WARNING

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

Hyundai Robot

Hi5130501OPEN7

Hi5 Controller Operation Manual

- Hi5-C10/C20
- Hi5-N00/N30/N50

HYUNDAI
HEAVY INDUSTRIES CO.,LTD.

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Contents

1. Safety

2. Basic Operation

Contents

Contents

Figure contents

Table contents

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 complies with the safety regulation of EU Machinery Directive 98/37/EC(2006/42/EC) and US OSHA. And the robot manipulator and controller is manufactured to comply with the safety standards EN ISO 10218-1:2006 and ANSI/RIA R15.06-1999.

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.

HHI user of industrial robot has responsibility to observe the safety regulation related to robot adopted in corresponding countries and responsibility to design, install and operate safety equipment well in order to protect workers who work at robot system.

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 workpiece from entering the zone. If a person or object should nevertheless enter 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.

The areas for which the robot can be applied and the environment in which it can be used are as follows.

Applicable areas

It is applied to the 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
- Palletizing
- Grinding
- LCD manufacturing process

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 10218-1:2006 safety standards for industrial robots, and furthermore in comply with ANSI/RIA R15.06-1999 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 highly dangerous situation, meaning that operating or handling in a wrong manner could result in death or serious injury to personnel, or damage to equipment. Attention should be paid to the operation and handling.
Mandatory		Indicate the compulsory measures that should be taken
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 Functions – IEC 204-1,10,7

There is one emergency stop button on the controller and teach pendant respectively. If necessary, additional emergency buttons can be connected to the robot's safety chain circuit. The emergency stop function, which overrides all other robot controls, can bring the current operation to a halt by cutting off the power supply to the motors of individual axes. This function will also shut down the power supply to other dangerous functions, which are controlled by the robot, to prevent them from being used

Safety Stop Function - EN ISO 10218-1:2006

A safety stop circuit needs to be configured, and, through this circuit, each robot should be connected with the safeguards and interlocks. 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 - EN ISO 10218-1:2006

In a manual mode, the maximum speed of the robot is limited to 250 mm per second.
The speed limitation applies not only to the TCP(Tool Center Point), 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

Operation area of each axis is restricted by soft limit and hardware limit. Axis 1, 2, and 3 can also be restricted by means of mechanical stopper.

Operation Mode Selection - ANSI/RIA R15.06-1999

The robot can be operated either in the manual mode or auto mode. In the manual mode, the robot can 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.

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 changing replacement, or to inspect welding equipment, opens the fence gate and approaches the equipment during operation.

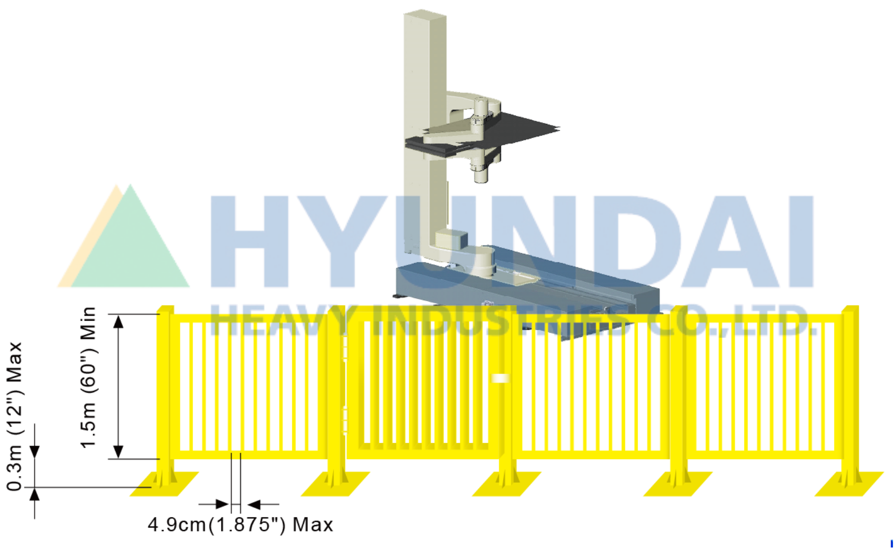


Figure 1.1 Recommended size for safety net and entrance gate (slot type entrance gate)

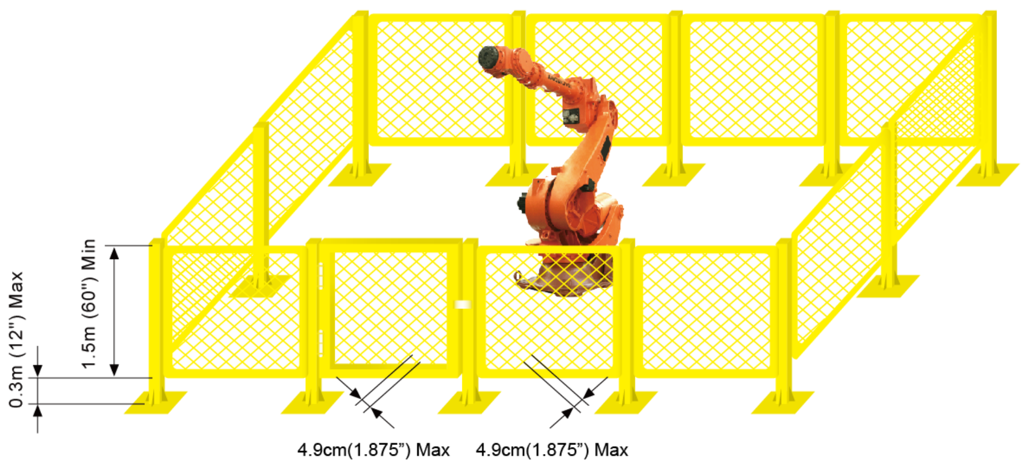


Figure 1.2 Recommended size for safety net and entrance gate (square type entrance gate)

(1) Enough space for safety net should be secured by covering robot operating area so as that workers would not have difficulty in teaching work or repairing work, and the safety net should have solid structure in order that it would not move easily and man cannot enter over easily.

(2) Safety net should be installed by static type in principle, and should not have hazardous parts such as prominence and depression or keen part, etc.

(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. Wiring should be carried out in a way that the robot should be in the operation ready OFF status as well as in the motor OFF status when the safety plug is pulled out or safety net is open.

(4) In order to operate the robot with the safety plug pulled out, wiring should be carried out in a way that will allow the playback to take place at a low speed.

(5) The emergency stop button should be installed at a place where it can be pushed quickly by the operator.

(6) If no safety net is to be installed, devices such as photoelectric switches, and mat switches, should be installed, instead of the safety plug, to cover the overall area within the robot's operation range in a way that the robot can be stopped automatically when a person enters the robot's operation range.

(7) Operation area of robot (hazardous area) should be distinguished by the method like painting on floor.

1.6.2. Placement of Robot & Peripheral Equipment

Please make sure that robot and peripheral equipment should be arranged by following method.

(1) In case of connecting primary power of controller or peripheral devices, please work after checking whether supply power has been deleted. 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.

(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 stopping in an emergency situation can be initiated from any place from which the robot is operated.

(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. Otherwise, the operator may suffer electrocution or the wire may suffer disconnection.

(6) Place the controller, interlock panel, and handling stand within the sight of robotic performance. It may cause a major accident to operate the robot while the robot is malfunctioning in an area where the robot’s activity can not be observed, or while the operator is working on it.

(7) Restrict the robot's working envelope by using the soft limits and the mechanical stopper if the necessary working envelope is narrower than the robot’s workable envelope. When the robot is to move beyond the restricted envelop due to abnormal operation, such as the robot being handled in a wrong way, the robot will be stopped automatically in advance thanks to the function that restricts the workable envelop.

(8) During the welding work, spatter could fall down to workers or the workers could be injured by burning, or fire could break out. 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, can be noticeable even from a slightly distant location. In the case of automatic start-up, a buzzer or a warning lamp will be useful.

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

(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.

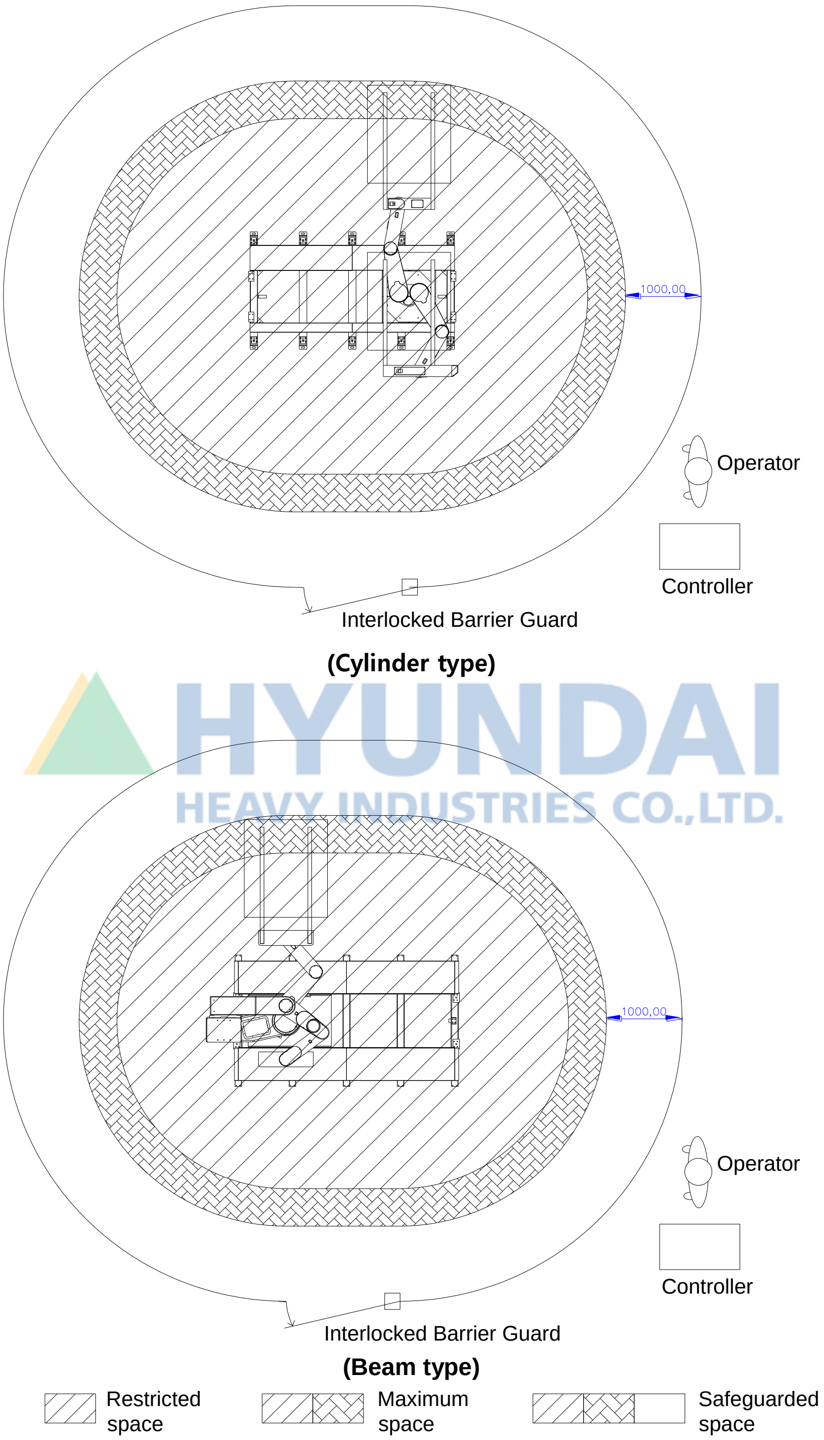


Figure 1.3 Arrangement of LCD robot peripheral devices and workers

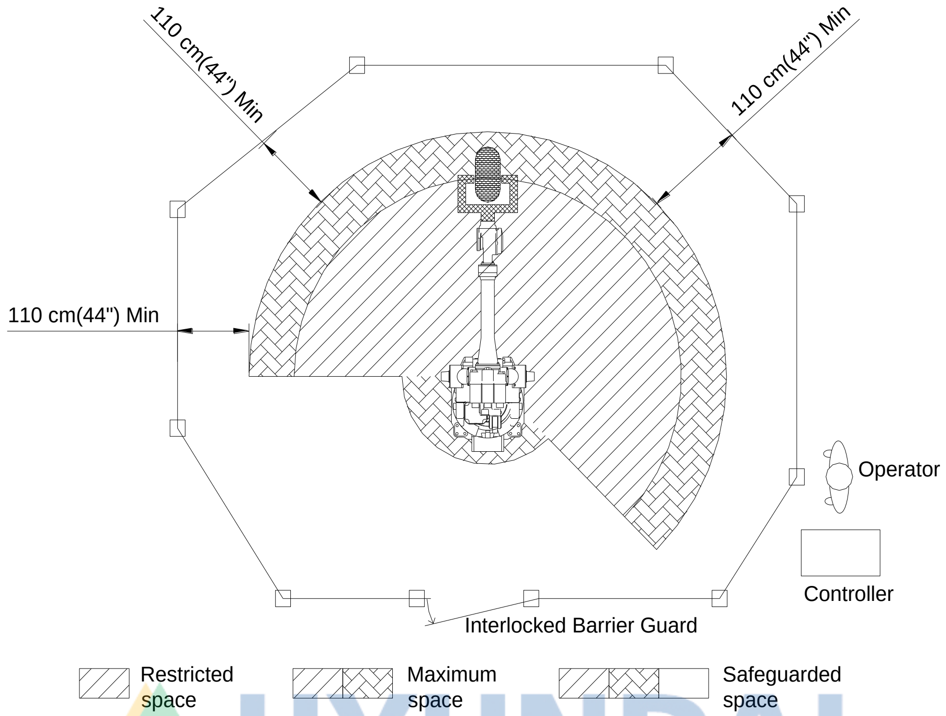


Figure 1.4 Arrangement of general robot peripheral devices and workers

1.6.3. Installing the Robot

Please install the robot in accordance with following method surely.

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 place 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, controller, and other peripheral equipment. To install the main body and controller, please secure the above mentioned installation area. Install controller outside of the safety fence in order to monitor the robot manipulator and to operate in a safe way.
When installing, be sure to make it easier to perform the maintenance when opening the Controller door. Secure the available space. The specifications of the controller can change according to the type of the controller. (For more details, please refer to the “Maintenance manual”.)

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

Please observe following countermeasures because safety is very important for the test operation of the robot.

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

(12) It is a repairing part to be prepared for when you buy many sets.

(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 are 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.

- **During temporary halt, the entrance countermeasure same as entrance of teaching work should be considered at the case (nozzle contact, welded part detected, arc error, and so on) of opening entrance gate for simple management against error.**

(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

Please observe following countermeasures because safety on robot operation is very important.

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

Please observe following countermeasures because safety on robot automatic operation is very important.

(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 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

Please observe following countermeasures because safety on robot automatic operation is very important.

The robot is very heavy and strong, even at low speeds. 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 teach pendant or control panel.

When entering the working envelope through the safety gate, you must take the teach pendant with yourself so that other people cannot operate the robot. Make sure to post up the control panel a sign indicating the state of robot handling.

People must understand the followings when they are to enter the robot's 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 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 teach 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 Controller Maintenance and Repair

Please observe following safety countermeasures on repair and check for robot controller.

(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) When you open the door of controller, you should turn off power, and please start working after 3 minutes.

(7) Please do not touch heat radiating plate of servo AMP and recovery resistance because they are very hot.

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

1.9.2. Safety Precautions for Robot System & Manipulator Maintenance

Please observe following safety countermeasures on repair and check for robot controller.

(1) Refer to the safety precautions for 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

Please install the robot in accordance with following method surely.

(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

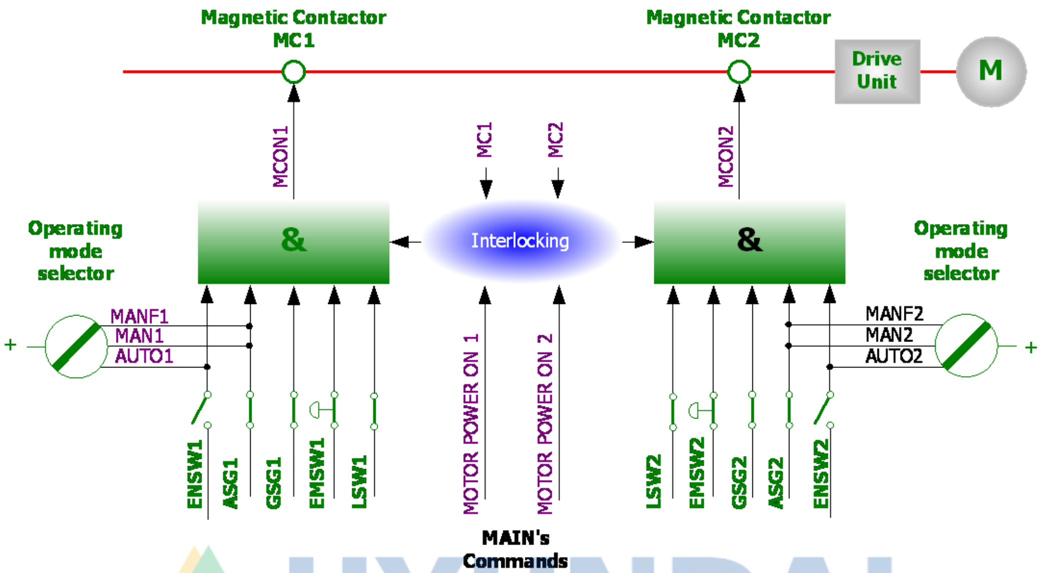


Figure 1.5 Configuration for safety chain

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, 『Operation manual』.)

Safety circuit

The emergency stop buttons on the controller panel and on the teach 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 with the limit switch, change the robot’s position by operating it with the pendant key at the constant setting mode. (Constant setting mode refers to the state of entry into the menu『[F2]: System』menu)

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 teach 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.

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

Above the control and teach pendant console.

(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.
(Please refer to system board in “basic configuration of controller”) At this time, the emergency stop must be connected to be “Normal On” and it must be check for proper operation during test run.

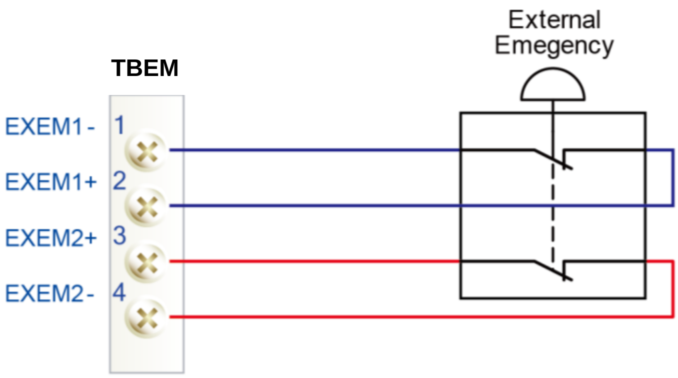


Figure 1.6 Connection with external emergency halt switch through system board terminal block TBEM

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. If necessary, movement of wrist 3 axes can be restricted, too. 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 EU Machinery Directive 98/37/EC(2006/42/EC) and US OSHA.

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

- ANSI/RIA R15.06-1999
  Industrial Robots and Robot Systems - Safety Requirements

- ANSI/RIA/ISO 10218-1-2007
  Robots for Industrial Environment - Safety Requirements - Part 1 - Robot

- ISO 11161:2007
  Safety of machinery - Integrated manufacturing systems - Basic requirements

- EN ISO 13849-1:2008
  Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2006)

- EN 60204-1:2006
  Safety of machinery - Electrical equipment of machines - Part 1: General requirements (IEC 60204-1:2005 (Modified))

- EN ISO 10218-1:2006
  Robots for industrial environments - Safety requirements - Part 1: Robot (ISO 10218-1:2006)

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 :

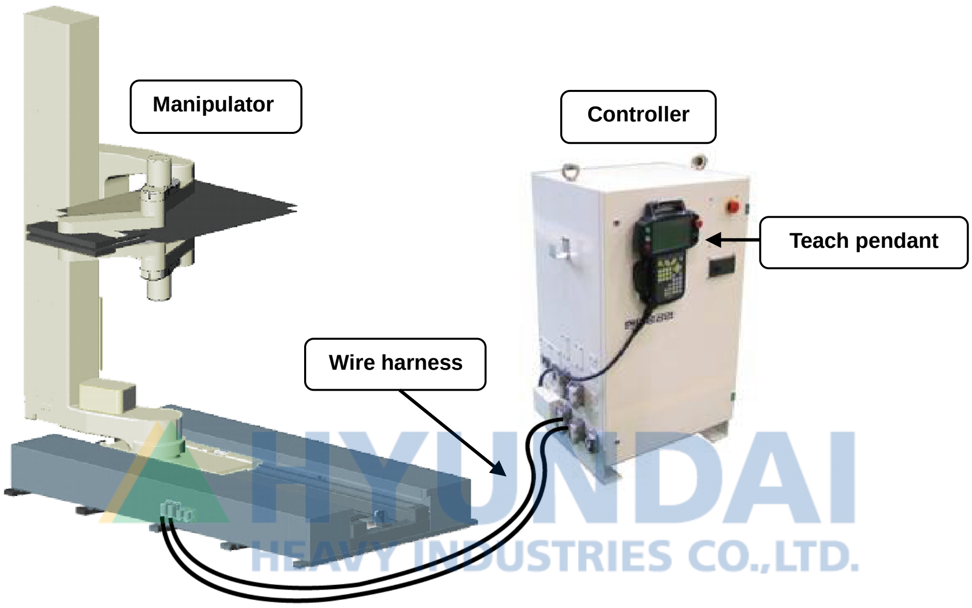


Figure 2.1 Basic Components of Manipulator and Controller (LCD Robot)

Figure 2.2 Teach Pendant (LCD Robot)

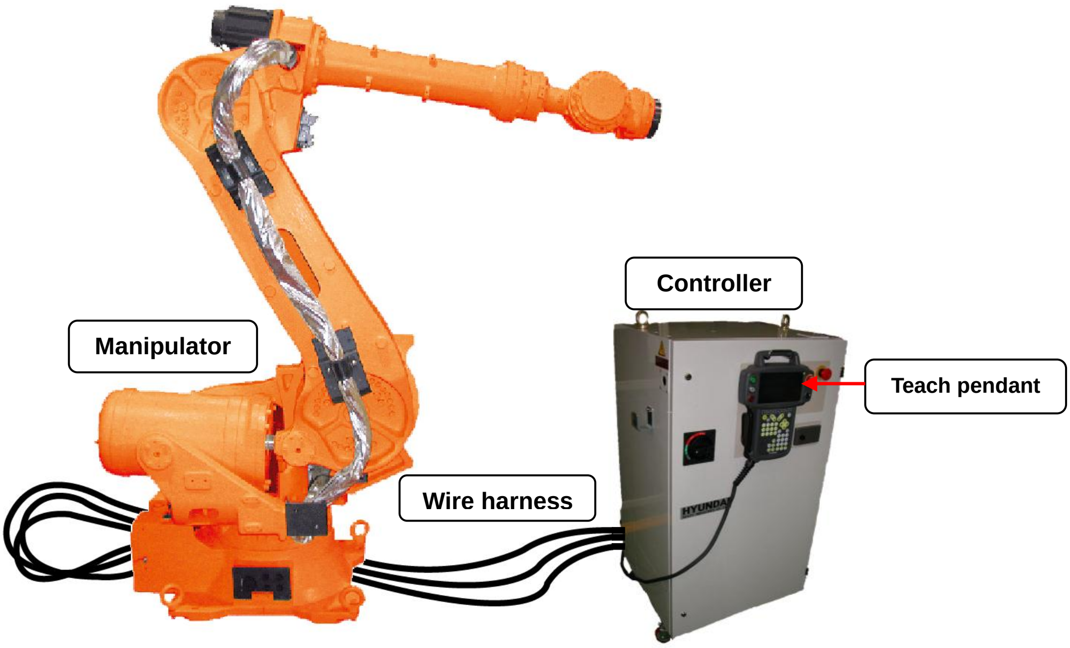


Figure 2.3 Basic configuration drawing of the Robot system (Vertical Articulated Robot)

Robot can be moved by using the teach pendant attached to the controller.

Figure 2.4 Teach Pendant (Vertical Articulated Robot)

2.2.2. Teach Pendant

2.2.2.1. External Appearance of Teach Pendant

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

Figure 2.5 External Appearance of Teach Pendant

2.2.2.2. Teach Pendant Screen

Following figure represents the screen displayed on teach pendant. Teach pendant screen is composed of 10 screen windows of color touch screens.

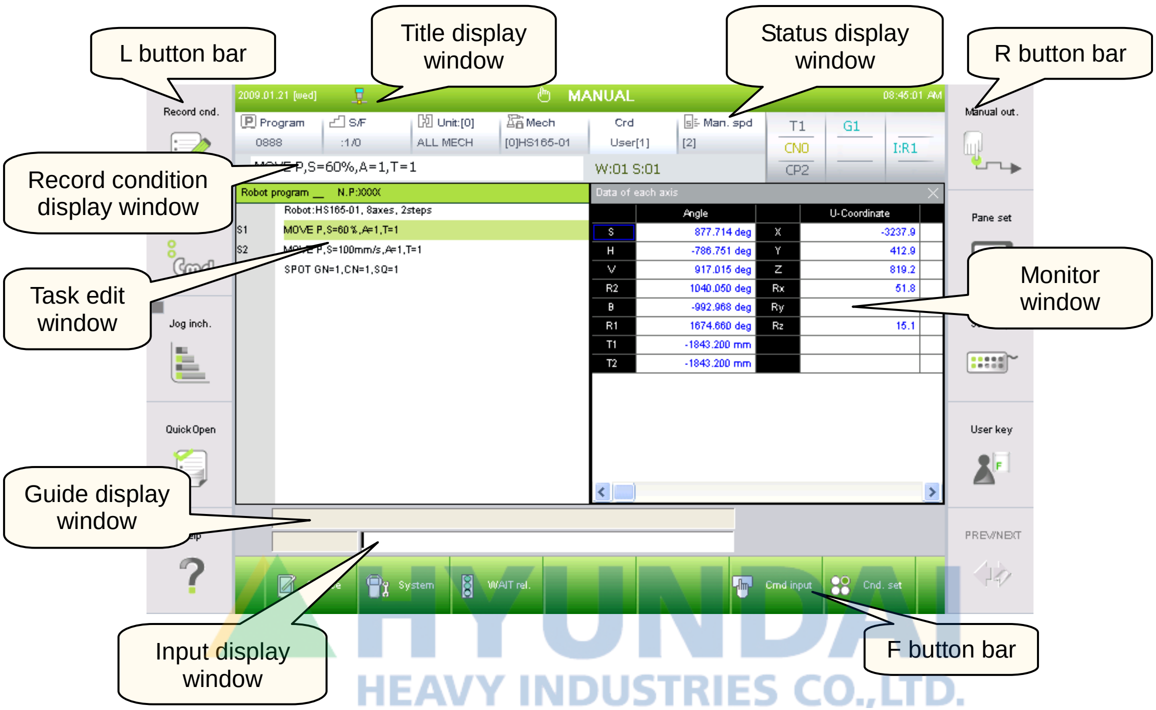


Figure 2.6 Teach pendant screen

■ Contents of screen

(1) Title display window

The date (Year, month, date), title (Mode) and time (Hour: minute: second) are displayed.

- ▶ Current time : This displays year, month, date, day, hour, minute and second.
  To change the current time, refer to 『[F1]: Service』 → 『8: Date, time setting』.

- ▶ Title : This displays the operating mode or title of the set screen.
  Depending on the [REMOTE/AUTO/MANUAL] switch on the operating panel, it will display MANUAL or AUTO. In MANUAL mode, it directs the robot work and in AUTO mode, the robot operates according to the directed work format (1Cycle, Continuous). Select the operation cycle in the Condition Setting menu

: Manual

: Auto 1 cycle

: Auto repeat

(2) Status display window

This displays various statuses of robot operation. You can set the displayed information by touching the applicable section from Program – 6 manual speed.

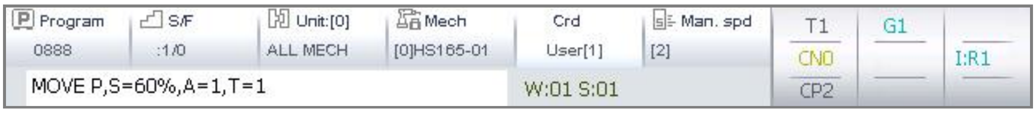


Figure 2.7 Status display bar

- Program
  This displays the currently selected work program number. When a recorded program exists, the program will be opened on the screen edit window. When external program is selected, icon is displayed and when external operation mode is selected, icon is displayed as shown below.

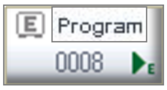


Figure 2.8 Icon for the external operation mode

- S/F
  This displays the number of the step or function within the currently selected program. The function number is not the total number of functions recorded within the program but the number of the function recorded between the steps.

- Unit/Mech
  Mechanism displays the robot type or the number of the selected additional axis. The robot is 0, and for the user refer to 『[F2]: System』→『5: Initialize』→『6: Mechanism setting』.
  Unit displays the assembled condition of the mechanism configured by the user. For setting of the status, refer to 『[F2]: System』→『5: Initialize』→『7: Unit setting』.

- Crd

  This displays the status of the robot coordinate system selected with key for manual operation.
  Status display of "JOINT, CART., TOOL" change in order. For robot movement during axis operation according to the coordinate system, refer to manual operation in chapter 2.3.

- Man. spd
  Determine the speed to operate the robot in the manual mode. In the manual mode, there are 2 different types of operation. One is to run it manually and the other is the step forward/backward operation. There are 8 different steps (1~8) in the level of the speed of manual operation.

  Speed level increases by a step if pressing the speed  key of teach pendant, and decreases by a step if pressing the speed  key.
  Speed level is set to 8 if pressing the [SHIFT (FAST)] + Speed  key, and is set to 1 if pressing the [SHIFT (FAST)] + Speed  key

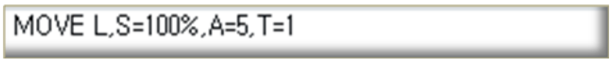
  When it comes to the step forward/backward speed, it should be set at the maximum level in the menu for setting the conditions.

  By pressing the [CTRL] + [Speed HI/LOW] keys, the speed limit for the step forward/backward operation can be changed. Please refer the items at 2.3 to Manual Operation for more details.

- This displays the tool number, the gun number and the on/off status of various functions.
  When the status of various functions including tool number, GUN number etc. changes the changed number or status is displayed.

(3) Record condition display window

This is the window to edit the condition of the step to record (Speed, accuracy, tool option etc.). Press the 『[L1]: Record condition』 to edit.



(4) Task edit window

This is the window to edit the program.

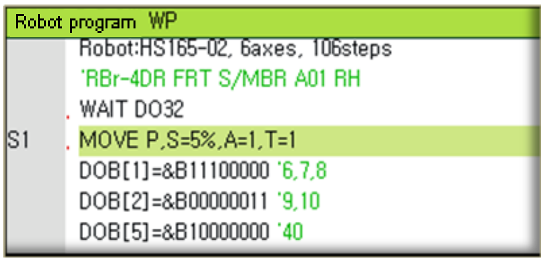
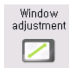


Figure 2.9 Task program edit window

▶ Protection status

"Robot program WP" displays the protected condition of the selected robot. For details on the program protection, refer to 『[F1]: Service』 → 『5: File manager』 → 『F7: Attribute』.

(5) Monitor window

This is the window to display the location data, I/O data and status data of each application by each axis in real time. Select and adjust window (Split, close) using the  key. You can display total of 3 monitors. (Refer to the "2.2.2.3. Window control function".)

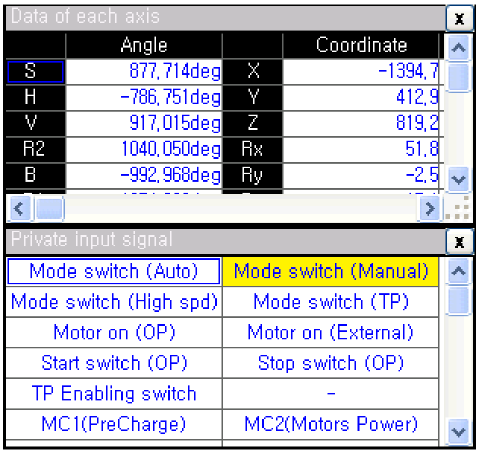


Figure 2.10 Monitoring window

(6) Guide display window

This displays the guide or direction message for the user to operate and is the area that displays the print message when the print direction is set to T/P in the PRINT command.

(7) Input display window

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

(8) F button bar

7 F buttons are displayed. You can use the F button by pressing the [F1] ~ [F7] key of the key pad or by pressing the F button on the display window screen.
F button changes according to the current operating screen with appropriate composition. For example in the highest level screen, the button to switch to Service menu or System menu is displayed. Also during task program editing, the button for command list or command parameter setting is displayed.

Figure 2.11 F buttons display window

When there are more than 7 buttons in the current screen, 

button will be activated, and every time this button is pressed, it will switch to the next button. (When you press [SHIFT] + 

button, it will switch back in the reverse direction.)

(9) L (Left) button bar, R (Right) button bar”

5 buttons are displayed on both the left and right side of the screen, and you can touch the screen to press the buttons. Inactive buttons will be grayed out. It can be understood when looking at the following automatic mode that the record condition, jog inching, and prev/next functions are disabled, making it impossible to use those functions.

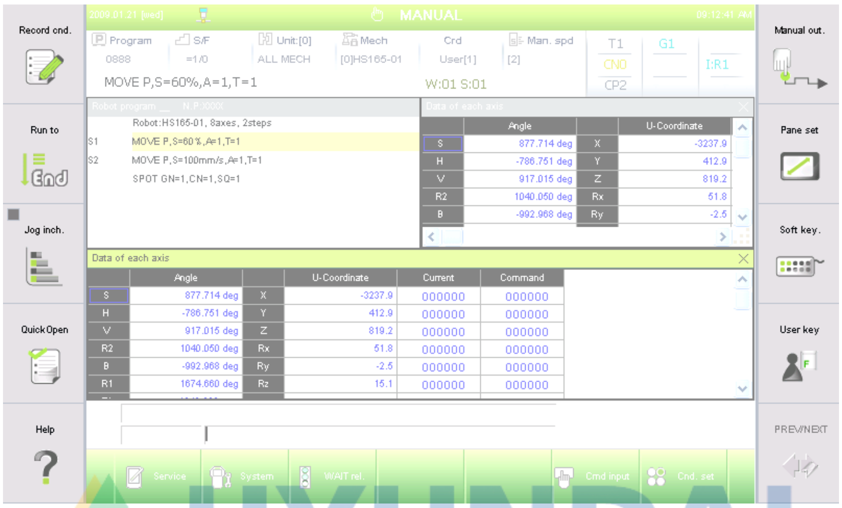


Figure 2.12 TP basic screen

Reference

- The highlighted part in yellow green color of screen S1 means that the current step is at No. 1. ‘.’ in front of the command prior to step No. 1 refers to the executed command, and the command after step No. 1 refers to the commands to be executed in the future. ‘>’ of step No.1 indicates that currently step No.1 is in progress.

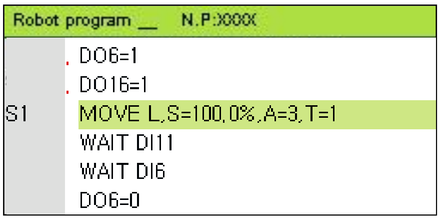
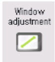


Figure 2.13 Command being executed

2.2.2.3. Window control function

You can display the monitoring information by splitting the full screen into 3 sections at maximum simultaneously

(1) Press the  button from the initial screen to enter the adjust window F menu.

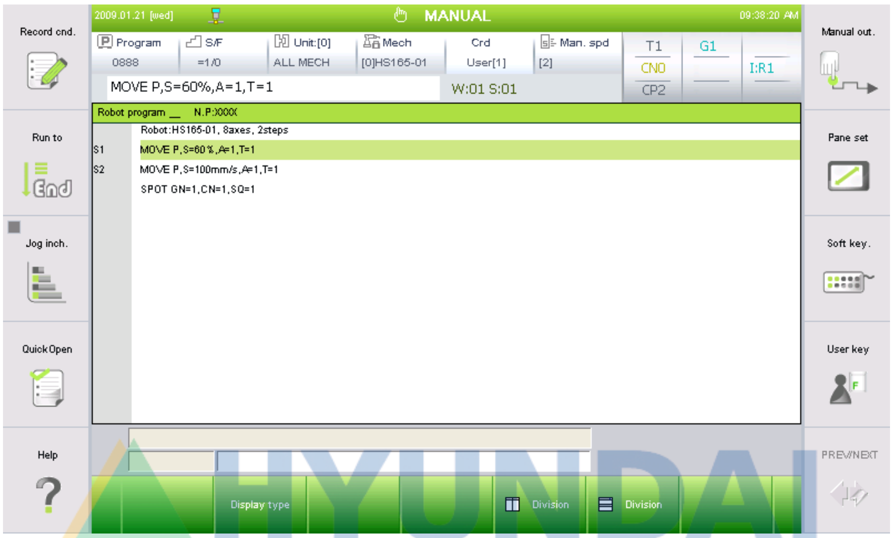


Figure 2.14 TP screen in the adjust window menu

For the adjust window F menu, appropriate buttons are displays depending on the current situation of the window split. The following picture shows all the buttons of the adjust window F menu.

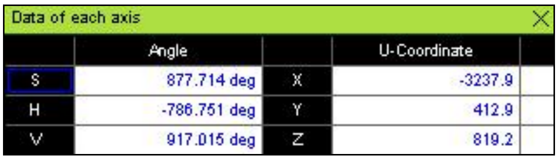
Figure 2.15 Adjust window F menu

(2) Click on 

to split the currently selected window horizontally. The basic data of each axis is displayed on the monitoring content of the newly created window.

Figure 2.16 TP screen horizontally split

When the window is split, the title bar of the currently selected window is displayed in green as shown below. Cursor movement using the key pad or adjusting the window will apply to the currently selected window.



Data of each axis

	Angle		U-Coordinate
S	877.714 deg	X	-3237.9
H	-786.751 deg	Y	412.9
V	917.015 deg	Z	819.2

When you want to select a different window, click on the window you want to select through the touch screen.

(3) When you click on the 

button, the currently selected window will be split into 2 windows vertically.

(4) When you click on the 

button, the currently selected window will be expanded horizontally. The existing window in the expanded space will be reduced or closed.

(5) When you click on the 

button, the currently selected window will be expanded vertically. The existing window in the expanded space will be reduced or closed.

(6) When you click on the 

button, you can designate the monitoring information to display on the currently selected window.
(The upper left split window can only display the current robot program edit screen.)
(Applied items such as spot, palletize etc. is displayed only when set to “Enable”.)

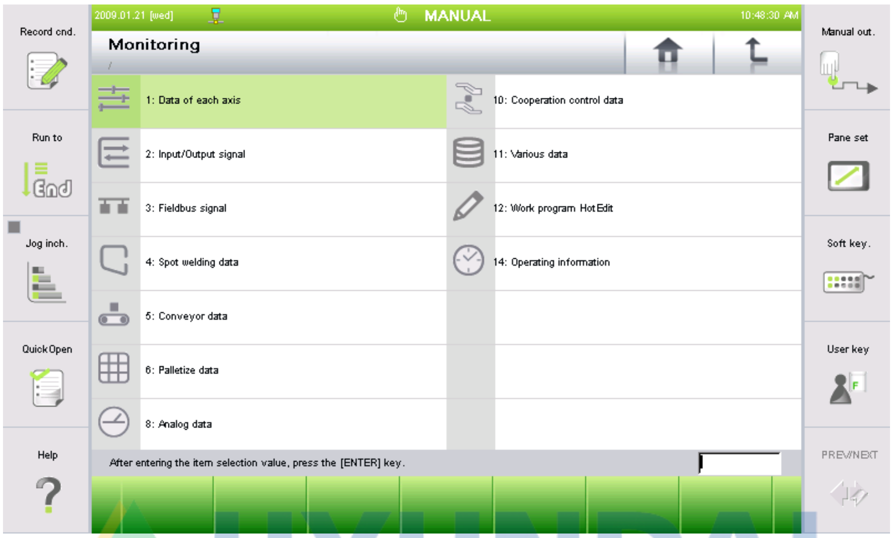


Figure 2.17 Monitoring type selection menu

The item on the list menu is the same as when you enter by pressing 『[F1]: Service』 → 『1: Monitoring』. If you select 『2: Input/output signal』 → 『1: Private input signal』, for example, the following screen will be displayed.

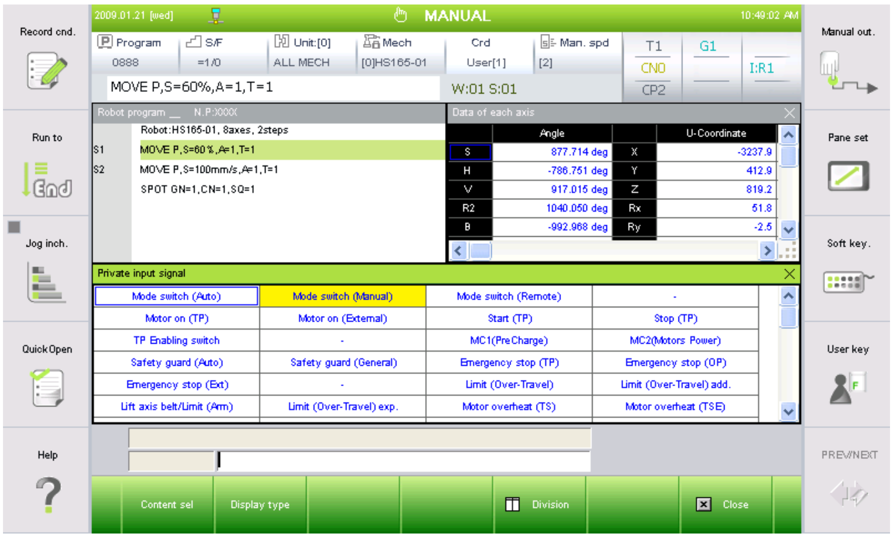


Figure 2.18 Private input signal monitoring screen

(7) When you click on the Display type button, the format in which the information is displayed will be changed.
In the current version, you can only change the font size of the robot program. While the robot program edit window is selected, if the display type button is clicked, the font size will be changed.

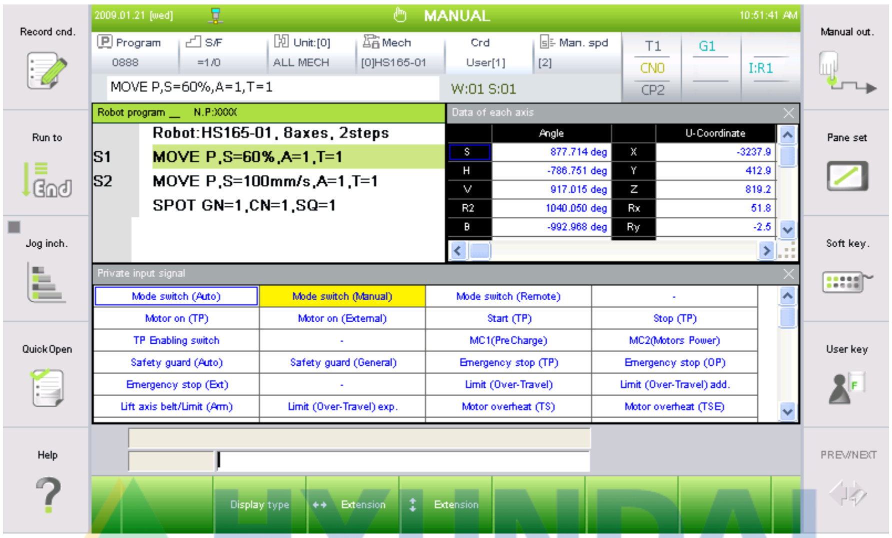


Figure 2.19 TP screen after the display type is clicked

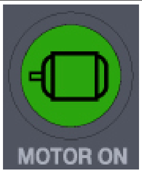
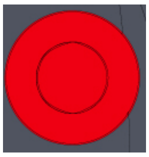
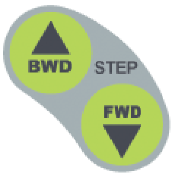
(8) When you click on the Close button, the currently selected window will be closed. Or you can click on the button on the upper right corner of the window to close the window.
(You cannot close the robot program edit window on the upper left side.)

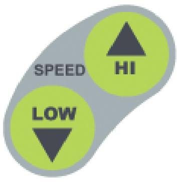
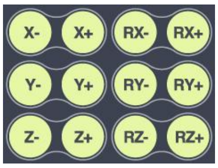
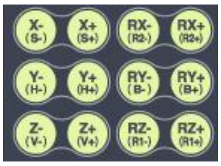
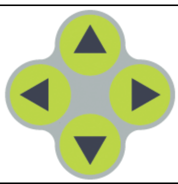
(9) When you press another key besides the F menu key (For example [ESC] key), the adjust window mode will end.

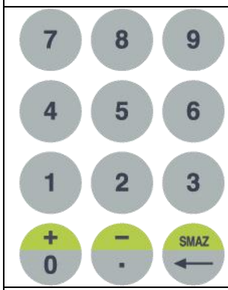
(10) Every time you press the [SHIFT] SHIFT [FAST] + [ESC] ESC key, the split window will be switched.
(If you want to see the robot program edit window widely, you can utilize this function.)

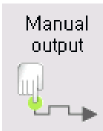
2.2.2.4. Key Description

Table 2-1 Key description

Button	Description
	**[REMOTE/AUTO/MANUAL]** This is the switch to change among (REMOTE), (AUTO) and (MANUAL) mode. In the REMOTE mode, the mode is decided by the MANUAL mode and AUTO mode signal of the input allocation signal.
	**[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.
	**[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]** Used to temporarily stop Robot during AUTO operation. If Robot stop, the [STOP] lamp turns on and the [START] lamp turns off. When the robot stops, there is no risk of colliding with other devices because it stops on the originally planned path.
	**[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.
	**[F1], [F2], [F3], [F4], [F5], [F6], [F7]** Used when selecting every menu of menu frames on the screen. Press the [F1] if selecting the first menu of menu frame.
	**[SHIFT(FAST)]** You must use this button when you want to execute the function displayed on the top part of the key (Light green). When this key is pressed together while operating the [Fast step forward/ backward] functions, the step forward/backward can be activated in high speeds. When editing a string from the input display window, you can move the cursor by pressing the button with the [⇐][⇒] key, From the task edit window, you can move the cursor by each screen by pressing the button with the [⇑]/[⇓] key.
	**[STEP FWD/BWD]** Used when going forward or backward step by step from Manual mode. See the 『[F7]: Condition setting』 → 『2: Step fwd/bwd max. speed』 for detailed description. When this key is pressed together with [SHIFT (FAST)], fast step forward/ backward functions can be activated.

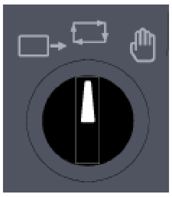
Button	Description
	**[SPEED]** Select the robot movement speed. In the manual mode, the manual jog and the step forward/backward functions exist. The manual jog has 8 different steps ranging from 1 to 8, while the speed of the step forward/backward activity will be increased by 50mm/s when the [CTRL] key is used together. Speed will change to the highest speed (S:8) / lowest speed (S:1) if the [SHIFT(FAST)] key and the  key are pressed together. In the automatic mode, when used together with the [CTRL] key, this key will allow the automatic operation speed rate to be adjusted. For more details, refer to 2.3 Manual Operation and 2.4 Auto Operation.
	**[ESC]** Used to cancel key inputs or various status process. This key has also function to convert the F 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.
	**[R..(NO)]** Used when performing function registered as R-code or when reset function is required. When you press the [ENTER(YES)] key after pressing the [R..(NO)] key, the same RESET function as “R0 : Step counter reset” of R code will be executed. See function of R-code for detailed description. This key can be also used when selecting refuse (No) for response of Permit/Refuse (Yes/No).
	**[ENTER(YES)]** Contents of Input frame is reflected on Edit frame if using this key for completing number input. This key can be also used when selecting permit (Yes) for response of Permit/Refuse (Yes/No). Additionally, this key can be used when modifying command sentence in the Manual mode.When you press this key from the sentence cursor, it will switch to the word cursor, with which the parameter can be edited.
	**[GUN]** This decides whether to record the GUN signal while recording the steps. Function selection status is displayed in the LED on the left side. When you press this button with the [SHIFT (FAST)] key, GUN1 signal will be outputted manually. When this LED is turned on during automatic operation using the arc welding, the robot will actually execute the arc welding. When this LED is turned off, it will not execute arc welding and just check the taught trace.

Button	Description
	**[TOOL / COORD]** You can select the coordinate system (axis, Cartesian, tool) to move the robot when pressing the axis operation key. When you press this with the [SHIFT] button, the message box to select the tool number will open.
	**[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 insert the next step when the cursor is placed at a step This key is used when modifying position of selected step if pressing this key with the [SHIFT] key.
	**[PROG / STEP]** Used when selecting step. This key is selected when selecting program if pressing this key with the [SHIFT] key. When you press the [PROG] key twice, the program list will be displayed. In the step selection window, the functions for directly moving to {PSF(Program/Step/Function for which moving is taking place)}, {PSF for which execution is taking place}, and { PSF saved in the call stack} will supported.
	**[UNIT / MECH]** You can use this button to select the mechanism and unit. For the mechanism, the robot is 0 and for additional axis, it follows the setting set by the user in the initial setting menu. When you press this button with the SHIFT key, you can use this button for the unit. Unit is used when the user wants to configure the program in specific combination of units.
	**[History]** This displays the History message box that records the execution history, error history, message history etc. of task command. When you press this once, it shows the output history of the main board and when you press it again, it shows the output history of the teach pendant.
	**[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. In case of arch application, this button can be used as a short key for the arc application function if pressed together with the [SHIFT(FAST)] key, while it can be also used to enter the '+' and '-' signs or to delete a command sentence or a parameter
	**[Record condition]** This is the key used to edit conditions including speed, accuracy, tool number, step option etc. of the recording step. Editing is done in the record condition window.
	**[Run to]** This selects whether to execute in steps or in functions when moving the steps forward/backward or whether to continuously execute up to the end of the task program. Currently selected condition is displayed on the button as an icon.

Button	Description
	**[JOG inching]** This is the key to use when you want to manually move the robot by the designated amount in inching level. This key will be displayed in green color when the jog inching is selected.
	**[Quick Open]** If this key is pressed while the cursor is placed at a certain command sentence, the Quick Open function related to the command sentence will be executed. 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. 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.
	**[Manual output]** This manually outputs common output, field bus output etc. or manually sets the value to the parameter.
	**[Window adjustment]** This will split the monitoring window, or combine the split windows.
	**[Soft keyboard]** This is used to edit a command sentence or a note. As a touch screen, it can be used just like a keyboard.
	**[User key]** This is used to define and use a user key in the F button bar.
	**[PREV/NEXT]** This is used to move to another page of the menu on the F button bar.

2.3. Manual Operation

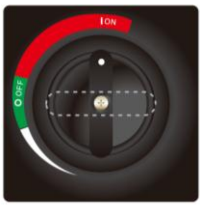
This means behavior to direct work contents to Robot and check the contents. Manual operation also means an operational activity to teach and check the robot at a safe speed.



To perform manual operation, firstly convert the [REMOTE/AUTO/MANUAL] switch of the teach pendant 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.

Reference

Whether the supply power to the motor and the possible operating condition are decided by the [REMOTE/AUTO/MANUAL] switch on the teach pendant and the condition of the safety plug as shown in the following table.
The safety plug is used for general industrial robots. But for the LCD robot, the light curtain will replace the role of the safety plug.

Table 2-2 AUTO/MANUAL switch, safety plug condition

[REMOTE/AUTO/MANUAL] / Safety plug	MANUAL	AUTO
OFF	Motor ON Step forward/backward	Emergency (Motor Off)
ON	Motor ON Step forward/backward	Motor ON Normal speed operation

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) Check whether the title display window of the teach pendant is in MANUAL mode. If it is in AUTO mode, switch the [REMOTE/AUTO/MANUAL] switch on the teach pendant to [MANUAL].

(2) Select the『[F2]: System』 → 『5: Initialize』 → 『1: System format』. When you reset the system, not just the control parameter file and mechanical parameter file, but all programs will be deleted. Therefore, do not use this function except for when you are installing the system for the first time.

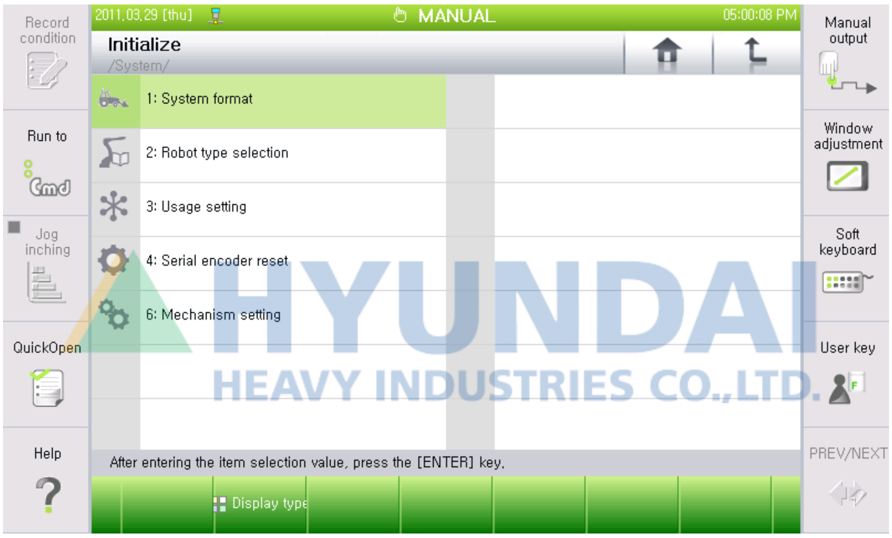


Figure 2.20 Initialization menu screen

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

(4) If you have additional axis, enter the number of additional axes and press the 『[F7]: Complete』 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 『[F2]: System』 → 『3: Robot parameter』 → 『4: Encoder offset』. The Motor On function can be made operable only when the Encoder Offset function is implemented, even when the robot may not in a reference posture

(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. 9999 by pressing the [SHIFT(FAST)]+[PROG/STEP] key of the teach pendant and then record a step. This position is used as standard position of Robot.

Reference

- To reset the system, consult the engineer.

2.3.3. Manual Operation

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

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

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

(3) Select desired program by pressing the [Shift (FAST)]+[PROG/STEP] key. (1-9999)

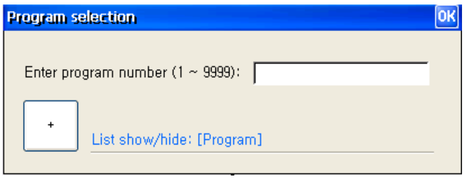


Figure 2.21 Program selection window implemented

▶ Method to confirm program list
1: When the List show / Hide: [Program] is selected, a program list will appear as below.

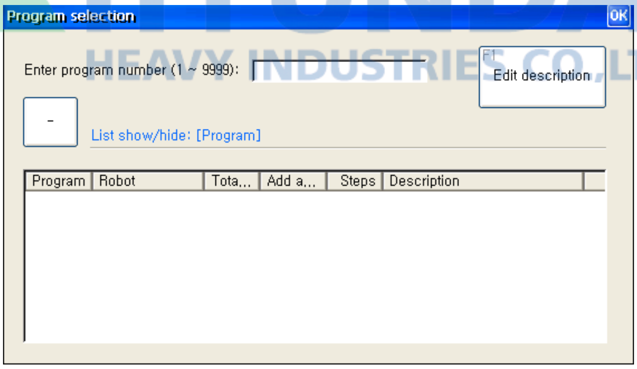


Figure 2.22 Program selection window with a list displayed

2: The program selection window can also be displayed even when the [SHIFT [FAST]] + [PROG/STEP] keys are pressed one more time.
3: All the files will be listed when selecting 『[F1]: Service』 → 『5: File manager』.
4: All the files can be also listed by using R code No. 17.

(4) After you press the [Motor ON] button on the teach pendant, check the on/off condition of the [MOTOR ON] lamp. This operation is the preparation step to supply the servo power to the motor of each axis of the robot.

(5) After you press the [ENABLE] switch on the rear side of the teach pendant, check the on/off condition of the [MOTOR ON] lamp. This operation will operate the MSPR and MSHP relay to release the motor brake and turn the servo on. That is, the robot can move now.

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

(7) Press the [POS.MOD / REC] key at a position to memorize current position of Robot, then, the step will be recorded.

(8) Record the function for the step by using the 『[F6]: Command Input』 key.

(9) 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.

2.3.4. Manual Operation Speed

In the manual mode, the robot can be activated through the manual jog operation and the step forward/backward operation. The individual control methods are as follows. Below the top right side of TP, the currently set speed is shown in the speed window.

The ‘manual speed’ window shown above is to be displayed only in the manual mode, while the ‘playback speed’ window will be displayed in the automatic mode. The number ‘5’ on the left bottom of the speed window indicates the level of jog speed, while the numeric datum ‘250mm/s’ on the right of the speed window signifies the speed limit for the step forward/backward. In this case, the speed limit means the speed within which the speed for the step forward/backward activity is restricted. The sign ‘<’ in front of the numeric datum means the speed is equal or slower. For example, when the recorded step speed is 1000mm/s and the speed limit for the manual mode is 250mm/s, then the step movement speed limit during the step forward/backward activities will be restricted to 250mm/s. If the recorded speed is 100mm/s, which is slower than the manual speed 250mm/s, so, the robot will move at the speed of 100mm/s.

For the jog operation, the [SPEED] key is used to adjust the speed by the unit of one level within the range from Level 1 to Level 8. Even in this operation, the maximum speed for the robot tool and link will be restricted below 250mm/s.

For the step forward/backward activities, the [CTRL] + [SPEED] keys are used to adjust the speed by the unit of 50mm/s within the range from 50mm/s to 250mm/s. The maximum speed for the robot tool and link will be restricted below the set speed.

The speed can be adjusted by manipulating the keys as illustrated above, the adjustment can be made also by applying the touch method. When the manual speed window is touched, the window shown below will appear, allowing the speed to be adjusted conveniently

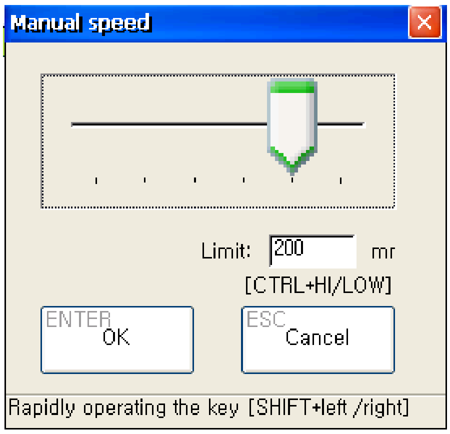


Figure 2.23 Manual speed setting window

If the length and angle values in the tool data are set differently from the actual ones, the tool could run in a very high speed when operated in the manual mode. So, it must be checked before the operation whether the tool data are correctly set.

2.3.5. Step Forward/Backward

The step forward/backward function refers to the playback of the recorded program in the manual mode. This function is used to check, within a safe speed range, the path of the recorded programs and their mutual interlocking relationship.

In the step forward/backward operation, there are totally 3 different modes depending on the unit of execution.

Execution Unit Cmd: Execute the program line by line
Execution Unit Step: Execute the program step by step
Execution Unit End: Execute the program to the end command

When Cmd or Step is set as the execution unit, the robot will reach the recorded step regardless of the set accuracy region. When End is set as the execution unit, the operation will take place along the same path as that of the playback in the automatic mode.

When the step forward/backward activity is to be executed in the Cmd/Step mode, the robot will be activated along the path without cornering as shown in the following picture. More detailed information regarding the cornering is illustrated in 7.3.6 Accuracy.

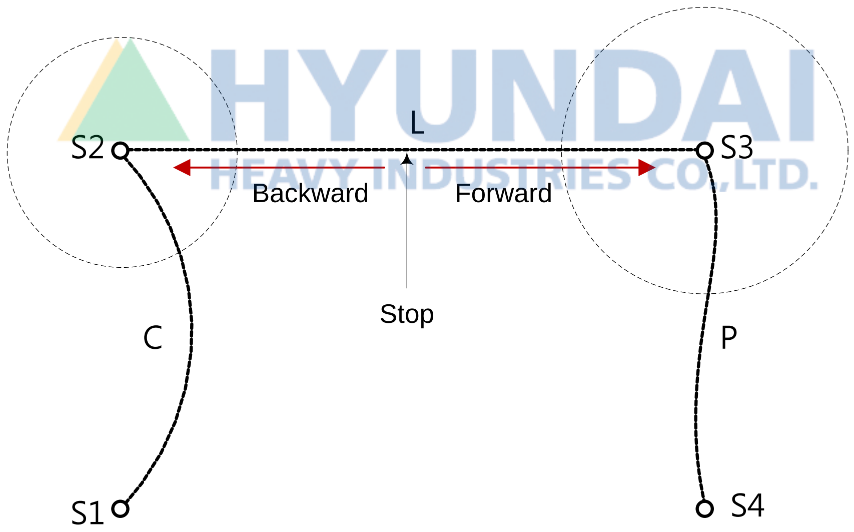


Figure 2.24 Cmd/Step mode playback forward/backward path

When the step forward/backward activity is performed in End mode, the path for the robot will vary depending on the stop position as shown in the following picture. In other words, when the robot tries to move forward after stopping at a location, while not cornering, the path for the cornering will be recovered. However, when moving backward is tried, the movement to the recorded step will be made. Then, the robot will stop at the recorded step, and, right after it, will move back to the previous step. When trying to move forward/backward after the robot stops while cornering, the robot will maintain all the previous paths. However, when the robot moves backwards, it will stop at the cornering starting point automatically, and, then, the relevant step of the TP screen will show ‘a’ (Refer to the TP screen hereinafter).

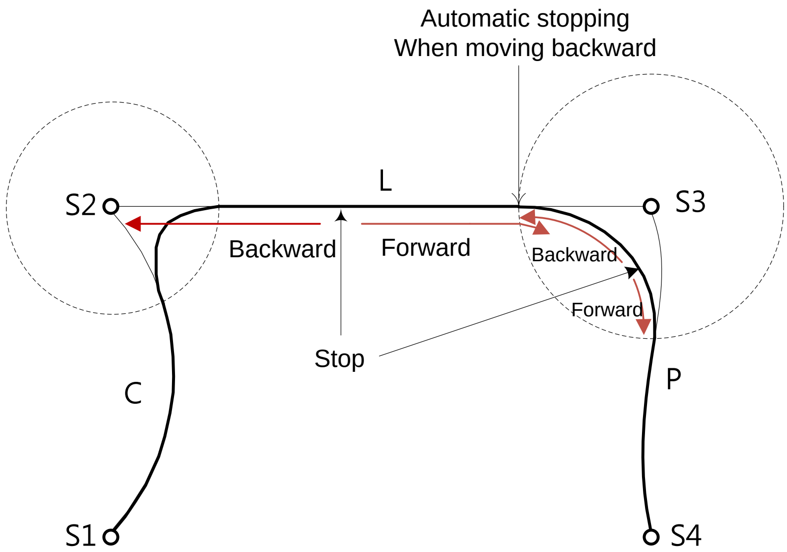


Figure 2.25 End mode playback forward/backward path

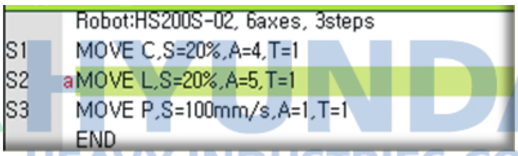


Figure 2.26 The state in which the automatic stopping occurred at the cornering start point after the backward movement during the cornering.

When the robot tries to move forward after stopping at a corner, the robot will run along the original cornering path. In this situation, if the robot tries to move backward, and, while not reaching the previous step completely, tries to move forward again, the original cornering path will not be made in some cases as shown in the picture below. In other words, when the step distance is shortened than the original one, causing the conditions of accuracy not to be fulfilled, the cornering path will be made in a smaller scale than the original cornering path.

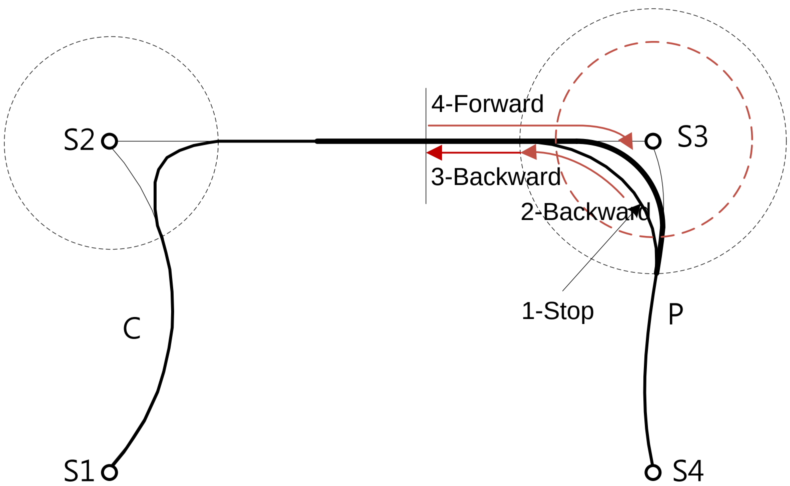


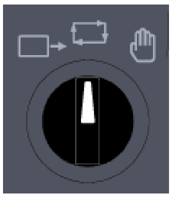
Figure 2.27 Changing of the path of the robot when moving forward after the step backward process.

The "Step fwd/bwd max. speed" and the "Function during step fwd/bwd" can be set in the menu for condition setting menu.
The "Step fwd/bwd max. speed" is the same as the one set for the manual speed.
There are 3 different methods, Off, On and I On, for setting the "Function during step fwd/bwd".

Off : Functions will not be executed during the step forward/backward activity.
Regardless of the external I/O conditions, so only the path of the robot can be checked.
Attention is required as the interlocking with the external systems will not be activated
On : All the functions will be executed.
After the completion of the external interlock is used.
I On : Only the input wait function will be executed.
To be used to check the security associated with the external interlocking.

2.4. Auto Operation

The operation, which will actually makes the robot carry out the work after teaching is done about the contents that the robot is required to execute, is referred to as AUTO operation.

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

2.4.1. Auto Operation

Procedure of AUTO operation is as follow:

(1) Turn the [REMOTE/AUTO/MANUAL] switch of the teach pendant to [AUTO] direction, and check whether the title on the display panel shows auto mode.

(2) Set condition of the desired operation cycle from the 『[F7]: Condition setting』 → 『1: Operation cycle type= < 1 cycle, Continuous>』.

(3) Set operation speed of Robot from the『[F7]: Condition setting』 → 『6: Playback speed ratio』. If set to 100, Robot moves at recorded speed. If set to 50, Robot moves at 50% rate of recorded speed.

(4) Press the [Start] button of the teach pendant and check the on condition of the [Start] lamp and check whether the robot operates according to the direction of the 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 teach pendant and then check that Robot stops. If the power is to be released for long hours, it is recommended to bring the robot to the reference location, before releasing the power, in an effort to prepare for the battery being discharged.

(2) Press the [Emergency Stop] button of operation panel or teach pendant. It becomes motor off status by this operation.

(3) Turn the main power switch in the controller main body to Off direction and release power of the controller. (Encoder data may be extinguished depending on status of battery.) However, when the power is released while an alarm is being generated due to the battery low voltage, the data in the encoder could be destroyed. The data in the encoder could be also destroyed while the power is in the released state depending on the state of the battery.

2.4.3. Auto operation speed ratio

In the automatic operation condition, it is possible to change the automatic operation speed in the Condition Setting menu to adjust the robot operation speed without changing the program.

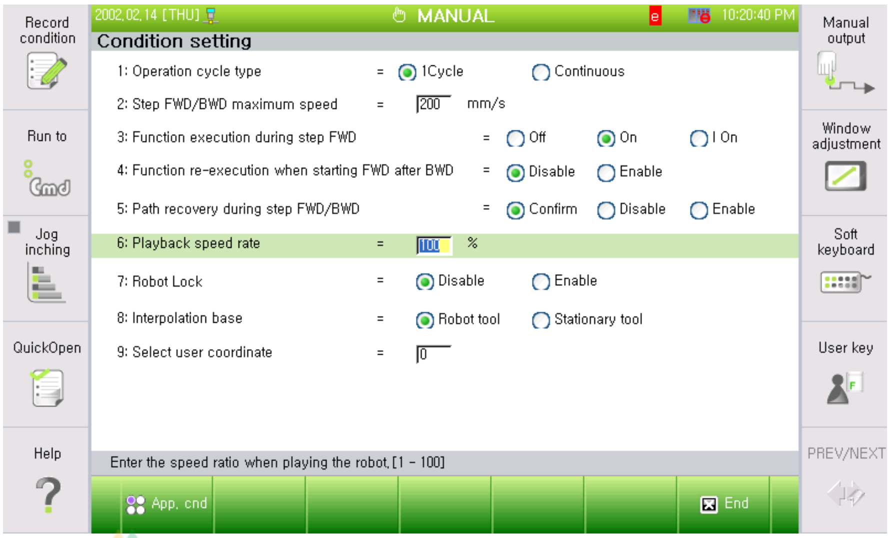


Figure 2.28 Auto operation speed ratio setting screen

In the auto operation mode, the auto operation speed ratio, currently set, is displayed on the top right of the TP as the playback speed as shown below. In the manual mode, this window changes to the manual speed window.

For adjusting the playback speed, the [CTRL] + [SPEED] keys are used to adjust the speed ranging from 1% to 100%, while the speed above 10% is to be adjusted by the unit of 10%. The speed can be adjusted by manipulating the keys as illustrated above, the adjustment can be made also by applying the touch method. When the manual speed window is touched, the window shown below will appear, allowing the speed to be adjusted conveniently

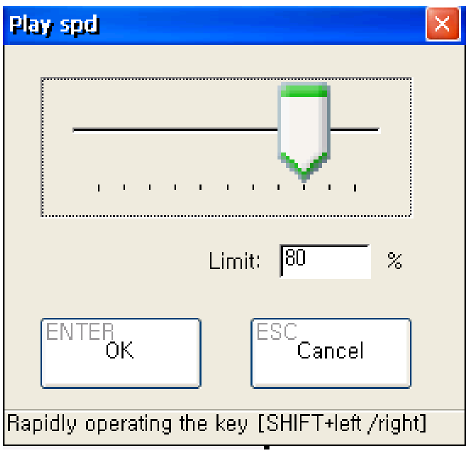


Figure 2.29 Playback speed setting window

2.5. Step

Step is a term to display the robot's specific posture (or position of the tool end) recorded in the work program. 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 basically of Robot programming. In other words, the items such as the position of the robot, the type of interpolation, speed, accuracy and tool number are included in a step.

