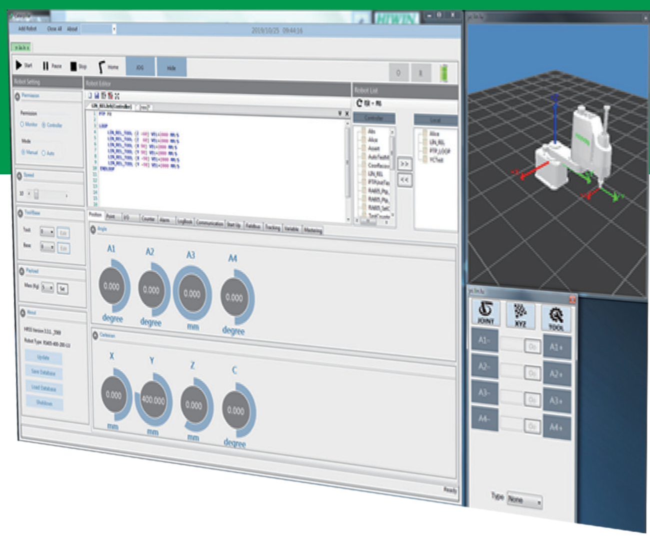
HIWIN®

Remote Operating Interface Software
(Caterpillar)

User Manual



Original Instruction

www.hiwin.tw

HIWIN®

INDUSTRIE 4.0 Best Partner

Multi-Axis Robot
Pick-and-Place / Assembly / Array and Packaging / Semiconductor / Electro-Optical Industry / Automotive Industry / Food Industry
- Articulated Robot
- Delta Robot
- SCARA Robot
- Wafer Robot
- Electric Gripper
- Integrated Electric Gripper
- Rotary Joint

Single-Axis Robot
Precision / Semiconductor / Medical / FPD
- KK, SK
- KS, KA
- KU, KE, KC

Torque Motor Rotary Table
Medical / Automotive Industry / Machine Tools / Machinery Industry
- RAB Series
- RAS Series
- RCV Series
- RCH Series

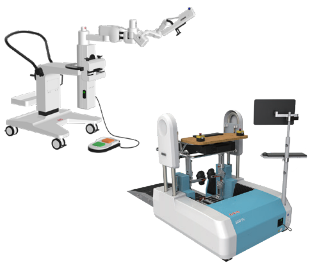
Ballscrew
Precision Ground / Rolled
- Super S Series
- Super T Series
- Mini Roller
- Ecological & Economical Lubrication Module E2
- Rotating Nut (R1)
- Energy-Saving & Thermal-Controlling (Cool Type)
- Heavy Load Series (RD)
- Ball Spline

Linear Guideway
Automation / Semiconductor / Medical
- Ball Type--HG, EG, WE, MG, CG
- Quiet Type--QH, QE, QW, QR
- Other--RG, E2, PG, SE, RC

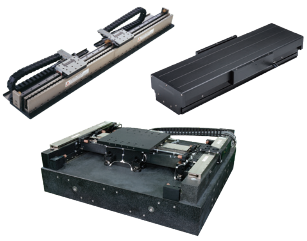
Bearing
Machine Tools / Robot
- Crossed Roller Bearing
- Ballscrew Bearing
- Linear Bearing
- Support Unit

DATORKER® Strain Wave Gear
Robot / Automation Equipment / Semiconductor Equipment / Machine Tools
- WUT-PO Type
- WUI-CO Type
- WTI-PH Type
- WTI-AH Type

AC Servo Motor & Drive
Semiconductor / Packaging Machine / SMT / Food Industry / LCD
- Drives--D1, D2T/D2T-LM, E1
- Motors--50W~2000W



Medical Equipment
Hospital / Rehabilitation Centers / Nursing Homes
- Robotic Gait Training System
- Robotic Endoscope Holder



Linear Motor Stage
Automated Transport / AOI Application / Precision / Semiconductor
- Iron-core Linear Motor
- Coreless Linear Motor
- Linear Turbo Motor LMT
- Planar Servo Motor
- Air Bearing Platform
- X-Y Stage • Gantry Systems
- Single-Axis Linear Motor Stage

Torque Motor & Direct Drive Motor
Machine Tools
- Torque Motor-- TM-2/IM-2, TMRW Series

Inspection / Testing Equipment / Robot
- Direct Drive Motor-- DMS, DMY, DMN, DMT Series

目 錄

0. Warranty Terms and Conditions

The period of warranty shall commence at the received date of HIWIN product (hereafter called "product") and shall cover a period of 12 months. The warranty does not cover any of the damage and failure resulting from:

1. The damage caused by using with the production line or the peripheral equipment not constructed by HIWIN.
2. Operating method, environment and storage specifications not specifically recommended in the product manual.
3. The damage caused by changing installation place, changing working environment, or improper transfer after being installed by the professional installer.
4. Product or peripheral equipment damaged due to collision or accident caused by improper operation or installation by the unauthorized staff.
5. Installing non-genuine HIWIN products.

The following conditions are not covered by the warranty:

1. Product serial number or date of manufacture (month and year) cannot be verified.
2. Using non-genuine HIWIN products.
3. Adding or removing any components into/out the product without authorized.
4. Any modification of the wiring and the cable of the product.
5. Any modification of the appearance of the product; removal of the components inside the product. e.g., remove the outer cover, product drilling or cutting.
6. Damage caused by any natural disaster. i.e., fire, earthquake, tsunami, lightning, windstorms and floods, tornado, typhoon, hurricane etc.

HIWIN does not provide any warranty or compensation to all the damage caused by above-mentioned circumstances unless the user can prove that the product is defective.

For more information towards warranty terms and conditions, please contact the technician or the dealer who you purchased with.

WARNING	❖ Improper modification or disassemble the robot might reduce the robot function, stability or life. ❖ The end-effector or the cable for devices should be installed and designed by a professional staff to avoid damaging the robot and robot malfunction. ❖ Please contact the technician for special modification coming from production line set up. ❖ For the safety reason, any modification for HIWIN product is strictly prohibited.

Safety Precautions

1.Safety Information

- Safety Responsibility and Effect

1. This chapter explains how to use the robot safely. Be sure to read this chapter carefully before using the robot.
2. The user of the HIWIN industrial robot has responsibility to design and install the safety device meeting the industrial safety regulations in order to ensure personal safety.
3. In compliance with the safety information on industrial robot described in this manual can't guarantee that *HIWIN* robot will not occur any safety problems.
4. This machine is defined as a partly completed machinery, the associated hazards must be handled by system integrator in accordance with ISO 102018-1/ ISO 102018-2.
5. A safety-related part of control system (SRP/CS) should conform to the requirement of performance level d and category 3 according to ISO 13849-1.
6. The installation for emergency functions shall be defined by the system integrator in accordance with ISO 10218-1/ ISO 10218-2.

- Safety Operation Principle

1. Before connecting the power supply for HIWIN industrial robot startup assembly procedure, check whether the specification of factory output voltage matches the specification of input voltage of the product. If it does not match, ensure to use the corresponding transformer (HIWIN optional transformer is recommended).
2. Emergency Stop button (on Teach Pendant or from external emergency stop switch) must be pressed before turning off the power, and then switch off the power switch.
3. While connecting to the external I/O or the signal, please operate in the condition that the power switch is turned off to prevent from a shortcut caused by mistaken touch in the process, and resulting in damage.

Safety Precautions

i.General

All personnel involved in the use or setup of the industrial robot arm must read the safety related literature for the robot arm and instruction manual in detail and operate it in accordance with the specifications.

Safety Symbol

Symbol	Description
DANGER	Failure to follow instructions with this symbol may result in serious hazard or personal injury. Please be sure to comply with these instructions.
WARNING	Failure to follow instructions with this symbol may result in personal injury or product damage. Please be sure to comply with these instructions.
CAUTION	Failure to follow instructions with this symbol may result in poor product performance. Please be sure to comply with these instructions.

