieve a specific output from the robot.

3.3.1. What is a command?

A general program consists of step commands to move the robot and function command to process an operation. These commands are composed of command and properties (additional option). Properties include mandatory base properties and optional properties.

When you enter a command, the default values are saved in the base properties, which can be changed. Optional properties are displayed with 『_』 in work cursor, and when you move to this item, you will see the properties in the main frame that can be entered.

When editing the properties of the command, you can directly enter the changes using the [Number] key, you can select the parameter or function from the menu and enter the index (the content in the parenthesis of parameter or function) or you can edit by Character units using a Formula or Character entry.

3.3.2. Command entry

1) Step command entry in hidden pose

If you move the robot with [Axis operation] key and press the [REC] key of teach pendant, the movement command to the current position will be recorded.

2) General command entry

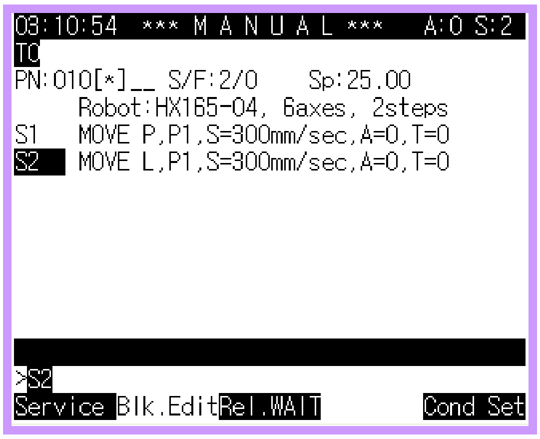
(1) To enter the command, press the [CMD] key from the initial screen in manual mode. If you press this key, you will see the following screen.

(2) Use the [PF] key to enter the command in main frame. Please refer to 『Chapter 10. Robot language』 for details on menu composition and description of each command.

3.3.3. Command composition

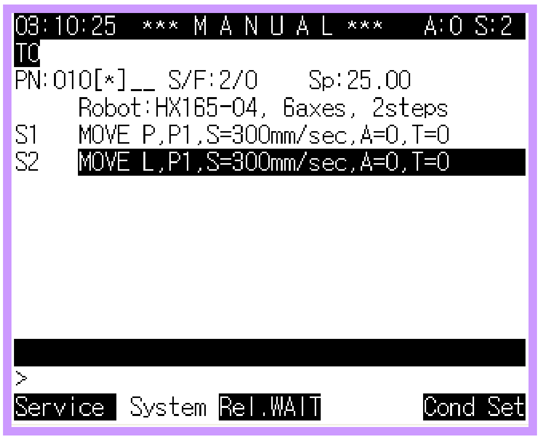
1) Address area

- The area where the line number (1 ~ 9999) or step number (S1 ~ S999) is displayed is called the address area.



2) Command area

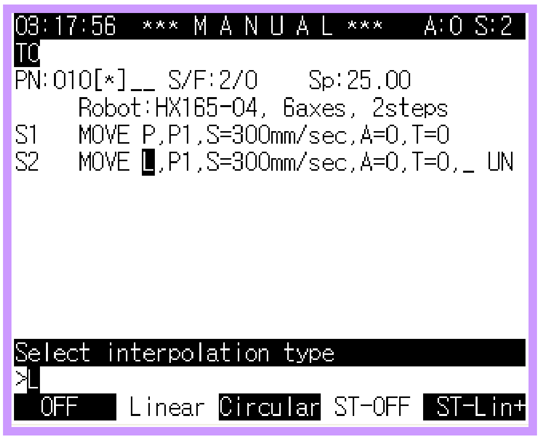
- The area where the command line is displayed is called the command area. When one whole line is selected in this area it is called sentence cursor condition.



- Use the [Arrow] key to move between address area and command line area.

3.3.4. Command edit

To edit a command, it must be in word cursor condition, which refers to the situation when the cursor is located in the property of the command as shown below. In word cursor condition, you can use the [Arrow] keys to move the cursor to the property you want to edit. To switch from sentence cursor to word cursor, press the [SET] key.



Press the [SET] key to reflect the content in the input frame to the edit frame. To finish the property edit and return to the word cursor before [Command edit], press the [SET] key one more time.

As shown, command edit can be divided into command selection and property entry. And property entry can be divided into 3 parts.

① Numeric type
– Numeric parameter(V%, V!, ...) and integer, real number, numeric function etc.
② Character type – Character constant, Character parameter, Character function etc.
③ Pose type – Pose constant, pose parameter, shift parameter etc.

3.3.5. Summary of operating key

Table 3-1 Summary of operating key

Operating key	Address area	Command area	
		Sentence cursor	Word cursor
[SHIFT]+ [POSE MOD]	Current step position edit ***(Hidden pose correction)***	◀	-
[ESC]	Moves the cursor to command area and changes content of menu frame	-	Cancels the entered value in input frame, shifts to sentence cursor and changes the content of menu frame
[Pose MOD]	Hidden pose move Add command	◀	-
[SHIFT]+ [Delete]	-	Deletes selected command and deletes program selected at step 0 location	-
[SET]	Reflects the line number entered in input frame to address area	Shifts to word cursor	Reflects property value entered in input frame to cursor location or shifts to sentence cursor when data setting is completed
[Speed]	Increase/decrease speed level in title frame, changes the step record speed in edit frame	◀	◀
[SHIFT]+ [WEAVON]	Adds WEAVON command in arc welding environment	◀	-
[SHIFT]+ [WEAVOF]	Adds WEAVOF command in arc welding environment	◀	-
[PF2] in initial screen	Shows [Block edit] and enables block editing	Shows [System] and enables various system parameter settings	Varies by command and property
[Arrow[⇑][⇓]	Moves the cursor up and down	◀	If there is a '+' on the right end, it scrolls the menu frame up and down. If there is no '+' on the right end, the word cursor moves up and down the lines
[Arrow][⇐]	Moves the cursor to command area	Moves the cursor to address area	Moves the word cursor to the left property
[Arrow][⇒]	Moves the cursor to command area	Moves the cursor to address area	Moves the word cursor to the right property

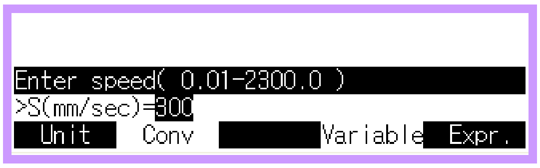
Operating key	Address area	Command area	
		Sentence cursor	Word cursor
[SHIFT]+ [⇑][⇓]	Page Up/Down	◀	-
[SHIFT]+ [⇐][⇒]	Moves the cursor left/right in input frame	-	Moves the cursor left/right in input frame and moves the cursor by 5 Characters in Character input condition
[BS]	First, it deletes the input frame address and during data entry, it deletes the number left to the cursor	-	First, it deletes the content in the input frame and during data entry, it deletes the number left to the cursor
[SHIFT]+ [Program]	Receives the program number and loads the applicable program	◀	◀
[Step]	Receives the step number, moves to the directed step	◀	◀
[Help]	Shows help screen of each command	◀	◀
[QuickOpen]	Shows you content or condition screen of each status	◀	-

3.4. Parameter, Formula and Character edit

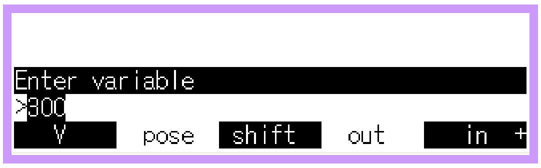
This explains how to edit parameter, Formula or Character during command property editing process.

3.4.1. Parameter edit

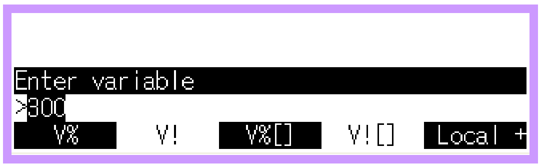
(1) We will use speed entry screen as an example. To edit the speed with parameter,



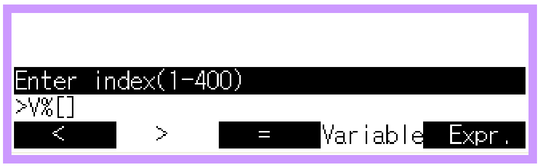
(2) Press the 『[PF4]: Variable』 key and move to parameter entry condition.



(3) Select V parameter by pressing 『[PF1]: V』 key.

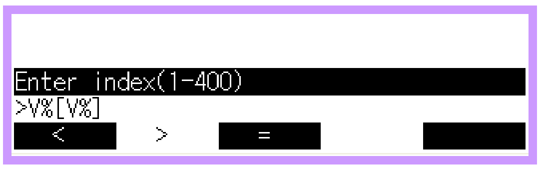


(4) Select the parameter type by pressing 『[PF3]: V%[ ]』 key.



(5) If you select a parameter type with scripts, the cursor is located to the script entry position Use the [Number] key to enter the script in the input frame and the script will be added right before the cursor.

(6) Press the 『[PF4]: Var.』 → 『[PF1]: V』 → 『[PF1]: V%』 key and select the parameter with script again.

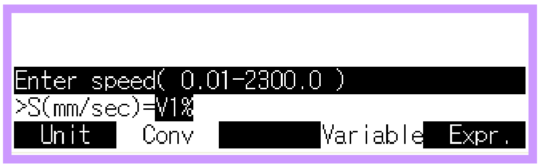


(7) Enter the number 2 using the [Number] key and press the [SET] key to reflect it to the edit frame.

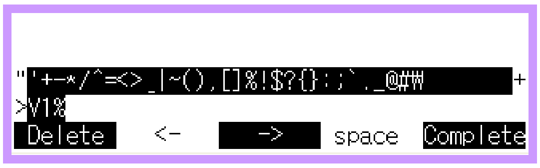
(8) Press the [SET] key one more time to return to sentence cursor.

3.4.2. Formula edit

(1) We will use speed entry screen as an example. Assuming that the current speed is V1%mm/sec, to edit the speed using the Formula.



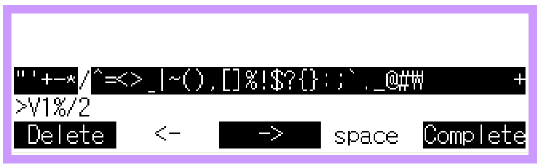
(2) Press the 『[PF5]: Expr.』 key to move to Formula entry condition.



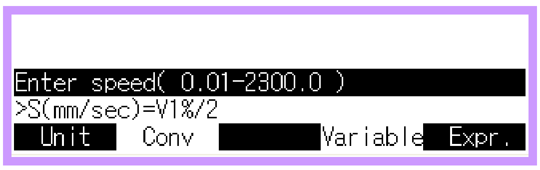
(3) The current value is highlighted. To ignore the existing data and enter new data, directly enter using the [Number] key. To modify the current data, press the 『[PF2]: <-』, 『[PF3]: ->』 key to switch the input from to normal condition with a cursor.

(4) Select the Character from the guide frame and press the [SET] key. The [Arrow] (<-,->) key moves the cursor by one letter and the [SHIFT]+ [Arrow] (<-,->) key moves by 5 letters.

(5) Set to cursor to "/" in the guide frame and press the [SET] key. Enter the number 2 with the [Number] key and you will see the following screen.



(6) Press the 『[PF5]: Complete』 key and it will return to the screen before Formula entry as shown below.



(7) Press the [SET] key to reflect the content in input frame to the edit frame.

(8) Press the [SET] key one more time to change to new command and return to sentence cursor.

3.4.3. Character edit

(1) We will use the speed entry screen as an example. Assuming that the current speed is V1%mm/sec, to edit the speed using the character,

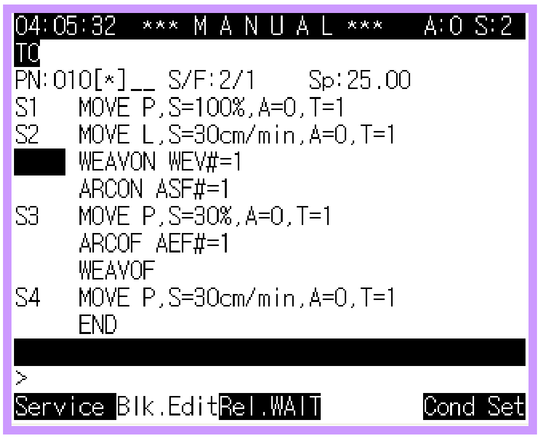
(2) Press the [SHIFT]+[Parameter/Formula/Variable] key to switch to the guide frame for character entry as shown below.

(3) Refer to the Formula, as the method of entry is same as Formula.

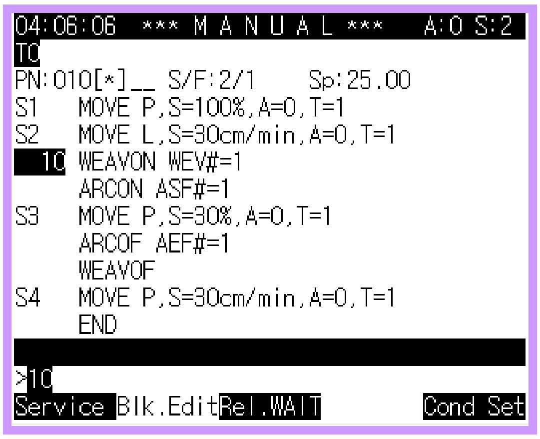
3.5. Line number edit

Line number can be set from 1 ~ 9999. You can enter the line number by using the [Number] key in address area and press the [SET] key when done.

(1) First, move the cursor to the address area and you will see the following screen.



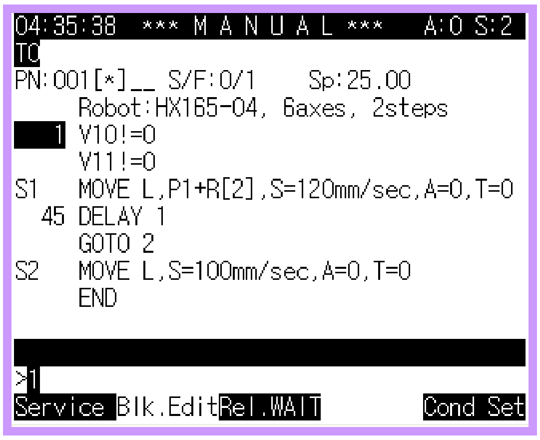
(2) Use the [Number] key to enter the number 10 and press the [SET] key.



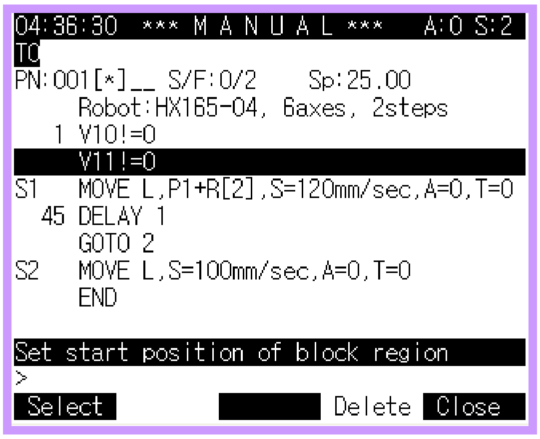
(3) The line number will be reflected in the edit frame.

3.6. Block edit

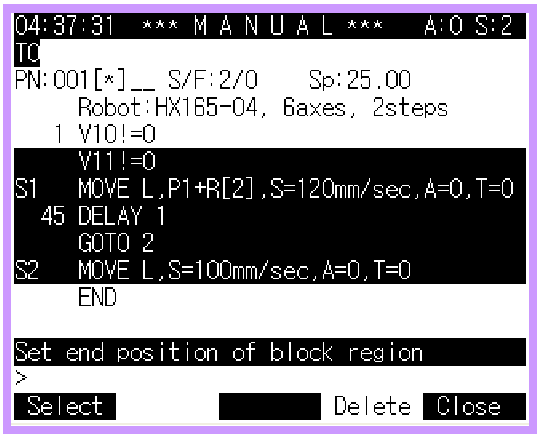
This copies a block of the program and enables the user to copy, cut or delete the block. The number of the control line including the step number is automatically changed after copying.



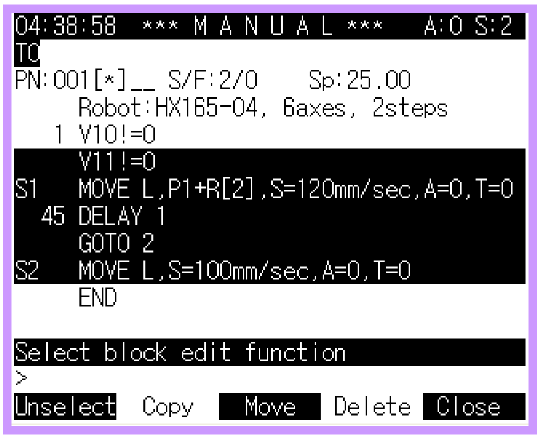
(1) To copy/cut/delete in line units, press the block edit 『[PF2]』 key. This will highlight all address and command area. Use the [Arrow] key to move the cursor to the starting line of the block selection.



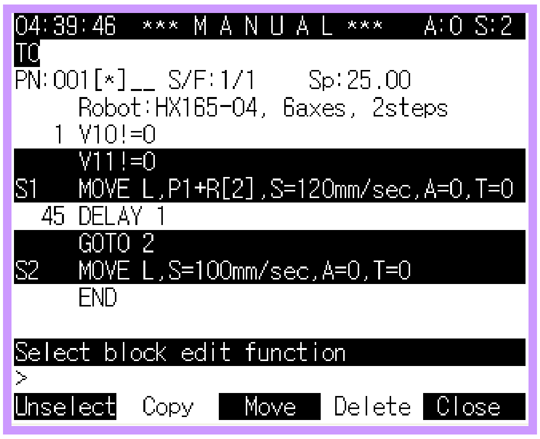
(2) Press the 『[PF1]』 key at the starting line of the block to select. Move to the last line of the block to select using the [Arrow] key. You will see the highlighted block as shown in the following screen.



(3) End the block selection at the last line using 『[PF1]』 key. The last line will blink meaning the copy and cut will be based on this line.



(4) Move the cursor to the line right before the line to copy by using the [Arrow] key. (45 DELAY 1 line)



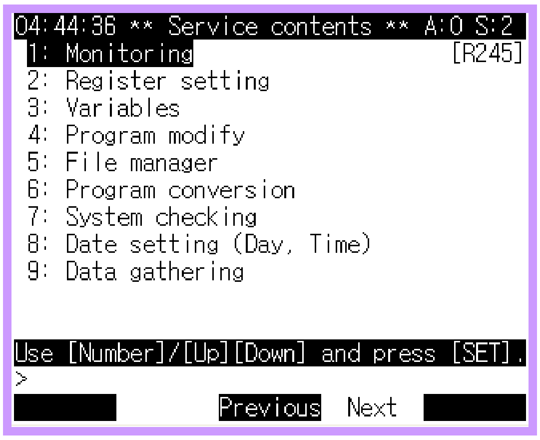
(5) If you press the [PF2] key, the selected block will be copied right below the line.

(6) Press the [PF5] key to return to the initial screen.

4 Service

4.1. Initial Screen

When『[PF1]: Service』 key is pressed on the initial screen of either manual or auto mode, the following screen appears.



Reference

- To selection sub menu, move the solarized bar to the chosen item by using [DIRECTION] and press [SET]. Or, type the number of the chosen item in the input frame by using [Number] and press [SET].

4.2. Monitoring

Monitoring indicates encoder value, angle, coordinates and data input/output state of each axis.

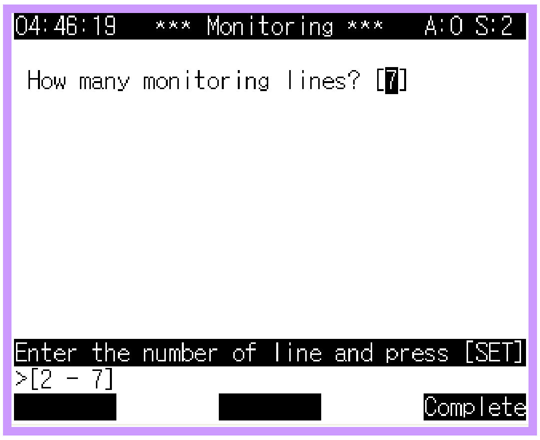
(1) Move from 『[PF1]: Service』 to 『1: Monitoring』 on the initial screen and selection sub menu as shown below.

```
04:45:53   *** Monitoring ***    A:0 S:2
   0: Monitor OFF
   1: Axis data
   2: DIO signal                    [R246]
   3: Spot/Stud welding data        [R247]
   4: Conveyor data
   5: Palletize data
   6: PLC Relay data                [R248]
   7: Analog data
   9: Servo hand data
  10: Cooperation control data
  11: System characteristic data
Use [Number]/[Up][Down] and press [SET].
>
  Line   Choose Previous  Next
```

Reference

- Changing number of lines

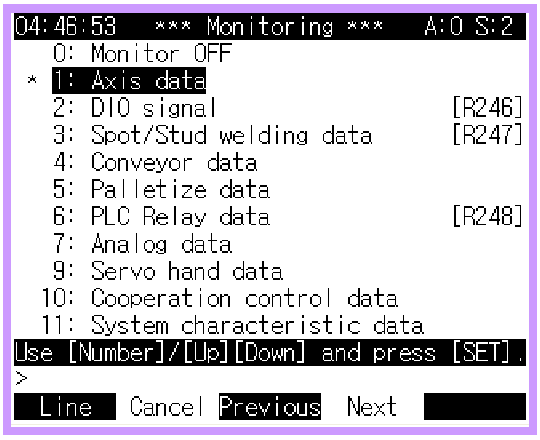
  ① By selecting 『[PF1]: Line』, number of lines on the screen can be changed between 2 and 7 in operating monitor functions.



  ② Type number of lines that will be shown on the screen, and press [SET] and then 『[PF5]: Complete』 for setup.

- Multiple Reference Monitoring Register and Indication

  ① Register monitor screen by using 『[PF2]: Choose』, and cancel the registration by using 『[PF2]: Cancel』. Registered monitoring screen has '*' next to the name on the menu, and '*' can be removed by using 『[PF2]: Cancel』.



  ② Up to 10 monitoring screens can be registered. To view registered monitoring screens, press [SHIFT]+[ESC] on the initial screen. Then, monitoring screens are viewed and changed according to the order of registration.

4.2.1. Basic Manipulation of Monitoring Functions

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → sub menu.

```
04:52:09  *** M A N U A L ***   A:0 S:2
TO
PN:001[*]__ S/F:1/0     Sp:25.00
     Robot:HX165-04, 6axes, 1steps
S1   MOVE L,S=100mm/sec,A=0,T=0
   Current Command    Angle  RobotCRD/mm
S :000000  000000  1076.5deg  X=     0.0
H :000000  000000  -987.9deg  Y=     0.0
V :000000  000000   969.6deg  Z=     0.0
R2:000000  000000  1057.4deg Rx=    -0.1
B :000000  000000 -1008.9deg Ry=     0.0
R1:000000  000000  1701.6deg Rz=     0.0

>
Service  System Rel.WAIT          Cond Set
```

(2) Possible manipulations on the screen as shown above are as follows.

Reference

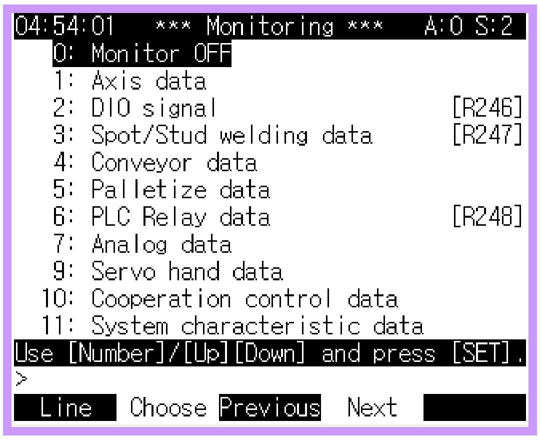
- **Monitoring screen toggle manipulation:**
  While a monitor function is applied, press [SHIFT]+[ESC] to stop the monitor function. To re-execute the monitor function, press [SHIFT]+[ESC] again.

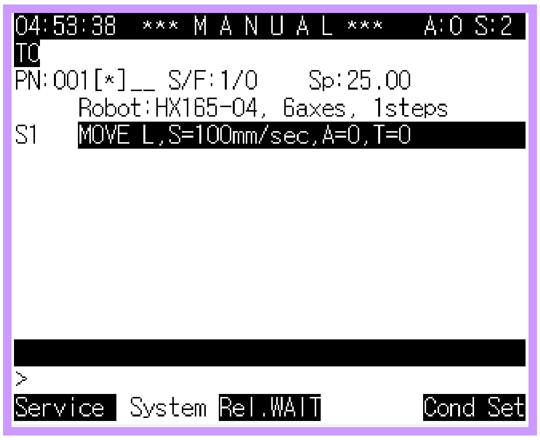
- **Monitoring screen indication area adjustment:**
  While a monitor function is used, monitoring area is adjusted by [SHIFT]+[↓][↑](up/down).

4.2.2. Monitor OFF

Monitor OFF cancels Previously selection monitoring. Use this function to remove monitoring screen.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『0: Monitor OFF』.

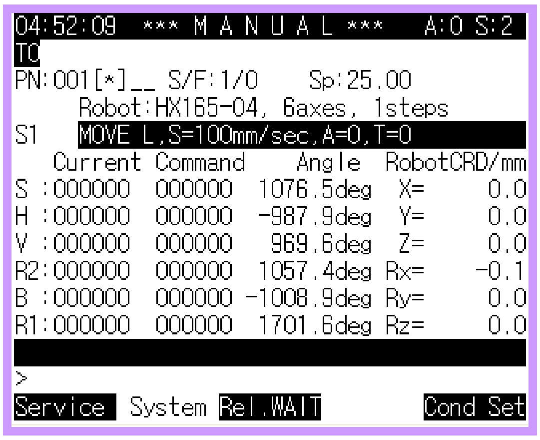




4.2.3. Axis Data

Axis Data indicates current encoder value, target encoder value, angle and coordinates of each robot axis.

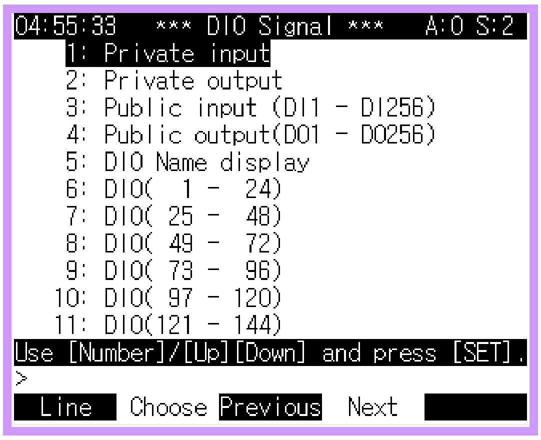
(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『1: Axis Data』.

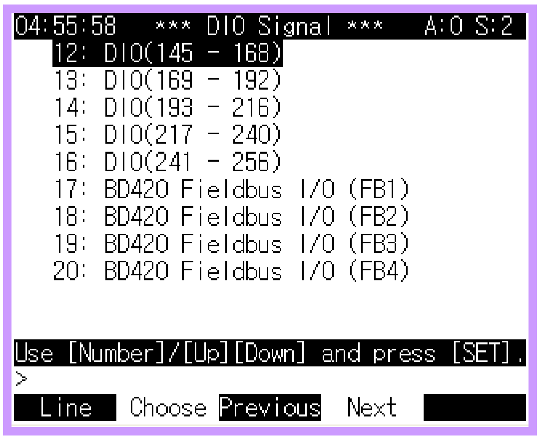


4.2.4. DIO signal

DIO signal indicates ON/OFF state in exclusive and general purpose DIO signals.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『2: DIO signal』 and choose an item to be monitored.





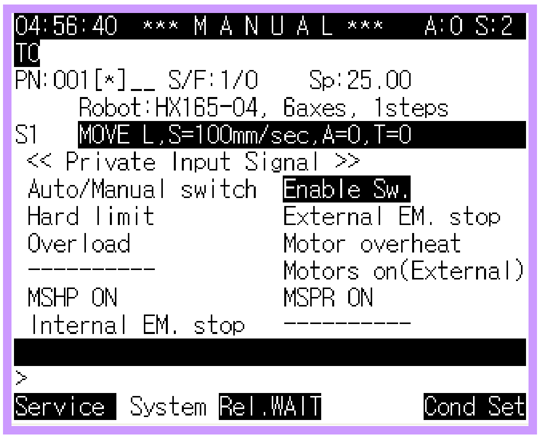
Reference

- 『R246 : DIO signal monitor』 of R code has the same function.

4.2.4.1. Private input

Private input indicates the state of exclusive input signal. Current exclusive input signal is highlighted.

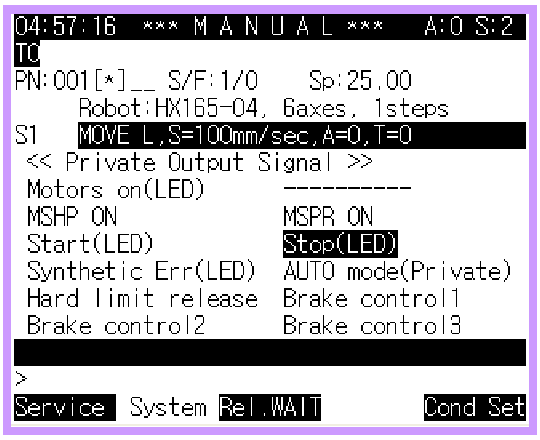
(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『2: DIO signal』 → 『1: Private input』.



4.2.4.2. Private output

Private output indicates the state of exclusive output signal. Current exclusive output signal is highlighted.

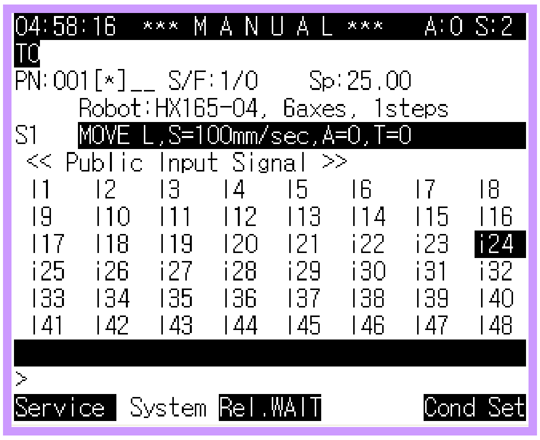
(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『2: DIO signal』 → 『2: Private output』.



4.2.4.3. Public input

Public input indicates the state of general purpose input signal. Public input means the signal inputted through the CNIN connector on the I/O board inside a controller.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『2: DIO signal』 → 『3: Public input』.



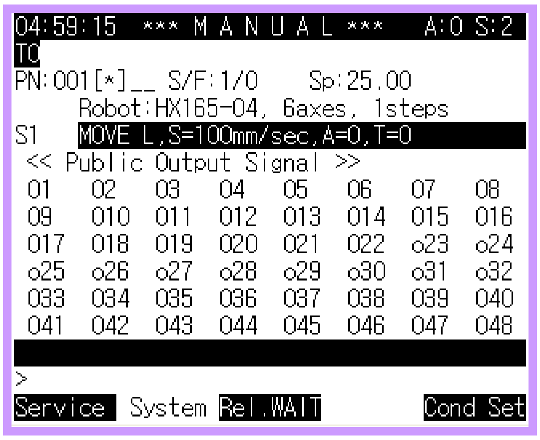
Reference

- Allocated general purpose input signals are indicated in lowercases, and the general purpose input signal currently inputted is highlighted.
  - Not allocated : I14 - Allocated : i14
  - Currently inputted : I14- Not inputted: I14

4.2.4.4. Public output

Public output indicates the state of general purpose output signal. Public output means the signal outputted through the CNOUT connector on the I/O board inside a controller.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『2: DIO signal』 → 『4: Public output』.



Reference

- Allocated signals are indicated in lowercases, and the signal currently inputted is highlighted.
  - Not allocated : O14 - Allocated : o14
  - Currently inputted : O14 - Not inputted : O14

4.2.4.5. DIO Name display

DIO Name display is used for confirming the name of DIO signals and the DIO state of signals.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『2: DIO signal』 → 『5: DIO Name display』.

```
05:02:41     *** DIO name ***     A:0 S:2
      1: Page 1
      2: Page 2
      3: Page 3
      4: Page 4

Use [Number]/[Up][Down] and press [SET].
>
             Previous  Next
```

(2) After a necessary page is selection, it is possible to check DIO name and monitor the state of signals.

```
05:08:11   *** M A N U A L ***    A:0 S:2
TO
PN:001[*]__ S/F:1/0    Sp:25.00
        Robot:HX165-04, 6axes, 1steps
S1      MOVE L,S=100mm/sec,A=0,T=0
 << DIO Name >>
  I1  :                 O1  :
  I2  :                 O2  :
  I3  :                 O3  :
  I4  :                 O4  :
  --------------       --------------
  --------------       --------------

>
Service  System Rel.WAIT           Cond Set
```

Reference

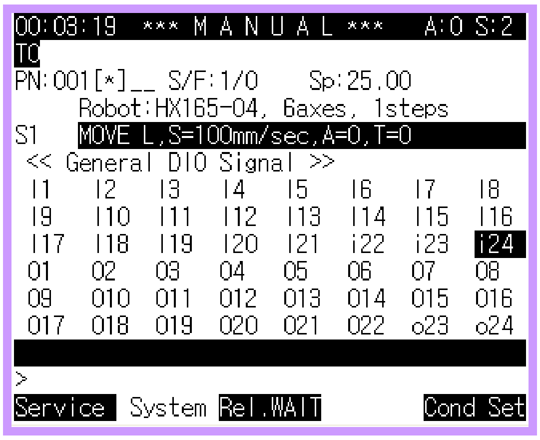
- To monitor DIO name tagging, selection 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『9: Editing DIO names』 and record names for DI/DO. Otherwise, the following message appears.

```
   10: DIO( 97 - 120)
   11: DIO(121 - 144)
Error! The program doesn't exist.   [ESC]
>
 Line        Previous  Next
```

4.2.4.6. DIO(1 -   24)
4.2.4.7. DIO(241 - 256)

Public DIO signal is indicated. Public DIO signal means the signal inputted/outputted through the CNIN/CNOUT connector on the I/O board inside a controller. This function indicates the same content as '2. Public Input' and '3. Public Output,' but the states of DIO signals can be checked on the same screen.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『2: DIO signal』 → 『6: DIO(1-24)』 on the initial screen of either manual or auto mode.



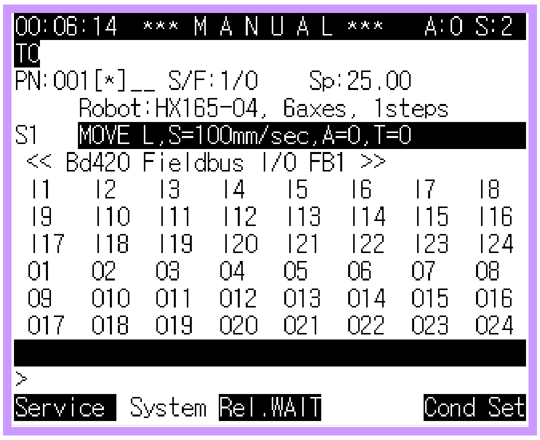
Reference

- Allocated signals are indicated in lowercases, and the signal currently inputted is highlighted.
  - Not allocated : O14 - Allocated : o14
  - Currently inputted : O14 - Not inputted : O14

4.2.4.8. BD420 Fieldbus I/O (FB1), (FB2), (FB3), (FB4)

BD420 Fieldbus I/O (FB1), (FB2), (FB3), (FB4) indicates the state of I/O signals of fieldbus channel 1~4.

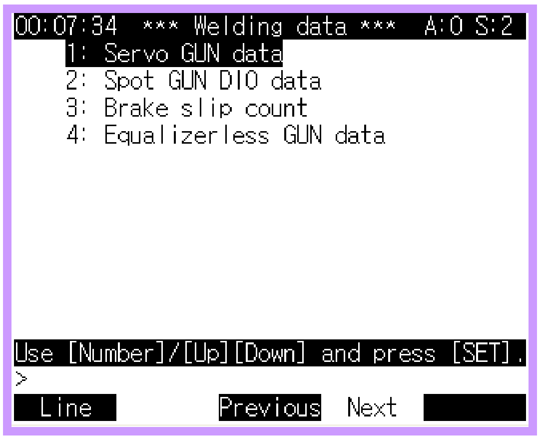
(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『2: DIO signal』 → 『17: BD420 Fieldbus I/O (FB1)』. (Or, choose one among F2~F4.)



4.2.5. Spot/Stud welding data

Spot/Stud Welding Data indicates the state of DIO signal used for spot/stud welding.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『3: Spot/Stud Welding Data』.



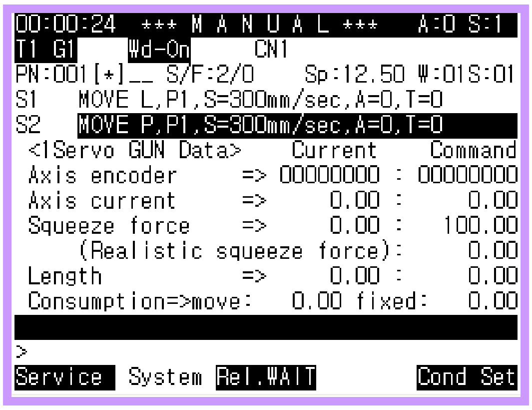
Reference

- 『R247 : Spot welding data monitor』 of R code has the same function.

4.2.5.1. Servo GUN data

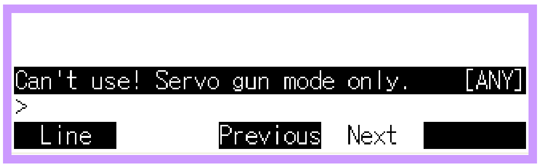
Servo gun Data indicates data on encoder, current, pressure when a servo gun is used, actual pressure measured during welding and the distance/abrasion between moving electrode and fixed electrode.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『3: Spot/Stud Welding Data』 → 『1: Servo GUN data』 on the initial screen of either manual or auto mode.



Reference

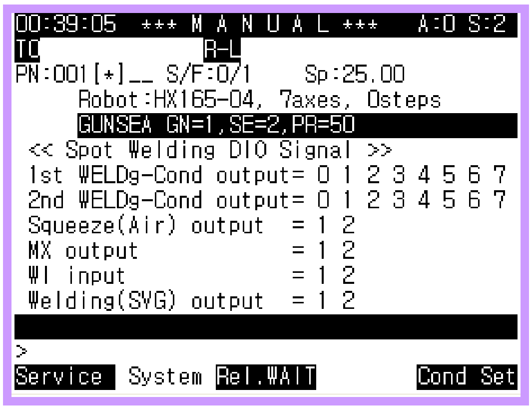
- For servo GUN data monitoring, register an additional axis as a servo gun. Otherwise, the following message appears.



4.2.5.2. Spot GUN DIO Data

Spot Gun DIO Data indicates the state of welding condition signal, GUN signal, MX signal and welding completion input signal when pneumatic gun is used.

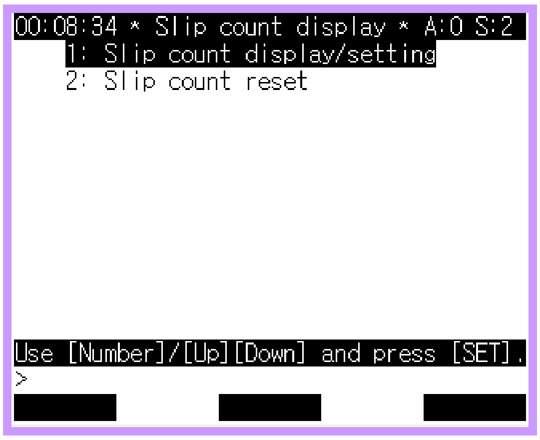
(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『3: Spot/Stud Welding Data』 → 『2: Spot Gun DIO Data』.



4.2.5.3. Brake slip count

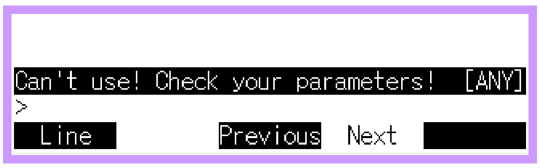
During stud welding (brake On method) brake slip occurs due to pressure resistance. Brake slip count indicates the number of counts exceeding the brake slip range, and perform setup and Initialize.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『3: Spot/Stud Welding Data』 → 『3: Brake slip count』 on the initial screen of either manual or auto mode.



Reference

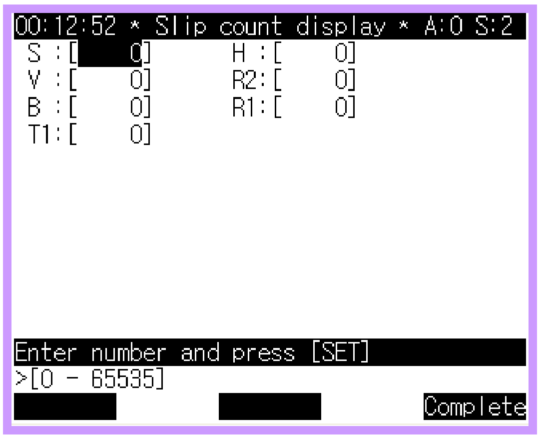
- For Brake slip count monitoring, selection 『[PF2]: System』 → 『5: Initialize』 → 『4: Setting usage of the robot』 and set GUN 1 or GUN 2 as Stud. Otherwise, the following message appears.



4.2.5.3.1. Slip count display/setting

Slip Count Indication/Setup indicates brake slip count that occurs at each axis, and sets a certain number of slip count.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『3: Spot/Stud Welding Data』 → 『3: Brake slip count』 → 『1: Slip count display/setting』



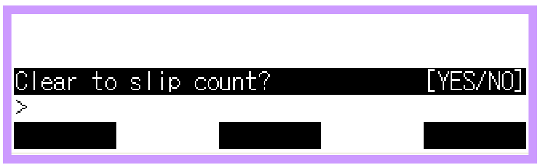
(2) Input brake slip count of each axis, and press [SET].

(3) To store the setup change, press 『[PF5]: Complete』. If [ESC] is pressed, changed data is not stored.

4.2.5.3.2. Slip count reset

Slip Count Reset initializes slip count of every axis.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『3: Spot/Stud Welding Data』 → 『3: Brake slip count』 → 『2: Slip count reset 』.



(2) [YES] initializes slip count of every axis at 0, and [NO] esc Initialize.

4.2.5.4. Equalizerless GUN data

Equalizerless Gun Data indicates welding condition number, pressure, 2-stage stroke, DIO signal state for welding completion and fix tip consumption.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『3: Spot/Stud Welding Data』 → 『4: Equalizerless GUN data』.

```
00:21:20  *** M A N U A L ***   A:0 S:2
TO G1
PN:001[*]__ S/F:2/0    Sp:25.00
     Robot:HX165-02, 7axes, 2steps
S1   MOVE L,P1,S=300mm/sec,A=0,T=0
S2   MOVE P,P1,S=300mm/sec,A=0,T=0
 <Equalizerless GUN Data>  Gun1    Gun2
 Welding CND number(M33) =  xxx     xxx
 Squeeze output          =  OFF     OFF
 Two step stroke output  =  OFF     OFF
 Welding complete input  =  OFF     OFF
 Fixed tip consumption   = 0.00

>
Service  System Rel.WAIT        Cond Set
```

Reference

- For equalizerless gun data monitoring, selection 『[PF2]: System』 → 『5: Initialize』 → 『4: Setting usage of the robot』, set GUN 1 or GUN 2 as Spot, and set the appropriate pneumatic GUN1 or pneumatic GUN2 as EQ'less.

```

Can't use! Check your parameters!  [ANY]
>
  Line          Previous  Next
```

4.2.6. Conveyor Data

Conveyor Data indicates robot axis data, Conveyor pulse count, Conveyor register and Conveyor speed.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『4: Conveyor Data』.

```
00:34:40   *** M A N U A L ***    A:0 S:2
TC                    CN1
PN:xxx[ ]__ S/F:0/0     Sp:25.00


   Current  Command    Angle  RobotCRD/mm
S :000000  000000  1076.5deg  X=     0.0
H :000000  000000  -987.9deg  Y=     0.0
V :000000  000000   969.6deg  Z=     0.0
R2:000000  000000  1057.4deg CP=       0
B :000000  000000 -1008.9deg CR=     0.0
R1:000000  000000  1701.6deg CS=     0.0

>
Service  System Rel.WAIT         Cond Set
```

Reference

- To use Conveyor function, selection 『[PF2]: System』 → 『5: Initialize』 → 『2: Robot Type Selection』, and set Conveyor use as <ENBL>. Otherwise, the following message appears.

```

Can't use! Check your parameters!   [ANY]
>
  Line          Previous  Next
```

4.2.7. Palletizing Data

Palletizing Data indicates work state of palletizing, pattern register number, palletizing counter, the number of total work pieces and work piece size.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『5: Palletize Data』.

```
00:42:19  *** M A N U A L ***    A:0 S:2
TC
PN:xxx[ ]__ S/F:0/0     Sp:25.00


 SFT+[<-][->]<Pa01> <Pa02> <Pa03> <Pa04>
Work state   :  OFF    OFF    OFF    OFF
Pattern Reg  :    0      0      0      0
Counter      :    0      0      0      0
Total No.    :    0      0      0      0
Work size(W):   0.0    0.0    0.0    0.0
Work size(L):   0.0    0.0    0.0    0.0

>
Service  System Rel.WAIT        Cond Set
```

(2) To show unseen items, press [SHIFT]+[⇒] and [SHIFT]+[⇓].

Reference

- For palletizing data monitoring, selection 『[PF2]: System』 → 『5: Initialize』 → 『4: Setting usage of the robot』, and set GUN 2 as “Palletizing”. Otherwise, the following message appears.

```

Can't use! Check your parameters!  [ANY]
>
  Line          Previous  Next
```

4.2.8. PLC Relay Data

PLC Relay Data indicates the state of contact points when Embedded PLC is used.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『6: PLC Relay Data』.

```
00:43:59  ** PLC Relay data **   A:0 S:2
    1: PLC X Relay (External Input)
    2: PLC Y Relay (External Output)
    3: PLC R Relay (Auxiliary)
    4: PLC K Relay (Nonvolatile)
    5: PLC T Relay (Timer)
    6: PLC C Relay (Counter)
    7: PLC SP Relay (Special)
    8: PLC DI Relay (PLC Output)
    9: PLC DO Relay (PLC Input)
   10: PLC MW Relay (Data Memory)
   11: PLC SW Relay (System Memory)
Use [Number]/[Up][Down] and press [SET].
>
  Line   Choose Previous  Next
```

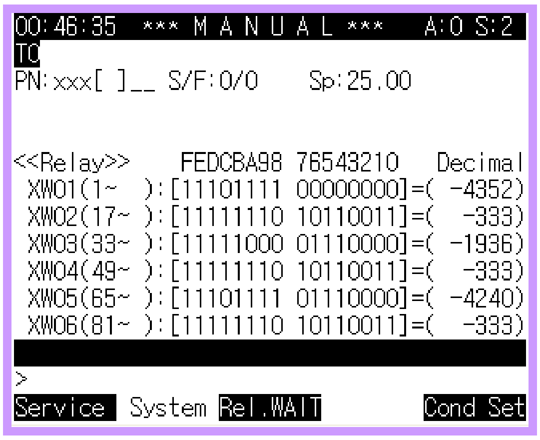
Reference

- 『R248 : PLC Relay Data Monitor』 of R code has the same function.

4.2.8.1. PLC X Relay (External Input)

PLC X Relay (External Input) indicates the state of signals inputted through standard IO board and Expansion IO board.

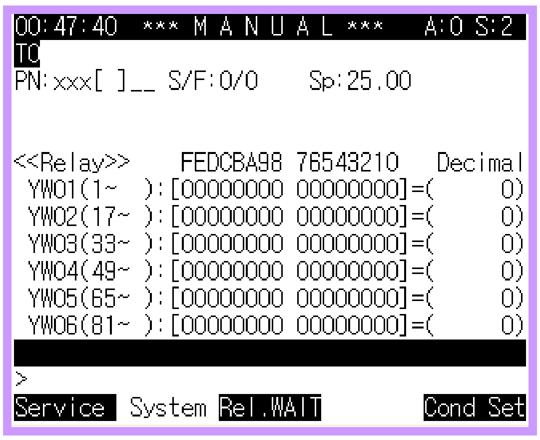
(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『6: PLC Relay Data』 → 『1: PLC X Relay (External Input)』 on the initial screen of either manual or auto mode.



4.2.8.2. PLC Y Relay (External Output)

PLC Y Relay (External Output) indicates the state of signals outputted through standard IO board and expansion IO board.

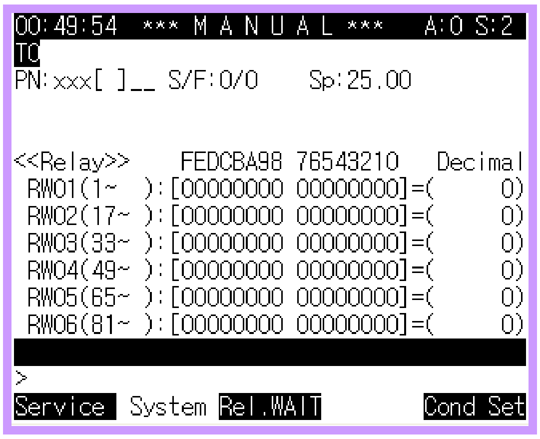
(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『6: PLC Relay Data』 → 『2. PLC Y Relay (External output)』.



4.2.8.3. PLC R Relay (Auxiliary)

PLC R Relay (Auxiliary) indicates the state of auxiliary relay used for PLC program.

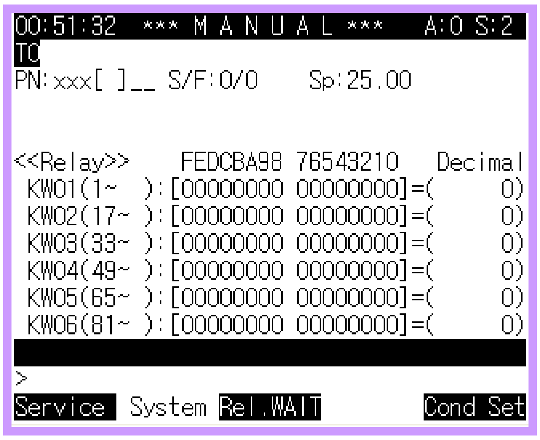
(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『6: PLC Relay Data』 → 『3. PLC R Relay (Auxiliary)』.



4.2.8.4. PLC K Relay (Nonvolatile)

PLC K Relay (Nonvolatile) indicates ON/OFF state is kept while power is off.

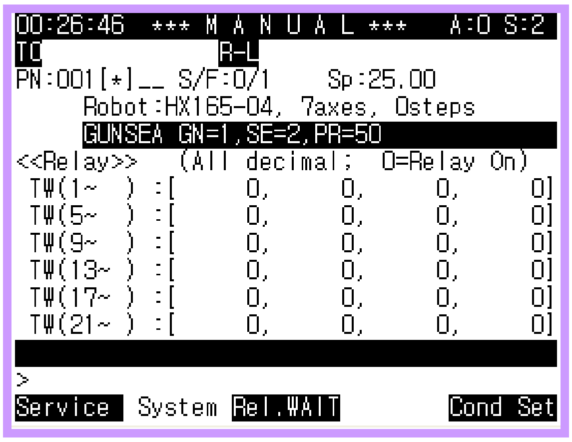
(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『6: PLC Relay Data』 → 『4: PLC K Relay (Nonvolatile)』.



4.2.8.5. PLC T Relay (Timer)

PLC T Relay is for timer function. When the value is 0, contact point is ON. Even in case of electricity failure, the value of PLC T Relay (Timer) is maintained.

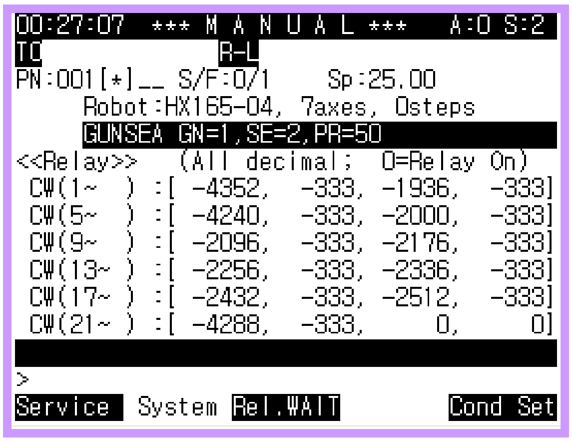
(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『6: PLC Relay Data』 → 『5: PLC T Relay (Timer)』.



4.2.8.6. PLC C Relay (Counter)

PLC C Relay is for counter function. When the value is 0, contact point is ON. Even in case of electricity failure, the value of PLC C Relay (Counter) is maintained.

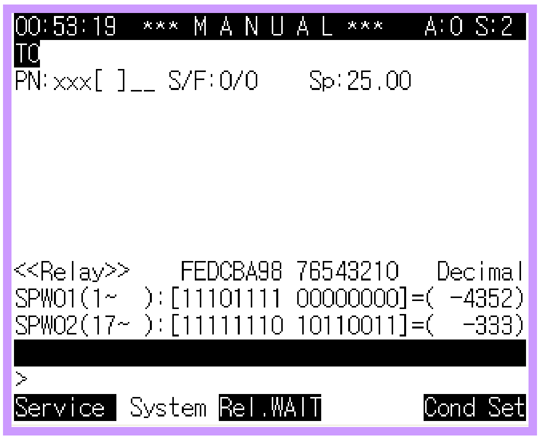
(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『6: PLC Relay Data』 → 『6: PLC C Relay (Counter)』.



4.2.8.7. PLC SP Relay (Special)

PLC SP Relay (Special) is for a special purpose. Refer to 『Embedded PLC Function Manual』 for details.

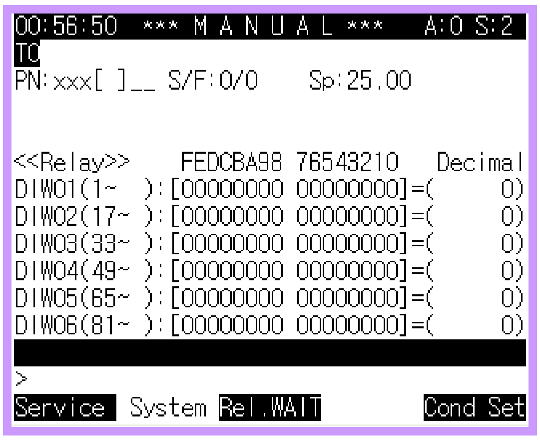
(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『6: PLC Relay Data』 → 『7: PLC SP Relay (Special)』.



4.2.8.8. PLC DI Relay (PLC Output)

PLC DI Relay (PLC Output) is to monitor the value inputted in PLC.

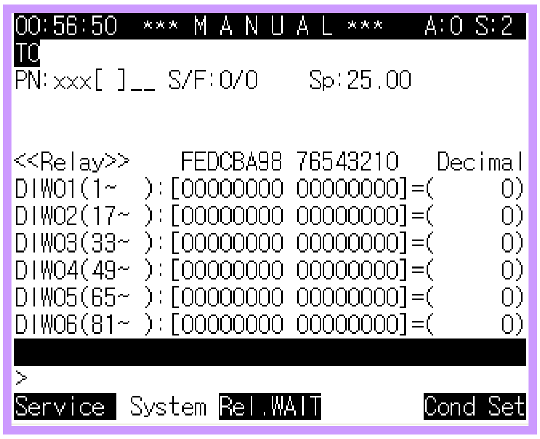
(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『6: PLC Relay Data』 → 『8: PLC DI Relay (PLC Output)』.



4.2.8.9. PLC DO Relay (PLC Input)

PLC DO Relay (PLC Input) is to monitor the value outputted from PLC.

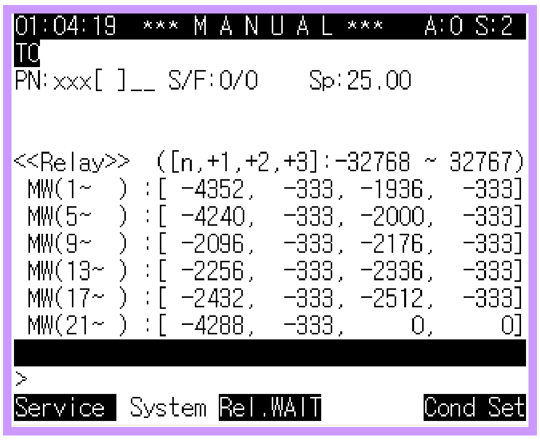
(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『6: PLC Relay Data』 → 『9: PLC DO Relay (PLC Input)』.



4.2.8.10. PLC MW Relay (Data Memory)

PLC MW Relay (Data Memory) is to store or retrieve the data asked by applied order. Even in case of electricity failure, the value of PLC MW Relay (Data Memory) is maintained.

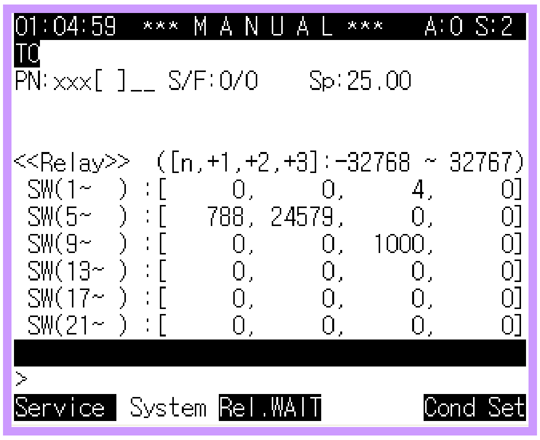
(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『6: PLC Relay Data』 → 『10: PLC MW Relay (Data Memory)』.



4.2.8.11. PLC SW Relay (System Memory)

PLC SW Relay (System Memory) is for a special purpose. Refer to 『Embedded PLC Function Manual』 for details.

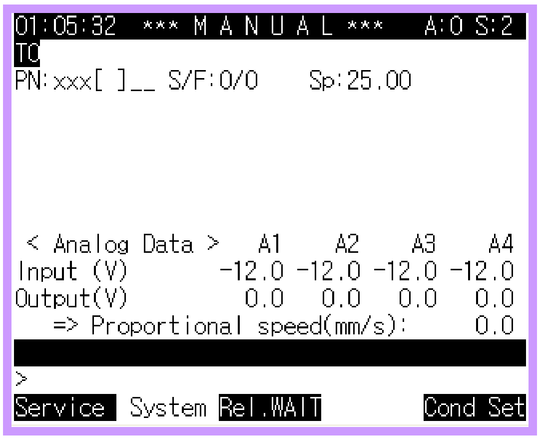
(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『6: PLC Relay Data』 → 『11: PLC SW Relay (System Memory)』.



4.2.9. Analog Data

Analog Data indicates input/output of voltage per robot pace and speed regarding analog output value by each analog port, when 『[PF2]: System』 → 『4: Application parameter』 → 『7: Volt. output proportional to speed』 is selectioned. Refer to 『[PF2]: System』 → 『4: Application parameter』 → 『7: Volt. output proportional to speed』 for details.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『7: Analog Data』.



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4.2.10. Servo hand data

Servo hand data indicates position data, current data, pressure data, distance between hands when servo hand is used for palletizing work. Refer to 『Servo Hand Function Manual』 for details.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『9: Servo hand data』.

```
01:10:34  *** M A N U A L ***    A:0 S:2
TO         SH-On
PN:xxx[ ]__ S/F:0/0     Sp:25.00




 <Servo Hand Data>    Current     Command
 Axis encoder      => 003E92F3 : 003E92F3
 Axis current      =>     0.00 :     0.00
 Squeeze force     =>     0.00 :     0.00
 Hand length       =>     0.00 :     0.00

>
Service  System Rel.WAIT         Cond Set
```

Reference

- For servo hand axis monitoring, set additional axis as <Hand> axis. Otherwise, the following message appears.

```

Can't use! Check your parameters!   [ANY]
>
  Line          Previous  Next
```

4.2.11. Cooperative Control Status Monitor

Applied Version

- Since Main V10.07-25

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『10: Cooperation control status』.

```
01:12:53 *** Cooperate data *** A:0 S:2
    1: Cooperation control status
    2: Hinet I/O [GE1~GE4]
    3: Hinet I/O [GE5~GE8]
    4: Hinet I/O [GE9~GE12]
    5: Hinet I/O [GE13~GE16]









Use [Number]/[Up][Down] and press [SET].
>
  Line   Choose Previous  Next
```

(2) Selection 『1: Cooperation control status』.

```
01:13:57  *** M A N U A L ***   A:0 S:2
TQ
PN:xxx[ ]__ S/F:0/0    Sp:25.00



 Status    Robot1  Robot2  Robot3  Robot4
Motor ON :------  ------  ------  ------
Man./Auto:------  ------  ------  ------
Jogging  :------  ------  ------  ------
Playback :------  ------  ------  ------
Error    :------  ------  ------  ------

>
Service  System Rel.WAIT         Cond Set
```

- Motor ON
  Indicates operation readiness (ON/OFF) of each robot.

- Man./Auto
  Indicates that each robot is set as manual/auto mode.

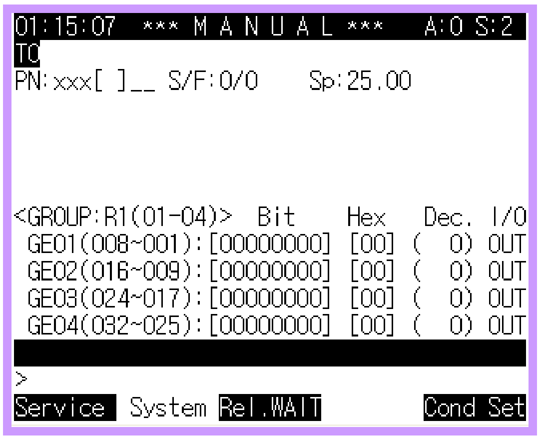
- Jogging : Indicates robot's manual mode cooperative state.
  Indiv. : Individual manipulation state
  Master : Set as MASTER in a cooperative manipulation state
  Slave : Set as SLAVE in a cooperative manipulation state

- Playback : Indicates the cooperative state when a robot performs a task.
  Stop : Not performing.
  Independent: Independently performing a task.
  Standby : Under COWORK command, waiting for a partner robot to be ready for cooperative position.
  Cooperation : performing cooperation work.

- Error
  Indicates recent error states of each robot. Error state clears when a robot moves.

(3) Selection HiNet I/O monitor 『2~5: Hinet I/O』 and set area (2~5) to be monitored. 4-byte area is shown on the screen.

(4) For example, if No.1 and then GE1~GE4 is selectioned, the following screen will appear. Signals are expressed in bit, hexadecimal and decimal, and indicate whether output or input according to each role.



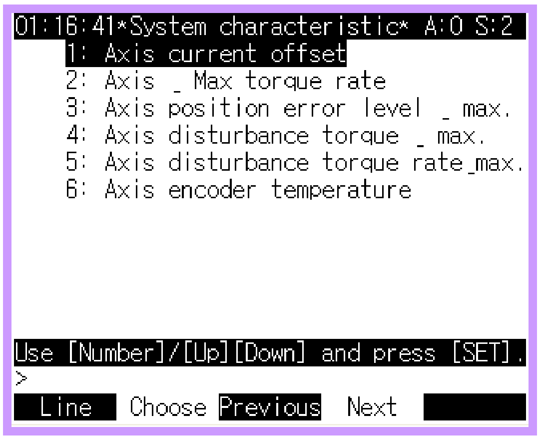
(5) As to robot 1, GE1~4 (output areas) are shown as OUT and GE5~16 (input areas) are shown as IN.

(6) Output areas of robot 2 are GE5~8, robot 3's are GE9~12, and robot 4's are GE13~16.

4.2.12. System characteristic data

By viewing System characteristic data in person, users can check if a robot and a controller are in a normal state and if a work program is appropriate for the robot.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『11: System characteristic data』.

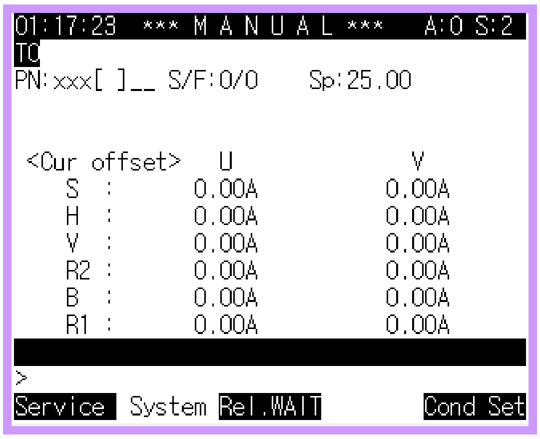


(2) Each sub menu can be selectioned and monitored.

4.2.12.1. Axis current offset

Current offset is the current amount found when there is no current running. If this value is too high, normal current control will be impossible, and a robot cannot perform its normal ability. Axis Current Offset checks if current control has a problem by monitoring current offset amount running in each axis.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『11: System characteristic data』 → 『1: Axis Current Offset』.



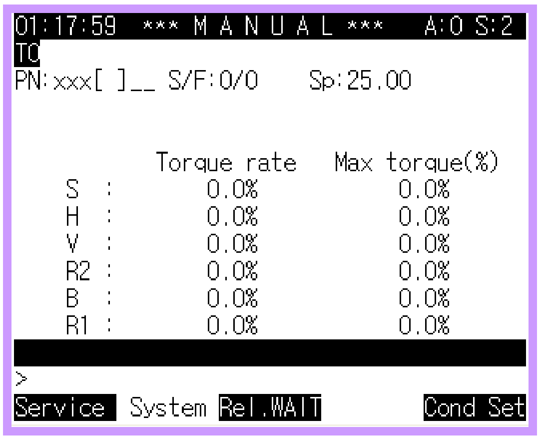
Reference

- Current offset running in U and V of each axis is expressed as Ampere peak.
- Current offset should be renewed only when the motor is off.

4.2.12.2. Axis & Max torque rate

Axis Load Factor and Max expresses the load amount for each robot axis at the rate of the rated torque of each motor. Load factor indicates instant load factor. Maximum load factor is the maximum load factor measured while the controller power is ON.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『11: System characteristic data』 → 『2: Axis & Max torque rate』.



(2) Load factor of each axis indicates the rate of current torque to rated torque. Load factor of each axis ranges from 0 [%] to Ipeak/Irate x 100 [%] and can exceed 100% for an instant while a robot moves.

(3) Excess load error detection
If load exceeds 100% when a robot is not moving, or if load exceeds 100% for a while when a robot is moving, excess load error (E0119) will occur.

(4) Maximum load factor reset
Use the R300 command of R code in order to re-measure the maximum load factor.

Reference

- Meaning of load factor

① Load factor formula
Load factor = Icurrent(actual current) / Irate(rated current) x 100 [%]
Load factor: value shown on monitor
Icurrent: actual current running in the motor. Current feedback which [Ap] DSP(BD440) reads from current sensor of AMP.

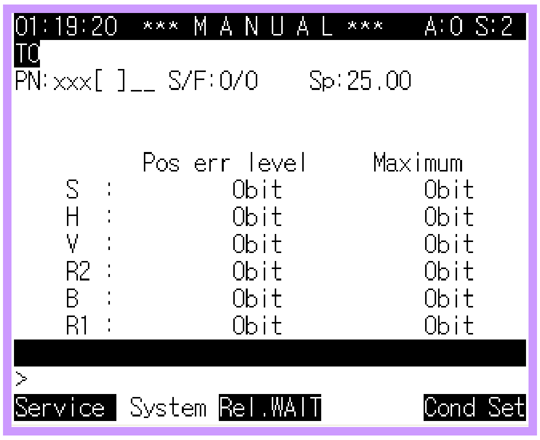
② Rated current Irate : = Ir(servo loop gain) x 0.01
Irate is set as a value within the rated torque(current) allowed by motor, reduction gear and AMP. If motor current exceeds Irate for a while, excess load error will occur.

③ Instant maximum current Ipeak : = Ip(servo loop gain) x 0.01
Ipeak is set as a value within instant maximum torque(current) allowed by motor, reduction gear and AMP, and used as a limit of current command.

4.2.12.3. Axis position error level & max.

Deviation occurs in robot movements. Deviation is difference between position command and actual position. Deviation value increases according to the increase/decrease pace of robot. However, deviation value increases drastically in unusual situations where a robot carries excess load or collision takes place. When deviation value exceeds a set deviation level, error stop occurs. Users can monitor instant and maximum value of deviation.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『11: System characteristic data』 → 『3: Axis position error level & max.』.



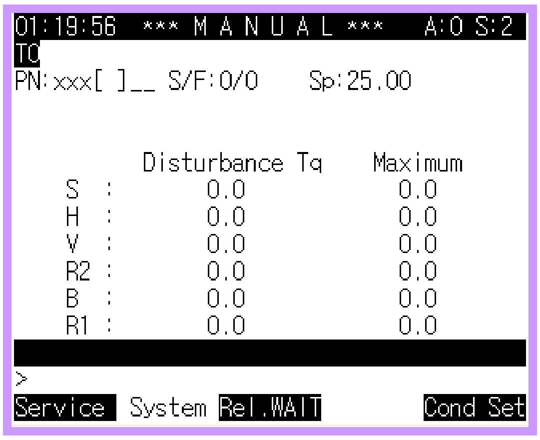
(2) Deviation is expressed in encoder bit.

(3) Deviation error detection
If deviation of each axis exceeds a set deviation error detection level, deviation error will occur.

(4) Deviation maximum reset
Use the R300 command of R code in order to re-measure the maximum deviation.

4.2.12.4. Axis disturbance torque & max.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『11: System characteristic data』 → 『4: Axis disturbance torque & max.』.



(2) Maximum disturbance torque reset
Use the R300 command of R code in order to re-measure the maximum disturbance torque.

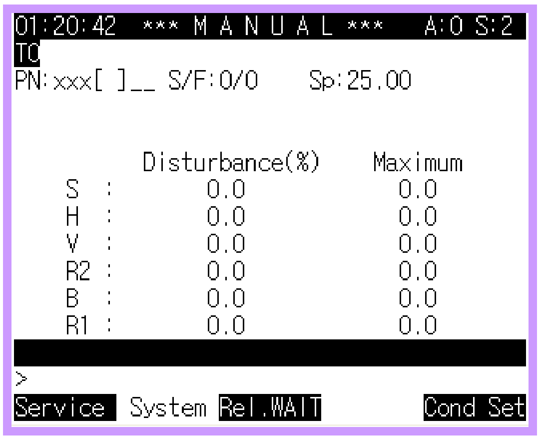
Reference

- Axis disturbance torque & max. is to tune a Collision detection setting which minimizes damage due to the collision between a robot and peripheral devices. Selection 『[PF2]: System』 → 『3: Machine parameter』 → 『13: Collision detection setting』)

- To set a collision detection level according to the maximum and change rate of disturbance torque, users can use “Axis disturbance torque & max.” and “Axis disturbance torque rate&max.” monitoring.

4.2.12.5. Axis disturbance torque rate&max.

(1) Selection 『[PF1]: Service』 → 『1: Monitoring』 → 『11: System characteristic data』 → 『5: Axis disturbance torque rate&max.』 on the initial screen of either manual or auto mode.



(2) Maximum disturbance torque change rate reset
Use the R300 command of R code in order to re-measure the maximum disturbance torque

Reference

- Same as the Reference of “Axis disturbance torque & max.”

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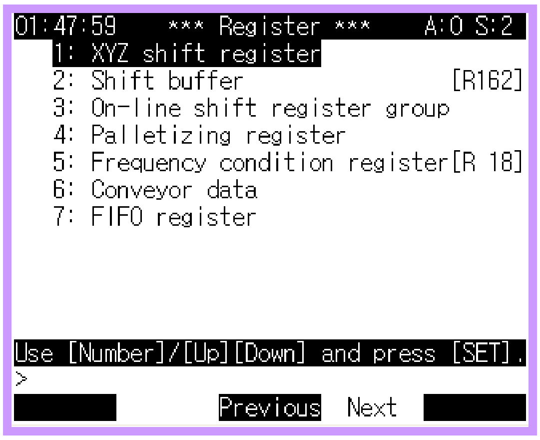
4.3. Register

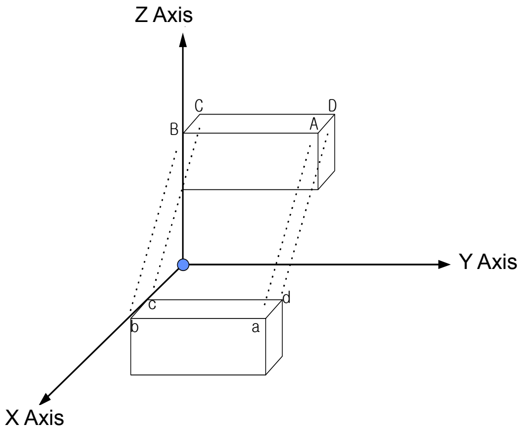
Register indicates and changes the value of XYZ shift register, shift buffer, On-line shift register group, palletizing register, frequency condition register, Conveyor data and FIFO register.

(1) Selection 『[PF1]: Service』 → 『2: Register setting』.



(2) Selection the necessary item and enter the sub menu.

4.3.1. XYZ Shift Register



XYZ shift register can be changed manually without 『SXYZ』 command or 『M58: XYZ Shift』.

XYZ shift is a horizontal move function which shifts to other XYZ coordinates, maintaining a Previously taught position. As seen on the right side, an original program with A, B, C, D can be horizontally shifted to a, b, c, d without additional teaching by using the XYZ shift function.

(1) Selection『[PF1]: Service』 → 『2: Register setting』 → 『1: XYZ Shift Register』.

(2) Input data in X,Y,Z and press [SET]. To store changed setup, press『[PF5]: Complete』. If [ESC] is pressed, changed data will not be stored.

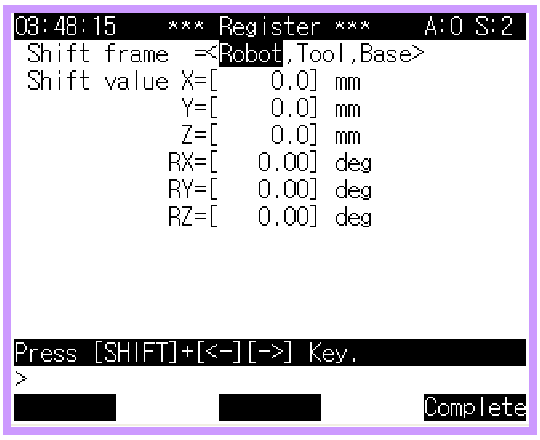
Reference

- If a shift value is set in『SXYZ』command or 『M58: XYZ Shift』, a register value will be automatically renewed.

4.3.2. Shift Buffers

Shift Buffers inputs shift amount in shift buffers and indicates the value when shift is performed by the online shift 『SONL』 function.

(1) Selection『[PF1]: Service』 → 『2: Register setting』 → 『2: Shift Buffers』. (OR『R162: Shift Register setting』)



(2) Set a shift standard coordinates. Options are robot, tool and base coordinates.

(3) Input shift data and press [SET]. To store changed setup, press 『[PF5]: Complete』. If [ESC] is pressed, changed data will not be stored.

Reference

- Horizontal move shift (in case of ‘Rx=Ry=Rz=0’)
  As seen below, horizontal move shift is used when point A, B, C, D and point a, b, c, d are parallel.

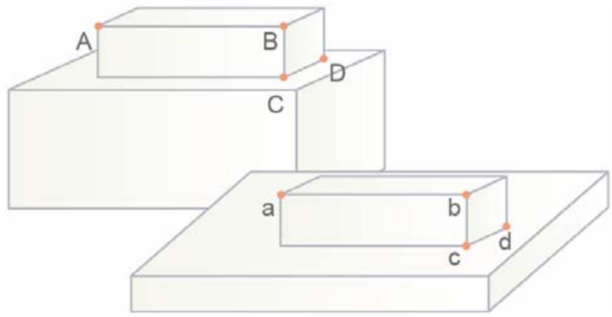


Fig 4.1 Horizontal move shift

- Angle Revision Shift (in case that at least one of Rx, Ry, Rz is not 0)
  Usually, work pieces are not located parallel. Work pieces can be shifted by revising their location and position. Users should calculate the relation between location and position of work pieces (A and a) in advance.

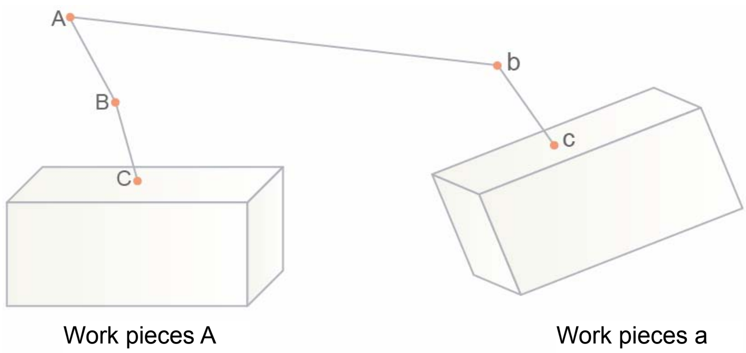
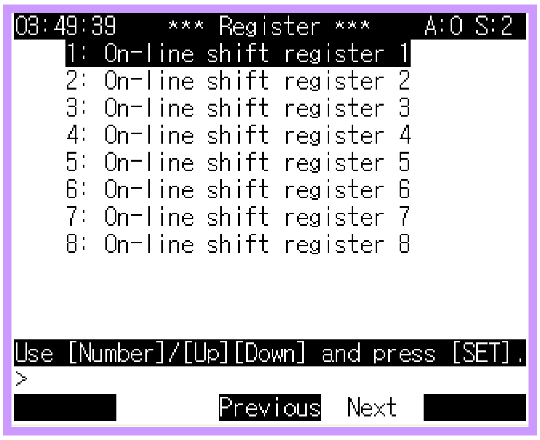


Fig 4.2 Angle revision shift

4.3.3. On-Line Shift Register Group

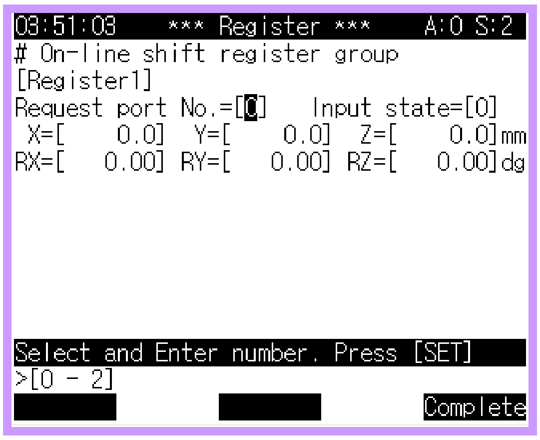
On-line shift register group stores shift amount received from external devices or palletizing length and spin value. There are eight groups in total.

(1) Selection 『[PF1]: Service』 → 『2: Register setting』 → 『3: On-line shift register group』.



(2) To set each register (1~8), enter sub menu.

(3) When On-line shift register 1 is selectioned, the following screen appears.



(4) Input data and press [SET]. To store changed setup, press 『[PF5]: Complete』. If [ESC] is pressed, changed data will not be stored.

- Shift Requirement Port sets serial port number which receives shift amount from external devices.
- When shift amount is reflected on position data of step, Shift Input becomes 1.

Reference

- Selection 『[PF5]: Condition setting』 → 『[PF1]: Application Condition』 → 『7: Shift register clear』, and set <ENBL>. Then, online shift register value automatically clears to 0 at beginning of a program.

4.3.4. Palletizing Register

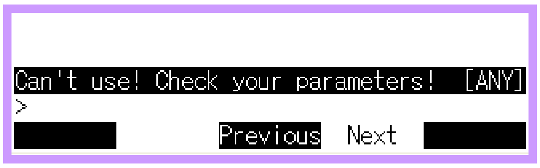
Refer to 『Palletizing Function Manual』 for details.

(1) Selection 『[PF1]: Service』 → 『2: Register Setting』 → 『4: Palletizing Register』.

(2) Selection sub menu for individual setup.

Reference

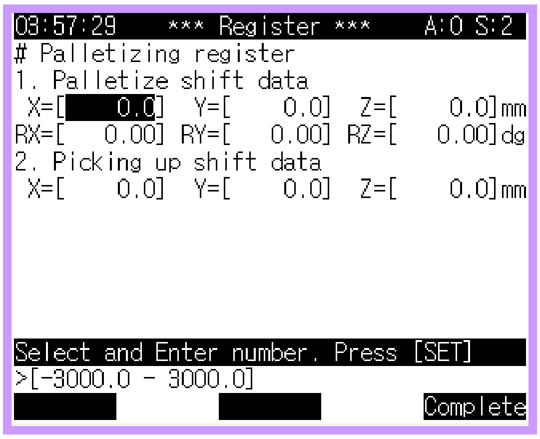
- To use palletizing register, selection 『[PF5]: System』 → 『5: Initialize』 → 『4: Setting usage of the robot』, and set GUN2 as "Palletizing". Otherwise, the following screen appears.



4.3.4.1. Palletizing Register

Palletizing Register helps users set palletizing shift amount manually.

(1) Selection 『[PF1]: Service』 → 『2: Register Setting』 → 『4: Palletizing Register』 → 『1. Palletizing Register』.



(2) Input data and press [SET]. If [ESC] is pressed, changed data will not be stored.

- Palletize shift data : Input palletizing shift amount.
- Picking up shift data : Input shift amount when work pieces are picked up.

4.3.4.2. Palletizing Preset

Palletizing Preset is used for setup of palletizing pallet number, palletizing pattern register number and number of starting work pieces in order to ask a robot a palletizing task.

(1) Selection 『[PF1]: Service』 → 『2: Register Setting』 → 『4: Palletizing Register』 → 『2: Palletizing Preset』.

(2) Input data and press [SET]. To store changed setup, press 『[PF5]: Complete』. If [ESC] is pressed, changed data will not be stored.

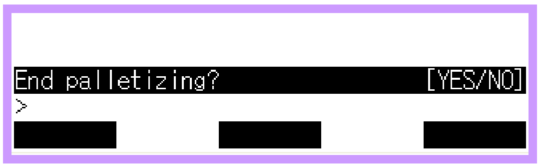
- Palletize Pallet No. : Pallet number when work begins.
- Palletize Pattern Register No.: Pattern register number to be used for starting work.
- Start count : Work Pieces is to set which work piece should be the first one on a pallet.

4.3.4.3. Palletizing Reset

Palletizing Reset forcibly initializes palletizing register and counter value. It is the same as 『R55: Palletizing Reset』 of R code.

(1) Selection 『[PF1]: Service』 → 『2: Register Setting』 → 『4: Palletizing Register』 → 『3: Palletizing Reset』.

(2) Input pallet number and press [SET].

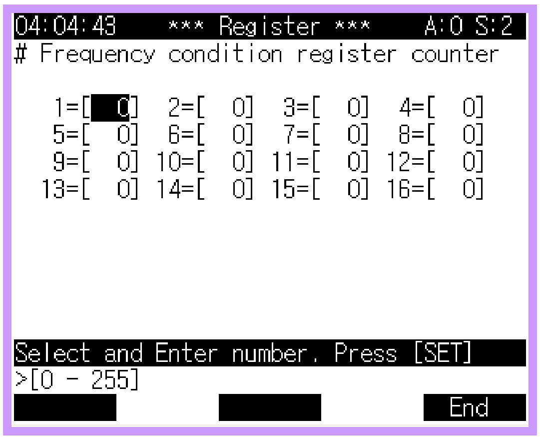


(3) Selection [YES]/ [NO] to start.

4.3.5. Frequency condition register

Frequency Condition Register sets frequency condition register value, and indicates current set value. To use functions such as step jump (Frequency condition), step call (Frequency condition), step return (Frequency condition), function-assigned step jump (Frequency condition), program call (Frequency condition), program jump (Frequency condition), function jump (Frequency condition) and partner program call (Frequency condition), the set value should be compared before deciding whether to perform a function.

(1) Selection 『[PF1]: Service』 → 『2: Register Setting』 → 『5: Frequency condition register』.



(2) Input Data and press [SET]. To store changed setup, press 『[PF5]: End』. If [ESC] is pressed, changed data will not be stored.

Reference

- 『R18: Frequency condition register』 of R code has the same function.

4.3.6. Conveyor Data

Conveyor Data is for monitoring data on Conveyor. Refer to 『Conveyor synchronization Function Manual』 for details.

(1) Selection 『[PF1]: Service』 → 『2: Register Setting』 → 『6: Conveyor data』.

```
04:07:58     *** Register ***     A:0 S:2
     1: Conveyor simulation data    [R 45]
     2: Conveyor data reset         [R 44]
     3: Current works' monitoring on C/V







Use [Number]/[Up][Down] and press [SET].
>
```

Reference

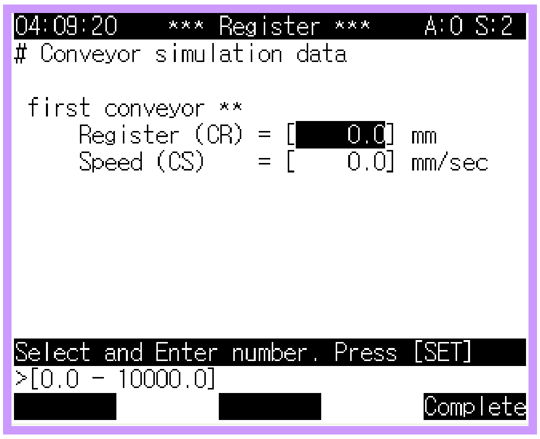
- To set Conveyor Data, selection 『[PF2]: System』 → 『5: Initialize』 → 『2: Robot Type Selection』 and set Conveyor use as <ENBL>. Otherwise, the following message appears.

```
In conveyor synchro. mode, Use!     [ESC]
>
                 Previous  Next
```

4.3.6.1. Conveyor Simulation Data

Conveyor Simulation Data is a function for simulation, not actually operating the Conveyor.

(1) Selection 『[PF1]: Service』 → 『2: Register Setting』 → 『6: Conveyor Data』 → 『1: Conveyor Simulation Data』 on the initial screen of either manual or auto mode.



(2) To store changed setup, press 『[PF5]: Complete』. If [ESC] is pressed, changed data will not be stored.

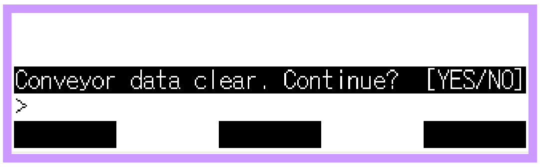
- Register (CR)
  Selection 『PF5: Condition Setting』 → Applied Condition → Conveyor Move, and set Conveyor Move as <Simulation>. To check a work program without activating the Conveyor, input Conveyor register value, which is the distance between limit switch and virtual work piece.

- Speed (CS)
  Selection 『PF5: Condition Setting』 → Applied Condition → Conveyor Move, and set Conveyor Move as <Test> or <Simulation>. To check a work program without activating the Conveyor, input virtual Conveyor speed.

4.3.6.2. Conveyor Data Reset

Conveyor Data Reset is to initialize Conveyor register value, Conveyor speed and Conveyor pulse.

(1) Selection 『[PF1]: Service』 → 『2: Register Selection』 → 『6: Conveyor Data』 → 『2: Conveyor Data Reset』.



(2) Selection [YES]/ [NO].

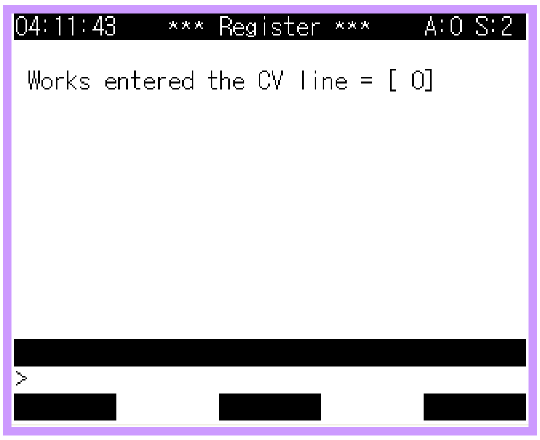
Reference

- 『R:44 Conveyor Data Clear』 of R code has the same function.

4.3.6.3. Number of Conveyor Work Pieces

Number of Conveyor Work Pieces is for monitoring the current number of work pieces on the Conveyor.

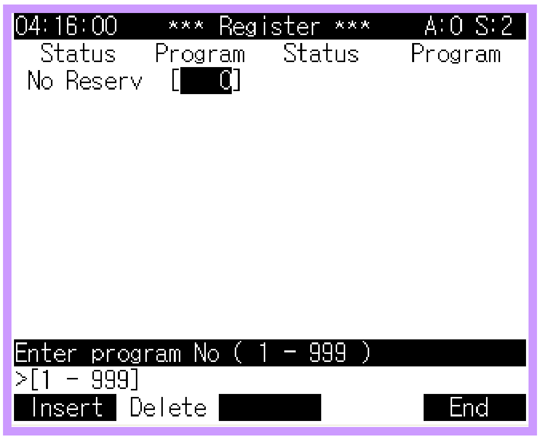
(1) Selection 『[PF1]: Service』 → 『2: Register Setting』 → 『6: Conveyor Data』 → 『3: Current works' monitoring on C/V』



4.3.7. FIFO Register

FIFO Register is to confirm, change, insert and delete a currently reserved program, when a program is reserved by an external signal and a program is performed in an order. Refer to 『FIFO Function Manual』 for details.

(1) Selection 『[PF1]: Service』 → 『2: Register Setting』 → 『7: FIFO Register』.



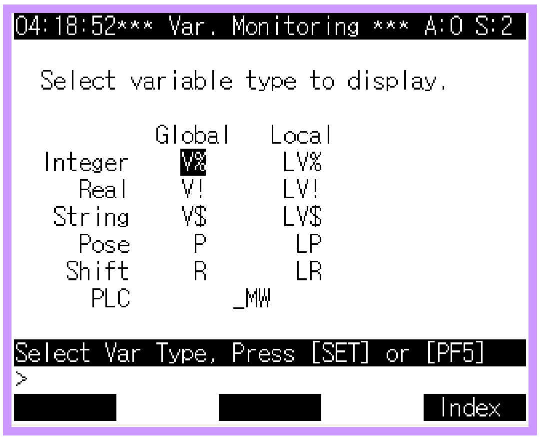
Reference

- To enter FIFO Register, selection 『[PF2]: System』 → 『1: User parameter』 → 『14: FIFO Function』 → 『2) Program Condition』, and satisfy the following conditions.
  ① <Int-Set.> → FIFO Function Application No.=<20>
  ② <Ext-Sel.> → External Program Select=<ENBL>, Program strobe signal use=<ENBL>, and FIFO Function Application No.=<20>

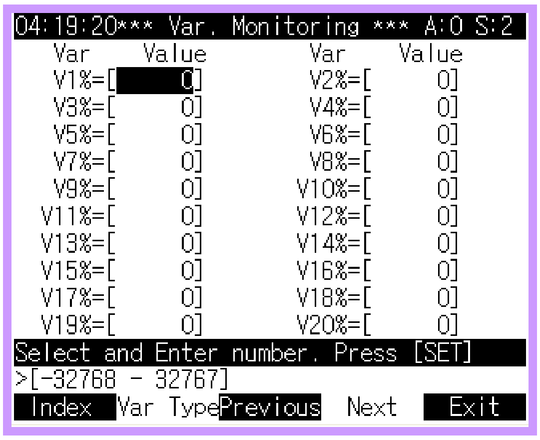
4.4. Variable

The current value of global Variable and local Variable can be checked and changed. Refer to 『Chapter 10 Robot Language』 → 『Variable』 for details.

(1) Selection 『[PF1]: Service』 → 『3: Variables』.



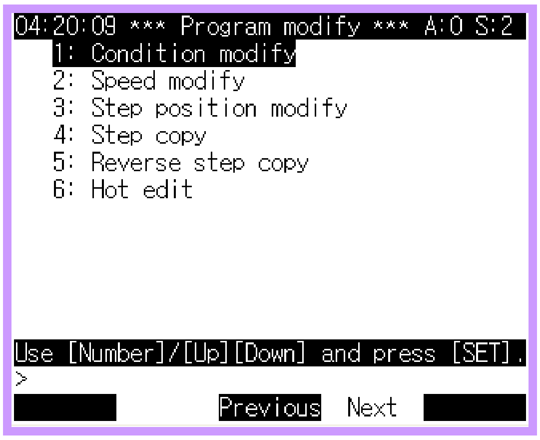
(2) Press [SET] or 『[PF5]: Index』. Each variable can be set.



4.5. Program Modify

A set program can be revised collectively or partially.

(1) Selection 『[PF1]: Service』 → 『4: Program Modify』 on the initial screen of either manual or auto mode.



Reference

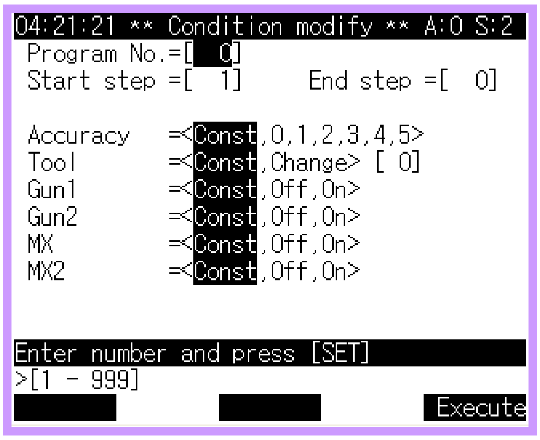
- 『1: Condition Modify』, 『2: Speed modify』, 『3: Step Position Modify』, 『4: Step Copy』 and 『5: Reverse Step Copy』 cannot be used, while a robot is moving.

- 『6: Hot Edit』 cannot be used while a robot is not moving. It should be used while a robot is moving in the auto mode.

4.5.1. Condition Modify

Recorded conditions regarding many steps of the same program can be changed at a time.

(1) Selection 『[PF1]: Service』 → 『4: Program Modify』 → 『1: Condition Modify』.



(2) After the condition change, press 『[PF5]: Execute』.

- Program No : The number of a program which needs condition change.
- Start Step : The first step which needs recorded condition change (initial value: 1).
- End Step :
  The last step which needs recorded condition change (initial value: the last step number).
- Set conditions of Accuracy, Tool, GUN1, GUN2, MX, MX2 as whatever conditions desired from beginning step to Completion step.

4.5.2. Speed Modify

Speed of several steps in a program can be collectively changed.

(1) Selection 『[PF1]: Service』 → 『4: Program Modify』 → 『2: Speed Modify』.

(2) To store changed setup, press 『[PF5]: Execute』. If [ESC] is pressed, Changed data will not be stored.

- Program
  Number of the program which needs speed change (The initial value is a program number already selectioned.)

- Step
  Range of the step which needs speed change (The initial values are 1 ~ the last step.)

- Mode : Means indicates how to change speed.
  1) Assign : used for collective change of recorded speed.
  2) Scale :
     used for conversion into percentage to recorded speed, when recorded speed unit and the unit which [Unit] indicates are the same.
  3) Alter Unit : used for unit change of recorded speed.

- Range
  Users can selection either the whole block or welding, non-welding, interpolating OFF(P) and interpolating ON (L,C) to Application the speed change.

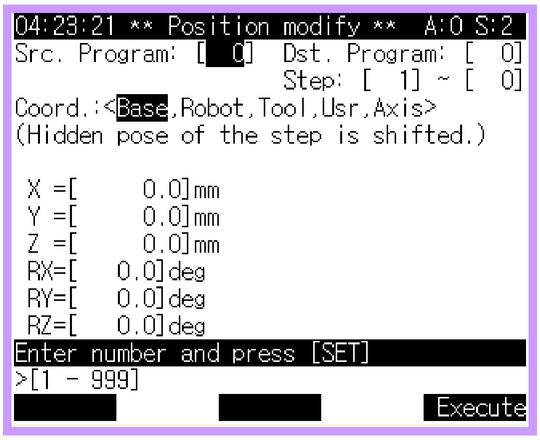
- Unit
  If [Means] is <Assign> or <Alter Unit>, the unit which unit indicates will be used for speed change. <Scale> can be used only when step speed unit and recorded speed unit are the same.

- Spd/Ratio
  When [Means] is <Assign>, Speed/Ratio indicates speed. When [Means] is <Scale>, Speed/Ratio indicates ratio.

4.5.3. Step Position Modify

Hidden step position can be shifted by setting coordinates.