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, X1, X2, UNTIL I4, V6% '
    (1)  (2)   (3)    (4)  (5)  (6)     (7)     (8)  (9)
```


(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}
Pose variable is not specified, is called the hidden pose.

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

(4) Accuracy : 0 ~ 7

(5) Tool number : 0 ~ 15

(6) Step option: Spot: X1, X2, X3, X4, Palletize: PK, PU, PS

(7) Stop condition

(8) Stop status parameter

(9) Note

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 - PTP (point to point)
  As the interpolation method of using each axis reference, rather than the tool end, for the path interpolation between two steps, generally this method is the fastest interpolation method among the various interpolation methods. Due to the characteristics of the industrial robots that are composed of rotational joints, the path of the tool end is generally in C shape.

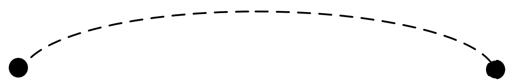


Figure 2.30 Example of tool end path of P-PTP interpolation

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

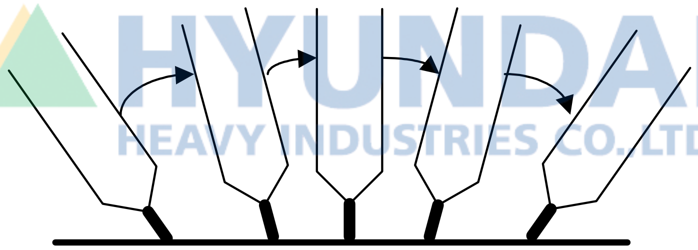


Figure 2.31 Example of L-linear interpolation

Linear interpolation moves while automatically changing wrist posture of the Robot and fails to automatically change wrist posture in specific condition. This condition is called Singular position.

Reference

The following is the Singular position and position calibration cannot be done.

- Where B-axis is located at near the dead zone. See the『[F2]: System』→ 『3: Robot parameter』→『5: B axis dead zone』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] needs to be referred to 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.

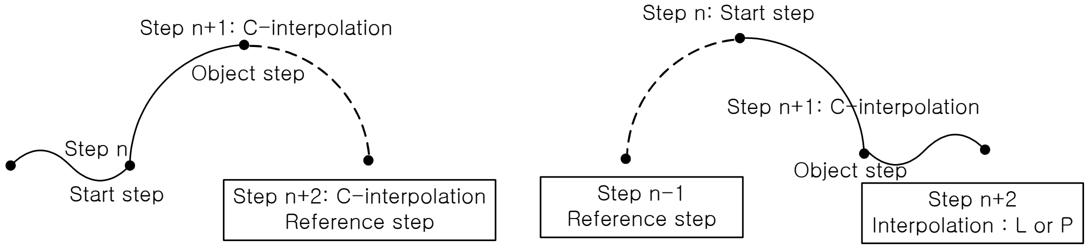


Figure 2.32 C – Example 1 of circular interpolation

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.

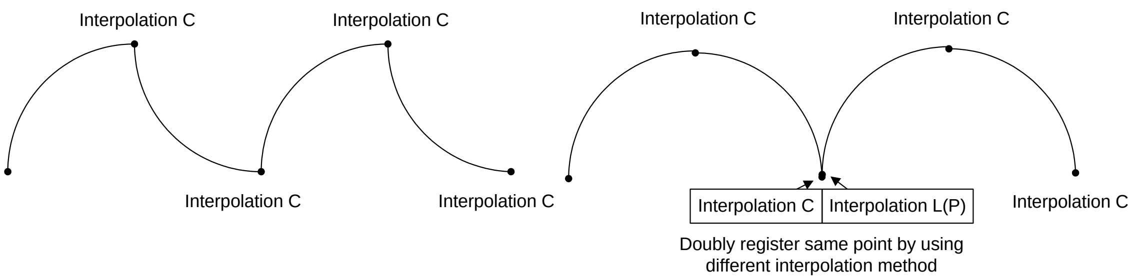


Figure 2.33 C – Example 2 of arc interpolation

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 『7.2.7.2. 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 “『[F6]: Command input』” key. No pose formula appears in case of inputting MOVE sentence by pressing the [POS.MOD / REC] key (Hidden pose). At that time, position and posture of Robot is recorded as possible as the [POS.MOD / REC] key is pressed.

Input Method

- 『[F6]: Command input』 key → 『[F1]: MOVE, I/O』 → 『F1: MOVE』
- [Quick Open] key → Pose number selection → 『[F1]: Current pose』 → 『[F7]: REC』

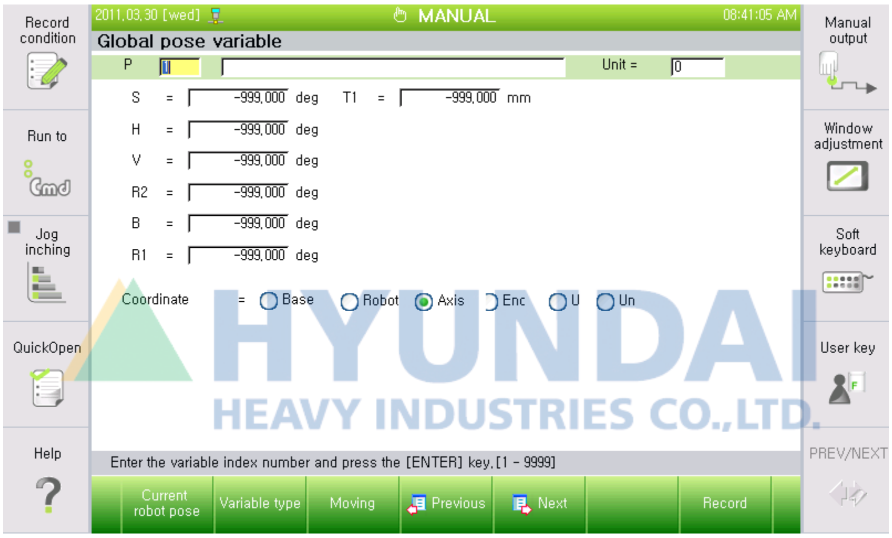


Figure 2.34 Pose data dialogue box

The pose and shift parameters are to be saved in the following format.

(1) Pose : (X, Y, Z, Rx, Ry, Rz, Cfg) {Coordinate system}
{Coordinate system} : ' ' = Base coordinate system
R = Robot coordinate system
U = User coordinate system
A = Axis coordinate
E = Encoder
M = Master tool end coordinate (Cooperation control)

(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
M = Master tool end coordinate (Cooperation control)

2.5.2.3. Speed

The unit of speed is totally 4, which are mm/s, cm/min, sec and %. They can be used for all different interpolation methods.

Mm/s, cm/min: Means the TCP maximum speed. Only when the recorded TCP speed is lower than the maximum speed of the robot, the robot can run at the recorded speed. If the recorded speed is higher than the maximum speed of the robot, the robot will run at its maximum speed. The maximum speed of the robot will be automatically calculated in the controller according to position or acceleration or deceleration parameters

sec: Time taken for the robot to move.
Only when the recorded robot's movement time is longer than the shortest movement time within which the robot can move within a physical boundary, the robot can move in the recorded time. If the recorded time is shorter than the shortest movement time of the robot, the robot will run at its shortest movement time. The shortest movement time of the robot will be automatically calculated in the controller according to position or acceleration or deceleration parameters

%: Ratio for the maximum speed of the robot.
If it is 100%, the robot will move at the fastest speed. Regardless of the unit of the recorded speed, the robot will always run at a speed equal to or lower than the speed at 100%

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 robot moves to the target step. Thus allowed difference called is accuracy.
As shown in the picture below, the path newly created by the accuracy within the accuracy range is the cornering path. Generally, as the accuracy increases, the cornering speed goes up, which is advantageous in terms of the movement time.

Accuracy 0 is most precise and accuracy 7 represents a case where difference is largest.
Accuracy is not applied more than ½ of the length of the shorter trace between both traces of the target step. That is, the following formula will be applied in the example of the following figure.

accuracy ≤ min(P1-P2, P2-P3) / 2

In the above formula, explanation is made using the TCP distance, while the same concept can be applied to the angle.

When it comes to the applied values of the accuracy level, they are defined by the robot's tool end distance and posture angle in case of the robot. When it comes to the additional axis, the values are defined by the length in case of the operating axis and by the angle in case of the rotating axis. These values can be changed directly from [F2]: System』 → 『3: Robot parameter』 → 『6: Accuracy』. Refer to 7.3.6 Accuracy for more details

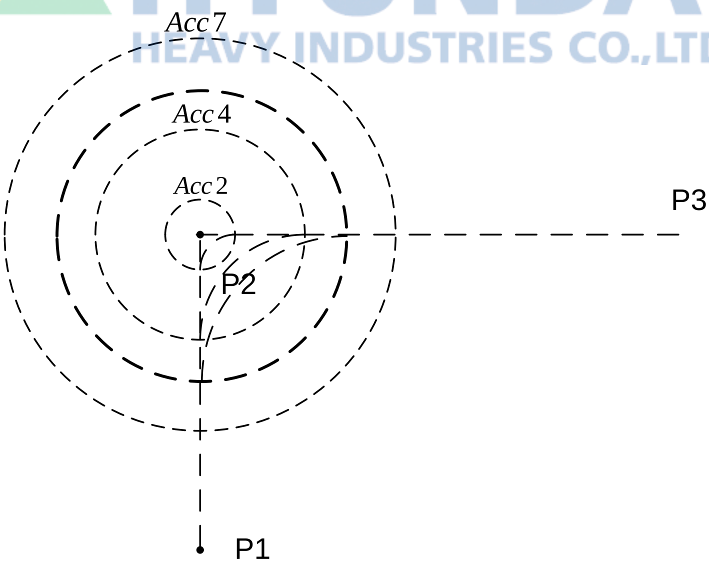


Figure 2.35 Path change depending on accuracy of P2

The following picture shows how the cornering path is created according to the values of the accuracy level. When it is the case of a 6-axis multi-joint robot and there is an auxiliary axis, the accuracy value, I other words, the tool end distance (TCP), the posture angle (ORN) and the auxiliary axis distance (AUX) can be set separately. As the cornering path is required to meet all the values of the relevant accuracy level, the path will be created based on the lowest value among the TCP, ORN and AUX values. The cornering path always meet the convex hull property (Refer to the picture) while being created in a certain curved form regardless of the change of speed. However, an error of a few mm could occur in low speed and high speed due to the servo delay

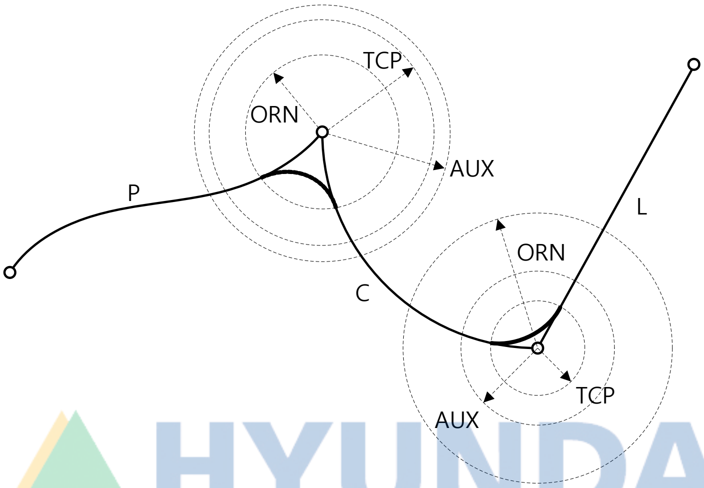


Figure 2.36 Cornering path according to the value of the accuracy level

The method for creating a cornering path according to the accuracy, as explained above, is applicable to all kinds of interpolation. In case of the P interpolation, the TCP distance accuracy is applied, with possible errors.

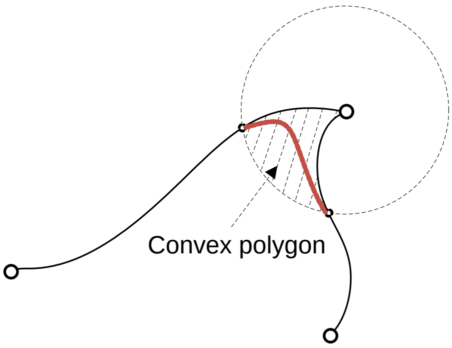


Figure 2.37 Convex hull property : All the points on the cornering path exist within the convex polygon (The part with slant lines)

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. Step Option

Step option As the spot welding output option, this is to select the X1, X2, X3 and X4 signals that are assigned for the small opening and closing of the air pressure gun.
As the palletizing option, this is to decide the shift application method for the PK (Picking), PU (Picking up), and PS (Place Shift) palletizing works

2.5.2.7. Stop Condition

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

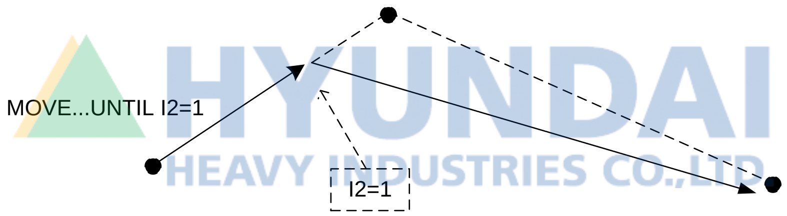


Figure 2.38 Example of stop condition

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.

2.5.2.9. Note

This is used to allow notes to be entered to provide explanation about the step. The note information can be entered conveniently by using the [Soft keyboard] 

2.5.3. Record/Modify of Step Position

Press the [POS.MOD/REC] key to record or change the location and position of the robot for the recorded step.

2.5.3.1. Axis Recording Coordinate

Following screen is displayed if pressing the [Quick Open] key in the MOVE command sentence selected and recorded as 『[F2]: System』 → 『1: User environment』 → 『1: Pose record type =<Axis>』 in the Manual Mode.
For position of Robot recorded as encoder, only position can be identified and you cannot modify position data.

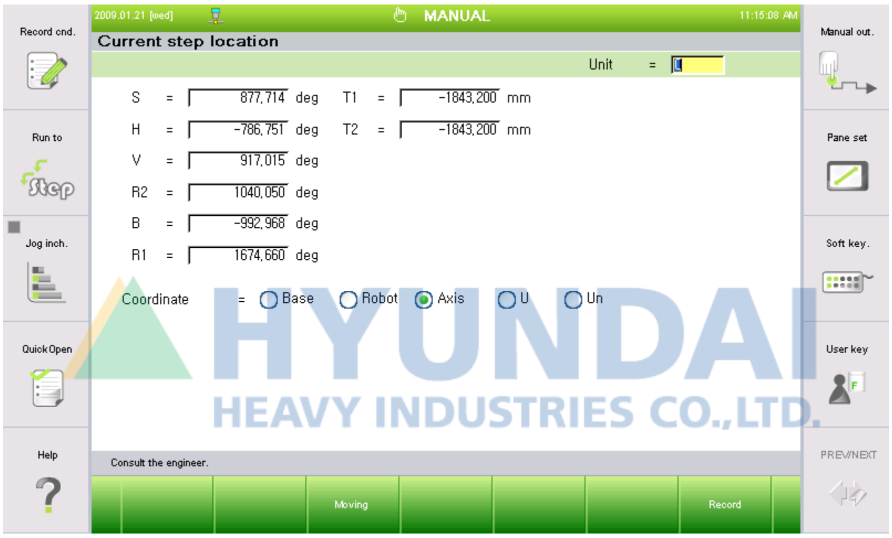


Figure 2.39 Quick Open from MOVE command

2.5.3.2. Base or Robot Recording Coordinate

Location and position of the robot may be different depending on the coordinate. Generally if there is no driving axis, the Base coordinate and the Robot coordinate are the same. But when the driving axis is defined, the location and position of the robot tool will be different for the Base coordinate and Robot coordinate.

You can check by pressing the [Quick Open] key from the recorded MOVE command by selecting 『[F2]: System』 → 『1: User environment』 → 『1: Pose record type =<Base> or <Robot>』 in manual mode.

Reference

- To change the pose record format, consult the engineer.

- Because multiple positions exist for one tool end location/direction due to the mechanical characteristics, you must designate the robot type to define a unique position.
  The robot type will be saved in [Pose parameter].CFG (P1.CFG, LP1.CFG) and each bit assignment of CFG is as the following.

  bit 0 : (0: Designated, 1: Not designated)
  Determines whether or not configuration pattern will be designated for posture that Robot currently poses. (If not designated, this will be automatically decided.)

  bit 1 : (0: Front, 1: Rear)
  If the tool end of the robot is in X axis + direction of the robot coordinate, select the front side, and if in – direction, rear side.

  bit 2 : (0: Up, 1: Down)
  This is the relationship between H axis and V axis.

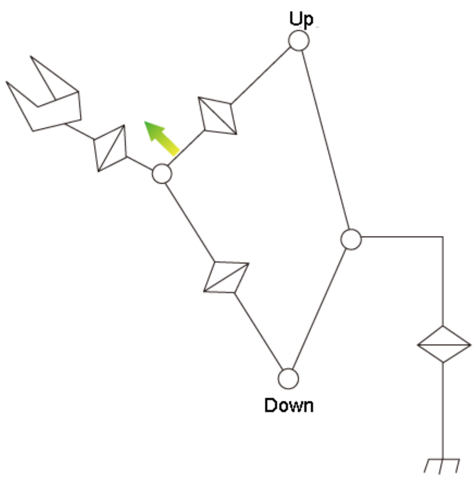


Figure 2.40 Up/Down posture

bit 3 : (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.

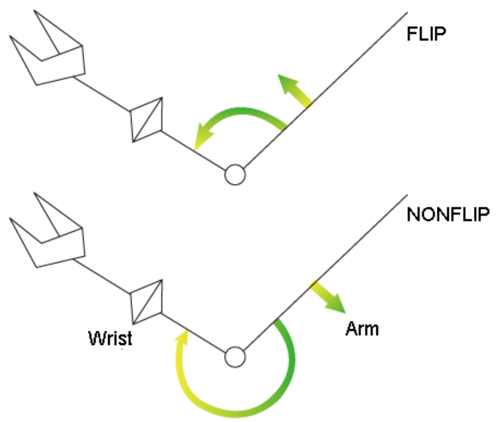


Figure 2.41 Flip/Non-flip posture

bit 4 : (0: |S|<180, 1: |S|>=180)
Select where angle of the S-axis is located at.

bit 5 : (0: |R2|<180, 1: |R2|>=180)
Select where angle of the R2-axis is located at.

bit 6 : (0: |R1|<180, 1:|R1|>=180)
Select where angle of the R1-axis is located at.

bit 7~9 : Represents coordinate system.
(0: Base, 1: Robot, 2: Angle, 3: Encoder, 4: User, 6: Master tool end)

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	
Axis coordinate system	= (S,H,V,R2,B,R1)A	
Encoder	= (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. R Code Key

R code is the unique code assigned to the frequently used function for quick operation.

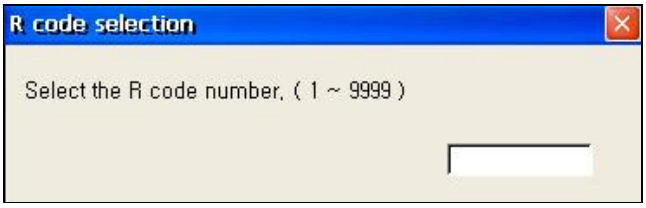


Figure 2.42 R code entering window

Press the [R..[NO]] key and enter the number so that you can use the quick function. You can press the [Help] key to show the list of R codes and select the code to use.

See『Chapter 8, R-code』for detailed description about R-code.

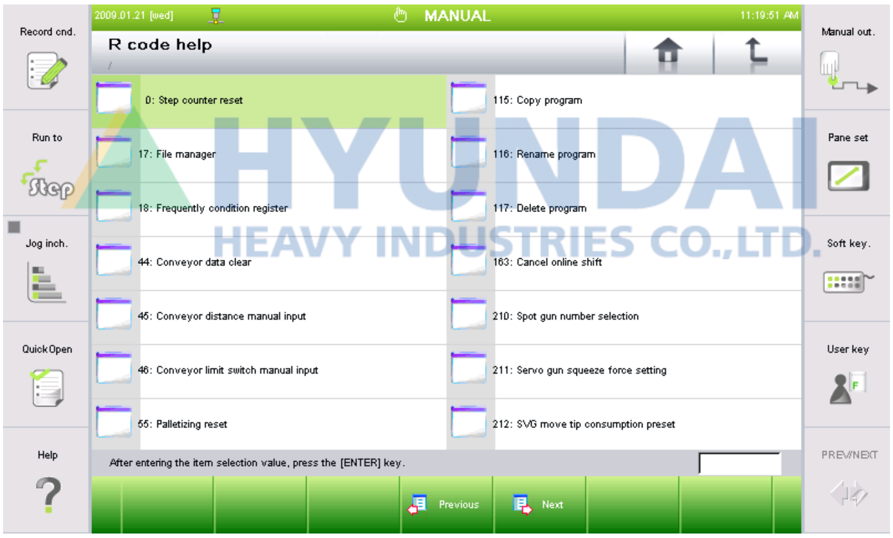


Figure 2.43 Display R code list with [Help] key

2.7. 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 Hi5 controller.

(1) Up to 100 errors recently occurred are recorded in 『[F1]: Service』 → 『7: System diagnosis』 → 『2: Error logging』.

(2) Numbers and messages about errors are displayed when all types of error occur in the Guide frame as below screen :
Items with yellow background refer to the newly generated errors.

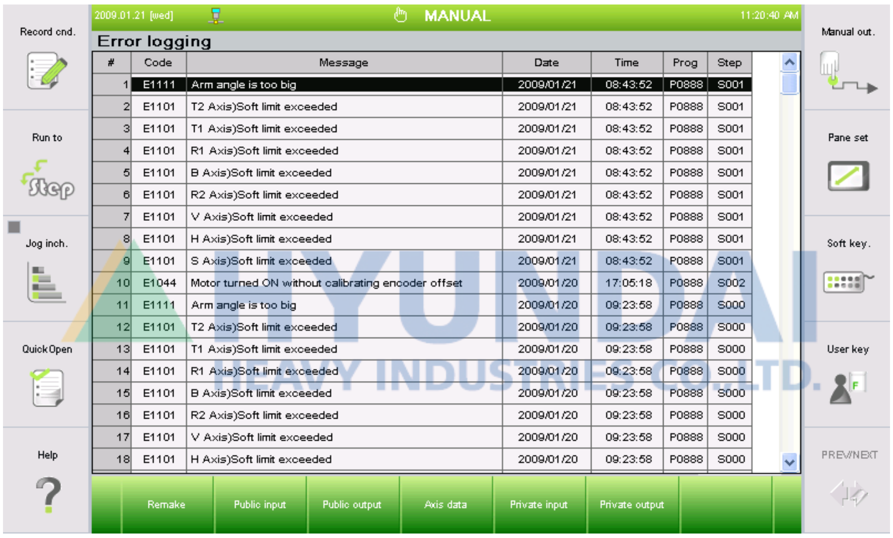


Figure 2.44 Error display screen

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

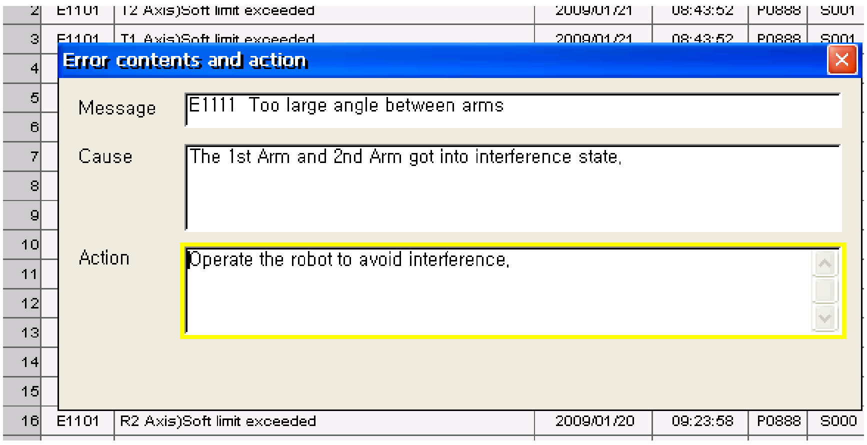


Figure 2.45 Error detail and action

2.8. User Key

The user can use this function to assign specific keys to F1 ~ F7 of the teach pendant to enhance the convenience of the robot teaching.

2.8.1. User key assignment

The user assigns a specific key to F1 ~ F7 of teach pendant. To automatically assign the keys depending on the task usage of spot/arc/palletizing, refer to 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』.

(1) Press the [SHIFT] + [User key] button to enter this function.

(2) Select the F key to assign using the direction key ([<=/=>]).

(3) Select the function to assign using the direction key ([⇑/⇓]).

(4) When you press the [F1: Selection] key or [Enter] key, you can assign the function you selected to the F key.

(5) When you press the [F2: Delete] key or select the “No. 0: Cancel setting” item, you can reset the allocation of the selected F key.

(6) When you press the [F7: Complete] key, the setting will be saved.

Figure 2.46 User key setting screen

2.8.2. User key use

This describes how to use the user key assigned to F1 ~ F7 of the teach pendant.

(1) When you press the [User key] button from the initial screen, the assigned F key menu will be displayed.

(2) Execute the function by pressing the [F?] or [SHIFT] + [F?] key depending on the assigned F key.

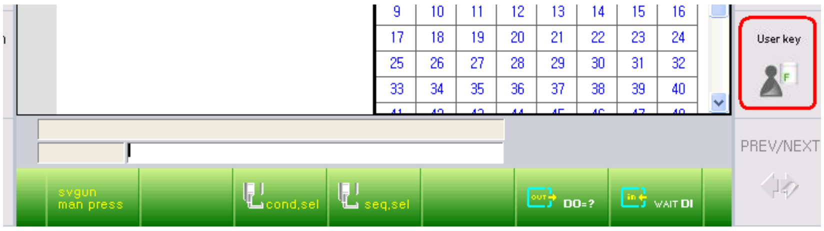


Figure 2.47 User key screen

Reference

- For functionality of key related to spot welding for the user key, refer to 『Hi5 spot welding function manual』.
- For functionality of key related to arc welding for the user key, refer to 『Hi5 controller arc welding function manual』.

2.9. History

This displays the History message box that records the execution history, error history, message history etc. of task command. When you press this once, it shows the output history of the main board and when you press it again, it shows the output history of the teach pendant. (Toggle operation)
The function of the history screen can be conveniently used to understand the flow of the program or analyze the causes for problems that could occur during the operation of the robot.

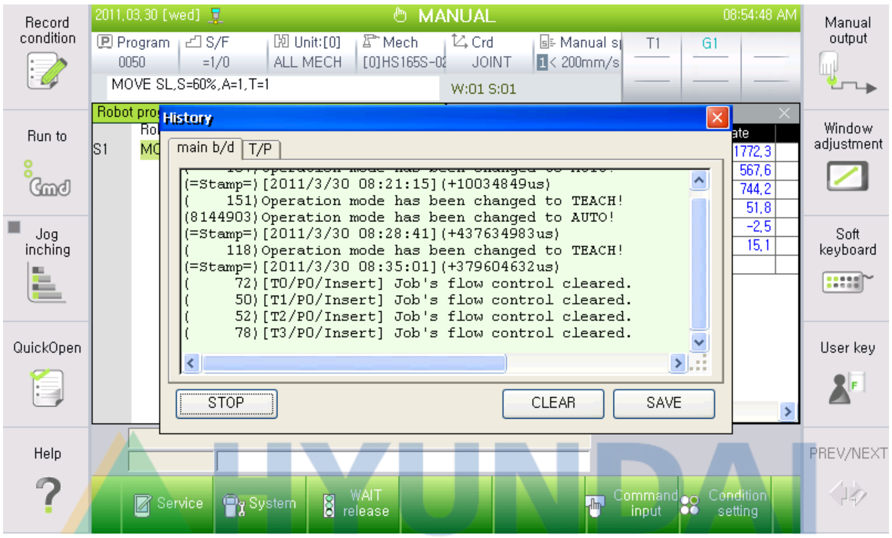


Figure 2.48 History

The [STOP] function is used to check the content of the screen by stopping the updating of the screen while the screen keeps changing as the work program is being executed.
The [CLEAR] function is used to clear out the overall screen and create a new one.
The [SAVE] function is used to save the history of the previous screen in files. 10 files, ranging from History0.txt to history9.txt, can be created.
When it is required to analyze the causes for the problems that could occur during the operation of the robot, the history of the previous screen can be saved in files, which would make it possible to check the flow of the problematic program always.

When it comes to this screen, about 2000 lines are saved in the Hi5 main board's RAM. Of the data, about 250 lines are saved in the backup region.
Thus saved file can be loaded in your PC when implementing backup by selecting HISTORY.TXT

2.10. Coordinate System

A coordinate in space is required to determine direction that Robot moves on space. At this time, the coordinate system defined for the robot to move is called the coordinate system, and Hi5 controller supports axis coordinate system, robot coordinate system, user coordinate system and tool coordinate system.

2.10.1. 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 teach pendant.
You can understand the robot's operation pattern in every coordinate system based on following table.

Table 2-3 Operation pattern of Robot in every coordinate system

Operation / Operation Key	[Coordinate system]			
	Axis-Coord	**Robot (Robot-Coord)**	**Robot (User-Coord)**	**Tool-Coord**
X-	S [-]	Xr (-)	Xu (-)	Xt (-)
X+	S [+]	Xr (+)	Xu (+)	Xt (+)
Y-	H [-]	Yr (-)	Yu (-)	Yt (-)
Y+	H [+]	Yr (+)	Yu (+)	Yt (+)
Z-	V [-]	Zr (-)	Zu (-)	Zt (-)
Z+	V [+]	Zr (+)	Zu (+)	Zt (+)
Rx-	R2 [-]	Rxr (-)	Rxu (-)	Rxt (-)
Rx+	R2 [+]	Rxr (+)	Rxu (+)	Rxt (+)
Ry-	B [-]	Ryr (-)	Ryu (-)	Ryt (-)
Ry+	B [+]	Ryr (+)	Ryu (+)	Ryt (+)
Rz-	R1 [-]	Rzr (-)	Rzu (-)	Rzt (-)
Rz+	R1 [+]	Rzr (+)	Rzu (+)	Rzt (+)

2.10.2. Axis Coordinate System

Press the [ENABLE] switch of the teach pendant when the motor is turned ON in MANUAL mode.

Press the coordinate system key of the teach pendant so that the coordinate of the status bar shows the axis. When you press the axis operation key, the robot will operate as follows.
When you operate the robot in the axis coordinate, each axis of the robot will move independently.
For proceeding direction of the robot by the axis operation key, refer to the 2. 10. 1 JOG operation key.

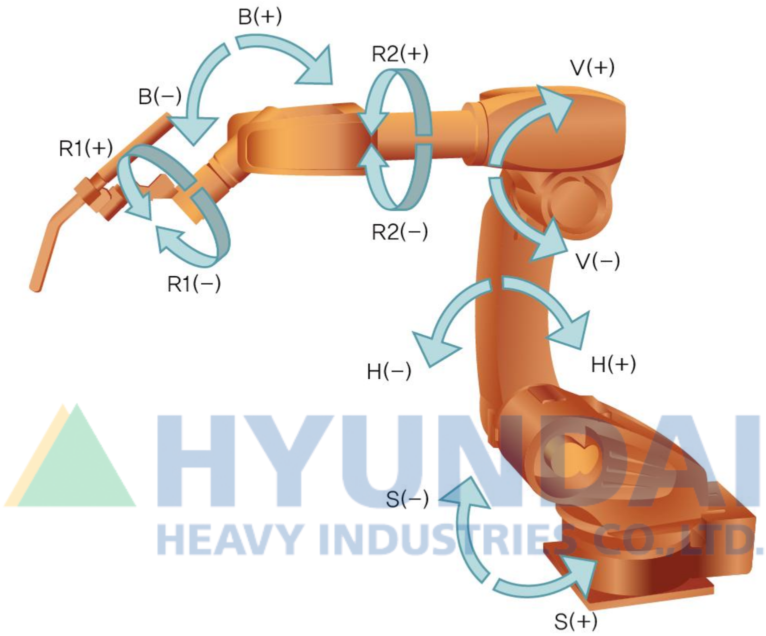


Figure 2.49 Axis Coordinate System

2.10.3. Robot coordinate system

Press the [ENABLE] switch of the teach pendant when the motor is turned ON in MANUAL mode.

Press the coordinate system key of the teach pendant so that the coordinate of the status bar shows the axis. When you press the axis operation key, the robot will operate as follows.
For proceeding direction of the robot by the axis operation key, refer to the 2.10.1 JOG operation key.

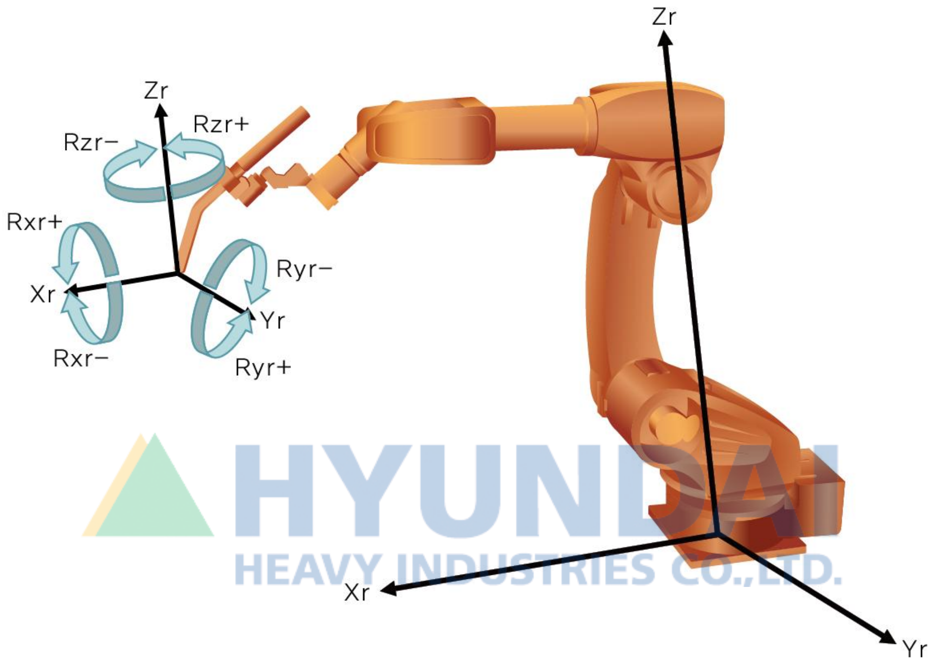


Figure 2.50 Robot coordinate system

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.

- When it comes to the rotational direction, the direction in which you can hold your fingers of right hand while placing the thumb in the axial direction of the rotation is the '+' direction of the rotating direction

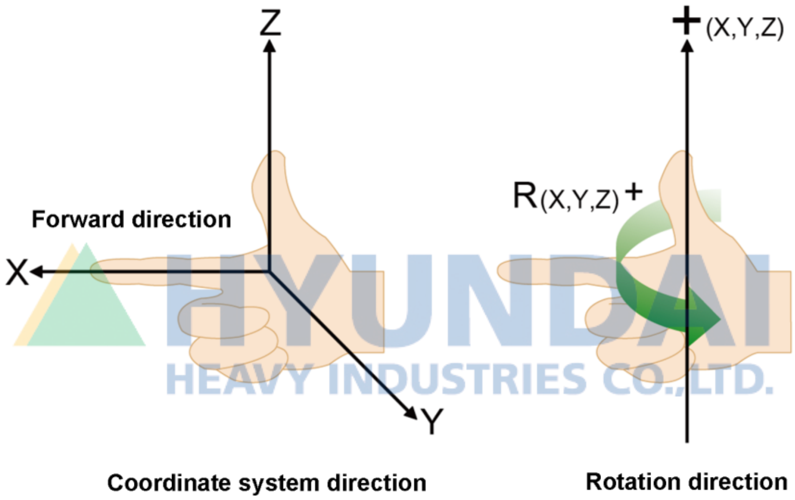


Figure 2.51 Direction and rotation direction of coordinate system

2.10.4. User Coordinate System

Register the user coordinate system by selecting the『[F2]: System』→『2: Control parameter』→『7: Coordinate registration』 →『1: User coordinate』. Robot operates as following figure if reproducing program after selecting the 『[F7]: Condition setting』→『9: Select user coordinate』.

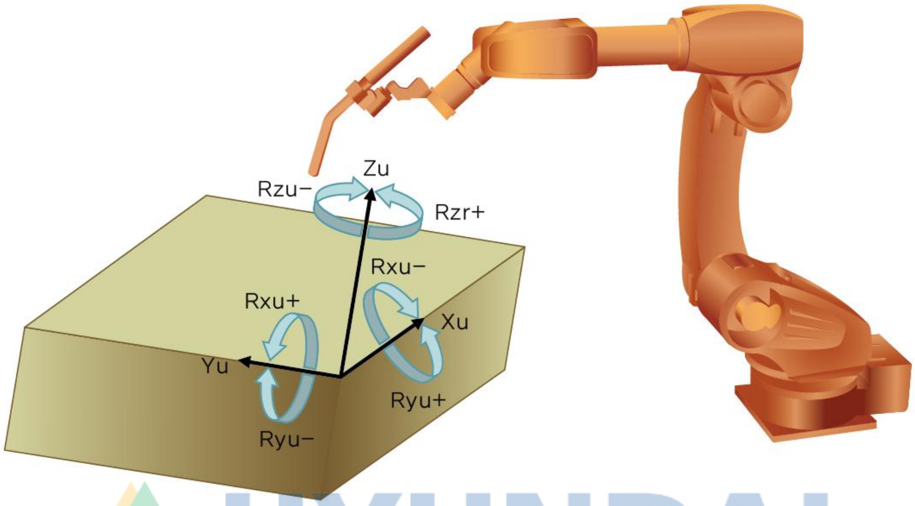


Figure 2.52 User coordinate system

2.10.5. Tool Coordinate System

Press the [ENABLE] switch of the teach pendant when the motor is turned ON in MANUAL mode.

Press the coordinate system key of the teach pendant so that the coordinate of the status bar shows the axis. When you press the axis operation key, the robot will operate as follows.

For proceeding direction of the robot by the axis operation key, refer to the 2.10.1 JOG operation key.

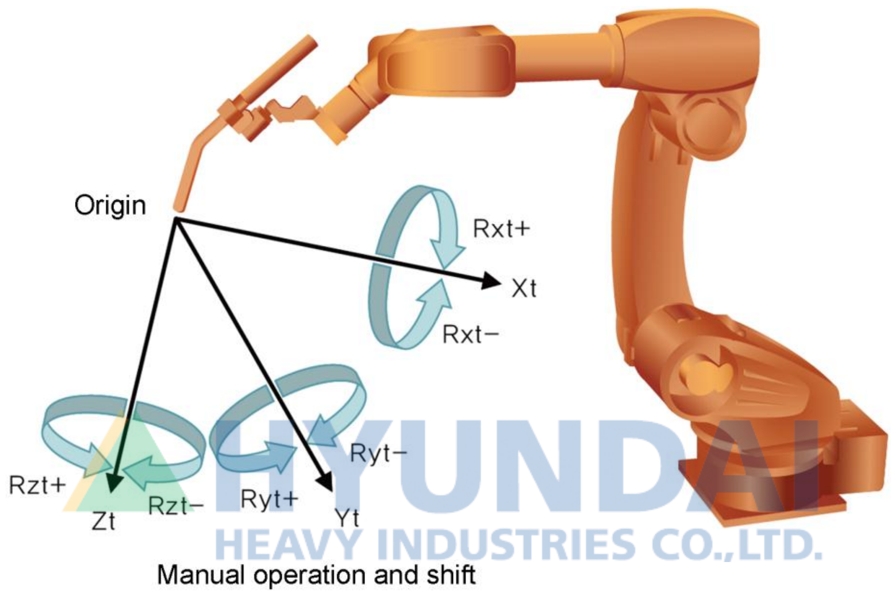


Figure 2.53 Tool coordinate system (for torch adhesion)

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

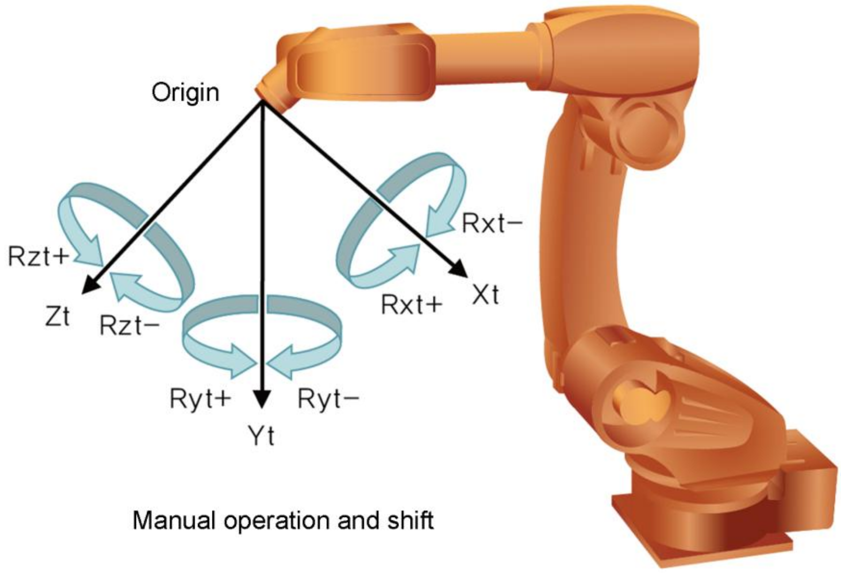


Figure 2.54 Tool coordinate system (without tool)

2.11. Axis constant and tool length optimization setting

This is the function to improve the accuracy of the linear interpolation trace and coordinate conversion by automatically setting the axis number and tool length. This is the principle of calculating the linear interpolation number calibrated from each step data of the recorded program for the same point in various positions.
With this function, you can automatically set the hard to measure distances to the tool end in 3D. The linear interpolation number calibrated is the axis number for H, V, R2 and B axis and tool length in X, Y and Z direction.
The 'axis constant and tool length' optimization and the 'tool length' optimization can be performed. Paying attention is required because the position of the existing program changes when the 'axis constant and tool length' optimization is performed if the robot program is already made.

(1) Shift the [Mode] switch to a manual mode.

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

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

(4) Presses the [ENABLE] switch in the rear of teach pendant and then check Robot manually operates by the [axis operation] key.

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

(6) Record step by pressing the [REC] key of teach pendant.

(7) Change the robot's posture (Overall posture of the axis 6, if possible) in a wide scope by more than 30deg, then repeat and perform No. (5), (6) by more than 4 times.

(8) Select 『[F2]: System』 → 『6: Automatic constant setting』 → 『1: Optimize axis constant and tool length』.

(9) If pressing the 『[F1]: Execute』 key after setting allowance scope of program number, tool number and step prepared for AUTO integer setting.

(10) When you are setting the tool number from the second one to use multiple number of tools, select and execute "Tool" from "Optimization selection = Constant & Tool, Tool" from the screen. When the axis constant and the tool length are selected, the previously set tool information will not be matching.

Reference

- See the 『[F2]: System』 → 『6: Automatic constant setting』 → 『1: Optimize axis constant and tool length』.

2.12. Tool integer automatic calibration

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. In order to use this function, teaching of one fixed standard point should be performed when the tool integer is determined. If tool deformity occurs, positioning in the same posture at the standard point, designated before the deformity, should take place, before the tool integer automatic calibration is executed.

Following figure is displayed if accessing the 『[F1]: Auto comp』menu in the 『[F2]: System』 → 『3: Robot parameter』 → 『1: Tool data』 setting screen. Moves to the changed tool end to the position by using the [Axis operation] key. Set 『[F7]: Complete』 after confirming the program number, step number and tool number to be set, all of which are associated with the previously determined standard point.

Reference

- See the『[F2]: System』 → 『3: Robot parameter』 → 『1: Tool data』.

3
Program preparation

3.1. Program Selection

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

Figure 3.1 Program number entering window

(2) If you cannot remember the program number in the above condition, select the List show/hide : [Program] or press the 『[SHIFT] + [PROG]』key one more time, and the following screen will be displayed.

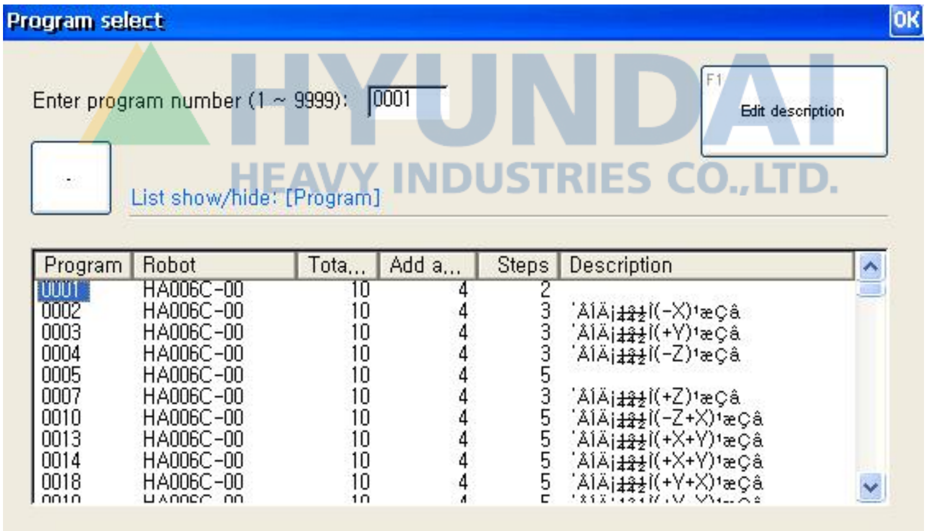


Figure 3.2 Program list show

You can check the detail content of the program already prepared from the above picture and make selections with the cursor. You can also edit the description of the program by pressing the [F1] key.

3.2. Program Deletion

There are two methods to delete the program. This can only be done after the robot is stopped.

(1) Move the cursor to the applicable file location through 『[F1]: Service』 → 『5: File manager』, and press 『[F4]: Cut』 as shown in the following picture.

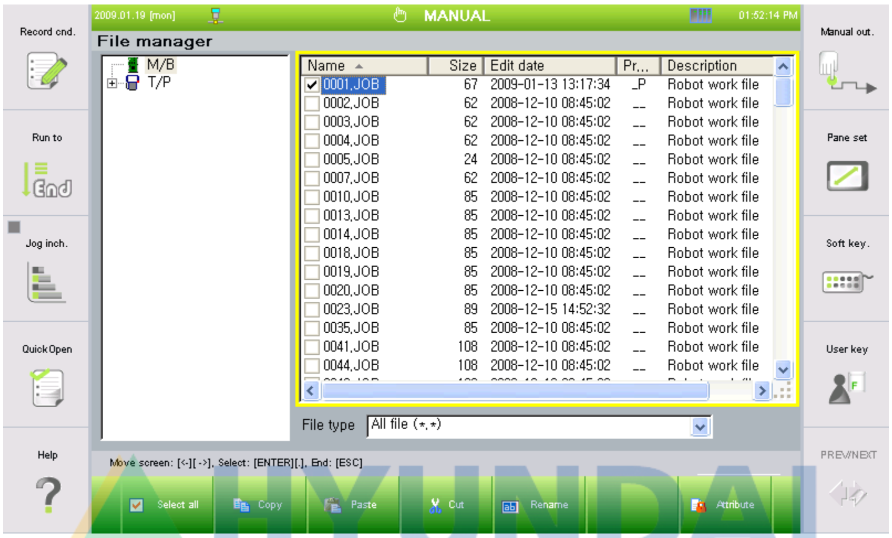


Figure 3.3 File manager

(2) A work program can be also deleted using the R117 shorthand command of 『Chapter 8. R code.

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.
Program preparation can be executed in the manual mode.

3.3.1. What is 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.

(Basic Parameter) **(Selective Parameter)**
MOVE L, P1, S=100%, A=0, T=0, X1, X2, UNTIL I4, V6% ‘

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. Record condition

(1) What is record condition?

This is the function to record the MOVE command in same format by pre-designating the format of MOVE command that is recorded when the [REC] key is pressed, and you can designate the interpolation type, moving speed and speed unit, ACC and tool number.

(2) Edit record condition

When you press the [Record condition] key, you can edit the following record condition as shown in the following picture.

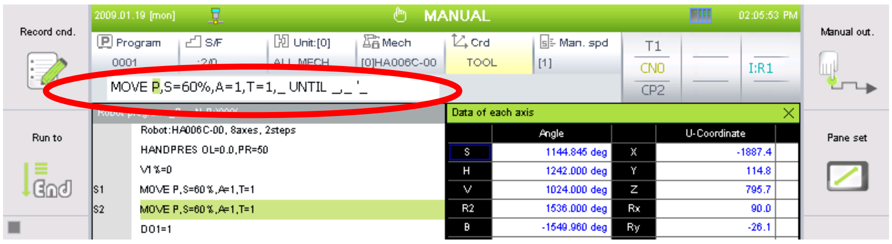


Figure 3.4 Record condition editing

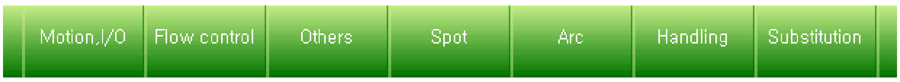
3.3.3. Command Entry

(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.
Differently from the way that the Move command is used as a method for using a command generally, the pose parameter is not shown in the step, which is why it is called hidden pose.

(2) General command entry

- To enter the command, press the [F6: Command input] key from the initial screen in manual mode. If you press this key, you will see the following screen.



- Use the [F] 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.

3.3.4. 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.

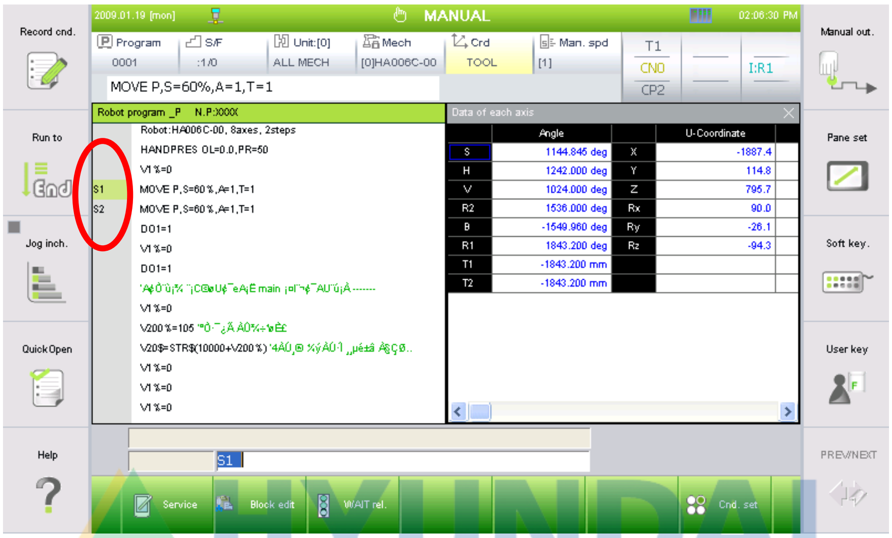


Figure 3.5 Address area

(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.

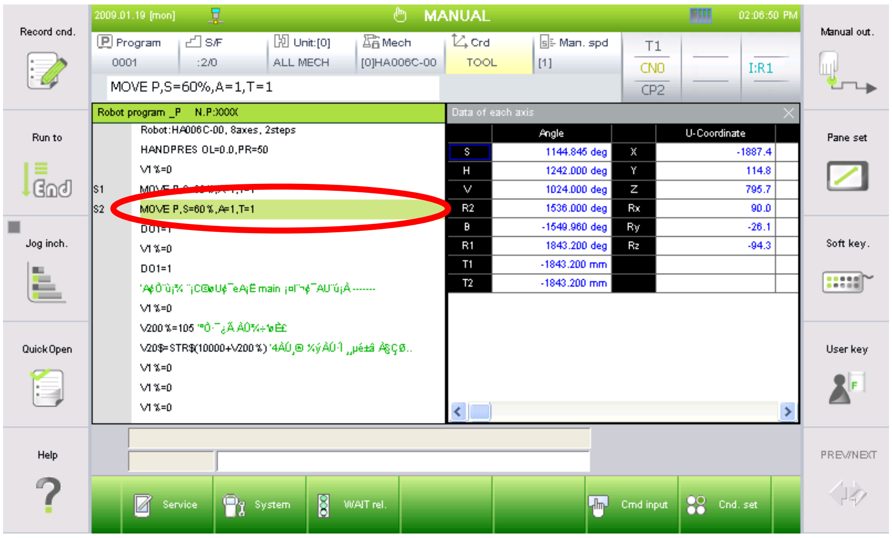


Figure 3.6 Command area

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

3.3.5. 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 [Direction] keys to move the cursor to the property you want to edit. To switch from sentence cursor to word cursor, press the [ENTER] key.

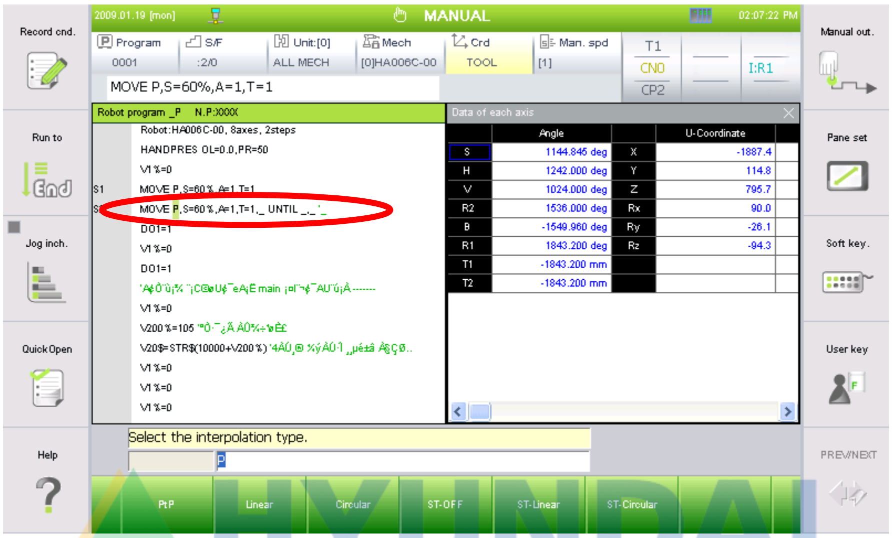


Figure 3.7 Command edit

Press the [ENTER] 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 [ENTER] 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.

3.3.6. Summary of Operation Key

Table 3-1 Summary of operation key

Operation key	Address area	Command area	
		Sentence cursor	Word cursor
[SHIFT]+ [POS. MOD]	Current step position edit (Hidden pose correction)	Same as address area	-
[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
[REC]	Hidden pose move Add command	Same as address area	-
[SHIFT]+[DEL]	-	Delete selected command	-
[ENTER]	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	Same as address area	Same as address area
[F2] in initial screen	Shows [Block edit] and enables block editing	Shows [System] and enables various system parameter settings	Varies by command and property
[Direction][⇑][⇓]	Moves the cursor up and down	Same as address area	Same as address area
[Direction][⇐]	Moves the cursor to command area	Moves the cursor to address area	Moves the word cursor to the left property
[Direction][⇒]	Moves the cursor to command area	Moves the cursor to address area	Moves the word cursor to the right property
[SHIFT]+[⇑][⇓]	Page Up/Down	Same as address area	-
[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
[←]	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

Operation key	Address area	Command area	
		Sentence cursor	Word cursor
[SHIFT]+[PROG]	Receives the program number and loads the applicable program	Same as address area	Same as address area
[STEP]	Receives the step number, moves to the directed step	Same as address area	Same as address area
[?] HELP	Shows help screen of each command	Same as address area	Same as address area
[QuickOpen]	Shows you content or condition screen of each status	Same as address area	-

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 『[F6]: Variable』 key and move to parameter entry condition.

(3) Select V parameter by pressing 『[F1]: V』 key.

(4) Select the parameter type by pressing 『[F3]: 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 『[F6]: Variable.』 → 『[F1]: V』 → 『[F1]: V%』 key and select the parameter with script again.

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

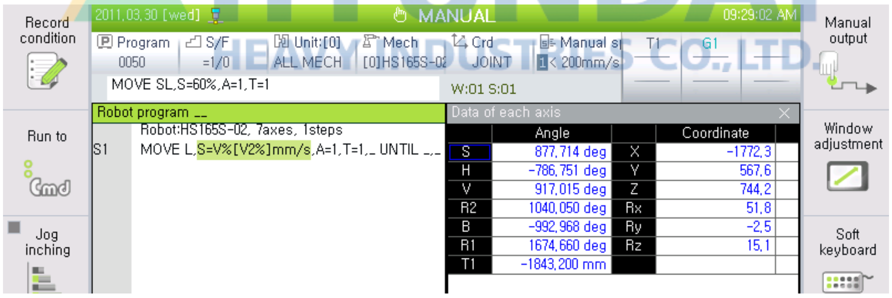


Figure 3.8 Parameter edit

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

3.4.2. Formula and Character Edit

(1) We will use speed entry screen as an example. Assuming that the current speed is “V%[V2%]mm/sec”, to edit the speed using the Formula.

(2) Press the [Soft keyboard] on the right side of TP to activate the soft keyboard.

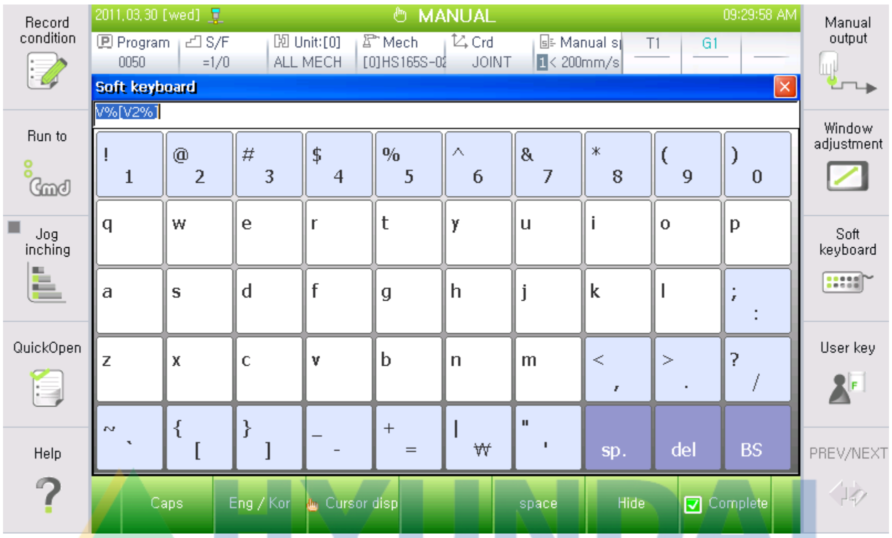


Figure 3.9 Soft keyboard

(3) The reason the current value is highlighted in the input frame is because it is in a condition to ignore the existing data and enter new data. If you want to add value after the current input value, press the direction key to change the cursor location.

(4) When you enter 1000 and select “/” with the arrow key or touch and enter 2, and then press the 『[F7]: Complete』, the following screen will be displayed.

(5) Press the [ENTER] key to reflect the content in input frame to the edit frame.

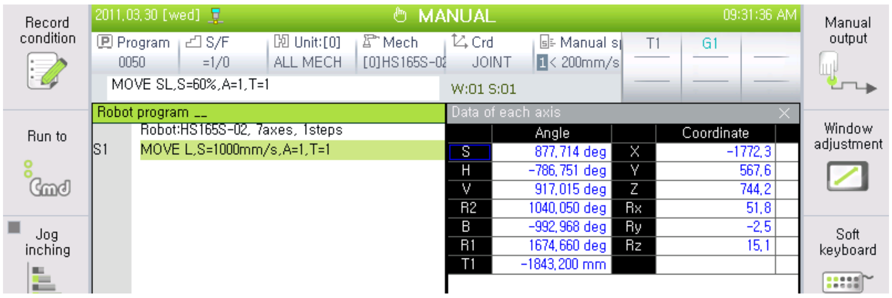


Figure 3.10 Reflected into the editing

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

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 [ENTER] key when done.

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

Figure 3.11 Line number edit 1

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

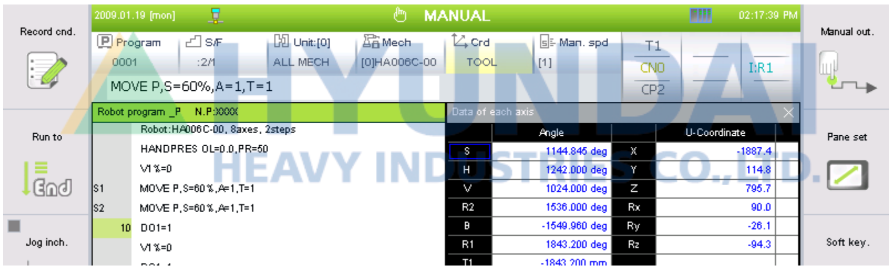


Figure 3.12 Line number edit 2

(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.

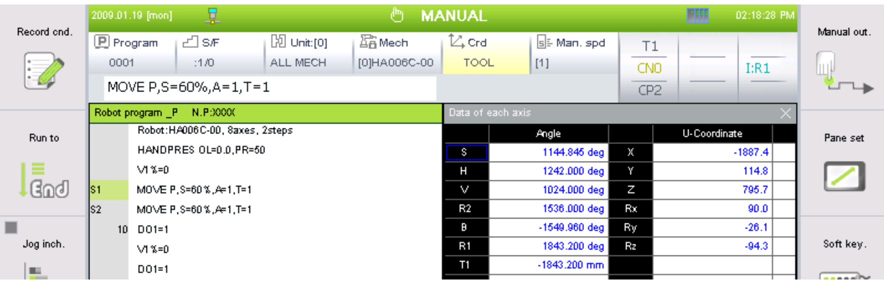


Figure 3.13 Block edit 1

(1) To copy/cut/delete in line units, move the cursor to the address area press the 『[F2]: block edit』 key. This will highlight all address and command area. Use the [Direction] key to move the cursor to the starting line of the block selection.

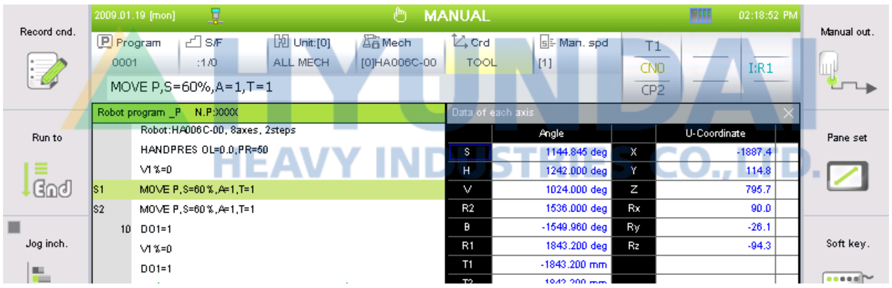


Figure 3.14 Block edit 2

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

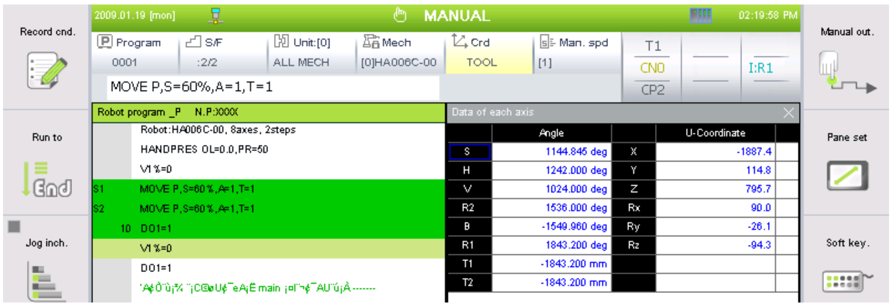


Figure 3.15 Block edit 3

(3) Move to the selected area and press the 『[F2]: Copy』 key to save the selected block to the clipboard and then the following 『[F3]: Paste』 menu will be displayed. Use the [Arrow] key to move the cursor to the previous row (S3 row) before the row to copy, and press 『[F3]: Paste』 to copy the saved block from the clipboard as follows.

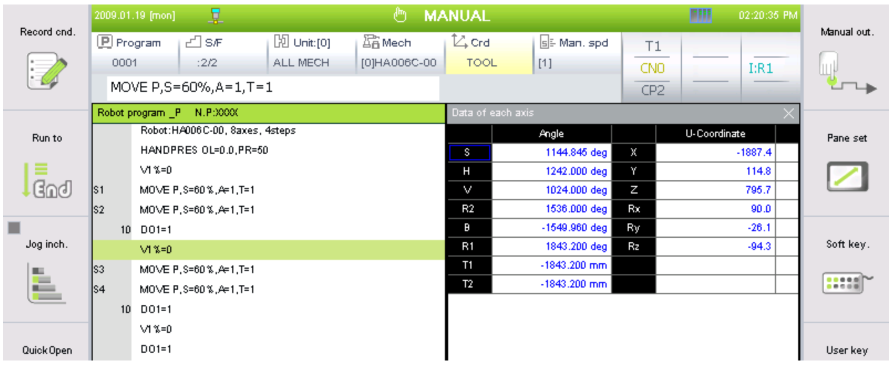


Figure 3.16 Block edit 4

4

Service

4.1. Initial Screen

When 『[F1]: Service』 key is pressed on the initial screen of either manual or auto mode, the following screen appears.

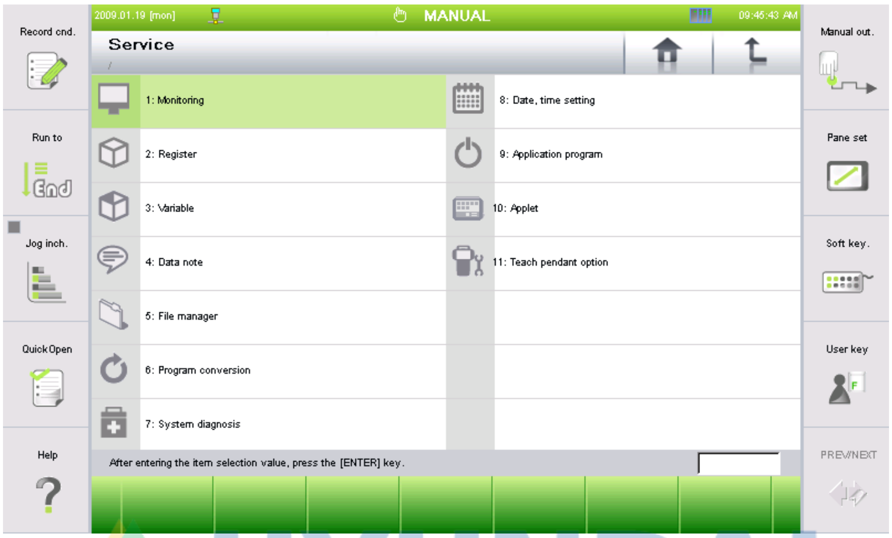


Figure 4.1 Service initial screen

Reference

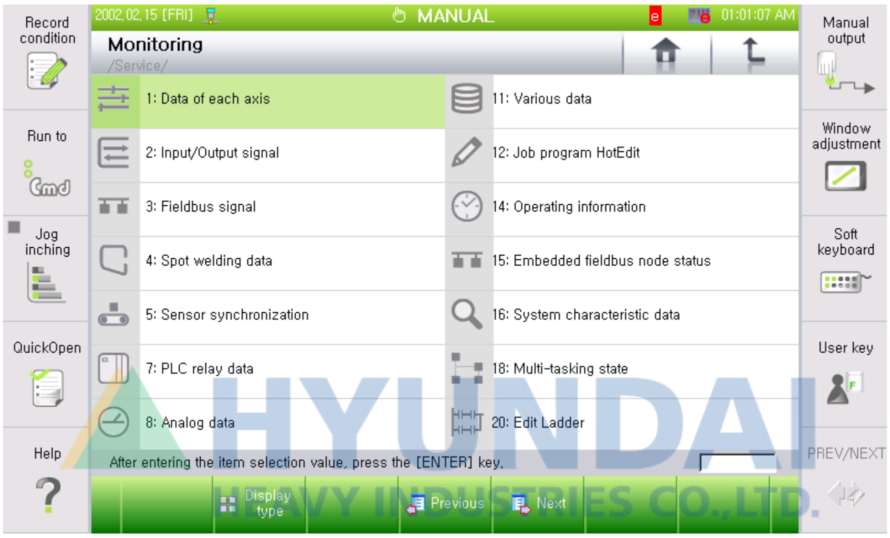
- Selection sub menu
  To selection sub menu, move the solarized bar to the chosen item by using [Direction] and press [ENTER]. Or, type the number of the chosen item in the input frame by using [Number] and press [ENTER].

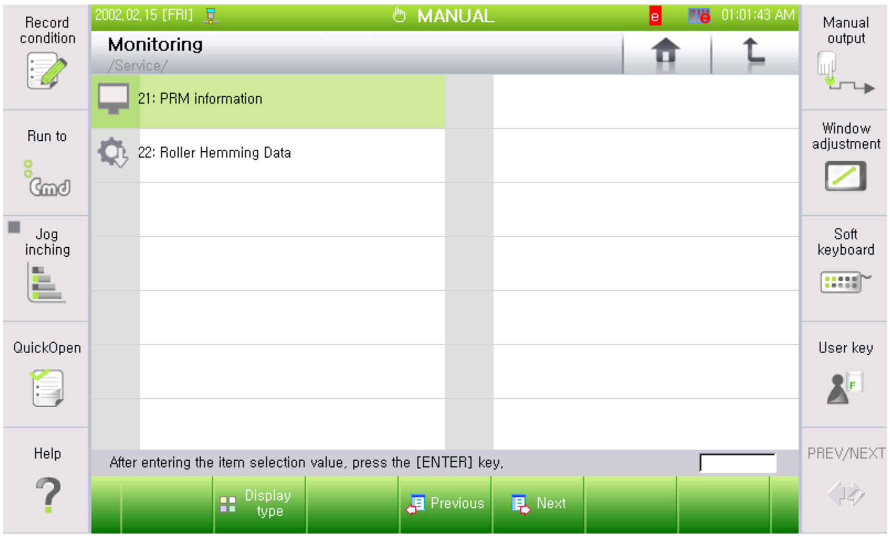
4.2. Monitoring

This function displays the condition of various data inside the controller.

Move from 『[F1]: Service』 to 『1: Monitoring』 on the initial screen and selection sub menu as shown below.

Menus that displayed on the screen may be different (from the following example) according to the controller's current setting





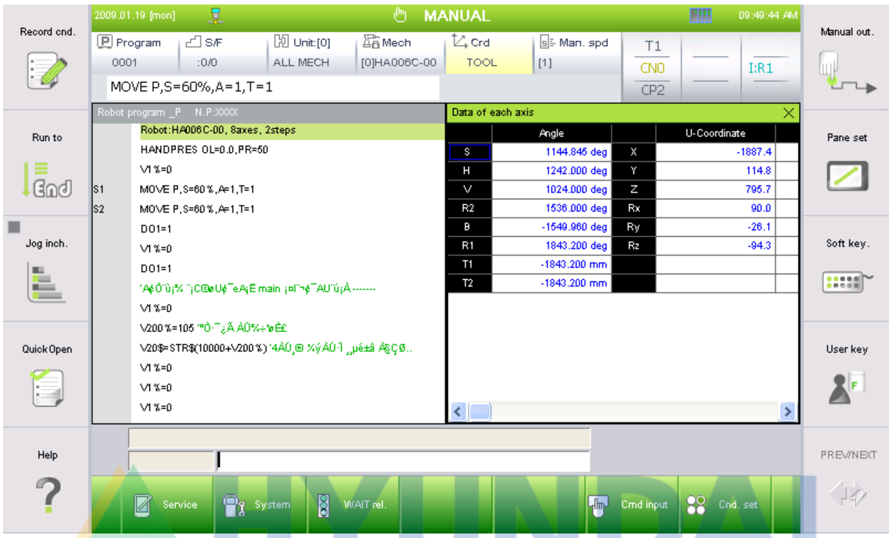
Reference

- For more details, refer to "2.2.2.3 Window control function" section of the Hi5 operations manual for window (TP screen) split function.

4.2.1. Data of each axis

This displays the current angle, coordinate, current value (encoder) and instruction value (encoder) of each axis of the robot.

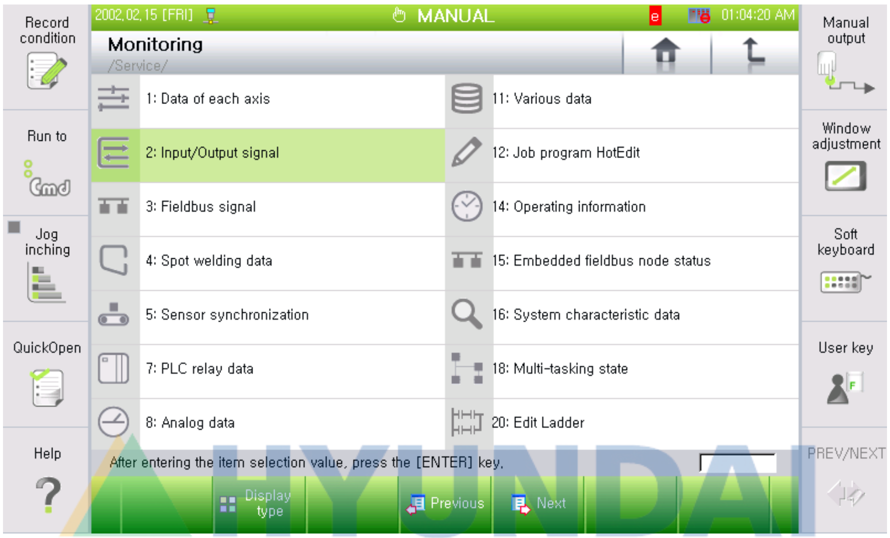
Selection 『[F1]: Service』 → 『1: Monitoring』 → 『1: Data of each axis』.



4.2.2. Input/Output Signal

I/O signal indicates the ON/OFF state in exclusive and general purpose I/O signals, as well as the names of those signals.

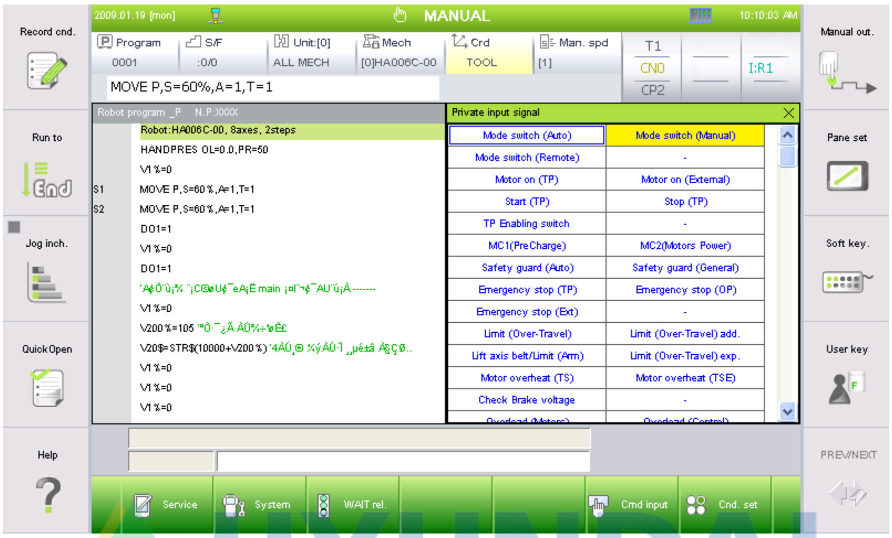
Selection 『[F1]: Service』 → 『1: Monitoring』 → 『2: Input/Output signal』 and choose an item to be monitored.



4.2.2.1. Private input signal

Indicates the state of private input signal. Current private input signal is highlighted.

Selection 『[F1]: Service』 → 『1: Monitoring』 → 『2: Input/Output signal』 → 『1: Private input signal』.



4.2.2.2. Private output signal

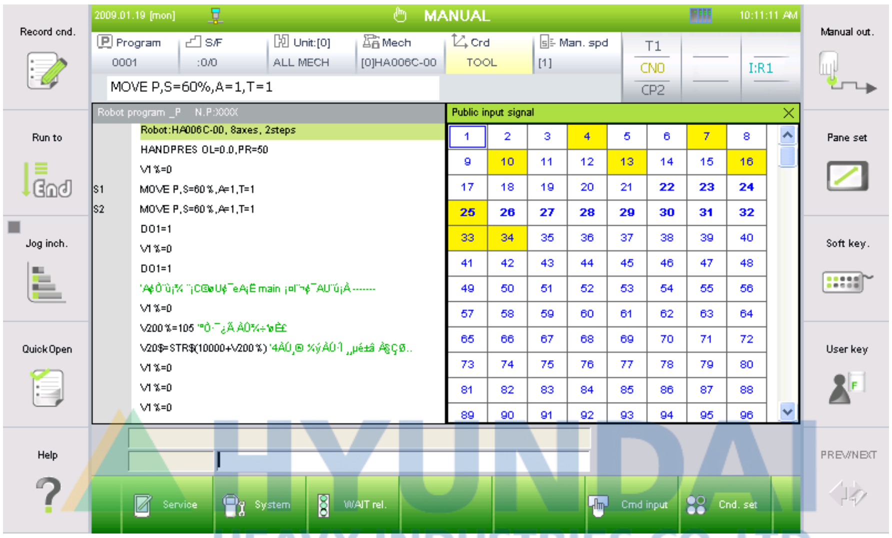
Indicates the state of private output signal. Current private output signal is highlighted.

Selection 『[F1]: Service』 → 『1: Monitoring』 → 『2: Input/Output signal』 → 『2: Private output signal』 .

4.2.2.3. Public input signal

Indicates the state of public input signal. Public input signal generally means the signal inputted through the CNIN connector on the I/O board inside a controller. However, when mapping of, for example, the field bus signals by using the embedded PLC is applied for the use, the input signal On/Off state may look different.

Selection 『[F1]: Service』 → 『1: Monitoring』 → 『2: Input/Output signal』 → 『3: Public input signal』



Reference

- The public input signal allocated is displayed in bold font and the public input signal currently entered is highlighted.

  - Not allocated : 24
  - Allocated : **24**
  - Currently inputted : **24**
  - Not inputted : **24**

- In normal conditions, the input logic value after the positive/negative logic property stage is displayed. While the [F2: Physical value] key is being pressed, the input physical value before the positive/negative logic property stage will be displayed.

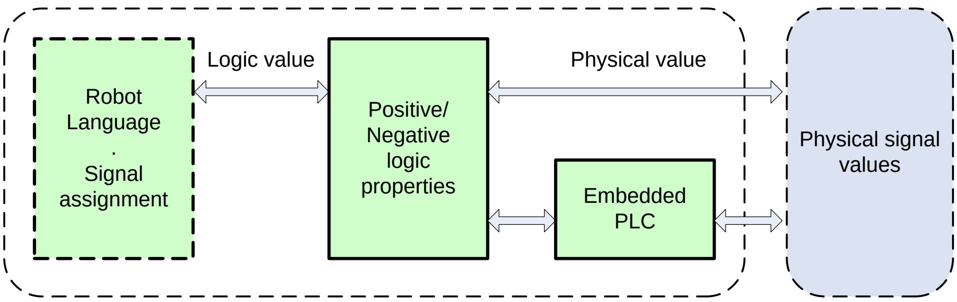
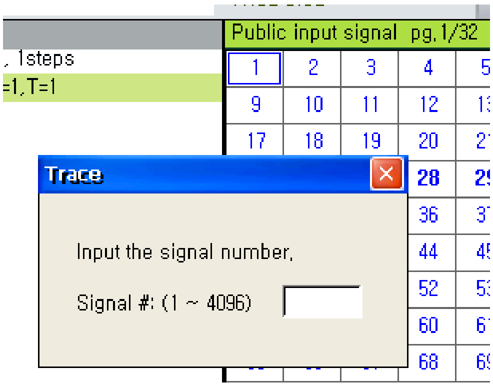


Figure 4.2 Input signal flow diagram

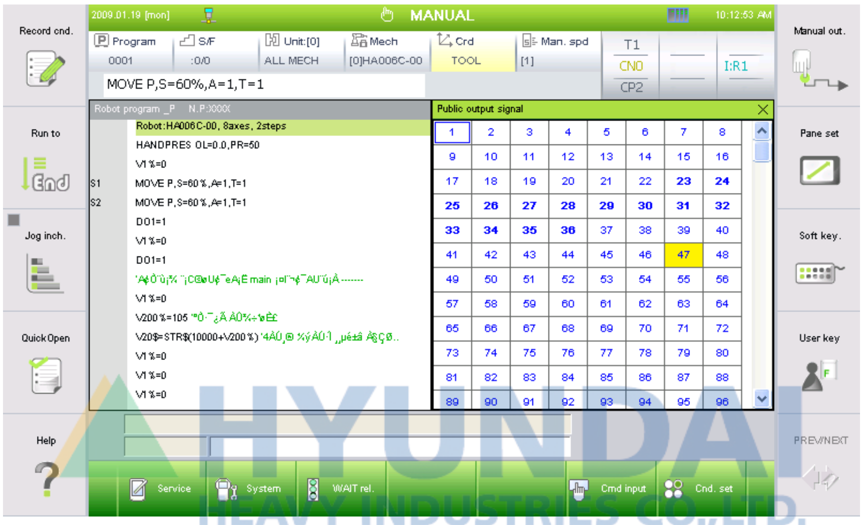
- The current page and the total number of pages are displayed beside the title of the monitoring window. Use the [F6: Previous] and [F7: Next] buttons to move between pages. Press the [F4: Trace] and enter the signal number, then the page signal location will be displayed.



4.2.2.4. Public output signal

Indicates the state of public output signal. Public output generally means the signal outputted through the CNOUT connector on the I/O board inside a controller. However, when mapping of, for example, the field bus signals by using the embedded PLC is applied for the use, the input signal On/Off state may look different.

Selection 『[F1]: Service』 → 『1: Monitoring』 → 『2: Input/Output signal』 → 『4: Public output signal』.



Reference

- The public input signal allocated is displayed in bold font and the public input signal currently entered is highlighted.
  - Not allocated : 26
  - Allocated : **26**
  - Currently inputted : **26**
  - Not inputted : **26**

- In normal conditions, the output logic value after the positive/negative logic property stage is displayed. While the [F2: Physical value] key is being pressed, the output logic value before the positive/negative logic property stage will be displayed.

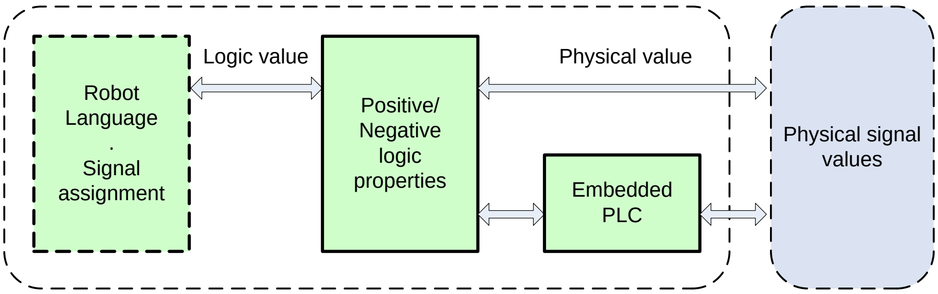
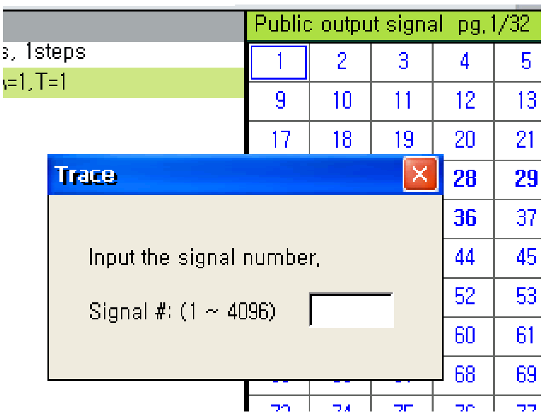


Figure 4.3 Output signal flow diagram

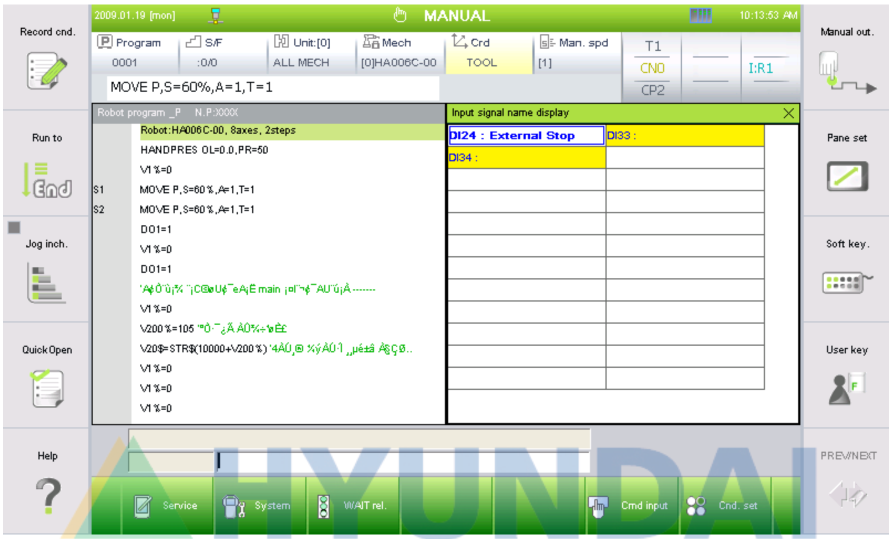
- The current page and the total number of pages are displayed beside the title of the monitoring window. Use the [F6: Previous] and [F7: Next] buttons to move between pages. Press the [F4: Trace] and enter the signal number, then the page signal location will be displayed.



4.2.2.5. Input signal name display

Use this when you want to check the name of the input/output signal as well as the input/output condition.

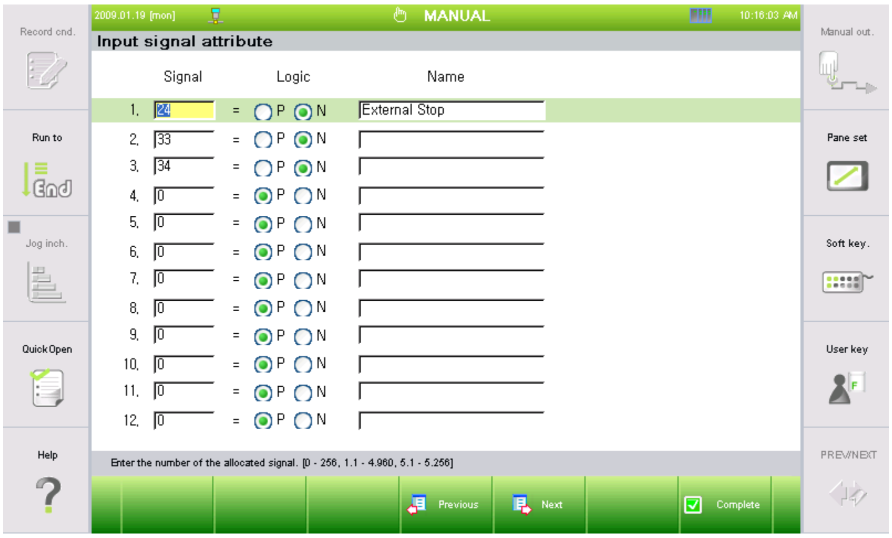
(1) Selection 『[F1]: Service』 → 『1: Monitoring』 → 『2: Input/Output signal』 → 『5: Input signal name display』 or 『6: Output signal name display』.



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

Reference

- To monitor the input/output signal name display, you must enter the name in 『[F2]: System』 → 『2: Control parameter』 → 『2: Input/Output signal setting』 → 『1: Input signal attribute』 / 『2: Output signal attribute』.



4.2.3. Field bus signal

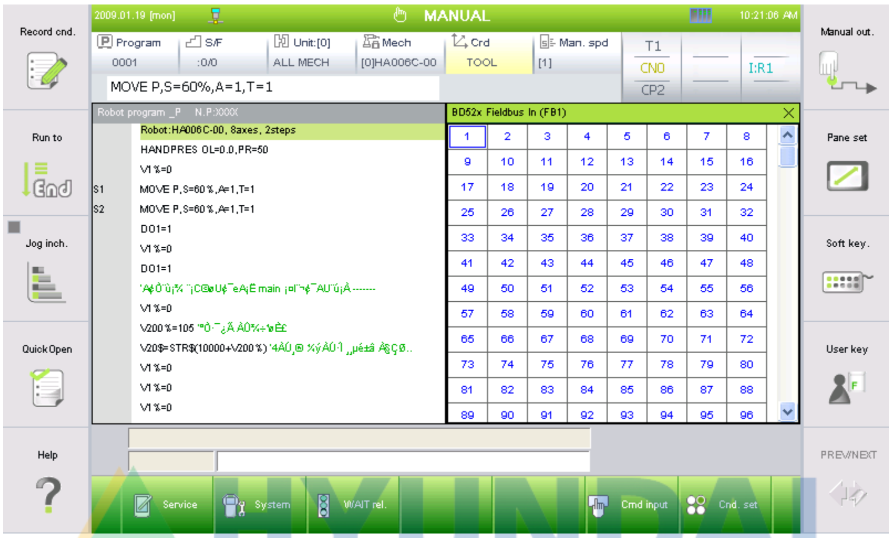
This displays the condition for I/O signal of BD52x field bus channel 1~4.

Selection 『[F1]: Service』 → 『1: Monitoring』 → 『3: Field bus signal』.

4.2.3.1. BD52X Field bus In / Out (FB1 ~ FB4)

This displays the condition for I/O signal of BD52x field bus channel 1~4.

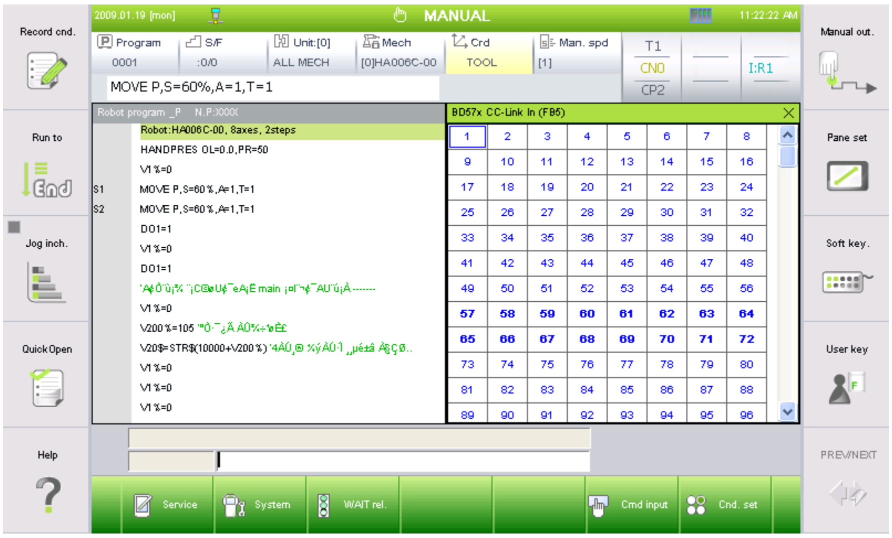
Select 『[F1]: Service』 → 『1: Monitoring』 → 『3: Field bus signal』 → 『1: BD52x Field bus In (FB1)』 / 『2: BD52x Field bus Out (FB1)』. (Or, one of FB2~FB4)



4.2.3.2. BD57x CC-Link In/Out (FB5)

This displays the condition of BD57x CC-Link In/Out signal.

Select 『[F1]: Service』 → 『1: Monitoring』 → 『3: Field bus signal』 → 『9: BD57x CC-Link In (FB5)』 / 『10: BD57x CC-Link Out (FB5)』.



4.2.4. Spot welding data

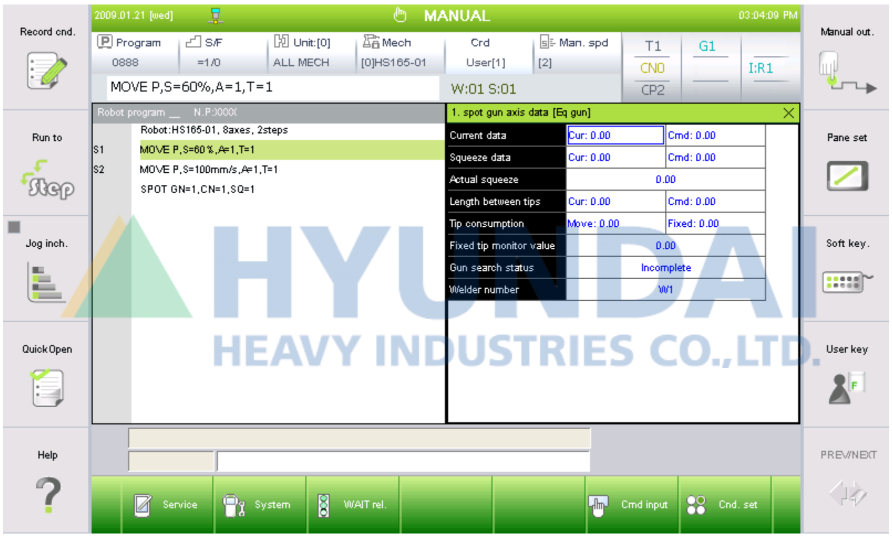
Displays the various data, welding input/output signals, operation information related to the spot welding.

Selection 『[F1]: Service』 → 『1: Monitoring』 → 『4: Spot welding data』.

4.2.4.1. Spot gun axis 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.

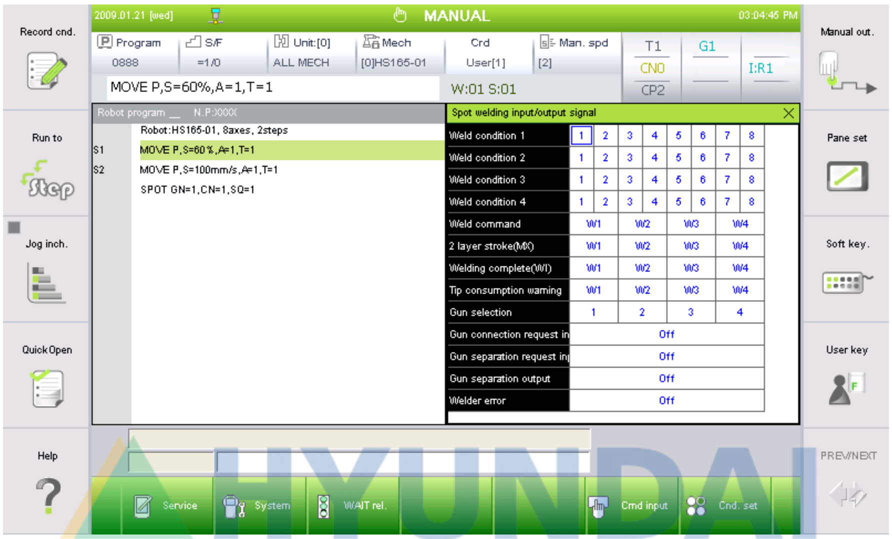
Selection 『[F1]: Service』 → 『1: Monitoring』 → 『4: Spot welding data』 → 『1: Spot gun axis data』 on the initial screen of either manual or auto mode.



4.2.4.2. Spot welding input/output signal

This is the function to display the input/output signal condition with the welder when using the spot welding gun.

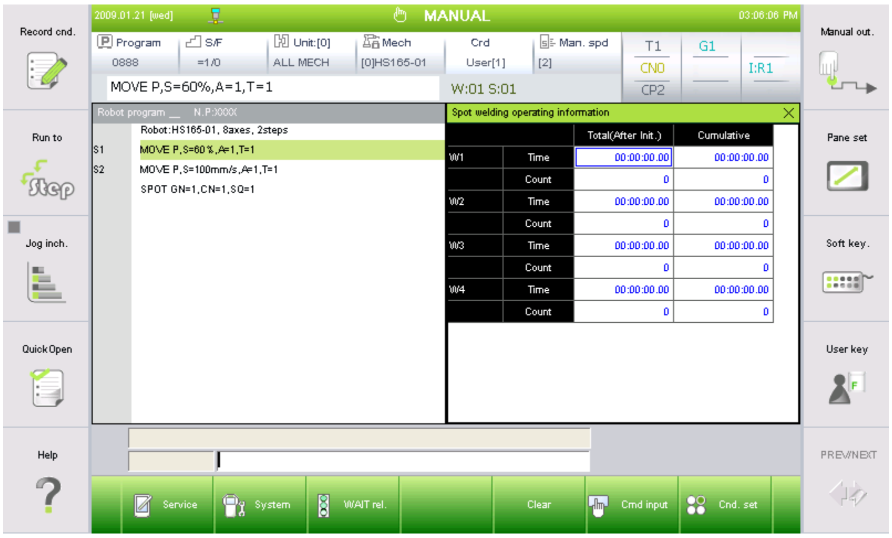
Selection 『[F1]: Service』 → 『1: Monitoring』 → 『4: Spot welding data』 → 『2: Spot welding input/output signal』 .



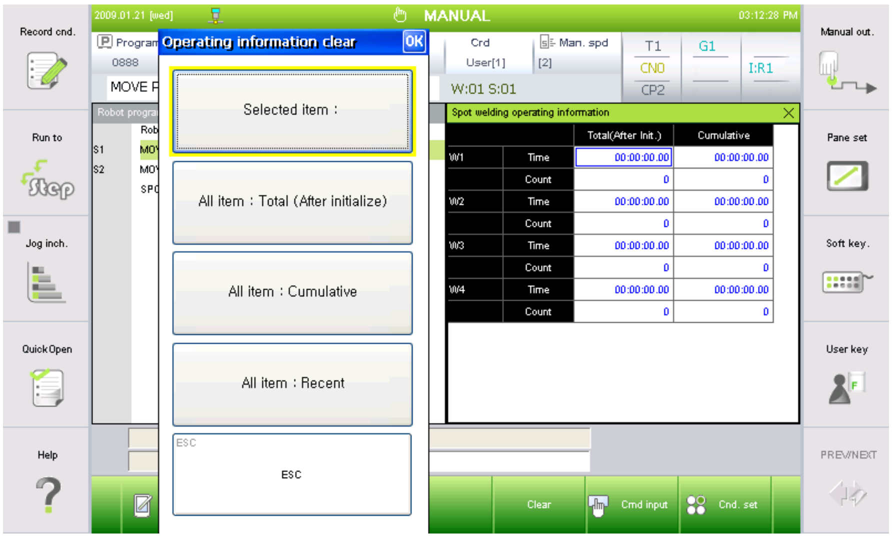
4.2.4.3. Spot welding operating information

This is the function to display the condition for the welding time and number of times of the welding when using the spot welding gun.

Select 『[F1]: Service』 → 『1: Monitoring』 → 『4: Spot welding data』 → 『3: Spot welding operating information』



- Spot welding operating information clear
  When the [Spot welding operating information] monitoring window is selected and activated, the 『[F5]: Clear』 button be displayed. Press this button.



You can clear the operating information from the created message box.

4.2.5. Sensor synchronization

This is to display various types of information related to use of conveyor synchronization function.

Select 『[F1]: Service』 → 『1: Monitoring』 → 『5: Sensor synchronization』.

Reference

- For the sensor synchronization, the sensor synchronization function of 『[F2]: System』 → 『4: Application parameter』 → 『4: Sensor synchronization』 → 『1: Whether to use the function』 → "1st sensor" or "2nd sensor" must be set to <Conveyor> or <Press>.

- For more details, refer to 『Hi5 Controller Sensor Synchronization Function Manual』

4.2.6. Palletize data

When the palletizing function is used, the palletizing data indicates the work state of palletizing, pattern register number, palletizing counter, the number of total workpieces and workpiece size.

(1) Selection 『[F1]: Service』 → 『1: Monitoring』 → 『6: Palletize data』.

(2) To show unseen items, select the “Palletize data” window and press [SHIFT] + [⇒] and [SHIFT] + [⇓].

Reference

- For palletization data monitoring, the palletization of 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』 must be selected to <Enable>.
- For more details. refer to 『Hi5 Controller Palletize Function Manual』

4.2.7. PLC relay data

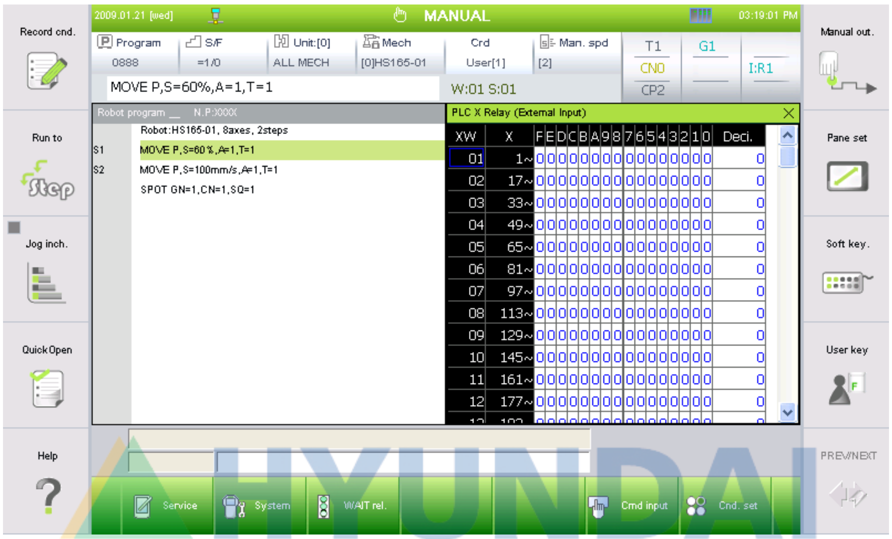
The PLC relay data indicates the state of contacts of various relays when an embedded PLC is used

Selection 『[F1]: Service』 → 『1: Monitoring』 → 『7: PLC relay data』.

4.2.7.1. PLC X Relay (External Input)

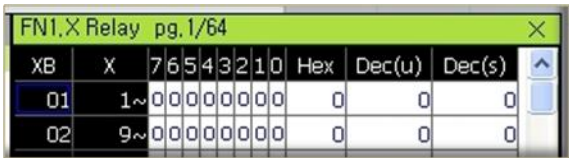
PLC X Relay (External Input) indicates the state of signals inputted through standard IO board and Expansion IO board.

Selection 『[F1]: Service』 → 『1: Monitoring』 → 『7: PLC Relay Data』 → 『1: PLC X Relay (External Input)』 on the initial screen of either manual or auto mode.

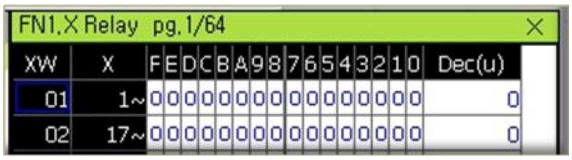


Reference

- Every time the [F5: Display type] button is pressed, the displayed data format will change as the following.



byte format (XB)



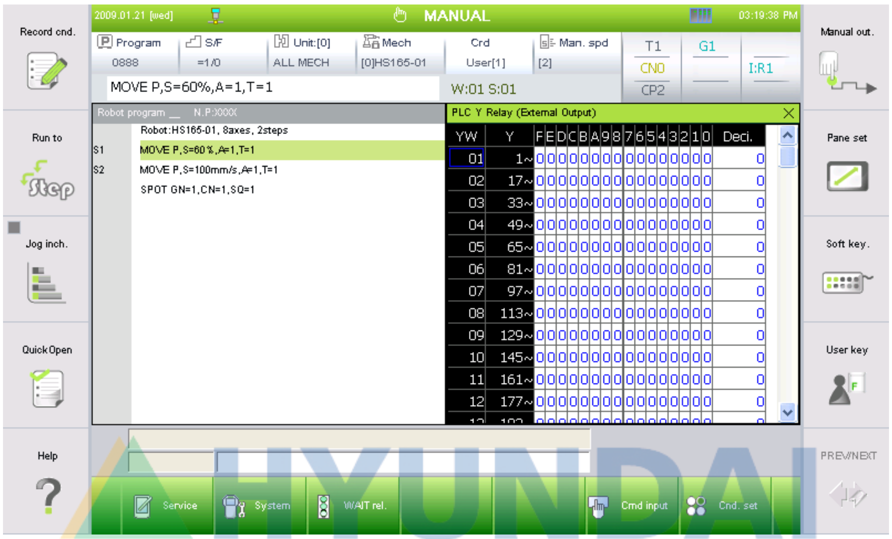
word format (XW)

long format (XL)

4.2.7.2. PLC Y Relay (External Output)

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

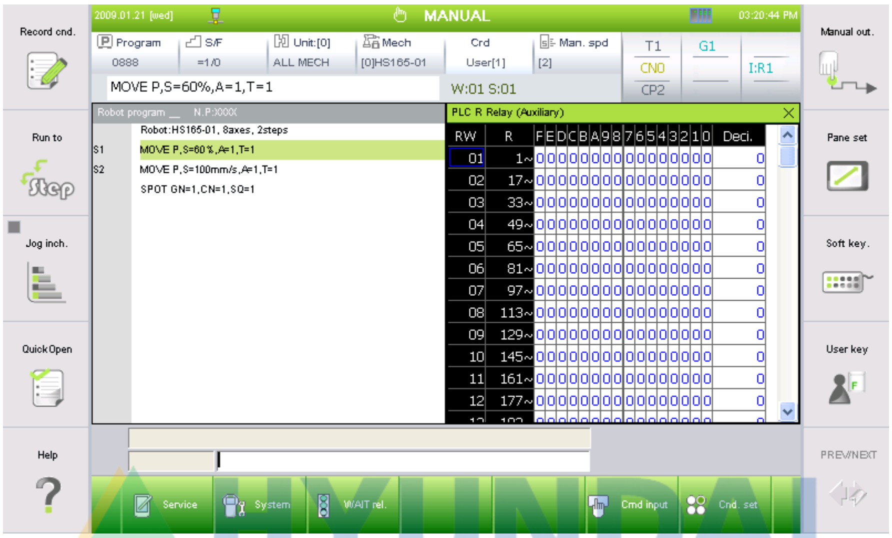
Selection 『[F1]: Service』 → 『1: Monitoring』 → 『7: PLC Relay Data』 → 『2. PLC Y Relay (External output)』.



4.2.7.3. PLC R Relay (Auxiliary)

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

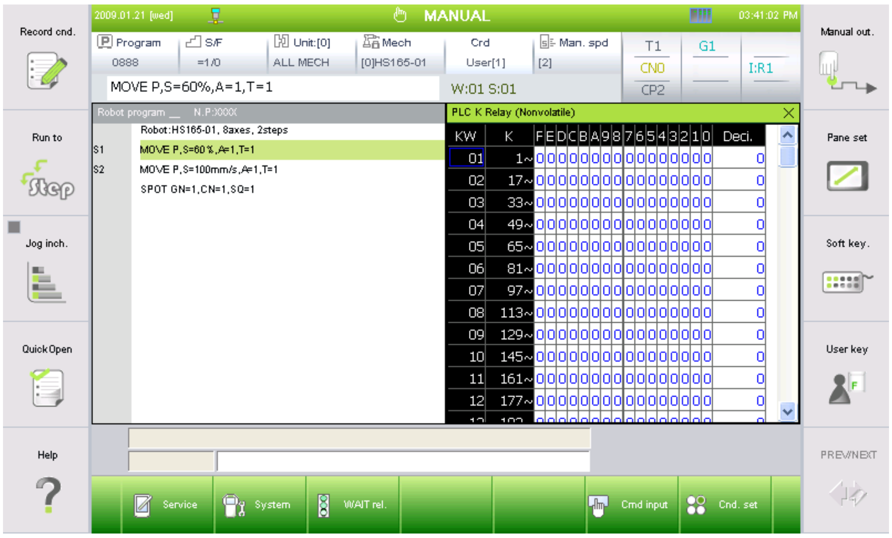
Selection 『[F1]: Service』 → 『1: Monitoring』 → 『7: PLC Relay Data』 → 『3. PLC R Relay (Auxiliary)』.



4.2.7.4. PLC K Relay (Nonvolatile)

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

Selection 『[F1]: Service』 → 『1: Monitoring』 → 『7: PLC Relay Data』 → 『4: PLC K Relay (Nonvolatile)』.



4.2.7.5. 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.

Selection 『[F1]: Service』 → 『1: Monitoring』 → 『7: PLC Relay Data』 → 『5: PLC T Relay (Timer)』.

4.2.7.6. PLC C Relay (Counter)

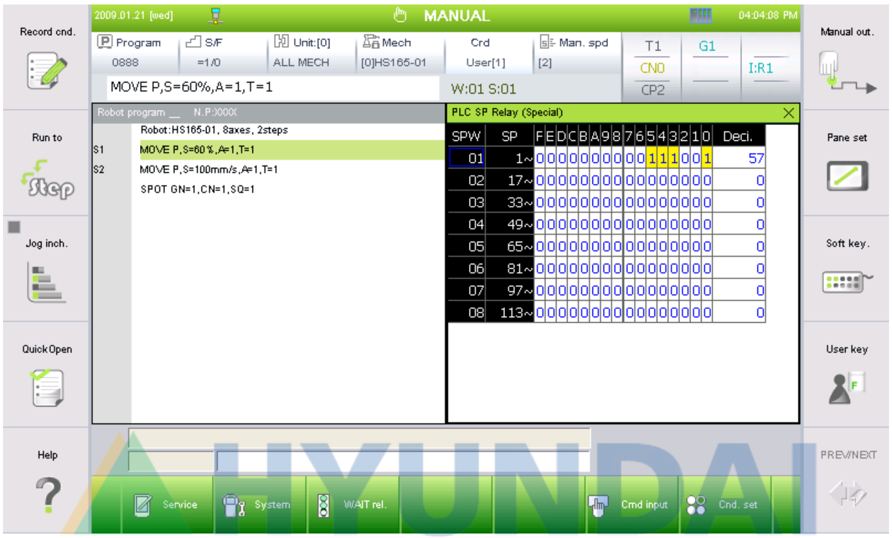
PLC C Relay is for counter function. When the value is 0, contact point is ON. Even in case of electricity failure, the value of PLC C Relay (Counter) is maintained.

Selection 『[F1]: Service』 → 『1: Monitoring』 → 『7: PLC Relay Data』 → 『6: PLC C Relay (Counter)』.

4.2.7.7. PLC SP Relay (Special)

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

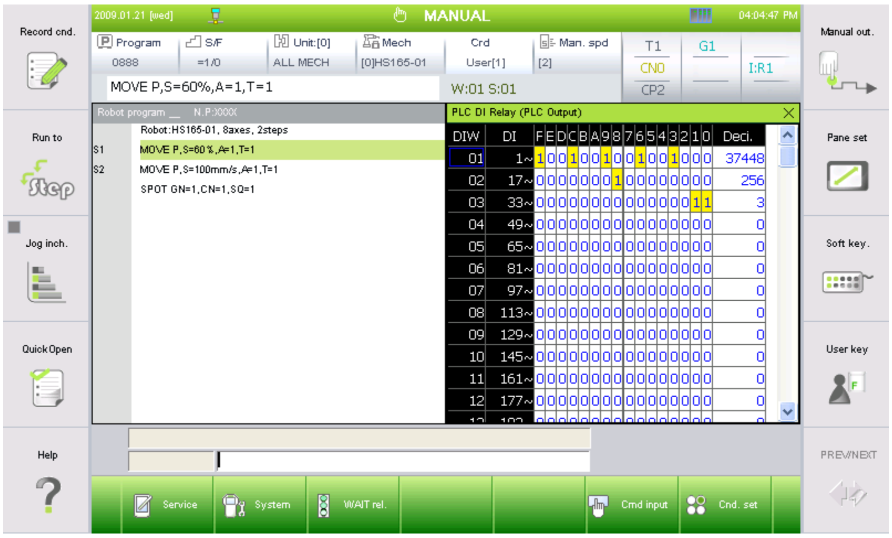
Selection 『[F1]: Service』 → 『1: Monitoring』 → 『7: PLC Relay Data』 → 『7: PLC SP Relay (Special)』.



4.2.7.8. PLC DI Relay (PLC Output)

This is the relay defined to monitor the output value from PLC

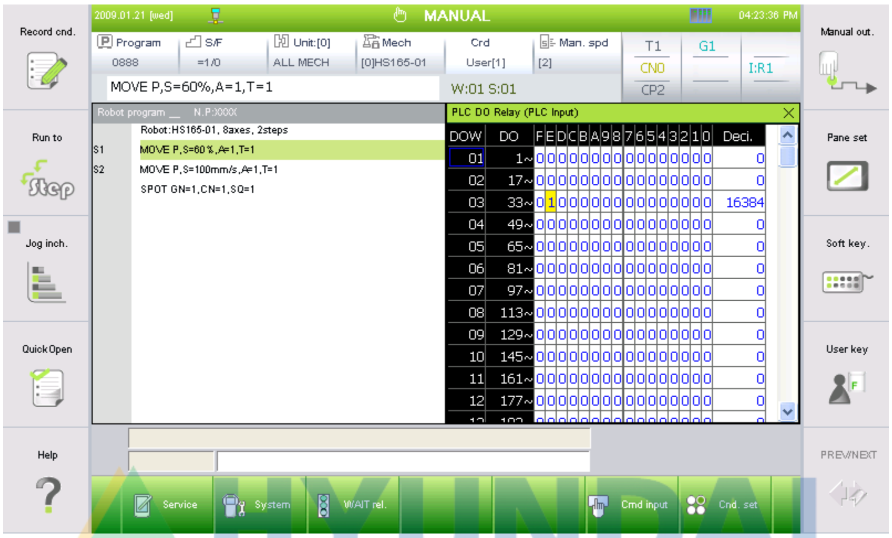
Selection 『[F1]: Service』 → 『1: Monitoring』 → 『7: PLC Relay Data』 → 『8: PLC DI Relay (PLC output)』.



4.2.7.9. PLC DO Relay (PLC Input)

This is the relay defined to monitor the input value from PLC.

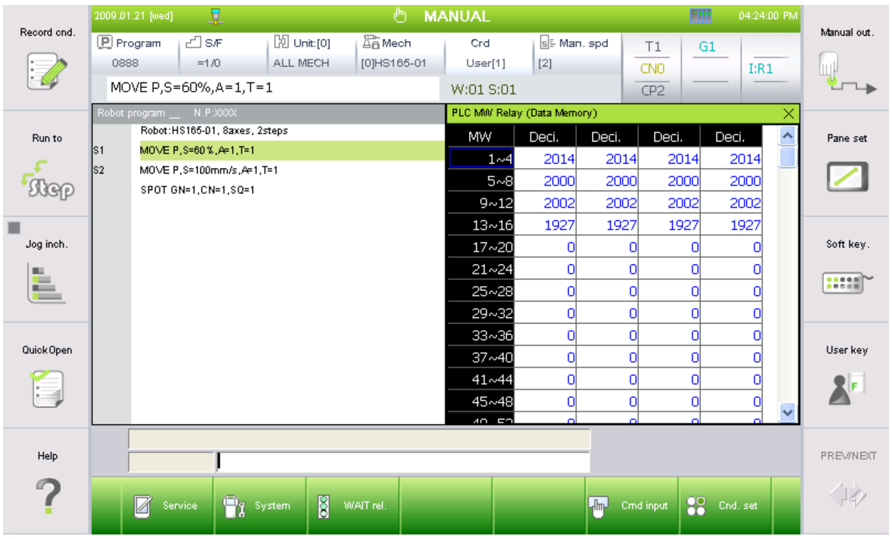
Selection 『[F1]: Service』 → 『1: Monitoring』 → 『7: PLC Relay Data』 → 『9: PLC DO Relay (PLC input)』.



4.2.7.10. PLC MW Relay (Data Memory)

This is used for saving or importing data saved with applied command. This relay value will be maintained even when the power is out.

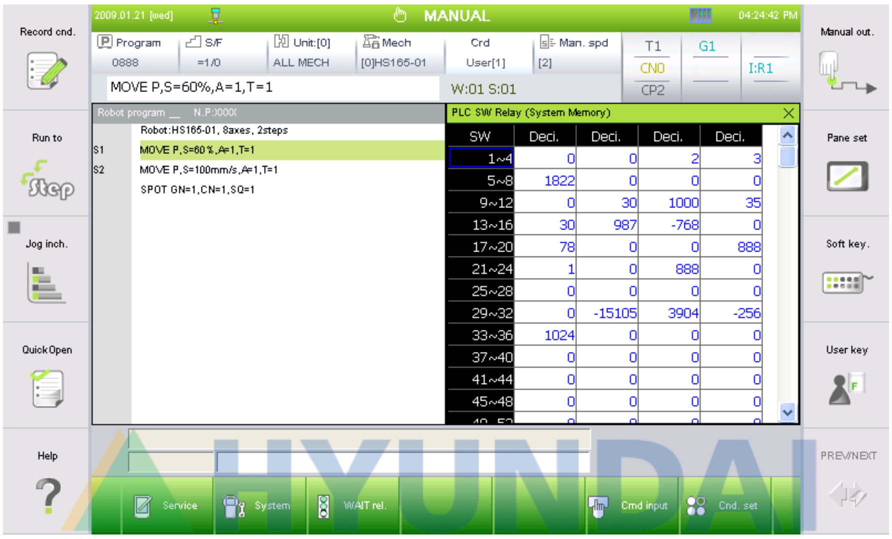
Selection 『[F1]: Service』 → 『1: Monitoring』 → 『7: PLC Relay Data』 → 『10: PLC MW Relay (Data Memory)』.



4.2.7.11. PLC SW Relay (System memory)

PLC SW Relay (System Memory) is for a special purpose. Refer to 『Hi5 Controller Embedded PLC Function Manual』 for details.

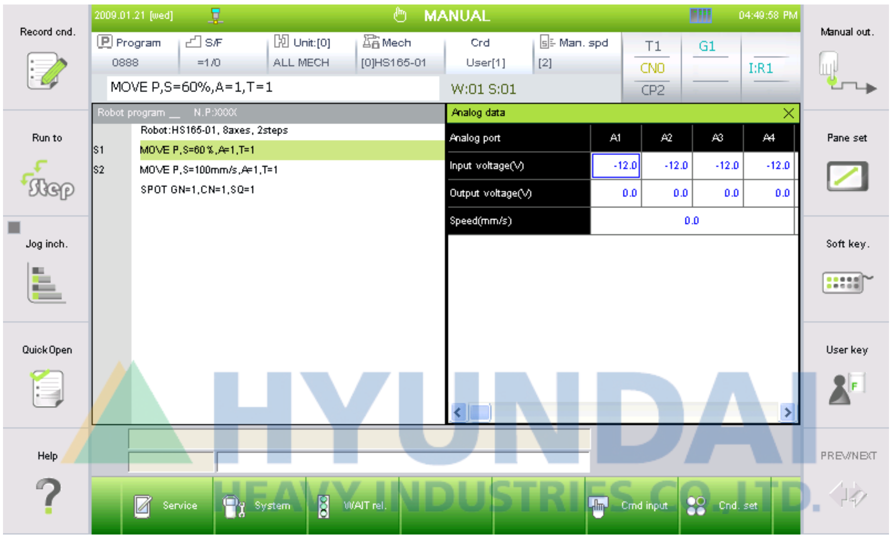
Selection 『[F1]: Service』 → 『1: Monitoring』 → 『7: PLC Relay Data』 → 『11: PLC SW Relay (System Memory)』.



4.2.8. Analog Data

This displays the analog voltage input/output through the analog input/output port of arc interface board. When using the function of 『[F2]: System』 → 『4: Application parameter』 → 『5: Speed vs. voltage output』 function, the voltage output will be proportionate to the linear end speed of the robot. Refer to 『[F2]: System』 → 『4: Application parameter』 → 『5: Speed vs. voltage output』 for details.

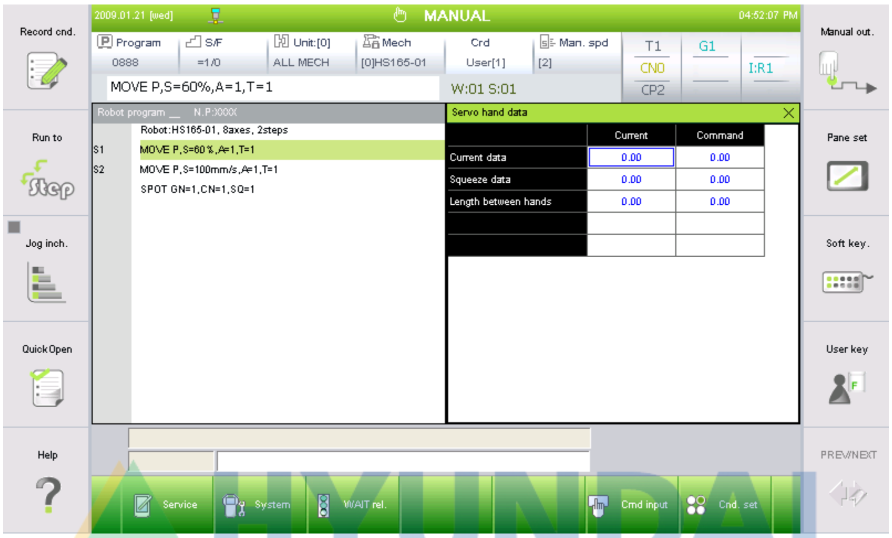
Selection 『[F1]: Service』 → 『1: Monitoring』 → 『8: Analog data』.



4.2.9. Servo hand data

This displays the servo hand axis and related information during palletizing task using the servo hand. Refer to 『Hi5 Controller Servo Hand Function Manual』 for details.

Selection 『[F1]: Service』 → 『1: Monitoring』 → 『9: servo hand data』.



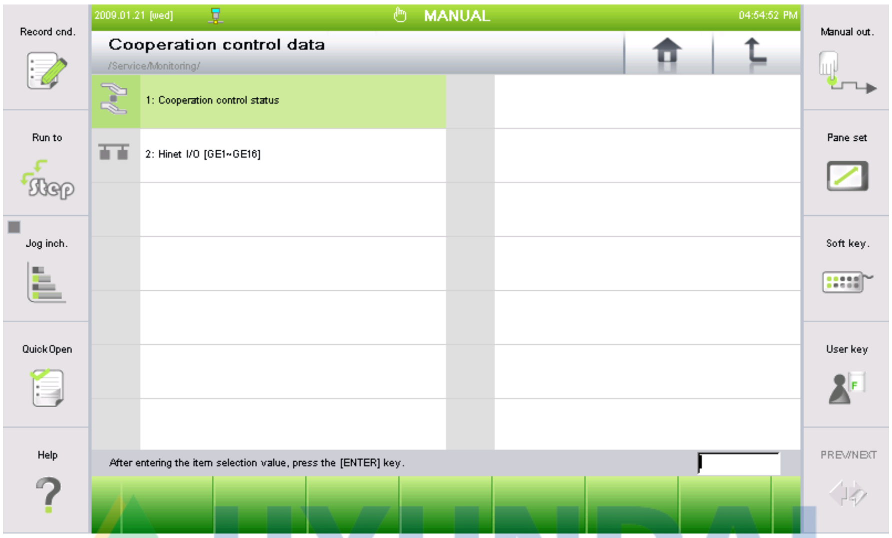
Reference

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

4.2.10. Cooperation control data

This monitors the Cooperation control or HiNet I/O condition.

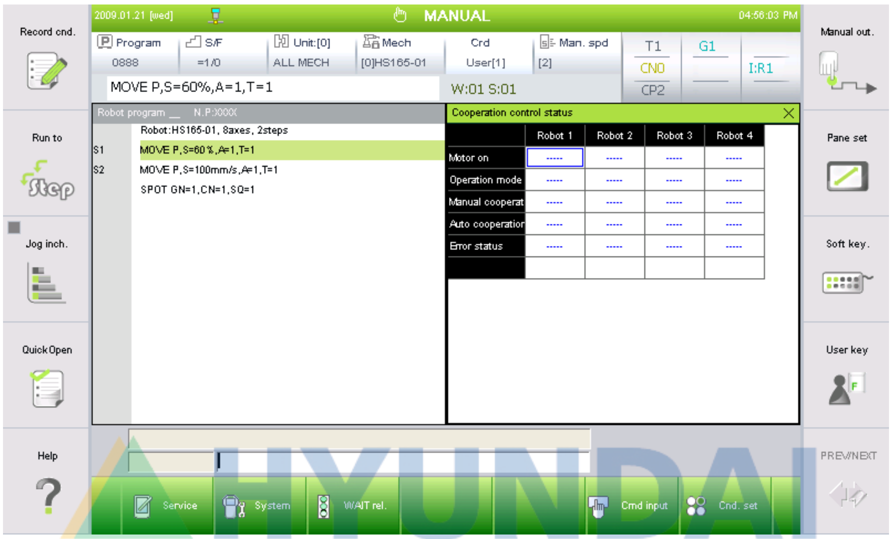
Selection 『[F1]: Service』 → 『1: Monitoring』 → 『10: Cooperation control data』



4.2.10.1. Cooperation control condition

You can monitor the operation preparation, manual cooperation, automatic cooperation, error status etc. of the robot during the cooperation work of the robot using the cooperation control function.

Selection 『[F1]: Service』 → 『1: Monitoring』 → 『10: Cooperation control data』 → 『1: Cooperation control status』

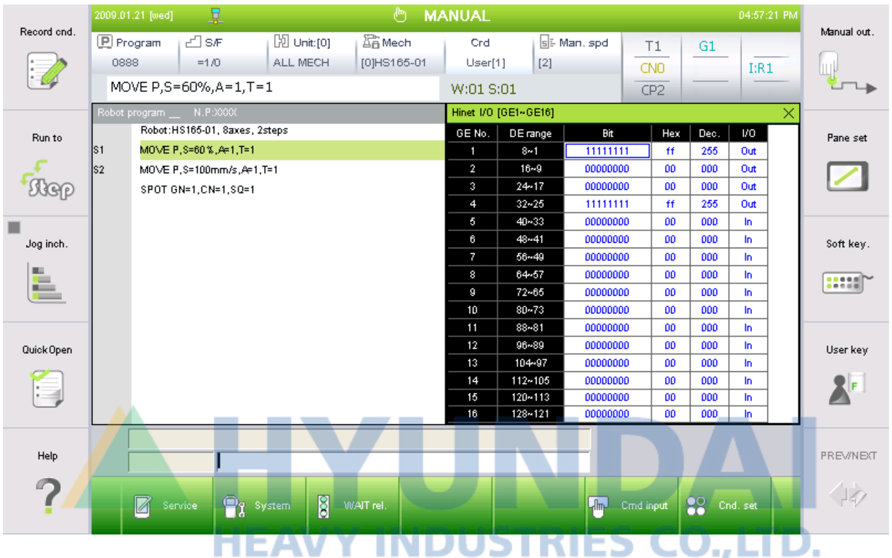


- Motor on : Indicates operation readiness (ON/OFF) of each robot.
- Operation mode : Indicates that each robot is set as manual/auto mode.
- Manual cooperation : Indicates robot's manual mode cooperative state.
  Individual : Individual manipulation state
  Master : Set as MASTER in a cooperative manipulation state
  Slave : Set as SLAVE in a cooperative manipulation state
- Automatic cooperation : Indicates the cooperative state when a robot performs a task.
  Stop : Not performing.
  Independent : Independently performing a task
  Wait :
  Under COWORK command, waiting for a partner robot to be ready for cooperative position.
  Cooperation : performing cooperation work.
- Error status
  Indicates recent error states of each robot. Error state clears when a robot moves.

4.2.10.2. HiNet I/O [GE1~GE16]

This monitors the input/output signal condition for HiNet. Each signal is displayed in binary (Bit), hexadecimal (Hex) and decimal (Dec.), and displays whether it is an output parameter or an input parameter depending on the role of the robot itself. (I/O)

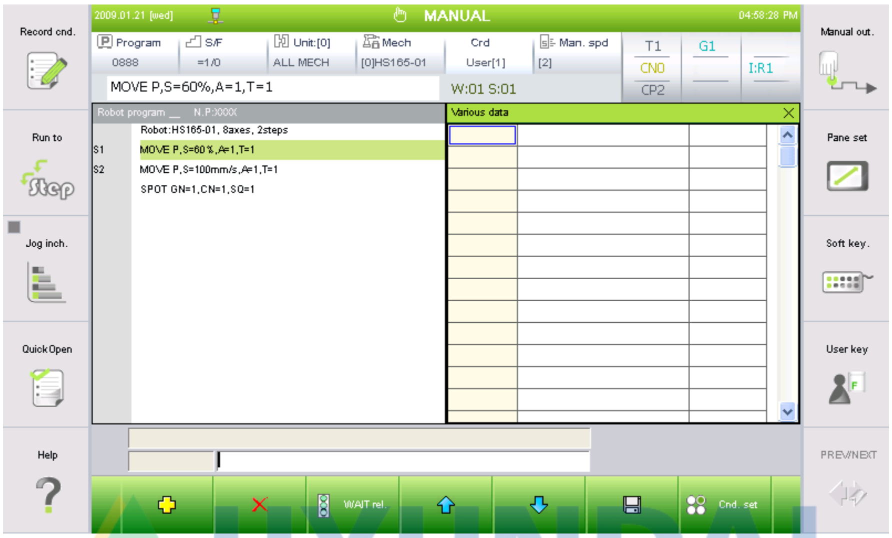
Selection 『[F1]: Service』 → 『1: Monitoring』 → 『10: Cooperation control data』 → 『2: Hinet I/O [GE1~GE16]』



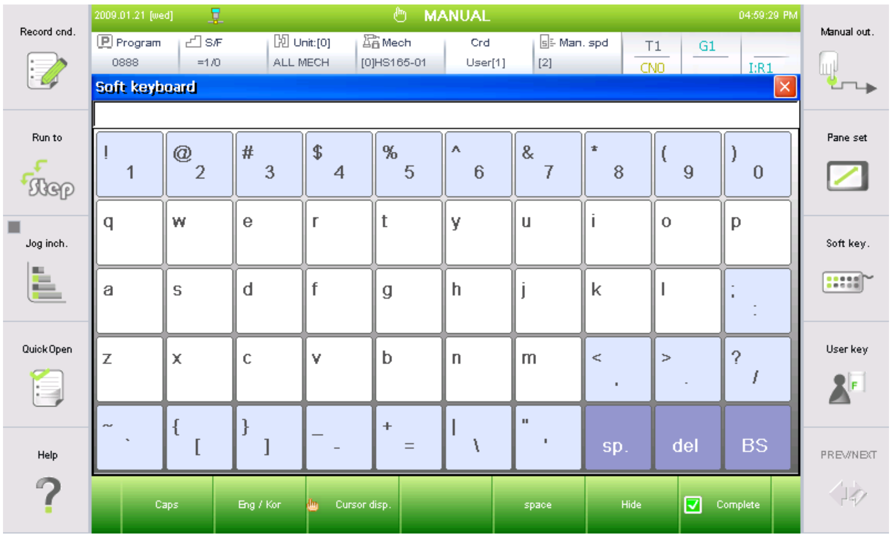
4.2.11. Various data

This is the function to prepare the list of data you want and monitor in one window.

(1) Select 『[F1]: Service』 → 『1: Monitoring』 → 『11: Various data』.



(2) Set the cursor on the most left column and press the, [Soft keyboard] key to enter the name of the data.



(3) The current value for the entered data is displayed respectively. For data of which a note is set, the note is automatically displayed as well.

(4) For integer data, the current value is displayed in decimal format. If you add a suffix of ",x" at the end, it can be displayed in hexadecimal format.

(5) When you press the 『[F1]: +』 key, a blank item will be added right on top of the current cursor.

(6) When you press the 『[F2]: x』 key, the currently selected item will be deleted.

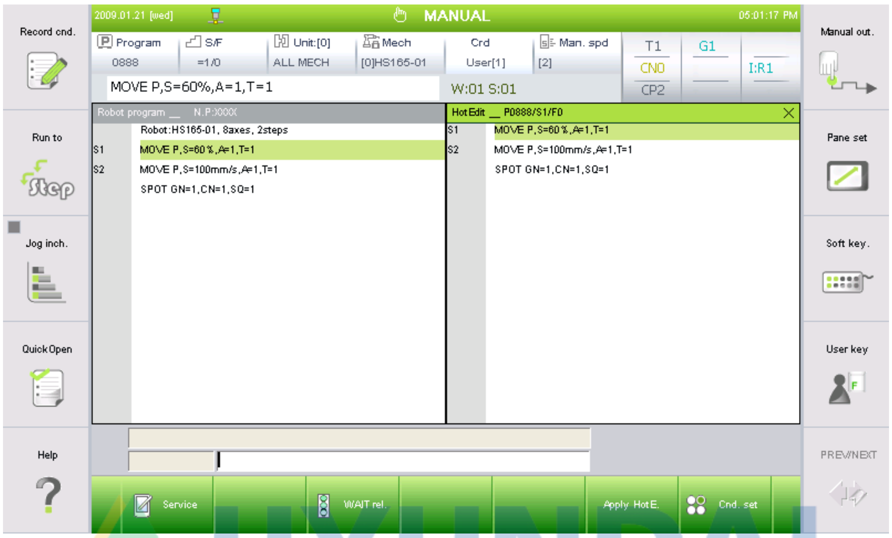
(7) When you press the 『[F4]: ⇧』 / 『[F5]: ⇩』 key, the order of the currently selected item moves up/down.

(8) When you press the 『[F6]: 』 key, the entered condition is saved. That is, the entered condition will be saved even when the power is turned off.

4.2.12. Work program HotEdit

This is the function to edit the program during playback.

(1) Select 『[F1]: Service』 → 『1: Monitoring』 → 『12: Work program HotEdit』.



(2) After editing the program, select 『[F6]: Apply HotE.』.

Warning

- When you edit and apply the program that is currently in auto operation or program that will be called, it will be applied from the next cycle (After the program end is executed) and play back the robot with the edited program. Please take maximum precaution since the wrongly implemented editing can cause major accident such as collision between robot and jig.

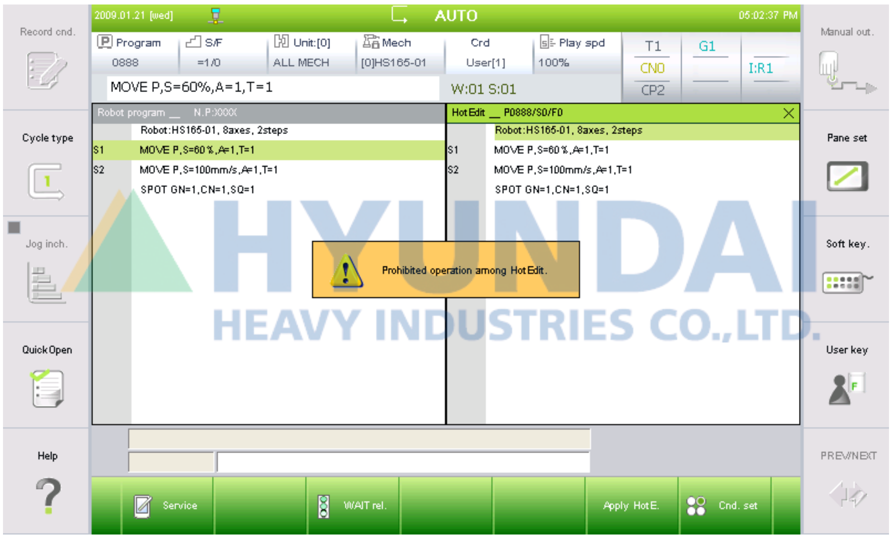
○ **Entry**

You can enter the edit mode during operation even when the robot is operating by using the [Quick Open] key or 『[F1]: Service』 → 『1: Monitoring』 → 『12: Work program HotEdit』.

○ **Type of possible edit**

The operating method is the same as the operation in the manual mode, but the following function cannot be used and the applicable keys are ignored.

① [Axis operation] key use
② [REC] key (Record hidden pose MOVE)
③ [POS. MOD] key



○ **Reflection**

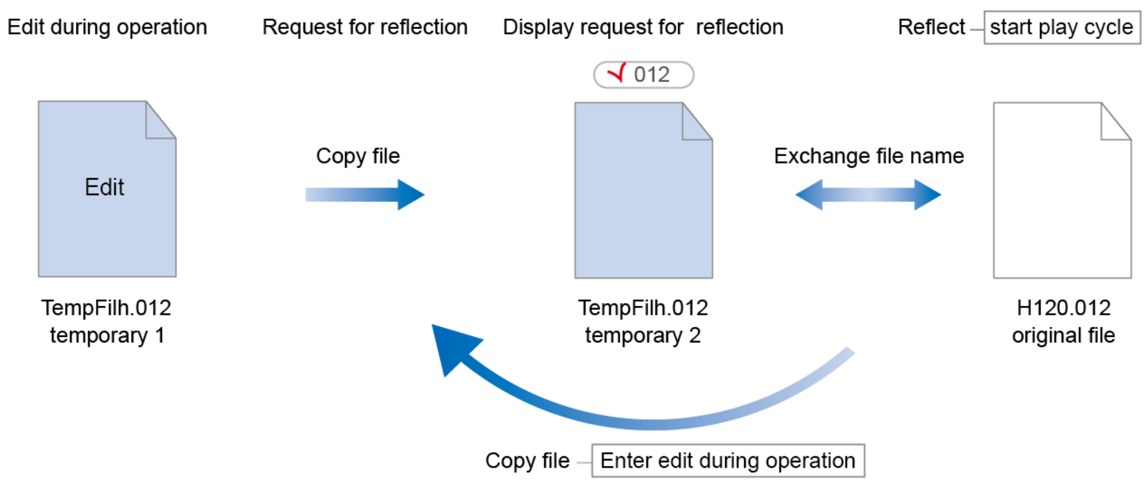
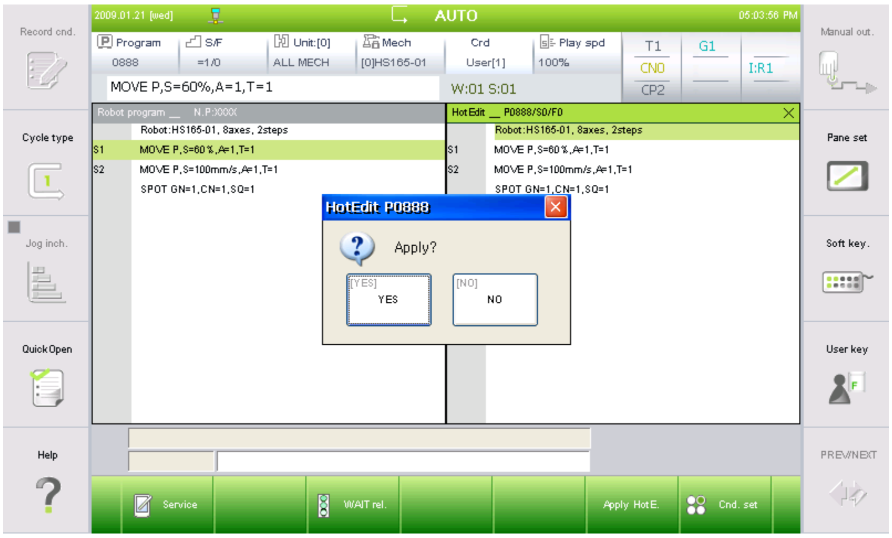


Figure 4.4 Edit during operation

Edit during operation is the method used by the user to edit the copy version by creating a copy, not the original file, for safety purposes.
When you execute edit during operation, the original file is copied as temporary file 1 as shown above. When the user edits the program and presses the 『[F6]: Apply HotE.』 key, the temporary file 1 is copied as temporary file 2 and the reflection request is displayed. The reflection is applied by renaming the temporary file 2 with the file name of the original file.



The actual timing of the reflection is displayed in the following table.

Table 4-1 Reflection timing

	Classification	Reflection timing
Executing during work	Work in execution Work executed by calling with CALL command	When the play cycle starts (All files requested for reflection are reflected.)
	Other work	Immediately request for reflection

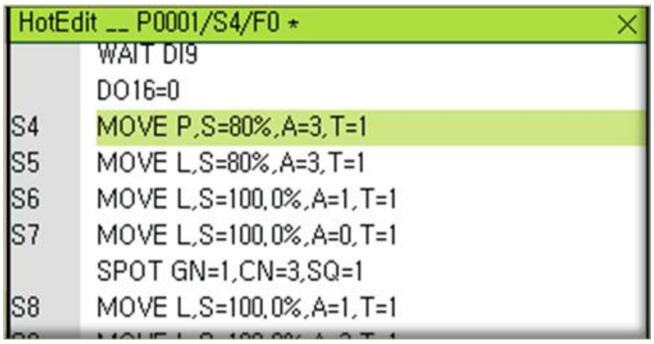
If the program is not in execution or in operation, it cannot be edited. But if the program stops while in edit mode during operation, the reflection is requested but not reflected until the play cycle restarts.

Press the [YES] key to first reflect the edit details during operation and press the [NO] key to cancel the request for reflection and delete temporary file 2 (Edit detail during operation).

At this time, if the program that used the CALL command was in progress, you must restart from the beginning because it is not a normal program flow.

○ **Program counter information**

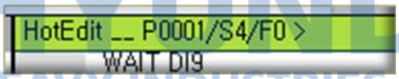
The following details are displayed on the title bar of the Hot Edit window.



① Program number/Step number/Function number : This displays the location of the cursor used for editing in the edit during operation mode.

② ‘*’: ‘*’ is displayed when edited from the original copy.

③ ‘>’: When the reflection request condition from the original copy is in effect, ‘>’ is displayed.



○ **Select different program**

When you press the [SHIFT] + [PROG] key, you can select a different program. You can also create a new program.

4.2.13. Arc welding data

This function displays the followings at the time of Arc Welding. The electric current and voltage for the welding, feed motor speed/current, analog output values for current/voltage controlling, current welding status, error code of the welder.

Please select『[F1]: Service』 → 『1: Monitoring』 → 『13: Arc Welding data』.

Arc welding data			
Welding cond	0 A	Current outpu	0 A
Welding cond	0.0 V	Current comn	0.0 V
Welding cond	0 변	Current outpu	0.0 V
Welding in st	ot in progress	Voltage comr	0.0 V
Wire status	).K. (Disable)	Gas status	).K. (Disable)
Welder status	).K. (Disable)	Coolant statu	).K. (Disable)

Arc Welding: Analog welder setting is on

Arc welding data	Current	Limit	Command
Welding current	0.0 A	---	0 A
Welding voltage	0.0 V	---	0 %
Welding in step	Welding is not in progress		
Welder error code	0x00000000		
Feeding speed	0.0 m/min	Feed current	0.0 A

Arc Welding: Fronius welder setting is on

Arc welding data	Current	Limit	Comman	Etc.
Welding current	0 A	--- A	0 A	0/s
Welding voltage	0.0 V	--.- V	0.0 V	0.0 V
Feeding motor	0.0 A	--.- A		0 rpm
Welder error coc	0x00000000		Status=0x00	
Send/Rec. info.	T0/R0		R00/B-1/N0/E0	
Welding in step	Welding is not in progress			
Welder version	(0x00) 0.0		Syn. Code:0000	

Arc Welding: Monitoring when the GB2 Welder setting is on

Reference

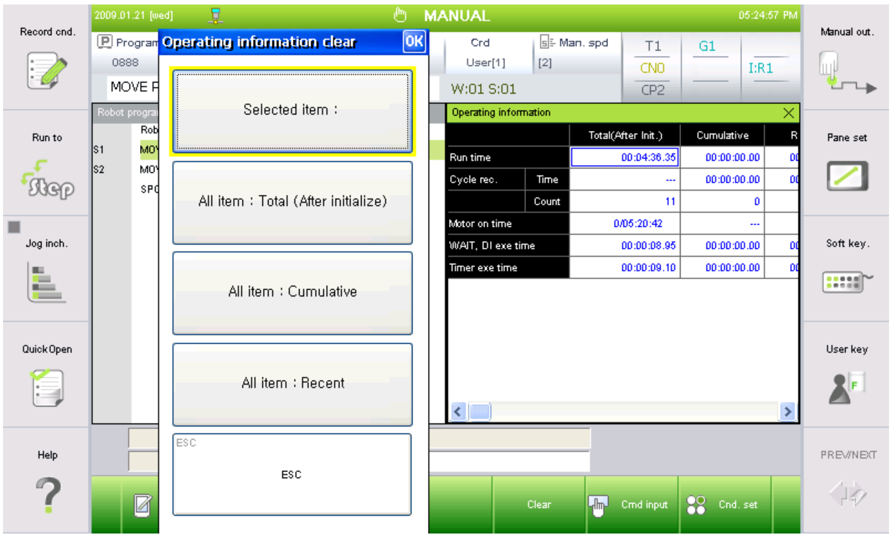
- Arc Welding data monitoring function will displays different contents according to the selected arc welding settings.
- Carry out the arc welding setting by selecting 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』
- Please refer to the “Hi5 Controller Arc Welding function manual” for the detailed information

4.2.14. Operating information

Operating information of the controller displays the information of previous cycle after the system is reset and then power turned back on.

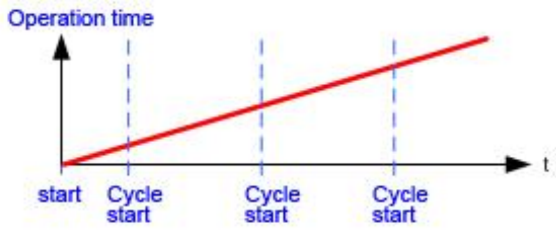
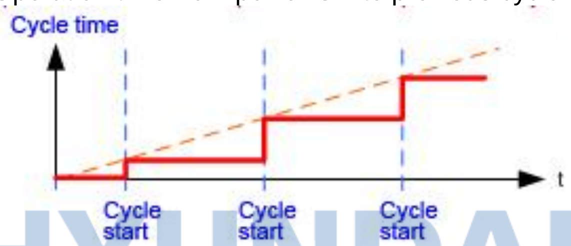
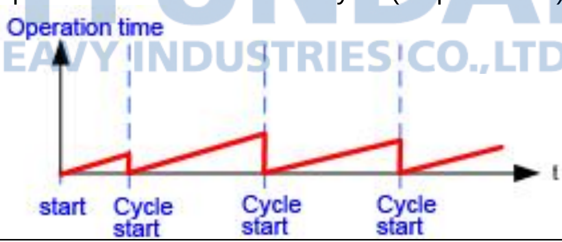
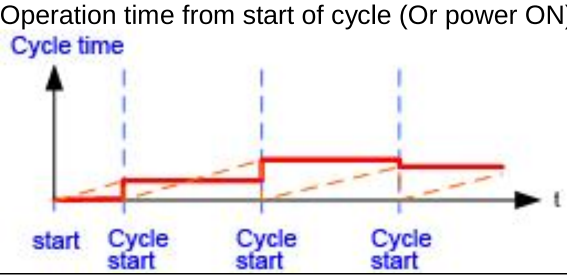
Select 『[F1]: Service』 → 『1: Monitoring』 → 『14: Operating information』.

- Operating information clear
  When the [Operating information] monitoring window is selected and activated, the 『[F5]: Clear』 button be displayed. Press this button.



You can clear the operating information from the created message box.

Table 4-2 Reflected timing

All (After resetting)	Measured time	Operation time from system reset to now
	Motor ON time	Motor ON time from system reset to now
Accumulative	Measured time	Operation time from power ON to now 
	Cycle recording time	Operation time from power ON to previous cycle 
Latest	Measured time	Operation time from start of cycle (Or power ON) to now 
	Cycle recording time	Operation time from start of cycle (Or power ON) to previous cycle 

4.2.15. Embedded field bus node state

Displays the embedded field bus node condition. The node state shows the connected node number, while the node #0 is the master. In the node state monitoring screen, the states of relevant nodes, associated not only with the input and output signals, but also with the errors and the executed state of the master, can be monitored, and accessing the embedded field bus setting screen is possible.

Select 『[F1]: Service』 → 『1: Monitoring』 → 『15: Embedded field bus node condition』

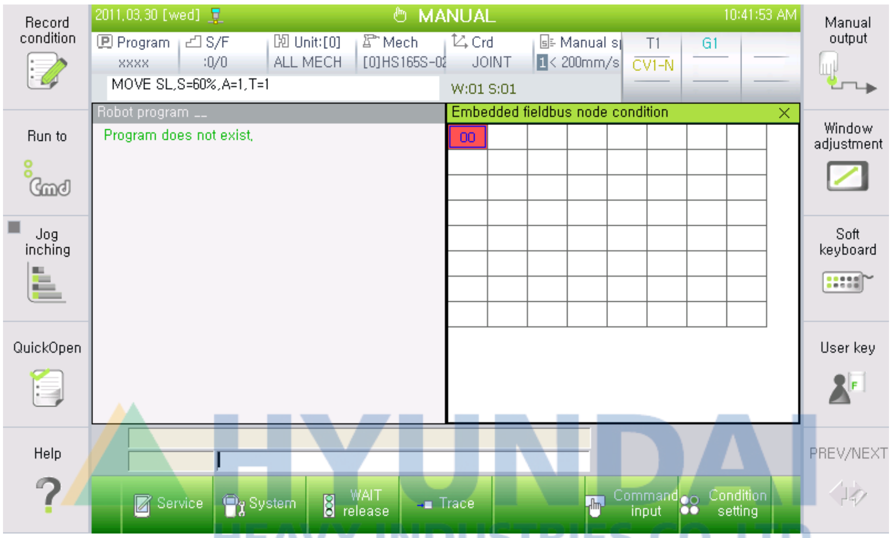


Figure 4.5 Embedded field bus node condition monitoring - 1

- Embedded field bus setting
  Press the [ENTER] key at the node #0 of the above embedded field bus node state monitoring screen, then, the screen will change to the embedded field bus setting screen, making it possible to search through nodes or check the detailed information of the connected nodes. Refer to 『[F2]: System』 → 『2: Control parameter』 → 『2: Input/output signal setting』 → 『12: Embedded field bus (Device Net) information and setting』 for explanation and details.

- Node error state
  The node colored in red on the monitoring screen is the one that has a problem. As shown in the above screen, the details associated with the error can be checked by moving the cursor to the relevant node and pressing the [ENTER] key.

- Master IDLE state
  If "IDLE" is displayed in the node #0, it is the case that the PLC is in the stopped state. When the PLC is off, the IDLE state that the robot controller's output signal is not delivered to the node is displayed.

■ Input/output signal monitoring