Use Limit

Robotic arm is prohibited for use in the following environments and uses

- Personnel carrying purposes
- Explosive environment
- Environment without safety precautions
- Outdoor environment
- Environment affected by oil, water, dust, etc.

ii.Relevant Personnel

Electrical or mechanical work on industrial robot arms is only permitted by professionals.

⚠ WARNING

All personnel working on industrial robotic arms must read and understand the manual containing the safety section of the system of the robotic arm All personnel working on industrial robotic arms must read and understand the manual containing the safety section of the system of the robotic arm.

System Integrator

Refers to the person who integrates the industrial robot arm into a set of equipment according to safety regulations and puts it into operation.

The system integrator is responsible for the following tasks:

- Install industrial robot arm.
- Industrial machinery arm related equipment connection work.
- Risk assessment of the overall system.
- Use safe guard devices.
- Confirm that the components used by the safe guard devices are in compliance with regulations.
- Placement, replacement, setup, operation, maintenance and repair work is only permitted for specially trained personnel in accordance with the operating instructions for the components of the industrial robot arm.

User

Users must be professionally trained, have the knowledge and experience in this area, and be familiar with the prescribed standards, and thus be able to make a correct judgment of the work to be performed and identify potential hazards.

Users can be defined into three categories based on operational permissions:

1. Operator
   - System startup and shutdown
   - Power on and off
   - Alarm system status recovery
2. Engineer
   - Operating personnel usage authority
   - Programming and changing
   - Arm teaching operation
3. Expert

- Engineer usage authority

Mechanical arm maintenance work

System Operation

Those who do not use functional safety kits must implement safety-fence guidance.

The system operation of personnel is divided into the following three levels

1. Operator
2. Engineer
3. Expert

Its control permissions are shown in the following table.

No	Function	Operator		Monitor
		Manual Mode	Automation Mode	
	Function Table			
1	Interface Languages	O	O	O
2	Permission Selection	O	O	O
3	Mode Selection	X	O	X
4	Velocity Adjustment	O	O	X
5	Tool/Base Selection	O	X	X
6	Update Software	O	X	X
7	Save Database	O	X	X
8	Load Database	O	X	X
9	Program execution	O	O	X
10	Hold Program	O	O	X
11	Stop Program	O	O	X
12	Homing	O	X	X
13	Jog	O	X	X
14	Program Edit	O	X	X
15	Program Update /Download	O	X	X
16	Add Point	O	X	X
17	Counter	O	X	X
18	System I/O	O	O	X
19	RSR Setting	O	X	X
20	Fieldbus	O	O	X
No	Function	Operator		Monitor
		Manual Mode	Automation Mode	
21	Clear Alarm	O	O	X
22	Conveyer Track ->Setting	O	X	X
23	Conveyer Track -> Vision Setting	O	X	X
24	Conveyer Track -> Vision Object Setting	O	X	X
25	Conveyer Track ->Sensor Object Setting	O	X	X

26	Conveyer Track ->Setting Calibration	O	X	X
27	Conveyer Track ->Setting Monitor	O	O	O
28	Axis Zero Position/calibration	O	X	X
29	Tool/Base calibration	O	X	X
30	Logbook	O	O	O
31	Network Config	O	X	X
32	Home Setting	O	X	X
33	Time Setting	O	X	X
34	RS-232	O	X	X
	Interface			
35	Add Robot	O	O	O
36	Close All	O	O	O

WARNING

Electrical or mechanical work is only allowed to be carried out by professionals。

Operator Safety Precautions

The manner and scale of the work and the possible hazards must be explained to the relevant personnel before work, and relevant training courses must be carried out on a regular basis. In the event of an accident or technical correction, a training course must be re-run.

System Set Up Safety Precautions

The system set up only allows specially trained personnel to perform and work in accordance with the installation, setup, operation and other relevant documents provided by the original manufacturer.

Maintenance Personnel's Precautions

Maintenance should only be carried out by specially trained personnel in accordance with the instructions and operating instructions.

iii.Robotic Arm Working Range Definition

●**Working area**

The working area of the robot is defined as the area of motion under motion constraints, and the working area must be limited to the minimum required.

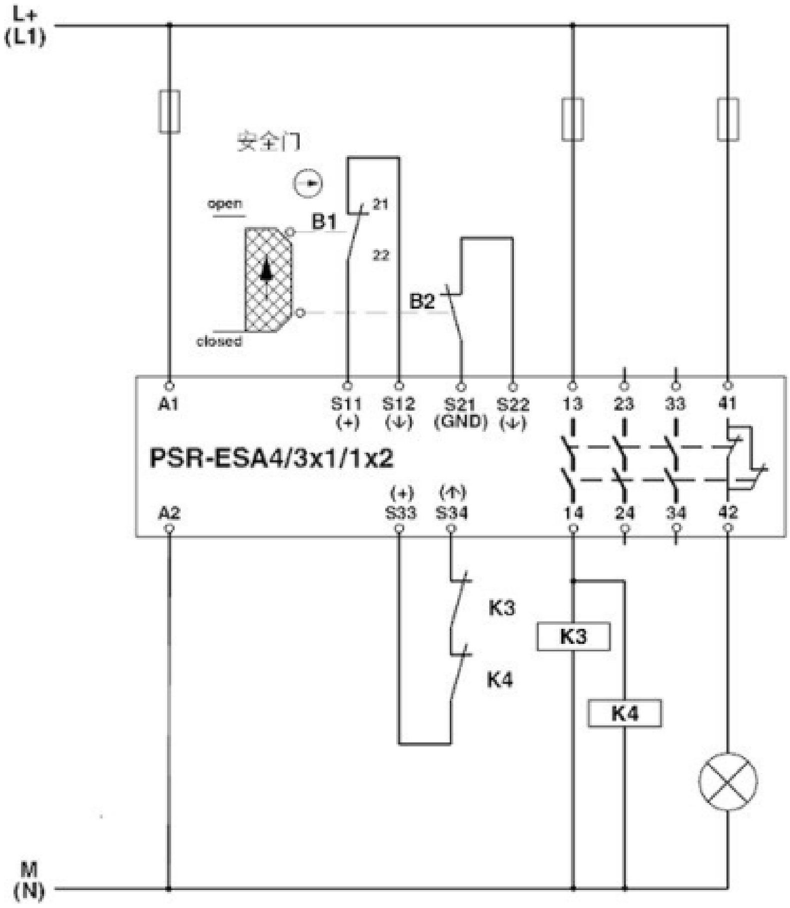
●**Protective area**

Operation must be carried out outside the protected area.

A protected area is an area of the working area that is protected by a safe guard device. Please ensure the protective area includes working area of the robot. A safety-related part of control system (SRP/CS) should conform to the requirement of performance level (PL)= d and category 3 according to ISO 13849-1.