(1) Selection 『[PF1]: Service』 → 『4: Program Modify』 → 『3: Step Position Modify』.



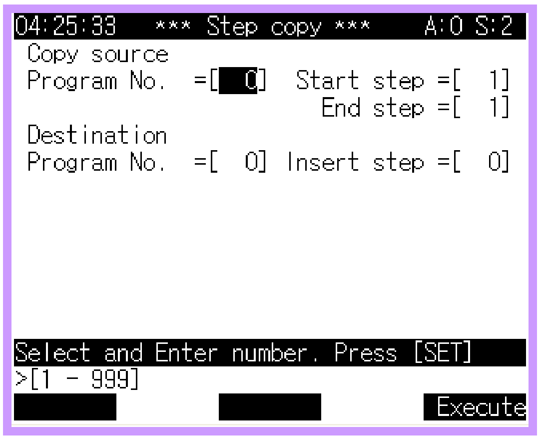
(2) Input data, and press 『[PF5]: Execute』. If [ESC] is pressed, changed data will not be stored.

- Src. Program : Number of Src. program which needs change
- Dst. Program
  Changed program is stored here. If the number is the same as the Src. program number, the number replaces the original program number.
- Step : Range of step which need recorded position change
- Coord.
  Coordinates for shift can be selectioned. Step position data will be shifted to the coordinates. 'Base, Robot, Tool and User are for orthogonal coordinates shift and 'Axis' is for axis angle shift.

4.5.4. Step Copy

Part of a program can be copied to other or the same program. The functions recorded in steps are also copied. Step numbers assigned as step jump (GOTO, GOSUB) are automatically changed.

(1) Selection 『[PF1]: Service』 → 『4: Program Modify』 → 『4: Step Copy』.



(2) Input data, and press [SET] and then『[PF5]: Execute』 to complete.

Reference

- The following is the example of copying “Step 2 to Step 5 of Program 1” to “Step 2 of Program 2.”

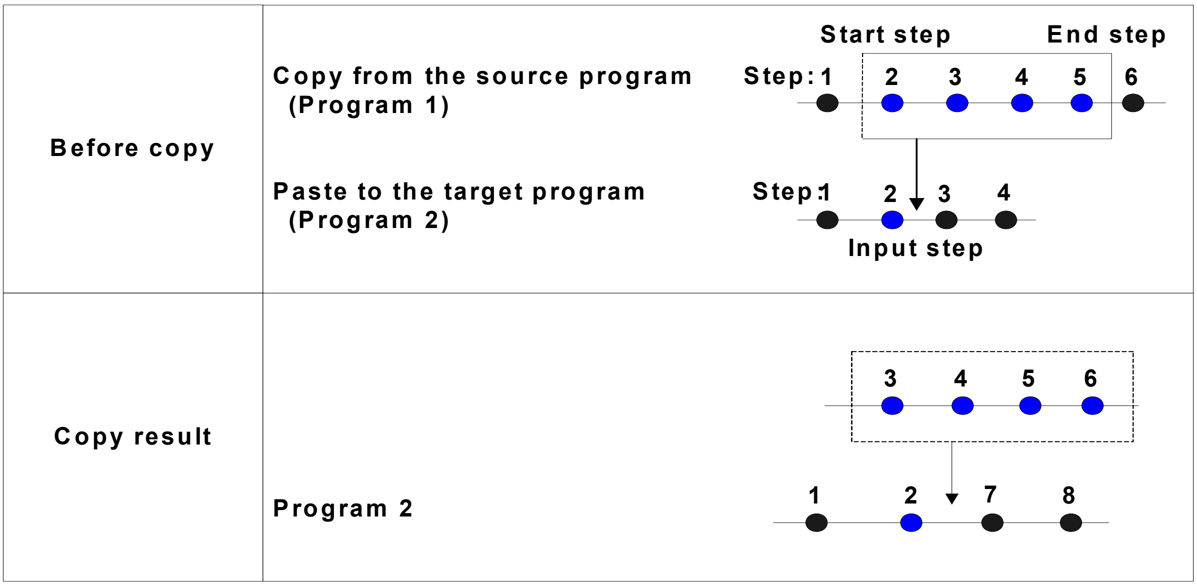


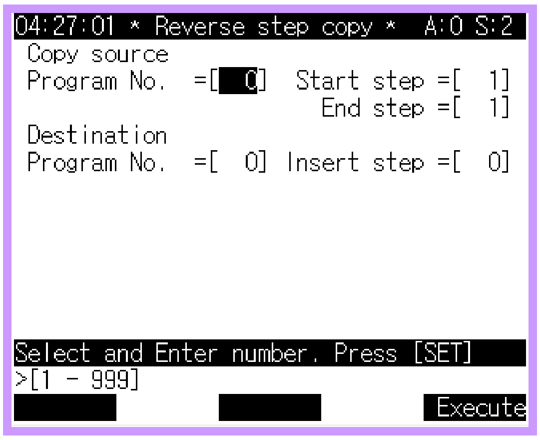
Fig 4.3 Step Copy

- Insert the Copy from the source program(original copy) behind the input step number of Paste to the target program(pasted copy).
- Delete steps which include “END” if necessary, because they copy “END” function, too.
- Programs with memory protection or program protection cannot be copied.
- If step jumps (GOTO, GOSUB) out of the copy range need to be copied, the numbers will not be changed. In such case, change the number after copy is completed.

4.5.5. Reverse Step Copy

Part of a program is copied to a target position in a reverse order.

(1) Selection 『[PF1]: Service』 → 『4: Program Modify』 → 『5: Reverse Step Copy』.



(2) Input data, and press [SET] and then 『[PF5]: Execute』.

Reference

- The following is the example of copying “Step 2 to Step 5 of Program 1” to “Step 2 of Program 2” in the reverse direction. Step 2, 3, 4 and 5 are copied in an order of 5, 4, 3 and 2.

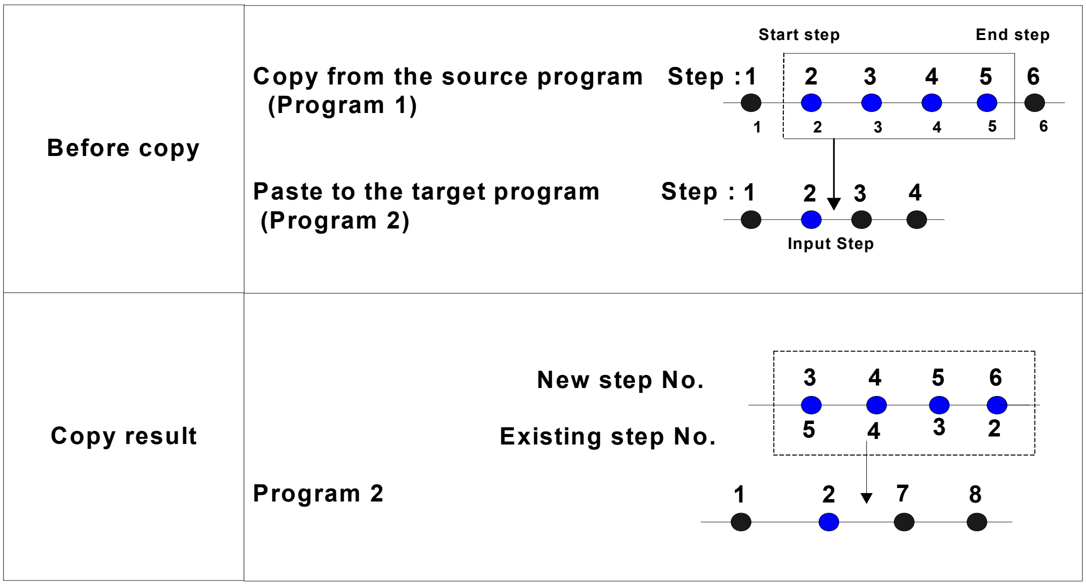


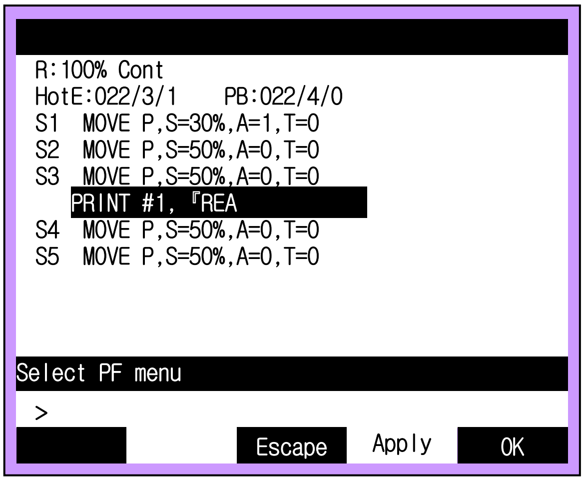
Fig 4.4 Reverse Step Copy

- Reverse Step Copy has the same function as Step Copy except that selectioned steps are copied in the reverse direction.

4.5.6. Hot Edit

A program can be edited while it is in operation.

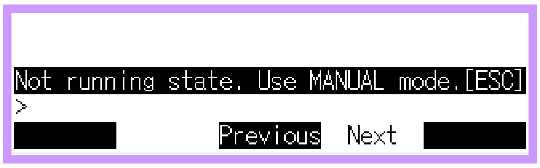
(1) Selection 『[PF1]: Service』 → 『4: Program Modify』 → 『6: Hot edit』.



(2) Edit a program, and selection 『[PF4]: Apply』 and 『[PF5]: OK』. 『[PF3]: Escape』 cancels the editing.

Reference

- The following will appear when a robot is not in operation.



Caution

If a program in operation or a program to be called is changed and applied by using "Program Modify during Operation," the change will be applied in the next cycle and a robot is operated in a changed program. Careless change may cause a serious accident such as collision between a robot and jig. Take extra care.

○ **Enter**

In the "Hot edit" mode, entry is possible by [Quick Open] while a robot is in operation.

○ **Possible Modify Type**

Manipulation method is the same as in the manual mode, but the following functions are not available.

1) [Axis Manipulation]
2) [Record] (This key is to record the move of hidden position.)
3) [Position Change]
4) [SHIFT]+[Delete] in program header

○ **Reflection**

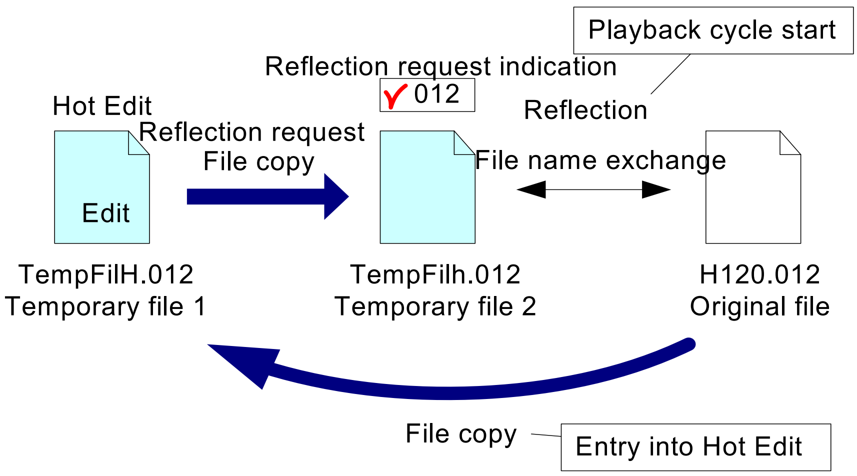


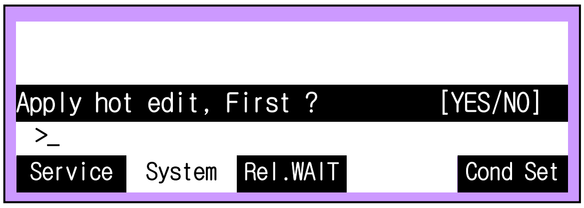
Fig 4.5 Hot Edit

"Hot Edit" is to edit a copy file not the original file for a safety reason. When a program is edited during operation, the original file is copied as a temporary file 1, as shown above. After a program is changed and 『[PF5]: OK』 is pressed, the temporary file 2 is copied as a temporary file 2, and reflection request appears. Reflection is done when the file names of the temporary file 2 and the original file are exchanged. The actual point of time of reflection is as follows.

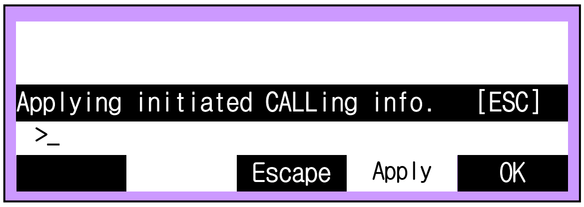
Table 4-1 Reflection point

	Classification	Reflection Point
During Operation	■ Program in operation ■ Program called by "CALL"	When operation cycle renews (All files which are requested for reflection will be reflected.)
	Other programs	At once

If a program is not in operation, "Hot Edit" cannot be used. If a program operation Completions while "Hot Edit" is used, reflection request will be accepted, but reflection will not be done until operation cycle renews. If users tries program change in the manual mode, the following message will appear.



If [YES] is pressed, changes of "Hot Edit" will be reflected first. If [NO] is pressed, reflection request will be canceled, and temporary file 2 (the changes) will be deleted. If the changes are reflected by [YES], program call information will be cleared, and the following will appear.



If a program using a CALL command is in operation, restart the program, because it is not a normal program operation.

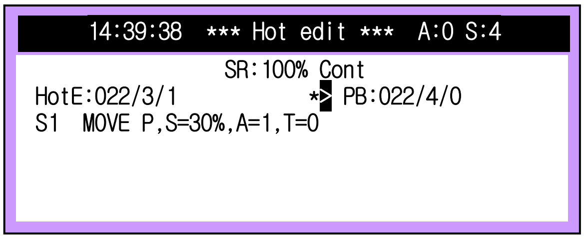
○ **OK, Apply, ESC**

1) 『[PF5]: OK』: Changes are reflected in the original file, and at the same time "Hot Edit" is Ended.
2) 『[PF4]: Apply』: Edited changes are requested to be reflected in the original file, and "Hot Edit" continues.
3) 『[PF3]: Escape』: "Hot Edit" is canceled and is Ended.

○ **Program Counter Information**

The following is shown in edit frame (third row) of teach pendant.

1) HotE : Cursor position (Program No. / Step No. / Function No.) for “Hot Edit” is indicated.
2) PB : Program count (Program No. / Step No. / Function No.) in the operation mode is indicated.
3) ‘*’: ‘*’ is indicated after the original is changed.
4) ‘>’: ‘>’ is indicated when reflection in the original is requested.



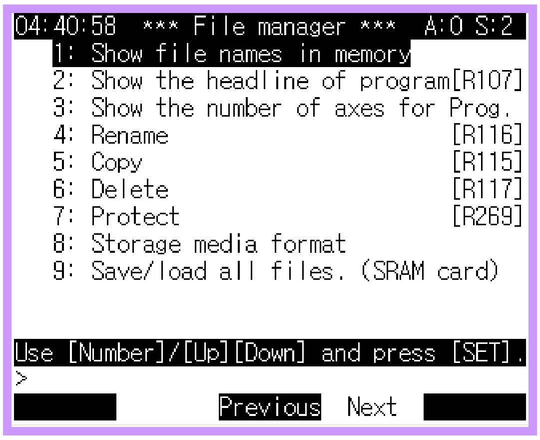
○ **Other program selection**

When [SHIFT]+[Program] are pressed, other program can be selectioned. Also, new program can be written.

4.6. File manager

Files in internal memory or SRAM card can be managed.

(1) Selection 『[PF1]: Service』 → 『5: File manager』.



(2) Selection sub menu for setup.

4.6.1. Show file names in memory

Name of File in the Memory indicates file name, file contents, number of steps stored in the internal memory.

(1) Selection 『1: Show file names in memory』.

```
All files? [Yes], or just programs? [No]
>
            Previous  Next
```

(2) If [YES] is pressed, program and integer files such as ROBOT.*** are indicated. If [NO] is pressed, information only on the program file is indicated.

```
04:42:34  *** File display ***   A:0 S:2
  {Name}       {Contents}          {Step}
HX165-02.001 '???                       2
HX165-04.001 '???                       1
HX165-04.010 '???                       4
POSE    .G00 'POSE file(Global)
ROBOT   .C00 'Control Const file
ROBOT   .C01 'Machine Const file
ROBOT   .E01 'Error logging file
ROBOT   .IM0 'DIO Name file
ROBOT   .INF 'System information .
ROBOT   .PAL 'Pallet pattern file
 12 file, 61417 block free.  Page[ 1/ 2]
>
            Previous  Next  Escape
```

- File Name : Names of program files, robot integer files and history files are indicated.

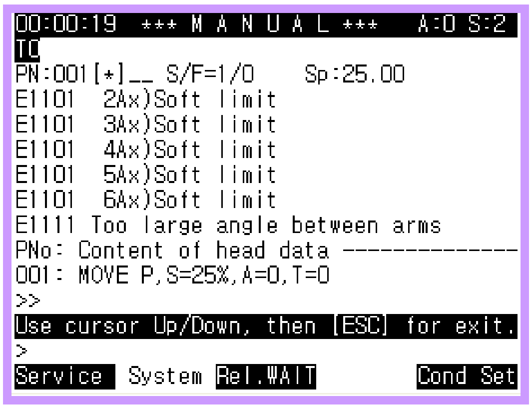
- Content
  Content of a program file is note. If the file does not have note, '??? is indicated. Contents of robot integer files and history file are explanation on the files.

- Step : Total number of steps recorded in the program.

4.6.2. Show the headline of program

Contents recorded in the first part of the program are indicated.

(1) Selection 『[PF1]: Service』 → 『5: File manager』 → 『2: Show the headline of program』.



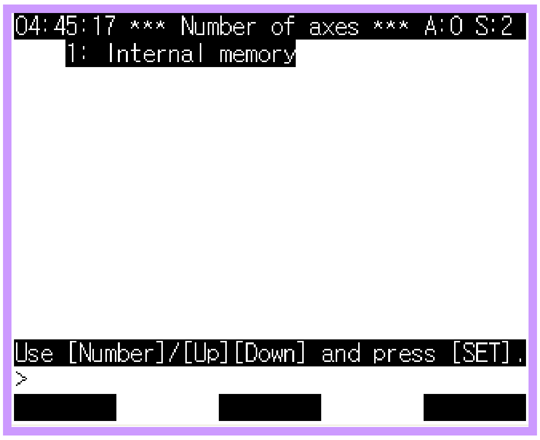
Reference

- 『R107 : Program Head Data Display』 of R code has the same function.

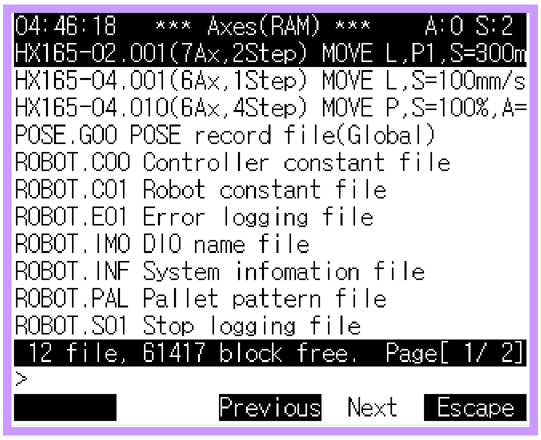
4.6.3. Show the Number of Axes for Prog.

Robot Integer files and history files indicate explanation on files, and program files indicate robot name, number of axes, total number of steps and first data of the program.

(1) Selection 『[PF1]: Service』 → 『5: File manager』 → 『3: Show the Number of Axes for Prog.』.



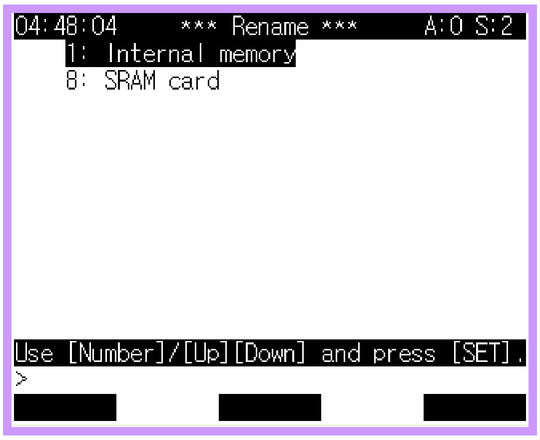
(2) Selection 『1: Internal Memory』, and the following appears.



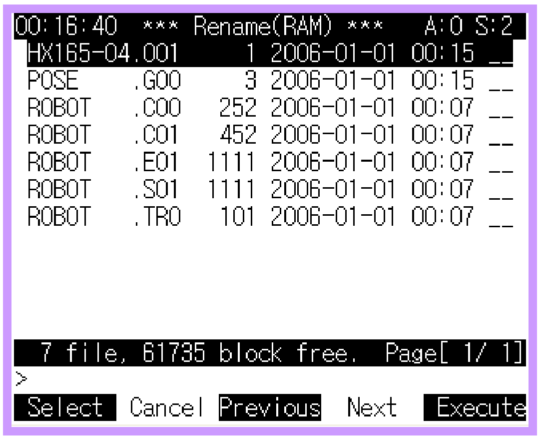
4.6.4. Rename

File numbers in internal memory and SRAM card can be changed. When numbers are changed, all information (date, attributes, etc.) remains. Numbers of protected files can be also changed. 『R116: Program renaming』 of R code has the same function.

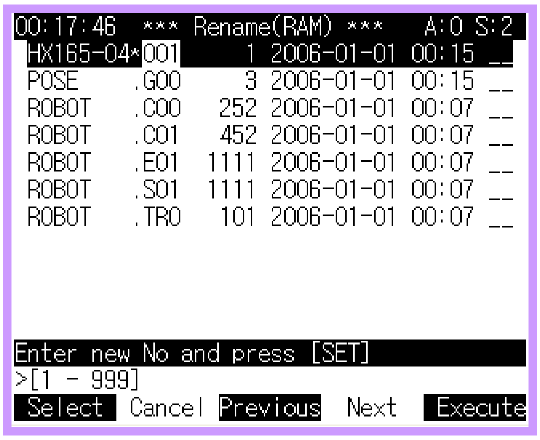
(1) Selection 『[PF1]: Service』 → 『5: File manager』 → 『4: Rename』.



(2) Selection 『1: Internal Memory』, and the following screen appears.



(3) Selection the file which needs number change, press 『[PF5]: Execute』, change the number, and press [SET]. Then the number will be changed. The following is the example that No. 991 Program is selectioned and 『[PF5]: Execute』 is pressed.



Reference

- Individual File Selection

① Place cursor on the file by using direction keys, and press [SET]. Then file is selectioned. If [SET] is pressed again, the selection will be canceled.

```
00:11:30  *** Rename(RAM) ***    A:0 S:1
 HX165-04.001       9 2006-01-01  00:09 __
 POSE     .G00      4 2006-01-01  03:34 __
 ROBOT    .C00    252 2006-01-01  02:45 __
 ROBOT    .C01    452 2006-01-01  02:46 __
 ROBOT    .E01   1212 2006-01-01  02:46 __
 ROBOT    .INF      0 2006-01-01  00:00 ₩_
 ROBOT    .PAL     50 2006-01-01  02:47 __
 ROBOT    .S01   1212 2006-01-01  02:46 __
 ROBOT    .TR0    101 2006-01-01  02:46 __
 ROBOT    .WL2    322 2006-01-01  03:11 __

 10 file, 61152 block free.   Page[ 1/ 1]
>
 Select  Cancel Previous  Next   Execute
```

② On the screen above, press [SET]. Then, an identification mark '*' will be indicated next to 『HR120 .991』, showing the file is selectioned. The cursor will move down, as shown below.

```
00:11:54  *** Rename(RAM) ***    A:0 S:1
 HX165-04*001       9 2006-01-01  00:09 __
 POSE     *G00      4 2006-01-01  03:34 __
 ROBOT    .C00    252 2006-01-01  02:45 __
 ROBOT    .C01    452 2006-01-01  02:46 __
 ROBOT    .E01   1212 2006-01-01  02:46 __
 ROBOT    .INF      0 2006-01-01  00:00 ₩_
 ROBOT    .PAL     50 2006-01-01  02:47 __
 ROBOT    .S01   1212 2006-01-01  02:46 __
 ROBOT    .TR0    101 2006-01-01  02:46 __
 ROBOT    .WL2    322 2006-01-01  03:11 __

 10 file, 61152 block free.   Page[ 1/ 1]
>
 Select  Cancel Previous  Next   Execute
```

- File Group Selection/Cancel

① Files can be selectioned or canceled by group. Press『[PF1]: Select』 or 『[PF2]: Cancel』, and a group to be selectioned or canceled will be selectioned.

```
Use PF key and select.
>
All fileAll ProgAll Log Separate  End
```

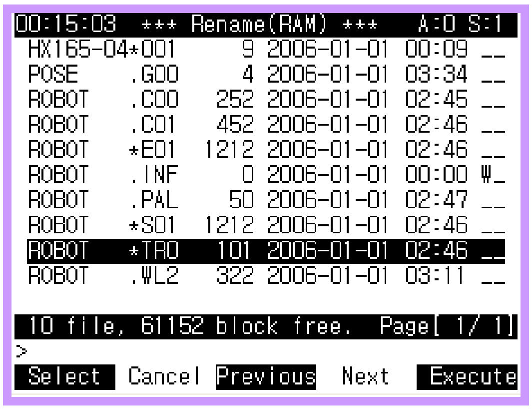
② Press 『[PF1]: All File』, and all files will be selectioned, as shown below.

```
00:14:03  *** Rename(RAM) ***   A:0 S:1
 HX165-04*001       9 2006-01-01 00:09 __
 POSE    *G00       4 2006-01-01 03:34 __
 ROBOT   *C00     252 2006-01-01 02:45 __
 ROBOT   *C01     452 2006-01-01 02:46 __
 ROBOT   *E01    1212 2006-01-01 02:46 __
 ROBOT   *INF       0 2006-01-01 00:00 W_
 ROBOT   *PAL      50 2006-01-01 02:47 __
 ROBOT   *S01    1212 2006-01-01 02:46 __
 ROBOT   *TR0     101 2006-01-01 02:46 __
 ROBOT   *WL2     322 2006-01-01 03:11 __

 10 file, 61152 block free.  Page[ 1/ 1]
>
 Select  Cancel Previous  Next   Execute
```

③ Press 『[PF2]: All Prog』, and only program files are selectioned, as shown below.

```
00:14:46  *** Rename(RAM) ***   A:0 S:1
 HX165-04*001       9 2006-01-01 00:09 __
 POSE    .G00       4 2006-01-01 03:34 __
 ROBOT   .C00     252 2006-01-01 02:45 __
 ROBOT   .C01     452 2006-01-01 02:46 __
 ROBOT   .E01    1212 2006-01-01 02:46 __
 ROBOT   .INF       0 2006-01-01 00:00 W_
 ROBOT   .PAL      50 2006-01-01 02:47 __
 ROBOT   .S01    1212 2006-01-01 02:46 __
 ROBOT   .TR0     101 2006-01-01 02:46 __
 ROBOT   .WL2     322 2006-01-01 03:11 __

 10 file, 61152 block free.  Page[ 1/ 1]
>
 Select  Cancel Previous  Next   Execute
```

④ Press 『[PF3]: All Log』, and only history files are selectioned, as shown below.



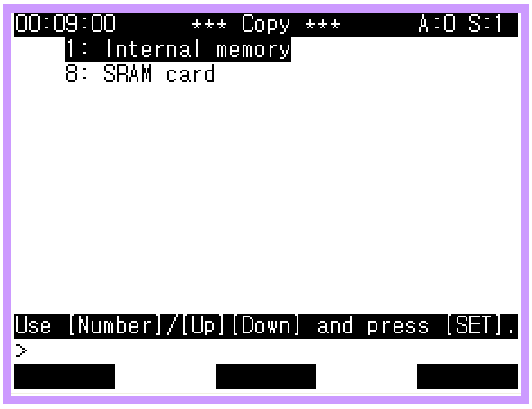
⑤ 『[PF4]: Separate』 is the same as “1. Individual File Selection.”

- Direct Input
  Input program number to selection a program. Press [Shift]+[Program], input the number of a program to be selectioned, and press [SET]. Then, the program file will be selectioned or canceled.

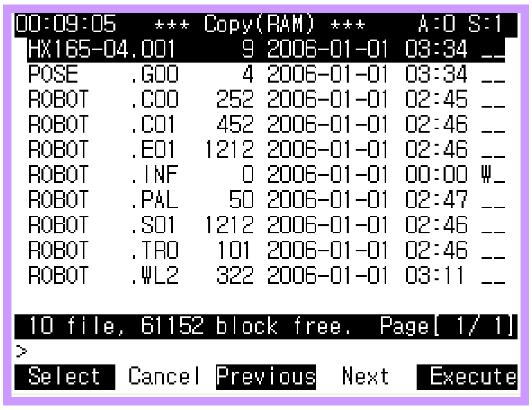
4.6.5. Copy

Files in SRAM card and internal memory can be copied. Copied files do not have attributes and current date is shown, because attributes and date are not copied.

(1) Selection 『[PF1]: Service』 → 『5: File manager』 → 『5: Copy』.

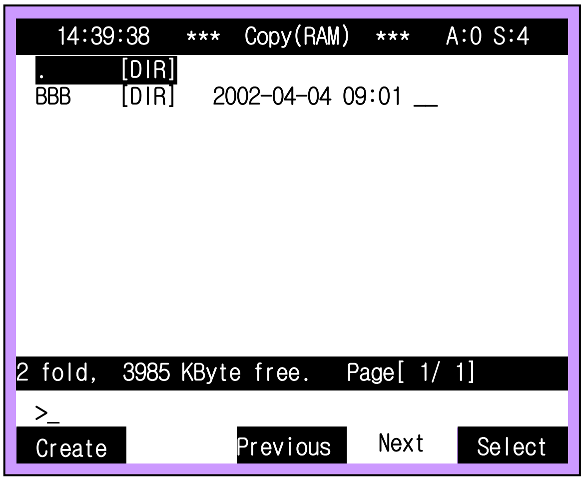


(2) Selection 『1: Internal Memory』, and the following screen appears.

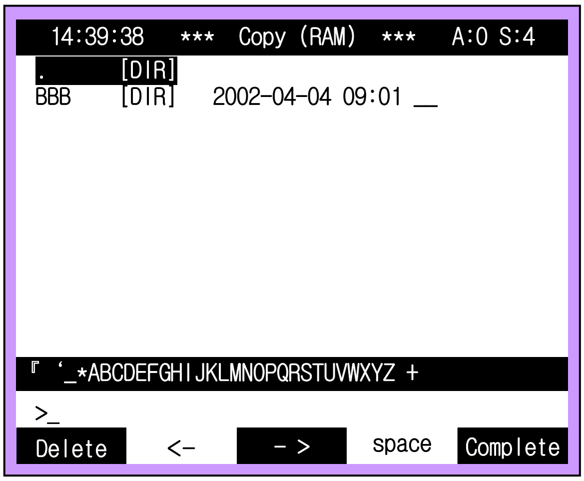


(3) Selection a file, and press 『[PF5]: Execute』. Refer to the Reference of 『4.6.4. Rename』 to learn how to selection a file.

(4) Selection where to copy (1: Internal Memory or 8: SRAM Card), and the following screen appears. Directory is also indicated.



(5) To copy a file to the directory already created or root directory, press 『[PF5]: Select』. Then the file will be copied to the folder. To create new directory and copy a file, press 『[PF1]: Create』. Folder name can be inputted in alphabet, as shown below.

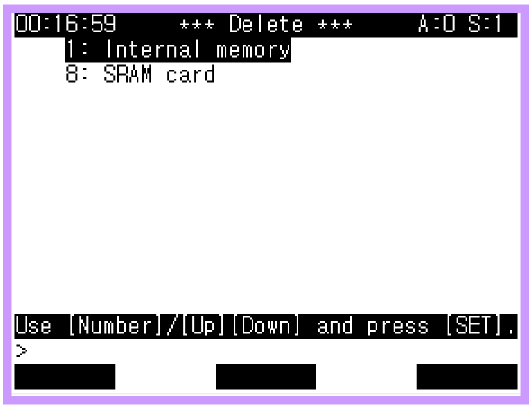


(6) Input a folder name, and press『[PF5]: Complete』. Then, new directory is created, and a file is copied into the directory. Name of the directory is limited to 8 letters and no space is allowed.

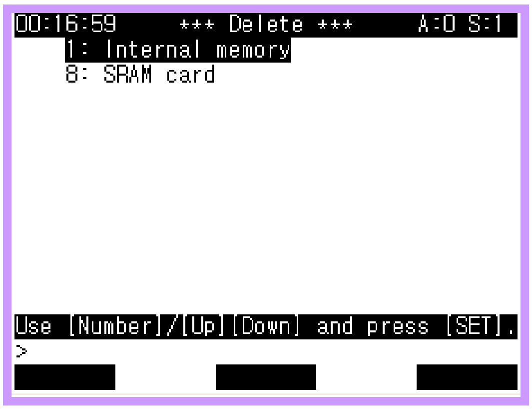
4.6.6. Delete

Files in internal memory and SRAM card can be deleted. If file attribute is set as full protection or partial protection, the file cannot be deleted. Directory in SRAM card cannot be deleted.

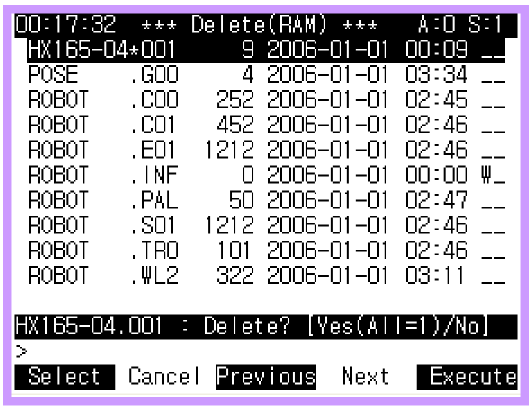
(1) Selection 『[PF1]: Service』 → 『5: File manager』 → 『6: Delete』.



(2) Selection the position (1: Internal Memory or 8: SRAM Card) which has the file to be deleted.



(3) Selection the file to be deleted, and press 『[PF5]: Execute』. Refer to the Reference of 『4.6.4. Rename』 to learn how to selection a file.



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(4) Reconfirm to delete a file. If [YES] is pressed, only one current file is deleted. To cancel deleting, press [ESC]. Then, the following message is indicated in the frame.

```
Cancel just one of the files?    [YES/NO]
>
 Select  Cancel Previous  Next   Execute
```

(5) To cancel deleting only the selectioned file, press [YES].

(6) To delete all selectioned files, press 1.

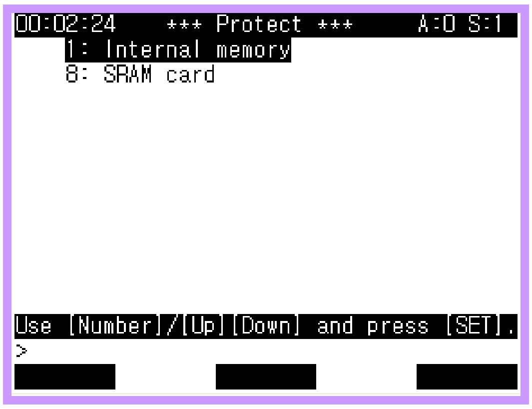
```
Delete all the selected files?   [YES/NO]
>
 Select  Cancel Previous  Next   Execute
```

(7) If [YES] is pressed, all the selectioned files will be deleted. If [NO] is pressed, the currently selectioned file will be deleted.

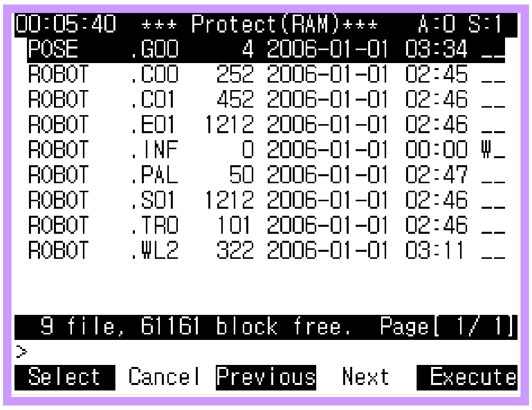
4.6.7. Protect

Important files are protected by prohibiting change and deletion of programs. Full protection prohibits change and deletion. Partial protection only allows position change. Renewal protection prohibits renewal and step advancement from the first part of a program. Only full protection is supported for files in SRAM card.

(1) Selection 『[PF1]: Service』 → 『5: File manager』 → 『7: Protect』.



(2) Selection 『1: Internal Memory』, and the following screen appears.



(3) Selection a file, and press 『[PF5]: Execute』. Refer to the Reference of 『4.6.4. Rename』 to learn how to selection a file.

```
00:06:04   *** Protect(RAM)***     A:0 S:1
 POSE     *G00       4 2006-01-01  03:34 __
 ROBOT    .C00     252 2006-01-01  02:45 __
 ROBOT    .C01     452 2006-01-01  02:46 __
 ROBOT    .E01    1212 2006-01-01  02:46 __
 ROBOT    .INF       0 2006-01-01  00:00 W_
 ROBOT    .PAL      50 2006-01-01  02:47 __
 ROBOT    .S01    1212 2006-01-01  02:46 __
 ROBOT    .TR0     101 2006-01-01  02:46 __
 ROBOT    .WL2     322 2006-01-01  03:11 __

Protect or Release?(1:Protect/2:Release)
>
 Select  Cancel Previous  Next   Execute
```

(4) (1: Protect) protects a file, and (2: Release) removes protection.

```
Protect type?(1:Whole/2:Section/3:Playb)
>1,
 Select  Cancel Previous  Next   Execute
```

(5) Selection (1: Protect) and then a protection type. If full protection is selectioned, 'W_' appears on the right side of the file.

```
00:01:05   *** Protect(RAM)***     A:0 S:2
 HX165-04.001        8 2006-01-01  00:00 W_
 ROBOT    .C00     255 2006-01-01  00:00 __
 ROBOT    .C01     452 2006-01-01  00:00 __
 ROBOT    .E01    1212 2006-01-01  00:00 __
 ROBOT    .IM0       8 2006-01-01  00:02 __
 ROBOT    .INF       0 2006-01-01  00:00 W_
 ROBOT    .S01    1212 2006-01-01  00:00 __
 ROBOT    .TR0     101 2006-01-01  00:00 __

  8 file, 61519 block free.   Page[ 1/ 1]
>
 Select  Cancel Previous  Next   Execute
```

▣ Screen signs

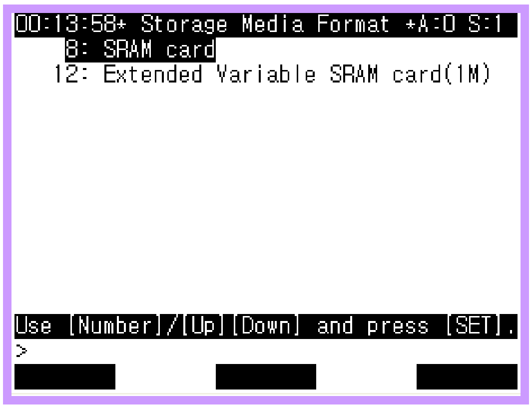
--	No protection	W_	Full protection
WP	Full + Renewal	S_	Partial protection
SP	Partial + Renewal	_P	Renewal protection

Reference

- Only full protection is supported for robot integer files.
- Only program files can be set for renewal protection.
- Partial protection for the files except program files is the same as full protection.
- History files can be updated despite full protection setup.
- Programs under renewal protection can be Executed, if they are Executed from the middle of the program, not from its first part.
- Either full protection (W) or partial protection (S) can be set. However, renewal protection (P) can be set with full protection (W) or partial protection (S).

4.6.8. Storage Media Format

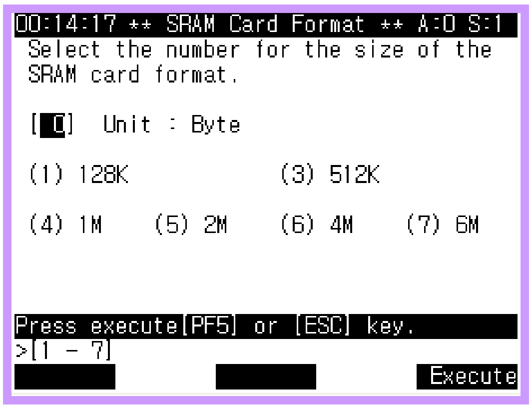
SRAM card can be initialized.



4.6.8.1. SRAM Card

(1) Selection 『[PF1]: Service』 → 『5: File manager』 → 『8: Storage Media Format』 → 『8: SRAM Card』.

(2) Selection 『8: SRAM Card』, and the following screen appears.



(3) Selection the storage capacity of the inserted SRAM card.

(4) Press 『[PF5]: Execute』. To cancel, press [ESC].

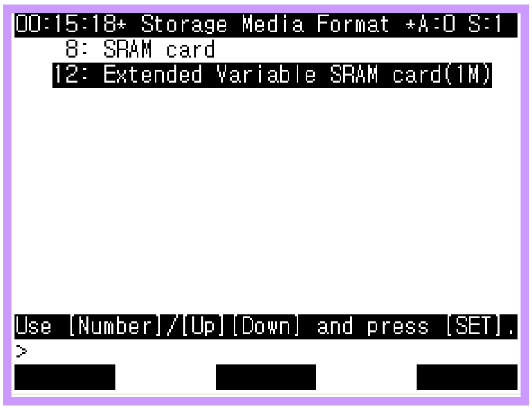
(5) Confirm whether to format the SRAM card by selectioning [YES]/ [NO].

4.6.8.2. Extended Variable SRAM Card

Extended Variable SRAM Card is for setting SRAM card as expansion variable storage media. Global Variable such as integer variable V%, real variable V!, pause variable P, shift variable R can be expanded up to 10,000.

(1) Selection 『[PF1]: Service』 → 『5: File manager』 → 『8: Storage Media Format』→ 『12: Extended Variable SRAM Card』.

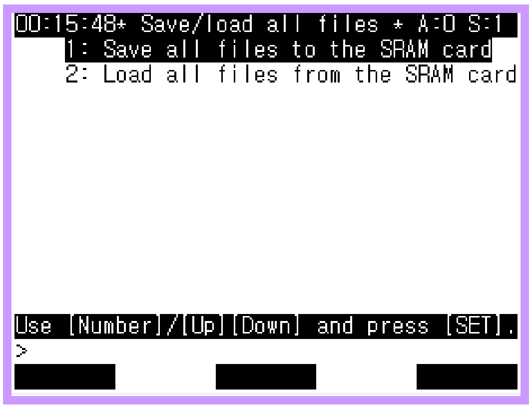
(2) Selection 『12: Extended Variable SRAM Card』.



4.6.9. Save/Load all Files (SRAM Card)

All Files Save/Load is to store or retrieve all system files and work program files.

(1) Selection 『[PF1]: Service』 → 『5: File manager』 → 『9: Save/load all files. (SRAM card)』.



4.6.9.1. Save all Files to the SRAM Card

『1: Save all files to the SRAM card』 is to store all the files of internal memory in SRAM card.

(1) Selection 『[PF1]: Service』 → 『5: File manager』 → 『9: Save/Load all files (SRAM card)』 → 『1: Save all files to the SRAM card』.

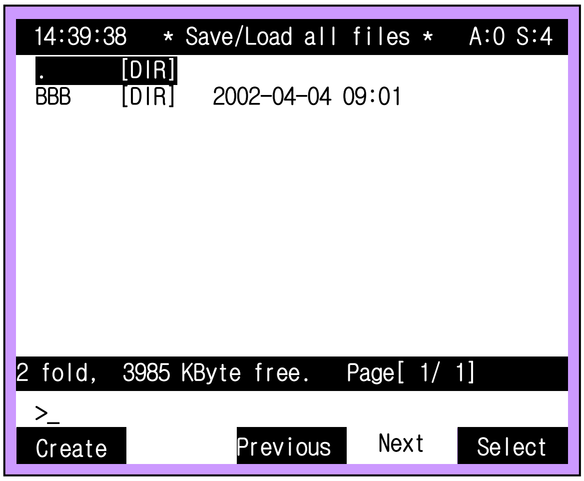
(2) Selection directory and store files. Refer to 『4.6.5 Copy』 to learn how to create a folder.

4.6.9.2. Load all Files from the SRAM Card

『2: Load all files from the SRAM card』 is to retrieve all files of SRAM card to internal memory.

(1) Selection 『[PF1]: Service』 → 『5: File manager』 → 『9: Save/Load all files (SRAM card)』 → 『2: Load all files from the SRAM card』.

(2) Press any key on teach pendant, and the following screen appears.



(3) Selection directory, and press 『[PF5]: Select』. Then, all files in the folder are retrieved to memory.

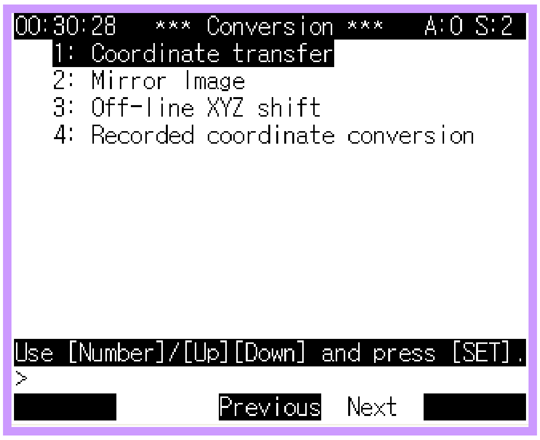
Reference

- To retrieve or store files individually, use the function of 『4.6.5 Copy』.
- Work in PC environment where SRAM card can be read, because directory created in SRAM card cannot be deleted and changed in controller environment.

4.7. Program Conversion

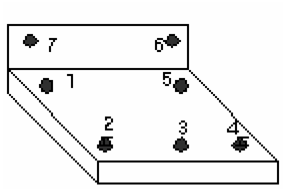
A program already taught can be re-written by converting coordinates.

(1) Selection 『[PF1]: Service』 → 『6: Program Conversion』.

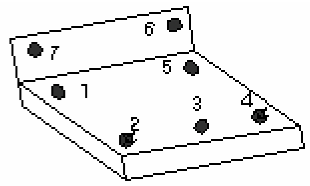


4.7.1. Coordinate Transfer

After teaching a work piece <Fig 1> [Program 1], [Program 2] can be easily written for another work piece <Fig 2> of the same shape as <Fig 1> without additional teaching by using Coordinate Transfer, if <Fig 2> needs to be placed in another position.



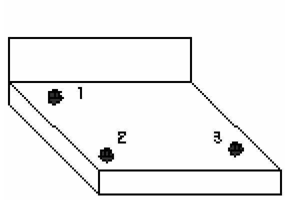
<Fig 1>



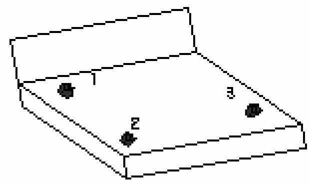
<Fig 2>

Fig 4.6 Coordinate Transfer

To convert coordinates, three standard points are needed. In the original position, mark three standard points on the work piece, and record the three points in [Program A]. After moving the work piece to the other position, mark the same standard points in [Program B].



[Program A]



[Program B]

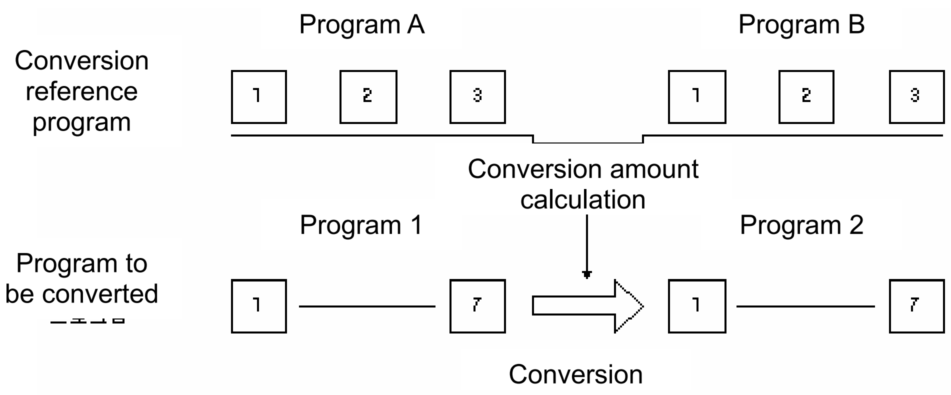
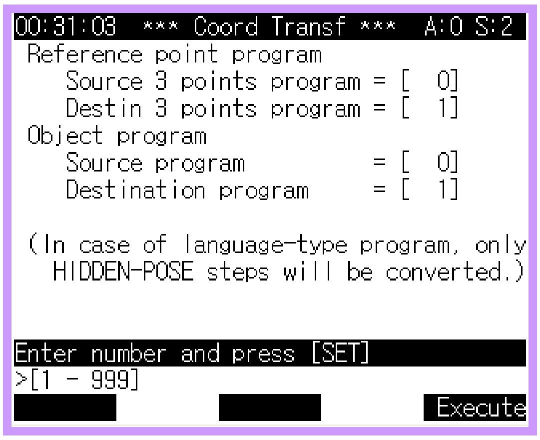


Fig 4.7 Coordinate Transfer Program

By calculating Coordinate Transfer quantity from Program A and B and the standard three steps, convert the original program [Program 1] to a new one [Program 2].

(1) Selection 『[PF1]: Service』 → 『6: Program Conversion』 → 『1: Coordinate Transfer』.



(2) After data setup, press『[PF5]: Execute』.

- Source 3 points program
  Number of a program with 3 standard points (Number of [Program A])

- Destin 3 points program
  Number of a program with 3 standard points (Number of [Program B])

- Source program
  Number of the original teaching program (Program number of [Fig 1])

- Destination program
  Number of a program which will be created by Coordinate Transfer (Program number of [Fig 2])

Reference

- The teaching level regarding 3 standard points affects accuracy of a Coordinate Transfer program. Teaching the 3 standard points should be as accurate as possible.
- The distance between the 3 standard points should be as far as possible.

4.7.2. Mirror Image

A program which sets the position of Axis S and that of wrist axis symmetrical can be drawn up. (Y-Z plane is the center of the symmetry.)

Mirror Image is useful when the same motions (including body welding of vehicles, etc.) for two robots on the opposite sides are required. After teaching a program to one robot, the other one on the opposite side retrieves and converts the program by using Mirror Image. Then, a new program which sets the symmetry about Axis S is created.

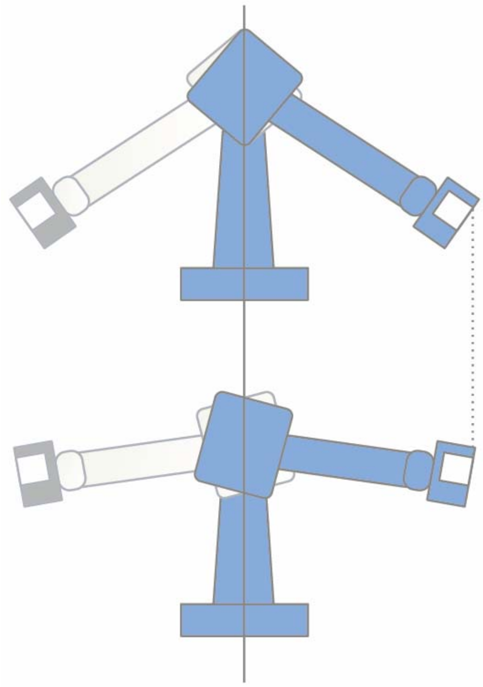


Fig 4.8 Original program → Converted program by using Mirror Image

(1) Selection 『[PF1]: Service』 → 『6: Program Conversion』 → 『2: Mirror Image』.

(2) Input data, press 『[PF5]: Execute』.

- Source program
  Number of the original program

- Destination program
  Number of a program to be created by using Mirror Image

- Additional axes
  Set as <ENBL>, if the Mirror Image conversion of main axis is needed.

Reference

- If any axis exceeds soft limit in the process of Mirror Image conversion, such axis will be indicated in 'Limit over(step#).'

```
00:03:25  *** Mirror Image ***   A:0 S:2
 Source Program       = [   1]
 Destination Program = [   0]
 Additional axes
  7Axis =<DSBL,ENBL>


 ========= Limit over(step#) ==========


 (In case of language-type program, only
   HIDDEN-POSE steps will be converted.)
Enter number and press [SET]
>[1 - 999]
                                Execute
```

If 'Limit over(step#)' indicates 'Completion,' it means review is over. If 'Steps Exceeding Limit' indicates '=>,' it means there are more steps exceeding limit.

- Check which axis exceeds soft limit in person, and adjust it.

- Use the Mirror Image function for the same type of robots, because soft limits are different according to each robot type.

- Set the standard position of encoder and 0 degree position of each axis to be the same for the robots on the both sides.

- Use symmetrical guns and tools, or attach guns and tools symmetrically.

4.7.3. Off-Line XYZ Shift

A new program can be created by shifting positions and postures of a program.

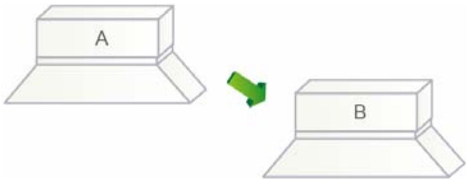


Fig 4.9 Parallel move of work pieces

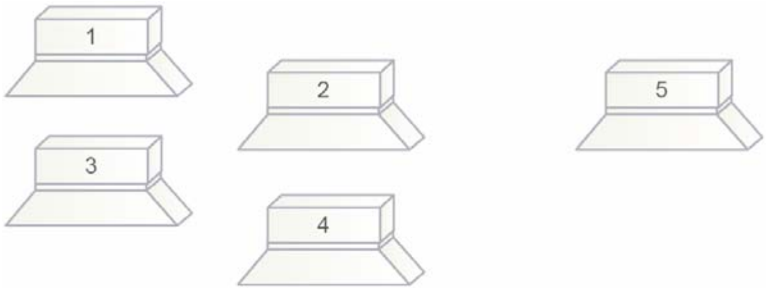
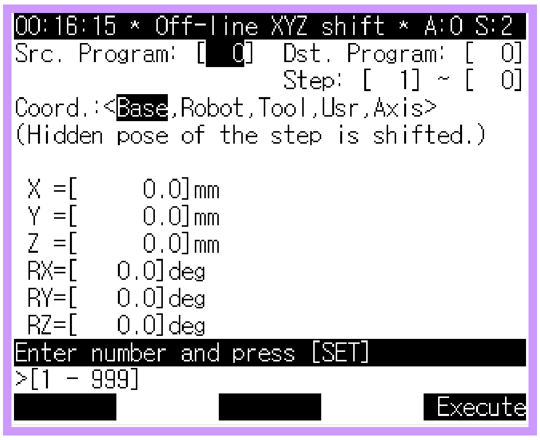


Fig 4.10 Several work pieces of the same kind

If a work piece in Position A needs to be moved to Position B, or if there are several work pieces, specify moving distance and position conversion quantity, and perform ‘Off-Line XYZ Shift.’ Then, several new programs can be created by shifting the original program. The values of moving distance and position conversion quantity should be given. If not, use the function of 『4.7.1 Coordinate Transfer』.

(1) Selection 『[PF1]: Service』 → 『6: Program Conversion』 → 『3: Off-Line XYZ Shift』.

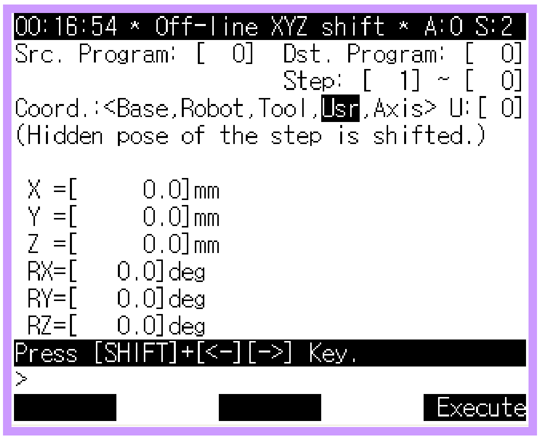


(2) Input data, and press 『[PF5]: Execute』.

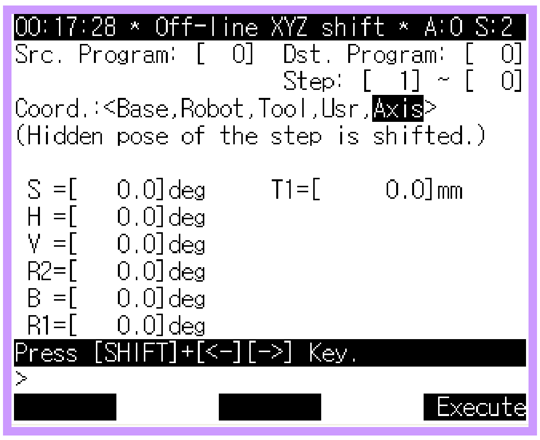
- Src. Program : Number of the standard program
- Dst. Program : Number of a new program to which the standard program will be copied
- Start step: First shift step of the copied program
- End step: Last shift step of the copied program
- Shift : Shift quantity

1) Coordinates: Standard coordinates for shift. 'Base, Robot, Tool and Usr' are for orthogonal coordinates shift and 'Axis' is for axis angle shift.

Ex. Usr coordinates)



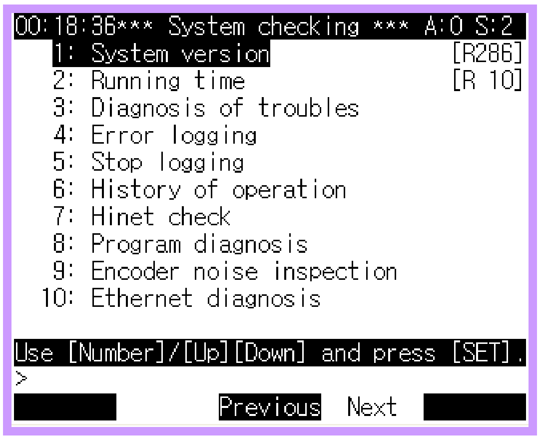
Ex. Axis coordinates) Input the degree of each axis.



4.8. System Checking

System Checking helps robot maintenance by inspecting the state of robots and controllers.

(1) Selection 『[PF1]: Service』 → 『7: System Checking』.



4.8.1. System Version

System Version indicates the system environment (software version) of Hi4 controller.

(1) Selection 『[PF1]: Service』 → 『7: System Checking』 → 『1: System Version』.

```
00:19:07  ** System version **  A:0 S:2
Robot type: HX165-04 (Axis: 6 Tot Ax: 7)
Main Software Version => Robot Language
     Main S/W: V20.03-03  2006-08-31
   Motion S/W: V07.18     2006-08-24
     T/P Ver : V03.03     2002-08-01
     I/O Ver : V06.00     2004-12-06
DSP Software Version
     DSP1 S/W: V05.04     2004-01-20
     DSP2 S/W: V05.04     2004-01-20
     DSP3 S/W: V00.00        0-00-00
     DSP4 S/W: V00.00        0-00-00
Press [ESC] or [R..]
>
                Previous  Next
```

```
00:19:27  ** System version **  A:0 S:2
System Control Environment
     Conveyor synchronization = OFF
     Vibration control mode   = OFF









Press [ESC] or [R..]
>
                Previous  Next
```

- Robot Type, Axis, Tot Ax
  Name of a robot, number of robot axes and total number of axes including additional axes are indicated.

- Main Software Version
  - Version and date of main S/W are indicated.
  - Version and date of motion S/W are indicated.
  - Version and date of T/P are indicated.
  - Version and date of I/O are indicated.

- DSP Software Version
  S/W version and date of DSP 1, 2, 3 and 4 are indicated.

- Systen Control Environment
  Conveyor synchronization state and vibration controller application state are indicated.

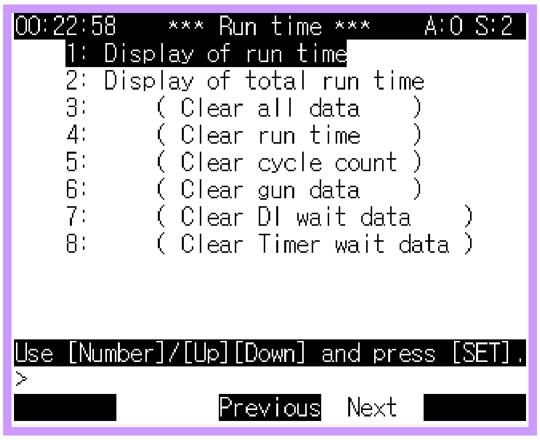
Reference

- 『R286: Software version』 of R code has the same function.

4.8.2. Running time

Total time from lighting to putting out the operation lamp is indicated. The following is indicated: Run time, one cycle progress time, number of operating cycles and GUN Run time, number of GUN operation, DI signal waiting time, timer waiting time in one cycle.

(1) Selection 『[PF1]: Service』 → 『7: System Checking』 → 『2: Running time』.



Reference

- 『R10 : Run time display』 of R code has the same function.

4.8.2.1. Display of run time

Run time Indication indicates robot Run time until the current time, one cycle progress time, number of operating cycles, GUN Run time, number of GUN operation, DI waiting time and timer waiting time, after the controller is turned on. When the controller is turned off, data is initialized.

(1) Selection 『[PF1]: Service』 → 『7: System Checking』 → 『2: Running time』 → 『1: Display of run time』.

```
00:31:51     *** Run time ***     A:0 S:2
*Run time         = 0:00:00.00
Cycle time= 0:00:00.00     Cycle = 0
Gun1 Time = 0:00:00.00     count = 0
Gun2 Time = 0:00:00.00     count = 0
Gun3 Time = 0:00:00.00     count = 0
Gun4 Time = 0:00:00.00     count = 0
WAIT,DI waiting time = 0:00:00.00
Timer waiting time   = 0:00:00.00



Press [ESC] or [R..]
>
```

- Run time
  Total time from lighting to putting out the operation lamp is indicated. After 24 hours since lighting, it is automatically initialized.

- Cycle Time
  Average time of 1 cycle can be calculated during operation. The formula is (Cycle Time)/(Cycles). When a robot stops the operation, Run time is set as the same value.

- Cycle
  Number of program operation cycles. When operation begins, step 0 is the starting point for count. When operation is Ended before finishing and then restarted, 'Cycles' clears to 0. 'Cycles' can count up to 255. When the number goes over 255, 'Cycles' is automatically initialized.

- GUN? Time
  Total time for which GUN signal is outputted in one cycle during operation is indicated. When GUN time goes over 24 hours, 'GUN? Time' is automatically initialized.

- Count
  Number of GUN signal output in one cycle during operation is indicated. When the number goes over 65535, 'Number' is automatically initialized.

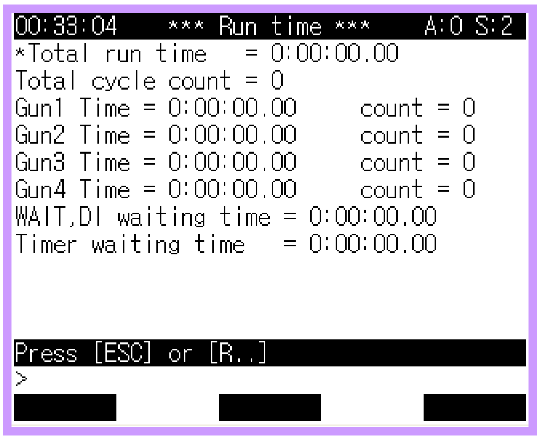
- Wait, DI waiting time
  Wait, DI waiting time in one cycle during operation is indicated. When DI signal waiting time goes over 24 hours, 'DI Signal Waiting Time' is automatically initialized.

- Timer Waiting Time
  Timer waiting time in one cycle during operation is indicated. When timer waiting time goes over 24 hours, 'Timer Waiting Time' is initialized.

4.8.2.2. Display of Total Run time

Total Run time is indicated. Total number of cycles, total GUN? Time, number, DI signal waiting time and timer waiting time are the same. Unlike Run time, when the power is off, ‘Total Run time’ is not initialized.

(1) Selection 『[PF1]: Service』 → 『7: System Checking』 → 『2: Running time』 → 『2: Display of total run time』.



4.8.2.3. Data Clear

Part or all of the data indicated in ‘Total Run time’ can be cleared.

(1) Selection 『[PF1]: Service』 → 『7: System Checking』 → 『2: Running time』 → 『3: Clear All Data』, 『4: Clear Run Time』, 『5: Clear Cycle Count』, 『6: Clear GUN Data』, 『7: Clear DI Wait Data』 or 『8: Clear Timer Wait Data』. Then, the following message appears.

```
Clear?                                  [YES/NO]
>
                Previous  Next
```

(2) If [YES] is pressed, data of selectioned item will be initialized.

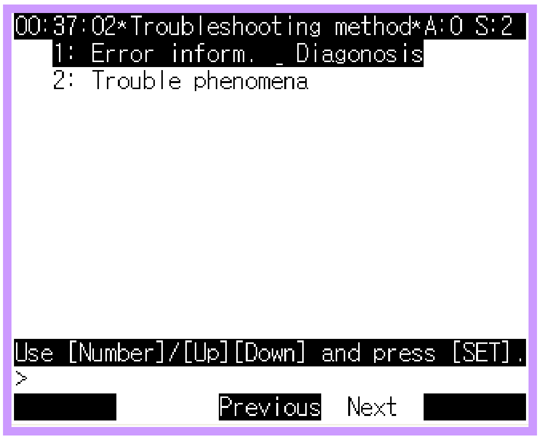
```
00:36:01    *** Run time ***     A:0 S:2
*Total run time   = 0:00:00.00
Total cycle count = 0
Gun1 Time = 0:00:00.00     count = 0
Gun2 Time = 0:00:00.00     count = 0
Gun3 Time = 0:00:00.00     count = 0
Gun4 Time = 0:00:00.00     count = 0
WAIT,DI waiting time = 0:00:00.00
Timer waiting time   = 0:00:00.00


Press [ESC] or [R..]
>
```

4.8.3. Diagnosis of Troubles

The cause of error can be diagnosed. When error occurs, ‘Error Diagnosis’ helps maintenance by indicating appropriate measures.

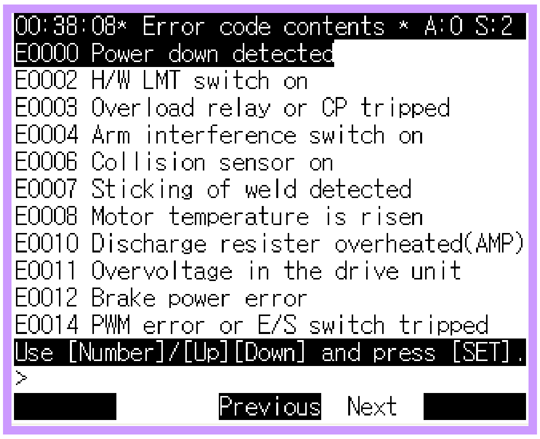
(1) Selection 『[PF1]: Service』 → 『7: System Checking』 → 『3: Diagnosis of Troubles』.



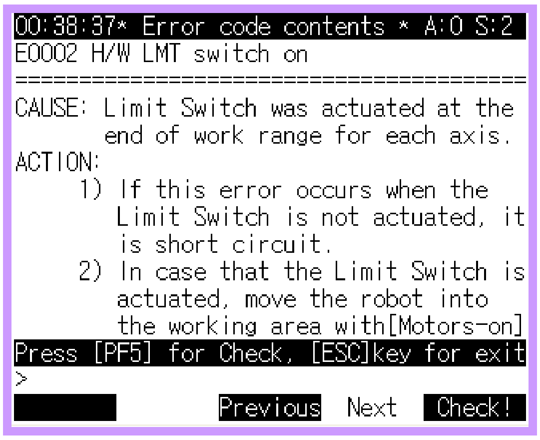
4.8.3.1. Error inform. & Diagnosis

Error inform. & Diagnosis indicates Error inform. & Diagnosis and repair measures.

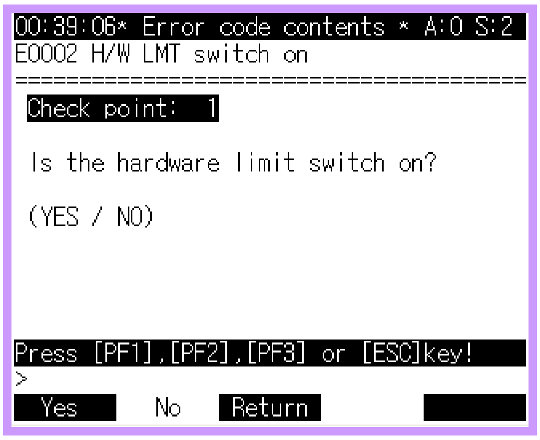
(1) Selection 『[PF1]: Service』 → 『7: System Checking』 → 『3: Diagnosis of troubles』 → 『1: Error inform. & Diagnosis』.



(2) Selection an error code. If 『E0002: H/W LMT switch on』 is selectioned, the following screen appears.



(3) If diagnosis is need, press 『[PF5]: Check!』 to diagnose one by one.



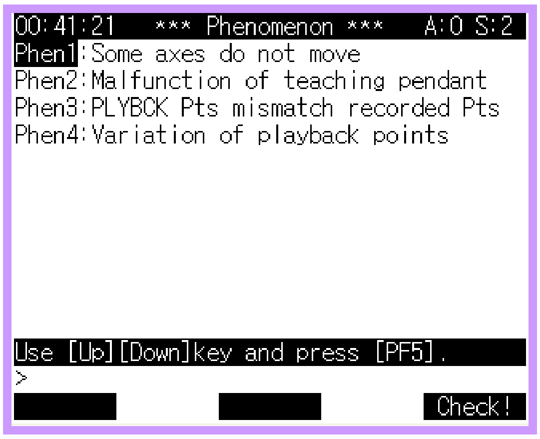
(4) Selection 『[PF1]: Yes』 or 『[PF2]: No』 in response to the diagnosis message. 『[PF3]: Return』 is gor going back to the Previous item, if 『[PF1]: Yes』 or 『[PF2]: No』 is pressed accidentally.

(5) Follow the test point message.

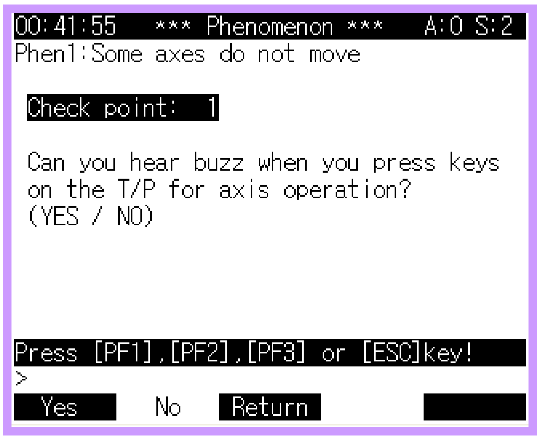
4.8.3.2. Trouble phenomena

Trouble phenomena helps robot maintenance by indicating appropriate measures to errors.

(1) Selection 『[PF1]: Service』 → 『7: System Checking』 → 『3. Diagnosis of troubles』 → 『2: Trouble phenomena』.



(2) Selection a error state, and press 『[PF5]: Check!』. If 『Phen1: Some axes do not move』 is selectioned, the following screen appears.



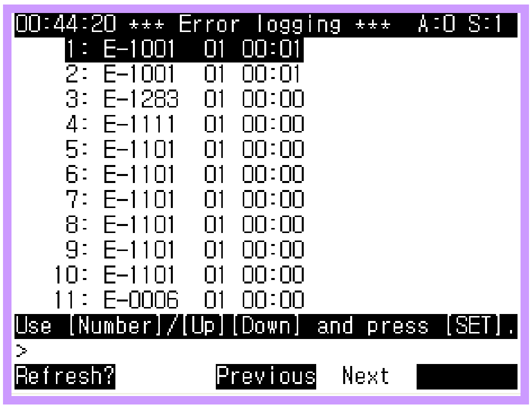
(3) Selection 『[PF1]: Yes』 or 『[PF2]: No』 in response to the indicated test pointer.

(4) Follow the test point message.

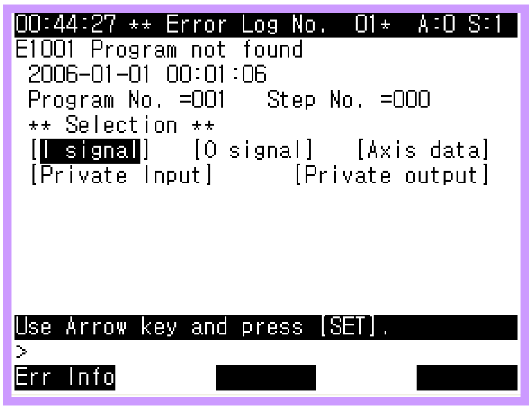
4.8.4. Error logging

History of error and warning is indicated. When an error occurs, details, time, program number, step number, axis data and input/output state can be checked. One hundred times of Error logging can be recorded. History can be initialized by pressing 'Rewrite [PF1]' key. Cause of error and restoration work can be precisely determined by referring to history.

(1) Selection 『[PF1]: Service』 → 『7: System Checking』 → 『4: Error logging』.



(2) Selection 『1: E-1001 01 00:01』, and press [SET]. Then, the following screen appears.



(3) Selection general I signal, O signal, Axis data, Private Input or Private output to learn the error state.

Reference

- Selection 『[PF1]: Refresh?』, and the following message appears.

```
Refresh the recorded data?          [YES/NO]
>
Refresh?          Previous   Next
```

- If [Yes] is selectioned, all the Error logging is cleared and initialized.

4.8.5. Stop logging

Stop logging of a robot is indicated. When stop command or emergency stop is inputted in a robot in operation, input details, stop time, program number, step number, axis data and input/output state are indicated. This information can be referred to for robot repair. One hundred times of Stop logging can be recorded. History can be initialized by pressing 『[PF1]: Refresh?』 key. (Refer to ‘Error logging.’)

(1) Selection 『[PF1]: Service』 → 『7: System Checking』 → 『5: Stop logging』.

```
 14:39:38    *** Stop logging ***    A:0 S:4
  1: F-01    25    10:36
  2: F-02    25    09:44
  3: F-03    24    13:54
  4: F-03    24    12:27
  5: F-03    24    10:44
  6: F-03    22    18:53
  7: F-03    22    17:36
  8: F-03    22    15:48
  9: F-03    22    15:27
 10: F-03    21    14:10
 11: F-03    21    09:44
Use [Number]/[Up][Down] and press [SET].
 >_
Refresh?          Previous    Next
```

(2) The following is an example of Stop logging.

```
  14:39:38  * Stop Log No.  01*   A:0 S:4

   2005-07-25 10:36:11
   Program No. =000    Step No. =000
 ** Selection **
 [I signal]   [O signal]   [Axis data]
 [Private Input]       [Private output]




Use Arrow Key and press [SET].
 >_
Err info
```

(3) Selection general I signal, O signal, Axis data, Private Input or Private output to learn the stop state of a robot.

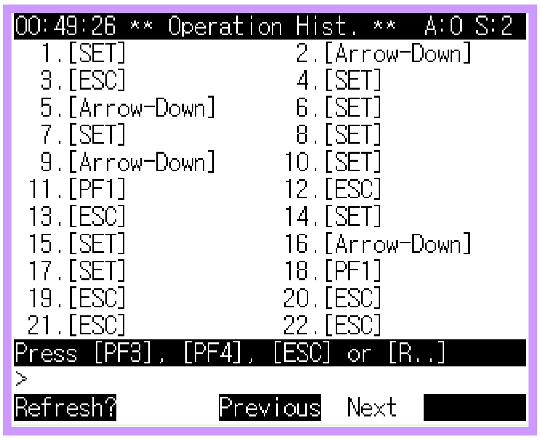
Reference

- Refer to 『4.8.4 Error logging』 for history file Initialize.

4.8.6. History of operation

One hundred times of History of operation of keys on teach pendant and buttons and switches on manipulation panel are stored. History of operation on key names on teach pendant, keys and buttons on manipulation panel (emergency stop, motor on, operation and stop), auto/manual switch and safety plug can be checked.

(1) Selection 『[PF1]: Service』 → 『7: System Checking』 → 『6: History of operation』.



Reference

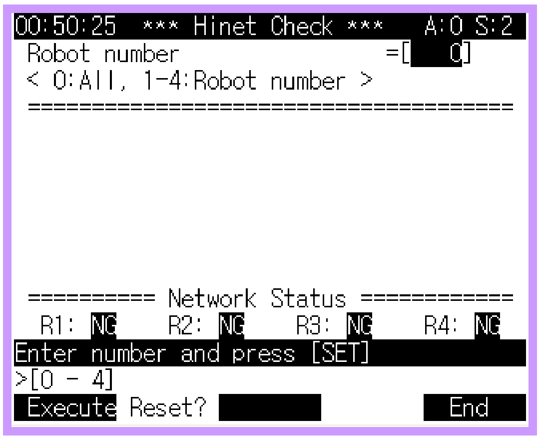
- Refer to 『4.8.4 Error logging』 for history file Initialize.

4.8.7. Hinet check Function

Hinet check Function is a service function used for the Hinet-network-based cooperative control method. Refer to 『Cooperative Control Function Manual』 for details.

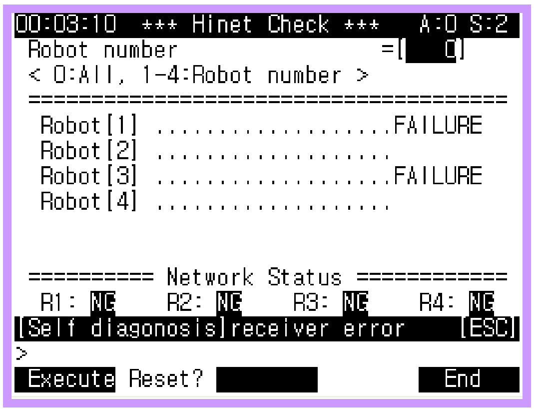
Applicable versions: after Main V10.07-25

(1) Selection 『[PF1]: Service』 → 『7: System Checking』 → 『7: Hinet check』.



If 0 is inputted, all robots (1~4) are tested, and if any of 1~4 is inputted, only the robot is tested. Press [PF1] to execute this function.

(2) If network is normal, SUCCESS is indicated, and if not normal, FAILURE is indicated, as shown below.



(3) Use 『[PF2]: Reset?』 function to initialize the cooperative control Hinet protocol.

Reference

- If diagnosis result is FAILURE, examine network card and cable connection.

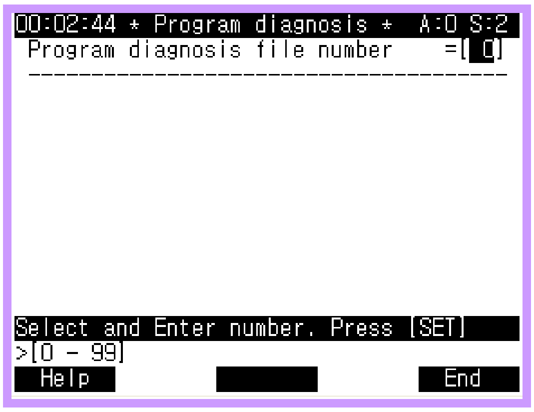
4.8.8. Program Diagnosis

States of a robot can be monitored while the robot work program is in operation. Diagnosis data is regularly updated and stored in a diagnosis file. Therefore, as robot Run time goes by, users can observe how diagnosis data of the robot changes when the same work is in operation

To set the program diagnosis function, selection 『[PF2]: System』 → 『1: User parameter』 → 『17: Make prog. diagnosis file』. Refer to the relevant guide.

Program diagnosis results can be viewed on a computer, because the result files are stored in the computer through HR-View transfer software. However, the final results are also available on teach pendant.

(1) Selection 『[PF1]: Service』 → 『7: System Checking』 → 『8: Program Diagnosis』.



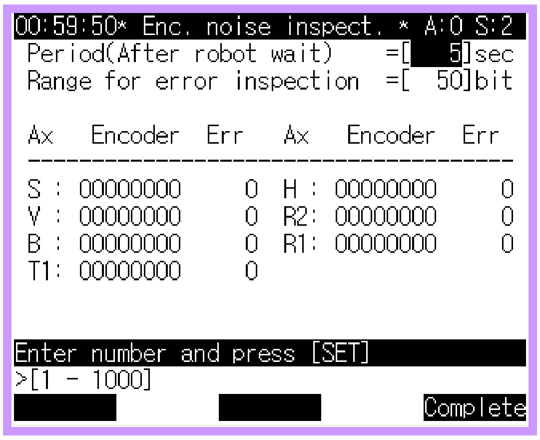
(2) To check program diagnosis results, press [Previous] or [Next] and then [ESC].

(3) Press [Help] to check the program diagnosis file.

4.8.9. Encoder Noise Inspection

Encoder Noise Inspection is the function which checks if noise comes into encoder line by retrieving RX signal of encoder and comparing it with current encoder value, while motor is off or not in motion for a while. This function is not performed while a robot is working.

(1) Selection 『[PF1]: Service』 → 『7: System Checking』 → 『9: Encoder Noise Inspection』.



- Period

  By allowing users to set check cycle, operation is temporarily possible, even though noise occurs.
  minimum cycle : 1sec
  maximum cycle : 1000 sec (= 16 min 40 sec)
  default : 5 sec
  'Encoder Noise Inspection' repeats according to the set check cycle, while a robot is not in motion or the motor is off.

- Range for error inspection

  Users decide how many bits will be determined as noise, and set range in order to check noise amount and to use the robot temporarily until the noise is removed.

  minimum amount: 10 bit
  maximum amount: motor electrical degree 30deg = 8192/4 * 30/360 = 170 bit
  default: 50 bit

- Encoder: Current data of encoder

- Noise amount monitoring

  ① Engineers set error detection amount as maximum and prepare for state observation.

  ② Because monitored noise amount is indicated according to the check cycle and noise amount is not updated while a robot is in motion, the heck cycle should be 1 sec, and a step for which the robot stops more than 1 sec should be included in the steps for noise amount monitoring.

③ If noise error occurs, noise amount will not be updated.

④ If noise error occurs, stop noise check and update for user confirmation, because noise can appear from one direction and then from the other direction, and finally disappear.

⑤ Do not perform noise detection for compact encoder until “premove” finishes.

⑥ Do not perform noise detection for servo gun axis which has separate function of servo gun change.

⑦ Noise detection function can be applied when servo gun is connected to a robot.

(2) New errors

- 『E0220 Axis ○ Encoder noise 』
  Error is dealt by motion part by comparing error amount sent from DSP and error detection amount.

- 『E0221 Axis ○ failed to receive encoder』
  Error is dealt when DSP fails to receive RX data four times. After encoder noise error occurs, motor cannot be turned on. When users try to turn on the motor, this message appears again. (The same treatment for encoder line disconnection)

(3) Encoder battery Voltage decrease detection function addition

- This function is operated with the encoder noise detection function. When voltage decrease is detected, warning is given.

4.9. Date setting (Day, Time)

Date and time of controller can be changed.

(1) Selection 『[PF1]: Service』 → 『8: Date setting (Day, Time)』.

(2) Input date and time, and press 『[PF5]: Complete』 to store changed information.

4.10. Data Gathering Function

Diverse data are collected for some time and stored in a file during robot operation.

(1) Selection 『[PF1]: Service』 → 『9: Data gathering』.

```
01:02:46  ** Data Gathering **  A:0 S:2
 Gathering file :          ROBOT.GD[0]

 Sampling time  :          [   20]msec
 Parameter
 1:[   0]  2:[   0]  3:[   0]  4:[   0]
 5:[   0]  6:[   0]  7:[   0]  8:[   0]
 9:[   0] 10:[   0] 11:[   0] 12:[   0]
 Refer to HELP for Parameter setting

 Max gathering time: [    1]sec

Enter number and press [SET]
>[0 - 9]
  Help                         Complete
```

- Gathering file
  Number of the file in which data collecting results will be stored. The collecting result file will be stored under the following name.
  ROBOT.GD0~GD9

- Sampling Time
  Sampling time for data collecting: minimum 10 msec

- Parameters: [ABCD]
  Data setup for collecting. Data of up to 12 parameters can be collected simultaneously.
  Refer to the guide by pressing '[PF1]: HELP' for parameter types.

  [AB] : Axis number
  - 0 : parameter which has no relation with axis
  - 1~12 : axis number

  [CD] : Parameter number

  In case of [AB]=0,
  - 00 : No parameter is assigned.
  - 01 : At the Completion of the tool X position
  - 02 : At the Completion of the tool Y position
  - 03 : At the Completion of the tool Z position
  - 31~46 : DIW01(DI016 DI1) ~ DIW16(DI256 DI241)
  - 71~86 : DOW01(DO016 DO1) ~ DOW16(DO256 DO241)

  In case of [AB]=1~12,
  - 00 : No parameter is assigned.
  - 01 : Axis degree
  - 02 : Axis degree
  - 03 : Axis load factor
  - 04 : Axis deviation

- Max gathering time
  Input maximum time for data collecting.

(2) Data Collecting Command
Use the following commands in a work program to set data collecting range.

GATHER var
var = 1: Data collecting begins.
var = 0: Data collecting Completions.

Data between data collecting start point and Completioning point is collected. The collecting time is limited to the maximum collecting time.

5

Condition Setting

5.1. Condition setting

Condition setting is the function to set the program playback condition.
This setting does not change the content of the teaching program. The changed conditions are saved not in the teaching program but in the system file within the controller. The changed conditions are maintained even when the power is turn off. Therefore please turn back all the temporary condition settings to its original setting.

(1) Press the 『[PF5]: Cond Set』 from the initial screen of manual or auto mode to see the following screen.

```
01:07:41 *** Condition set ***   A:0 S:2
 1: Cycle type    =<1Step,1Cycle,Continu>
 2: Step go/back max.speed(mm/s)  =[200]
 3: Func in step GO/BACK   =<Off,On,I On>
 4: Speed rate=[100] GunStep=<DSBL,ENBL>
 5: Robot lock                =<DSBL,ENBL>
            Servo gun lock    =<DSBL,ENBL>
 6: Rec speed type=<Standard,[%],[mm/s]>
 7: Interpolation base   =<R-tool,S-tool>
 8: Select user coordinate          =[ 0]


Press [SHIFT]+[<-][->] Key.
>
ApplICnd                          End
```

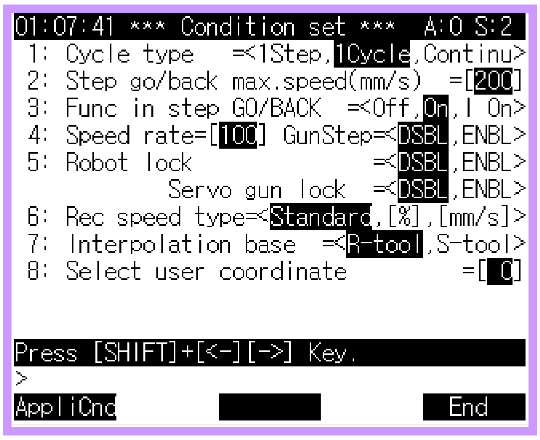
Reference

- Move the cursor to this item. When entering a number, enter the number in the input frame. Key in the number using the [Number] key and press the [SET] key to reflect the input.
- When selecting an item in the < >, use the [SHIFT]+[->][<-] key to move the cursor and it is immediately reflected.
- Condition setting data is saved in control constant file (ROBOT.C00).
- You can make changes to the control constant file (ROBOT.C00) even when the file is completely protected.

5.2. Cycle type

This decides the method of playback for the prepared program. There are 3 method of playback method available; 1 step playback, 1 cycle playback and continuous playback. This must be set before the playback.

(1) Select 『[PF5]: Cond Set』 → 『1: Cycle type』 from the initial screen of manual or auto mode.



- 1Step
  This will playback 1 step while you keep the move button pressed.
  (When you release the move button, step playback and the robot will stop.)

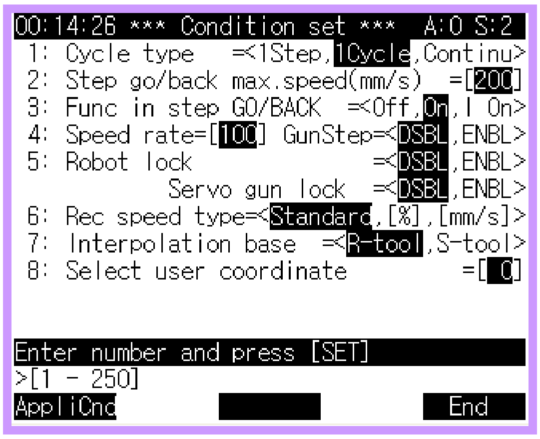
- 1Cycle
  This will playback the program for one cycle when you press the move button. (The robot will stop at program end.)

- Continu
  This repeats the prepared program and plays back continuously.
  (The robot will stop when there is an external stop operation.)

5.3. Step go/back max.speed(mm/s)

The robot can move in the speed of 1 ~ 250mm/s during step forward/backward movement in manual mode.

(1) Select 『[PF5]: Cond Set』 → 『2: Step go/back max.speed』 from the initial screen of manual or auto mode.



Reference

- When the maximum speed of step forward/backward is set to 250,
  ① When the recorded speed of the step is 250mm/s or higher, the robot will move at a speed of 250mm/s during step forward/backward.
  ② When the recorded speed of the step is 250mm/s or below, the robot will move at the speed recorded in the step.

5.4. Func in step GO/BACK

This decides whether to execute the function recorded within the program for step forward/backward in manual mode. This can be set in 3 ways; Off, On and I On.

(1) Select 『[PF5]: Cond Set』 → 『3: Func in step GO/BACK』 from the initial screen of manual or auto mode.

```
01:07:41 *** Condition set ***   A:0 S:2
 1: Cycle type    =<1Step,1Cycle,Continu>
 2: Step go/back max.speed(mm/s)   =[200]
 3: Func in step GO/BACK   =<Off,On,I On>
 4: Speed rate=[100] GunStep=<DSBL,ENBL>
 5: Robot lock              =<DSBL,ENBL>
            Servo gun lock  =<DSBL,ENBL>
 6: Rec speed type=<Standard,[%],[mm/s]>
 7: Interpolation base  =<R-tool,S-tool>
 8: Select user coordinate         =[ 0]


Press [SHIFT]+[<-][->] Key.
>
AppliCnd                          End
```

- Off : This only executes the program end function and ignores all other functions.
- On: This executes all the functions recorded within the program.
- I On : This only executes the input signal standby function and program end function.

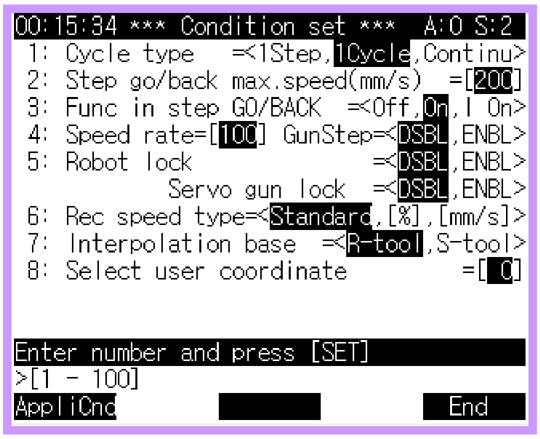
Reference

- For step backward movement, all other functions besides the input signal standby function are not executed.

5.5. Speed rate

This modifies the robot speed during playback to the ratio set within the range of [1 ~ 100]% to the speed recorded in the step. The condition for gun step decides whether to apply the variable speed or not for the speed recorded in step in which G1 or G2 is set as the step property.

(1) Select 『[PF5]: Cond Set』 → 『4: Speed rate』 from the initial screen of manual or auto mode.



(2) Set the variable speed function for gun step, use the [Arrow] key to move the cursor to the gun step and then use the [SHIFT]+[->][<-] key to move the cursor. The changes will be immediately reflected.

< Gun step >

- DSBL
  This disables the variable speed function for the step with property of G1 or G2.

- ENBL
  This enables the variable speed function for the step with property of G1 or G2.

5.6. Robot lock

This plays back the program without actually moving the robot. By using this function, you can check the input/output condition with peripheral devices, soft limit and cycle time etc.

(1) Select 『[PF5]: Cond Set』 → 『5: Robot lock』 from the initial screen of manual or auto mode.

```
01:07:41 *** Condition set ***   A:0 S:2
 1: Cycle type   =<1Step,1Cycle,Continu>
 2: Step go/back max.speed(mm/s)  =[200]
 3: Func in step GO/BACK  =<Off,On,I On>
 4: Speed rate=[100] GunStep=<DSBL,ENBL>
 5: Robot lock               =<DSBL,ENBL>
              Servo gun lock  =<DSBL,ENBL>
 6: Rec speed type=<Standard,[%],[mm/s]>
 7: Interpolation base  =<R-tool,S-tool>
 8: Select user coordinate          =[ 0]


Press [SHIFT]+[<-][->] Key.
>
ApplICnd                           End
```

(2) For the system including the servo gun axis, you can control the servo gun axis lock by setting it to gun lock or unlock.

Reference

- If the robot lock is set to 『Robot lock=<ENBL>』, you will see a R-L on the top of the manual or auto mode screen. But in the system including the servo gun axis, it must be set to『Servo gun axis lock=<ENBL>』 at the same time.

- The R code of R123 serves the same function as robot lock.

- Gun lock is the function to lock only the servo gun axis in the system including the servo gun. Set it to 『Robot lock = <DSBL>』, 『Servo gun axis lock = <ENBL>』. You will see a G-L on top of the screen. Gun lock function can only be used when the gun change function is set to 'Enable'. If the gun change function is set to Disable, set the servo gun axis lock to Enable and it cannot be set to Disable.

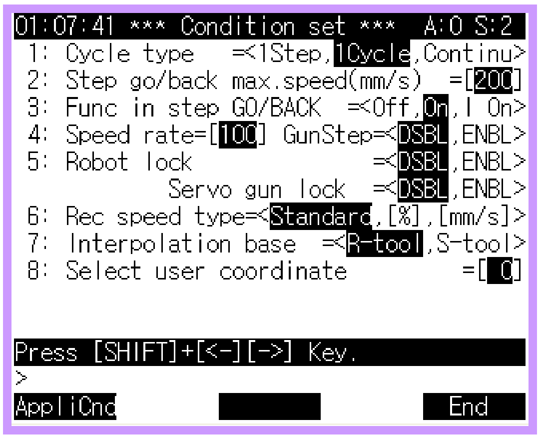
- Gun lock function can only be used for Hi4 Controller of version 10.05-05 or newer with the separate option for welding gun exchange function.

- Gun unlock is the function that only operates the servo gun axis in the system including the servo gun and that sets the robot not to move. Set it to 『Robot lock = <ENBL>』 and 『Servo gun axis lock = <DSBL>』. You will see [redacted] on top of the screen. This function is useful in checking the status of the servo gun pressure step of the program with the robot stopped.

5.7. Rec speed type

This decides the speed unit recorded to the step according to the interpolation condition. There are 3 ways to designate the speed; Standard, % and mm/s.

(1) Select 『[PF5]: Cond Set』 → 『6: Rec speed type』 from the initial screen of manual or auto mode.



- Standard
  Interpolation OFF : Ratio designation[%]
  Line interpolation : Speed designation [mm/sec]
  Arc interpolation : Speed designation [mm/sec]

- [%]
  Interpolation ON/OFF : Ratio designation [%]

- [mm/s]
  Interpolation ON/OFF : Speed [mm/sec]

Reference

- This is the same function as 『R71 : Speed definition type selection』 as the R code.

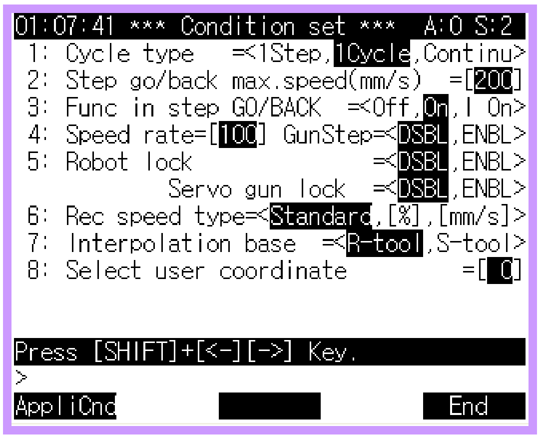
5.8. Interpolation base

This selects the interpolation standard selected automatically when recording the step. The general interpolation method of the robot is the robot tool interpolation. Therefore the default in the controller is set to robot tool.

To record the stationary interpolation step, select the stationary tool for the interpolation standard. To record the step in stationary interpolation standard, the stationary tool coordinate system must be set.