When you bring the cursor to the number of the node that is operating normally, and press the [ENTER] key, you can change to a screen that allows you to monitor the state of the input and output of the node, as the following figure.

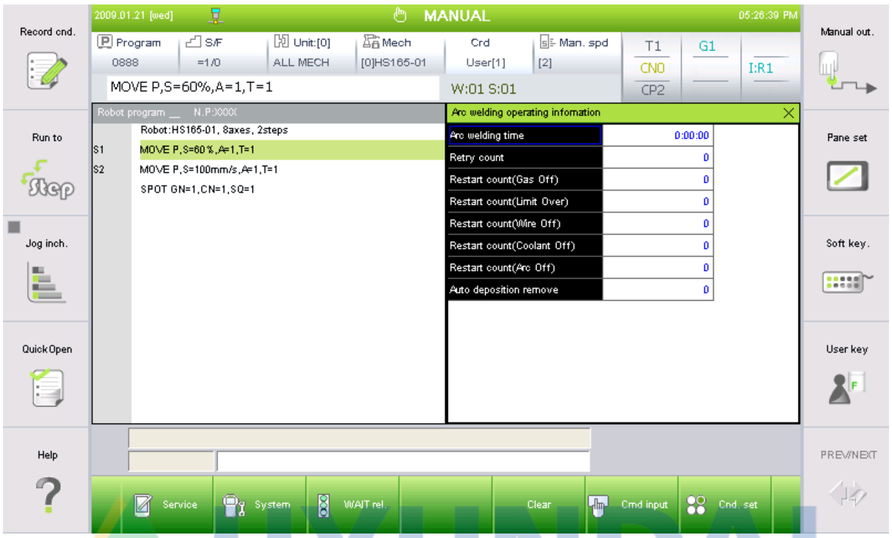
Figure 4.6 Embedded field bus node condition monitoring - 2

When the node input/output state monitoring window, is selected, as shown in the above figure, the F keys for node state, physical/logic, X/Y, Trace, display type, node (Prev FN), and next node (Net FN) will be shown, allowing you to change to the screen for monitoring the relevant items.

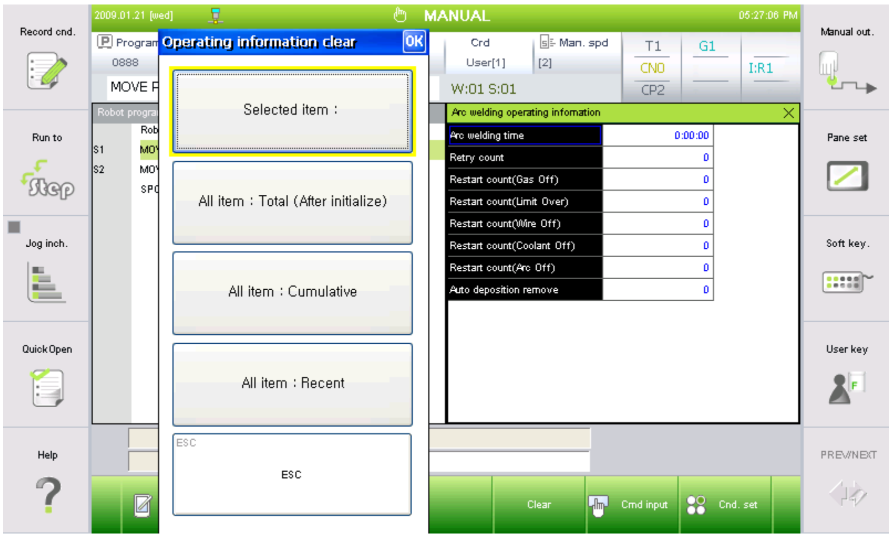
4.2.16. Arc welding operating information

This displays the operating information related to arc welding.

Select 『[F1]: Service』 → 『1: Monitoring』 → 『17: Arc welding operating information』.



- Arc welding operating information clear
  When the [Arc welding operating information] monitoring window is selected and activated, the 『[F5]: Clear』 button be displayed. Press this button.



You can clear the operating information from the created message box.

4.2.17. Multi-tasking state

When it comes to the multitasking, the program that is running automatically, steps, functions, activation state and work state in the current main task the subtasks 1 - 3 are displayed

Select『[F1]: Service』 → 『1: Monitoring』 → 『18: Multi-tasking state』.

Reference

- Refer to 『Hi5 Controller Multitasking Function Manual』 for details.

4.3. Register

You can display or change various registry value.

(1) Selection 『[F1]: Service』 → 『2: Register』. The register menu screen will be displayed as shown below. Detailed configuration of the menu will vary depending on the setting of the robot.

(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.

XYZ shift is a horizontal move function which shifts to other XYZ coordinates, maintaining a previously taught position. As seen on the right side, a source program with A, B, C, D can be horizontally shifted to a, b, c, d without additional teaching by using the XYZ shift function. Initialization to 0 will take place after the relevant cycle (Program end is executed).

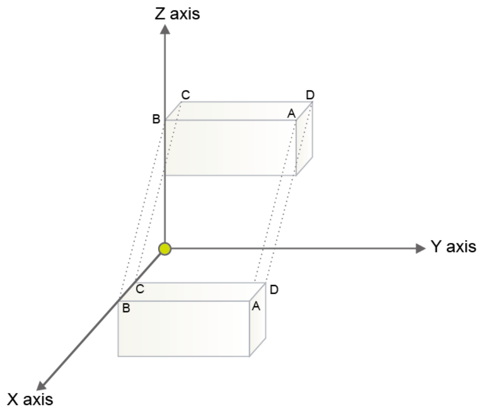
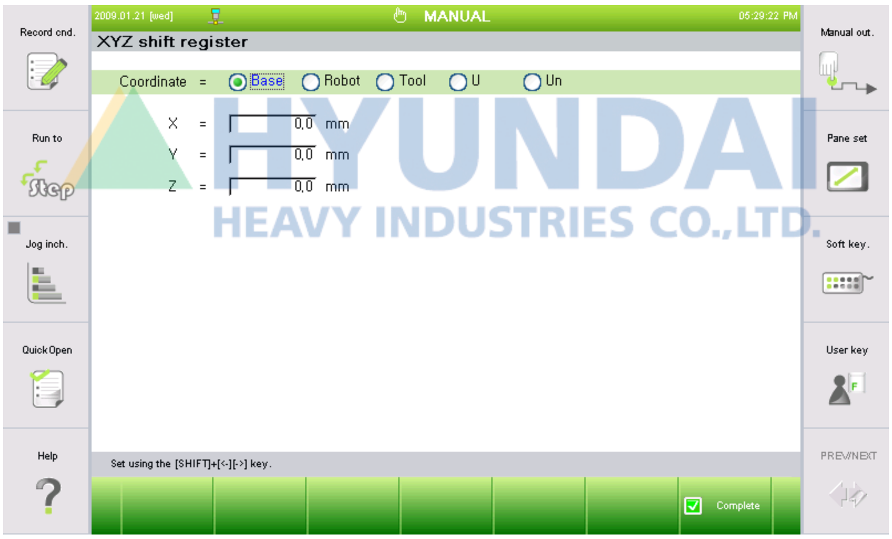


Figure 4.7 XYZ shift

(1) Selection 『[F1]: Service』 → 『2: Register』 → 『1: XYZ Shift Register』.



(2) Input data in X, Y, Z and press [ENTER]. To store changed setup, press 『[F7]: Complete』. If [ESC] is pressed, changed data will not be stored.

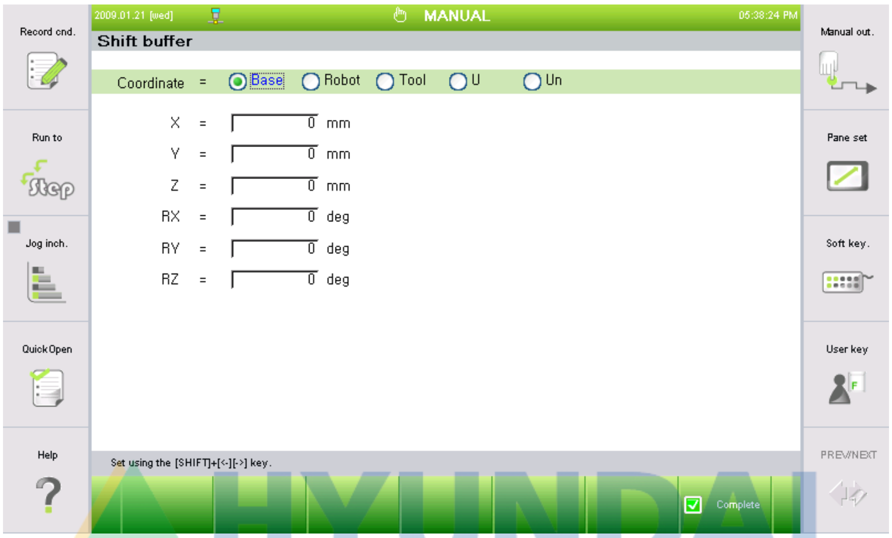
Reference

- If a shift value is set in 『SXYZ』 command, a register value will be automatically renewed.
- The change in the XYZ shift register during the operation of the robot is to be reflected when the next execution is implemented, once after the operation of the robot stops.

4.3.2. Shift Buffer

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

(1) Selection 『[F1]: Service』 → 『2: Register』 → 『2: Shift Buffer』.



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

(3) Input shift data and press [ENTER]. To store changed setup, press 『[F7]: 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.

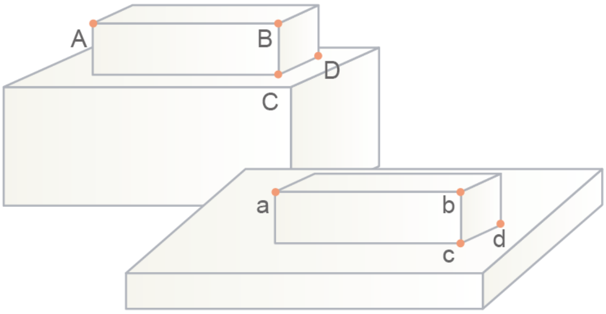


Figure 4.8 Horizontal move shift

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

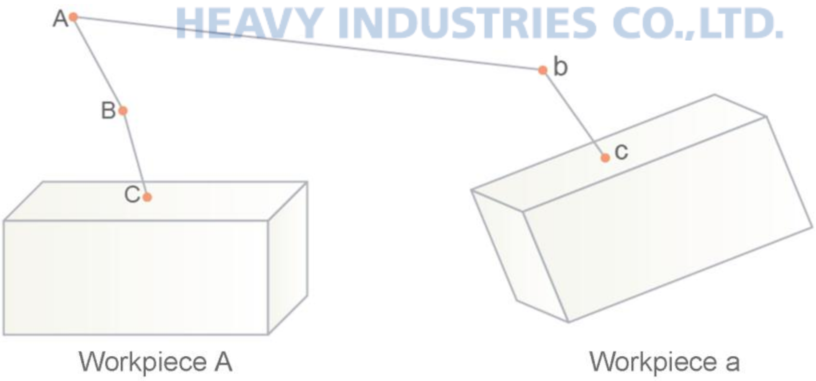
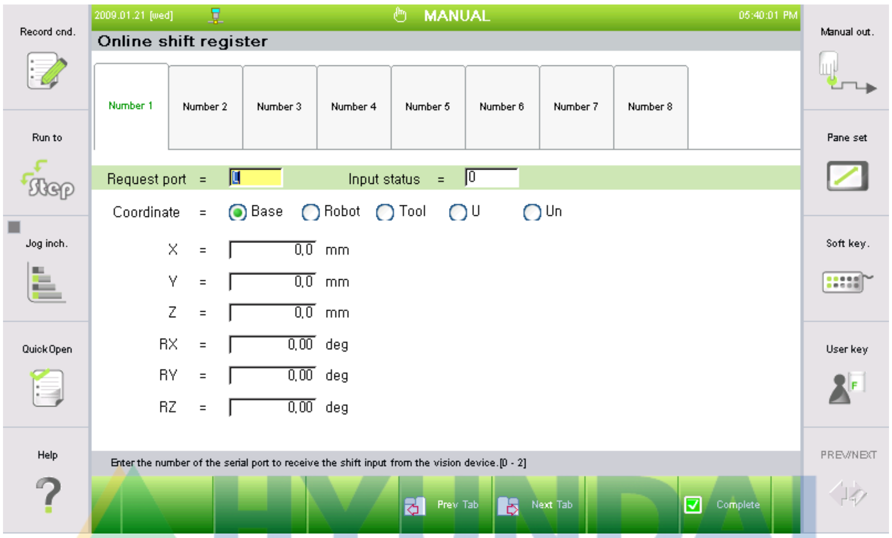


Figure 4.9 Angle revision shift

4.3.3. Online shift register

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 『[F1]: Service』 → 『2: Register』 → 『3: Online shift register』



(2) Input data and press [ENTER]. To store changed setup, press 『[F7]: Complete』. If [ESC] is pressed, changed data will not be stored.

- Request port
  Sets serial port number which receives shift amount from external devices

- Input status
  When shift amount is reflected on position data of step, Shift Input becomes 1.

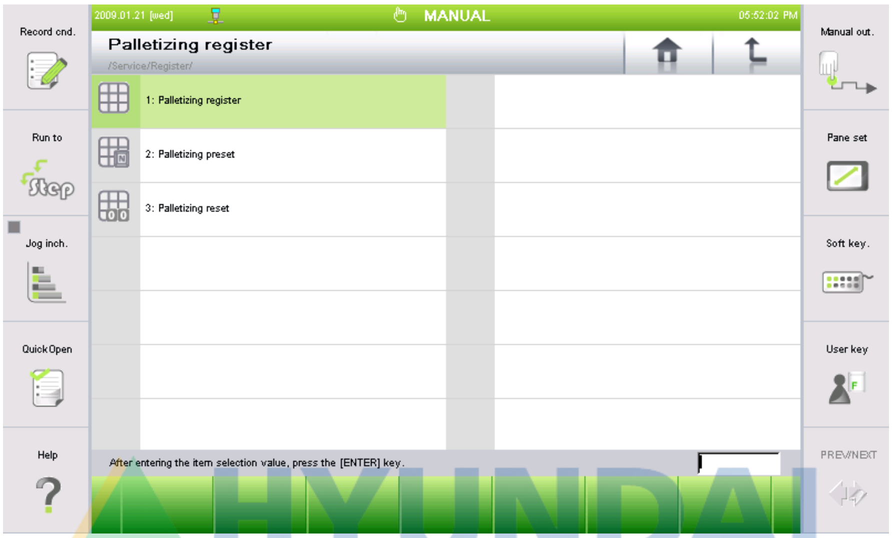
Reference

- Selection 『[F7]: Condition setting』 → 『[F1]: App.cnd』 → 『4: Online shift register clear』, and set <Enable>. Then, online shift register value automatically clears to 0 at beginning of a program.

4.3.4. Palletizing register

To use the palletizing function, enter the shift data and the counter preset and reset data. Refer to 『Hi5 Controller Palletizing Function Manual』 for details.

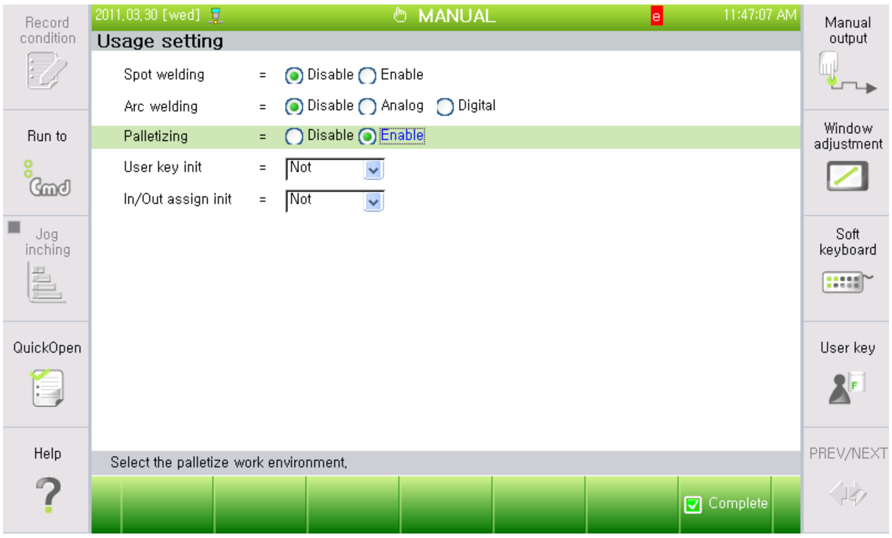
(1) Selection 『[F1]: Service』 → 『2: Register』 → 『4: Palletizing register』.



(2) Selection sub menu for individual setup.

Reference

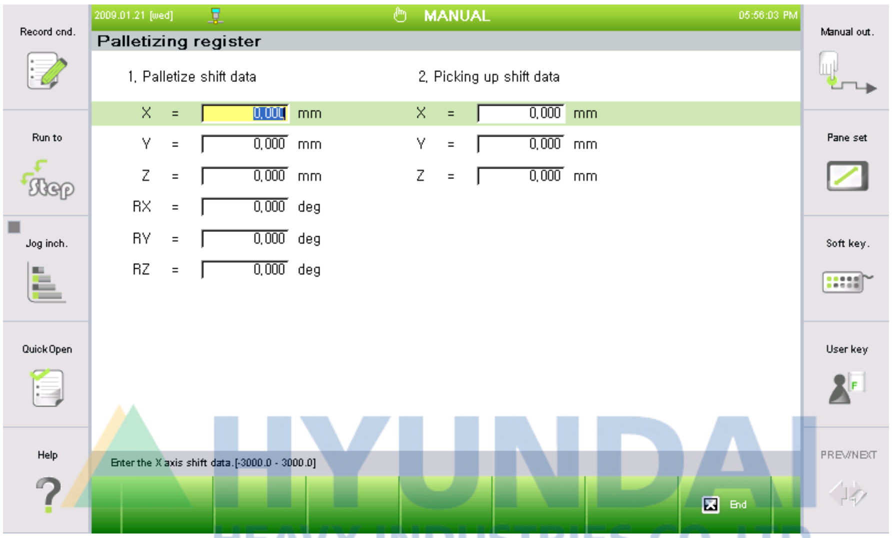
- To use palletizing register, selection 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』, and set “Palletizing=[Enable]”.



4.3.4.1. Palletizing register

Input the palletizing shift amount arbitrarily. You can set arbitrary values for the palletizing shift data and the picking-up shift data. Use this menu to check the palletizing amount and the coordinate during the work.

(1) Selection 『[F1]: Service』 → 『2: Register』 → 『4: Palletizing register』 → 『1. Palletizing register』.



(2) Input data and press [ENTER]. 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 workpieces are picked up.

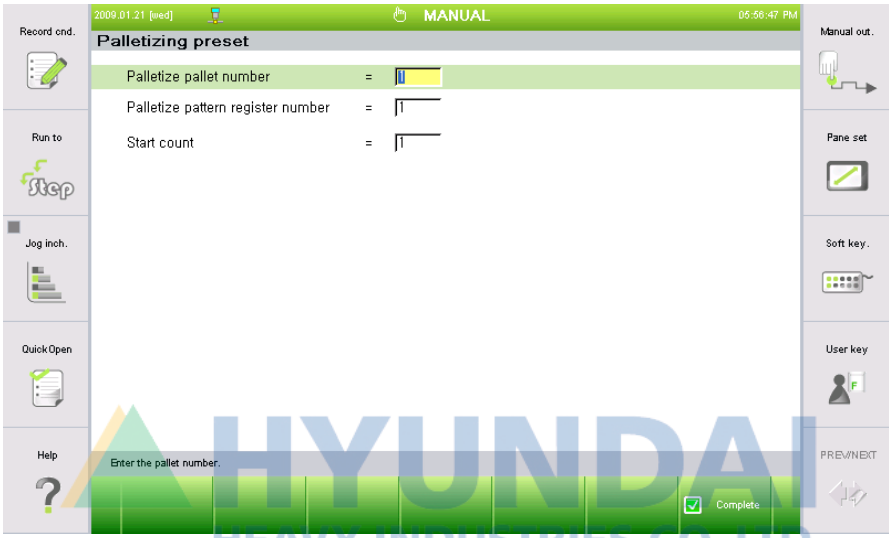
Reference

- When 『PAL』 and 『PALPU』 commands are executed, the shift amount is automatically updated.

4.3.4.2. Palletizing preset

This is to set the palletizing counter value arbitrarily. Palletizing starts with the set counter. This function is to set the palletizing pallet number, palletizing pattern register number and number of starting workpieces.

(1) Selection 『[F1]: Service』 → 『2: Register』 → 『4: Palletizing register』 → 『2: Palletizing preset』.



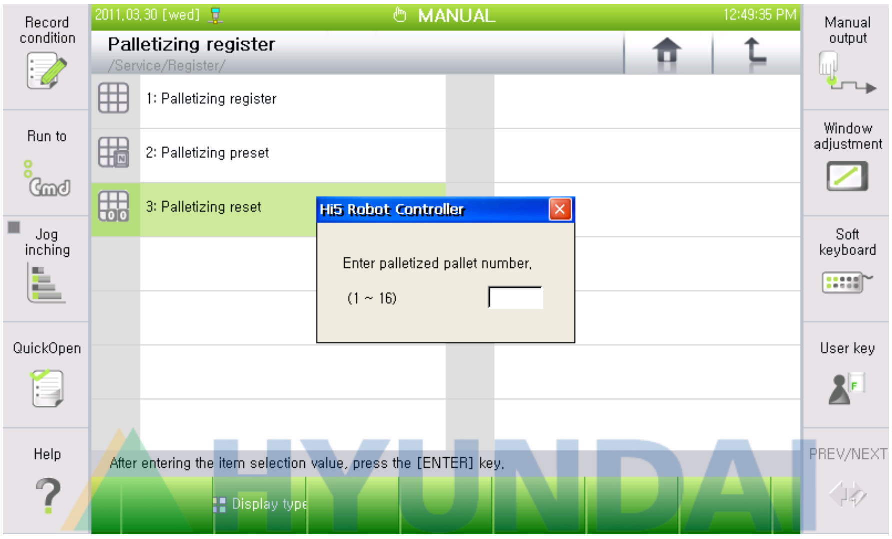
(2) Input data and press [ENTER]. To store changed setup, press 『[F7]: Complete』. If [ESC] is pressed, changed data will not be stored.

- Palletize pallet number: Pallet number when work begins.
- Palletize pattern register number: Pattern register number to be used for starting work.
- Start count: Workpieces is to set which workpiece should be the first one on a pallet.

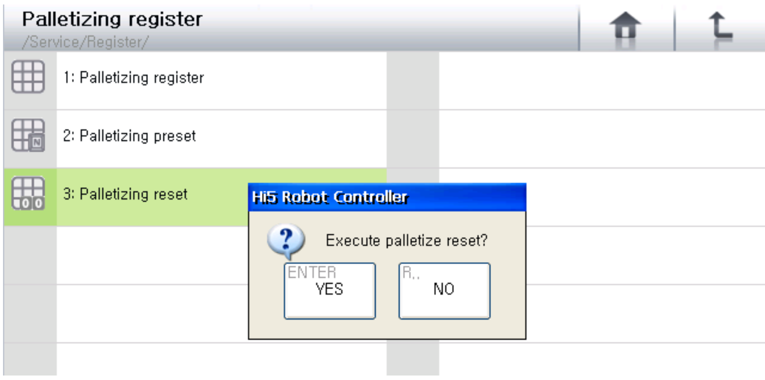
4.3.4.3. Palletizing reset

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

(1) Selection 『[F1]: Service』 → 『2: Register』 → 『4: Palletizing register』 → 『3: Palletizing reset』.



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



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

4.3.5. Frequency register

You can set the value for the frequency register of the system parameter or check the current setting value. The frequency register is a constant type register as well as a counter parameter with a constant vale. This is mainly used for the branch condition and the counting, for example, on the program, while the value saved in the register can be checked and changed using this menu.

Selection 『[F1]: Service』 → 『2: Register』 → 『5: Frequency register』.

Reference

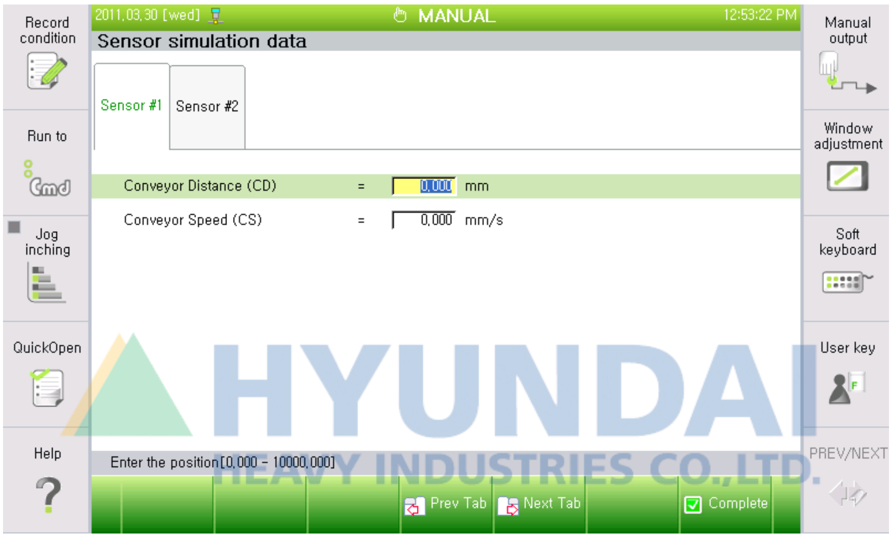
- This menu can be accessed through『R18: Frequency condition register』 of R code.

4.3.6. Sensor simulation data

Refer to 『Hi5 Controller Sensor Synchronization Function Manual』 for details. If set when the sensor synchronization function is enabled as the conveyor or press mode is used, the robot performs the playback of the simulation according to the speed and distance set by the user. .

(1) Select 『[F1]: Service』 → 『2: Register』 → 『6: Sensor simulation data』.

(2) To save the changed setting, press the 『[F7]: Complete』 key. When you press the [ESC] key, the changed data will not be saved.



- Conveyor Distance/Press Distance: Indicates the current position of the conveyor/press.
- Conveyor speed/Press speed: Designate the conveyor/press moving speed

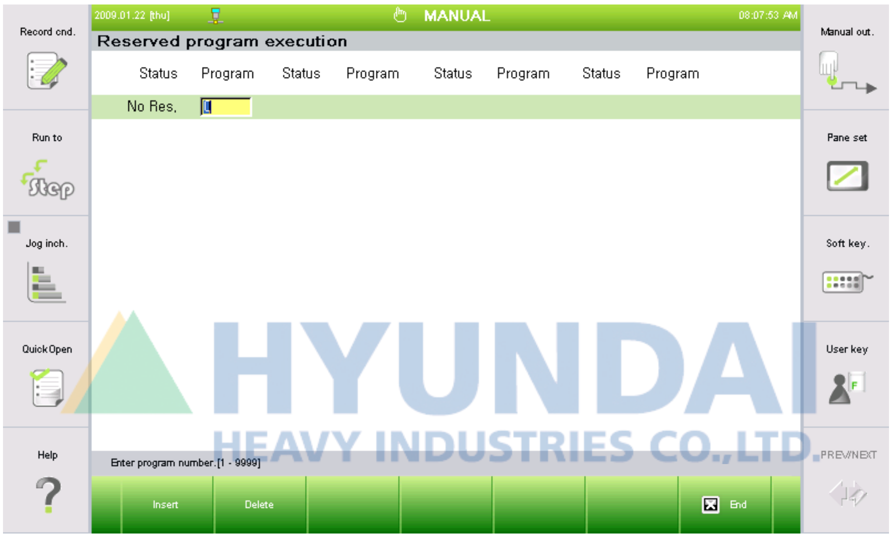
Reference

- This menu will be enabled when the sensor synchronization function, among the applied functions, is set for the use of conveyor or press.

4.3.7. Reserved program execution

When reserving the program through external signal and executing the program in order, this is the function to check, change, insert or delete the currently reserved program. When reserving the program through external signal and executing the program in order, this is the function to check, change, insert or delete the currently reserved program. Depending on the setting, 20 or 1 program can be set for reservation wait. If a program is executed through the remote control once after the setting is finished, the reserved program will be automatically executed after the currently running program ends. For details, refer to the functional manual of the reserved execution of the program.

(1) Selection 『[F1]: Service』 → 『2: Register』 → 『7: Reserved program execution』.



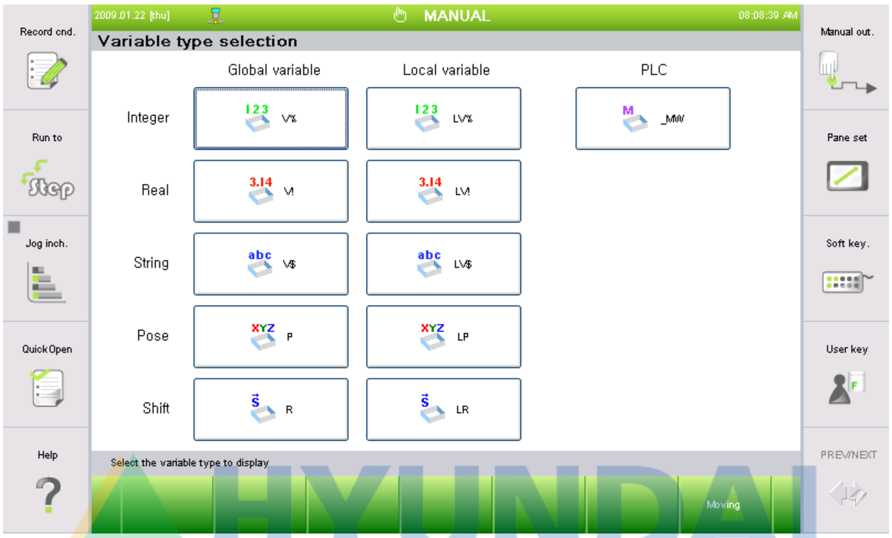
(2) 『[F1]: Insert』 : Add or insert the reserved program.

(3) 『[F2]: Delete』 : Delete the reserved program.

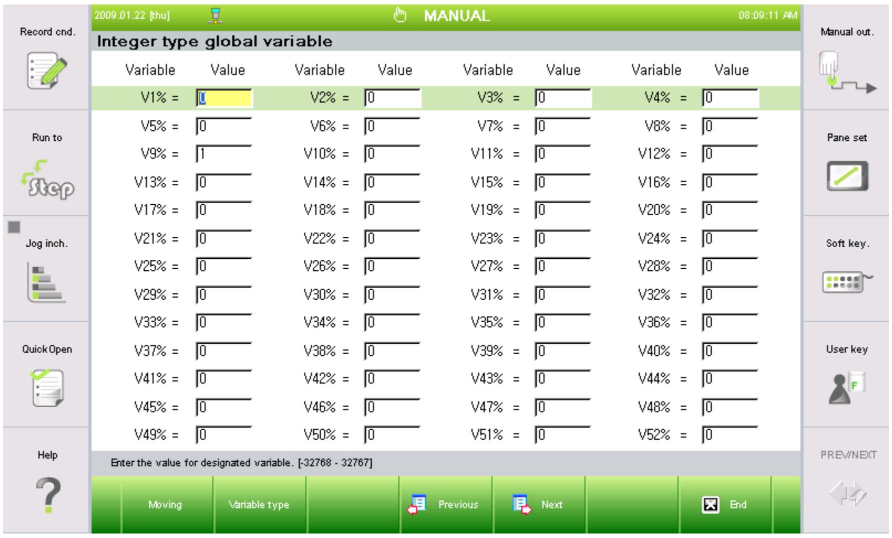
4.4. Variable

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

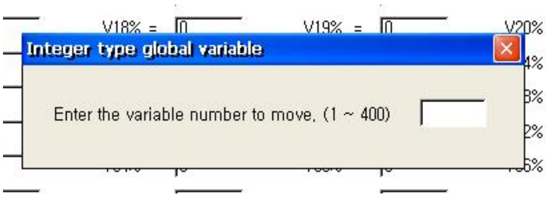
(1) Selection 『[F1]: Service』 → 『3: Variable』.



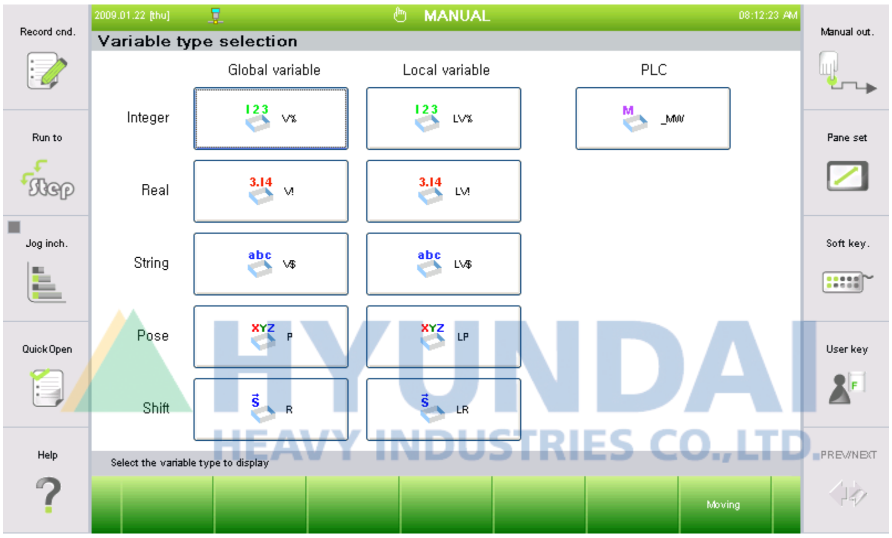
(2) All parameters of the selected type will be displayed. Use the arrow direction key to move to the desired parameter and enter the new value. And then when you press the [ENTER] key, the entered value will be set.



(3) You can press the 『[F1]: Moving』 key and move to the parameter of the specific number.



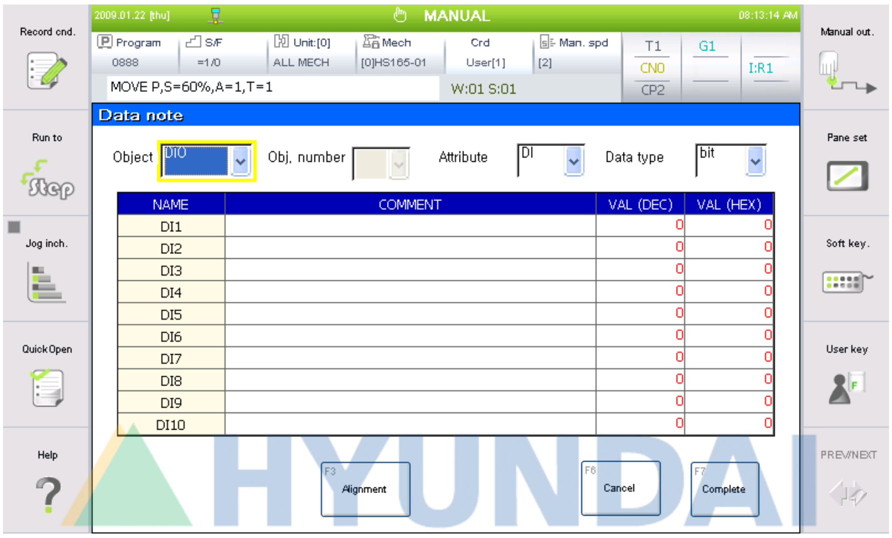
(4) When you press the 『[F2]: Variable type』 key, it will return back to the parameter type selection screen.



4.5. Data note

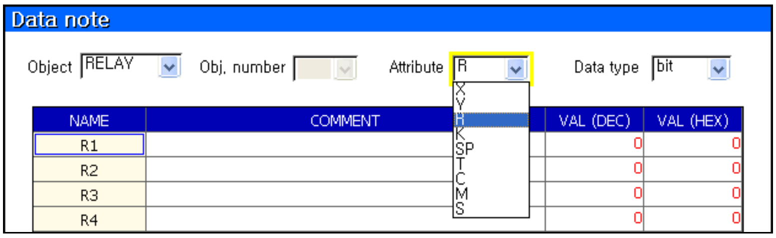
You can add a note for each relay of the embedded PLC. Set note is displayed on the various data monitoring windows and saved as \Resident Flash\datacmt.txt file. This file format is compatible with the function of 『Import relay description』 / 『Export relay description』 of HRLadder.

(1) Select 『[F1]: Service』 → 『4: Data note』.

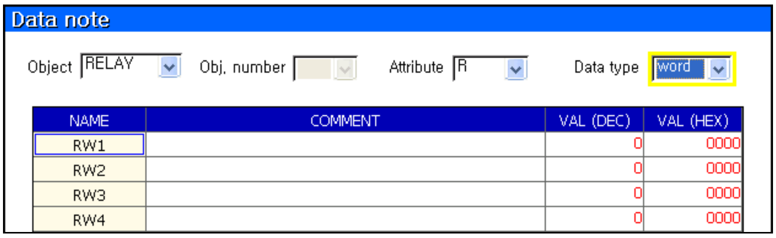


(2) Yellow rectangular label shows which control is the focus of the current key pad operation. When you press the arrow key, you can move this focus to the prior/next control.

(3) When you set the focus on the dropdown list on the top of the screen and press the [ENTER] key, the items that can be selected will be displayed. First, select the object and object number and then select the detail item through property.



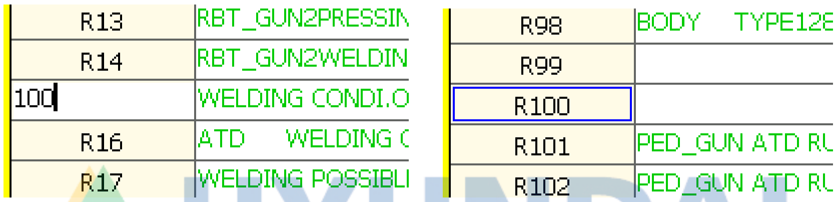
(4) Adjust the data type dropdown list to change the display method.



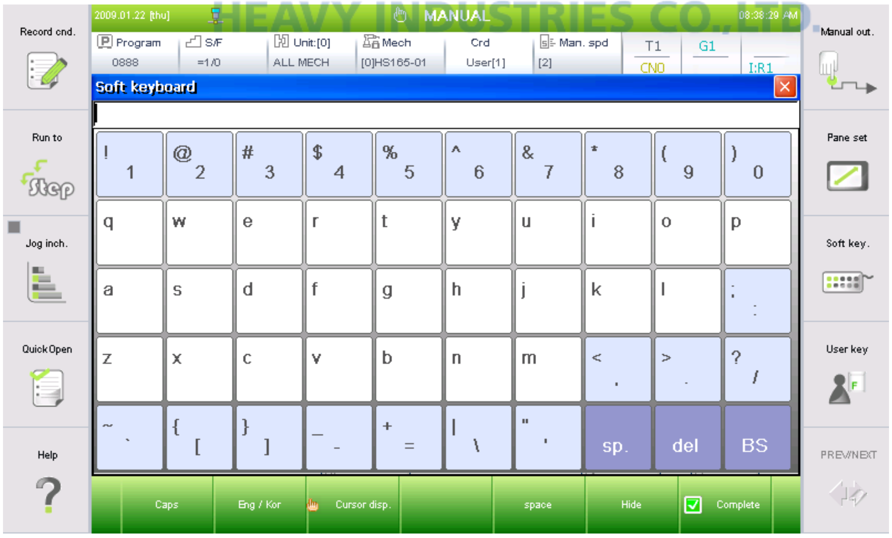
(5) When the focus is on the note table, you can use the arrow key [⇑] [⇓] to move the cursor to another relay. When you press [SHIFT] + [⇑] [⇓], you can move faster.

NAME	COMMENT	VAL (DEC)	VAL (HEX)
R10	BUZZER STOP_AUX	0	0
R11	RBT_GUN PRESSINGAUX	0	0
R12	RBT_GUN WELDING COMPLETEAUX	0	0
R13	RBT_GUN2PRESSINGAUX	0	0
R14	RBT_GUN2WELDING COMPLETEAUX	0	0
R15	WELDING CONDI.OKAUX	0	0
R16	ATD WELDING CONDI.OKAUX	0	0
R17	WELDING POSSIBLEAUX	0	0
R18	ATD CONDI.OKAUX	0	0
R19	RBT GUN ATD RUN AUX	0	0

(6) Enter the relay number next to the name and press the [ENTER] key to immediately move to the applicable relay.



(7) When you press the [Soft keyboard] key in the note column, you can edit the note.

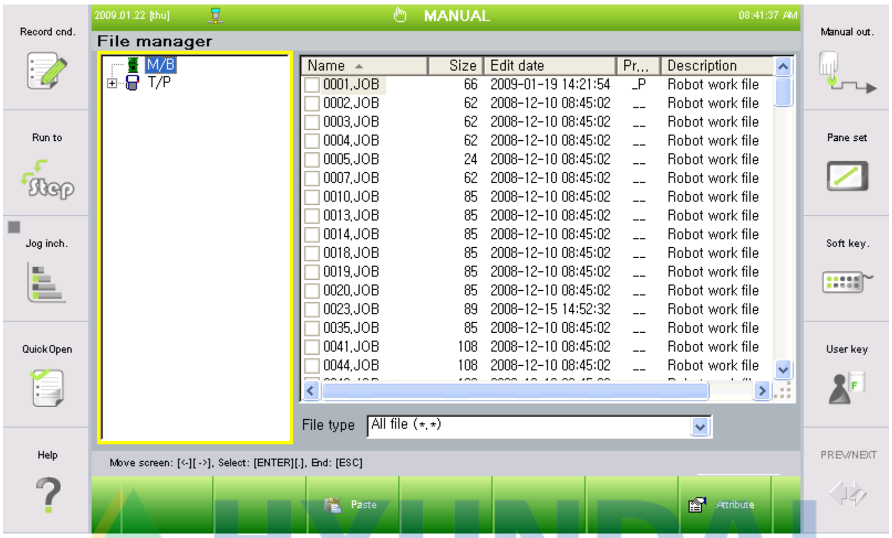


(8) When you press the 『[F3]: Alignment』 key, you can sort the whole data note in an appropriate order. Be careful that sorting can take a long period of time depending on the condition. Because the data notes are displayed is sorted format, you do not need to sort every time. Unsorted datacmt.txt file is imported externally and execute this function once only when you want to sort and save the file.

4.6. File manager

You can manage the file of internal memory of the main board, teach pendant or USB memory.

(1) Selection 『[F1]: Service』 → 『5: File manager』.

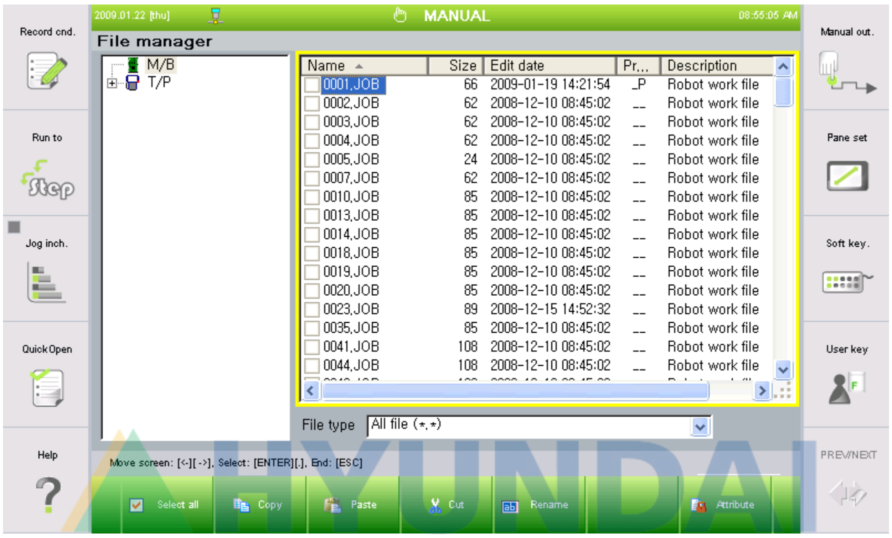


(2) Yellow rectangular label shows which window is currently the focus of the current key pad operation. You can use the arrow key [<=] [=>] to move this focus to a different window.

Reference

- This is the same function as the 『R17: File Manager』 of R Code
- Once USB memory is installed, the icon will appear the title bar. Please do not remove the USB memory while a file management (copy, delete) is being operated.

(3) The left side of the screen shows the tree window that shows the 3 devices, M/B (Main board), T/P (Teach pendant) and USB (USB external memory) and the sub folders.
(USB is displayed when the USB memory is installed on the teach pendant.)
When you press the arrow keys [⇑] [⇓], you can move the cursor between the nodes of the tree.
Select the node with the ⊞ sign and press the [ENTER] key to display the sub nodes. Select the node with the ⊟ sign and press the [ENTER] key to hide the sub nodes.



(4) The top right part of the screen is the file list window that displays the file list within the selected folder from the tree window. This displays the name, size, edited date, protection and description of each file.

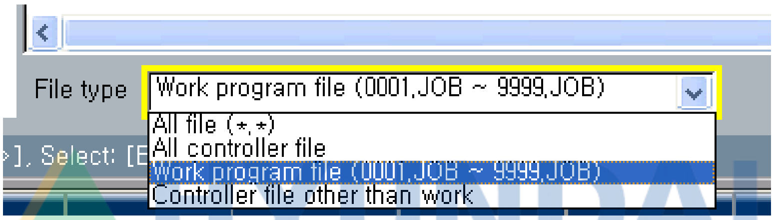
Name	Size	Edit date	Pr...	Description
0001.JOB	14	2008-03-12 09:43:14	__	Robot work file
0002.JOB	14	2008-03-12 09:56:38	__	Robot work file
0003.JOB	15	2008-03-12 10:23:14	__	Robot work file
0004.JOB	5	2008-03-12 10:35:14	__	Robot work file
ROBOT.AAE	65	2008-03-12 09:55:12	__	Arc welding end cor
ROBOT.AAP	129	2008-03-12 09:55:12	__	Arc welding unique

(5) [Size] column displays the file size and the unit for M/B is number of blocks, and for T/P or USB, the unit is byte.

(6) [Protection] column displays the file protection condition. The meaning of the displayed symbol is as follows.

--	No protection	W_	Complete protection
WP	(Complete + Playback) protection	S_	Partial protection
SP	(Partial + Playback) protection	_P	Playback protection

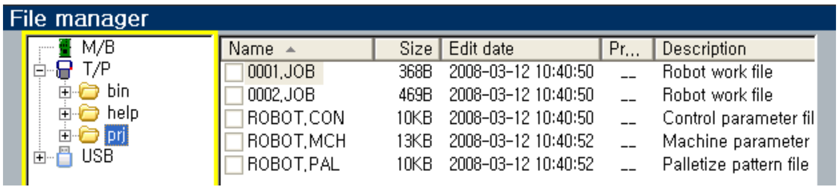
(7) There is a dropdown list box that you can select the file type to display from the file list at the bottom right side of the screen.
You can use the arrow keys [<=] [=>] to set the focus on the file type list box and then use the arrow keys [⇑] [⇓] to select the type. (You can press the [ENTER] key to open and close the dropdown menu of the file type list box.)



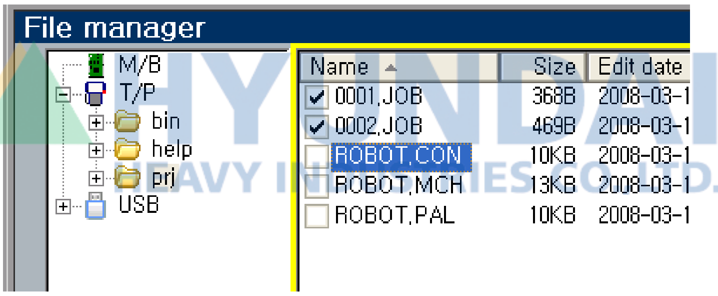
4.6.1. Copy/Paste/Delete file

You can copy, paste and delete one or several files.
(When copying the file within the main board, the property of the copied file will not be included because the property or date cannot be copied. The current time will be copied as the date. When copying the file within T/P or USB memory, the date and property are also copied.)

(1) Set the focus to the folder tree window and select the folder you want.



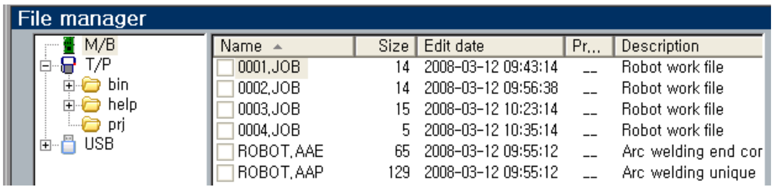
(2) Move the focus to the file list window.
Use the arrow keys [⇑] [⇓] to set the cursor to the file you want to copy and select the file by press the [ENTER] key. A check sign is displayed on the left side of the selected file name.
You can select several files in the same method.



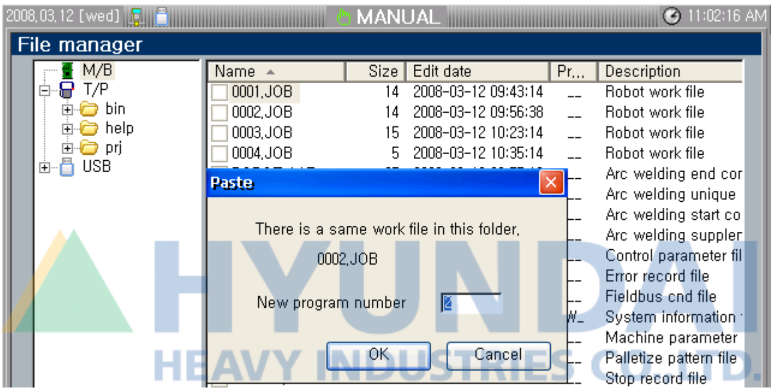
(3) To cancel the selection, press the [ENTER] key one more time.
When you press the 『[F1]: Select all』 key, all the files currently displayed will be marked with the check sign. If you press [ESC], all the “marked” will be canceled

(4) When you press the 『[F2]: Copy』 key, all the selected files will first be copied to the clipboard of the teach pendant (actually to a temporary folder).
(If there is only 1 file to copy, you can also press the 『[F2]: Copy』 key without checking the file.)

(5) After moving the focus to the folder tree window again, select the target folder to copy the files to.



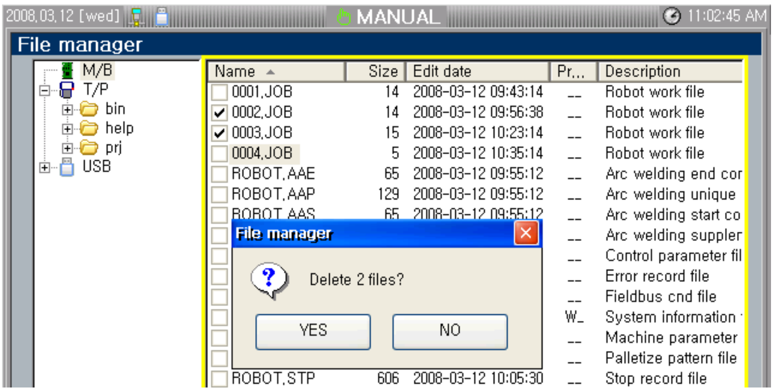
(6) Press the 『[F3]: Paste』 key to copy the files on the clipboard to the selected folder. If the work file of same number already exists, it will request for a different work file number. Enter an appropriate number in this case.
(You can use this function to copy the same work file in the same folder to a different number.)



(7) If there is a file with the same file name as the work file, it will prompt you to ask whether to overwrite the file.

If this dialog appears when number of files are selected, you may press [.] to mark “Apply to all’ and select “Yes” or “No”. This will apply the same selection to the all other files

(8) To delete the file, set the focus to the file list window and select the file you want to delete. And then press the 『DEL』 key.
(When the file property is set to fully protect or partially protected, the file cannot be deleted.)

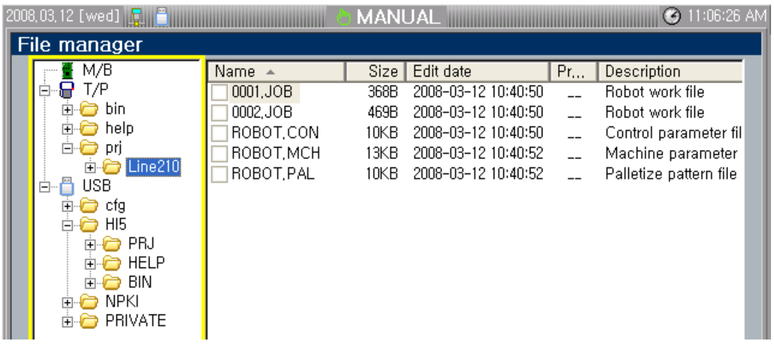


(9) A message box will be displayed to confirm to delete the file and then press the [ENTER] key to delete the file.
(When there is only 1 file to delete, you can use the 『DEL』 key directly without checking the file.)

4.6.2. Copy/Paste/Cut folder

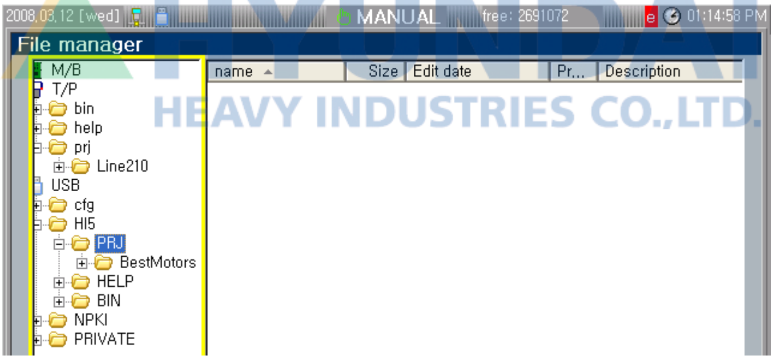
You can copy, paste and delete one folder and all the folders and files under that folder.

(1) Set the focus on the folder tree window and move the cursor to the folder you want to select.

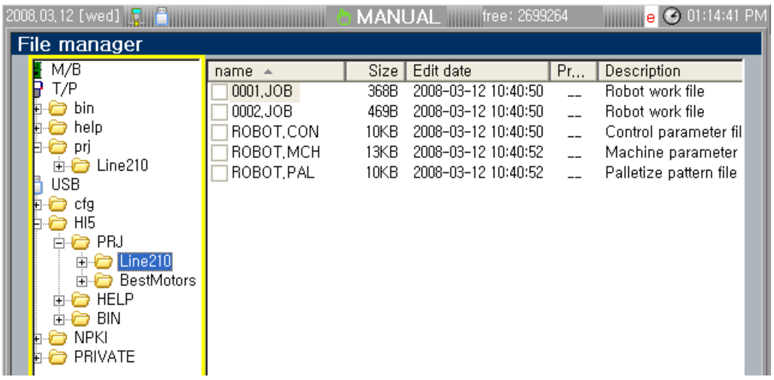


(2) When you press the 『[F2]: Copy』 key, you can copy the selected folder and all the folders and file under that folder to the clipboard (actually to a temporary folder).

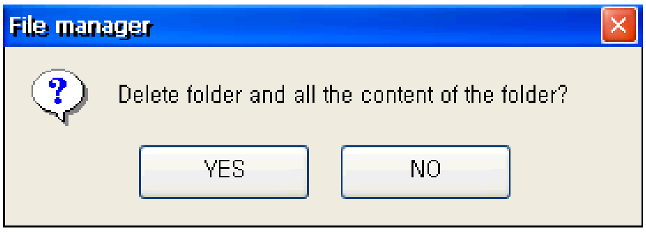
(3) Select the target folder to paste the folder copied from the folder tree window.



(4) When you press the 『[F3]: Paste』 key, the folder copied to the clipboard will be copied as the sub folder under the selected folder.



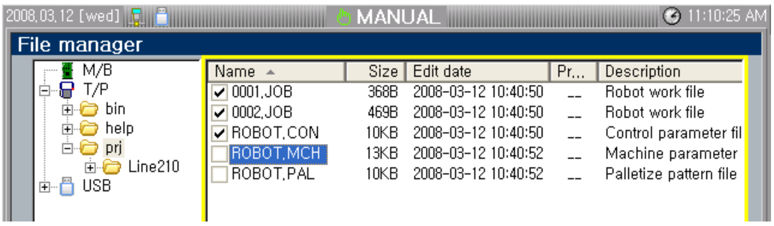
(5) To delete the folder, set the focus to the folder tree window and select the folder you want to delete, and then press the 『[F4]: Cut』 key. A message box will be displayed to confirm to delete the folder and then press the [ENTER] key to delete the file.



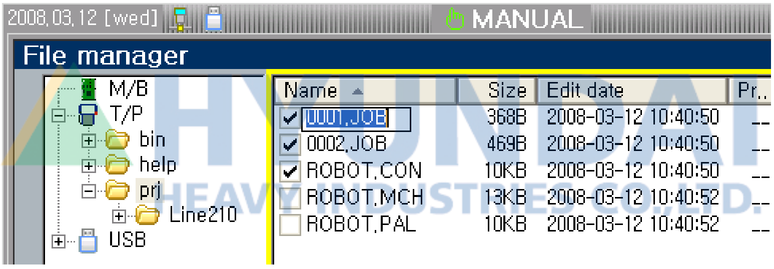
4.6.3. Rename file

You can change one or several file names.
When the number is changed, all information [Date, property…] will be maintained. You can change the number for the protected file as well. R116 of R code: This is the same function as the change in program number.

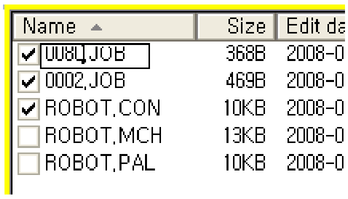
(1) Set the focus on the file list window and select the file to rename.



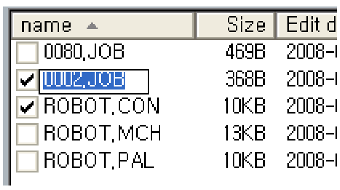
(2) When you press the 『[F5]: Rename』 key, the selected file names will switch to edit condition.



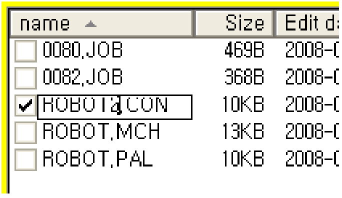
(3) When you are entering only the numbers, you can use the [SHIFT] + [<=] [=>] key to move the cursor and use the [Backspace / DEL] and number keys to rename the file.



(4) When you press the [ENTER] key the edit will be completed, and the next file will be in edit condition.



(5) You can only rename files other than the work file in the T/P or USB mode. You can only rename the work file in M/B.

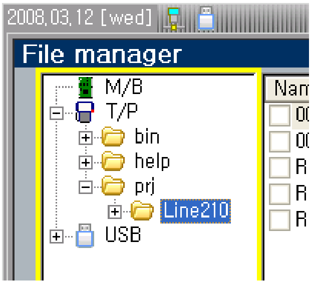


(6) When you have to enter characters besides numbers, press the [Soft keyboard] key in the edit condition of the file name and use the soft keyboard to edit the name.

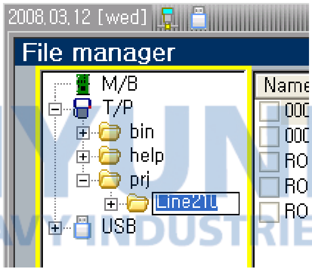
4.6.4. Rename folder

You can rename the folder.

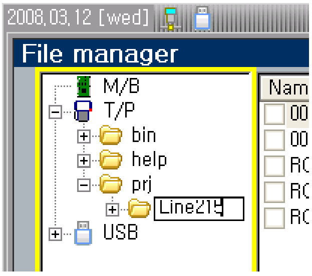
(1) Set the focus on the folder tree window and select the folder you want to rename by moving the cursor.



(2) When you press the 『[F5]: Rename』 key, the folder name will switch to edit condition.



(3) When you are entering only the numbers, you can use the [SHIFT] + [<=] [=>] key to move the cursor and use the [Backspace / DEL] and number keys to rename the folder. When you press the [ENTER] key, the edit will be completed.

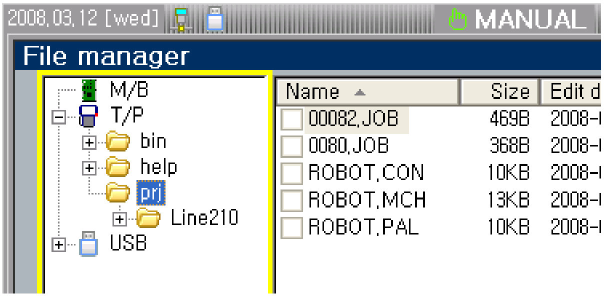


(4) When you have to enter characters besides numbers, press the [Soft keyboard] key in the edit condition of the folder name and use the soft keyboard to edit the name.

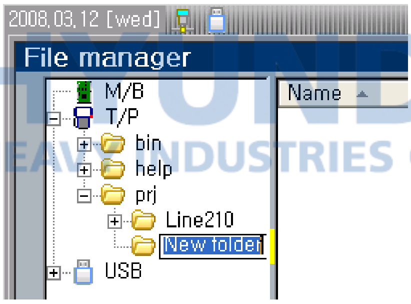
4.6.5. Create new folder

You can create a new folder in T/P or USB.
(You cannot create a new folder in M/B.)

(1) Set the focus on the folder tree window and move the cursor to the folder you want to create a new folder.



(2) Press the 『[F6]: New folder』 key to create a new folder as a sub folder of the selected folder.

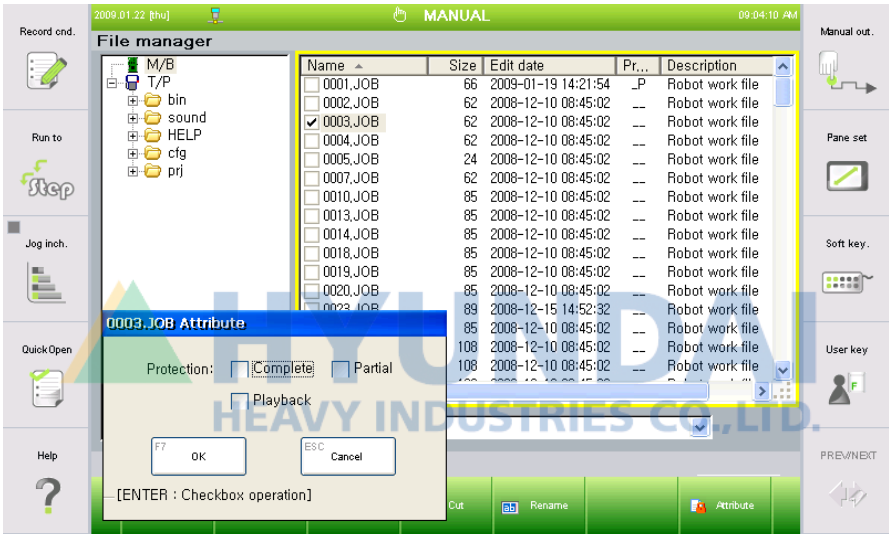


(3) Use the rename method to designate a new name.

4.6.6. Edit property

You can edit the property of one or several file names.
You can protect important files by prohibiting changing the program or deleting the file. When you set to fully protected, the file cannot be edited or deleted, and if you set the file to partially protected, only the location can be edited from the fully protected and when the playback function is set to be protected, the program protects the file from playing or moving the steps forward. For the files within T/P or USB, you can only enable fully protected option.

(1) Set the focus on the file list window and select one or several files to change the property of, and the press the 『[F7]: Attribute』 key. The following property change message box will be displayed.



(2) You can use the arrow key to move the cursor and toggle the check mark with the [.] key. After editing the property, press the [ENTER] key to complete the edit.
(When you have selected several files, new property will be applied to all the files in a batch process.)

Reference

- The properties of M/B files are only to be modified by the engineer for safety reasons.
- You can apply all properties for the work file of M/B.
- You cannot apply the playback protection for other files of M/B besides the work file.
- You can only apply fully protected option for the T/P or USB file.
(Fully protected corresponds to read only in the Windows file system.)
- Even though the record file is fully protected, it will still continue to be updated.
- Even through the program is playback protected, you can still execute the program is you execute from the midpoint of the program and not the start.
- You can only set between complete protection (W) and partial protection (S). But playback protection (P) can be applied with complete protection (W) or partial protection (S).

4.7. Program conversion

This provides the function of editing various record conditions and locations of the existing program individually or in a batch process, or the function of creating a new program with the coordinates converted.

Selection 『[F1]: Service』 → 『6: Program conversion』.

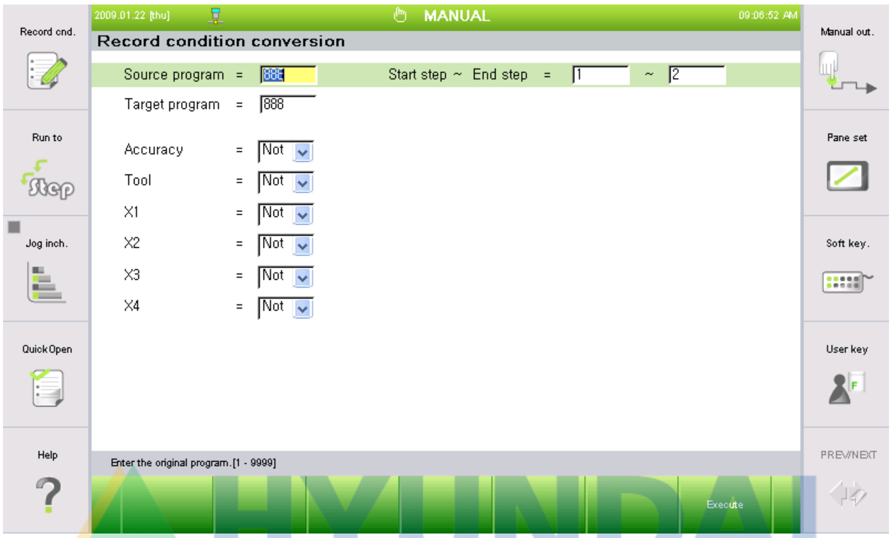
Reference

- You cannot enter the『4: Record coordinate』, 『5: Coordinate transfer』, 『6: Mirror image』, 『7: Step copy』 while the robot is operating.

4.7.1. Record condition

You can change the condition recorded for various steps within the program to create the same or new program.

(1) Select 『[F1]: Service』 → 『6: Program conversion』 → 『1: Record condition』.



(2) Execute with 『[F7: Execute]』 key after changing the condition.

- Source program : Number of the source program to change the condition of

- Target program
  Number of the target program to save after changing the condition
  If the number is the same as that of the source program, it will be overwritten.

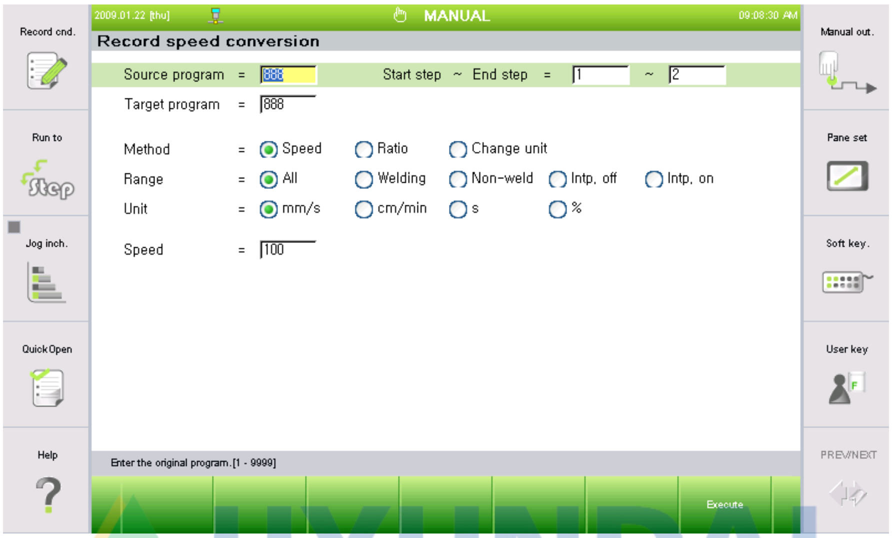
- Start step ~ End step
  Range of steps to change the record condition. (Default value 1~ End step)

- User sets the conditions including accuracy, tool, X1, X2, X3 and X4 condition from the start to end step.

4.7.2. Record Speed

You can change the speed of several steps of the program at once.

(1) Select 『[F1]: Service』 → 『6: Program conversion』 → 『2: Record speed』



(2) To save the changed setting, press the 『[F7]: Execute』 key. When you press the [ESC] key, the changed data will not be saved.

- Source program
  Number of source program to change the speed.
  (Default value is the program number currently selected)

- Target program
  Number of the target program to newly save after changing the speed
  If the number is the same as that of the source program, it will be overwritten.

- Start step ~ End step
  Range of steps to change the speed. (Default value is 1~ End step)

- Method: Decide the speed designation method.
  Speed designation: Batch conversion of recorded speed
  Percentage designation: When the speed unit recorded is the same as the designated unit in [Unit], you can use this to convert to a specific percentage for the recorded speed
  Unit conversion: Use this to convert the unit of the recorded speed

- Range
  Select from the range (steps) to change the speed whether to apply to all intervals or just to the welding, non-welding, interpolation OFF (P) or interpolation On (L, C) part.

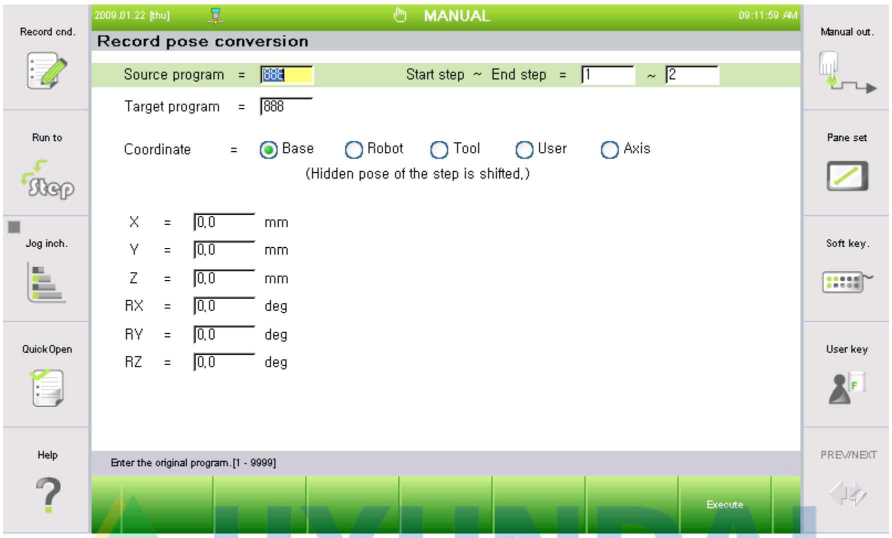
- Unit
  If the [Method] is set to <Speed> or <Change unit>, then you can change the speed in the set unit here. If it is set to <Ratio>, it will convert to the ratio of the percentage only when the recording speed unit on the step is aligned.

- Speed: (Changes by the selection of [Method])
  When the [Method] is set to <Speed>, it refers to the speed value and if set to <Ratio>, it refers to the percentage value.

4.7.3. Record Position

You can change the coordinate system of the step location recorded with hidden pose.

(1) Select 『[F1]: Service』 → 『6: Program conversion』 → 『3: Record position』.



(2) After entering the data, press the 『[F7]: Execute』 key. When you press the [ESC] key the changed data will not be saved.

- Source program: Number of the source program to change

- Target program
  Location where the changed program will be saved.
  If the number is the same as that of the source program, it will be overwritten.

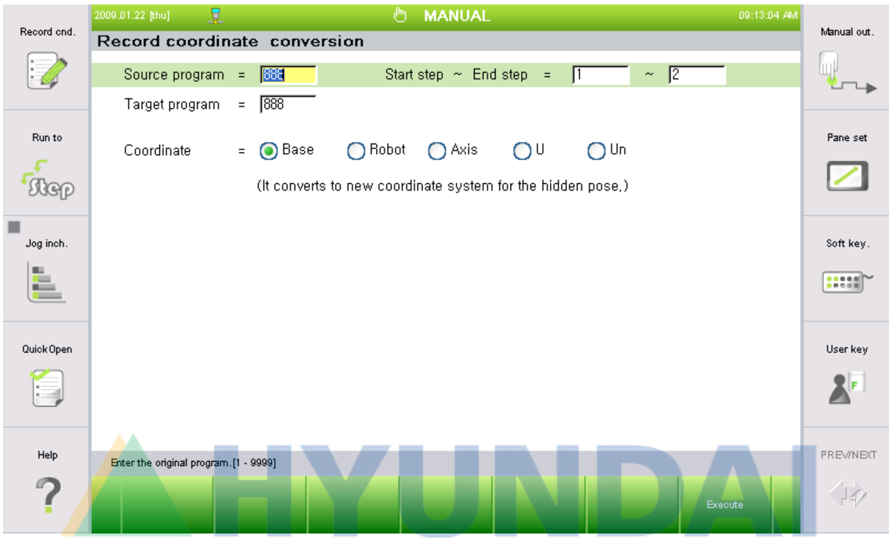
- Start step ~ End step
  Range of steps to change the record location. (Default value is 1~ End step)

- Coordinate
  Select the coordinate system to shift the location data recorded in the step. Base, robot, tool and user coordinate systems can be shifted in Cartesian coordinate value and axis can be shifted in axis angle.

4.7.4. Record Coordinate

You can change the coordinate system of the step location to record with hidden pose. You can change the coordinate system of the step location to record with hidden pose. The changed coordinate system can be checked by pressing the Quick Open button in the relevant step.

(1) Select 『[F1]: Service』 → 『6: Program conversion』 → 『4: Record coordinate』



(2) After entering the data, press the 『[F7]: Execute』 key. When you press the [ESC] key the changed data will not be saved.

- Source program : Number of the source program to change

- Target program
  Location where the changed program will be saved.
  If the number is the same as that of the source program, it will be overwritten.

- Start step ~ End step
  Range of steps to change the record location. (Default value is 1~ End step)

- Coordinate
  Select the new coordinate system to designate. You can select from base, robot, axis, current user (U) and number designation user (Un) coordinate system.

4.7.5. Coordinate conversion

Through this coordinate conversion function, once after teaching a program for the workpiece shown in the <Figure 1>, the program can be easily prepared for another workpiece of the same shape placed in a different position as shown in <Figure 2> without additional teaching

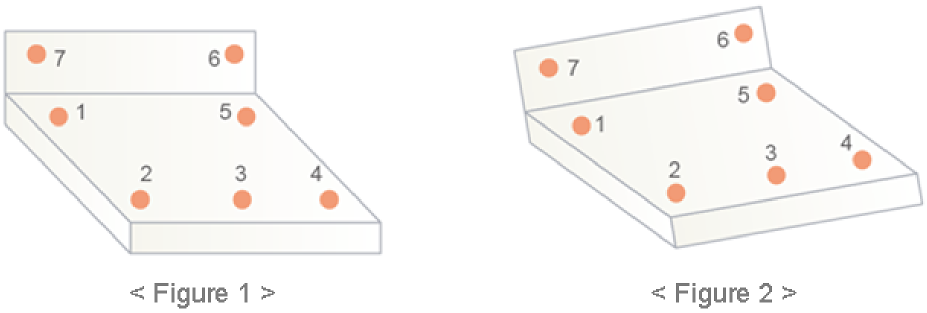
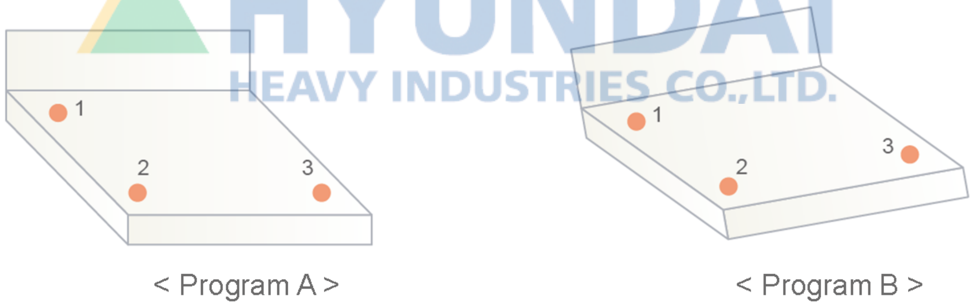


Figure 4.10 Coordinate conversion

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



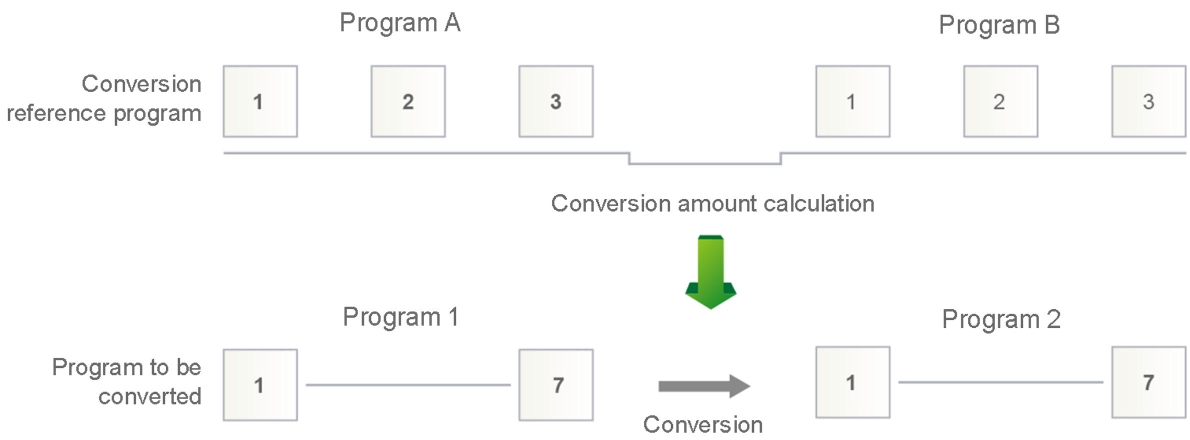
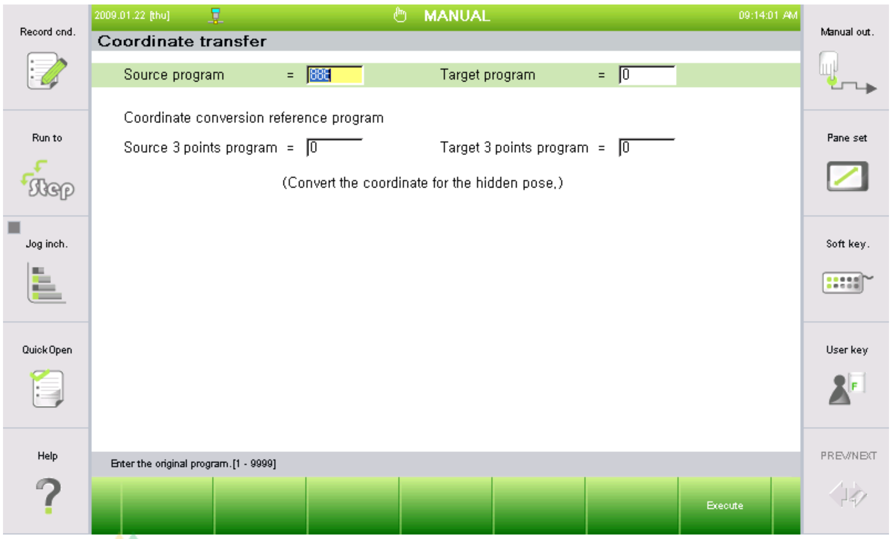


Figure 4.11 Coordinate conversion Program

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

(1) Selection 『[F1]: Service』 → 『6: Program Conversion』 → 『5: Coordinate transfer』.



(2) After data setup, press 『[F7]: Execute』.

- Source program : Existing teaching program number (Program number of [Figure. 1])

- Target program
  Program number to newly create by executing coordinate conversion (Program number of [Figure. 2])

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

- Target 3 points program
  Program number in which the 3 points of reference for conversion are recorded ([Program B] number)

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.

4.7.6. 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.

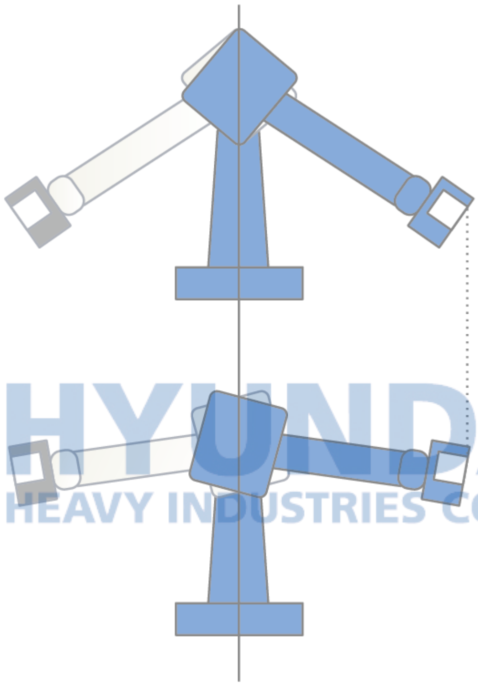
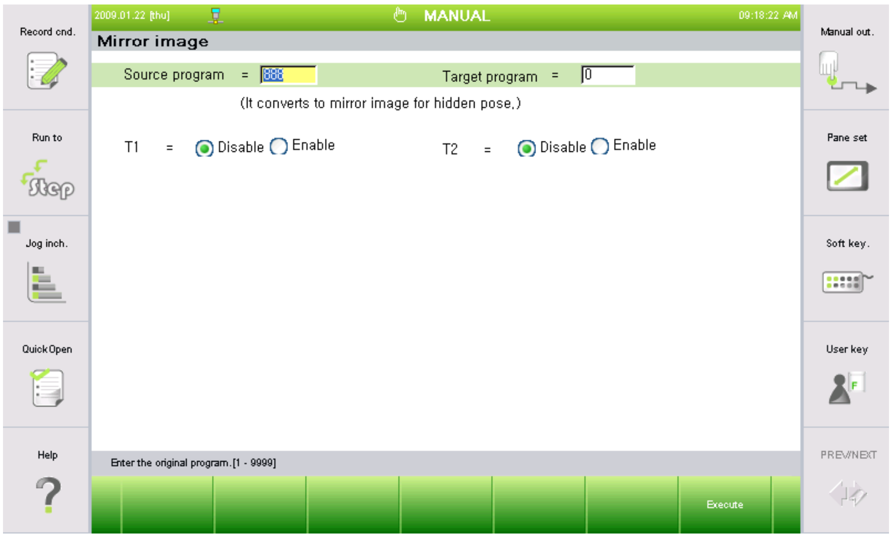


Figure 4.12 Source program → Converted program by using Mirror Image

(1) Selection 『[F1]: Service』 → 『6: Program conversion』 → 『6: Mirror image』.

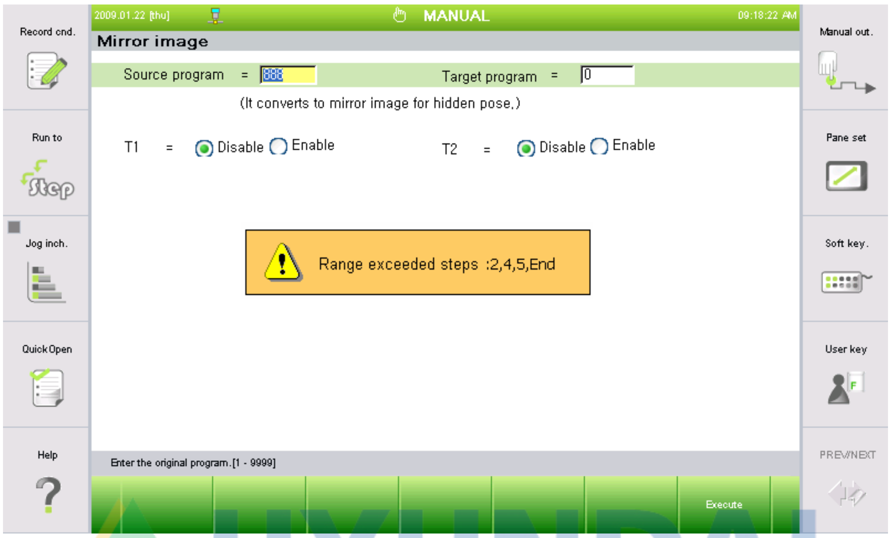


(2) Input data, press 『[F7]: Execute』.

- Source program: Number of the source program
- Target program: Number of a program to be created by using Mirror Image
- T1: Set as <Enable>, 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 ‘Range exceeded steps.’



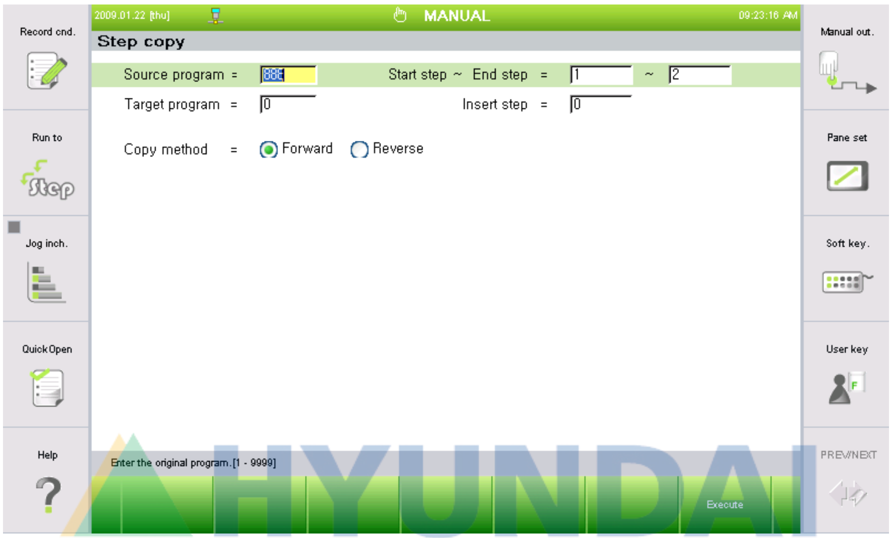
If ‘Range exceeded steps’ indicates ‘End,’ it means review is over. If ‘Range exceeded steps’ indicates ‘=>,’ it means there are more steps exceeding limit.

- 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.

4.7.7. Step copy

This is the function to copy part of the program to another program or to the same program. The function recorded on the step is also copied at the same time and the step number designated with step jump (GOTO, GOSUB) is also automatically changed.

(1) Select 『[F1]: Service』 → 『6: Program conversion』 → 『7: Step copy』.



(2) Enter the data and press the [ENTER] key. And then press the 『[F7]: Execute』 key to complete the process.

Reference

- The following picture shows the case of copying the forward and reverse direction to step 2 of program 2 from step 2 to 5 of program 1.

<table>
<tr><td>Before copying</td><td>Copy from the source program (Program 1)

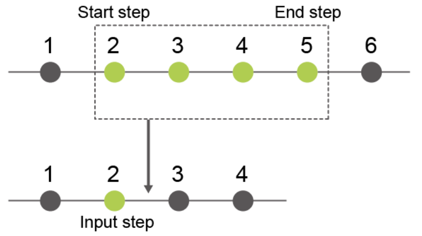
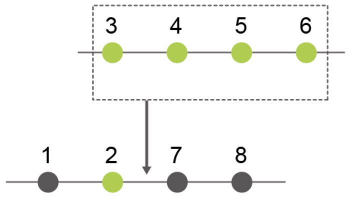
Paste to the target program (Program2)</td><td>
</td></tr>
<tr><td>After copying</td><td>Program2</td><td>
</td></tr>
</table>

Figure 4.13 Copy step

<table>
<tr><td>Before copying</td><td>Copy from the source program (Program 1)

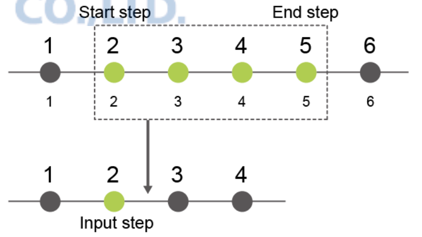
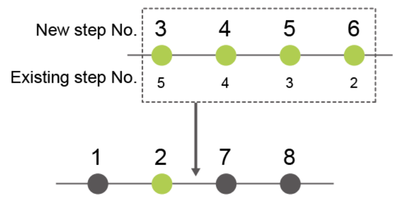
Paste to the target program (Program2)</td><td>
</td></tr>
<tr><td>After copying</td><td>Program2</td><td>
</td></tr>
</table>

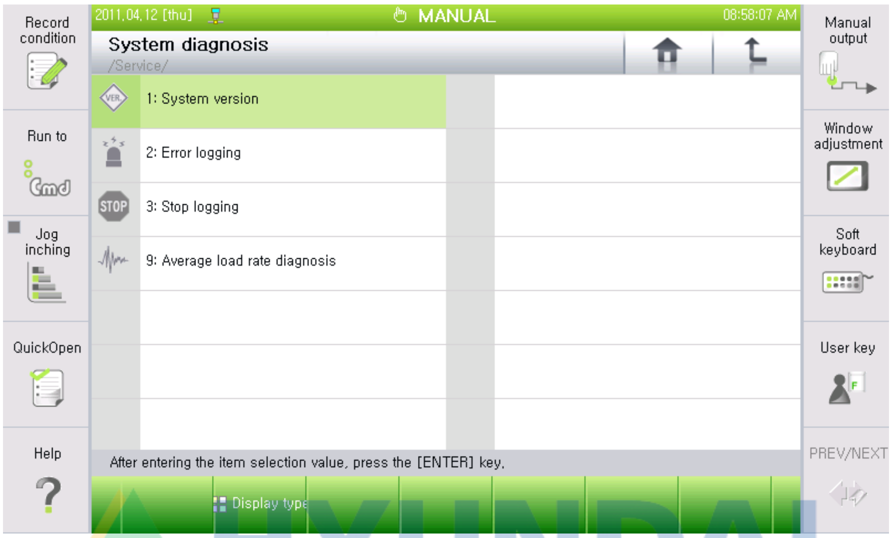
Figure 4.14 Copy step in reverse direction

- Insert the program to after the insertion step number of the program to copy.
- Because the step that includes the END copies the END function as well, you may need delete depending on the need.
- You cannot copy the program that is protected.
- If there is a step jump (GOTO, GOSUB) outside of the range to copy from the program to copy, the number will not change and you must change after the coping is completed.

4.8. System diagnosis

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

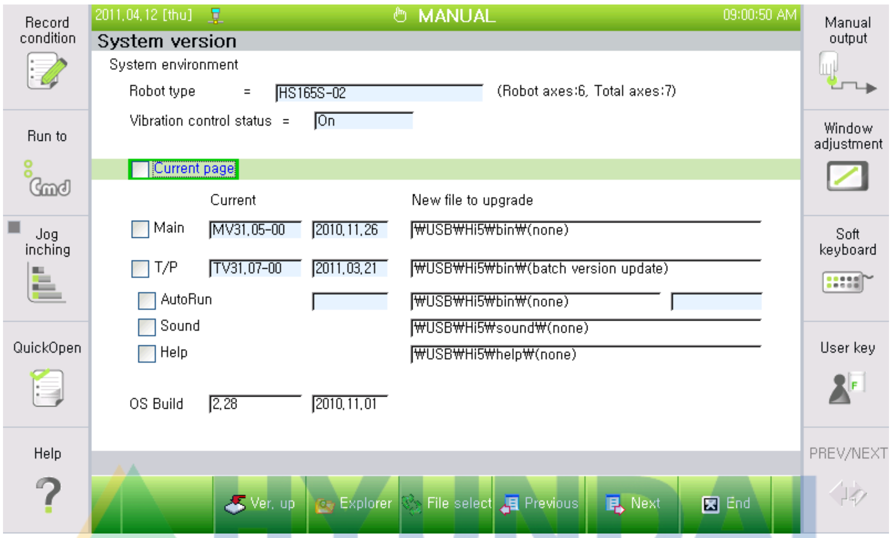
Selection 『[F1]: Service』 → 『7: System diagnosis』.



4.8.1. System version

This displays the system environment of Hi5 controller (Software version) and you can download the new version for each component.

(1) Selection 『[F1]: Service』 → 『7: System diagnosis』 → 『1: System Version』.



Page 1 (Robot type, main board, teach pendant, help, system environment)

Designate the new software file for the items to update the version and check by pressing the [ENTER] button. When you press the 『[F2]: Ver. up』 button, the designated items will be updated in order.

- System environment
  Robot type, number of basic axes, total number of axes including additional axis and condition of anti-vibration control function application will be displayed.

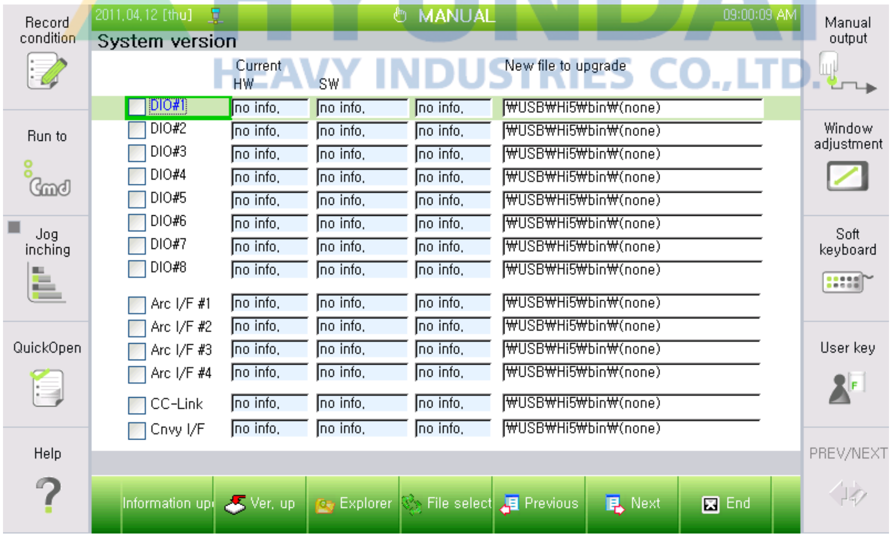
- Current page: Check all the items that can be update din the current page.

- Current: This displays the current version and date of each device.

- New file to upgrade
  When you want to upgrade the version of the device, you must designate the path and name of the software file that you want to newly download. The software file must be saved in T/P or USB memory.

(2) It is composed of total of 3 pages. You can move between pages using the 『[F5]: Previous』 and 『6: Next』 button.

Page 2 (DSP, system IO board)



Page 3 (DIO, arc welding, CC-Link, conveyer interface board)

Because the operating methods of the following items are similar, examples of only certain items will be described.

4.8.1.1. Main board

(1) Prepare the USB memory with the new files to update the version with. It is convenient to select the files if they are located in the following directory.

{USB Memory}/hi5/bin/hi5main*.hdi

(2) Install the USB memory to the teach pendant. When the USB memory device is recognized, the icon will appear on the title bar of the teach pendant screen.

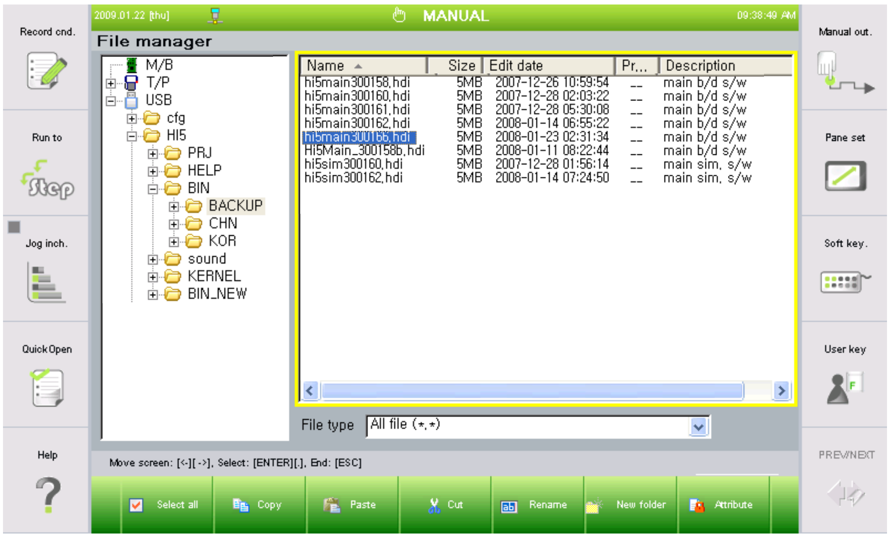
(3) Enter the 『[F1]: Service』 → 『7: System diagnosis』 → 『1: System version』 screen.

(4) Locate the cursor on the main item and check with the [ENTER] key. <Current> row displays the version and date of the current S/W installed on the main board.

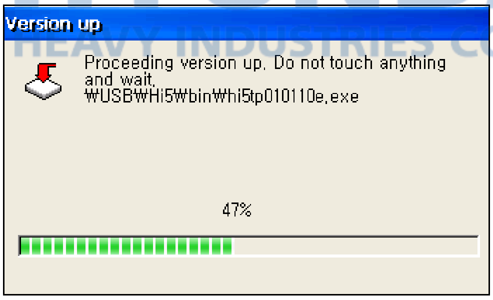
(5) The new file you want must be displayed in the <New file to upgrade> row. If the file you are trying to select has the same path and file name as shown in the following table, you can easily select the applicable file by switching the file name by pressing the 『[F4]: Refresh』 key.

T/P software	{USB memory}/hi5/bin/hi5tp*.exe
Main board software	{USB memory}/hi5/bin/hi5main*.hdi or {USB memory}/hi5/bin/hi5sim*.hdi
DSP I/O	{USB memory}/hi5/bin/sv5_*.hex
System I/O	{USB memory }/hi5/bin/bd530v*.hex
User I/O	{USB memory }/hi5/bin/bd580v*.hex
Arc Welding Interface	{USB memory }/hi5/bin/bd584v*.hex
CC-Link	{USB memory }/hi5/bin/bd570v*.hex
Conveyor Interface	{USB memory }/hi5/bin/bd585v*.hex

(6) When the file is located in a different directory, press the 『[F3]: File select』 key to open the file selection message box to find the file. Set the cursor on the file you want and press the [ENTER] key to display the path and name of the file selected from [New file to upgrade].



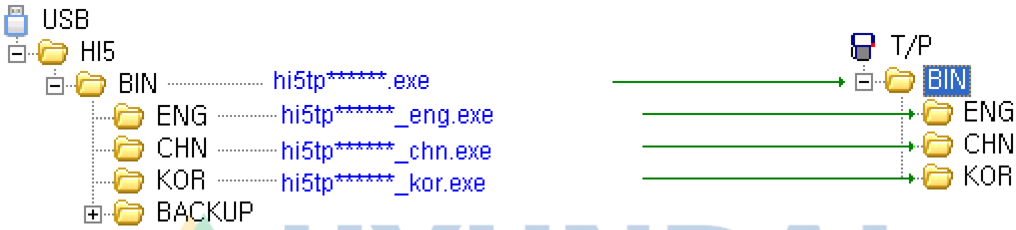
(7) Now press the 『[F2]: Ver. up』 to carry out the version updating. During the version-up process, you should follow instructions, without doing any operation.



4.8.1.2. Teach pendant batch version update

(1) If you see the following, it is in teach pendant batch version update mode. This is the function to update the version of the teach pendant software of various language versions in a batch. (Only the teach pendant of all devices for Hi5 Controller has software files by language.)

(2) You must have the new software files prepared in the USB memory according to the following directory structure. It doesn't matter what the name of the subfolder is and as long as the file name starts with 'hi5tp' and has an extension of exe, it will be recognized as the software file for teach pendant. Folders not including any part of hi5tp*.exe will be ignored. That is, subfolders must exist with only 1 file for each language at the bottom of {USB}/hi5/bin/. (If there are more than 1 software files included, only 1 file will be used for the update.)

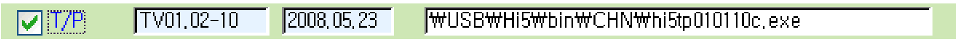


(3) After checking by pressing the [ENTER] key, press the 『[F2]: Ver. up』 to execute batch version update for all folders. That is, language folders will be created under the bin/ folder of the teach pendant flash memory and the software files will be copied.

4.8.1.3. Teach pendant single version update

(1) Every time you press the 『[F4]: Refresh』 key, the software file name for teach pedant at the bottom of {USB}/hi5/bin/ will be displayed in order. (When all file names are displayed, it will return to batch version update mode.)

(2) When you press [SHIFT]+『[F4]: Refresh』, you can switch to the sub folder. Every time you press the 『[F4]: Refresh』button in this condition, the file name of the applicable sub folder will be displayed in order.



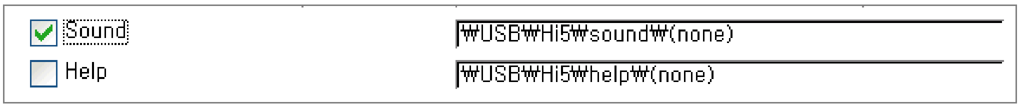
(3) After checking by pressing the [ENTER] key, press the『[F2]: Ver. up』to execute single version update by using the indicated file.

4.8.1.4. Auto Run

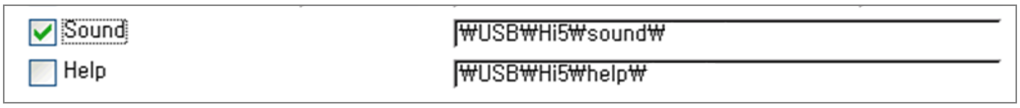
This is the Auto Run utility for automatically executing the execution file of the teach pendant. New version will be executed when you completely reboot the controller after the version update. Currently, no version-up is available.

4.8.1.5. Sound effect, help

(1) The version update for sound effect and help function is done by copying the entire folder and not just 1 file. Create a new folder for the new version in the directory as shown in the following figure in the USB memory, and then connect the USB memory. (You cannot change the directory.) If you do not see the (none) message, it means that it is recognized correctly.



When not recognized



When recognized

(2) After checking by pressing the [ENTER] key, press the『[F2]: Ver. up』to update the version.

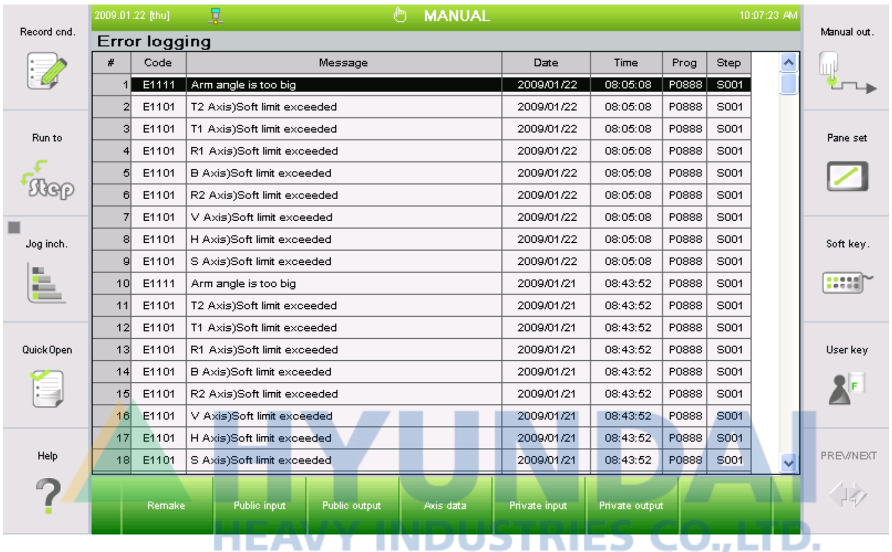
Reference

- 『R286: System version display』 of R code has the same function.
- To update the version, the motor must be turned OFF.
- When the version is upgraded, the system will reboot if necessary

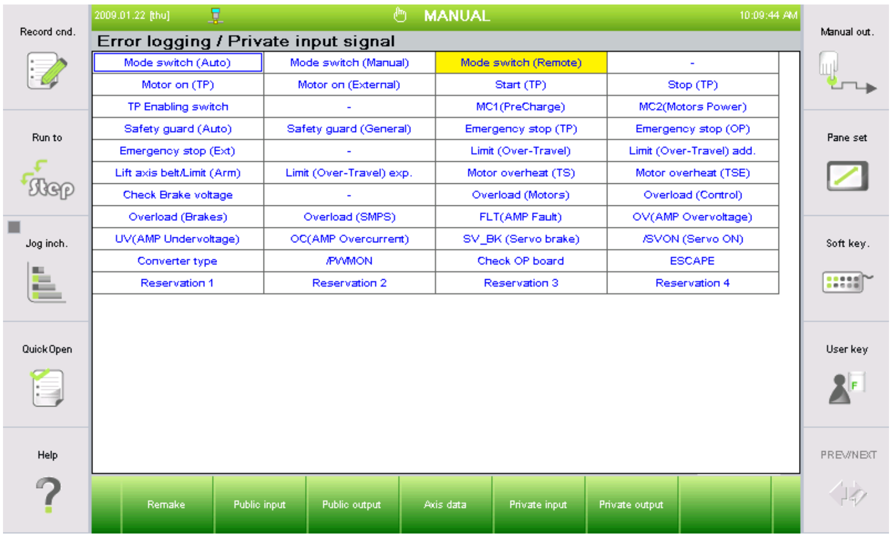
4.8.2. Error logging

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. The content of errors can be recorded to manage the history of errors. History can be initialized by pressing 『[F1]: Remake』 key. Cause of error and restoration work can be precisely determined by referring to history.

(1) Selection 『[F1]: Service』 → 『7: System diagnosis』 → 『2: Error logging』.

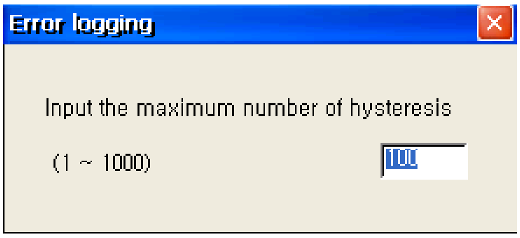


(2) When you select a specific error item, and click on one of 『[F2]: Public input』, 『[F3]: Public output』, 『[F4]: Axis data』, 『[F5]: Private input』, 『[F6]: Private output』, you can check the status in case of an error. For example, if you select 『1: E1111 Arm angle is too big』 with the arrow key and press the 『[F5]: Private input』 key, the following screen will be displayed.



Reference

- Selection 『[F1]: Remake』, and the following message appears.

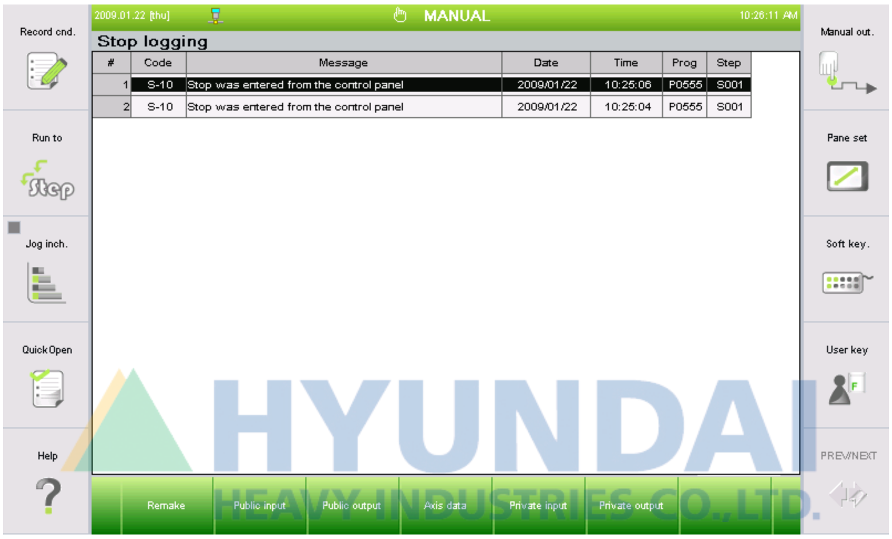


- The Error record basically holds up to 100 error histories. However, the number of error histories can be set within the range of 1~1000 depending on the needs of the user. When the user enters the maximum number of histories and press the [Enter], all the histories saved up to now will be deleted, making it possible to save the error histories in the number set by the user.

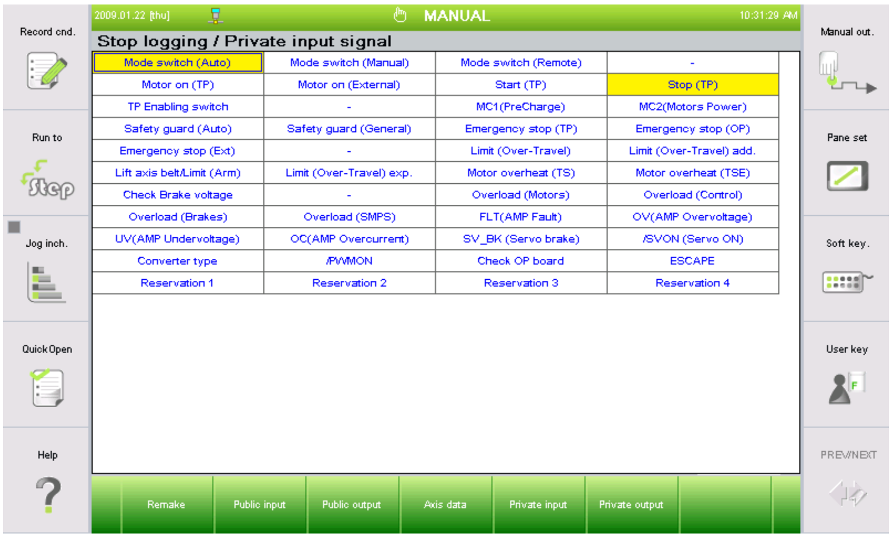
4.8.3. Stop logging

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 basically, while it can be saved up to 1000 times if set by the user. History can be initialized by pressing 『[F1]: Remake』 key.

(1) Selection 『[F1]: Service』 → 『7: System diagnosis』 → 『3: Stop logging』.

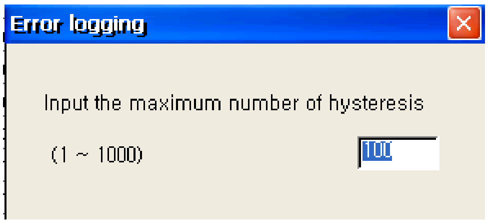


(2) When you select a specific stop item, and click on one of 『[F2]: Public input』, 『[F3]: Public output』, 『[F4]: Axis data』, 『[F5]: Private input』, 『[F6]: Private output』, you can check the status in case of an error. For example, if you select 『1: S-10 Stop was entered from the control panel』 with the arrow key and press the 『[F6]: Private output』 key, the following screen will be displayed.



Reference

- When you select 『[F1]: Remake』, the following message will be displayed in the frame.

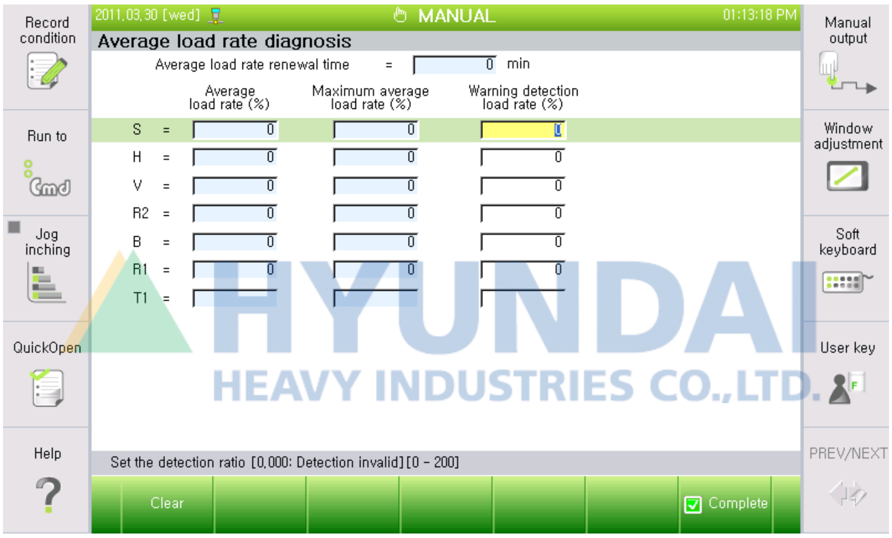


- The Stop record basically holds up to 100 stop histories. However, the number of stop histories can be set within the range of 1~1000 depending on the needs of the user. When the user enters the maximum number of histories and press the [Enter], all the histories saved up to now will be deleted, making it possible to save the stop histories in the number set by the user.

4.8.4. Average load rate diagnosis

This is to display the average load rate of the motor torque applied for each axis during the robot operation. The calculation of the average load rate is to be made only during the normal operation without the robot suffering any servo errors or emergency stops, excluding the excessive torque that will be generated during the abrupt stop.
The average load rate is calculated based on the motor torque I/Ir, and the calculation takes place by using the buffer fixed inside the robot controller, so, the average load rate renewal time will vary depending on the characteristics of the work program of the robot. When it comes to each axis, the average value is calculated by taking into consideration the moving time of each axis, so the torque during the stop of the robot operation will not be taken into the calculation of the average load rate.

Select『[F1]: Service』 → 『7: System diagnosis』 → 『9: Average load rate diagnosis』.



(1) Average load rate renewal time [min]
This is the time of the robot operation by calculating the average load rate. In those cases where servo errors or emergency stops occur, their load factors will not be taken into the calculation.

(2) Average load rate [%]
This is the average load rate (I/Ir) of the motor of each axis generated during the average load rate renewal time. The average load rate will start to be displayed when the targeted butter is filled in the robot controller, while '0' for it is displayed before that. The time required for the buffer to be filled will vary depending on the characteristics of the work of the robot.

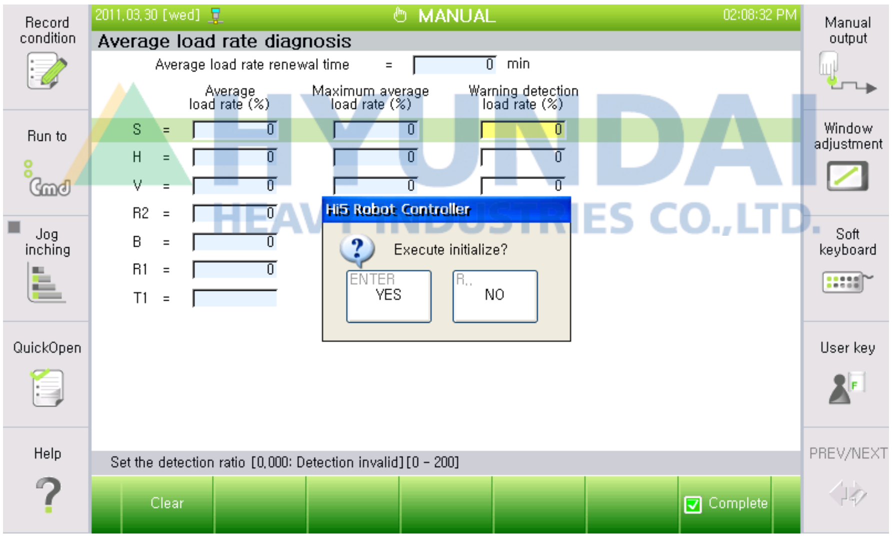
(3) Maximum average load rate
This is the maximum value of the average load rate generated during the robot operation. When the controller power is turned off, or 『[F1]: Clear』 is selected, the value can be measured again. However, the data will be displayed '0' during the average load rate renewal time.

(4) Warning detection load factor
This needs to be set to generate a warning for the user if the average load rate of each axis exceeds the general usage level. If it is ‘0’, detection will not occur, so it is required to set the value. When an warning occurs, the “W0142 %s axis) Average load rate error during task.” notification will be displayed on the teach pendant, while the set output will be generated according to the average load rate diagnosis of 『[F2]: System』 → 『2: Control parameter』 → 『2: Input/output signal setting 』→ 『4: Output signal assignment』. Even when the warning occurs, the robot will continue the work without stopping.

(5) 『[F1]: Clear』
Measuring will start again. Even in this situation, waiting for the buffer to be filled is still required

Reference

- When 『[F1]: Clear』 is selected, the guide frame will display the following message.

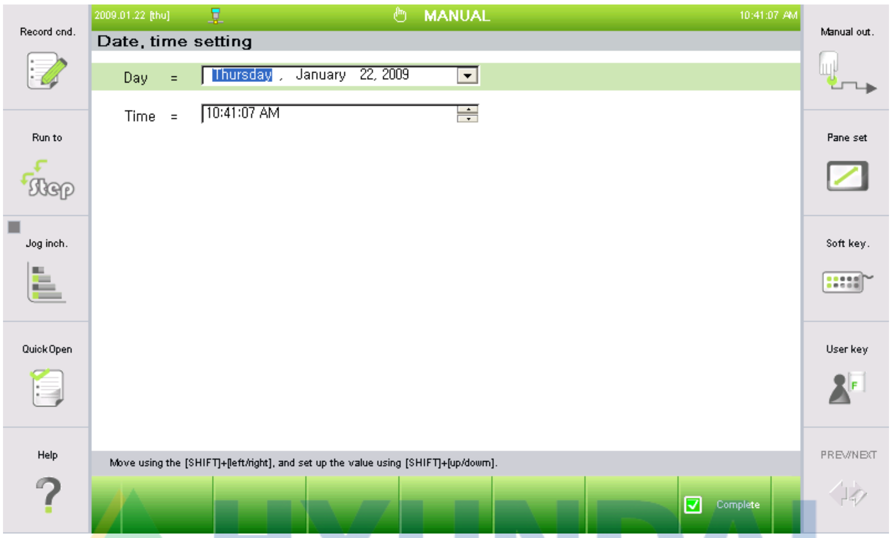


- When the [Yes] key is selected, all the average load rates saved up to now will be deleted and initialization will take place.

4.9. Date, time setting

Date and time of controller can be changed.

(1) Selection 『[F1]: Service』 → 『8: Date, time setting』.

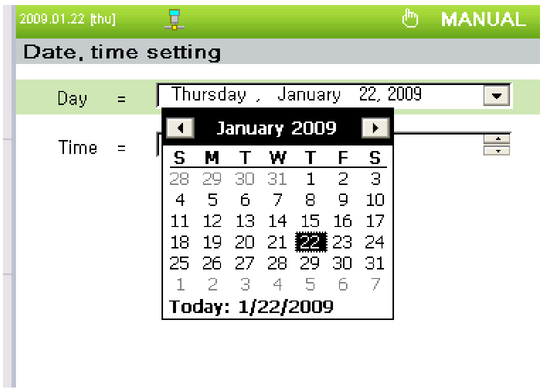


(2) Press the arrow key [⇑] [⇓] to cursor between the date and time.

(3) When you press [SHIFT] + [<=][=>], the cursor on the date moves from year, month, date to day, and the cursor on the time moves from AM/PM, hour, minute to second.

(4) Set the cursor to the item you want and press [SHIFT] + [⇑] [⇓] to change the value.

(5) When you set the cursor on the date and press the [ENTER] key, the calendar will be displayed. Use the cursor key to select the date and press the [ENTER] key again to set the selected date.

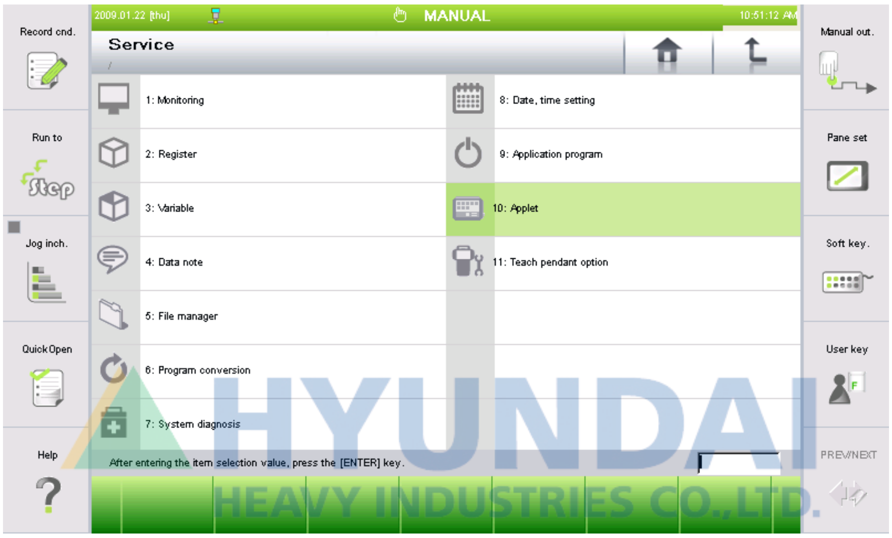


(6) When you press the 『[F7]: Complete』 after entering the date and time, the changed information will be saved.

4.10. Applet

For special requirements for special robot construction difficult to correspond with the common functionality of Hi5 Controller, you can create and execute an Applet, a separate Add-on execution file. Applet for Hi5 Controller must be created and registered in accordance with the set specification and it cannot be guaranteed to run normally, if it does not comply the rules.
For detail, please contact the service center.

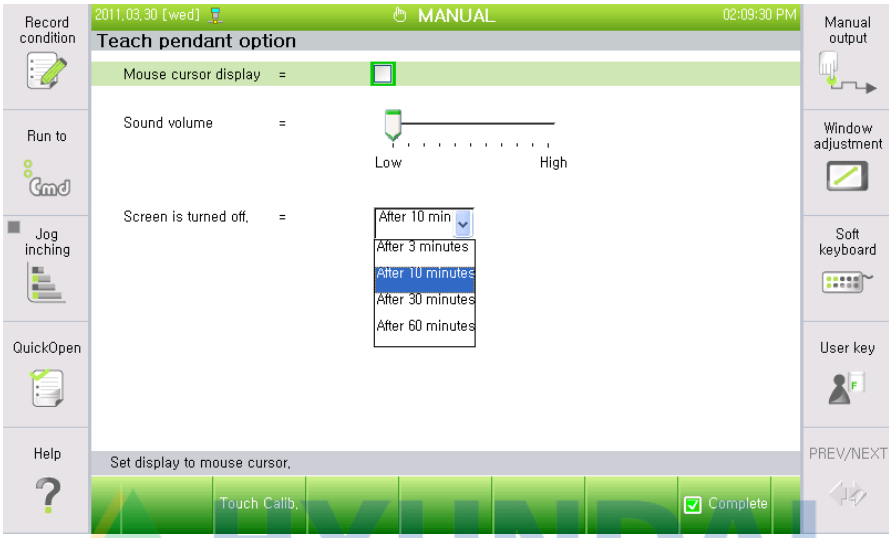
When you 『[F1]: Service』 → 『10: Applet』, Applet management screen will be opened



4.11. Teach pendant option

This is the screen to set only the function related to the user interface of the teach pendant itself.

(1) Select 『[F1]: Service』 → 『11: Teach pendant option』.



- Mouse cursor display
  Even though you can execute all the operations using the key pad and touch screen, you can connect the mouse to the USB terminal at the bottom of the teach pendant. At this time, check this option so that the cursor of the mouse can be displayed.

- Sound volume
  This adjusts the volume of the sound effect generated through the speakers of the teach pendant.

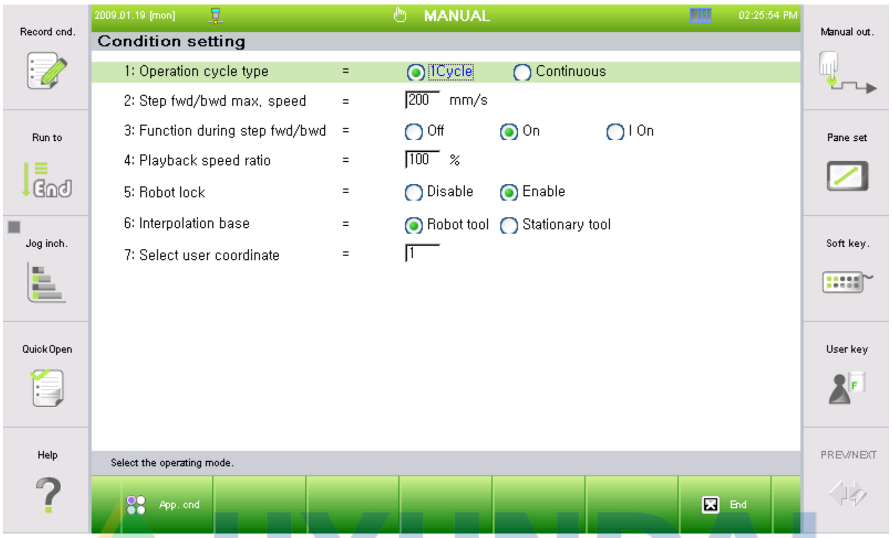
- Screen is turned off
  If there is no input by the user within the preset time, the screen will change to the saving mode, turning off the screen of the teach pendant.

(2) Set the date and press the 『[F7]: Complete』 key. The setting is saved on the teach pendant itself and not on the main board of the controller.

5 Condition Setting

The condition setting menu is to change the operation condition easily without changing the program. The set values will be maintained even when the controller power is supplied again.

Press the 『[F7]: Condition setting』 from the initial screen of manual or auto mode to see the following screen.



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 [ENTER] key to reflect the input.
- When you select one of the items used with the radio button and press the [SHIFT] + (Left/Right), the highlighted bar moves and is immediately reflected.
- Condition setting data is saved in control constant file (ROBOT.CON).
- You can make changes to the control constant file (ROBOT.CON) even when the file is completely protected.

5.1. Operation cycle type

This is to decide whether to carry out the repetition of the program to be implemented during the auto operation, while changing in the middle of the operation can be also allowed, but not applicable for the manual operation.

- 1Cycle
  This wills operation the work program for one cycle when you press the move button.
  (The robot will stop at program end.)

- Continuous
  This repeats the prepared program and operation continuously.
  (The robot will stop when there is an external stop operation.)

5.2. Step fwd/bwd max. Speed

The speed limit for the step forward/backward operation can be entered directly. Refer to the manual operation of the basic operation for details.

5.3. Function during step fwd/bwd

This decides whether to execute the function recorded within the program for step forward/backward. This can be set in 3 ways; Off, On and I On for deciding whether to execute the function.

- Off : This only executes the work program end function and ignores all other functions.
- On : This executes all the functions recorded within the work 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.

5.4. Playback speed ratio

For the speed recorded on the step during the playback of the program in the auto mode, the moving speed of the robot varies within the range of [1 ~ 100]% in an overall manner. The speed value recorded on the step of the work program does not change.

Reference

- For low speed operation mode by external input during AUTO operation, the AUTO operation speed percentage is not applied. At this time, the maximum speed of step forward/backward will be applied.

5.5. 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.

Reference

- When you set 『Robot lock = <Enable>』, yellow lock icon as 

will be displayed with the robot on the status display window in MANUAL or AUTO mode.

5.6. Interpolation tool

Interpolation tool is the function to select the base tool when manually operating the robot using the jog. There are two tool bases, the robot tool and the stationary tool. The general interpolation tool is the robot tool.

- Robot tool: Interpolation is done based on the tool attached to the robot's end.
- Stationary tool:
  Interpolation is done based on the tool attached to the fixture such as the floor.

Reference

- When selecting the interpolation reference as stationary tool, STO sign is displayed on the top and you must set the stationary tool coordinate system. Refer to the setting in 『[F2]: System』 → 『2: Control parameter』 → 『7: Coordinate Registration』 → 『2: Stationary tool coordinate』.
- To select the stationary tool number during AUTO operation, use the SELPTNO command.
- For details, refer to "Hi5 Controller Stationary Tool Interpolation Function Manual".

5.7. Select user coordinate

When manually operating the jog based on the user coordinate defined by the user, select the user coordinate number for Cartesian operation. 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.

Select 『[F7]: Condition setting』 → 『9: 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. Crd CART. is displayed on the top of the screen. When you select the axis data monitoring, the following screen will be displayed.

Data of each axis

	Angle		Coordinate
S	1144.845 deg	X	-1887.4
H	1242.000 deg	Y	114.8
V	1024.000 deg	Z	795.7
R2	1536.000 deg	Rx	90.0
B	-1549.960 deg	Ry	-26.1
R1	1843.200 deg	Rz	-94.3
T1	-1843.200 mm		
T2	-1843.200 mm		

- Number besides 0 displayed on the edit box is displayed as the number off the coordinate system registered as user coordinate system in the registration process of 『[F2]: System』 → 『2: Control parameter』 → 『7: Coordinate registration』 → 『1: User coordinate』.

- When you select the user coordinate system number, Crd User[1] is displayed on the top of the screen. When you select 『[F1]: Service』 → 『1: Monitoring』 → 『1: Data of each axis』, the following screen will be displayed. At this time, the changed coordinate value by [Axis operation] key changes to the value based on the user coordinate system.

Data of each axis

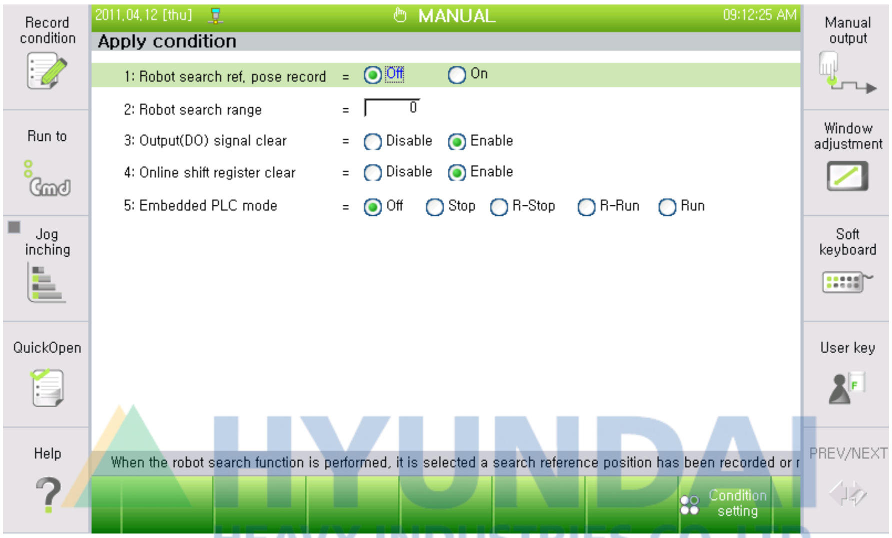
	Angle		U-Coordinate
S	1144.845 deg	X	-1887.4
H	1242.000 deg	Y	114.8
V	1024.000 deg	Z	795.7
R2	1536.000 deg	Rx	90.0
B	-1549.960 deg	Ry	-26.1
R1	1843.200 deg	Rz	-94.3
T1	-1843.200 mm		
T2	-1843.200 mm		

- For the user coordinate registration, refer to the 『[F2]: System』 → 『2: Control parameter』 → 『7: Coordinate registration』 → 『1: User coordinate』

6
Application Condition

Applied condition is the menu to set various applied functions (Ex.: Welding, handling, embedded PLC etc.) during automatic operation of the program. Changing the setting value does not change the content of the program. Also the set condition values are saved in the internal system file (ROBOT.CON) of the controller and are maintained even when the power is interrupted.

Select 『[F7]: Condition setting』 from the initial screen of manual or auto mode. You will see the 『Application Condition』 label on [F1] key in the condition setting screen. Press the 『[F1]: App. cnd』 and you will see the following screen.



Reference

- Move the highlighted bar to the item. When entering numbers, enter the numbers in the editor box. After entering the numbers you want using the [Number] key, press the [ENTER (YES)] key to reflect the details.
- After selecting one among the items used with the radio button, press the [SHIFT] + direction key ([->], [<-]) to move the highlighted bar to reflect the change immediately.
- Condition setting data is saved in control constant file (ROBOT.CON).
- You can make changes to the control constant file (ROBOT.CON) even when the file is completely protected.

6.1. Robot search reference pose record

This function automatically records the reference location to execute the robot search function. After completing the teaching including the robot search function, if you set this condition to ON and play back 1 cycle, the reference location of the work object is automatically recorded.

Select 『[F7]: Condition setting』 → 『[F1]: App. cnd』 → 『1: Robot search ref. pose record』 from the initial screen of manual or auto mode.

- Off : Do not use the robot search reference pose record function.
- On : Use the robot search reference pose record function.

Reference

- If you set the robot search reference pose record function to ON, you will see the "?" on the top left side of the screen.
- The AUTO operation speed to record the robot search reference pose data and common AUTO operation speed must be the same.

6.2. Robot search range

This decides the range to search when using the robot search function.

Select 『[F7]: Condition setting』 → 『[F1]: App. cnd』 → 『2: Robot 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)                          →|
```