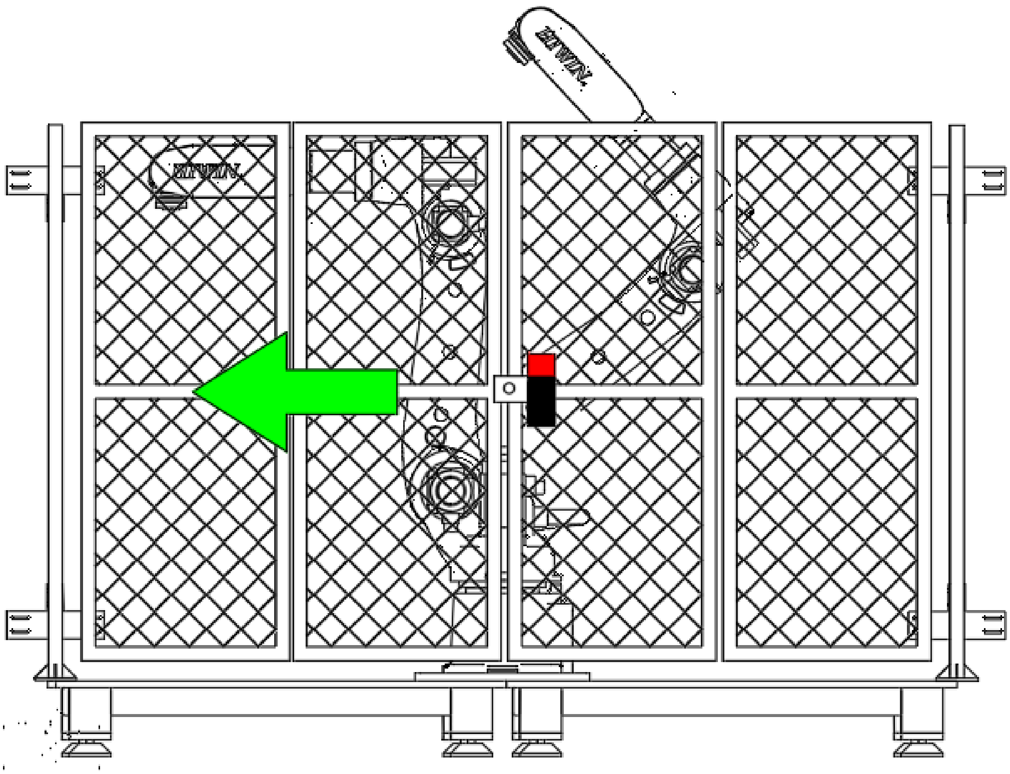
⚠ CAUTION

- ❖ Please ensure the emergency stop switch is in reset status before the robot functions.
- ❖ The external device connected to the emergency stop switch circuit should be dry contact (uncharged) switch. It is forbidden to use a live circuit to connect to the controller emergency stop switch circuit.



⚠ CAUTION

●It must use EMO-Emergency stop (EN 60947-5-1 positive opening) with safety module to meet ISO 13849-1 performance level (PL)= d



Interlock

iv.Description of Safety Functions

Industrial robotic arms must have the following safety features:

- Selection of operating mode of the robot arm
- Safe guard devices
- Emergency stop device
- Teach pendant enable switch

The safety function of the robot arm system is to prevent loss of personnel or property. If the function is not complete or in failure state, the industrial robot arm must be prohibited from operating.

Manual Mode

The manual mode is used for program design, program operation check or teaching, etc. When performing manual operation, pay attention to the followings:

- All actions must be operated within the protection area.
- Do not damage or potentially damage the relevant equipment due to operates the robotic arm.
- Operation must be carried out outside the protected area as much as possible.

Both manual and automatic modes of operation in the protected area are not permitted unless the arm is equipped with a certified speed monitoring accessory from the manufacture.

Automatic Mode

The automatic mode startup should include the following conditions:

- The safe guard devices have been set up and confirmed that their functions are working properly.
- All suspended security should restore its full functionality.
- Confirm that there are no people in the protected area.
- Relevant workflow rules are complied.

To enter the protection area in this mode, the emergency stop function must be activated before entering.

Safe Guard Devices Description

The safe guard device must use the components approved by the safety regulations and set and plan according to the relevant regulations.

The robotic arm system must be automatically activated to receive the safety signal. In the event of a connection failure during automatic mode operation, an emergency stop must be triggered. When reconnecting after disconnection, the device cannot be automatically started directly and must be started manually. Manual slow running (T1) and manual fast running (T2) modes allow the guard not activate. A method must be provided to confirm that no personnel are in the protected area when the automatic mode is activated.

Users must strictly abide by the content description, otherwise it will cause serious casualties.

Temporary fences can be used during system installation and can be set according to ISO 10218-2 regulations

Stop Functions

Emergency Stop Description

Emergency stop related precautions

- Confirm that the function is functioning normally every six months.
- System integrators should provide emergency stop devices to ensure that the machine is operational or that a hazardous situation exists.
- At least one external emergency stop device is installed. Make sure that additional emergency stop devices are available for use without or losing the teach pendant.
- Provide interface to connect external emergency stop devices.
- The emergency stop function can be triggered when the safety control system connected to the robot arm is cut off.
- The risk assessment should assess whether the emergency stop is not triggered when the robotic arm control system is turned off and provides a response.

- If a tool or other device connected to the robot is dangerous, it must be connected to the emergency stop circuit on the equipment side.

v. Warnings and Precautions

General considerations

DANGER

1. All operating procedures should be assessed by professional and in compliance with related industrial safety regulations.
2. When operating robot, operator needs to wear safety equipment, such as workwear for working environment, safety shoes and helmets.
3. When encountering danger or another emergency or abnormal situation, please press the emergency stop button immediately. After danger is eliminated, move the robot away with low speed in manual mode.
4. When considering safety of the robot, the robot and the system must be considered at the same time. Be sure to install safety fence or other safety equipment and the operator must stand outside the safety fence while operating the robot.
5. A safety zone should be established around the robot with an appropriate safety device to stop the unauthorized personnel from access.
6. While installing or removing mechanical components, be aware of a falling piece which may cause injury to operator.
7. Ensure the weight of workpiece does not exceed the rated load or allowable load moment at wrist. Exceeding these values could lead to the driver alarm or malfunction of the robot.
8. Do not climb on manipulator.
9. Do not store the machine in the environment with corrosion and flammable gas or close to the flammable object.
10. Do not operate the machine in the environment with moisture, water or grease.
11. Do not operate the machine at the place where vibration or the strong impact occurs.
12. Do not immerse the electric wires into grease or water.
13. Do not connect or operate the machine with wet hands.
14. Do not operate the machine in potentially explosive environment.
15. Please ensure the controller is grounded.
16. Keep hands away from the inner part of the controller while it is connecting to the power or during operating.
17. Do not touch the heat sink, regenerative resistance, the power supply or the computer inside the controller while it is operating due to its high temperature.
18. Be sure power is disconnected prior to repair and maintenance, and ensure to operate under the condition of no electrical shock risk.

19. Do not disassembly the controller without permission. If there’s any issues, please contact our engineers.

⚠ WARNING

1. The personnel installing robot should be trained and licensed.
2. To ensure personal safety, robot installation must comply with this manual and related industrial safety regulations.
3. The control cabinet should not be placed near high voltage or machines that generate electromagnetic fields to prevent interference that could cause the robot to deviation or malfunction.
4. Using non-HIWIN spare parts to repair may cause robot damage or malfunction.
5. Beware of the heat generated by the controller and servo motor.
6. Do not overbend the cable to avoid poor circuit contact or unexpected damage.
7. Do not stand on the controller or put heavy objects on it.
8. Do not block the vent or put foreign objects into the controller.
9. Please ensure the controller is fixed on the base.
10. Do not pull the connector violently or twist the electric wires excessively.
11. Do not frequently switch ON/OFF the power switch and the control button.
12. Please ensure that the robot, the emergency stop switch and the controller are functioning properly before performing any work.
13. Do not shutdown the power switch during the operation.
14. Do not open, modify, disassemble and maintain the machine without permission.
15. The power must be disconnected when the machine does not operate in a long time.
16. Do not turn off the power of the controller when modifying the program or parameter. Otherwise, the data stored in the controller will be damaged.
17. When changing the program or parameters inside the robot controller, do not turn off the power of the controller. Otherwise, the internal data of the controller will be damaged.
18. After the brake of a servo motor is released, the robot will be moved due to gravity and it may injure the operator.
19. The industrial robots can be applied for the different industrial environments.
20. When the operating procedures are interrupted, the special attention should be paid during the troubleshooting.

Precautions during operations

DANGER

1. Teaching, jogging or programming should be done outside of the safety fence. If it is inevitable to enter the safety fence, press the emergency stop button before entrance. Operation should be restricted at low speed and beware of surrounding safety.
2. All operations shall be executed by trained staff.
3. All operations are required to perform in the safe area.

Maintenance Precautions

DANGER

1. Please contact us if the procedure not specified by HIWIN is needed.
2. Please contact us if the replacement of the component not specified by HIWIN is needed.
3. Be sure to carry out regular maintenance, otherwise it will affect the service life of the robot or other unexpected danger.
4. Prior to repair and maintenance, please switch off power supply.
5. Maintenance and repair should be performed by a qualified operator with a complete understanding of the entire system to avoid risk of robot damage and personal injury.
6. When replacing the components, avoid foreign object going into the robot.