Refer to the setting in 『[PF2]: System』 → 『2: Controller parameter』 → 『12: Coordinate setting』 → 『2: Stationary tool coordinate』.

(1) Select 『[PF5]: Cond Set』 → 『7: Interpolation base』 from the initial screen of manual or auto mode.



- R-tool : Interpolation is done based on the tool attached to the robot's end.
- S-tool : Interpolation is done based on the tool attached to the fixture such as the floor.

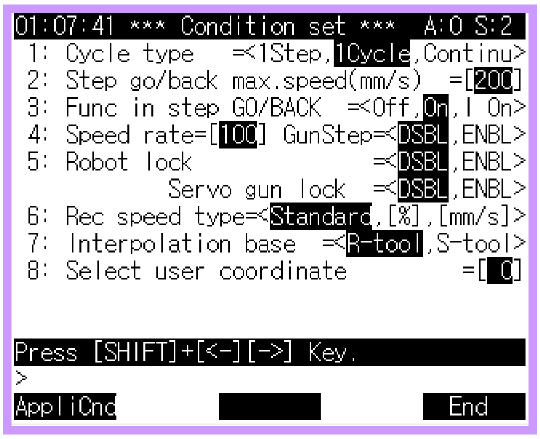
Reference

- The step is recorded with stationary tool selected in manual mode, the type of interpolation is recorded as SP, SL or SC according to whether interpolation OFF, line interpolation or arc interpolation respectively.
- When recording the step based on stationary interpolation standard, refer to 『M67: Selection of stationary tool』 to select the stationary tool number.
- Refer to 『7.3.12.2 Stationary tool interpolation function』 for explanations on types of stationary interpolation.

5.9. Select user coordinate

This selects the coordinate system for orthogonal coordinate operation for manual operation. This is used for operating the orthogonal coordinate to the user coordinate during robot jog operation in manual mode.
At this time, the robot executes the orthogonal coordinate operation in X, Y and Z axis direction of set user coordinate. Also when using the monitoring function, the X, Y and Z coordinates of the tool end displayed in the screen is displayed in coordinates in user coordinate system.

(1) Select 『[PF5]: Cond Set』 → 『8: Select user coordinate』 from the initial screen of manual or auto mode.

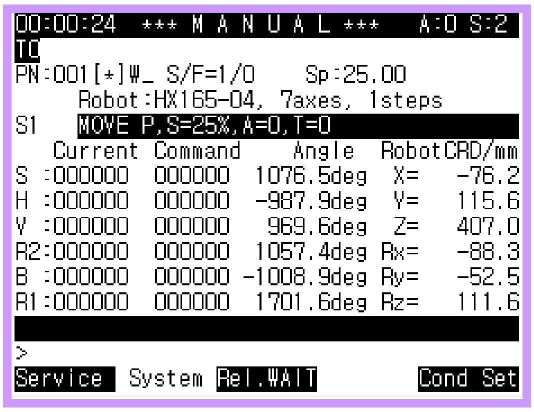


Reference

- If the user coordinate system number is set to “0”, the operation is canceled for the user coordinate and the orthogonal operation and monitoring is done in the robot coordinate.

- The non-zero number displayed in the input frame is the coordinate number registered as the user coordinate in 『[PF2]: System』 → 『2: Controller parameter』 → 『12: Coordinate setting』 → 『1: User coordinate』. If you try to a number not registered as a user coordinate, you will see the following screen.

- If you select the user coordinate number and 『[PF1]: Service』 → 『1: Monitoring』 → 『1: Axis data』, you will see the following screen. At this time, the coordinate value changed by [Axis operation] key is done based on the user coordinate.



- For the user coordinate registration, refer to the 『[PF2]: System』 → 『2: Controller parameter』 → 『12: Coordinate setting』 → 『1: User coordinate』

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6
Application Condition

6.1. Application condition

Application condition is the function to set the program playback condition. This setting does not change the content of the taught program. The changed conditions are saved not in the taught program but in the system file within the controller. The changed conditions are maintained even when the power is turn off. Therefore please turn back all the temporary condition settings to its original setting.

(1) Select 『[PF5]: Cond Set』 from the initial screen of manual or auto mode. You will see the 『Application Condition』 label on [PF1] key in the condition setting screen. Press the 『[PF1]: AppliCnd』 and you will see the following screen.

```
00:11:58*Application Condition* A:0 S:2
 1: Conveyor Oper=<Normal,Simulat.,Test>
 2: Search range                 =[0.0]
 3: Search reference Pt. record=<Off,On>
 4: Spot welding     =<Wd-On,Sq-On,SqOff>
 5: Gun search Ref.point record=<Off,On>
 6: Output(DO) signal clear =<DSBL,ENBL>
 7: Shift register clear    =<DSBL,ENBL>
 8: Emb.PLC mode=<Stop,R-Stop,R-Run,Run>
 9: Servo hand squeeze command =<Off,On>

Press [SHIFT]+[<-][->] Key.
>
                                Cond Set
```

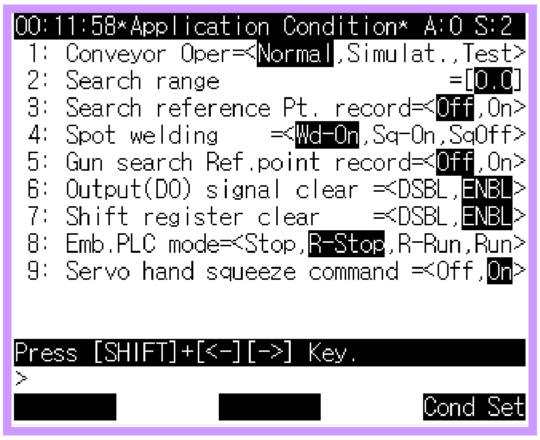
Reference

- Move the cursor to this item. When entering a number, enter the number in the input frame. Key in the number using the [Number] key and press the [SET] key to reflect the input.
- When selecting an item in the < >, use the [SHIFT]+[<-][->] key to move the cursor and it is immediately reflected.
- Application condition data is saved in control constant file (ROBOT.C00).
- You can make changes to the control constant file (ROBOT.C00) even when the file is completely protected.

6.2. Conveyor operation

This decides the operation type of the robot when the robot is working on the Conveyor. There are 3 types of Conveyor operation type; normal mode, simulation mode and test mode. This must be set before the playback. For more details, please refer to the 『Conveyor synchronization Function Manual』.

(1) Select 『[PF5]: Cond Set』 → 『[PF1]: AppliCnd』 → 『1: Conveyor Oper』 from the initial screen of manual or auto mode.



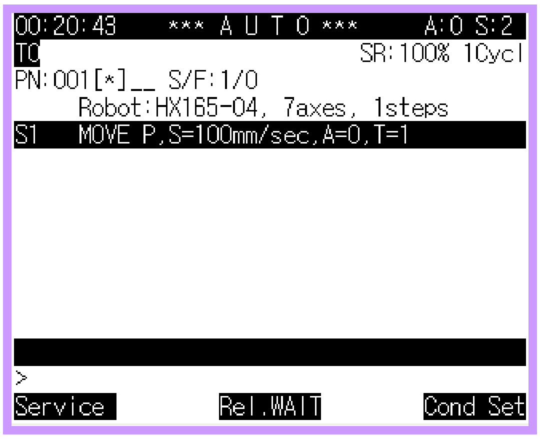
- Normal : The robot moves to the work object on the moving Conveyor.

- Simulat.
  The user can test the robot operation according to the Conveyor speed entered by the user without the actual operation. It is efficient for checking the cycle time after teaching.

- Test
  This is done in the similar environment as the simulation in that the robot operation is checked without operating the Conveyor. Unlike the simulation mode, you can check the teaching point with the work object stopped because the pulse count is not reset even after the program end function is executed.

Reference

- The following screen is displayed in manual or auto mode according to the set Conveyor operation condition.



- The Conveyor pulse count is triggered only by the limit switch operation irrelevant of the operation type.

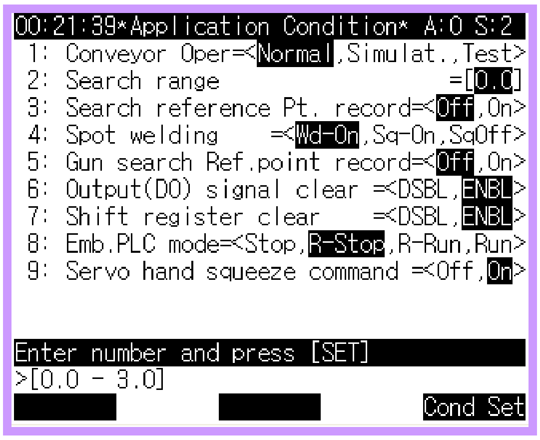
- In simulation operation, the Conveyor pulse count and register are separated. Therefore sure to check that the calculated distance is aligned to the actual Conveyor location.

- In general playback operation, the Conveyor speed is always the actual moving speed of the Conveyor. But in the simulation, the Conveyor speed is the simulation speed entered by the user and in the test mode it is always 0.

6.3. Search range

This decides the range to search when using the search function.

(1) Select 『[PF5]: Cond Set』 → 『[PF1]: AppliCnd』 → 『2: Search range』 from the initial screen of manual or auto mode.



Reference

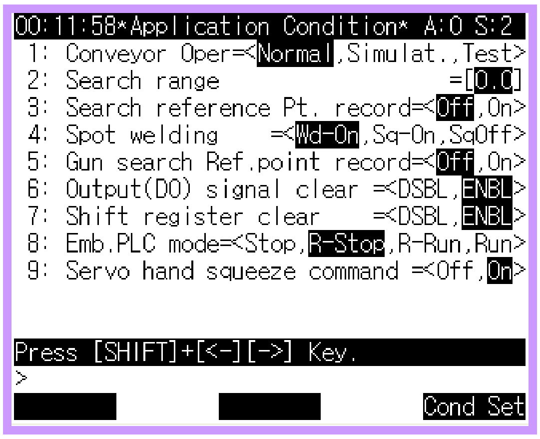
- X can be set from 0.0 to 3.0 and the range setting is as follows.

```
                Record point              Record point
|←                  L          →|←            X              →|
●-----------------------------------●--------------------------------------------- |
|←                    Search range = L(1+X)                   →|
```

6.4. Search reference Pt. record

This function automatically records the reference location to execute the search function. After completing the teaching process including the search function, if you set this condition to ON and play back 1 cycle, the reference location of the work object is automatically recorded.

(1) Select 『[PF5]: Cond Set』 → 『[PF1]: AppliCnd』 → 『3: Search reference Pt. record』 from the initial screen of manual or auto mode.



- Off : Do not use the search reference location data record function.
- On : Use the search reference location data record function.

Reference

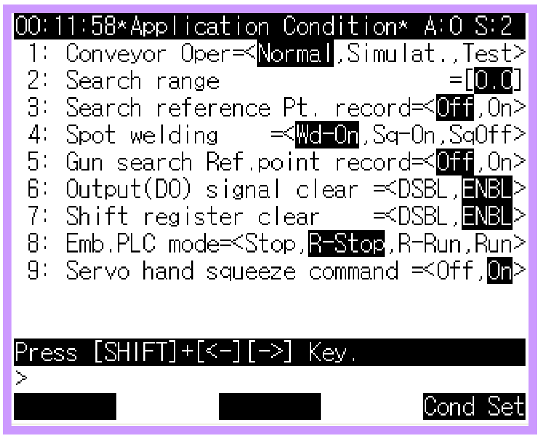
- If you set the search reference location data record function to ON, you will see the SW on the top left side of the screen.
- When recording the search reference location data, 1 cycle playback should be at the same speed as the general playback.

6.5. Spot welding

When executing spot welding function, this can prohibit the pressure operation and power signal output irrelevant of the welding sequence setting designated in servo gun application.

With this function, you can conveniently check the teaching location or pressure point even when the welding is not done or when the welding equipment and external signal equipment is not installed. There are 3 types of spot welding ouput; Wd-On type, Sq-On type and SqOff type.

(1) Select 『[PF5]: Cond Set』 → 『[PF1]: AppliCnd』 → 『4: Spot welding』 from the initial screen of manual or auto mode.



- Wd-On : Executes all the welding sequence designated in the spot welding function.

- Sq-On
  Only executes the pressure operation but no output for power signal.
  This is used for checking the pressure location because it stands by for the welding completion signal.

- SqOff
  It does not operate to any of the pressure operation, power signal output or welding completion standby.

Reference

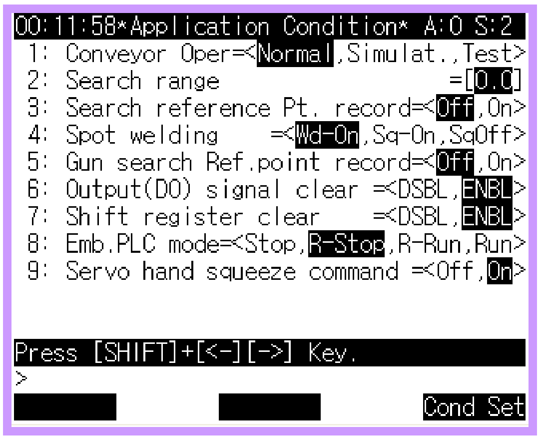
- You can see the Wd-On sign on the top of the screen according to the spot welding output type.
- For playback with function set to SqOff, do not execute the pressure operation in the welding location and move the robot to the next step.
- To execute welding after checking the teaching location, the function must be set to Wd-On.

6.6. Gun search Ref.point record

This records the reference location to measure the electrode wear-off during servo gun or equalizer gun operation.

Please refer 『Servo gun Function Manual』 or 『Equalizer Function Manual』 for method of using gun search.

(1) Select 『[PF5]: Cond Set』 → 『[PF1]: ApplICnd』 → 『5: Gun search Ref.point record』 from the initial screen of manual or auto mode.



- Off : Do not use the search reference location data record function.
- On : Use the search reference location data record function.

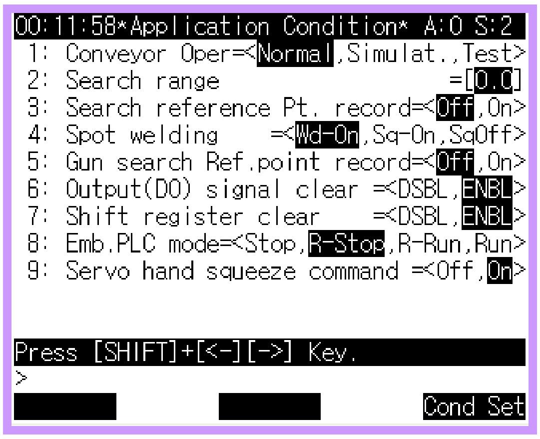
Reference

- When the Gun search Ref.point record is ON, you will see the SW sign on the top left part of the screen.
- After installing the system, you must change the electrode to a new one and must operate it only once before starting the teaching process.
- Gun search Ref.point record must be executed in 1 cycle playback and it must be done after accurately setting the 『[PF2]: System』 → 『3: Machine parameter』 → 『5: Setting encoder offset』 and 『2: Axis constant』.
- An error will occur when gun search or spot welding is executed without recording the gun search reference location.

6.7. Output(DO) signal clear

When executing the program head, this decides whether to initialize the general user signal and welding condition signal that is currently being sent out.

(1) Select 『[PF5]: Cond Set』 → 『[PF1]: AppliCnd』 → 『6: Output(DO) signal clear』 from the initial screen of manual or auto mode.



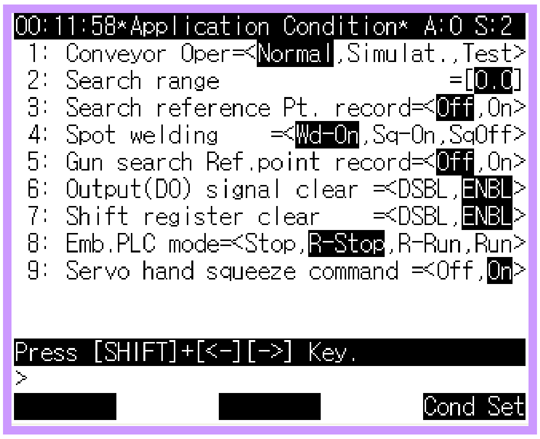
- DSBL
  When executing the program head, this does not initialize the public output signal (DO) and welding condition signal.

- ENBL
  When executing the program head, this initializes the general output signal (DO) and welding condition signal.

6.8. Shift register clear

When executing the program head, this decides whether to initialize the register content for shift of the online shift register group.

(1) Select 『[PF5]: Cond Set』 → 『[PF1]: AppliCnd』 → 『7: Shift register clear』 from the initial screen of manual or auto mode.



- DSBL
  When executing the program head, this does not initialize the content of the online shift register group.

- ENBL
  When executing the program head, this initializes the content of the online shift register group.

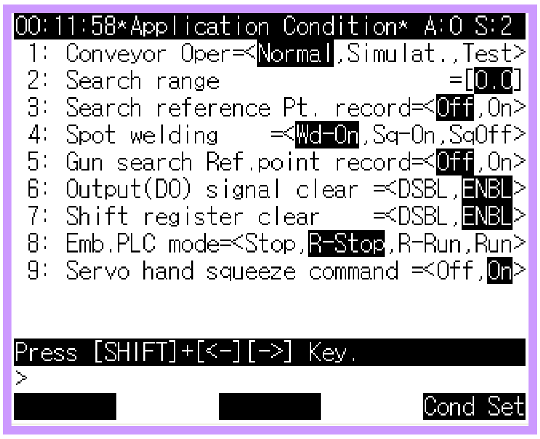
Reference

- This function decides the initialization of the content of online shift register group. Unlike this, content such as XYZ shift register or online shift buffer etc. is always initialized when executing program head.

6.9. Emb. PLC mode

This sets the mode to control the Internal PCL when controlling the input/output signal using the embedded PLC. There are 4 types for Embedded PLC mode; stop mode, R-stop mode, R-run mode and run mode. Please refer to 『Embedded PLC Function Manual』 for more details.

(1) Select 『[PF5]: Con Set』 → 『[PF1]: AppliCnd』 → 『8: Emb. PLC mode』 from the initial screen of manual or auto mode.



- Stop: Do not use Internal PLC mode.

- R-Stop(Remote Stop)
  This indicates the condition when the Internal PLC operation stopped from PLC ladder diagram of PC.

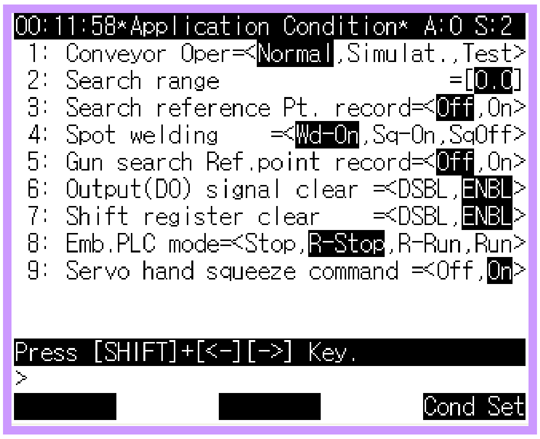
- R-Run(Remote Run)
  This indicates the condition when the Internal PLC operation is executed from PLC ladder diagram of PC.

- Run: The controller operates the PLC program downloaded to controller.

6.10. Servo hand squeeze command

This function prohibits the pressure and open operation so that the taught locations can easily be checked without having to attach/detach the work object when preparing the work program to handle the work object using the servo hand.

(1) Select 『[PF5]: Cond Set』 → 『[PF1]: AppliCnd』 → 『9: Servo hand squeeze command』 from the initial screen of manual or auto mode.



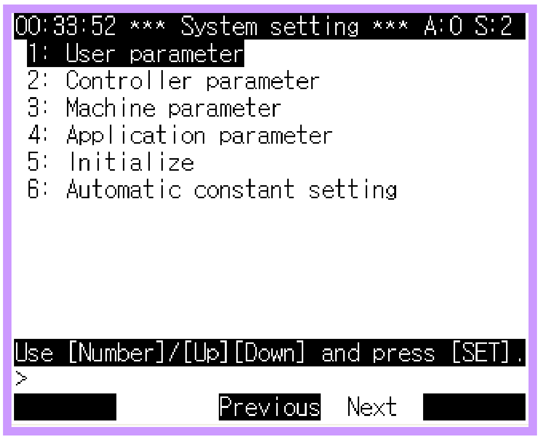
- Off
  This directly moves to the next step without pressurizing/opening the servo hand axis when playing the program.

- On
  This permits the pressurize/open operation of the servo hand axis when playing the program. When the servo hand is set, you will see the sign “SH-On” on the top of the teach pendant screen.

7
System setting

7.1. System setting

(1) Select 『[PF2]: System』 from the initial screen of manual mode.



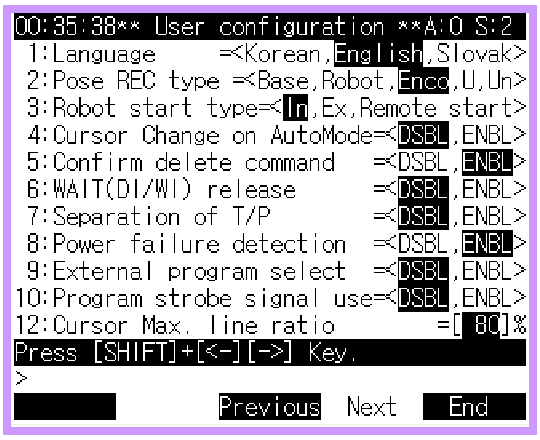
Reference

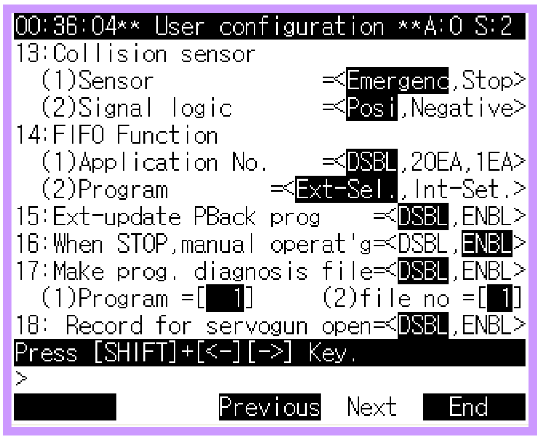
- Move the cursor with arrow keys to the item to select, and press the [SET] key. Or you can select and enter the number of the item to select, and press the [SET] key.
- System configuration data is stored in the control parameter file (ROBOT.C00) or the machine parameter file (ROBOT.C01).
- You cannot make any changes to the control parameter file (ROBOT.C00) or the machine parameter file (ROBOT.C01) when they are completely protected.

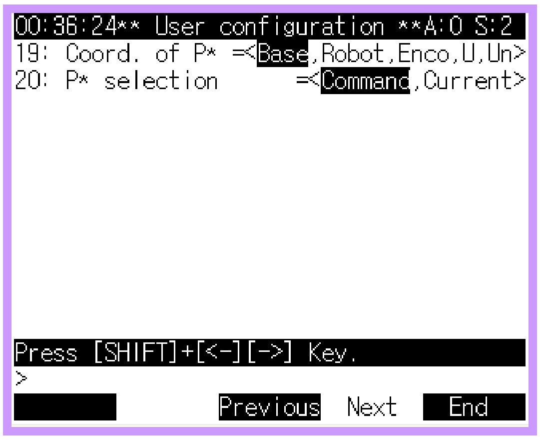
7.2. User configuration

This function enables the user to set the various conditions necessary for the work.

(1) Select 『[PF2]: System』 → 『1: User parameter』 from the initial screen of manual mode.







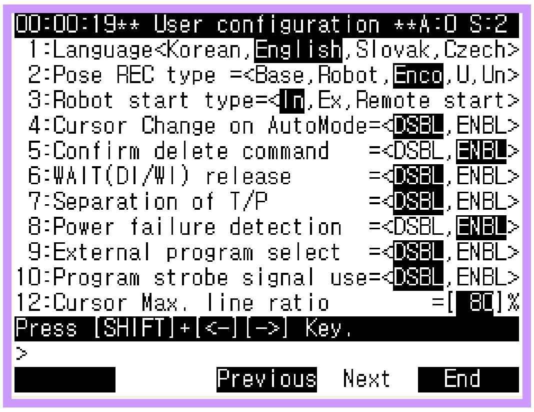
Reference

- User environment data is stored in the control parameter file (ROBOT.C00).
- You cannot make any changes to the control parameter file (ROBOT.C00) when it is completely protected. But you can change the Display language function, which is always set to the default when the main power is on.

7.2.1. Language

This function sets the current language display in the teach pendant.

(1) Select 『[PF2]: System』 → 『1: User parameter』 → 『1: Language』 from the initial screen of the manual mode.



(2) You can move the cursor by pressing [SHIFT]+[←][→] and the changes are immediately reflected.

- Korean: This sets the displayed language to Korean in the teach pendant.
- English: This sets the displayed language to English in the teach pendant.
- Slovak : This sets the displayed language to Slovak in the teach pendant.
- Czech : This sets the displayed language to Czech in the teach pendant.

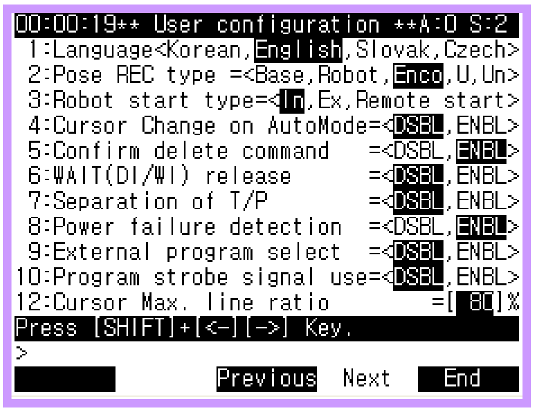
Reference

- When the power is reconnected, the displayed language in the teach pendant is decided by whether the dip switch no. 1 is on → English or off → Korean.

7.2.2. Pose REC type

When you move the robot and press the [REC] key, the position of the robot is recorded in a hidden position. This function sets the robot's recording position.

(1) Select [PF2]: System』 → 『1: User parameter』 → 『2: Pose REC type』 from the initial screen of manual mode.



(2) u can move the cursor by pressing [SHIFT]+[←][→] and the changes are immediately reflected.

- Base: The position is recorded based on the base coordinate.
- Robot: The position is recorded based on the robot's coordinate.
- Enco.(Encoder): The position is recorded in encoded value.
- U
  This sets the position in the user coordinate when the user coordinate number is not set. This method can set any position based on any user coordinate number through User Coordinate Registration/Selection function.
- Un
  This records the position based on the currently set user coordinate number. Because this follows the currently set user coordinate, you must change the same coordinate to move or chance the coordinate.

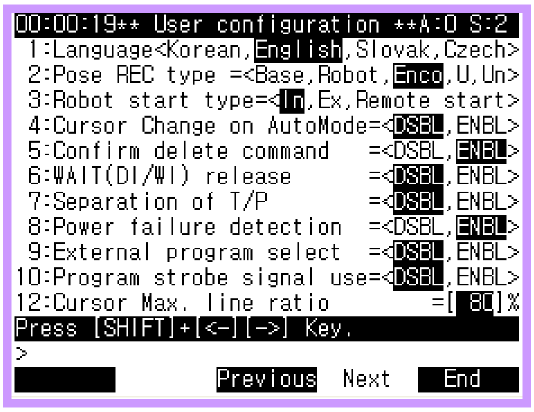
Reference

- By pressing the [Quick Open] key when recording the robot's position, you can check or change the recording pose. Please refer to the section on Quick Open for details.

7.2.3. Robot Start type

This function sets the start type of the robot.

(1) Select 『[PF2]: System』 → 『1: User parameter』 → 『3: Robot Start type』 from the initial screen of manual mode.



(2) You can move the cursor by pressing [SHIFT]+[←][→] and the changes are immediately reflected.

- In(Internal) : This starts the robot by pressing the start button on the operating panel.

- Ex(External)
  This starts the robot by receiving the external digital signal.
  Please refer to 『Chapter 11. Various Signal Connections』 → 『External start of standard input signal』.

- Remote start
  This starts the robot by receiving the command from the central control panel.
  Currently remote control is not supported.

Warning

- When the start type is set to External or Remote while working within the safety fence, it can be dangerous even with the stop lamp on. This is because the robot can abruptly start by external command. For safety purposes, set the start type to Internal unless it is critically needed to be set otherwise.

Reference

- The title frames are as follows based on the combination of items from 『[PF2]: System』 → 『1: User parameter』 → 『3: Robot Start type』 and 『9: External program select』.

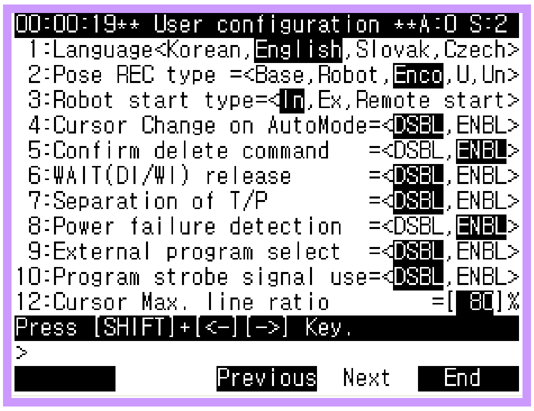
External program / Start type	Disable	Enable
Internal	Auto	Auto (Ext.Prog)
External	Auto (Ext.Start)	Auto (Ext.P&S)

- This is the same function as the 『R5 : External start selection (Enable/Disable)』 of R code.

7.2.4. Cursor change on automode

This function decides whether to permit the arrow keys in auto mode to be able to move the current step or a function. For safety reasons, it is recommended to have it disabled.

(1) Select 『[PF2]: System』 → 『1: User parameter』 → 『4: Cursor Change on AutoMode』 from the initial screen of manual mode.

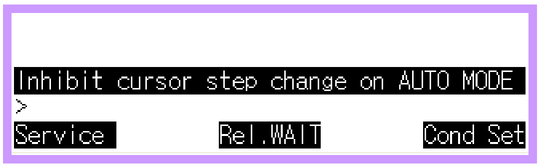


(2) You can move the cursor by pressing [SHIFT]+[←][→] and the changes are immediately reflected.

- DSBL : This disables the arrow keys from moving a step or a function in auto mode.
- ENBL : This actives the arrows keys from moving a step or a function in auto mode.

Reference

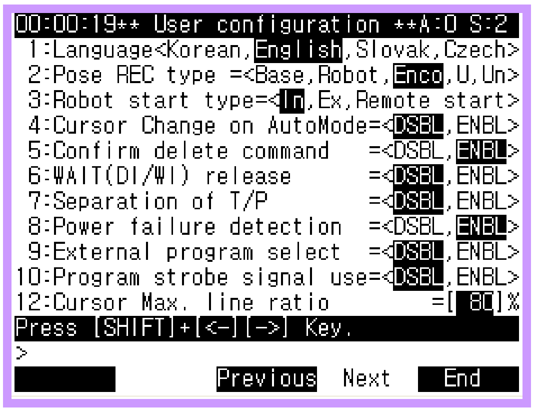
- If you set the Cursor Position Change in Auto Mode to <DSBL> and press the up or down arrow key, you will see the following message.



7.2.5. Confirm delete command

This function decides whether to ask and confirm with the user when a command is deleted in the manual mode, that the selected command will be deleted.

(1) Select 『[PF2]: System』 → 『1: User parameter』 → 『5: Confirm delete command』 from initial screen of manual mode.



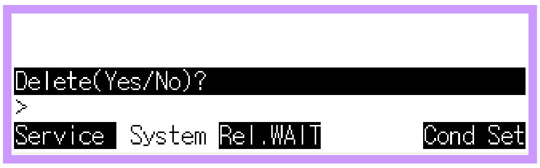
(2) You can move the cursor by pressing [SHIFT]+[←][→] and the changes are immediately reflected.

- DSBL
  This will not confirm with the user when a step or a function is deleted in manual mode by pressing [SHIFT]+[DELETE] keys.

- ENBL
  This will confirm with the user when a step or a function is deleted in manual mode by pressing [SHIFT]+[DELETE] keys.

Reference

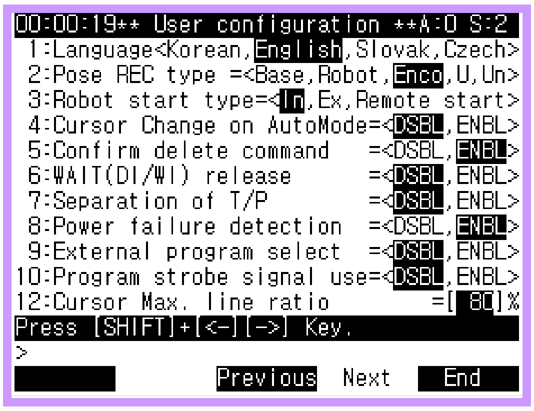
- If you set the Confirmation for Command Deletion in Manual Mode to <ENBL> and press the [SHIFT]+[DELETE] keys to delete a step or a function, you will see the following message.



7.2.6. Wait(DI/DW) release

This function decides whether to force cancellation or not for signal waiting when 『[PF3]: Rel.WAIT』 key is pressed for the waiting input signal or welding completion signal during manual or auto mode.

(1) Select 『[PF2]: System』 → 『1: User parameter』 → 『6: WAIT(DI/WI) release』 from the initial screen of manual mode.



(2) You can move the cursor by pressing [SHIFT]+[←][→] and the changes are immediately reflected.

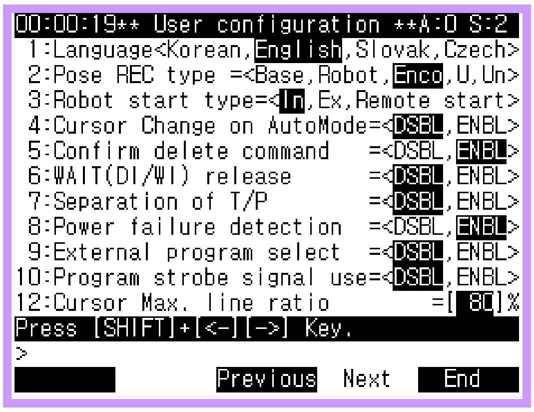
- DSBL
  This will not cancel the waiting input signal or welding completion signal when the user presses the 『[PF3]: Rel.WAIT』 key.

- ENBL
  This will cancel the waiting input signal or welding completion signal when the user presses the 『[PF3]: Rel.WAIT』 key.

7.2.7. Separation of T/P

This function separates and runs the teach pendant to protect the program after the teaching process.

(1) Select 『[PF2]: System』 → 『1: User parameter』 → 『7: Separation of T/P』 from the initial screen of manual mode.



(2) You can move the cursor by pressing [SHIFT]+[←][→] and the changes are immediately reflected.

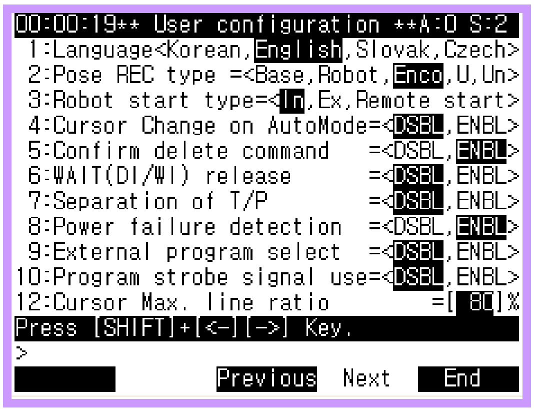
- DSBL
  When the teach pendant is separated, it generates a teach pendant communication error.

- ENBL : This enables the robot start after separating the teach pendant.

7.2.8. Power failure detection (unchangeable)

This function enables the system to remember the robot's position in case of a power outage, and recovers the robot's position once the power is recovered. Currently the power outage detection set to <ENBL>. This setting cannot be changed to <DSBL>.

(1) Select 『[PF2]: System』 → 『1: User parameter』 → 『8: Power failure detection』 from the initial screen of manual mode.



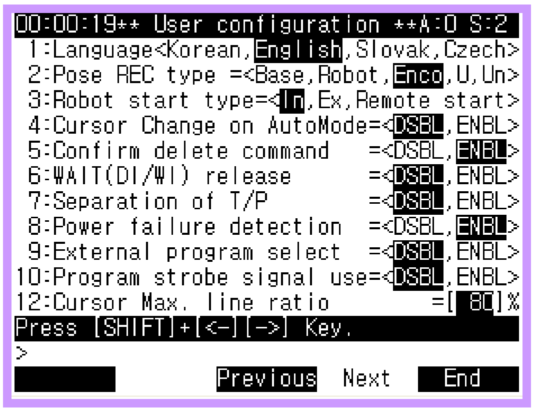
(2) You can move the cursor by pressing [SHIFT]+[←][→] and the changes are immediately reflected.

- DSBL : Does not use the power outage detection function.
- ENBL : Uses the power outage detection function.

7.2.9. External program select

This function decides the method of selecting the external program. You can receive the external digital signal and select the program if the External program function is enabled.

(1) Select 『[PF2]: System』 → 『1: User parameter』 → 『9: External program select』 from the initial screen of manual mode.



(2) You can move the cursor by pressing [SHIFT]+[←][→] and the changes are immediately reflected.

- DSBL
  Select the program from the teach pendant by pressing [SHIFT]+[Program] keys.

- ENBL
  Select the program by receiving external digital signal. Please refer to 『Chapter 11. Various signal connections』 → 『Program selection signal of standard input signal』.

Reference

- The title frames are as follows based on the combination of items from 『[PF2]: System』 → 『1: User parameter』 → 『3: Robot start type』 and 『9: External program select』.

External program / Start type	Disable	Enable
Internal	Auto	Auto (Ext.Prog)
External	Auto (Ext.Start)	Auto (Ext.P&S)

- When the internal or external start command is entered without external program signal, the following message will be displayed.

```
The value of Prog Selec Sig input is 0
 >_
 Service  System  Rel.WAIT        Cond Set
```

- In Hi4a controller, you can only select the external program when the cursor is located on the current program head.

- Please refer to 『Chapter11. Various signal connections』 → 『External Program selection of standard input signal』.

- When (1) the number of FIFO function application is set to <20> or <1> and (2) the program is set to <External program>, and you try to disable the External Program selection, the following message will be displayed.

```
10:Program strobe signal use=<DSBL,ENBL>
12:Cursor Max. line ratio       =[ 80]%
Confirm FIFO application setting   [ESC]
>
                Previous  Next   End
```

- R6 of code : Same function as External [Program selection (ENBL/DSBL).

7.2.10. Program strobe signal use

This function enables you to select the external program by receiving the external digital signal from the external device.

(1) Select 『[PF2]: System』 → 『1: User parameter』 → 『10: Program strobe signal use』 from initial screen of manual mode.

```
00:00:19** User configuration **A:0 S:2
 1:Language<Korean,English,Slovak,Czech>
 2:Pose REC type =<Base,Robot,Enco,U,Un>
 3:Robot start type=<In,Ex,Remote start>
 4:Cursor Change on AutoMode=<DSBL,ENBL>
 5:Confirm delete command   =<DSBL,ENBL>
 6:WAIT(DI/WI) release      =<DSBL,ENBL>
 7:Separation of T/P        =<DSBL,ENBL>
 8:Power failure detection  =<DSBL,ENBL>
 9:External program select  =<DSBL,ENBL>
10:Program strobe signal use=<DSBL,ENBL>
12:Cursor Max. line ratio       =[ 80]%
Press [SHIFT]+[<-][->] Key.
>
                Previous  Next    End
```

(2) You can move the cursor by pressing [SHIFT]+[←][→] and the changes are immediately reflected.

- DSBL
  This function selects a program to be worked by receiving only program selection signal.

- ENBL
  This function selects a program to be worked by receiving the program selection signal in the moment of turning on input signal of program strobe.

Reference

- Please refer to 『Chapter 11. Various signal connections』 → 『Program strobe signal of standard input signal』.

- When (1) the number of FIFO function application is set to <20> or <1> and (2) the program is set to <External program>, and you try to disable the Program Strobe signal, the following message will be displayed.

```
10:Program strobe signal use=<DSBL,ENBL>
12:Cursor Max. line ratio       =[ 80]%
Confirm FIFO application setting   [ESC]
>
                Previous  Next    End
```

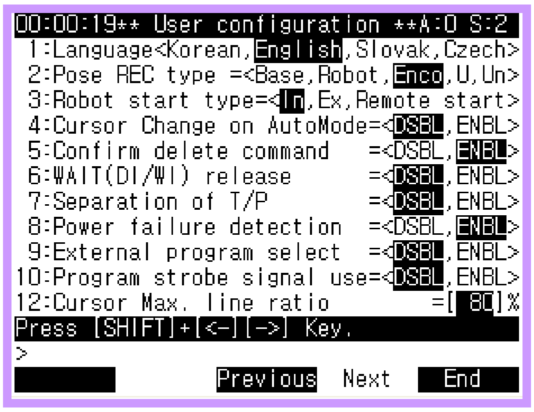
7.2.11. Cursor Max. line ratio

You can adjust the cursor position from the upper part to the lower part of the screen by adjusting the position proportion of the cursor in the edit screen of manual mode.

You can't see the next function, step of the lowest part of the screen because the cursor moves to the lowest part of the screen in case that you adjust the position proportion to maximum 100%.

The cursor can move within the range from the upper to the center if the proportion is 50%, the screen scroll if the cursor moves from the center to the lower.

(1) Select 『[PF2]: System』 → 『1: User parameter』 → 『12: Cursor Max. line ratio』 from the initial screen of manual mode.



(2) You can move the cursor by pressing [SHIFT]+[←][→] and the changes are immediately reflected. Enter number and press [SET]

7.2.12. Collision sensor

It selects one of the method that can stop the robot if the collision sensor active.

(1) Select 『[PF2]: System』 → 『1: User parameter』 → 『13: Collision sensor』 from the initial screen of manual mode.

```
00:11:36** User configuration **A:0 S:2
13:Collision sensor
  (1)Sensor              =<Emergenc,Stop>
  (2)Signal logic        =<Posi,Negative>
14:FIFO Function
  (1)Application No.     =<DSBL,20EA,1EA>
  (2)Program         =<Ext-Sel.,Int-Set.>
15:Ext-update PBack prog     =<DSBL,ENBL>
16:When STOP,manual operat'g=<DSBL,ENBL>
17:Make prog. diagnosis file=<DSBL,ENBL>
  (1)Program =[   1]     (2)file no =[ 1]
18: Record for servogun open=<DSBL,ENBL>
Press [SHIFT]+[<-][->] Key.
>
                Previous   Next    End
```

(2) You can move the cursor by pressing [SHIFT]+[←][→] and the changes are immediately reflected.

(3) Robot stop type

- Emergenc(Emergency stop) : It stops the robot with MOTOR OFF.
- Stop : It stops the robot with MOTOR ON status.

(4) Signal logic

- Posi(Positive)
  It configures the input signal logic of the collision sensor to positive.
- Negative
  It configures the input signal logic of the collision sensor to negative.

7.2.13. FIFO function

This function reserves the program through external signal and sets up the environment that the robot controller will execute the program. For more details, please refer to the 『FIFO Function manual』.

(1) Select 『[PF2]: System』 → 『1: User parameter』 → 『14: FIFO function』 from the initial screen of manual mode.

(2) You can move the cursor by pressing [SHIFT]+[←][→] and the changes are immediately reflected.

(3) Number of applications

- DSBL(Disable) : FIFO function will be disabled.
- 20EA : This will allocate 20 registries for FIFO and reserve the program in sequence.
- 1EA
  This will allocate 1 FIFO register and reserve the program. If there is a program already allocated in the register, the newly entered program will override.

(4) Program

- Ext-Sel.
  This selects the program through external signal to the assigned external program selection bit, and reserves the FIFO register. There must be a signal assigned to the external program selection bit and program strobe.
- Int-Set.
  When the user has set the input signal and the corresponding program and when the designated input signal is ON, this function reserves the applicable program to the FIFO register. Please refer to 『[PF2]: System』 → 『2: Controller parameter』 → 『13: Reserve program setting』 to setup the input signal, output signal and the program.

Reference

- When it is set to external selection and the user is trying to select <20> or <1> to apply the FIFO function, the following message will be displayed. Therefore check if the external program selection is set to <Enable> and program strobe signal use set to <Enable>.

```
  (1)Program =[   1]      (2)file no =[ 1]
18: Record for servogun open=<DSBL,ENBL>
Confirm program strobe siganal use![ESC]
>
                  Previous  Next    End
```

7.2.14. Ext-update Playback program

This function decides whether to execute the external revision of the currently running program from an external PC by making changes and downloading to the controller.

(1) Select 『[PF2]: System』 → 『1: User parameter』 → 『15: Ext-update PBack prog』 from the initial screen of manual mode.

(2) You can move the cursor by pressing [SHIFT]+[←][→] and the changes are immediately reflected.

- DSBL
  This disables the modifications from the external PC and downloading to the controller.

- ENBL
  This enables the modifications from the external PC and downloading to the controller.

Warning

- Making modifications to the currently running program from and external PC and downloading back to the controller involves considerable risk. Please consult your engineer for more details.

7.2.15. When STOP manual operation

This function sets whether to enable the job operation in case of external stop signal input.

(1) Select 『[PF2]: System』 → 『1: User parameter』 → 『16: When STOP, manual operat'g』 from initial screen of manual mode.

(2) You can move the cursor by pressing [SHIFT]+[←][→] and the changes are immediately reflected.

- DSBL
  This disables the run and step run operation for external stop signal input. Jog operation is still possible.

- ENBL
  This disables all operations including running, step run operation and jog operation etc. for external stop signal input..

7.2.16. Make program diagnosis file

The program diagnosis function monitors the robot's condition during program operations.

Because the program diagnosis function constantly renews and saves the diagnosis data, you can monitor how the robot's condition change when doing repeated operations.

You can check the program diagnosis results at 『[PF1]: Service』 → 『7: System diagnosis』 → 『8: Program diagnosis』.

(1) Select 『[PF2]: System』 → 『1: User parameter』 → 『17: Make prog. diagnosis file』.

- Program : The program operation number of the robot that is the diagnosis target.

- file no(File number) :
  The file number of the report to save the diagnosis results. (ROBOT. R01~R99)

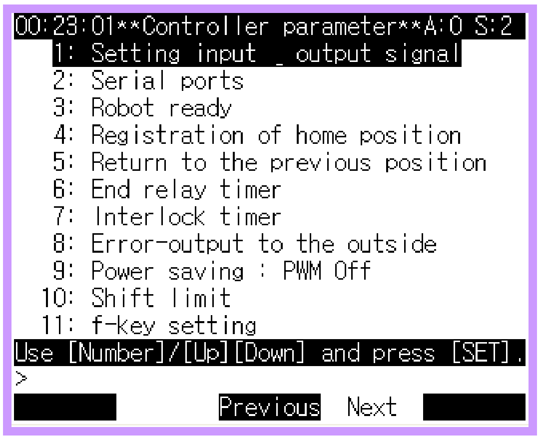
(2) File contents from program diagnosis result

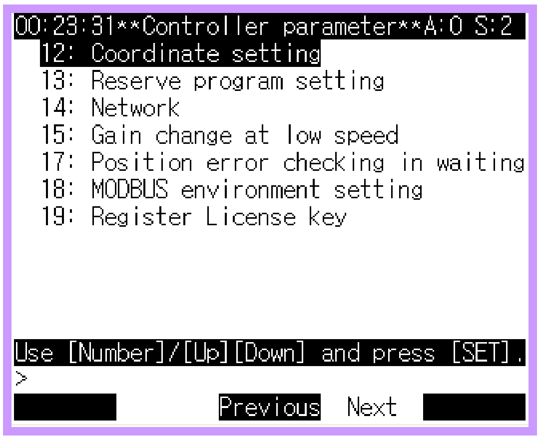
- Basic program data
  Robot type, total number of axis, program number, total number of steps, run speed ratio, run time, generated date

- Diagnosis data
  Current offset, average load rate, maximum load rate, time over rate torque, average position deviation, and maximum position deviation

7.3. Controller parameter

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 from initial screen of manual mode.





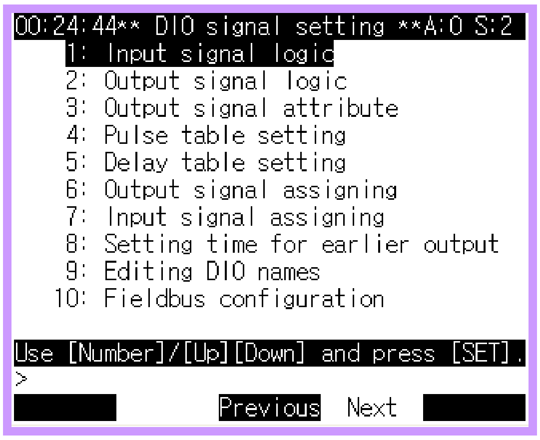
Reference

- The control parameter is saved in the control parameter file (ROBOT.C00).
- You cannot make changes to the control parameter when the control parameter file (ROBOT.C00) is completely protected.

7.3.1. Setting Input & Output signal

This function enables the user to configure the properties of the input and output signal.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 from initial screen of manual mode.



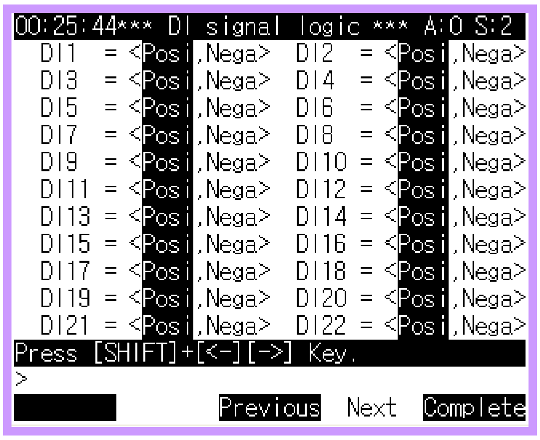
(2) Use the [Arrow] keys to move the cursor to the item to select and press the [SET] key. Or you can enter the number of the item to select by pressing the [Number] key and then pressing the [SET] key to enter the sub menu.

7.3.1.1. Input signal logic

This function sets the positive or negative logic of the general input signal.

Figure 7.1 Positive and negative logic of general input signal

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『1: Input signal logic』 from initial screen of manual mode.



(2) You can move the cursor by pressing [SHIFT]+[←][→] and the changes are immediately reflected.

(3) If you press the 『[PF3]: Previous』 or 『[PF4]: Next』 key, the following input signal (1 – 256) will be displayed.

(4) Press 『[PF5]: Complete』 to save the changed input signal logic. If you press the [Cancel] key, the modified data will not be saved.

7.3.1.2. Output signal logic

This function sets the positive or negative logic of the general output signal.

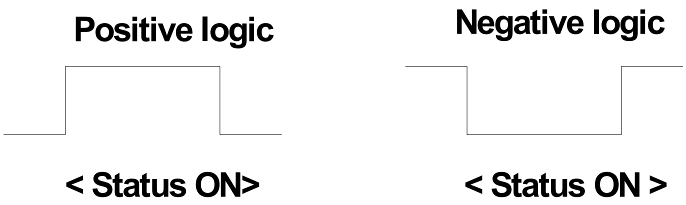
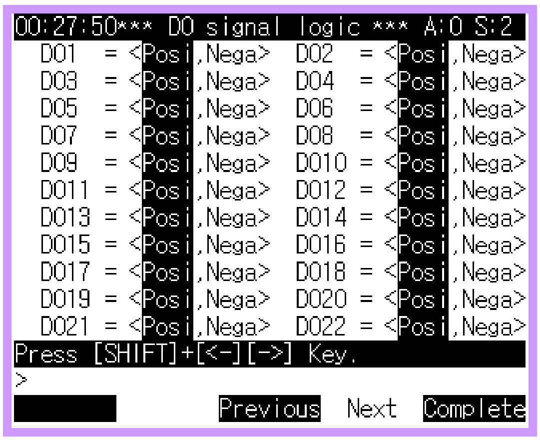


Figure 7.2 Positive and negative logic of general output signal

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『2: Output signal logic』 from initial screen of manual mode.



(2) You can move the cursor by pressing [SHIFT]+[←][→] and the changes are immediately reflected.

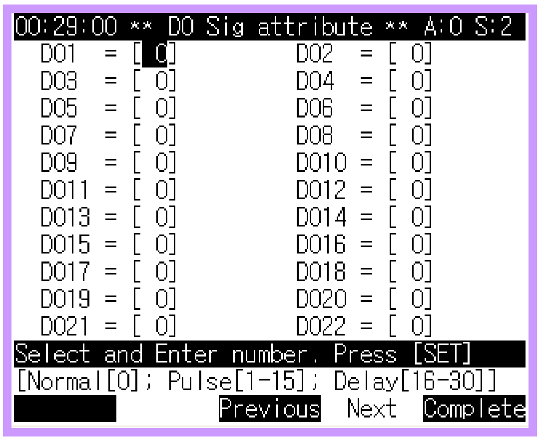
(3) If you press the 『[PF3]: Previous』 or 『[PF4]: Next』 key, the following output signal (1 – 256) will be displayed.

(4) Press 『[PF5]: Complete』 to save the changed output signal logic. If you press the [ESC] key, the modified data will not be saved.

7.3.1.3. Output signal properties

This function sets the properties of the output signal. When it is set to 0, numbers from 1 to 15 generally outputs the pulse signal assigned by the pulse table and numbers from 16 to 30 outputs the delay signal assigned by the delay table.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal 』→ 『3: Output signal attribute』 from initial screen of manual mode.



(2) Enter the number of the output signal property using the [Number] key and press the [SET] key.

(3) If you press the 『[PF3]: Previous』 or 『[PF4]: Next』 key, the following output signal (1 – 256) will be displayed.

(4) Press 『[PF5]: Complete』 to save the changed output signal logic. If you press the [ESC] key, the modified data will not be saved.

Reference

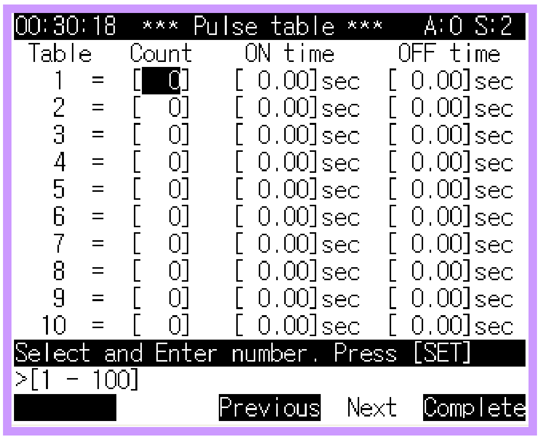
- For setting the pulse table, please refer to 『[PF2]: System』 → 『2: Controller parameter』 → 『1: DIO signal setting』 → 『4: Pulse table setting』.

- For delay table setting, please refer to 『[PF2]: System』 → 『2: Controller parameter』 → 『1: DIO signal setting』 → 『5: Delay table setting』.

7.3.1.4. Pulse table setting

This function sets the pulse signal content of pulse number entered in output signal properties.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『4: Pulse table setting』.



(2) Enter the data of the pulse table using the [Number] key and press the [SET] key .

(3) If you press the 『[PF3]: Previous』 or 『[PF4]: Next』 key, the following table number (1-15) will be displayed.

(4) Press 『[PF5]: Complete』 to save the pulse table setting. If you press the [ESC] key, the modified data will not be saved.

Reference

- Example of pulse output

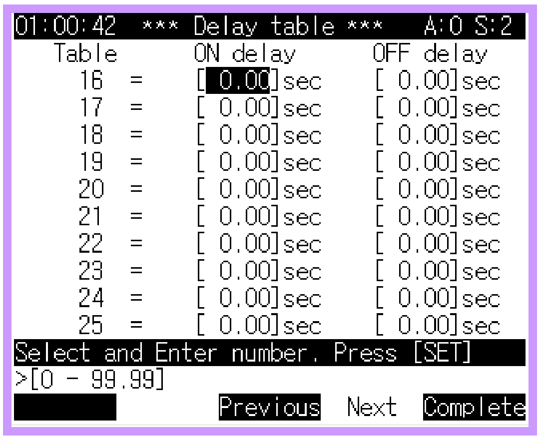
Occurrence : 3   ON time: 1 sec OFF time: 0.2 sec

Figure 7.3 Example of pulse output

7.3.1.5. Delay table setting

This function sets the delay signal content of delay signal number entered in output signal properties.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『5: Delay table setting』 from initial screen of manual mode.



(2) Enter the data for the delay table using the [Number] key and press the [SET] key.

(3) If you press the 『[PF3]: Previous』 or 『[PF4]: Next』 key, the following table number (16~30) will be displayed.

(4) Press 『[PF5]: Complete』 to save the delay table setting. If you press the [ESC] key, the modified data will not be saved.

Reference

- Example of delay output

ON delay time : 1 sec OFF delay time : 0.5 sec

Figure 7.4 Example of delay output

7.3.1.6. Output signal allocation

This function allocates the output signal to a specific DO (Digital Output) signal.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『6: Output signal assigning』 from initial screen of manual mode.

(2) Enter the data for output signal allocation using the [Number] key and press the [SET] key.

(3) If you press the 『[PF3]: Previous』 or 『[PF4]: Next』 key, the following output signal will be displayed.

(4) Press 『[PF5]: Complete』 to save the output signal allocation setting. If you press the [ESC] key, the modified data will not be saved.

Reference

- All Form
  ① This initializes all the output allocation signals. If you select the All initialize function, the following screen will be displayed.

```
 Step set warning             =    [  0]
 Interlock-abnormal warning   =    [ 28]
All Init.?Hardwiring:0,Fieldbus:1(0 - 1)
>[0 - 1]
All FormOne FormPrevious  Next  Complete
```

  ② If you select standard (0), the entire allocated signal will be initialized to its default value.

  ③ If you select the field bus (1), the output signal is reallocated for field bus use. When you select the field bus (1) function, the following screen will be displayed.

```
 Step set warning             =    [  0]
 Interlock-abnormal warning   =    [ 28]
Input the start port number.(1 - 32)
>[1 - 32]
All FormOne FormPrevious  Next  Complete
```

  ④ Enter the number of the starting port to allocate. When you selected 1 as the port number to start allocating, the following screen will be displayed.

```
01:09:40** DO Sig assignment **  A:0 S:2
 GUN (squeeze) Sig = G1 [  1]  G2 [  2]
 MX(Unfolding) Sig = X1 [  3]  X2 [  0]
 Alarm to welding system      =    [  0]
 Weld stick warning           =    [  0]
 Program end                  =    [  4]
 Synthetic error              =    [  5]
 Emergency stop               =    [  0]
 Manual mode                  =    [  0]
 Collision sense              =    [  0]
 Step set warning             =    [  0]
 Interlock-abnormal warning   =    [  6]
Select and Enter number. Press [SET]
>[0 - 256]
All FormOne FormPrevious  Next  Complete
```

- One Form

This initializes the currently selected output allocation signal to its default value.

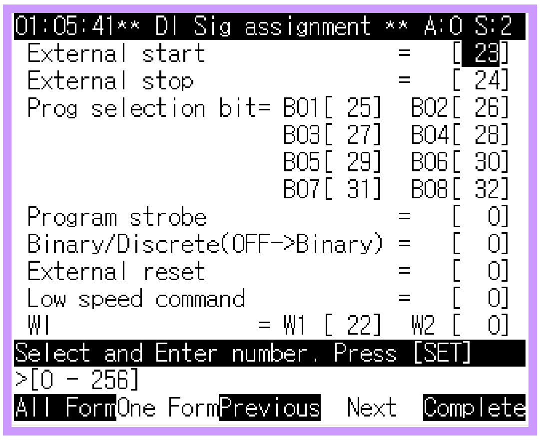
- The specifically allocated DO signal is displayed in low case letters in『[PF1]: Service』 → 『1: Monitoring』 → 『2: DIO signal』.

ex) Not allocated : O31 / Allocated : o31

7.3.1.7. Input signal allocation

This function allocates the input signal to a specific DI (Digital Input) signal.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『7: Input signal assigning』 from initial screen of manual mode.



(2) Enter the data for input signal allocation using the [Number] key and press the [SET] key.

(3) If you press the 『[PF3]: Previous』 or 『[PF4]: Next』 key, the following input signal will be displayed.

(4) Press 『[PF5]: Complete』 to save the input signal allocation setting. If you press the [ESC] key, the modified data will not be saved.

Reference

- All Form

① This initializes all the input allocation signals. If you select the All initialize function, the following screen will be displayed.

```
 Low speed command              =   [  0]
 WI                  = W1  [ 22]  W2 [  0]
All Init.?Hardwiring:0,Fieldbus:1(0 - 1)
>[0 - 1]
All FormOne FormPrevious  Next  Complete
```

② If you select standard (0), the entire allocated signal will be initialized to its default value.

③ If you select the field bus (1), the input signal is reallocated for field bus use. When you select the field bus (1) function, the following screen will be displayed.

```
 Low speed command              =   [  0]
 WI                  = W1  [ 22]  W2 [  0]
Input the start port number.(1 - 32)
>[1 - 32]
All FormOne FormPrevious  Next  Complete
```

④ Enter the number of the starting port to allocate. When you selected 1 as the port number to start allocating, the following screen will be displayed.

```
01:10:34** DI Sig assignment ** A:0 S:2
 External start                 =   [  1]
 External stop                  =   [  2]
 Prog selection bit= B01[  3]  B02[  4]
                     B03[  5]  B04[  6]
                     B05[  7]  B06[  8]
                     B07[  9]  B08[ 10]
 Program strobe                 =   [  0]
 Binary/Discrete(OFF->Binary)   =   [  0]
 External reset                 =   [  0]
 Low speed command              =   [  0]
 WI                  = W1  [ 11]  W2 [  0]
Select and Enter number. Press [SET]
>[0 - 256]
All FormOne FormPrevious  Next  Complete
```

- One Form

  This initializes the currently selected input allocation signal to its default value.

- The specifically allocated DI signal is displayed in low case letters in『[PF1]: Service』 → 『1: Monitoring』 → 『2: DIO signal』.

  ex) Not allocated : I31 / Allocated : i31

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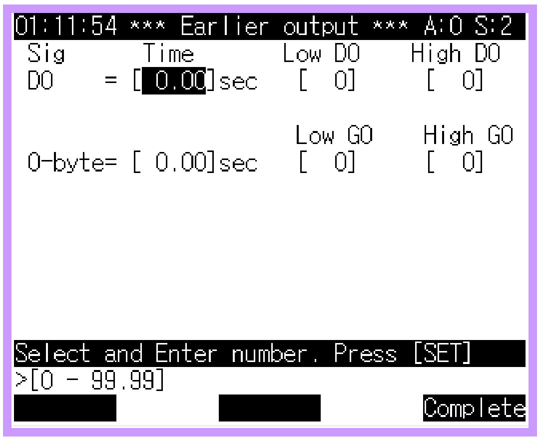
7.3.1.8. Setting time for earlier output

Usually the DO signal is released after reaching the target step but this function enables earlier DO signal to be released before reaching the target step. But this function is not applied to step forward/reverse movement in manual mode.

Figure 7.5 Earlier output setting

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『8: Setting time for earlier output』 from initial screen of manual mode.



(2) Enter the data for earlier output setting using the [Number] key and press the [SET] key.

(3) Press 『[PF5]: Complete』 to save the earlier output setting. If you press the [ESC] key, the modified data will not be saved.

- Time
  This sets the earlier time of individual output signal (DO) or group output signal (GO) before reaching target step.

- Low DO : The first number of individual output signal (DO) for earlier output.

- High DO : The last number of individual output signal (DO) for earlier output.

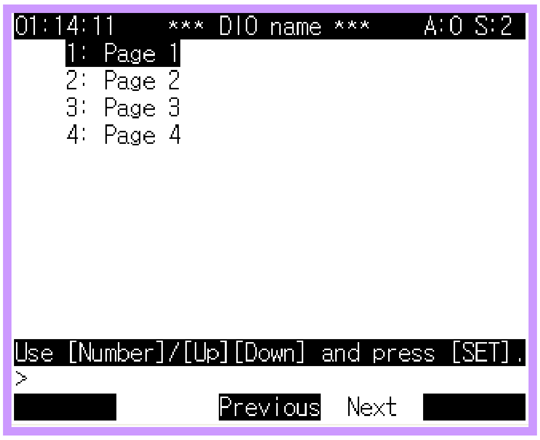
- Low GO : The first number of group output signal (GO) for earlier output.

- High GO : The last number of group output signal (GO) for earlier output.

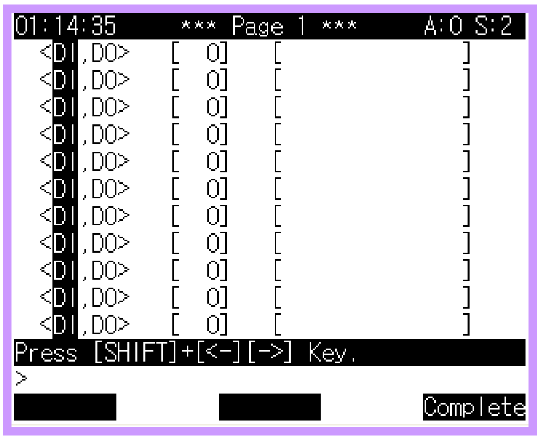
7.3.1.9. Editing DIO names

This function enables the user to name the general input/output signal.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『9: Editing DIO names』 from initial screen of manual mode.



(2) When you select page 1, the following screen is displayed.



(3) The user can select whether to name the general input or output signal by using the [SHIFT]+[←][→] keys.

(4) Enter the general input signal number using the [Number] key and press the [SET] key.

(5) Enter the name in the character screen by using the [Arrow] and [SET] keys.

(6) Press 『[PF5]: Complete』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

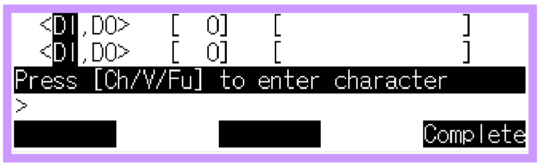
- <DI, DO>
  The user can select the input or output signal to edit the name by using the [SHIFT]+[←][→] keys.

- [0]
  Enter the number of the input or output signal to edit the name of. Enter the number in the input frame and press the [SET] key.

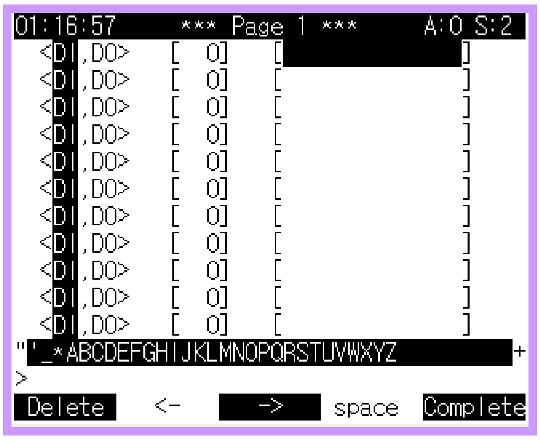
- [ ] : Enter the name of the input or output signal.

Reference

- When the position the cursor to [ ] part using the [Arrow] keys, the following screen will be displayed.



- When you press the [SET] key -> [SHIFT + Ch/V/Fu] key, the following screen will appear for character entry.



- Enter the characters using the [Arrow] keys and the [SET] key, and then press『[PF5]: Complete』 to finish the DIO name entry.

- Enter the name in the DIO name display and press the 『[PF5]: Complete』 key to generate the ROBOT.IM0 file (DIO name file).

- For the entered DIO name, you can check the name in 『[PF1]: Service』 → 『1: Monitoring』 → 『2: DIO signal』.

7.3.1.10. Fieldbus configuration

This sets the field bus environment.
You can choose between the BD430 I/O board type and BD420 multi-communication board type for the field bus function. Items from 1 to 5 in the field bus setting menu are for the BD430 field bus function and item 6 is for BD420 field bus function.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『10: Fieldbus configuration』 from initial screen of manual mode.

```
01:18:10*** Fieldbus Config *** A:0 S:2
    1: En/Disable fieldbus adapter
    2: Sel. input src. _ Assign input No
    4: Assign output No
    5: Set fieldbus configuration
    6: BD420 fieldbus info. and setting




Use [Number]/[Up][Down] and press [SET].
>
               Previous  Next
```

(2) Use the [Arrow] keys to move the cursor to the item to select and press the [SET] key. Or you can enter the number of the item to select by using the [Number] keys and then press the [SET] key to move to the sub menu.

Reference

- If you are setting the field bus for the first time after formatting the controller, you will see the following screen for the 4 menus.

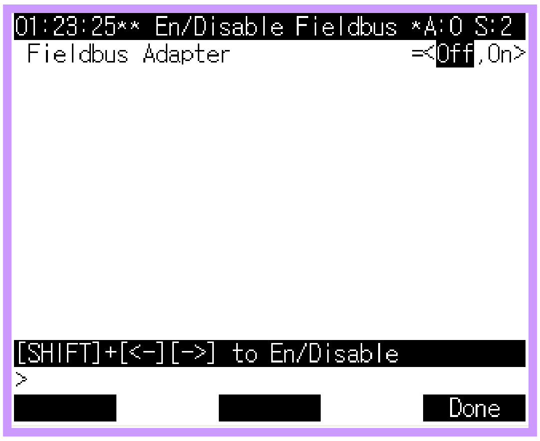
```
File not exist, Create file?     [YES/NO]
>
                                   Done
```

- When you press the [YES] key, the field bus setting file, ROBOT.FBU, is generated and then starts the setting process.

7.3.1.10.1. En/Disable Fieldbus adapter

This lets the user select whether to use the field bus or not.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『10: Fieldbus configuration』 → 『1: En/Disable fieldbus adapter』 from initial screen of manual mode.



(2) Use the [SHIFT]+[←][→] keys to select whether to use the adapter or not.

(3) Press 『[PF5]: Done』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

- Fieldbus adapter
  This sets the field bus function <ON> for usage and <OFF> for non-usage.

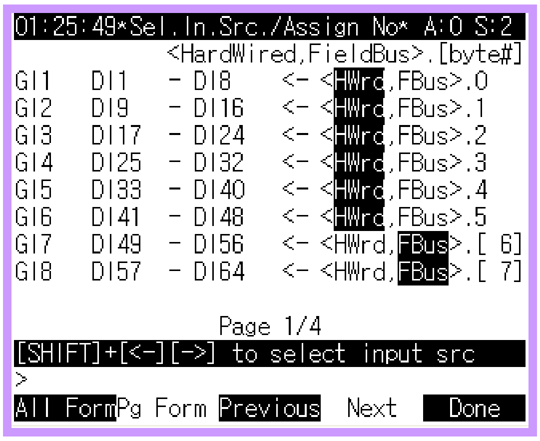
Warning

- Always keep this function OFF if BD470 is not installed. If you have not installed the BD470 and have set it as ON, it can create an error in the controller to disable all I/O functions.

7.3.1.10.2. Input source selection

This sets up which side to receive the input from between hard wire and field bus.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『10: Fieldbus configuration』 → 『2: Sel. input src. & Assign input No』 from initial screen of manual mode.



(2) Use the [SHIFT]+[←][→]keys to select whether to set each signal group for hard wired use or field bus use.

(3) You can move to other signal group (GI1-GI32) by pressing 『[PF3]: Previous』 and, 『[PF4]: Next』 key.

(4) Press 『[PF5]: Done』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

Reference

- All Form

① This changes all the input source selections to hard wired or field bus. If you select 『[PF1]: All Form』, the following screen will be displayed.

```
01:26:08*Sel.In.Src./Assign No* A:0 S:2
                   <HardWired,FieldBus>.[byte#]
GI1    DI1    - DI8     <- <HWrd,FBus>.0
GI2    DI9    - DI16    <- <HWrd,FBus>.1
GI3    DI17   - DI24    <- <HWrd,FBus>.2
GI4    DI25   - DI32    <- <HWrd,FBus>.3
GI5    DI33   - DI40    <- <HWrd,FBus>.4
GI6    DI41   - DI48    <- <HWrd,FBus>.5
GI7    DI49   - DI56    <- <HWrd,FBus>.[ 6]
GI8    DI57   - DI64    <- <HWrd,FBus>.[ 7]

                Page 1/4
All Init.?Hardwiring:0,Fieldbus:1(0 - 1)
>[0 - 1]
All FormPg Form Previous  Next   Done
```

② If you enter HWrd[0] and press the [SET] key and all the input sources will be switched to <HWrd>. If you enter Fbus[1] and press the [SET] key, all the input sources will be switched to <Fbus>.

- Pg Form

① This changes the current page to hard wired or field bus. If you select 『[PF2]: Pg Form』, the following screen will be displayed.

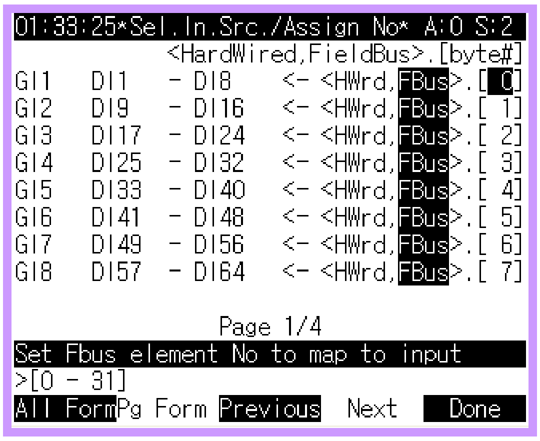
```
                Page 1/4
Page Init?Hardwiring:0,Fieldbus:1(0 - 1)
>[0 - 1]
All FormPg Form Previous  Next   Done
```

② If you enter HWrd[0] and press the [SET] key, the input sources currently displayed in the teach pendant will be switched to <HWrd>. If you enter Fbus[1] and press the [SET] key, the input sources currently displayed in the teach pendant will be switched to <Fbus>.

7.3.1.10.3. Input signal allocation

This enables the user to map each field bus input group (Fbus_0 ~ Fbus_31) to the wanted group signal (GI1 ~ GI32).

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『10: Fieldbus configuration』 → 『2: Sel.In.Src. & Assign input No』 from initial screen of manual mode.



(2) Use the [Number] key to map each input signal group to each field bus number, and then press the [SET] key.

(3) If you press the 『[PF3]: Previous』 or 『[PF4]: Next』 key, the following signal group (1 - 31) will be displayed.

(4) Press 『[PF5]: Done』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

7.3.1.10.4. Output signal allocation

This enables the user to map each output to the group signal. In other words, the user will select which field bus number to use for each general output signal.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『10: Fieldbus configuration』 → 『4: Assign Output No』 from initial screen of manual mode.

```
01:37:20*** Assign Output No ***A:0 S:2
 Assign Output No to Fbus Data
G01   D01   - D08    ->  [ 0]  Fbus_0
G02   D09   - D016   ->  [ 1]  Fbus_1
G03   D017  - D024   ->  [ 2]  Fbus_2
G04   D025  - D032   ->  [ 3]  Fbus_3
G05   D033  - D040   ->  [ 4]  Fbus_4
G06   D041  - D048   ->  [ 5]  Fbus_5
G07   D049  - D056   ->  [ 6]  Fbus_6
G08   D057  - D064   ->  [ 7]  Fbus_7

                Page 1/4
Set Fbus element No to map to output
>[0 - 31]
All Form        Previous  Next   Done
```

(2) Use the [Number] key to map each output signal group to each field bus number, and then press the [SET] key.

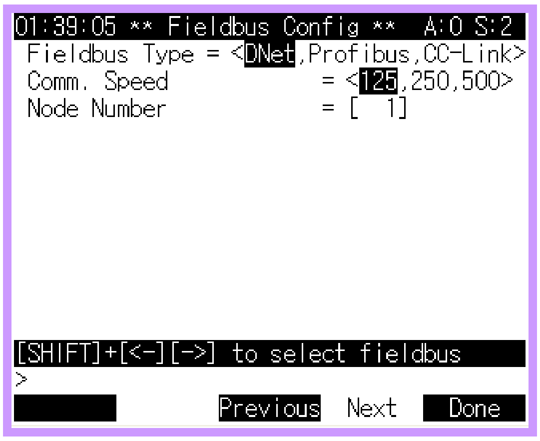
(3) If you press the 『[PF3]: Previous』 or 『[PF4]: Next』 key, the following signal group (1 - 31) will be displayed.

(4) Press 『[PF5]: Done』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

7.3.1.10.5. Network parameter setting

This enables the user to set the field bus type and various parameters.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『10: Fieldbus configuration』 → 『5: Set fieldbus configuration』 from initial screen of manual mode.



(2) Use the [SHIFT]+[<-][->] keys to select the field bus type and decide the communication speed.

(3) Use the [Number] keys to enter the node number, and then press the [SET] key.

(4) Press 『[PF5]: Done』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

- Fieldbus type: Select the field bus type connected to the controller.

- Comm. speed
  Select the communication speed of the field bus to use. If the field bus type is set to Profibus, you do not need to select the communication speed. In case of CC-Link, this is adjusted with the dip switch of BD471 board and not this screen.

- Node number
  Enter the node number of the controller when using the field bus connected to the controller. In case of CC-Link, this is adjusted with the dip switch of BD471 board and not this screen.

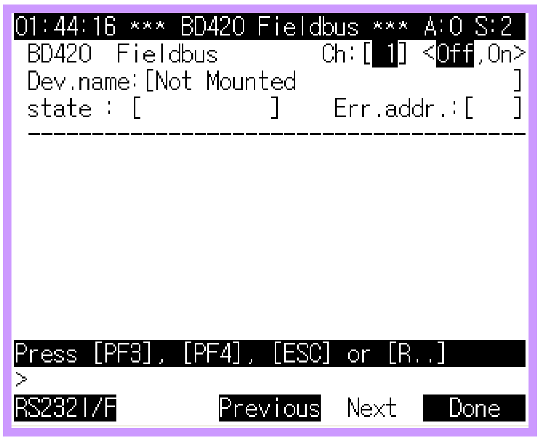
- Region to Use, system signal
  This only appears for CC-Link. Select the utilization method of I/O area.

(5) For details on the field bus setting, please refer to the 『Fieldbus Function Manual』.

7.3.1.10.6. BD420 field bus information and setting

This sets the field bus when using the BD420 field bus function.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『10: Fieldbus configuration』 → 『6: BD420 fieldbus info. and setting』 from initial screen of manual mode.



(2) This screen is composed of 4 pages and each page corresponds to a channel. You can move to the different channel with 『[PF3]: Previous』 and 『[PF4]: Next』 keys.

- Ch : This shows the currently select channel number.
- <Off, On> : This shows whether to operate the field bus module of the specific channel.
- Dev. Name : This shows names of all the modules in the specific channel.
- State : This shows whether the module is correctly operating the network.
- Err. addr.
  This shows the address (node number etc.) when a slave is identified within the network causing problems for field bus master module.

(3) The field bus parameter, below the dotted line, appears in various ways depending on the field bus protocol type. In case of field bus slave module, set the parameter and press the 『[PF5]: Done』 to generate the BD420 field bus setup file, ROBOT.FB2.

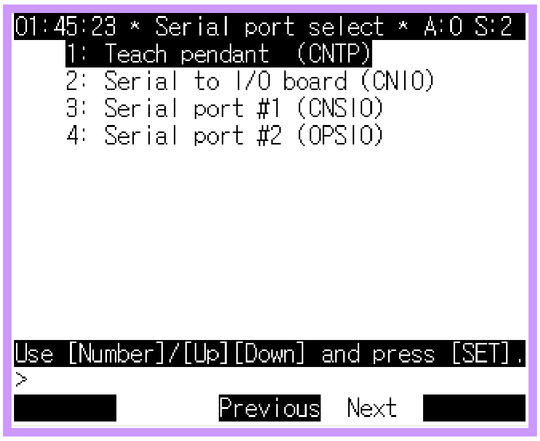
(4) Saved values are applied to the field bus module every time the controller is turned on. If the parameter is set appropriately to the network condition, the field bus operates every time the controller is turned on.

(5) For more details on BD420 use, please refer to 『BD420 multicommunication board Functional Manual』.

7.3.2. Serial port

This sets up the parameters for RS232C and RS422C, and sets up the usage for serial ports.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『2: Serial ports』 from initial screen of manual mode.



(2) Use the [Arrow] keys to move the cursor to the item to select and press the [SET] key. Or you can enter the number of the item to select and press the [SET] key to move to the sub menu.

7.3.2.1. Teach Pendant (CNTP)

This is the serial port only for the teach pendant. The user cannot make arbitrary changes.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『2: Serial ports』 → 『1: Teach Pendant(CNTP)』 from initial screen of manual mode.

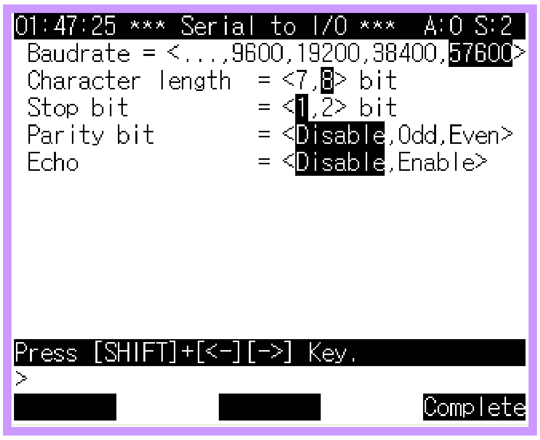
```
Can't modify! Private port for T/P.[ESC]
>
                Previous  Next
```

(2) Press the [ESC] key to move to the higher menu.

7.3.2.2. Exclusively for I/O board

This sets up the serial port exclusively for I/O board. Set the communication speed, text length, stop bit, parity bit, and echo to the I/O board attached to the current controller.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『2: Serial ports』 → 『2: Exclusively for I/O board』 from initial screen of manual mode.



(2) Use the [SHIFT]+[←][→] keys to setup the I/O board environment inside the controller.

(3) Press 『[PF5]: Complete』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

7.3.2.3. Serial port #1 (CNSIO)

This function sets up the communication information for serial communication using serial port CNSIO. Select the appropriate communication speed, text length, stop bit, parity bit, echo, serial port #1 usage.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『2: Serial ports』 → 『3: Serial port #1 (CNSIO)』 from initial screen of manual mode.

(2) Use the [SHIFT]+[←][→] keys to setup the data for serial port 1.

(3) Press 『[PF5]: Complete』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

Reference

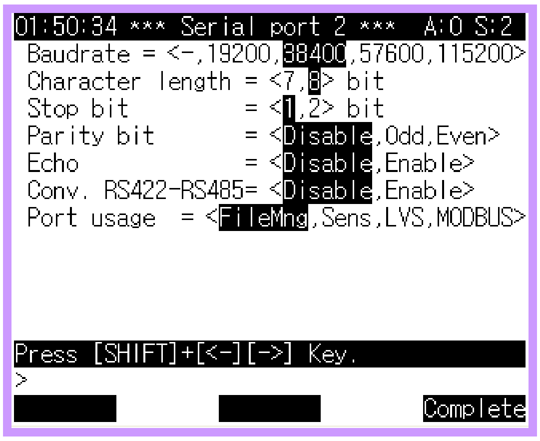
- Serial port usage
  ① FileMng ... This is used for saving or opening files (HR-View) for the interface with the computer.
  ② Sens ... This is used for receiving shift data with interface with the vision sensor.
  ③ LVS
  ④ MODBUS

- CNSIO connector exists within the main board (BD411) inside the controller.

7.3.2.4. Serial port #2 (OPSIO)

This function sets up the communication information for serial communication using serial port OPSIO. Select the appropriate communication speed, text length, stop bit, parity bit, echo, serial port #2 usages.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『2: Serial ports』 → 『4: Serial port #2 (OPSIO)』 from initial screen of manual mode.



(2) Use the [SHIFT]+[←][→] keys to setup the data for serial port 2.

(3) Press 『[PF5]: Complete』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

Reference

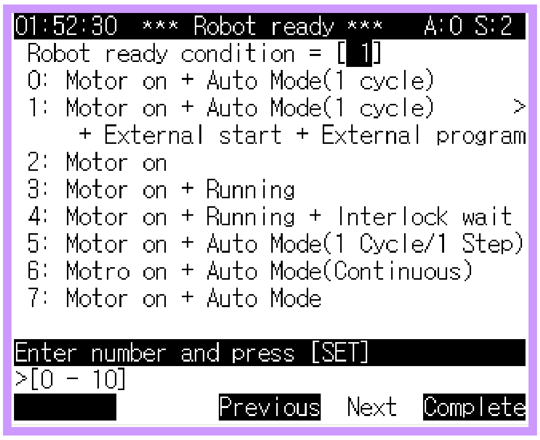
- Serial port usage
  ① FileMng ...... This is used for saving or opening files (HR-View) for the interface with the computer.
  ② Sens ...... This is used for receiving shift data with interface with the vision sensor.
  ③ LVS
  ④ MODBUS

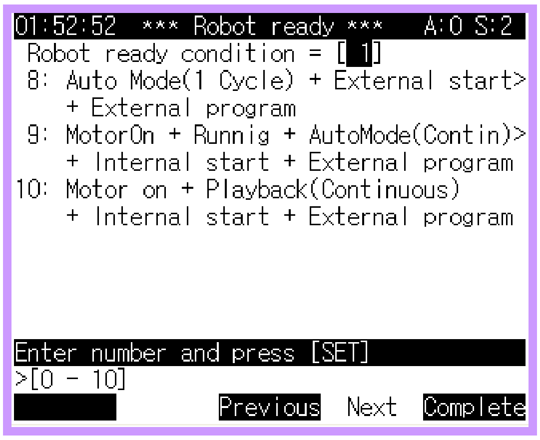
- OPSIO connector exists within the main board (BD411) inside the controller.

7.3.3. Robot preparation

This outputs the ready signal for robot preparation.
Robot ready signal is the DO signal allocated in『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『6: Output signal assigning』.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『3: Robot ready』 from initial screen of manual mode.





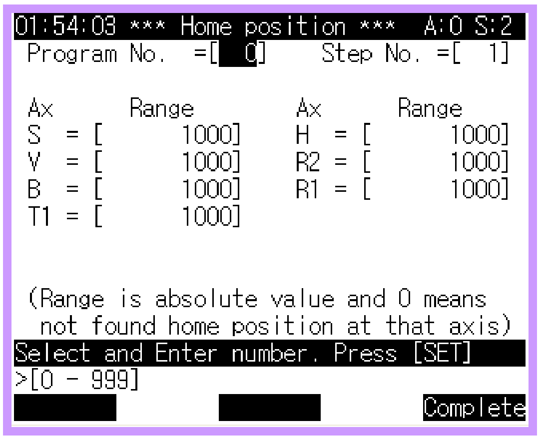
(2) Use the [Number] keys to enter the robot preparation condition and press the [SET] key.

(3) Press 『[PF5]: Complete』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

7.3.4. Registration of home position

This signal is released when the robot motion is within a certain margin from the home position after a specific position of the robot is registered as the home position.
Home position output signal is the DO signal allocated in 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『6: Output signal assigning』.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『4: Registration of home position 』 from initial screen of manual mode.



(2) Use the [Number] keys to enter the program number, step number, range of each axis and then press the [SET] key.

(3) Press 『[PF5]: Complete』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

- Program No.
  Enter the program number of the robot position to register the home position.

- Step No. : Enter the step number of the robot position to register the home position.

- Range
  Enter the range of position for each axis of the robot from the home position. When this value is set to 0, the home position check is disabled.

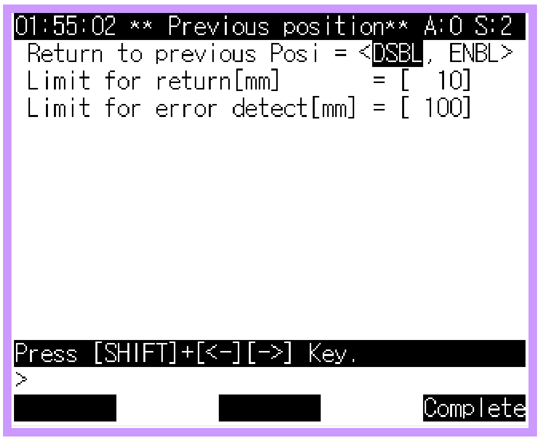
Reference

- The range is set by the encoder bit value of each axis unit. The set value is used for '+' direction and '-' direction from the home position point. For example, if you set the value to 100 bit, the output range of the home position signal will be 200 bit.
- If you delete the program or step registered for home position, the registration is automatically canceled.
- If you delete or add a step before or after the home position with the program that registered the home position, the registered step number automatically changes.
- You can check the home position signal at 『[PF1]: Service』 → 『1: Monitoring』.

7.3.5. Return to the Previous position

In case not ready for operation from emergency stopping or a hardware error, this functions recovers to the prior position as soon as it is ready for operation so that it doesn't free fall.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『5: Return to the Previous position』 from initial screen of manual mode.



(2) Use the [SHIFT]+[←][→] keys to enable or disable the Prior position recovery function.

(3) When the Prior position recovery function is enabled, use the [Number] keys to enter the recovery distance and error detection distance, and then press the [SET] key.

(4) Press 『[PF5]: Complete』 to save the modified setting. If you press the [Cancel] key, the modified data will not be saved.

- Return to previous Posi. :
  This decides whether to use the Prior position recovery function.

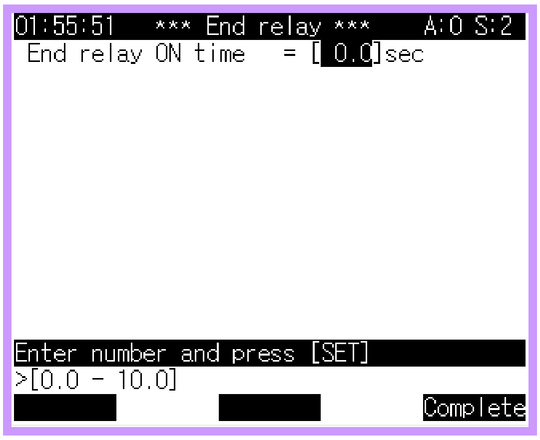
- Limit for return
  This sets the limit for recovering after the robot free falls. When the robots falls more than the set value, a warning message will be displayed.

- Limit for error detection
  This prevents the error with the peripheral devices. An error will occur when the robot free falls more than the set value and you cannot operate the robot without setting the steps.

7.3.6. End relay timer

When running the program in continuous automatic mode, this function sets the time between the end of the program and the restart of the program head.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『6: End relay timer』 from initial screen of manual mode.



(2) Use the [Number] keys to enter the end relay time and press the [SET] key.

(3) Press 『[PF5]: Complete』 to save the modified setting. If you press the [Cancel] key, the modified data will not be saved.

Reference

- The End relay output time function also applies when the FIFO function (function that runs the program in sequence saved at FIFO register through external digital signal) is applied.

7.3.7. Interlock timer

This sets up the maximum wait time for the input signal. The interlock error signal is released when the time exceeds the input signal standby time. This limited time set is the interlock error time.
Interlock error time is the signal allocated at 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『6: Output signal assigning』.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『7: Interlock timer』 from initial screen of manual mode.

(2) Use the [Number] keys to enter the Interlock error time and press the [SET] key. When it is set to 0, the input signal standby time becomes infinite.

(3) Press 『[PF5]: Complete』 to save the modified setting. If you press the [Cancel] key, the modified data will not be saved.

7.3.8. Error-output to the outside

This outputs the detected error number. Usually it outputs the error code displayed in the teach pendant.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『8: Error-output to the outside』 from initial screen of manual mode.

(2) Use the [SHIFT]+[←][→] keys to decide the serial output and line number designation output.

(3) Press 『[PF5]: Complete』 to save the modified setting. If you press the [Cancel] key, the modified data will not be saved.

- Serial output outputs the ASCII code to the external device using the serial interface (RS232C). The output formats are as follows.

  1st byte : "$"
  2~6th byte : "ERROR"
  7th byte : " " (Blank)
  8~11th byte : Error number
  12th byte : CR
  13th byte : LF

  Ex) Error number 0101 (E0101)

$	E	R	R	O	R		0	1	0	1	CR	LF
1	2	3	4	5	6	7	8	9	10	11	12	13

- Line number designation output sends out the error number to the external device through the allocation signal in 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『6: Output signal assigning』.

Table 7-1 Output allocation by allocated signal

Name of allocated signal	Allocation and number	
	Type 1	Type 2
Error output selection	○ : 1	×
Error output STRB	○ : 1	×
Error output Bit	○ : 8	○ : 16

① Type 1 (8 bit output) – This converts the error number into a binary number and outputs the low 8 bits and high 8 bits. The error output selection signal distinguishes between the low and high data. The strobe signal that decides the data check timing is the error output STRB signal.

Ex) Timing diagram for E0101
($101_{10} = 0065_{16} = 0000\ 0000\ 0110\ 0101_2$)

```
                    |←    Low data    →|←    High data    →|
                    +---------1-----------+
          01   -+                         +----------0-----------

          02   ----------0---------------------0-----------
                    +---------------------+
          03   -+            1            +----------0-----------

          04   ----------0---------------------0-----------

          05   ----------0---------------------0-----------
                    +---------1----------+
          06   -+                        +-----------0------------
                    +---------1----------+
          07   -+                        +-----------0------------

          08   ----------0---------------------0------------
               +--------------------+
Err output Selecton-+                  +-------------------------
                         +---------+              +----------+
Err output STRB   ------+          +-------------+           +------
                  |←   →|←    →|←→|←   →|←      →|←→|
                    100ms   200ms   50ms   100ms    200ms    100ms
```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② Type 2 (16 bit output) – This converts the error number into a binary number and outputs a 16 bit data. The strobe signal that decides the data check timing is

- System error => General error
- Operation error => Operating error.

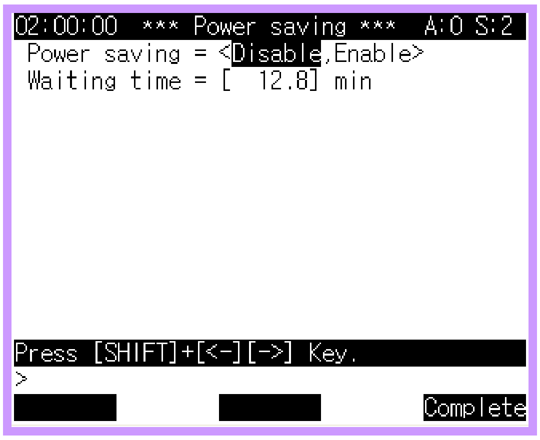
Ex) Timing diagram for E0101 (System error)

```
                 +-------1---------------------------------------
        01    ---+

        02    -----------0---------------------------------------
                 +-------1---------------------------------------
        03    ---+

        04    -----------0---------------------------------------

        05    -----------0---------------------------------------
                 +-------1---------------------------------------
        06    ---+
                 +-------1---------------------------------------
        07    ---+

        08    -----------0---------------------------------------

        09    -----------0---------------------------------------

        10    -----------0---------------------------------------

        11    -----------0---------------------------------------

        12    -----------0---------------------------------------

        13    -----------0---------------------------------------

        14    -----------0---------------------------------------

        15    -----------0---------------------------------------

        16    -----------0---------------------------------------

Operation error  ---------------------------------------------------
                 +-----------------------------------------------
General error ---+
```

7.3.9. Power saving (PWM OFF)

This sets the standby time for power save. When the robot stands by for operation or input signal in the automatic mode for longer than the set time, the power to the motor is cut to save power consumption.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『9: Power saving : PWM Off』 from initial screen of manual mode.



(2) Use the [SHIFT]+[←][→] keys to decide whether to use the power save function.

(3) When the power save is <Enabled>, use the [Number] key to enter the standby time and press the [SET] key.

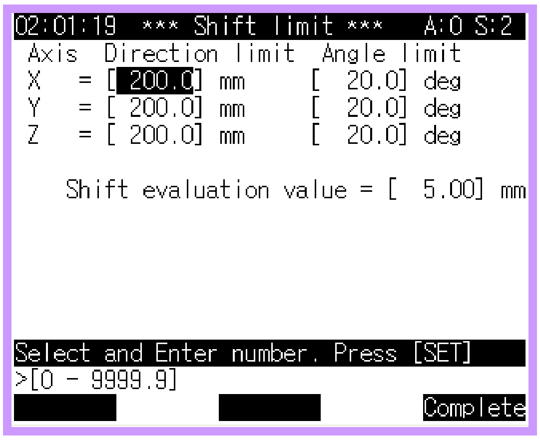
(4) Press 『[PF5]: Complete』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

- Power saving : This sets whether to use the power save function.
- Waiting time : This enters the time to switch to power save function.

7.3.10. Shift limit

This sets the limit that the robot can shift. This sets the shift limit through XYZ shift or online shift function and generates an error when it exceeds the shift limit.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『10: Shift limit』 from initial screen of manual mode.



(2) Use the [Number] keys to enter the direction limit, angle limit and calculated evaluation value, and the press the [SET] key.