Figure 6.1 Search range setting

6.3. Output (DO) signal clear

When executing the work program head (First line at the top), this decides whether to initialize the general user signal and welding condition signal that is currently being generated.

Select 『[F7]: Condition setting』 → 『[F1]: App. cnd』 → 『3: Output(DO) signal clear』 from the initial screen of manual or auto mode.

- Disable
  When executing the work program head, this does not initialize the public output signal (DO) and welding condition signal.

- Enable
  When executing the work program head, this initializes the general output signal (DO) and welding condition signal.

Reference

- This does not operate in the work program head executed by CALL or JMPP command.

6.4. Online shift register clear

When executing the work program head, this decides whether to initialize the register content for shift of the online shift register group.

Select 『[F7]: Condition setting』 → 『[F1]: App. cnd』 → 『4: Online shift register clear』 from the initial screen of manual or auto mode.

- Disable
  When executing the work program head, this does not initialize the content of the online shift register group.

- Enable
  When executing the work 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 only. Unlike this, content such as XYZ shift register or online shift buffer etc. is always initialized when executing the work program head.

- This does not operate in the work program head executed by CALL or JMPP command.

6.5. Embedded PLC mode

This sets the mode to control the Embedded PLC when controlling the input/output signal using the embedded PLC. There are 4 embedded PLC modes totally. Please refer to 『Hi5 Controller Embedded PLC Function Manual』 for more details.

Select 『[F7]: Condition setting』 → 『[F1]: App. cnd』 → 『5: Embedded PLC mode』 from the initial screen of manual or auto mode.

- Off
  Set the function as disable.

- Stop
  This stops the embedded PLC operation. DI, Y, R relay are cleared with the Stop.

- R-Stop (Remote Stop)
  This is the remote mode and stops the embedded PLC operation from HRLadder of PC connected to the controller. DI, Y, R relay are cleared with R-Stop

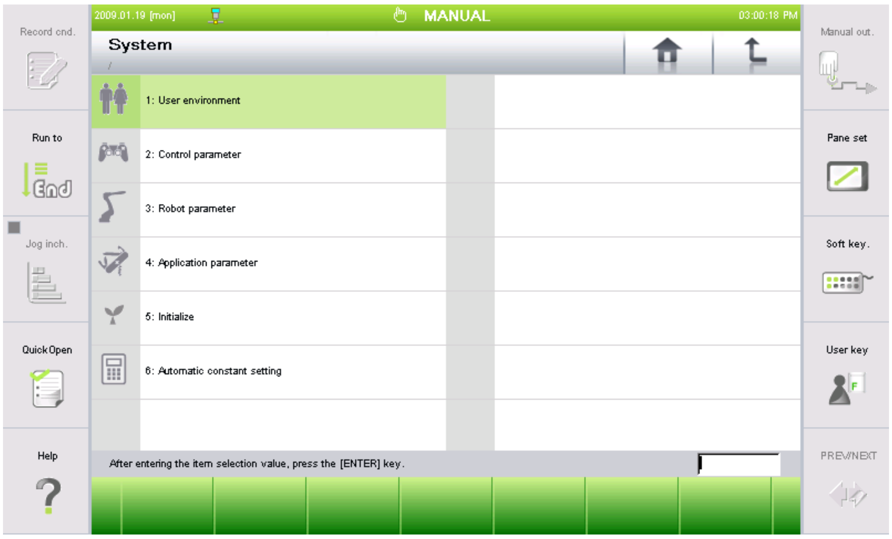
- R-Run (Remote Run)
  This is the remote mode and stops the embedded PLC operation from HRLadder of PC connected to the controller.

- Run
  The controller operates the PLC program downloaded to controller.
  This is enabled only for the monitoring in HRLadder of the PC.

Reference

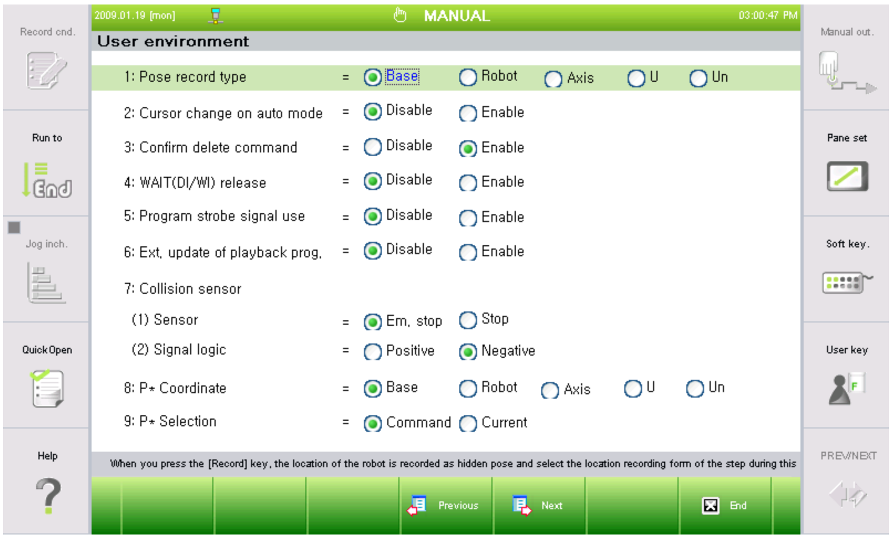
- This function operates only when the dip switch number 5 of the BD510 main board is turned on. When it is turned off, the warning that execution will be impossible will be displayed.

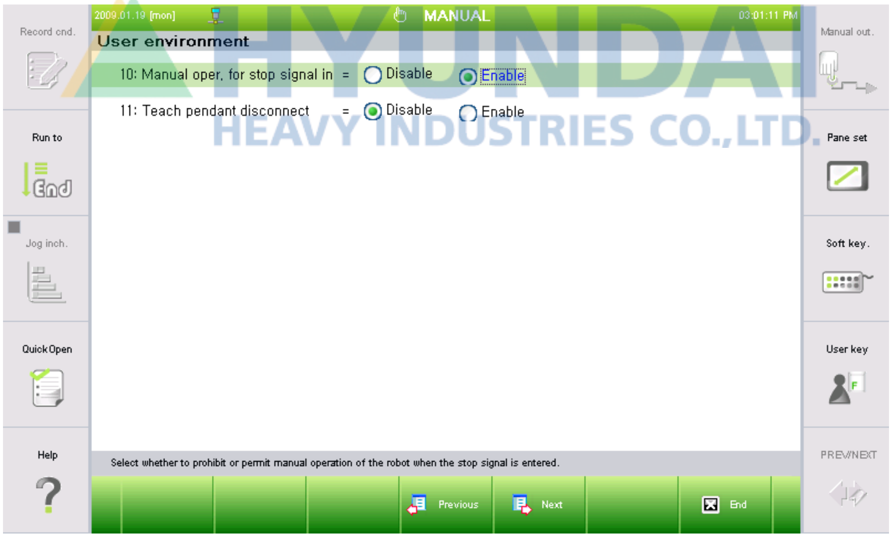
7 System setting


2009.01.19 [mon]
MANUAL
03:00:18 PM
System
Record cmd.
Run to
Jog inch.
QuickOpen
Help
Manual out.
Pane set
Soft key.
User key
PREV/NEXT
1: User environment
2: Control parameter
3: Robot parameter
4: Application parameter
5: Initialize
6: Automatic constant setting
After entering the item selection value, press the [ENTER] key.

7.1. User environment

This is the function for the user to set various conditions to execute necessary tasks.





7.1.1. Pose Record 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.

- Base: The position is recorded based on the base coordinate.
- Robot: The position is recorded based on the robot's coordinate.
- Axis: The position is recorded in axis angel 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.

7.1.2. Cursor change on Auto mode

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.

7.1.3. Confirm delete command

This function decides whether to confirm one more time with the user through the message box, when a command is to be deleted.

7.1.4. WAIT (DI/WI) release

This function decides whether to force cancellation or not for signal waiting when [SHIFT] +『[F3]: WAIT rel.』 keys are pressed for the waiting input signal or welding completion signal during manual or auto mode.

7.1.5. Program strobe signal use

When you receive the external digital signal and select the external program, this function decides the time the external program is selected.

- Disable: Only reads the external program selection signal and selects the external program.
- Enable
  Reads the external program selection signal at the timing the program strobe is entered to select the program.

7.1.6. Ext. update of playback program

This function decides whether to allow the program, currently in playback, to be edited externally (PC) and downloaded into the controller. (When it comes to the program currently in playback, its newly downloaded version will be applied from the next time.)

Warning

- Editing the program currently in playback and downloading it with the controller has a fairly dangerous aspect. Please consult the engineer before using this function.

7.1.7. Collision sensor

When the collision sensor is operating, this function decides the method to stop the robot.

(1) Sensor

- Em. Stop
  When the collision sensor operates, it sets the operation preparation to OFF and stops the robot.
- Stop
  When the collision sensor operates, it sets the operation preparation to ON and stops the robot.

(2) Signal logic

- Positive: This sets the input signal logic of the collision sensor to positive logic.
- Negative: This sets the input signal logic of the collision sensor to negative logic.

7.1.8. P* Coordinate

You can designate the coordinate system when using the pose formula (P*) obtained from the current location of the robot from the work program.

7.1.9. P* Selection

You can designate whether to obtain the command value of the robot or the current value of the current location when using the pose formula (P*) obtained from the current location of the robot from the work program.

7.1.10. Manual oper. For stop signal input

This sets whether to enable jog operation when external stop signal is entered.

7.1.11. Teach pendant disconnect

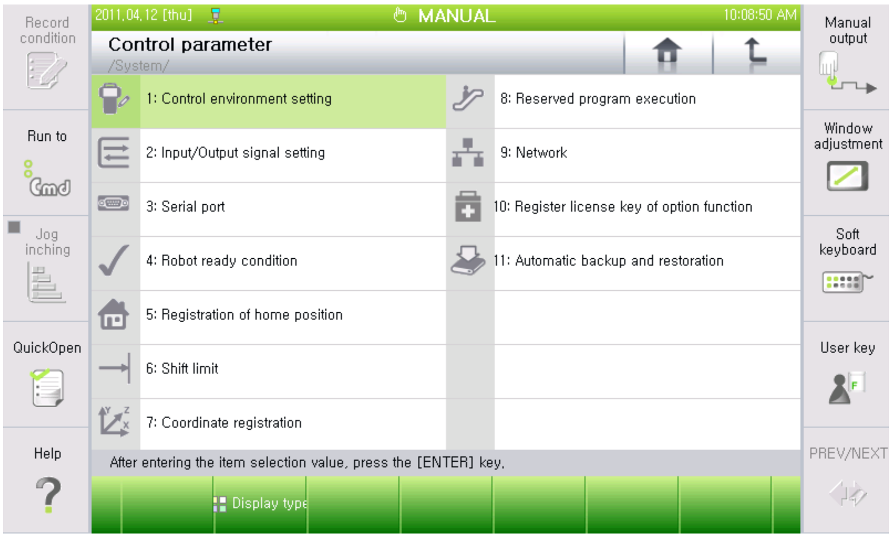
This setting is required to operate the robot automatically, after the teach pendant is disconnected from the controller. When the setting is <Enable>, the “E0015 Teaching pendant operation error” error, which would occur when the communication between the teach pendant and the main board is disconnected, would not be generated.

If the power is supplied while the setting is <Enable> and the teach pendant is disconnected from the controller, the controller will recognize the current mode as the remote mode and turn on the external motor and operates the robot automatically through the external starting.

But because the emergency switch and mode conversion switch are separately connected through a signal wire to the teach pendant, you must appropriately wire this signal wire.

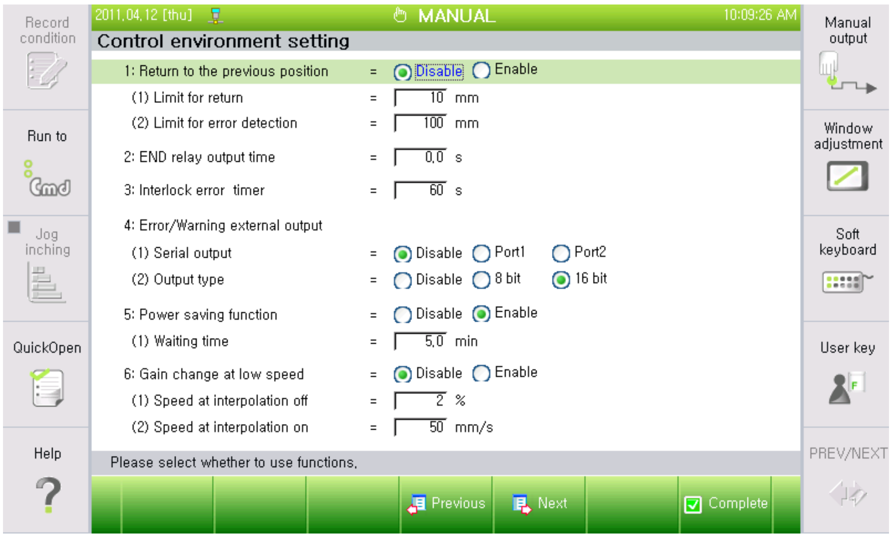
Connect CNRTP connector pin #9 (Auto) to #2 (M1) and pin #5 (Emergency stop 1) to #2 (M1), and use the exclusive CNRTP connector with pin #6 (Emergency stop 2) connected to #1 (P1) instead of the teach pendant.