Precautions for using End Effector

End effectors can be basically divided into the following two categories:

A. Gripper: Mainly for pick and place operations, such as pneumatic, electric gripper, vacuum suction cup, etc.

B. Tools: Mainly for processing operations, such as welding, cutting, surface treatment, etc.

DANGER

1. More attention must be paid to the design of the end effector to prevent power loss or any other errors that could lead to workpiece falling or damage.
2. The tool-type end effector is usually equipped with high voltage, high temperature and active rotary shaft. Special attention should be paid to the operating safety.
3. The end effector should be mounted firmly on the robot to avoid workpiece fall during operation which may cause personal injury or hazard.

WARNING

1. The end effector may be equipped with its own control unit. During installation, pay attention to installed location. Ensure that the control unit does not interfere with robot operation.
2. The gripper-type end effector should prevent the workpiece from dropping or damaging when the robot experiences a power error or other errors. If potential dangers or abnormal situations exist when using end effector, the associated hazards must be handled by the system integrator in accordance with the related standards.

Precautions for using Hydraulic and Pneumatic

DANGER

1. When using the pneumatic or hydraulic system, the gripped workpiece may fall due to insufficient pressure or gravity.
2. The pneumatic or hydraulic system must be equipped with the relief valve, so that it can be applied in an emergency.

WARNING

1. More attention should be paid to the pressure remained in the pneumatic systems after the power is disconnected.
2. The internal pressure must be released before the pneumatic systems are maintained.
3. More attention should be paid to the pressure in the pneumatic system as it is several times more than the atmosphere pressure.

Emergency Stop Switch Precautions

DANGER

1. The robot or other control component should have at least one device for immediate halt, such as an emergency stop switch.
2. The emergency stop button must be installed in an easily accessible location for quick stop.
3. While executing an emergency stop, power to the servo motor will be cut, and all movements will be stopped. And the control system will be shut down. Emergency stop should be reset if the restoration of operating procedure is wanted.
4. Avoid using emergency stop to replace a normal stop procedure. This could reduce the lifespan of the robot.

WARNING

1. When an emergency stop is performed, the power of the drive is cut off, all operations are stopped, and the control system of the robot arm is turned off.
2. To resume execution, reset the emergency stop switch.
3. Emergency stop is immediate stop: Immediately stop the movement of the robot arm and cut off the power of the drive.
4. The emergency stop switch is for emergency stop only.
5. HIWIN's industrial robot arm has two emergency stop switches, one of which is located on the teach pendant and the other is automatically connected to the controller via a dedicated cable. If there is a need for other emergency stop switches, the other means of connection can be used to achieve the purpose of emergency stop.
6. Based on the relevant industrial safety regulations, the emergency stop switch needs to be directly connected to the control box of the robot arm through a physical connection line.
7. Additional installed safety equipment must comply with PLD level.

1. Introduction

1.1 Remote Robot Control Software (Caterpillar) Overview

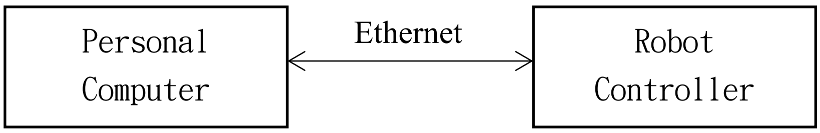
Welcome to the Remote Robot Control Software management and development environment; features of the Remote Robot Control Software includes:

- ■Can be run under Microsoft Windows 7 and Windows 10
- ■Communicate with robot controller through Ethernet
- ■Allow personal computer to connect to single or multiple robot controllers. Maximum number of connections is four.
- ■HIWIN Robot language editor
- ■Robot program files management
- ■I/O management
- ■TCP/IP and RS232 management
- ■Logbook

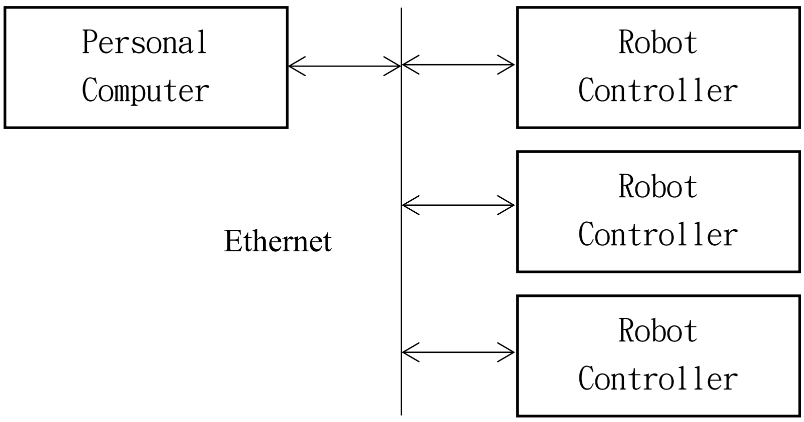
1.2 System connection architecture overview

The following system block diagram displays how remote-control robot software connects to single or multiple robot controllers. :

System 1 : Connect a robot controller to personal computer through Ethernet



System 2 : Connect multiple controllers to personal computer through Ethernet

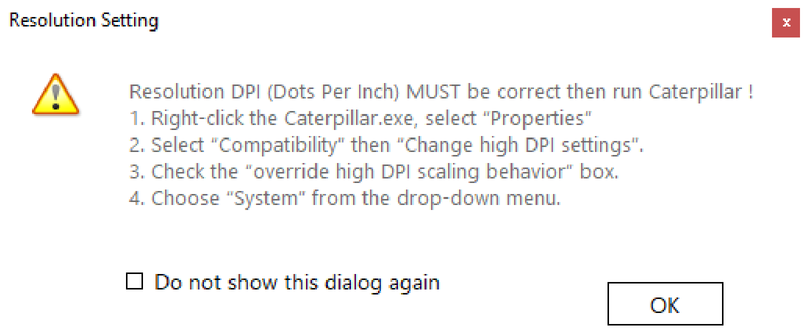


System Block Diagram

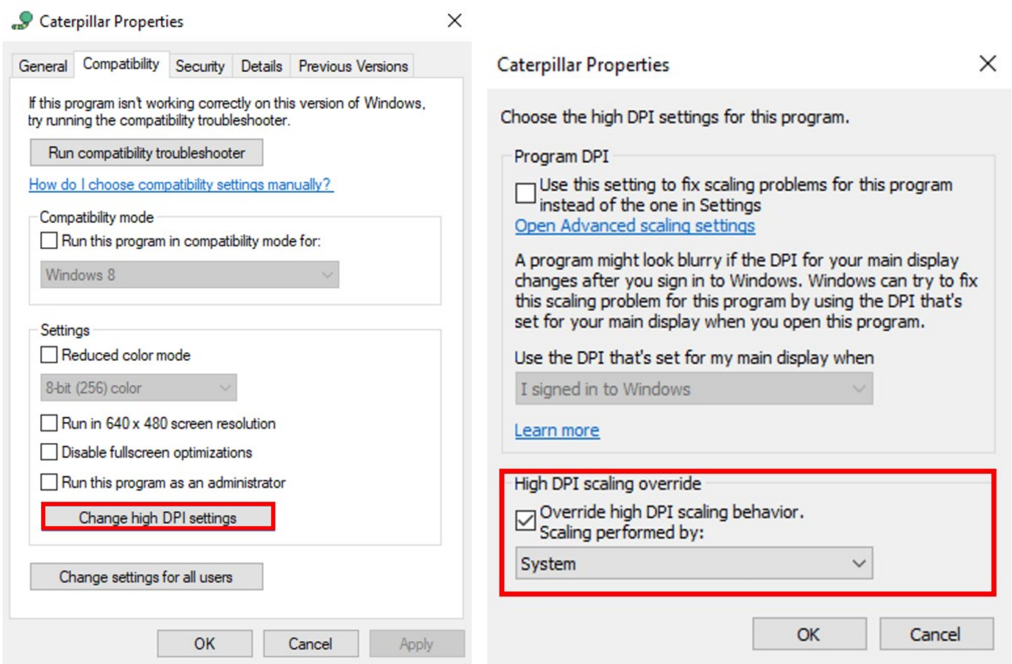
1.3 Windows System Recommended Environment