(3) Press 『[PF5]: Complete』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

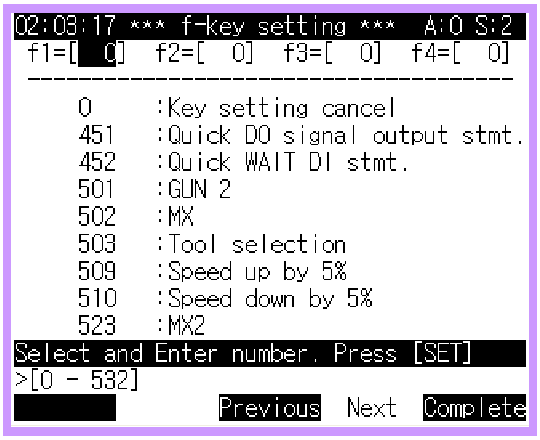
Name	Contents	Standard value
X axis direction limit	This is the shift limit in X axis direction.	200 mm
Y axis direction limit	This is the shift limit in Y axis direction.	200 mm
Z axis direction limit	This is the shift limit in Z axis direction.	200 mm
X axis angle limit	This is the shift limit in X axis angle.	20 deg
Y axis angle limit	This is the shift limit in X axis angle.	20 deg
Z axis angle limit	This is the shift limit in X axis angle.	20 deg
Calculated evaluation value	Option	5.0 mm

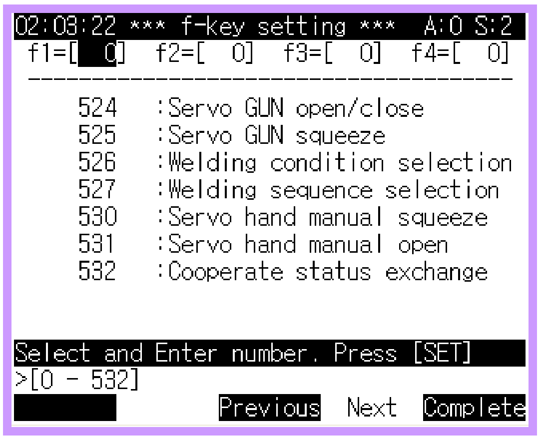
7.3.11. F-key setting

This function is used for assigning some function in f1 - f4 key of the teach pendent when the user wants to operate the robot easily. If the user is in manual mode and the GUN2 item in 『[PF2]: System』 → 『5: Initialize』 → 『4: Setting Usage of the robot』 is set to Palletizing, the contents and the functions of the user key setting may be different.

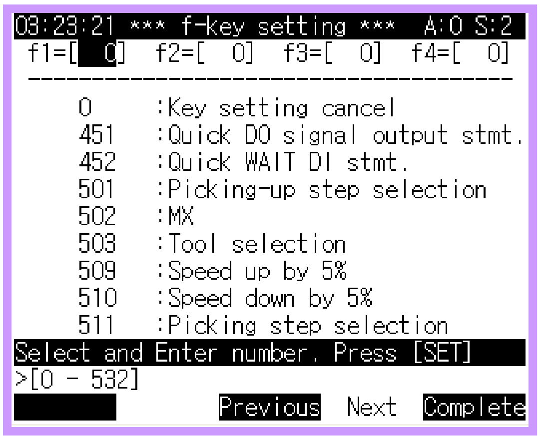
(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『11: f-key setting』 from initial screen of manual mode.

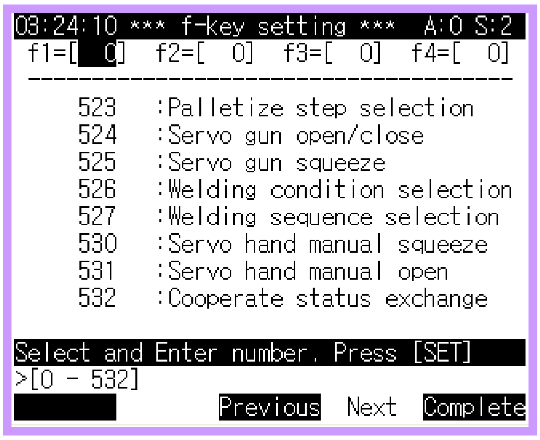
(2) If the usage of GUN2 is not for Palletizing, the following screen will be displayed.





(3) If the usage of GUN2 is for Palletizing, the following screen will be displayed.





(4) Use the [Number] keys to enter each allocation number for the user key and press [SET] key.

(5) Press 『[PF5]: Complete』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

◆ **When the usage of GUN2 is not for Palletizing**

No.	F key	Description
0	Cancel setting	It cancels the setting.
451	Fast entry of DO signal output message	It enters fast the DO signal output message.
	[f?] key	It enters the DO?=? fast by function in the edit frame in manual mode.
	[Shift]+[f?] key	No function.
452	Fast entry of WAIT DI message	It enters the WAIT DI fast.
	[f?] key	It enters the WAIT DI? fast by function in the edit frame in manual mode.
	[Shift]+[f?] key	No function.
501	GUN2	This is the key for GUN2 with the same function as the GUN key.
	[f?] key	The “G2” in the status display in manual mode goes ON and OFF. If it is ON, press the [REC] key to record G2 in step condition.
	[Shift]+[f?] key	It manually outputs GUN2 signal with the allocated number from G2 from 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『6: Output signal assigning』 in manual mode.
502	MX	It sets the MX status (ON/OFF).
	[f?] key	The “MX” in the status display in manual mode goes ON and OFF. If it is ON, press the [REC] key to record MX in step condition.
	[Shift]+[f?] key	It manually outputs the MX signal with the allocated number from MX in 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『6: Output signal assigning 』 in manual mode.
503	Tool selection	It selects the tool number.
	[f?] key	It displays “T0~T3” in the status display line of manual mode. For example, if ”T2”.
	[Shift]+[f?] key	No function.
509	5% speed increase	It increases the speed that is currently selected by 5%. If there is a step with Block Mark (BM), the speed of those steps will not be changed.

No.	F key	Description
	[f?] key	It increases the recorded speed by 5%.
	[Shift]+[f?] key	No function.
510	5% speed decrease	It decreases the speed that is currently selected by 5%. If there is a step with Block Mark (BM), the speed of those steps will not be changed.
	[f?] key	It decreases the recorded speed by 5%.
	[Shift]+[f?] key	No function.
523	MX2	It is the key for MX2 with the same function as MX (502).
	[f?] key	The “X2” in the status display in manual mode goes ON and OFF. If it is ON, press the [REC] key to record X2 in step condition.
	[Shift]+[f?] key	It manually outputs MX2 signal with the allocated number from X2 in 『[PF2]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『6: Output signal assigning』 in manual mode.
524	Manual open/close for manual gun	It decides whether to manually open the servo gun in large or small space.
	[f?] key	No function.
	[Shift]+[f?] key	It moves with the servo gun key pressed by large of small stroke set in 『[PF2]: System』 → 『4: Application parameter』 → 『1: Spot & stud』 → 『2: Servo gun parameter』.
525	Manual pressure for manual gun	It decides the manual pressure of the servo gun.
	[f?] key	No function.
	[Shift]+[f?] key	It applies the pressure by moving the servo gun key pressed by large of small stroke set in 『[PF2]: System』 → 『4: Application parameter』 → 『1: Spot & stud』 → 『2: Servo gun parameter』.
526	Welding condition number selection for servo gun	It manually sets the welding condition number for servo gun.
	[f?] key	The W value changes in W:1S:0 in the status display line in manual mode.
	[Shift]+[f?] key	No function.

No.	F key	Description
527	Welding sequence number selection for servo gun	It manually sets the welding sequence number for servo gun.
	[f?] key	The S value changes in the W:1S:0 in the status display line in manual mode.
	[Shift]+[f?] key	No function.
530	Manual pressure for servo hand	It decides the manual press for servo hand.
	[f?] key	No function.
	[Shift]+[f?] key	While pressing the key to target the maximum pressure position in 『[PF2]: System』 → 『4: Application parameter』 → 『3: Palletizing』 → 『3: Servo hand parameter』, pressure is added until the currently set pressure reaches the target.
531	Manual open for servo hand	It decides on the manual opening of the servo hand.
	[f?] key	No function.
	[Shift]+[f?] key	While pressing the key to target the maximum opening position in 『[PF2]: System』 → 『4: Application parameter』 → 『3: Palletizing』 → 『3: Servo hand parameter setting』, the opening is widened until the currently set open position reaches the target.
532	Collaboration condition change	It decides the collaboration condition or role.
	[f?] key	It changes the collaboration control status to independent or collaborative.
	[Shift]+[f?] key	It changes the collaboration role to master or slave.

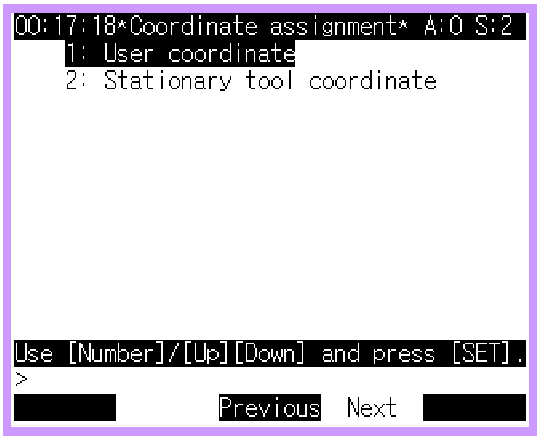
◆ **When the usage of GUN2 is for Palletizing**

No.	F key	Description
501	Workload pickup step selection	It controls the PU status (ON/OFF).
	[f?] key	The "PU" in the status display in manual mode goes ON and OFF. If it is ON, press the [REC] key to record PU in step condition.
	[Shift]+[f?] key	No function.
511	Workload picking step selection	It controls the PK status (ON/OFF).
	[f?] key	The "PK" in the status display in manual mode goes ON and OFF. If it is ON, press the [REC] key to record PK in step condition.
	[Shift]+[f?] key	No function.
523	Palletized step selection	IT controls the PS status (ON/OFF).
	[f?] key	The "PS" in the status display in manual mode goes ON and OFF. If it is ON, press the [REC] key to record PS in step condition.
	[Shift]+[f?] key	No function.

7.3.12. Coordinate assignment

It is used for setting up the user coordinate or stationary tool coordinate.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『12: Coordinate assignment』 from initial screen of manual mode.

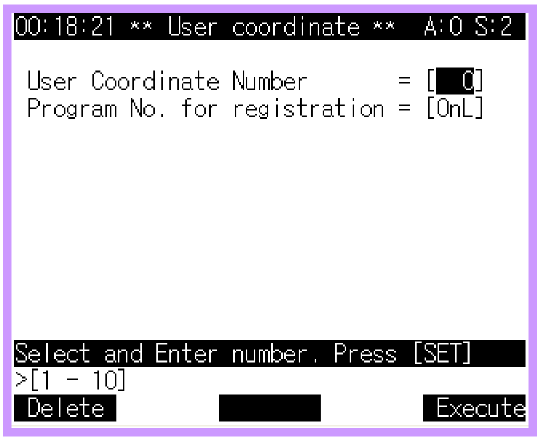


(2) Use the [Arrow] keys to move the cursor to the item to select and press the [SET] key. Or you can enter the number of the item to select and press the [SET] key to move to the sub menu.

7.3.12.1. User coordinate

User coordinate refers to the coordinate set to the location set by the user. In order to use the user coordinate, first you must follow the 3 standard teaching to define the user coordinate mentioned below. This menu designates the program number and user coordinate number that has taught so that the user coordinate can be registered to Hi4a controller.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『12: Coordinate assignment』 → 『1: User coordinate』 from initial screen of manual mode.



(2) Use the [Number] keys to enter the number to use for the user coordinate and the program number to register the user coordinate, and then press the [SET] key.

(3) Press the『[PF5]: Execute』 to calculate the user coordinate.

- User Coordinate Number : Enter the coordinate number to use for user coordinate.
- Program No. for registration : Enter the program number to register the user coordinate.

Reference

- Teaching method of 3 standard steps to define the user coordinate

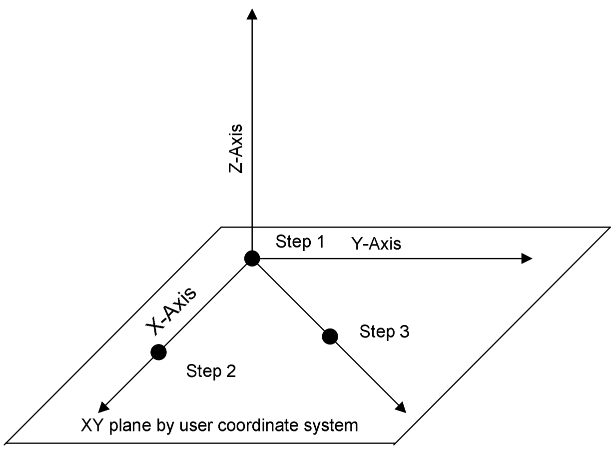


Figure 7.6 Teaching method of 3 standard steps to define the user coordinate

① Define the location of the user coordinate and X, Y, Z axis. (Z axis is automatically defined according to X and Y axis.)
② Step 1 : Step to define the 0 position in the user coordinate.
③ Step 2 : Step to define the X axis of the user coordinate. Teach any point on the X axis. It is recommended to set a point more than 200mm away from the 0 point.
④ Step 3 : Step to define the XY surface of the user coordinate. It defines the Y and Z axis. Teach any point on the surface that X and Y axis creates. It is recommended to set a point more than 200mm away from the 0 point.

※ When teaching the program to set the user coordinate, the TCP (Tool Center Point) must be set accurately. Check the currently set tool number. To set the TCP, use the 'Automatic constant setting' function or check if the accurate value has been entered in the tool data.

- You can register up to 10 user coordinates.

- Note when recording the reference point to define the coordinate
① 3 references points cannot be in one line.
② Make sure the distances among the 3 reference points are not too close.
③ Steps after step 4 doe not affect the coordinate registration.

- For example, after teaching the 3 reference points to define the user coordinate using program 8, set the user coordinate number to 1. And then press the 『[PF5]: Execute』 key and you will see the following screen.

```
 00:00:00   *User coordinate *     A:0 S:8
 User Coordinate Number       = [   1]
 Program No. for registration = [OnL]

 Defined User-coordinate
   {1}
 User-coordinate pose : number 1
 Origin:{X=0, Y=1677.23, Z=2212.02}
 X-Dir.:{X=-1.00, Y=0, Z=0}
 Y-Dir.:{X=0, Y=-1.00, Z=0}


Executing completed
 >[1 -  10]_
                                  Execute
```

① Set user coordinate:
It displays all the number of coordinates that is currently registered as user coordinate.

② No. # location of user coordinate:
It shows the user coordinate registered as number # and shows the directions.

- Please refer to 『[PF5]: Cond set』 → 『8: Select user coordinate』 when selecting the user coordinate for jog operation or coordinate monitoring.

- Please refer to 『[PF2]: System』 → 『1: User parameter』 → 『2: Pose REC type』 when setting up the user coordinate for teaching process.

7.3.12.2. Stationary tool coordinate

This is to set the location of the stationary tool to use the interpolation of the stationary tool.

Up to 4 coordinates (0 ~ 3) can be registered for the stationary tool. Manually enter the X, Y and Z coordinates of the stationary tool number.

You must enter the X, Y and Z coordinates of the end point of the stationary tool to set the base coordinate of the controller. Generally, the base coordinate of the controller is the base coordinate of the robot base.

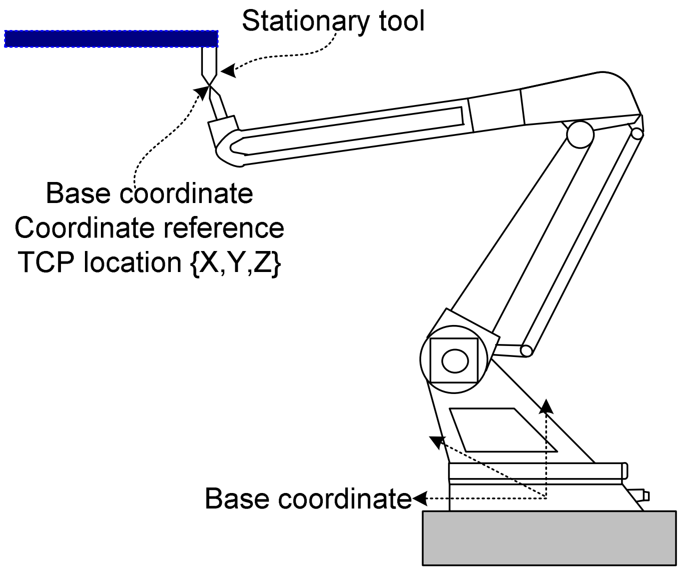
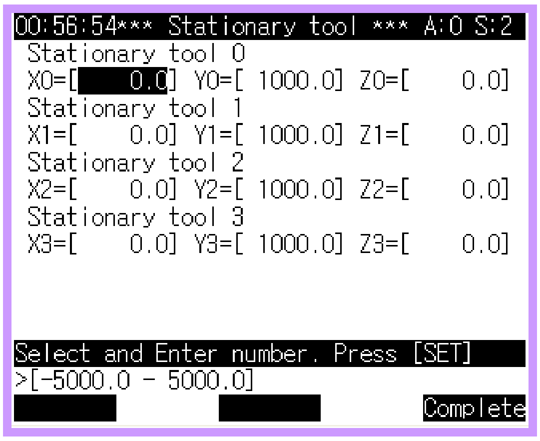


Figure 7.7 Location of stationary tool

(1) Select 『[PF1]: Service』 → 『1: Monitoring』 → 『1: Axis data』 to read the current location of the robot TCP.

(2) Align the robot's TCP to the stationary tool's TCP, and remember the current X, Y and Z coordinate value of the base coordinate displayed in the monitoring.

(3) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『12: Coordinate assignment』 → 『2: Stationary tool coordinate』 from initial screen of manual mode.



(4) Enter the coordinate that you memorized in (2) to the coordinate of the stationary tool and press the [SET] key to confirm the setting.

(5) Press 『[PF5]: Complete』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

Reference

- When teaching the program to set the user coordinate, the TCP must be set accurately. Check the currently set tool number. To set the TCP, use the 'Automatic constant setting' function or check if the accurate value has been entered in the tool data.

7.3.12.2.1. Stationary tool interpolation function

Stationary tool interpolation function enables the interpolation operations such as straight or arc movement to the working object by moving the robot in reference to the stationary tool. If the user designates the working object in the stationary tool, and record and runs the interpolation steps, the robot will move in straight or arc in reference to the stationary tool.

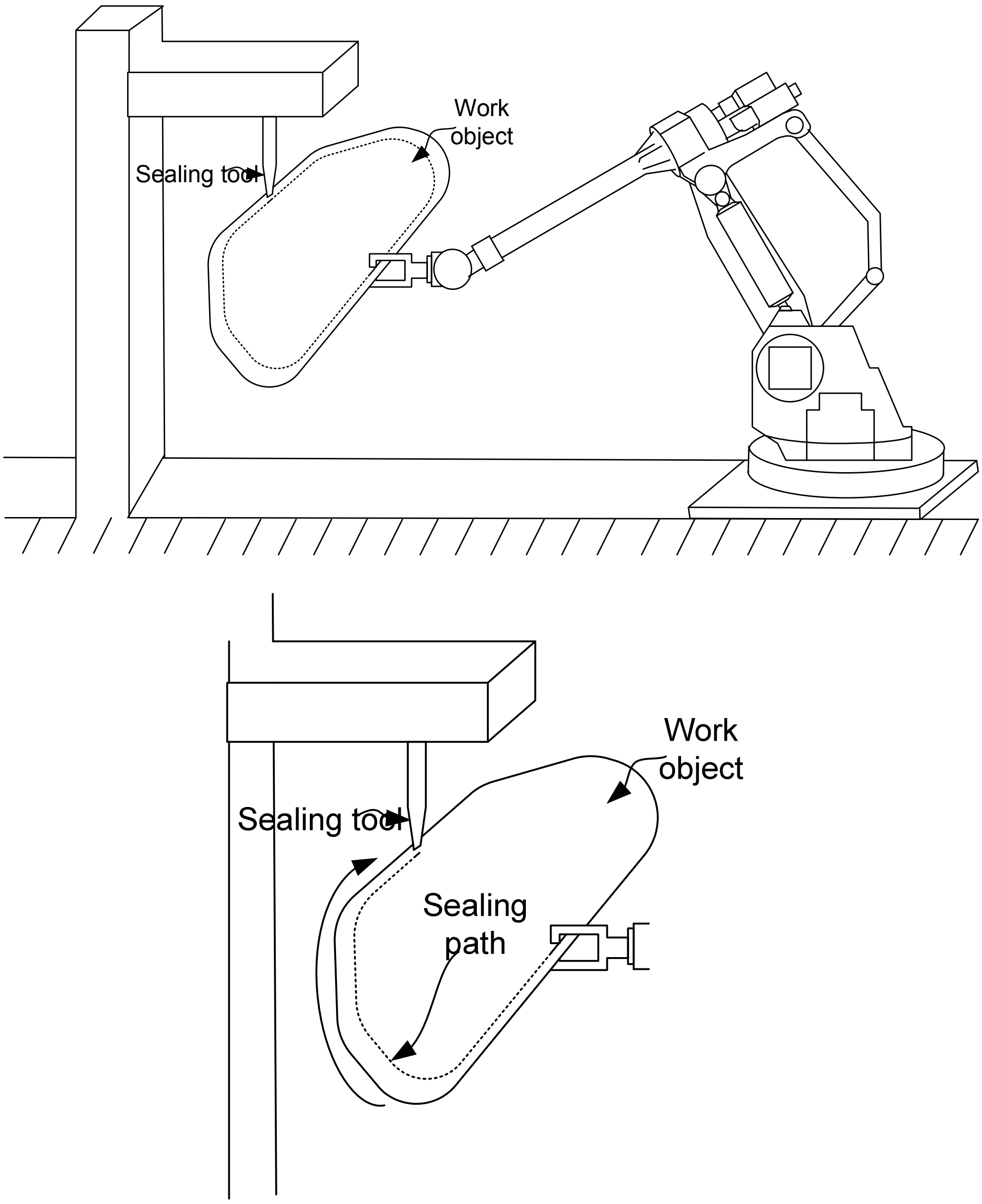


Figure 7.8 Stationary tool interpolation function

(1) Operating sequence

Stationary tool coordinate setting
The location of the stationary tool is set based on the robot base coordinate.

→ **Change in step record method**
Change the condition setting to record the stationary tool calibration step.

→ **Program teaching**
Select the stationary tool number with M67 function and teach the work program of each robot.

→ **Check operation**
Run the program to check the calibrated trace based on the stationary tool.

→ **Continuous operation**
Continuously operate the work program.

(2) Stationary tool number selection
To use the registered stationary tool number, you must select and use the number in the robot program. You can use the M67 command to select the stationary tool number.

M67 parameter 1 (Tool no.)		Remarks
Parameter 1 (Tool no.)	Stationary tool no. selection	Range:0~3

<Example of stationary tool no. change program>

```
00:00:00    *** M A N U A L ***    A:0 S:8
T0
PN:100[*]__S/F:0/0      Sp:100.0
    Robot:Hx165-01, 6 Axis, Total 2 steps
S1  MOVE L,S=1000mm/sec,A=0,T=0
    M67 0  '  stationary tool 0
S2  MOVE SL,S=1000mm/sec,A=0,T=0
S2  MOVE SL,S=1000mm/sec,A=0,T=0
S1  MOVE P,S=100%,A=0,T=0
    M67 1  '  stationary tool 1
S2  MOVE SL,S=1000mm/sec,A=0,T=0
S2  MOVE SC,S=1000mm/sec,A=0,T=0
S2  MOVE SC,S=1000mm/sec,A=0,T=0
    END
```

- S1 MOVE L,S=1000mm/sec,A=0,T=0 → Straight interpolation movement of robot tool
- M67 0 ' stationary tool 0 → Sealing tool no. selection
- S2 MOVE SL,S=1000mm/sec,A=0,T=0 → Straight interpolation movement of stationary tool
- S1 MOVE P,S=100%,A=0,T=0 → Interpolation OFF movement
- M67 1 ' stationary tool 1 → Sealing tool no. change (0->1)
- S2 MOVE SL,S=1000mm/sec,A=0,T=0 → Straight interpolation movement of stationary tool
- S2 MOVE SC,S=1000mm/sec,A=0,T=0 → Arc interpolation movement of stationary tool

◆ 【Caution】 ◆

- Stationary tool number selection must be done before the interpolation step (SL, SC).
- Please refer to the next section for recording method of stationary tool interpolation step.

(3) Teaching method

The operator moves the work object for the stationary tool, like the fixed sealing nozzle, to operate the straight interpolation movement along the work object. When the user is trying to move from S1 to S2 as shown in the below figure, S2 is recorded with stationary tool interpolation. Step 1 is recorded as shown in Figure b) and step 2 which is to move with the stationary tool interpolation, can be taught with the robot movement.

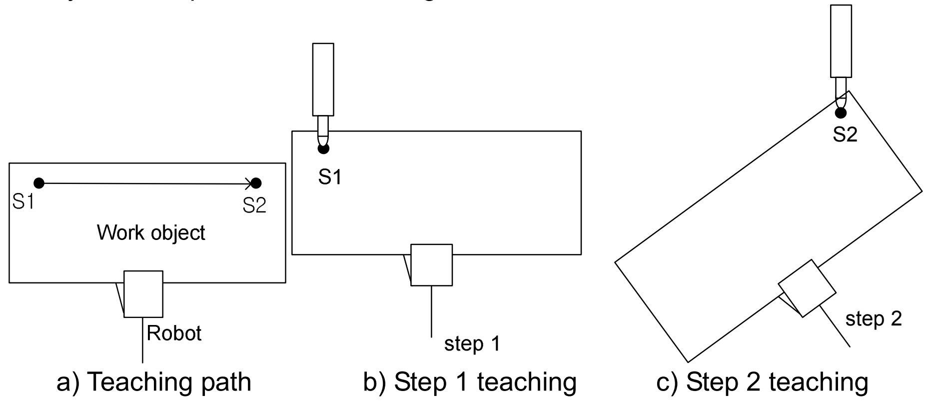


Figure 7.9 Teaching method

When running the taught program, the sealing nozzle path of the work object is same as the sealing path of the figure.

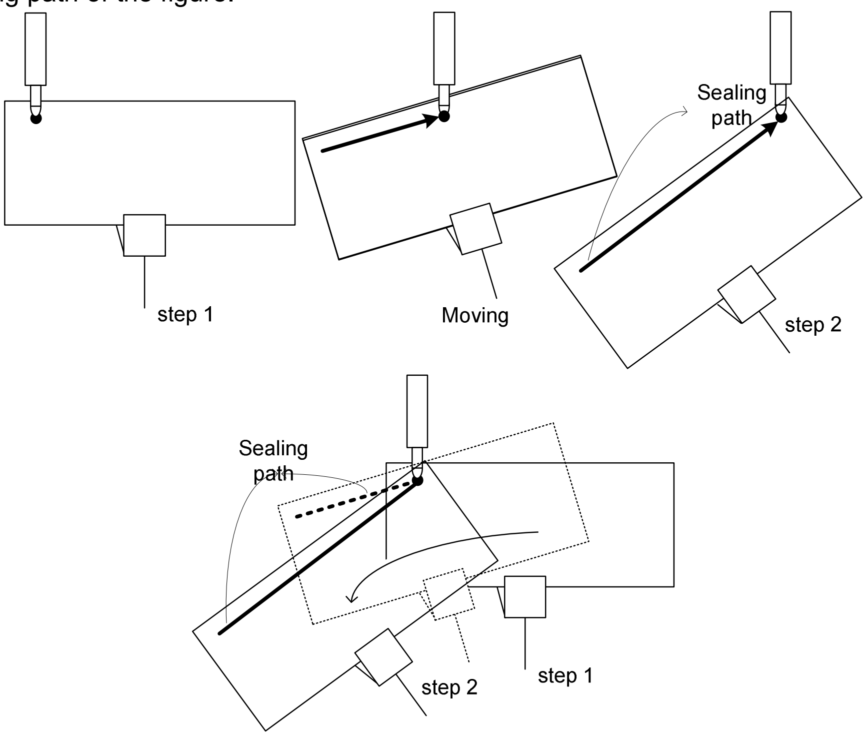
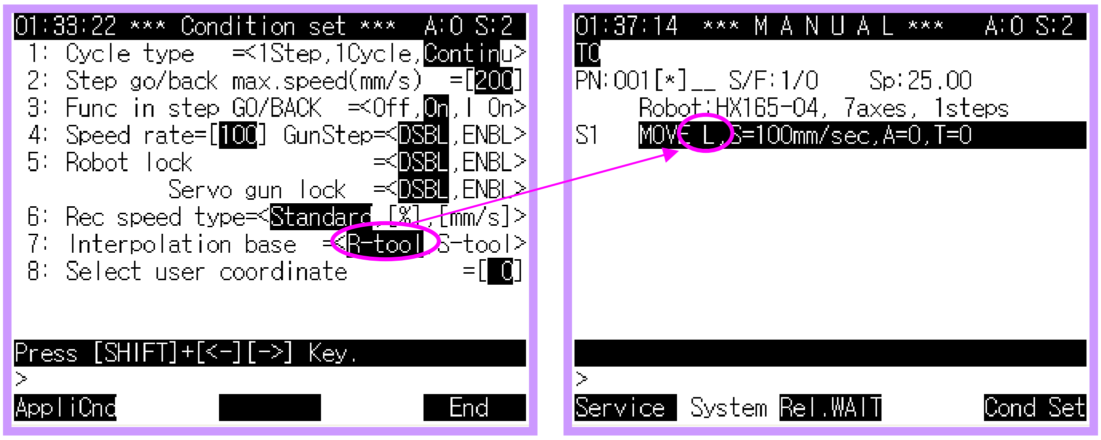


Figure 7.10 Sealing path

(4) Recording method

① Recording method for general interpolation step

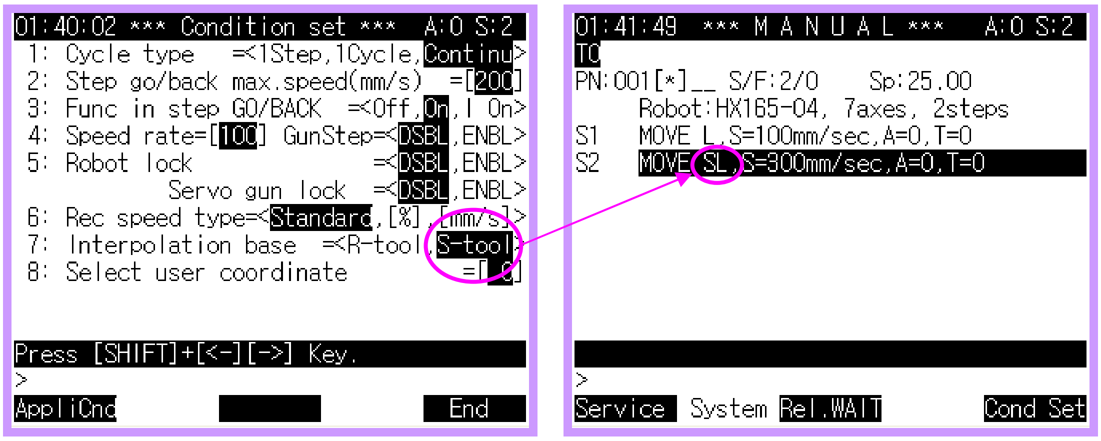
The robot tool interpolation records when the condition setting is 『7: Interpolation base= <R-tool>』. The recording method for the robot tool interpolation is set as default in the controller. (Recording of general interpolation step 1)



When it is set to 'Robot tool', the straight line interpolation is set to “L” and arc interpolation is set to “C”.

② Recording method of stationary tool interpolation step

When you are recording the stationary tool interpolation, the condition should be set to 『7: Interpolation base= <S-tool>』 before recording. (Recording of stationary tool interpolation step 2)



When the 'Stationary tool' is selected as shown above, the straight line interpolation is set to “SL” (SL : Stationary Linear Interpolation) and the arc interpolation set to “SC”.

◆【Caution】◆

- Before recording the stationary tool interpolation step using the M67 command, program the tool so that the right number is selected for the stationary tool number.

(5) Arc interpolation teaching
Stationary tool interpolation function also supports arc interpolation. It records the step to draw the arc path as shown below in the Figure is recorded.

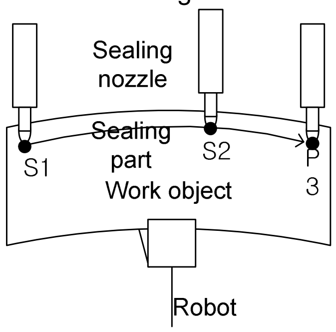


Figure 7.11 Arc interpolation teaching

Teach step 1 as shown in the above Figure and teach step 2 with stationary tool arc interpolation. Then teach step 3 as shown in the above Figure so that it is an appropriate reference step for arc interpolation. The taught steps from stationary tool arc interpolation enables the robot to generate an arc path on the work object in reference to the fixed stationary tool.

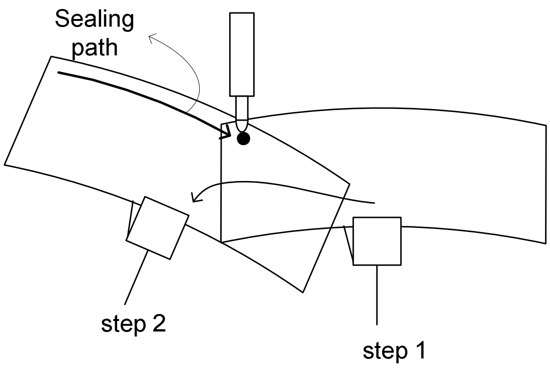


Figure 7.12 Sealing path of arc interpolation

◆【Caution】◆

- The reference point for the arc interpolation is the starting point, target point and the reference point for generating the arc interpolation.
- The method of reference step for stationary tool arc interpolation is based on the following principle.
  If step 2 is recorded as arc interpolation in the above example, the reference point for step 2 when moving is as follows.

  ① The next step (S3) when the next step (S2) is arc interpolation.
  ② The prior step (S1) when the next step (S2) is not an arc interpolation.

(6) Check operation
Check if there is any problem in running the program recorded with the stationary tool function.

- Select manual mode.
- Press the ON switch of the motor and hold the ENABLE switch for operation.
- Set the ‘continuous’ LED to OFF in the teach pendant and press the step forward key to move forward by each step. Check if the teaching position is same as the teaching position for all steps. In case of stationary tool interpolation, check if there is any problem on the path on the work object.
- Set the ‘continuous’ LED to ON in the teach pendant and using the ‘Step forward’ key, check the path.

(7) Run
If there is no problem in the check operation, switch to automatic mode and execute the operation.

◆【Caution】◆

- For cornering from straight line interpolation and interpolation OFF accuracy, and when trying to switch from robot tool to stationary tool (stationary tool to robot tool), operate in a discontinuous way without corning process.
- If there is a problem in the path during check operation, check if the stationary tool position is correctly set and if the stationary tool number (M67) is correctly selected.

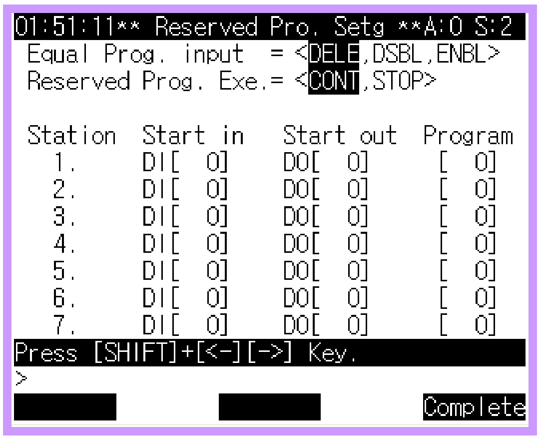
7.3.13. Reserve program setting

This sets the user environment of FIFO function. If the following condition is satisfied in the 『[PF2]: System』 → 『1: User parameter』 → 『14: FIFO function』 from the initial screen in manual mode, the input/output signal and program must be allocated for the FIFO function to work.

For more details, please refer to the『FIFO Function Manual』.

- When the number of application is <20 > or <1>
- Program is set to <Internal setting>

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『13: Reserve program setting』 from initial screen of manual mode.



- Equal prog. Input
  When registering the selected program to FIFO register, it processes the registration if it exists in the register.
  ① DELE : It deletes the program already in the register.
  ② DSBL : It does not register the selected program to the register.
  ③ ENBL : It adds the selected program to the register.

- Reservde prog. Exe.
  It decides the running method of the program registered in the FIFO register.
  ① CONT : It runs continuously for all the registered programs.
  ② STOP : It only runs the first registered program. The next command must be entered for the next registered program.

- Start in : It sets the digital input signal number.

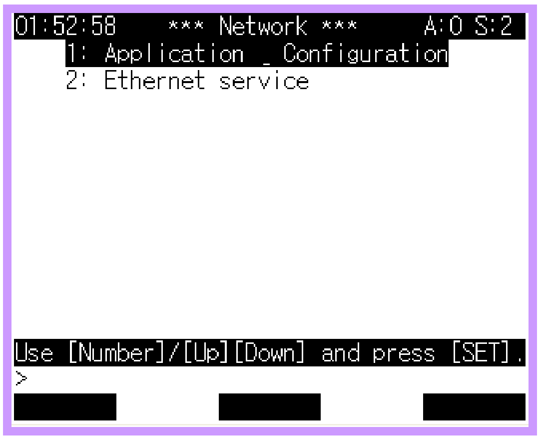
- Start out : It sets the digital output signal number.

- Program
  It is the reserved program number when the applicable input signal is set to ON.

7.3.14. Network

It sets the usage and environment for Ethernet network function and other selected usages.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『14: Network』 from initial screen of manual mode.

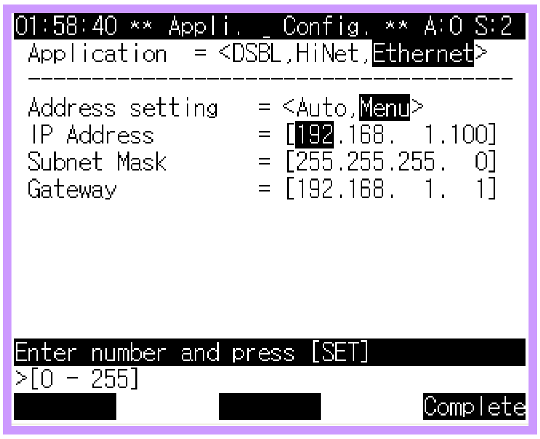


(2) Use the [Arrow] keys to move the cursor to the item to select and press the [SET] key. Or you can enter the number of the item to select and press the [SET] key to move to the sub menu.

7.3.14.1. Application & Configuration

Ethernet network provides two functions, the robot collaboration and Ethernet function. These two functions operate in mutually independent environment and are mutually exclusive. Therefore make an appropriate functional selection based on the usage and set the environment for the selected function.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『14: Network』 → 『1: Application & Configuration』 from initial screen of manual mode.



(2) Use the [SHIFT]+[←][→] keys to select the Ethernet network usage. The sub menu will change according to the selected usage.

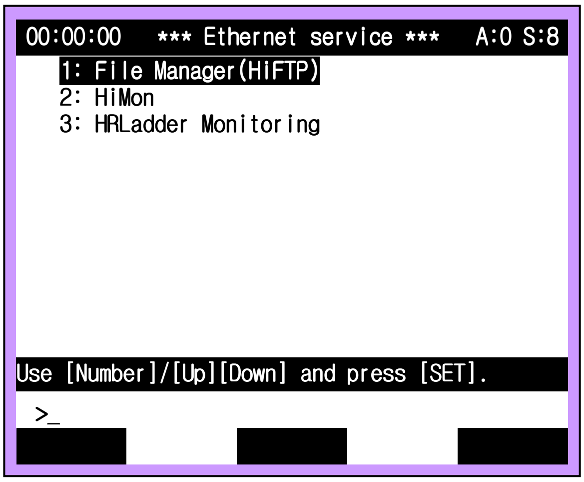
(3) If robot collaboration function is selected, enter the robot number. If Ethernet function is selected, enter the IP address, subnet mask, gateway information according to the network where the controller is installed.

(4) To save the modifications, press the 『[PF5]: Complete』 key.

7.3.14.2. Ethernet service

This sets up the operating environment for Ethernet service when the usage of the Ethernet network is set to Ethernet function.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『14: Network』 → 『2: Ethernet service』 from initial screen of manual mode.

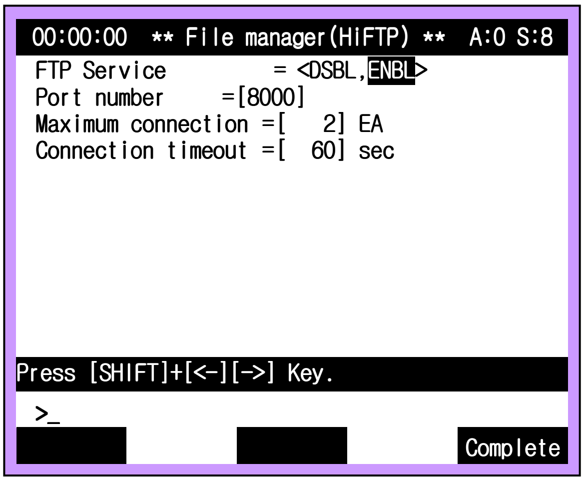


(2) Use the [Arrow] keys to move the cursor to the item to select and press the [SET] key. Or you can enter the number of the item to select and press the [SET] key to move to the sub menu.

7.3.14.2.1. File manager (HiFTP)

This sets up the environment to use the file management service through Ethernet.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『14: Network』 → 『2: Ethernet service』 → 『1: File manager (HiFTP)』 from initial screen of manual mode.



(2) This sets up whether to use the file management with FTP (File Transfer Protocol). Once the service is <ENBL>, the service automatically starts.

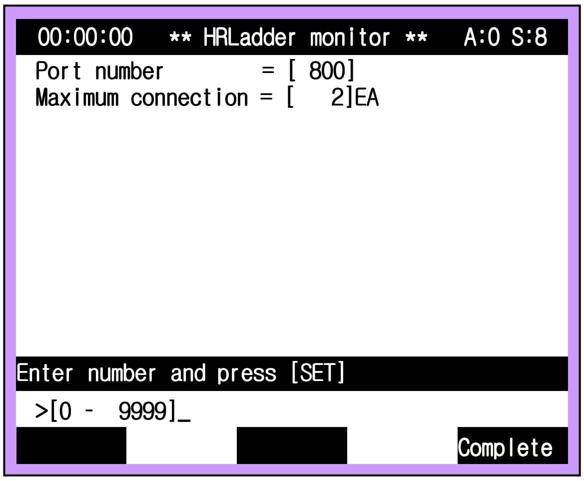
- Port number : Enter the socket number to access the service.
- Max connection : This sets the maximum number of concurrent users for this function.
- Connection timeout
  This sets the maximum length of time the user stays connected to the service while idle. When the user stays idle more than the time set in Connection timeout, the user is automatically disconnected.

(3) To save the modifications, press the 『[PF5]: Complete』 key.

7.3.14.2.2. HRLadder monitoring

This sets the environment to use the HRLadder monitoring service through Ethernet.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『14: Network』 → 『2: Ethernet service』 → 『3: HRLadder monitoring』 from initial screen of manual mode.



(2) Use the [Number] keys and [Arrow] keys to set the HRLadder monitoring environment.

- Port number : Enter the socket number to access the service.

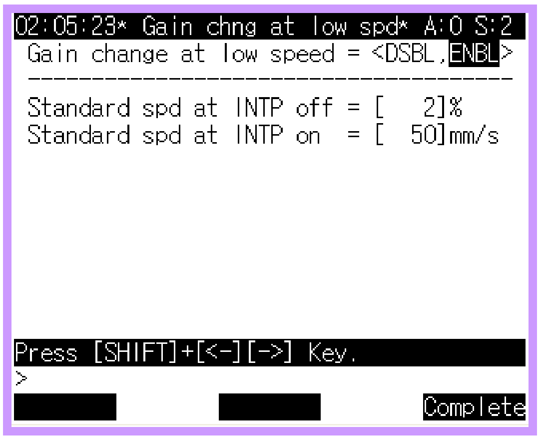
- Maximum connection :
  This sets the maximum number of concurrent users for this function.

(3) To save the modifications, press the 『[PF5]: Complete』 key..

7.3.15. Gain change at low speed

A vibration that typically does not happen can happen in the low speed movement zone. This is caused from the characteristics of the motor. In this case, the vibration can be reduced by separately setting the low speed gain.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『15: Gain change at low speed』 from initial screen of manual mode.



- Gain change at low speed : The function applies when this is enabled.

- Standard spd at INTP off
  This is the reference speed to change for gain in the zone where interpolation is turned off.

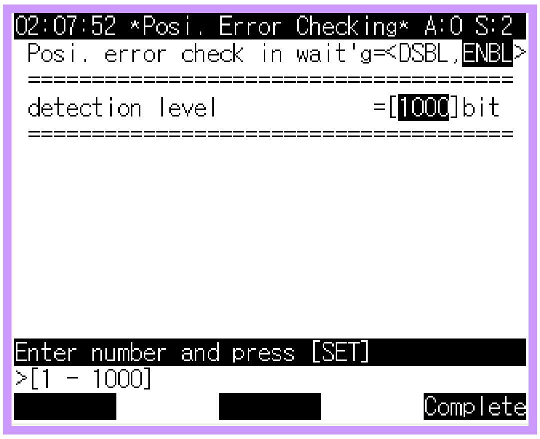
- Standard spd at INTP on
  This is the reference speed to change for gain in the straight line interpolation or arc interpolation zone.

7.3.16. Position error checking in waiting

Position deviation refers to the difference between the robot command and the current location. When the robot starts to move, a deviation starts to exist and grows as speed increases. When the robot is in a collision or is in an abnormal situation, the deviation can grow abnormally. The location deviation error detection function sends an error message and protects the robot.

Generally because the location deviation error detection level is set in reference to the maximum speed of the robot, the robot is insensitive to the error detection when the robot is standing still or when the robot is moving in low speed. Therefore this function enables the robot to detect the error even in standby mode by separately setting the location deviation error detection level.

(1) Select 『[PF2]: System』 → 『2: Controller parameter』 → 『17: Position error checking in waiting』 from initial screen of manual mode.



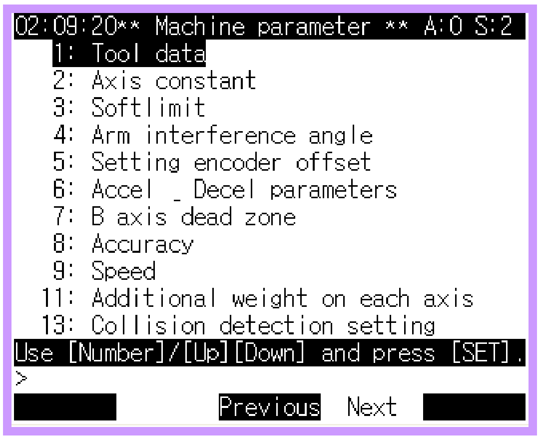
- Posi. Error check in wait’g : This function applies when [ENBL].

- Detection level
  This is the location deviation error detection level of robot in standby, and it is set by number of bits in the encoder.

7.4. Machine parameter

This sets up various parameters for the robot body.

(1) Select 『[PF2]: System』 → 『3: Machine parameter』 from initial screen of manual mode.



(2) Select the parameter item to change.

Reference

- The machine parameter is saved in the machine parameter file (ROBOT.C01).
- If the machine parameter file (ROBOT.C01) is completely protected, you cannot make any changes.

7.4.1. Tool data

Set the distance and angle of the robot's R1 axis flange in reference to TCP (Tool Center Point) and register the center of gravity and inertia. The user can manually enter the items.

Another method is to use the automatic constant setting function for the tool distance. The center of gravity and inertia can be registered using the load estimate function.

The tool distance and angle must be correctly set before the teaching process. This is because the path during straight line or arc interpolation is generated based on TCP.

Tool distance is as follows.

(1) Distance in X axis X dist (2) Distance in Y axis
(3) Distance in Z axis Z dist

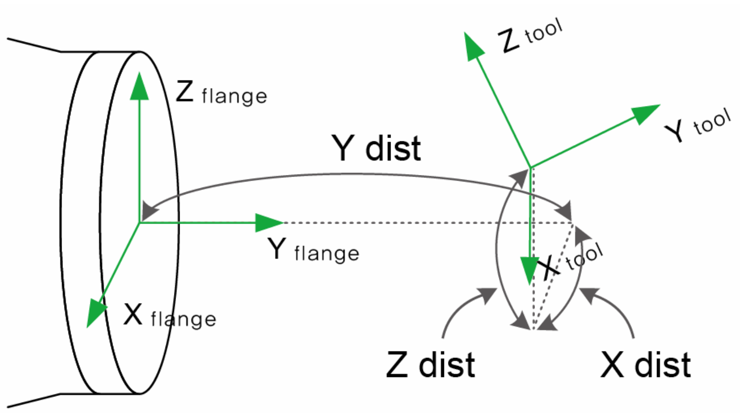


Figure 7.13 Tool distance

Tool angle is as follows in the Figure.

(1) Angle in X axis Rx (2) Angle in Y axis Ry
(3) Angle in Z axis Rz

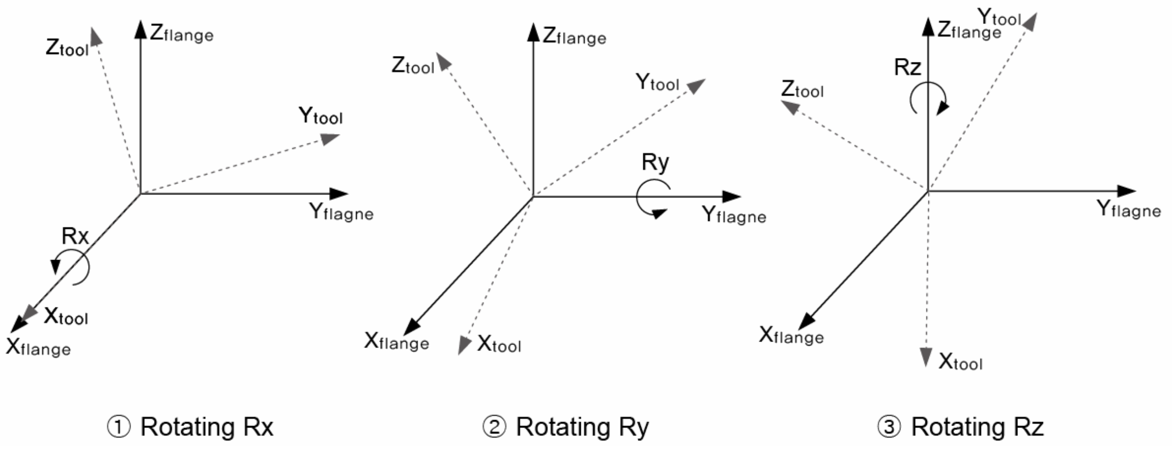


Figure 7.14 Tool angle

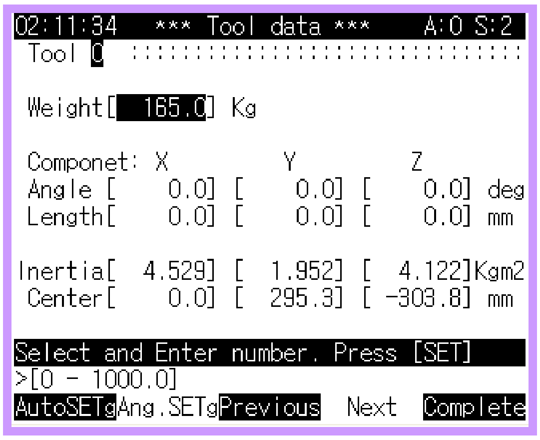
Therefore, the tool distance and angle is set based on the flange coordinate. Tool distance is the set between the center of the flange coordinate and TCP.

The tool position is the rotated values of X, Y and Z axis direction in reference to the tool flange coordinate according to the set tool angle.

Reference

Rxyz = Rot(z,Rz)Rot(y,Ry)Rot(x,Rx)
Rxyz is the tool position rotation matrix based on tool flange
Rot(z,RZ) is the rotation matrix that shifted by Rz to the Z axis direction of flange coordinate
Rot(y,Ry) is the rotation matrix that shifted by Ry to the Y axis direction of flange coordinate
Rot(x,Rx) is the rotation matrix that shifted by Rx to the X axis direction of flange coordinate.

(1) Select 『[PF2]: System』 → 『3: Machine parameter』 → 『1: Tool data』 from initial screen of manual mode.

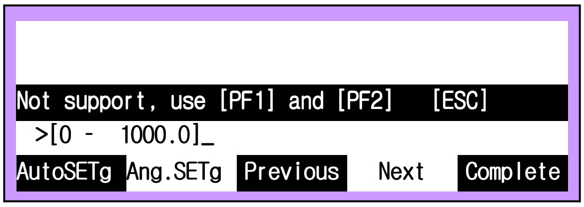


(2) Use the 『[PF3]: Previous』 and 『[PF4]: Next』 keys to select the tool number.

- Weight : Weight of tool
- Angle
  You can use the tool angle, automatic constant setting or 『[PF2]: Angle SETg』 function.
- Length
  You can use the tool distance, automatic constant setting or 『[PF1]: Automatic SETg』 function.
- Inertia : Tool inertia of tool coordinate
- Center
  You can use the center of gravity based on R1 axis center or the load estimate function.

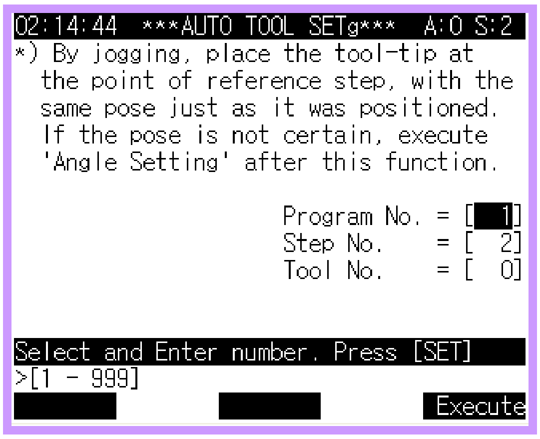
Reference

- If you move the cursor to angle or distance item, you will see the following screen. Use the 『[PF1]: AutoSETg』 or 『[PF2]: Ang.SETg』 keys. Please refer to the following detail for automatic calibration and angle calibration.



- Automatic calibration

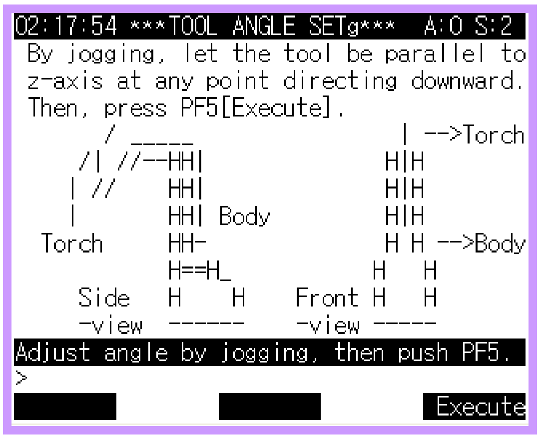
  ① If you locate new tool for setting to the step location where existing step was, and then the distance and the angle for the new tool is calculated. At this time, the position data of the step that is taught is recorded as the coordinate type and not the encoded type.



  - ■ Program No. : Enter the program number taught before the tool change.
  - ■ Step No. : Enter the step number to execute tool constant auto calibration.
  - ■ Tool No. : Enter the tool number to newly set.

  ② You can easily generate the tool data using the automatic constant calibration function. Also when the step location is recorded in coordinate type rather than encoded type, you can use the existing program by generating the tool data through automatic calibration function.

- Angle calibration
  ① This sets the tool angle and calibration.



- Locate the robot with the X, Y and Z direction of the tool for angle calibration to the X, Y and Z direction of the robot coordinate, and then press the 『[PF5]: Execute』 key. At this time, the direction the tool end is moving is set as the Y direction.

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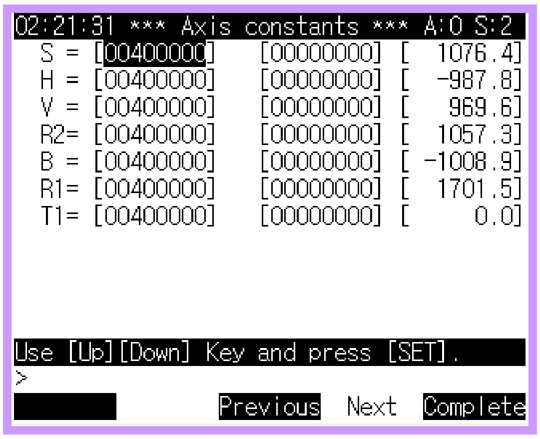
7.4.2. Axis constant

It registers the reference position of each axis. Because the axis contact setting affects the accuracy of the robot's perpendicular operation, it must be set to the correct value.

If you calibrate the 'Constant and tool' using automatic constant setting function for H, V, R2 and B axis, it is automatically set here.

When manufactured out of the factory, standard value is set. This is used when S axis constant is changed according to the installed situation of the robot and jig situation, or when R1 axis constant is changed.

(1) Select 『[PF2]: System』 → 『3: Machine parameter』 → 『2: Axis constant』 from initial screen of manual mode.



(2) Select the axis and using the [Axis operation] key, move the robot to the reference location. Press the [REC] key.

- S : Set in location where axis angle is 0° with left/right key
- H : Set in location where the angle between the H axis and the flat surface forms 90°
- V : Set in location where the angle between the V axis and the flat surface forms 0°
- R2 : Set R2 axis at 0° location
- B : Set B axis at 0° where R2 axis is 0°
- R1 : Set R1 axis at 0° where R2 and B axis is 0°

Reference

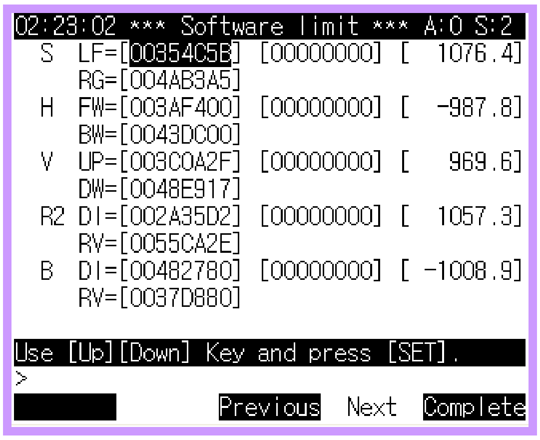
- Axis constant function must be done after the 『Encoder offset calibration』. When the encoder offset calibration location changes, the axis constant must be set again.

- The H, V, R2 and B axis constants can be automatically set with the automatic constant set function.

7.4.3. Soft limit

This limits the operating range of the robot in each axis. The factory default is set to maximum range. Make adjustments according to the installation environment.

(1) Select 『[PF2]: System』 → 『3: Machine parameter』 → 『3: Softlimit』 from initial screen of manual mode.



(2) Select the axis and decide the operating range using the [Axis control] key, and then press the [REC] key.

- S
  LF : Left soft limit of S axis
  RG : Right soft limit of S axis

- H
  FW : Front soft limit of H axis
  BW : Back soft limit of H axis

- V
  UP : Top soft limit of V axis
  DW : Bottom soft limit of V axis

- R2
  DI : Forward soft limit of R2 axis
  RV : Reverse soft limit of R2 axis

- B
  DI : Forward soft limit of B axis
  RV : Reverse soft limit of B axis

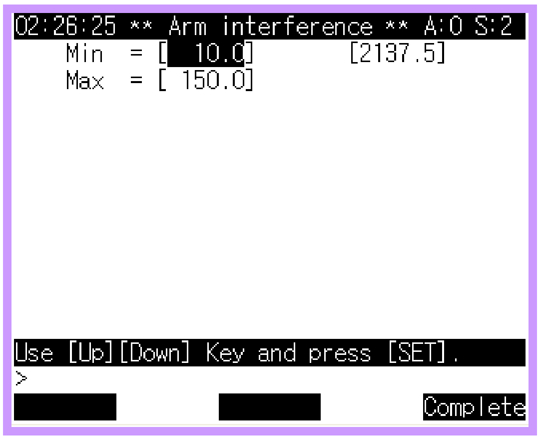
- R1
  DI : Forward soft limit of R1 axis
  RV : Reverse soft limit of R1 axis

It also sets up other additional axis.

7.4.4. Arm interference angle

This sets the working limit of the arm between H axis and V axis. For vertical multi-level arm, there is a limit in the movement of the angle formed by H and V axis. The factory default is set to maximum.

(1) Select 『[PF2]: System』 → 『3: Machine parameter』 → 『4: ARM interference angle』 from initial screen of manual mode.



(2) Select maximum or minimum arm interference angle using the [Axis control] key, and press the [REC] key.

- Min
  Enter the low limit of ARM interference angle (minimum angle between H and V axis).

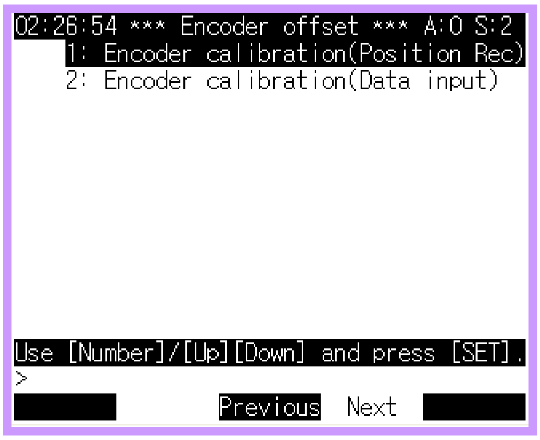
- Max
  Enter the high limit of ARM interference angle (maximum angle between H and V axis).

7.4.5. Setting encoder offset

This can set the current encoder location as the zero point (0X400000 location). It decides the zero point of the encoder from the reference location of each axis of the robot.

Because factory default is already set, only make changes in case of motor exchange, encoder exchange or other cases when needed.

(1) Select 『[PF2]: System』 → 『3: Machine parameter』 → 『5: Setting encoder offset』 from initial screen of manual mode.

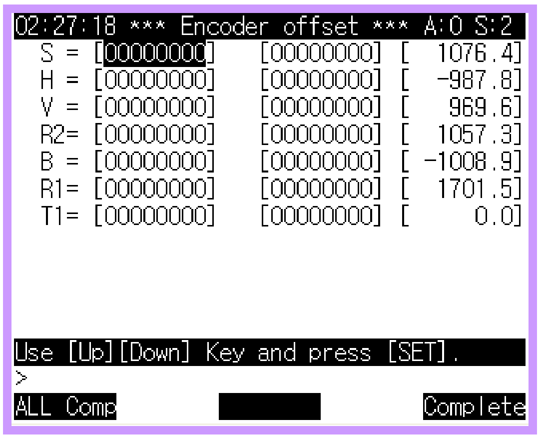


(2) Select the sub menu according to the method to set.

7.4.5.1. Encoder calibration (Position REC)

Set the offset value by operating each axis of the robot. The recorded encoder value is in hexa unit.

(1) Select 『[PF2]: System』 → 『3: Machine parameter』 → 『5: Setting encoder offset』 → 『1: Encoder calibration(position rec)』 from initial screen of manual mode.



(2) Select the axis and move the axis to the reference position, and press the [REC] key.

(3) Press the 『[PF5]: Complete』 key to save the data. Press the [ESC] key to cancel the change.

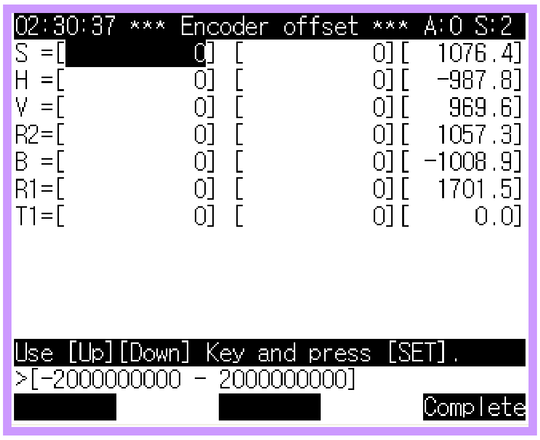
Reference

- ALL Comp
  When you position all the axes to the reference location using the [Axis control] and press the 『[PF1]: ALL Comp』 key, all axes will be calibrated for encoder offset.

7.4.5.2. Encoder calibration (data input)

You can directly enter the value to the encoder calibration. If you have to back-up the current work program and do 『[PF2]: System』 → 『5: Initialize』 → 『1: System format』, to use the existing program the robot has to move to the same position before initialization. In this case, please write the encoder offset value some where and enter the value. The recorded value is in decimals.

(1) Select 『[PF2]: System』 → 『3: Machine parameter』 → 『5: Setting encoder offset』 → 『2: Encoder calibration (data input)』 from initial screen of manual mode.

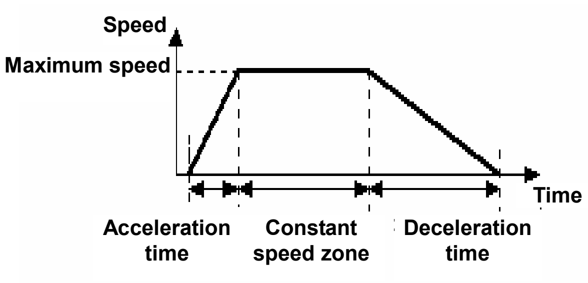


(2) Select the axis and enter the offset value. Press the [SET] key.

(3) Press the 『[PF5]: Complete』 key to save the data. Press the [ESC] key to cancel the change.

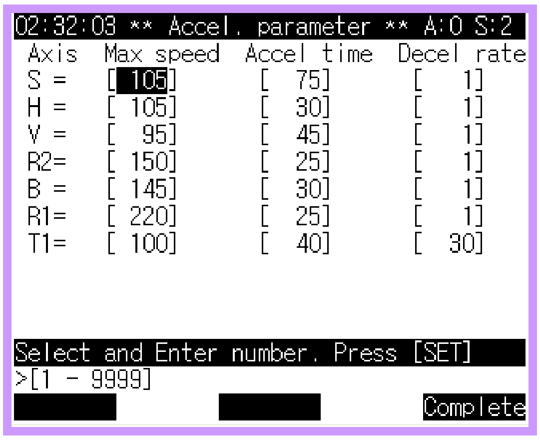
7.4.6. Accel & Decel parameter

This sets the acceleration and deceleration time. This also sets the maximum speed, acceleration and deceleration time. The factory default is set to optimum.



$$Deceleration\_time = Acceleration\_time + \frac{100}{100 - Deceleration\_rate}$$

(1) Select 『[PF2]: System』 → 『3: Machine parameter』 → 『6: Accel & Decel parameters』 from initial screen of manual mode.

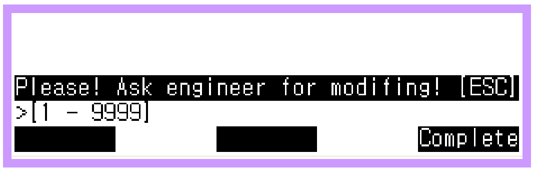


(2) Use the [Number] key to enter the maximum speed, acceleration time and deceleration rate. Press the [SET] key when done.

- Max speed : Enter the maximum speed of each axis (Unit deg/sec)
- Accel time : Enter the time of the acceleration zone. (Unit 10msec)
- Decel rate
  This is the rate of acceleration and deceleration time, and it decides the deceleration time.

Reference

- If there is an assisting axis, it is also displayed.
- Use the [Number] keys to enter the maximum speed, acceleration time and deceleration rate of each axis. Press the [SET] key when done and you will see the following screen.

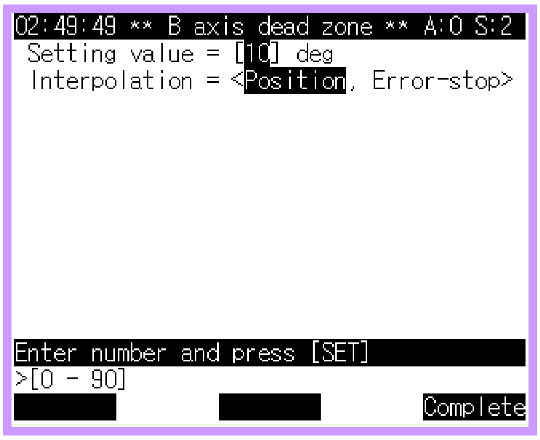


- Generally this cannot be changed but in case you have to, please consult your operator or contact our A/S representative.

7.4.7. B axis dead zone

This sets the dead zone of the B axis. At 0 degrees of B axis, the central rotating axis of R1 and R2 nearly parallel. But when the TCP of the robot has to make a movement such as straight line or arc movement, a small movement can cause an abrupt movement to the wrist axis.
Zone near 0 degrees of B axis is called the dead zone and you can set the how the controller operates near the dead zone.

(1) Select 『[PF2]: System』 → 『3: Machine parameter』 → 『7: B axis dead zone』 from initial screen of manual mode.



(2) When you see the dead zone value setting for B axis, decide and select the value you want to set when the controller enters the dead zone and when the calibration is ON.

(3) Press the 『[PF5]: Complete』 key to save the data. Press the [ESC] key to cancel the change.

- Setting value : Enter the angle for B axis dead zone.

- Interpolation
  ① Position
  This does not calibrate the position and maintains the location of the tool end.
  ② Error-stop
  When the path passes through the B axis dead zone, an error message is generated and the robot stops.

7.4.8. Accuracy

This sets the alignment degree to the target location.

You can register the range of accuracy level from 0 to 5. You can enter the accuracy value by setting the bit or by setting the distance.

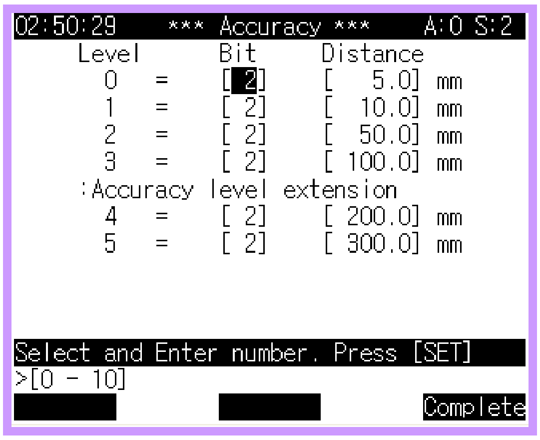
If the moving step and next step is set to calibration ON, the accuracy level of the recording point is automatically set by distance. Even though factory default is set to standard value, please reset according to the situation.

Table 7-2 Accuracy level entry

Type / Level	Bit entry (X = 0 ~ 9)	Distance entry (Factory default is standard)
Accuracy 0	128 × X + 128	5 mm
Accuracy 1	256 × X + 128	10 mm
Accuracy 2	640 × X + 128	50 mm
Accuracy 3	3200 × X + 128	100 mm
Accuracy 4	6400 × X + 128	200 mm
Accuracy 5	9600 × X + 128	300 mm

※ When X=10, the accuracy check is not done.

(1) Select 『[PF2]: System』 → 『3: Machine parameter』 → 『8: Accuracy』 from initial screen of manual mode.



(2) Enter the bit and distance data for each level and press the [SET] key.

(3) Press the 『[PF5]: Complete』 key to save the data. Press the [ESC] key to cancel the change.

Reference

- In case of GUN step, ignore the actual accuracy and set the bit to 196 bit when calibration is Off and limit the distance to less than 1.0mm when calibration is ON.

- Discontinuous step / Continuous step

  ① Discontinuous step:
  This means the step the robot is stopping at the target step. Stopping point is the point where accuracy level (bit, distance) is reached.

  ② Continuous step:
  This means the step without the stopping point. There are cornering enabled step and cornering disabled step.

- Cornering enabled step

  ① There are P (Interpolation OFF), L (Straight line interpolation) and C (Arc interpolation) in the interpolation type which supports the Hi4a controller. The continuous system which supports the cornering in these types are L-L, L-P, P-L, C-P, P-C, P-P.

  ② Only, the step which the coordinate system changes (for example, such case as it shifts for the direction of the positioner motive interpolation step from the robot tool interpolation) is excluded in the cornering step. Please refer to the following table for details.

Table 7-3 Cornering enabled

Interpolation method for current step	Interpolation method for next step	Cornering
MOVE L	MOVE L	○
MOVE L	MOVE P	○
MOVE C	MOVE P	○
MOVE P	MOVE P	○
MOVE P	MOVE L	○
MOVE P	MOVE C	○
Stationary tool line interpolation	**Stationary tool line interpolation**	○
SMOV L	SMOV L	○
SMOV L	MOVE P	○
SMOV C	MOVE P	○
MOVE P	SMOV L	○
MOVE P	SMOV C	○
Other continuous step		×

- L-L cornering path
  The L-L cornering is a method that plans the path with an arc between two paths of continuous straight line. It corners describing the path circular arc that circumscribes on the circle of accuracy range from two straight lines and a point which is applicable to Step1 in the following Figure. When replaying in the automatic mode, the path should be checked in advance due to shifting without reaching to designated step.

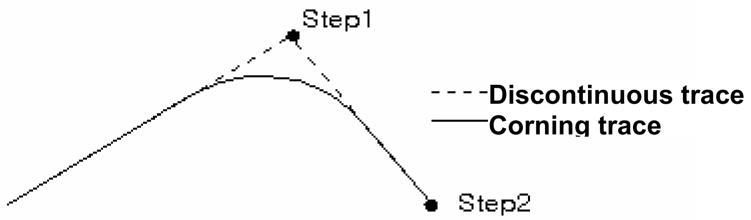


Figure 7.15 L-L cornering path

- P-L, P-C cornering path
  If the P-L (or P-C) cornering enters in the accuracy range from the P step (Previous step), it plans to shift to the next step.

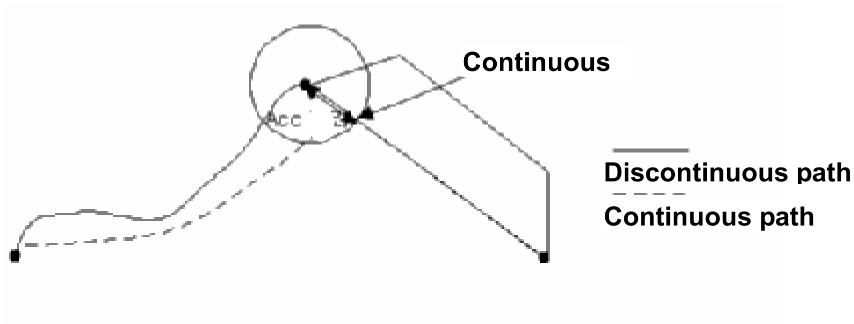


Figure 7.16 P-L, P-C cornering path

- L-P, C-P cornering path
  If the L-P (or C-P) cornering enters in the accuracy range from the L step (Previous step), it plans to shift to the next step.

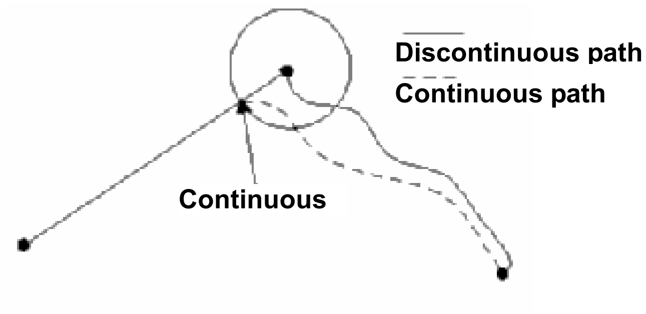


Figure 7.17 L-P, C-P cornering path

7.4.9. Speed

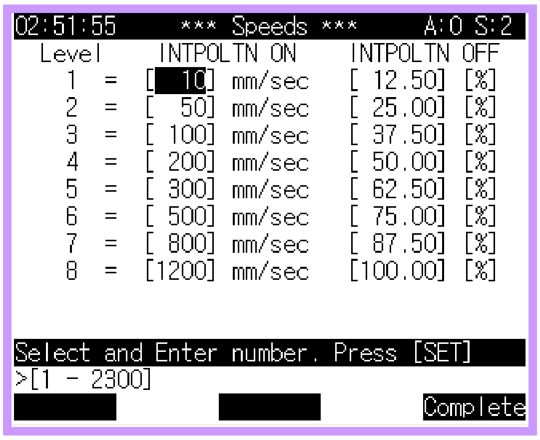
This decides the record speed in making a program. It is a value that is recorded at the same time when you record the step. If it is necessary, please set it again according to the use of robot.

There are from level 1 to 8 in manual speed to be recorded. in the playback speed to be recorded. It is recorded to the speed already decided according to the level as shown in the following table.

Table 7-4 Recording speed for program

Classification / Level	Interpolation ON (Interpolation operation)	Interpolation OFF (Step operation)
1	10 mm/sec	12.50 %
2	50 mm/sec	25.00 %
3	100 mm/sec	37.50 %
4	200 mm/sec	50.00 %
5	300 mm/sec	62.50 %
6	500 mm/sec	75.00 %
7	800 mm/sec	87.50 %
8	1200 mm/sec	100.00 %

(1) Select 『[PF2]: System』 → 『3: Machine parameter』 → 『9: Speed』 from initial screen of manual mode.



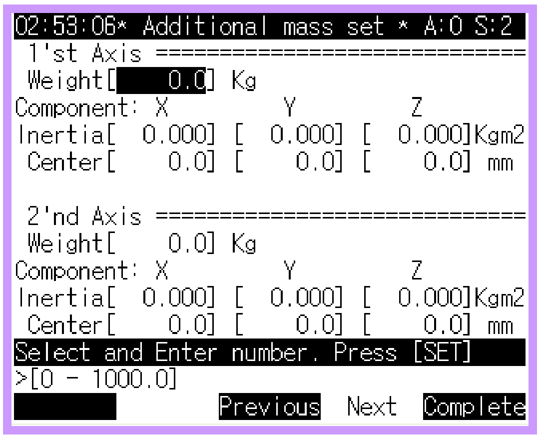
(2) Enter the speed data for each level when the interpolation is ON and when it is OFF. Press the [SET] key when done.

(3) Press the 『[PF5]: Complete』 key to save the data. Press the [ESC] key to cancel the change.

7.4.10. Additional weight on each axis

It registers the information of transformer or the supporting structure for wiring which is equipped on the basic axis of robot.

(1) Select 『[PF2]: System』 → 『3: Machine parameter』 → 『11: Additional weight on each axis』 from initial screen of manual mode.



(2) Enter the load information for each axis and press the [SET] key.

(3) Press the 『[PF5]: Complete』 key to save the data. Press the [ESC] key to cancel the change.

Reference

- For the zero point of each axis coordinate, please refer to Figure 7.16. The direction of each X, Y and Z axis is same as the one set in robot coordinate.

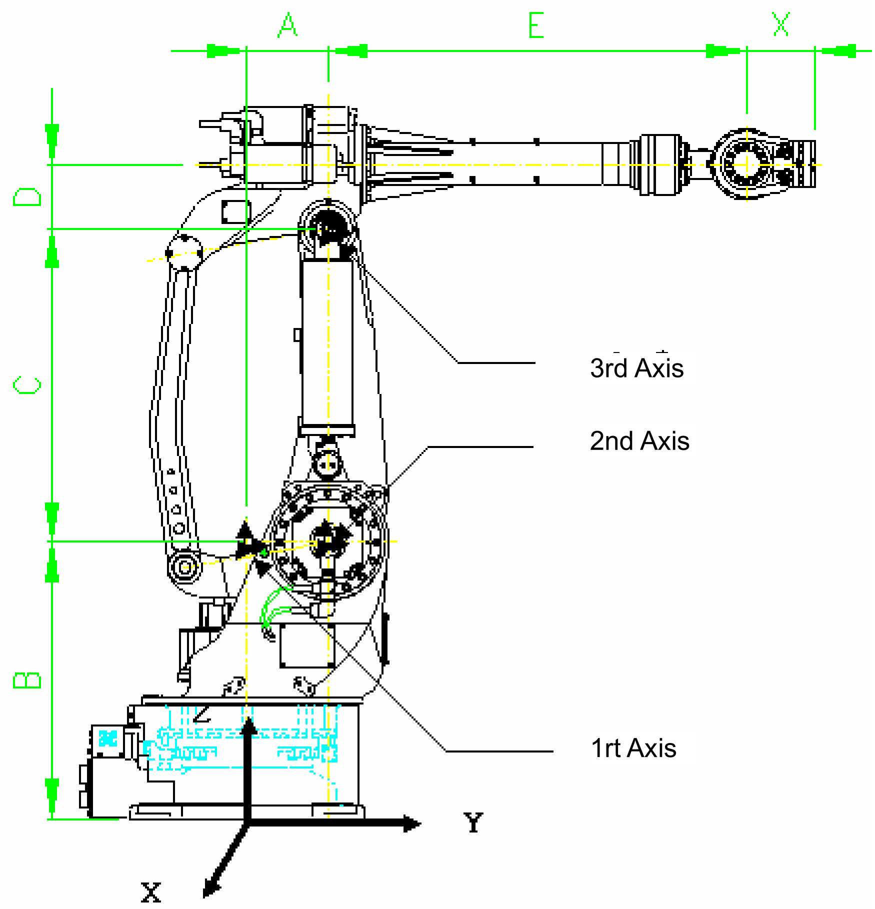


Figure 7.18 Zero point of each axis coordinate

7.4.11. Collision detection setting

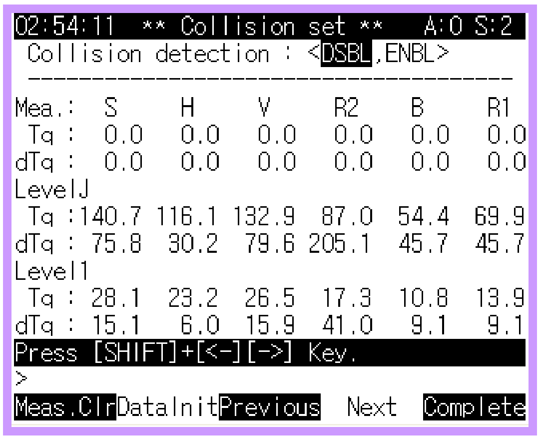
Collision detection function is to minimize the damage from collision during robot operation. It compares the currently generated torque with the normal torque of the robot and when an abnormal torque is generated from the robot, it sends out an error message.

This plays the role as a safety device from abnormal operation or malfunctioning in Hi4a controller. Collision detection function mutually complements the existing over-current, over-load, over-speed, location deviation error detection function to improve the safety of the robot.

The collision detection function monitors the disturbance torque generated from each axis and the disturbance torque rate, and sends an error when the measured value exceeds the set value.

- 『E0160 (○ axis) collision detection』 when the disturbance torque exceeds the set value.
- 『E0161 (○ axis) shock detect』 when the disturbance torque rate the set value.

(1) Select 『[PF2]: System』 → 『3: Machine parameter』 → 『13: Collision detection setting』 from initial screen of manual mode.



(2) Enter whether to use the collision detection function, the disturbance torque by level for each axis and the disturbance torque rate. Press the [SET] key when done.

(3) Press the 『[PF5]: Complete』 key to save the data. Press the [ESC] key to cancel the change.

- Collision detection
  Select whether to use the collision detection function. But the collision detection function only applies to the robot body. So you cannot enable this function to the robot that does not have this function.
  You might have to adjust the detection level according to the installation location or environment, and for the step that requires high sensitivity for collision detection, you will have to adjust it very accurately. Even with the collision detection function enabled, it will not operate during GUN pressure.

- Mea.
  It shows the disturbance torque Tq and the disturbance torque rate dTq from when the power of the controller is on. The user can use this value to set the level of disturbance torque and the disturbance torque rate. If you use the 『PF1: Re-measurement』 key, you can re-measure the maximum value of the disturbance torque and the disturbance torque rate of each axis.

- LevelJ
  This is the error detection level applied to the manual mode. This level is applied to teaching process or program step forward/reverse in manual mode.

- Level1 ~ Level4
  This is the error detection level applied to the automatic mode. Level 4 is applied when collision detection function is enabled. This detection level can be set by the user in the program with the following commands.

  ```
  Cmd.No=163
  COLDET level
  ```

  The level can be set between 0 and 4. For 0, it does not detect collision. Also the collision is not detected for axis with collision detection level of 0.0. Set level is valid until the next COLDET command is executed.

  For example, when the collision detection function is enabled and the work program is as follows.

  ```
  S1 MOVE
  S2 MOVE
  COLDET 1
  S3 MOVE
  COLDET 0
  S4 MOVE
  S5 MOVE
  S6 MOVE
  END
  ```

  Step S1 and S2 are detected in level 4 and S3 with level 1. S4, S5 and S6 do not detect collision.

Reference

- Tq shows the disturbance torque.
- dTq shows the disturbance torque rate.
- Re-measurement
  This function initializes and re-measures the maximum of the disturbance torque and the disturbance torque rate.
- Initialization
  This function initializes the disturbance torque and the disturbance torque rate entered by the user according to the collision detection level. If you press the『[PF2]: DataInit』 key, you will see the following message. Enter the number of the collision detection level to initialize, and then press [SET] key.

```
 Tq : 28.1   23.2  26.5  17.3  10.8  13.9
dTq : 15.1    6.0  15.9  41.0   9.1   9.1
Initialize=>Jog:0,Level:1-4,All:5(0 - 5)
>[0 - 5]
Meas.ClrDataInitPrevious  Next  Complete
```

- Disturbance torque monitor
  You can monitor the measured disturbance torque value during robot operation. You can monitor the disturbance torque and the disturbance torque rate from 『[PF1]: Service』 → 『1: Monitoring』 → 『11: System characteristic data 』.

  Also because you can re-measure the maximum value using the R300 code, it can be used setting the collision detection level for each term of the program.

7.4.12. Soft floating

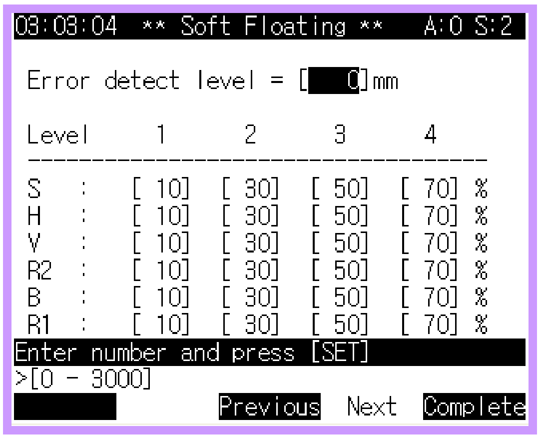
When using a robot during the work process, slight errors can happen during loading and unloading the work object.

And when maximum torque is applied by the robot, the twisting effect can cause overload error or cause damage to the work object.

To deal with this process, the function of sliding in and out the work object with only appropriate force is called the soft floating function.

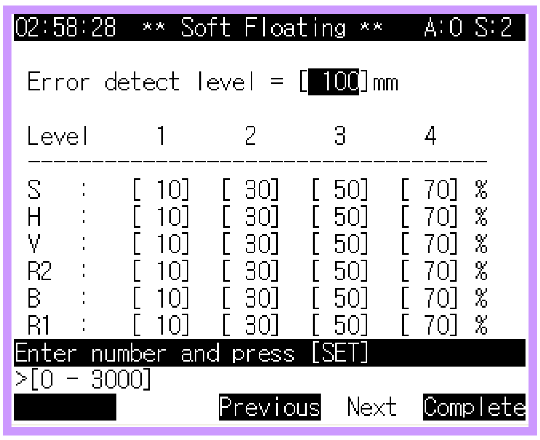
7.4.12.1. Soft floating level setting

(1) Select 『[PF2]: System』 → 『3: Machine parameter』 → 『14: Soft Floating』.



(2) Soft floating sets the flexibility of each axis according to the condition number.
There are 4 levels from 1 to 4 in soft floating. Level 0 is to set the soft floating function off.

(3) Soft floating data designates the flexibility of each axis.
When the flexibility is set to 0, it means for that axis the soft floating function is not applied. From 1 to 100, the flexibility increases as it increases. When using this function, it is recommended that all axes are set because the power is transferred to all axes.



(4) Error detection distance is to process the error when the tool end exceeds the set distance from the command value. When the error detection distance is set to 0, the function is disabled.
Error detection is not done for milling in additional axis.

7.4.12.2. Soft floating command

The soft floating function can be programmed with On/Off.

Cmd.No=164
SOFT=Level

Soft floating function is off when level is set to 0.

Level from 1 to 4 indicates the level of flexibility of each axis.

Soft floating function starts in the zone where the level is set from 1 to 4, and ends where the step is level , where the program ends or where step is 0.
Cornering does not apply to the step with soft floating command and is set as complete stop step.

7.4.12.3. Soft floating command zone

Soft floating is enabled from the next step the soft floating level is designated, and also the change in level is applied from the next step.

For example, if the work program is as follow,

```
S1 MOVE
S2 MOVE
SOFT 1
S3 MOVE
S4 MOVE
SOFT 2
S5 MOVE
S6 MOVE
SOFT 0
S7 MOVE
END
```

Step S1 and S2 runs normal operation. S3 and S4 do soft floating level 1. S5 and S6 do soft floating level 2.
Soft floating function ends when it meets SOFT 0 command or step 0.

7.4.12.4. Soft floating function off

Soft floating function is disabled for program step 0, power save function, enable switch disabled in teach mode, motor off and power off.
Therefore soft floating only applies to normal operation, step forward/reverse or in manual operation.

7.4.12.5. Soft floating level setting in manual mode

- R355 : Command for manual soft floating level setting.
- When the motor is turned off during and error with SOFT on, you will need the soft floating function to recover the motor power to on. This is why soft floating level setting function exists in manual mode.

7.4.12.6. Precaution for using

(1) Setting error detection distance
If the error detection distance is too short, an error can occur even during normal operations. In this case increase the detection distance.

(2) Enable switch Off during manual mode
If you turn the Enable switch to off and then back to on with SOFT floating on, SOFT will change to off. You must set the SOFT back to on with R355 command.

(3) Precaution for power save function
If you enable power save function in automatic mode with SOFT on, SOFT function will be disabled to off. Therefore be careful not to use the power save function during SOFT on zone.

(4) Precaution for using step back
Because the function starts operating at the SOFT command, you must be careful in using the step back function. Maintain the existing SOFT condition and do not execute a new SOFT function for step back.
In example program 7.4.12.3., if you continuously do step back after executing up to S7 with step go, all zone will be SOFT off. If you step back in S5 or S6, SOFT 2 condition is maintained.

(5) SOFT command step
Because the gain changes in the step with SOFT command, vibration can occur if you do not set the accuracy low. Use Acc0 for SOFT command step.

7.4.13. Reduce Holding Curr.

This function reduces the gravity load of robot motor in the static position.

(1) Select 『[PF2]: System』 → 『3: Machine parameter』 → 『16: Set reduce holding Current』

```
03:05:42* Reduce Holding Curr. *A:0 S:2
 Reduce holding curr. use = <DSBL,ENBL>
 Reduce starting time     = [ 10]sec
 ======================================
        Encoder           Radian Value
 S  = [    0]bit    ->      0.000 deg
 H  = [    0]bit    ->      0.000 deg
 V  = [   10]bit    ->      0.002 deg
 R2 = [   10]bit    ->      0.003 deg
 B  = [   10]bit    ->      0.002 deg
 R1 = [   10]bit    ->      0.004 deg

Press [SHIFT]+[<-][->] Key.
>
DataInit                        Complete
```

- Reduce holding curr. Use : Function is activated when [ENBL].

- Reduce starting time
  When the robot is in standby and operation time exceeds the current reduction time, the current reduction function is enabled. If you set this time too short, it can operate frequently even during robot operations to increase the cycle time.

- Encoder
  Operation per axis when the current reduction function is in effect. Angle converted value is automatically calculated to the set encoder value. If the angle converted value is high, the operating distance of the tool end increases. Set the encoder value appropriately.

7.4.14. Jog inching function

This designates the movement for job operation in manual mode. This limits the movement within the set range. This is efficient in controlling the jog movement for a desired distance.

Table 7-5 Job inching function specification

Major function	Remarks
Inching enabled coordinate	Joint, Perpendicular, Tool, User
Inching distance speed level	8

- Inching support for joint coordinate
  If you select the axis coordinate, you can control the operating degree within the set degree for each axis.

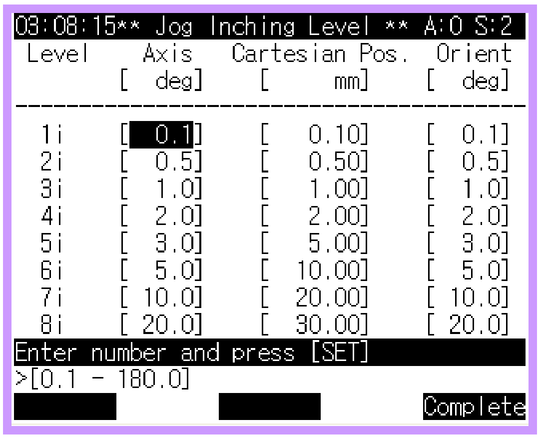
- Inching support for Cartesian coordinate
  If you select the Cartesian coordinate, you can control the distance by designating the X, Y and Z location (mm) and Rx, Ry and Rz position (degree) of the Cartesian coordinate.

- Inching support for tool coordinate
  If you select the tool coordinate, you can control the distance by designating the X, Y and Z location (mm) and Rx, Ry and Rz position (degree) of the tool coordinate.

- Inching support for user coordinate
  If you register the user coordinate and select the user coordinate number in the condition setting, you can control the distance by designating the X, Y and Z location (mm) and Rx, Ry and Rz position (degree) in Cartesian coordinate jog.

- Inching level
  If you set the same level of inching distance as the existing job speed in 8 levels. You can set the inching distance for each level.

(1) Select 『[PF2]: System』 → 『3: Machine parameter』 → 『17: Jog Inching level setting』. You can set the inching distance according to the jog speed level as shown below.



(2) You can set the inching distance of the speed level by setting the Axis, Cartesian Pos. and Orient.

- Axis is when the jog coordinate is 'Joint'.
- Cartesian Pos. is when the coordinate is Cartesian, tool or user.
- Orient is same as Cartesian Pos. but used for position change.

(3) Inching distance of additional axis

- Even though it is set using axis coordinate, if the additional axis is in mm units, apply the set value from Cartesian Pos. item (ex, main axis, servo gun axis, straight line jig axis)
- Even though it is set using the Cartesian axis, if the additional axis is in deg unit, apply the set value from Axis item (ex, rotating jig axis)

■ **Inching jog mode selection**

(1) You can switch back and forth from general jog mode to inching jog mode by pressing Shift+Rx key.

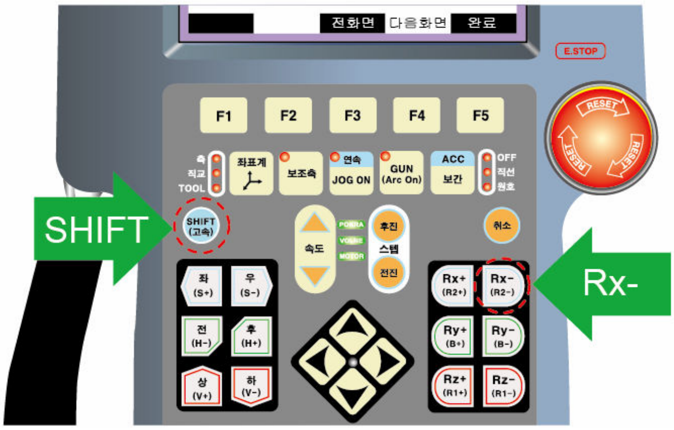


Figure 7.19 Switching between general jog and inching jog mode

(2) If you see a small 'I' next to the speed level as shown below, it is in inching jog status. To switch to the general job mode, press the Shift+ Rx key.