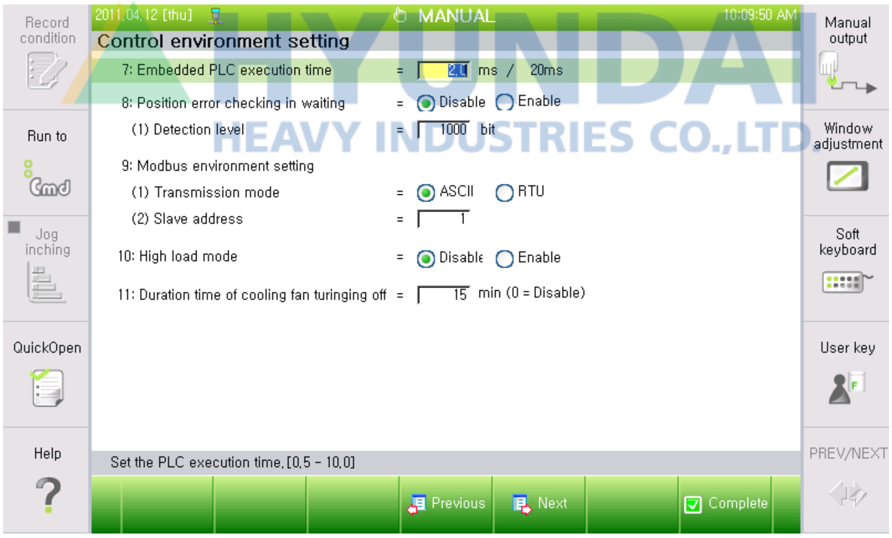
7.2. Control parameter



7.2.1. Control environment setting

This function sets various conditions of the controller and executes the necessary work.





7.2.1.1. Return to the previous position

When the operation preparation is turned Off by emergency stop or other hardware error, the robot will free fall. This function recovers the robot to return to the previous location automatically because the robot can free fall by the weight of the robot.

- Limit for return

  This sets the limit the robot can recover after the free fall. When the robot falls freely over this set value, a warning message will be displayed.

- Limit for error detection

  This is to prevent interference with the peripheral devices. When the robot falls freely over the value set here, an error is generated and the robot cannot be operated without designating the step.

7.2.1.2. END relay output time

This function set the wait time after executing program END until the program head is executed again during program execution in continuous AUTO mode,

7.2.1.3. Interlock error timer

This function sets the maximum wait time of the input signal. When the time of input signal wait condition during playback exceeds the regulated time, it outputs interlock error signal. This regulated time is the interlock error time.
Interlock error signal is the signal assigned from 『[F2]: System』 → 『2: Control parameter』 → 『2: Input/output signal setting』 → 『4: Output signal assign』.

7.2.1.4. Error output to the outside

This function outputs the detected error number to the external party through the serial port.

- Serial output

  Use the serial port (RS232C) to output ASCII code to the external device.
  Output formats are

  1^{st} byte : "$"
  $2\sim6^{th}$ byte : "ERROR"
  7^{th} byte : " " (Blank)
  8~11th byte : Error number
  12^{th} byte : CR
  13^{th} byte : LF

  Ex) For error 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

■ Number pre-designation output

Output of pre-designated number outputs the error/warning number of the signal assigned 『[F2]: System』 → 『2: Control parameter』 → 『2: Input/output signal setting』 → 『4: Output signal assign』 .

Table 7-1 Output of signal assignment by assigned signal

Assigned signal name	Whether to assign and how many	
	8 bit	16 bit
Error/Warning output selection	○ : 1	×
Error/Warning output STRB	○ : 1	×
Error/Warning output Bit	○ : 8	○ : 16
System error, operation error	○ : 1	○ : 1
Warning generated	○ : 1	○ : 1

Reference

- If the warning generation output signal is ‘0’, it is an error number. If it is ‘1’, it is a warning number.
- When a warning is generated, system error signals as well as operation error signals will not be turned on.

① 8 bit – Convert the error/warning number to a binary number and divide the bottom 8 bit and top 8 bit for output. The signal to classify the bottom and top data is the error/warning output selection signal. The strobe function that decides the data check timing is the error output STRB signal.

Ex) In case of E0101, the timing as well,
(101_{10} = 0065_{16} = 0000 0000 0110 010_{12})

```
                         |←   Bottom data   →|←     Top 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----------
                         +------------------+
Error output selection   -+                 +----------------------
                             +---------+        +----------+
Error output STRB  -------+           +------------+          +------
                  |←   →|←      →|←  →|←     →|←        →|←  →|
                   100ms  200ms   50ms  100ms    200ms    100ms
```

② 16 bit – Convert the error number into 2digit number and output the 16 bit data.
The strobe signal that decides the data check timing
- System error => Overall error
- Operating error => Operational error or above.

Ex) In case of E0101, the time as well (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   -------------------------------------------------------
                        +----------------------------------------------
Overall Error     ---+
```

7.2.1.5. Power saving function

This is the function to set whether to activate/deactivate the power save function and to set the standby time. If the robot is in stopped condition during operation standby or input signal standby during auto mode for more than the set standby time, the power supply to the motor will be blocked to save power consumption. When the robot operation command is received, the power will be supplied to the motor to exit from the power save function and the robot will start to operate. Because there is a delay element during this process compared to the normal operation, you must deactivate the power save function when you are executing a task that projects the expected speed of the robot.

7.2.1.6. Gain change at low speed

Sometimes unnoticed vibration in normal speed occurs in low speed interval. This occurs due to the characteristics of the motor. In this case, set the gain for low speed interval separate to reduce the vibration.

- Speed at interpolation off
  This is the reference speed to change the gain in the interval where interpolation is Off.

- Speed at interpolation on
  This is the reference speed to change the gain in the linear or arc interpolation interval.

7.2.1.7. Embedded PLC execution time

When using the embedded PLC, you can adjust the PLC execution time within the controller. The controller executes the PLC ladder program every 20ms internally and you can set the level to assign PLC execution.
The longer this time is set, the shorter the scan time of the PLC program will be. But if set to high, the CPU execution time will be insufficient to cause “E0047 Exceed motion processing time” error or “E0186~E0189 1st/2nd/3rd/4th DSP main watchdog detection” error.

7.2.1.8. Position error checking in waiting

Location deviation refers to the different between the location commanded and the current location of the robot. When the robot starts to move, the deviation starts and increase and as the speed increases the deviation increases as well. When the robot collides or is in an abnormal condition, the location deviation becomes abnormally high. Location deviation error detection function is the function to process this situation as an error and protect the robot.

Because the general location deviation error detection level is set based on the maximum speed of the robot, it is disadvantageous to detect the error while the robot is stopped or operating at low speed. Therefore, this function enables you to set a separate location deviation error detection level when the robot is, especially in standby condition, to detect the error more sensitively.

- Detection level
  This is the level to detect the location deviation error and bit set in encoder bit.

7.2.1.9. Mod bus environment setting

This function sets the environment to use the mod bus.

7.2.1.10. High load mode

If the tool load, calculated in 『[F2]: System』 → 『3: Robot parameter』 → 『1: Tool data』 using the tool weight, center and inertia, exceeds the robot's own allowed tool load during the setting, or if the Motor On operation is initiated with such setting, the warning 'W0141 Tool?) Allowable inertia exceeded. High load mode is used." will be generated. If the robot is operated while disregarding the warning, severe vibration will occur, and, together with it, the lifetime of the robot will be significantly reduced.

In this case, if it is set <Enable>, the filter time and acceleration/deceleration time will be increased, leading to significantly increased robot' own operation cycle time. However, such operation will reduce vibration that the robot could suffer, and make its lifetime longer.

7.2.1.11. Cooling fan operation on/off time

When the robot is operating, the temperature inside the controller increases due to the regenerative resistor. In order to prevent the temperature from increasing, the cooling fan should run.

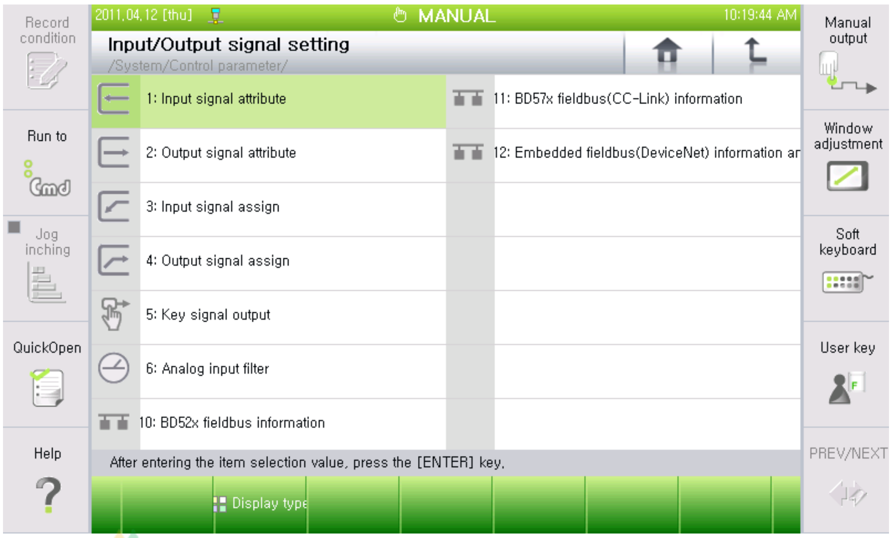
When the robot is inactivated, the temperature inside the controller does not go up any more. In such condition, there is no reason for the cooling fan to run. However, if the cooling fan runs even in such condition, reverse effects such as shortening of the fan's lifetime, generation of noise, and increasing of power consumption, will be caused.

When the robot is activated (Motor On), the cooling fan should run immediately. When the robot is deactivated, (Motor Off or Power Saving), the cooling fan should stop running after a certain time. If the cooling fan cannot run immediately, the latent heat of the regenerative resistor will cause the temperature inside the controller to go up.

The output for controlling the cooling fan's on/off activity is provided through DO3 of TBIO of the system board. The circuit for controlling the cooling fan power should be configured using the output signal.

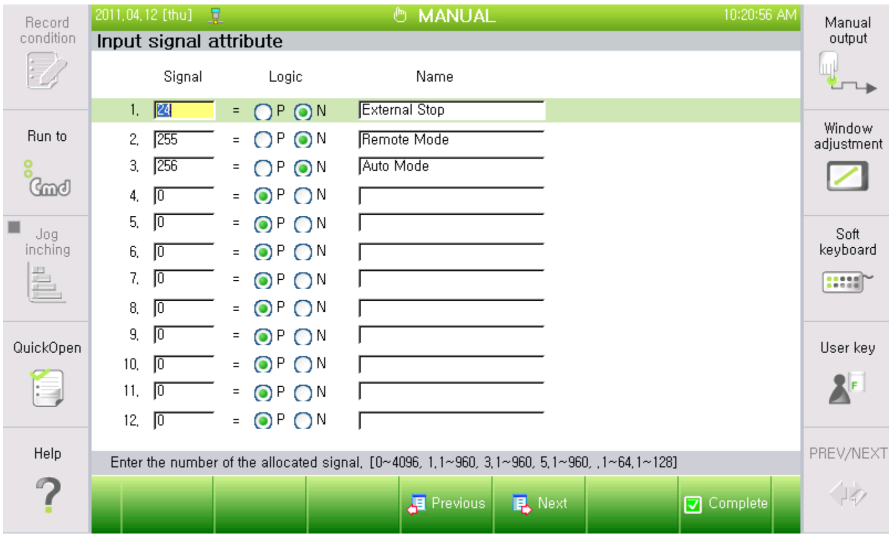
7.2.2. Input/output signal setting

This function enables the user to configure the properties of the input and output signal, the assignment of signals, and the setting of the field bus, for example.



7.2.2.1. Input signal attribute

This function sets the positive or negative logic of the common input signal.



- Signals
  The user is required to set as the following depending on the types of input.

Type	Setting range	Setting example
Hardwired	0 ~ 4096	35 → DI35
Field bus	1.1 ~ 1.960 3.1 ~ 3.960 5.1 ~ 5.960	5.48 → FB5.DI48
Embedded field bus	.1~64.1~128	.61.108 → FN61.DI108

- Logic

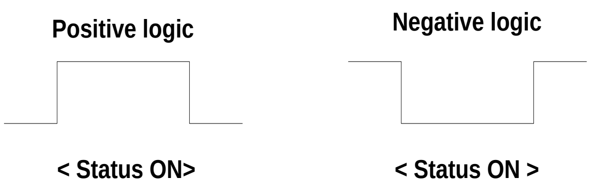
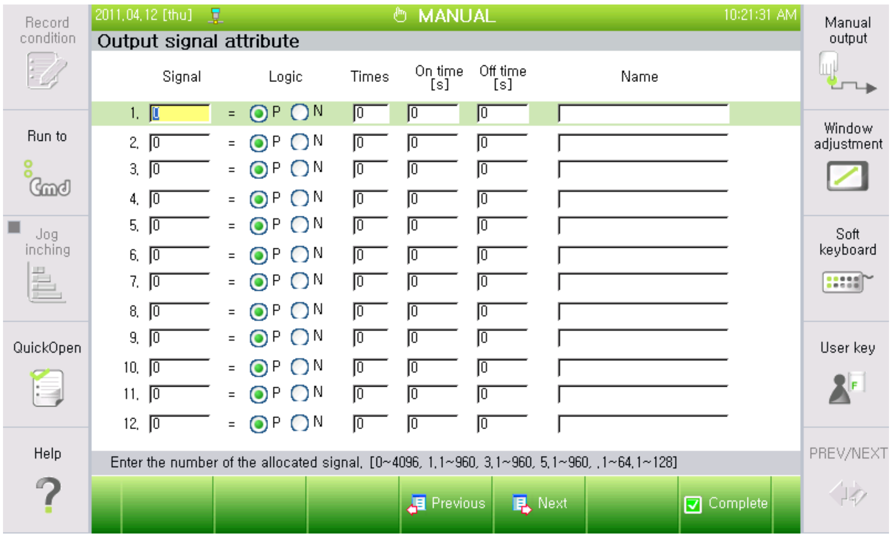


Figure 7.1 Positive and negative logic of common input signal

- Name
  You can check the name of the set signal and the status in the function of 『[F1]: Service』 → 『1: Monitoring』 → 『2: Input/output signal』 → 『5: Input signal name display』.

7.2.2.2. Output signal attribute

This function sets the signal logic, pulse property and name for the common output signal.



- Signals
  The user is required to set as the following depending on the types of output.

Type	Setting range	Setting example	
Hardwired	0 ~ 4096	35	→ DO35
Field bus	1.1 ~ 1.960 3.1 ~ 3.960 5.1 ~ 5.960	5.48	→ FB5.DO48
Embedded field bus	.1~ 64.1~128	.61.108	→ FN61.DO108

- Logic

Figure 7.2 Positive and negative logic of common output signal

- Times
  When set to 0, it is the delayed output and when set in the range of 1~100, it is the pulse output.

  Example of pulse output

Occurrence : 3   ON time: 1 sec OFF time: 0.2 sec

Figure 7.3 Example of pulse output

Example of delay output

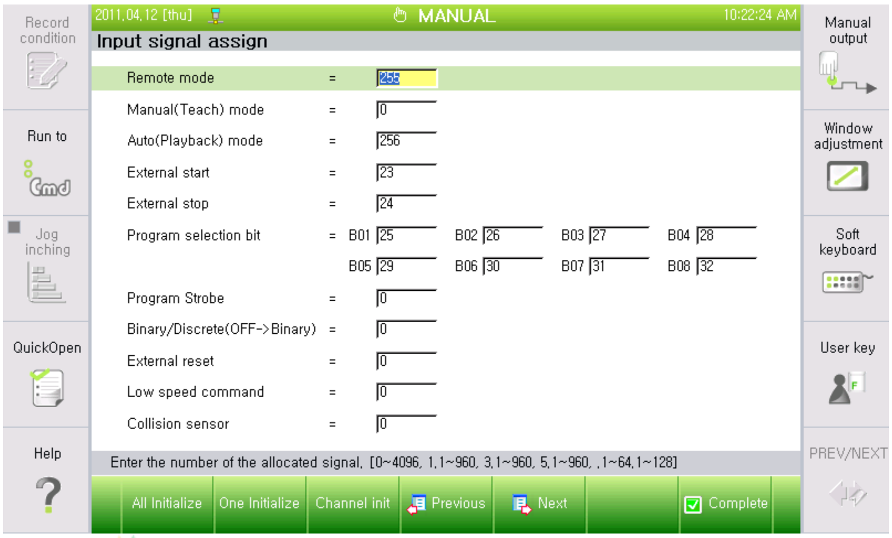
ON delay time : 1 sec   OFF delay time : 0.5 sec

Figure 7.4 Example of delay output

- On time : Set the On time of the output signal for pulse output or delayed output.
- Off time : Set the Off time of the output signal for pulse output or delayed output.
- Name
  You can check the name and the status of the set signal in the function of 『[F1]: Service』 → 『1: Monitoring』 → 『2: Input/output signal』 → 『6: Output signal name display』.

7.2.2.3. Input signal assign

The state and activity of the controller can be remote-controlled through the controller’s input signal. This function is to assign the input signal number for each remote control items.

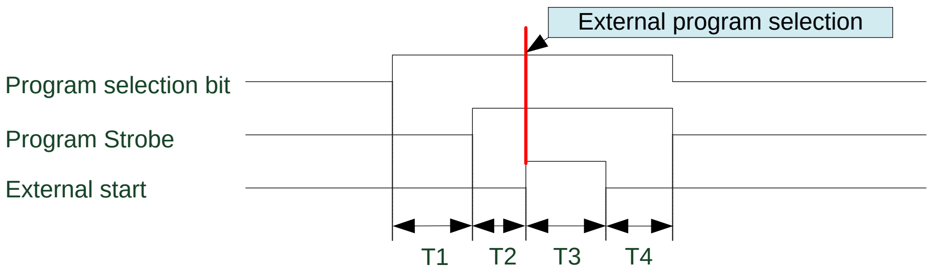


Reference

- All Initialize: This initializes all the input allocation signals.
- One Initialize: This initializes the currently selected input allocation signal to its default value.
- Channel init
  This function resets the input channel for the assigned signals.
  (0: Digital signal, 1,3:BD52X field bus, 5:BD57X field bus (CC-Link))

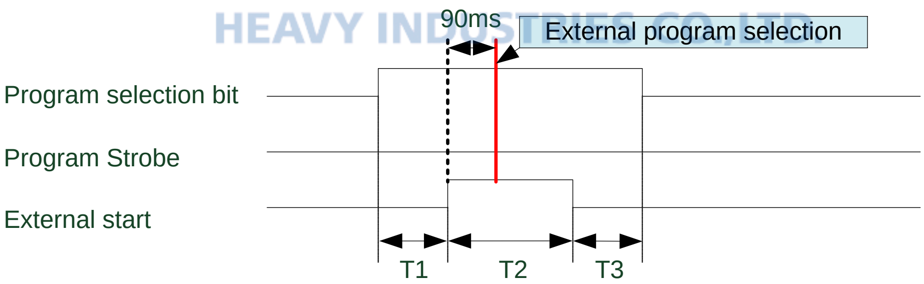
- External program selection
  In case of the externally started operation, the time, in which the external program is confirmed as it is after the program selection bit is read, varies depending on whether the strobe signal is used.

  - If the program strobe signal use is <Enable>
    When the external start input is made, if the program strobe signal is on, the program selection bit will be read. Then, the read value will be confirmed as the program number.



T1 $\geq$ 0.3sec   T2,T4 $\geq$ 0.15sec   T3 $\geq$ 0.2sec

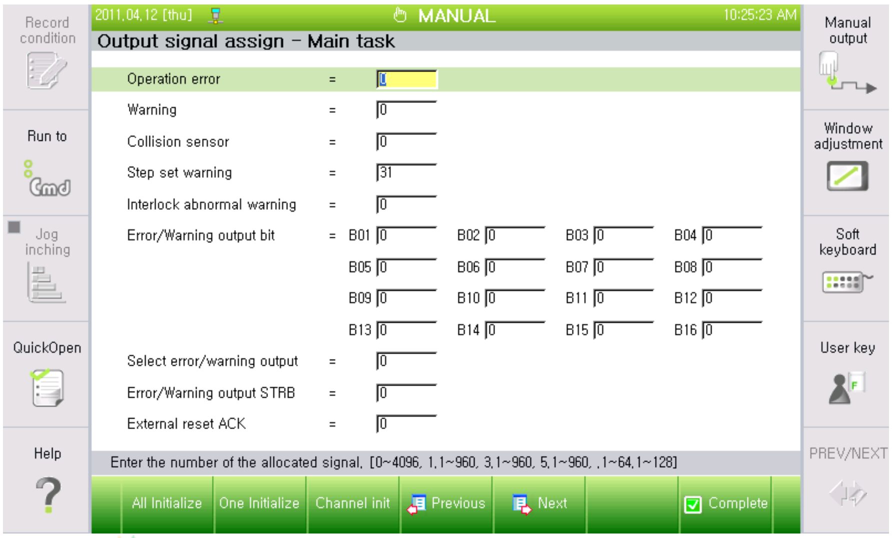
  - If the program strobe signal use is <Disable>
    After the external start input is made and the program selection bit is read, then, if thus read value does not change for 90ms, it will be confirmed as the program number



T1,T3 $\geq$ 0.15sec   T2 $\geq$ 0.2sec

7.2.2.4. Output signal assign

This is to allow the event data or state data generated from the controller to be transferred externally through the output signal. This function is to assign the output signal number for such data individually.



Refer to the following sequence for the output signals related to error/warning output bit, error/warning STRB, overall error, operation error and alarm. The sequence will vary depending on whether the “system / 1: control parameter/ 4: Error/Warning external output / (2) output type” are set in 8-bit or 16-bit. Refer to the following.

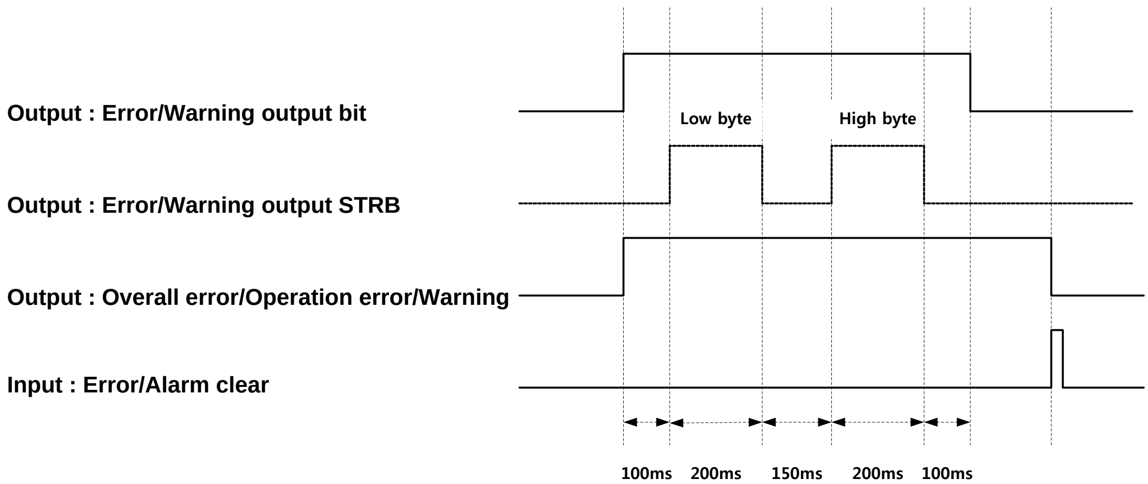


Figure 7.5 8-bit output

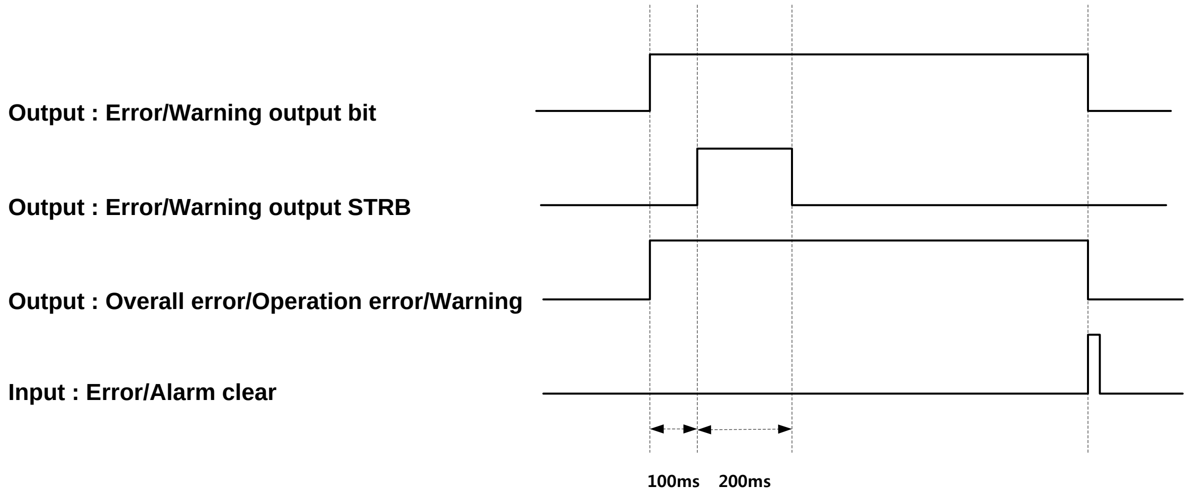


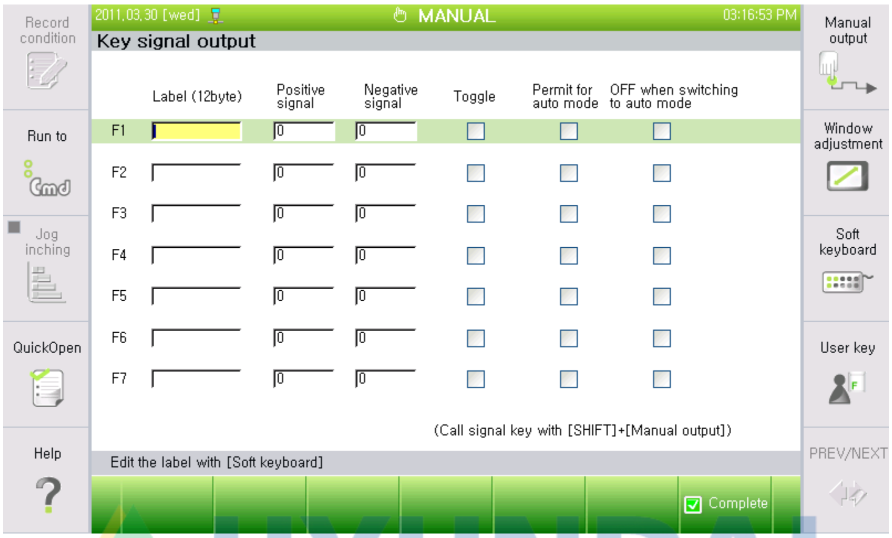
Figure 7.6 16-bit output

Reference

- All Initialize: This initializes all the output allocation signals.
- One Initialize
  This initializes the currently selected output allocation signal to its default value.
- Channel init
  This resets the output channel for the assigned signals.
  (0: Digital signal, 1, 3:BD52X field bus, 5:BD57X field bus (CC-Link))

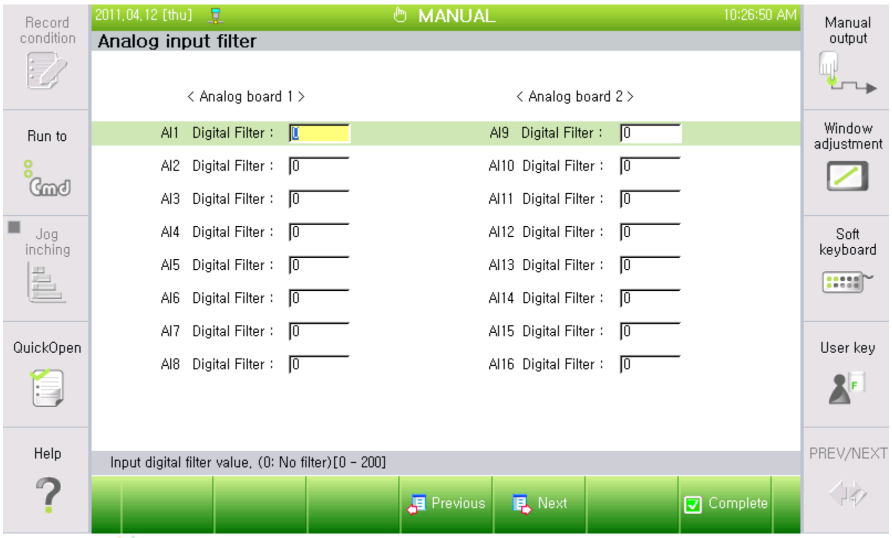
7.2.2.5. Key signal output

This is to set in a way to allow the desired output signal to be turned on/off by using the signal keys of the teach pendant ([SHIFT] + [F1] ~ [F7]).
Refer to the key signal output operation manual for more details.



7.2.2.6. Analog input filter

You can use the digital filter for the analog input signal.
Set this when you need to reduce the noise level in the noisy analog input

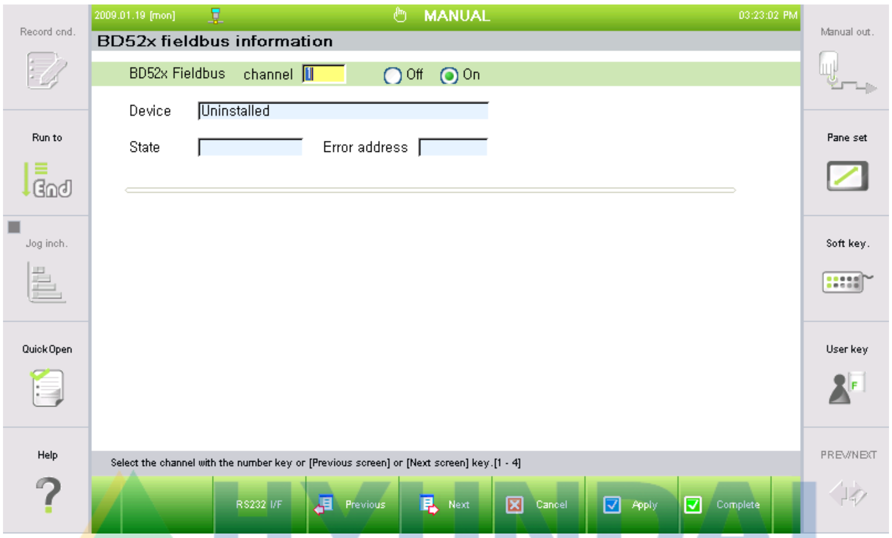


Reference

- You can set the analog input filter for arc sensing used for arc welding from the message box in 『[F2]: System』 → 『4: Application parameter』 → 『2: Arc welding』.
- There are 8 analog input ports per BD58X board.
- Maximum number of analog input port is 32.

7.2.2.7. BD52X field bus information

This is to set the BD52X field bus function, and is to be used for the Device Net master or slave functions, and profibus-DP master or slave functions. The screen configuration varies depending on the installed field bus module.
Refer to 『Hi5 Controller BD52X Multi-Communication Function Manual』



- Channel :
  This displays the number of the currently selected channel. Use [F3: Previous] and [F4: Next] to shift between channels.

- Use: Select whether to operate the field bus module of the applicable channel.

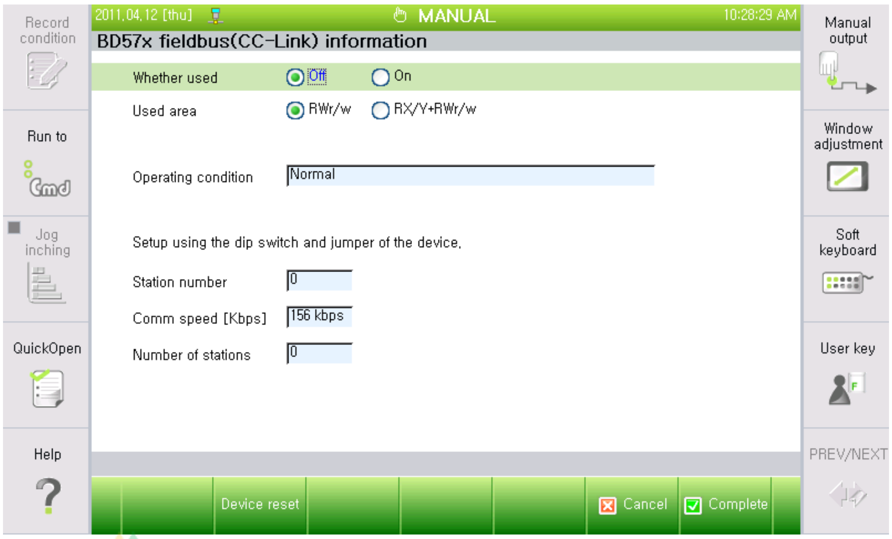
- Device: This displays the name of the module installed in the applicable channel.

- Status: This displays whether the module is executing the network operation normally.

- Error address
  For the field bus master module, this displays the address (Node number etc.) when the slave that caused the problem within the network is identified.

7.2.2.8. BD57X field bus (CC-Link) information and setting

This function sets the CC-LINK of BD57X (Or, BD58A).
Refer to 『Hi5 Controller CC-Link Function Manual』 for more details.



- Whether used: Select whether to use the function.

- Used area: Select the utilization method of I/O area.

- Operating condition :
  This displays whether the module is executing the network operation normally.

- Station number: Displays the station number of the CC-Link set by the BD57X dip switch.

- Station number:
  Displays the communication speed of the CC-Link set by the BD57X dip switch.

- Number of stations:
  Displays the number of occupied stations of the CC-Link set by the BD57X jumper.

Reference

- Device reset: This function is to re-initialize the BD57X CC-Link board.

7.2.2.9. Embedded field bus (Device Net) information and setting

This function sets the embedded Device Net master. In case of the embedded Device Net master function, no additional tool for the network configuration is to be used.

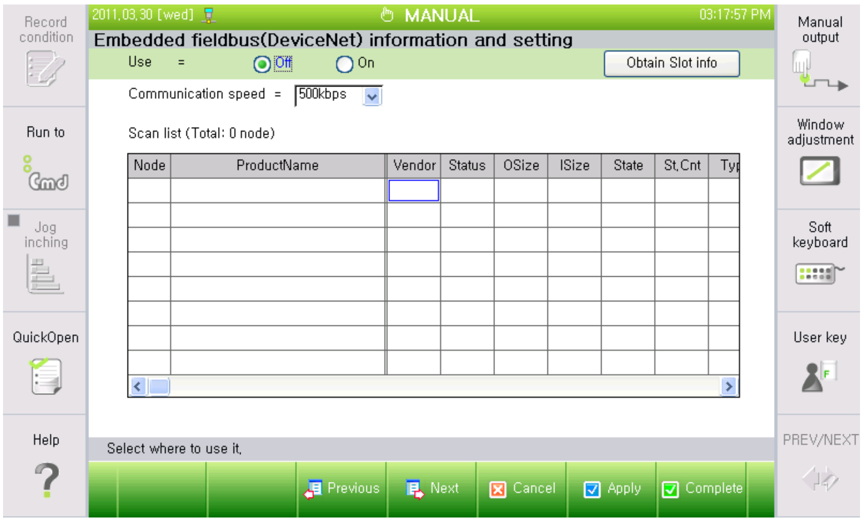


Figure 7.7 Embedded field bus setting screen

- Use: Select whether to use.

- Communication speed:
  Select the one communication speed for the Device Net among the speeds, 125kbps, 250kbps, and 500kbps

When you press [F6: Apply] after setting the above, the setting will be saved in the main board. After a short while, [Node Retrieval] will be shown as below.

When you press [F1: Node Retrieval] after connecting the slave device that you will use, the connected nodes will be automatically scanned as shown below.

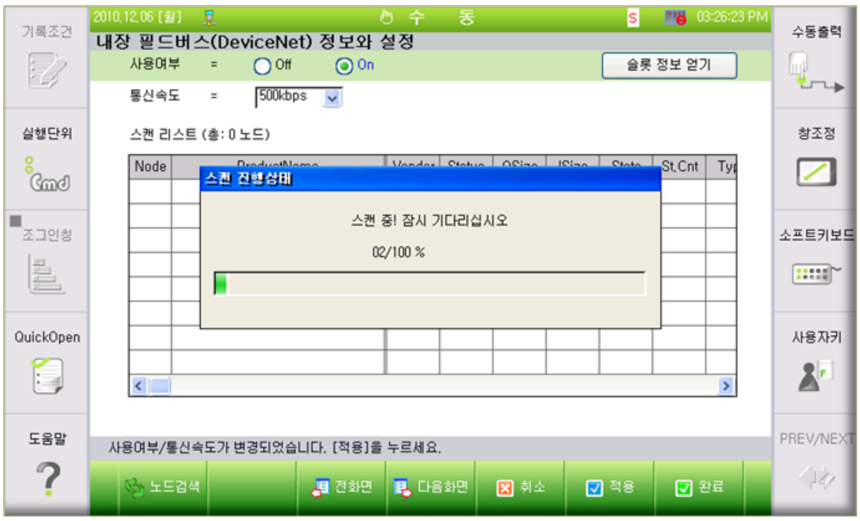


Figure 7.8 Node scanning for setting the embedded field bus

The scanned results to be displayed include, as shown below, the product name, vendor ID, status, count of output bytes (Osize), count of input bytes (ISize), state (42=IO Polling), state change counter (St. Cnt), device type, CCV, and the serial number

Figure 7.9 Node scanning results for setting the embedded field bus - 1

When the vendor of the connected node is Crevis, you need to press the [Obtain Slot Info]. Then, the names of devices connected to the slot will be displayed as shown in the following screen.

Figure 7.10 Node scanning results for setting the embedded field bus - 2

When there is no error, just like the case shown above, the Get Set Object function, [F2: Get Set], which will make it possible to have a direct access to the node object, will be displayed.

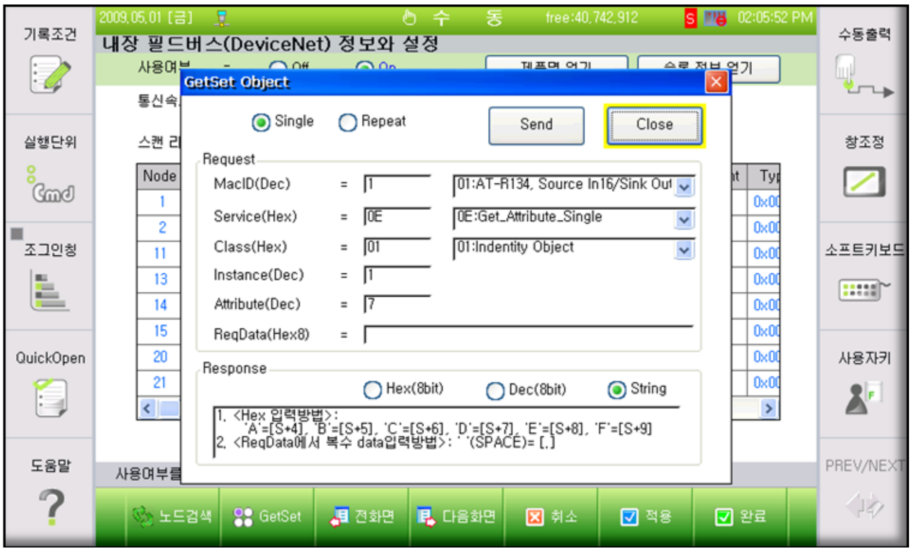
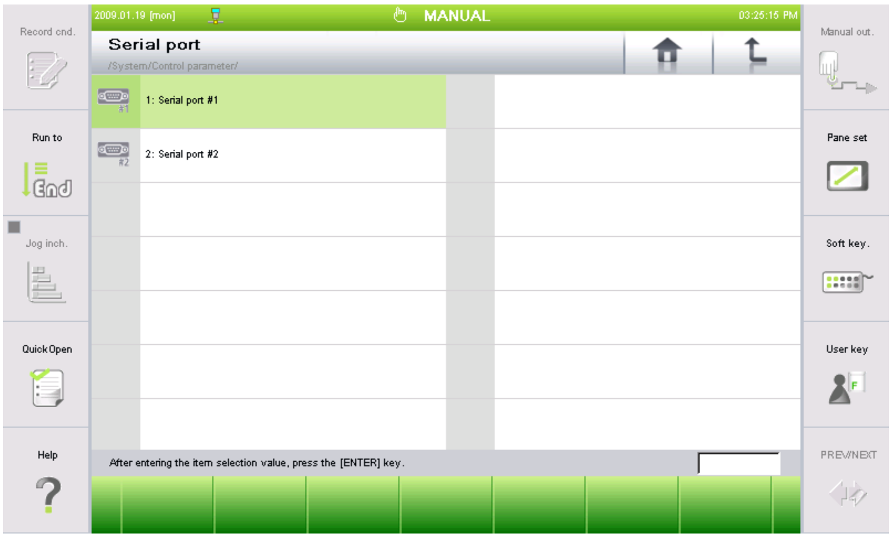


Figure 7.11 Embedded field bus Get/Set Object

As shown in the above screen, in the case of the Mac ID, Service, and Class items, values can be entered or a list can be selected from the combo box. This function can check the internal state of each node or make a change in it. For example, if the communication with the master is disconnected, a change can be made in a way that the state of the output is maintained, or turn 0 or 1, Refer to the information provided by the maker of each connected node.

7.2.3. Serial port

This sets up the parameters for RS232, RS422 and RS485, and sets up the usage for serial ports.



7.2.3.1. Serial port #1

This function sets the communication information when communicating with serial port #1.

Reference

- Serial port usage

  ① File Manager
  This is used for saving or opening files (HR-View) for the interface with the computer.

  ② Sensor
  This is used for the usage of receiving the shift data by interfacing with the vision sensor.

  ③ LVS
  This is used for the usage of connecting the laser vision sensor to track the welding line.

  ④ MODBUS
  This is used for the usage of using the MODBUS slave function of Hi5.

- [F1: Communication test]

  This function is to check whether the serial port communication connection is normal. If there is a problem, this function provides procedures for identifying the cause of the problem.

7.2.3.2. Serial port #2

This function sets the communication information when communicating with serial port #2.

Reference

- Serial port usage

  ① File Manager
  This is used for saving or opening files (HR-View) for the interface with the computer.

  ② Sensor:
  This is used for the usage of receiving the shift data by interfacing with the vision sensor.

  ③ LVS
  This is used for the usage of connecting the laser vision sensor to track the welding line.

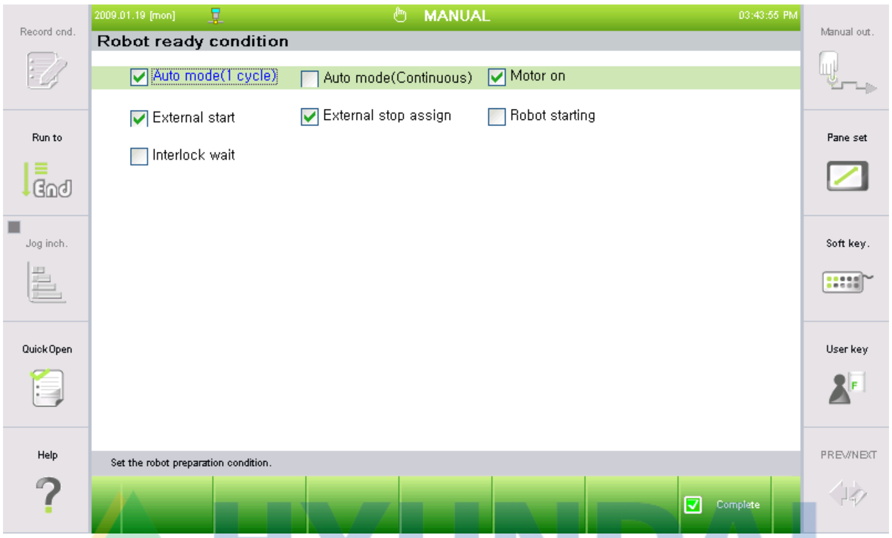
  ④ MODBUS
  This is used for the usage of using the MODBUS slave function of Hi5.

- [F1: Communication test]

  This function is to check whether the serial port communication connection is normal. If there is a problem, this function provides procedures for identifying the cause of the problem.

7.2.4. Robot ready condition

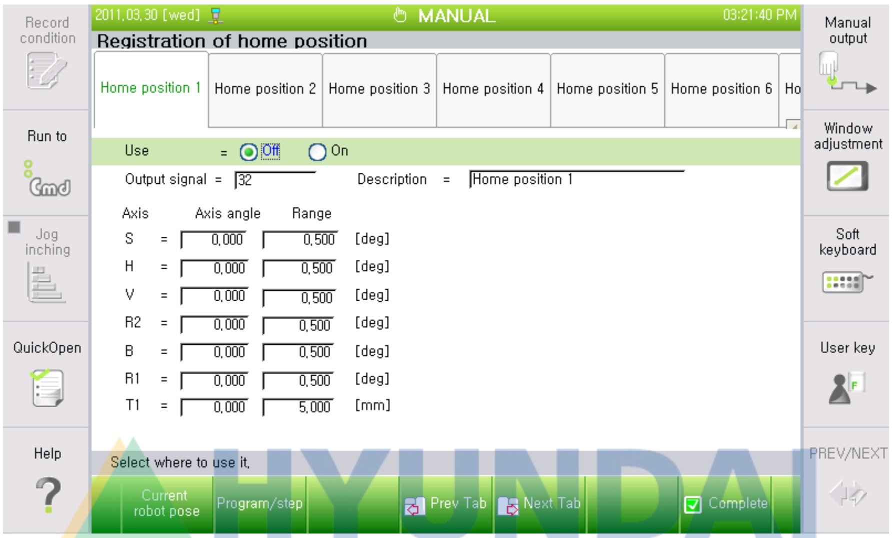
This sets the conditions to generate the ready signal for robot preparation.
Robot ready signal is the DO signal allocated in 『[F2]: System』 → 『2: Control parameter』 → 『2: Input/output signal setting』 → 『4: Output signal assign』.



7.2.5. Registration of home position

This is the function to output the original location signal, set in the output signal section, if the user registered an arbitrary posture of the robot as its original location and the robot came into that location. The original location is designated by each axis posture and here the margin by each axis can be set.

Up to 8 original locations can be registered and used.



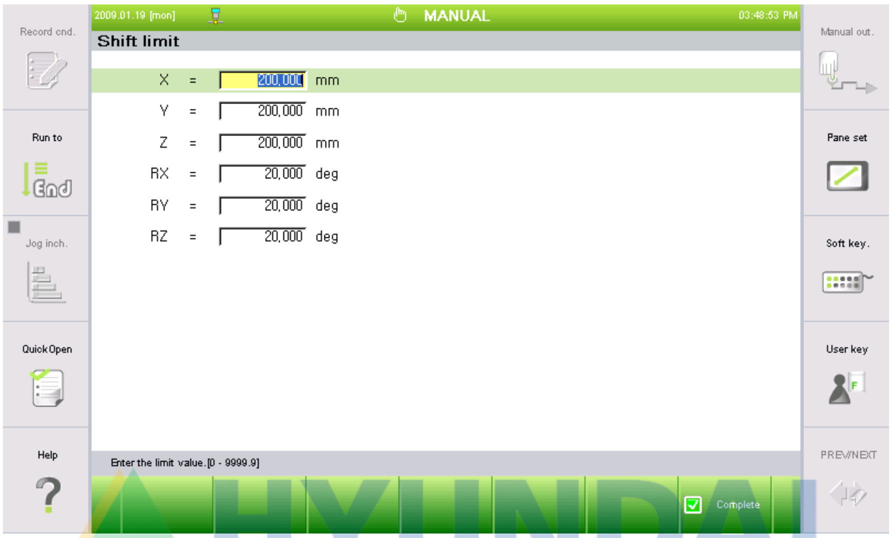
- Axis angle, range
  Enter the range of position for each axis of the robot at the home position. When the range value is set to 0, the home position check will not be carried out for the relevant axis.
  The range value is used in the '+' direction and '-' direction ranges of the original location point. For example, when it is set to 0.5, the output range of the original location signal becomes 1.

- [F1: Current robot pose]
  This function is to allow the axis angle of the current posture of the robot to be entered into the screen automatically.

- [F2: Program/Step]
  This function is to allow the axis angle of the relevant step to be entered into the screen automatically after the program and step number are entered by the user

7.2.6. Shift limit

This is the function to set the shift limit of the robot to improve the stability when using the shift function. Set the shift limit of XYZ shift or online shift function, and an error is generated when the shift exceeds this setting.
By setting the shift limit, you can process the error when incorrect shift data is received externally.

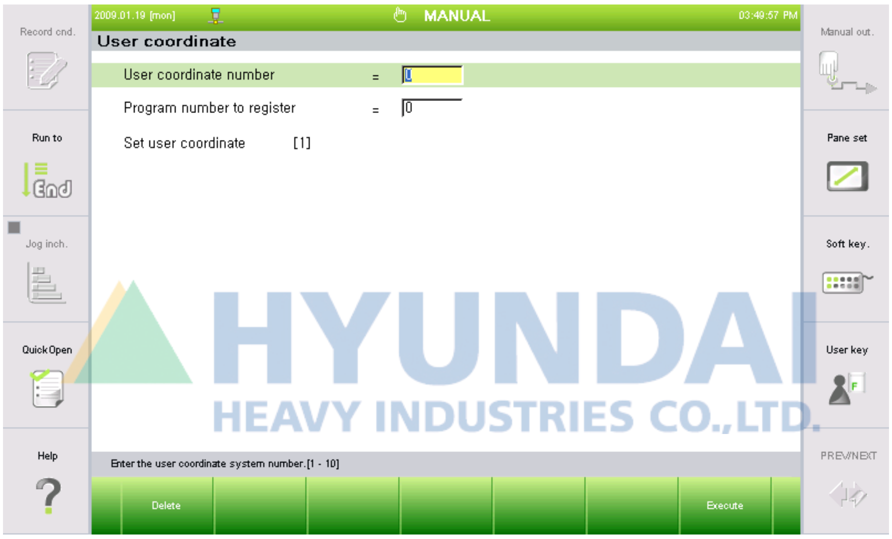


7.2.7. Coordinate registration

It is used for setting up the user coordinate or stationary tool coordinate.
Select and access 『[F2]: System』 → 『2: Control parameter』 → 『7: Coordinate registration』

7.2.7.1. 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 coordinates can be registered to Hi5 controller.



Reference

- Teaching method of 3 standard steps to define the user coordinate

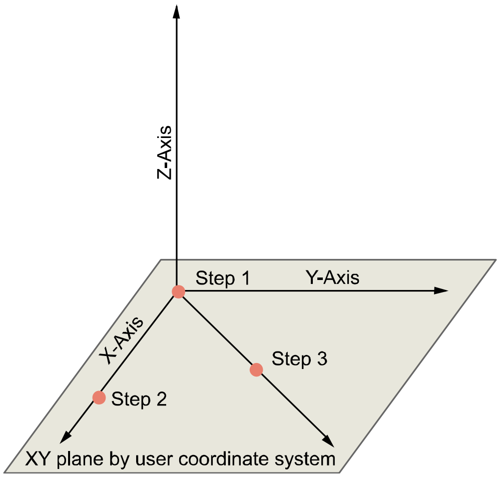


Figure 7.12 Teaching method of 3 standard steps to define the user coordinate

① Step 1 : Step to define the 0 position in the user coordinate

② 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.

③ 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 A step after step 4 does not affect the coordinate registration.

7.2.7.2. Stationary tool coordinate system

The stationary tool coordinate system is to perform the setting necessary for using the stationary tool interpolation.

- About the stationary tool interpolation
  A robot tool is a tool that is attached at the front end of the robot. Generally, the work to be done by the robot is carried out by using those attached tools. Arc welding is the representative case. The arc welding tool is commonly attached at the front end of the robot and carries out welding for the workpiece that is externally attached.

  On the contrary, the stationary tool is a working tool that is attached externally, not to the robot. In case of the stationary tool, the robot handles and places the workpiece at the externally fixed tool in order to process the work.

  Sealing is the representative work for which a stationary tool is used. Generally, the sealing work is carried out in a way that the externally fixed tool discharges the solvent necessary for the sealing work, and then, the robot picks up the workpiece and creates the trajectory necessary for the sealing work while carrying out sealing.

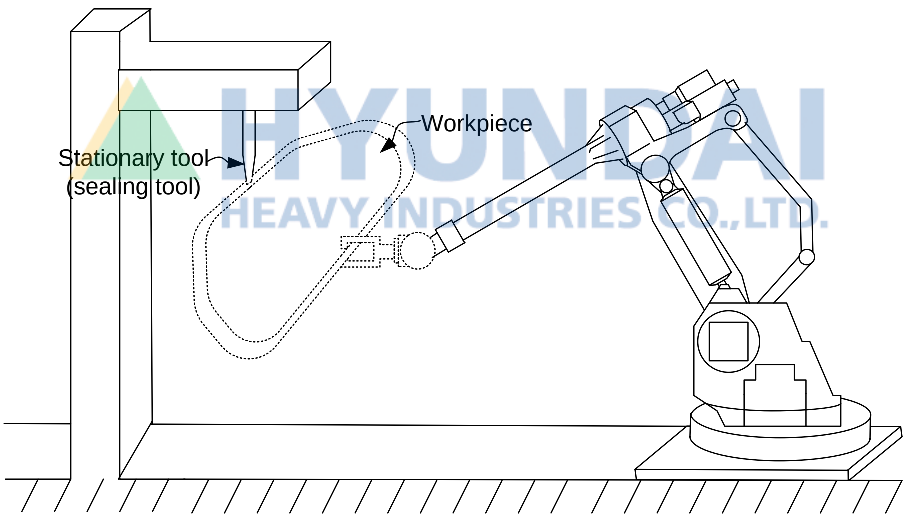


Figure 7.13 Example of the sealing work

In order for the robot to create the trajectory, the robot is required to perform the linear (L) and circular (C) interpolations based on the tool that is externally attached, not based on the tool that is attached to the robot itself. The stationary tool interpolation function is required in such situation.

When the stationary tool interpolation function is used, the moving linear and circular paths of the stationary tool on the work can be maintained even when the posture of the workpiece that is attached by the robot.

Accordingly, in case of such works for which the moving path against the external tool is so critical, the stationary tool interpolation function must be used.

- Stationary tool coordinate system setting

Select 『[F2]: System』 → 『2: Control parameter』 → 『7: Coordinate registration』 → 『2: Stationary tool coordinate』.

Register the position in the stationary tool coordinate system as the robot base coordinate reference. In order to set the position of the stationary, TCP needs to be located correctly and, as shown in the below picture, the stationary tool and the robot tool need to be matched, and F1 'Auto setting' needs to be carried out, then the current TCP location can be registered.

Totally 4 stationary tools can be set ranging 0~3.

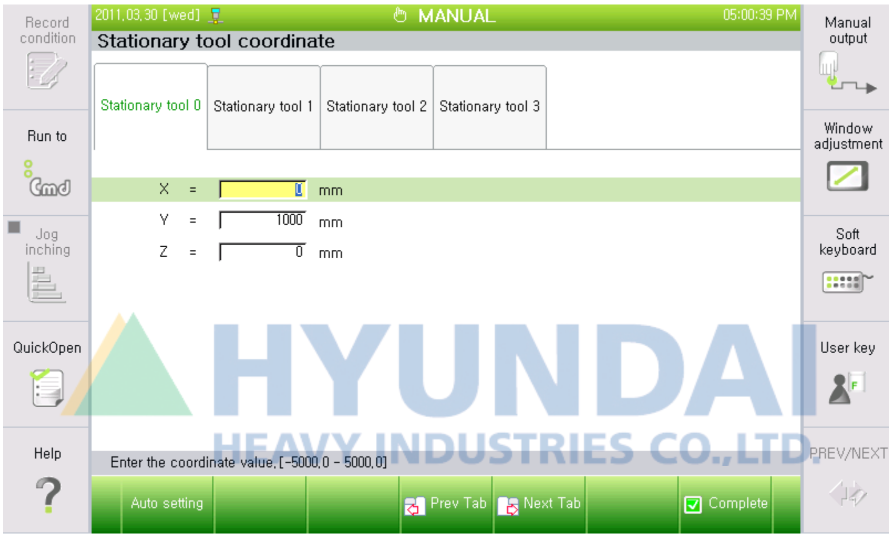


Figure 7.14 Stationary tool coordinate setting method

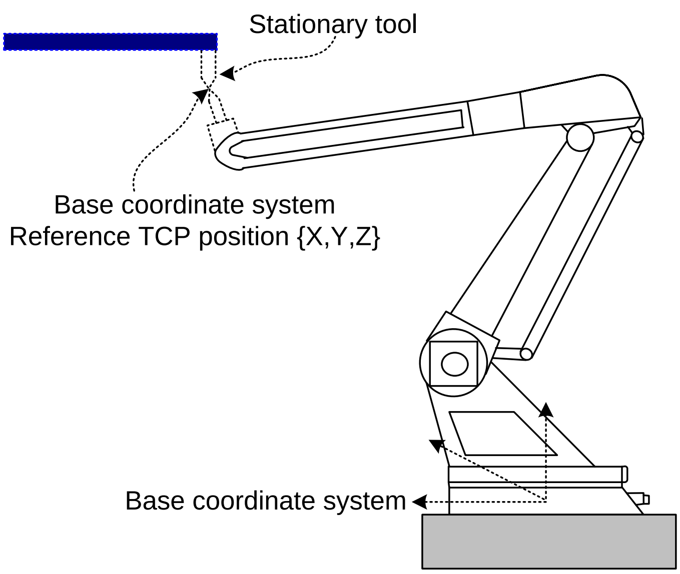


Figure 7.15 Teaching method when using the auto setting function

- Program preparation

  The step needs to be as SL or SC to make the recording as the stationary tool interpolation. Use the record condition key to change the record condition as SL or SC and use it.

  For example, when the stationary tool coordinate system #1 is to be registered and used, the program needs to be prepared as shown below. .

Reference

- There is no need to use the stationary tool interpolation function for the stationary servo gun. In case of the servo gun welding, there is no need for the path of the work to be made in linear or circular line against the stationary servo gun, as only the welding points matter.

- Refer to the method for using the command SELPTNO.

7.2.8. Program reservation execution

Refer to 『Hi5 Controller Program reservation execution function manual』

7.2.9. Network

Set the environment when using the network.

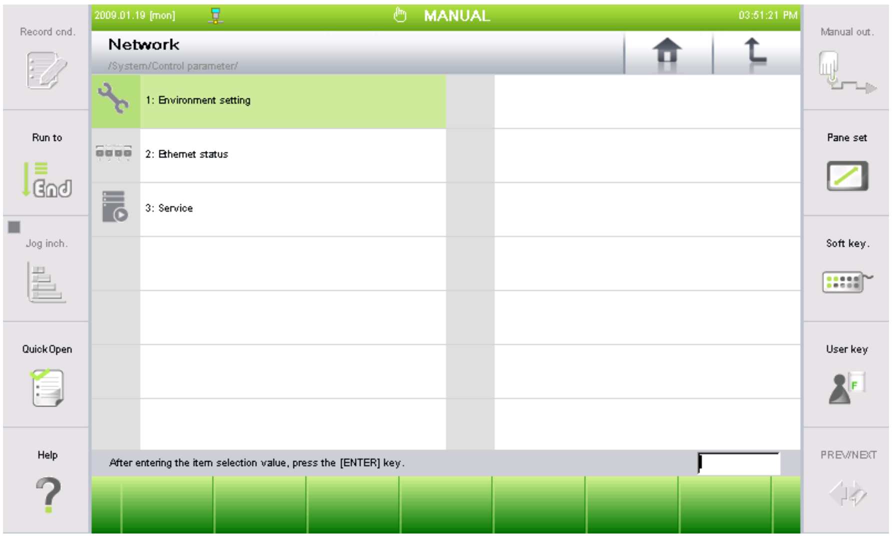


Figure 7.16 Network menu screen

7.2.9.1. Environment setting

3 network ports (EN0, EN1, EN2) for main board of the controller and 1 network port (EN_TP) for the teach pendant are provided, and this sets the environment for these network ports. Set the IP address, sub net mask and gateway information so that the controller fits the installed network after the setting, the power must be rebooted to reflect the setting.
(EN0: For Cooperation control, EN1: For TP communication, EN2: Public, EN_TP: Teach pendant)

Figure 7.17 Network/Environment setting screen

7.2.9.2. Ethernet status

This monitors the various types of status for the network port provided on the main board of the controller.

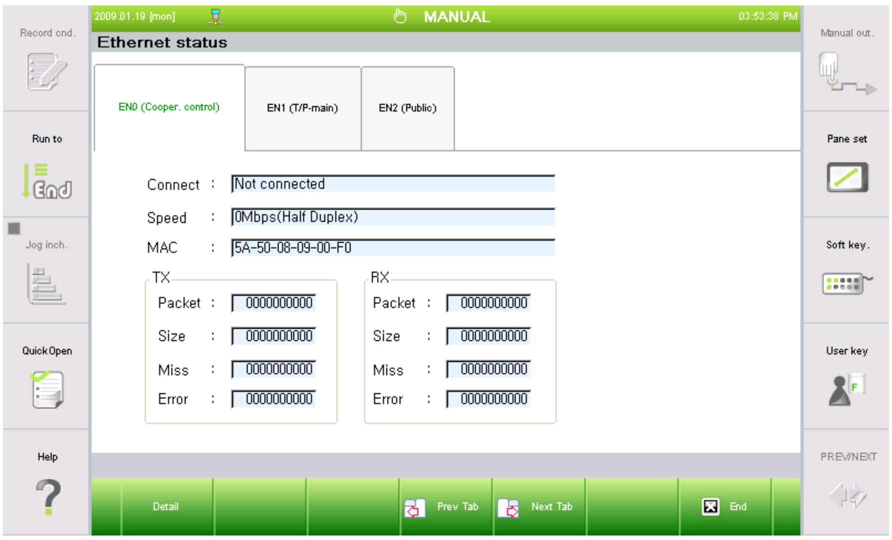


Figure 7.18 Ethernet state monitoring screen

7.2.9.3. Service

This function sets the service environment for the network.

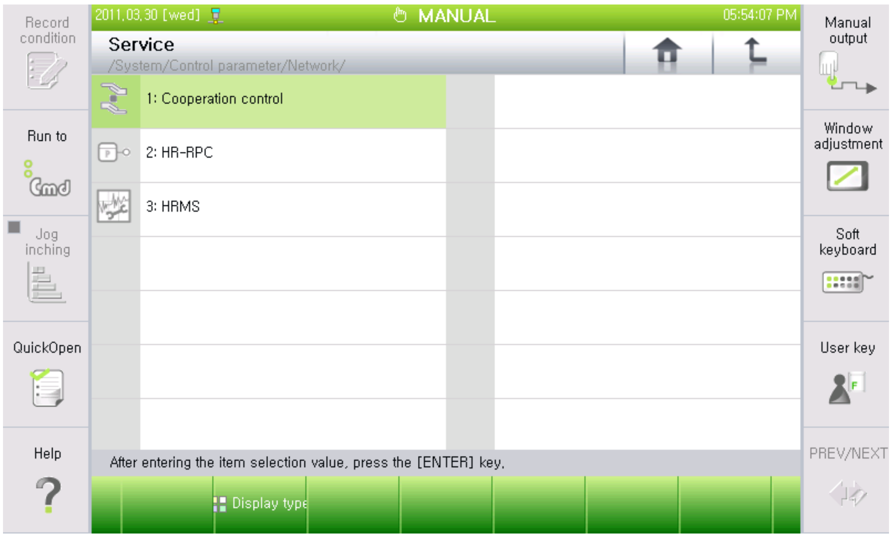


Figure 7.19 Network/Service menu screen

7.2.9.3.1. Cooperation control

This function sets the environment to use the robot Cooperation control function.
For details, refer to 『Hi5 Controller cooperation control function manual』

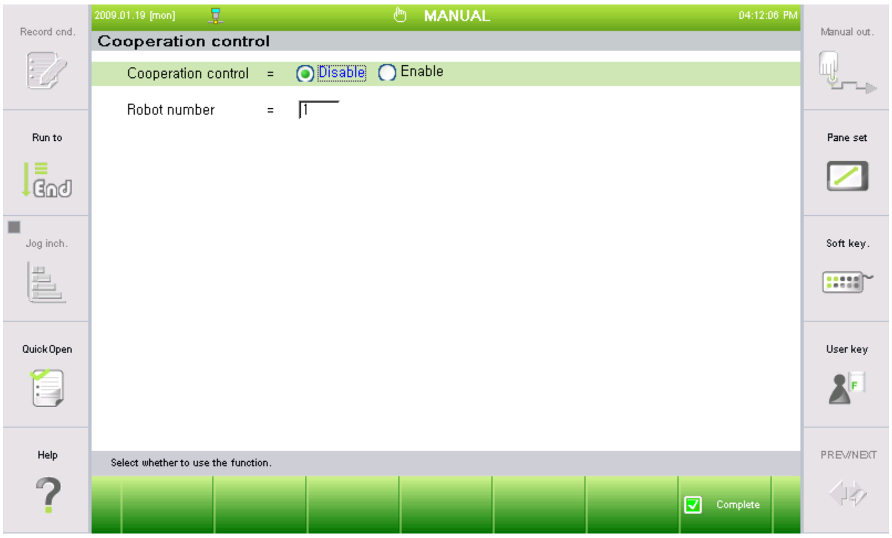


Figure 7.20 Cooperation control setting screen

7.2.9.3.2. HR-RPC

This function re-initializes the HR-RPC service that performs various types of monitoring and remote control through Ethernet.

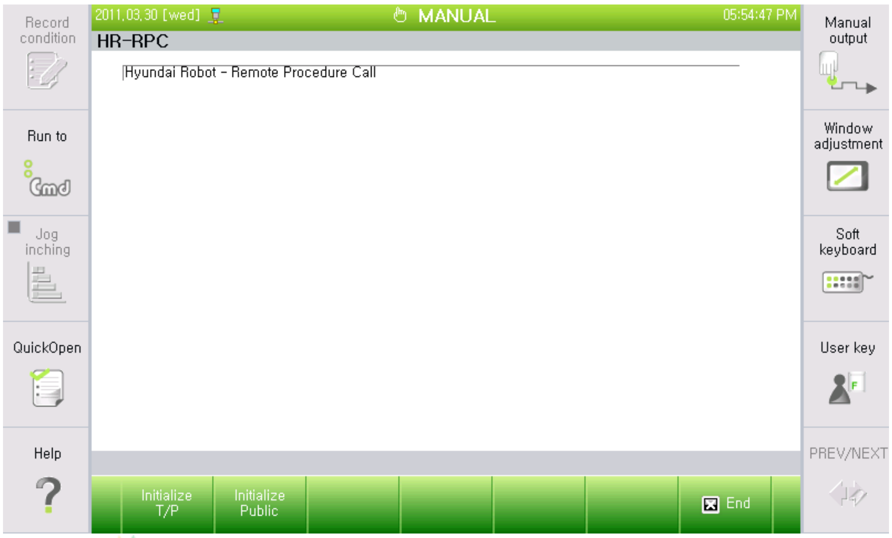


Figure 7.21 HR-RPC initialization screen

- [F1: Initialize T/P]
  Re-initialize the HR-RPC service of the main board for the teach pendant.

- [F2: Initialize Public]
  Re-initialize the HR-RPC service of the main board for the external Ethernet connection (PC).

7.2.9.3.3. HRMS

HRMS (Hyundai Robot Monitoring System) is a centrally integrated PC-based robot management solution, which, through the Ethernet connection of scattered multiple robots, provides the real-time monitoring service in which the operation time, activation state, error/repair history, preserved data and the like can be available, as well as the version management service. Refer to 『HRMS Manager Manual』 and 『HRMS User Manual』 for more details.

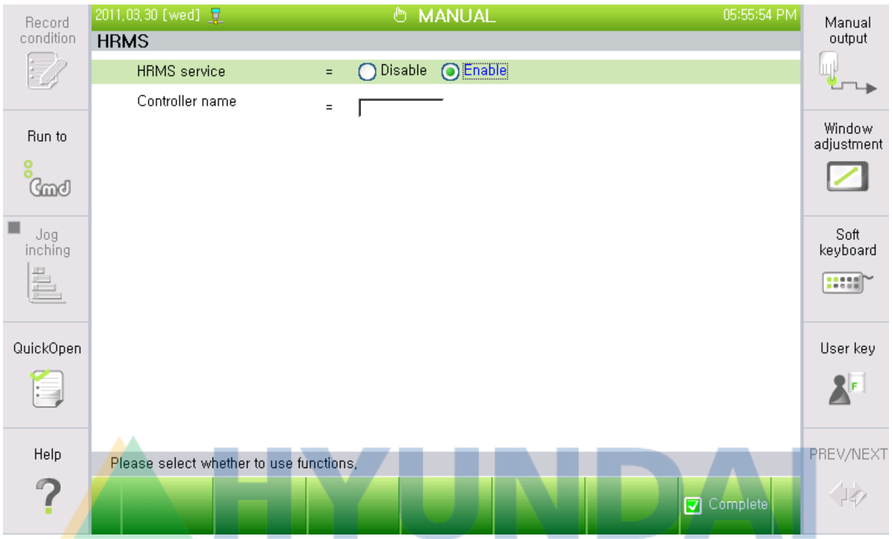


Figure 7.22 HRMS setting screen

- HRMS service: Set the service to be enable/disable.
- Controller name: Set the controller name on the network.

7.2.10. Register license key of option function

7.2.10.1. What is the optional function license key?

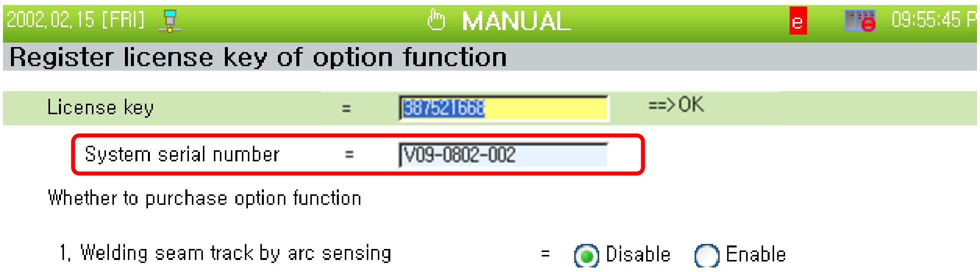
Of the functions of the Hi5 robot controller, some specific optional functions are to be sold separately. In order to use those functions, users need to purchase them.
The license keys of those options are generated by a separate license key generation program, which combines the unique number assigned to the robot controller's main board and the purchased optional functions, so the purchased function will operate only through the purchased controller.
Accordingly, the robot controller's main board that uses those optional functions cannot be replaced with other controller.
If the main board has a problem, so it needs to be replaced with the spare one, you can use a temporary key that can be used for 30 days.
In this situation, you are required to contact our A/S department to get the official license key before the 30 days expire.

- Function configuration
  Set whether to purchase the optional functions
  Set the license key

7.2.10.2. License key registration procedure

- Purchase the license key of the optional function matching with the system serial number.
  The system serial number is saved in the license registration screen or the ROBOT.INF file.

  - Optional function license key registration screen



  - ROBOT.INF

```
=<< Main Board Information >>==========================
        Main S/W      =V30.18-30, 2009.04.27
        Built it at May 02 2009, 19:53:07
        Main B/D Serial Number = BD510V09-0802-002
        Main B/D PLD = V0.7
        Dip Switch=10
```

  - Select whether to purchase the options first, and then, enter the license key.
    If the selected data regarding whether to purchase and the license key do not match, an error will occur when the relevant function is run.

7.2.10.3. License key registration

- Registration screen
  『[F2]: System』 → 『2: Control parameter』 → 『10: Register license key of option function』

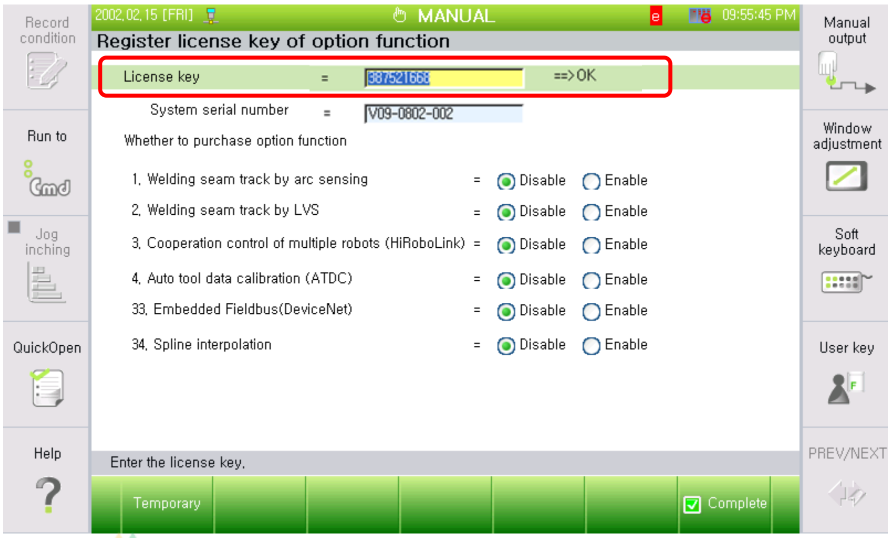


Figure 7.23 Optional function license key registration screen

- When the license key is entered correctly, “==>OK” will be displayed at the right side of the space for entering the license key.

- If “==> NG” is displayed, it means that the license key is incorrect or the selection regarding whether to purchase is wrongly made.

7.2.10.4. What is the temporary key?

- The temporary key can be used only for 30 days, it will be issued only for one time in case of Hi5 controller.
- When the remaining days for the temporary key are within 10 days, then, every time the controller is booted, the following warning will be generated.

W0025 Only (n) days for free usage of temporary license key of option function are remained.

- The temporary key is to be used until our A/S section reissues its license key, if the main board of the controller suffer problems and should be replaced with a spare one.

7.2.10.5. Temporary key issue

- Press the [F1] key to get the temporary key issued.

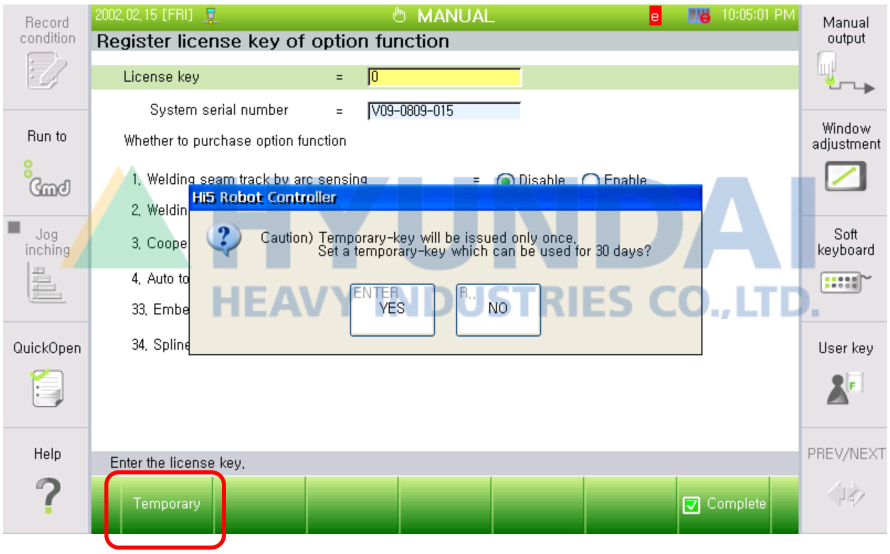


Figure 7.24 Optional function license key registration screen

- If the issuing is processed normally, the remaining days will be display as shown below.

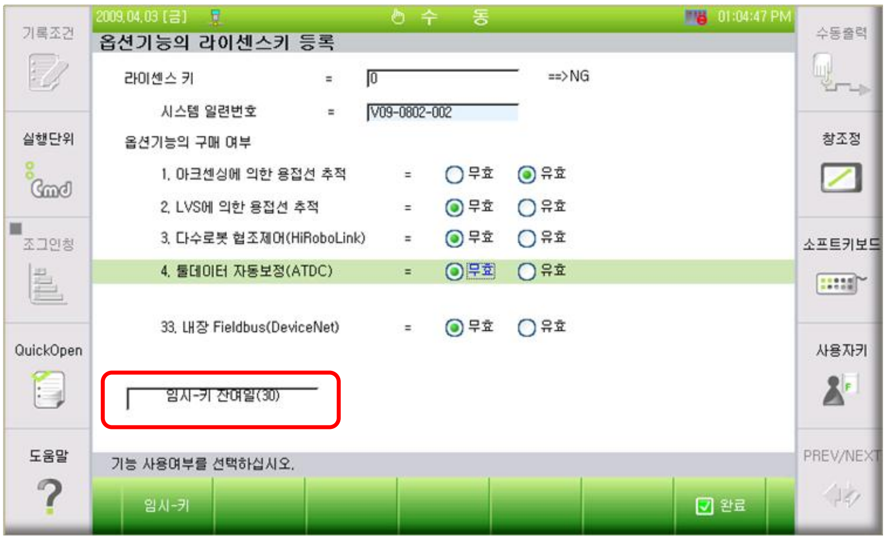
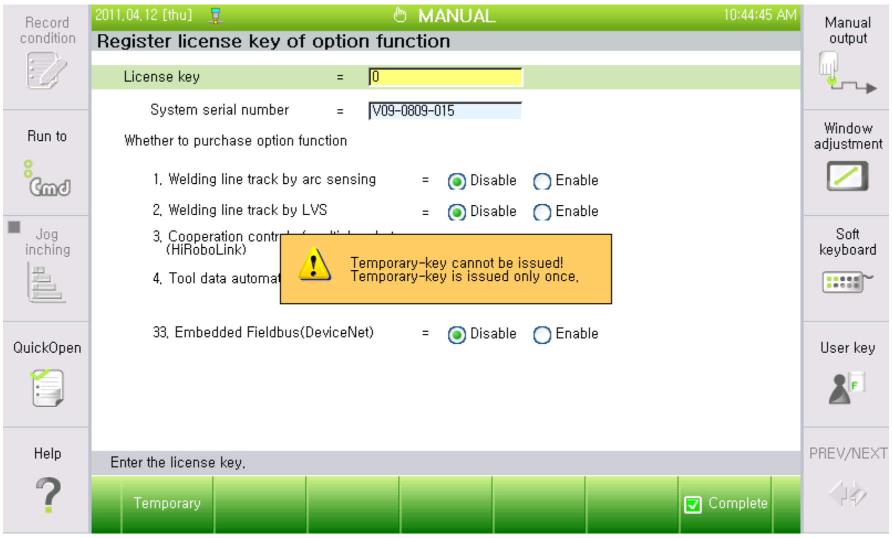


Figure 7.25 Remaining days of the optional function license key

- Caution) when the remaining day is 0, the optional function cannot be used any longer and the temporary key will not be re-issued.

- When you get your temporary key issued due to the malfunctioning main board after purchasing the normal optional function, the production line could be stopped due to the optional function. You must contact us to get the official license key issued before the remaining day is 0.



7.2.11. Automatic backup and recovery

Refer to 『Hi5 Controller Auto Backup Function Manual』.

7.3. Robot parameter

This sets up various parameters for the robot body.

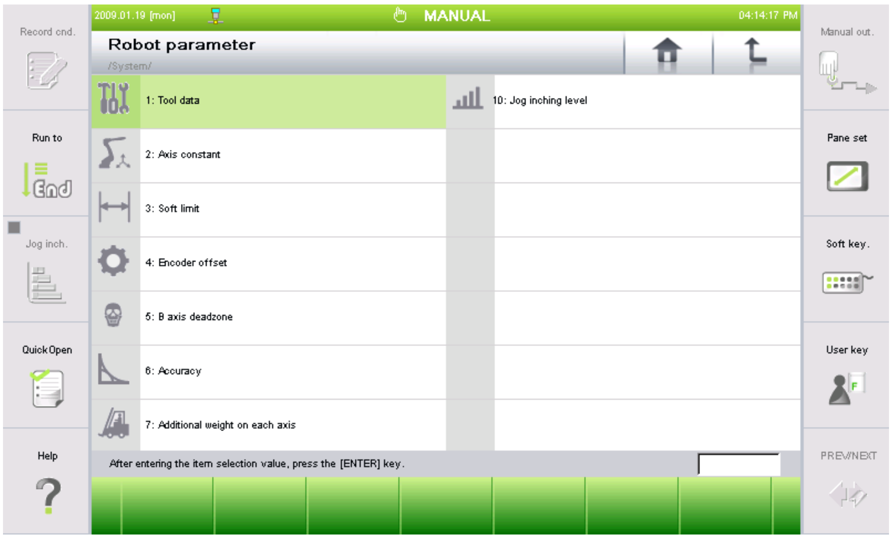


Figure 7.26 Robot parameter menu screen

7.3.1. 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.

Hi5 controller is controlled based on the robot dynamics. The weight, inertia and center of the tool must be set accurately for the robot to operate quickly and safely. When this value is incorrect, it can cause serious problems to the performance and life of the robot.
Especially if you are using the tool change function, you must allocate a separate tool number not just for the condition in which the tool is separated but also for the information of each tool to enter and use the tool information for the tool change function.
Also for the handling of heavy objects, each tool number must be allocated for the attach/detach condition of the object for use.

Tool length is the length by each direction in the flange coordinate system shown as follows.

(1) Distance in X axis : Xt
(2) Distance in Y axis : Yt
(3) Distance in Z axis : Zt

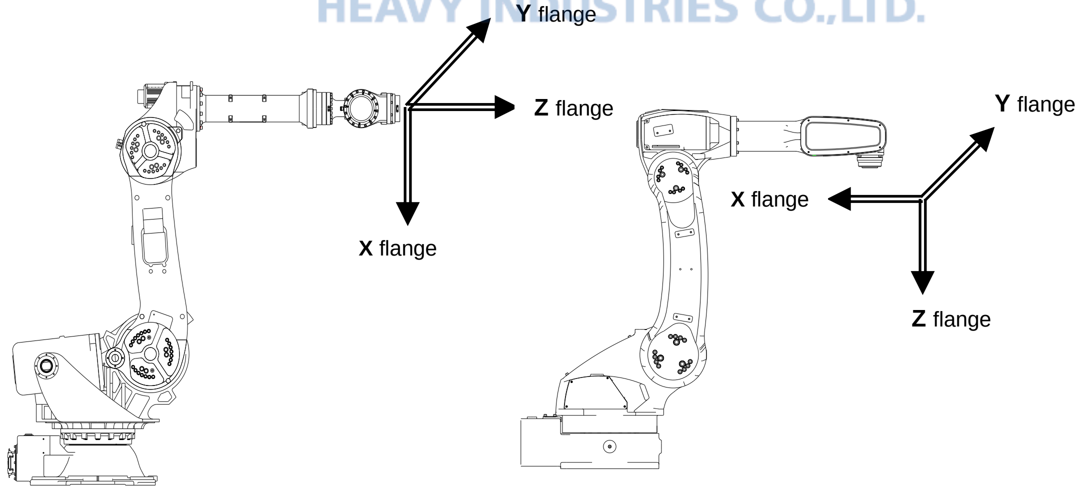
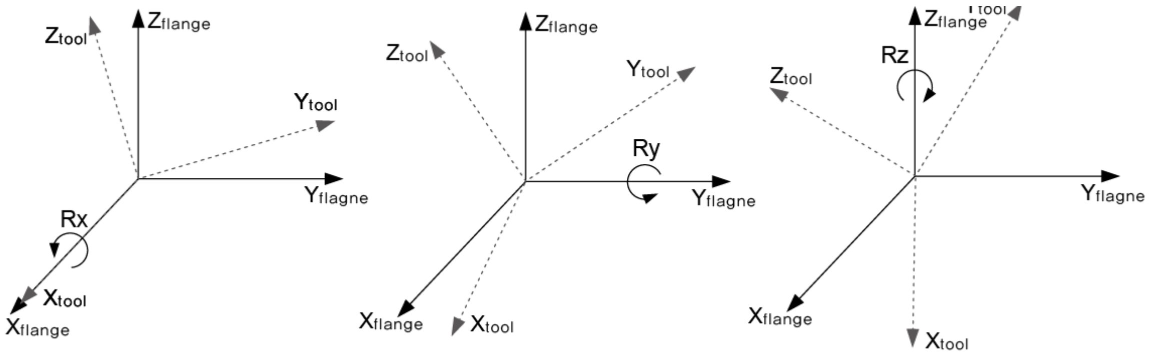


Figure 7.27 Flange coordinate system by robot type

Tool angle is the amount of position change in each direction in the flange coordinate system.

(1) Angle in X axis : Rx
(2) Angle in Y axis : Ry
(3) Angle in Z axis : Rz



① Rotating Rx　　② Rotating Ry　　③ Rotating Rz

Figure 7.28 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.

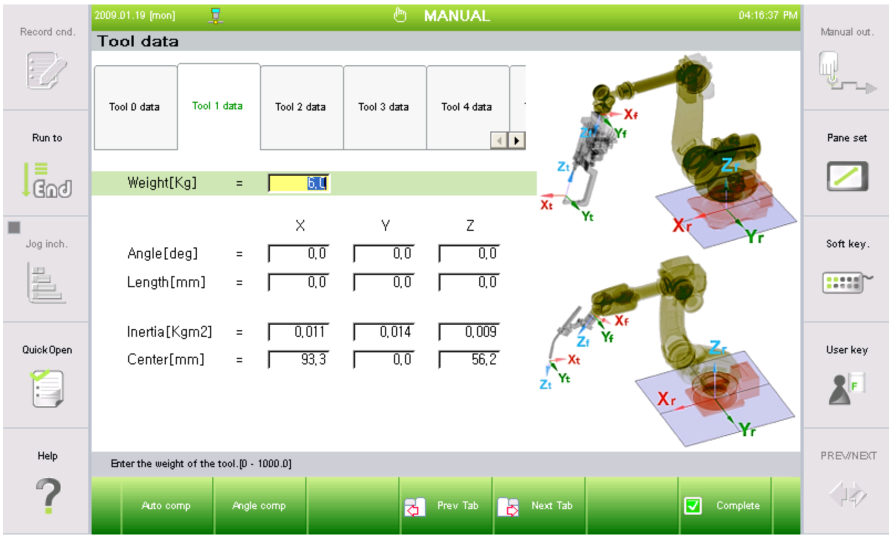


Figure 7.29 Tool data setting screen

- Weight (Kg) : Weight of tool

- Angle(deg)
  You can use the tool angle, automatic constant setting or 『[F2]: Angle comp』 function.

- Length (mm)
  You can use the tool distance, automatic constant setting or 『[F1]: Auto comp』 function.

- Inertia (Kgm2)
  You can use the tool inertia load calculation function for the tool coordinate.

- Center (mm)
  You can use the weight center location and load calculation function of the tool based on the flange center.

Reference

- When moving the cursor and entering the data for the angle or distance item, it may prompt you the message saying "Consult the engineer" in the guide frame. Use the 『[F1]: Auto comp』 or 『[F2]: Angle comp』 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.

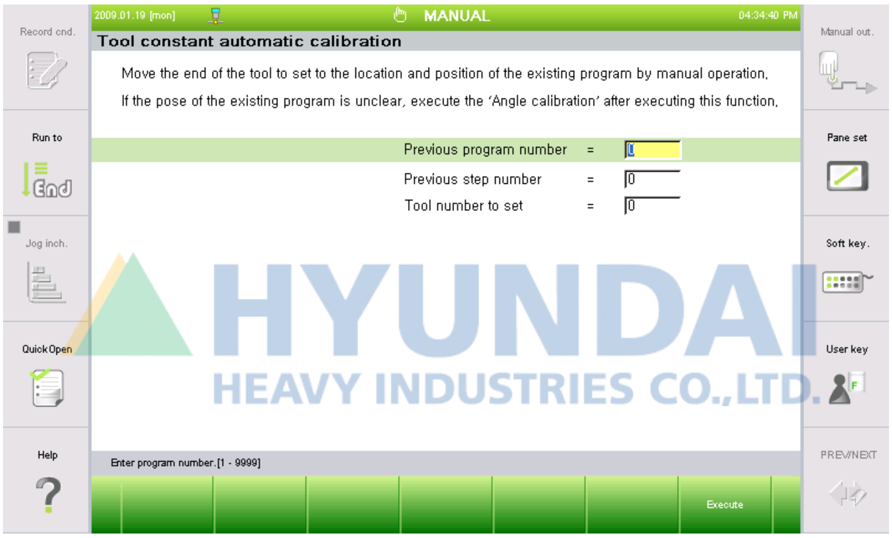


Figure 7.30 Tool constant automatic calibration screen

- Previous program number
  Enter the program number taught before the tool change.

- Previous step number
  Enter the step number to execute tool constant auto calibration.

- Tool number to set: Enter the tool number to newly set.

② Through the automatic calibration function, you can easily generate the tool data and also use the existing program as it is.

- Angle calibration
  This sets the tool angle and calibration.

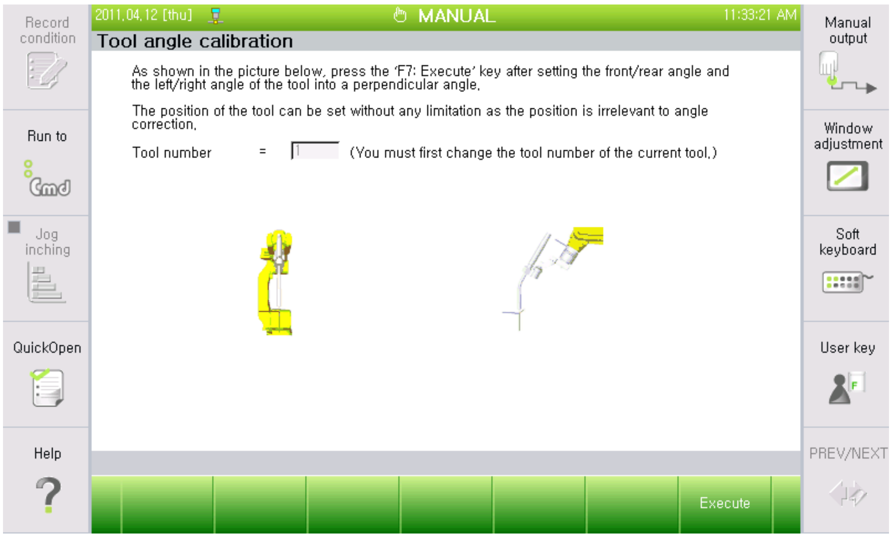


Figure 7.31 Tool angle calibration screen

7.3.2. 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.

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.

If you calibrate the 'Constant and tool' using automatic constant setting function for H, V, R2 and B axis, it is automatically set here.

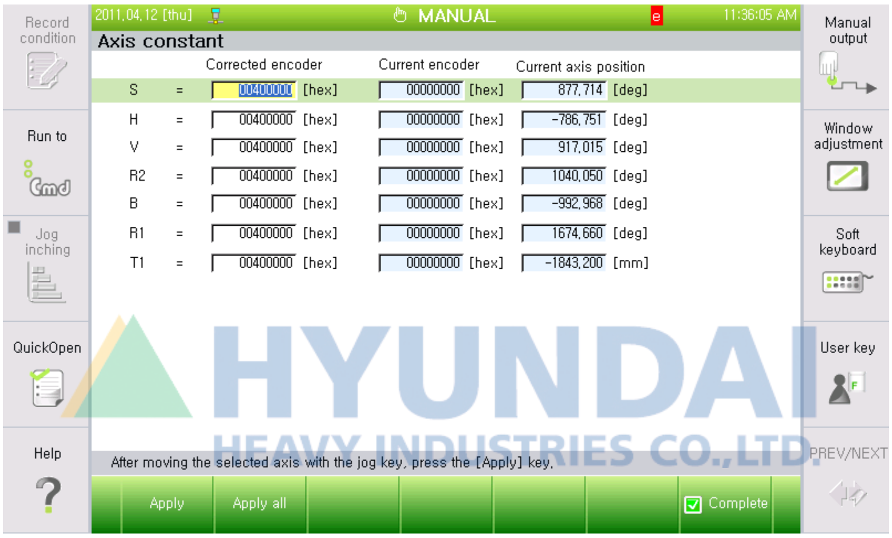


Figure 7.32 Axis constant setting screen

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.
- When you change the axis number, the location of the existing program will change as well. The setting for the axis number must be done during the initial installation stage.

7.3.3. 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.

Figure 7.33 Soft limit setting screen

7.3.4. Encoder offset

You can set the current location of the encoder as the zero point location of the encoder (0X400000 locations). Decide the zero point of the encoder from the reference location (Location where scale is attached for each axis) of each axis of the robot.

Because this value is set as factory default value, reset it as needed for cases such as motor, encoder exchange etc.

Operate each axis of the robot to set the offset value of the encoder. The recorded encoder value is hexa-decimal value.

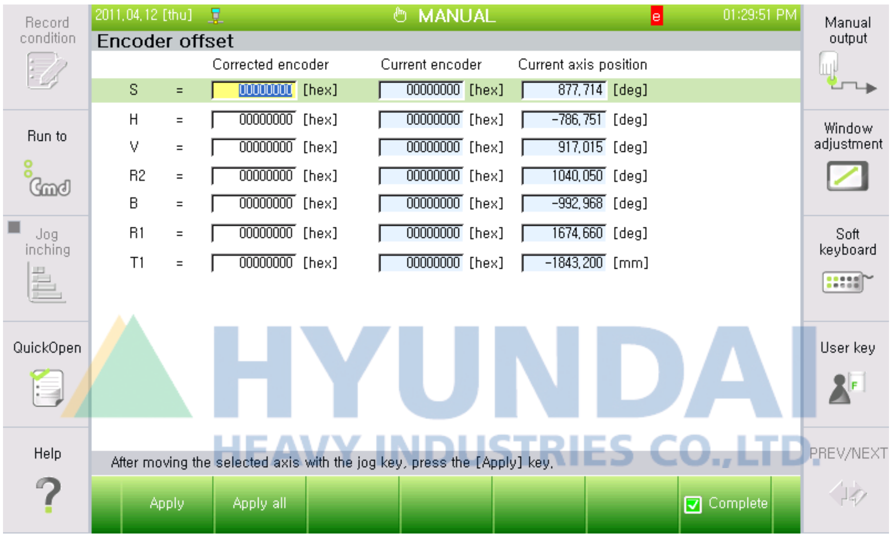


Figure 7.34 Encoder offset screen

If you need to back up the current task program and execute 『[F2]: System』 → 『5: Initialize』 → 『1: System format』 for any reason during the task, the robot must be maintained at the same location as the reference location prior to the resetting. For this, write down the encoder offset value and enter the value to use it. You can enter the calibration value by opening the soft keyboard on the right side of the screen and directly entering as hexa-decimal value.

7.3.5. 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.
When the trajectory of the robot has to go through the B axis dead zone due to the interpolation activity, the robot will be stopped as the process will be handled as an error.

Figure 7.35 B axis dead zone setting screen

- Setting value: Enter the angle for B axis dead zone.

7.3.6. Accuracy

Review the 2.5 Step section first to understand this section. This section provides the values of the accuracy level that was explained in the 2.5 Step section.
The accuracy level can be set within the range from 0 – 7, and the level will be recorded as one of the parameters of the step. Except for the accuracy level 7, the TCP distance and posture values as well as the additional axis distance and angle values can be entered in each level (Picture below). If a robot does not provide support for the linear or circular interpolation, just like the case of a LCD robot, the same method as that for the additional axis will be applied.

When the accuracy level 7 is used, the maximum cornering path that can meet the condition of being 1/2 of the step distance will be created. The value for a level is calculated automatically in the controller, not to be entered directly. Generally speaking, the accuracy level 7 is useful when it is required to operate the robot with the most smoothness but also with swiftness. For example, when it is used for the air cutting step for the spot welding pattern, or the entry/exit of the LCD hand, more smoothness and swiftness in its operation can be acquired.

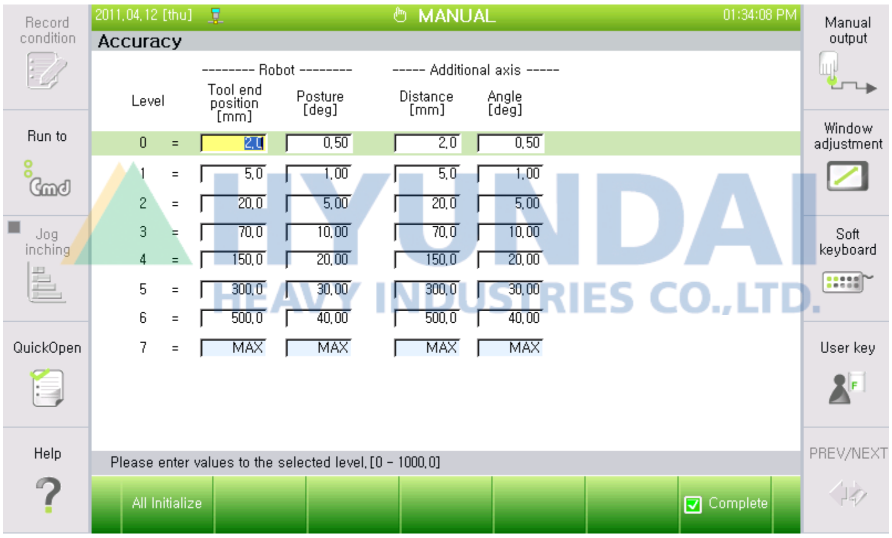


Figure 7.36 Accuracy setting screen

Reference

- For the GUN step, the controller automatically controls the limit irrelevant from the accuracy level set.

7.3.7. 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. If the additional weight is not registered accurately, it can cause an error when calculating the tool load to cause problems including vibration and reduced life span of the robot. When the robot has additional weight besides the tool, you must enter the data for the additional weight.

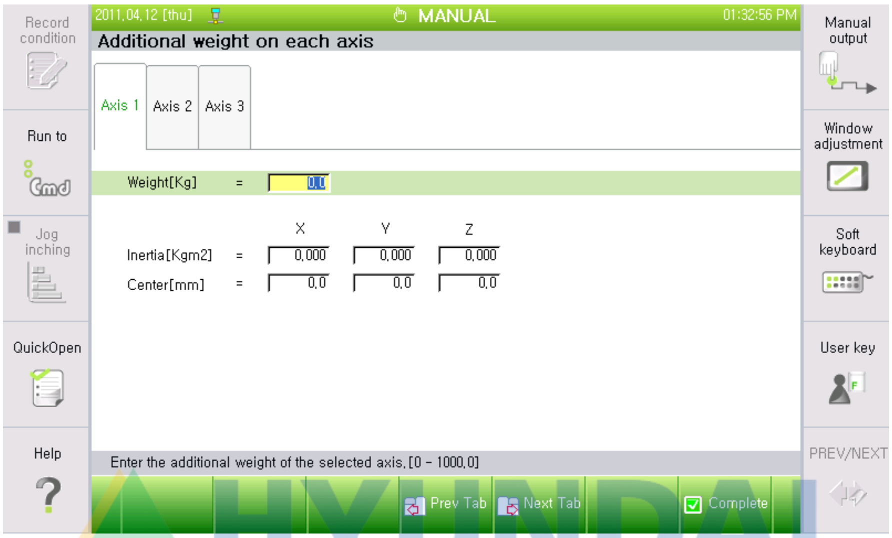


Figure 7.37 Individual axis additional weight setting screen

Reference

- For the zero point of each axis coordinate, please refer to Figure 7.38. The direction of each X, Y and Z axis is same as the one set in robot coordinate.

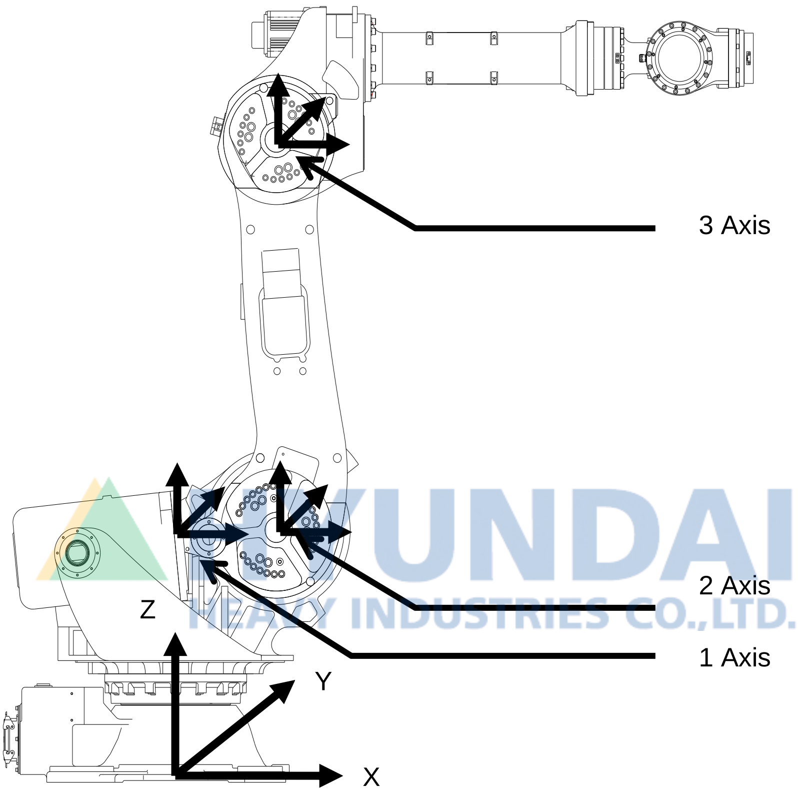


Figure 7.38 Zero point of each axis coordinate

7.3.8. 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.

Hi5 controller increases the safety of the robot by mutually supplementing the collision detection function to the existing over-current, overload, over speed and location deviation error detection function as the safety device when the robot is operating in an abnormal condition or malfunctioning.

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 detected』 when the disturbance torque exceeds the set value.
- 『E0161 (○ axis) Impact detected』 when the disturbance torque rate the set value.

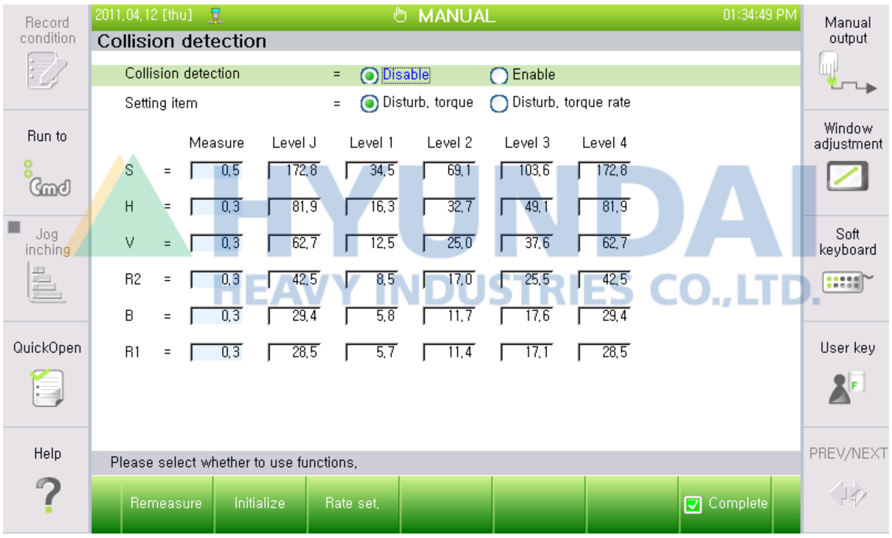


Figure 7.39 Collision detection setting screen

- Collision detection
  Select whether to use the collision detection function. But, the collision detection function only applies to the robot main unit and not to the additional axis.
  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 squeeze force. Collision detection function operates only while the robot is moving and does not operate when the robot is in stopped condition.

- Setting items
  Select whether it is the disturbance torque or the rate of change of the disturbance torque that will be displayed on the screen. .

- Measured
  It shows the maximum values not only of the disturbance torque but also of the rate of change of disturbance torque rate, both of which would occur since the power of the controller was on. The user can refer to these values to set the disturbance torque and the rate of change of disturbance torque for each level.

- Level J
  This is the error detection level applied to the jog activity or the step forward/backward activity in the 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.