- Robot controller does not support TCP/IPv6. TCP/IPv4 is allowed.
- .NetFrameWork 4.6.1。
- Visual studio 2017 redistributable
- Resolution 1024x768 above
- Support robot type: RS405-500-200-LU、RS405-500-400-LU、RS405-400-200-LU、RS405-400-400-LU、RS410-600-200-LU、RS410-700-400-LU、RS410-800-400-LU

  At least one external emergency stop button is installed
- Caterpillar DPI will be set automatically upon start up so that the user interface can be displayed correctly; if the setting fails, users must set it manually to ensure normal operation。



- Adjust display settings for Windows scaling issues with high-DPI devices. Right-click the application (Caterpillar.exe), select “Properties”, select “Compatibility” tab, and then select the “Change high DPI settings”. Check the “override high DPI scaling behavior” box and choose “System” from the drop-down menu. Finally, click ”OK”.



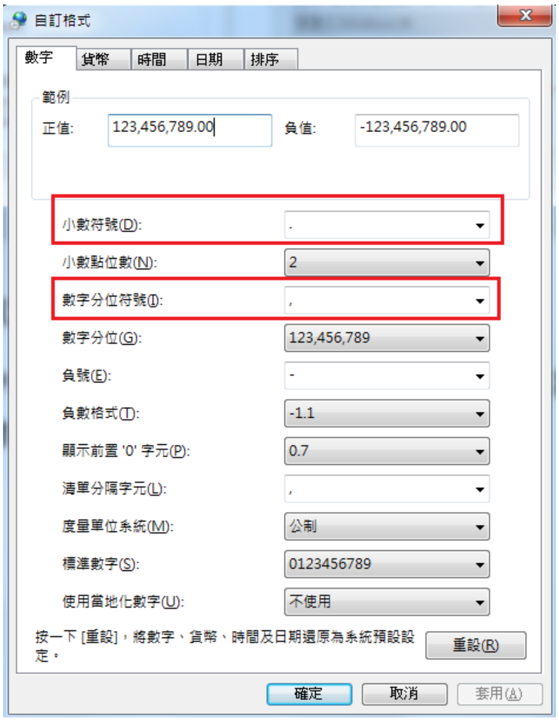
1.3.1 Windows System Setting for Different Area

■Select Control Panel\All Control Panel Items => Region and Language => Other Settings

■Custom Format => Numbers

■Select. for the decimal symbol

■Select, for the digit quantile



1.4 Software Version Compatibility Description

Please refer to the following table for the software version compatibility correspondence between Caterpillar (remote connection interface software) and HRSS (HIWIN robot software system):

Caterpillar and HRSS version Correspondence table

Edition	Date	Applicable Software	Applicable Range	Remark
1.0.1.5952	2020.01.01	HRSS 3.3.2a.5953	RS405 RS410 系列	SDK 2.2.1
1.0.2.6133	2020.02.27	HRSS 3.3.3a.6128	RS405 RS410 系列	SDK 2.2.2
1.0.3.6314	2020.03.27	HRSS 3.3.4a.6309	RS405 RS410 系列	SDK 2.2.3
1.0.4.6478	2020.04.27	HRSS 3.3.6a.6472	RS405 RS410 系列	SDK 2.2.4
1.0.5.6779	2020.07.10	HRSS 3.3.7a.6777	RS405 RS410 系列	SDK 2.2.5
1.0.6.6940	2020.08.05	HRSS 3.3.8a.6933	RS405 RS410 系列	SDK 2.2.6
1.0.7.7071	2020.09.01	HRSS 3.3.9.7074	RS405 RS410 系列	SDK 2.2.7
1.0.8.7244	2020.10.01	HRSS 3.3.10.7245	RS405 RS410 系列	SDK 2.2.8
1.0.9.7487	2020.11.01	HRSS 3.3.11.7492	RS405 RS410 系列	SDK 2.2.9
1.0.10.7634	2020.11.30	HRSS 3.3.12.7633	RS405 RS410 系列	SDK 2.2.10
1.0.11.7843	2020.12.29	HRSS 3.3.13.7842	RS405 RS410 系列	SDK 2.2.11
1.0.12.7958	2021.01.29	HRSS 3.3.14.7959	RS405 RS410 系列	SDK 2.2.12
1.0.13.8062	2021.02.26	HRSS 3.3.15.8063	RS405 RS410 系列	SDK 2.2.13
1.1.0.8168	2021.03.30	HRSS 3.3.16.8169	RS405 RS410 系列	SDK 3.0.1

Update Version Notice

WARNING

1. The software update package contains the robot system software HRSS and the remote control software Caterpillar. The two versions have the corresponding relationship as above, and must be updated at the same time.
2. When Caterpillar is used for connection, the HRSS version will be detected automatically; a window prompt will appear if the HRSS is too old, ; notifying that the HRSS version must be updated.
3. Next, select the Upgrade HRSS page to upload the updates file in order to get a new version of HRSS as shown below:

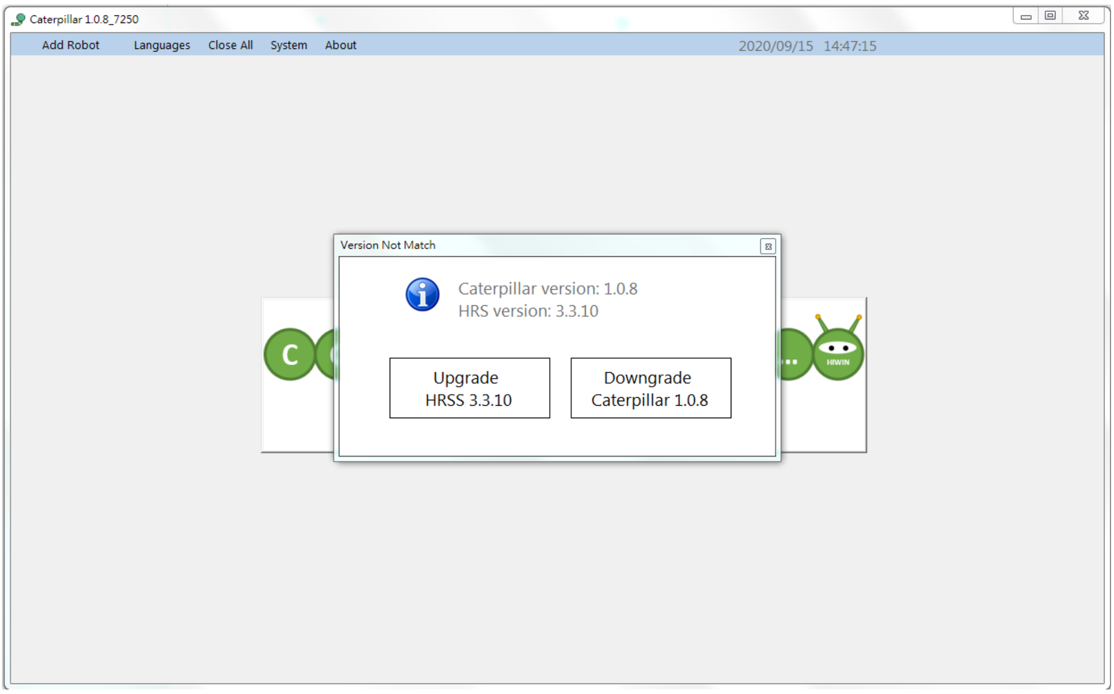
■ **Software Update SOP**

1. Download the latest version of Caterpillar (folder) and the HRSS update package (.exe file).
2. Open your old version of Caterpillar and connect to the robot. An option window will pop up automatically for choosing whether the HRSS need to upgraded or download Caterpillar (this feature will work for HRSS 3.3.10 and Caterpillar 1.0.8 or above), as shown in Figure (Img 0.1).