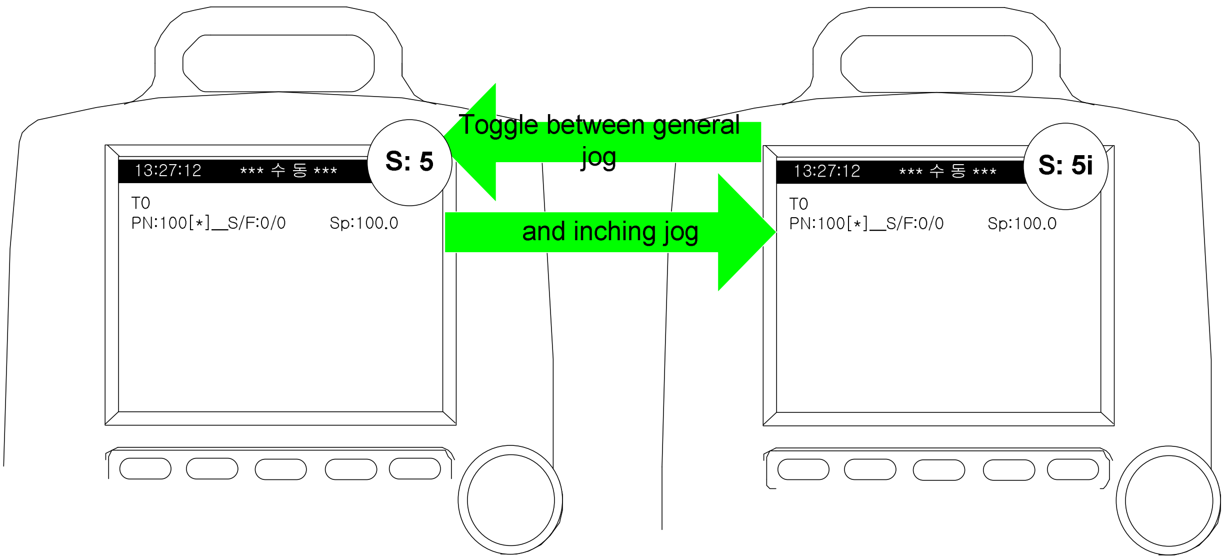
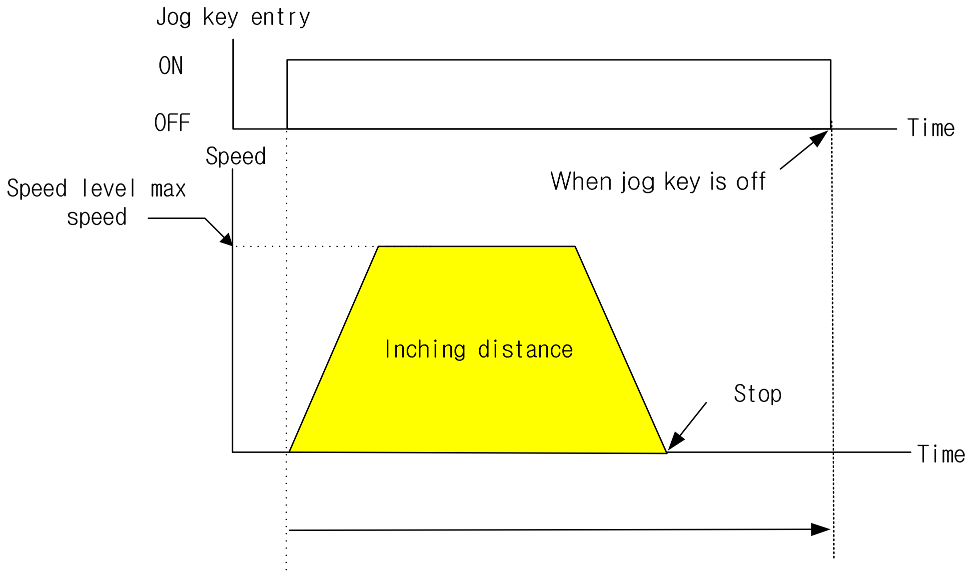


Figure 7.20 Toggle switching between general jog and inching jog

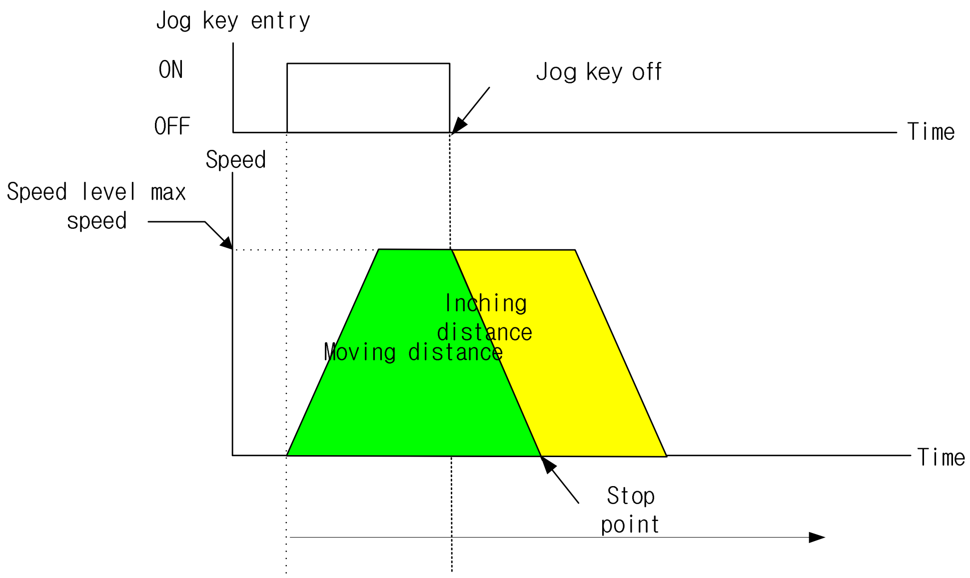
■ Inching jog operation

This is when you have selected jog inching mode. Check if there is an 'I' next to the jog speed level.

(1) If you press the key for longer than to reach the inching distance, even with the jog key, the speed decelerates to the inching distance and stops as shown below.



(2) If you release the key before reaching the inching distance, it decelerates from the release point and stops as shown below. This is same as general jog mode.



(3) Inching function limits the maximum distance per push as shown above.

- **Others**

① This jog inching function is available only in the main version after 10.07-15.

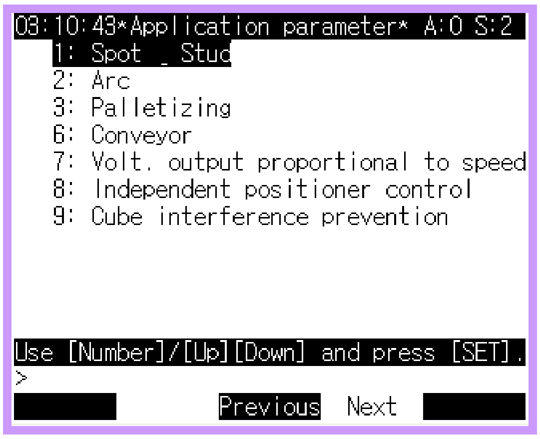
② When the speed level is 1 in axis coordinate, jog operation is by encode 1 bit. But when the speed level is 1i, it moves by the set distance (deg) in the inching level.

③ When the speed level is 1 in Cartesian coordinate, inching is done by 0.1mm.

7.5. Application parameter

Application parameter is used for applied function including spot & stud welding, arc welding, palletizing , conveyor movement etc.

(1) Select 『[PF2]: System』 → 『4: Application parameter』 from initial screen of manual mode.

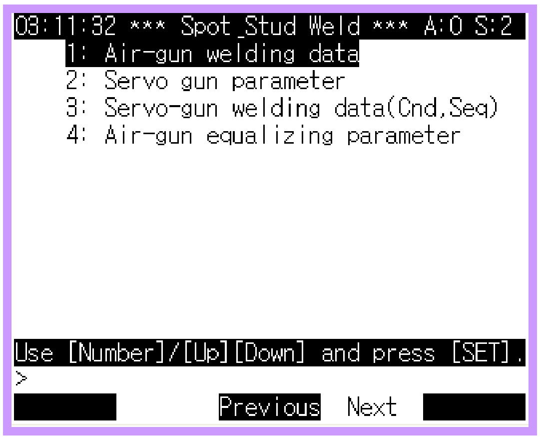


(2) Use the [Arrow] keys to move the cursor to the item to select and press the [SET] key. Or you can enter the number of the item to select and press the [SET] key to move to the sub menu.

7.5.1. Spot & stud

This sets various parameters for spot and stud welding.

(1) Select 『[PF2]: System』 → 『4: Application parameter』 → 『1: Spot & stud』 from initial screen of manual mode.



(2) Use the [Arrow] keys to move the cursor to the item to select and press the [SET] key. Or you can enter the number of the item to select and press the [SET] key to move to the sub menu.

Reference

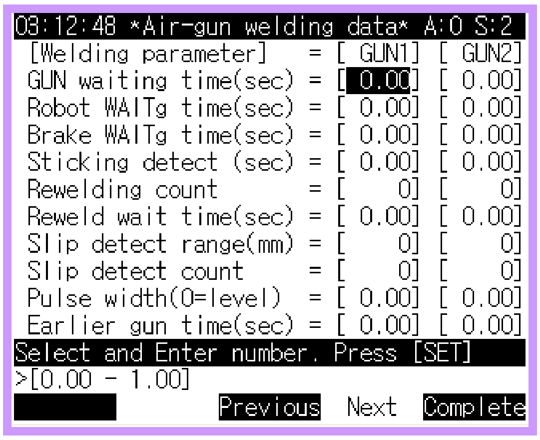
- Air pressure gun welding data is saved in control constant file (ROBOT.C00), servo gun parameter and air pressure gun equalizing parameter is saved in mechanical constant file (ROBOT.C01), and servo gun welding data (condition, sequence) is saved in spot welding condition file (ROBOT.WSD).

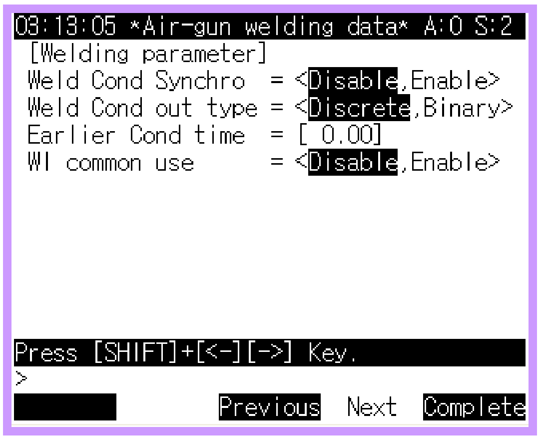
- You cannot change the control parameter file, machine parameter file and the spot welding condition file, if they are completely protected.

7.5.1.1. Air pressure gun welding data

This enables efficient welding by saving the necessary information for spot welding or stud welding using the air pressure gun welding data.

(1) Select 『[PF2]: System』 → 『4: Application parameter』 → 『1: Spot & stud』 → 『1: Air-gun welding data』 from initial screen of manual mode.





(2) When entering a number using the [Number] key, enter the number in the input frame and press the [SET] key. When selecting an item in the < > field, select by using the [SHIFT]+[←][→] key.

(3) Press 『[PF5]: Complete』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

- GUN waiting time (sec)
  This is the time standing by for the robot to completely stop before the gun signal is sent out.

- Robot WAITg time (sec)
  This is the time standing by for the gun to completely open after the gun signal output and welding completion signal entry. In other words, it is the standby time before the robot movement opening after gun pressure is applied.

- Brake WAITg time (sec)
  This is the time to prevent poor welding by adjusting the motor brake OFF/ON operation completion time. The motor brake is kept on hold (ON) because of the repulsive pressure from stud welding. Brake standby time is the time waiting for the motor brake to completely stop.

- Sticking detect (sec)
  This is the time for detecting whether the welding tip is attached to the welding after completion. This is an optional function.

- Rewelding count
  This decides how many times to output the gun signal when the welding completion signal is not entered within the set time in re-welding standby time after the gun signal has been sent out.

- Rewelding wait time (sec): This sets the standby time for re-welding.

- Slip detect range (mm)
  It detects the slip error of robot location from pressure in stud welding. It refers to the range to display the error.

- Slip detect count
  It counts the number of times of deviation error caused by pressure in stud welding and generates an error if the count exceeds the set value.

- Pulse width (0= level)
  This decides whether to output the gun signal in level or pulse. In case of level, set it as 0 and it goes off after entering the welding completion signal (WI). In case of pulse, set it with value bigger than 0 and the gun signal goes off automatically irrelevant of the welding completion signal (WI).

- Earlier GUN time (sec)
  Normally, the gun signal output is done after the robot moves within the accuracy range. But this enables it to be sent out earlier by setting the time. This is possible only in general run mode (auto mode).

- Weld Cond Synchro
  Generally, the welding condition signal and gun signal operates separately. But this is enabled to synchronize the gun signal and the welding condition signal output.

- Welding Cond out type
  This decides whether to output the welding condition signal in discrete type or binary type.
  ① Discrete : The number of welding condition can be from 0 to 7 (8 numbers).
  ② Binary : You can output 256 numbers of welding conditions from 0 to 255.

- Earlier Cond time
  Enter the time for the welding condition signal to be sent out earlier than the gun signal.

- WI common use
  Normally, the welding completion signal is set by GUN1 and GUN2 signal, but if you are using 2 or more air pressure guns, this decides the data whether to share the welding completion signal. The input signal allocated in WI (Welding completion) set in 『[PF5]: System』 → 『2: Controller parameter』 → 『1: Setting input & output signal』 → 『7: Input signal assigning』 becomes the WI signal for GUN1 and GUN2.

7.5.1.2. Servo gun parameter

This is to set the parameters for spot welding using the servo gun. The additional axis must be registered as a servo gun and the default value is set in the machine parameter file. If needed, please refer to the『Servo gun functional manual』 for details.

(1) Select 『[PF2]: System』 → 『4: Application parameter』 → 『1: Spot & stud』 → 『2: Servo gun parameter』 from initial screen of manual mode.

```
03:24:15* Servo Gun Parameter * A:0 S:2
     1: First(1) servo gun parameter
     2: Second(2) servo gun parameter
     3: Third(3) servo gun parameter
     4: Fourth(4) servo gun parameter
     5: Fifth(5) servo gun parameter
     6: Sixth(6) servo gun parameter
     7: Seventh(7) servo gun parameter
     8: Eighth(8) servo gun parameter
     9: Gun No. vs. Tool No.
    15: Auto tunning for SVG's squeeze

Use [Number]/[Up][Down] and press [SET].
>
                Previous  Next
```

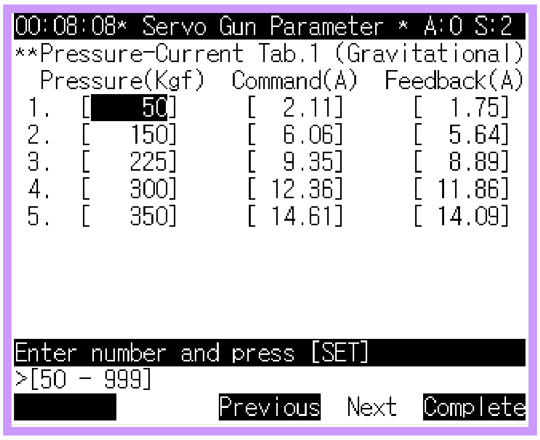
(2) Use the [Arrow] keys to move the cursor to the item to select and press the [SET] key. Or you can enter the number of the item to select and press the [SET] key to move to the sub menu.

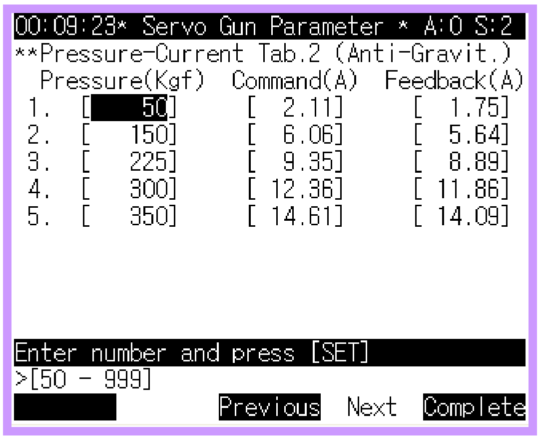
(3) When using multi-guns, you must set the parameter for 1st servo gun parameter and 2nd servo gun parameter.

```
00:06:42* Servo Gun Parameter * A:0 S:2
 Large stroke (mm)            = [    90]
 Small stroke (mm)            = [    20]
 Move tip clearance (mm)      = [  10.0]
 Fix tip clearance (mm)       = [   2.0]
 Max tip consumption (mm)     = [  10.0]
 Tip change consumption (mm)  = [   6.0]
 Gun arm bent offset (mm)     = [  0.00]
 Gun arm bent per 100Kgf (mm)= [  0.31]
 Fix tip bent rate (%)        = [   100]
 Pressure match rate (%)      = [     5]
 Pressure fault check time(s)= [   3.0]
Enter number and press [SET]
>[10 - 999]
                Previous  Next  Complete
```

```
00:07:10* Servo Gun Parameter * A:0 S:2
 Max move tip consumption(mm)= [   0.0]
 Max fix tip consumption (mm)= [   0.0]
 Move tip change consumption = [   0.0]
 Fix tip change consumption  = [   0.0]
 Press speed (mm/sec)        = [   120]
 Command offset (mm)         = [   5.0]
 Gun  = <Robot,Stationary> Coord.=[   0]
 Move tip consumption rate(%)= [     0]
 Maximum allowed thickness(mm)=[   5.0]

Enter number and press [SET]
>[0.0 - 20.0]
                Previous  Next  Complete
```





(4) When entering a number using the [Number] key, enter the number in the input frame and press the [SET] key. When selecting an item in the < > field, select by using the [SHIFT]+[←][→] key.

(5) Press 『[PF5]: Complete』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

- Large stroke (mm)
  For manual opening operation ([SHIFT]+[f?]), the maximum distance for move tip and fix tip is set.

- Small stroke (mm)
  For manual opening operation ([SHIFT]+[f?]), the maximum distance for move tip and fix tip is set. Also set the maximum distance of the move tip and fix tip for manual gun pressure operation. (Enable+f).

- Move tip clearance (mm), Fix tip clearance (mm)
  This sets the starting location for applying pressure for spot welding function.

- Fix tip clearance (mm)

- Max tip consumption (mm)
  Decide the search range when using the gun search function. The search range is twice the maximum tip consumption.

- Tip change consumption (mm)
  It notifies to exchange the tip when the consumption detected from gun search exceeds the tip change consumption. If set to 0mm, it does not check the consumption.

- Gun arm bent offset (mm)
  To generate pressure power, the fix tip bends slightly. This bend to generate pressure is called the gun arm bent offset. For spot welding function, pressure must be applied adjusting the offset set from the fix tip location.

- Gun arm bent per 100Kgf (mm)
  Set the gun arm bend from applying pressure for 100Kgf. For spot welding function, pressure must be applied adjusting this set value and the gun arm bend from the target pressure this value from the fix tip location. The move tip bend is not adjusted.

- Fix tip bent rate (%)
  When both the static and move tips are bent during pressure application, this is set with the ratio of fix tip bend to total bend.

- Pressure match rate (%)
  This compares the applied pressure to the target pressure and detects alignment when the applied pressure reaches the target pressure. If this is set as 0, it will not detect the pressure alignment.

- Pressure fault check time (sec)
  This sets the time between the start to point of pressure alignment. If the pressure is aligned within this time, it outputs a pressure alignment signal. If not, it sends out an error signal and stops the robot. If set to 0.0, it will not detect pressure alignment and will send out power signal.

- Max move tip consumption (mm)
  If the dynamic consumption detected with gun search exceeds this value, an error message is sent out and the robot stops. If set to 0.0mm, it will not detect the error.

- Max fix tip consumption (mm)
  If the static consumption detected with gun search exceeds this value, an error message is sent out and the robot stops. If set to 0.0mm, it will not detect the error.

- Move tip change consumption (mm)
  If the move tip consumption detected with gun search exceeds this value, a warning message is sent out and notifies the tip exchange. If set to 0.0mm, it will not detect the error.

- Fix tip change consumption (mm)
  If the fix tip consumption detected with gun search exceeds this value, a warning message is sent out and notifies the tip exchange. If set to 0.0mm, it will not detect the error.

- Press speed (mm/sec)
  It decides the speed of the fix and move tip for manual gun pressure ([SHIFT]+[f?]), gun search pressure and spot welding function.

- Command offset (mm)
  To generate pressure for spot welding function, the move tip is offset by the command offset in the direction from the recording location to the pressure direction.

- Gun = <Robot, stationary> Coord.=[0]
  When using the stationary servo gun, the stationary gun coordinate is set as the user coordinate. If not a stationary gun, change the setting to robot gun. When using the stationary gun, set the fix tip direction to Z direction of user coordinate, and set the user coordinate number to the coordinate number. When the coordinate number is set to 『0』 it becomes the robot coordinate.

- Move tip consumption rate (%)
  This sets the ratio of move tip consumption rate.

- Maxiumum allowed thickness (mm)

■ Pressure-current Tab.1 (Gravitational), pressure-current table 2 (Anti-Gravit.)
This is used for adjusting the pressure that exceeds the permitted range for the set pressure and actual pressure. You can set any 5 pressure values for the current using the pressure-current table. Also the high and low values entered in this function become the pressure limit.

Reference

- If the set value is incorrect, the value is not saved when you press the『PF5: Complete』key.
  ① Large stroke must be set within the soft limit range.
  ② Small stroke must be set lower than the large stroke.
  ③ The move tip clearance must be set lower than the small stroke.

- When registering a stationary gun for multi-gun, the motor must be turned off and when the robot gun is set together, you cannot turn on the motor. Therefore, you must select the robot gun or set all to stationary guns.

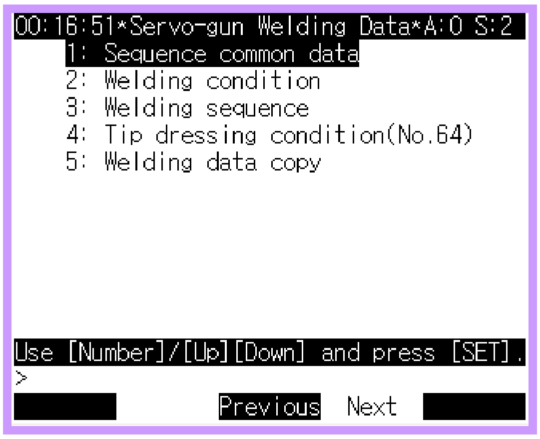
- Stationary gun coordinate number is only valid for stationary gun type.

- You must measure and set the pressure because the pressure-current table can be different according to the move tip direction; gravity or anti-gravity direction.

7.5.1.3. Servo gun welding data (Condition, sequence)

This displays and changes the welding condition and sequence for servo gun application. The servo gun welding condition and welding sequence saved in the spot welding file (ROBOT.WSD) is the data use for spot welding function.

(1) Select 『[PF2]: System』 → 『4: Application parameter』 → 『1: Spot & stud』 → 『3: Servo-gun welding data (Cnd, Seq)』 from initial screen of manual mode.

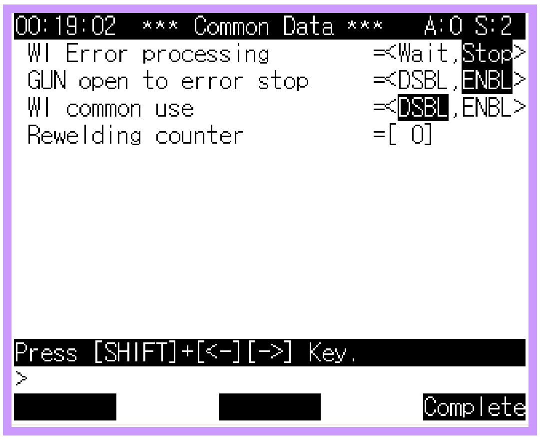


(2) Use the [Arrow] keys to move the cursor to the item to select and press the [SET] key. Or you can enter the number of the item to select and press the [SET] key to move to the sub menu.

7.5.1.3.1. Sequence common data

This is the common data applied to all irrelevant from the welding condition and sequence number.

(1) Select 『[PF2]: System』 → 『4: Application parameter』 → 『1: Spot & stud』 → 『3: Servo-gun welding data (Cnd, Seq)』 → 『1: Sequence common data』 from initial screen of manual mode.



(2) When entering a number using the [Number] key, enter the number in the input frame and press the [SET] key. When selecting an item in the < > field, select by using the [SHIFT]+[←][→] key.

(3) Press 『[PF5]: Complete』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

- WI Error processing
  You can select whether to send out an error message and stop the robot when the welding completion signal is not entered until it is entered.

- Gun open to error stop
  It opens and stops the servo gun when there is an error or when it stops during a welding process. This item is fixed to <ENBL>.

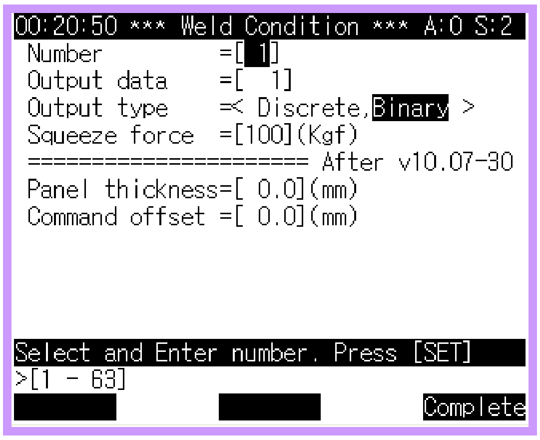
- WI common use
  When using 2 or more servo guns, you can select whether to share the welding completion signal or to use it separately.

- Rewelding counter
  This sets the number of times to output the GUN signal when the welding completion signal is not entered.

7.5.1.3.2. Welding condition

This is the data that decides the spot welding condition and servo gun pressure etc.

(1) Select 『[PF2]: System』 → 『4: Application parameter』 → 『1: Spot & stud』 → 『3: Servo-gun welding data (Cnd, Seq)』 → 『2: Welding condition』 from initial screen of manual mode.



(2) When entering a number using the [Number] key, enter the number in the input frame and press the [SET] key. When selecting an item in the < > field, select by using the [SHIFT]+[←][→] key.

(3) Press 『[PF5]: Complete』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

- Number
  This is the welding number designated in spot welding function and has 63 numbers.

- Output data : Enter the welding condition signal to output to welder controller.

- Output type
  This is the data that designates the output signal type of the welding condition. This is fixed to <Binary>.

- Squeeze force : Enter the applied pressure of the servo gun.

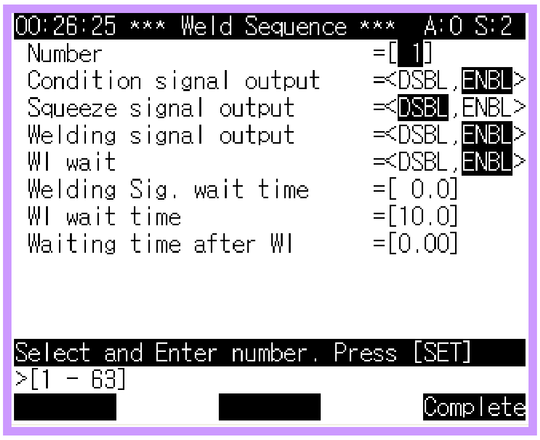
- Panel thickness

- Command offset

7.5.1.3.3. Welding sequence

This data decides the welding sequence of the controller during spot welding function.

(1) Select 『[PF2]: System』 → 『4: Application parameter』 → 『1: Spot & stud』 → 『3: Servo-gun welding data (Cnd, Seq)』 → 『3: Welding sequence』 from initial screen of manual mode.



(2) When entering a number using the [Number] key, enter the number in the input frame and press the [SET] key. When selecting an item in the < > field, select by using the [SHIFT]+[<-][->] key.

(3) Press 『[PF5]: Complete』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

- Number
  This is the welding sequence number designated in spot welding function and has 63 numbers.

- Condition signal output
  This decides whether to output the welding condition signal. It is fixed to <ENBL>.

- Squeeze signal output
  This decides whether to output the pressure signal. It is fixed to <DSBL>. (This is not used in the current specification)

- Welding signal output
  This decides whether to output the welding signal. It is fixed to <ENBL>.

- WI wait
  This decides whether to standby for welding completion after sending out the welding signal. It is fixed to <ENBL>.

- Welding Sig. wait time
  This decides the standby time for welding completion signal after sending out the welding signal. 0.0 means infinite standby.

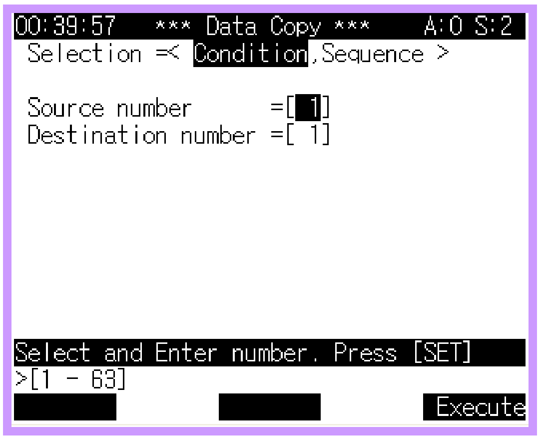
- WI wait time
  This designates the standby time for welding completion signal entry.

- Waiting time after WI
  This designates the standby time from welding completion to gun open. But when the gun open time is very short, welding completion standby is also completed.

7.5.1.3.4. Data copy

This function copies the welding condition number and welding sequence number to another number.

(1) Select 『[PF2]: System』 → 『4: Application parameter』 → 『1: Spot & stud』 → 『3: Servo-gun welding data (Cnd, Seq)』 → 『5: Welding Data copy』 from initial screen of manual mode.



(2) When entering a number using the [Number] key, enter the number in the input frame and press the [SET] key. When selecting an item in the < > field, select by using the [SHIFT]+[←][→].

(3) To copy the welding condition or sequence number to another number, press the 『[PF5]: Execute』 key. Press the [ESC] key to cancel the copy.

- Selection
  This decides whether the data to copy is welding condition or welding sequence number.
- Source number : This designates the data number to copy. (1 - 63)
- Destination number : This designates the data number to be copied. (1 - 63)

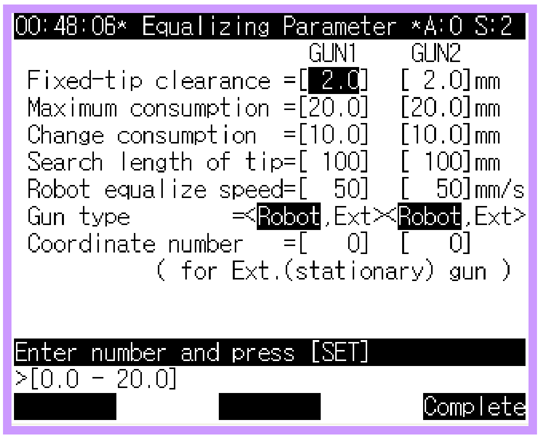
Reference

- Servo gun welding data can only be used in servo gun environment.
- You can change the data even during an operation.
- You cannot output the welding condition signal earlier in the servo gun.
- Welding tip error in servo gun can only be detected through an external signal.

7.5.1.4. Equalizing parameter

This sets up spot welding using the equalizerless air pressure gun. The air pressure GUN1 or GUN2 must be set to <Equalizerless> in 『[PF2]: System』 → 『5: Initialize』 → 『4: Setting usage of the robot』. When creating the machine parameter file, it is all set as default. So make changes to welding method etc. as needed. For more details, please refer to the 『Robot equalizer function manual』.

(1) Select 『[PF2]: System』 → 『4: Application parameter』 → 『1: Spot & stud』 → 『4: Air-gun equalizing parameter』 from initial screen of manual mode.



(2) When entering a number using the [Number] key, enter the number in the input frame and press the [SET] key. When selecting an item in the < > field, select by using the [SHIFT]+[←][→] key.

(3) To saving the set data, press the 『[PF5]: Complete』 key. Press [ESC] to cancel the changes.

- Fixed-tip clearance
  It designates the pressure start location in the step of GUN pressure command.

- Maximum consumption
  If the fix tip consumption detected with gun search exceeds this value, an error message is sent out and the robot stops.

- Change consumption
  If the fix tip consumption detected with gun search exceeds this value, an error message is sent out, tip consumption alarm signal is sent out and notifies of tip exchange.

- Search length of tip
  This parameter is to decide the maximum range a robot can move to measure the fix tip consumption. The reference coordinate of this gun search operation is tool coordinate, and it measures the distance to move in Z direction and enters the target location. If the robot runs over the fix tip consumption search distance, the robot stops.

- Robot equalize speed
  This is the speed necessary for fix tip equalizing operation for the robot. The speed of the fix tip approaching test location changes according to the given speed. When the fix tip opens after the welding, the maximum speed of the robot is applied.

- Gun type
  When using the equalizerless stationary air pressure gun, the stationary gun coordinate is set as the user coordinate. If not a stationary gun, change the setting to robot gun. When using the stationary gun, set the fix tip direction to Z direction of user coordinate, and set the user coordinate number to the coordinate number. When the coordinate number is set to『0』 it becomes the robot coordinate

- Coodinate number

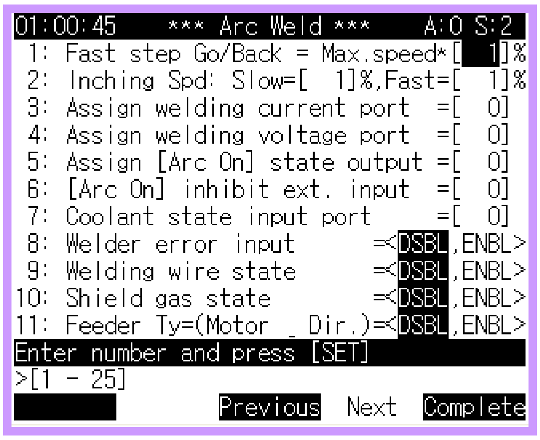
Reference

- You must set the data before using the robot equalizer function.
- The stationary gun coordinate number is only valid for stationary type.

7.5.2. Arc

This sets various conditions for welding process.
Please refer to the 『Arc function manual』 for details.

(1) Select 『[PF2]: System』 → 『4: Application parameter』 → 『2: Arc』 from initial screen of manual mode.



(2) When entering a number using the [Number] key, enter the number in the input frame and press the [SET] key. When selecting an item in the < > field, select by using the [SHIFT]+[←][→] key.

(3) Press 『[PF5]: Complete』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

■ Fast step Go/Back
This sets the speed when using the high speed function. In other words, it is the moving speed when pressing [SHIFT(High speed)]+[Forward step], [Reverse step].

■ Inching Spd
This is the wire feeding speed for wire inching and retracting when using the [SHIFT]+[Forward step], [SHIFT]+[Reverse step] key. Wire speed is set as the ratio to the maximum speed and it sets the feeding speed for low and high speed (operates when you press for more than 3 seconds.)

■ Assign welding current port
This allocates the output port of the welding current used for arc welding.

■ Assign welding voltage port
This allocates the output port of the welding voltage used for arc welding.

■ Assign [ARC On] state output
This sets the number of the signal to output [ARC ON] key status in arc welding.

■ [ARC On] inhibit ext. input
This sets the port number to receive the external input signal prohibiting [ARC ON].

- Coolant status input port
  When using a water cooling torch, this sets the port number to receive the coolant circulation error signal.

- Welder error input
  This decides whether to use the input signal of welding device error used in arc welding.

- Welding wire state
  This decides whether to use the input signal of welding device wire condition used for arc welding.

- Shield gas state
  This decides whether to use the input signal for gas pressure condition for arc welding.

- Feeder Ty=(Motor & Dir.)
  This decides whether to output signal when [Retract] key is pressed for welding wire retract.

- Digital filter for ArcSens'g

- Gas postflow at weld stop
  Enter the how long the gas is going to be exhausted when the robot stops by emergency stop or external error.

- Assign AIn port of the sens'g
  This allocates the input port for welding current detection for arc sensing.

- When I,V modify, autosave
  This sets whether to automatically save the current and voltage when they are changed during operation.

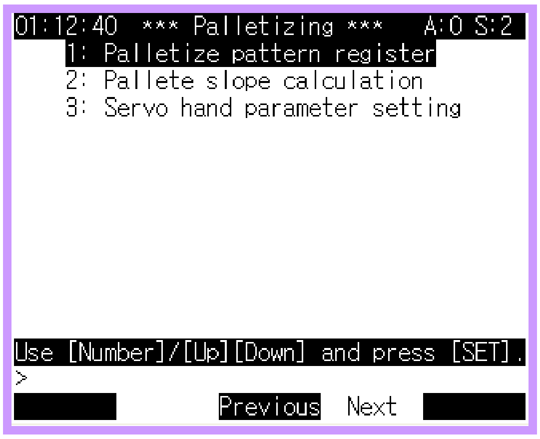
Reference

- Arc condition parameter is saved in control parameter file (ROBOT.C00).
- You cannot make changes when the control parameter file (ROBOT.C00) is completely protected.

7.5.3. Palletizing

This function sets up the necessary information to use the palletizing function. GUN 2 in 『[PF2]: System』 → 『5: Initialize』 → 『4: setting usage of the robot』 must be set to Palletizing. For more details, please refer to 『Palletizing Function Manual』.

(1) Select 『[PF2]: System』 → 『4: Application parameter』 → 『3: Palletizing』 from initial screen of manual mode.



(2) Use the [Arrow] keys to move the cursor to the item to select and press the [SET] key. Or you can enter the number of the item to select and press the [SET] key to move to the sub menu.

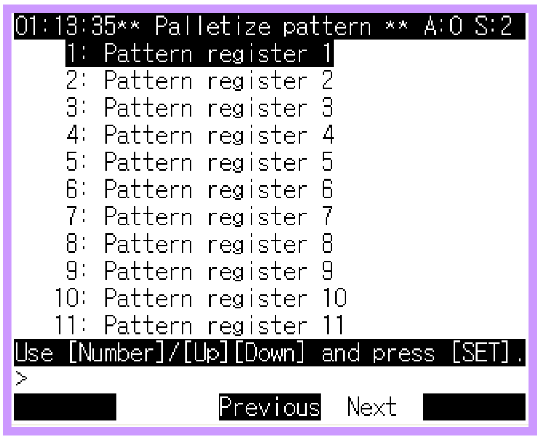
Reference

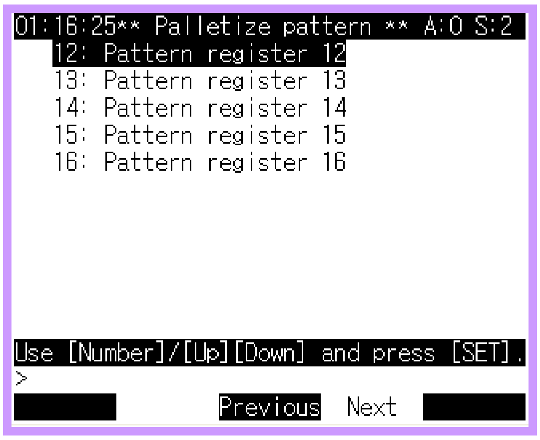
- Palletize pattern register is saved in palletize pattern file (ROBOT.PAL).
- You cannot make changes to palletize pattern file (ROBOT.PAL) if the file is completely protected.

7.5.3.1. Palletize pattern register

You can enter the basic elements for palletize function. This must be done to use the palletize function. Maximum of 16 『Pattern register』 can be saved. If needed, change the palletize pile pattern.

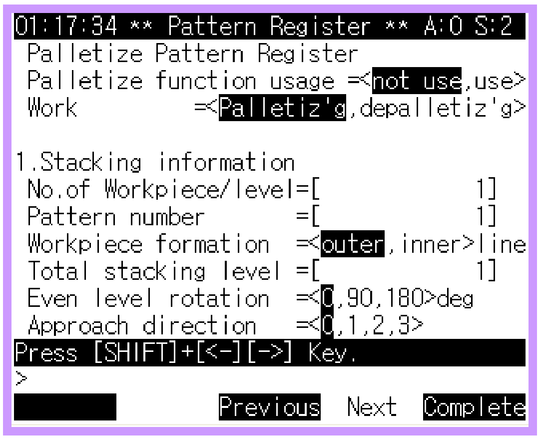
(1) Select 『[PF2]: System』 → 『4: Application parameter』 → 『3: Palletizing』 → 『1: Palletize pattern register』 from initial screen of manual mode.

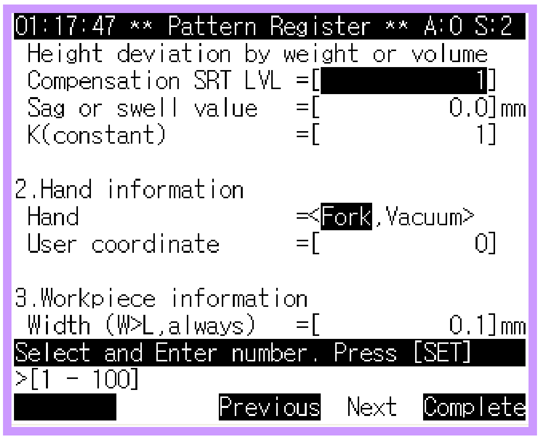


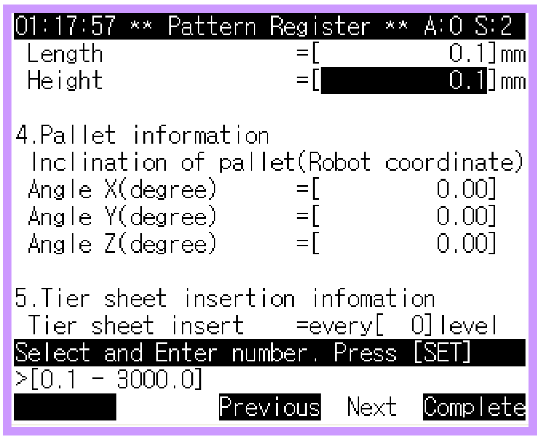


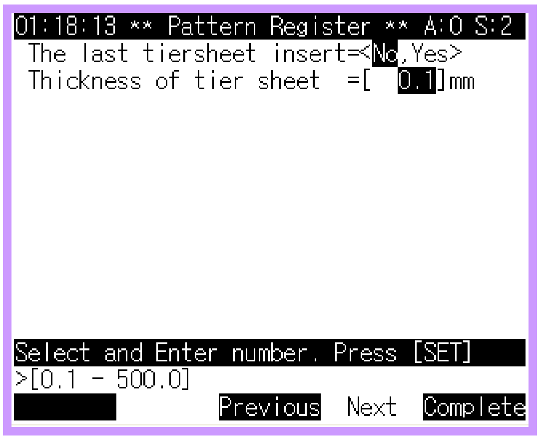
(2) Use the [Arrow] keys to move the cursor to the item to select and press the [SET] key. Or you can enter the number of the item to select and press the [SET] key to move to the sub menu.

(3) If you select pattern register 1, you will see the following screen.









(4) When entering a number using the [Number] key, enter the number in the input frame and press the [SET] key. When selecting an item in the < > field, select by using the [SHIFT]+[←][→] key.

(5) Press 『[PF5]: Complete』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

■ Palletize function usage
This decides whether to currently use the pattern register.

■ Work
This decides whether to do a palletizing or depalletizing operation for the pattern number.

■ No. of Workpiece/level
Pattern number refers to total number of work object in one layer. There are 25 patterns for 1 layer. Set the number of work objects.

■ Pattern number
The robot distinguishes different patterns by work object number and each pattern number has 6 different pile shape or size. Select the shape of the pattern number you want.

- Workpiece formation
  This decides whether to align the work object to the outer line or to the central reference.

- Total stacking level
  This sets the total number of layers to pile.

- Even level rotation
  To prevent the work object from fall off, the pattern in even number layers are rotated. Even number layers can be rotated 0, 90 or 180 degrees. Generally odd number layers are rotated by 180 degrees.

- Approach direction

- Height deviation by weight or volume
  This decides the direction the robot is moving to decide the work sequence for piling.

- Compensation SRT LVL : This sets the number of layers to shift for change adjustment.

- Sag or swell value
  Enter the Total change (mm) ÷ total number of layers.

- K (constant) : This reflects the work object's weight according to the how off it is.

- Hand
  There are two ways to set this. The robot should be flexible to deal with the location change for the case where to hold the work object changes according to the handle tool type and the case where to hold the work object changes according to the work object size.

- User coordinate
  User coordinate can only be used when the 『Hand』 is set to "Vacuum". 『User coordinate』 only applies to the step where the step condition is "PK". (PK refers to picking)

- Width (W>L,always) : This sets the standard work object width.

- Length : This sets the standard work object length.

- Height : This sets the standard work object height.

- Inclination of pallet(Robot coordinate)
  It considers the slope of the pallet and adjusts this slope. Adjustment is reduced from the shift length. Measure the slope angle of the pallet and enter the value.

- Tier sheet insert
  It sets the reference for inserting a divider. Set the number of layers to insert the divider.

- The last tiersheet insert : This decides whether to insert the divider in the last layer.

- Thickness of tier sheet : This sets the thickness of the divider.

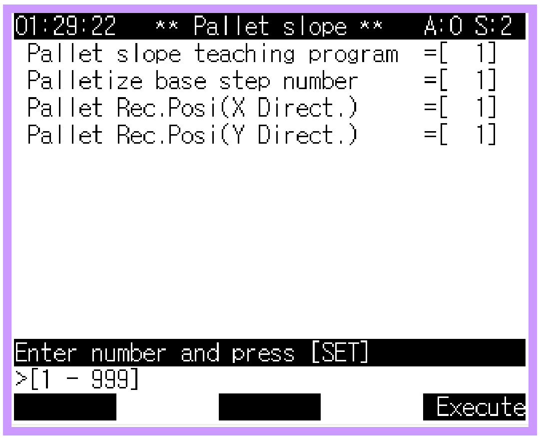
Reference

- If the set value is inappropriate, it will not be saved even if you press 『[PF5]: Complete』. Therefore, set an appropriate value as shown below and retry.
  ① To use the palletize pattern register, the GUN 2 must be set to palletize.
  ② Check if the pattern number and sub pattern number are supported numbers.
  ③ Refer to the pallet angle measurement for pallet angle.
  ④ The divider insert reference cannot be larger than the total number of layers.

7.5.3.2. Pallet slope calculation

Physically it is hard to measure the pallet angle. This function enables the user to easily measure the pallet angle by using a teaching program.

(1) Select 『[PF2]: System』 → 『4: Application parameter』 → 『3: Palletizing』 → 『2: Pallete slope calculation』 from initial screen of manual mode.



(2) Use the [Number] keys to enter the number in the input frame and press [SET].

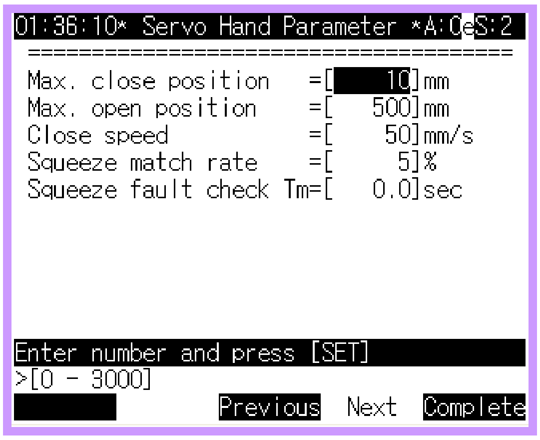
(3) Press 『[PF5]: Execute』 key to measure the palletize angle.

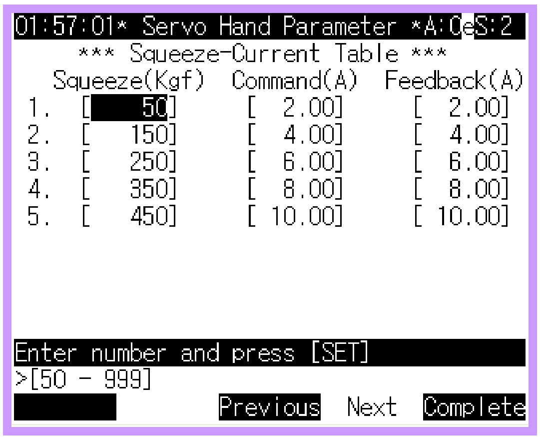
- Pallet slope teaching program : Enter the program number to measure the angle.
- Palletize base step number
  This records the location step where the pallet and the work object will initially be located.
- Pallet Rec.Posi(X Direct.) : Record the step in X direction of pallet (in robot coordinate).
- Pallet Rec.Posi(Y Direct.) : Record the step in Y direction of pallet (in robot coordinate).

7.5.3.3. Servo hand parameter setting

This enables the user to handle the work object using servo hand.
Additional axis must be registered to servo hand and default value is set in the machine parameter file. Please refer to 『Servo hand Function Manual』 for details..

(1) Select 『[PF2]: System』 → 『4: Application parameter』 → 『3: Palletizing』 → 『3: Servo hand parameter setting』 from initial screen of manual mode.





(2) Use the [Number] key to enter the number in the entry frame and press the [SET] key

(3) Press 『[PF5]: Complete』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

- Max. close position
  This is the maximum pressure distance of servo hand pressure process, and it is the pressure target location for manual and automatic pressure operation.

- Max. open position
  This is the maximum open distance for servo hand open operation. For manual opening, it is the target location and for automatic opening, it is the information used as limit. When the open distance of M39 exceeds the open stroke, 『E1327 over servo hand maximum open location』 will be generated.

- Close speed
  This sets the servo hand moving axis speed for servo hand operation (manual pressure, automatic pressure).

- Squeeze match rate
  For pressure alignment detection, this compares the actual pressure to the command pressure and when it reaches the pressure range, detects the pressure alignment.

- Squeeze fault check Tm
  This refers to the time the pressure operation starts to pressure alignment. If the pressure is not aligned within this time, an error message 『E1329 Servo hand squeezing time is over』 is sent out and the robot steps.

- Squeeze-Current Table
  This sets the relationship between the pressure generated from the servo hand and the current level in the motor. You can set any 5 pressure values for the current using the pressure-current table. Also the high and low values entered in this function become the pressure limit. Because there is a gap between the actual current and the target current, for the pressure table, measure both currents.

7.5.4. Conveyor

This sets the various parameters for conveyor movement function. 『Conveyor synchronization』 in 『[PF2]: System』 → 『5: Initialize』 → 『2: Robot type selection』 must be set to <ON>.
For more details, please refer to the 『Conveyor Synchronizaton Function Manual』.

(1) Select 『[PF2]: System』 → 『4: Application parameter』 → 『6: Conveyor』 → 『1: First conveyor parameter setting』 from initial screen of manual mode.

```
02:05:43  *** 1st Conveyor ***   A:0 S:2
 Conveyor type(Angle set) = <Lin.,Rot.>
 Conveyor constant(Pul/m) = [        0]
 Conveyor max speed(mm/s) = [    150.0]
 Conveyor max frequency   = [     10.0]
 Allowed pulse error cnt. = [        0]
 Sampling time (Second)   = [     0.10]
 Robot when CNVY stopped  = <Stop,Star>
 CNVY TRACKg during hold  = <DSBL,ENBL>
 CNVY system error detect = <ENBL,DSBL>
 Repeated LS on       = <Allo,Err.,Igno>
 CNVY Pulse count type   = <UP,UP/DOWN>
Press [SHIFT]+[<-][->] Key.
>
Ang. Set        Previous  Next  Complete
```

```
02:06:07  *** 1st Conveyor ***   A:0 S:2
 Lin. horizontal angle    = [     100.0]
 Lin. vertical angle      = [       0.0]

Enter number and press [SET]
>[0.0 - 360.0]
                Previous  Next  Complete
```

(2) When entering a number using the [Number] key, enter the number in the input frame and press the [SET] key. When selecting an item in the < > field, select by using the [SHIFT]+[←][→] key.

(3) Press 『[PF5]: Complete』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

- Conveyor type(Angle set)
  This decides the working conveyor type. Currently circular type conveyor is not supported.

- Conveyor constant(Pul/m)
  Enter the number of pulses generated from the pulse generator when the conveyor is moving 1m. Refer to 『Conveyor synchronization Function Manual』 for automatically setting the conveyor constant.

- Conveyor max speed (mm/s)
  Error is generated if the conveyor speed exceeds the permitted speed.

- Conveyor max frequency
  This sets the high limit of how many normal number of pulse can be output from the pulse generator in 1 sec. Currently it can be set from 1 to 15kHz.

- Allowed pulse error cnt.
  Even with the pulse error, the conveyor process is continued to protect the work object. For example, if the number of times permitted for pulse error detection is set to 3, the conveyor will continue to operate on the same object even with 3 pulse errors by generating an appropriate artificial pulse.

- Sampling time (Second): Currently fixed to 0.1 sec.

- Robot when CNVY stopped
  This decides the robot operation when the signal is not entered during conveyor operation, i.e. when the conveyor stops.
  ① Star
  In case of no signal, it finishes the current cycle and stops. It then waits for the operation signal.
  ② Stop : In case of no signal, the robot stops.

- CNVY TRACKg during hold
  It decides whether to run the conveyor tracking when the robot is temporarily stopped from stop command.
  ① DSBL
  The conveyor tracking is not executed when the robot is temporarily stopped during an operation.
  ② ENBL
  The conveyor tracking is executed when the root is temporarily stopped from a stop function or an error. Please consult with an expert.

- CNVY system error detect
  When the robot operation ready cannot be ON due to system error such as incomplete system installation or damage to board etc., this function sets the environment so that the system error is suppressed for manual movement operation.

- Repeated LS on
  This sets how the robot should operate when there already is one work object in process and another work object comes in hitting the limit switch. If permitted, maximum of 10 multiple work objects can be permitted.
  ① Allo: Permits multiple work objects.
  ② Err : Generates error for multiple work object entry and stops the robot.
  ③ Igno : Ignores the multiple work object entry.

- CNVY pulse count type
  This is to notify to the controller the jumper setting of option 48X board pulse counter circuit. Set the jumper setting to UP or UP/DOWN.

- Lin. horizontal angle
  Enter the angle that the conveyor rotated in positive Z direction in robot coordinate in reference to the X axis of robot coordinate. Refer to『Conveyor synchronization Function Manual』 for automatically setting the conveyor constant.

- Lin. vertical angle
  Enter the angle that the conveyor rotated in positive Y direction in robot coordinate in reference to the X axis of robot coordinate. Refer to『Conveyor synchronization Function Manual』 for automatically setting the conveyor constant.

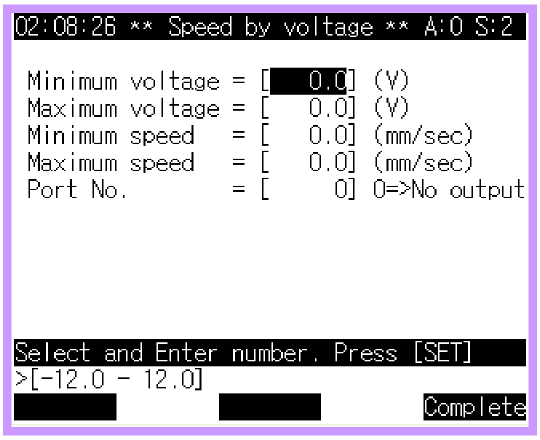
Reference

- The conveyor constant is saved in control parameter file (ROBOT.C00).
- If the control parameter file (ROBOT.C00) is completely protected, you cannot make any changes.

7.5.5. Volt. output proportional to speed

This function outputs the analog voltage from the option BD48X board proportionate to the robot linear speed.
If the output voltage is combined with the sealing device for voltage controller, the sealing start position and output of cornering can be maintained.

(1) Select 『[PF2]: System』 → 『4: Application parameter』 → 『7: Volt. output proportional to speed』 from initial screen of manual mode.



(2) Use the [Number] key to enter the number in the entry frame and press the [SET] key.

(3) Press 『[PF5]: Complete』 to save the modified setting. If you press the [ESC] key, the modified data will not be saved.

- Minimum voltage : Enter the minimum voltage for output in voltage unit.
- Maximum voltage : Enter the maximum voltage for output in voltage unit.
- Minimum speed : Enter the minimum speed to set the robot in mm/sec unit.
- Maximum speed :Enter the maximum speed to set the robot in mm/sec unit.
- Port No. : Set the analog port number for output.

Analog voltage output is done through TBAIO terminal in option BD48X board connected to I/O board.

Table 7-6 Option(BD48X) board analog output specification

Number of output channel	4 channels
Output voltage range	-12.0V ~ +12.0V
DAC Resolution	0 ~ 3

Table 7-7 Analog output voltage for digital input

Digital input	Analog output voltage 4 channel
FFFh	+12V
800h	0V
000h	-12V

Table 7-8 Analog output terminal pin arrangement

Terminal name	Connector no.	Connector name	Usage
TBAI0	1	AIN1	Analog input channel 1 (-12V ~ +12V)
	2	AIN2	Analog input channel 2 (-12V ~ +12V)
	3	AIN3	Analog input channel 3 (-12V ~ +12V)
	4	AIN4	Analog input channel 4 (-12V ~ +12V)
	5	AGND	Analog ground
	6	AGND	Analog ground
	7	AOUT1	Analog output channel 1 (-12V ~ +12V)
	8	AOUT2	Analog output channel 2 (-12V ~ +12V)
	9	AOUT3	Analog output channel 3 (-12V ~ +12V)
	10	AOUT4	Analog output channel 4 (-12V ~ +12V)

Reference

- If you select 『[PF1]: Service』 → 『1: Monitoring』 → 『7: Analog data』, you can monitor the analog input/output signal condition.
- Output data proportionate to speed is saved in control parameter file (ROBOT.C00).
- If the control parameter file (ROBOT.C00) is completely protected, it cannot be changed.
- It can only be used when the interpolation type recorded in the step is ON. If the interpolation is set to OFF, the moving speed of the robot tool cannot be measured. Therefore make sure the interpolation is set to ON.

7.5.6. Positioner independent operation function

7.5.6.1. Introduction

Positioner independent operation function is a function that can be used for a system to control multiple positioners. When operating multiple positioners, one positioner is operating with the robot and sometimes manual operation is needed for other idle positioners such as work object setting. This function allows the user to run the program to a specific positioner and for the positioners not selected, the user can do an independent operation with external input signal.

The positioner independent operation function allocates the input signal for positioner operation to the controller so that it can be manually operated. The user selects the positioner to operating using the robot program language command (SELSTN). Through SLELSTN, the user can judge the current positioner's operating condition based on whether there is a signal or not and decide whether to continue the program or not.

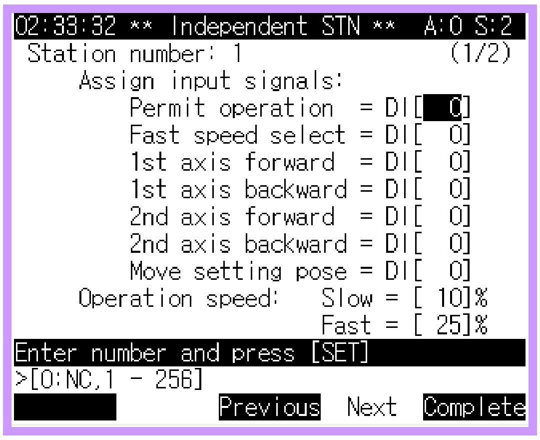
This function can change the positioner to operate for each program period and during playback the user can separately control the positioner being operated by the program and the one separately operated.

Reference

- You can setup an operator exclusively for separate positioner in the controller.
- Positioner independent operation function is valid only during playback in auto mode.
- The positioner is also called station because it decides the work object's location.

7.5.6.2. Independent positioner control

(1) Select 『[PF2]: System』 → 『4: Application parameter』 → 『8: Independent positioner control』 from initial screen of manual mode.



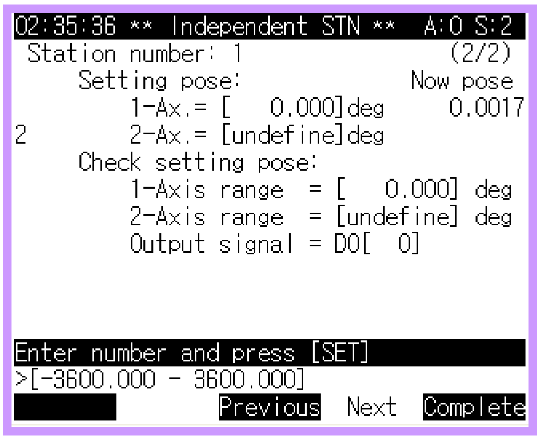


Table 7-9 Use of allocation area

Input/Output signal	Content	Remarks
1.Independent operation permitted	Input signal number allocation to prohibit (0)/permit (1) independent operation	Independent operation possible after permitted.
2.High speed selection	Input signal number allocation for speed level selection (0= low speed, 1=high speed)	Speed selected to level set in operating speed
3.Forward rotation of 1st axis	Input signal allocation for forward (+) rotation (0=Off/1=On) of positioner 1st axis	1st and 2nd axis can be operated at the same time
4.Reverse rotation of 1st axis	Input signal allocation for reverse (-) rotation (0=Off/1=On) of positioner 1st axis	1st and 2nd axis can be operated at the same time
5.Forward rotation of 2nd axis	Input signal allocation for forward (+) rotation (0=Off/1=On) of positioner 2nd axis	1st and 2nd axis can be operated at the same time
6.Reverse rotation of 2nd axis	Input signal allocation for reverse (-) rotation (0=Off/1=On) of positioner 2nd axis	1st and 2nd axis can be operated at the same time
7.Setting location change	Input signal allocation to move setting location to target point (0=Off/1=On)	1st and 2nd axis all move to target point Cannot be used with axis operation signal
8.Operating speed	Set what % of maximum speed to use for each axis	If the 'high speed' is 0, low speed will e selected and vise versa
9.Setting location	Set location to move when '7.Setting location change' signal is entered	
10.Setting location check	Set range of degree to reach 'setting location'	If the setting location is 0 deg and the location check range is 1 deg, The 'alignment output signal' is sent out in the range of -1 ~ 1 deg.
11.Alignment output signal	Setting location alignment output signal when both 1st and 2nd axes reach within the setting location range from '10.Setting location check'	Allocated signal output [DO# signal]

7.5.6.3. SELSTN command

SELSTN command is the command for robot program to independently control the positioner and is used for selecting the positioner to operate. Therefore the positioner group not selected by SELSTN becomes the independent positioner group.

SELSTN , Station number, Time out time, Shelter address			
Station number	ALL	Select all positioner Impossible to independently control all positioners	SELSTN S# cancel All positioner playback
	S0	Do not operate positioner Possible to independently control all positioners	Positioner playback not possible
	S1~S3	Select positioner of playback selection number Possible to independently control other positioner besides the selected	Selected positioner playback
Time out time	0~60	Standby time until independent operation of selected station is completed	0 = Infinite standby
Shelter address	Jump address	Designating the step to exit in case the independent operation is not completed during the standby time	STEP, LABEL, Line number

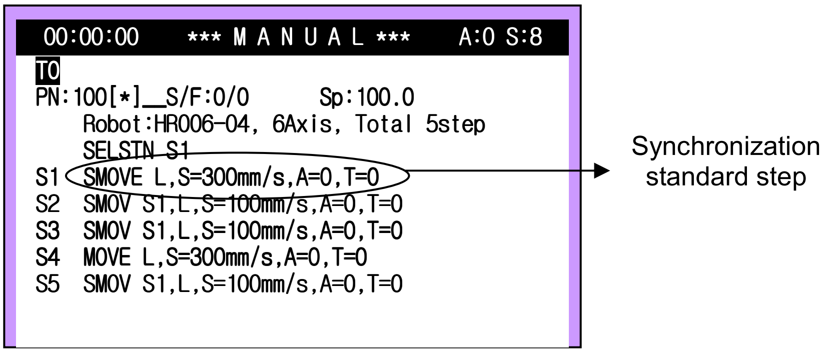
7.5.6.4. Positioner group selection

(1) Designates the station number to control using SELSTN S#. When this command is in effect, the selected station will operate as programmed while other positioners can be controlled independently through external program. (SELSTN S1)

(2) After SELSTN command, record the synchronization standard step where to start the positioner synchronization. (S1)

(3) Operate the selected positioner and record the step. (S2, S3, S4, S5) At this time it is recommended that the positioners not selected (positioner group 2, positioner group 3 etc.) stay idle.

(4) At this time positioner group 2 and 3 can be independently operated through external input signal.



◆【Caution】◆

- If the station number set from SMOV is different from the station number set from SELSTN, it can cause an error (E0219) during playback.

- If you set to SELSTN S0, all stations set (S1~S3) will playback with this program. In this case all stations can be independently operated.

7.5.6.5. Positioner group change

(1) When the positioner group number has changed during playback, this will set the new station number. (SELSTN S2)

(2) Record the standard step for synchronized operation of robot and positioner with MOVE command. (S6)

(3) Operate the selected positioner and record the step. (S2, S3, S4, S5) At this time it is recommended that the positioners not selected (positioner group 2, positioner group 3 etc.) stay idle.

(4) At this time positioner group 2 and 3 can be independently operated through external input signal.

```
 00:00:00    *** M A N U A L ***    A:0 S:8
TO
PN:100[*]__S/F:0/0      Sp:100.0
Robot:HR006-04, 6Axis, Total 9step
SELSTN S1
S1  MOVE L,S=300mm/s,A=0,T=0
S2  SMOV S1,L,S=100mm/s,A=0,T=0
S3  SMOV S1,L,S=100mm/s,A=0,T=0
S4  MOVE L,S=300mm/s,A=0,T=0
S5  SMOV S1,L,S=100mm/s,A=0,T=0
    SELSTN S2
S6  MOVE L,S=300mm/s,A=0,T=0
S7  SMOV S2,L,S=100mm/s,A=0,T=0
S8  MOVE L,S=300mm/s,A=0,T=0
S9  SMOV S2,L,S=100mm/s,A=0,T=0
```

Station change, positioner group 2 plays back from step 6

◆【Caution】◆

- If the station number (S1~S3) changes with SELSTN command, the existing positioner group that has been selected is canceled and becomes available for independent operation.

7.5.6.6. Positioner group cancel

(1) If you want to prohibit independent operation of all positioner groups and to move all registered axes with jig to the position for step recording, use SELSTN ALL command to cancel the positioner selection. (SELSTN ALL)

(2) After SELSTN ALL command, all positioners are positioned to the step location for record and operated by the playback command. Independent operation is not possible even with independent operation input signal. (Independent operation is not possible after step S10)

```
 00:00:00   *** M A N U A L ***    A:0 S:8
T0
PN:100[*]__S/F:0/0      Sp:100.0
    Robot:HR006-04, 6Axis, Total 12step
    SELSTN S1
S1  MOVE L,S=300mm/s,A=0,T=0
S2  SMOV S1,L,S=100mm/s,A=0,T=0
S3  SMOV S1,L,S=100mm/s,A=0,T=0
S4  MOVE L,S=300mm/s,A=0,T=0
S5  SMOV S1,L,S=100mm/s,A=0,T=0
    SELSTN S2
S6  MOVE L,S=300mm/s,A=0,T=0
S7  SMOV S2,L,S=100mm/s,A=0,T=0
S8  MOVE L,S=300mm/s,A=0,T=0
S9  SMOV S2,L,S=100mm/s,A=0,T=0
    SELSTN ALL
S10 MOVE P,S=100%,A=0,T=0
S11 MOVE L,S=1200mm/s,A=0,T=0
S12 MOVE L,S=200mm/s,A=0,T=0
```

Station selection cancel

◆【Caution】◆

- In case of entered operation such as step change, program change, external reset etc., station selection cancel is automatically done to stop all independently operating positioner.

7.5.6.7. Positioner independent operation playback

(1) When the SELSTN is set and the independent control signal already in process, new SELSTN command cannot be executed.

(2) To process the command SELSTN S# and SELSTN ALL to change the stations during playback, you must finish the independent operations of the positioners to move to the next step. Refer to the next program example.

```
 00:00:00   *** M A N U A L ***   A:0 S:8
TO
PN:100[*]__S/F:0/0      Sp:100.0
    Robot:HR006-04, 6Axis, Total 12step
    SELSTN S1, 5.0, S12
S1  MOVE L,S=300mm/s,A=0,T=0
S2  SMOV S1,L,S=100mm/s,A=0,T=0
S3  SMOV S1,L,S=100mm/s,A=0,T=0
S4  MOVE L,S=300mm/s,A=0,T=0
S5  SMOV S1,L,S=100mm/s,A=0,T=0
    SELSTN S2,10.0,S12
S6  MOVE L,S=300mm/s,A=0,T=0
S7  SMOV S1,L,S=100mm/s,A=0,T=0
S8  MOVE L,S=300mm/s,A=0,T=0
S9  SMOV S1,L,S=100mm/s,A=0,T=0
    SELSTN ALL
S10 MOVE P,S=100%,A=0,T=0
S11 MOVE L,S=1200mm/s,A=0,T=0
S12 MOVE L,S=200mm/s,A=0,T=0
```

→ Execute **SELSTN S1, 5.0, S12** after independent operation signal off of station 1 (Standby time 5 sec)

→ Execute **SELSTN S2, 10.0, S12** after independent operation signal off of station 2

→ Execute after independent operation signal of al all stations

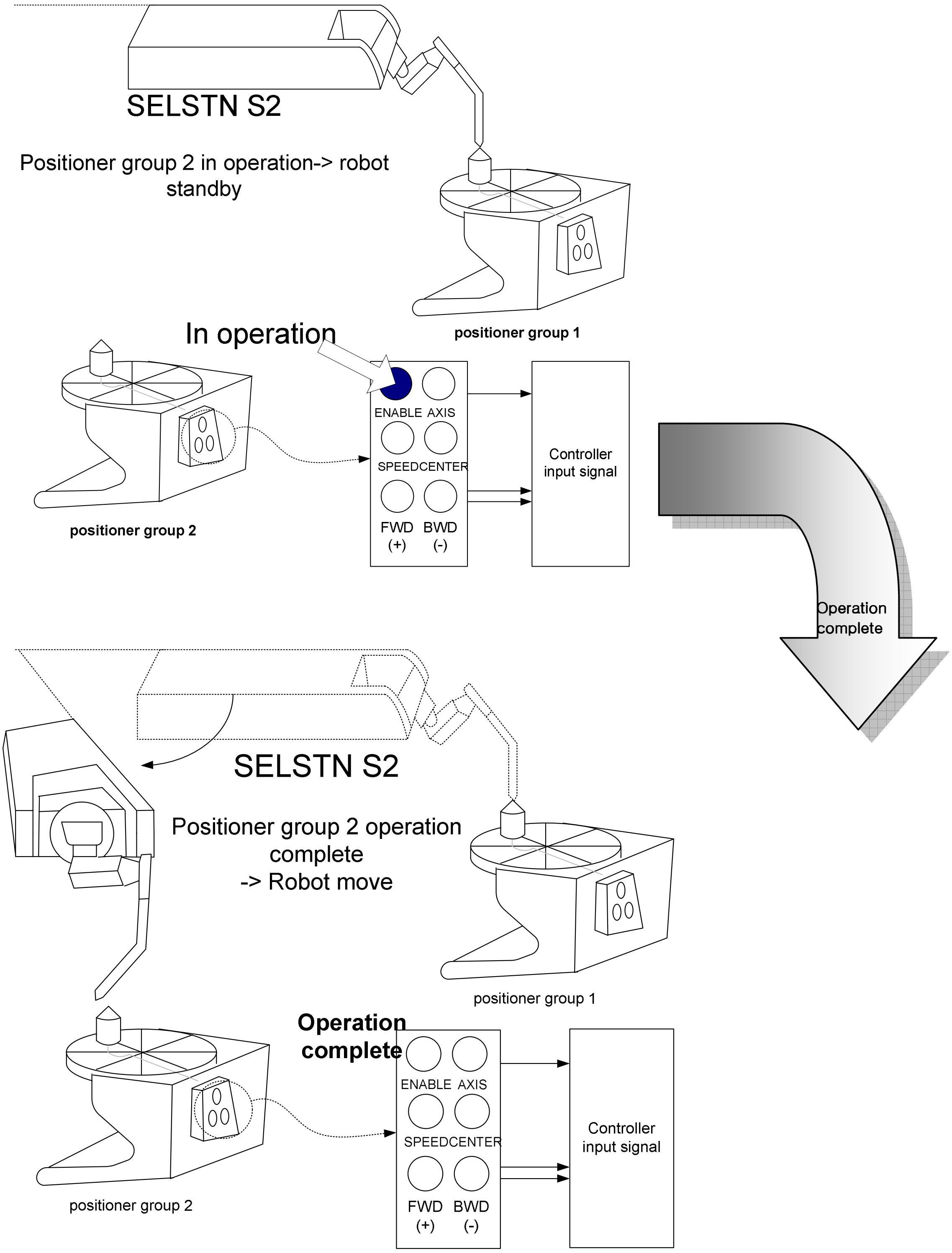


Figure 7.21 Positioner independent operation

Reference

- If the 'independent operation permission' signal of allocated input signal of selected positioner is entered, the robot stands by in SELSTN position.
- Therefore as shown above, if the robot meets SELSTN S2 command and the positioner group 2 is in independent operation, the robot outputs the message 'SELSTN cancel standby' in SELSTN S2, and stands by.
- When the independent operation of the selected positioner is completed, then the robot starts moving.

◆【Caution】◆

- When operating the program, the robot waits for the independent operation signal to be <Prohibited> according to the positioner group selection condition. This is for user's safety because the independent operation signal of the positioner is in <Permitted>, it considers that the user is present.
- The station selection is canceled (SELSTN ALL) in case of step change, program change or external reset. Therefore to re-operate, the robot has to wait until all independent operation signals switched to <Prohibited>.
- The independent operation of positioner does not work when the following function is in process.
  ① During auto reset function of endless step
  ② During cooperative control
  ③ During endless reset, spot, gunsea function
  ④ During gun change, manual operation of servo gun

7.5.7. Cube interference prevention

This connects several robots with I/O signals, sets the common cube area among robots, stops robots to prevent interference when robots are trying to work in the cube at the same time.

Table 7-10 Cube interference prevention function specification

Major function specification	Remarks
Number of cube setting	8
I/O signal specification	Common DIO signal
Cube setting coordinate	Supports base, user coordinate
Work area output	Output whether robot entered robot TCP cube area
Robot auto standby/resume	Robot standby/resume according to cube entry prohibition signal

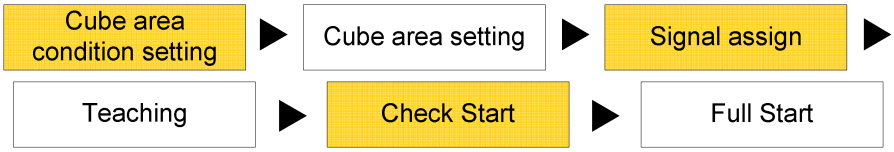
- Multiple cube area setting
  You can set up to 8 cube interference areas and set the interference area in various locations and sizes.

- Signal allocation
  This allocates 1 input and output signal to each cube. The input signal stops the cube entry and the output signal notifies that the robot is in the cube.

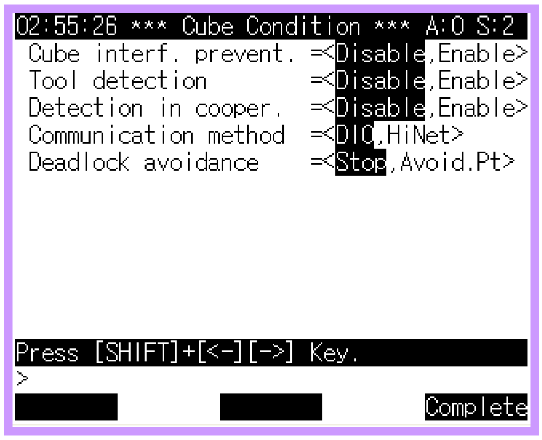
- User coordinate support
  Because of user coordinate support, various shapes of cubes can be set in the space.

- Automatic stop
  When the robot is trying to enter the cube, it detects the prohibition signal from the other robot and automatically stops.

- Automatic resume
  When the prohibition signal of the other robot is off, the robot automatically tries to enter the cube area.



(1) Select 『[PF2]: System』 → 『4: Application parameter』 → 『9: Cube interference prevention』. Select 『1: Condition setting』 and you will see the following screen.



- Cube interf. Prevent. < Disable, Enable >
  This function sets the enable/disable.
  To set the cube area and use the interference prevention function, it must be set to 『Enable』. If set to 『Disable』, the interference area cannot be set and the signal I/O will not be processed.

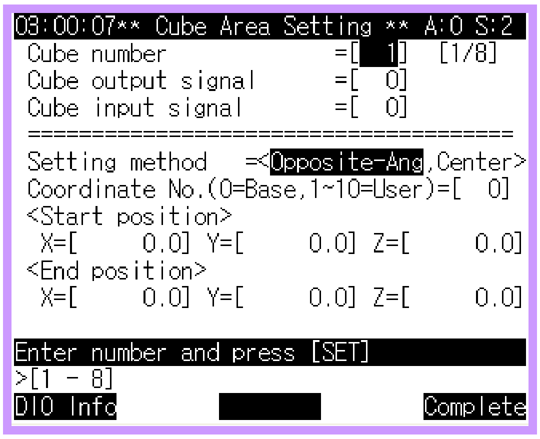
- Tool detection : ‘Disable’ (OPTION)

- Detection in cooper. : ‘Disable’ (OPTION)

- Communication method <DIO,HiNet>
  Default is set to DIO. (HiNet is optional)
  Common DIO I/O signal is used for cube operation area entry.

- Deadlock avoidance <Stop, avoid.Pt >
  This option is to prevent robots from entering the same cube.
  If you select 『Stop』, the robot automatically stops if there is another robot in the cube interfering.
  『Avoid.Pt』 is optional.

(2) Select 『[PF2]: System』 → 『4: Application parameter』 → 『9: Cube interference prevention』. Select 『2: Cube area setting』 and you will see the following menu.



(3) Input/Output signal setting

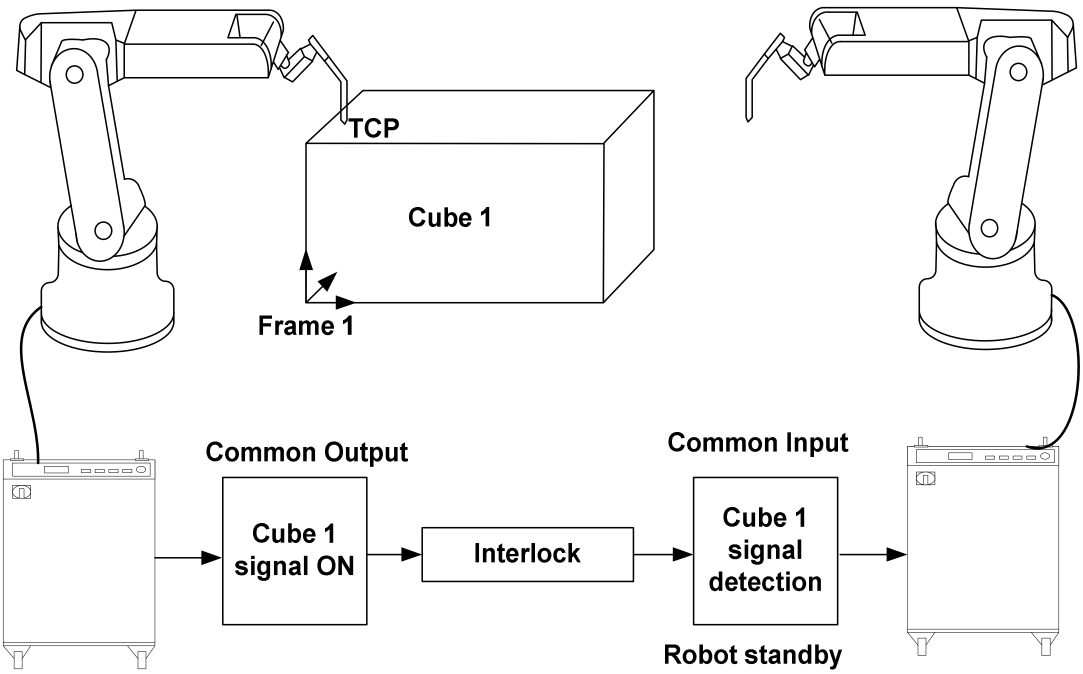


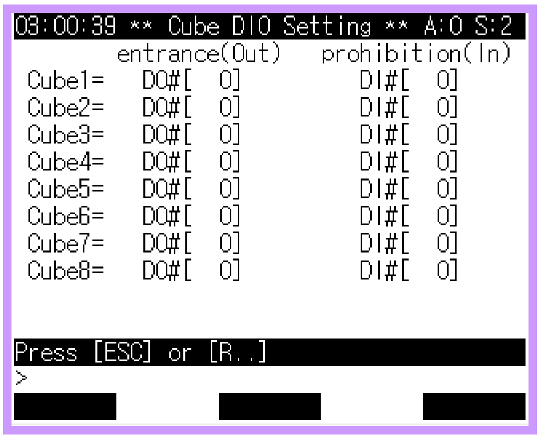
Figure 7.22 Input/Output signal setting

As shown above in the Figure, two robots are set for the common cube area and the output signal and input signal are matched to the same cube. It can be set to monitor whether common cube is entered.

- Cube output signal
  This function detects whether the robot entered the common cube and outputs the signal. Set this signal number to the cube entry output signal.

- Cube input signal
  Set the signal number to receive when another robot is entering the cube.

(4) DIO setting information view
This service shows the set values of cube number from 1 to 8. Press PF1 from the cube area setting menu.


03:00:39 ** Cube DIO Setting ** A:0 S:2

	entrance(Out)	prohibition(In)
Cube1=	DO#[0]	DI#[0]
Cube2=	DO#[0]	DI#[0]
Cube3=	DO#[0]	DI#[0]
Cube4=	DO#[0]	DI#[0]
Cube5=	DO#[0]	DI#[0]
Cube6=	DO#[0]	DI#[0]
Cube7=	DO#[0]	DI#[0]
Cube8=	DO#[0]	DI#[0]

Press [ESC] or [R..]
>

Signals not allocated are shown in 0.

(5) Cube setting method
Cube setting method is provided in 2 methods.

- Diagonal point setting method

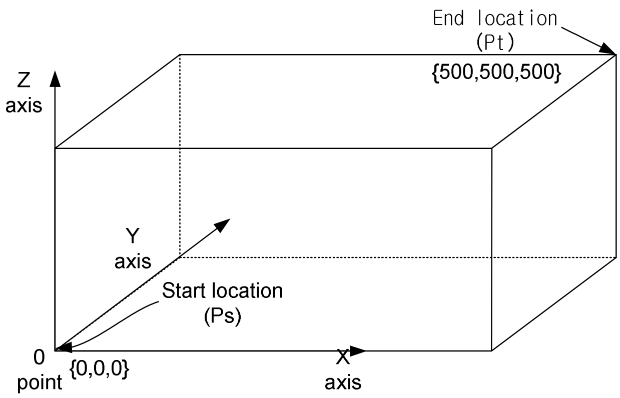
  Set the two diagonal points of the cube. Directly enter the starting and ending points of the diagonal line as shown below in the figure.

  To record the current robot TCP location set the cursor to <Start location> or <End location> and press the 『SET+Record』 key to record the current location.

Example)

```
03:01:57** Cube Area Setting ** A:0 S:2
 Cube number                =[  1]  [1/8]
 Cube output signal         =[  1]
 Cube input signal          =[  1]
 ======================================
 Setting method    =<Opposite-Ang,Center>
 Coordinate No.(0=Base,1~10=User)=[  0]
 <Start position>
  X=[     0.0] Y=[     0.0] Z=[     0.0]
 <End position>
  X=[     0.0] Y=[     0.0] Z=[     0.0]

Press [SHIFT]+[<-][->] Key.
>
DIO Info                        Complete
```



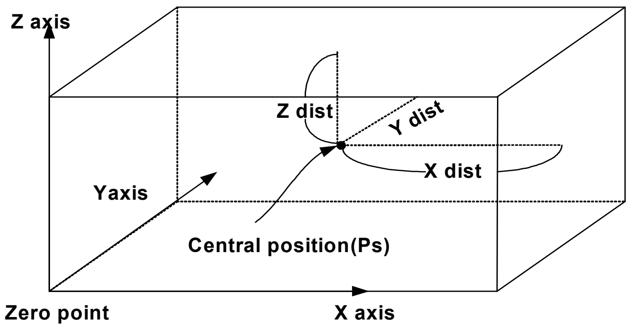
- Center point setting method
  Center point setting method is setting the cube by setting the center point and the distances in X, Y and Z axis direction.

  To record the current robot TCP location set the cursor to <Center location> and press the 『SET+REC』 key to record the current location.

Example)

```
03:02:35** Cube Area Setting ** A:0 S:2
 Cube number                =[  1]  [1/8]
 Cube output signal         =[  1]
 Cube input signal          =[  1]
 ======================================
 Setting method    =<Opposite-Ang,Center>
 Coordinate No.(0=Base,1~10=User)=[  0]
 <Center position>
  X=[     0.0] Y=[     0.0] Z=[     0.0]
 <End position>
  X=[     0.0] Y=[     0.0] Z=[     0.0]

Press [SHIFT]+[<-][->] Key.
>
DIO Info                        Complete
```



(6) Cube setting in user coordinate
Because the area is set as a cube, it can be set in various positions in space. If you setup the user coordinate you can setup the cube in various different ways.

As shown below in the figure, it is possible to set cube 1 in base coordinate, cube 2 in user coordinate 1 and cube 3 in user coordinate 2.

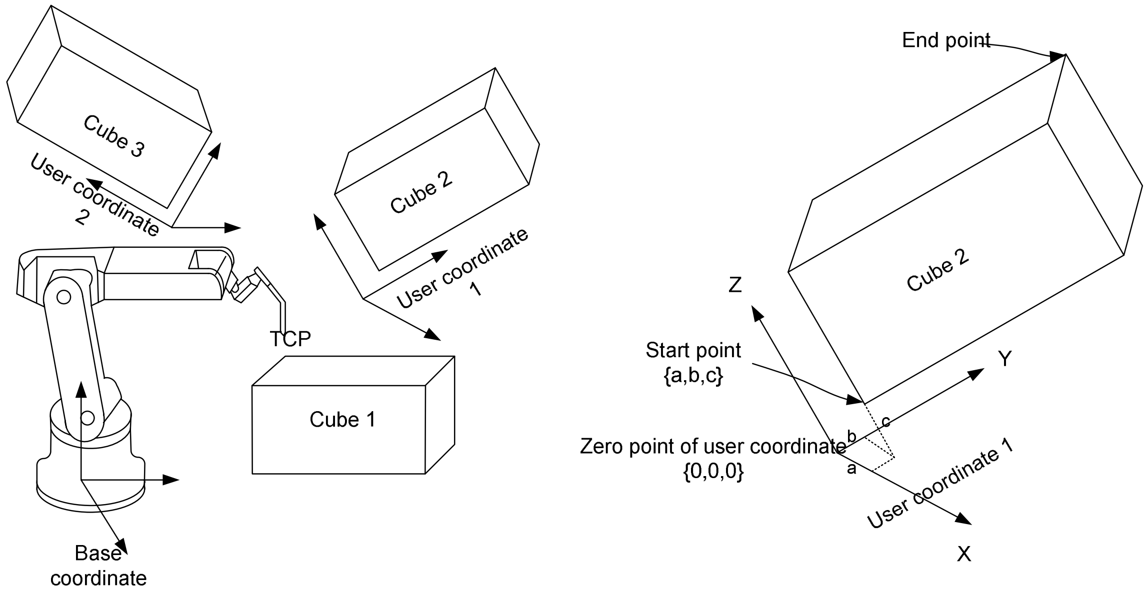


Figure 7.23 Cube setting in user coordinate

When setting in user coordinate, both the diagonal method and center point method must be set in user coordinate.

Reference

- You can set a common interference area to more than two robots and connect them with DIO signals.
- Teach the two robots' work into common cube area work and individual work.
- Operate both robots and check if there is a dead lock between the two.
- Dead lock

  Dead lock is when two robots enter the interference area at the same time and both wait because they both think that there is a robot in operation.
  You can prevent and avoid this dead lock by adjusting the step speed and location to the common cube area.
  For example, as shown in below figure, let's look at robot 1 and 2 that are taught.
  The entry path of robot 1 is from prior step S (n) to common cube in short distance. The entry path of robot 2, on the other hand, is set from prior step S (k) to common area in relatively long distance.
  In this case, when robot 2 is moving from S (k)' to S (k+1) in high speed and entered the common cube area with robot 1, robot 2 TCP can intrude the common cube area because it will decelerate to stop.
  Like this case when two robots enter the common cube area, both robots will wait until the other robot exits the cube.

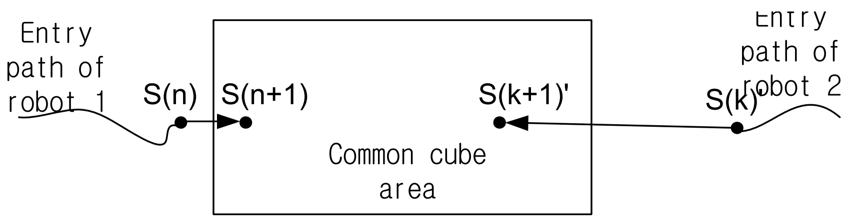


Figure 7.24 Dead lock

■ To end the dead lock condition, the user must manually exit the robot.

■ To avoid dead lock, it is recommended to teach so that distance to stop is ensured for S (n) and S (k)'.

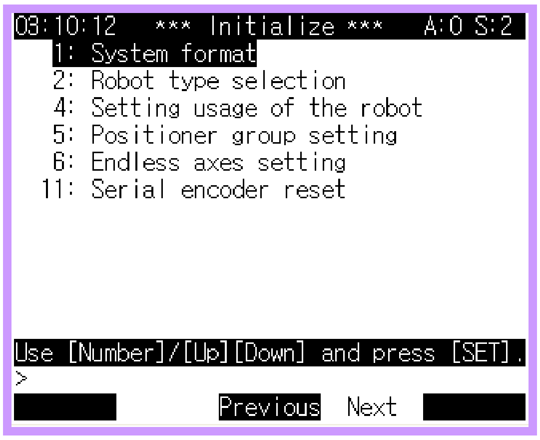
① Signal output principle
- When TCP is within the cube
- When the target step in process is within the cube where prohibition signal is not entered.

② Stop standby principle
- When approaching the cube where cube prohibition signal is entered
- When TCP entered the cube when the cube prohibition signal was being entered

7.6. Initialize

This is to initialize the robot to set to working system.

(1) Select 『[PF2]: System』 → 『5: Initialize』 from the initial screen in manual mode.



(2) Use the [Arrow] keys to move the cursor to the item to select and press the [SET] key. Or you can enter the number of the item to select and press the [SET] key to move to the sub menu.

7.6.1. System format

This deletes all the data in the saved area of the controller and sets all the values in the control parameter file (ROBOT.COO) to factory default.

(1) Select 『[PF2]: System』 → 『5: Initialize』 → 『1: System format』 from the initial screen of manual mode.

```
Format?                              [YES/NO]
>
                    Previous  Next
```

(2) Press the [YES] key for format process and [NO] key to cancel.

Reference

- It is impossible to cancel once it goes into initialization. Therefore you must execute 『2: Robot type selection』.

- If you select 『[PF1]: File manager』, you will see the following screen. This is the function necessary to use the existing constant file when the constant file does not exist. The operating method is the same as 『[PF1]: Service』 → 『5: File manager』.

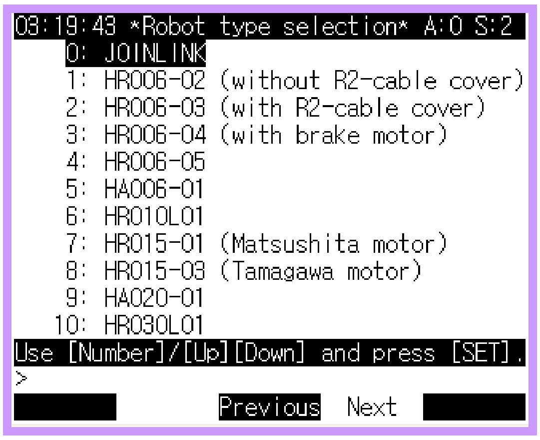
```
03:12:54  *** File manager ***   A:0 S:2
   1: Show file names in memory
   2: Show the headline of program[R107]
   3: Show the number of axes for Prog.
   4: Rename                      [R116]
   5: Copy                        [R115]
   6: Delete                      [R117]
   7: Protect                     [R269]
   8: Storage media format
   9: Save/load all files. (SRAM card)

Use [Number]/[Up][Down] and press [SET].
>
                    Previous  Next
```

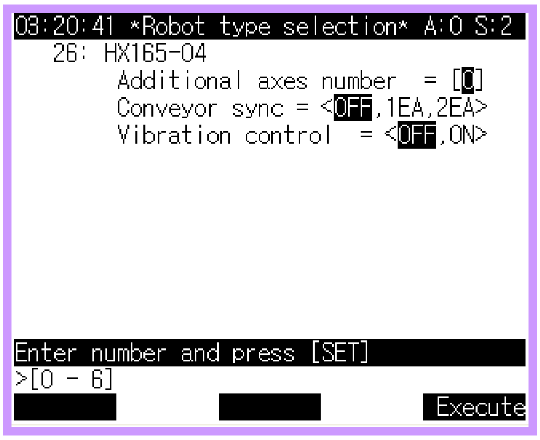
7.6.2. Robot type selection

This sets the machine parameter file (ROBOT.C01) to factory default and also sets the various record file to the values in the control parameter file (ROBOT.C00) for new setting.

(1) Select『[PF2] System』 → 『5: Initialize』 → 『2: Robot type selection』 from the initial screen of manual mode.



(2) Select the name of the robot body and press the [SET] key to see the following screen.



(3) When entering the number use the [Number] key to enter it in the input frame. When done press the [SET] key and when selecting the items in the < >, use the [SHIFT]+[←][→] keys to decide.

(4) To save the set data press the『[PF5]: Execute』 key. To cancel the changes pres the [ESC] key.

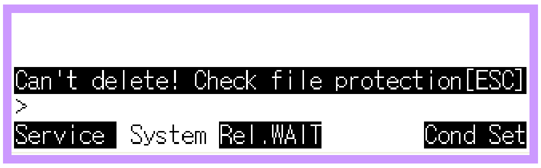
- additional axis number
  If there is an additional axis, enter the number of additional axis.
- Conveyor sync : Select the number of conveyors to synchronize.
- Vibration controller : If you want to use the vibration controller, set it ON.

Reference

- If the system is not initialized, the following message will be displayed. Press [ESC] if you want to restart.

- If there is a machine parameter file (ROBOT.C01), the following message will be displayed. Press [YES] to create a new one and [NO] key to cancel.

- If there is a machine parameter file (ROBOT.C01) and the properties are set to complete protection, the following message will be displayed. Press the [ESC] key to restart.



- If there is error record file (ROBOT.E01), stop record file (ROBOT.S01) and operation history file (ROBOT.TR0), the following message will be displayed. Press [YES] to create new or [NO] to cancel.

- If the error record file (ROBOT.E01), stop record file (ROBOT.S01) and operation history file (ROBOT.TR0) exist and the file property is set to complete protection, the following message will be displayed. Press the [ESC] key to restart.

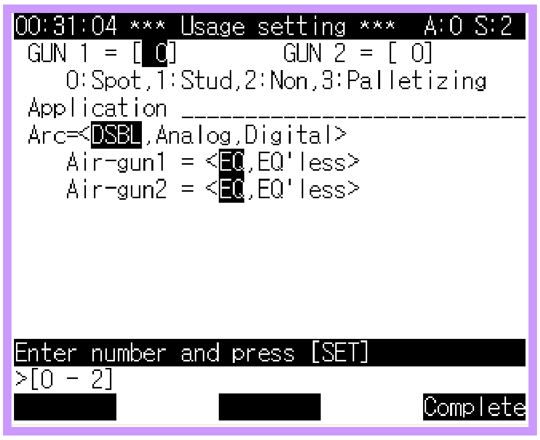
```
Can't delete! Check file protection[ESC]
>
Service  System Rel.WAIT        Cond Set
```

- You can change the file protection in 『[PF1]: Service』 → 『5: File manager』 → 『7: Protect』.

7.6.3. Usage setting

This sets the work usage.
Use setting must be done for palletize and robot equalizer function.

(1) Select 『[PF2]: System』 → 『5: Initialize』 → 『4: Setting usage of the robot』 from initial screen of manual mode.



(2) When entering the number use the [Number] key to enter it in the input frame. When done press the [SET] key and when selecting the items in the < >, use the [SHIFT]+[←][→] keys to decide.

(3) To save the set data press the “[PF5]: Complete” key. Press the [ESC] key to cancel the changes.

- GUN1 : Select the usage of GUN 1.
- GUN2 : Select the usage of GUN 2.
- ARC
  Set this to <Analog, Digital> to use the robot for arc welding. For details, please refer to the 『Arc welding Function Manual』.
- Air-gun1 and air-gun 2
  Select whether to use the equalizer function or the equalizerless function for gun 1 and gun 2.