```
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.

- 『F1: Re measure』
  Measure the values of the individual axis disturbance torque and the rate of change of the disturbance torque (Maximum value) again.

- 『F2: Initialize』
  Set to initialize the values of all the set levels of individual axes. .

- 『F3: Rate set.』
  Quickly set the values of the error detection levels of all the axes for each selected level, by applying the magnification based on the measured value.

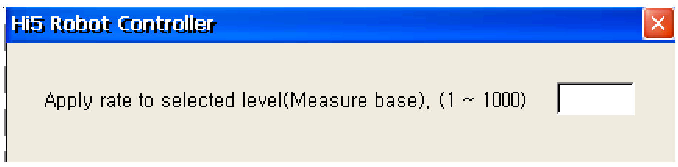


Figure 7.40 Magnification selection and entry screen

7.3.9. Maintain current reduction

This function reduces the gravity load of robot motor in the static position.

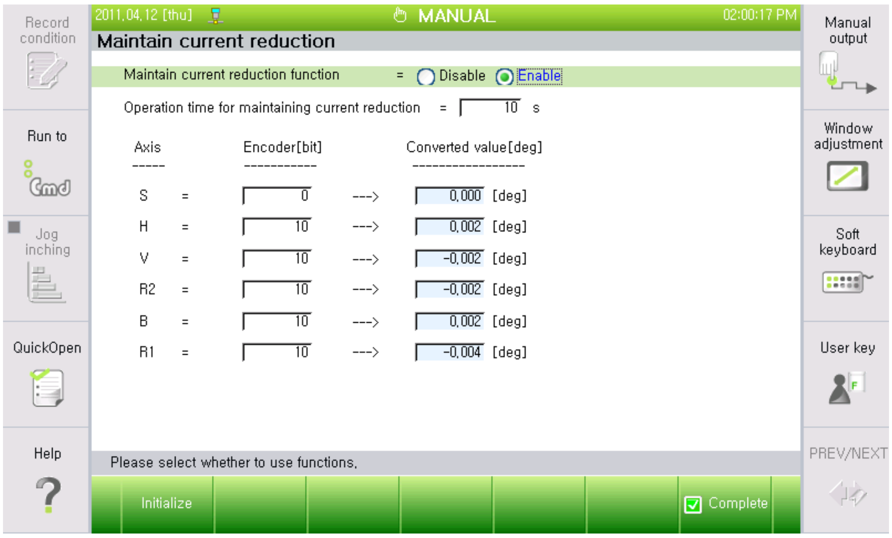


Figure 7.41 Holding current reduction setting screen

- Maintain current reduction: Function is activated when [Enable].

- Operating time for maintaining current reduction
  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 and Converted value
  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.

Reference

When the start is entered while the maintain current reduction function is operating while the robot is in wait mode, the maintain current reduction function will be completed and the robot will start. This takes 1-2 seconds and this delay time can be a problem when the robot must move in synchronization with the external system. When this problem occurs, you must change the Maintain current reduction function to “Disable”.

7.3.10. Jog inching level

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.

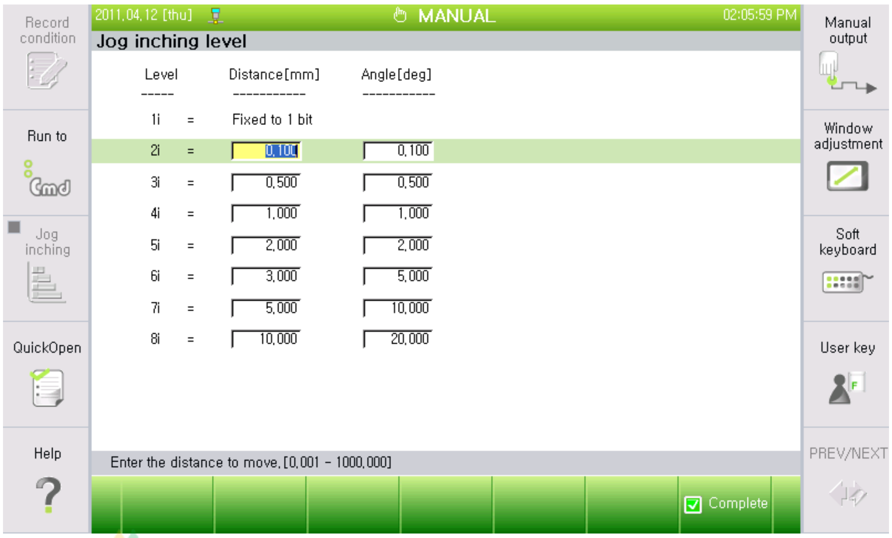


Figure 7.42 Jog inching level setting screen

Table 7-2 Job inching function specification

Major function	Remarks
Inching enabled coordinate	Axis, Rectangular, 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.

■ Inching jog operation

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.

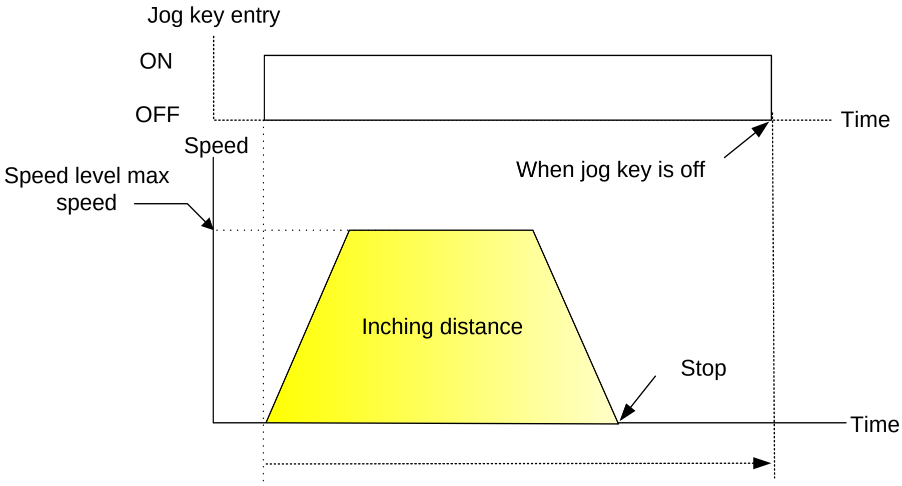


Figure 7.43 Robot activity when the key is off after the inching distance is reached.

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.

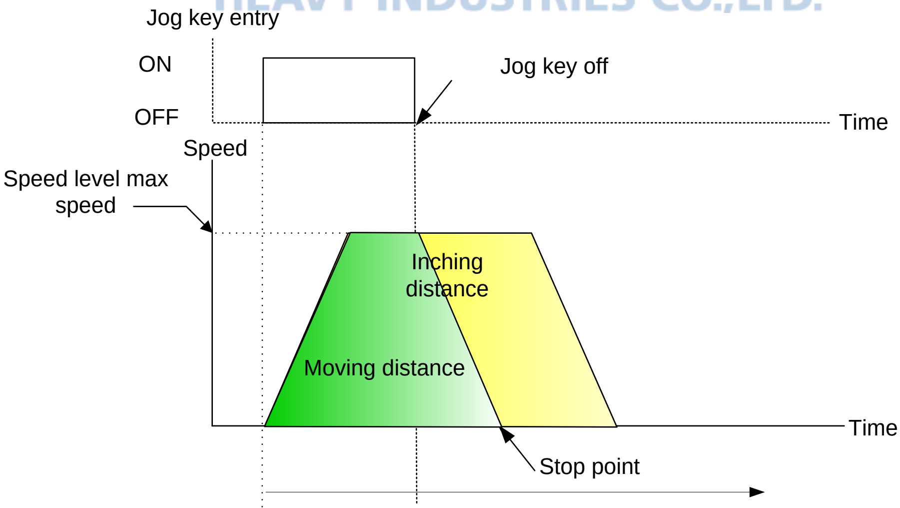


Figure 7.44 Robot activity when the key is off before the inching distance is reached

③ Inching function limits the maximum distance per push as shown above.

■ Others
When the speed level is 1 in the axis coordinate system, it is fixated for the encoder to move by 1 bit.

7.3.11. Grease injection scheduling setting

Refer to『Hi5 Controller Grease Injection Scheduling Function Manual』.

7.4. Application parameter

This is the function to set various parameters to use the robot applied function.

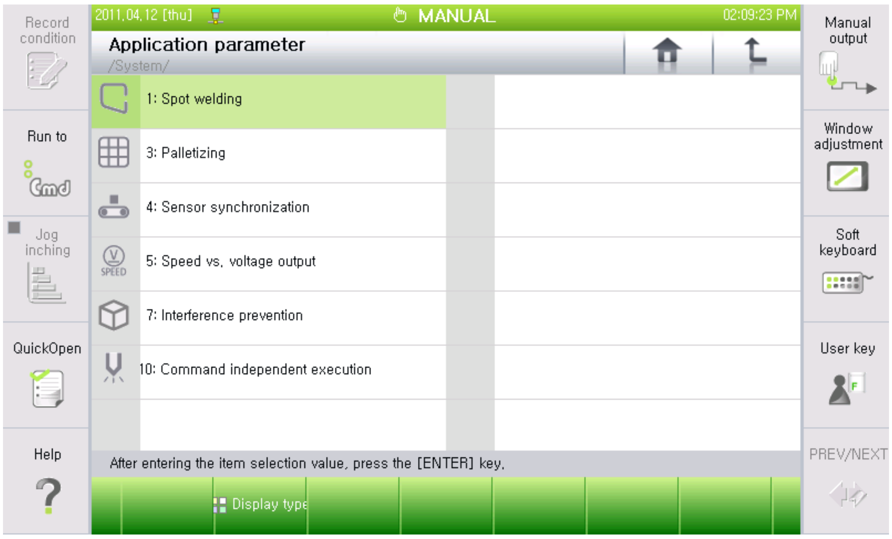


Figure 7.45 Applied parameter selection

For details, refer to the 『Function manual』 by each applied function.

7.5. Initialize

When the controller is to be used for the first time after installing the robot, this menu is used for setting the necessary items for the initial setting. This includes the menu that will initialize the serial encoder.

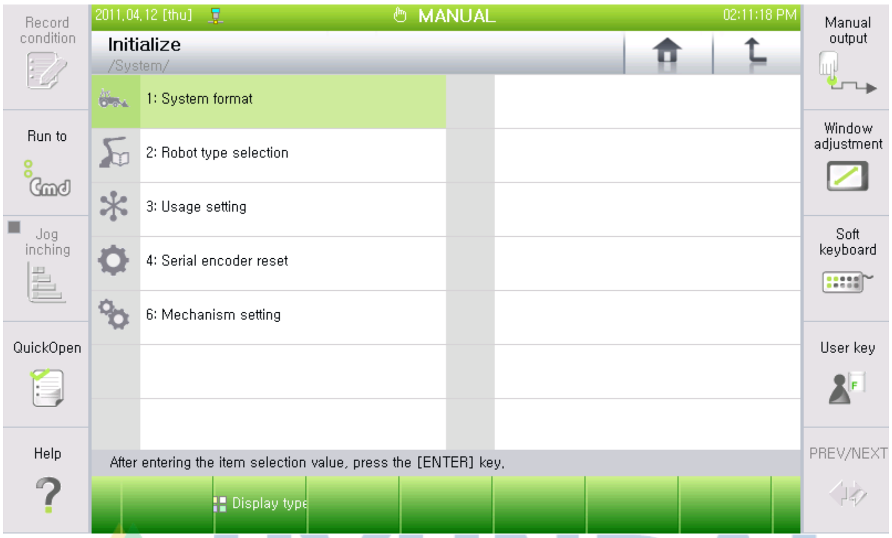


Figure 7.46 Initialize

Some specific items are displayed only when the engineer codes are entered. When you access the initialization menu while R314 is entered, the following menu will appear.

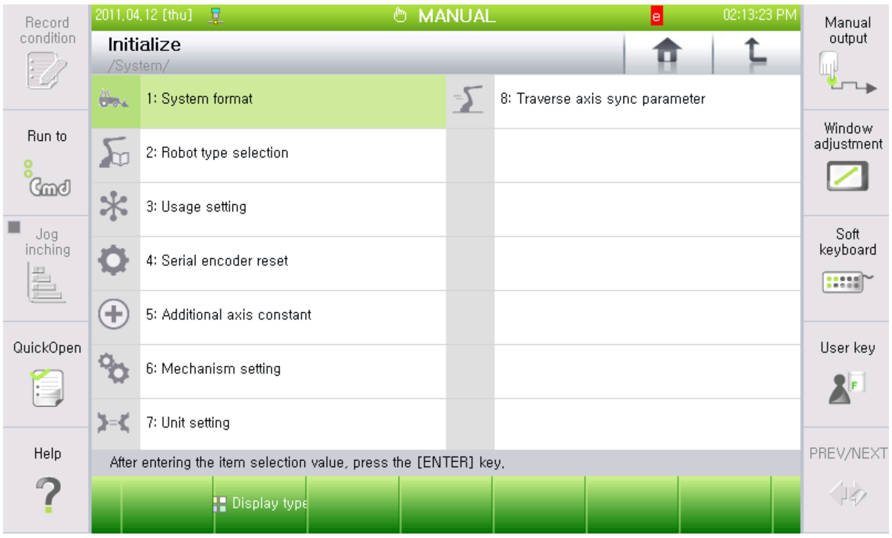


Figure 7.47 Initialization selection screen

7.5.1. System format

When ‘1: System initialize’ is selected, all the backup data of the controller will be deleted. So, it is recommended to make backup programs and files that are necessary in the controller.

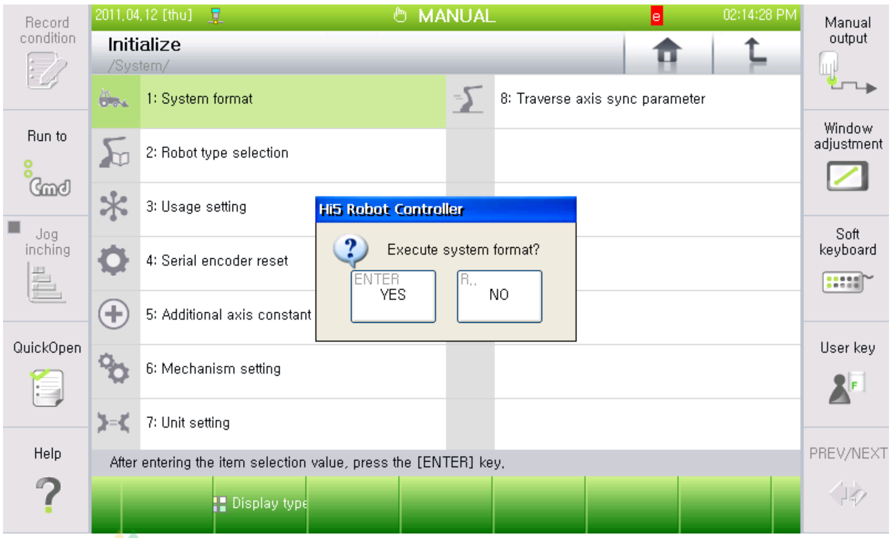


Figure 7.48 System initialization

When the system is initialized, the values prepared upon the shipping of the controller based on the control constant file (ROBOT.CON) will be set. Select the robot type after initializing the robot.

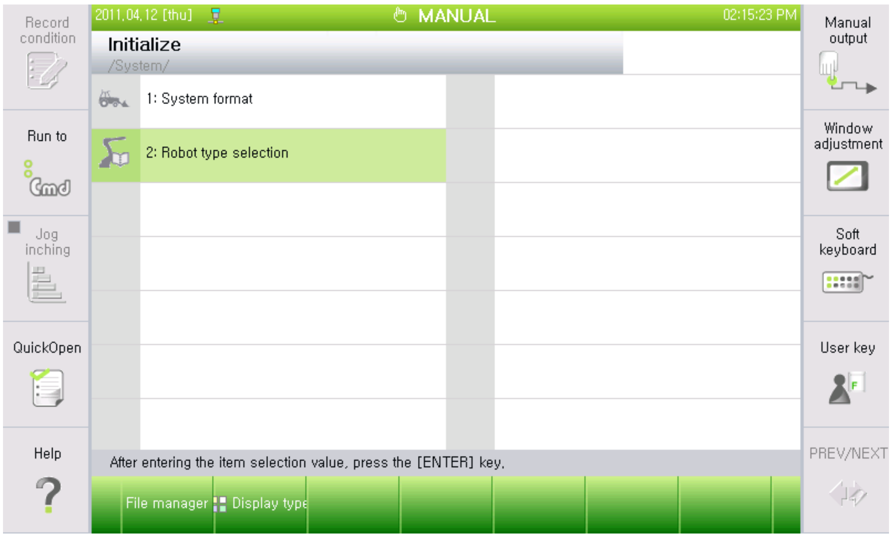


Figure 7.49 Robot type selection and initialization screen

In order to prevent faulty operation, this menu can be used only by a qualified engineer. Accordingly, in order to initialize the system, the engineer code (R134) should be entered.

7.5.2. Robot type selection

When ‘2: Robot type selection’ is selected, the list of robots that can be selected will be displayed as shown below. When the robot type is selected, the mechanical constant file (ROBOT.MCH) will be set to the initial values provided upon the shipping of the controller, and other history files will be initialized also. The robots are classified according to each weight-bearing capacity of the vertical articulated robot, and also the classification is also made according to the generation (G) of the LCD transfer robot.

Figure 7.50 Robot type selection

Figure 7.51 Vertical articulated robot type selection

When shipped, the robot controller and the main body of the robot are delivered as one system. In the robot controller, the drive for the driving power of the robot is installed. So, if it is to be reset according to the needs of the user, it is required to pay attention to the type of the robot set upon the shipping.

7.5.3. Usage setting

This is the function to reset the user key and input/output allocation signal according to the task usage setting and task usage.
Depending on the type of robot, the spot welding is set as enable automatically.

1) When the spot welding is “Enable” :
   - The SPOT command can be used.
   - In ‘『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』’, the spot welding parameters can be set.
   - When the servo gun change function (GUNCHNG) is used, the number of guns needs to be set in ‘Gun change number’.
   - The user key initialization and the input/output assignment initialization are to be set as ‘Spot’.

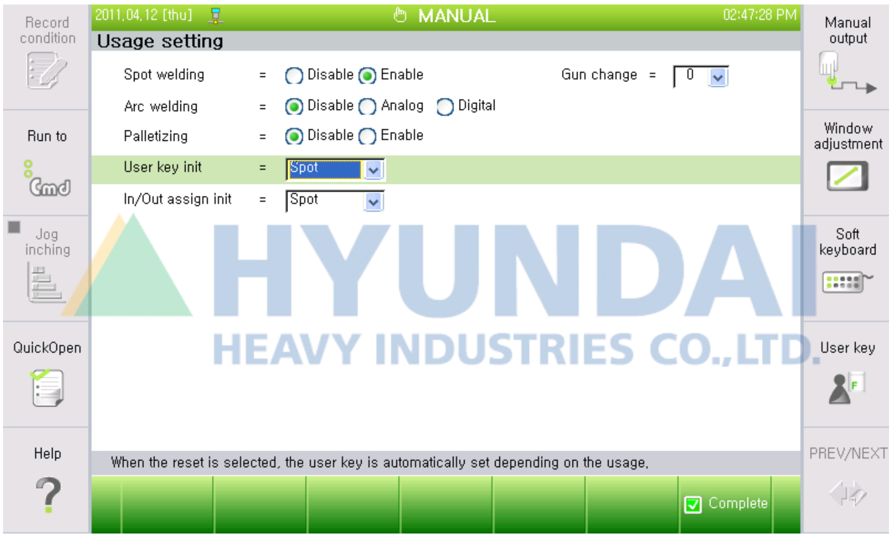


Figure 7.52 Usage setting

2) When arc welding is used

- Commands related to the arc welding can be used.
- Menus related to the arc welding can be accessed.
- Select whether to use an analogue or digital welding device.
- The welding devices displayed on the screen are provided by our company. Select the number of the relevant welding device.
- The user key initialization and the input/output assignment initialization are to be set as ‘Arc’.

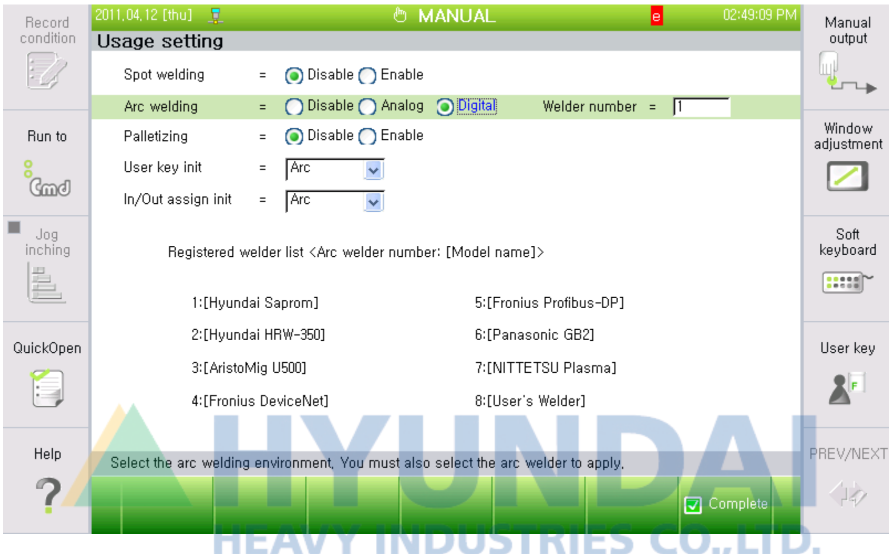


Figure 7.53 Usage setting (Arc)

3) When the palletizing is set to be “Enable”

- Commands related to the palletizing can be used.
- Menus related to the palletizing can be accessed.

7.5.4. Serial encoder reset

The serial encoder reset function is to release the error state of the motor or to newly set the zero-point of the encoder. When the encoder reset is implemented, the rotational frequency of the encoder will be cleared to become 0. So, the usage range of the motor will be maximized when measured from the zero-point setting position.

The internal memory of the serial encoder stores the rotational frequency information of the encoder. The encoder reset function needs to be carried out at the initialization work stage, while the function must not be used at all when the robot is operating normally. However, when the encoder suffers errors due to abnormal communication, for example, or when it is required to reset the encoder due to its battery runs out, the function can be performed. Even in such situation, the modification work needs to be carried out while checking the real positions in the robot program, considering that there could be some difference compared with the original position of the robot.

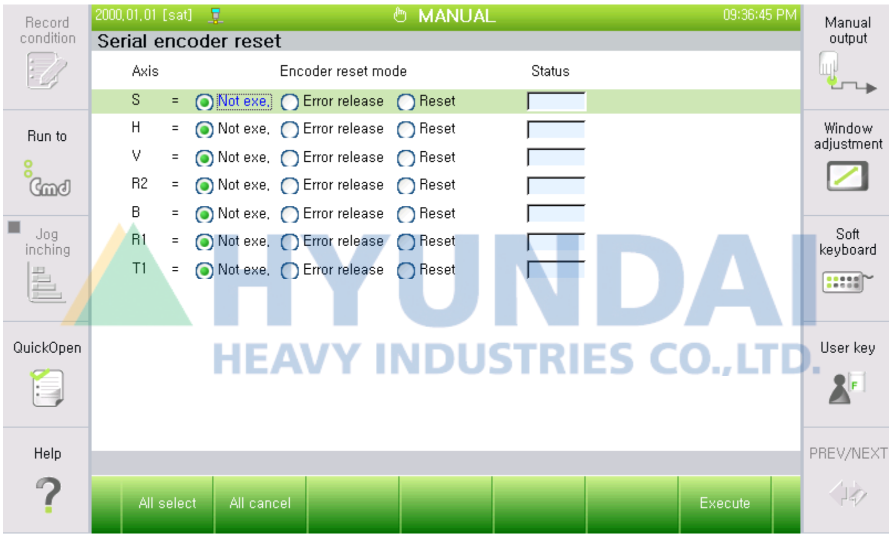


Figure 7.54 Serial encoder resetting

Reference

- In order for the serial encoder to memorize the location even when the power of the controller is out, there is a battery attached for the encoder. If both the power for the controller and the battery power for the encoder are not supplied at all, the location information of the encoder will be deleted, causing you to suffer some difficulties in using the work program.
- Accordingly, in case of encoder battery voltage error, the replacement of the encoder battery must take place only when the power of the controller is turned on.

7.5.5. Additional axis constant setting

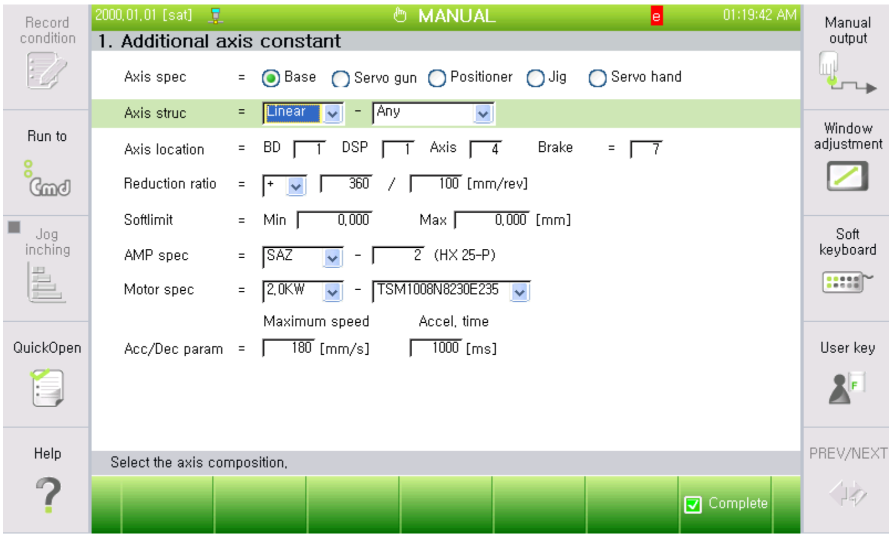


Figure 7.55 Additional axis constant setting

- In addition to the robot, when an additional axis needs to be used, its setting can be carried out in this menu. Additional axes include the robot's base axis (travelling axis), servo gun axis, positioner axis, jig axis and servo hand axis. This menu is to set the specification and configuration of these additional axes. Refer to 『Hi5 Controller Palletizing Function Manual』

7.5.6. Mechanism setting

Mechanism is a component that forms the unit and is to be utilized as a group when the jog is operated. The Hi5 controller supports up to 16 at maximum, while there are only 6 jog switches prepared on the teach pendant. When less than 6 mechanisms are individually assigned and used, an environment in which all the axes can be operated only by altering the mechanism while working with the jog, will be configured.
When the setting of mechanism is carried out, the mechanism number (M#) will be assigned to each group of individual axes. This menu is to set the endless function as enable/disable, and set the positioner group.

(1) Select『[F2]: System』 → 『5: Initialize』 → 『6: Mechanism setting』from the initial screen of MANUAL mode.

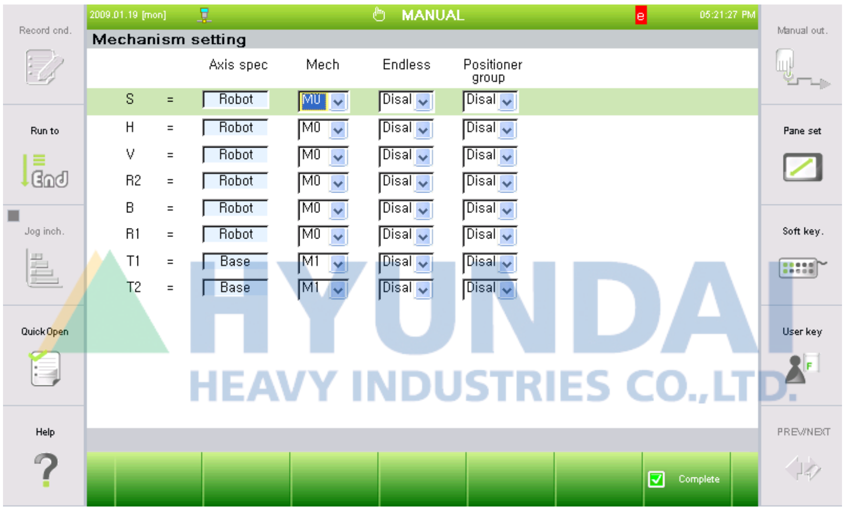


Figure 7.56 Mechanism setting

(2) Set the mechanism number, endless function Enable/Disable and positioner group number of each axis.

(3) The content of each item is as follows.

- Mechanism
  - Set the mechanism number of the relevant axis.
  - When the axis specification is a robot, this will be fixed as mechanism MO.
  - Mechanism 1~8 can be assigned starting from the additional axis.
  - Those axes set with the identical mechanism number will be managed as the same group.
  - For the jog of the additional axis, the [Mechanism] key is used to shift between mechanism groups, and, if the jog is pressed at that time, the jog activity will take according to the sequence of the axes of the mechanism.

- Endless : Set whether to use the endless function in the relevant axis in the enable/ disable state

- Positioner group
  Set the positioner group number of the positioner axis. You can only set the positioner group number to the axis set with the positioner.

(4) To save the set data, press the 『[F7]: Complete』 key. When you press the [ESC] key, the changed data will not be saved.

Reference

- The combination of set mechanisms can be used by being assigned as a unit. For concept and content related to the unit, consult the following paragraph.
- How to designate the positioner group

  ① Designate the group in the order from the lowest axis.

  ② Designate [0] for the group not synchronized and then set the axis that is synchronized later.

  ③ Because only 2 axes are supported for the same group of the positioner, you must not set 3 axes for one group.

  ④ If you are redefining the group setting, the calibration value of the positioner designated before will be invalid and the calibration of the positioner must be re-executed.

7.5.7. Unit setting

Unit refers to setting the combination of axes that can be moved by the task program. Through this message box, you can set each unit with various combinations of mechanisms.

A mechanism is the combination of individual axes, so, consequently, a unit is also the combination of individual axes. However, there is difference because mechanism is used during the jog activity, while the unit is used for recording the step position in the program. In general conditions, a unit is set as being unit#0, which signifies the state in which all mechanisms are included, meaning the state in which all axes are included. In this state, if the robot program is recorded, the positions of all of the axes are recorded. During the playback, all the axes move to those positions.

If the user wants to prepare a program that will run only some specific mechanisms (axes), units need to be assigned through this menu and used.

(1) Because the unit change of the system has a big impact to the operation of the controller, only the engineer can set it up and make changes.

(2) Select 『[F2]: System』 → 『5: Initialize』 → 『7: Unit setting』 from the initial screen of the manual mode.

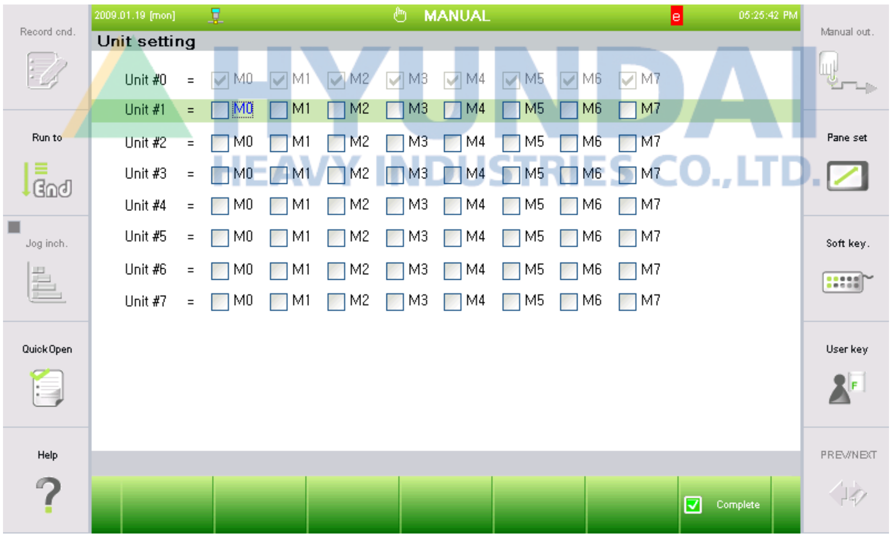


Figure 7.57 Unit setting

(3) Unit #0 is fixed to all mechanism.

(4) For unit #1 to #7, the user can select various mechanisms.

(5) In order to record a step of a program in a manual mode, the user can select the unit number using the [Unit] key and can press the [REC] key to save only the location of the axis relevant to the unit.

(6) When you press the [POS. MOD] key from the recorded step, the location of the unit saved on the step will be changed.

(7) If you proceed the step by changing or executing the step with the cursor, the current unit number recorded will automatically change to the unit number recorded on the step.

Reference

- Refer to the following function related to the unit.

  ① You can change the unit of pose parameter. (Ex, “P1.Unit=2”)

  ② You can designate the unit of the pose constant. (Ex, “P1=(12.00,13.00)UNIT2”)

  ③ When you look at the task program from the PC, the unit is included in the hidden pose. (Ex, “S3 MOVE, P,S=50%,A=0,T=0 (12.00,27.00)UNIT2”)
  (When the unit is 0, UNIT0 is not included.)

- Robot coordinates interpolation function (Applied since MV31.06)

  1) Conditions for the usage of this function:

  ① At a system with a travelling axis, a unit with a travelling axis needs to be set, and the coordinates for the step should be set as ‘Robot’.

  ② In case of the system with a travelling axis, the processing should take place while differentiating between the step (Support only the base coordinates interpolation) that includes a travelling axis and the step (Support only the robot coordinates interpolation) that does not include a travelling axis
  ➔ Non-applicable for a system that has no travelling axis.

Figure 7.58 Robot coordinates setting for the step

2) Explanation about the function:

① If the unit of a step is set as ‘robot only.’

- The coordinates are recorded as ‘robot’ or ‘axis angle
➔ The liner interpolation (L) and the circular interpolation (C) need to be executed based on the coordinates of the robot. .

- If the coordinates are recorded as ‘base’, when playing back is in progress, it will be handled as an error.
➔ “E1483 Setting of the coordinate system and unit of step doesn't match.” error occurs.

- It is impossible to execute the stationary tool interpolation, the conveyor synchronization and the positioner synchronization.
➔“E1484 Error in unit setting - Unable to use synchronous feature” error occurs.

② If the unit of a step is set as ‘all travelling axes + robot”

-If the coordinates are recorded as ‘base’ or ‘User U, Un’
➔ The L and C interpolation should take place using the designated ‘base coordinates’ or ‘user coordinates’. The robot coordinates interpolation (L, C) is not to be supported. .

- However, if the unit is ‘travelling axis + robot’, all the travelling axes are included in the unit. When there are multiple travelling axes, they need to be included in the unit. If not, it will be considered as ‘robot only’.

3) How to use the function

① Even when the standalone operation needs to take place by using the ‘multitasking’ or ‘command standalone execution’ function needs to be used, the operation will be possible when operating through the L and C interpolations.

② When the unit function is used, the robot coordinates P, L and C interpolations will be possible.
- Support for the servo gun and Eqless gun
- Support for the shift function

③ A program can be prepared in an instinctive and simple manner.
- It will be made easier to prepare a program that can carry out the same work only shifting the base axis.
- It will be made easier to prepare a program that can carry out the gun search regardless of the location of the base axis.

7.6. Automatic constant setting

The automatic constant setting function is to find the correct values of the constants, necessary for using the robot, such as robot's axis constant, tool length, load mass, and base axis direction, by using the instructed program or the automatically activated movement. The constant values calculated by using this function can be reflected as the robot's constant data.

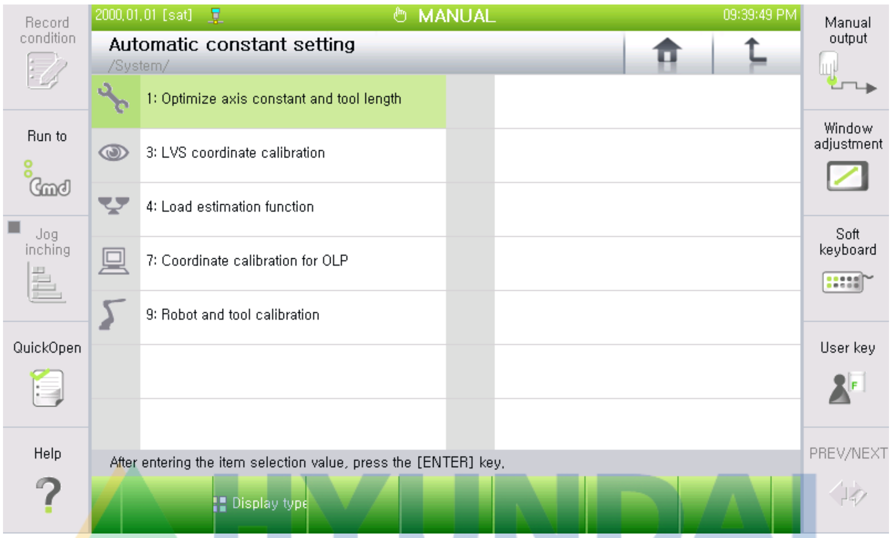


Figure 7.59 Automatic constant setting items

7.6.1. Optimize axis constant and tool length

This is to calibrate the zero point of each axis of the robot as well as the tool length, without using an external measuring sensor. When this function is used, the encoder offset and the tool length will be changed, causing the previously taught work position of the program to change also. So, this function must be performed before carrying out a work.

When it comes to the teaching method, you need to prepare two pointed tips, and then fix one tip externally and the other one at the tool. After that, you need to carry out the recording for multiple points by using the robot program only by changing the posture of the tool end of the robot against the externally fixed tip.

At this time, 7 points should be taught when both the axis constant and the tool length are to be found, while 4 points or more should be taught when only the tool length is to be found

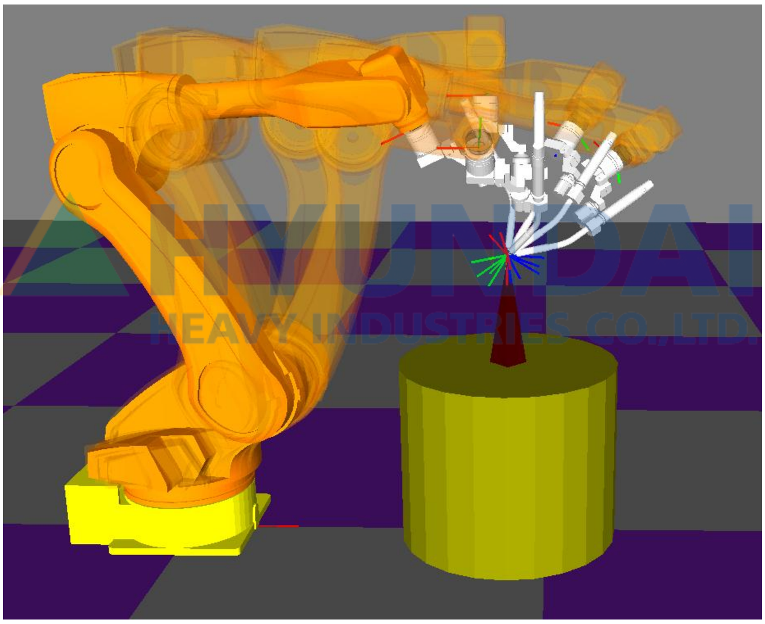


Figure 7.60 Teaching method for optimizing the axis constant and the tool length

When this function is used, not only the tool lengths, X, Y and Z, which have no CAD data, but also the zero points of the H, V, R2, and B axes of the robot can be located by using the optimization method.

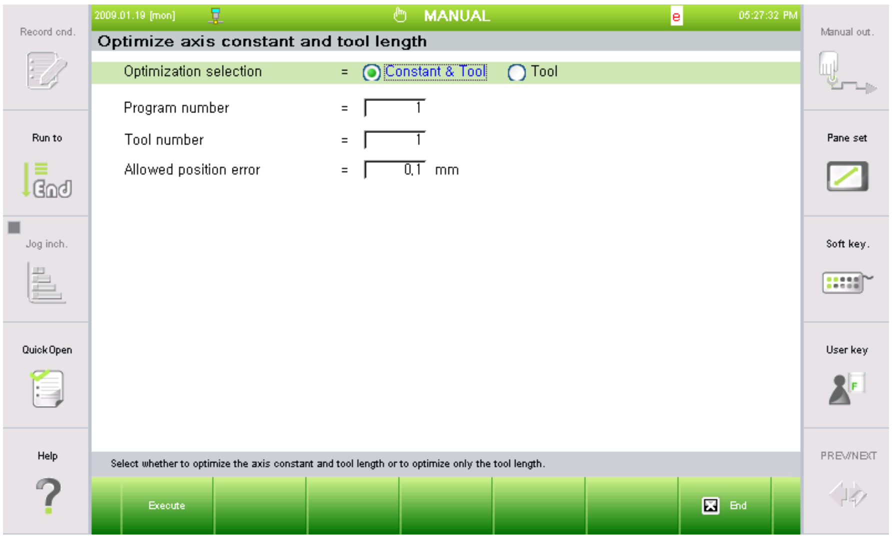


Figure 7.61 Results of the axis constant and tool length optimization

■ Setting

① Constant & tool

- The tool length that should be set from 『[F2]: System』 → 『3: Robot parameter』 → 『1: Tool data』 and the robot's zero point that should be set from 『[F2]: System』 → 『3: Robot parameter』 → 『2: Axis constant』 will be automatically calculated.
- This function needs to be selected to calibrate both the zero point and the tool length of the robot. Generally, this is used to set the correct zero point initially after installing the robot.
- Once after the robot's zero point is set correctly, you need to shift the optimization selection method to the 'tool length' option in order to calibrate the tool length only. When the 'axis constant and tool length' is changed, the zero points of all of the robots will change. So pay attention as the location of the previously prepared program will change.

② Tool

The set value is adjusted from the tool length set in 『[F2]: System』 → 『3: Robot parameter』 → 『1: Tool data』

■ program number

This sets the program number that records the same point in various positions..

■ Tool number

This is the tool number to automatically set and it must be same with the tool number recorded in the program for setting.

■ Allowed position error

If the expected error following the automatic constant setting is smaller than the value set here, the constant data will be updated automatically. If the expected error is bigger than value set here (Initial set value 0.1mm), it will be checked with the user first whether to reflect the constant, before making it reflected.

Reference

- In this function, the correctness of the teaching is proportionate to the correctness of the maximum step position error result. Accordingly, it is required to prepare, if possible, two pointed tips and carry out the teaching in a way that correct matching can be made possible. Make sure that the correctness in matching between the tool end and the fixed point in space is within 0.5mm when visually checked.

- Teach so that the posture of each step should not be similar to each other, and the new posture should be different (Different by 30dge or higher) from the previous one.

- 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.MCH) is set as being protected, this function cannot be run. Try after canceling the file protection

7.6.2. Positioner calibration

You can use this when the positioner group is set. For details, please refer to 『Hi5 Controller Positioner function manual』.

7.6.3. Laser vision sensor coordinate calibration

This is used to track the welding line by using the laser vision.
For details, please refer to the 『Hi5 Controller LVS tracking Function Manual』.

7.6.4. Load estimation function

The load estimate function is to acquire the mass and central position of the load attached at the front end of the robot. The Hi5 controller is based on the dynamics. Accordingly, when the activity is planned, the torque to be generated at each axis needs to be calculated, and, based on the calculation, the acceleration/deceleration needs to be planned also.

The mass, center of mass and inertia of each link of the robot’s main body is registered in the controller. However, in case of individual tools, the user needs to enter the values because the tools are attached because of the user’s purpose. If the mass and center of gravity of the tool are known already through the CAD data, the values can be entered directly by the user. The mass (kg), center and inertia of the tool can be entered ‘『[F2]: System』 → 『3: Robot parameter』 → 『1: Tool data』’.

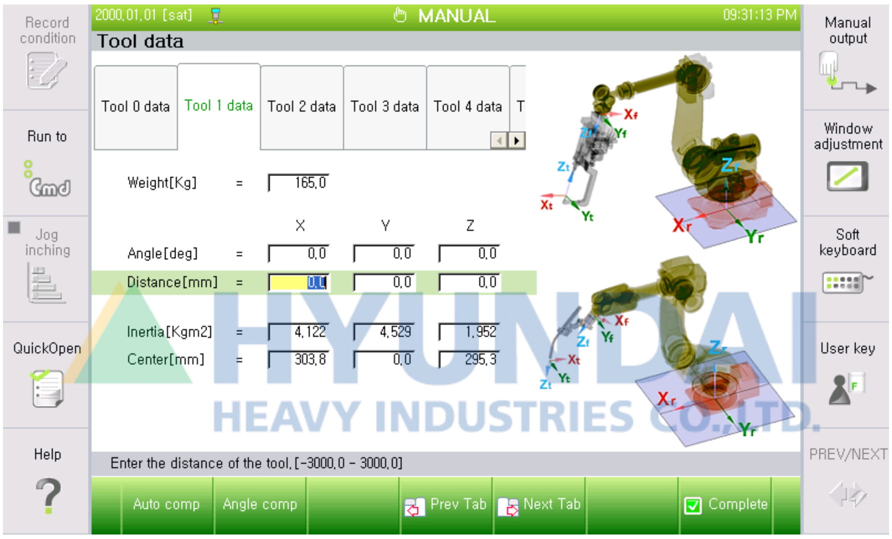


Figure 7.62 Tool data setting screen

However, generally, it is not easy to acquire the mass and center of gravity of the tool from the CAD data. Accordingly, we have the load estimate function, which calculates the dynamics data of the tool through the robot controller.

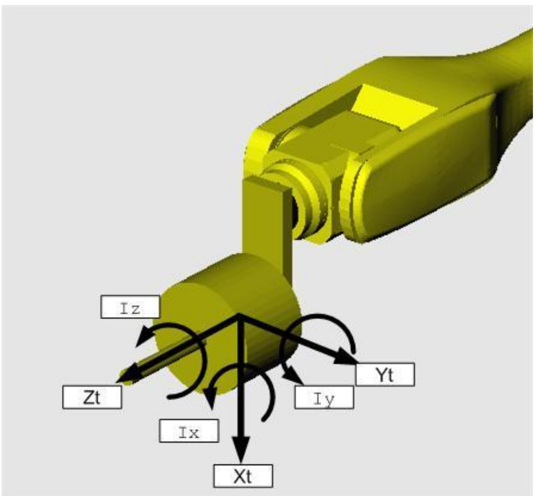


Figure 7.63 Tool data

7.6.4.1. Weight

This refers to the total load weight applied at the robot end. (Kg) In addition to the tool, the total mass that includes additional devices, such as cables, will be calculated.

7.6.4.2. Distance of center of gravity

This is the distance from the center of flange surface to the center of gravity of the load in the x, y and z direction. The unit is mm.

7.6.4.3. 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.
Kgm^2 unit is used for x, y and z axis.

For example, the methods calculating the inertia for the parallelepiped and cylinder shapes, shown below, are as follows.

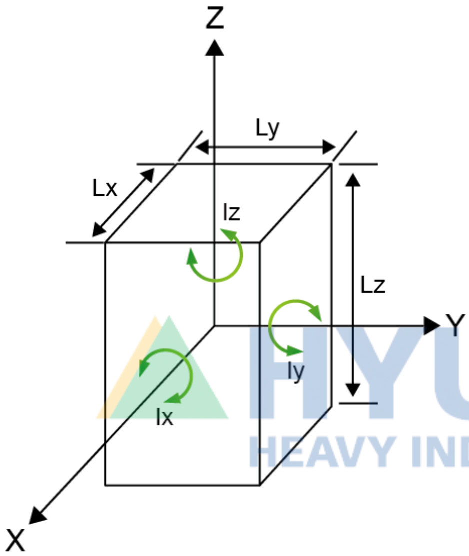


Figure 7.64 Inertia calculation for cube tool

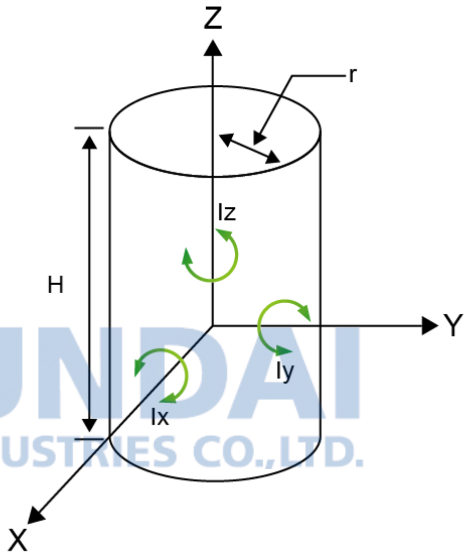


Figure 7.65 Inertia calculation for cylinder tool

$$Ix = \frac{\left(Ly^2 + Lz^2\right)}{12} \times W$$

$$Iy = \frac{\left(Lx^2 + Lz^2\right)}{12} \times W$$

$$Iz = \frac{\left(Lx^2 + Ly^2\right)}{12} \times W$$

$$Ix = Iy = \frac{\left(3r^2 + H^2\right)}{12} \times W$$

$$Iz = \frac{r^2}{2} \times W$$

Unit: Weight [㎏], Length [m], Inertia [㎏㎡]

7.6.4.4. How to execute load calculation function

There are two ways to use the load estimate function; load estimate 1 and load estimate 2.
In case of the load estimate 1, it is carried out in no-load condition and the no-load data file is made. After that, the load is attached again and the load estimate is carried out. The load estimate 1 makes it possible to gain the load value correctly when compared with the load estimate 2. However, it requires the measurement to take place first in no-load condition, which causes difficulties for sites.

In case of the load estimate 2, it has lower accuracy compared with the load estimate 1 method. However, it does not require no-load data to be prepared, allowing the method to be used conveniently and usefully. The steps of each method are as follows.

(1) Load estimation 1

Load estimate 1 is divided into 2 steps.

The first stage is to prepare the no-load data in a condition in which no load is attached to the robot. The result of the no load data is prepared with the robot name .NLD file. If you cannot prepare the no load data on the site, you can copy and use the robot name.NLD file from the controller and use that file.

Figure 7.66 When the no-load data preparation is completed normally

The second step is to apply the load to the robot and calculate the weight and center of gravity. At this stage it requires your attention that the load estimate 1 should be carried out in the same initial posture as the one for the preparation of the no-load data. This initial posture is recorded in the no-load data together. Accordingly, the starting posture of the main axis is to be selected automatically, and in such condition, the load estimate just needs to be carried out. When you operate by changing the starting posture arbitrarily, the following message will be displayed, leading to no execution.

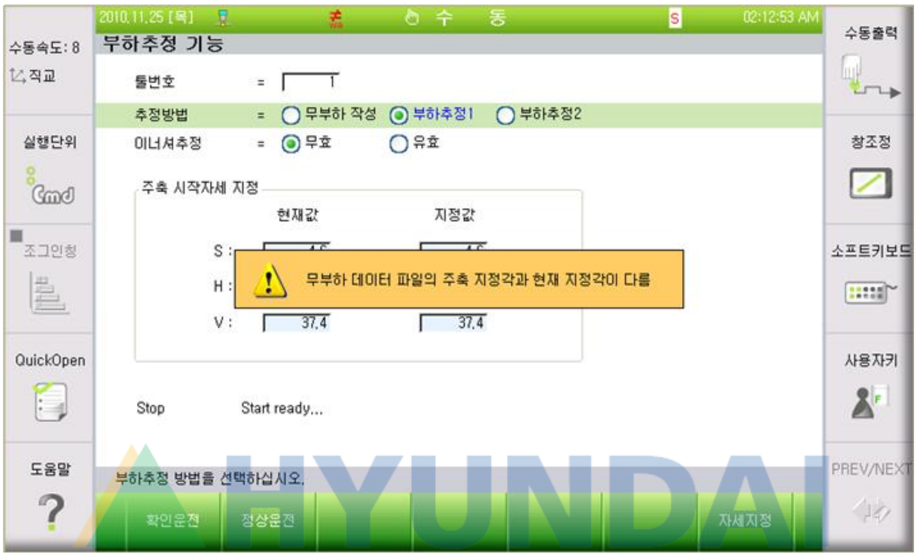


Figure 7.67 Handling a case in where the selected angles are different

(2) Load estimation 2

Load estimate 2 is lower in accuracy but it is used when it is difficult to get non-load data. 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

7.6.4.5. Menu composition

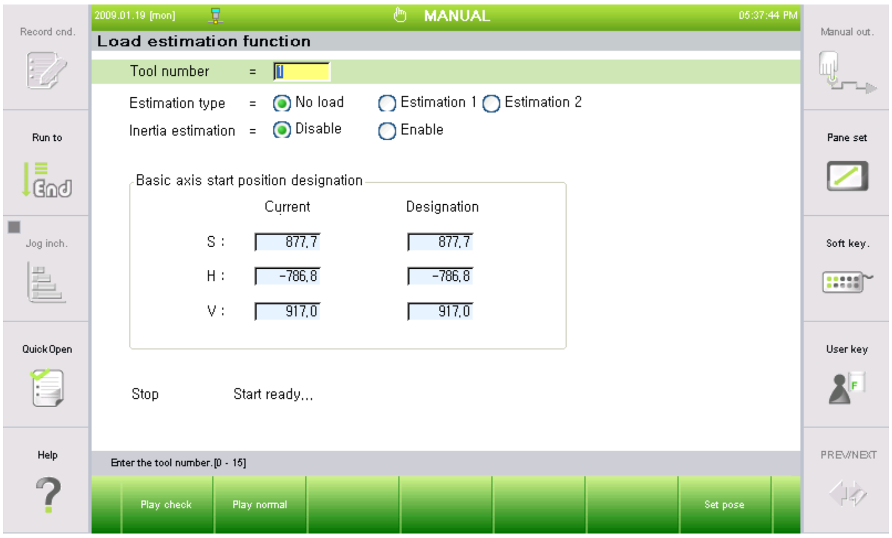


Figure 7.68 Load estimate setting

(1) Use the [SHIFT] + [←] [→] key to decide the tool number at the end of the current robot and the load estimate method number.

(2) Move the location of the robot so that the load calculation program does not interfere with the nearby jig and then press the 『[F7]: Set pose』 key to designate the start position of the robot to execute the load calculation program.

(3) Press the 『[F1]: Play check』 key to check whether the robot may collide with the surrounding objects. In case of collision risk, press the 『Emergency stop』 key to stop the robot.

(4) After checking, press the 『[F2]: Play normal』 key to start the load calculation.

(5) When <Load estimation 1> or < Load estimation 2> is selected, press the 『[F2]: Play normal』 key to run the pattern to obtain the load information. The robot controller will automatically calculate the load data and display the load data in the following screen.

Figure 7.69 Load estimate results

(6) When the above load calculation results are displayed after completing the load calculation program, press the 『[F7]: End』 key. It will prompt you with a question to ask whether to reflect the calculation result. When you press the [YES] key, the calculated result is reflected to 『[F2]: System』 → 『3: Robot parameter』 → 『1: Tool data』, and when you press [NO] key, it will not be reflected.

■ Tool number
Enumerate the tool on the robot end to use. Hi5 controller can use up to 15 tools ranging 0 ~ 15.

■ Estimation method

① No load preparation
On how to create the no load data file, move the robot to a location where there will be no interference with the activity, and press the 『[F7]: Set pose』 key and 『[F2]: Play normal』 key. To obtain data using load estimate 1, you must have a non-load data file (ROBOT.NL0).

② Load estimation 1
When a no load data file (Robot name, NLD) exists in the internal memory, select load calculation 1 and measure the weight and center of the load by pressing the 『[F2]: Play normal』 key. If the no load data file (Robot name, NLD) does not exist, and you pressed the 『[F2]: Play normal』 key, a message saying “No load data file does not exist.”, Will be displayed in the guide frame.

③ Load estimation 2
When there is a no load data file (Robot name, NLD) in the internal memory, select load calculation 2 and press the『[F2]: Play normal』key to calculate the weight and center.

- Inertia estimation
This not only calculates the tool load weight and central location, but also the inertia of the tool. Because the robot operates at high speed, always check the operation to see if it is operating without any interference safely to calculate the tool inertia.

- Basic 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 『[F7]: Set pose』key to designate the starting position. In order 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, in case of the V axis, the position should be set to -60 deg or above and +60 deg or below, and, when the V axis link is set in parallel to the ground as much as possible, the estimate results will be made better.

As shown in the second following figure, the V axis angle, displayed in the teaching pendant of the Hi5 controller, is the angle against the previous axis, not the angle against the ground surface. For your information, as shown in the first following figure, the V axis of the previous Hi4 controller is displayed after being converted in the angle against the ground surface.

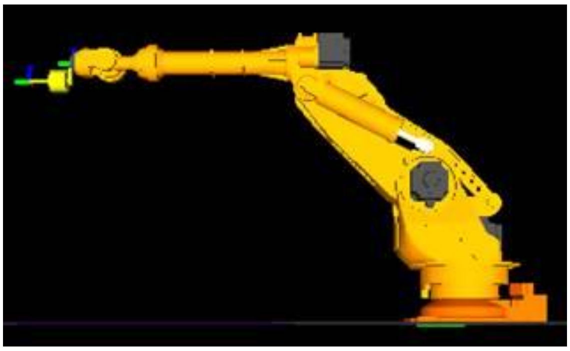


Figure 7.70 [HX165-Hi4 H=40deg, V=0deg, V axis ground surface based angle 0deg]

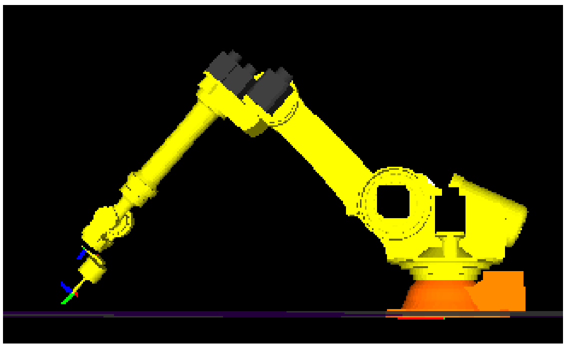


Figure 7.71 [HS165-Hi5 H=40deg, V=0deg, V axis ground surface based angle -50deg]

The conversion formula in Hi5 controller for the angle of the V axis against the ground surface is as follows.

Angle of the V axis against the ground surface = H axis angle + V axis angle -90 deg

When the 『[F7]: Set pose』 key is pressed, while the position is outside range where the angle measured for the V axis against the ground surface is within -60deg~60deg, the message 『The angle of the V axis should be kept within 60 degrees against the ground surface』 will be displayed.

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
It indicates the position of the main axis (S, H, V) of the robot in degrees..

② Designation
When the non-load data file (ROBOT.NL0) exists, the angle of main axis of the robot (S, H, V) is shown.

7.6.5. Cooperation robot common coordinate system setting

Refer to 『Hi5 Controller Cooperation control function manual』.

7.6.6. Base axis calibration

7.6.6.1. Introduction

This function is to calibrate the direction in which the axis is installed. It is impossible to install the base axis accurately aligned to the direction (X, Y and Z) of robot coordinate. Therefore this function calculates the direction of the base axis and improves the straight line interpolation path performance including the main axis.

As shown in the figure, install the robot in the base axis and find an arbitrary direction vector to do the location calibration of the robot.

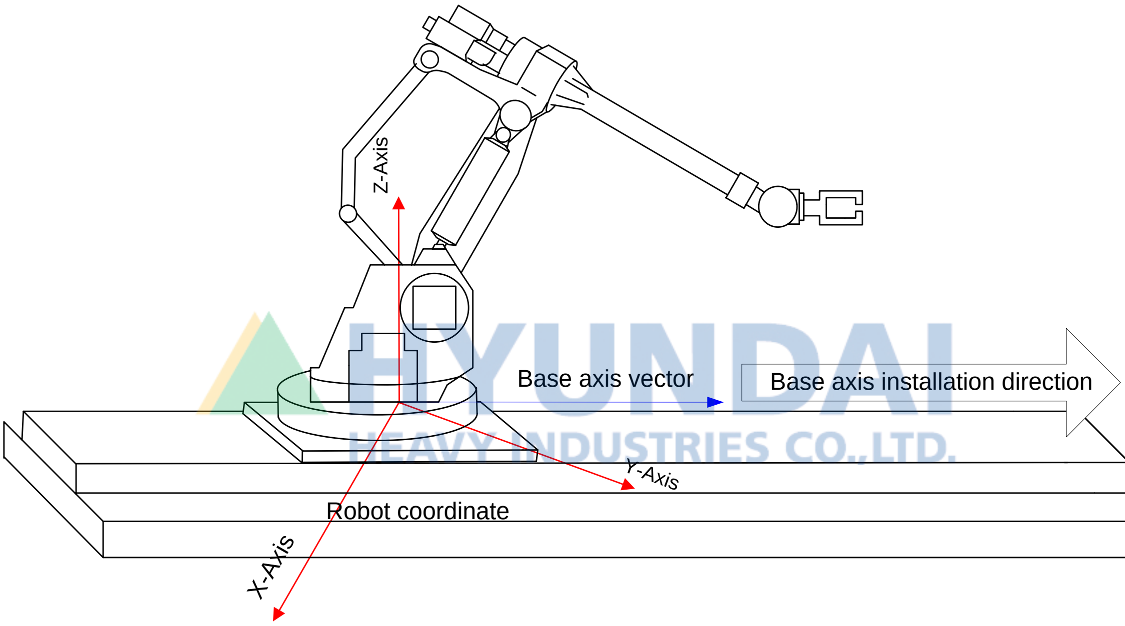


Figure 7.72 The concept of base-axis vector

7.6.6.2. Function usage

Generally the use of main axis is to move the robot to the work location but in special cases call for the base 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 base axis

7.6.6.3. Initial setting of base axis

(1) Select 『[F2]: System』 → 『5: Initialize』 → 『5: Additional axis constant』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 <Base> and set the application to <Any> and set the other parameters to the device design value and controller composition specification.

Warning

- You can only use the calibration function for the first base axis. Therefore, only the first base axis should be set to <Any>. Do not set it as Arbitrary from second on.

7.6.6.4. Calibration program teaching

(1) Establish the reference point in space and record the first reference point.

(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.

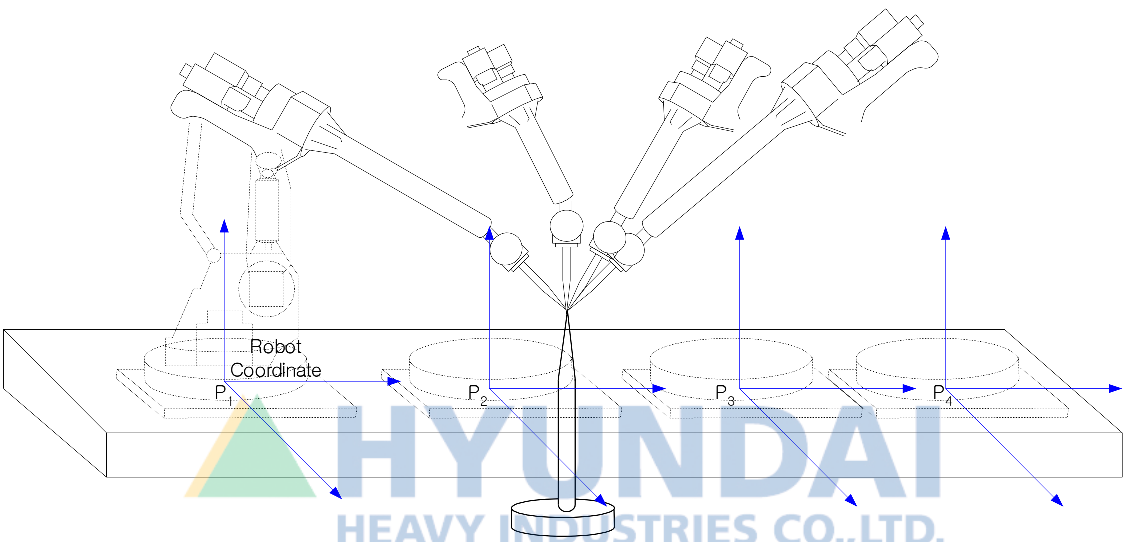


Figure 7.73 Base axis calibration program teaching

Warning

- Teach the driving axis calibration program by using the tool for which the robot calibration (Axis constant and tool length optimization) is completed
- Keep the tool number in mind when recording. You must enter the tool number for base axis calibration.
- Record the locations as farther away as you can for between steps.

7.6.6.5. Base axis calibration Executing

After entering the program number for base axis calibration, execute [F1]. The installation directional vector value of base axis. Press the [F7] key to complete.

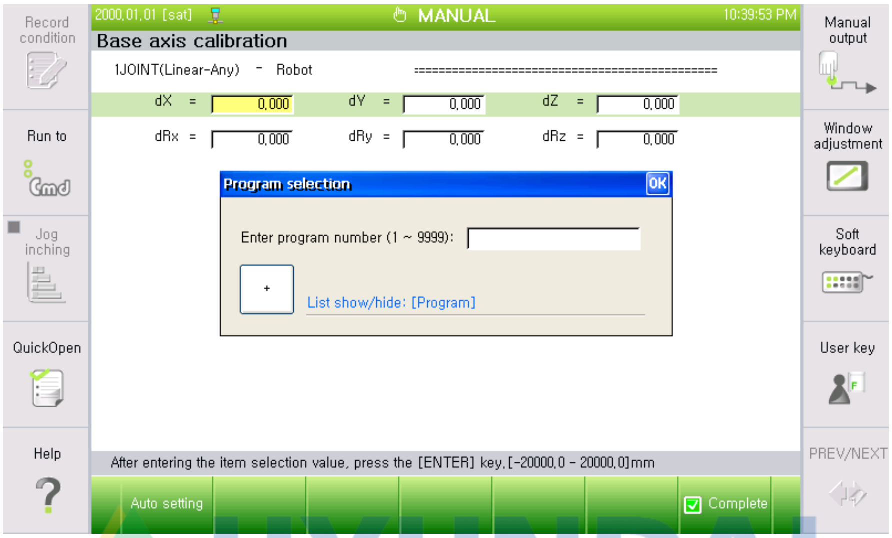


Figure 7.74 Base axis calibration execution screen

7.6.6.6. Operation after calibration for base axis

When you operate the jog for the base axis after the base axis calibration, the driven distance in the directional vector of the base axis generated through jog operation of the base axis is calculated to the current coordinate value.

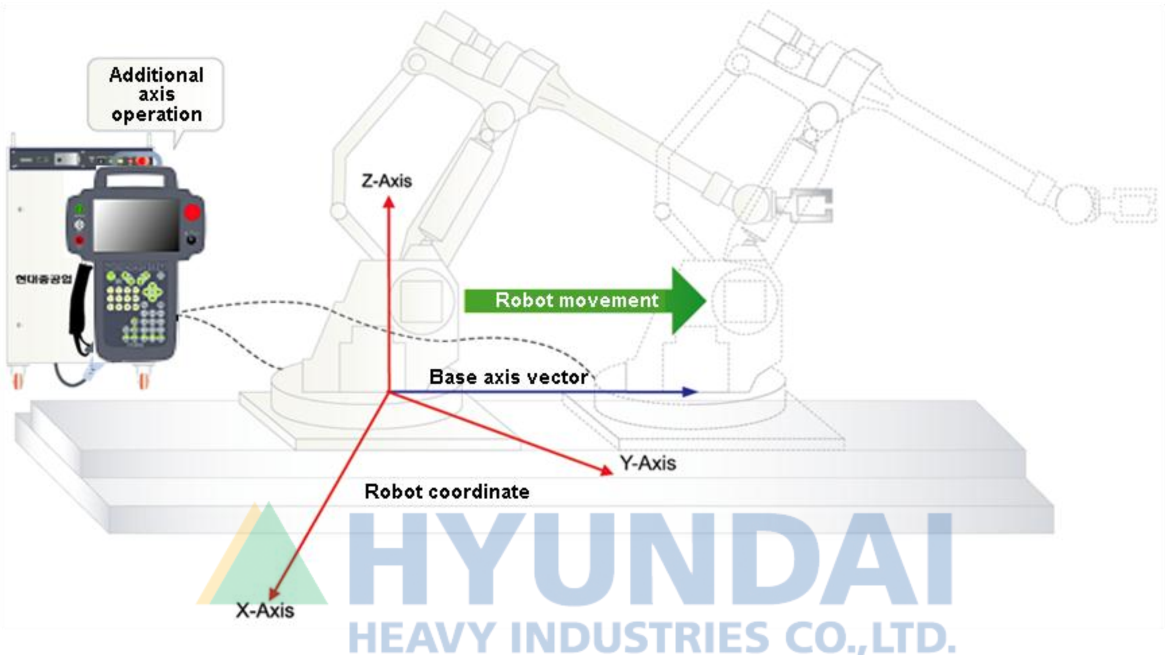


Figure 7.75 Operation after calibration for base axis

(1) Select 『[F1]: Service』 → 『1: Monitoring』 → 『1: Data of each axis』 and you can check the calculated coordinate value from base axis movement.

(2) Jog operation and coordinate check
When you execute the jog operation of the base axis when the data monitoring of each axis from the teach pendant is selected, it calculates the driven distance in the base axis direction and calculates the XYZ value to display on the monitoring screen of teach pendant.

(3) Step recording and playback are same as typical steps.

Warning

- Set the jog coordinate to tool coordinate after calibration and execute the jog operation for base axis to make it a static operation for the tool end. Using this method, check whether the calibration is normally executed.

7.6.7. Coordinate system calibration for OLP

Refer to『User manual for the coordinate system calibration for OLP』for more detail.

7.6.8. Gravitation direction automatic setting

As the Hi5 controller is based on the dynamics control, the gravitation direction setting is critical. Generally, the robot installation direction is perpendicular to the gravitational direction as shown below.

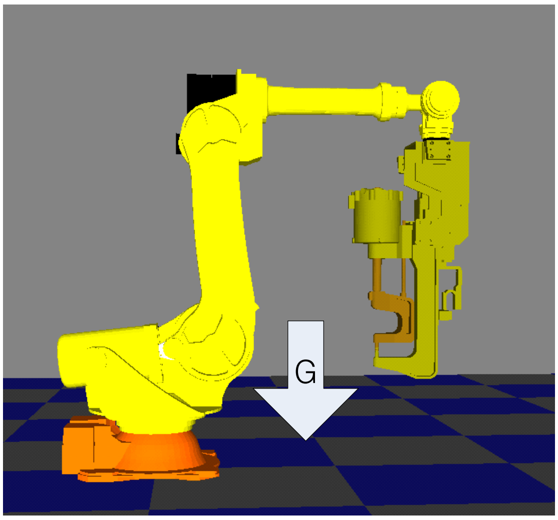


Figure 7.76 Gravitation direction of a robot on a ground surface

In a case in which the robot is installed in an inclined direction, not perpendicular to the ground surface, the gravitation direction should be set in the robot controller. In order for such setting, the gravitation direction automatic setting function is used.

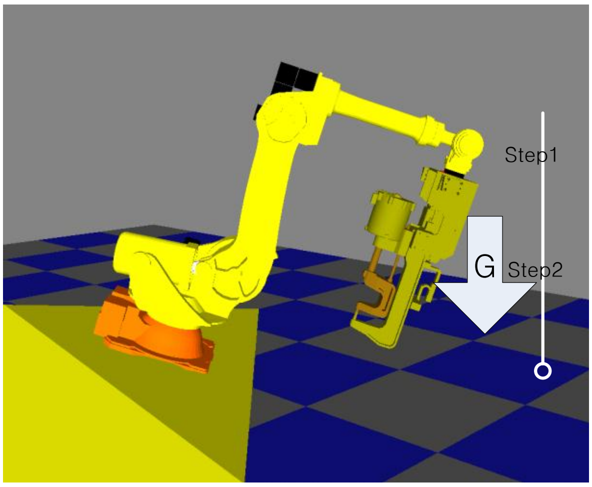


Figure 7.77 Gravitation direction of a robot on an inclined surface

In order to set the gravitation direction, a weight needs to be hanged externally to indicate the gravitational direction, and teaching about the two points (Step 1, Step 2) in the gravitational direction needs to be performed.

When the relevant program is selected and the execution key F1 is pressed, the direction vector will be calculated. When the completion key [F7] is pressed then, this direction will be set as the gravitation direction.

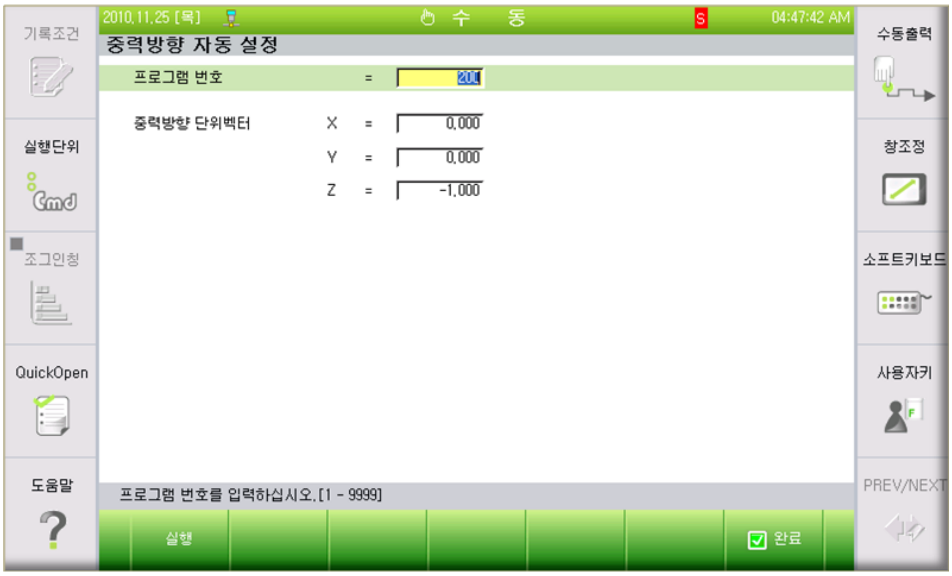


Figure 7.78 Gravitation direction selection results

7.6.9. Robot and tool calibration

This function is to be used in an environment in which the position of a robot can be measured using by a 3-dimensional measuring device.

(1) Set the position, targeted for the measurement, at the end of the too. While moving the robot in various positions and postures, measurement should be taken at more than 15 points. The positions measured while doing this need to be recorded using the program.

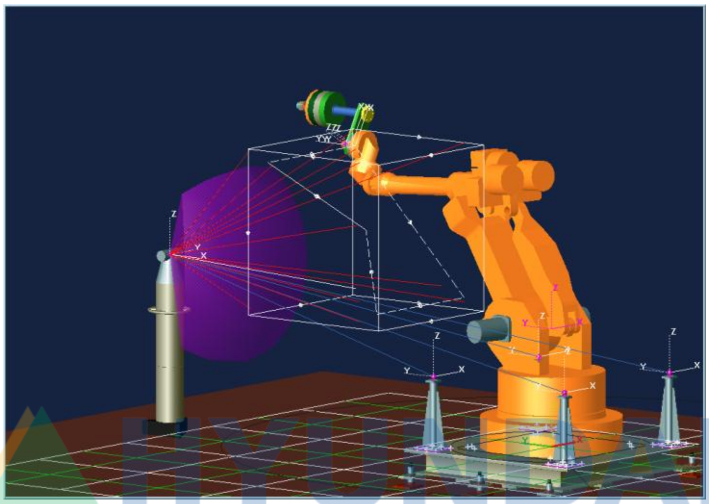
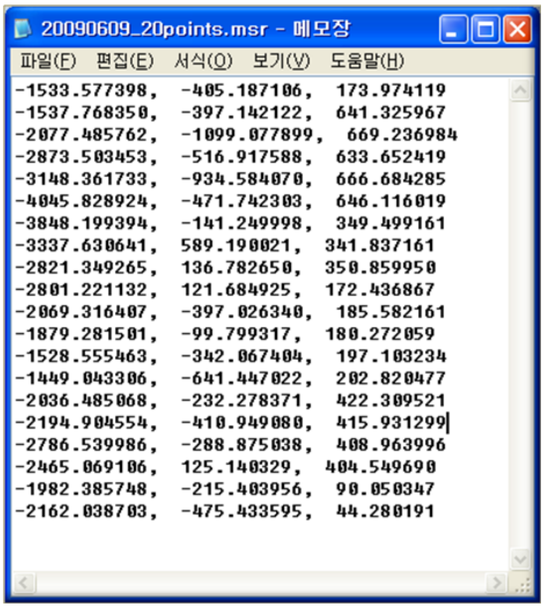


Figure 7.79 Robot data measurement method

(2) The data of the measured points need to be arranged in the X, Y and Z formats and saved in ASCII file format. However, the extension should be *.msr for saving the file. This file needs to be copied and inserted into the teaching pendant using a USB memory




```
-1533.577398,  -405.187106,  173.974119
-1537.768350,  -397.142122,  641.325967
-2077.485762,  -1099.077899,  669.236984
-2873.503453,  -516.917588,  633.652419
-3148.361733,  -934.584070,  666.684285
-4045.828924,  -471.742303,  646.116019
-3848.199394,  -141.249998,  349.499161
-3337.630641,  589.190021,  341.837161
-2821.349265,  136.782650,  350.859950
-2801.221132,  121.684925,  172.436867
-2069.316407,  -397.026340,  185.582161
-1879.281501,  -99.799317,  180.272059
-1528.555463,  -342.067404,  197.103234
-1449.043306,  -641.447022,  202.820477
-2036.485068,  -232.278371,  422.309521
-2194.904554,  -410.949080,  415.931299
-2786.539986,  -288.875038,  408.963996
-2465.069106,  125.140329,  404.549690
-1982.385748,  -215.403956,  90.050347
-2162.038703,  -475.433595,  44.280191
```

Figure 7.80 Measured robot position data

(3) Access the robot and tool calibration menu and use the explorer key [PF3] to select the relevant msr file.

(4) Select the robot program that was used for the measurement.

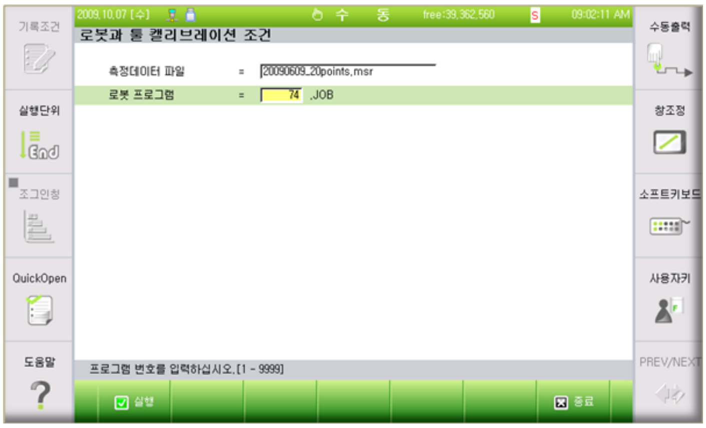


Figure 7.81 Robot calibration data entry

(5) Press the execution key [F7], then, the calibration screen will show up. Then, if you press the execution key [F1], the calibration results will be displayed.