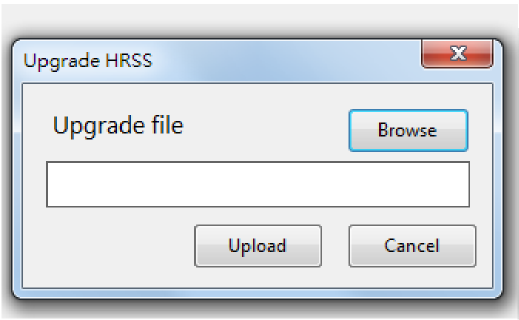
3-1. Select the Upgrade HRSS option, and upload the HRSS update package (.exe file) to update (there will be a disconnection when the update is completed). As shown in Figure (Img 0.2).

3-2. Select the Downgrade Caterpillar option to download the correspondence HRSS version of Caterpillar (Img 0.3)

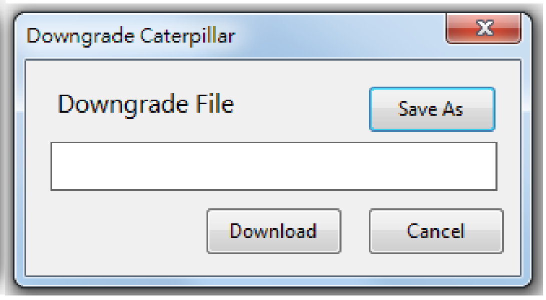
4.Refresh the Caterpillar and connect the HIWIN robot with a new version of Caterpillar after updates. (Do not use the old version of Caterpillar).



(Img 0.1)



(Img 0.2)



(Img 0.3)

■ Software Compatibility Description

<u>Description</u>

Caterpillar version 1.1.0 (included) and above can operate any version of HRSS 3.3.16 (included) and above without version restrictions; if Caterpillar and HRSS versions are does not match during the login process, a prompt message window pop-up as “some of the functions are not available”, but still you can “skip update” and continue to the HIWIN robot connection if the updates is minor. The update cannot be skipped when there are major revisions (when the first digit of the local terminal connection is different); users will be forced to update HRSS to the latest version in order to continue using it.

There are 4 different versions; refer to the figure below:

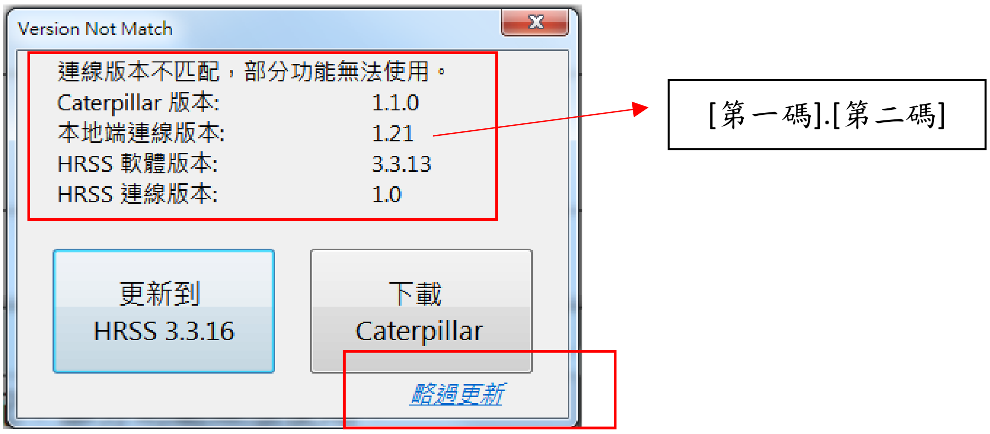
(1). Caterpillar's software version, for example: Caterpillar 1.1.0

(2). Caterpillar's local terminal connection version, for example: 1.21.

(3). HRSS' software version, for example: HRSS 3.3.13.

(4). HRSS' connection version, for example: 1.0.

The pairing of Caterpillar and the robot is based on the Caterpillar and HRSS's connection version digits. If their first digits are different; they must be updated in order to work. If their second digits are different; then some of the functions are not supported, but still can "skip update" can be selected to continue operation.



HRSS & Caterpillar version description window

Prerequisites

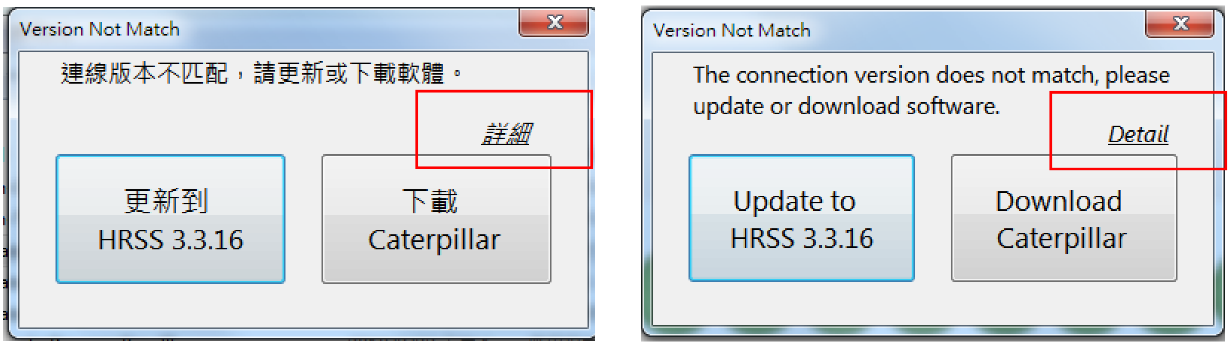
1.Must be download the compatible versions of Caterpillar 1.1.0 and HRSS 3.3.16 (included) or above.

Instructions

As previously described, the release methods include major versions (changes in the first digit) and general versions (changes in the second digit):

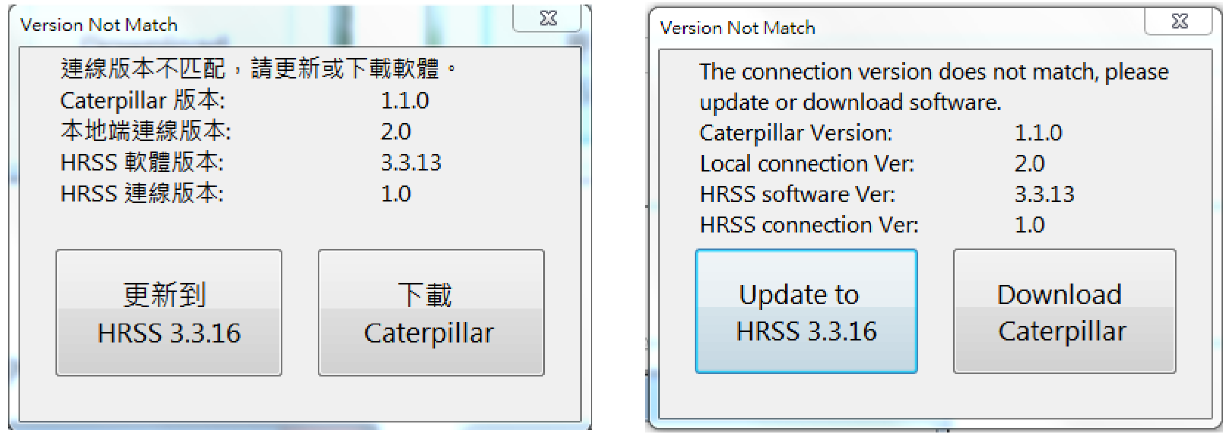
⇨**Release steps for major revisions:**

1.When major revisions are released, updating is mandatory; the Figure that will appear when connecting two different versions as shown below.



Major revision connection window (Chinese on the left and English on the right)

2.Clicking on “Details” on the screen will connect to the figure below; it will explain 4 different connection versions details.