Reference

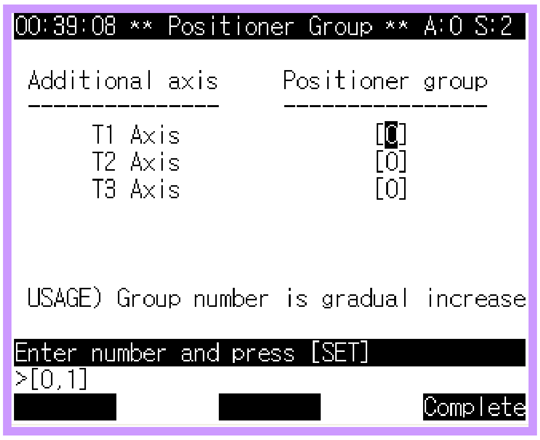
- To change the content of the usage setting, please consult with your engineer.

7.6.4. Positioner group setting

This is the process for positioner manipulation. You can set the additional axis set to jig axis in the initialization menu to the positioner group.

Hi4a controller supports up to 2 positioners and 2 axes allocation for each positioner. For more details, please refer to the 『Positioner function manual』.

(1) Select 『[PF2]: System』 → 『5: Initialize』 → 『5: Positioner group setting』 from initial screen of manual mode.



(2) Using the [Number] key, enter the positioner group of the additional axis in the input frame and press the [SET] key.

(3) Press the 『[PF5]: Complete』 key to save the data. Press the [ESC] key to cancel the change.

Reference

- When setting 2 axes positioner and 1 axis positioner (when all additional axes are set to jig) → In group 1, T1 and T2 axis form the first positioner group and T3 axis separately forms the second positioner group.

Additional axis	Positioner group
T1 Axis	[1]
T2 Axis	[1]
T3 Axis	[2]

- When setting the 1 axis positioner and 2 axis positioner (when all additional axes are set to jig) → In group 1, T1 axis forms the first positioner group and T2 and T3 form the second positioner group.

Additional axis	Positioner group
T1 Axis	[1]
T2 Axis	[2]
T3 Axis	[2]

- When there are two 1 axis positioner → T1 axis forms positioner group 1, and T2 axis forms the positioner group 2.

Additional axis	Positioner group
T1 Axis	[1]
T2 Axis	[1]
T3 Axis	[0]

- When setting it with jig axis not synchronized → Use the basic value.

Additional axis	Positioner group
T1 Axis	[0]
T2 Axis	[0]
T3 Axis	[0]

- Positioner group setting method

  ① Group designation must be done from low axis in order.

  ② Groups not synchronized are designated to [0] and must be set after the synchronized axis.

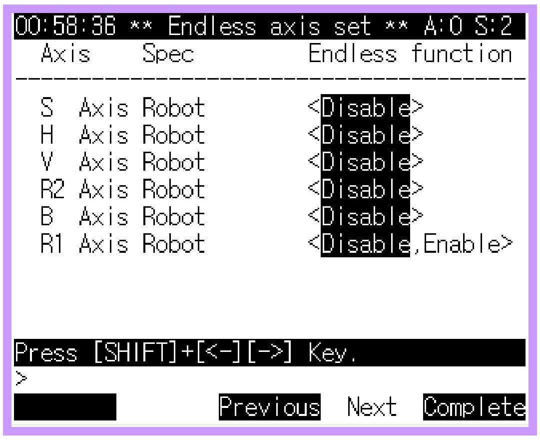
  ③ Because the same positioner group supports only up to 2 axes, you must not designate 3 axes in one group.

  ④ When setting the group, the prior calibration constant of the positioner becomes invalid and the positioner calibration must be done again.

7.6.5. Endless axis setting

This function sets the axis to apply the endless function. For more details, please refer to 『Endless function manual』.

(1) Select 『[PF2]: System』 → 『5: Initialize』 → 『6: Endless axis setting』 from initial screen of manual mode.



(2) Use the [SHIFT]+[←][→] keys to decide the axis to use for the endless function.

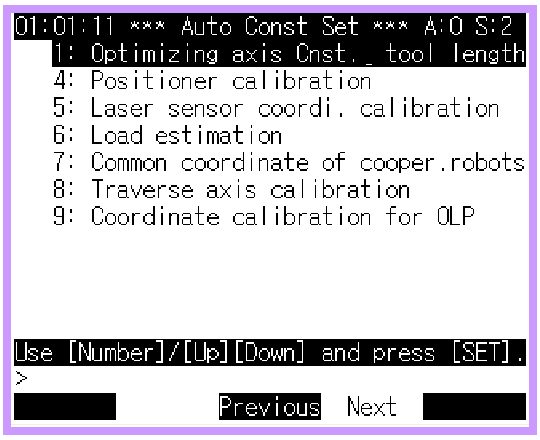
(3) Press the 『[PF5]: Complete』 key to save the data. Press the [ESC] key to cancel the change.

- Axis : It displays the names of the currently registered robot axis and additional axis.
- Spec : It displays the robot axis, main axis, servo gun axis and jig axis for each axis.
- Endless function : Decide whether to apply the endless function to the applicable axis.

7.7. Automatic constant setting

For the automatic constant setting function, the robot controller automatically calculates the parameter values for the work system environment to fit the system environment.

(1) Select 『[PF2]: System』 → 『6: Automatic constant setting』 from initial screen of manual mode.



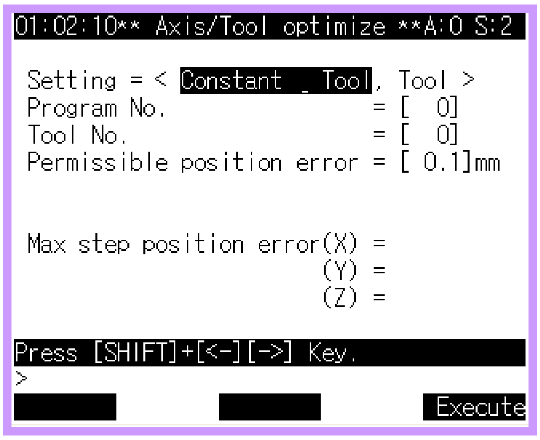
(2) Use the [Arrow] keys to move to the item to select and press the [SET] key or press the number of the item to choose using the [Number] key and press the [SET] key to enter the sub menu.

7.7.1. Optimizing axis Cnst. & tool length

This function obtains the straight line interpolation constant adjusted from the each step encoder data of the program that records the same point in different positions to improve the straight line interpolation path and coordinate transition level.

If you use this function, you can automatically calculate the distance of the tool end in 3 dimension. The straight line interpolation constant is H, V, R2, B axis constant and tool length of X, Y and Z direction.

(1) Select 『[PF2]: System』 → 『6: Automatic constant setting』 → 『1: Optimizing axis Cnst.& tool length』 from initial screen of manual mode.



(2) When entering the number use the [Number] key to enter it in the input frame. When done press the [SET] key and when selecting the items in the < >, use the [SHIFT]+[←][→] keys to decide.

(3) To optimize the axis constant and tool length, press the 『[PF5]: Execute』 key. Press the [ESC] key to cancel.

■ Setting

① Constant and tool: The values from 『[PF2]: System』 → 『3: Robot parameter』 → 『1: Tool data』 and from 『[PF2]: System』 → 『3: Robot parameter』 → 『2: Axis constant 』 are adjusted. Therefore this mode is only used to executing the first tool, and from the second tool, you must use the tool mode to adjust the tool length.

② Tool : The set value is adjusted from the tool length set in 『[PF2]: System』 → 『3: Robot parameter』 → 『1: Tool data』.

■ Program No.
This sets the program number that records the same point in various positions.

■ Tool No.
This is the tool number to automatically set and it must be same with the tool number recorded in the program for setting.

- Permissible position error
  It calculates the X, Y and Z coordinate of tool end from each step data of the setting program using the adjusted constant data. If the maximum deviation among the coordinates is within the permitted range of step position deviation, the constant data is renewed.

- Max step position error
  This outputs the maximum value from the X, Y and Z coordinates from each step from the permitted range of step position deviation.

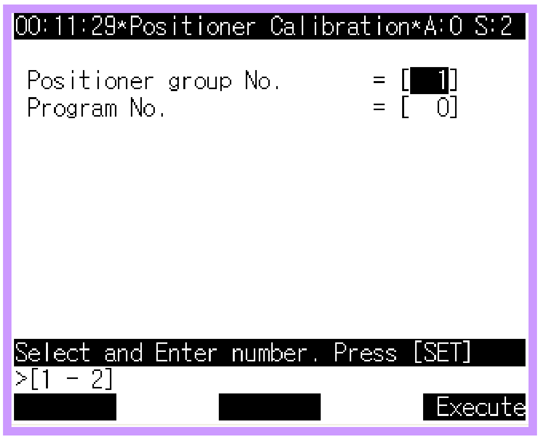
Reference

- Teach so that the error from the tool end to the fixed point in space (the same point to record various positions) is within 0.5mm.
- Teach so that all the axes of the robot are operating in wide movements.
- Teach so that the movement of the wrists (R2, B, R1) of each step is large as possible and so that the angle difference of each step is enough (as wide as possible).
- When the machine parameter file (ROBOT.C01) is protected, it cannot be run. Try after canceling the file protection.

7.7.2. Positioner calibration

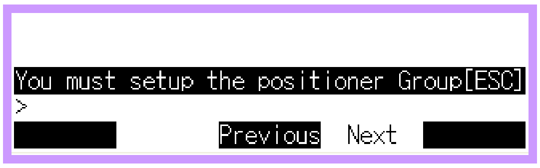
For details, please refer to 『Positioner function manual』.

(1) Select 『[PF2]: System』 → 『6: Automatic constant setting』 → 『4: Positioner calibration』 from initial screen of manual mode.



(2) Enter the program number for each positioner group and press the 『[PF5]: Execute』 key to see the results.

(3) If you do not do 『[PF2]: System』 → 『5: Initialize』 → 『5: Positioner group setting』 and select the positioner calibration, the following screen will appear.



Reference

- Calibration of 1 axis positioner

In case of 1 axis positioner, fix the sharp teach point on top of the positioner and teach 3 points and record the program while rotating by 30 degrees. The teaching method is as follows.

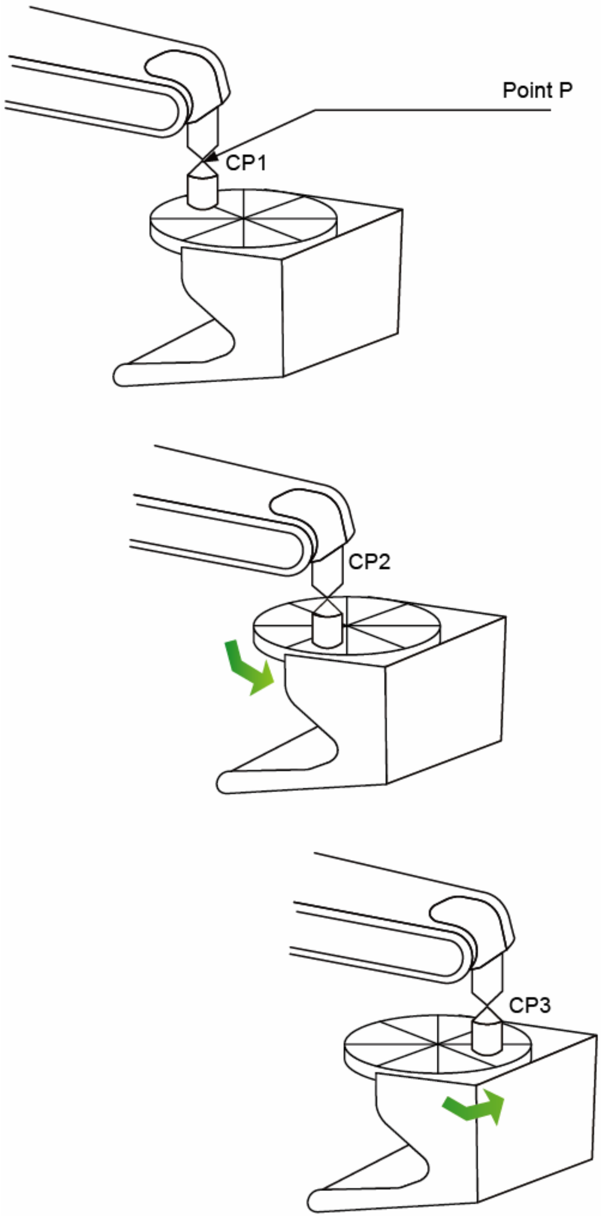


Figure 7.25 Calibration of 1 axis positioner

- Calibration of 2 axis positioner

  It is same as the 1 axis positioner but the only difference is that you need to record the program that teaches 5 points.

  ① Set the positioner on the standard location and record the first teaching point.

  ② Record the same teaching point by rotating the 2 axes of the positioner by 30 degrees.

  ③ Record the same teaching point by rotating the 2 axes of the positioner by another 30 degrees.

  ④ Only rotate 1 axis by 30 degrees and measure the 4th point.

  ⑤ Only rotate 1 axis by 30 degrees and measure the 5th point.

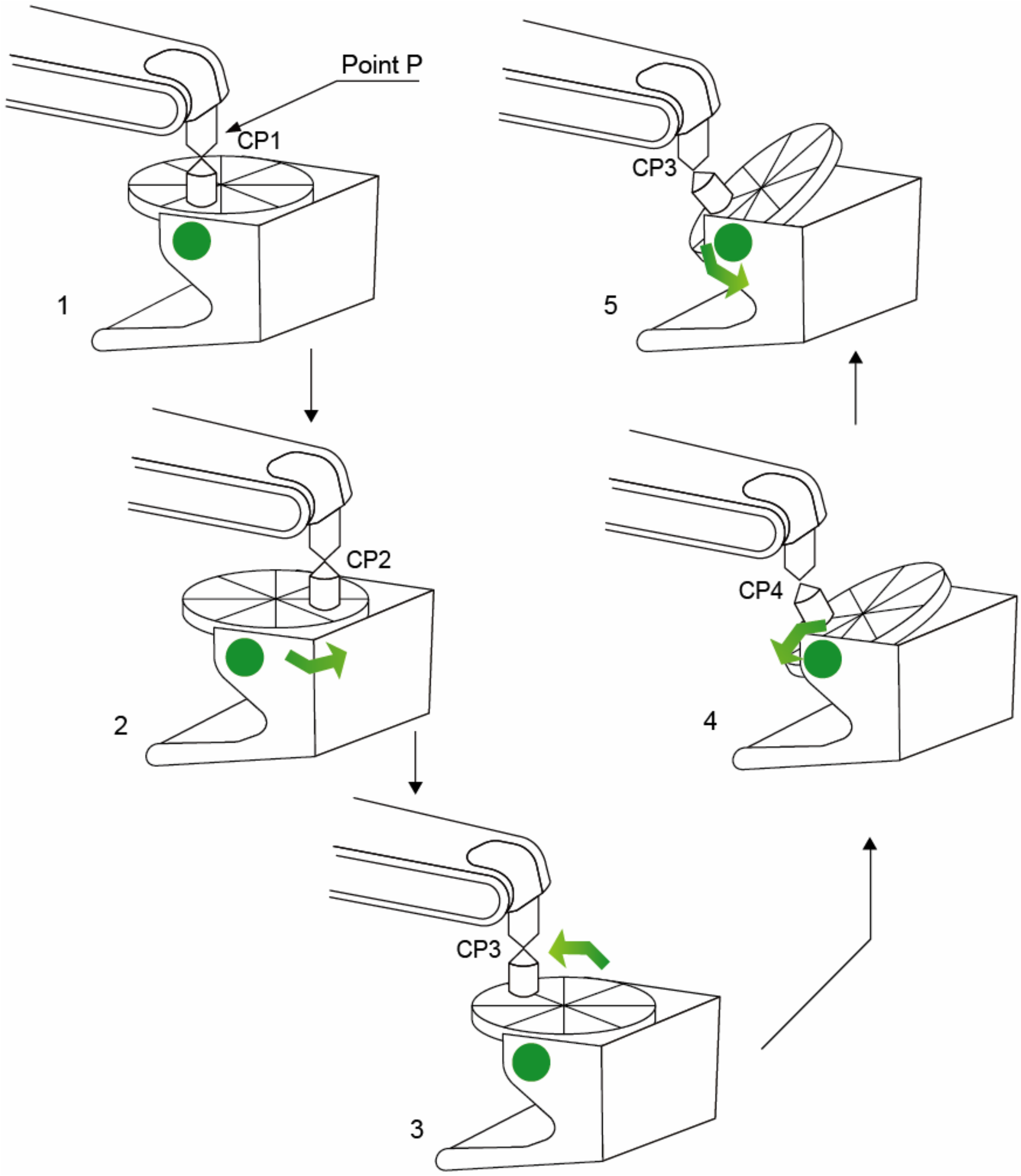
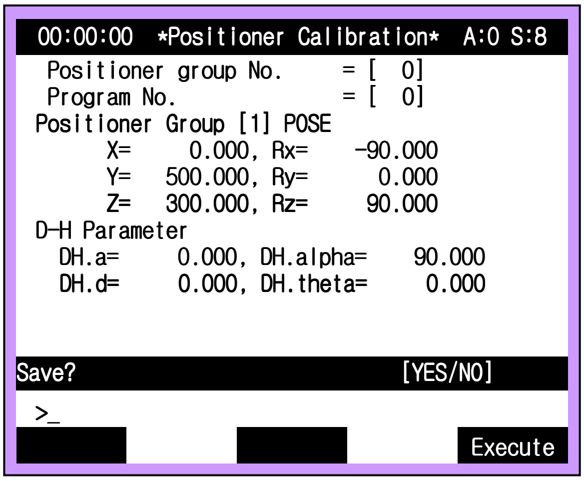


Figure 7.26 Calibration of 2 axis positioner

- Select 『[PF2]: System』 → 『6: Automatic constant setting』 → 『4: Positioner calibration』 and enter the program number 5 point teaching and the applicable positioner group. If you press the run key you will see the results and the positioner constant is saved in the controller. (확인 X - You must setup the positioner Group[ESC]



① Positioner Group [1] Pose
This is the location value from the base coordinate to base coordinate of the positioner. Rx, Ry and Rz angle values are absolutely converted from the base coordinate.

② D-H Parameter
For 2 axis positioner, DH.a and DH.alpha values are calculated. DH.a value refers to the distance between the two rotating axis and DH.alpha refers to the angle [deg] of the two rotating axis.
DH.d and DH.theta are always fixed to 0.

- The location of the robot tool end must be accurate. Therefore you must have the accurate robot tool information.

- The robot calibration must be done before positioner calibration.

- When the machine parameter file (ROBOT.C01) is protected, it cannot be executed. Cancel the file protection and move.

7.7.3. Laser vision sensor calibration

This is used to track the welding line by using the laser vision.

For details, please refer to the 『LVS tracking Function Manual』.

7.7.4. Load estimate function

The load estimate function is the function to calculate the weight and center of gravity of the load of the robot end based on the torque generated from each axis when the robot is operating.
Because the robot is controlled based on the dynamics model, you need the dynamics parameter for both the robot and the load. You can obtain the robot data from CAD in design phase but the load data can vary and it is impossible to calculate. This is why an automatic estimating function is needed.

7.7.4.1. Weight

This refers to the total load wait applied at the robot end. (kg)

7.7.4.2. Distance of center of gravity

This is the distance from the center of gravity of robot end to x, y and z direction. The unit is mm.

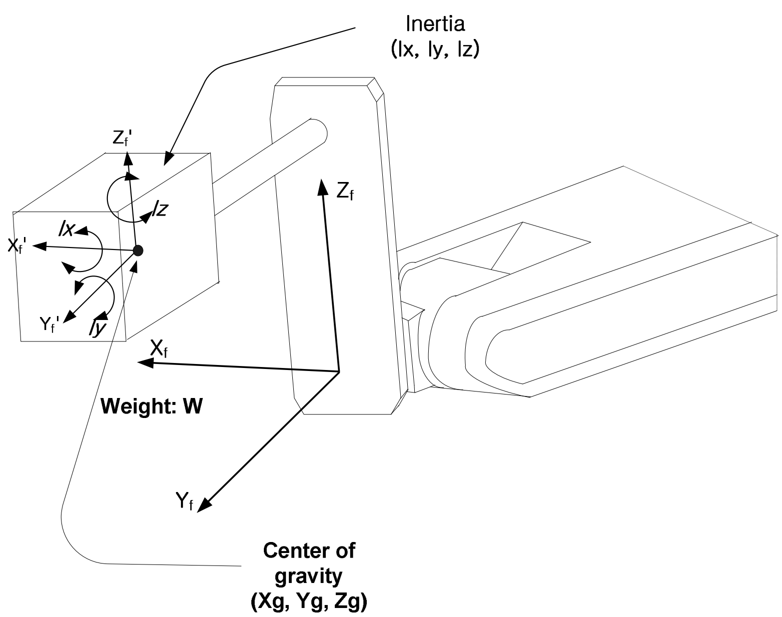
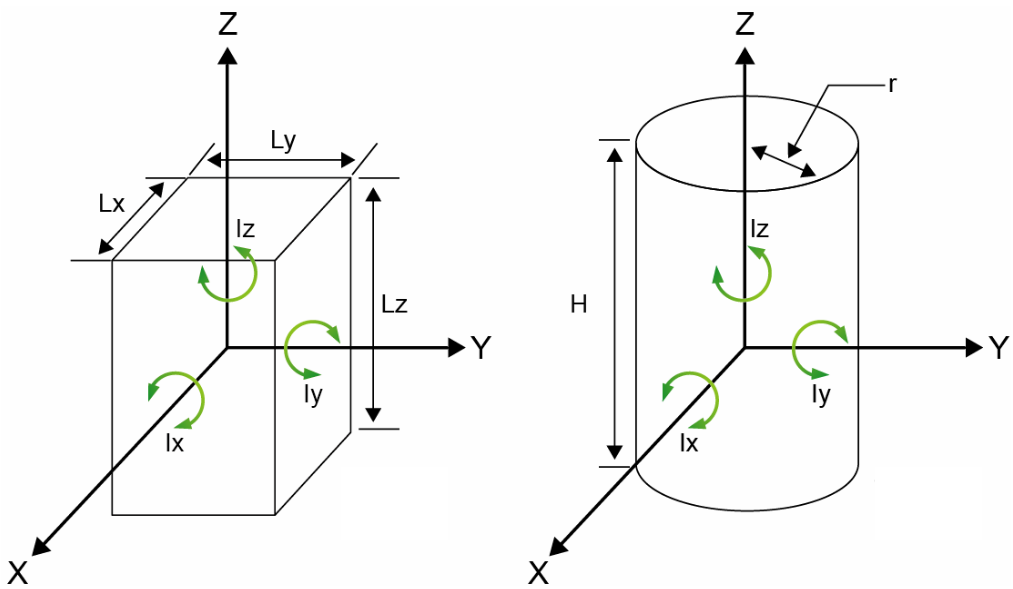


Figure 7.27 Center of gravity

7.7.4.3. Inertia

This refers to the inertia momentum of the load. Assuming that it rotates in x, y and z direction, it is the sum of square value of the mass distributed in the load and distance from the rotating axis.
Inertia is decided by the mass distribution around the axis and the farther away from the axis, the bigger the inertia.
Kgm2 unit is used for x, y and z axis.
There is no function in Hi4a controller to automatically calculate the inertia.
The method of calculating the inertia for the cube and cylinder, shown below, is as follows.



Inertia calculation for cube tool Inertia calculation for cylinder tool

$$Ix = \frac{\left(Ly^2 + Lz^2\right)}{12} \times W \quad Ix = Iy = \frac{\left(3r^2 + H^2\right)}{12} \times W$$

$$Iy = \frac{\left(Lx^2 + Lz^2\right)}{12} \times W \quad Iz = \frac{r^2}{2} \times W$$

$$Iz = \frac{\left(Lx^2 + Ly^2\right)}{12} \times W$$

Unit: Weight [kg], Length [m], Inertia [kg m²]

7.7.4.4. Method of executing load estimate function

There are two ways to use the load estimate function; load estimate 1 and load estimate 2.
The pro of using load estimate 1 is that it uses the non-load data to provide accurate estimate. But the con is that the non-load data file must be prepared before the load is applied.

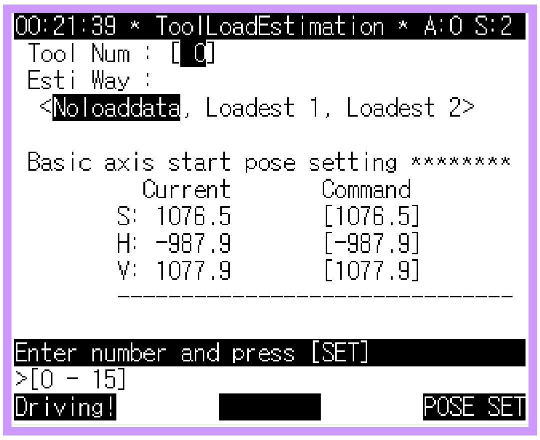
Load estimate 2 method has lower accuracy but does not require non-load data. So if the load is already applied without preparing the non-load data, load estimate 2 can be used. The steps of each method are as follows.

(1) Load estimate 1
Load estimate 1 is divided into 2 steps.
First step is to prepare the non-load data before applying the load. As a result, *.NL0 file will be created. Therefore when it is difficult to create a non-load data, you can use the file already created and copy to the controller.
Second step is to apply the load to the robot and calculate the weight and center of gravity. At this stage it is important to keep the same position as step 1. To do this, you just need to maintain the initial position in the load estimate function menu.

(2) Load estimate 2
Load estimate 2 is lower in accuracy but it is used when it is difficult to get non-load data, such as field site etc. In load estimate 2, you can run the function without the *.NL0 file. The operation to measure the load is same as load estimate 1.

7.7.4.5. Menu composition

(1) Select 『[PF2]: System』 → 『6: Automatic constant setting』 → 『6: Load estimation』 from initial screen of manual mode.

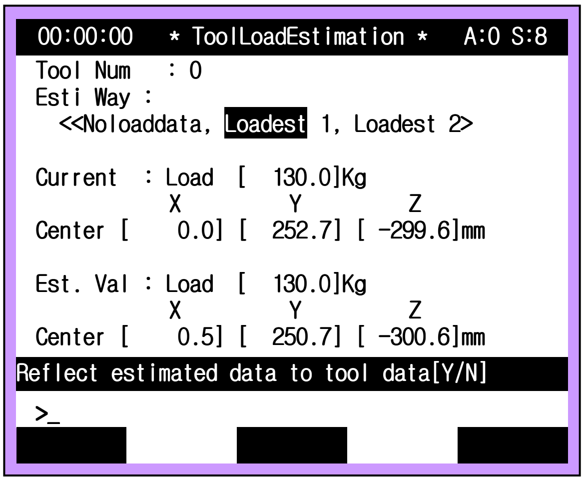


(2) Use the [SHIFT]+[←][→] key to decide the tool number at the end of the current robot and the load estimate method number.

(3) The load estimate program will move to the robot body without colliding with the surrounding jig. Press the 『[PF5]: POSE SET』 key to designate the starting position of the robot to do the load estimate program.

(4) Press the 『[PF1]: Driving!』 key to start the load estimate.

(5) When <Load estimate 1> or <Load estimate 2> is selected, press the 『[PF1]: Driving!』 key to run the operation to obtain the load information and the robot controller will calculate the load data and display the load data in the following screen.

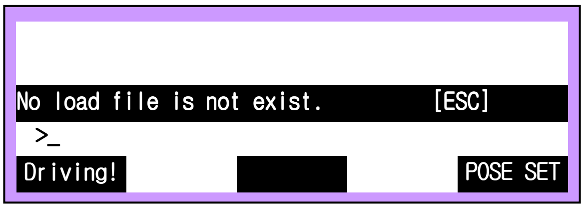


(6) If you press [YES] to the question in the screen『Reflect estimated data to tool data? [Y/N]』, the estimated results are reflected to 『[PF2]: System』 → 『3: Robot parameter』 → 『1: Tool data』. If you press [NO] it will not be reflected.

- Tool Num
  Enumerate the tool on the robot end to use. In Hi4a controller, you can set up to 10 tools from 0 to 9.

- Esti Way
  ① Noloaddata
  Select to create the non-load data file (ROBOT.NL0) without applying the load to the robot. To create the file, move the robot to an appropriate location and press『[PF5]: pose setting』 key, and then the 『[PF1]: Driving!』 key. To obtain data using load estimate 1, you must have a non-load data file (ROBOT.NL0).

  ② Loadest 1
  If you have a non-load data file in the internal memory, select load estimate 1 and press the "Operation start"[PF1] key to calculate the weight and center of gravity. If the non-load data file (ROBOT.NL0) does not exist, press the 『[PF1]: Driving!』 key to see the following message.



  ③ Loadest 2
  If you do not have a non-load data in internal memory, press 『[PF1]: Driving!』 key to calculate the weight and center of gravity.

- Main axis start position designation

This designates the starting position of the robot to be used for estimate methods. Move the base axis of the robot to move to a location without interference and press the 『PF5: POSE SET』 key to designate the starting position. As explained before, to use the load estimate 1 function, the starting position of non-load preparation must be the same as the starting position.

Even though S axis and H axis does not have a position limit, V axis should set the position to -60 deg or above. Keeping the angle near 0 increases the accuracy of the measurement. If you set the V axis angle to below -60deg, you will see the message 『V axis angle must be over -60degree[ESC]』.

The starting position of the write axis is defined automatically to be R2=0.0deg, B=-Vdeg and R1=0.0deg. In other words, R2 and R1 axis is set to 0 deg and the B axis should be set to opposite of V axis to maintain horizontal position.

① Current value: It indicates the position of the main axis (S, H, V) of the robot in degrees.
② Designated value
When the non-load data file (ROBOT.NL0) exists, the angle of main axis of the robot (S, H, V) is shown.

7.7.4.6. Load estimate program composition

Load estimate program is composed as follows. S and H axis is to maintain the used angle and must be in stopped. V axis requires stopped condition besides the 5 deg lift at the last stage.

『Driving!』 → 『R1 axis 5deg round trip operation』 → 『R1 axis 60deg position change』 → 『R1 axis 5deg round trip operation』 → 『Recover to start position』 → 『B axis 5deg round trip operation』 → 『V axis 5deg round trip operation』 → 『Complete』

7.7.5. Common coordinate of cooper. robots

This function is only used for 『Cooperative control』 function. If you are not using collaborative control, you cannot set this function. Cooperative control function is an option and please refer to 『Cooperative control Function Manual』 for more details.

(1) Check if the robot collaboration is set to ‘Enable’ in 『[PF2]: System』 → 『2: Controller parameter』 → 『14: Network』 → 『1: Application & Configuration』 from initial screen of manual mode.

(2) Teach the common coordinate setting program. Teach in sequence, the common 3 points in space using calibrated TCP.

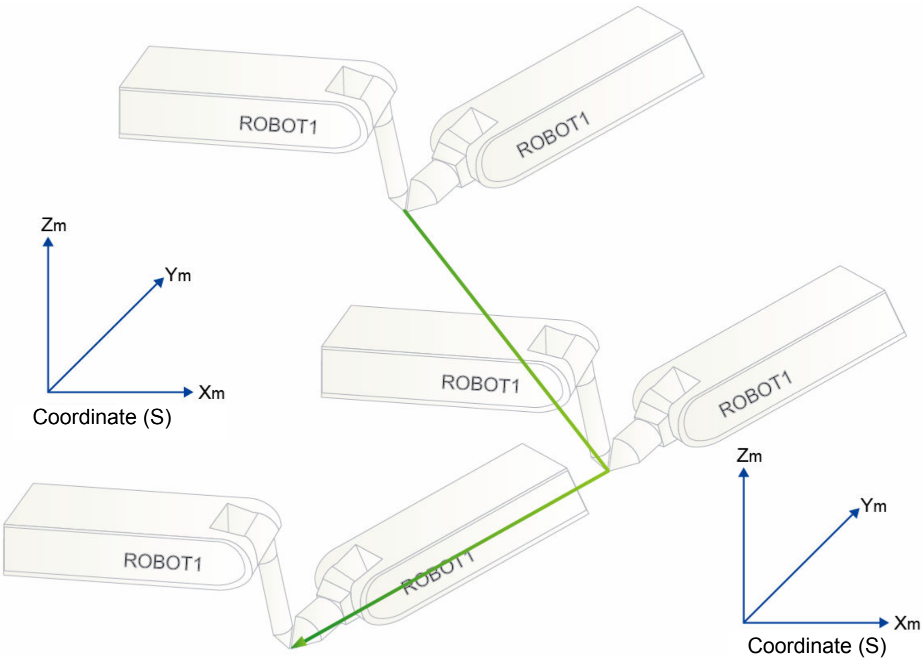
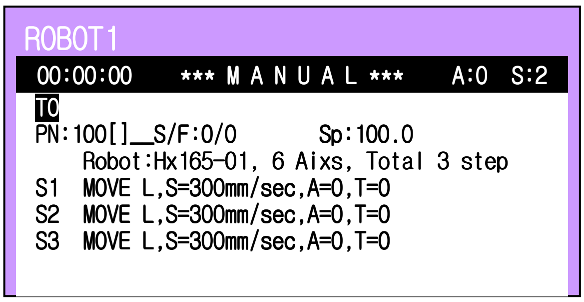
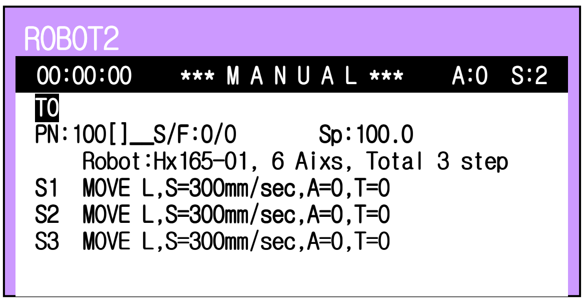
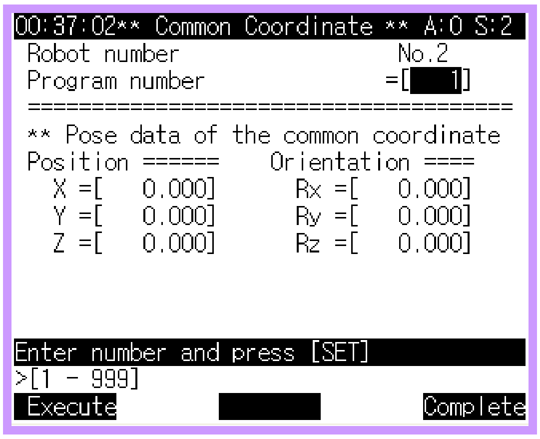


Figure 7.28 Common coordinate setting for collaborative robot

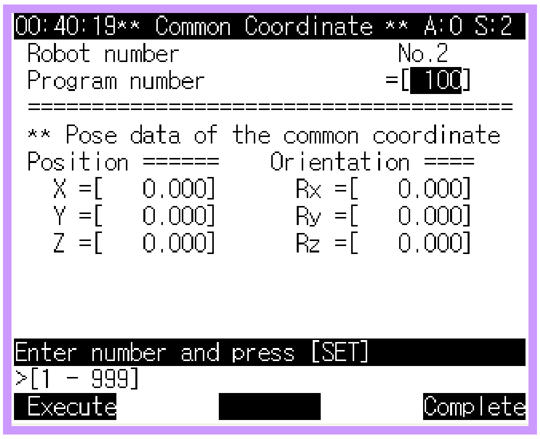




(3) Select 『[PF2]: System』 → 『6: Automatic constant setting』 → 『7: Common coordinate of cooper.robots』 from initial screen of manual mode.



(4) Enter the program number taught in ‘program number’ and press 『[PF1]: Execute』 key to display the common coordinate set value. Press the 『[PF5]: Complete』 key to save the values and complete the setting.



7.7.6. Traverse axis calibration

Applied version

- Main V10.07-25 or later

7.7.6.1. Introduction

This function is to calibrate the search direction of the traverse axis. It is impossible to install the traverse axis accurately aligned to the direction (X, Y and Z) of robot coordinate. Therefore this function calculates the direction of the traverse axis and improves the straight line interpolation path performance including the main axis.

As shown in the figure, install the robot in the traverse axis and find an arbitrary direction vector to do the location calibration of the robot.

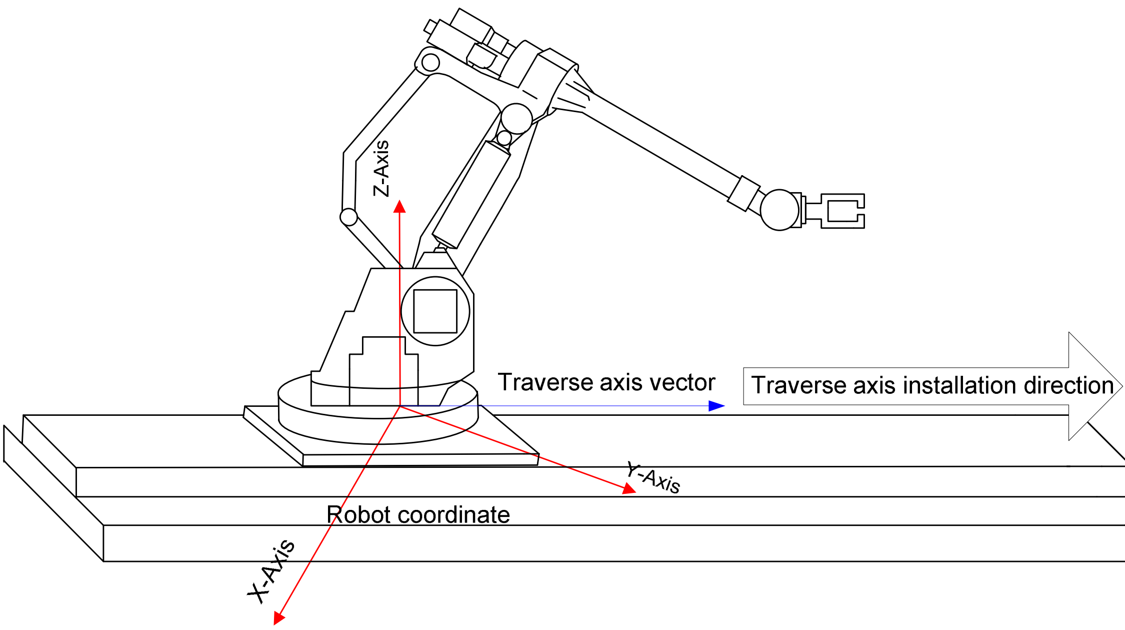


Figure 7.29 Traverse axis calibration

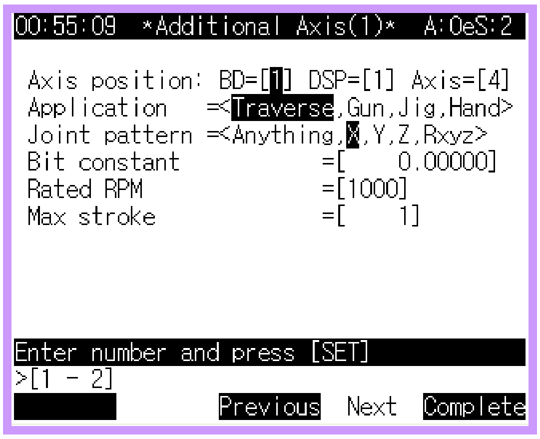
7.7.6.2. Function usage

Generally the use of main axis is to move the robot to the work location but in special cases call for the traverse axis to ensure straight path.

- When two robots are moving back the work object in cooperative control
- When the robot is doing interpolation along the traverse axis

7.7.6.3. Initial setting of traverse axis

(1) Select 『[PF2]: System』 → 『5: Initialize』 → 『21: Additional axes setting』 from initial screen of manual mode. (or additional axis setting menu appears during system initialization.) Additional axis constant setting menu is for engineers. Therefore general users cannot check the menu. Please consult your engineer for more details.



(2) Set the axis position to <Traverse> and set the application to <Anything>. Then enter the bit constant, rated RPM and max stroke by mechanical specification.

(3) The servo parameter of the additional axis is accurately set to the specification. Please refer to the additional axis user manual for details.

◆【Caution】◆

- You can only use the calibration function for the first traverse axis. Therefore, only the first traverse axis should be set to <Anything>. Do not set it as <Anything> from second on.

7.7.6.4. Calibration program teaching

(1) Establish the reference point in space and record the first reference point.

```
 00:00:00   *** M A N U A L ***   A:0  S:3
T0
PN:100[*]__S/F:0/0        Sp:100.0
    Robot:Hx165-02, 6Aixs, Total 4step
S1  MOVE L,S=300mm/sec,A=0,T=0
```

(2) Move the main axis more than 200mm and record the same point in the second step.

(3) Just like the prior step, do the same for 1st and 2nd point and record 3rd and 4th point at least 200mm apart.

```
 00:00:00   *** M A N U A L ***   A:0  S:3
T0
PN:100[*]__S/F:0/0        Sp:100.0
    Robot:Hx165-02, 6 Aixs, Total 4 step
S1  MOVE L,S=300mm/sec,A=0,T=0
S2  MOVE L,S=300mm/sec,A=0,T=0
S3  MOVE L,S=300mm/sec,A=0,T=0
S4  MOVE L,S=300mm/sec,A=0,T=0
```

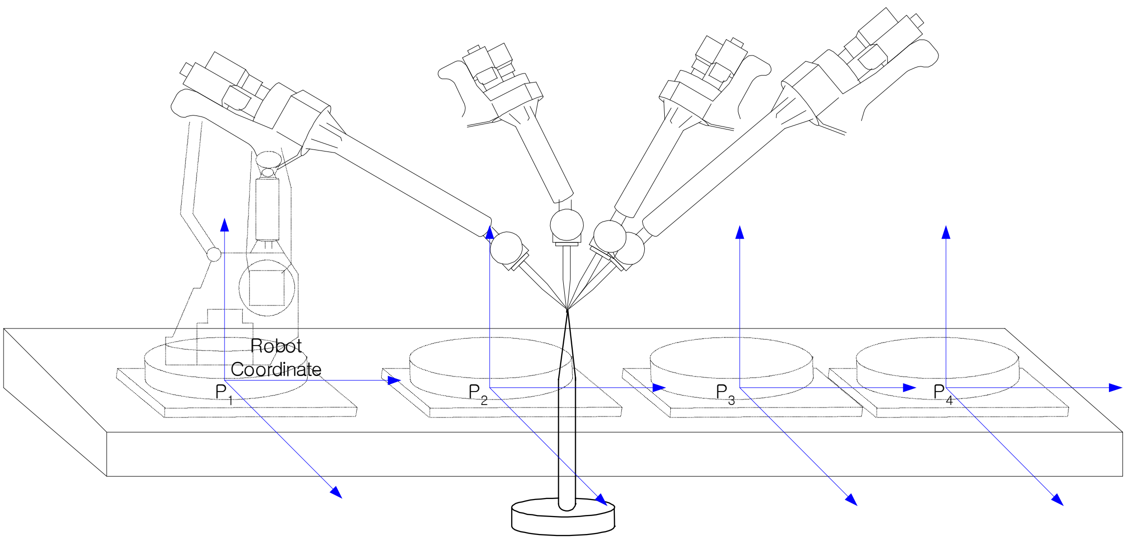


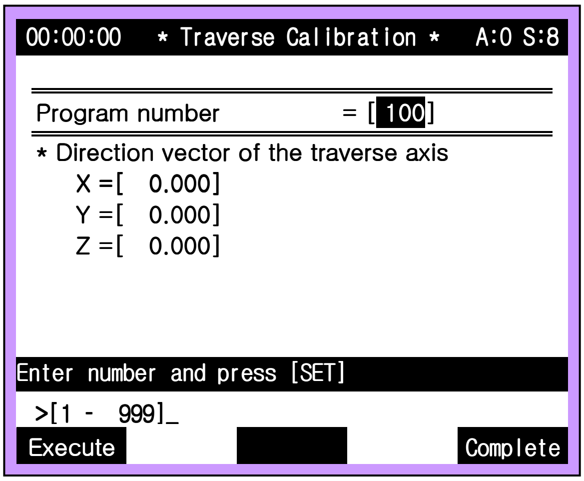
Figure 7.30 Calibration program teaching

◆【Caution】◆

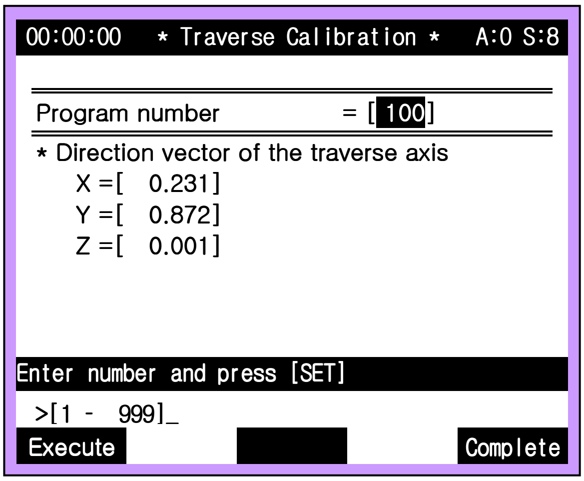
- Keep the tool number in mind when recording. You must enter the tool number for traverse axis calibration.
- Record the locations as farther away as you can for between steps.

7.7.6.5. Traverse axis calibration

(1) Select 『[PF2]: System』 → 『6: Automatic constant setting』 → 『8: Traverse axis calibration』 from initial screen of manual mode.



(2) Enter the program number for main axis calibration and press [PF1] key. The installation direction vector value of the traverse axis is displayed. Press the [PF5] key.



7.7.6.6. Operation after calibration for traverse axis

If you operate the jog function after the calibration, you can calculate the current coordinate from directional vectors generated from the traverse axis.

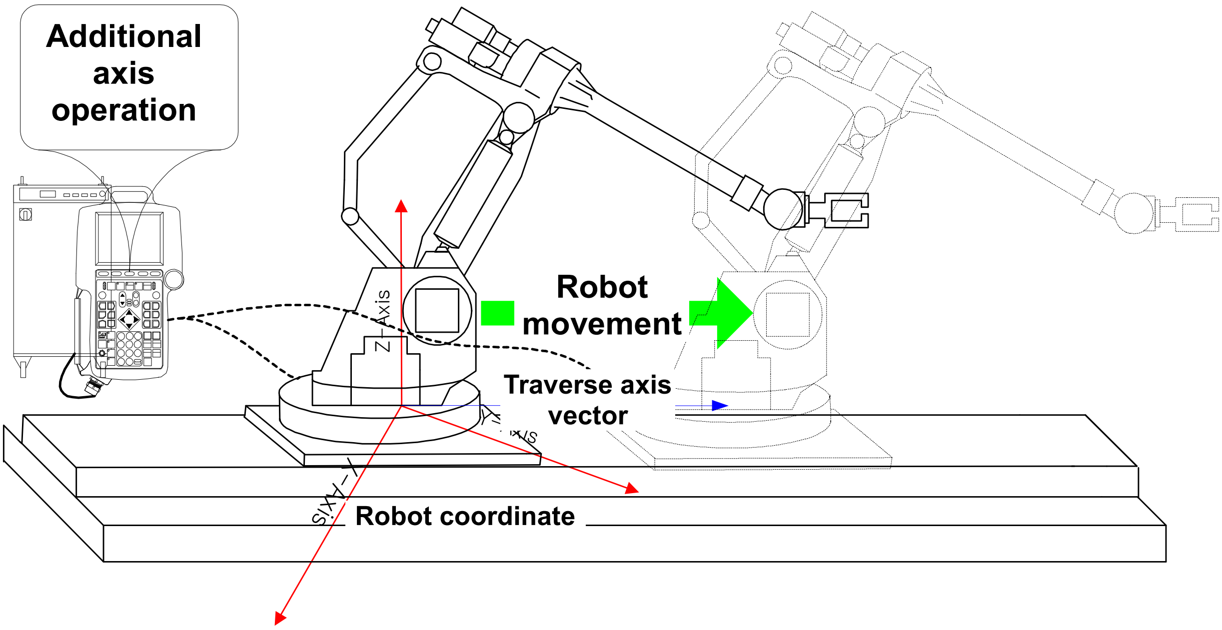
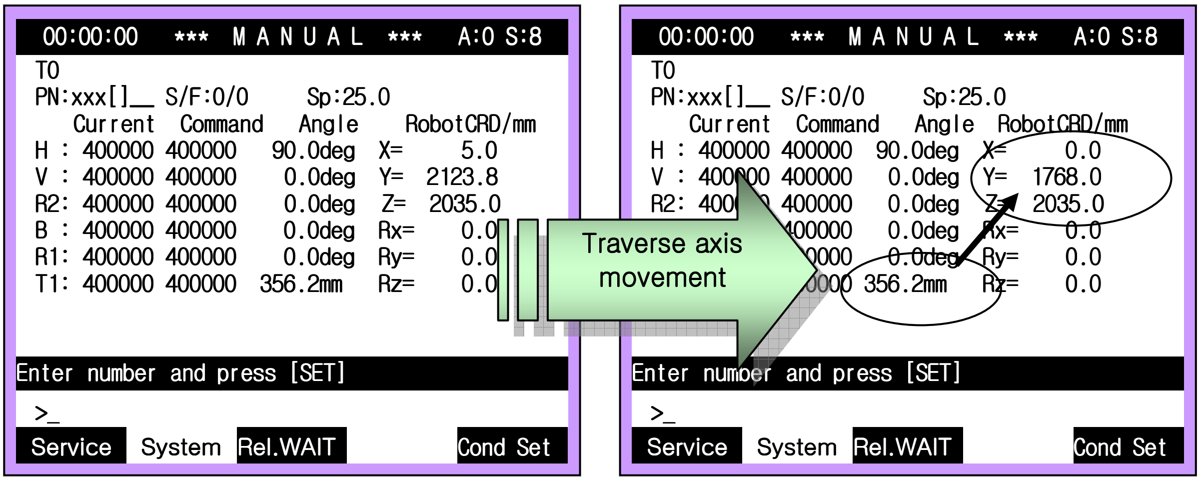


Figure 7.31 Operation after calibration for traverse axis

(1) Select 『[PF1]: Service』 → 『1: Monitoring』 → 『1: Axis data』 and you can check the calculated coordinate value from traverse axis movement.



(2) Jog operation :

If you jog operate the main axis, you can calculate the direction of the traverse axis in XYZ value and monitor the coordinates.

(3) Step recording and playback are same as typical steps.

◆【Caution】◆

- When you set the traverse axis composition to <Anything> and not do the calibration, the traverse axis will not operate.
- Set the jog coordinate to tool coordinate after calibration and execute the jog operation for traverse axis to make it a static operation for the tool end. Using this method, check whether the calibration is normally executed.

8

R-code

8.1. R-code

R-code is function equivalent to the [R..(NO)] of teaching pendant. (R means 『Reset』 and 『Rapid』)

This function enables to rapidly manipulate operation procedure such as contents modify of program or change of controller setting status by abbreviating them to one service code.

(1) Following screen is displayed in the Guide frame if pressing the [R..(NO)] key:

```
Enter R code No ( 0 - 9999 )
>R
Service  System Rel.WAIT          Cond Set
```

(2) Relevant function is executed if inputting desired code number and then pressing the [SET] key.

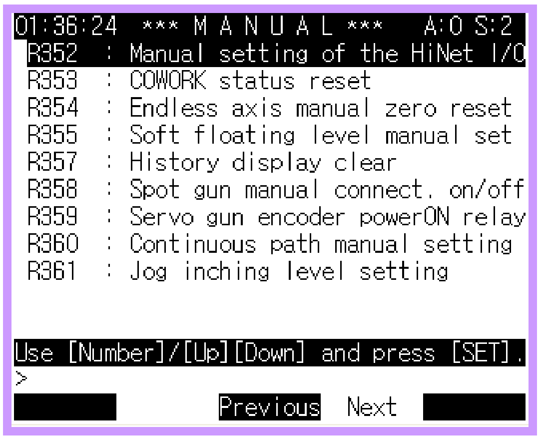
(3) Following screen is displayed pressing the [Help] key when failing to momorize code number and you can execute functions by inputting a cursor key or numbers.

```
01:33:36  *** M A N U A L ***    A:0 S:2
 R0    : Step counter reset
 R5    : External start selection
 R6    : External program selection
 R10   : Run time display
 R17   : Name of file in the memory
 R18   : Frequency condition register
 R29   : Tool number setting
 R44   : Conveyor data clear
 R45   : Conveyor register manual input
 R46   : Manual conveyor limit switch on
 R49   : Speed rate setting
Use [Number]/[Up][Down] and press [SET].
>
                Previous  Next
```

```
01:34:46  *** M A N U A L ***    A:0 S:2
 R55   : Palletizing reset
 R71   : Speed definition type selection
 R107  : Program head data display
 R115  : Program copy
 R116  : Program renaming
 R117  : Program deleting
 R123  : Robot lock
 R136  : Modifying accuracy in steps
 R137  : Modifying MX in steps
 R138  : Modifying gun in steps
 R162  : Shift buffers setting
Use [Number]/[Up][Down] and press [SET].
>
                Previous  Next
```

```
01:35:07  *** M A N U A L ***    A:0 S:2
 R163  : Online shift cancel
 R204  : Spot Weld. Cond. manual output
 R210  : Servo gun number selection
 R211  : Squeeze force setting
 R212  : Moving-tip consumption preset
 R213  : Fixed-tip consumption preset
 R219  : Equalizerless gun No. selection
 R220  : Equalizing tip consump. preset
 R225  : Squeeze force set of servo hand
 R245  : Monitor mode selection
 R246  : DIO signal monitor
Use [Number]/[Up][Down] and press [SET].
>
                Previous  Next
```

```
01:35:40  *** M A N U A L ***    A:0 S:2
 R247  : Spot welding data monitor
 R248  : PLC relay data monitor
 R250  : Data display for Laser sensor
 R269  : Program protect
 R286  : Software version
 R300  : Maximum value clear
 R310  : Manual output of 0-byte signal
 R320  : Set max speed of step go/back
 R341  : Execution code backup
 R350  : Endless axis manual reset
 R351  : Cooperation status exchange
Use [Number]/[Up][Down] and press [SET].
>
                Previous  Next
```


01:36:24 *** M A N U A L *** A:0 S:2
R352 : Manual setting of the HiNet I/O
R353 : COWORK status reset
R354 : Endless axis manual zero reset
R355 : Soft floating level manual set
R357 : History display clear
R358 : Spot gun manual connect. on/off
R359 : Servo gun encoder powerON relay
R360 : Continuous path manual setting
R361 : Jog inching level setting
Use [Number]/[Up][Down] and press [SET].
>
Previous Next

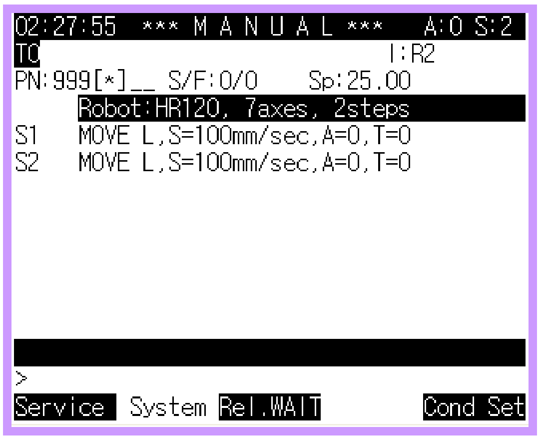
8.2. R0 Step counter reset

Initialize step counter. Namely, move to the STEP0.

Besides,

- Clear playback execution status
- Turn off general failure signal lamp
- Turn off alarm signal
- Execute WAIT standby status clear.

(1) Press the [R..(NO)] key → [0] → [SET(YES)] key.



Reference

- This function cannot be used when Robot operates.
- Robot operates in the same manner even by pressing the [R..] [SET] key.

8.3. R5 External start selection

Determines whether outside operation is selected. Set set Select Outside Operation as ENBL when desiring to operate Robot with outside digital input (DI) signal without operating Robot by pressing operation button of the operation panel.

(1) Following screen is displayed if pressing the [R..(NO)] key→ [5] → [SET(YES)] key:

```
Set Ext start selection (DSBL=0, ENBL=1)
>R5,0
Service  System Rel.WAIT          Cond Set
```

(2) Input 1(= ENBL) or 0(= DSBL) with [Number] key and then press the [SET] key.

Reference

- Displayed on the Title frame in the AUTO mode as follow if pressing outside operation as ENBL:

```
02:30:00    * AUTO(Ext.Start)*    A:0 S:2
TC                          SR:100% 1Cycl
PN:999[*]__ S/F:0/0
     Robot:HR120, 7axes, 2steps
S1   MOVE L,S=100mm/sec,A=0,T=0
S2   MOVE L,S=100mm/sec,A=0,T=0

>
Service          Rel.WAIT          Cond Set
```

- This function cannot be used when Robot operates.
- Values displayed on the screen before inputting frequency display status currently set.
- This is same function as 『[PF2]: System 』 → 『1: User parameter』 → 『3: Robot start type』.

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8.4. R6 External program selection

Determines whether Select Outside Program is performed. Set set Select Outside Program as ENBL when desiring to select outside digital input (DI) signal without using the [SHIFT]+[program] key of teaching pendant.

(1) Following screen is displayed if pressing the [R..(NO)] key→ [6] → [SET(YES)] key:

```
Set Ext program selection(DSBL=0,ENBL=1)
>R6,0
Service          Rel.WAIT          Cond Set
```

(2) Input 1(= ENBL) or 0(= DSBL) with [Number] key and then press the [SET] key.

Reference

- Displayed on the Title frame in the AUTO mode as follow if pressing outside program as ENBL:

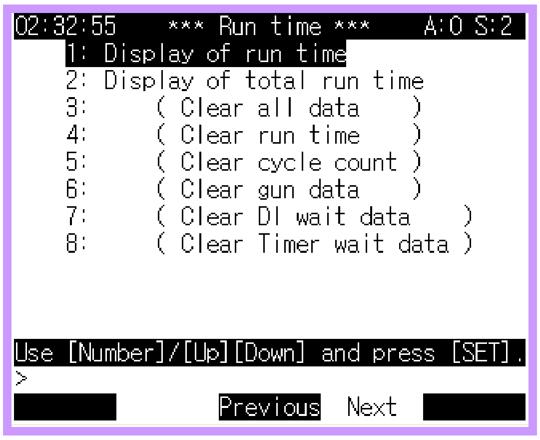
```
02:31:54    ** AUTO(Ext.P_S)**    A:0 S:2
TC                          SR:100% 1Cycl
PN:999[*]__ S/F:0/0
     Robot:HR120, 7axes, 2steps
S1    MOVE L,S=100mm/sec,A=0,T=0
S2    MOVE L,S=100mm/sec,A=0,T=0



>
Service          Rel.WAIT          Cond Set
```

- This function cannot be used when Robot operates.
- Values displayed on the screen before inputting frequency display status currently set.
- This is same function as 『[PF2]: System 』 → 『1: User parameter』 → 『9: External program select』.

8.5. R10 Run time display



Reference

- This is same function as『[PF1]: Service』 → 『7: System checking』 → 『2: Running time』.

8.6. R17 Name of file in the memory

Displays file name (Robot type, program number), file size, preparation date, file protection status, etc of inner memory. Displays information of total file numbers, remained memory quantity in the last after displaying files of inner memory.

(1) Following screen is displayed if pressing the [R..(NO)] key → [17] → [SET(YES)] key:

```
02:34:12  *** M A N U A L ***   A:0 S:2
TC                            I:R2
PN:999[*]__ S/F:0/0     Sp:25.00
 ROBOT    .C00    252 2006-01-01 00:57 __
 ROBOT    .C01    452 2006-01-01 01:40 __
 ROBOT    .E01   1212 2006-01-01 01:40 __
 ROBOT    .INF      0 2006-01-01 00:00 W_
 ROBOT    .S01   1212 2006-01-01 01:40 __
 ROBOT    .TR0    101 2006-01-01 01:40 __
 ROBOT    .WL2    322 2006-01-01 00:31 __
 12 file, 60962 block free.
>>
Use cursor Up/Down, then [ESC] for exit.
>
Service  System Rel.WAIT         Cond Set
```

Reference

- This function cannot be used when Robot operates.
- The WSP_ displayed in the end displays protection of file.
  W: Complete protection (prohibiton of various delete/change)
  S: Partial protection(only position modification allowed in complete protection)
  P: Replay protection(prohibition of replay/step forward from step No. 0)
  _: No protecton
- You can scroll the screen by using the [Direction] key.
- Displayed contents are different from the『[PF1]: Service』 → 『5: File manager』 → 『1: Show file names in memory 』.

8.7. R18 Frequency condition register

This is function to check contents of frequency condition register or change them to optional values. For example, determines whether function will be executed by comparing functions used with setting values of frequency conditions register, when using functions such as Step jump (frequency condition), Step call (frequency condition), Step return(freq condition), Step jump with function(Freq), Program call (freq condition), Program jump (frequency condition), Function jump (frequency condition) and Relative Prog call(Freq condi).

(1) Following screen is displayed if pressing the [R..(NO)] key → [18] → [SET(YES)] key:

```
Enter frequency register No ( 1 - 16 )
>R18,0
Service  System Rel.WAIT          Cond Set
```

(2) Following screen is displayed if pressing the [SET] key after inputting frequency register number with the [Number] key:

```
Enter register data ( 0 - 255 )
>R18,1,0
Service  System Rel.WAIT          Cond Set
```

(3) Input frequency register value with the [Number] key and then press the [SET] key.

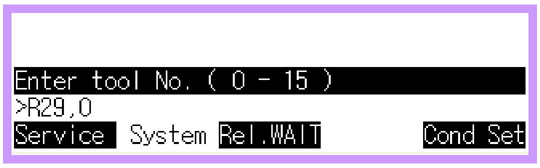
Reference

- This function cannot be executed in AUTO mode. Always use it in Manu al mode.
- Values displayed on the screen before inputting numbers represents current setting status.
- This is same function as『[PF1]: Service』 → 『1: Register』 → 『5: Frequency condition Register』.

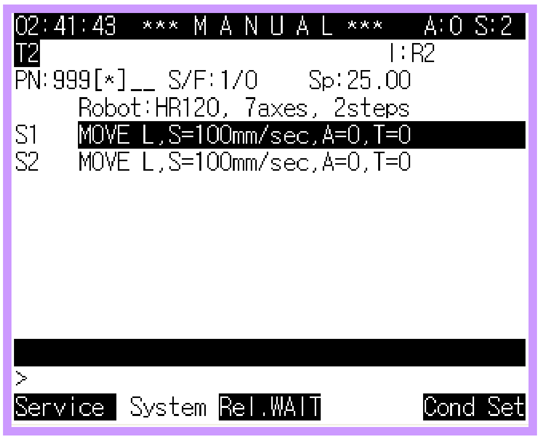
8.8. R29 Tool number setting

Changes tool number attached to the end of R1 axis of current Robot.

(1) Following screen is displayed if pressing [R..(NO)] key → [29] → [SET(YES)] key:



(2) Tool number is changed if pressing the [SET] key after inputting tool number with the [Number] key. The changed tool number is displayed on the firt line of the Edit frame. Following screen represents case that sets 2 as tool number.



Reference

- This function cannot be executed in AUTO mode. Always use this function in Manual mode.
- Values displayed on the screen before inputting numbers represents current setting status.

8.9. R44 Conveyor data clear

Clears conveyor data(CP, CR, CS).
Cleared items are as follow depending on the mode from the『[PF1]: AppliCnd』 → 『1: Conveyor Oper=<Normal,Simulat.,Test>』:

	Normal	Simulation	Test
CP (pulse)	Clear	Maintains current pulse	Clear
CR (distance)	Clear	Clear	Clear
CS (speed)	Clear	Clear	Always “0”

(1) Following screen is displayed if pressing the [R..(NO)] key → [44] → [SET(YES)] key: (확인 X - In conveyor synchro. mode, Use! [ESC])

```
Conveyor data clear. Continue?  [YES/NO]
>
Service  System Rel.WAIT        Cond Set
```

Press the [YES] key to clear conveyor data.

Reference

- This function cannot be used when Robot operates.
- Input status of limit switch is also cleared. Therefore, new limit switch input must be done to start pulse counting.
- This function is same as『[PF1]: Service』 → 『2: Register setting』 → 『6: Conveyor data』 → 『2: Conveyor data reset』.

8.10. R45 Conveyor register manual input

Changes Conveyor Register(CR) value.
In this case, conveyor pulse (CP) value is changed to pulse value equivalent to input Conveyor Register value.

(1) Following screen is displayed if pressing the [R..(NO)] key → [45] → [SET(YES)] key:

```
Warning!)Change Conveyor Register? [Y/N]
>
Service  System Rel.WAIT          Cond Set
```

(2) Conveyor register value is changed if pressing the {YES} key. This function is cancelled if pressing the [NO] key.

```
02:50:09  *** M A N U A L ***   A:0 S:2
T2                  CN1        I:R2
PN:xxx[ ]__ S/F:0/0    Sp:25.00



Enter CR value. (-99999.9 - 99999.9 mm)
>R45,
Service  System Rel.WAIT          Cond Set
```

(3) Input value of Conveyor Register with the [Number] key and then prerss the [SET] key.

Reference

- This function cannot be executed in AUTO mode. Always use it in Manual mode.
- CP/CR value do not increase even though the conveyor goes unless the limit switch does not operate if Conveyor Register(CR) value is changed (If not beding '0').
- Value of changed Conveyor Register can be checked with monitoring of conveyor data.
- This is same function as Register (CR) on the『[PF1]: Service』 → 『2: Register setting』 → 『6: Conveyor data』 → 『1: Conveyor simulation data』 screen.

8.11. R46 Manual conveyor limit switch on

Starts pulse counting by compulsorily inputting limit switch operation signal from teaching pendant irrespective of operation of actual limit switch.

(1) Following screen is displayed if pressing the [R..(NO)] key → [46] → [SET(YES)] key:

```
Warning!) Limit Switch ON?        [YES/NO]
>
Service  System Rel.WAIT          Cond Set
```

(2) If pressing the [YES] key, the limit switch is compulsorily input so as to start pulse counting or enter into multiple of works. This function is cancelled if pressing the [NO] key.

Reference

- This function cannot be executed in AUTO mode. Always use it in Manual mode.
- This is function only when set to Simulation Test or Test in the『[PF1]: AppliCnd』 → 『1: Conveyor oper=<Normal,Simulat.,Test>』.

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8.12. R49 Speed rate setting

Sets speed variable value for replay. Namely, varies speed recorded in step within scope of [1 ~ 100]% for replay.

(1) Following screen is displayed if pressing the [R..(NO)] key → [49] → [SET(YES)] key:

```
Enter speed rate ( 1 - 100 )
>R49,50
Service  System Rel.WAIT          Cond Set
```

(2) You can identify changed value from the first line of AUTO mode edit frame if pressing the [SET] key after inputting speed variable value with the [Number] key. Following screen shown case that sets speed variable value to 100%.

```
03:00:48     *** A U T O ***      A:0 S:2
T2                           SR:100% 1Cycl
PN:999[*]__ S/F:0/0
     Robot:HR120, 7axes, 2steps
S1   MOVE L,S=100mm/sec,A=0,T=0
S2   MOVE L,S=100mm/sec,A=0,T=0





>
Service         Rel.WAIT          Cond Set
```

Reference

- Values displayed on the screen before inputting numbers represents current setting status.
- This is same function as『[PF5]: Cond set』 → 『4:. Speed rate』.

8.13. R55 Reset of palletize

This function is used when using palletize function and initializes contents of palletize pattern register.

(1) Following screen is displayed if pressing the [R..(NO)] key → [55] → [SET(YES)] key:

```
Input the palletize pallet number.(1-16)
>[1 - 16]
Service        Rel.WAIT        Cond Set
```

(2) Following screen is displayed if pressing the [SET] key after inputting desire pallet number (palletize pattern register number):

```
End palletizing?                [YES/NO]
>
Service        Rel.WAIT        Cond Set
```

(3) Setting value of the selected palletize pattern register is initialize if pressing the [YES] key. This function is cancelled if pressing the [NO] key.

Reference

- This function cannot be used when Robot operates.

8.14. R71 Speed definition type selection

Selects method to designate speed when recording step. There are three selection methods such as Standard=0, [%] designation=1, [mm/s] designation=2.

0	**Standard**	Interpolation OFF	[%] designation
		Interpolation ON	[mm/s] designation
1	**[%]**	Interpolation OFF	[%] designation
		Interpolation ON	[%] designation
2	**[mm/s]**	Interpolation OFF	[mm/s] designation
		Interpolation ON	[mm/s] designation

Interpolation ON is a case of straight interpolation or arc interpolation.

(1) Following screen is displayed if pressing the [R..(NO)] key → [71] → [SET(YES)] key:

```
Rec speed type?(Standard=0,%=1,mm/s=2)
>R71,0
Service          Rel.WAIT          Cond Set
```

(2) Following screen is displayed if pressing [SET] key after selecting record speed designation method.

```
03:04:55  *** M A N U A L ***   A:0 S:2
T2                              I:R2
PN:999[*]__ S/F:0/0     Sp:50
     Robot:HR120, 7axes, 2steps
S1   MOVE L,S=100mm/sec,A=0,T=0
S2   MOVE L,S=100mm/sec,A=0,T=0

>
Service  System Rel.WAIT          Cond Set
```

Reference

- This function cannot be used when Robot operates.
- This is same function as 『[PF5]: Cond Set』 → 『6: Rec speed type』.

8.15. R107 Program head data display

Displays notations recorded in Step 0. Displays contents of Step 1 where there is no notation statement recored idn Step 0.

(1) Following screen is displayed if pressing the [R..(NO)] key → [Number] key [107] → [SET(YES)] key:

```
00:02:34  *** M A N U A L ***   A:0 S:2
TC
PN:001[*]__ S/F:0/0    Sp:50
E1101  2Ax)Soft limit
E1101  3Ax)Soft limit
E1101  4Ax)Soft limit
E1101  5Ax)Soft limit
E1101  6Ax)Soft limit
E1111 Too large angle between arms
PNo: Content of head data -------------
001: MOVE L,P1,S=100mm/sec,A=0,T=0
>>
Use cursor Up/Down, then [ESC] for exit.
>
Service  System Rel.WAIT         Cond Set
```

(2) Press the [ESC] key after checking contents.

Reference

- This function cannot be used when Robot operates.
- You can scroll a screen by using [Direction] key.
- This is same function as『[PF1]: Service』 → 『5: File manager』 → 『2: Program head data display』.

8.16. R115 Program copy

Copies program of inner memory to different program number of inner memory. First program number to copy and then input program number to be copied.

(1) Following screen is displayed if pressing the [R..(NO)] key → [115] → [SET(YES)] key:

```
Source program to copy? (1-999)
>R115,
Service  System Rel.WAIT        Cond Set
```

(2) Following screen is displayed if pressing the [SET] key after inputting program number to copy with the [Number] key:

```
Destination program to copy? (1-999)
>R115,999,
Service  System Rel.WAIT        Cond Set
```

(3) Program copy is done if selecting the [SET] key after inputting program number to be copied with the [Number] key.

Reference

- Following message is displayed where program to be copied exists.

```
File already exists. Save anyway?  [Y/N]
>
Service  System Rel.WAIT        Cond Set
```

- Overwrite is executed if selecting the [YES] key. This function is cancelled if pressing the [NO] key

- This function cannot be executed in AUTO mode. Always use it in Manual mode.

8.17. R116 Program renaming

Changes program number of inner memory to different program number of inner memory. Firstly input program number to change and then input program number to be changed.

(1) Following screen is displayed is displayed if pressing the [R..(NO)] key → [116] → [SET(YES)] key:

```
Source program to modify? (1-999)
>R116,
Service  System Rel.WAIT        Cond Set
```

(2) Following screen is displayed if pressing the [SET] key after inputting program number to change with the [Number] key:

```
Destination program to modify? (1-999)
>R116,999,
Service  System Rel.WAIT        Cond Set
```

(3) Following screen is displayed if pressing the [SET] key after inputting program number to be changed with the [Number] key:

```
HR120.999->.005  : Modify?     [YES/NO]
>
Service  System Rel.WAIT        Cond Set
```

(4) Change of program number is executed if pressing the [YES] key. This function is cancelled if pressing the [NO] key.

Reference

- Following screen is displayed where program to be changed exists

```
Failure! File name already exist.  [ESC]
>
Service  System Rel.WAIT        Cond Set
```

- This function cannot be executed in AUTO mode. Always use it in Manual mode.

8.18. R117 Program deleting

This is function to individually delete program of inner memory.

(1) Following screen is displayed is displayed if pressing the [R..(NO)] key → [117] → [SET(YES)] key:

(2) Following screen is displayed if pressing the [SET] key after inputting program number to delete with the [Number] key:

```
HR120.001 : Delete? [YES/NO]
>
Service  System Rel.WAIT        Cond Set
```

(3) Program is deleted if pressing the [YES] key. This function is cancelled if pressing the [NO] key.

Reference

- Following message is displayed if attempting to delete program not existing:

```
Error! Program doesn't exist!       [ANY]
>
Service  System Rel.WAIT        Cond Set
```

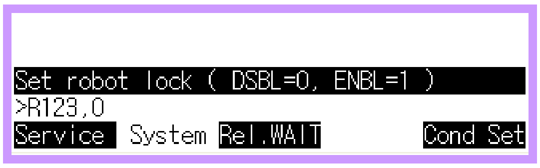
- This function cannot be executed in AUTO mode. Always use it in Manual mode.

8.19. R123 Robot lock

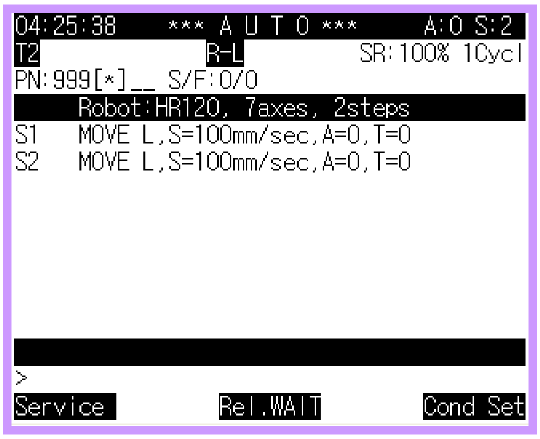
Set ENBL/DSBL of Robot Lock function. If Robot Lock function is ENBL, you can execute program with Robot not moved for replay in AUTO mode operation preparation ON status or step forward/backward of Manual mode.

After creating work program, you can check flow of work program, I/O status or cycle time, etc with Robot not moved.

(1) Following screen is displayed is displayed if pressing the [R..(NO)] key → [123] → [SET(YES)] key:



(2) Following screen is displayed in the first line of the Edit frame in Manual or AUTO mode if selecting ENBL (1):



Reference

- This function cannot be used when Robot operates.
- This is same function as 『[PF5]: Cond Set』 → 『5: Robot lock』.

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8.20. R136 Modifying accuracy in steps

Changes accuracy value of currently selected step.

(1) Following screen is displayed is displayed if pressing the [R..(NO)] key → [136] → [SET(YES)] key:

```
Enter accuracy ( 0 - 5 )
>R136,3
Service  System Rel.WAIT          Cond Set
```

(2) Press the [SET] key after inputting desired accuracyvalue with the [Number] key, Following screen shows a case that inputs 3 as accuracy value:

```
00:09:31   *** M A N U A L ***    A:0 S:2
T2                              I:R2
PN:999[*]__ S/F:1/0    Sp:50
     Robot:HR120, 7axes, 2steps
S1   MOVE L,S=100mm/sec,A=3,T=0
S2   MOVE L,S=100mm/sec,A=0,T=0





Enter accuracy ( 0 - 5 )
>R136,3
Service  System Rel.WAIT          Cond Set
```

Reference

- This function cannot be executed in AUTO mode. Always use it in Manual mode.
- Values displayed on the screen before inputting numbers represents current setting status.

8.21. R137 Modifying MX in steps

Adds or deletes MX status of step currently selected.

(1) Following screen is displayed is displayed if pressing the [R..(NO)] key → [137] → [SET(YES)] key:

```
Enter MX No ( 1 - 2 )
>R137,0
Service  System Rel.WAIT         Cond Set
```

(2) Following screen is displayed if pressing the [SET] key after inputting desired MX value with the [Number] key:

```
Set MX signal ( Off=0, On=1 )
>R137,1,0
Service  System Rel.WAIT         Cond Set
```

(3) MX status is recorded in step if pressing the (On)[1] [SET] key. Recorded MX status is deleted if pressing the (Off)[0] [SET] key. Following screen shows case that selects 1 as MX value, and signal as ON.

```
00:11:40  *** M A N U A L ***   A:0 S:2
T2                             I:R2
PN:999[*]__ S/F:1/0    Sp:50
     Robot:HR120, 7axes, 2steps
S1   MOVE L,S=100mm/sec,A=3,T=0,MX
S2   MOVE L,S=100mm/sec,A=0,T=0





>
Service  System Rel.WAIT         Cond Set
```

Reference

- This function cannot be executed in AUTO mode. Always use it in Manual mode.
- Values displayed on the screen before inputting numbers represents current setting status.

8.22. R138 Modifying gun in steps

Adds or deletes gun status of step currently selected.

(1) Following screen is displayed is displayed if pressing the [R..(NO)] key → [138] → [SET(YES)] key:

```
Enter gun No.( 1 - 2 )
>R138,0
Service  System Rel.WAIT          Cond Set
```

(2) Following screen is displayed if pressing the [SET] key after inputting desired gun value with the [Number] key:

```
Set the gun signal (Off=0,On=1)
>R138,1,0
Service  System Rel.WAIT          Cond Set
```

(3) Gun status is recorded in step if pressing the (On)[1] [SET] key. Gun status is deleted if pressing the (Off)[0] [SET] key. Following screen shows case that selects gun value as 1, and sigal as On.

```
00:14:09  *** M A N U A L ***    A:0 S:2
T2                              I:R2
PN:999[*]__ S/F:1/0    Sp:50
     Robot:HR120, 7axes, 2steps
S1   MOVE L,S=100mm/sec,A=3,T=0,G1
S2   MOVE L,S=100mm/sec,A=0,T=0





>
Service  System Rel.WAIT          Cond Set
```

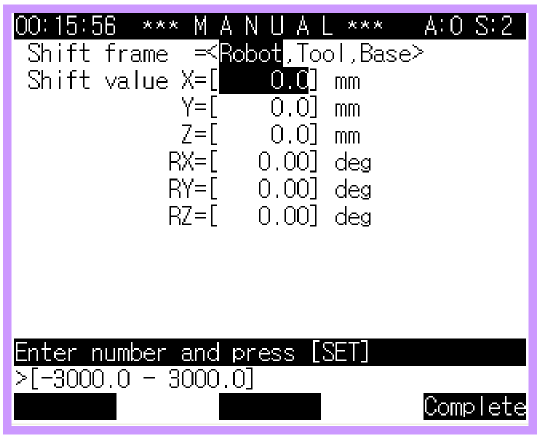
Reference

- This function cannot be executed in AUTO mode. Always use it in Manual mode.
- Values displayed on the screen before inputting numbers represents current setting status.

8.23. R162 Shift buffers setting

Displays or changes content of the shift buffer. This is function to maintain pointer already taught as tool angel and move it in parallel. Standard coordinate system of Shift supports Robot, tool and base coordinate system.

(1) Following screen is displayed is displayed if pressing the [R..(NO)] key → [162] → [SET(YES)] key:



(2) Press the [SET] key after inputting numbers with the [Number] key for relevant item.

(3) Changed data are saved only when selecting the [PF5]: Complete』 key after finishing input. Data are not saved if pressing the [ESC] key.

Reference

- This function cannot be used when Robot operates.
- This is same function as『[PF1]: Service』 → 『2: Register setting』 → 『2: Shift buffer』.

8.24. R163 Online shift cancel

Receives shift data quantity from vision units, etc and stops Online Shift that Robot performs shift function and then initializes shift quantity saved in the shift buffer to 0 (zero).

(1) Following screen is displayed is displayed if pressing the [R..(NO)] key → [163] → [SET(YES)] key:

```
WARNg) Cancel on-line shift?      [YES/NO]
>
Service  System Rel.WAIT          Cond Set
```

(2) Cancel Online Shit, and press the [YES] key to initialize content of the shift buffer to 0 (zero). This function is cancelled if pressing the [NO] key.

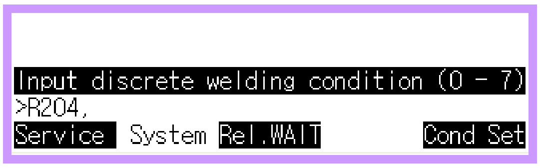
Reference

- This function cannot be used when Robot operates.

8.25. R204 Spot Weld. Cond. manual output

Changes and outputs spot welding condition in Spot Welding using air-pressure gun.

(1) Pree the [R..(NO)] key → [204] → [SET(YES)] key.



(2) Press the [SET] key after inputting welding condition number to output with the [Number] key:

Reference

- Following screen is displayed where output pattern of welding condition is selected as <Discrete> in the 『[PF2]: System』 → 『4: Application parameter』 → 『1: Spot & stud』 → 『1: Air-gun welding data』 item:

```
Input discrete welding condition (0 - 7)
>R204,
Service  System Rel.WAIT          Cond Set
```

  - Following screen is displayed where output pattern of welding condition is selected as <Binary> in the 『[PF2]: System』 → 『4: Application parameter』 → 『1: Spot & stud』 → 『1: Air-gun welding data』 item:

```
Input binary WELDg condition ( 0 - 255 )
>R204,
Service  System Rel.WAIT          Cond Set
```

- Error occurs as follow if executing this function where not allocating signal to output of welding condition in the『[PF2]: System』 →『2: Controller parameter』 → 『1: Setting input & output signal 』 → 『6: Output signal assigning』.

```
E1021 Unassigned weld condition signal
>>
E1021 Unassigned weld condition signal
>
Service  System Rel.WAIT          Cond Set
```

- This function cannot be used when Robot operates.

8.26. R210 Servo gun number selection

Selects Servo gun to use if desiring to use multi (both heads) Servo gun.
Select gun number for manual switching or manual gun pressure applied.

(1) Following screen is displayed if pressing the [R..(NO)] key → [210] → [SET(YES)] key

```
Enter gun number.
>R210,
Service  System Rel.WAIT          Cond Set
```

(2) Press the [SET] key after inputting gud number to select with the [Number] key.

Reference

- This function cannot be used when Robot operates.
- If selecting gun number, tool number is also change to AUTO.
- Following screen is displayed if selecting additial axis, not regiserting it as Servo gun:.

```
Can't use! Servo gun mode only.     [ANY]
>
Service  System Rel.WAIT          Cond Set
```

- Following screen is displayed if registering only an axis of additional axis as Servo gun and then selecting Gun number 2.

```
Can't use without the 2th servo gun[ANY]
 >_
Service  System Rel.WAIT          Cond Set
```

8.27. R211 Squeeze force setting

This is function to allow that user can manually set wearing quantity of mobile electrode

(1) Following screen is displayed pressing the [R..(NO)] key → [211] → [SET(YES)] key

```
Enter gun pressure. ( 50 - 999 )Kgf
>R211,100
Service  System Rel.WAIT        Cond Set
```

(2) Press the [SET] key after inputting applied pressure to set with the [Number] key.

Reference

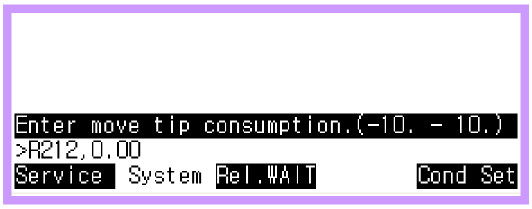
- This function cannot be used when Robot operates.
- Applied pressure of welding condition file is not changed.
- Where pressure setting applied is larger than or less than upper limit value on displayed on current application pressure of the Servo gun parameter, executes pressure application of manual gun by it to the upper limit value.
- Following message is displayed if selecting additial axis as, not regiserting it as Servo gun:

```
Can't use! Servo gun mode only.    [ANY]
>
Service  System Rel.WAIT        Cond Set
```

8.28. R212 Moving-tip consumption preset

User can manually set wearing quantity of mobile electrode of Servo gun.

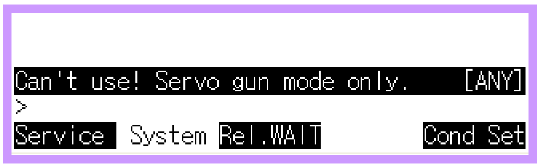
(1) Following screen is displayed of pressing the [R..(NO)] key → [212] → [SET(YES)] key:



(2) Press the [SET] key after inputting wearing quantity of mobile electrode with the [Number] key.

Reference

- This function cannot be used when Robot operates.
- Setting wearing quantity of mobile electrode larger than or less than actual wearing quantity of electrode may cause inconsistency of applied pressure or interference of works. Appropriate carefulness is required.
- Following screen is displayed if selecting additial axis, not regiserting it as Servo gun:



8.29. R213 Fixed-tip consumption preset

This is function to allow that user can manually set wearing quantity of mobile electrode of Servo gun.

(1) Following screen is displayed if pressing the [R..(NO)] key → [213] → [SET(YES)] key

```
Enter fix tip consumption. (-10. - 10.)
>R213,0.00
Service  System Rel.WAIT          Cond Set
```

(2) Press the [SET] key after inputting wearing quantity of fixed electrode with the [Number] key.

Reference

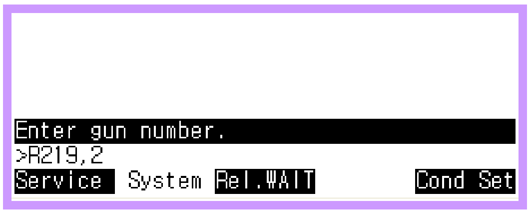
- This function cannot be used when Robot operates.
- Where pressure setting applied is larger than or less than upper limit value on displayed on current application pressure of the Servo gun parameter, executes pressure application of manual gun by it to the upper limit value.
- Following message is displayed if selecting additial axis, not regiserting it as Servo gun:

```
Can't use! Servo gun mode only.      [ANY]
>
Service  System Rel.WAIT          Cond Set
```

8.30. R219 Equalizerless gun No. selection

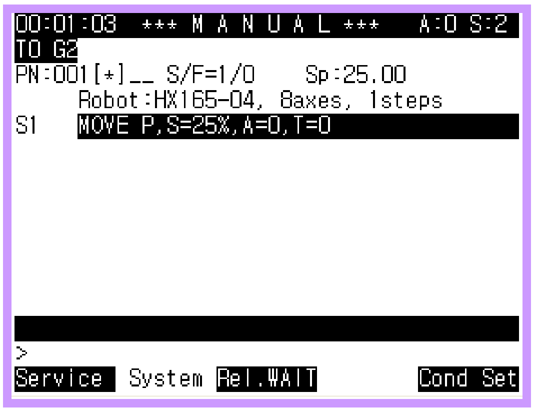
User manually selects gun if using multi (both heads) equalizerless air-pressure gun.
Select gun number for manual switching or manual gun pressure applied.

(1) Following screen is displayed is displayed if pressing the [R..(NO)] key → [219] → [SET(YES)] key:



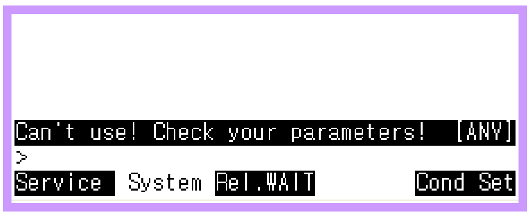
(2) Press the [SET] key after inputting gun number to select with the [Number] key.

(3) Number of selected gun is displayed on the first line of the Edit frame. Following screen is displayed if selecting 2 as gun number.



Reference

- This function cannot be used when Robot operates.
- Following screen is displayed if selecting without setting air-gun 1 or 2 to <EQ'less> in the『[PF2]: System』 → 『5: Initialize 』 → 『4: Setting usage of the robot』.



8.31. R220 Equalizing tip consump. preset

This is function to allow that user can manually set wearing quantity of fixed electrode of Equalizer air-pressure gun.

(1) Following screen is displayed is displayed if pressing the [R..(NO)] key → [220] → [SET(YES)] key.

```
Enter fix tip consumption. (-10. - 10.)
>R220,0.00
Service  System Rel.WAIT          Cond Set
```

(2) Press the [SET] key after inputting wearing quantity of fixed electrode with the [Number] key.

Reference

- This function cannot be used when Robot operates.
- Setting wearing quantity of mobile electrode larger than or less than actual wearing quantity of electrode may cause inconsistency of applied pressure or interference of works. Appropriate carefulness is required.
- Following screen is displayed if desiring to set without setting air-gun 1 or 2 to <EQ'less> in the『[PF2]: System』 → 『5: Initialize』 → 『4: Setting usage of the robot』:

```
Can't use! Check your parameters!   [ANY]
>
Service  System Rel.WAIT          Cond Set
```

- Number of selected gun is displayed on the first line of Edit frame. Following screen is displayed if desiring to set wearing quantity of fixed electrode where number of gun currently selected does not correspond to number of the air-gun 1 or 2, which is selated to <EQ'less> in the 『[PF2]: System』 → 『5: Initialize』 → 『4: Setting usage of the robot』:

```
Can't use! Check your parameters!   [ANY]
>
Service  System Rel.WAIT          Cond Set
```

8.32. R225 Squeeze force set of servo hand

This is function to allow that user can manually set applied pressure of Servo hand when performing Robot work by using a Servo hand.

(1) Following screen is displayed is displayed if pressing the [R..(NO)] key → [225] → [SET(YES)] key:

```
Input the hand squeeze force(50-999)Kgf
>R255,50
Service  System Rel.WAIT         Cond Set
```

(2) Press the [SET] key after inputting applied pressure to hand with the [Number] key.

Reference

- This function cannot be used when Robot operates.

- Following screen is displayed if desiring to set applied squeeze force without selecting [Application=<Hand>] in the screen of additional axis setting:

```
Can't use! Check your parameters!  [ANY]
>
Service  System Rel.WAIT         Cond Set
```

- Following screen is displayed where applied squeeze force of Servo hand to set is beyond the scope of the applied pressure table as set in the applied 『Pressure-Current Tab.1 (Gravitational)』 or 『Pressure-Current Tab.2 (Anti-Gravit.)』 of 『[PF2]: System』 → 『4: Application parameter』 → 『1: Spot & stud』 → 『2: Servo gun Parameter』 → 『Pressure-Current Tab.1 (Gravitational)』

```
Invalid data.Refer to Squeeze table[ESC]
>
Service  System Rel.WAIT         Cond Set
```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8.33. R245 Monitor mode selection

Displays encoder value, ange, coordinate value, I/O status of each axis.

(1) Following screen is displayed is displayed if pressing the [R..(NO)] key → [Number] key [245] → [SET(YES)] key:

(2) Press the [SET] key after selecting desired item by using the [Number] key or the arrow key.

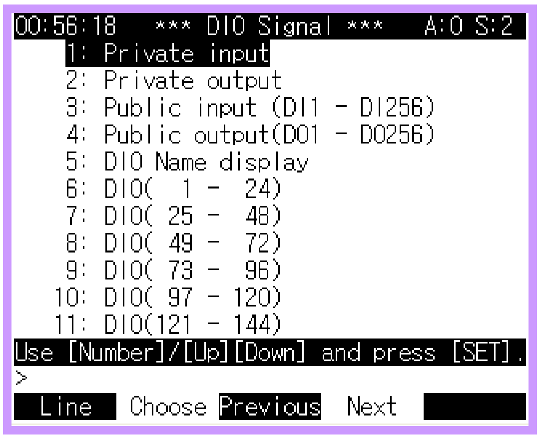
Reference

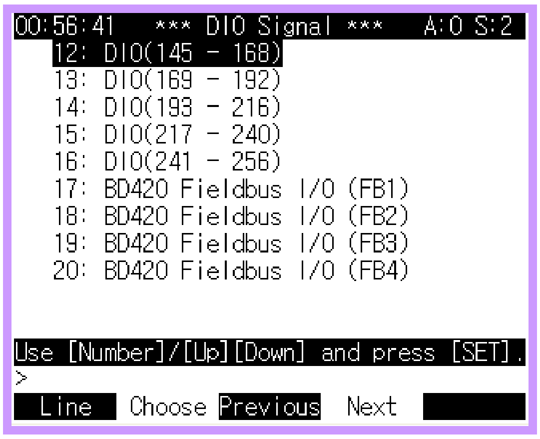
- This function can be used even in status that Robot is operating.
- This is same function as 『[PF1]: Service』 → 『1: Monitoring』.

8.34. R246 DIO signal monitor

DIO signal displays staus of signal on private I/O signal, public I/O signal.

(1) Following screen is displayed is displayed if pressing the [R..(NO)] key → [Number] key [246] → [SET(YES)] key:





(2) Press the [SET] key after selecting desired item by using with the [Number] key or arrow key.

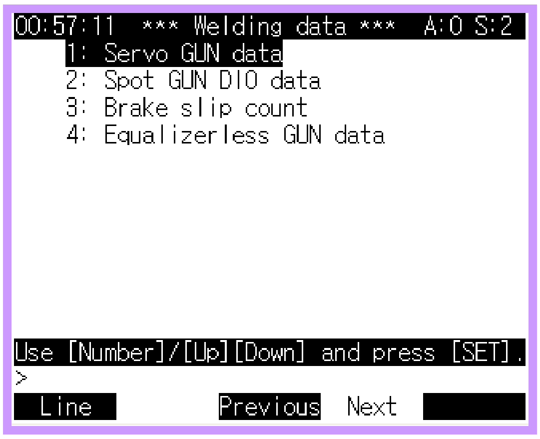
Reference

- This function can be used even in status that Robot is operating.
- This is same function as 『[PF1]: Service』 → 『1: Monitoring』 → 『2:DIO signal』 monitor.

8.35. R247 Spot welding data monitor

Displays I/O status for signal used for spot welding or stud welding.

(1) Following screen is displayed is displayed if pressing the [R..(NO)] key → [Number] key [247] → [SET(YES)] key:



(2) Press the [SET] key after selecting desired item by using with the [Number] key or arrow key.

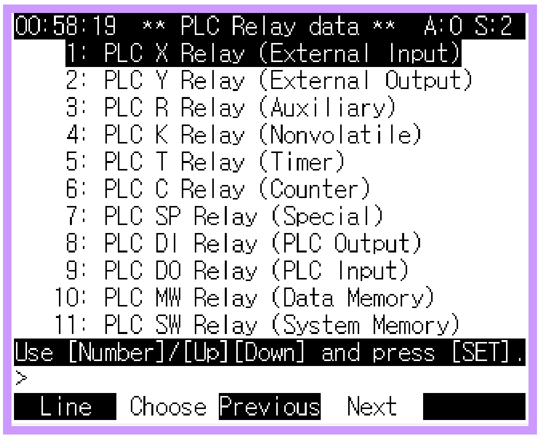
Reference

- This function can be used even in status that Robot is operating.
- This is same function as『[PF1]: Service』 → 『1: Monitoring』 → 『3: Spot/stud welding data』.

8.36. R248 PLC relay data monitor

Displays status of contact for varisou relays used in bulti-in PLC.

(1) Following screen is displayed is displayed if pressing the [R..(NO)] key → [248] → [SET(YES)] key:



(2) Press the [SET] key after selecting desired item by using with the [Number] key or arrow key.

Reference

- This function can be used even in status that Robot is operating.
- This is same function as『[PF1]: Service』 → 『1: Monitoring』 → 『6: PLC relay data』.

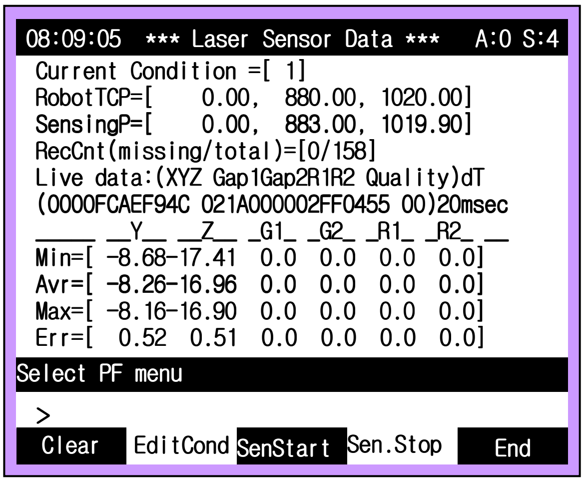
8.37. R250 Data display for Laser sensor

Displays data used when using tracking function of welding line using a laser sensor.

(1) Following screen is displayed is displayed if pressing the [R..(NO)] key → [250] → [SET(YES)] key:

(2) If entering into this monitoring function when program is executed, contents are displayed but menu of [PF2]~[PF4] is displayed for safety and function is also not executed.

(3) The above status shows example that the sensor fails to transmit data, and following screen is displayed when the sensor transmits data by pressing the 『[PF3]: SenStart』 key.