(6) Press the completion key [F7], then the following message will show up. Then, if you select ‘Yes’, the calibrated values will be applied to the axis constant and tool constant automatically

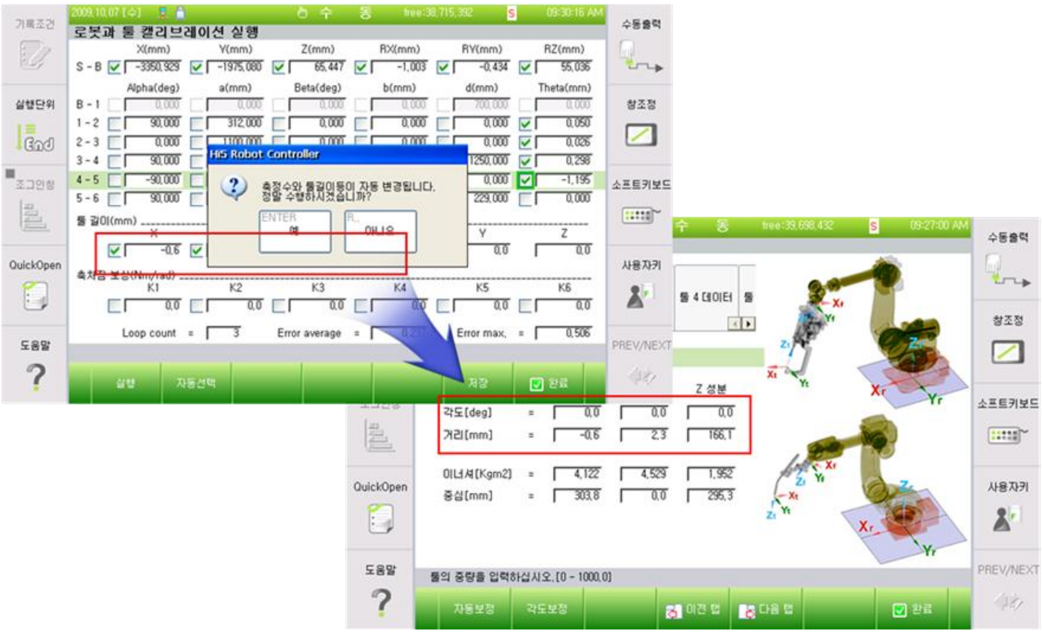


Figure 7.82 Robot calibration execution screen

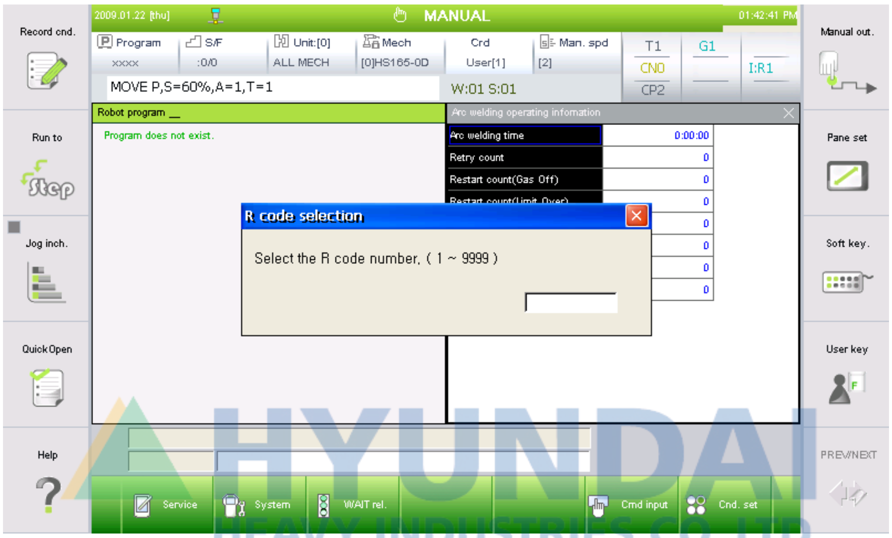
Information) The basically selected calibration parameters are the axis constants of the H, V, R2 and B axes, as well as the X, Y, and Z values of the tool length. In order to calibrate the tool only, the marked check box for each axis should be unchecked before the execution.

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) When you press the [R..(NO)] key, the edit box shown as the following is displayed on the main screen.



(2) Relevant function is executed if inputting desired code number and then pressing the [ENTER (YES)] key.

(3) The following screen is displayed when pressing the [Help] key in the above screen. In this screen, the function can be executed by using a cursor key or inputting numbers

(4) Press the [F5] key, and the code in the follow screen will be continuously displayed.

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
- WAIT condition clear
- Clear various applied function conditions and signal.

Press the [R..(NO)] key → [0] → [ENTER(YES)] key.

Reference

- This function cannot be used when Robot operates.
- Robot operates in the same manner even by pressing the [R..] [ENTER(YES)] key

8.3. R10 operating information display

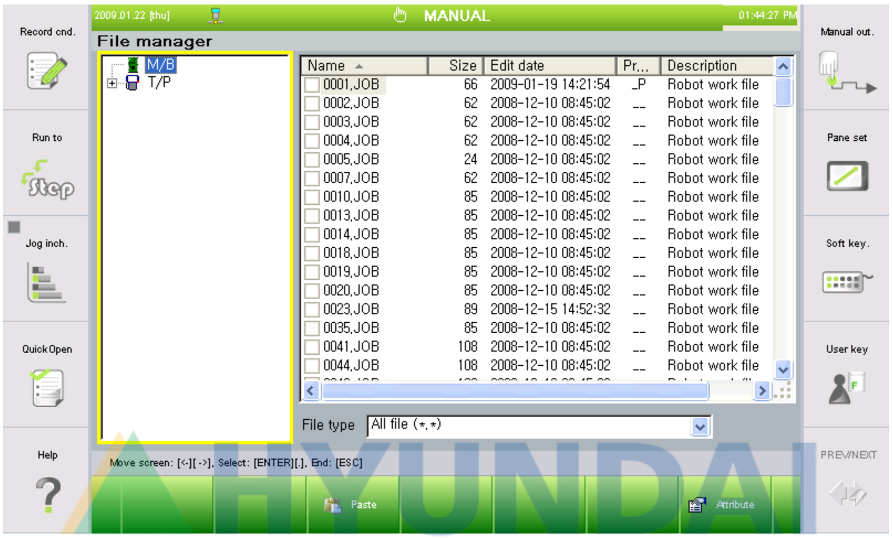
Displays the 'operation information' monitoring window.

When the spot welding is set, the 'spot welding operating information' monitoring window will be executed together.

8.4. R17 File manager

This function displays the system file and work file in the internal memory for example, and also edit and manages the file including copying file, deleting file or changing the file property, renaming the file etc.

Following screen is displayed if pressing the [R..(NO)] key → [17] → [ENTER (YES)] key.



Reference

- The WSP_ displayed in the end displays protection of file.
  W: Complete protection (prohibition of various delete/change)
  S: Partial protection (only position modification allowed in complete protection)
  P: Playback protection (prohibition of replay/step forward from step No. 0)
  _: No protection

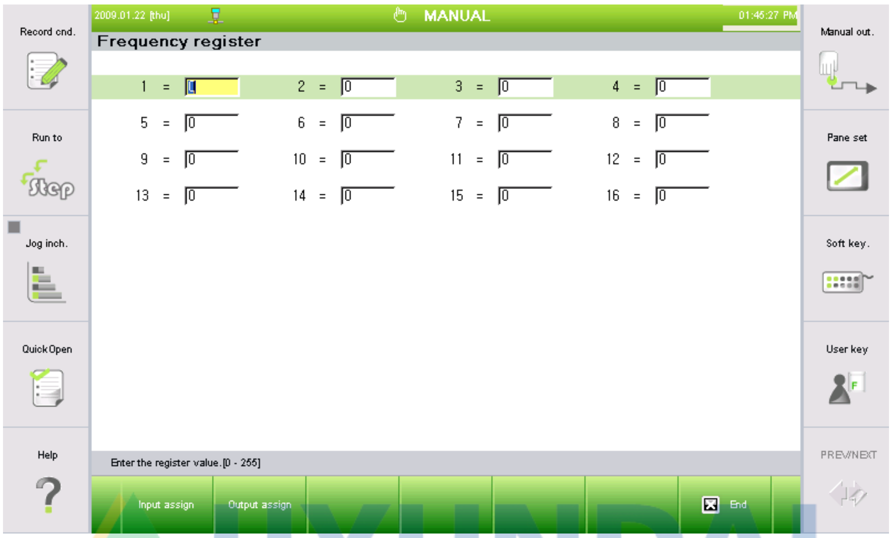
- You can scroll the screen by using the [Arrow] key.

- This is same function as 『[F1]: Service』 → 『5: File manager』.

8.5. R18 Frequently condition register

This function checks or edits the content of the frequency condition register.

Following screen is displayed if pressing the [R..(NO)] key → [18] → [ENTER (YES)] key.



Reference

- This cannot be used while the robot is in operation.
- The value displayed on the screen is the counter currently set for the number of times.
- This is same function as 『[F1]: Service』 → 『2: Register』 → 『5: Frequency register』.

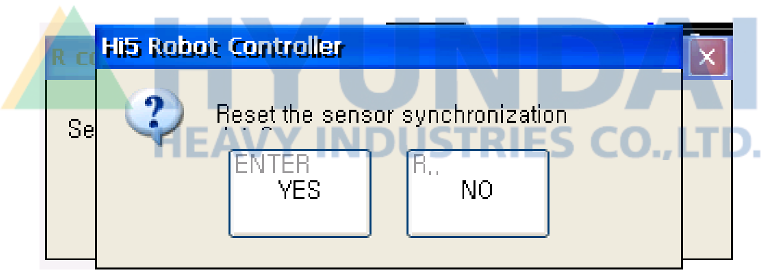
8.6. R44 Sensor synchronization data clearing

Clear the sensor synchronization data.
Then, the items to be cleared are as follows depending on the sensor activation mode.

The sensor activation mode can be set from 『[F2]: System』 → 『4: Application parameter』 → 『4: Sensor synchronization』 → 『2: Environment setting』 → 『Sensor activation = <Normal, Simulation, Test』 .

	Normal	Simulation	Test
Pulse data	Clear	Maintains current pulse	Clear
Sensor location	Clear	Clear	Clear
Moving speed	Clear	Clear	Always “0”

(1) Following screen is displayed if pressing the [R..(NO)] key → [44] → [ENTER (YES)] key.



(2) Press the [ENTER(YES)] key to clear the sensor data

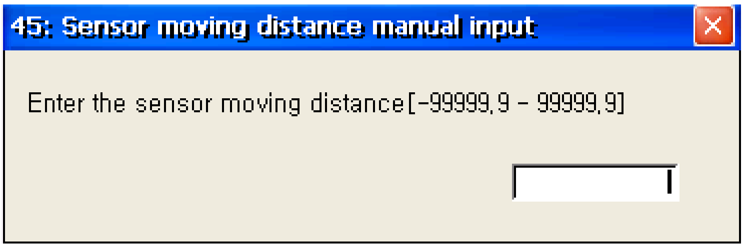
Reference

- 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 cannot be used if the sensor synchronization function is “Disable”

8.7. R45 Sensor moving distance manual input

Set the sensor distance manually.

(1) Following screen is displayed if pressing the [R..(NO)] key → [45]→ [ENTER(YES)] key.



(2) Use the [Number] key to enter the sensor distance and press the [ENTER(YES)] key.

Reference

- This function cannot be executed in AUTO mode.

- The pulse data/sensor position value does not increase even though the conveyor goes unless the limit switch does not operate if the sensor distance is changed (Even if not being '0').

- The changed sensor distance can be checked through the sensor synchronization monitoring

Sensor synchronization

	Sensor #1	Sensor #2
Pulse data	0	0
Sensor position	0.000	0.000
Moving speed	0.000	0.000
Number of incoming	0	0
Limit switch input	Off	Off
Low Pulse	0000	0000

- This is same function as that for changing the conveyor/press position on the screen of 『[F1]: Service』 → 『2: Register』 → 『6: Sensor simulation data』.

- This cannot be used if the sensor synchronization function is "Disable".

8.8. R46 Limit switch manual input

Starts pulse counting by compulsorily inputting limit switch operation signal from teaching pendant irrespective of operation of actual limit switch.

(1) When you press the [R..(NO)] key → [46] → [ENTER(YES)] key, the limit switch forced input selection window will be displayed.

(2) If pressing the [ENTER (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 [R..(NO)] key.

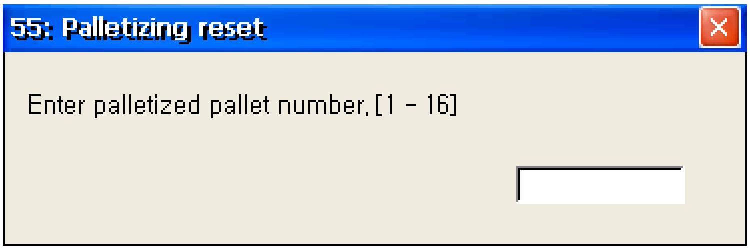
Reference

- This function cannot be executed in AUTO mode. Always use it in Manual mode.
- This is a function that will operate only when set to Simulation Test or Test in 『[F2]: System』 → 『4: Application parameter』 → 『4: Sensor synchronization』 → 『2: Environment setting』 → 『Sensor activation = <Normal, Simulation, Test>』

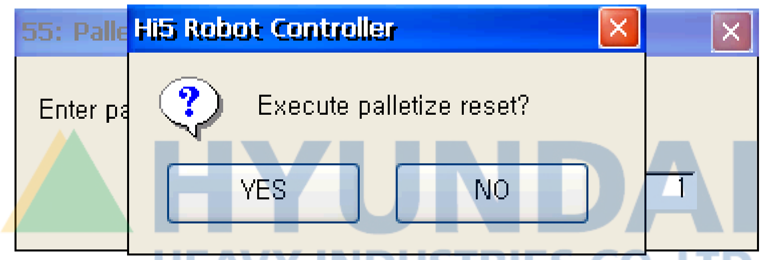
8.9. R55 Palletizing reset

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] → [ENTER (YES)] key.



(2) Following screen is displayed if pressing the [ENTER (YES)] key after inputting desire pallet number (palletize pattern register number).



(3) Setting value of the selected palletize pattern register is initialize if pressing the [ENTER (YES)] key. This function is cancelled if pressing the [R..(NO)] key.

Reference

- This function cannot be used when Robot operates.

8.10. R115 Copy program

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) When you press the [[R..(NO)] key → [115] → [ENTER (YES)] key, screen to enter the number of the original program will be displayed.

(2) Enter the number of the program to copy using the [Number] key and select [ENTER (YES)] key, and the screen to enter the target program number to copy will be displayed.

(3) Program copy is done if selecting the [ENTER (YES)] key after inputting program number to be copied with the [Number] key.

Reference

- This function cannot be executed in AUTO mode. Always use it in Manual mode.
- This is the screen to select whether to overwrite or not when the program to copy already exists.
- Overwrite is executed if selecting the [ENTER (YES)] key. This function is cancelled if pressing the [R..(NO)] key
- When the original file to copy does not exist, a message saying that the "Original file does not exist" will be displayed.

8.11. R116 Rename program

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) When you select [R..(NO)] key → [116] → [ENTER(YES)] key, the screen to enter the program number to change will be displayed.

(2) Enter the program number to change with [Number] key and press the [ENTER (YES)] key, and the screen to enter the program number to change will be displayed.

(3) Pressing the [ENTER (YES)] key after inputting program number to change with the [Number] key.

Reference

- This function cannot be executed in AUTO mode. Always use it in Manual mode.
- When the program to copy already exists, a message saying the "File to change exists." will be displayed.
- When the program to change does not exist, a message saying that the "Original file does not exist." will be displayed.

8.12. R117 Delete program

This is function to individually delete program of inner memory.

(1) When you select [R..(NO)] key → [117] → [ENTER (YES)] key, the screen to enter the program number to delete will be displayed.

(2) Enter the program number to delete with [Number] key and press the [ENTER (YES)] key, and the screen to confirm the delete process will be displayed.

(3) When you press the [ENTER (YES)] key, the program will be deleted.

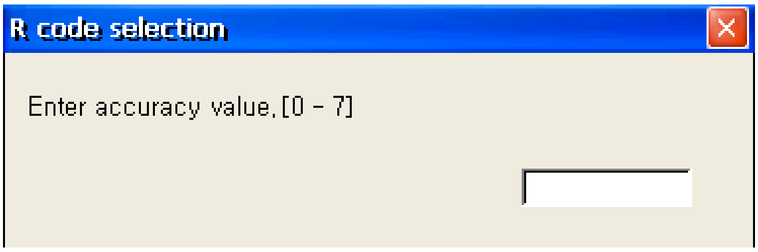
Reference

- This function cannot be executed in AUTO mode. Always use it in Manual mode.
- If you try to delete a program that does not exist, a message saying "File does not exist" will be displayed.
- If you try to delete a protected program, a message saying "File is protected" will be displayed.

8.13. R136 Change step accuracy

This function is to change the accuracy value of the currently selected step.

(1) Press the [R..(NO)] → [136] → [ENTER (YES)] keys. Then, the following screen will be displayed.



(2) Enter the value, then, the accuracy value of the step where the cursor is currently placed will be changed.

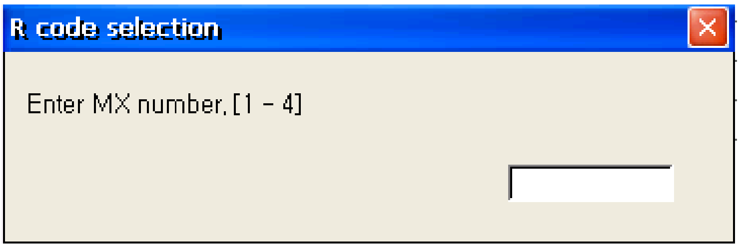
Reference

- This cannot be used while the robot is operating.
- If the line where the cursor is currently placed is not the Move command, the accuracy of the Move command that is placed the nearest the top will be changed.

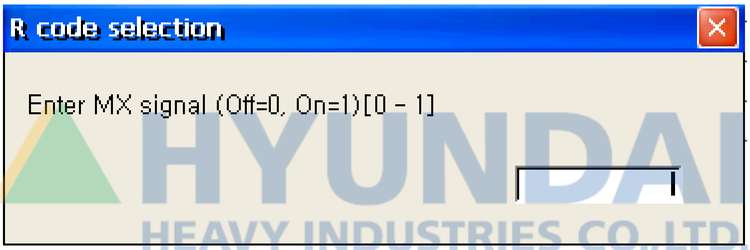
8.14. R137 Change step MX

This function is to change the MX setting value of the currently selected step.

(1) Press the [R..(NO)] → [137] → [ENTER (YES)] keys. Then, the following screen will be displayed.



(2) Enter the desired MX value and press the [ENTER (YES)] key. Then, the following screen will be displayed.



(3) Enter the value that is for setting the MX signal, and press the [ENTER (YES)] key. Then, the result of the change will be reflected into the selected step.

Reference

- This cannot be used while the robot is operating.
- If the line where the cursor is currently placed is not the Move command, the MX signal change will be reflected into the Move command that is placed the nearest the top

8.15. R163 Cancel online shift

The online shift function is for the robot to receive the input of the shift data quantity from vision units, for example, and to carry out the shifting. The R163 function initializes the shift quantity saved in the shift buffer to 0 in order to stop the shift function.

(1) When you press [R..(NO)] key → [163] → [ENTER(YES)] key, the screen to cancel online shift will be displayed.

(2) To cancel the online shift and reset the content within the shift butter to 0, enter [1] and press the [ENTER (YES)] key.

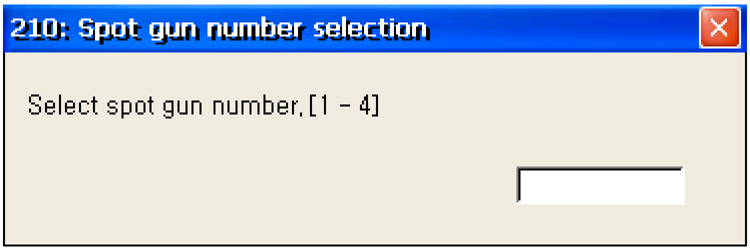
Reference

- This function cannot be used when Robot operates.

8.16. R210 Spot gun number selection

This function is to select the servo guns to be used, when planning to use multiple spot welding guns (Servo gun or air pressure gun).
For details, refer to 『Hi5 Controller Spot Welding Function Manual』

(1) Following screen is displayed if pressing the [R..(NO)] key → [210] → [ENTER(YES)] key.



(2) Press the [ENTER (YES)] key after inputting gun number to select with the [Number] key. The changed spot gun numbers are displays on the status display screen as 

.

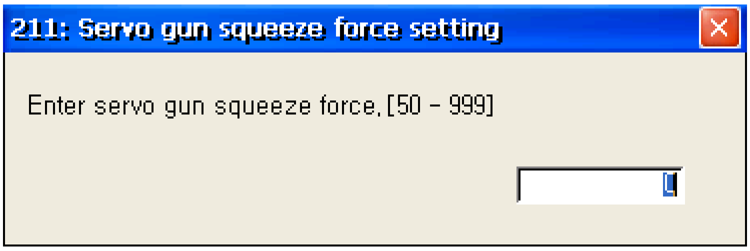
Reference

- This function cannot be used when Robot operates.
- This can only be set in the spot welding environment. The spot welding item in 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』 must be set to “Enable”.
- When you select the gun number, the tool number designated to the tool number corresponding to the spot gun automatically changes with the schedule. For the spot gun corresponding tool number, refer to 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『1: Tool No. Corresponding to Gun No., and gun-type set』.

8.17. R211 Servo gun squeeze force setting

This function is to manually set the pressurizing force when performing the servo gun pressurization. For details, refer to 『Hi5 Controller Spot Welding Function Manual』

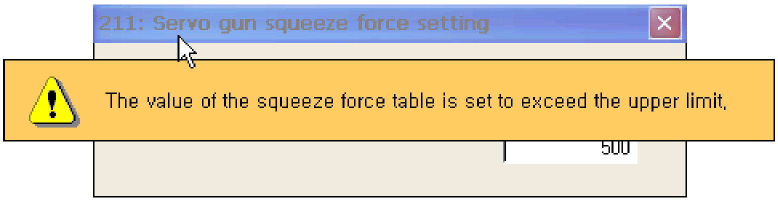
(1) Following screen is displayed if pressing the [R..(NO)] key → [211] → [ENTER(YES)] key.



(2) Press the [ENTER (YES)] key after inputting applied pressure to set with the [Number] key.

Reference

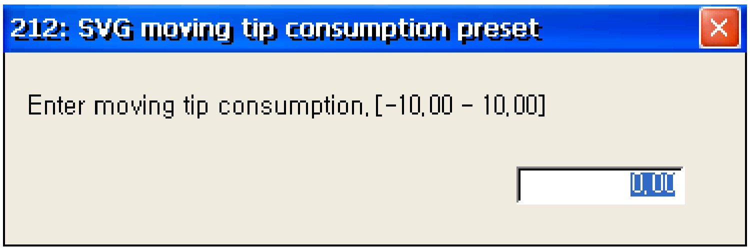
- This function cannot be used when Robot operates.
- This can only be set in the spot welding environment. The spot welding item in 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』 must be set to "Enable".
- Applied pressure of welding condition file is not changed.
- When the set pressurization force is higher or lower than the upper limit value of the current pressurization force table of the servo gun parameter, the following message will be displayed.



8.18. R212 SVG moving tip consumption preset

User can manually set wearing quantity of move tip of Servo gun.
For details, refer to 『Hi5 Controller Spot Welding Function Manual』

(1) Following screen is displayed if pressing the [R..(NO)] key → [212] → [ENTER(YES)] key.



(2) Press the [ENTER (YES)] key after inputting wearing quantity of move tip with the [Number] key.

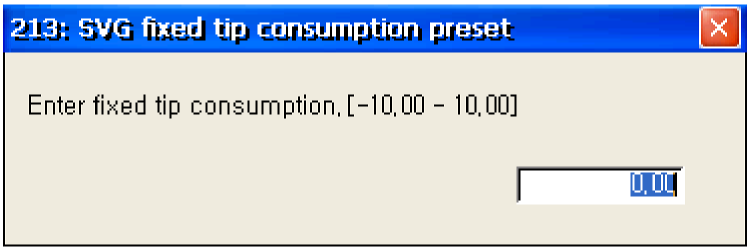
Reference

- This function cannot be used when Robot operates.
- This can only be set in the spot welding environment. The spot welding item in 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』 must be set to "Enable".
- When the actual abrasion of the tip is higher or lower than the set value, be careful since it can cause pressurization force misalignment or workpiece interference etc.

8.19. R213 Servo-gun fixed tip consumption preset

This is function to allow that user can manually set wearing quantity of fixed tip of Servo gun.
For details, refer to Hi5 servo gun function manual.

(1) Following screen is displayed if pressing the [R..(NO)] key → [213] → [ENTER(YES)] key.



(2) Press the [ENTER (YES)] key after inputting wearing quantity of fixed tip with the [Number] key.

Reference

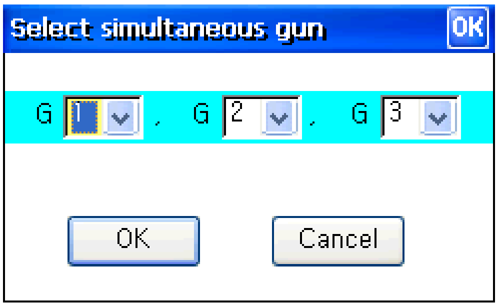
- This function cannot be used when Robot operates.
- This can only be set in the spot welding environment. The spot welding item in 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』 must be set to "Enable".
- When the actual abrasion of the tip is set higher or lower than the setting, you must be careful not to cause pressurization force misalignment or workpiece interference etc.

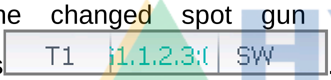
8.20. R214 Simultaneous welding gun selection

This function is to select the numbers of the spot welding guns that are to be used simultaneously when multiple spot welding guns (Servo guns or air pressure guns) are to be used to execute the welding works simultaneously,

For the selected spot welding gun, manual operation is possible. For details, refer to 『Hi5 Controller Spot Welding Function Manual』

(1) Following screen is displayed if pressing the [R..(NO)] key → [214] → [ENTER(YES)] key.



(2) Use the [Number] key to enter the gun number to select and press the [ENTER (YES)] key. The changed spot gun numbers are displays on the status display screen as .

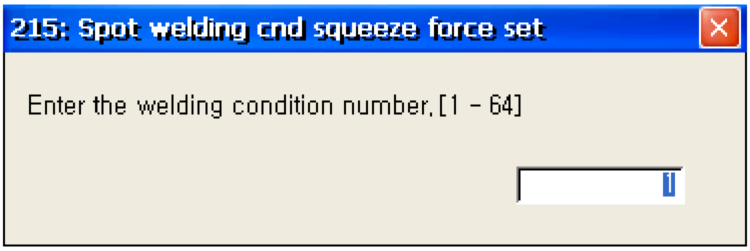
Reference

- This cannot be used when the robot is in operation.
- This can only be set in the spot welding environment. The spot welding item in 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』 must be set to “Enable”.
- When the type of the spot welding gun to select is different, a message saying “The type of the currently selected GUN type is set incorrectly” will be displayed.
- For the type where the spot welding gun is designated, refer to 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『1: Tool No. Corresponding to Gun No., and gun-type set』 .
- When you select the multi sink gun, manual pressurization and open/close operation is executed with the previously selected gun.
- When the multi sink gun is selected and the GUN LED is turned ON, SPOT command is recorded in multi sink spot type. Ex) SPOT GN=1,CN=1,SQ=1,MG=2

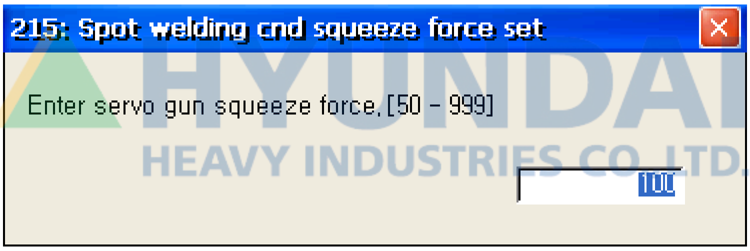
8.21. R215 Spot welding cnd squeeze force set

This function sets the welding condition table of the necessary pressurization force during servo gun welding. This is the same as setting pressurization force (Kgf) in 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『4: Spot gun welding data (Cnd, Seq)』 → 『2: Welding condition』.

(1) Following screen is displayed if pressing the [R..(NO)] key → [215] → [ENTER (YES)] key.



(2) Use the [Number] key to enter the welding condition number and press the [ENTER (YES)] key.

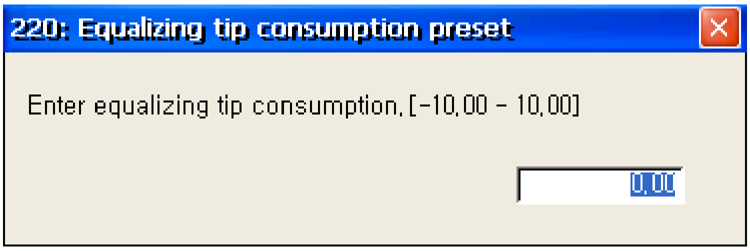


(3) Use the [Number] key to enter the servo gun pressurization force and press the [ENTER (YES)] key.

8.22. R220 Equalizing tip consumption preset

This is function to allow that user can manually set wearing quantity of fixed tip of Equalizer air-pressure gun.

(1) Following screen is displayed if pressing the [R..(NO)] key → [220] → [ENTER(YES)] key.



(2) Press the [ENTER (YES)] key after inputting wearing quantity of fixed tip with the [Number] key.

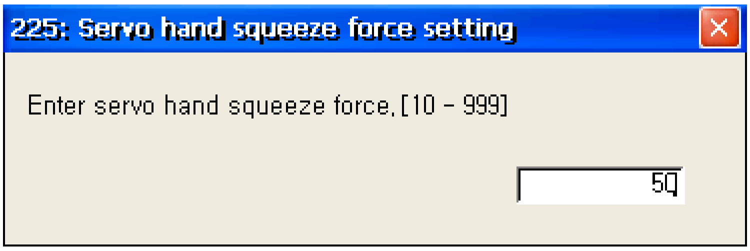
Reference

- This function cannot be used when Robot operates.
- This can only be set in the spot welding environment. The spot welding item in 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』 must be set to “Enable”.
- When the designated type of spot welding gun is “EQ’less”, it is “Enable”. Refer to 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『1: Tool No. Corresponding to Gun No., and gun-type set』.
- When setting the actual abrasion of the tip higher or lower than the setting, be careful since the pressurization force can be misaligned or it can cause workpiece interference.

8.23. R225 Servo hand squeeze force setting

This is function to allow that user can manually set applied pressure of Servo hand when performing Robot work by using a Servo hand.

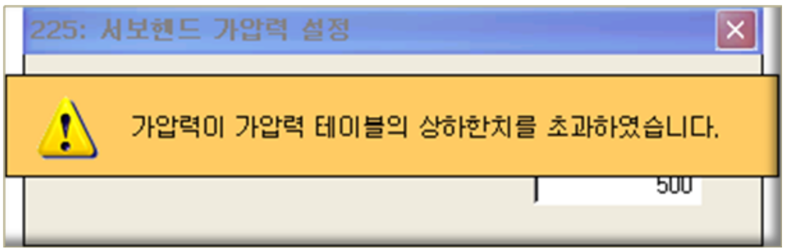
(1) Following screen is displayed if pressing the [R..(NO)] key → [225] → [ENTER (YES)] key.



(2) Press the [ENTER (YES)] key after inputting applied pressure to hand with the [Number] key.

Reference

- This function cannot be used when Robot operates.
- To be used only when there is an additional axis that is set for a servo hand
- Palletizing item in 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』 must be set to "Enable".
- When the servo hand pressurization force to set exceeds the range of the table set in 『[F2]: System』 → 『4: Application parameter』 → 『3: Palletizing』 → 『3: Servo hand parameter』 → 『Squeeze force-Current table』, a message saying "Squeeze force exceeds the maximum or the minimum value of a squeeze force table." Will be displayed.



8.24. R249 PLC all relay clear

This clears all relays related to PLC when the PLC is stopped.

(1) When you press the [R..(NO)] key → [249] → [ENTER (YES)] key, PLC all relay clear screen will be displayed.

(2) When you press the [ENTER (YES)] key, the function will be executed.

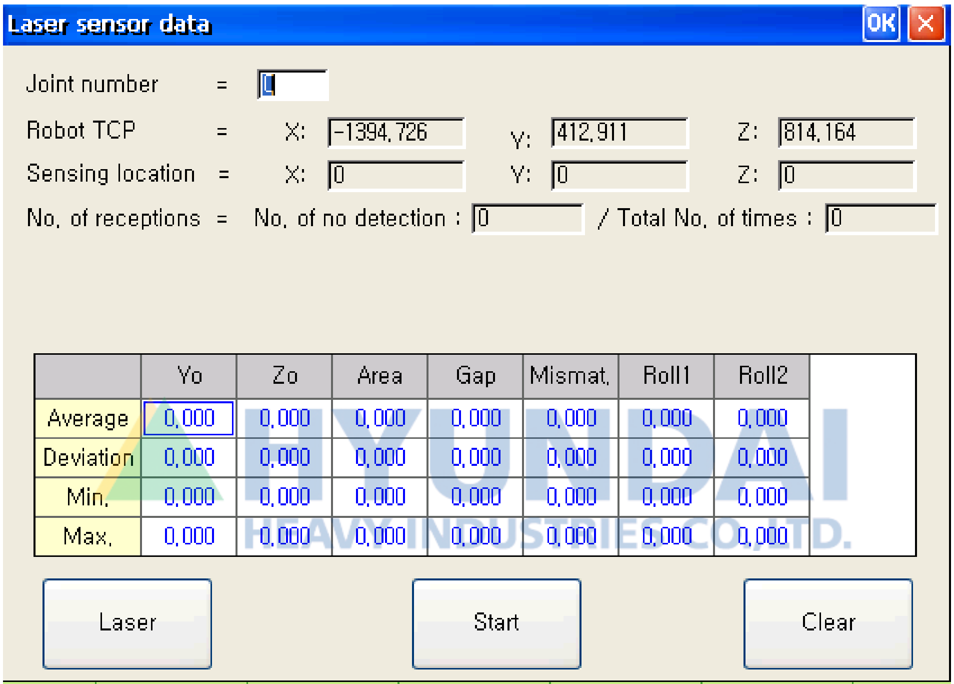
Reference

- This function only works when the embedded PLC is used and when the embedded PLC is stopped or remotely stopped.

8.25. R250 Laser sensor data display

This function is to display the message box to check the sensor data when the laser vision sensor is used.
Refer to 『Hi5 Controller LVS Tracking Function Manual』 for more details.

(1) Press the [R..(NO)] → [250] → [ENTER (YES)] keys. Then, the following message box will be executed to display the laser sensor data as shown below.



(2) Press the [Start] button. Then, the sensor will be activated

Reference

- This function can be operated normally when the laser vision sensor is installed. .
- The LVS tracking function can be operated only in a controller in which the license is entered. .

8.26. R269 Program protection

Sets protection function for program within inner memory.

(1) When you press the [R..(NO)] key → [269] → [ENTER (YES)] key, the screen to enter the program number to set will be displayed.

(2) When you enter the program number with the [Number] key and press the [ENTER (YES)] key, the screen to select the function to protect or cancel will be displayed.

(3) When you press the [1] key to protect and then the [ENTER (YES)] key, the screen to select the type of protection will be displayed.

(4) Input type of protection with the [Number] key and then press the [ENTER (YES)] key

Reference

- This cannot be used when the robot is in operation.
- Protection status is displayed as follow in the rear of fine name when performing display of inner memory or file name depending on type of protection selected.

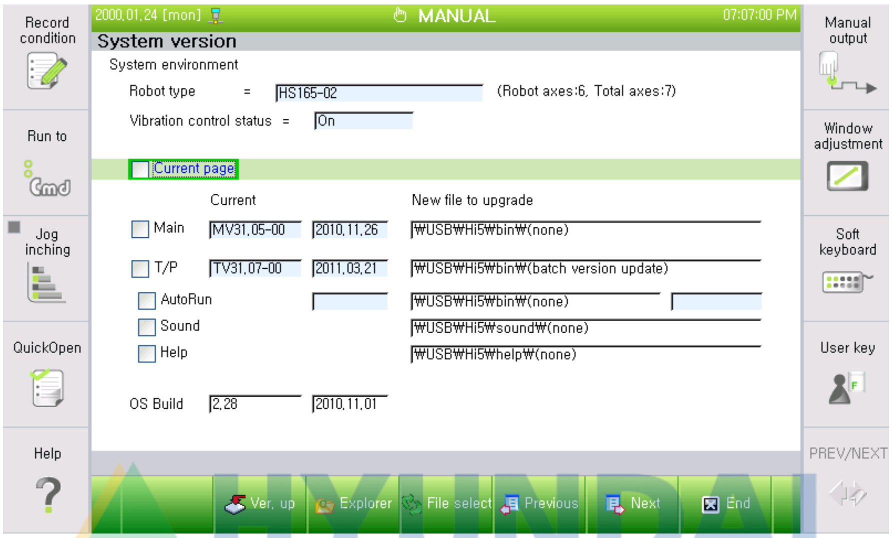
__ : No protection	W_ : Complete protection
WP : [Complete + Playback] protection	S_ : Partial protection
SP : [Partial + Playback] protection	_P : Playback protection

- If you do not enter the engineer code when canceling the program protection, a message saying “Consult the engineer” will be displayed.

8.27. R286 Software version display

This displays the system environment of the controller (Robot type, software version by system board, operating use environment) or upgrades the system version.

Following screen is displayed if pressing the [R..(NO)] key → [286] → [ENTER(YES)] key.



Reference

- This is same function as 『[F1]: Service』 → 『7: System diagnosis』→ 『1: System version』.

8.28. R350 Endless axis manual reset

For the axis of which the endless function is set to “Enable” in 『[F2]: System』 → 『5: Initialize』 → 『6: Mechanism setting』, this function resets the rotation of the rotating axis manually.

(1) Assume that data for each axis of current Robot is as in below screen after setting endless function to “Enable” for the R1 axle of Robot.

Data of each axis			
	Angle		Coordinate
S	0.000deg	X	1562.0
H	90.000deg	Y	0.0
V	0.000deg	Z	1806.0
R2	0.000deg	Rx	-180.0
B	-90.000deg	Ry	-0.0
R1	200.000deg	Rz	-20.0

(2) When you press the [R..(NO)] key → [350] → [ENTER (YES)] key, the screen to enter the axis number to reset will be displayed.

(3) Performs initialization function within scope of -180 ~ 180 degree for all axis if pressing the [ENTER (YES)] key after inputting 0 (zero). Performs initialization function within scope of -180 ~ 180 degree for relevant axis if pressing the [ENTER (YES)] key after inputting axis number. Following screen is displayed when selecting axle number to initialize to 6.

Data of each axis			
	Angle		Coordinate
S	0.000deg	X	1562.0
H	90.000deg	Y	0.0
V	0.000deg	Z	1806.0
R2	0.000deg	Rx	-180.0
B	-90.000deg	Ry	-0.0
R1	-160.000deg	Rz	-20.0

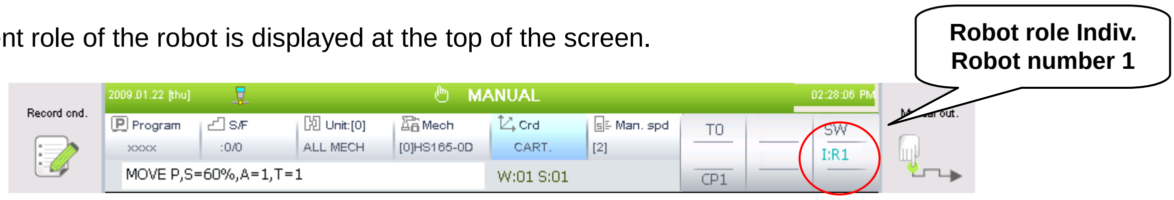
Reference

- This function cannot be used when Robot operates.
- This can be set only when the motor is turned on. When you try to set this when the motor is turned off, a message saying “This can only be executed when the motor is turned ON” will be displayed.

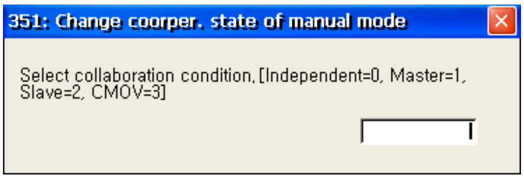
8.29. R351 Change cooper. State of manual mode

This is to set the jog role necessary for the robot cooperative control mode.
For more details, refer to 『Hi5 Controller Cooperative Control Function Manual』.

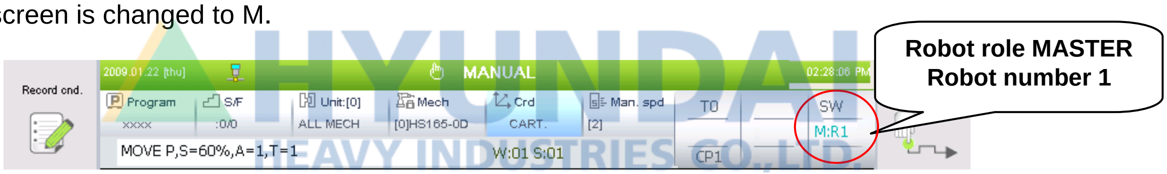
The current role of the robot is displayed at the top of the screen.



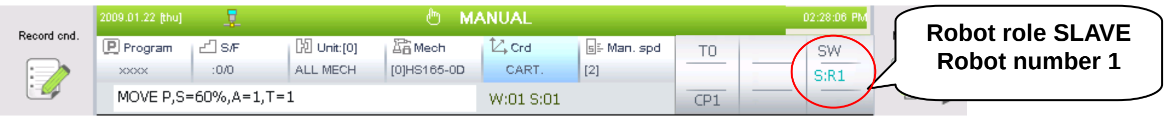
(1) Following screen is displayed if pressing the [R..(NO)] key → [351] → [ENTER (YES)] key.



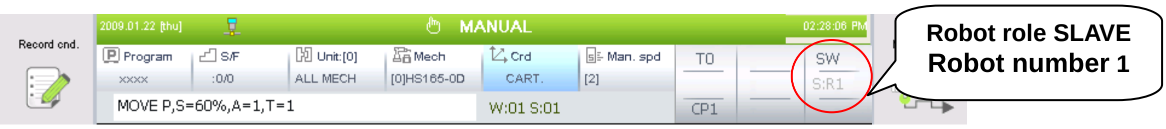
(2) Input R351, 1 when desiring to change role of Robot to master. Role of Robot on the top of screen is changed to M.



(3) Input R351, 2 when desiring to change role of Robot to slave. Role of Robot on the top of screen is changed to S.

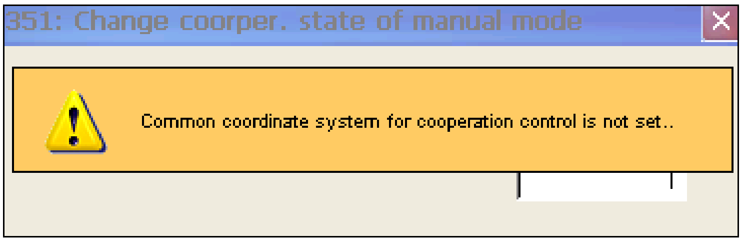


(4) Input R351, 3 in Slave status when desiring to change role of Robot to CMOV record status. Robot role is displayed as S and the font color is white.



Reference

- This cannot be used when the robot is in operation.
- When the common coordinate system between the robots for cooperative control is not set, the following message will be displayed.



- Refer to 『[F2]: System』 → 『6: Automatic constant setting』 → 『5: Common coordinate of cooperate robots』.

8.30. R352 HiNet I/O manual setting

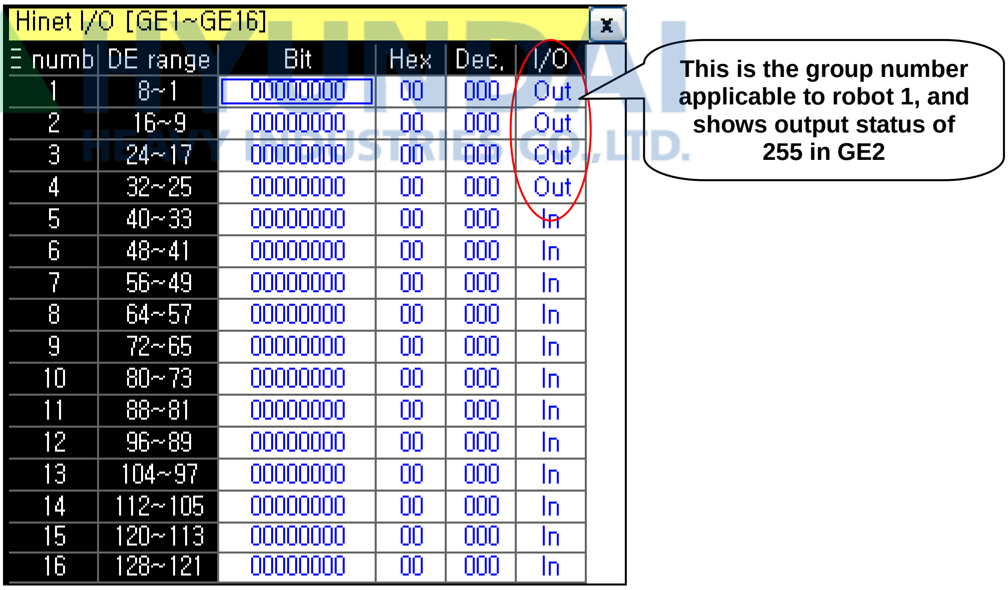
This function is to manually output the HiNet I/O signal for cooperative control.

Operation	Output signal
R352,Group number(1~16), output value(0~255) Robot 1 : Group 1~4 Robot 2 : Group 5~8 Robot 3 : Group 9~12 Robot 4 : Group 13~16	Output signal equivalent to group number When the output of 255 in Group 2 is made in case of the robot 1 Ex) R352,2,255

(1) When you press the [R..(NO)] key → [352] → [ENTER (YES)] key, the screen to enter the group number to set will be displayed.

(2) When you enter the group number with the [Number] key and press the [ENTER (YES)] key, the screen to enter the data to print manually will be displayed.

(3) After outputting R352,2,255, you can check the output status through the monitor. All other than the group number applicable is the input area.


Hinet I/O [GE1~GE16]

E numb	DE range	Bit	Hex	Dec.	I/O
1	8~1	00000000	00	000	Out
2	16~9	00000000	00	000	Out
3	24~17	00000000	00	000	Out
4	32~25	00000000	00	000	Out
5	40~33	00000000	00	000	In
6	48~41	00000000	00	000	In
7	56~49	00000000	00	000	In
8	64~57	00000000	00	000	In
9	72~65	00000000	00	000	In
10	80~73	00000000	00	000	In
11	88~81	00000000	00	000	In
12	96~89	00000000	00	000	In
13	104~97	00000000	00	000	In
14	112~105	00000000	00	000	In
15	120~113	00000000	00	000	In
16	128~121	00000000	00	000	In

Reference

- This cannot be used when the robot is in operation.

8.31. R353 Robot cooperation status reset

This function is to be used to perform the playback of individual robots after they stopped in the middle of the cooperative operation.
This function is necessary when stopping the robot in the cooperative interval COWORK ~ COWORK END and then changing the step.

(1) Following screen is displayed if pressing the [R..(NO)] key → [353] → [ENTER(YES)] key.

(2) Press the [ENTER (YES)] key. Then, the cooperation condition of the robot will be reset.

Reference

- This cannot be used when the robot is in operation.
- When the cooperative condition is reset, the robot is individually controlled. Therefore you must operate after checking whether there is any interference between the workpiece and corresponding robot.

8.32. R354 Endless ZERO execution

For the axis with the endless function set to “Enable” in 『[F2]: System』 → 『5: Initialize』 → 『6: Mechanism setting』, this function completely resets not only the rotation of the rotating axis but also the residual angle manually.

(1) Set the endless function for the R1 axis of the robot to “Enable” and assume that the data of each axis of the current robot is as follows.

Data of each axis

	Angle		Coordinate
S	0.000deg	X	1562.0
H	90.000deg	Y	0.0
V	0.000deg	Z	1806.0
R2	0.000deg	Rx	-180.0
B	-90.000deg	Ry	-0.0
R1	200.000deg	Rz	-20.0

(2) When you press the [R..(NO)] key → [350] → [ENTER(YES)] key, the screen to enter the axis number to reset will be displayed.

(3) After entering 0, press the [ENTER (YES)] key to reset the range -180 ~ 180 degrees. After entering the axis number to reset from axis 6 to 12, press the [ENTER (YES)] key to reset the range of -180 ~ 180 degrees for the applicable axis. When you selected 6 as the axis number to reset, the following screen will be displayed.

Data of each axis

	Angle		Coordinate
S	0.000deg	X	1562.0
H	90.000deg	Y	0.0
V	0.000deg	Z	1806.0
R2	0.000deg	Rx	-180.0
B	-90.000deg	Ry	-0.0
R1	200.000deg	Rz	-20.0

Reference

- This cannot be used when the robot is in operation.
- This can be set only when the motor is turned on.

8.33. R358 Spot gun manual connection/disconnection

This function connects/disconnects the welding gun from the spot welding gun change system. To change the spot welding gun from the welding gun change system, you must use the physical ATC (Automatic Tool Change) to connect/disconnect the power and various signal lines. To execute this operation manually, move to the welding gun holder to connect/disconnect the robot with the motor turned On (Turn on Enable switch). For details, refer to 『Hi5 Controller Spot Welding Function Manual』

Operation	Parameter	#1	#2
R358,#1,#2	Meaning	Connection / disconnection	Gun number
	Setting value	Connection = 1, disconnection = 0	1~3
	Example of use	R358,1,2 (Gun number 2 connection)	
		R358,0 (Gun disconnection)	

(1) When you press the [R..(NO)] key → [358] → [ENTER(YES)] key, the screen to confirm whether to connect/disconnect the spot gun manually will be displayed.

(2) After entering 1 or 0 (Connect or disconnect) using the [Number] key and pressing the [ENTER(YES)] key, the screen to enter the spot gun number to change will be displayed.

(3) Enter the welding gun number to change and press the [ENTER(YES)] key. The change welding gun number is displayed on the status display screen.

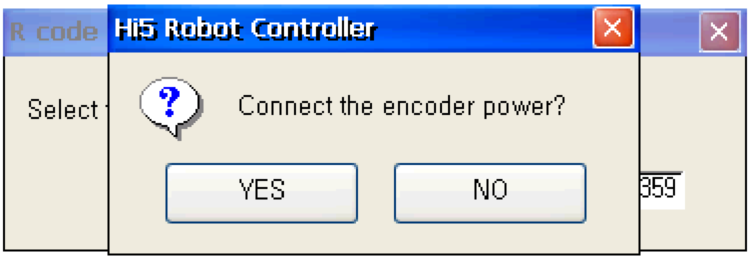
Reference

- This function cannot be executed in AUTO mode.
- When you select the gun number, the spot gun corresponding to the tool number will automatically be changed to the designated tool number. For the spot gun corresponding tool number, refer to 『[F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『1: Tool No. Corresponding to Gun No., and gun-type set』.
- This can be set only when the motor is turned on.

8.34. R359 Servo gun encoder power ON Relay

When the servo gun is applied to the spot welding gun change system, this function is used to reset the encoder of the servo gun axis when installing the servo gun initially.
For detail content, refer to 『Hi5 Controller Spot Welding Function Manual』

(1) Following screen is displayed if pressing the [R..(NO)] key → [359] → [ENTER (YES)] key.



(2) Press the [ENTER (Yes)] key to connect the power to the encoder.

Reference

- This cannot be executed in AUTO mode.
- Turn off the controller power and turn it back on to release the compulsory input of the servo gun encoder power. Therefore, after the encoder resetting is completed, you need to turn the controller power off and turn it back on in order to progress the manual assembly of the servo gun.
- Because this function is for the engineer, general operator cannot use this function.

Warning

- Never mechanically assemble or separate Servo gun in compulsory input status of encoder power.

8.35. R360 CONPATH 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.

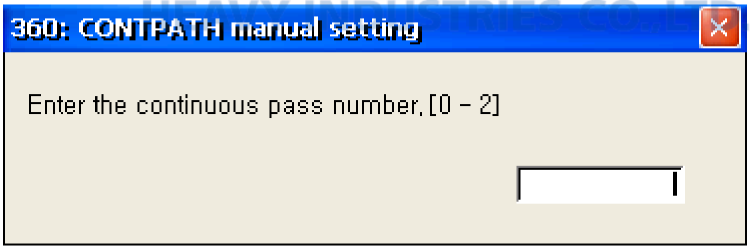
1 :
After executing commands recorded in target step during step movement, Robot moves to the next step via the target step without Robot stopping.

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 signal 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 interpretation.

(1) Following screen is displayed if pressing the [R..(NO)] key → [360] → [ENTER (YES)] key



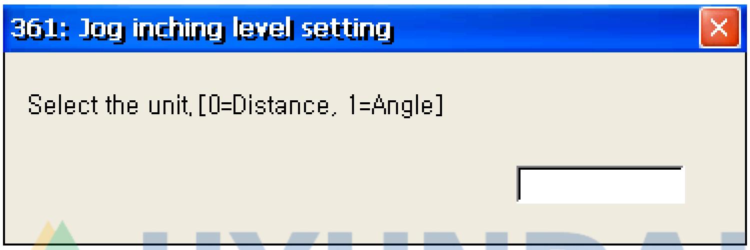
(2) Enter the number you want (0~2) using the [Number] key and the [ENTER (YES)] key. You can check the input condition from the status screen.

8.36. R361 Jog inching level setting

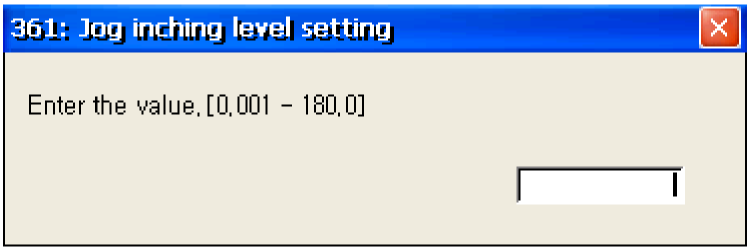
Use this to change the inching distance of the currently set level.

Operation	#1 (Unit)	#2 (Input value range)
R361,#1, #2	0 : Distance	0.001 ~ 1000.00 mm
	1 : Angle	0.001 ~ 180.0 deg

(1) Following screen is displayed if pressing the [R..(NO)] key → [361] → [ENTER (YES)] key.



(2) To set the distance of the currently set jog inching level, enter 0. To set the angle, enter 1 and press the [ENTER (Yes)] key. When 1 (Angle) is entered, the following screen will be displayed.



(3) Enter the inching angle and press the [ENTER (Yes)] key.

Reference

- This function cannot be executed in AUTO mode.
- 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 8.
- Jog inching operation can only be done when the jog inching key is activated (LED On).
- Because this function is for the engineer, general operator cannot use this function.

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. Quick Open 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 [Quick Open] key in specific command. Press the 『[F7]: Record』 key to exit after saving, and press the [ESC] key to exit without changing.

Table 9-1 Contents appearing when pressing the [Quick Open] key in command

Command sentence	File, contents	Detailed contents
MOVE	Step position	Current step position or global pose parameter X Y Z (mm), Rx Ry Rz (˚), T1~T10 Unit, Coordinate, Robot configuration
REFP	Reference location	
CALL	Called program	You can open to check or edit the applicable program.
JMPP		
Replacement statement	Variable check and change	You can monitor and change the applicable variable depending on the variable type of the replacement statement. V%, V!, V$, P, R, LV%, LV!, LV$, LP, LR, system variable etc.
ARCON ASF#=	Arc start condition file, Arc auxiliary condition file, welder condition data file	● Arc start condition Condition number, description, voltage check, whether to RETRY, operating mode, current, voltage, whether to apply WCR input wait, wait (delay) time ● Arc auxiliary condition - RETRY : Repetition, Retract time, Reentrance/path distance, shift distance, speed, current, voltage - RESTART : Repetition, Over.Leng., speed, current, voltage, overlap conditions ● Welder condition Welder number, name, description, power, setting, wire diameter, projected length, deposition detection time, arc off detection time - Feature of current : Polarity, ref. (V), measuring value (A), adj. - Feature of voltage : Polarity, ref. (V), measuring value (V,%), adj.
ARCOF AEF#=	Crater condition file, Arc auxiliary condition file, welder condition data file	● Crater condition file Condition number, voltage check, description, automatic deposition cancel, current, voltage, condition maintenance time, gas maintenance time ● Arc auxiliary condition file Auto stick recovery: Repetition, current, voltage, delay time
WEAVON WEV#=	Weaving condition	● Weaving condition file Condition number, weaving pattern, frequency, basic pattern, forward angle, moving time, timer

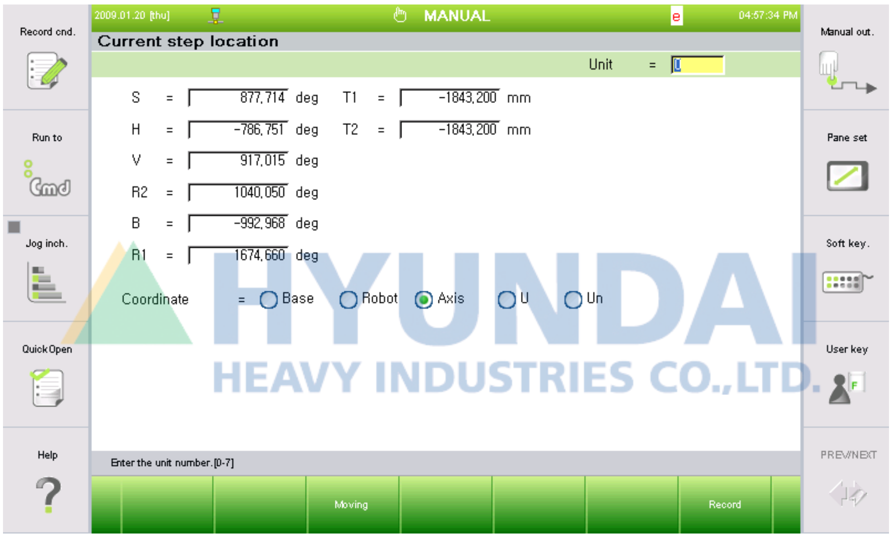
9.2. MOVE – Step location

This is function to check or modify step location where the reverse bar is currently located at in work program.

9.2.1. Hidden pose MOVE sentence

This is a function that confirms, or modifies the current step location from the hidden pose MOVE sentence (step that recorded by the [REC] key of Teach Pendant, which is the MOVE sentence that does not include the post variable).

(1) Position of current step appears as in following screen if pressing the [Quick Open] key in the MOVE sentence recorded as hidden pose.



(2) Move the cursor line to the item. If inputting figure, contents are reflected if pressing the [ENTER] key after numbers in the Input frame.

(3) Please press the [SHIFT] + [<-] [->] key to control the radio button.

(4) Step number (S)
It displays the current step number. If you enter another step number and press [ENTER], it will move to the step.

(5) Coordinates value of the current step
It displays the factor values of the step. Use cursor key to select the item that you wish to make changes. Enter the integer value and press [ENTER] to reflect the changes. However the changes will not be made if the Encoder has been selected as the type of coordinates system.

(6) Types of coordinates system
It selects the types of coordinates system (among the Base coordinates system, Robot coordinates system, axis angle, User coordinates system, Encoder value) that will represent the current step location.

(7) Robot’s structure component
It is displayed when the type of coordinates system is Base or Robot.
When Robot’s location is to be recorded, plural value may exist due to the characteristics of the equipment, so the Robot’s structure component must be configured in order to record the unique value for its location

(8) 『[F1]: Current robot pose / Original value』
If press once, the value of the Robot’s current pose will be displayed. If press once more, the hidden original value of the current step will be displayed (Toggle operation)

(9) 『[F3]: Moving』
While pressed, the Robot will move to the location of recorded step (Jog)

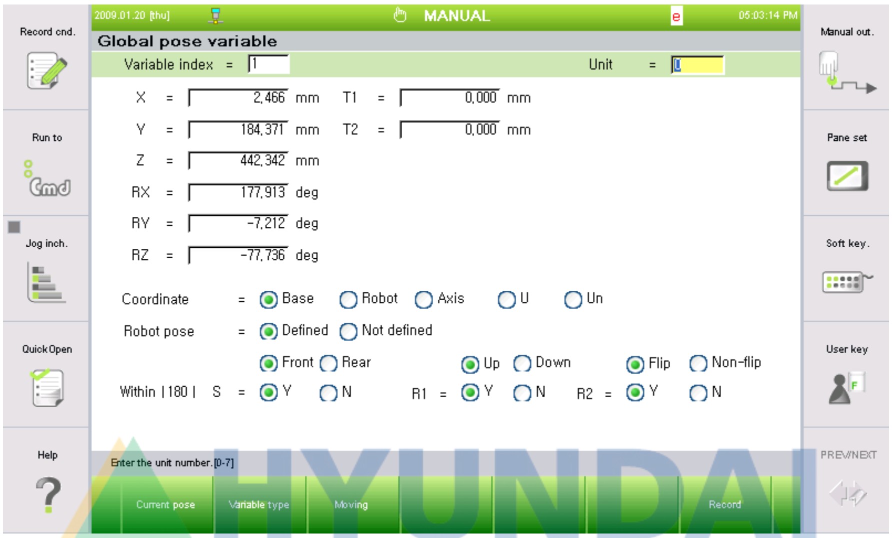
(10) 『[F4]: Previous』 / 『[F5]: Next』
Move to the previous step / Next step.

(11) 『[F7]: Record』
Reflect to the job program. If press [ESC] to finish without records it, the contents that displayed on the screen will not be reflected.

9.2.2. Pose record MOVE sentence, Post substitute sentence

This is a function that modifies the pose variable values of the MOVE sentence that includes the post variables, or the substitute sentence

(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) Move the cursor line to the item. Contents are reflected if pressing the [ENTER] key after entering numbers in the Input frame for inputting numbers.

(3) Please press the [SHIFT] + [<-] [->] key to control the radio button

(4) Post number (P)
It displays the current post number. If you enter another variable number and press [ENTER], it will move to the variable.

(5) Comments
It displays the comments that explain the current pose variable. Comments can be edited with the key pad or the soft keyboard. (Entered comments will be saved in the /Resident Flash /CataCmtP.txt file of Teach Pendant and it can be edited on PC

(6) Coordinates value of the current pose variable
It displays the factor values of the pose variable. Use cursor key to select the item that you wish to make changes. Enter the integer value and press [ENTER] to reflect the changes. However the changes will not be made if the Encoder has been selected as the type of coordinates system

(7) Types of coordinates system
It selects the types of coordinates system (among the Base coordinates system, Robot coordinates system, axis angle, User coordinates system, Encoder value) that will represent the location of pose variable.

(8) Robot's structure component
It is displayed when the type of coordinates system is Base or Robot.
When Robot's location is to be recorded, plural value may exist due to the characteristics of the equipment, so the Robot's structure component must be configured in order to record the unique value for its location

(9) 『[F1]: Current robot pose / Original value』
If press once, the value of the Robot's current pose will be displayed. If press once more, the hidden original value of the current step will be displayed (Toggle operation)

(10) 『[F3]: Moving』
While pressed, the Robot will move to the location of recorded pose variable (Jog)

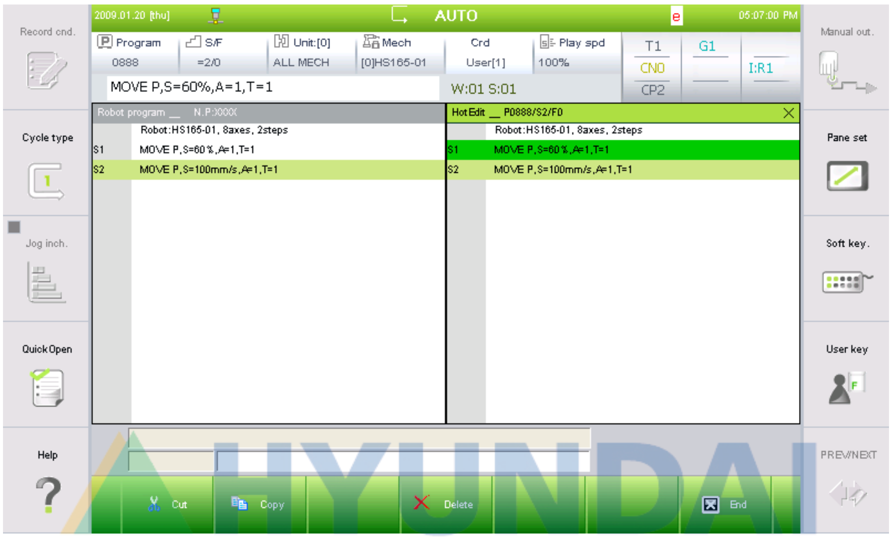
(11) 『[F4]: previous』 / 『[F5]: next』
Move to the previous variable / Next variable.

(12) 『[F7]: Record』
Reflect to the pose variable. If press [ESC] to finish without records it, the contents that displayed on the screen will not be reflected.

9.3. Program edit during the operation (Hot Edit)

This is function used to modify conditions, command or function recorded in step without stopping Robot during operation.

(1) When you press the [Quick Open] key during the operation, you can enter the program edit (Hot Edit) during operation as shown below.



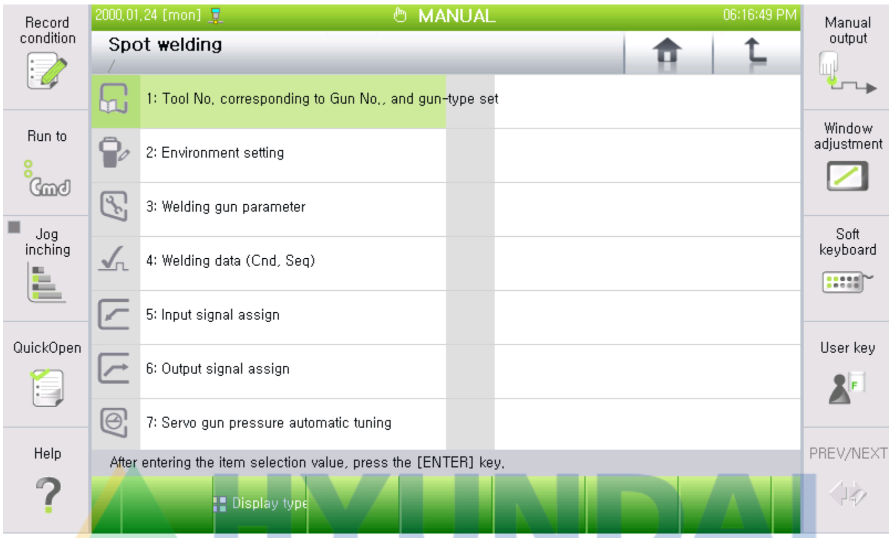
(2) After editing the program in the same method as MANUAL mode, press the 『[F6]: Apply HotE.』 key to apply the changed results.

Reference

- For more details on the program edit during operation (Hot Edit), refer to 『[F1]: Service』 → 『1: Monitoring』 → 『12: Work program Hot Edit』.

9.4. Spot welding function

When preparing the program and you have recorded the “SPOT” command, move the cursor to the location of this function in MANUAL or AUTO mode and press the [Quick Open] key. The following screen will be displayed. The purpose of this function is to quickly edit the content of the welding condition and welding sequence during the spot welding using the servo gun.



Reference

- Refer to [F2]: System』 → 『4: Application parameter』 → 『1: Spot welding』 → 『4: Welding data (Cnd, Seq)』 → 『2: Welding condition』.

- For more details on the spot welding function, refer to 『Hi5 Controller Spot Welding Function Manual』

9.5. Arc welding condition setting

You can edit condition setting of relevant commands if pressing the [Quick Open] key in ARCON, ARCOF, WEAVON, REFP, LVSON, CHGLVS as commands related with arc welding. See ‘Manual for Hi5 Controller Arc Welding Function’ for detailed contents of condition setting of each command. However, see 『Hi5 Controller LVS tracking Function Manual』 for detailed contents of LVSON and CHGLVS commands.

10
Robot Language

10.1. Robot Language Guide

There are roughly two industrial robot programming languages: command code and robot language. Between these methods, Hi5 controller creates the program using the robot language method.

With the command code method, you can create work program that can control the robot operation in detail using hundreds of command codes. But, processing formula or string, saving and processing large scale data is difficult or impossible to process using the command code. Also because the command is composed of number codes, it is difficult for the novice user to analyze the program.

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 Hi5 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.

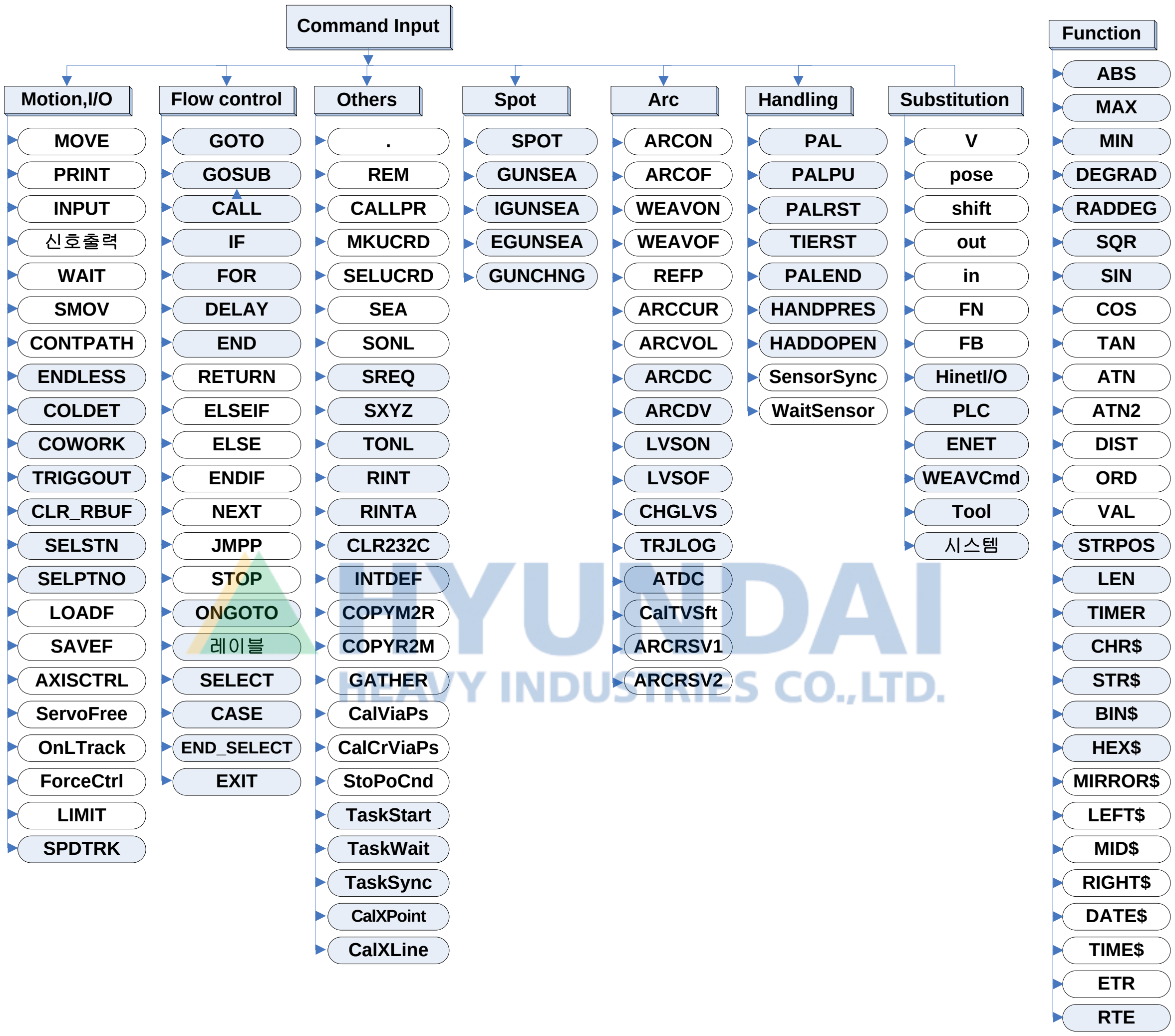


Figure 10.1 Menu Overview

10.3. Basic Elements

10.3.1. Row

Except for step statements (MOVE statement, SMOVE statement, etc.) for moving 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. Constant

Constant		Range	Example
Integer	Decimal	-32768~32767	2150, -440
	Binary	&B0~B1111111111111111	&B01101011, &B1000
	Hexadecimal	&H0~&HFFFF	&H3F77, &H2A
Real number with adjustable decimal point		-1.17E-38 ~ 3.4E+38	55.6, 0.5E-2
Real number with fixed decimal point		-2147483.648 ~ 2147483.647	3050.76, -2.714
String		Up to 240characters	"INPUT WORK NUMBER:", "INVALID DATA"

Constant	Coordinates System	Range	Example
Pose	Base coordinates System	Real number with fixed decimal point	(204.5, 3719.35, 277.94, 0, 50, 0,&H0001) (P* is the current pose of a robot.)
	Robot coordinates System	Real number with fixed decimal point	(204.5, 3719.35, 277.94, 0, 50, 0,&H0001)R
	Axis angle coordinates system	Real number with fixed decimal point	(0, 0, 30, 0, 0, 0, &H0001)A
	Encoder coordinates system	32bit hexadecimal number	(&H00400000,&H00400000,&H00400000, &H00400000,&H00400000,&H00400000)E
	User coordinates system (Number not designated)	Real number with fixed decimal point	(204.5, 3719.35, 277.94, 0, 50, 0, &H0001)U (The coordinates system number is that of the condition setting)
	User coordinates system	Real number with fixed decimal point	(204.5, 3719.35, 277.94, 0, 50, 0, &H0001)U4
	Axis angle coordinates system	Real number with fixed decimal point	(0, 0, 30, 0, 0, 0, &H0001)A
	Master coordinates system	Real number with fixed decimal point	(0, 50, 0, 0, 0, 0, &H0001)M
Shift	Base coordinates system	Real number with fixed decimal point	(0, 50, 0, 0, 0, 0)

Constant	Coordinates System	Range	Example
	Robot coordinates System	Real number with fixed decimal point	(0, 50, 0, 0, 0, 0)R
	Tool coordinates System	Real number with fixed decimal point	(0, 50, 0, 0, 0, 0)T
	User coordinates system (Number not designated)	Real number with fixed decimal point	(0, 50, 0, 0, 0, 0)U (The coordinates system number is that of the condition setting)
	User coordinates system	Real number with fixed decimal point	(0, 50, 0, 0, 0, 0)U4 (U4 is the number 4 of the user coordinates system)
	Master coordinates System	Real number with fixed decimal point	(0, 50, 0, 0, 0, 0)M
	Axis angle coordinates System	Real number with fixed decimal point	(0, 0, 30, 0, 0, 0)A

Reference

- There is no suffix for base coordinate but the robot coordinate uses the suffix R, axis coordinate A and user coordinate U or Un. (n is the user coordinate number, if n=0, use the User coordinates system's designated number of condition setting
- For the base coordinate or robot coordinate, each element is (X, Y, Z, RX, RY, RZ, cfg.). If there is an additional axis, it continues after RZ. X, Y and Z is the coordinate (Unit: mm), and RX, RY and RZ is the rotating angle (Unit: degree) from respective X, Y and Z axis. cfg. (Configuration) is composed of the information setting for shape of 14 bit robot (0~&H3FFF). (Coordinates system information will be ignored from the bit components of cfg. Coordinates system will follow the suffix.)
- 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.
- 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. Pose CFG information

The pose CFG consists of the axis configuration and coordinates systems of the robot as shown in the table below.

Table 10-1 .CFG element value structure of pose constant or pose variable

6 bit	5 bit	4 bit	3 bit	2 bit	1 bit	0 bit
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: Designated (manual) 1: Undesignated (auto)
13~10 bit		**9~7 bit**				
0~10 User coordinate number		0: base, 1: robot 2: angle	3: encoder 4: user 6: master			

Reference

- 0 bit :
  auto. config. 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. If coordinates system suffix and this bit are different, follow the suffix. “CRD” is provided as a member of CFG to make it easy to access this bit. For example, when P1.CFG.CRD=4 is executed, the coordinate system form of P1 is set as user.

- 10~13 bit :
  User coordinates system number of pose. When the coordinate’s system form is user, the user coordinates system number is essentially used. If the user coordinates system number needs to be read or changed, this bit needs to be used.
  “.UCRD” is provided as a member of CFG to make it easy to access this bit. For example, when P1.CFG.UCRD=2 is executed, the user coordinates system number of P1 is set as 2

10.3.6. Shift CFG information

13~10 bit	5 bit (Reception state)	4, 3 bit (Online shift request)	2, 1, 0 bit (Shift coordinates system)	
0~10 User coordinates system number	0: no reception 1: reception completed	0: OFF 1: COM 1 2: COM 2	0: base, 1: robot 2: tool	4: user 5: master 6: angle

- 3, 4, 5 bit are not usually used by users. However, after string shift value in register and setting 5 bit as 1 as if reception is completed, users can apply them to online shift or online coordinates conversion (SONL, TONL1 and TONL2).

- 4, 3 bit is used for storage of whether online shift request (SREQ) is forwarded and to which serial port the request is forwarded.
  ".REQ" is provided as a member of CFG to make it easy to access this bit, For example, when R1.CFG.REQ=1 is executed, request for the online shift data is made through the serial port 1.

- 5 bit is used for storage of whether online shift response is received.
  ".ASSIGN" is provided as a member of CFG to make it easy to access this bit. The setting will be made in a way that, for example, when R1.CFG.ASSIGN=1 is executed, it is considered that the online shift data is received through the serial port #1.

- 0~2 bit :
  Coordinates system form of shift. This bit is used when the coordinates system data of the shift parameter within the program routine should be retrieved and used.
  ".CRD" is provided as a member of CFG to make it easy to access this bit. For example, when P1.CFG.CRD=4 is executed, the coordinate system form of P1 is set as user.

- 10~13 bit :
  User coordinates system number of shift. When the coordinates system from of shift is user, the user coordinates system number is to be used essentially. Then, this bit needs to be used when the user coordinates system number is to be retrieved and changed.
  ".UCRD" is provided as a member of CFG to make it easy to access this bit. For example, when P1.CFG.UCRD=2 is executed, the user coordinates system number is set.

10.3.7. Variable

10.3.7.1. Global Variable

Global variable are shared by all programs.

Variable		Grammar	Example
Arithmetic	Integer	V1%~V600% or V%[1]~V%[600]	V10%, V%[20], V%[50+V2%] (Formulas should be in [ ].)
	Real number	V1!~V600! or V![1]~V![600]	V10!, V![20], V![50+V2%]
String		V1\$~V999\$ or V\$[1]~V\$[999]	V10\$, V\$[20], V\$[V2%]
Pose		P1~P9999 or P[1]~P[9999]	P50, P[70], P[50+V2\$] , P[20].RZ, P[10].X (Elements (X, Y, Z, RX, RY, RZ, T1, T2,... T10, CFG) are accessible.)
Shift		R1~R9999 or R[1]~R[9999]	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.
- 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 constant) are used for No. 2 online shift register setup.

10.3.7.2. Local Variable

A main program and each called assistant program have its own local variable. Each program cannot access local variable of other programs.

<table>
<tr><th colspan="2">Variable</th><th>Grammar</th><th>Example</th></tr>
<tr><td rowspan="2">Arithmetic</td><td>Integer</td><td>LV1%~LV50% or LV%[1]~LV%[50]</td><td>LV10%, LV%[5], LV%[5+LV2%]
(Formulas should be in [ ].)</td></tr>
<tr><td>Real number</td><td>LV1!~LV50! or LV![1]~LV![50]</td><td>LV10!, LV![5], LV![5+LV2%]</td></tr>
<tr><td colspan="2">String</td><td>LV1$~LV100$ or LV$[1]~LV$[100]</td><td>LV10$, LV$[5], LV$[LV2%]</td></tr>
<tr><td colspan="2">Pose</td><td>LP1~LP100 or LP[1]~LP[100]</td><td>LP5, LP[7], LP[5+LV2$], LP[2].RZ, LP[10].X
(Elements (X, Y, Z, RX, RY, RZ, T1, T2,... T6, CFG) are accessible.)</td></tr>
<tr><td colspan="2">Shift</td><td>LR1~LR50 or LR[1]~LR[50]</td><td>LR2, LR[3], LR[2+LV2$], LR[2].RZ, LR[10].X
(Elements (X, Y, Z, RX, RY, RZ) are accessible.)</td></tr>
</table>

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.
- 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.

10.3.7.3. Input/Output Variable

Variable			Grammar	Example
Output parameter	Digital	DO (bit)	DO[1~4096]	DO2=1 (Reset if it is 0. Set if it is not 0)
		DOB (byte)	DOB[1~512]	DOB3=&B00001111, DOB3=&H0F
		DOW (word)	DOW[1~256]	DOW7=30000, DOW3=&HFF38, V25%=DOW5
		DOL (long)	DOL[1~128]	DOL5=1000000000, DOL2=&H4000FFA0
		DOF (float)	DOF[1~128]	DOF3=3.141592, DOF7=31459.2E-4
	Exclusive	SO (bit)	SO[1~8]	SO4=0 (Reset if it is 0. Set if it is not 0)
	Analogue	AO(float)	AO[1~32]	AO1 = 3.5 (3.5V output at the analogue #1 output channel)
	Embedded field bus	FNi.Y	FN[1~64].Y[1~128]	FN3.Y2=1, FN[LV3%].Y[LV1%]=1
		FNi.YB	FN[1~64].YB[1~16]	FN4.YB2=54, FN[LV3%].YB[LV1%]=54
		FNi.YW	FN[1~64].YW[1~8]	FN1.YW2=1234, FN[LV3%].YW[LV1%]=1234
		FNi.YL	FN[1~64].YL[1~4]	FN32.YL2=12345, FN[LV3%].YL[LV1%]=12345
		FNi.YF	FN[1~64].YF[1~4]	FN25.YF2=12.34, FN[LV3%].YF[LV1%]=12.34
	Field bus (ch1, ch3, ch5)	FBj.Y	FB[1/3/5].Y[1~960]	FB1.Y2=1, FB[LV3%].Y[LV1%]=1
		FBj.Y	FB[1/3/5].YB[1~120]	FB3.YB2=54, FB[LV3%].YB[LV1%]=54
		FBj.Y	FB[1/3/5].YW[1~60]	FB1.YW2=1234, FB[LV3%].YW[LV1%]=1234
		FBj.Y	FB[1/3/5].YL[1~30]	FB3.YL2=12345, FB[LV3%].YL[LV1%]=12345
		FBj.Y	FB[1/3/5].YF[1~30]	FB5.YF2=12.34, FB[LV3%].YF[LV1%]=12.34
Input parameter	Digital	DI (bit)	DI[1~4096]	V2%=DI2, WAIT DI[V1%]
		DIB (byte)	DIB[1~512]	V1%=DIB3, WAIT DIB2=123
		DIW (word)	DIW[1~256]	V1%=DIW2, WAIT DIW2=456
		DIL (long)	DIL[1~128]	V1%=DIL3, WAIT DIL3=12345
		DIF (float)	DIF[1~128]	V1!=DIF2, WAIT DIF2<12.345

Variable			Grammar	Example
	Exclusive	SI (bit)	SI[1~8]	V3%=SI4
	Analogue	AI(float)	AI[1~32]	V2!=AI2 Put the value of the analogue #2 input channel in the V2!)
	Embedded field bus	FNi.X	FN[1~64].X[1~128]	V2%=FN3.X2, WAIT FN[LV3%].X[LV1%]
		FNi.XB	FN[1~64].XB[1~16]	V2%=FN4.XB2, WAIT FN[LV3%].XB[LV1%]=23
		FNi.XW	FN[1~64].XW[1~8]	V2%=FN1.XW2, WAIT FN[LV3%].XW[LV1%]=1234
		FNi.XL	FN[1~64].XL[1~4]	V2%=FN32.XL2, WAIT FN[LV3%].XL[LV1%]=78
		FNi.XF	FN[1~64].XF[1~4]	V2%=FN25.XF2, WAIT FN[LV3%].XF[LV1%]<34.6
	Field bus (ch1, ch3, ch5)	FBj.X	FB[1/3/5].X[1~960]	V2%=FB3.X2, WAIT FB[LV3%].X[LV1%]
		FBj.XB	FB[1/3/5].XB[1~120]	V2%=FB5.XB2, WAIT FB[LV3%].XB[LV1%]=23
		FBj.XW	FB[1/3/5].XW[1~60]	V2%=FB1.XW2, WAIT FB[LV3%].XW[LV1%]=1234
		FBj.XL	FB[1/3/5].XL[1~30]	V2%=FB1.XL2, WAIT FB[LV3%].XL[LV1%]=78
		FBj.XF	FB[1/3/5].XF[1~30]	V2%=FB3.XF2, WAIT FB[LV3%].XF[LV1%]<34.6

Reference

- When using the index in numeric format, use the [ ] as shown in DO[ ], DOB[ ] and AO[ ].
- DOB, DOW, DOL, DIB, DIW and DIL are recognized as number with a sign.
- Analog input/output values are between -12V~12V, when BD58X is attached.

10.3.7.4. System Variable

These variables are used for the acquisition or setup of internal state of the system.
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	
_TEINPUT	Variable to set the method for recognizing the end of a string when entering the string through the controller by using the serial port. + value : When they entered ASCII code value matches with the set value of _TEINPUT, the end of the string will be recognized. - value : When the absolute value of the set value of –TEINPUT matches with the count of the entered strings, the end of the string will be recognized.	
_PALCNT	To count the work corresponding to the pallet number when the palletizing process is carried out.	
_SPDRATE	To select the ratio of the playback speed of the robot when trying to arbitrarily change and apply it in the program. Its unit is %.	
_ACCRATE	To select the ratio of the acceleration speed of the robot when trying to arbitrarily change and apply it in the program. Its unit is %.	
_DECRATE	To select the ratio of the deceleration speed of the robot when trying to arbitrarily change and apply it in the program. Its unit is %.	
_INT.NO	Variable to gain the number of the interrupt that occurs in the interrupt function.	Read only
_INT.TARGET	Select the arrival completion of the step which is in the process of moving when the interrupt function is being executed. 0: After the interrupt activity is completed, moving to the step, which was in the process of moving previously, will occur. 1: After the interrupt activity is completed, moving to the next step of the step that was in the process of moving previously will occur.	Read only
_SensorPos	Sensor position in the sensor synchronization function (Distance between the start limit switch and the work)	Read only
_StoPoDt1~10 or _StoPoDt[1] ~ _StopoDt[10]	Variable for the axis data to be saved by StoPoCnd statement	
_MacInSpd	(Macro Inspection Speed) LCD inspection robot speed. The unit is %	Read only
_TIPWEAR	Total abrasion of the servo gun or the equalizer less gun	
_OrtAcDcR	Posture interpolation ratio variable. 1 ~ 100 can be entered	
_SensorPls1	Encoder pulse count of the conveyor board channel 1	Read only
_SensorPls2	Encoder pulse count of the conveyor board channel 2	Read only

_SensorStat	Conveyor board state Bit 0: Encoder disconnection error state (active high) Bit 1: Start limit switch (active high)	Read only
_MECHTYPE	Type number of the robot's main body currently selected in the system.	Read only
_TOTAL_AX	Total number of axes currently set in the system.	Read only
_AUX_AX	Total number of additional axes currently set in the system.	Read only
_AX_{name}	Axis number (1-base) for the selected axis name ({Name})	Read only
_CnstOrnt	Set whether to fix the TCP angle during the CMOV and SMOV movement. 0: Change the TCP angle, 1 : Fix the TCP angle	
_CNVYNUM	Conveyor number (1,2) currently in synchronization when using multiple conveyors	Read-only
_INTNUM	Occurred interrupt number. If interrupt does not occur, this variable is 0.	Read-only
_ZRATIO	Retrieve the distance ratio (Z2/(Z1+Z2) of Z1 and Z2, when the distance of the lift axis (Z1, Z2) of the LCD transfer robot is different Example: V1!=_ZRATIO	Read only

10.3.7.5. PLC parameter

This is the parameter that can be accessed from robot language among the embedded PLC relays.

_MB (byte)	_MB1~2000	Byte with sign _MB850=-120, _MB[V5%]=V8%
_MW (word)	_MW1~1000	Word with sign
_ML (long)	_ML1~500	Double word with sign
_MF (float)	_MF1~500	Real number with adjustable decimal point

10.3.7.6. HiNet variable

You can send the variable status through HiNet connected to the collaborative network. Each controller monitors the signal between the collaborative robots and assigns the I/O for the part that is set to share so that the input and output are freely used. The size of the output that each controller can use is 4byte.

Use this variable so that the collaborative network can be applied to usages including detection of signal I/O without external interlock signal based on the robot language (HR-BASIC).

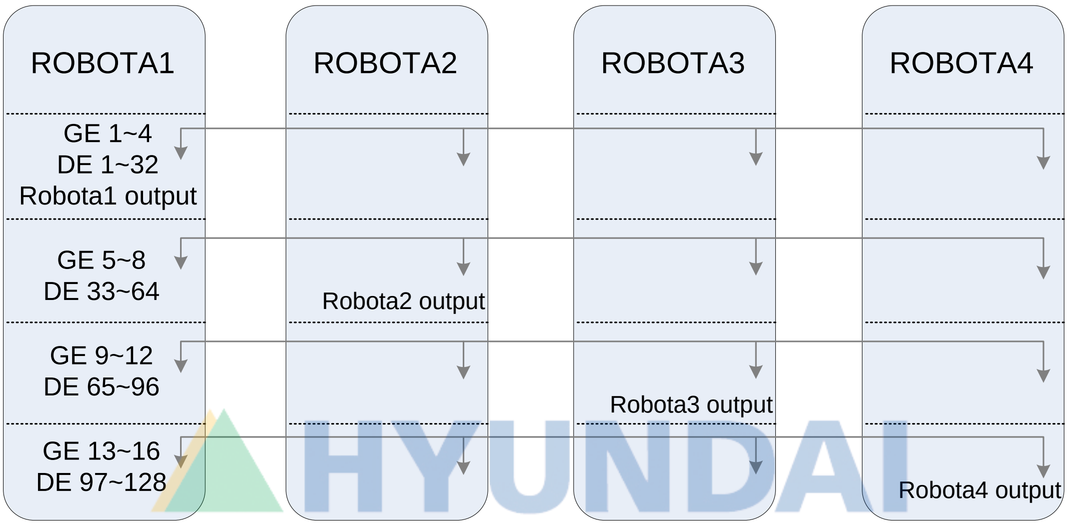


Figure 10.2 HiNet I/O

Table 10-2 Output/Input area by robot number

Robot number	GE (OUT)	GE (IN)	DE (OUT)	DE (IN)
	Output area assigned	**Input area assigned**	**Output area assigned**	**Input area assigned**
Robot 1	1~4	5~16	1~32	33~128
Robot 2	5~8	1~4, 9~16	33~64	1~32, 65~128
Robot 3	9~12	1~9, 13~16	65~96	1~64, 97~128
Robot 4	13~16	1~12	97~128	1~96

(1) DE/DE[ ] command

DE command is the variable used to access and assign the self output area in HiNet I/O function in 1 bit unit.