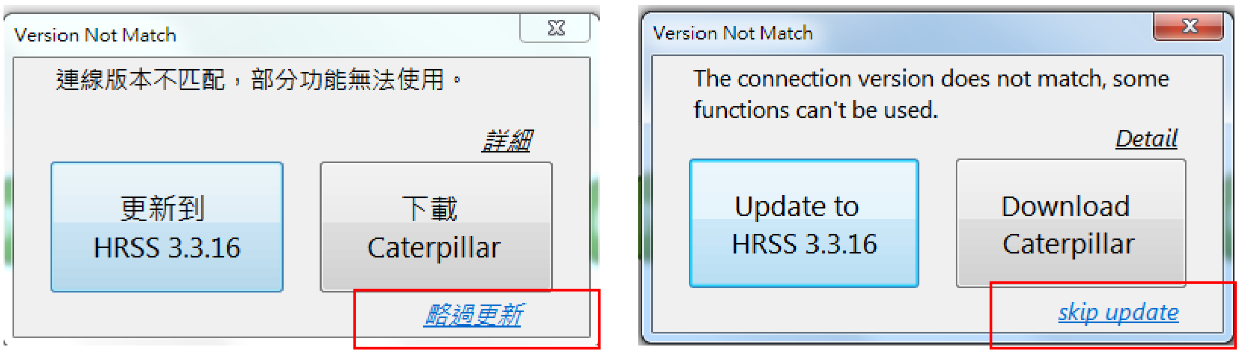


Detail description figure (Chinese on the left and English on the right)

3.The “Update to HRSS” or “Download Caterpillar” button must be selected to update the HRSS software or to download the Caterpillar software for the current controller.

⇨**Release steps for general versions:**

1.The skip update figure will appear when connecting different version of Caterpillar and HRSS as shown below.



Gerneral versions description figure (Chinese on the left and English on the right)

2.Three are three options are available; “Update to HRSS”, “Download Caterpillar,” or “Skip update”.

3.Pressing the “Update HRSS” button can update the HRSS with respective specified version.

4.Pressing the “Download Caterpillar” button will obtain the currently connected operating software from the controller; refer to Chapter 1.5.

5.“Skip update” will perform the connection directly (this function appears on Caterpillar 1.1.0 and HRSS 3.3.16 (included) or above); however, some of the new/old functions are not supported. This means the two versions are compatible.

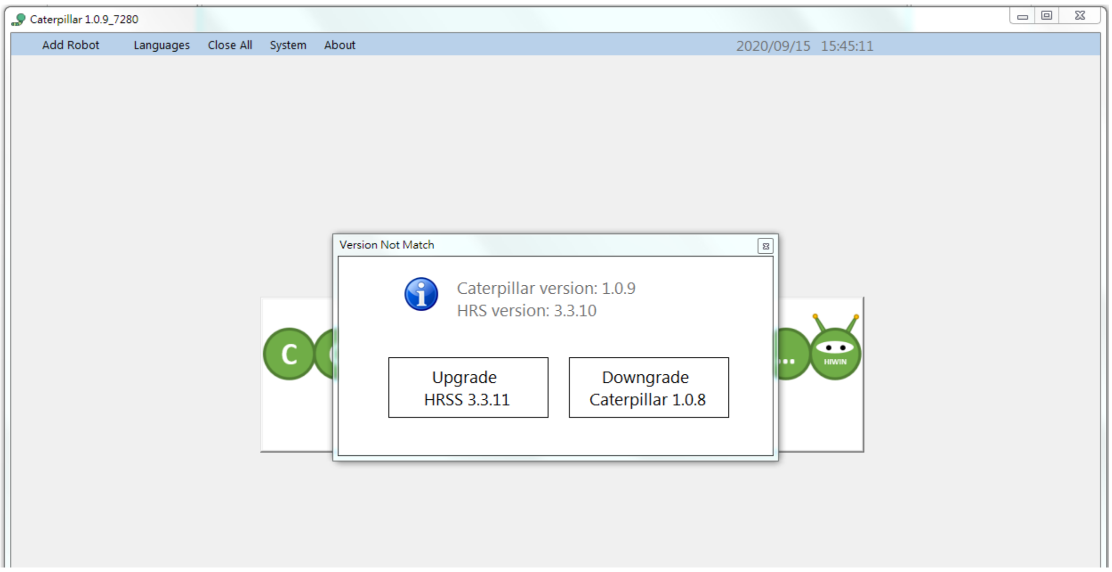
1.5 Download Controller's HRSS Version of Remote operation software

Description

When Caterpillar and HRSS versions does not match, users can choose to update HRSS or download the Caterpillar version with respect to the HRSS version which is currently connected. This function is only supported for HRSS 3.3.10 and Caterpillar 1.0.8 (included) or above.

Operator Step

1.When Caterpillar version 1.0.8 and HRSS version 3.3.10 or above are opened and does not match; if the Caterpillar version is newer than HRSS, a selection window will pop up to either Upgrade HRSS or Downgrade Caterpillar.

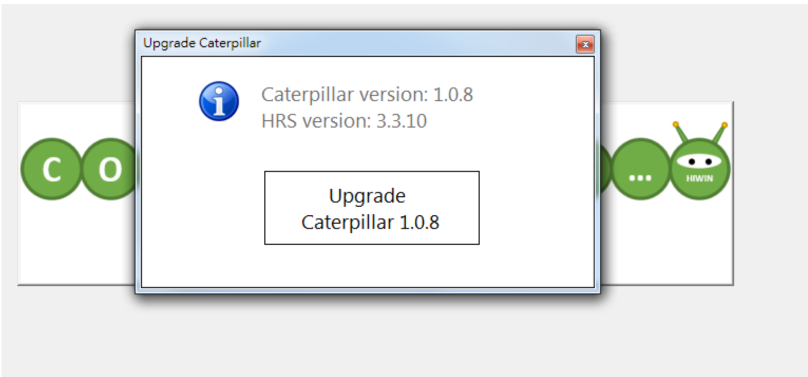


Selection of Upgrade HRSS or Downgrade Caterpillar

2.Clicking Upgrade HRSS will allow the user to update the HRSS version.

3.Clicking Downgrade Caterpillar will download the remote operator interface software that matches with the currently connected HRSS.

4.If the HRSS version is newer than Caterpillar, there is only the option to Upgrade Caterpillar.



Download Caterpillar

2.Put Into Operation of Description

2.1 Check Robot Plate and Software Version Data

Operation Steps

1.The correct robot program data must be loaded. During parameter check, the loaded robot data must match with the data of the model plate.

2.If loading the new data is required, the status of the robot data must fully match with the HRSS. This is to ensure that when the data is applied, it can be submitted with the HRSS.

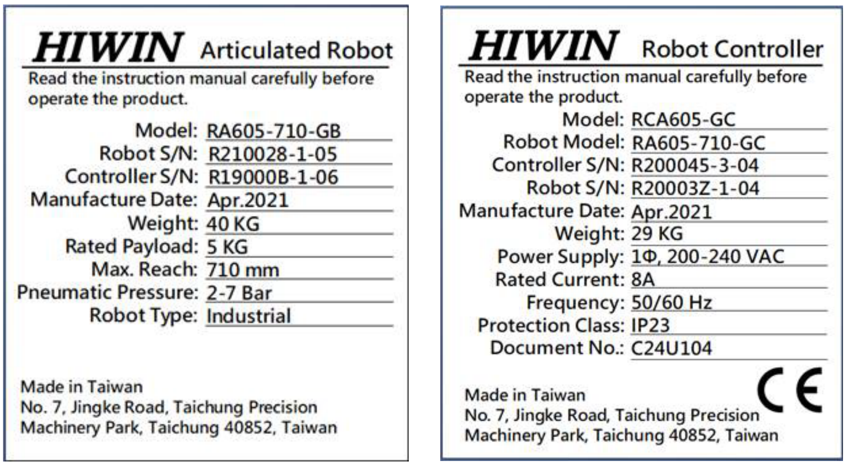
3.When connecting the robot system software HRSS, be sure to use the delivered Caterpillar for connection to avoid incompatible versions and cause injury to the robot system.