Reference

- 『[PF1]: Clear』: Initializes Maximum, minimum, error, RecCntvalue.
- 『[PF2]: EditCond』: Edits LVS Condition currently selected.
- 『[PF3]: SenStart』/[SET]: Starts communication with laser vision sensor.
- 『[PF4]: Sen.Stop』/[R..]: Stops communication with laser vision sensor.
- 『[PF5]: End』: Exits from monitoring function.
- See『LVS tracking Function Manual』 for more information.

8.38. R269 Program protect

Sets protection function for program within innser memory.

(1) Following screen is displayed if pressing the [R..(NO)] key → [269] → [SET(YES)] key

```
Program to protect? (1-999)
>R269,
Service  System Rel.WAIT        Cond Set
```

(2) Following screen is displayed if pressing the [SET] key after inputting program number with the [Number] key

```
Protect or Release?(1:Protect/2:Release)
>R269,999,
Service  System Rel.WAIT        Cond Set
```

(3) Following message is displayed if pressing the [1] key and then pressing the [SET] key in order to set protection function.

```
Protect type?(1:Whole/2:Section/3:Playb)
>R269,999,1,
Service  System Rel.WAIT        Cond Set
```

(4) Input type of protection with the [Number] key and then press the [SET] key.

Reference

- This function cannot be excuted in AUTO mode (except for 1 step mode).
- Protection status is displayed as follow in the rear of fine name when peforming display of inner memory or file name depending on type of protection selected:

__ : No protection	W_ : Whole protection
WP: [Whole + Playback] protection	S_ : Section protection
SP: [Section + Playback] protection	_P : Playback protection

8.39. R286 Software version

Displays system environment (software version) of the controller.

(1) Following screen is displayed is displayed if pressing the [R..(NO)] key → [Number] key [286] → [SET(YES)] key

```
01:03:10  ** System version **   A:0 S:2
Robot type: HX165-04 (Axis: 6 Tot Ax: 7)
Main Software Version => Robot Language
     Main S/W: V20.03-03  2006-08-31
   Motion S/W: V07.18     2006-08-24
     T/P Ver : V03.03     2002-08-01
     I/O Ver : V06.00     2004-12-06
DSP Software Version
     DSP1 S/W: V05.04     2004-01-20
     DSP2 S/W: V05.04     2004-01-20
     DSP3 S/W: V00.00        0-00-00
     DSP4 S/W: V00.00        0-00-00
Press [ESC] or [R..]
>
                Previous  Next
```

```
01:03:54  ** System version **   A:0 S:2
System Control Environment
     Conveyor synchronization = OFF
     Vibration control mode   = OFF










Press [ESC] or [R..]
>
                Previous  Next
```

Reference

- This is same function as『[PF1]: Service』 → 『7: System checking』→ 『1: System version』.

8.40. R300 Maximum value clear

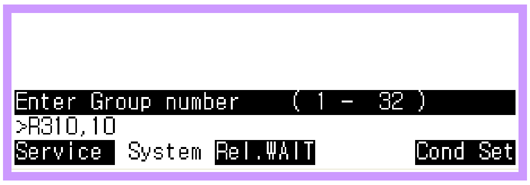
When the monitoring is ON in『[PF1]: Service』 → 『1: Monitoring』 → 『11: System characteristic data』→ 『2: Axis & Max torque rate』, 『3: Axis position error level & max.』, 『4: Axis disturbance torque & max.』, 『5: Axis disturbance torque rate&max.』, initialize the maximum value of this monitoring item and measure it again.

(1) Press the [R..(NO)] key → [300] → [SET(YES)] key.

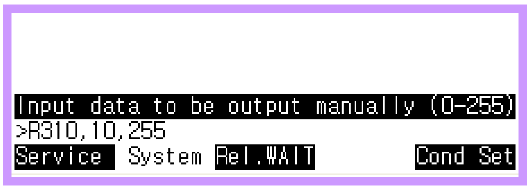
8.41. R310 Manual output of O-byte signal

This is function to output value to group output sigan (GO) which binds and uses 8 output signal in a bundle.

(1) Following screen is displayed is displayed if pressing the [R..(NO)] key → [310] → [SET(YES)] key



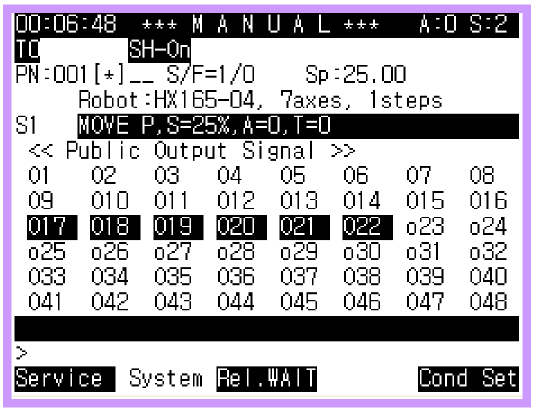
(2) Following screen is displayed if pressing the [SET] key after inputting group number with the [Number] key



(3) Input date to manually output with the [Number] key and then press the [SET] key.

Reference

- This function cannot be used when Robot operates.
- Values displayed on the screen before inputting numbers represents current setting status.
- You can select R246 I/O signal monitor and check output status for group signal in the『[PF1]: Service』 → 『1: Monitoring』 → 『2: DIO signal』. Following screen is displayed if selecting group number as No.3 and data to manually output 255.



8.42. R320 Set max speed of step go/back

Sets maximum speed at that Robot moves for step forward/backward in the Manual mode. Reproduces speed for step forward/backward to 1 ~ 250mm/s irrespective of record speed.

(1) Following screen is displayed if pressing the [R..(NO)] key → [320] → [SET(YES)] key:

```
Step GO/BACK speed? ( 1 - 250mm/s )
>R320,100
Service  System Rel.WAIT        Cond Set
```

(2) Press the [SET] key after inputting speed rate for step forward/backward with the [Number] key.

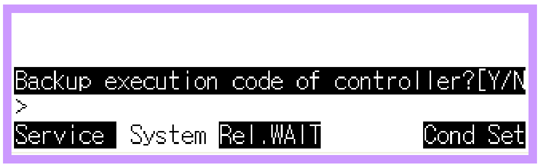
Reference

- This function cannot be used when Robot operates.
- This is same function as『[PF5]: Cond Set』 → 『2: Step go/back max.speed』.

8.43. R341 Execution code backup

Backup controller execution code recorded in the inner flash memory of the main board to Linear Flash Memory Card or SRAM Card through the PCMCIA slot. (Reference: Card whose write voltage is not 5V of Linear Flash Memory Cards is not supported.)

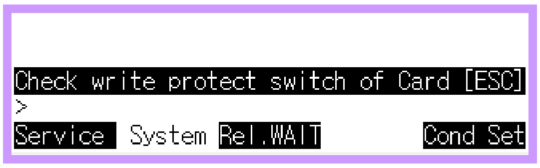
(1) Following screen is displayed if pressing the [R..(NO)] key → [341] → [SET(YES)] key:



(2) Backup of execution code is performed if press the [YES] key. This function is cancelled if pressing the [NO] key.

Reference

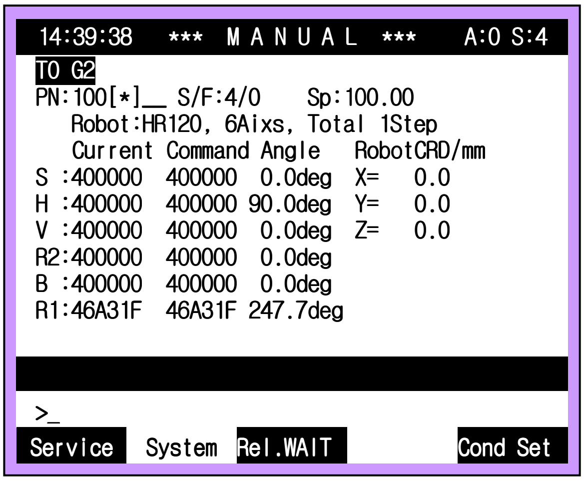
- This function cannot be used when Robot operates.
- Following screen is displayed if attempting to backup execution code with no PC card existed.



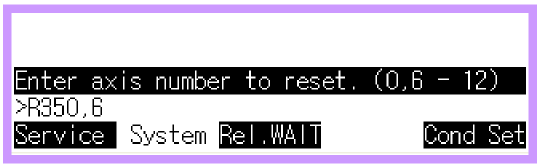
8.44. R350 Endless axis manual reset

This function is used for teaching over soft limit when performing teaching for the axis seting endless function to <Enable> in the『[PF2]: System』 → 『1: Initialize』 → 『6: Endless axis setting』.

(1) Assume that data for each axis of current Robot is as in below screen after seting endless function to <Enable> for the R1 axle of Robot.



(2) Following screen is displayed if pressing the [R..(NO)] key → [350] → [SET(YES)] key:



(3) Performs initialization function within scope of -180 ~ 180 degree for all axis if pressing the [SET] key after inputting 0 (zero). Performs initialization function within scope of -180 ~ 180 degree for relevant axis if pressing the [SET] key after inputting axis number. Following screen is displayed when selecting axle number to initialize to 6.

```
 14:39:38   ***  M A N U A L  ***    A:0 S:4
TO G2
PN:100[*]__ S/F:4/0    Sp:100.00
   Robot:HR120, 6Aixs, Total  1 Step
   Current Command Angle   RobotCRD/mm
S :400000  400000  0.0deg  X=   0.0
H :400000  400000 90.0deg  Y=   0.0
V :400000  400000  0.0deg  Z=   0.0
R2:400000  400000  0.0deg
B :400000  400000  0.0deg
R1:3CFD56  3CFD56-112.3deg


>_
Servie    System  Rel. WAIT        Cond set
```

Reference

- This function cannot be used when Robot operates.

8.45. R351 Cooperation status exchange

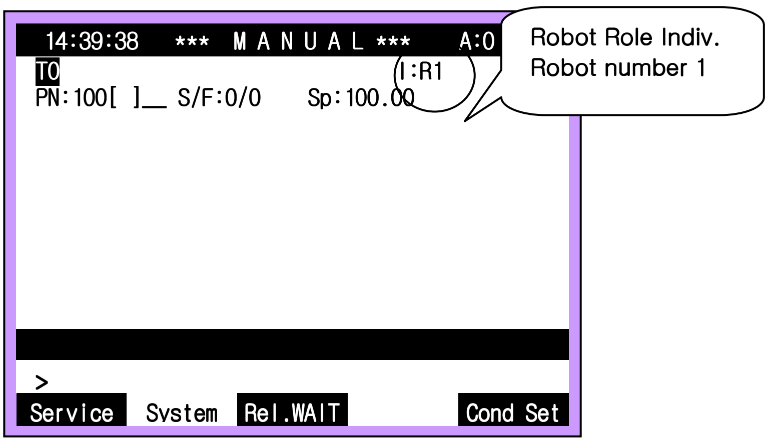
Applicable version

- **Since Main V10.07-25**

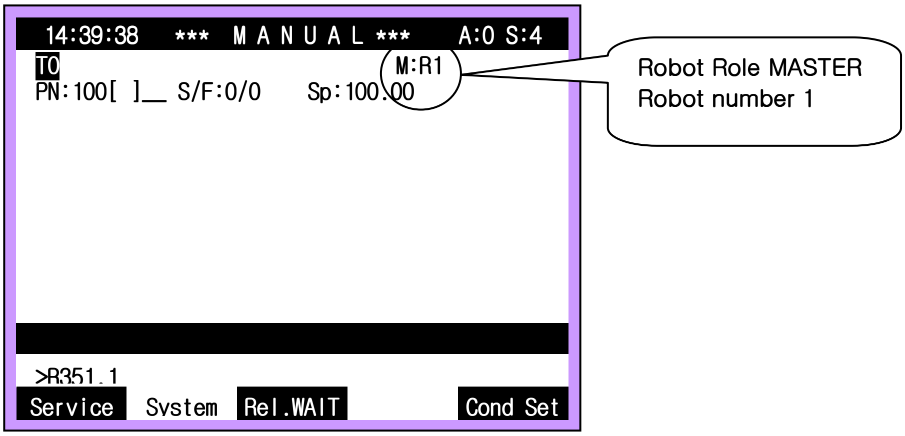
This function is R-code usable in the cooperation control system that cooperation control is set to ENBL. R-code used in cooperation control is as following table:

Operation	#1	#2	Contents
R351,#1	Role of Robot		Role of Robot 0 = Indiv.(individual)
			1 = Master
			2 = Slave
			3 = Slave (CMOV record mode; option)
R352,#1,#2	Group number	Output value	Manual output of output value equivalent to group number
R353			Clear cooperation replay status

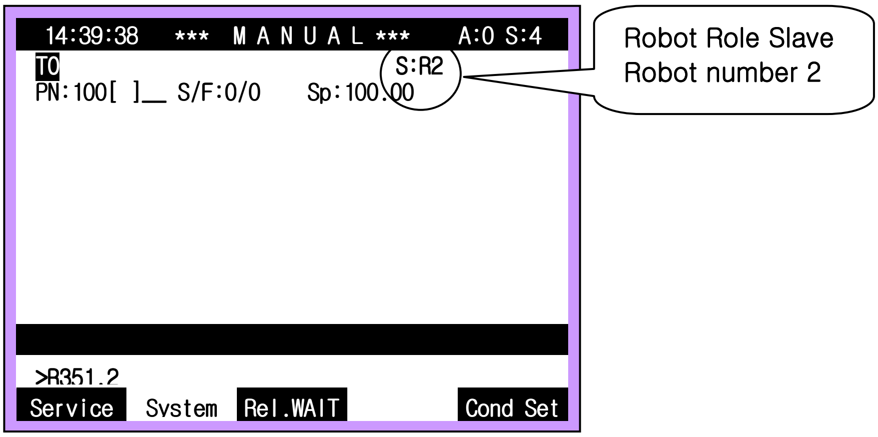
R351 command is used when desiring to set necessary Jog role for cooperation control. Role of current Robot is displayed on the top of screen.



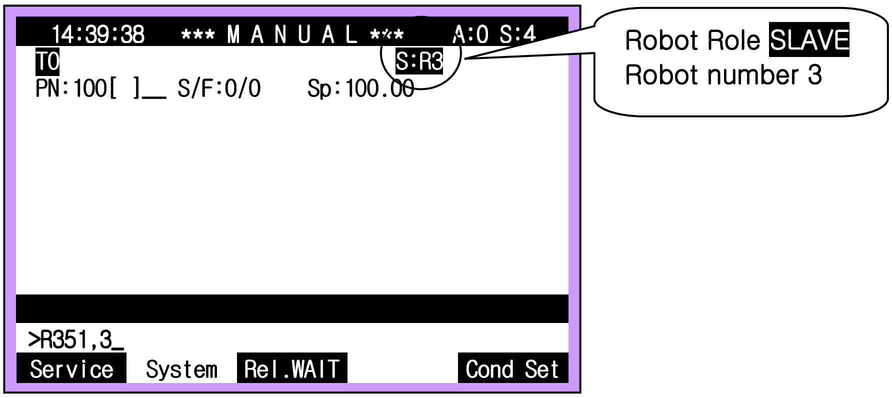
(1) Input R351, 1 when desiring to change role of Robot to master. Role of Robot on the top of screen is changed to M.



(2) Input R351, 2 when desiring to change role of Robot to slave. Role of Robot on the top of screen is changed to S.



(3) Input R351, 3 in Slave status when desiring to change role of Robot to CMOV record status. Role of Robot on the top of screen is changed to M. Role of Robot is displayed. However, this function is option for Jigless cooperation control.



8.46. R352 Manual setting of the HiNet I/O

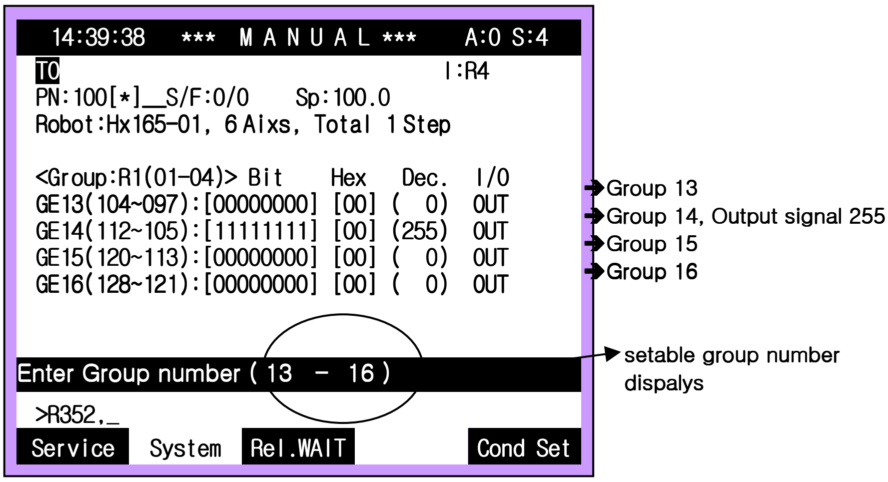
Applicable version

- **Since Main V10.07-25**

Manually outputs HiNet I/O signal for cooperation control.

Operation	Output signal
R352,Groupnumber(1~32), output value(0~255)	Output signal equivalent to group number Ex) R352,14,255

(1) For R352,14,255, your own Robot number is number to GE5. Up to GE13~GE16 is output allocation area of Robot No.2. It is impossible to input for other area. (확인 x - Can't use! Check your parameters! [ANY])



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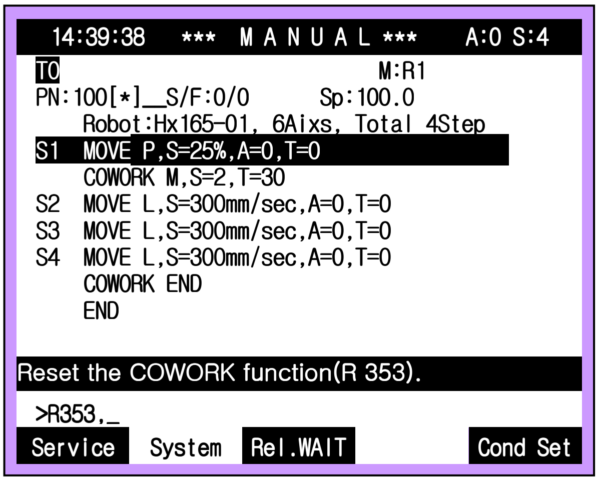
8.47. R353 COWORK status reset

Applicable version

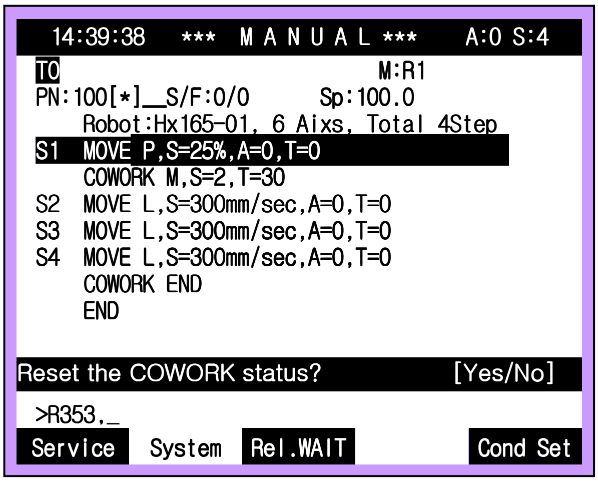
- **Since Main V10.07-25**

This is function used when desiring to individually playback respective Robot during replay of cooperation operation or after stop.

(1) Message 『Reset the COWORK function(R 353).』 is output if changing step after stopping Robot between COWORK and COWORK END of cooperation zone.



(2) Press the R353+[SET(Yes)] key.



(3) Setting is completed if pressing the [SET(Yes)] key.
Operate Robot after always checking whether there is interference between works and counter Robot since Robot is individually controlled if reseting cooperation status.

8.48. R355 Soft floating level manual set

This is used to manually apply soft floating by application of level value of each axis set in the『[PF2]: System』 → 『3: Machine parameter』 → 『14: Soft floating』.

(1) Following screen is displayed is displayed if pressing the [R..(NO)] key → [355] → [SET(YES)] key:

```
Input soft floating level.(0 - 4)
>R355,0
Service  System Rel.WAIT        Cond Set
```

(2) Soft floating function is not performed if pressing the [SET] key after inputting 0 (zero). Soft floating is applied on level value of each axis set in the『[PF2]: System』 → 『3: Robot parameter』 → 『14: Soft floating』.

Reference

- This function cannot be executed in AUTO mode. Always use it in Manual mode.

8.49. R357 History display clear

This is function to clear all contents displayed when pressing the [Past screen] key in the initial screen of Manual or Auto mode.

(1) All contents displayed on last screen are cleared if pressing the [R..(NO)] key → [357] → [SET(YES)] key.

8.50. R358 Spot gun manual connect. on/off

Applicable version

- **Since main V10.05-05**

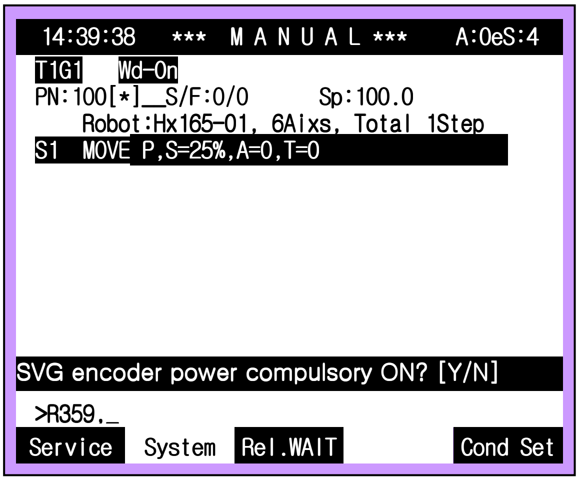
This function is R-code used in the change system (option) of spot gun. This is function to change of number of spot gun (change of tool number in ENBL of Servo gun change) or manually separate spot gun. R358 code is used Motor On status (Enable switch On).

Operation	Parameter	#1	#2
R358,#1,#2	Meaning	Connection on/off	Gun number
	Setting value	Connection = 1, separation = 0	1~3
	Example of use	R358,1,2 (connect gun number 2)	
		R358,0 (separate gun)	

8.51. R359 Servo gun encoder powerON relay

This is function used for encoder reset work when firstly mounting Servot gun in application of welding gun change system.
General operator cannot operate this function since it is function for engineer.

(1) Input R359.



(2) Exit after continuing to proceed forced input by pressing the [SET(Yes)] key.

Reference

- Never mechanically assemble or separate Servo gun in compulsory input status of encoder power.
- Reinput power to release compulsory input of Servo gun encoder. Therefore reinput power after encoder reset work is completed, and proceed manual assembly of Servo gun.

8.52. R360 Continuous path manual setting

This is function to compulsorily change execution of CONTPATH. Scope of input is 0, 1, 2 and explanation by each number is as follow. (Same as CONTPATH number)

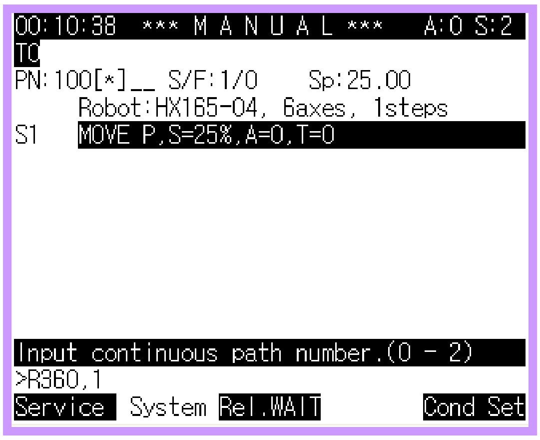
0 : For step where command (function) is included in step, execute command (function) in status Robot stops and move to the next step.

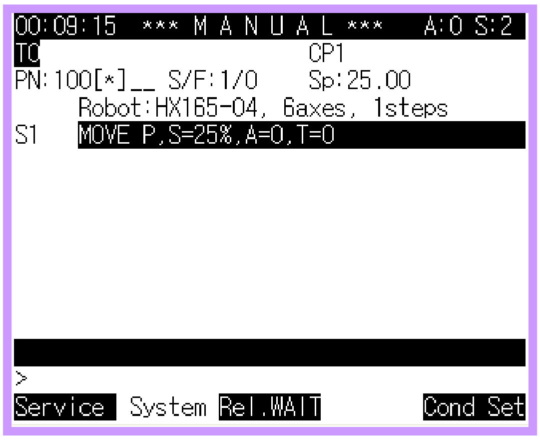
1 : After executing commands recorded in target step during step movement, Robot moves to the next step via the target step without Robot stopping.

However, for output command, time actually output outside is when command value arrives within scope of accuracy.
Non-consecutive is done for case using input sigal in parameter of command. If command value arrives within scope of accuracy, execute command in status Robot stops and moves to the next step.

2 : Even for command that input signal is included, Robot consecutively moves through previous intepretation.

(1) Press the [R..(NO)] key → [360] →[SET(YES)] key and input desired numbers (0~2).





8.53. R361 Jog inching level setting

This function is used when desiring to rapidly change inching distance of level of current set without passing through menu operation.

Operation	#1	#2
R361,#1, #2	Unit, unit (0~2)	Range of designation , range
	0 : Axis (deg)	0.1~ 180.0
	1 : Cartesian Pos. (mm)	0.05 ~ 1000.0
	2 : Cartesian Orient (deg)	0.1 ~ 180.0

(1) Input R361. Input 1, To set inching distance for axis coordinate system, 1 to input inching distance for other right-cross coordinate system and 2 to set inching angle for pose of right-cross coordinate system and then press the [SET(Yes)] key.

```
Select unit.(0:Axis,1:Position,2:Orient)
>R361,1
Service  System Rel.WAIT          Cond Set
```

(2) To select unit, input inching distance and press the [SET(Yes)].

```
Input range. (0.05~1000.0 mm)
>R361,1,100
Service  System Rel.WAIT          Cond Set
```

Reference

- Inching distance set by R361 code is set for jog level currently set. Therefore, inching distance is changed equivalent to 8i where current jog level is 8i.
- General operator cannot operate this function since it is function for engineer.

9
Quick Open

9.1. Outline of function

Detailed setting of exclusive functions of arc such as weaving, retry/restart, features of welding machine as well as welding-related conditions including voltage, current if teaching program for arc welding work. In addition, there is also a case of checking position of step or auxiliary point basically. QuickOpen function is function to easily and rapidly such condition setting and position check with one-stroke of key manipulation.

For example, contents equivalent of condition number currently used in command of various welding start conditions if pressing the [Quick Open] key, when the cursor is located at ARCON command that plays role of Arc On function. You can check or change details of welding start conditions from this screen. In addition, where other condition files exist in relation with the relevant condition files, you can directly move to there. In other words, this is function to easily and rapidly check, change detailed contents such as conditions files related with specific command or step position.

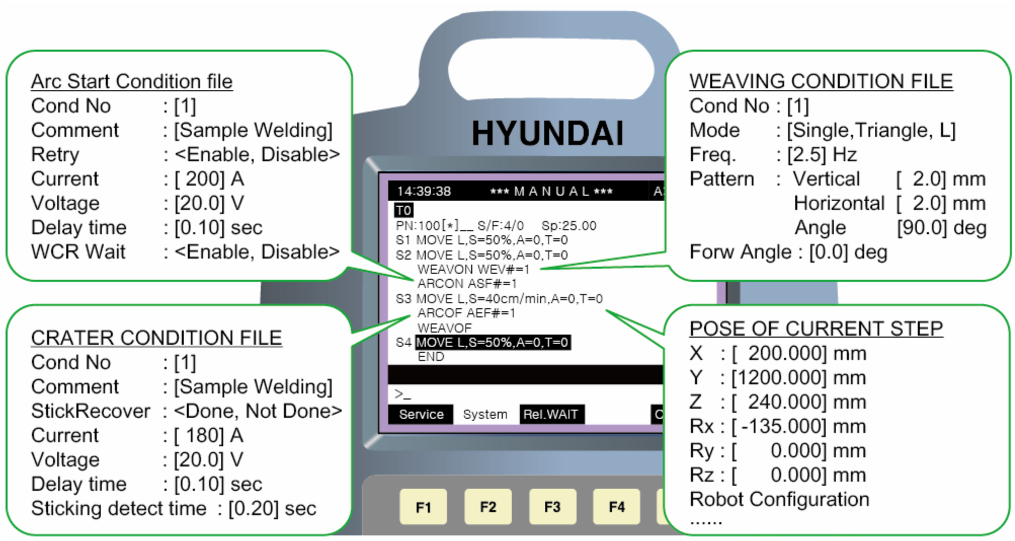


Figure 9.1 [Quick Open] function

Related files or detailed contents are displayed on the screen if pressing the [QuickOpen] key in specific command. Press the 『[PF5]: Complete』 key to exit after saving, and press the [ESC] key to exit without changing.

Table 9-1 Contents appearing when pressing the [QuickOpen] key in command

Command sentence	File, contents	Detailed contents
MOVE	POSITION	Current step position or global pose parameter X Y Z(mm), Rx Ry Rz(。), T1~T6 Coordinate , Robot configuration
ASF#=	Arc start condition file, Arc auxiliary condition file, welder condition data file	1. Arc start condition ➢ Condition number, comment , voltage confirm, RETRY existence, retry mode, current, voltage, waiting for WCR input, waiting (delay) time, gas preflow ➢ Initial conditions: Initial time, initial current, initial voltage, output method 2. Arc auxiliary condition ➢ RETRY: Repetition, Retract time, Reentrance/path distance, shift distance, speed, current, voltage ➢ RESTART: Repetition , Over.Leng. , speed, current, voltage, overlap conditions 3. welder condition ➢ Welder number, model type, description, power control mode, wire diameter, stick out, stick detect time, arc off detect time, control signal ➢ Feature of current : Polarity, ref. (V), measuring value (A), adj. ➢ Feature of voltage : Polarity, ref. (V), measuring value (A), adj.
AEF#=	Crater condition file, Arc auxiliary condition file, welder condition data file	1. Crater condition file ➢ Condition number, comment, voltage confirm, auto stick recovery, output current, output voltage, crater time, output method, gas postflow 2. Arc auxiliary condition file ➢ Auto stick recovery: Repetition, current, voltage, delay time

Command sentence	File, contents	Detailed contents
WEAVON WEV#=	Weaving condition	1. Weaving condition file ➢ Condition number, weaving pattern, frequency, basic pattern, forward angle, moving time, timer
REFP	Auxiliary point	Position of current step or global pose parameter X Y Z(mm), Rx Ry Rz(。), T1~T6 Coordinate system, Robot configuration pattern
Assignment statement	Check and change parameter	Monitors relevant parameters and changes values depending on parameter type of assignment statement V%, V!, V$, P, R, LV%, LV!, LV$, LP, LR, DO, GO
Program edit during operation (Hot edit)	Check and change recording position and recording conditions	Checks and changes positions and conditions recorded during operation of Robot.
Welding conditions function	Welding condition, welding sequence, Tip dressing condition	1. Welding conditions ➢ Output data, output type, Squeeze force 2. Welding sequence ➢ Arc condition signal, Squeeze signal, electrical conductance signal, waiting for WI, electrical conductance signal output delay time, WI input waiting time, Waiting time after WI input 3. Tip dressing condition Output data, output type, Squeeze force, Time for tip dressing

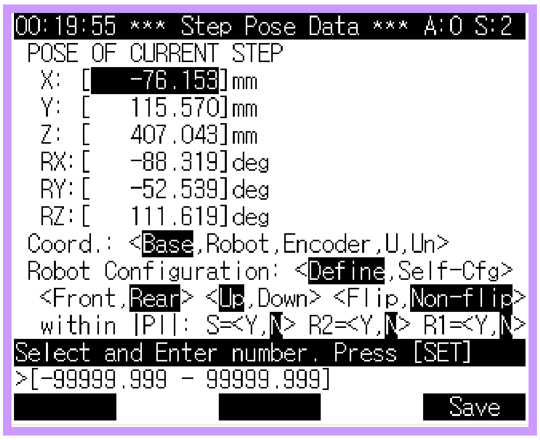
9.2. MOVE – Step position

This is function to check or modify step position where the reverse bar is currently located at in work program.

9.2.1. Hidden pose MOVE sentence

This is function to check or modify current step position when recording step by the [REC] key of teaching pendant, namely in MOVE sentence where no Pose parameter exists.

(1) Position of current step appears as in following screen if pressing the [QuickOpen] key in the MOVE sentence recorded as hidden pose.



(2) Move the Reverse bar to relevant item. If inputting figure, contents are reflected if pressing the [SET] key after numbers in the Input frame.

(3) The Reverse bar moves if pressing the [SHIFT]+[<-][->] key where selecting or desiganating one of items in the < >. To reflect the result on program, exit by pressing the『[PF5]: Wrte_Ref』key. Contents displayed on the screen are not reflected if exiting by pressing the [ESC] key.

- POSE OF CURRENT STEP
  Displays position of relevant step (pose). Moves by using the cursor key when changing step position. Entered contents are reflected if pressing the [SET] key after inputting numbers when modifying. However, contents are not reflected when pattern of the coordinate system is selected as Encoder.

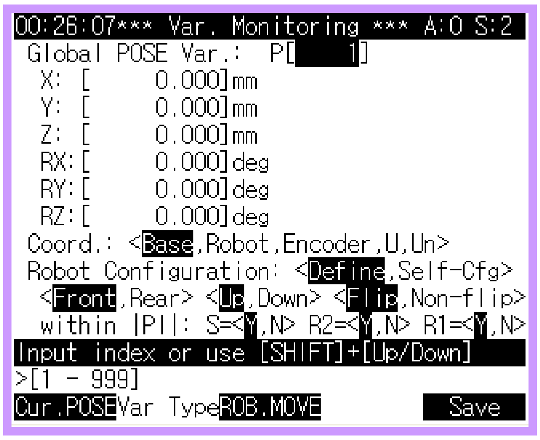
- Coord.
  Select how to express position of current step with which pattern of coordinate system must be used of Base coordinate system, Encoder value and user coordinate system.

- Robot configuration
  Displayed when coordinate system is of Base or Robot. Designation of Robot pattern is needed in order to only describe the pattern since multiple of solution exist in respect of features of tool when describing position of robot. Use the [SHIFT]+[<-][->] key if selecting items.

9.2.2. Pose record MOVE sentence

This is function used to modify position of current step when selecting MOVE with [CMD] key and recording step, namely in MOVE sentence where pose parameter exists as step data.

(1) Monitoring for Pose parameter appears as following screen if pressing the [Quick Open] key in MOVE command (MOVE sentence) recorded as pose parameter.



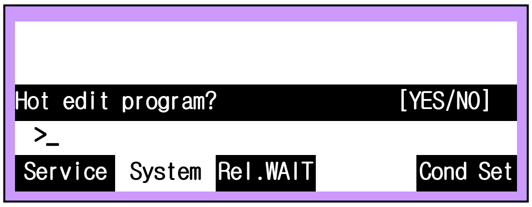
(2) Moves the reverse bar to the relevant item. Contents are reflected if pressing the [SET] key after entering numbers in the Input frame for inputting numbers.

(3) The Reverse bar moves if pressing the [SHIFT]+[<-][->] key where selecting and desiganating one of items in the < >. To reflect the result on program, exit by pressing the『[PF5]: Wrte_Ref』key. Contents displayed on the screen are not reflected if exiting by pressing the [ESC] key.

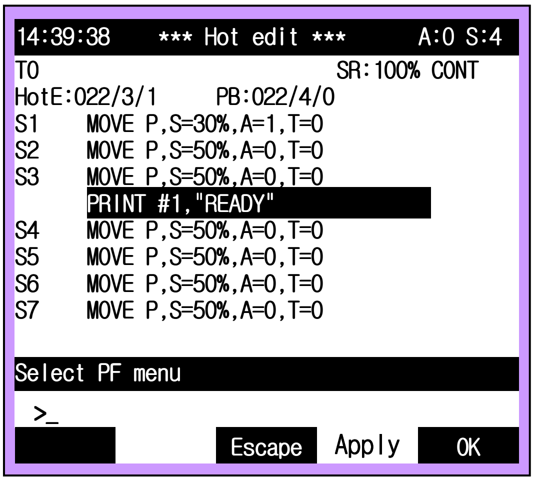
9.3. Hot Edit

This is function used to modify conditions, command or function recorded in step without stopping Robot during operation.

(1) Following screen is displayed if pressing the [Quick Open] key during operation of Robot by pressing the operation switch in AUTO mode.



(2) Enter into the Hot Edit if pressing the [YES] key as in following screen. This function is cancelled if pressing the [NO] key.



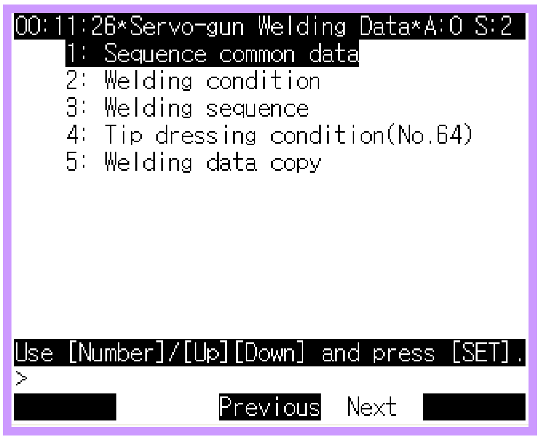
(3) Press the 『[PF3]: Escape』, 『[PF4]: Apply』, 『[PF5]: OK』 key after editing program in the same method as in Manual mode.

Reference

- See the 『[PF1]: Service』 → 『4: Program modify』 → 『6: Hot Edit』 for description about Hot Edit.

9.4. Spot welding function

(1) Following screen is displayed if pressing the [Quick Open] key after moving cursor from Manual or AUTO mode to this function position when recording "SPOT" command or M72(Spot welding function) when creating program. This function is used to rapidly modify contents of welding conditions and welding sequence when performing spot welding by using Servo gun.



(2) Enter into sub-menu if pressing after pressing the [SET] key aft er moving a reverse bar with the [Direction] key to the item to select, or inputting number of the item to select into the Input frame with the [NUMBER] key.

Reference

- See the『[PF2]: System』 → 『4: Application parameter』 → 『1: Spot & stud』 → 『3: Servo gun welding data (condition, sequence)』 → 『2: Welding condition』.
- See the 『[PF2]: System』 → 『4: Application parameter』 → 『1: Spot & stud』 → 『3: Servo gun welding data (condition, sequence)』 → 『3: Welding sequence』.
- See the 『[PF2]: System』 → 『4: Application parameter』 → 『1: Spot & stud』 → 『3: Servo gun welding data (condition, sequence)』 → 『4: Tip dressing condition(No. 64)』.

9.5. Arc welding condition setting

You can edit condition setting of relevant commands if pressing the [QuickOpen] key in ARCON, ARCOF, WEAVON, REFP, LVSON, CHGLVS as commands related with arc welding. See ‘Manual for Arc Welding Function’ for detailed contents of condition setting of each command. However, see 『LVS tracking Function Manual』 for LVSON, CHGLVS command.

10
Robot Language

10.1. Robot Language Guide

There are roughly two industrial robot programming languages: command code and robot language. Command code is used for programming with Hi3CE and Hi3TB controllers – old models among Hi controller series.

Table 10-1 Command Code of Hi3CE and Hi3TB Controller

Class	Type	Role	Example	
Step	Step Code	Moving ends of robot tool	340.5mm/s(L) A0 T0 G1 X2 Speed of 340.5mm/s, linear interpolation, precision 0, tool 0, gun 1 pressure signal, gun 2 open size signal	
Function	M Code	Signal input/output jump, call/stop conditional jump, call/stop repetitive operation, conditional repetitive operation, online shift, welding condition, palletize and other applied functions	M1 1 M20 M81 5,I1 M44 3,50 M53 1,1,5,7 M33 2 M99 'spot	DO1 signal output Step jump DI conditional program call GI3 group signal output Online coordinates conversion Spot welding condition output Note
	I Code	DI signal waiting	I25 I18 I53 IB1,101,2,0	DI18 signal waiting Time conditional GI signal (AND)
	T Code	Time delay	T 5.0	5 sec waiting

Programmers can write an operating program which closely controls robot movements by using hundreds of command codes. However, it is impossible to solve numerical formulas, string handling, problems requiring huge data storage and handling with command code. Besides, it is not easy for beginners to analyze programs, because commands are expressed in number codes.

Unlike command code, robot language provides English statement set, various arithmetic and string variables, functions and numerical forms.

As industrial robot makers usually offer their own robot language, Hyundai Hi4a offers 'HR-BASIC,' Hyundai's own robot language. HR-BASIC is similar to BASIC, a programming language used for PC.

10.2. Menu Overview

Menu overview indicates initial menu and command groups under command input.

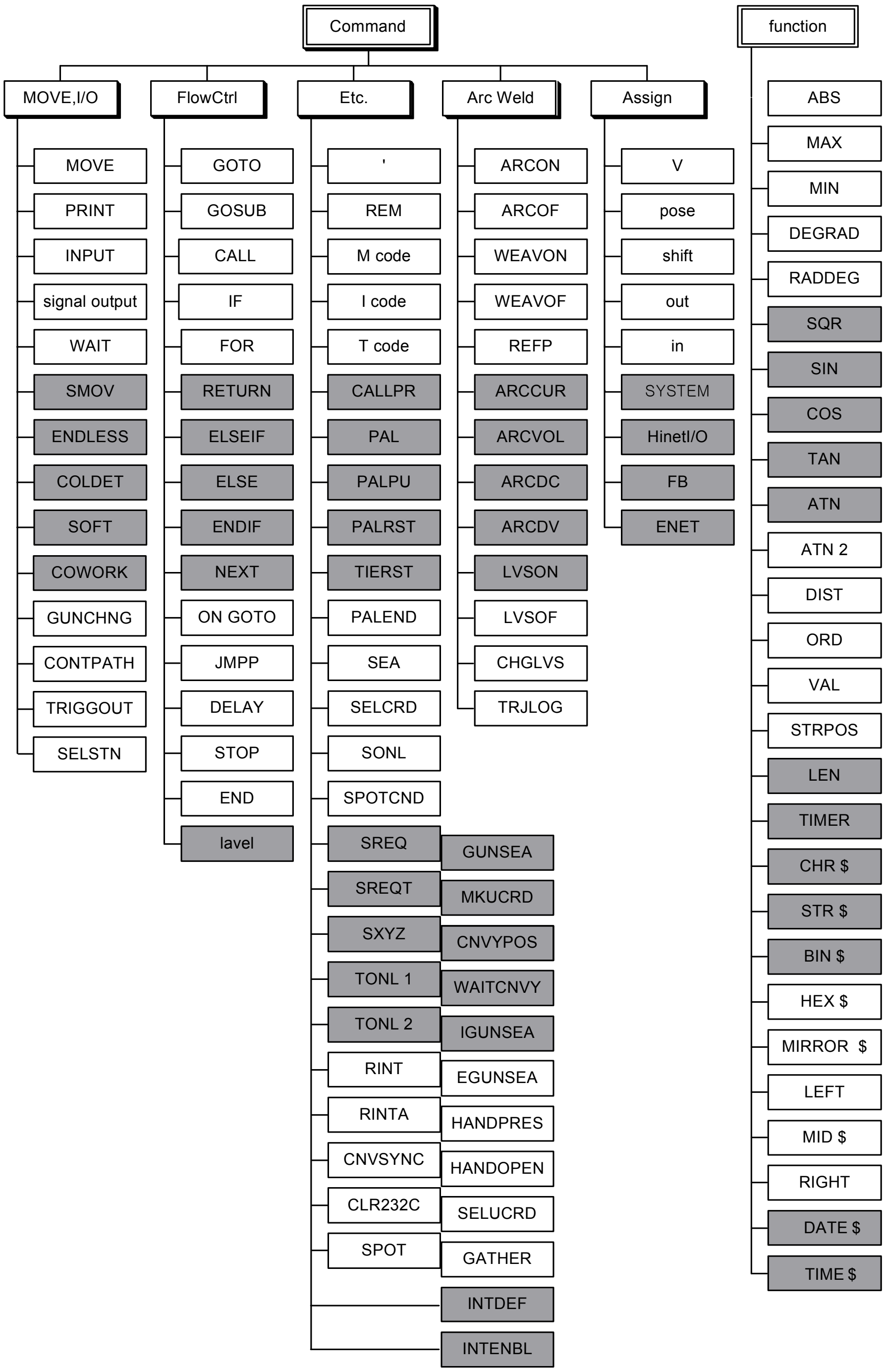


Fig 10.1 Menu Overview

10.3. Basic Elements

10.3.1. Row

Except for step statements (MOVE statement, SMOVE statement, etc.) for position shift of a robot, row numbers (1~9999) may be optionally attached in front of rows. A row may have up to 254 characters. Only one statement is allowed for a row.

10.3.2. Character

Letter	A ~ Z, a ~ z, Korean letters (Except notes and strings, every letter should be uppercase.)
Digit	0 ~ 9
Symbol	! " ' # $ % & ( ) * + - . , / \ : ; = < > ? @ ` [\ ] ^ { } ｜ _
Space	<space>, <tab>(Before being transferred to the controller, <tab> is converted to <space>.)

10.3.3. Address

Explanation	Address includes row number, step number and label. Address is used for branch such as GOTO and GOSUB. Row number can be omitted.	
Step number	S0~S999	Step number is automatically marked when step statement (MOVE statement, etc.) is inputted.
Row number	1~9999 (Arithmetic)	Order of row numbers is not relevant to program operation order.
Label	*<Label>	Label should be in English letters, numbers and underline and cannot be over 8 characters. The first letter should be an English letter.
Example	50 PRINT.... *ERRHDL	GOTO 10 GOTO V1% GOSUB *CALC
Note	Only integers without signs can be used for step number. Arithmetic can be used for row number. Number of row numbers per program cannot be over 1000. Number of labels preprogram should not be over 100.	

10.3.4. Invariable

Invariable		Range	Example
Integer	Decimal	-32768~32767	2150, -440
	Binary	&B0~B1111111111111111	&B01101011, &B1000
	Hexadecimal	&H0~&HFFFF	&H3F77, &H2A
Real number		-3.4E+38~3.4E+38	55.6, 0.5E-2
String		Up to 35 characters	"INPUT WORK NUMBER:", "INVALID DATA"

Invariable	Coordinates System	Range	Example
Pose	Base coordinates System	Each element is within the range of real number.	(204.5, 3719.35, 277.94, 0, 50, 0,&H0001) (P* is the current pose of a robot.)
	Robot coordinates System	Each element is within the range of real number.	(204.5, 3719.35, 277.94, 0, 50, 0, ,&H0001)R
	Encoder form	Each element is within 0~&HFFFFFFFF	(&H400000,&H400000,&H400000,&H400000 ,&H400000,&H400000)E
	User coordinates System	Each element is within the range of real number.	(204.5, 3719.35, 277.94, 0, 50, 0, &H0001)U4
Shift	Base coordinates System	Each element is within the range of real number.	(0, 50, 0, 0, 0, 0)
	Robot coordinates System	Each element is within the range of real number.	(0, 50, 0, 0, 0, 0)R
	Tool coordinates System	Each element is within the range of real number.	(0, 50, 0, 0, 0, 0)T
	User coordinates System	Each element is within the range of real number.	(0, 50, 0, 0, 0, 0)U4 (U4 means user coordinates system number 4.)

Reference

- Base coordinates system has no suffix. Suffix of robot coordinates system is R, and user coordinates system's is U or Un. (n means number of user coordinates system.)

- Each element of base coordinates or robot coordinates system is (X, Y, Z, RX, RY, RZ, cfg.). If there is additional axis, elements continues after RZ. 'X, Y, and Z' are coordinates (unit: mm), and 'RX, RY and RZ' are revolving degree (unit: degree). 'cfg.(configuration)' is composed of robot form data setup value of decimal (0~7H3FF).

- If there is no additional axis, it is the same whether coordinates has R or not, because base coordinates system and robot coordinates system are the same.

- In case of encoder form, suffix E is added.

- Each element of encoder form is (S, H, V, R2, B, R1) and no cfg.. If there is additional axis, the element continues after R1.

- If T is attached, user coordinates system is ignored even though it is already set, because only tool coordinates system is applied.

10.3.5. Robot Form Data

Table 10-2 .CFG element value structure of pose invariable or pose variable

9~7 bit	6 bit	5 bit	4 bit	3 bit	2 bit	1 bit	0 bit
0: base 1: robot 3: encoder 4: user	0: R1<180 1: R1>=180	0: R2<180 1: R2>=180	0: S<180 1: S>=180	0: flip 1: nonflip	0: up 1: down	0: front 1: back	0: manual 1: auto

Reference

- 0 bit: auto. cfg. Function. If it is set as 0, form data assigned to 1 bit ~ 6 bit is applied. If it is set as 1, assigned forms are ignored, and appropriate forms are created.
- 9~7 bit: Coordinates system form of pose. This bit is used, when coordinates system data of pose within program routine should be retrieved. If coordinates system suffix and this bit are different, follow the suffix.
- .CFG element value structure of shift variable

4 bit (Reception state)	3, 2 bit (Online shift request)	1, 0 bit (Shift coordinates system)
0: no reception 1: reception completed	0: OFF 1: COM 1 2: COM 2	0: Base coordinates system 1: Robot coordinates system 2: Tool coordinates system 3: User coordinates system

- 3, 2 bit is used for storage of whether online shift request (SREQ) is forwarded and to which serial port the request is forwarded.
- 4bit is used for storage of whether online shift response is received.
- 2, 3, 4 bit are not usually used by users. However, after string shift value in register and setting 4 bit as 1 as if reception is completed, users can apply them to online shift or online coordinates conversion (SONL, TONL1 and TONL2).

10.3.6. Variable

10.3.6.1. Global Variable

Global variable are shared by all programs.

Variable		Grammar	Example
Arithmetic	Integer	V1%~V400% or V%[1]~V%[400]	V10%, V%[20], V%[50+V2%] (Formulas should be in [ ].)
	Real number	V1!~V400! or V![1]~V![400]	V10!, V![20], V![50+V2%]
String		V1$~V40$ or V$[1]~V$[40]	V10$, V$[20], V$[V2%]
Pose		P1~P999 or P[1]~P[999]	P50, P[70], P[50+V2$] , P[20].RZ, P[10].X (Elements (X, Y, Z, RX, RY, RZ, T1, T2,... T6, CFG) are accessible.)
Shift		R1~R100 or R[1]~R[100]	R20, R[30], R[20+V2$], R[20].RZ, R[10].X (Elements (X, Y, Z, RX, RY, RZ) are accessible.)

Reference

- Pose elements and shift elements are treated as real number.
- Number of pose elements T1, T2... should be the same as the number of additional axes.
- When pose is encoder type, elements (S, H, V, R2, B, R1) can be accessed by using X, Y, Z, RX, RY or RZ.
- As soon as controller system is initialized, all arithmetic variables, pose, shift variables become 0 and string variables are initialized to empty string. When a new cycle begins or a program is changed, they are not automatically initialized.
- All variable values remain, even though the power is off.
- R1~R8 are mapped to online shift register as they are. For example, assignment statements such as R2=(shift invariable) are used for No. 2 online shift register setup.
- Number of global variables can be drastically increased by using the SRAM expansion variable function.

10.3.6.2. Local Variable

A main program and each called assistant program have its own local variable. Each program cannot access local variable of other programs.

Variable		Grammar	Example
Arithmetic	Integer	LV1%~LV50% or LV%[1]~LV%[50]	LV10%, LV%[5], LV%[5+LV2%] (Formulas should be in [ ].)
	Real number	LV1!~LV50! or LV![1]~LV![50]	LV10!, LV![5], LV![5+LV2%]
String		LV1$~LV10$ or LV$[1]~LV$[10]	LV10$, LV$[5], LV$[LV2%]
Pose		LP1~LP100 or LP[1]~LP[100]	LP5, LP[7], LP[5+LV2$], LP[2].RZ, LP[10].X (Elements (X, Y, Z, RX, RY, RZ, T1, T2,... T6, CFG) are accessible.)
Shift		LR1~LR50 or LR[1]~LR[50]	LR2, LR[3], LR[2+LV2$], LR[2].RZ, LR[10].X (Elements (X, Y, Z, RX, RY, RZ) are accessible.)

Reference

- Pose elements and shift elements are treated as real number.
- Number of pose elements T1, T2... should be the same as the number of additional axes.
- When pose is encoder type, elements (S, H, V, R2, B, R1) can be accessed by using X, Y, Z, RX, RY or RZ.
- As soon as controller system is initialized, all arithmetic variables, pose, shift variables become 0 and string variables are initialized to empty string. When a new cycle begins or a program is changed, they are not automatically initialized.
- All variable values remain, even though the power is off.

10.3.6.3. Input/Output Variable

Output variable	**Public output single DO (bit)**	DO1~256	DO2=1 (If 0, RESET. If not, SET.) (SET general purpose signal DO2.)
	Public output group GO (byte)	GO1~32	GO3=&B00001111 or GO3=&H0F (Through GO3, hexadecimal 0F output)
	Exclusive output single SO (bit)	SO1~8	SO4=0 (If 0, RESET. If not, SET.) (RESET exclusive output signal SO4.)
	Analog AO	AO1~4	AO1 = 3.5 (Through output channel Analog 1, 3.5 volt output)
Input variable	**Public input single DI (bit)**	DI1~240	V2%=DI3 (1 or 0. Read-only variable) (Current state of general purpose input signal DI3 is set as V2% variable.)
	Public input group GI (byte)	GI1~30	V3%=GI4 (0~255, Read-only variable) (Current state of general purpose input signal GI4 is set as V3% variable.)
	Exclusive input single SI (bit)	SI1~8	V3%=SI4 (1 or 0. Read-only variable) (Current state of exclusive input signal SI4 is set as V3% variable.)
	Analog AI	AI1~4	V3!=AI2 (Read-only variable) (Value of input channel Analog 2 is inputted in V3!.)

Reference

- When index is expressed in arithmetic, it should be in [ ]. (For example, DO[ ], GO[ ], AO[ ])
- Analog input/output values are between -12V~12V , when BD48X is attached.

10.3.6.4. System Variable

System variable is used for acquisition or setup of internal state of the system. Currently, there are three read-only variables: frequency register variable, serial port data input variable and option board variable. Values cannot be inputted in read-only variable. In other words, read-only variable cannot be on the left side of assignment statement.

_RN1~16 or _RN[1]~_RN[16]	Frequency register 1~16	
$CONVPLS1	Encoder pulse count of option board channel 1	read-only
$CONVPLS2	Encoder pulse count of option board channel 2	read-only
$CONVSTAT	Option board state Bit 0: Encoder disconnection error state (active high) Bit 1: Start limit switch (active high)	read-only
_TEINPUT	When string is inputted in controller through serial port, this variable sets a method for recognizing the end of the string. + value: When inputted ASCII code value is equal to _TEINPUT setup value, it is recognized as the end of the string. - value: When _TEINPUT setup value is equal to the number of inputted strings, it is recognized as the end of the string.	
_PALCNT	During palletizing, work piece count coming under the pallet number	
_INTNUM	Occurred interrupt number. If interrupt does not occur, this variable is 0.	read-only
_SPDRATE	For optional change in robot operation speed, this variable sets the rate.	
_ACCDEC	For optional change in robot acceleration/deceleration, this variable sets the rate.	
_MW or _MW[]	This variable is used by GP, internal PLC and robot language. 521 system variables are assigned to internal PLC, and 5000 are assigned to the other devices.	

10.3.7. Operator

↑ High priority

( )
Symbols (+ -)
^
* / \ MOD
+ -
= <> < > <= >=
NOT
AND OR XOR

↓ Low priority

Example V10! = (V1!^2 + V2!^2 + V3!^2)*2.5
IF(V24!>=V50! AND V10$= “WELD”)

Reference

- For string operation, only three operators – ‘+ (connecting two strings),’ ‘= (equal)’ and ‘<> (not equal)’ – are available.
- Pose operation is possible only in the form of ‘<pose> + <shift>.’
- \ means integer division. Left operand is divided by right operand, and the value is rounded off.
- MOD is an operation to calculate a remainder of a division.
- AND, OR and XOR are bit operators. If these operators need be used as logical operators, operand should be 0 or 1 to assure correct results.
- NOT is only used as bit operator. There is no logical NOT. Deal with such problems using <> properly.
- In case of operation between integers and real numbers, execute operation after automatic type conversion of integer into real number. (Operation result is real number.)

10.3.8. Formula

Arithmetic formula	Integer, real number, integer variable, real number variable, input/output variable, arithmetic function, pose element, shift element and operation formula whose result is integer or real number are included. Example: -10, 10.12, V1%, V1!, SQR(V1%), P1.X, R2.Y, (V2!+V3!)/2+&HC000, V1%+GI2, DI1+DI2*2+DI3*4, AI3<5.2
String formula	String invariable, string variable, string function and operation formula whose result is string are included. Example: "COMM ERR", "ABCD"+"EFCD", LEFT$("ROBOT INIT", 5)
Pose formula	Pose invariable, pose variable and operation formula whose result is pose are included. Example: (204.5, 37.35, 2.94, 0, 50, 0, 24)R+(0, 10, 0, 0, 0, 0)T, P1+R1

10.4. Statement

10.4.1. Assignment Statement

Explanation	Values are assigned to variable.	
Grammar	<Variable>=<Value>	
Parameter	Variable	Arithmetic, string, pose, shift
	Value	Arithmetic formula, string formula, pose formula, shift invariable, shift variable
Example	V5%=20 V![V1%]=5.5 V2$= "EMERGENCY STOP!!" P3 = P3+R1 R2 = (0, 100, 0, 0, 0, 0)	
Note	Value type should be the same as variable type. Automatic type conversion is executed for integer and real number.	

10.4.2. Robot Command

10.4.2.1. MOVE Command

Explanation	Ends of robot tool move to target pose.		
Grammar	MOVE <Interp.>, [<Pose>], S=<Speed >, A=<Accu.>, T=<Tool> [,<Output option>] [UNTIL <Condition>[,<Interrupt state variable>]]		
Parameter	Interp.	P: no interpolation, L: linear interpolation, C: circular interpolation	
	Pose	Pose formula. Target pose. In case of hidden pose, it is omitted, or only shift formula is assigned.	
	Speed	Arithmetic formula. Moving speed of tool ends. Unit (mm/sec, cm/min, sec, %) should be accompanied.	
	Accu.	Arithmetic formula. 0~3. 0 is the most accurate.	
	Tool	Arithmetic formula. 0~7	
	Output option	MX, MX2, G1, G2, BM (MulReferencele assignments are possible.)	
	Condition	When a conditional formula is true, robot motion is ended, and is considered to reach the assigned pose.	If not 0, true. If 0, false.
	Interrupt state variable	Result value of conditional formula is kept. This indicates whether MOVE motion is ended by conditional formula.	Used with UNTIL command.
Example	MOVE C,P[0]+R[1],S=800mm/s,A=0,T=1 MOVE P,R1, S=80%,A=1,T=3 UNTIL DI1 (Hidden pose) MOVE L,S=0.5sec,A=0,T=0,MX,G1 UNTIL DI2=&H7F,V1% (Hidden pose)		

Reference

- If MOVE command is inputted by a <Record> key on T/P, it becomes hidden pose form.
- If shift formula is recorded in <pose> on T/P, it becomes hidden pose form and the target pose becomes (hidden pose + shift formula).
- Output options are MX, G1, PU, PK and PS in the palletizing mode. ‘MX and G1’ and ‘PU, PK and PS’ cannot be assigned at the same time. Refer to “Palletizing Function Manual” for details.
- When robot equalizer is used, G1 and G2 cannot be assigned at the same time.

10.4.2.2. SMOV Command

Explanation	Ends of robot tool move to target pose. Positioner synchronous motion.		
Grammar	SMOV <Positioner no.>,<Interp.>,[<Pose>], S=<Speed>, A=<Accu.>, T=<Tool> [,<Output option>] [UNTIL <Condition>[,<Interrupt state variable>]]		
Parameter	Positioner no.	Refer to “Positioner Synchronous Function Manual.”	
	Interp.	P: no interpolation, L: linear interpolation, C: circular interpolation	
	Pose	Pose formula. Target pose. In case of hidden pose, it is omitted, or only shift formula is assigned.	
	Speed	Arithmetic formula. Moving speed of tool ends. Unit (mm/sec, cm/min, sec, %) should be accompanied.	
	Accu.	Arithmetic formula. 0~3. 0 is the most accurate.	
	Tool	Arithmetic formula. 0~7	
	Output option	MX, MX2, G1, G2, BM (MulReferencele assignments are possible.)	
	Conditional formula	When a conditional formula is true, robot motion is ended, and is considered to reach the assigned pose.	If not 0, true. If 0, false.
	Interrupt state variable	Result value of conditional formula is kept. This indicates whether MOVE motion is ended by conditional formula.	Used with UNTIL command.
Example	SMOVE S1,C,P[0]+R[1],S=800mm/s,A=0,T=1 SMOVE S1,P,R1,S=80%,A=1,T=3 UNTIL DI1(Hidden pose) SMOVE S1,L,S=0.5sec,A=0,T=0,MX,G1 UNTIL DI2=&H7F,V1% (Hidden pose)		

Reference

- Refer to “Positioner Synchronous User Guide” for details about SMOV.
- If [Record] is pressed in the positioner synchronous mode, SMOV command, not MOVE command, is inputted.
- If shift formula is recorded in <pose>, it becomes hidden pose form.
- Output options are MX, G1, PU, PK and PS in the palletizing mode. ‘MX and G1’ and ‘PU, PK and PS’ cannot be assigned at the same time. Refer to “Palletizing Function Manual” for details.
- When robot equalizer is used, G1 and G2 cannot be assigned at the same time.

10.4.2.3. ENDLESS Command

<table>
<tr><td>Explanation</td><td colspan="3">This function is to reset or revolve the assigned axis for recorded number of rotations. (Set this function available on the ENDLESS axis setup screen.)</td></tr>
<tr><td>Grammar</td><td colspan="3">ENDLESS < Axis name >=< The num. of rot.>
ENDLESS RESET</td></tr>
<tr><td rowspan="3">Parameter</td><td>Axis name</td><td>R1: Axis R1, T1~T6 : additional axis 1~6</td><td rowspan="3">Applied only to MOVE P</td></tr>
<tr><td>The num. of rot.</td><td>Number of rotations of an axis to be applied to the first step after command is given. (1=360deg, -1=-360deg)</td></tr>
<tr><td></td><td>Current axis rotation value is converted to “-180deg ~ 180deg” value.</td></tr>
<tr><td>Example</td><td colspan="3">S1 MOVE P,S=50%,A=0,T=0
ENDLESS R1=10
S2 MOVE P,S=50%,A=0,T=0
(-> Axis R1 moves to where 10 more rotations than the recorded position of step.)
ENDLESS T1=10
ENDLESS T2=10
S3 MOVE P,S=50%,A=0,T=0
(-> Axis T1 and Axis T2 move to where 10 more rotations than the recorded position)
ENDLESS T1=10
S4 MOVE L,S=800mm/s,A=0,T=0
(->ENDLESS rotation command is not executed except MOVE P.)
ENDLESS RESET
(-> Axis out of one rotation range is converted to -180deg ~ +180deg value.)
END</td></tr>
</table>

Reference

- ENDLESS command is available for the first interpolation OFF step behind the command.
- Steps where ENDLESS command is executed are automatically converted to the value within one rotation after revolving for the assigned times.

10.4.2.4. COLDET Command

When the collision detection function is available, COLDET command sets collision detection level of a robot. For collision detection function availability setup and collision detection value according to level, go to 『[PF2]: System』 → 『3: Machine parameter』 → 『13: Collision Detection Setting』.

When the collision detection function is available, its detection level is level 4 without COLDET command. Under COLDET command, collision detection is executed at the proper level until next COLDET command is given. If COLDET is 0, the collision detection function becomes unavailable. In the manual manipulation mode, level J for manual mode is applied.

Explanation	Collision detection level setup	
Grammar	COLDET <level number>	
Parameter	level number	0~4
Example	When the collision detection function is available and operation program is as follows: S1 MOOE S2 MOVE COLDET 1 S3 MOVE COLDET 0 S4 MOVE S5 MOVE END Detection level is 4 at step 1 and step 2, the level is 1 at step 3, and collision detection is unavailable after step 4.	
Note	As of March 3rd, 2005, robot types which has the collision detection function are as follows: HR006-04, HR006-05 / HR015-01 HX130-02 / HX165-02, HX165-04 HX200-L20 / HX300-02 /HX400-02	

10.4.2.5. SOFT Command

In the work piece loading/unloading process or the assembling process, work piece positions deviate due to position decision error a robot or work piece error. The twist between work pieces may cause an overload error or work piece damage. To deal with such process, the “soft floating” function allows work pieces to slide in and out by operating the work with reasonable amount of power.

SOFT command designates flexibility level of the Soft floating function.
Soft floating sets flexibility of each axis according to the level.
Go to 『[PF2]: System』 → 『3: Machine parameter』 → 『14: Soft Floating』 for setup.

There are four levels (1~4), and if the level is 0, the soft floating function is off.

The soft floating function is cleared, when power is off, motor is off, enable switch is disconnected in the manual mode, and a power saving function is on. Also, at program step 0, the soft floating function is cleared. In other words, previously set soft floating function works only at normally working step GO/BACK with the motor on and in the manual manipulation mode. When the motor is off, the function is ended.

Set new soft floating level by using R355 with the enable switch on in order to reactivate the soft floating function in the manual manipulation mode.

<table>
<tr><td>Explanation</td><td colspan="2">Soft floating flexibility level setup</td></tr>
<tr><td>Grammar</td><td colspan="2">SOFT <level number></td></tr>
<tr><td>Parameter</td><td>level number</td><td>0~4</td></tr>
<tr><td>Example</td><td colspan="2">When an operation program is as follows:
S1 MVOE
S2 MOVE
SOFT 1
S3 MOVE
S4 MOVE
SOFT 2
S5 MOVE
SOFT 0
S6 MOVE
END
The robot works under the normal torque at step 1 and step 2, under level 1 torque at step 3 and step 4, and under level 2 torque at step 5. At step 6, the soft floating function is off, and the robot works under the normal torque.</td></tr>
<tr><td>Note</td><td colspan="2">Only HR006 and HR015 have the soft floating function.</td></tr>
</table>

10.4.2.6. COWORK Command

<table>
<tr><td>Explanation</td><td colspan="2">This command designates master robot and slave robot by using the cooperative handling function, and starts and ends the synchronous motion of the robots.</td></tr>
<tr><td>Grammar</td><td colspan="2">COWORK {Master|Slave|END},{S=<slave#>|M=<master#>,T=<wait time></td></tr>
<tr><td rowspan="3">Parameter</td><td>master|slave|end</td><td>M: master robot　S: slave robot　END: cooperative control end</td></tr>
<tr><td>slave|master No.</td><td>Role and number of relative robot are designated.

When robot role is designated as M, slave robot number is assigned.
S = Number 1, number 2, number 3

When robot role is designated as S, master robot number is assigned.
M = robot number</td></tr>
<tr><td>wait time</td><td>Waiting time until relative robots reach the COWORK command</td></tr>
<tr><td>Example</td><td colspan="2">S1 MOVE P,S=100%,A=0,T=0
S2 MOVE P,S=100%,A=0,T=0
S3 MOVE P,S=100%,A=0,T=0
DO1=1
COWORK M,S=2,T=30
-> Robot role is master, cooperative control begins, and slave waiting time is 30 seconds.
S4 MOVE L,S=800mm/sec,A=0,T=0
S5 MOVE L,S=500mm/sec,A=0,T=0
S6 MOVE L,S=800mm/sec,A=0,T=0
COWORK END
-> Cooperative control ends.
DO1=0
S7 MOVE P,S=100%,A=0,T=0</td></tr>
</table>

Reference

- To use the COWORK function, more than two robots should be connected to the cooperative control network.
- Refer to 『Cooperative Control Function Manual』 for details.

10.4.2.7. GUNCHNG Command

Explanation	Welding gun (servo gun and air gun) change command	
Grammar	GUNCHNG {ON|OFF},GN=<gun number>,DI<gun connection confirm input>,WT=<connection waiting time>	
Parameter	ON|OFF	ON: connection command, OFF: disconnection command
	gun number	Servo gun number for connection
	connect. con	Input number which should be inputted before GUNCHNG command is executed.
	waiting time	Waiting time until relative robots reach the COWORK command.
Example	.... GUNCHNG OFF -> servo gun (or pneumatic gun) disconnection sequence execution DO11=1 WAIT DI11 MOVE L, ... MOVE L, ... MOVE L, ... WAIT DI12 DO11=0 GUNCHNG ON,2,DI#1 -> If DI#1 is inputted, connection sequence of gun No.2 is executed. MOVE L, ...	

Reference

- As to DI# signal of GUNCHNG function, connection completion signal should be inputted in the controller only after the gun for change is completely connected to the robot.
- Refer to 『Welding Gun Change Function Manual』 for signal input/output and details.

10.4.2.8. CONTPATH Command

Explanation	Consecutive path is selected.		
Grammar	CONTPATH <option>		
Parameter	Option	0: If the step includes command (function), the command (function) is executed after reaching step position, and moves to the next step.	
		1: Commands recorded in the target step do not stop after execution, and pass the target step to the next step. If the command is output command, it is outputted when the order value reaches in the accuracy range. Also, if input signal is used for command parameter, it is treated as discontinuous. When the order value reaches in the accuracy range, the command is executed and moves to the next step.	If the program is executed from the first, this parameter becomes 0. CALL/JUMP is excluded.
		2: Even commands including input signals are analyzed and consecutively move.	Same as above
Example	CONTPATH 0 CONTPATH 1 'Consecutive handling (except for input signals) CONTPATH 2 'Consecutive handling including input signals		

Reference

- Input signal: DI, GI, FBn., AI, DE, GE, INPUT
- Output signal: DO, GO, FBn., AO, DE, GE, PRINT, ENET
- Other discontinuous conditions
  ① When RINT(Robot interrupt) or UNTIL command is in operation
  ② Discontinuous operation: Under Step FWD and discontinuous conditions, Step BWD and one step are executed.
  ③ Steps with GUN1 or GUN2
  ④ When Acc=0 and the value is 0
  ⑤ When tool number is changed

10.4.2.9. SELSTN Command

<table>
<tr><td>Explanation</td><td colspan="3">Selecting group number for positioner synchronous motion. This function allows independent manipulation of positioners other than selected positioner group by using external signal assigned by the user.</td></tr>
<tr><td>Grammar</td><td colspan="3">SELSTN <station>[,<timeout time>,<shelter address>]</td></tr>
<tr><td rowspan="3">Parameter</td><td>station</td><td>ALL: all positioners are operated.
S0: Each positioner is independently operated.
S1~S3: Selected positioners are operated.</td><td></td></tr>
<tr><td>timeout time</td><td>Waiting time until independent operation is completed.</td><td></td></tr>
<tr><td>shelter addr.</td><td>If independent operation is not completed until waiting time is up, positioners are withdrawn to this address.</td><td></td></tr>
<tr><td>Example</td><td colspan="3">SELSTN S1 → Positioner group 1 is selected.
S1 MOVE L,S=300mm/s,A=0,T=0 → Only positioner group 1 is operated.
S2 SMOV S1,L,S=100mm/s,A=0,T=0 → Only positioner group 1 is operated.
S3 SMOV S1,L,S=100mm/s,A=0,T=0 → Only positioner group 1 is operated
S4 MOVE L,S=300mm/s,A=0,T=0 → Only positioner group 1 is operated.
S5 SMOV S1,L,S=100mm/s,A=0,T=0 → Only positioner group 1 is operated.
SELSTN S2 → Positioner group 2 is selected.
S6 MOVE L,S=300mm/s,A=0,T=0 → Only positioner group 1 is operated.
S7 SMOV S2,L,S=100mm/s,A=0,T=0 → Only positioner group 1 is operated.
S8 MOVE L,S=300mm/s,A=0,T=0 → Only positioner group 1 is operated.
S9 SMOV S2,L,S=100mm/s,A=0,T=0 → Only positioner group 1 is operated.
SELSTN ALL → All positioner groups are selected.
S10 MOVE P,S=100%,A=0,T=0 → All positioner groups are operated.
S11 MOVE L,S=1200mm/s,A=0,T=0 → All positioner groups are operated.
S12 MOVE L,S=200mm/s,A=0,T=0 → All positioner groups are operated.</td></tr>
</table>

Reference

- To select positioner group, set positioner group first.
- Refer to 『Positioner Synchronous Function Manual』 for setup and details.

10.4.3. Input/Output

10.4.3.1. Input/Output Assignment Statement

Explanation	DO signal is outputted or current DI signal state is inputted.	
Grammar	<output variable>=<output value> <arithmetic variable>=<input variable>	
Parameter	Output variable	This variable is assigned to DO signal. Single signal is DO, and group signal is GO. AO variable assigned to analog output signal.
	Output value	Arithmetic formula. 0~255. (If the value is real number, drop numbers after the decimal point.) As to single signal output, if the value is 0, it is off. If not, on. As to analog output, use numbers after the decimal point, because the value is real number.
	Input variable	This variable is assigned to DI signal. Single signal is DI, group signal is GI. AI variable is assigned to analog input signal.
Example	DO3 = 1 GO2 = &H7F AO2 = 3.4 V20% = DI2 V21% = GI2 V1! = AI3	

10.4.3.2. PRINT Statement

Explanation	Assigned data is printed on teach pendant screen or serial port.	
Grammar	PRINT <output direction>,<info,..>	
Parameter	Output direction	#0 : teach pendant #1 : serial port COM 1 #2 : serial port COM 2
	infomation	Arithmetic formula, string formula
Example	PRINT #0, "SIGNAL VALUE = " ; V1!	
Note	If there is ‘,’ in the space between data, the data are distinguished by printed space as a character. If there is ‘;’ no space is printed. If there is ‘;’ at the end, new-line character is not attached.	

10.4.3.3. INPUT Statement

<table>
<tr><td>Explanation</td><td colspan="3">Data is inputted from teach pendant screen or serial port in the form of variables.</td></tr>
<tr><td>Grammar</td><td colspan="3">INPUT <input direction>, <variable> , [<timeout time>]</td></tr>
<tr><td rowspan="3">Parameter</td><td>Input direction</td><td colspan="2">#0 : teach pendant
#1 : serial port COM 1
#2 : serial port COM 2</td></tr>
<tr><td>Variable</td><td colspan="2">Arithmetic variable, string variable</td></tr>
<tr><td>Timeout</td><td>Arithmetic formula. If assigned time is up, a new line begins. If this parameter is 0, key value inputted before execution. If there is no key value, -999 is stored.</td><td>Sec unit
Integer
0.0~60.0</td></tr>
<tr><td>Example</td><td colspan="3">INPUT #1, V20!, 5
INPUT #0, V1$</td></tr>
<tr><td>Note</td><td colspan="3">On teach pendant, input is completed by [SET].
On serial port, input is completed by recognizing NULL character (ASCII code 0).
When data is inputted in the form of arithmetic variable: if string which cannot be translated into numbers is inputted, -999 is inputted in variable.
When input fails within the assigned time: if data is in the form of arithmetic variable, -999 is inputted, and if string variable, empty string is inputted.
If timeout time is set to 0, the value previously inputted by [Number] keys on the teach pendant is assigned. If there is no such value, -999 is assigned to variable.</td></tr>
</table>

10.4.4. Program Flow Control

10.4.4.1. GOTO Statement

Explanation	Branching to assigned address	
Grammar	GOTO <address>	
Parameter	Address	Address for branching Arithmetic formula can be used, if the address is row number.
Example	GOTO 99 GOTO V1% GOTO *ERRHDL	

10.4.4.2. GOSUB ~ RETURN Statement

Explanation	Calling the address assigned by GOSUB. When RETURN statement is given, data returns to the next row of the called GOSUB statement.	
Grammar	GOSUB <address> ...... RETURN	
Parameter	Address	Address to call Arithmetic formula can be used, if the address is row number.
Example	GOSUB 150 END 150 REM ---- sub routine for test ---- PRINT #0, "Subroutine Start" PRINT #1, "Subroutine End" RETURN	

10.4.4.3. JMPP Statement

Explanation	Branching to assigned address		
Grammar	JMPP <program number>		
Parameter	Program number	Arithmetic formula. Program number to call.	1~999

Example	IF DI29 THEN
	JMPP 909
	ENDIF
		REM --- subprogram 909 - ERROR STOP
		PRINT #0, "Unrecoverable Error!!!", TIME$
		END	

10.4.4.4. CALL Statement

Explanation	Calling the assigned program. When END statement is given, data returns to the next row of the called CALL statement.		
Grammar	CALL <program number> ...... END		
Parameter	Program number	Arithmetic formula. Program number to call.	1~999
Example	Distance calculation between ‘P4 and P7. P300=P4 P301=P7 CALL 902 ‘Result output PRINT #0, "Dist = "; V300!	REM --- subprog. 902 ------------------- REM V300! = <distance between P300 and P301> REM ----------------------------------- V300! = (P300.X-P301.X)^2 + (P300.Y-P301.Y)^2 + (P300.Z-P301.Z)^2 V300! = SQR(V300!)	

10.4.4.5. ON~GOTO Statement

Explanation	Branching to various addresses according to the condition number after ON.	
Grammar	ON <num.> GOTO <addr>[,<addr>,<addr>,..]	
Parameter	num.	Arithmetic formula. This number determines the address for branching. If this number is real number, drop numbers after the decimal point. If the number is less than 1 or more than the number of addresses, the next statement is processed.
	Add.	The address is branched as follows: If condition formula is one, the first address, if two, second… The addresses can be inputted up to 10.

Example	ON V5% GOTO 210, 220, *CONT
	    GOTO *ERR
	210 PRINT #0, "V5%=1"
	    GOTO *CONT
	220 PRINT #0, "V5%=2"
	*CONT	

10.4.4.6. DELAY Statement

Explanation	Delay as assigned.		
Grammar	DELAY <time>		
Parameter	Time	Arithmetic formula. Waiting time	Unit : sec (0.1~60.0)
Example	DELAY 0.5		

10.4.4.7. STOP Statement

Explanation	Program is stopped. When restarted, the program is executed from the next row.
Grammar	STOP

Example	IF DI9 THEN
	STOP
	ENDIF

10.4.4.8. END Statement

Explanation	Program is stopped. When restarted, the program is executed from the beginning.
Grammar	END
Example	END

10.4.4.9. WAIT Statement

Explanation	Program waits until condition formula is satisfied. If timeout time is up, the program is branched to withdrawal address.		
Grammar	WAIT <condition>[,<timeout time>,<shelter address>]		
Parameter	Condition	Arithmetic formula. Standby until the condition formula is satisfied.	If 0, true. If not, false.
	Timeout time	Arithmetic formula. Waiting limit time	Unit: sec (0.0~60.0)
	shelter address	Branch address when timeout is over.	
Example	WAIT D120=1, 1.5, *ERR		

10.4.4.10. IF~ELSEIF~ELSE~ENDIF Statement

<table>
<tr><td>Explanation</td><td colspan="3">Program is branched according to condition. Or, blocs after this statement are executed or not executed.</td></tr>
<tr><td rowspan="2">Grammar</td><td>Simple sentence IF</td><td colspan="2">IF <condi.> THEN <addr.> [ELSE <addr.>]</td></tr>
<tr><td>Compound sentence IF</td><td colspan="2">IF <condi.> THEN
~
[ELSEIF <condi.> THEN]
~
[ELSE]
~
ENDIF</td></tr>
<tr><td rowspan="2">Parameter</td><td>Condition</td><td>Arithmetic formula, string condition formula</td><td>If 0, true.
If not, false.</td></tr>
<tr><td>Address</td><td>THEN : If the condition is true, the address is branched.
ELSE : If the condition is false, the address is branched.</td><td></td></tr>
<tr><td rowspan="2">Example</td><td>Example of simple sentence IF</td><td colspan="2">IF V2!>SQR(V50!^2+V51!^2) THEN 150 ELSE *AGAIN</td></tr>
<tr><td>Example of compound sentence IF</td><td colspan="2">IF GI1>=10 THEN
PRINT #0, "HIGH"
PRINT #1, "HR-MSG: HIGH"
ELSEIF GI1>=0
PRINT #0, "LOW"
ELSE
GOTO *ERR
ENDIF</td></tr>
</table>

10.4.4.11. FOR~NEXT Statement

Explanation	As long as variable is equal to or less than ending value, the variable value is increased, and bloc is repeatedly executed.	
Grammar	FOR <variable>=<init.value> TO <end value> [STEP <increment >] ~ NEXT	
Parameter	Variable	Arithmetic variable. This variable determines whether to repeat the execution.
	init.value	Arithmetic variable. A value for initial setup.
	End value	Arithmetic variable. When the variable is equal to or less than this ending value, bloc is repeatedly executed.
	increment	Arithmetic variable. Increase amount value to increase the variable value.
Example	Slowly moving to 'R1 shift direction. FOR V1!=300 TO 0 STEP -33.3 P1=P1+R1 MOVE L,P1,S=V1!mm/sec,A=3,T=1 UNTIL DI1 NEXT	

※**Caution**

- Statements between GOSUB~RETURN, IF~ENDIF, FOR~NEXT statements should be executed as a single statement bloc. Therefore, while the statement group is executed, branch out of the statement bloc should not occur by GOTO statement or a simple sentence IF.

Other GOSUB, IF, FOR statements after the statement bloc might be executed in the wrong way, and 『E1245 Bloc Stack Excess』 error can occur. However, moving within the statement bloc is ok.

```
IF V1%>100 THEN
GOTO *RANGE
ENDIF
PRINT V1%
END
*RANGE
PRINT "RANGE ERROR"
END
```

1) Moving out of the bloc. (X)

```
IF V1%>100 THEN *RANGE
PRINT V1%
END
*RANGE
PRINT "RANGE ERROR"
END
```

2) Moving by simple sentence IF. (O)

```
IF V1%>100 THEN
GOSUB *RANGE
ENDIF
PRINT V1%
END
*RANGE
PRINT "RANGE ERROR"
END
```

3) Moving out of the bloc and into the bloc again. (O)

```
IF V1%>100 THEN
JMPP 201
ENDIF
PRINT V1%
END
```

```
(Job 201)
```

4) Moving out of the bloc (to another job). (X)

```
   IF V1%>100 THEN 10
   PRINT V1%
   END
10 JMPP 201
```

```
(Job 201)
```

5) Moving by simple sentence IF and to another job.(O)

```
   GOTO 10

   IF V1%>100 THEN
10 PRINT V1%
   ENDIF
   END
```

6) Moving from outside the bloc. (X)

```
IF V1%>100 THEN
GOTO *RANGE
PRINT V1%
*RANGE
ENDIF
END
```

7) Moving within the bloc. (O)

10.4.5. Arc Welding

10.4.5.1. Commands on Arc Welding

The following commands are related to arc welding. Refer to 『Arc Welding Function Manual』 for details.

Command	Explanation
ARCON	Arc welding begins.
ARCOF	Arc welding ends.
ARCCUR	Welding current output value is set for an assigned value.
ARCVOL	Welding voltage output value is set for an assigned value.
ARCDC	Welding current command value is directly set for an analog output value.
ARCDV	Welding voltage command value is directly set for an analog output value.
WEAVON	Weaving motion begins.
WEAVOF	Weaving motion stops.
REFP	Reference point setup for weaving motion.
TRJLOG	Moving trace of arc sensing is stored.

10.4.5.2. Commands on Welding Line Tracking by LVS

The following commands are related to arc welding. Refer to 『LVS Tracking Function Manual』 for details.

Command	Explanation
LVSON	Welding line search or tracking by LVS begins.
LVSOF	Welding line tracking by LVS ends.
CHGLVS	Condition number is changed in the welding line tracking section by LVS.

10.4.6. Others

When the [CMD] key is pressed on the initial screen in the manual mode, items appears on the PF menu. When 『[PF3]: Etc』 key is pressed among the items, the following statements are included. Arithmetic formula can be used as all factor values.

10.4.6.1. Note

Explanation	Note is inserted to explain program motions, and does not affect execution. This is a statement which has the same function as 'REM(Remark) statement' or 'M99: Note Function of M code.'	
Grammar	<comment>	
Parameter	Explanation	String for explanation. Up to 254 simplified characters are allowed.
Example	'Variables Setting ------------ REM SPOT WELDING #1 M99 Programmer is hajung 'Call program No.25!!	

10.4.6.2. MIT Code

Explanation	Command code is used for programming with Hi3CE and Hi3TB controllers – old models among Hi controller series. The command code can be used for Hi4 controller. All kinds of M, I, T function codes can be used, if needed.		
Grammar	M<code number> <factor 1>,<factor 2>,<factor 3>,<factor 4> I<code number> <factor 1>,<factor 2>,<factor 3>,<factor 4> T<delay time>		
Parameter	Code number	Positive integer, M : 20~113, I : 1~55	
	Factor	Factors to be transferred arithmetic formula, M, I, T function	
Example	M20 7 M81 5,1 M99 ARC WELDING 1 M101 1,"JOB FINISHED" M105 8,V1% I52 1,2.0,1 I53 1,&B10001,2.0,1 T 0.5		

10.4.6.3. CALLPR Statement

There are repeated motions in several places in the working space, when one robot handles two and more work pieces of the same shape in different places, or a series of loading/unloading jobs (in handling, etc.) is repeated.

When such movements have the same relative position and direction, although the absolute position and direction are different, a separate program (a relative program) for repeated movements can be written. Then, the relative program can be called to execute the job in all position where the motions should be operated. This function is different from a simple program call function in that the called relative program is executed based on the current position and pose at the point of which the program is called.

The following figure shows the result that the main program No.1 called program No.2 as a relative program.

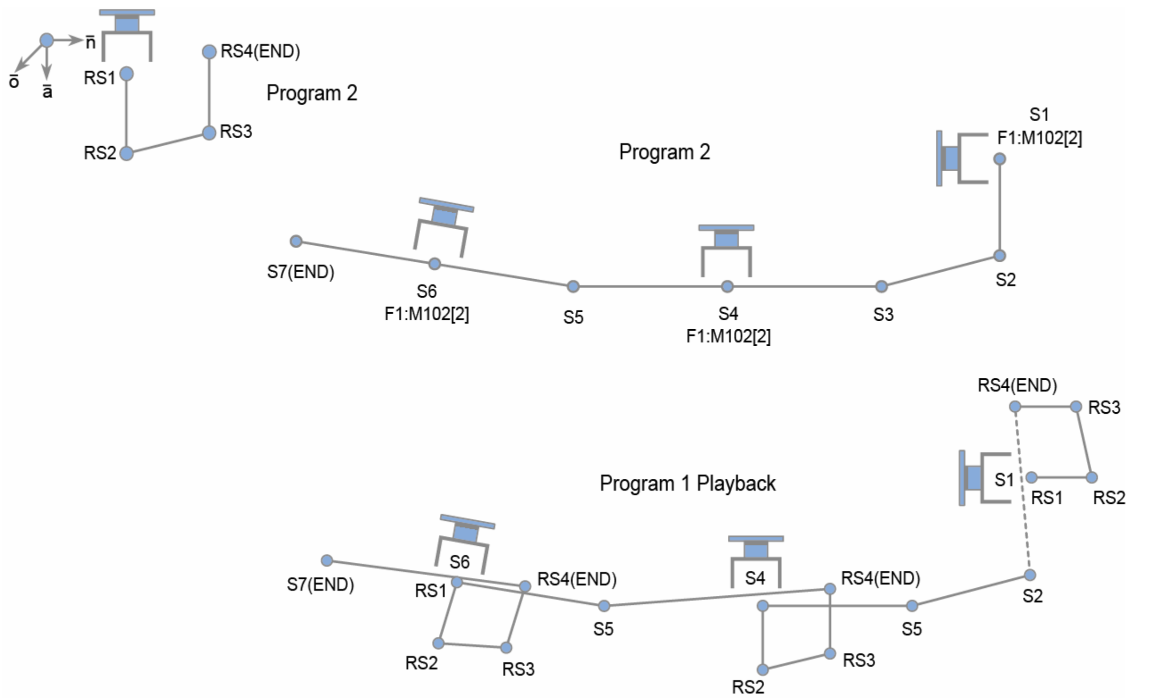


Fig 10.2 Relative program call

Explanation	Relative program call (unconditional) (M102)		
Grammar	CALLPR <program number>		
Parameter	Program number	Program number to be called	1~999
Example	CALLPR 2		
Note	When the called relative program execution is completed, the next function or step of the original program is executed.		

10.4.6.4. PAL Statement

Shift amount for the palletize work is made based on the values stored in the palletize pattern register.

Explanation	Palletize (Data input) (M96)		
Grammar	PAL P=< pallete num.>,PR=< pattern register num.>,W=< work width >,L=< work length >,H=< work height >		
Parameter	pallete num.	Pallet entry number	1~16
	pattern register num.	Palletize pattern register number	1~16
	work width(W)	Width of work piece X(mm)	0.1~3000.0
	work length(L)	Length of work piece Y(mm)	0.1~3000.0
	work height(H)	Height of work piece Z(mm)	0.1~3000.0
Example	PAL P=1,PR=1,W=500,L=300,H=250.5		

Reference

- To use this function, go to 『[PF2]: System』 → 『5: Initialize』 → 『4: Setting usage of the robot』 and set GUN2 as palletize.
- Before using this function, go to 『 [PF2]: System』 → 『4: Application Parameter』 → 『3: Palletizing』 → 『1: Palletize Pattern Register』 and confirm the data value. If the set value is wrong, the robot may execute unwanted jobs.
- This function is reflected only to the step whose step condition is PS.
- Palletize shift (M96) can be used only when paired with 'palletize end (M97).'

10.4.6.5. PALPU Statement

This function is for shifting a work piece up to the inputted height after picking up the work piece while palletize job is executed. This function executes the optimal palletize path in comparison to the current height of stages to be piled.

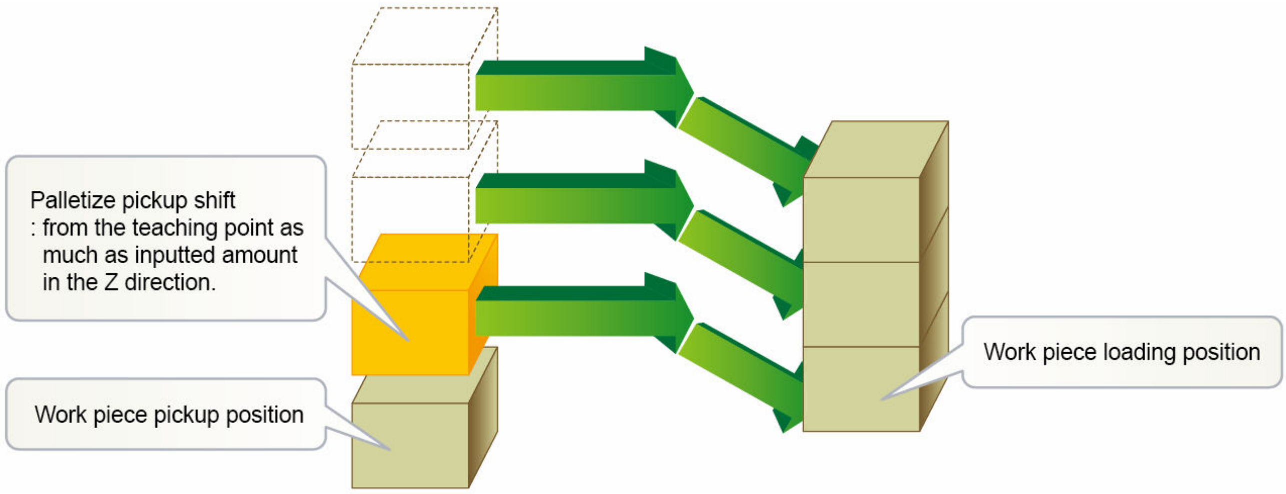


Fig 10.3 Palletize pickup shift

Explanation	Palletize pickup shift (M95)		
Grammar	PALPU P=< pallete num.>,SL=< start layer >,SH=< amount of shift >		
Parameter	pallete num.	Pallet entry number	1~16
	start layer	Number of stages to start pickup (1-base)	1~100
	amount of shift	Shift value when picking goes up	-2000.0~2000.0
Example	PALEND P=1,SL=4,SH=1000		
Note	This function always should be between PAL(M96) and PALEND(M97).		

10.4.6.6. PALRST Statement

This function forces palletize job to be ended. When assigned signal is inputted, all data for the job is initialized, and the responding signal is outputted and used as a discharge signal of pallet.

Explanation	Palletize reset (data input) (M98)		
Grammar	PALRST P=<pallete num.>,CS=<cond.signal>, RS=<response signal>		
Parameter	pallete num.	Pallet entry number	1~16
	cond.signal	Number of a DI input signal to be received from the outside, when palletize is forced to be reset. If the number is 0, the signal is reset unconditionally.	DI range
	response signal	Number of a DO output signal to respond to the condition signal, when palletize is forced to be reset.	DO range
Example	PALRST P=1,CS=1,RS=5		

10.4.6.7. TIERST Statement

This function is to insert papers on pallets during the palletize job. This function calls and executes a program, when the paper insertion condition is satisfied.

Explanation	Paper insertion program call (M94)		
Grammar	TIERST R=<reg. num.>,P=<pallete num.>,PR=<pattern register num.>,TP=< tier sheet inserting program >		
Parameter	reg. num.	Online shift register number	1~8
	pallete num.	Pallet entry number	1~16
	pattern register num.	Palletize pattern register number	1~16
	tier sheet inserting program	Paper program number	1~999
Example	TIERST R=1,P=4,PR=2,TP=800		

Reference

- Before this function is used, a program for paper insertion should be written.
- Data for paper insertion to pattern register should be checked. If wrong data is set, intervention may occur.
- To use the paper insertion function, the function should be between PAL and PALEND function.
- Before the first work piece is loaded/unloaded, paper insertion cannot be executed. The initial position for palletize paper insertion is the lower stage of the first stage work pieces. De-palletize paper insertion should be positioned on top of the highest stage.

10.4.6.8. PALEND Statement

This function ends the palletize job (M96). This function initializes palletize shift amount. When all work pieces are loaded, an assigned output signal is transmitted to outside and used as a pallet discharge signal.

Explanation	Palletize ends (data input) (M97)		
Grammar	PALEND P=< pallete num.>,ES=< end signal >		
Parameter	Pallet num.	Pallet entry number	1~16
	End signal	DO signal number to be transmitted to outside after completing the palletize job. If the number is 0, the signal is not outputted to outside.	DO range
Example	PALEND P=1,ES=81		

10.4.6.9. SEA Statement

The search function is for detecting the difference of work piece position and compensating the difference. Not only robot coordinates system but also tool coordinates system and base coordinates system can be used as the standard to detect and compensate the position difference.

Explanation	Search function (M59)		
Grammar	SEA ST=<On/Off>,RF=< reference >,R=<register number>		
Parameter	On/Off	If 1, on. If 0, off.	0~1
	reference	0=robot, 1=tool, 2=base coordinates	0~2
	Register number	Number to be used for online shift	1~8
Example	SEA ST=1,RF=0,R=1		

(1) Assign search range. (Application condition → 2. Search Range)

(2) Perform program teaching and set the search function for teaching.
① Search start
② Robot interrupt (RINT or RINTA)
③ Search end
④ Online shift

(3) Set search standard position record ‘ON.’ (Application condition → 3: Search Standard Position data record)

(4) Operate the program in the 1Cycle Mode to retrieve the standard position of work piece through robot interrupt.

(5) Set search standard position data record ‘OFF.’ (Application condition → 3: Search Standard Position Data Record)

(6) Operate the program ordinarily.

Reference

- Application of the search function

  ① One-dimension search

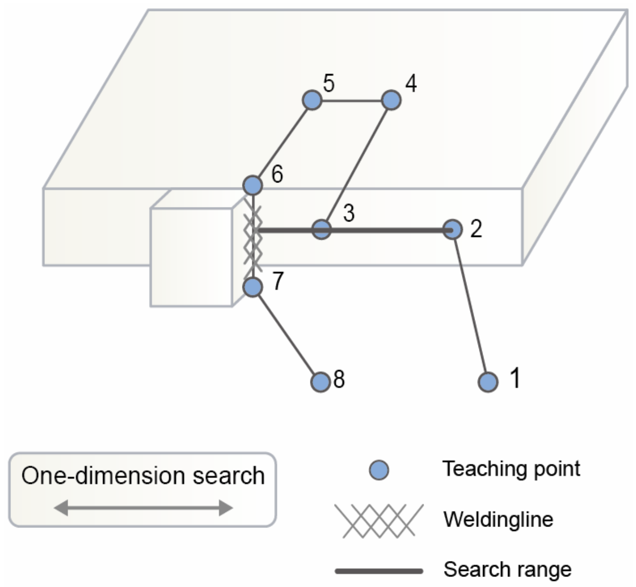


Fig 10.4 One-dimension Search

Figure 10.4 shows the error is corrected by one-dimension search when work pieces of the same kind or of the same shape and different size move.