DE[{subscript}]={Parameter}	
Subscript	. Designate I/O output signal (1~128) 0 : Select all I/O bit 1~128 : Select applicable I/O bit
Parameter	. On/Off setting 1 : On 0 : Off

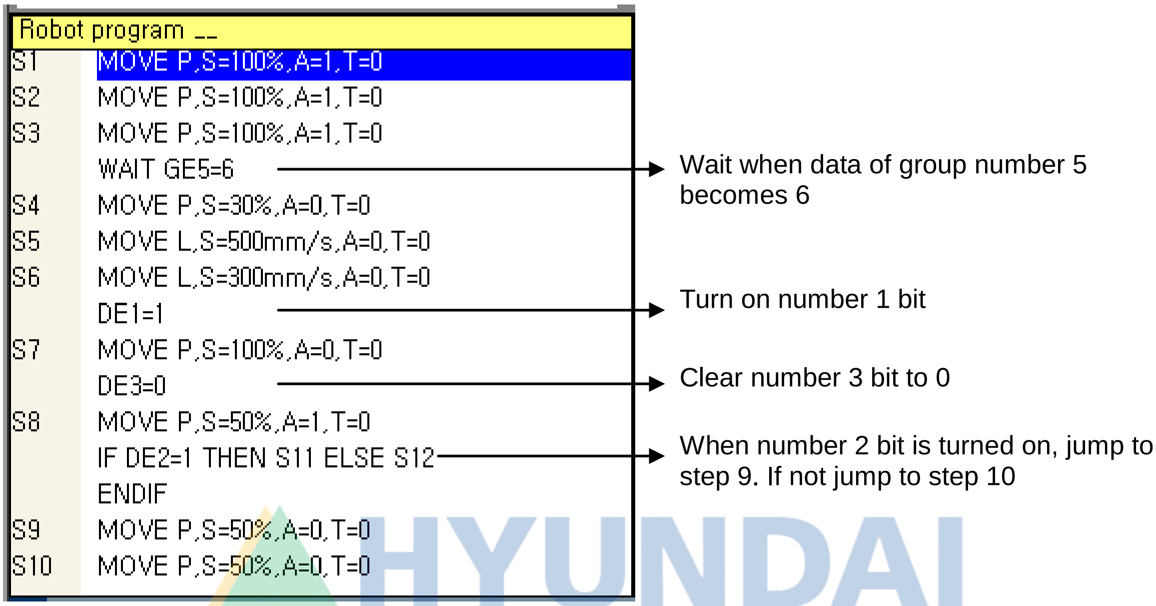
(2) GE/GE[ ] command

GE command is the variable to access and assign the self output area in HiNet I/O function in 1 byte unit. It can read the value in 1byte for all areas including the self.

GE[{subscript}]={Parameter}	
Subscript	. Designate input signal group (1~32) 0 : Select all I/O group 1~32 : Select applicable I/O group
Parameter	. Designate I/O signal of 1byte. (0~255)

(3) Example of application

Even though we can't describe all the examples of various applications using the robot language, the following screen displays a simple example. Because DE and GE are I/O that can be used as a variable, it has the advantage of being applied to various applications.



10.3.7.7. ENET parameter

10.4.7 Refer to ENET member parameter/command.

10.3.7.8. WEAVCmd member parameter

This is the member parameter used to set the parameter of the weaving function used in the arc welding. For details and using method of each member parameter, refer to the 『Hi5 controller arc welding function manual』

Table 10-3 Setting details by member parameter

Parameter name	Description	Example [Scope]
Type	Set the weaving type. [Simple, triangle, L type]	WEAVCmd.Type=0 [0,1,2]
Freq	Set the weaving frequency. [0Hz : Apply moving time]	WEAVCmd.Freq=1 [0.5 ~ 10.0 Hz]
PatVert	Set the oscillating distance in vertical direction (Wall direction)	WEAVCmd.PatVert=2.5 [1.0 ~ 25.0 mm]
PatHori	Set the oscillating distance in horizontal direction (Bottom surface direction)	WEAVCmd.PatHori=2.5 [1.0 ~ 25.0 mm]
PatAngle	Enter the angle between wall direction and bottom surface direction	WEAVCmd.PatAngle=90 [0.1~180 deg]
PatWalDi	Select the weaving wall direction. [Vertical, Horizontal]	WEAVCmd.PatWalDi=0 [0,1]
FwdAngle	Set the proceeding angle (Weaving direction vs welding line direction). [Execute weaving perpendicular to welding line when set to 0 degrees]	WEAVCmd.FwdAngle=0 [-90 ~ 90 deg]
BoundLmt	Set whether to use the boundary limit. [Enable, Disable]	WEAVCmd.BoundLmt=1 [0,1]
MoveTime	Set the moving time by each interval. The interval is classified by the script at the end of the parameter name.	WEAVCmd.MoveTime1=1 WEAVCmd.MoveTime2=1 [0.04 ~ 9.99 sec]
Timer	Set the time to stop only the weaving operation (Welding movement continues) between each interval. The interval is classified by the script at the end of the parameter name.	WEAVCmd.Timer1=1 WEAVCmd.Timer2=1 [0.0 ~ 2.00 sec]

10.3.8. Operator

Operator	Priority
( )	⇑ 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 calculation can only be done in <Pose>+<Shift>+<Shift>+<Shift>+… format.
- “\” is the integer division that divides the left value by the right value and then rounds up.
- 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.)

10.3.9. 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 constant, 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 constant, 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. Motion, I/O

10.4.1.1. MOVE Statement

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 : Axis interpolation, L: linear interpolation, C: circular interpolation SP: Static tool axis interpolation, SL: Static tool linear interpolation, SC: Static tool arc 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. 0~7. 0 is the most accurate.	0~7
	Tool	Arithmetic formula.	0~15
	Output option	X1, X2, X3, X4, PU, PK, PS (Multiple 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, X1 UNTIL DI2=&H7F,V1% (Hidden pose)		

Reference

- If MOVE command is inputted by a <REC> 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 X1, X2, PU, PK and PS in the palletizing mode. 'X1 and X2' and 'PU, PK, PS' cannot be assigned at the same time. Refer to 『Hi5 Controller Palletize Function Manual』 for detailed explanation about the individual member variables.

10.4.1.2. PRINT

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 ENET1 : Common Ethernet port (EN2) object 1 ENET2 : Common Ethernet port (EN2) object 2 ENET3 : Common Ethernet port (EN2) object 3
	Information	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.	

10.4.1.3. INPUT

<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
ENET1 : Common Ethernet port (EN2) object 1
ENET2 : Common Ethernet port (EN2) object 2
ENET3 : Common Ethernet port (EN2) object 3</td></tr>
<tr><td>Variable</td><td colspan="2">Arithmetic variable, string variable</td></tr>
<tr><td>Timeout</td><td>Arithmetic formula: When the designated time passes, it moves to the next row. When it is 0, the key value entered prior to the execution is saved to the parameter, and if there was no key entry, the parameter value is maintained.</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 [ENTER].
On serial port, input is completed by recognizing NULL character (ASCII code 0).
When a string that cannot be interpreted as a number when the numeric parameter is entered, the existing value of the parameter is maintained.
When it is not entered within the designated time, the existing value of the parameter will be maintained.
When the timeout period is set to 0, the value entered using the [Number] key of the teach pendant beforehand will be entered and if there is not key value entered, the existing value of the parameter will be maintained.</td></tr>
</table>

10.4.1.4. Signal output

Explanation	Output signal to designated port as output variable.	
Grammar	<Output variable> = <Output value>	
Parameter	Output variable	Parameter corresponding to the output signal. DO, DOB, DOW, DOL, DOF parameter corresponding to common output AO variable corresponding to analog output signal SO variable corresponding to exclusive output signal
	Output value	Calculation formula. (If the number is a real number, drop the decimal points) For single signal output(D0), 0 is OFF and non-zero is ON Because the DOF or analog output uses a real number, the decimal points are also used.
Example	DO3 = 1 DOB2 = &H7F AO2 = 3.4	

Reference

- For details on signal output, refer to I/O variable.

10.4.1.5. WAIT

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		

10.4.1.6. SMOV

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 : Axis interpolation, L : linear interpolation, C : circular interpolation SP : Static tool axis interpolation, SL: Static tool linear interpolation, SC: Static tool arc 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. 0~7. 0 is the most accurate.	
	Tool	Arithmetic formula. 0~15	
	Output option	X1, X2, X3, X4, PU, PK, PS (Multiple 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,X1 UNTIL DI2=&H7F,V1% (Hidden pose)		

Reference

- Refer to “Positioner Synchronous User Guide” for details about SMOV.
- If [REC] key 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 X1, X2, PU, PK and PS in the palletizing mode. ‘X1 and X2’ and ‘PU, PK and PS’ cannot be assigned at the same time. Refer to 『Hi5 Controller Palletize Function Manual』 for details.

10.4.1.7. CONTPATH

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.	
		2 : Even commands including input signals are analyzed and consecutively move.	
Example	CONTPATH 0 CONTPATH 1 'Consecutive handling (except for input signals) CONTPATH 2 'Consecutive handling including input signals		

Reference

- If CONTPATH command is not explicitly executed, CONTPATH 1 will be applied by default. Even when the command is explicitly designated, it will be reset to CONTPATH 1 before the cycle starts.
- 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

10.4.1.8. ENDLESS

Explanation	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.)	
Grammar	ENDLESS < Axis name >=< The num. of rot.> ENDLESS RESET ENDLESS ZERO	
Parameter	Axis name	R1: Axis R1, T1~T16 : additional axis 1~16
	The num. of rot.	Number of rotations of an axis to be applied to the first step after command is given. (1=360deg, -1=-360deg)
	RESET	Current axis rotation value is converted to “-180deg ~ 180deg” value.
	ZERO	Always set the current axis rotation value to 0deg.
Example	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	

Reference

- Steps where ENDLESS command is executed are automatically converted to the value within one rotation after revolving for the assigned times.

10.4.1.9. COLDET

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 『[F2]: System』 → 『3: Robot parameter』 → 『8: Collision Detection Setting』.
(This menu is shown only when the robot that can use the collision detection function is selected.)

When the collision detection function is enabling, 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 disabling. 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		

10.4.1.10. COWORK

<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 <Robot role>,<Relative robot number>,T=<Standby time></td></tr>
<tr><td rowspan="3">Parameter</td><td>Robot role</td><td>M: master robot S: slave robot END: cooperative control end
WITH : Standby until another robot meets COWORK WITH</td></tr>
<tr><td>Relative robot number</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>Standby 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 『Hi5 Controller Cooperation Control Function Manual』 for details.

10.4.1.11. TRIGGOUT

<table>
<tr><td>Explanation</td><td colspan="2">This commands adjusts the signal output time to First Out (-) or Last Out (+) that occurs from the command location where the accuracy is OK in the interval where it is processed continuously with CONTPATH 1 or 2.</td></tr>
<tr><td>Grammar</td><td colspan="2">TRIGGOUT <Output variable>=<Output value>, OT=<FO, LO time></td></tr>
<tr><td rowspan="3">Parameter</td><td>Output variable</td><td>Parameter corresponding to the output signal.
DO, DOB, DOW, DOL, DOF parameter corresponding to common output
AO variable corresponding to analog output signal
SO variable corresponding to exclusive output signal</td></tr>
<tr><td>Output value</td><td>Calculation formula. (If the number is a real number, drop the decimal points)
For single signal output(DO), 0 is OFF and non-zero is ON
For analog output, the decimal in real number is also used</td></tr>
<tr><td>FO(-), LO(+)time</td><td>-10.00 ~ 2.00 [sec]
When (-), the signal is outputted first and when (+) later.</td></tr>
<tr><td>Example</td><td colspan="2">TRGGOUT DO3 = 1,OT=1.23
TRGGOUT DOB2 = &H7F,OT=-2.34
TRGGOUT AO2 = 3.4,OT=0.12</td></tr>
</table>

10.4.1.12. CLR_RBUF

<table>
<tr><td>Explanation</td><td colspan="2">If you don't know if there is a residual string not recognized in the received buffer of the INPUT statement before receiving the new string with the INPUT command, you can empty the buffer with this command.</td></tr>
<tr><td>Grammar</td><td colspan="2">CLR_RBUF <Input direction></td></tr>
<tr><td>Parameter</td><td>Input direction</td><td>#0 : Teach pendant
#1 : Serial port COM 1
#2 : Serial port COM 2
ENET1 : Common Ethernet port (EN2) object 1
ENET2 : Common Ethernet port (EN2) object 2
ENET3 : Common Ethernet port (EN2) object 3</td></tr>
<tr><td>Example</td><td colspan="2">CLR_RBUF #1
CLR_RBUF ENET2</td></tr>
</table>

10.4.1.13. SELSTN

Explanation	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.	
Grammar	SELSTN <station number>[,<timeout time>,<shelter address>]	
Parameter	station	ALL : all positioners are operated. S0 : Each positioner is independently operated. S1~S3 : Selected positioners are operated.
	timeout time	Waiting time until independent operation is completed.
	shelter addr.	If independent operation is not completed until waiting time is up, positioners are withdrawn to this address.
Example	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.	

Reference

- To select positioner group, set positioner group first.
- Refer to 『Hi5 Controller Positioner Synchronous Function Manual』 for setup and details.

10.4.1.14. SELPTNO

<table>
<tr><td>Explanation</td><td colspan="2">Enter the stationary tool number.
This command sets the XYZ value of the stationary tool coordinate system according to the selected stationary tool number.</td></tr>
<tr><td>Grammar</td><td colspan="2">SELPTNO TN=<Stationary tool number></td></tr>
<tr><td>Parameter</td><td>Stationary tool number</td><td>0 ~ 3</td></tr>
<tr><td>Example</td><td colspan="2">S1 MOVE L,S=300mm/s,A=0,T=0
SELPTNO TN=1 → Select stationary tool number 1
S2 MOVE SL,S=300mm/s,A=0,T=0 → Linear interpolation step by stationary tool number 1 coordinate
S3 MOVE L,S=300mm/s,A=0,T=0 → Linear interpolation step by robot tool coordinate
SELPTNO TN=0 → Select stationary tool number 0
S4 MOVE SL,S=300mm/s,A=0,T=0 → Linear interpolation step by stationary tool number 0 coordinate
S5 MOVE SL,S=300mm/s,A=0,T=0 → Linear interpolation step by stationary tool number 0 coordinate
S6 MOVE L,S=300mm/s,A=0,T=0 → Linear interpolation step by robot tool coordinate
END</td></tr>
</table>

Reference

- Stationary tool number runs from 0 to 3, and 0 is the default value.
- Set the stationary tool coordinate system from 『[F2]: System』 → 『2: Control parameter』 → 『7: Coordinate registration』 → 『2: Stationary tool coordinate』 menu.
- For the stationary tool number, when “Stationary tool” of 『[F7]: Condition setting』 → 『8: Interpolation base』 is selected, you can check the tool number of the status display window of the MANUAL or AUTO main screen.

10.4.1.15. LOADF

Explanation	This is the command to copy the controller file located in T/P flash memory, USB memory or external PC to the main board. This is the function to store large scale step data in large supplementary memory device to open and play during the task.		
Grammar	LOADF <Result parameter>,<Original location>,<Original path file name>[,<Target file name>]		
Parameter	Result parameter	Result is saved after the execution. 1 : Success -1 : Failed to open original file -2 : Failed to open target file -3 : Failed to record target file -4 : Unsupported file type -5 : Target file is protected -6 : Cannot copy during playback -9 : Other error	
	Original location	TP : /Resident Flash/prj/ of teach pendant USB : / (root) of USB memory EXT : External PC	
	Original path file name	Path + File name of original file to copy	
	Target file name	If the target file name to copy to main board is omitted, apply the same file name as the original file name	
Example	LOADF V1%,TP,"L203/2500.JOB","0001.JOB" (Copy /Resident Flash/prj/L203/2500.JOB of T/P to 0001.JOB of main board)		

Reference

- When using the original location as EXT, LOADF/SAVEF service must be running on the external PC.

10.4.1.16. SAVEF

Explanation	This is the command to copy the controller file located in main board to T/P flash memory, USB memory or external PC. This is the function to back up the task program edited on the main board in robot language command.		
Grammar	SAVEF <Result parameter>,<Target location>,<Target path file name>[,<Original file name>]		
Parameter	Result parameter	Result is saved after the execution. 1 : Success -1 : Failed to generate target file -2 : Failed to open original file -9 : Other error	
	Target location	TP : /Resident Flash/prj/ of teach pendant USB : / (root) of USB memory EXT : External PC	
	Target path file name	Path + File name of target file to be copied	
	Original file name	If the original file name to copy from the main board is omitted, apply the same file name as the target file name.	
Example	SAVEF V1%,USB,"L203/2500.JOB","0001.JOB" (Copy the 0001.JOB file of main board to /Resident Flash/prj/L203/2500.JOB of T/P)		

Reference

- When using the original location as EXT, LOADF/SAVEF service must be running on the external PC.

10.4.1.17. AXISCTRL

Explanation	Set whether to move the additional axis to its targeted position when the position of each axis is moving due to the execution of the MOVE statement.		
Grammar	AXISCTRL <ON/OFF>, <Additional axis>, [<Additional axis>], [<Additional axis>], [<Additional axis>]		
Parameter	ON/OFF	ON : Enable, OFF : Disable	
	Additional axis	Totally up to 4 additional axes can be selected.	
Example	AXISCTRL OFF,T1,T2 : Select the enable state for the axis control of T1 andT2 MOVE P,S=80%,A=1,T=1 : Move except for the T1 and T2 axes AXISCTRL ON,T1 : Select the enable state for the axial control T1 MOVE P,S=60%,A=1,T=1 : Move, with the axis T1 included		

Reference

- Does not provide the axis control function for the axis of the robot.
- The relevant step does not perform the cornering due to being processes as discontinuous statement.

10.4.1.18. ServoFree

Explanation	Control the robot by reflecting the positional increment calculated through the force control in the controller.	
Grammar	ServoFree <ON/OFF>,CRD=<Base coordinate system>,[<User coordinate system number>],DIR=<Push direction>,GAIN=<Gain>,F=<Threshold>	
Parameter	ON/OFF	ON : Enable, OFF : Disable
	Base coordinate system	Arithmetic formula. Base coordinate system for the robot's being pushed. (0=Base,1=Robot,2=Too,3=U, 4=Un).
	User coordinate system number	Arithmetic formula. The user coordinate system when the base coordinate system is U and Un.
	Direction	The direction of the robot being pushed in the base coordinate system(+X,-X,+Y,-Y,+Z,-Z).
	Gain	Gain. 1~100
	Threshold	The threshold value required for the robot to be pushed.
Example	ServoFree ON,CRD=1,DIR=+Z,GAIN=1,F=1 'ServoFree function activating MOVE P,S=60%,A=1,T=1 'Robot moves by reflecting the positional increment due to the external force. ServoFree OFF 'ServoFree function ending	

Reference

- To be activated only in the ServoFree ON ~ OFF range.
- Support is available only for one direction in which the robot is pushed.
- When the threshold gets higher, larger external force needs to be applied to push the robot.

10.4.1.19. OnLTrack

Explanation	Controls the robot by reflecting the positional increment when it is entered through the Ethernet by UDP/IP	
Grammar	OnLTrack <ON/OFF>,IP=<IP address>,PORT=<Port number>,CRD=<Base coordinate system>,[<User coordinate system number>],[Bypass],[Fn=<Frequency>]	
Parameter	ON/OFF	ON : Enable, OFF : Disable
	IP address	IP address of a PC for the Ethernet communication.
	Port number	Port number for the Ethernet communication.
	Base coordinate system	Arithmetic formula. The user coordinate system when the base coordinate system is U and Un (0=Base,1=Robot, 2=Tool,3=U,4=Un).
	User coordinate system number	Arithmetic formula. The user coordinate system when the base coordinate system is U and Un
	Bypass	Whether to go through the filter (ON=Through, OFF=Not through),
	Frequency	Frequency to be applied when not going through the filter (Bypass ON).
Example	OnLTrack ON,IP=192.168.1.254,PORT=7127,CRD=1,Bypass,Fn=10 'OnLTrack function activating MOVE P,S=60%,A=1,T=1 'Moves the robot by reflecting the positional increment when it is entered through the Ethernet by UDP/IP OnLTrack OFF 'OnLTrack function ending	

Reference

- To be activated only in the OnLTrack ON ~ OFF range.
- Frequency will be meaningful only when the bypass function is on.

10.4.1.20. ForceCtrl

Explanation	Controls the robot by reflecting the positional increment of analogue input by the arc board.		
Grammar	ForceCtrl <ON/OFF>,Fn=<Frequency>		
Parameter	ON/OFF	ON : Enable, OFF : Disable	
	Frequency	Frequency	5 ~ 30 Hz
Example	ForceCtrl ON,Fn=10 'ForceCtrl function activating MOVE P,S=60%,A=1,T=1 'Moves the robot by reflecting the positional increment by the arc board ForceCtrl OFF 'ForceCtrl function ending		

Reference

- To be activated only in the ForceCtrl ON ~ OFF range.

10.4.1.21. LIMIT

<table>
<tr><td>Explanation</td><td colspan="2">Statement that selects the maximum distance or speed for each movement when controlling the robot by reflecting the positional increment by the ServoFree or OnLTrack function.</td></tr>
<tr><td>Grammar</td><td colspan="2">LIMIT POS,[+X=<+X distance>],[-X=<-X distance>],[+Y=<+Y distance>],
[-Y=<-Y distance>],[+Z=<+Z distance>],[-Z=<-Z distance>]
LIMIT VEL,[X=<X speed>],[Y=<Y speed>],[Z=<Z speed>],
[RX=<RX speed>],[RY=<RY speed>],[RZ=<RZ speed>]</td></tr>
<tr><td rowspan="3">Parameter</td><td>POS/VEL</td><td>Restriction item. POS : Distance, VEL : Speed</td></tr>
<tr><td>Distance limit</td><td>Arithmetic formula. The maximum distance for each movement when controlling the robot by reflecting the positional increment</td></tr>
<tr><td>Speed limit</td><td>Arithmetic formula. The maximum speed for each movement when controlling the robot by reflecting the positional increment</td></tr>
<tr><td>Example</td><td colspan="2">ServoFree ON,CRD=1,DIR=+Z,GAIN=1,F=1 'ServoFree function activating
LIMIT POS,+Z=300 'The maximum distance for one movement in the +Z direction by ServoFree is restricted to 300mm
LIMIT VEL,Z=50 'The maximum speed for one movement in the Z direction by ServoFree is restricted to 50mm/s
MOVE P,S=60%,A=1,T=1 'Moves the robot by reflecting the positional increment due to the external force.
ServoFree OFF 'ServoFree function ending</td></tr>
</table>

Reference

- Needs to be used appropriately as necessary because this is to be commonly used for ServoFree and OnLTrack.

10.4.1.22. SPDTRK

Explanation	Statement that changes the moving speed of the robot according to the ratio of the reference value against the input value in real time.		
Grammar	SPDTRK [ST=<ON/OFF>],[Input variable],[REF=<Reference value>],		
Parameter	ON/OFF	SPDTRK function On/Off setting	0:OFF, 1:ON
	Input variable	Input variable to change the moving speed of the robot.	
	Reference value	Input of the reference value equivalent to 100% of the robot's moving speed. Maximum moving speed ratio: 500%	0.0001 ~ 10000
Example	SPDTRK ST=1,AI3,REF=10.0 'SPDTRK function On, analogue input #3 value-induced moving speed Ratio change. When 10.0V is inputted, movement occurs in the MOVE statement record speed (100%) MOVE L,S=10mm/s,A=1,T=0 'Robot's moving speed changes due to the analogue input value ration SPDTRK ST=0,AI3,REF=10 'SPDTRK function Off		

Reference

- As the input values, the analogue input signals and general input signals can be used.

10.4.2. FLOW control

10.4.2.1. GOTO

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	

10.4.2.2. GOSUB ~ RETURN

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	

10.4.2.3. JMPP

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	

10.4.2.4. CALL

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!)	

10.4.2.5. ON~GOTO

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	

10.4.2.6. DELAY

Explanation	Delay as assigned.		
Grammar	DELAY <time>		
Parameter	Time	Arithmetic formula. Waiting time	Unit : sec (0.1~60.0)
Example	DELAY 0.5		

10.4.2.7. STOP

Explanation	Program is stopped. When restarted, the program is executed from the next row.
Grammar	STOP

Example	IF DI9 THEN
	STOP
	ENDIF

10.4.2.8. END

Explanation	Program is stopped. When restarted, the program is executed from the beginning.
Grammar	END
Grammar	MOVE P,S=50%,A=0,T=0 MOVE P,S=50%,A=0,T=0 END

10.4.2.9. IF~ELSEIF~ELSE~ENDIF

Explanation	Program is branched according to condition. Or, blocs after this statement are executed or not executed.		
Grammar	Simple sentence IF	IF <condi.> THEN <addr.> [ELSE <addr.>] IF <condi.> THEN CALL <program No.> IF <condi.> THEN JMPP <program No.> IF <condi.> THEN GOSUB <addr.>	

	Compound sentence IF	IF <condi.> THEN
		~
		[ELSEIF <condi.> THEN
		~]
		[ELSE
		~]
		ENDIF	

Parameter	Condition	Arithmetic formula, string condition formula	If 0, true. If not, false.
	Address	THEN: If the condition is true, the address is branched. ELSE: If the condition is false, the address is branched.	
Example	Example of simple sentence IF	IF V2!>SQR(V50!^2+V51!^2) THEN 150 ELSE *AGAIN	

	Example of compound sentence IF	IF GI1>=10 THEN
		PRINT #0, "HIGH"
		PRINT #1, "HR-MSG: HIGH"
		ELSEIF GI1>=0 THEN
		PRINT #0, "LOW"
		ELSE
		GOTO *ERR
		ENDIF	

10.4.2.10. FOR~NEXT

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. When there is no interval or is positive, it is repeated only when the variable value is smaller than the end value. When the internal is negative, it is repeated only when the variable value is equal to or higher than the end value.
	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**

- If the command exits from or to the command block of GOSUB~RETURN, IF~ENDIF and FOR~NEXT command for Hi4 and Hi4a controller, the task execution can malfunction or cause『E1245 Block stack exceeded』error.

- Hi5 controller does not have this restriction. But, if you execute the CALL command too many times without an END command, or if you have too many GOSUB without any RETURN, you must be careful because it can cause a『E1245 Block stack exceeded』error.

10.4.2.11. SELECT~CASE~END_SELECT

<table>
<tr><td>Explanation</td><td colspan="3">Evaluate the <Condition formula> value, and branch into the CASE statement that satisfies one condition of <Item>.
If there is no CASE statement that satisfies <Item>, branch into the CASE ELSE statement.
When meeting the next CASE statement, branch into the END_SELECT statement.
When the EXIT SELECT statement is executed, immediately branch into the END_SELECT statement.</td></tr>
<tr><td>Grammar</td><td colspan="3">SELECT <Condition formula>
   CASE <Item>[,<Item>…]
      :
   [CASE ELSE]
END_SELECT</td></tr>
<tr><td rowspan="3">Parameter</td><td>Condition formula</td><td>Arithmetic formula, string formula.</td><td></td></tr>
<tr><td>Item</td><td>[<Comparison operator>]<Condition formula>
<Condition formula> TO <Condition formula></td><td>The comparison operator or TO can be used only in the arithmetic formula</td></tr>
<tr><td>Comparison operator</td><td><, >, <=, >=, <></td><td>If failing to consider, take it as =</td></tr>
<tr><td rowspan="2">Example</td><td>Arithmetic comparison example</td><td colspan="2">SELECT V3%*2
    CASE 1,2,3,<0,<>-9
        V4%=400
        IF V3%=50 THEN
            EXIT SELECT
        ENDIF
        V5%=500
    CASE 4 TO 6, 7, 8, 9
        V4%=800
    CASE 10
        STOP
    CASE ELSE
        GOTO _ERR
END_SELECT</td></tr>
<tr><td>String comparison example</td><td colspan="2">SELECT V5$
    CASE "ROBOT","HUMAN"
        V4%=400
    CASE "DOG"
        V4%=800
    CASE ELSE
        GOTO _ERR
END_SELECT</td></tr>
</table>

10.4.2.12. EXIT

<table>
<tr><td>Explanation</td><td colspan="2">If it is to be used within the FOR ~ NEXT block, stop the FOR repetition and branch into the next statement of NEXT

If it is to be used within the SELECT ~ CASE ~ END_SELECT block, stop processing the SELECT statement and branch into the next statement of END_SELECT.</td></tr>
<tr><td>Grammar</td><td colspan="2">EXIT <Kinds of statements></td></tr>
<tr><td>Parameter</td><td>Kinds of statement</td><td>FOR : Stop the FOR statement repetition
SELECT : Stop the SELECT statement branching</td></tr>
<tr><td>Example</td><td colspan="2">FOR V1%=1 TO 50
V20%=V20%-V25%
IF V20%<=0 THEN
EXIT FOR 'Stop processing the FOR statement block and branch into the next step of NEXT
ENDIF
NEXT
MOVE P,S=50%,A=0,T=0</td></tr>
</table>

10.4.3. Others

When the [Command input] key is pressed on the initial screen in the manual mode, items appears on the F menu. When 『[F3]: Other』key is pressed among the items, the following statements are included. Arithmetic formula can be used as all factor values.

10.4.3.1. Note

Explanation	Note is inserted to explain program motions, and does not affect execution. This is a statement which has the same function ‘REM (Remark) statement’.	
Grammar	’ <comment> REM <comment>	
Parameter	Explanation	String for explanation. Up to 254 simplified characters are allowed.
Example	'Variables Setting ------------ REM SPOT WELDING #1 ’ Call program No.25!!	

10.4.3.2. CALLPR

There are repeated motions in several places in the working space, when one robot handles two and more workpieces 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.

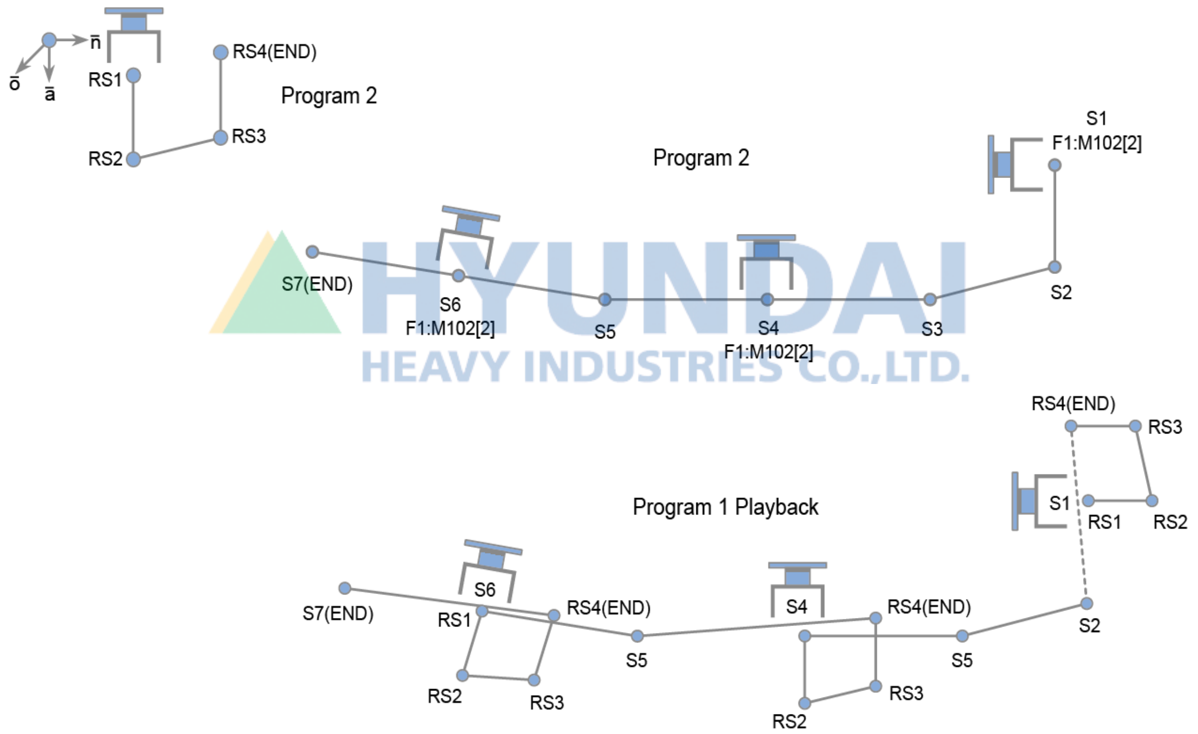


Figure 10.3 Relative program call

Explanation	Relative program call (unconditional)		
Grammar	CALLPR <program number>		
Parameter	Program number	Program number to be called	1~9999
Example	CALLPR 2		
Note	When the called relative program execution is completed, the next function or step of the original program is executed.		

10.4.3.3. MKUCRD

This function creates a user coordinates system based on three poses.

Explanation	This is the function to generate the user coordinate with 3 (or 1) 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 MKUCRD 1,P1 (When you designate only 1 pose, the coordinate is designated in the location/direction of the pose)		

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.

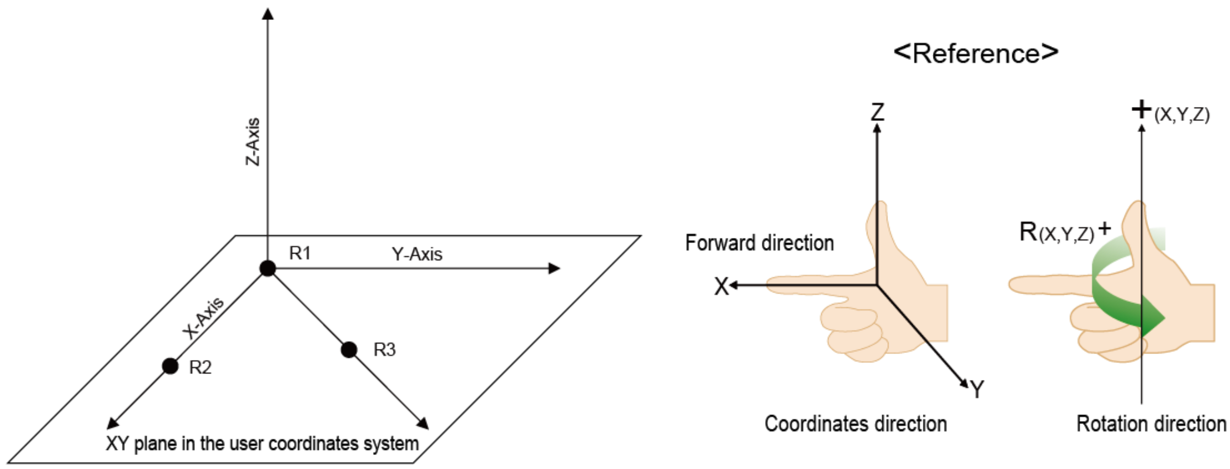


Figure 10.4 User coordinates system

Warning

- 『E1010 Number of teaching step is insufficient』
  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 Recorded dots are too close』
  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 dots exist on a straight line』
  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.

- 『Check coordinate system / Jog status [Any]』
  When a user coordinates system is selected (『[F7]: Condition setting』 → 『9: 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.

10.4.3.4. SELCRD

This is the function to change the user coordinate system number that is designated in the user coordinate system of the condition setting.

Explanation	User coordinates system selection of condition setup		
Grammar	SELCRD < coordinate system number >		
Parameter	coordinate system number	Robot coordinate system, User coordinates system to be selected	0, 1~10
Example	SELUCRD 1 SELUCRD DI1+DI2*2+DI3*4		

Reference

- Function is in 『[F7]: Condition setting』 → 『9: Select user coordinate』.

Warning

- 『E1336 Unregistered user coordinate system.』
  You must register the coordinate system to use. After creating the program to register the coordinate system, register the coordinate system through 『[F2]: System』 → 『2: Control parameter』 → 『7: Coordinate registration』.

10.4.3.5. SEA

The search function is for detecting the difference of workpiece 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		
Grammar	SEA ST=<On/Off>, CRD=<Reference coordinate>[,<User coordinate number>] ,R=<register number>		
Parameter	On/Off	If 1, on. If 0, off.	0~1
	Reference coordinate	0=Base, 1=Robot, 2=Tool, 3=User, 4=User n	0~4
	User coordinate number	User coordinate number when reference coordinate is used	0,1~10
	Register number	Number to be used for online shift	1~8
Example	SEA ST=1,RF=0,R=1		

(1) Assign search range. (From 『[F7]: Condition setting』 menu 『[F1]: App. cnd』 → 『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.' From 『[F7]: Condition setting』 menu 『[F1]: App. cnd』 → 『1: Search reference pose record』)

(4) Operate the program in the 1Cycle Mode to retrieve the standard position of workpiece through robot interrupt.

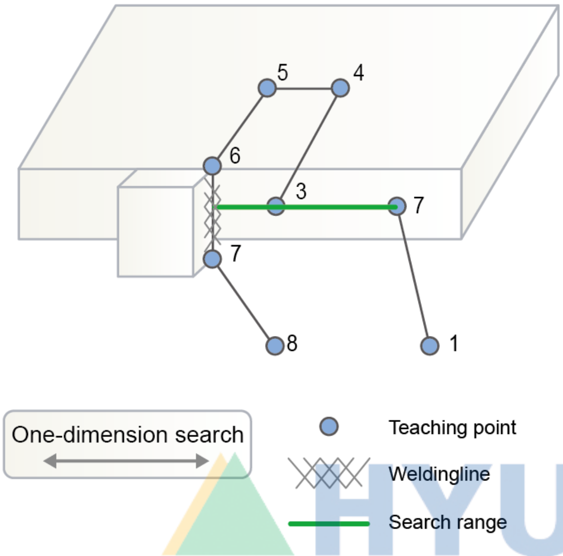
(5) Set search standard position data record 'OFF.' From 『[F7]: Condition setting』 menu 『[F1]: App. cnd』 → 『1: Search reference pose record』)

(6) Operate the program ordinarily.

Reference

- Application of the search function

① One-dimension search




```
S1    MOVE P,S=30%,A=2,T=0
S2    MOVE L,S=20%,A=0,T=0
      SEA ST=1,CRD=0,R=1
      RINT =1,RC=0,X=0,Y=0,Z=0
S3    MOVE L,S=10%,A=0,T=0
      SEA ST=0,CRD=0,R=1
      SONL ST=1,CRD=0,R=1,S1
S4    MOVE L,S=30%,A=2,T=0
S5    MOVE L,S=30%,A=2,T=0
S6    MOVE L,S=10%,A=0,T=0
S7    MOVE L,S=10%,A=0,T=0
      SONL ST=0,CRD=0,R=1,S1
S8    MOVE L,S=30%,A=2,T=0
      END
```


Figure 10.5 One-dimension Search

Figure 10.5 shows the error is corrected by one-dimension search when workpieces 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.

② Two-dimension search

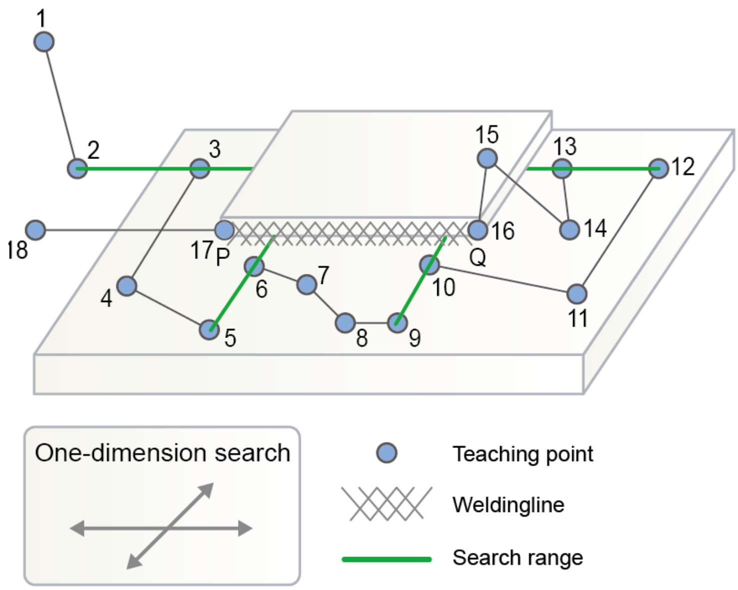


Figure 10.6 Two-dimension search

S1 MOVE P,S=20%,A=2,T=0 S2 MOVE L,S=20%,A=0,T=0 SEA ST=1,CRD=0,R=1 RINT I=1,RC=0,X=0,Y=0,Z=0 S3 MOVE L,S=20%,A=0,T=0 S4 MOVE L,S=20%,A=0,T=0 S5 MOVE L,S=20%,A=0,T=0 RINT I=1,RC=0,X=0,Y=0,Z=0 S6 MOVE L,S=20%,A=0,T=0 S7 MOVE L,S=20%,A=0,T=0 SEA ST=0,CRD=0,R=1 S8 MOVE L,S=20%,A=0,T=0 S9 MOVE L,S=20%,A=0,T=0 SEA ST=1,CRD=0,R=2 RINT I=1,RC=0,X=0,Y=0,Z=0 S10 MOVE L,S=20%,A=0,T=0	S11 MOVE L,S=20%,A=0,T=0 S12 MOVE L,S=20%,A=0,T=0 RINT I=1,RC=0,X=0,Y=0,Z=0 S13 MOVE L,S=20%,A=0,T=0 S14 MOVE L,S=20%,A=0,T=0 S15 MOVE L,S=20%,A=0,T=0 SEA ST=0,CRD=0,R=2 SONL ST=1,CRD=0,R=2,S1 S16 MOVE L,S=20%,A=0,T=0 SONL ST=0,CRD=0,R=2,S1 SONL ST=1,CRD=0,R=1,S1 S17 MOVE L,S=20%,A=0,T=0 SONL ST=0,CRD=0,R=1,S1 S18 MOVE L,S=20%,A=0,T=0 END

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.

10.4.3.6. SONL

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.

<table>
<tr><td>Explanation</td><td colspan="3">Online shift</td></tr>
<tr><td>Grammar</td><td colspan="3">SONL ST=<st./end>,CRD=<ref.>[,<User coordinate number>], R=<register number>, <Exit address></td></tr>
<tr><td rowspan="5">Parameter</td><td>st./end</td><td>If 1, shift application starts. If 0, it ends, and the rest factors are ignored.</td><td>0~1</td></tr>
<tr><td>Reference coordinate</td><td>0=Base, 1=Robot, 2=Tool, 3=User, 4=User n</td><td>0~4</td></tr>
<tr><td>User coordinate number</td><td>User coordinate number when reference coordinate is used</td><td>0,1~10</td></tr>
<tr><td>register number</td><td>Register in which transmitted shift amount is inputted.</td><td>1~8</td></tr>
<tr><td>Exit address</td><td>Address to exit to when shift is not entered within the given time</td><td>Row number
Step number
Label</td></tr>
<tr><td>Example</td><td colspan="3">SONL ST=1,CRD=1,R=1,S99</td></tr>
</table>

Reference

- Related function

  ① Shift request amount function (SREQ)
  ② Timer conditional shift amount request function (SREQT)

10.4.3.7. SREQ

This function requests the shift amount measured from the external device and saves the shift data to the online shift register after receiving the data.

Explanation	Shift amount request		
Grammar	SREQ R=< register num.>,PT=<Port num.> [,<Standby time>,<Exit address>]		
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
	Standby time	Standby time until the shift is received	0.0~60.0 (sec)
	Exit address	Address to exit when the standby time is exceeded	
Example	SREQ R=1,PT=1 SREQ R=1,PT=1,3,999		

Reference

- The received shift amount is saved as the data in online shift register number designated in 『[F1]: Service』 → 『2: Register』 → 『3: Online shift register』.

- 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.

10.4.3.8. SXYZ

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.

Explanation	XYZ shift		
Grammar	SXYZ CRD=<reference>[,<User coordinate number>],X=<X shift amount>,Y=<Y shift amount>,Z=<Z shift amount>		
Parameter	Reference coordinate	0=Base, 1=Robot, 2=Tool, 3=User, 4=User n	0~4
	User coordinate number	User coordinate number when reference coordinate is used	0,1~10
	Shift amount	Shift amount for three-dimension parallel shift	-3000.0~3000.0
Example	SXYZ CRD=0,X=10.50,Y=20.50,Z=0.00		

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.

10.4.3.9. TONL

If the new locations of the 3 reference steps are measured with the external detection device (RS232C port) such as visual device as shown in Fig. 10.7, and each shift is transmitted to the robot controller, the robot controller will use the 3 reference points and 3 shifted points to calculate the absolute location or shift. This is the function to execute and play the location calibration for the steps between TONL start and end.

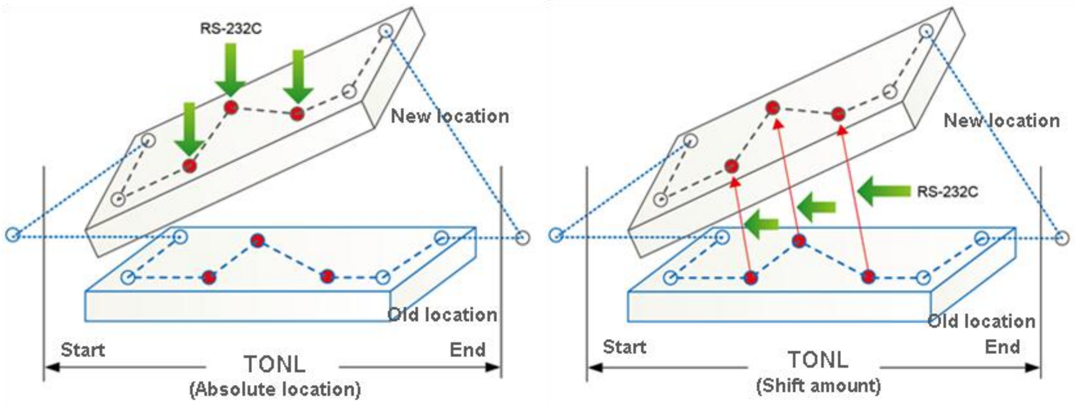


Figure 10.7 Online coordinates conversion

Explanation	Online coordinates conversion (shift amount)		
Grammar	TONL SFT=<Receipt format>, ST=<start/end>, <ref.step num.1>, <ref.step num.2>, <ref.step num.3>		
Parameter	Receipt format	Data receipt format. 0=Absolute coordinate, 1=Shift	0~1
	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	TONL SFT=0,ST=1,S1,S5,S7		
Note	To execute this function, SREQ statement is required before TONL statement. This function receives the new locations of the 3 reference steps in 3 absolute location or shifts to calculate the shifts.		

10.4.3.10. RINT

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)		
Grammar	RINT I=<DI signal>,RC=< ref. complete >,[X=< ref.X >,Y=< ref.Y >, Z=< ref.Z >]		
Parameter	Number of DI signal	Number of DI signal to receive interrupt signal	1~4096
	ref. complete	If 0, general robot interrupts 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=8, rc=0, X=0, Y=0, Z=0 ← X, Y, Z be ignored RINT I=8, rc=1, X=1000, Y=2000, Z=3000		

10.4.3.11. RINTA

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.

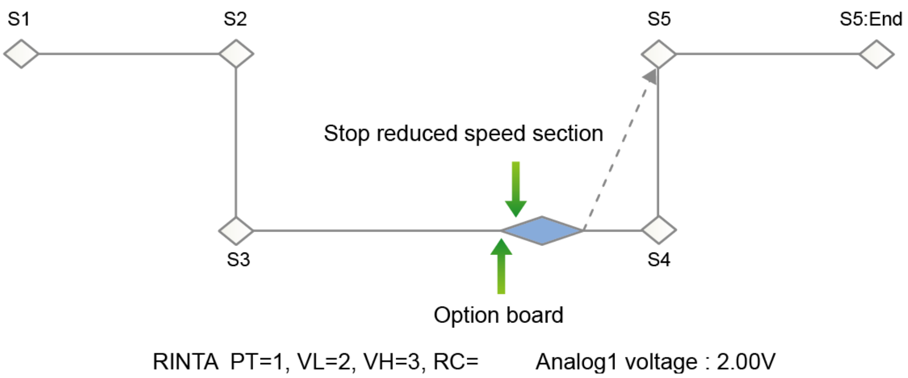


Figure 10.8 Robot interrupt (Analog signal)

Explanation	Robot interrupt (Analog signal)		
Grammar	RINTA PT=<port number>,VL=< voltage low limit >,VH=< voltage high limit >,RC=< reference complete >,[X=< ref.X >,Y=< ref.Y >,Z=< ref.Z >]		
Parameter	Port number	Analog port which will receive interrupt signal	1~32
	voltage low limit	If analog value is between lowest voltage and highest voltage, interrupt occurs.	-10.0~10.0
	voltage high limit		
	reference complete	0 is general robot interrupt and 1 is the search function. Refer to the SEA (Search) function.	0, 1
	ref. X, Y, Z	These are used for the search function. If RC = 0 is ignored.	-3000.0~3000.0
Example	RINTA PT=1, VL=2, VH=9, RC=0, X=0, Y=0, Z=0 ← X, Y, Z be ignored RINTA PT=1, VL=2, VH=9, RC=1, X=1000, Y=2000, Z=3000		

10.4.3.12. CLR232C

Explanation	RS232C buffer initialization		
Grammar	CLR232C <port number>		
Parameter	Port number	Serial (RS232C) port number	1~2
Example	CLR232C 1		

10.4.3.13. INTDEF

When the interrupt function is used, this function defines new interrupt state or deletes previously defined interrupt. Refer to the『Hi5 Controller Interrupt Function Manual』 for details.

Explanation	This function defines new interrupt or deletes defined interrupt.		
Grammar	INTDEF <Define/Dele>, NO=<Interrupt number>, <Interrupt condition>, PN= <call program>, [1times Permitted]		
Parameter	Define/Dele	Interrupt is newly defined or defined interrupt is deleted. When interrupted is deleted, third and the rest of parameters are ignored.	ON/OFF
	Interrupt number	Interrupt to be defined or deleted	1~2
	Interrupt 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 ~9999
	1times Permitted	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,PN=991,SINGLE INTDEF OFF,NO=1		

10.4.3.14. COPYM2R

This command replaces the shift variable R with the MW variable for embedded PLC sequentially. This command reduces the execution time when many MW, R variables are repeatedly replaced.

Explanation	This is the function of replacing the X, Y, Z, Rx, Ry, Rz and cfg item of R variable with the values in MW variable.		
Grammar	COPYM2R SM=<MW start number>,SR=<R variable start number>,Rcnt=<Number of R variable to copy>,MWInt=<Number to variables to jump between the 7 MWs>		
Parameter	MW start number	Enter the number of MW variable to start copying.	1~1000
	R variable start number	Enter the number of R variable to start copying.	9~100
	Number of R variable to copy	Enter the number of R variable to copy. 7 MW variable values are entered to one R variable.	1~92
	Number to variables to jump between the 7 MWs	Enter the number of variables to jump after copying 7 MW variables and before copying 7 variables. That is, if the value is 3, it copies to 1~7 and then to 11~17.	0~15
Example	COPYM2R SM=1,SR=9,Rcnt=1,MWInt=0		

Reference

- Enter the X, Y and Z item of R variable with MW/10 value, and Rx, Ry and Rz item with MW/100. But for cfg, replace the value as is.

10.4.3.15. COPYR2M

This command replaces the saved value of each item of shift variable R to the MW variable for embedded PLC sequentially. This command reduces the execution time when many MW, R variables are repeatedly replaced.

Explanation	This is the function of replacing the MW variable with the values entered in X, Y, Z, Rx, Ry, Rz and cfg item of R variable.		
Grammar	COPYR2M SR=<R variable start number>,SM=<MW start number>,Rcnt=<Number of R variables to copy>,MWInt=<Number to variables to jump between the 7 MWs>		
Parameter	R variable start number	Enter the number of R variable to start copying.	9~100
	MW start number	Enter the number of variable to start copying MW.	1~1000
	Number of R variables to copy	Enter the number of R variables to copy. 7 MW variable values are entered to one R variable.	1~92
	Number to variables to jump between the 7 MWs	Enter the number of variables to jump after copying 7 MW variables and before copying 7 variables. That is, if the value is 3, it copies to 1~7 and then to 11~17.	0~15
Example	COPYR2M SR=9,SM=1,Rcnt=1,MWInt=0		

Reference

- Among the values entered to MW variable, 10 times the X, Y and Z item of R variable is entered and 100 times the Rx, Ry and Rz item. But, cfg value is replaced as is.

10.4.3.16. GATHER

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 <Start/End>		
Parameter	Start/End	If 1, start. If 0, end.	0~1
Example	GATHER 1		

10.4.3.17. CalViaPs

This saves the pose value to the pose variable considering the location and position in arbitrarily number of times by dividing the distance between the start location and target location evenly.

Explanation	CalViaPs (Calculate Via Points) passing point calculation command	
Grammar	CalViaPs <Start pose>,<End pose>,<DivNo=Number of divisions>, <CntNo=Counter>,<Output pose>	
Parameter	Start pose	Start location
	End pose	Target location
	Number of divisions	It can be divided between 1 and 30000 The number of division cannot be 0.
	Counter	It can be entered between 0 and 30000 Start pose is 0.
	Output pose	Save the calculated pose. The config value of created pose variable is undesignated and the additional axis is considered.
Example	V10%=100 FOR V2%=1 TO 10 CalViaPs P1,P2,DivNo=10,CntNo=V2%,P[V10%] MOVE P,P[V10%],S=300mm/sec,A=0.T=0 V10%=V10%+1 NEXT END	

Figure 10.9 P3 work location

For example, for CalViaPs P1,P2,DivNo=3,CntNo=2,P3,
Divide the distance from P1 start location to P2 target location evenly in 3 divisions and save the pose value considering the location and position of designated 2nd pose to the P3 pose variable.

10.4.3.18. CalCrViaPs

This saves the pose value to the pose variable considering the location and position in an arbitrary number of times by evenly dividing the circular distance consisting of the start location, passing point and target location.

Explanation	Statement to calculate the passing points evenly divided on a circular line consisting of the 3 input points.		
Grammar	CalViaPs <Start pose>,<Passing pose>,<End pose>,<DivNo= Number of divisions >,<CntNo=Counter>,<Output pose>		
Parameter	Start pose	Start location	
	Passing pose	Passing location	
	End pose	Target location	
	Number of divisions	It can be divided between 1 and 30000. The number of divisions cannot be 0.	
	Counter	It can be divided between 0 and 30000. Start pose is 0	
	Output pose	Save the calculated pose. The config value of created pose variable is undesignated and the additional axis is considered.	
Example	V10%=100 FOR V2%=1 TO 10 CalCrViaPs P1,P2,P3,DivNo=10,CntNo=V2%,P[V10%] MOVE P,P[V10%],S=300mm/sec,A=0.T=0 V10%=V10%+1 NEXT END		

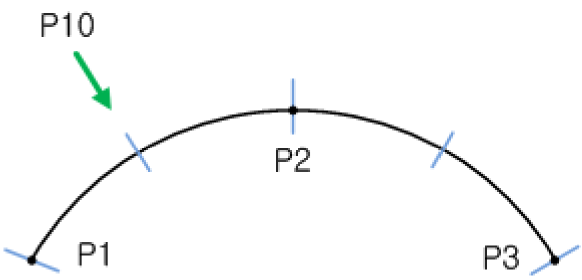


Figure 10.10 P10 work location

For example, CalViaPs P1,P2,P3,DivNo=4,CntNo=2,P10,
Divide the circular distance, which consists of P1 start pose, P2 passing pose, and P3 target pose, evenly in 4 divisions and save the pose value, which considers the location and position of the designated 2nd pose, to the P10 pose variable.

10.4.3.19. StoPoCnd

This is the axis data save function command. This function is to save the location of the designated axis to the _StoPoDt[] system parameter when the input signal is entered, and to read the save value through the HRBASIC command.

<table>
<tr><td>Explanation</td><td colspan="3">StoPoCnd (Store Pose Condition) : Command to save the axis data
_StoPoDt[] : System parameter to retrieve the saved location (Read/Write)</td></tr>
<tr><td>Grammar</td><td colspan="3">StoPoCnd StoNr=<System parameter number>, DI=<Input signal number>, Axis=<Axis number></td></tr>
<tr><td rowspan="3">Parameter</td><td>System parameter number</td><td>Set the system parameter number to store the axis data</td><td>1~10</td></tr>
<tr><td>Input signal number</td><td>Positive logic: When the input signal number goes up, the axis location designated by the axis number is saved to the parameter.
Negative logic: When the input signal number goes down, the axis location designated by the axis number is saved to the parameter.</td><td>1~255</td></tr>
<tr><td>Axis number</td><td>The axis number to store the axis data
When the axis designated by Axis is a rotational axis, the angle value is to be saved, while the length value will be saved in case of linear axis.</td><td>1~16</td></tr>
<tr><td>Example</td><td colspan="3">StoPoCnd StoNr=1,DI=11,Axis=V1%
(At the moment when DI11 이 is entered, the location of the 5ths axis is saved to _StoPoDt1[V1%])

V1!=_StoPoDt2
Retrieve the value saved in the 2nd number of V1! (Real number parameter).

V1!=_StoPoDt[V1%]
Can designate the location, to be retrieved, as V1%.

_StoPoDt2=100.0
Set the value saved in the 2nd number as 100.0.

_StoPoDt2=0
Set the value saved in the 2nd number as 0.

IF _StoPoDt2<50 OR _StoPoDt2>60 THEN 10
If the value saved in the 2nd number exceeds the 50~60 range, jumping to the row number 10 will be executed</td></tr>
</table>

10.4.3.20. TaskStart

Explanation	Creates the sub-task, and starts the program designated to the created subtask.		
Grammar	TaskStart SUB=<Subtask>,JOB=<Program>		
Parameter	Subtask	Designate the subtask to be created	1~3
	Program	Program to be started in the created subtask	1~9999
Example	TaskStart SUB=1,JOB=10 'Start the program 10 using the subtask 1		

Reference

- If a program is in the middle of being started by a previously created subtask, this statement will be disregarded.

10.4.3.21. TaskWait

Explanation	Waits for the relevant subtask to be destroyed and a subtask will be automatically destroyed when the program end is executed.		
Grammar	TaskWait SUB=<Subtaks>		
Parameter	Subtask	Designate the subtask to be destroyed	1~3
Example	TaskWait SUB=1 'Waits for the subtask 1 to be destroyed		

Reference

- Generally, this is to be used together with the TaskStart statement.

10.4.3.22. TaskSync

Explanation	- Synchronization wait between tasks Wait for the TaskSynck statements with an identical ID to be executed in the same number as designated. In other words, this can be used conveniently when synchronizing between tasks.		
Grammar	TaskSync ID=<Identifier>,NO=<Number of tasks>		
Parameter	Identifier	Designate the identifier	1 ~ 32
	Number of tasks	Designate the number in which a same identifier is executed	2 ~ 4
Example	TaskSync ID=1,NO=2 'Wait for the ID=1 TaskSync statement to be executed 2 times.		

Reference

- Using this requires your attention as it is identical to the mutual interlock

10.4.3.23. CalXPoint

Explanation	This function is to acquire a point where one linear line consisting of 2 points meets with another point in the shortest distance.	
Grammar	CalXPoint <Linear line reference pose 1>,< Linear line reference pose 2>,<Location reference pose>,<Result pose>	
Parameter	linear line reference pose 1	First reference pose to calculate the linear line
	linear line reference pose 2	Second reference pose to calculate the linear line
	Location reference pose	Reference pose to acquire the location in the shortest distance from the linear line
	Result pose	The pose which is the closest to the location reference pose on the calculated linear line
Example	CalXPoint P1,P2,P3,LP1	'Put into LP1 the cross pose, where the extension line of the linear line, calculated using P1 and P2, cross the liner line which connects to the location reference pose P3 in the shortest distance.

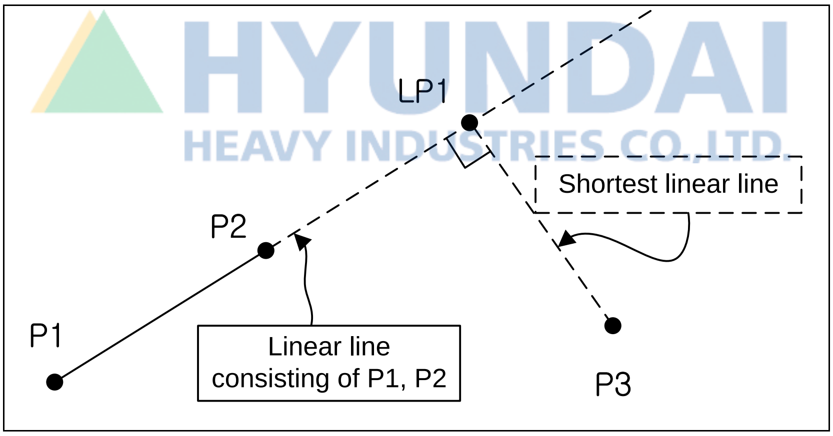


Figure 10.11 CalXPoint usage

Reference

- Useful when used in setting the user coordinate system while used together with the touch sensing function of the arc welding function.

10.4.3.24. CalXLine

Explanation	This function is to acquire the point on the linear line, where one linear line consisting of 2 points meets with another liner line consisting another 2 points in the shortest distance	
Grammar	CalXLine <Linear line reference pose1>,< Linear line reference pose2>,< Linear line reference pose3>,< Linear line reference pose4>, <Result pose>	
Parameter	Linear line reference pose 1	First reference pose to calculate the fist linear line
	Linear line reference pose 2	Second reference pose to calculate the fist linear line
	Linear line reference pose 3	First reference pose to calculate the second linear line
	Linear line reference pose 4	Second reference pose to calculate the second linear line
	Result pose	The cross pose, where the liner line that connects the two lines in the shortest distance cross the first linear line.
Example	CalXLine P1,P2,P3,P4,LP1	'Put into LP1 the cross pose, where the linear line, which connects the linear line that consists of P1 and P2 to the linear line that consists of P3 and P4 in the shortest distance, cross the first linear line.

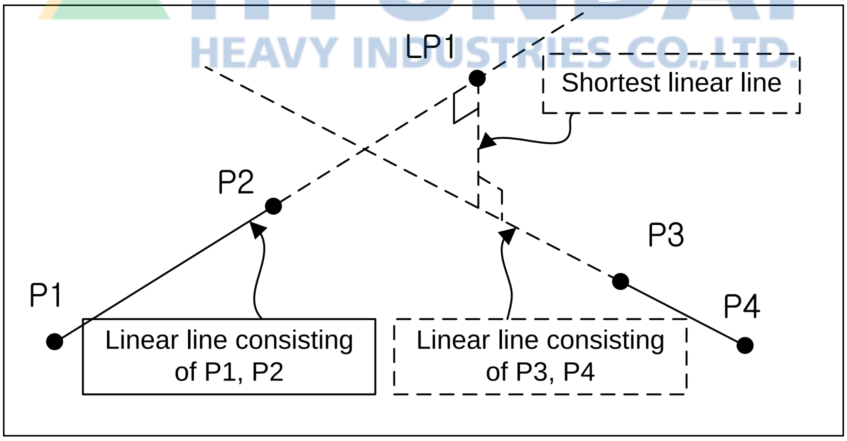


Figure 10.12 CalXLine usage

Reference

- Useful when used in setting the user coordinate system while used together with the touch sensing function of the arc welding function.

10.4.4. Spot welding

10.4.4.1. SPOT

This is a spot welding command that is commonly applicable for the air pressure gun and servo gun. This command is to set the following 3 parameters shown below.

For example, if there is a need to select more than 2 servo guns and operate them or use them for welding simultaneously, you need to select more than 2 guns simultaneously (R214) and, while turning on the GUN LED, record and use their locations, which will allow the record to be recorded as multi synch gun step.

Explanation	Spot welding (SPOT)		
Grammar	SPOT GN=<Gun number>, CN=<Welding condition number>, SQ=<Sequence number>, MG=<Mult gun>, MC=<Multi welding condition>, MS=<Multi welding sequence>		
Parameter	Gun number/Mult gun	Number of gun used in welding / Gun number to execute the welding simultaneously	1~8
	Welding condition number/ Multi welding condition	Welding condition which specifies pressure and welding condition output data	1~64
	Sequence number/ Multi welding sequence	Welding sequence which specifies pressure signal, electric current sending signal, etc.	1~64
Example	SPOT GN=1,CN=1,SQ=10,MG=2 Weld the server gun 1 and 2 to welding condition 1 and sequence 10 simultaneously.		

Reference

- When you select multiple servo guns (Multi-Sync Servogun) by using R214, or change the gun number by using R210, the tool number will be changed automatically. However, even when you change the tool number (R29), the gun number will not be changed automatically.

- The SPOT command must be recorded as the first function of a step. If not, the spot welding function may not be carried out correctly.

- Recording while the GUN LED is on is called one-touch recording function. In this, the SPOT command is to be recorded automatically as the first function, and, in terms of the step location, the location for which the compensation for the abrasion is made will be recorded automatically.

- When you execute the multi-sync spot command (SPOT GN=1,…,MG=2), which will allow multiple spot guns to be executed simultaneously, all the designated guns will be selected. Accordingly, when the manual pressurizing/opening and closing activities are performed in this condition, all the designated multiple guns will be activated.

10.4.4.2. GUNSEA

The GUNSEA statement is used to detect the reference location and abrasion location to measure the abrasion of the electrode of the servo gun. When this function is executed, the servo gun moves from the start location to the location where two tips touch each other. When the pressure designated in the command statement is reached during the movement, the location will be used for calculating the abrasion.

Explanation	Measure servo gun abrasion (GUNSEA)		
Grammar	GUNSEA GN=<Gun number>, SE=<search num.>, PR=<gun pressure>, SP=<Search speed>, MG=<Multi gun number>, MP=<Multi gun pressurization force>		
Parameter	Gun number/ Multi gun number	Servo gun for welding operation / Servo gun number to execute gun search simultaneously	1~8
	Search number	1 : gun search 1 movement, 2 : gun search 2 movement	1~2
	Gun pressure / Multi gun pressurization force	Ordered pressure / Multi gun pressurization force	50~999
	Search speed	Operating speed of the gun axis during search operation	1.0~250.0 (mm/sec)
Example	Ex) When you set the pressurization force to 100, 200 and 300kgf respectively for gun 1, 2 and 3 while executing the gun search. GUNSEA GN=1, SE=1, PR=100, MG=2,3,MP=200,300		

Reference

- For the initial use, the tip without abrasion needs to be mounted and the reference location needs to be recorded. This is called gun search reference location recording.

- For the gun search reference record, the condition setting/application condition/gun search reference location record need to be shifted to the ON state, before executing the GUNSEA command. The location detected then will be used as the reference value for measuring the abrasion.

- When a certain value is set for the moving electrode abrasion/overall abrasion (%) ratio in the servo gun parameter, it is called ‘single gun search 1 environment’. In that condition, only the gun search 1 is to be executed to calculate the abrasion both at the moving and the fixed electrodes. If the gun search is executed in the single gun search 1 environment, an error will occur.

- When 0 is set for the moving electrode abrasion/overall abrasion (%) ratio in the servo gun parameter, it means that in that condition, both the gun search 1 and 2 can be executed. In this case, the gun searches 1 and 2 need to be executed sequentially to calculate the abrasion.

- GUNSEA step must be recorded in the open location of 20mm or more from the abrasion detection target location.

10.4.4.3. IGUNSEA

The IGUNSEA command performs the same function as GUNSEA command. In case of the GUNSEA command, the servo gun's pressure is used to detect the location, while the IGUNSEA command is used when using the external sensor to detect the On or Off signals of this sensor in order to detect the abrasion. However, the gun search 1 command cannot be replaced with the IGUNSEA command. Only in case of the gun search 2, the IGUNSEA command can be used instead.

IGUNSEA GN=gun number, SP=search speed, DI=DI signal, DT=On/Off

Item	Range	Content
GUN number	1~8	Designate servo gun number to measure abrasion
Search speed	1.0~250mm/s	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.
DI signal	1~256	Designate number for accessing input signal for photo electric tube
On/Off	0~1	Detection condition of signal is assigned. 0 = Detection when Low (Normal High) 1 = Detection when High (Normal Low)

Input signal logic of assigned I signal	IGUNSEA I signal On/Off	Output signal of photo electric tube during signal detection
Positive	On (1)	Detected high (Normal Low)
	Off (0)	Detected low (Normal High)
Negative	On (1)	Detected low (Normal High)
	Off (0)	Detected high (Normal Low)

Reference

- When setting I signal On/Off, check 『[F2]: System』 → 『2: Control parameter』 → 『2: Input/output signal setting』 → 『1: Input signal attribute』.
- 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.

10.4.4.4. EGUNSEA

The EGUNSEA statement is the function used to calculate the tip abrasion of the fixed electrode when using the equalizer less air pressure gun.

When this command is executed, the gun will move for the designated search distance until the sensor detects a signal. When the sensor detects a signal at a certain location, the location will be used for calculating the abrasion

EGUNSEA GN=gun number, SP=search speed, SD= Search distance, DI=DI signal, DT=On/Off

Item	Range	Content
GUN number	1~8	Designate the equalizer less gun number to measure the abrasion
Search speed	1.0~250mm/s	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.
Search distance	1.0~1000.0mm	Designate the maximum gun search distance of the fixed electrode
DI signal	1~256	Designate number for accessing input signal for photo electric tube
On/Off	0~1	Detection condition of signal is assigned. 0 = Detection when Low (Normal High) 1 = Detection when High (Normal Low)

Reference

- For the initial use, the tip without abrasion needs to be mounted and the reference location needs to be recorded. This is called gun search reference location recording.
- For the gun search reference record, the condition setting/application condition/gun search reference location record need to be shifted to the ON state, before executing the EGUNSEA command. The location detected then will be used as the reference value for measuring the abrasion.

10.4.4.5. GUNCHNG

The GUNCHNG statement is used for connecting and disconnecting the welding gun when trying to exchange it for the use. When executing GUNCHNG ON, supply the power to the motor and encoder of the gun to connect and execute the preparation for operation. When executing GUNCHNG OFF, disconnect the power to the motor and encoder of the servo gun axis to switch to the condition which can be separated.

<table>
<tr><th colspan="4">GUNCHNG ON/OFF, GN=gun number, DI=connection completion input, WT=connection completion wait time</th></tr>
<tr><td rowspan="2">ON/OFF</td><td>ON</td><td>Connection command of gun</td><td></td></tr>
<tr><td>OFF</td><td>Disconnection command of gun</td><td></td></tr>
<tr><td rowspan="2">Gun number</td><td>0</td><td>Select gun number by external input signal</td><td rowspan="4">Ignored parameter when the GUNCHNG is OFF</td></tr>
<tr><td>1~8</td><td>Select gun number to exchange</td></tr>
<tr><td>Connection completion input</td><td>1~256</td><td>Select input signal number for mechanical connection completion of the servo gun</td></tr>
<tr><td colspan="2">Connection completion wait time
<0~5.0> (sec)</td><td>Wait time until servo gun connection completion signal input until the gun is connected</td></tr>
</table>

Reference

- When you set the connection completion wait time to 0, it waits until the connection completion signal is received.

10.4.5. Arc Welding

10.4.5.1. ARCON

ARCON statement is the command that starts the arc welding.

Explanation	Start arc welding. This can be used in 3 formats.		
Grammar	ARCON ARCON ASF#=<Arc start condition number> ARCON C=<Current output value>, V(VP)=<Voltage output value>, ASF#=<Arc start condition number>		
Parameter	Arc start condition number	Arc welding start and welding condition number used for this condition But, if there is current or voltage output in the previous article, the condition set in the previous article is reflected to the current and voltage of the applicable arc welding start condition.	1~32
	Current output value	Output current for arc welding	0~500
	Voltage output value(V) Voltage output value(VP)	Output voltage value for individually set arc welding Output voltage value for one source set arc welding	0.0~40.0 -20~200
	Stop time	Enter the stop time after the arc ignition until the start.	0.00 ~10.00
	RETRY	Set whether to use the RETRY function when arc welding fails.	RETRY
Example	ARCON ARCON ASF#=1 ARCON C=200,V=22,T=1,RETRY		

Reference

- To use all of the 3 formats of the command statement, you must set the arc welding to analog in 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』.
- When setting the arc welding to digital, you can only use the format of using the condition number.

10.4.5.2. ARCOF

ARCOF statement is the command to end the arc welding.

Explanation	End arc welding. This can be used in 4 formats.		
Grammar	ARCOF ARCOF ASF# ARCOF AEF#=<Arc end condition number> ARCOF C=<Current output value>,V(VP)=<Voltage output value>,AEF#=<Arc welding end condition number>		
Parameter	Arc end condition number	Number of welding condition used when ending arc welding But, if there is current or voltage output in the previous article, the condition set in the previous article is reflected to the current and voltage of the applicable arc welding start condition.	1~32
	Current output value	Output current value when ending arc welding	0~500
	Voltage output value (V) Voltage output value (VP)	Output voltage when ending individually set arc welding. Output voltage when ending one source set arc welding	0.0~40.0 -20~200
	Stop time		0.00~10.00
	Whether to cancel auto deposition	In case of wire stick after ending arc welding, set whether to use the auto deposition cancel function.	ANTSTK
Example	ARCOF ARCOF ASF# ARCOF AEF#=1 ARCOF C=200,V=22,T=1,ANTSTK		

Reference

- When the arc welding is set to digital in 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』 item, command statement of ‘ARCOF ASF#’ format can only be used.
- When setting the arc welding to analog, all 3 formats excluding the above format can be used.

10.4.5.3. WEAVON

WEAVON statement is the command to start the weaving operation.

Explanation	Start weaving operation.		
Grammar	WEAVON WEV#=<Weaving condition number>		
Parameter	Weaving condition number	Condition number to use during weaving operation from weaving condition saved file	1~32
Example	WEAVON WEV#=1		

10.4.5.4. WEAVOF

WEAVOF statement is the command to end the weaving operation.

Explanation	End weaving operation.
Grammar	WEAVOF
Example	WEAVOF

10.4.5.5. REFP

REFP statement is the command to enter the reference point necessary for weaving operation.

Explanation	Enter the reference point.		
Grammar	REFP <Reference point number>,<Pose number> REFP <Reference point number>		
Parameter	Reference point number	Number to set the type of reference point	1~8
	Pose number	Enter the pose of reference point. But, when entered as hidden pose, it is omitted.	
Example	REFP 1,P1 REFP 1		

10.4.5.6. ARCCUR

ARCCUR statement sets the welding current output value to designated value.

Explanation	Set the welding current output value.		
Grammar	ARCCUR C=<Current output value>		
Parameter	Current output value	Set the current output value to use in the arc welding condition.	0~500
Example	ARCCUR C=200		

10.4.5.7. ARCVOL

ARCVOL statement sets the welding voltage output value to the designated value.

Explanation	Set the welding voltage output value.		
Grammar	ARCVOL V(VP)=<Voltage output value>		
Parameter	Voltage output value(V) Voltage output value (VP)	Output voltage when ending individually set arc welding. Output voltage when ending single source set arc welding	0.0~40.0 -20~200
Example	ARCVOL V=20 ARCVOL VP=100		

10.4.5.8. ARCDC

ARCDC statement is the command that sets the voltage value outputted through analog port assigned to welding current.

Explanation	Set the voltage value outputted through analog port assigned for welding current.		
Grammar	ARCDC <Current command value [V]>		
Parameter	Current command value	Set the voltage value outputted through the current output port of analog arc welding.	-14.0~14.0
Example	ARCDC 10		

10.4.5.9. ARCDV

ARCDV statement is the command to set the voltage value outputted through the analog port assigned with welding voltage.

Explanation	Set the voltage value outputted through analog port assigned with welding voltage.		
Grammar	ARCDV <Voltage command value [V]>		
Parameter	Voltage command value	Set the voltage value outputted through voltage output port of analog arc welding.	-14.0 ~14.0
Example	ARCDV 10		

10.4.5.10. LVSON

LVSON statement starts the welding line search or tracking by LVS.

Explanation	Start the welding line search or tracking by LVS.		
Grammar	LVSON LVS#=<LVS condition file number>		
Parameter	LVS condition file number	LVS condition file number to be used for LVS welding line search or tracking	1~32
Example	LVSON LVS#=1		

10.4.5.11. LVSOF

LVSOF statement is the command to end the welding line search or tracking by LVS.

Explanation	Ends the welding line search or tracking by LVS.
Grammar	LVSOF
Example	LVSOF

10.4.5.12. CHGLVS

CHGLVS statement is the command to change the welding line search or tracking setting by LVS.

Explanation	Change the welding line search or tracking setting condition number by LVS.		
Grammar	CHGLVS LVS#=<LVS condition file number>		
Parameter	LVS condition file number	LVS condition file number to be used for LVS welding line search or tracking	1~32
Example	CHGLVS LVS#=2		

10.4.5.13. TRJLOG

TRJLOG statement is the command to save the moving trace of arc sensing.

Explanation	Save the moving trace by arc sensing.		
Grammar	TRJLOG ST=<Start/End>,SC=<Sampling cycle>,LSP=<Record start pose variable>, LCV=<Number of records LV% number for exchange>		
Parameter	Start/End	1 : Start trace record 0 : End trace record	0, 1
	Sampling cycle	0 : Save path step 1~100 : Sampling weaving cycle	0~100
	Record start pose variable	Pose variable number that starts the record	1~999
	Number of records LV% number for exchange	Number of LV% variable to designate/check the number of record. Designate the maximum value to record before executing the command and reduce by -1 for every recording	1~50
Example	TRJLOG ST=1,SC=5,LSP=0,LCV=1		

10.4.5.14. ATDC

ATDC statement is the command to execute auto tool data calibration function.

Explanation	Execute auto tool data calibration function.		
Grammar	ATDC T=<Tool number>,OrgP=<Original pose>,NewP=<Current pose>		
Parameter	Tool number	Tool number to execute auto tool data calibration function	0~15
	Original pose	Pose originally saved	
	Current pose	Deformed current pose	
Example	ATDC T=1,OrgP=P1,NewP=P2		

10.4.5.15. CalTVSft

CalTVSft statement is the command to calculate the shift value that can set the tool from the two pose variables entered.

Explanation	Calculate the shift value to set the tool from the two pose variables entered.	
Grammar	CalTVSft <Pose 1>,<Pose 2>,<Shift variable>	
Parameter	Pose 1	Pose 1 calculated by sensing
	Pose 2	Pose 2 calculated by sensing
	Shift variable	Shift variable to set the tool slope calculated by two pose values
Example	CalTVSft LP1,LP2,LR1	

10.4.5.16. ARCRSV1, ARCRSV2

The ARCRSV1 and ARCRSV2 statements are the commands to generate the analogue instruction output, besides the outputs for the current and voltage, in the analogue arc welding

Explanation	Generate the analogue instruction output in the analogue arc welding.		
Grammar	ARCRSV1 RSV1=<Auxiliary variable 1 output value> ARCRSV2 RSV2=< Auxiliary variable 2 output value >		
Parameter	Auxiliary variable 1	Auxiliary variable for the arc welding. Generates the instruction value, proportionate to the variable, to the auxiliary 1 port assigned in the arc welding output port.	-200 ~ 1000
	Auxiliary variable 2	Pose 2 acquired through sensing Generates the instruction value, proportionate to the variable, to the auxiliary 2 port assigned in the arc welding output port.	-200 ~ 1000
Example	ARCRSV1 RSV1=100 ARCRSV2 RSV2=-50		

Reference

- Only when you select the arc welding as analogue in 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』, and set the 'analogue signal add' as +2 (Auxiliary 1~2) in the 『F1: Welder』 item.
- The variable values and the analogue voltage output table can be set in the 'Auxiliary A01' and 'Auxiliary A02' message box.

10.4.6. Handling

When you press the [Command input] key from the initial screen of the MANUAL mode, and press the 『[F6]: Handling』 key from the item displayed in F menu, the commands included are described as follows. Arithmetic formula can be applied with all parameter values. Handling items include the robot language used in palletizing, handling and conveyer synchronization function.

Robot language	Explanation
PAL	Start palletizing
PALPU	Calculate palletized pick up shift amount
PALRST	Reset palletization
TIERST	Call paper insertion program
PALEND	End palletization
HANDPRES	Command pressurization of servo hand
HANDOPEN	Command open of servo hand
CNVYSYNC	Synchronized playback of conveyer
SensorSync	Sensor synchronization playback
WaitSensor	Function to set the work start location

10.4.6.1. PAL

The PAL statement makes the shift amount for the palletize work based on the values stored in the palletize pattern register.

Explanation	Palletize (Data input)		
Grammar	PAL P=<pallet num.>,PR=<pattern register num.>,W=<work width>,L=<work length >,H=<work height>		
Parameter	Pallet num.	Pallet entry number	1~16
	Pattern register num.	Palletize pattern register number	1~16
	Work width(W)	Width of workpiece X(mm)	0.1~3000.0
	Work length(L)	Length of workpiece Y(mm)	0.1~3000.0
	Work height(H)	Height of workpiece Z(mm)	0.1~3000.0
Example	PAL P=1,PR=1,W=500,L=300,H=250.5		

Reference

- To use this function, the palletizing must be set to <Enable> in 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』 item.
- Before using this function, go to 『[F2]: 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 (PAL) can be used only when paired with ‘palletize end (PALEND).’

10.4.6.2. PALPU

The PALPU statement is the function to shift a workpiece up to the inputted height after picking up the workpiece while palletize job is executed. This function executes the optimal palletize path in comparison to the current height of stages to be piled.

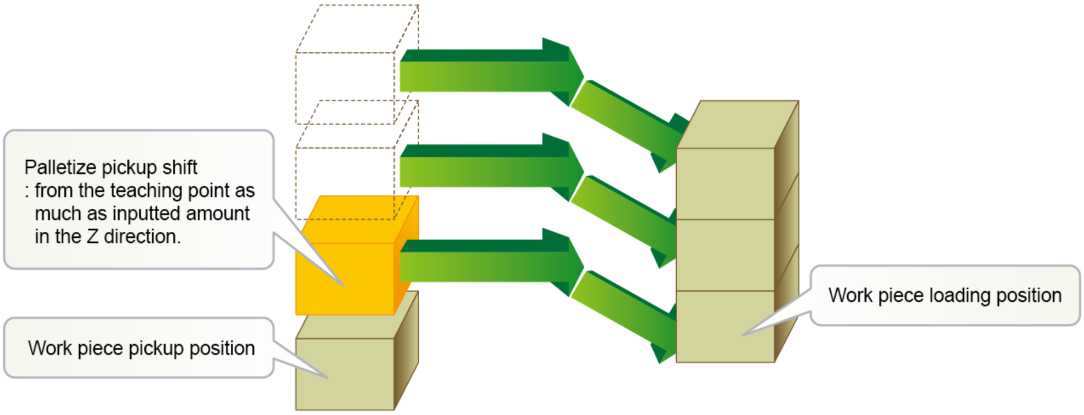


Figure 10.13 Palletize pickup shift

Explanation	Palletize pickup shift		
Grammar	PALPU P=<pallet num.>,SL=<start layer >,SH=<amount of shift>		
Parameter	pallet 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).		

Reference

- To use this function, the palletizing must be set to <Enable> in 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』 item.
- Before using this function, always check the data value in 『[F2]: System』 → 『4: Application parameter』 → 『3: Palletizing』 → 『1: Palletize pattern register』. When the setting value is incorrect, the robot may execute unwanted work.
- This is reflected to step of which step option is PU.

10.4.6.3. PALRST

The PALRST statement is the function to reset the counter by force during the palletization operation. When the designated input signal is entered, the counter in work is reset to 0. It outputs the response signal and uses the signal as pallet exhaust signal.

Explanation	Palletize reset (data input)		
Grammar	PALRST P=<pallet num.>,CS=<cond.signal>, RS=<response signal>		
Parameter	pallet 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		

Reference

- To use this function, the palletizing must be set to <Enable> in 『[F2]: System』 → 『5: Initialize』 → 『3: Usage setting』 item.
- Before using this function, always check the data value in 『[F2]: System』 → 『4: Application parameter』 → 『3: Palletizing』 → 『1: Palletize pattern register』. When the setting value is incorrect, the robot may execute unwanted work.

10.4.6.4. TIERST

The TIERST statement 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		
Grammar	TIERST R=<reg. num.>,P=<pallet num.>,PR=<pattern register num.>,TP=<tier sheet inserting program>		
Parameter	reg. num.	Online shift register number	1~8
	pallet num.	Pallet entry number	1~16
	pattern register num.	Palletize pattern register number	1~16
	tier sheet inserting program	Paper program number	1~9999
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 workpiece is loaded /unloaded, paper insertion cannot be executed. The initial position for palletize paper insertion is the lower stage of the first stage workpieces. De-palletize paper insertion should be positioned on top of the highest stage.

10.4.6.5. PALEND

The PALEND statement is the command to end the palletization work.
This function initializes palletize shift amount. When all workpieces are loaded, an assigned output signal is transmitted to outside and used as a pallet discharge signal
If there is no PALEND after the PAL input, an error of “E1147 Palletized start and end are not aligned” occurs. When PAL is executed again without PALEND, an error of “E1148 Palletized function already executed” occurs.

Explanation	Palletize ends (data input)		
Grammar	PALEND P=< pallet 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		

10.4.6.6. HANDPRES

The HANDPRES is the function to pick up a workpiece during palletizing by servo hand or general handling.

Explanation	Servo hand pressure command during automatic operation		
Grammar	HANDPRES OL=<Pressurization offset distance>, PR=<Pressurization force>		
Parameter	Pressurization offset distance	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
	Pressurization force	This factor determines the degree of grabbing power. When pressure is inputted, sufficient review is required in order to prevent actual workpieces damage.	50~999
Example	HANDPRES OL=100,PR=150		

10.4.6.7. HANDOPEN

The HANDOPEN is the function to place a workpiece during palletizing by servo hand or general material handling

Explanation	Servo hand open command during automatic operation		
Grammar	HANDOPEN OL=<Open offset distance>		
Parameter	Open offset distance	Open point of servo hand moving Reference. Open point is teaching point plus open offset distance.	0~2000
Example	HANDOPEN OL=600		

10.4.6.8. SensorSync

The SensorSync statement determines whether to execute the sensor synchronous operation. When the sensor synchronous operation (Sync=1) is executed, a robot applies the shift as much as the distance that the sensor moves to the rest of the steps until the sensor synchronous operation is off (Sync=0) or the sensor synchronous reset is executed (Sync=2).

Explanation	Sensor synchronous playback		
Grammar	SensorSync Sensor=<Synchronization parameter number>,Sync=<Synchronized state>		
Parameter	Synchronization parameter number	Synchronization parameter number for the application of the sensor synchronization	1~2
	Sync state	0 : conveyer synchronous operation OFF 1 : conveyer synchronous operation ON 2 : conveyer synchronous operation OFF and conveyer data reset 3 : Completion of the current work	0~3
Example	SensorSync Sensor=1,Sync=1		

10.4.6.9. WaitSensor

The WaitSensor statement is the function to determine whether to make the robot start the work when the work passes through the start limit switch and arrives at a certain location, during the sensor synchronized operation.

Explanation	This function determines the job starting point.		
Grammar	WaitSensor Sensor=<Synchronization parameter number>,Sync=<Wait status>, Pos=<Wait distance>		
Parameter	Synchronization parameter number	Synchronization parameter number for the application of the sensor synchronization	1~2
	Wait status	Determines whether to make the robot wait by turning on or off the sensor synchronization.	0~1
	Wait distance	Enter the work start distance by using the unit of mm and deg, beginning form the start limit switch.	0~20,000
Example	WaitSensor Sensor=1,Sync=1,Pos=400		

10.4.7. ENET Member Variable/Statement

You can use the ENET object to send/receive the string with the external device through Ethernet UDP communication. Because there are 3 ENET objects, you can communicate with 3 targets simultaneously.

First, set the IP address and port number as member parameter and open the communication channel with the OPEN command. And then execute the send/receive with PRINT and INPUT statements.

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>RPORT</td><td colspan="2">Integer variable. Read/write allowed.
Port number of communication partner(Remote) is appointed or returned.
※ This is applied only when OPEN statement is called.</td><td>ENET3.RPORT = 1042</td></tr>
<tr><td>LPORT</td><td colspan="2">Integer variable. Read/write allowed.
You can designate or obtain the local port number of the controller.
Default value is 0 (When not designated), and in this case, the local port number is automatically generated.
※ This only applies when the OPEN statement is called.</td><td>ENET2.LPORT = 500</td></tr>
<tr><td rowspan="5">STATE (read only)</td><td colspan="2">Integer variable. Read-only.
For checking status after executing the OPEN command</td><td rowspan="5">IF ENET1.STATE<1 THEN *ERR</td></tr>
<tr><td>1</td><td>Connected.</td></tr>
<tr><td>0</td><td>Not connected.</td></tr>
<tr><td>-1</td><td>UDP OPEN failure</td></tr>
<tr><td>-2</td><td>Ethernet device BIND failure</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. Example

This is the task program to request for task file to the remote PC and to receive the result.

```
_TEINPUT=0 'INPUT Ending character
'
'Ethernet setting -----------
ENET1.IP="192.168.1.172"
ENET1.LPORT=500
ENET1.RPORT=7000
ENET1.OPEN 1
CLR_RBUF ENET1
'
'Request for file transmission
PRINT ENET1,"LDFILE ";V200%; 'V200% is the task number to request

'Standby for result response
INPUT ENET1,V20$,8,*NO_RESP
ENET1.OPEN 0

'Result interpretation
V21$=LEFT$(V20$,11)
IF V21$<>"LDFILE RES=" THEN *INV_RES
V21$=MID$(V20$,12,4)
V201%=VAL(V21$) 'Return value'
IF V201%<0 THEN *ERR_RES
'
'Call sub robot task
CALL V200%
END
'
'Exception processing -----------
*NO_RESP
PRINT #0,"There is no response for LDFILE request."
END
*INV_RES
PRINT #0,"LDFILE response is not valid."
END
*ERR_RES
PRINT #0,"LDFILE response error code =";V201%
END
```

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

Function name	Explanation	Example	Returned value
ETR(a,b)	Return the radian value of the axis angle for the encoder value ‘b’ of the axis in the order ‘a’(1~).	ETR(2,&H400000)	1.571
RTE(a,b)	Return the encoder value ‘b’ for the axis angel radian value of the axis in the order ‘a’(1~).	RTE(2,1.3)	4120080

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"

HYUNDAI
HEAVY INDUSTRIES CO.,LTD.

HYUNDAI
HEAVY INDUSTRIES CO.,LTD.

- **Head Office**
  Tel. 82-52-202-7901 / Fax. 82-52-202-7900
  1, Jeonha-dong, Dong-gu, Ulsan, Korea

- **A/S Center**
  Tel. 82-52-202-5041 / Fax. 82-52-202-7960

- **Seoul Office**
  Tel.82-2-746-4711 / Fax. 82-2-746-4720
  140-2, Gye-dong, Jongno-gu, Seoul, Korea

- **Ansan Office**
  Tel.82-31-409-4945 / Fax.82-31-409-4946
  1431-2, Sa-dong, Sangnok-gu, Ansan-si, Gyeonggi-do, Korea

- **Cheonan Office**
  Tel.82-41-576-4294 / Fax.82-41-576-4296
  355-15, Daga-dong, Cheonan-si, Chungcheongnam-do, Korea

- **Daegu Office**
  Tel.82-53-746-6232 / Fax.82-53-746-6231
  223-5, Beomeo 2-dong, Suseong-gu, Daegu, Korea

- **Gwangju Office**
  Tel. 82-62-363-5272 / Fax. 82-62-363-5273
  415-2, Nongseong-dong, Seo-gu, Gwangju, Korea

- 본사
  Tel. 052-202-7901 / Fax. 052-202-7900
  울산광역시 동구 전하동 1 번지

- A/S 센터
  Tel. 82-52-202-5041 / Fax. 82-52-202-7960

- 서울 사무소
  Tel. 02-746-4711 / Fax. 02-746-4720
  서울특별시 종로구 계동 140-2 번지

- 안산 사무소
  Tel. 031-409-4945 / Fax. 031-409-4946
  경기도 안산시 상록구 사동 1431-2 번지

- 천안 사무소
  Tel. 041-576-4294 / Fax. 041-576-4296
  충남 천안시 다가동 355-15 번지

- 대구 사무소
  Tel. 053-746-6232 / Fax. 053-746-6231
  대구광역시 수성구 범어 2 동 223-5 번지

- 광주 사무소
  Tel. 062-363-5272 / Fax. 062-363-5273
  광주광역시 서구 농성동 415-2 번지