The search function is used with robot interrupt as shown above. The difference in shift amount is corrected by the online shift function after the amount is recorded in shift register.

In the figure above, shift amount is recorded in shift register through robot interrupt operation while moving to the step 3. By referring to this shift register, step 4 ~ step 7 are shifted and operated. Also, the robot interrupt function is used with interpolation record step.

★ Interpolation record step means a step recorded as “Interpolation (linear and circular) ON.”

② Two-dimension search

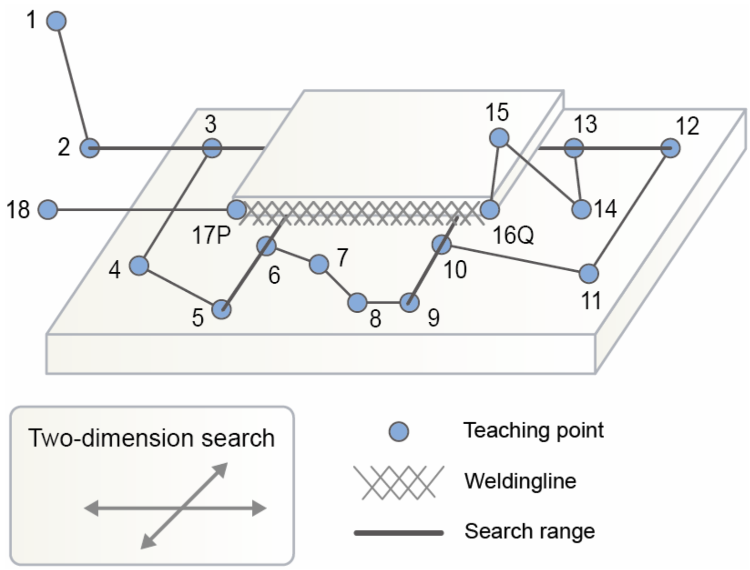


Fig 10.5 Two-dimension search

Two-dimension search records shift amounts of each point (P and Q) by using the search function twice. The shift amount of point P is stored in R1 register and referred to when P is shifted. The shift amount of point Q is stored in R2 register and referred to when Q is shifted.

10.4.6.10. SELCRD Statement

This function is for changing the shift in robot coordinates system to that in user coordinates system by using SELCRD statement when shift amount in user coordinates system, not in robot coordinates system, is inputted from outside.

After this function is executed, all shifts in robot coordinates system are operated as the shift in the selected user coordinates system. SELCRD 0 should be executed in order to convert the shifts to the shifts in robot coordinates system.

Explanation	Shift coordinates system selection (M113)		
Grammar	SELCRD < coordinate system number >		
Parameter	coordinate system number	Coordinates system to be used among set user coordinates systems	0~10
Example	SELCRD 4		

Reference

- For the shift of tool coordinates system based on tool coordinates, the tool coordinates system cannot be converted by this function.

Table 10-3 Result of SELCRD statement execution according to the condition

Coordinates system number / Standard	0	1 ~ 10
Robot coordinates system	Robot coordinates system shift	User coordinates system shift
Tool coordinates system	Tool coordinates system shift	Tool coordinates system shift
Base coordinates system	Base coordinates system shift	Base coordinates system shift

- When this function is operated, shift coordinates system is converted from the step after this statement.

- The SELCRD function can be applied to the following shift-related functions.
  ① SONL (M52) online shift
  ② TONL1 (M53) & TONL2 (M54) online coordinates conversion
  ③ SXYZ (M58) XYZ shift
  ④ SEA (M59) search
  ⑤ PAL (M96) palletize (data input)

- For other two related functions: 『[PF2]: System』 → 『2: Controller Parameter』 → 『12: Coordinate setting』 → 『1: User Coordinate』 and 『[PF5]: Cond Set』 → 『8: Select user coordinate』.

10.4.6.11. SONL Statement

The online shift function is for parallel shift of a previous teaching position to any position on X, Y, Z coordinates based on the shift amount transmitted from outside devices such as visual equipment. Usually, online shift is based on robot coordinates system, but tool coordinates system or base coordinates system can be also used.

Explanation	Online shift (M52)		
Grammar	SONL ST=< st./end >,RF=< ref.>,R=<register number> ,SS=< shelter step no.>		
Parameter	st./end	If 1, shift application starts. If 0, it ends, and the rest factors are ignored.	0~1
	ref.	0=robot, 1=tool, 2=base coordinates	0~2
	register number	Register in which transmitted shift amount is inputted.	1~8
	shelter step no.	Jump step, if shift amount is not inputted within assigned time.	0~999
Example	SONL ST=1,RF=0,R=1,SS=10		

Reference

- Related function
  ① Shift request amount function (SREQ, M51)
  ② Timer conditional shift amount request function (SREQT, M56)

10.4.6.12. SPOTCND Statement

Explanation	Spot welding condition (M33)		
Grammar	SPOTCND <condition number>		
Parameter	Condition number	Condition number outputted to a welding machine for welding current change	0~255
Example	SPOTCND 2		

Reference

- Welding condition signal is for changing welding current and etc. according to materials' thickness or number of panels.
- By connecting this signal to the welding machine, users can change welding conditions at their disposal. Welding condition can be set within 1~255 steps.
- Conditions are outputted in 8 bit (0~255) signals in binary. However, conditions can be outputted in discrete (0~7) signals, if <Wire Gauge> is selected in 『Welding Condition Output Form』 (Go to 『[PF5]: System』 → 『4: Application Parameter』 → 『1: Spot & Stud』 → 『1: Air-gun welding data』 → 『Weld Cond out type』 under 『Welding Parameter』 .)
- This condition signal is outputted in welding condition number set in 『6: Output Signal Assignment』 (Go to 『[PF5]: System』 → 『2: Controller Parameter』 → 『1: Setting input & output signal』 → 『6: Output signal assigning』 .)

10.4.6.13. SREQ Statement

Explanation	Shift amount request (M51)		
Grammar	SREQ R=< register num.>, PT=<port num.>		
Parameter	Register num.	Register in which transmitted shift amount is stored.	1~8
	Port num.	RS232C port number to be used for shift amount request and transmission	1~2
Example	SREQ R=1,PT=1		

Reference

- The online shift function requests an outside device for shift amount.
- Received shift amount is stored in online shift register group.
- When this function is executed, SHIFT ※1 CR LF (※1: register number) is outputted through RS232C port, and SHIFT X, Y, Z, θX, θY, θZ, CR is inputted from an outside device through RS232C port. Inputted data is stored in ※1 register. Transmitted/received data is ASCII code.

10.4.6.14. SREQT Statement

This is the same function as the SREQ statement. The only difference is jump to withdrawal step, if shift amount is not inputted until the assigned time is over.

Explanation	Timer condition shift amount request (M56)		
Grammar	SREQT R=<reg. num.>,PT=<port num.>,WT=<wait time> ,SS=<shelter step num.>		
Parameter	reg. num.	Register in which transmitted shift amount is stored	1~8
	port num.	RS232C port number to be used for shift amount request and transmission	1~2
	wait time	Waiting time until which shift amount transmission is completed.	0.0~60.0 (sec)
	Shelter step num.	Step for jump when waiting time is over.	0~999
Example	SREQT R=1,PT=1,WT=10.0,SS=100		

10.4.6.15. SXYZ Statement

This function is for parallel shift of previous teaching points while tool angle is maintained on XYZ plane. Three-dimension shift amount is executed after being stored in XYZ shift register.

<table>
<tr><td>Explanation</td><td colspan="3">XYZ shift (M58)</td></tr>
<tr><td>Grammar</td><td colspan="3">SXYZ RF=<reference>,X=<X shift amount>,Y=<Y shift amount>,Z=<Z shift amount></td></tr>
<tr><td rowspan="2">Parameter</td><td>reference</td><td>0=robot, 1=tool, 2=base coordinates</td><td>0~2</td></tr>
<tr><td>Shift amount</td><td>Shift amount for three-dimension parallel shift</td><td>-3000.0~3000.0</td></tr>
<tr><td>Example</td><td colspan="3">SXYZ RF=0,X=10.50,Y=20.50,Z=0.00</td></tr>
</table>

Reference

- XYZ shift function operation
  The length of X, Y, Z should be exactly equal to the length to GUN mechanical interface, because the slant angle of GUN should be maintained for this parallel shift.

10.4.6.16. TONL1 Statement

As shown in Fig 10.6, new positions of three standard steps are measured by external detection equipment (RS232C port) such as visual equipment. Each shift value is transmitted to the robot controller, and the controller calculates the shift values for coordinates conversion by using the three standard points and three shifted points. Then, the position of steps between TONL1 start and end is corrected.

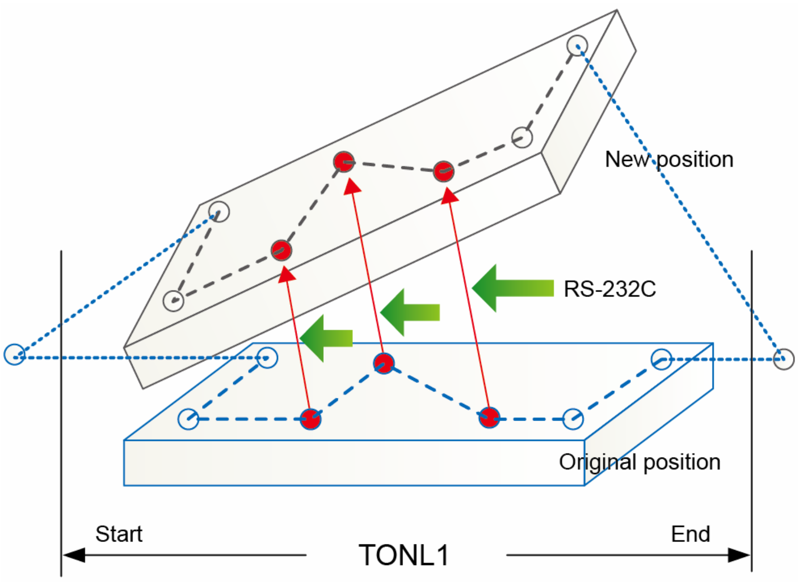


Fig 10.6 Online coordinates conversion (Shift amount)

Explanation	Online coordinates conversion (shift amount) (M53)		
Grammar	TONL1 ST=<start/end>,RF1=< ref.step num.1>,RF2=< ref.step num.2>,RF3=< ref.step num.3>		
Parameter	start/end	If 1, coordinates conversion begins. If 0, coordinates conversion ends.	0~1
	ref.step num.	Steps to be assigned as the three standard points	0~999
Example	TONL1 ST=1,RF1=1,RF2=5,RF3=7		
Note	To execute this function, SREQ statement is required before TONL1 statement. Shift value is calculated by receiving new positions of three standard steps in the form of three shift amounts.		

10.4.6.17. TONL2 Statement

This function is the same as TONL1. The only difference is that new values of three standard steps are received in the form of absolute position values, not of shift values.

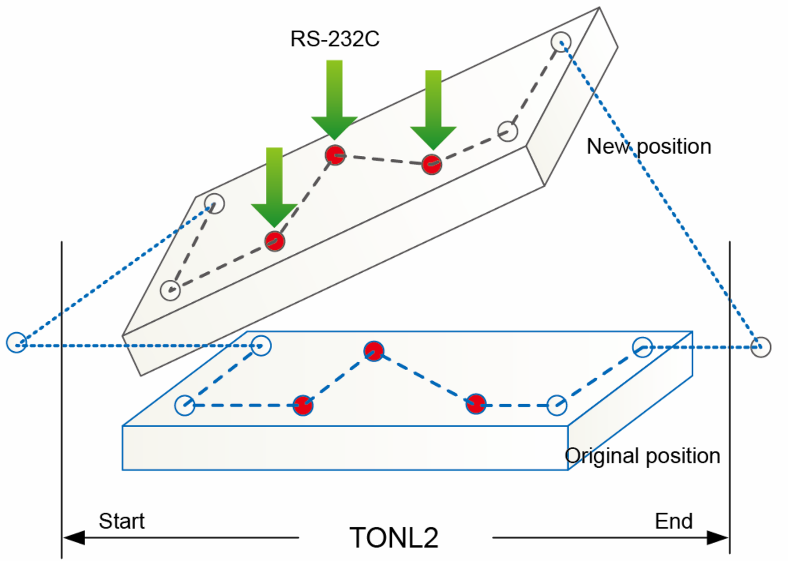


Fig 10.7 Online coordinates conversion (Absolute position)

Explanation	Online coordinates conversion (absolute position) (M54)		
Grammar	TONL2 ST=< st/end >,RF1=< ref.step num.1>,RF2=< ref.step num.2>,RF3=< ref.step num.3>		
Parameter	st/end	If 1, coordinates conversion begins. If 0, coordinates conversion ends.	0~1
	ref.step num.	Steps to be assigned as the three standard points	0~999
Example	TONL2 ST=1,RF1=1,RF2=5,RF3=7		
Note	To execute this function, SREQ statement is required before TONL1 statement. Shift value is calculated by receiving new positions of three standard steps in the form of three absolute positions.		

10.4.6.18. RINT Statement

While a robot is moving to the target step, if an assigned DI signal (input signal) is inputted, the robot is immediately stopped by interrupt. Then, the robot executes a command recorded in the step, and restarts moving to the next step.

Explanation	Robot interrupt (DI signal) (M29)		
Parameter	RINT I=<I signal>,RC=< ref. complete >,X=< ref.X >,Y=< ref.Y >, Z=< ref.Z >		
Parameter	I signal	DI signal to receive interrupt signal	DI range
	ref. complete	If 0, general robot interrupt function. If 1, search function. Refer to the SEA (search) function.	0~1
	ref. X, Y, Z	These are used for the search function.	-3000.0 ~3000.0
Example	RINT I=<I signal>,RF=<standard amount setup>,X=<standard X>,Y=<standard Y>, Z=<standard Z>		

10.4.6.19. RINTA Statement

While a robot is moving toward the target step, if analog voltage satisfies the range set by the user, interrupt occurs to stop the robot immediately. Then, the robot executes commands recorded in the step, and moves to the next step.

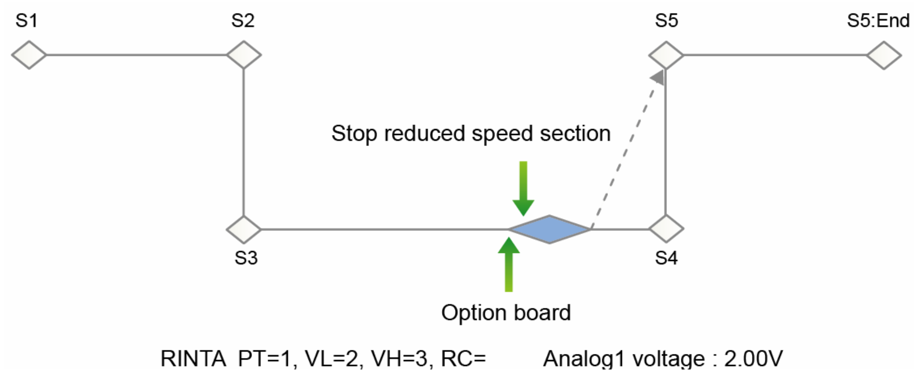


Fig 10.8 Robot interrupt (Analog signal)

Explanation	Robot interrupt (Analog signal) (M30)		
Grammar	RINTA PT=<port number>,VL=< voltage low limit >,VH=< voltage high limet > ,RF=< reference complete >,X=< ref.X >,Y=< ref.Y >,Z=< ref.Z >		
Parameter	Port number	Analog port which will receive interrupt signal	1~4
	voltage low limit	If analog value is between lowest voltage and highest voltage, interrupt occurs.	-10.0~10.0
	voltage high limit		
	reference complete	If 0, off. If 1, on.	0~1
	ref. X, Y, Z	These are used for the search function.	-3000.0~3000.0
Example	RINTA PT=<port number>,VL=<lowest voltage>,VH=<highest voltage> ,RF=<standard value setup>,X=<standard X>,Y=<standard Y>,Z=<standard Z>		

10.4.6.20. CNVSYNC Statement

This statement determines whether to execute conveyer synchronous operation. When conveyer synchronous operation (CNVSYNC 1 or M55 1) is executed, a robot applies the shift as much as the distance that the conveyer moves to the rest of the steps until conveyer synchronous operation is off (CNVSYNC 0 or M55 0) or conveyer synchronous is reset (CNVSYNC 2 or M55 2).

Explanation	Conveyer synchronous operation (M55)		
Grammar	CNVSYNC <Sync state>		
Parameter	Sync state	0 : conveyer synchronous operation OFF 1 : conveyer synchronous operation ON 2 : conveyer synchronous operation OFF and conveyer data reset	0~2
Example	CNVSYNC 1		

10.4.6.21. CLR232C Statement

Explanation	RS232C buffer initialization (M111)		
Grammar	CLR232C <port number>		
Parameter	Port number	Serial (RS232C) port number	1~2
Example	CLR232C 1		

10.4.6.22. SPOT Statement

Servo gun welding function. Unlike a pneumatic gun, gun pressure and open movements are made by servo control, and welding is operated through an electric current sending signal outputted to outside after pressure.

<table>
<tr><td>Explanation</td><td colspan="3">Servo gun welding (M72)</td></tr>
<tr><td>Grammar</td><td colspan="3">SPOT GN=<gun num.>,CN=<weld.cond.num.>,SQ=<sequence num.></td></tr>
<tr><td rowspan="3">Parameter</td><td>Gun num.</td><td>Gun to be used for welding</td><td>1~2</td></tr>
<tr><td>Welding cond num.</td><td>Welding condition which specifies pressure and welding condition output data</td><td>1~64</td></tr>
<tr><td>Sequence num.</td><td>Welding sequence which specifies pressure signal, electric current sending signal, etc.</td><td>1~64</td></tr>
<tr><td>Example</td><td colspan="3">SPOT GN=1,CN=1,SQ=10</td></tr>
</table>

Reference

- As to multi-gun, when gun number is selected (R210), tool number changes automatically. However, when tool number is selected (R49), gun number does not automatically change.
- Spot welding function should be recorded as the first function of a step. Otherwise, the function cannot be executed.
- Steps should be recorded through one-touch record (Gun LED lighting) so that positions with tip abrasion amount compensation can be recorded.
- When welding points are recorded, manual gun pressure is operated. At this point, the pressure should be low in order to prevent object from being transformed by gun arm bend. If object is bent under pressure, fixed tips should be moved.
- When the step in which the spot welding function (M72) is recorded is corrected, abrasion amount of tips should be reflected.

10.4.6.23. GUNSEA Statement

This function is used for measuring abrasion amount of tips of the welding gun.

There are two gun search functions: gun search 1 for measuring total tips abrasion amount and gun search 2 for measuring moving tips abrasion amount. Total tips abrasion amount minus moving tips abrasion amount is fixed tips abrasion amount after gun search measuring.

Explanation	Gun search (M73)		
Grammar	GUNSEA GN=< servo gun num.>,SE=<search num.>,PR=<gun pressure>		
Parameter	servo gun num.	Gun for welding operation	1~2
	search num.	1: gun search 1 movement, 2: gun search 2 movement	1~2
	Gun pressure	Ordered pressure	50~999
Example	SPOT GN=1,SE=1,PR=50		

Reference

- Before measuring tip abrasion amount, axis constant of servo gun and gun search standard position should be recorded.
- In order to record the standard of gun search, go to “Application Condition” → “Gun Search reference Position Record” and set ON. The measured value is not tips abrasion amount, but a standard value for abrasion amount measuring.
- When gun search 2 is operated, gun search 1 should be operated first.
- Gun search function record should be done in a position where the gun is open.

10.4.6.24. MKUCRD Statement

This function creates a user coordinates system based on three poses.

Explanation	This function creates a user coordinates system based on three poses.		
Grammar	MKUCRD <coord. number>,<origin pose>,<X dir. pose>,<XY plane pose>		
Parameter	Coord. number	User coordinates system to be created	0~10
	Origin pose	Pose at the starting point	
	X dir. pose	Pose on the axis X	
	XY plane pose	Pose on the XY plane	
Example	MKUCRD 1,P1,P2,P3		

The user coordinates system function is that a user sets a coordinates system in a certain position, and manual manipulation or shift manipulation is available on the set user coordinates system. Also, step position can be taught based on the user coordinates system.

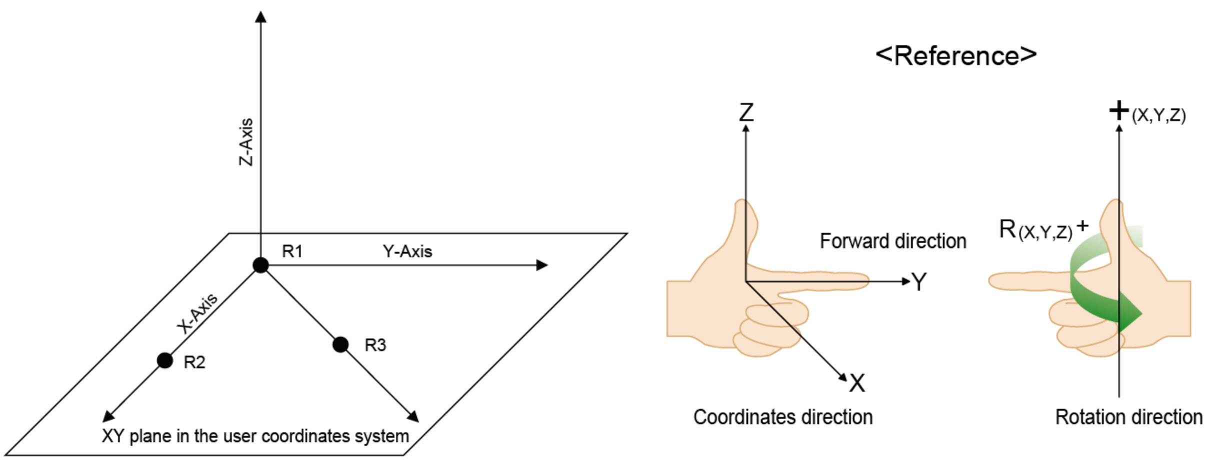


Fig 10.9 User coordinates system

Reference

- Refer to 『User Coordinates System Manipulation Manual』.

Warning

- 『E1010: More teach points required.』
  This warning occurs when steps recorded in the teaching program for coordinates system registration are less than three. There should be three teaching steps in the assigned program.

- 『E1011 Points too close to one another.』
  This warning occurs when the distance between the three points in the teaching program is less than 1mm. Teaching steps should be corrected.

- 『E1012 Recorded points are linear.』
  This warning occurs when the three points recorded in the teaching program for coordinates system registration are almost on the same straight line. In this case, the direction of each axis in the user coordinates system cannot be determined. The teaching program should be checked.

- 『Verify the coordinate & Jog state. [ANY]』
  When a user coordinates system is selected (『[PF5]: Cond Set』 → 『8: Select user coordinate』), if the coordinates system is set as an axis or tool coordinates system, or a robot is in jog operation, user coordinates system cannot be selected and changed.

10.4.6.25. CNVYPOS Statement

If a robot needs to be synchronized with conveyer, the robot controller should be aware of the current position of conveyer when the work program setup is done. This function informs the controller of the current position of conveyer – the distance between the work piece and the start limit switch.

Explanation	This function informs the robot controller of the work piece position during teaching.		
Grammar	CNVYPOS <Channel>,< Ref. Position >		
Parameter	Channel	Conveyer input channel to be used on BD48X board. Currently, conveyer channel 2 is not supported.	1~2
	Ref. Position	Work piece position, when a work program is written regarding the work pieces on conveyer. In other words, the distance between the work piece and the start limit switch is inputted in millimeter(s). Check the CR value of conveyer data monitoring.	
Example	CNVYPOS CHANNEL=1,DIST=700		

10.4.6.26. WAITCNVY Statement

During conveyer synchronous operation, when a work piece reaches a certain position passing the start limit switch, this function determines whether a robot would start the job.

Explanation	This function determines the job starting point.		
Grammar	WAITCNVY <Wait state>,<Wait distance>		
Parameter	Wait state	This parameter determines whether a robot would wait with the conveyer synchronous function ON or OFF. Currently, the conveyer synchronous function for conveyer channel 2 is not supported.	0~2
	Wait distance	Distance in millimeter(s) to start the job from the start limit switch	
Example	WAITCNVY SYNC=1,DIST=400		

10.4.6.27. IGUNSEA Statement

In order to measure moving tip abrasion amount of the servo gun, usually pressure is measured after moving tips are compressed in firm and flat jig fixed outside. However, in case of a fixed servo gun, pressure measuring is not available, because the servo gun is not attached to the robot. Therefore, when a moving tip is moving, abrasion amount is measured after the end of the tip is detected by a sensor (phototube).

<table>
<tr><td>Explanation</td><td colspan="3">Moving tip abrasion amount of servo gun is detected by a phototube sensor.</td></tr>
<tr><td>Grammar</td><td colspan="3">IGUNSEA GN=<Gun num.>,SP=<Search speed>,
DI=<Input sig.>,DT=<Detection log.></td></tr>
<tr><td rowspan="4">Parameter</td><td>Gun num.</td><td>Gun for abrasion amount measuring</td><td>1~2</td></tr>
<tr><td>Search speed</td><td>During the search movement, speed of gun axis is assigned. Search speed by input signal as based on safety speed. Recommended speed is 10mm/sec.</td><td>1.0~250</td></tr>
<tr><td>Input sig.</td><td>Input signal connected to a phototube</td><td>1~256</td></tr>
<tr><td>Detection log.</td><td>Detection condition of signal is assigned.
0 = Detection when Low (Normal High)
1 = Detection when High (Normal Low)</td><td>0~1</td></tr>
<tr><td>Example</td><td colspan="3">IGUNSEA GN=1,SP=1.0,DI=1,DT=1</td></tr>
</table>

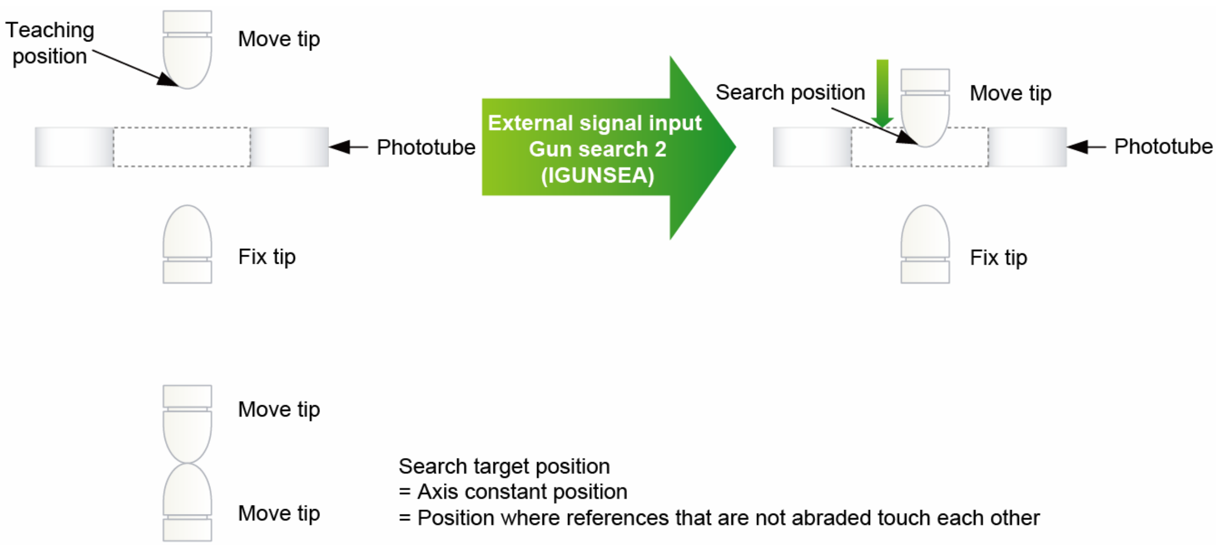


Fig 10.10 Detecting abrasion amount of moving tip by phototube

<u>**Warning**</u>

- Gun search 1 should be recorded before gun search 2 is recorded.
- Teaching position should be where the gun is open, and the phototube should be in the middle.
- When the value of moving tip abrasion amount/total abrasion amount (%) is stored in servo gun parameter, only gun search 1 is operated. In this case, IGUNSEA (M74) cannot be used.
- While gun search 2 is operated by external signal input, if input signal DI is not received by search target position, the error 『E1320 Sensor doesn't search operation.』 occurs.
- It is convenient to set assigned input signal logic as 'POSITIVE' first, and then to set the phototube logic.
- If input signal logic is set as 'NEGATIVE,' the signal outputted as HIGH in phototube is detected as LOW in controller.

10.4.6.28. EGUNSEA Statement

This function is for searching fixed tip abrasion amount of the equalizer-less pneumatic gun. Also, this function is for grinding tip by Reference dressing or for detecting the amount of fixed tip abrasion due to welding. When spot welding step is operated, the pressure position of object fixed Reference is automatically shifted as much as the abrasion amount detected by the fixed tip abrasion search function in order to improve welding quality. The fixed tip abrasion search function determines newly detected amount compared to previously measured standard value (of new tip) as abrasion amount, when fixed part of the gun is moved by a robot toward a jig with a non-contact proximity sensor and enters a certain distance of fixed Reference.

Explanation	This function is for detecting fixed tip abrasion amount of equalizer-less pneumatic gun by using phototube sensor.		
Grammar	EGUNSEA GN=<Gun num.>,SP=<Search speed>, DI=<Input sig.>,DT=<Detection log.>		
Parameter	Gun num.	Gun to measure abrasion amount	1~2
	Search speed	Movement speed of gun axis, when the search function is in operation. Search speed by input signal is based on safety speed. Recommended speed is 10mm/sec.	1.0~100
	Input sig.	Input signal connected to phototube.	1~256
	Detection log.	Detection condition of signal 0 = Detection when Low (Normal High) 1 = Detection when High (Normal Low)	0~1
Example	EGUNSEA GN=1,SP=1.0,DI=1,DT=1		

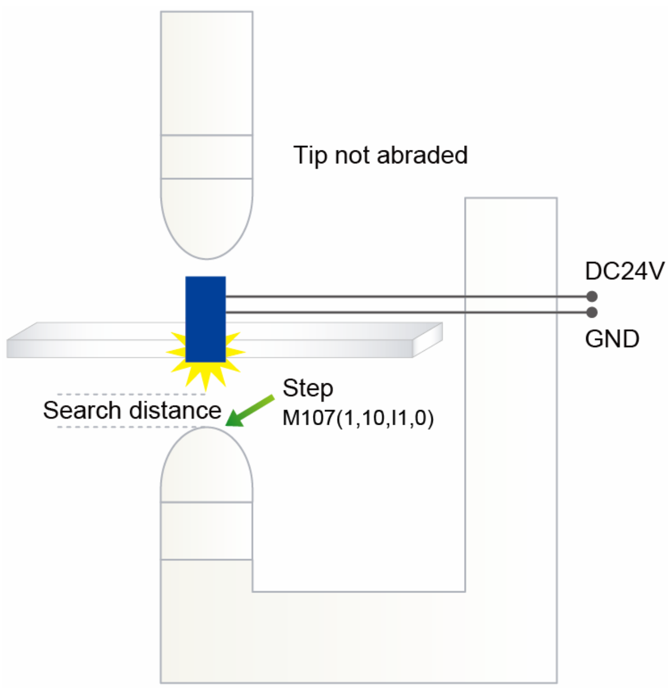


Fig 10.11 Fixed tip abrasion search teaching

Warning

- EGUNSEA (M107) function should be the first function of a step and should not be recorded in step 0.
- Before I signal On/Off setup, check 『[PF2]: System』 → 『2: Controller Parameter』 → 『1: Setting input & output signal』 → 『1: Input Signal Logic』.
- It is convenient that assigned input signal logic is set as 'POSITIVE' before phototube logic setup.
- If input signal logic is set as 'NEGATIVE,' the signal outputted as HIGH in phototube is detected as LOW in controller.

10.4.6.29. HANDPRES Statement

This function is used for work piece pickup during palletizing by servo hand or general material handling.

Explanation	Servo hand pressure command during automatic operation		
Grammar	HANDPRES OL=<Offset_len>,PR=<Squeeze>		
Parameter	Offset_len	Start point of servo hand moving Reference. Pressure start point is teaching point plus pressure offset distance. If pressure offset distance has a minus value, pressure start point will be before the teaching point.	-2000 ~2000
	Squeeze	This factor determines the degree of grabbing power. When pressure is inputted, sufficient review is required in order to prevent actual work pieces damage.	50~999
Example	HANDPRES OL=100,PR=150		

10.4.6.30. HANDOPEN Statement

This function is used for placing work pieces during palletizing by servo hand or general material handling.

Explanation	Servo hand open command during automatic operation		
Grammar	HANDOPEN OL=<Offset_len>		
Parameter	Offset_len	Open point of servo hand moving Reference. Open point is teaching point plus open offset distance.	0~2000
Example	HANDOPEN OL=600		

10.4.6.31. SELUCRD Statement

Explanation	User coordinates system selection of condition setup		
Grammar	SELUCRD <Coord. number>		
Parameter	Coord. number	Arithmetic formula. User coordinates system to be selected	0, 1~10
Example	SELUCRD 1 SELUCRD DI1+DI2*2+DI3*4		

10.4.6.32. GATHER Statement

When the data gathering function is used, this function appoints a data gathering start step and an end step. Refer to the data gathering function manual for details.

Explanation	This function appoints data gathering start and end.		
Grammar	GATHER <status number>,		
Parameter	Status number	If 1, start. If 0, end.	0~1
Example	GATHER 1		

10.4.6.33. INTDEF Statement

When the interrupt function is used, this function defines new interrupt state or deletes previously defined interrupt. Refer to the interrupt function user manual for details.

Explanation	This function defines new interrupt or deletes defined interrupt.		
Grammar	INTDEF ON/OFF,NO=<Interrupt number>,<Interrupt condition> , PN=<Call program> {,SINGLE}		
Parameter	ON/OFF	Interrupt is newly defined or defined interrupt is deleted. When interrupted is deleted, third and the rest of parameters are ignored.	ON/OFF
	NO	Interrupt to be defined or deleted	1~2
	int. condition	Condition for interrupt occurrence (EX. DI1=1,AI4=3.5,P*.X=P1.X)	
	call program	Program to be called, when interrupt condition is satisfied.	1 ~999
	SINGLE	Only the first interrupt is handled, even though interrupts occur many times within the interrupt watch section.	Single
Example	INTDEF ON,NO=1,DI5=1,991,Single INTDEF OFF,NO=1		

10.4.6.34. INTENBL Statement

This function activates or inactivates a previously defined interrupt. Activation means that interrupt handling is immediately operated when interrupt condition is satisfied. Inactivation means that interrupt handling is not operated although interrupt condition is satisfied. Refer to the interrupt function user manual for details.

Explanation	This function activates or inactivates a previously defined interrupt.		
Grammar	INTENBL ON/OFF{,NO=<interrupt number>}		
Parameter	ON/OFF	Handling of defined interrupt is activated or inactivated.	ON/OFF
	Interrupt number	Interrupt to be activated or inactivated	1~2
Example	INTENBL ON,NO=1 INTENBL OFF,NO=1		

10.4.7. ENET Member Variable/Statement

ENET object has the function to transmit error and user data to outside through the Ethernet. Refer to 『Hi4 Error Monitoring Service』 for details.

10.4.7.1. Member Variable

<table>
<tr><th>Variable name</th><th colspan="2">Explanation</th><th>Example</th></tr>
<tr><td>IP</td><td colspan="2">String variable. Read/write allowed.
IP address of communication partner is appointed or returned.
※ This is applied only when OPEN statement is called.</td><td>ENET2.IP = “10.7.4.136”</td></tr>
<tr><td>PORT</td><td colspan="2">Integer variable. Read/write allowed.
Port number of communication partner is appointed or returned.
※ This is applied only when OPEN statement is called.</td><td>ENET3.PORT = 1042</td></tr>
<tr><td>SYSERR</td><td colspan="2">Integer variable. Read/write allowed.
This variable determines whether system error will be attached to communication frame.
0: not attached. (system domain size: 0)
1: attached
※ This variable setup can be changed both before and after OPEN statement is called.</td><td>ENET2.SYSERR = 1
ENET2.SYSERR = 0</td></tr>
<tr><td>USERSIZE</td><td colspan="2">Data domain size of communication frame (byte).
Default value is the value set on “Frame Setup.”
※ This variable setup can be changed both before and after OPEN statement is called.
※ Maximum value is 200 byte.</td><td>ENET2.USERSIZE=50</td></tr>
<tr><td rowspan="5">STATE
(read only)</td><td colspan="2">Integer variable. Read-only.</td><td rowspan="5">WAIT
ENET1.STATE=1,3,*ER
R
ENET1.SENDFRM</td></tr>
<tr><td>2</td><td>Connected.
SENDFRM is in operation.</td></tr>
<tr><td>1</td><td>Connected.
SENDFRM can be called.</td></tr>
<tr><td>0</td><td>Not connected.</td></tr>
<tr><td>-1</td><td>Error</td></tr>
<tr><td>SBUF[]</td><td colspan="2">Integer variable. Read/write allowed.
This variable accesses transmission buffer in bit.
※ If ENET is not in the “OPEN” state, this variable cannot be accessed.</td><td>Access to ‘92nd bit
ENET2.SBUF[92]=1
IF ENET2.SBUF[92]
THEN
…</td></tr>
<tr><td>SBUFB[]</td><td colspan="2">Integer variable. Read/write allowed.
This variable accesses transmission buffer in byte.
※ If ENET is not in the “OPEN” state, this variable cannot be accessed.</td><td>Access to ‘5th byte
ENET2.SBUFB[5]=&HF
F
IF ENET2.SBUFB[5]=16
THEN
…</td></tr>
</table>

10.4.7.2. OPEN

Explanation	Communication channel for monitoring communication is opened or closed.		
Grammar	<ENET object>.OPEN <connection status>		
Parameter	Connection status	0: Communication channel is closed. 1: Communication channel is opened and ENET object is initialized.	0~1
Example	ENET1.OPEN 0 ENET1.OPEN 1		

10.4.7.3. SENDFRM

Explanation	SBUF[] contents of ENET object and header and tail are transmitted to communication partner.
Grammar	<ENET object>.SENDFRM
Parameter	None
Example	ENET1.OPEN 0 ENET1.OPEN 1

10.4.7.4. CLRSBUF

Explanation	All SBUF[] contents of ENET object are initialized.
Grammar	<ENET object>.CLRSBUF
Parameter	None
Example	ENET1.OPEN 0 ENET1.OPEN 1

10.5. Function

10.5.1. Arithmetic Function

Returned value of arithmetic function is numeral.
Example: V1!=10, V2!=-1.23, V3!=3.14152, V20%=16, V21%=5, V7$="XDIST:20"

Function name	Explanation	Example	Returned value
ABS(a)	Absolute value of a is returned.	ABS(V2!)	1.23
MAX(a, b)	Bigger value between a and b is returned.	MAX(V2!,-3)	-1.23
MIN(a, b)	Smaller value between a and b is returned.	MIN(V2!,-3)	-3
DEGRAD(a)	Radian value of a is returned in a degree form.	DEGRAD(270)	4.712389
RADDEG(a)	Degree value of a is returned in a radian form.	RADDEG(2*V3!)	359.997
SQR(a)	Square root of a is returned.	SQR(V20%)	4
SIN(a)	Sine value of a is returned in a radian form.	SIN(V3!/6)	0.5
COS(a)	Cosine value of a is returned in a radian form.	COS(V3!/6)	0.866
TAN(a)	Tangent value of a is returned in a radian form.	TAN(V3!/6)	0.577
ATN(a)	Arctangent value of a is returned in a radian form.	ATN(0.5)	0.464
ATN2(a,b)	Arctangent value of a triangle whose y length is a and x length is b is returned in a radian form.	ATN(-2,0)	-1.571
DIST(a,b)	Distance to a point whose x coordinate is a and y coordinate is b is returned.	DIST(V21%,V21%)	7.071
ORD(a)	ASCII code of the first character in a string is returned.	ORD("ERROR")	69
VAL(a)	Value expressed in a string is returned.	VAL("29.38E-2")	0.2938
STRPOS(a,b)	First point where part of a string corresponds to b string is returned. (First character point is 1.)	STRPOS(V7$,":")	6
LEN(a)	Length of a string is returned.	LEN(V7$)	8
TIMER	Passed time from the power input time is returned in second(s).	TIMER	2796.37

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10.5.2. String Function

Returned value of string function is string.

Function name	Explanation	Example	Returned value
CHR$(a)	Character whose ASCII code is a is returned.	CHR$(65)	“A”
STR$(a)	Decimal digit string of numeral a is returned.	STR$(13.25)	“13.25”
BIN$(a)	Binary digit string of numeral a is returned.	BIN$(&B0010)	“10”
HEX$(a)	Hexadecimal digit string of numeral a is returned.	HEX$(&H7A2F)	“7A2F”
MIRROR$(a)	Reversed string of string a is returned.	MIRROR$("HELLO")	“OLLEH”
LEFT$(a,b)	String with first b character(s) of string a is returned.	LEFT$("HELLO",2)	“HE”
MID$(a,b,c)	String with c character(s) from b character of string a is returned.	MID$("HELLO",2,3)	“ELL”
RIGHT$(a,b)	String with last b character(s) of string a is returned.	RIGHT$("HELLO",2)	“LO”
DATE$	Current date converted into string is returned. (YYYY/MM/DD)	DATE$	“2001/02/18”
TIME$	Current time converted into string is returned. (HH:MM:SS)	TIME$	“08:48:14”

10.6. Existing MIT Function Code Corresponding to Robot Language

With the appropriate use of robot language statements, the same result as each movement of existing MIT function code can be obtained. The following is examples. Codes corresponding to other statements are highlighted.

M I T function code		Corresponding HR - BASIC sentence examples
M0	DO signal RESET	GO1=0
M1~8	DO signal ON/OFF	DO1=1~DO8=1 or DO1=0~DO8=0
M10	DO signal RESET	GO2=0
M11~18	DO signal ON/OFF	DO11=1~DO18=1 or DO11=0~DO18=0
M20	Step jump (unconditional)	GOTO <address>
M21	Step call (unconditional)	GOSUB <address>
M22	Step return (unconditional)	RETURN
M23	Step jump (I conditional)	IF DIn=1 THEN <address>

M24	Step call (conditional)	IF DIn=1 THEN
		GOSUB <address>
		ENDIF

M25	Step return (conditional)	IF DIn=1 THEN 99 END 99 RETURN
M26	Step jump (frequency condition)	IF _RN4=<frequency> THEN <address>

M27	Step call (frequency condition)	IF _RN7=<frequency> THEN
		GOSUB <address>
		ENDIF

M28	Step return (Freq condition)	IF _RN15=< frequency > THEN 99 END 99 RETURN
M29	Robot interrupt (DI signal)	RINT I=1,RF=1,X=100.0,Y=50.0,Z=85.7
M30	Robot interrupt (Analog)	RINTA I=1,RF=1,X=100.0,Y=50.0,Z=85.7
M32	Output signal setting	DOn=1
M33	Spot welding condition	SPOTCND <condition number>
M34	Output signal resetting	DOn=0
M37	Reference position record	CNVYPOS CHANEL=1,DIST=1000
M38	Servo hand squeeze	HANDPRES OL=20.0, PR=100
M39	Servo hand open	HANDOPEN OL=300.0
M41	Robot stop (unconditional)	STOP

M42	Robot stop (I condition)	IF DIn=1 THEN
		STOP
		ENDIF

M43	Discrete output to O-byte port	GO<group number>=&B100101
M44	Binary output to O-byte port	GO<group number>=37

M I T function code		Corresponding HR - BASIC sentence examples
M51	Shift data request	SREQ R=1,PT=1
M52	On-line shift	SONL ST=1,RF=0,R=1,SS=10
M53	On-line transfer(Shift value)	TONL1 ST=1,RF1=1,RF2=5,RF3=7
M54	On-line transfer(Coord. value)	TONL2 ST=1,RF1=1,RF2=5,RF3=7
M56	Shift data request(Timer Cond)	SREQT(SREQT)
M58	XYZ shift	SXYZ RF=0,X=10.50,Y=20.50,Z=0.00
M59	Searching	SEA ST=1,RF=0,R=1
M62	Step jump with function(Uncond)	GOTO <address>
M63	Step jump with function(I Cond)	IF Din=1 THEN <address>
M64	Step jump with function(Freq)	IF Vn%=<frequency> THEN <address> Vn%=Vn%+1 (Vn% is initialized outside the cycle.)
M68	Substitution of shift value	Rn=<pose invariable> n is between 1 and 8.
M69	Addition of shift value	Rn.X=Rn.X+<adding value>.... By each element. n is between 1 and 8.
M70	Frequency register setting	_RN7=10
M71	Freq. Register Addi/Subtr	_RN5=_RN7+_RN9
M72	Spot welding function	SPOT GN=1,CN=5,SQ=23
M73	Gun search function	GUNSEA GN=1,SE=2,PR=112
M74	Gun search2 by Input signal	IGUNSEA GN=1,SP=10.0,DI=1,DT=1
M75	Freq.Register INC/DEC	_RN5=_RN5+4

M76	Step jump by comparing Freq.	IF _RN2>55 THEN
		GOSUB 16
		ENDIF

M80	Program call(Unconditional)	CALL <program number>

M81	Program call(I condition)	IF Din=1 THEN
		CALL <program number>
		ENDIF

M82	Program call(Freq condition)	IF _RN4=<frequency> THEN
		CALL <program number>
		ENDIF

M83	Program jump(Unconditional)	JMPP <program number>

M84	Program jump(I condition)	IF Din=1 THEN
		JMPP <program number>
		ENDIF

M85	Program jump(Freq condition)	IF _RN2=<frequency> THEN
		JMPP <program number>
		ENDIF

M86	Function jump(Freq condition)	Vp%=_RN7/<number of division> or Vp%=_RN7 MOD <number of division> ON Vp%+1 GOTO <address 1>,<address 2>,<address 3>...
M87	Function jump(I condition)	Vn% = Din2*2^2 + Din1*2 + Din0 ON Vn%+1 GOTO <address 1>,<address

M I T function code		Corresponding HR - BASIC sentence examples
		2>,<address 3>...
M88	Function jump end	Not necessary
M92	Step end	END

M93	Function jump(Palletize count)	IF PALCNT7=56 THEN
		GOTO <address>
		ENDIF

M94	Tiersheet insert program call	TIERST R=1,P=4,PR=2,TP=800
M95	Palletize picking up shift	PALPU P=1,SL=4,SH=1000
M96	Palletizing shift	PAL P=1,PR=1,W=500,L=300,H=250.5
M97	Palletizing end	PALEND P=1,ES=81
M98	Palletizing reset (Data input)	PALRST P=1,CS=1,RS=5
M99	Comment	'SPOT WELD or REM SPOT WELD
M101	String output	PRINT #1,"<string>"
M102	Relative Prog call(Uncondi)	CALLPR <program number>
M103	Relative Prog call(I condi)	IF statement used
M104	Relative Prog call(Freq condi)	IF statement and variable increase used
M105	Output signal(On/Off)	Don=1 or Don=0
M107	Equalizerless gun search	EGUNSEA GN=1,SP=10.0,DI=1,DT=1
M111	RS232C buffer clear	CLR232C 2
M113	Shift coordinate	SELCRD <coordinates system number>
I1~24	Signal standby	WAIT DIn=1
I25	DI signal wait(I signal setting)	WAIT DIn=1
I26	DI signal wait (Negative logic)	WAIT DIn=0
I50	Conveyor interlock (Sync.Off)	WAITCNVY SYNC=0,DIST=500
I51	Conveyor interlock (Sync.On)	WAITCNVY SYNC=1,DIST=500
I52	DI signal wait (Time condition)	WAIT DIn=1,<waiting time>,<withdrawal address>
I53	GI Sig with time condition(AND)	WAIT (GIn AND <binary condition>)=<binary condition>, <waiting time> , <withdrawal address>
I54	GI Sig with time condition(OR)	WAIT GIn AND <binary condition>, <waiting time>, <withdrawal address>
I55	GI Sig with time condition	WAIT GIn=<binary condition>, <waiting time>, <withdrawal address>
T	Delay time setup	DELAY <delay time>

11

Various Signal Connections

Reference

- For power supply, use external power source.
- The user input signal (CNIN2) is separated in to 4 groups, each group having 8 signals and a common signal. (Ex, DI01~08, COMIN5) The common signal of each group is not connected. (COMIN5,6,7,8)
- All output signals must be within the rated output range. (If it exceeds the rated range, it can cause damage to the circuit)
- The user output signal (CNOUT2) is separated in to 4 groups, each group having 8 signals and a common signal. (Ex, DO01~08, COMOUT5)
- The common signal of each group is not connected. (COMOUT5,6,7,8)
- Attach a noise reduction diode on the load.

11.1. Standard external input signal (I/O board)

11.1.1. Introduction

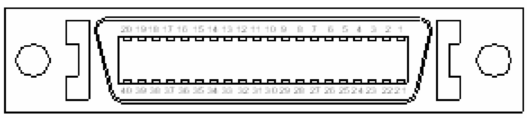
The input signal is connected to the I/O board through the right side opening of the control panel.

11.1.2. Standard external input signal

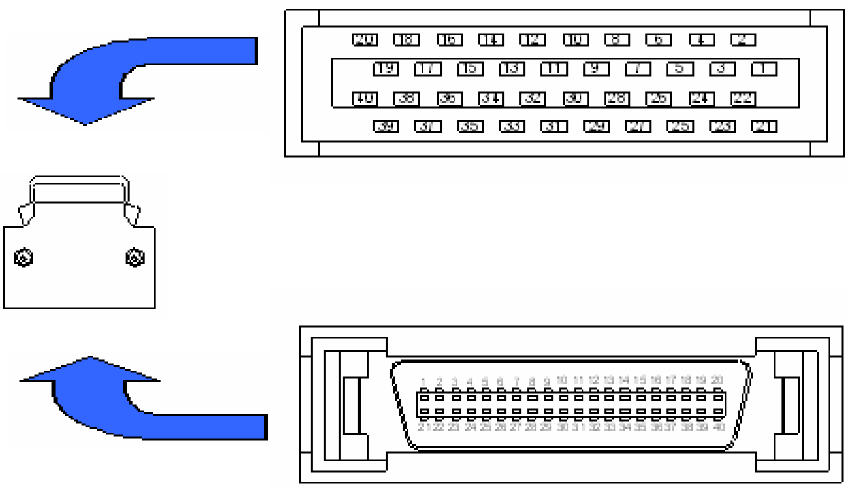
11.1.2.1. Input circuit

- Connector specification

I/O board side : 3M MDR 10240-52A2JL

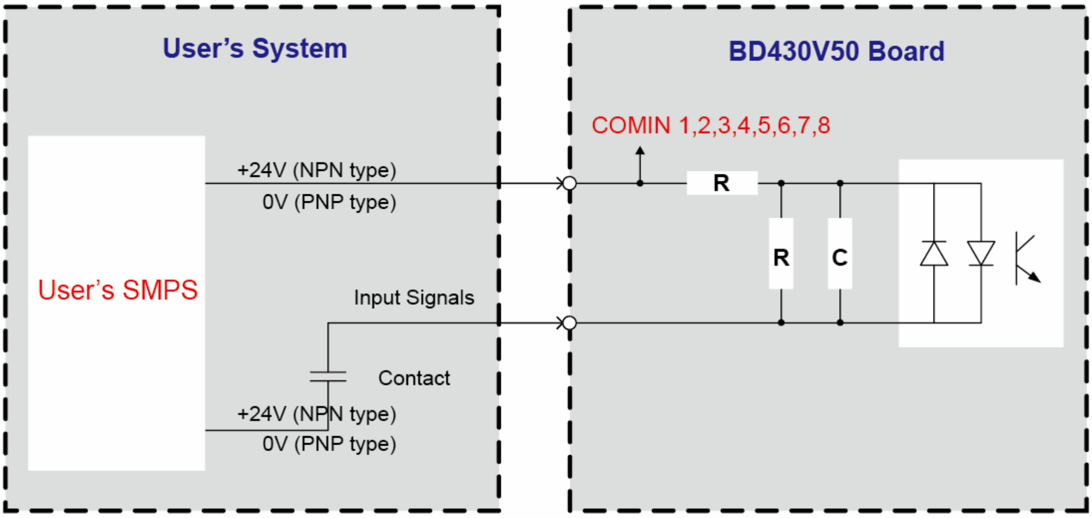


Plug (user preparation) side : 3M MDR 10140-3000VE (HOOD;10340-55F0-008)



- Input specification
  Input port : AC input type porter coupler
  Input impedance = 3 kΩ
  (+) common input voltage = 24VDC
  (-) common input voltage = 0VDC

- Connection diagram
  (+) common : NPN type, (-) common : PNP type



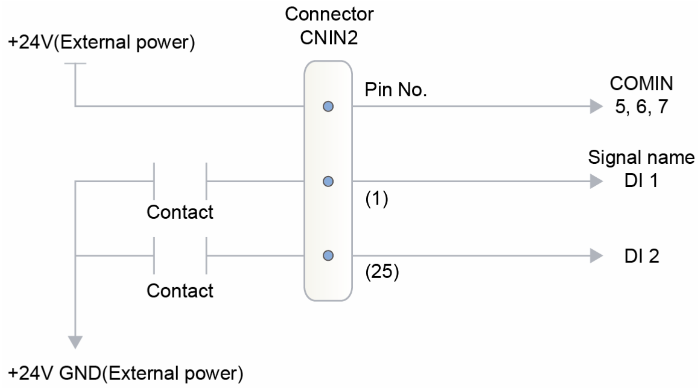
11.1.2.2. CNIN1 Input signal

Pin No.	Signal name	Function description
1	SDI01	Public input 1 / MOTON ON SW input
2	SDI02	Public input 2 / reserved system input
3	SDI03	Public input 3 / START SW input
4	SDI04	Public input 4 / STOP SW input
5	SDI05	Public input 5 / reserved system input
6	SDI06	Public input 6 / reserved system input
7	SDI07	Public input 7 / reserved system input
8	SDI08	Public input 8 / reserved system input
9	COMIN1	External power input (User's power) +24V (NPN type) / 0V (PNP type)(for SDI01~SDI08)
10	COMIN1	
11	SDI09	Public input 9 / AUTO/MAN SW input
12	SDI10	Public input 10 / OL input
13	SDI11	Public input 11 / MSHPON input
14	SDI12	Public input 12 / DMAN input
15	SDI13	Public input 13 / EM STOP input
16	SDI14	Public input 14 / TSP input
17	SDI15	Public input 15 / OVT input
18	SDI16	Public input 16 / ARM input
19	COMIN2	External power input (User's power) +24V (NPN type) / 0V (PNP type)(for SDI09~SDI16)
20	COMIN2	
21	SDI17	Public input 17 / EX MON input
22	SDI18	Public input 18 / EX MON input
23	SDI19	Public input 19 / EX MON input
24	SDI20	Public input 20 / EX MON input
25	SDI21	Public input 21 / EX MON input
26	SDI22	Public input 22 / EX MON input
27	SDI23	Public input 23 / EX MON input
28	SDI24	Public input 24 / EX MON input
29	COMIN3	External power input (User's power) +24V (NPN type) / 0V (PNP type)(for SDI17~SDI24)
30	COMIN3	
31	SDI25	Public input 25 / WCR input
32	SDI26	Public input 26 / COLLISION SEN input
33	SDI27	Public input 27 / WIRE STICK input
34	SDI28	Public input 28 / WELDER ERR input
35	SDI29	Public input 29 / WIRE STATE input
36	SDI30	Public input 30 / GAS STATE input
37	SDI31	Public input 31 / reserved system input
38	SDI32	Public input 32 / reserved system input
39	COMIN4	External power input (User's power) +24V (NPN type) / 0V (PNP type)(for SDI25~SDI32)
40	COMIN4	

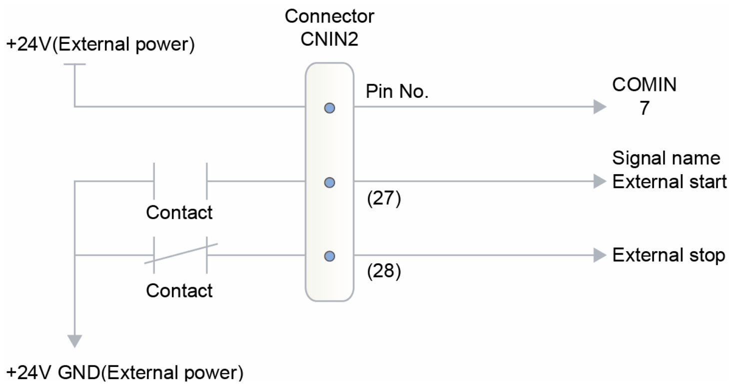
11.1.2.3. CNIN2 Input signal

Pin No.	Signal name	Function description
1	DI01	Public input 1
2	DI02	Public input 2
3	DI03	Public input 3
4	DI04	Public input 4
5	DI05	Public input 5
6	DI06	Public input 6
7	DI07	Public input 7
8	DI08	Public input 8
9	COMIN5	External power input (User's power) +24V (NPN type) / 0V (PNP type) (for DI01~DI08)
10	COMIN5	
11	DI09	Public input 9
12	DI10	Public input 10
13	DI11	Public input 11
14	DI12	Public input 12
15	DI13	Public input 13
16	DI14	Public input 14
17	DI15	Public input 15
18	DI16	Public input 16
19	COMIN6	External power input (User's power) +24V (NPN type) / 0V (PNP type) (for DI09~DI16)
20	COMIN6	
21	DI17	Public input 17
22	DI18	Public input 18
23	DI19	Public input 19
24	DI20	Public input 20
25	DI21	Public input 21
26	DI22/ (WI)	Public input 22 (for WI signal)
27	DI23/External start	Public input 23 (for External start signal)
28	DI24/External stop	Public input 24 (for External stop signal)
29	COMIN7	External power input (User's power) +24V (NPN type) / 0V (PNP type) (for DI17~DI24)
30	COMIN7	
31	DI25/PI1	Public input 25 (External program selection signal 1)
32	DI26/PI2	Public input 26 (External program selection signal 2)
33	DI27/PI3	Public input 27 (External program selection signal 3)
34	DI28/PI4	Public input 28 (External program selection signal 4)
35	DI29/PI5	Public input 29 (External program selection signal 5)
36	DI30/PI6	Public input 30 (External program selection signal 6)
37	DI31/PI7	Public input 31 (External program selection signal 7)
38	DI32/PI8	Public input 32 (External program selection signal 8)
39	COMIN8	External power input (User's power) +24V (NPN type) / 0V (PNP type) (for DI17~DI24)
40	COMIN8	

(1) Public DI signal
Connect the DI1 ~ DI21 signals as follows.

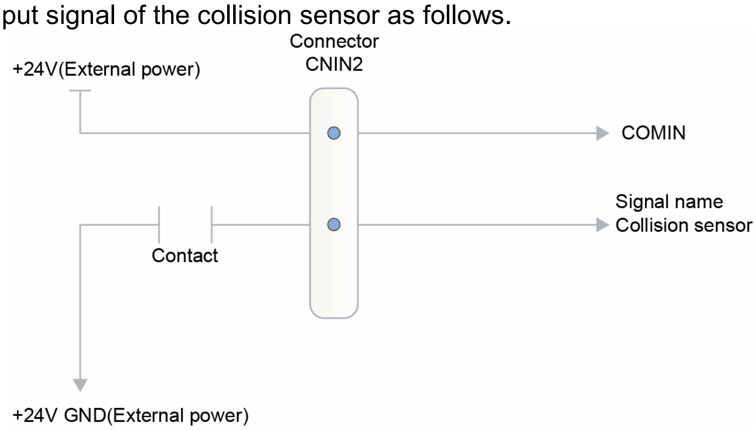


(2) External start and external stop signal
Connect the external start/stop signal to control the operations from an external peripheral device.

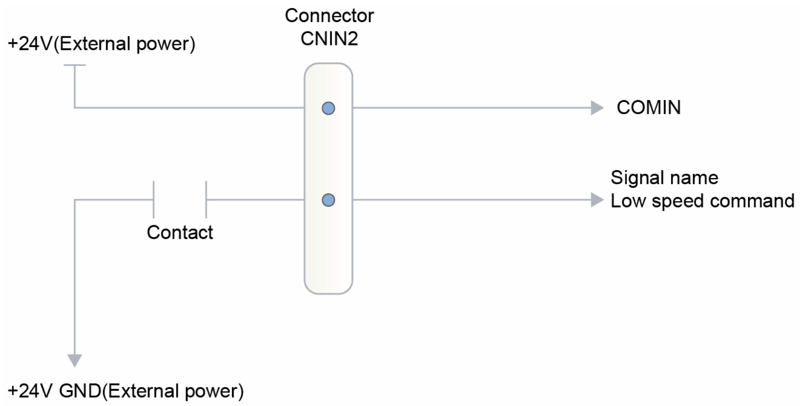


But when you are not using the external stop function, the external stop setting in 『[PF2]: System』 → 『2: Control parameter』 → 『1: Setting input & output signal』 → 『7: Input signal assigning』 must be 0.

(3) Collision sensor
Connect the input signal of the collision sensor as follows.



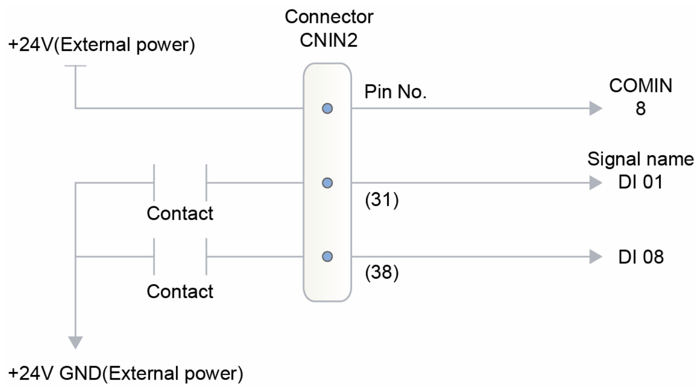
(4) Low speed command signal
When this signal is entered during playback, the play speed changes to low speed mode from the next step. The speed in the low speed mode is irrelevant from the recording speed and it set in 『[PF5]: Cond Set』 → 『2: Step go/back max.speed(mm/s)』.



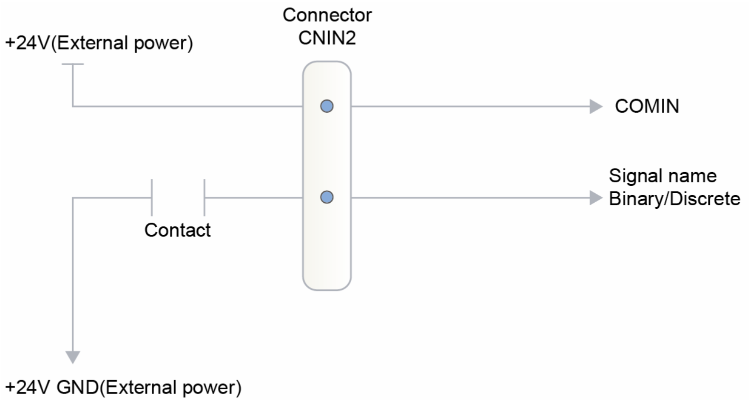
(5) Program selection signal and discrete/binary signal connection
For automatic operation, the external program is selected by this signal. This must be [Enable] in 『[PF2]: System』 → 『1: User parameter』 → 『9: External program select』.

There are two types for program selection signal; discrete and binary input.
For the discrete input, you can choose one program from 8 programs and for binary input, you can choose one program from 255 programs.

Connect the program selection signal as follows.



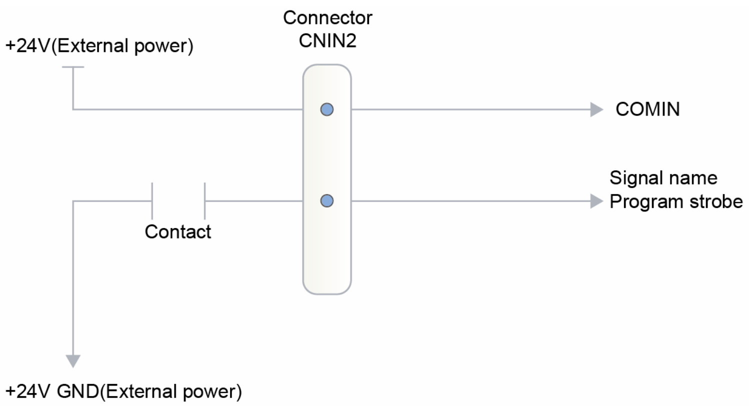
Connect the discrete/binary input signal as follows.



※ Signal OPEN (Off): Binary input.

(6) Program strobe signal
This is the confirmation signal for program selection signal. Decide the timing to read the external program selection signal and set it so that the input signal can be received in stable timing.

- Discrete program selection when not using program strobe signal



※ Always set to signal to ON.

11.2. Standard external output signal (I/O board)

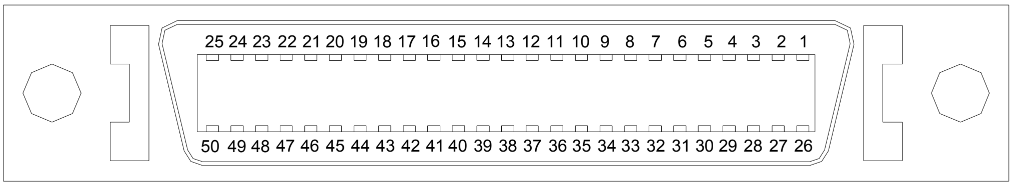
11.2.1. Introduction

The output signal is connected to the DIO (I/O board) through the right opening of the control panel.

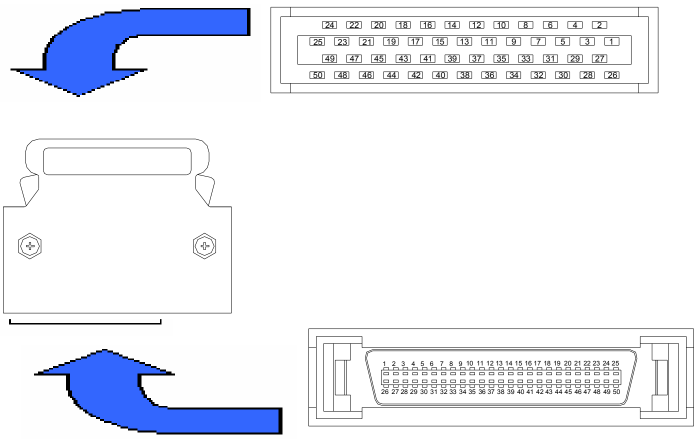
11.2.2. Output circuit

All output circuits are same as the following figure.

- Connector specification
  IO board side: 3M MDR 10250-52A2JL

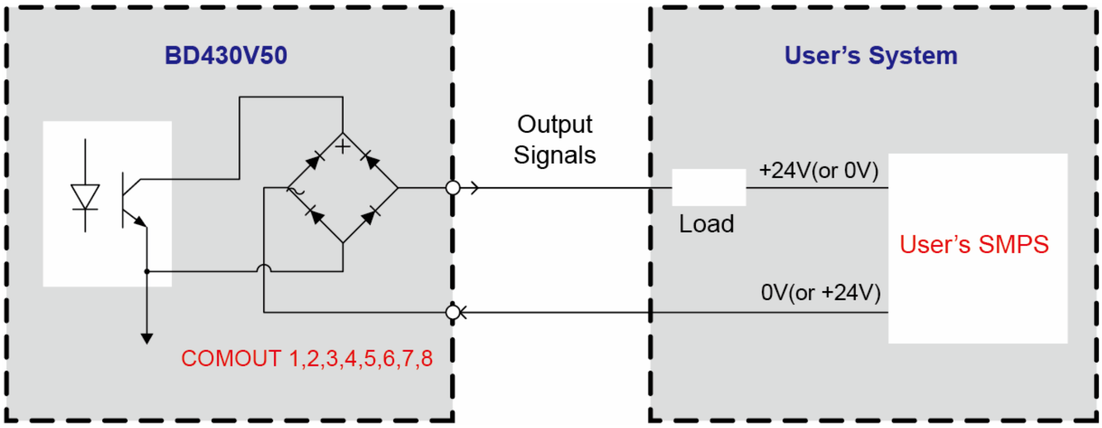


Plug (User preparation) side: 3M MDR 10150-3000VE (HOOD;10350-55F0-008)



- Output specification
  - Output port : NPN transistor open collector + bridge diode
  - Rated output : 125mA (continuous load current), 24V DC

- Connection diagram



11.2.2.1. CNOUT1 Output signal

Pin No.	Signal name	Function description
1	SDO01	Public output 1 / MOTOR ON LED output
2	SDO02	Public output 2 / reserved system output
3	SDO03	Public output 3 / START LED output
4	SDO04	Public output 4 / STOP LED output
5	SDO05	Public output 5 / reserved system output
6	SDO06	Public output 6 / reserved system output
7	SDO07	Public output 7 / reserved system output
8	SDO08	Public output 8 / reserved system output
9	COMOUT1	Public output (User's power): 0V or +24V (for SDO01~SDO08)
10	COMOUT1	
11	SDO09	Public output 9 / SYS ERR LED output
12	SDO10	Public output 10 / reserved system output
13	SDO11	Public output 11 / TORCH SW output
14	SDO12	Public output 12 / INCHING output
15	SDO13	Public output 13 / RETRACT output
16	SDO14	Public output 14 / STICK CHK output
17	SDO15	Public output 15 / GAS VALVE output
18	SDO16	Public output 16 / WELDOUT RSV output
19	COMOUT2	Public output (User's power): 0V or +24V (for SDO09~SDO16)
20	COMOUT2	
21	N.C	-
22	N.C	-
23	N.C	-
24	N.C	-
25	N.C	-
26	N.C	-
27	N.C	-
28	N.C	-
29	N.C	-
30	N.C	-
31	SDO17	Public output 17 / MOTOR POWER ON output
32	SDO18	Public output 18 / BRAKE RELEASE ON1 output

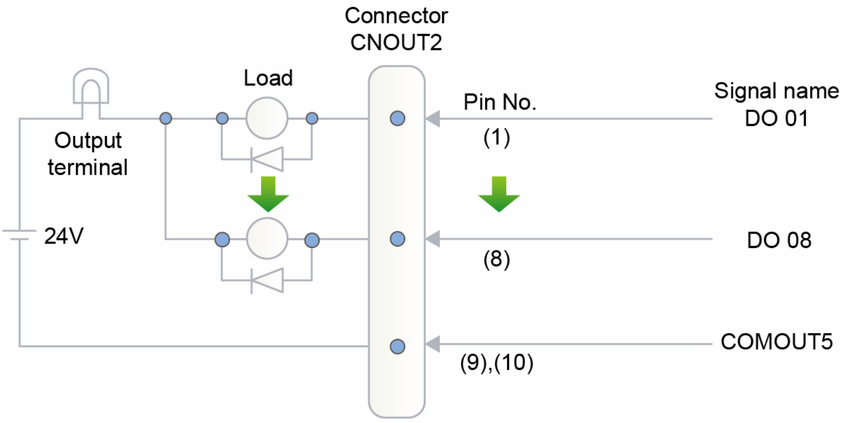
Pin No.	Signal name	Function description
33	SDO19	Public output 19 / BRAKE RELEASE ON2 output
34	SDO20	Public output 20 / BRAKE RELEASE ON3 output
35	SDO21	Public output 21 / BRAKE RELEASE ON4 output
36	SDO22	Public output 22 / BRAKE RELEASE ON5 output
37	SDO23	Public output 23 / reserved system output
38	SDO24	Public output 24 / PLAYBACK output
39	COMOUT3	Public output (User's power): 0V or +24V (for SDO17~SDO24)
40	COMOUT3	
41	SDO25	Public output 25
42	SDO26	Public output 26
43	SDO27	Public output 27
44	SDO28	Public output 28
45	SDO29	Public output 29
46	SDO30	Public output 30
47	SDO31	Public output 31
48	SDO32	Public output 32
49	COMOUT4	Public output (User's power): 0V or +24V (for SDO25~SDO32)
50	COMOUT4	

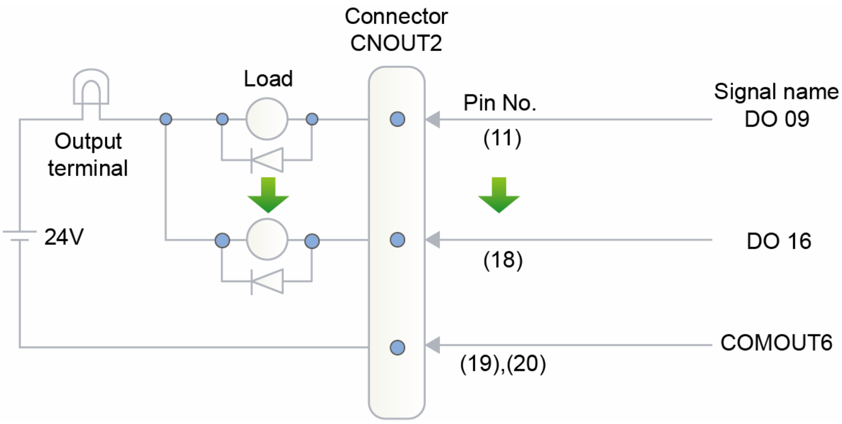
11.2.2.2. CNOUT2 Output signal

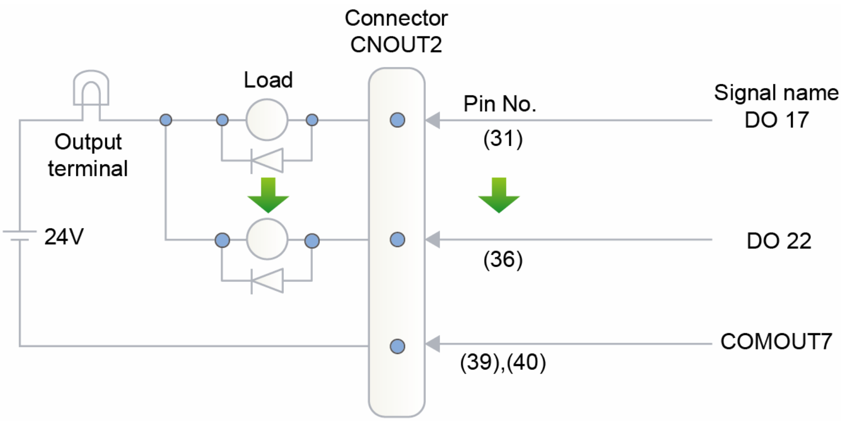
Pin No.	Signal name	Function description
1	DO01	Public output 1
2	DO02	Public output 2
3	DO03	Public output 3
4	DO04	Public output 4
5	DO05	Public output 5
6	DO06	Public output 6
7	DO07	Public output 7
8	DO08	Public output 8
9	COMOUT5	Public output (User's power): 0V or +24V (for DO01~DO08)
10	COMOUT5	
11	DO09	Public output 9
12	DO10	Public output 10
13	DO11	Public output 11
14	DO12	Public output 12
15	DO13	Public output 13
16	DO14	Public output 14
17	DO15	Public output 15
18	DO16	Public output 16
19	COMOUT6	Public output (User's power): 0V or +24V (for DO09~DO16)
20	COMOUT6	
21	N.C	-
22	N.C	-
23	N.C	-
24	N.C	-
25	N.C	-
26	N.C	-
27	N.C	-
28	N.C	-
29	N.C	-
30	N.C	-
31	DO17	Public output 17
32	DO18	Public output 18

Pin No.	Signal name	Function description
33	DO19	Public output 19
34	DO20	Public output 20
35	DO21	Public output 21
36	DO22	Public output 22
37	DO23/GUN1	Public output 23 / GUN signal 1
38	DO24/GUN2	Public output 24 / GUN signal 2
39	COMOUT7	Public output (User's power): 0V or +24V (for DO09~DO16)
40	COMOUT7	
41	DO25/MX	Public output 25 / MX signal
42	DO26/Proram END	Public output 26 / Output when the program END
43	DO27/Synthetic error	Public output 27 / Output when there is a system error
44	DO28/Interlock-abnormal warning	Public output 28 / Ouput when interlock time is over
45	DO29/In operation	Public output 29 / Output for in-operation
46	DO30/Auto mode	Public output 30 / Output for Auto mode
47	DO31/Robot ready OK	Public output 31 / Output when Robot ready OK
48	DO32/Home position	Public output 32 / Output for home position status
49	COMOUT8	Public output (User's power): 0V or +24V (for DO09~DO16)
50	COMOUT8	

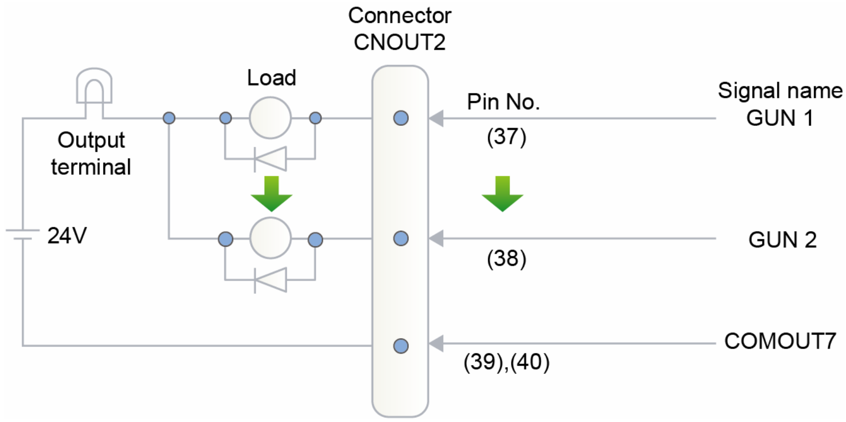
(1) Public DO signal
Connect the DO 1 ~ DO 8 and DO 11 ~ DO 22 output signal as follows.



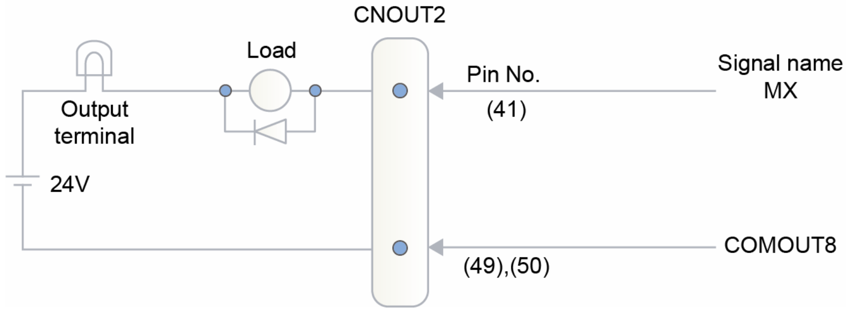




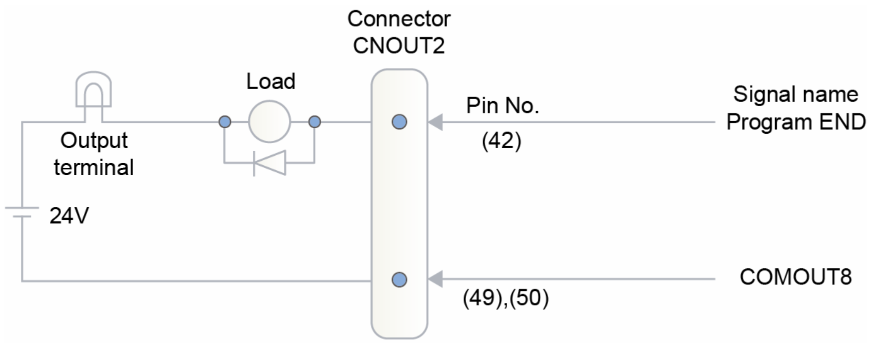
(2) GUN signal
If the gun output function is in effect at the target step during playback, this signal will be sent out after reaching the recorded point (target point).



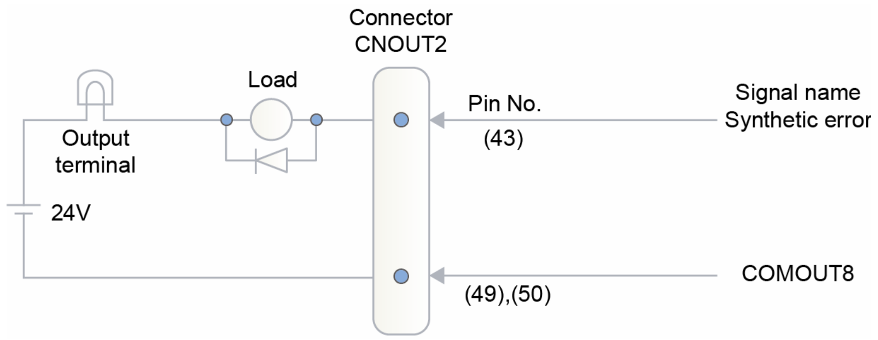
(3) MX signal
MX signal is set on/off according to the target step MX condition before starting the target step.



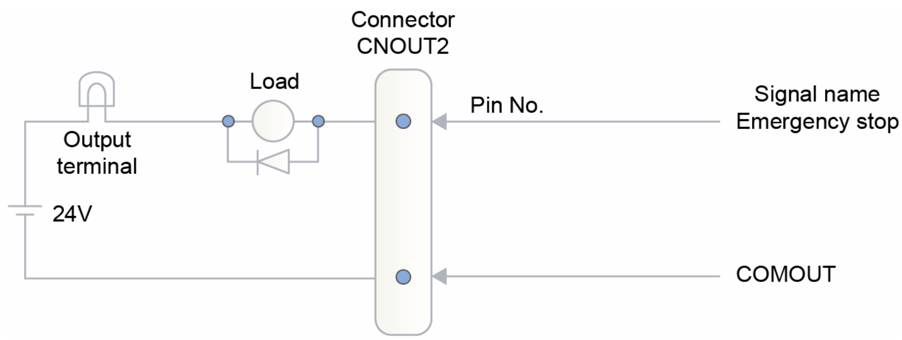
(4) Program END
This is the output signal that is sent out when the program ends. The setting for program end signal is in 『[PF2]: System』 → 『2: Controller parameter』 → 『6: End relay ON time』.



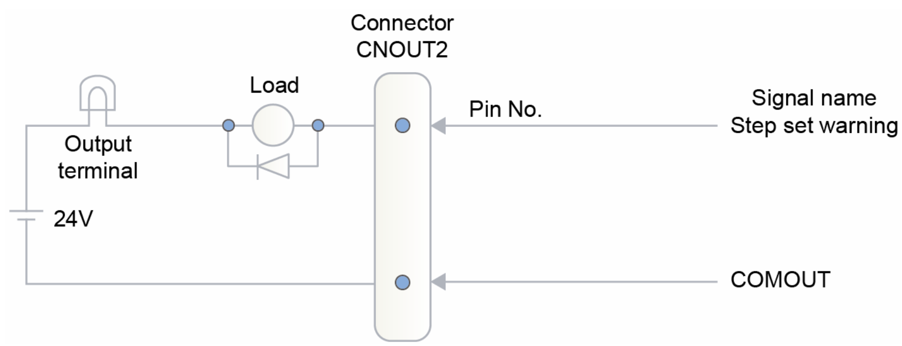
(5) Synthetic error signal
This is sent out when there is an important error in the system.
Initialize the output condition by setting the operation standby to ON after pressing the [R..] key or recovering from the error.



(6) Emergency stop signal
This signal is sent out when the emergency stop button is pressed.

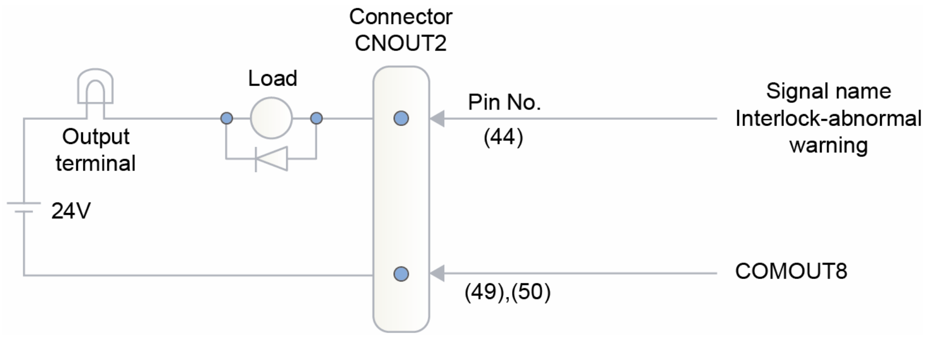


(7) Step set warning signal
This signal is sent out when you designated the gap between current step and 2 steps in manual mode or 1 step mode. This signal is sent out for 200 msec in pulse.

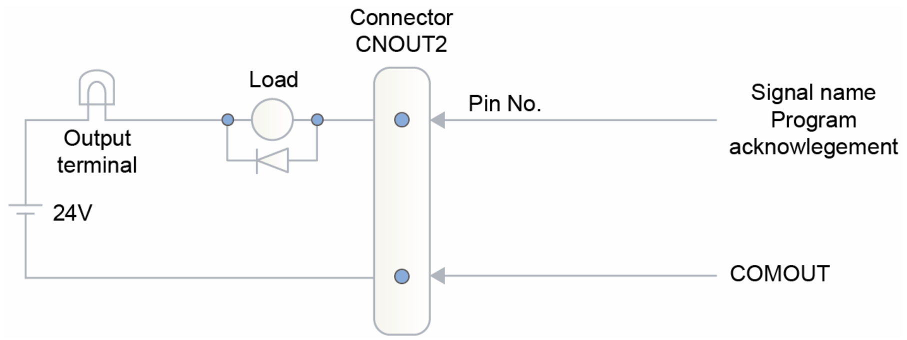


(8) Interlock-abnormal warning signal
This signal is sent out when the interlock standby time exceeds the time set in 『[PF2]: System』 → 『2: Controller parameter』 → 『7: Interlock timer』, and the interlock signal is not received.

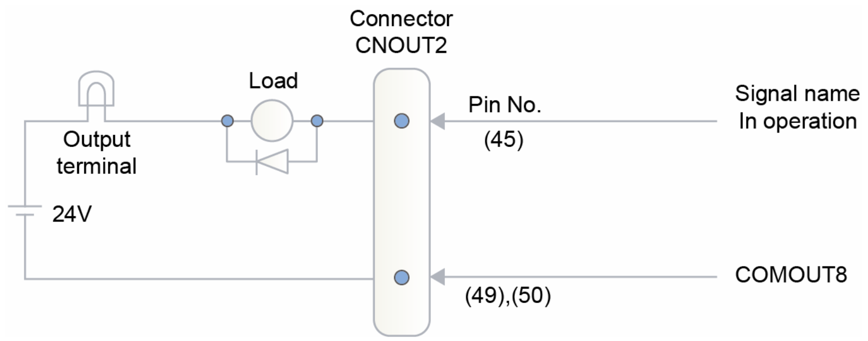
When the interlock signal is received after this signal is sent out, it proceeds to the next step.



(9) Program acknowledgement signal
This signal is sent out when a program is selected by external program. This signal is sent out for 200 msec in pulse.

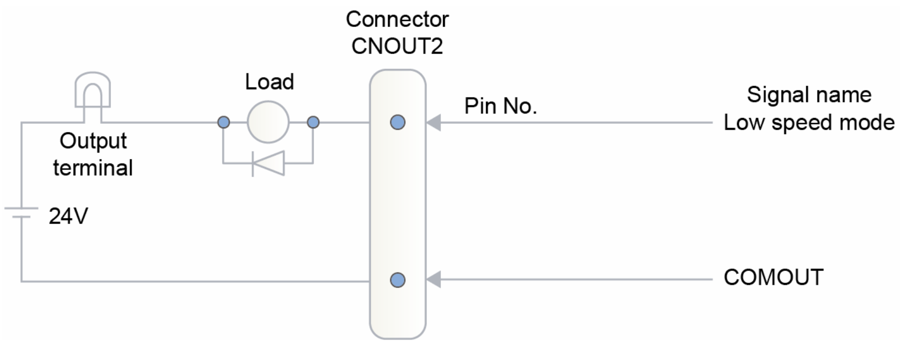


(10) In-operation signal
This signal is sent out when the robot is in operation.



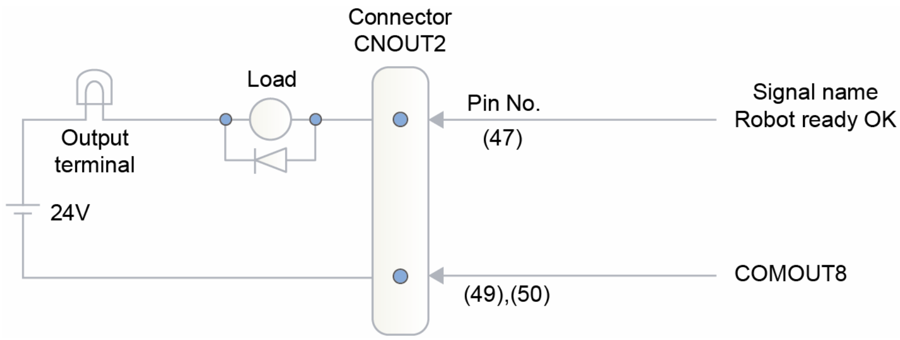
(11) Low speed mode signal

This signal is sent out when there is a low speed command or when it is in low speed mode.



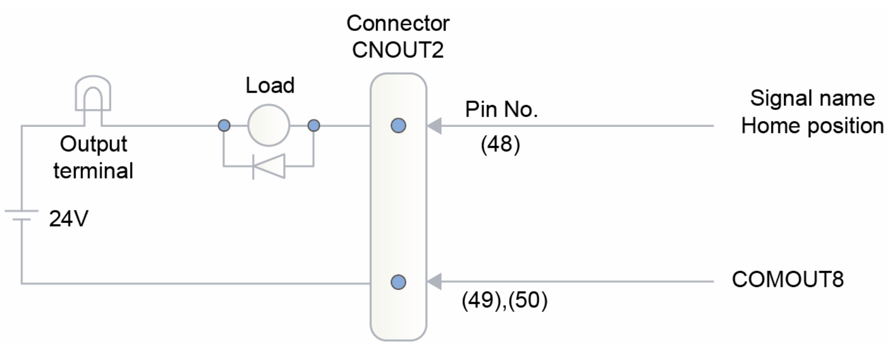
(12) Robot ready OK signal

This signal is sent out when the robot is ready for automatic operation. The condition of this signal, please refer to 『[PF2]: System』 → 『2: Controller parameter』 → 『3: Robot ready』.



(13) Home position signal

This signal is sent out when the robot is in the location set in 『[PF2]: System』 → 『2: Controller parameter』 → 『4: Registration of home position』.



11.3. BD481 input/output signal

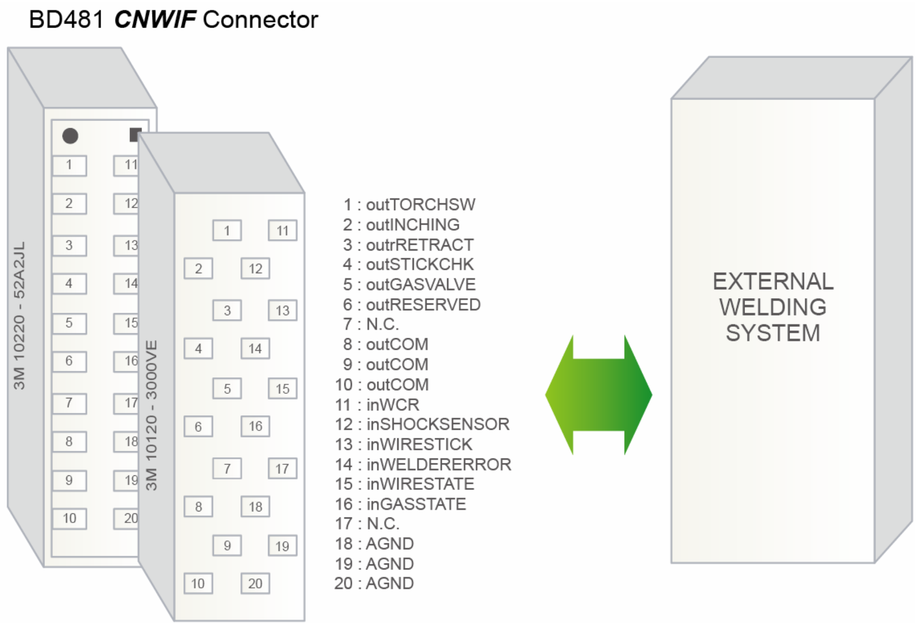


Figure 11.1 BD481 CNWF Connector

Table 11-1 Connector specification

Item	Manufacturer	Type	Specification
Receptacle	3M	10220-52A2JL	MDR system, 20-Pin
Header	3M	10120-3000VE	MDR system, 20-Pin
Hood	3M	10320-52F0-008	MDR system, 20-Pin

BD481 ***TBAIO*** Terminal Block

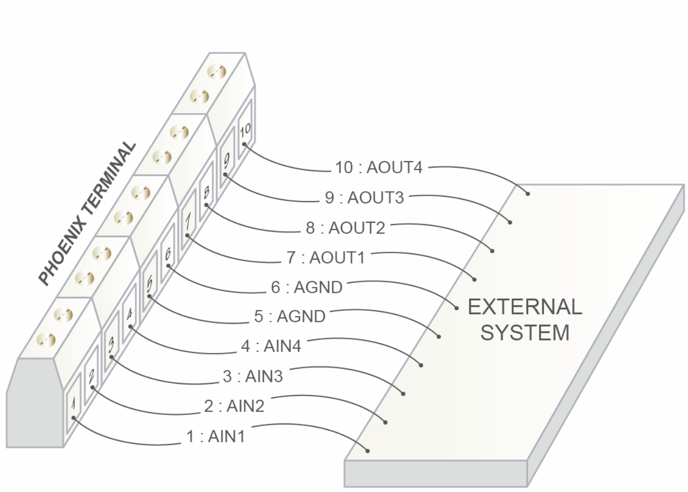


Figure11.2 BD481 TBAIO Terminal Block

Table 11-2 BD481 Terminal Block

Item	Manufacturer	Type	Specification
TERMINAL BLOCK (Plug Part)	PHOENIX	MCV1.5/10-ST-3.81	10-pin, 3.81mm pitch, Plug Part
TERMINAL BLOCK (Housing)	PHOENIX	MCV1.5/10-G-3.81	10-pin, 3.81mm pitch, Housing

BD481 ***CNSTK*** Connector

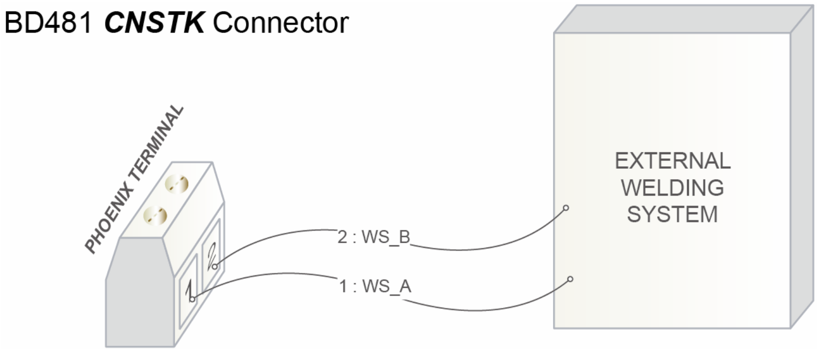


Figure11.3 BD481 CNSTK Connector

Table 11-3 Terminal Block

Item	Manufacturer	Type	Specification
TERMINAL BLOCK	PHOENIX	MKDS 1/2-3.81	2-pin, 3.81mm pitch, Terminal Block

BD481 ***CNPOW*** Connector

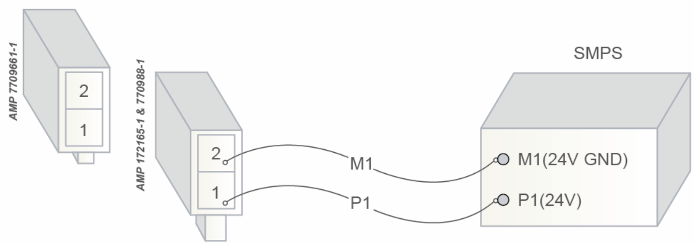


Figure11.4 BD481 CNPOW Connector

Table 11-4 Connector

Item	Manufacturer	Type	Specification
Connector (Header)	AMP	770966-1	MATE-N-LOCK Header, 2-Pin
Connector (Plug)	AMP	172165-1	MATE-N-LOCK Plug, 2-Pin
Connector (Contact)	AMP	770988-1	MATE-N-LOCK Contact, AWG22

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