4.When updating the software, be sure to download HRSS on the official website and Caterpillar at the same time to update.

5.As described in section 1.4, first update the new version of HRSS with the old version of Caterpillar. After the update is successful, you must copy your program to the new Caterpillar folder. Only new HRSS can be connected with the new Caterpillar.

DANGER

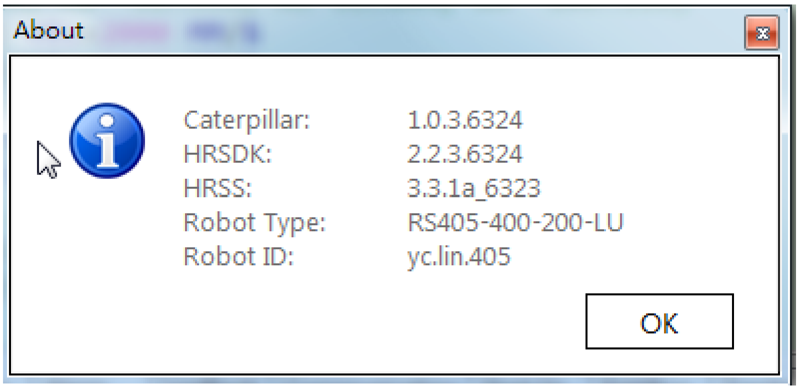
If the wrong data is loaded, the robot should not be operated! Failure to take these measurements could lead to serious injury, death or equipment damage



Name Plate (Example RA605 model)

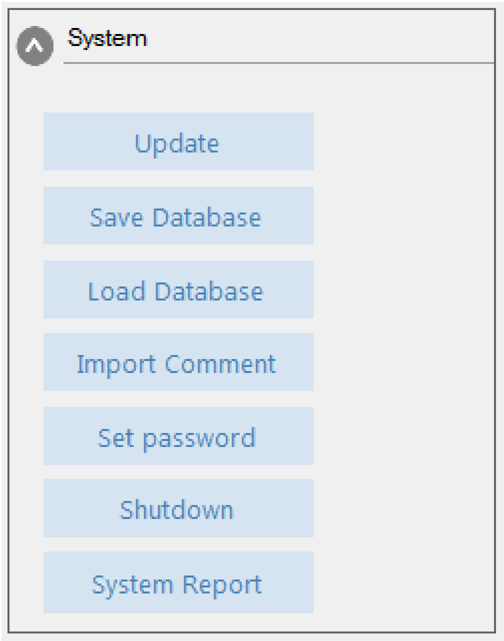
Operation steps

- View the [About] page on the above side of the remote interface software.



About interface

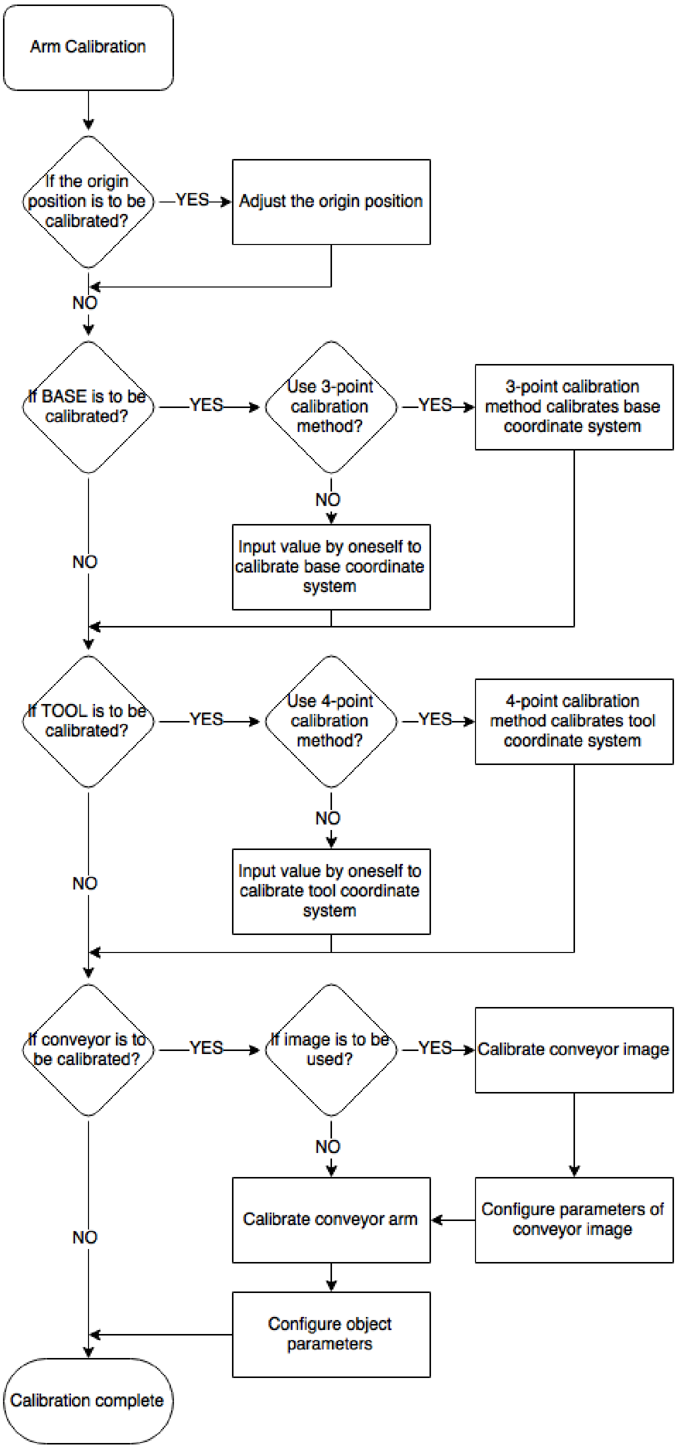
■ View the [System] page on the life side of the remote interface software.



2.2 Calibration Flow

Below Figure is the calibration flowchart of robot. According to the user's requirements, they are: Adjusting the origin position (3.6)→ Calibrate the base coordinate system (3.4.1 、3.5.1) → Calibrate the tool coordinate system (3.4.2 、3.5.2) → Calibration of conveyor image (2.12.1) → Calibration of conveyor and robot (2.12.2) → Configure the parameters of conveyor image (2.12.3) → Configure the parameters of conveyor object (2.12.4).

The above-mentioned calibration steps will be introduced in the subsequent sections.

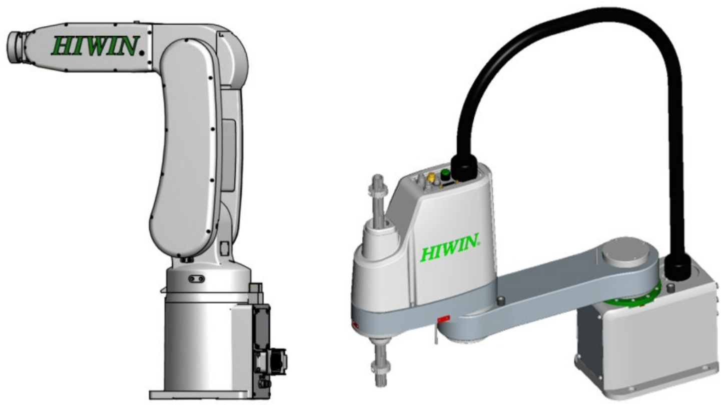


Calibration flowchart of robot

2.3 Adjust Origin Position of Hardware Mechanism

Overview

Each robot must be mastered. The robot can make Cartesian motion only after being mastered and moved to the programmed position. The mechanical position of the robot will be made consistent with the encoder during mastering. The robot must be placed on a defined mechanical position, which is the mastered position. The encoder value of each axis will be saved.



Adjust the approximate position of origin

position of origin calibrate distinguish two method : Zero position(定位校正)與 Calibration(校正)，

(1) [Calibration] Click this to return to the origin position set by the manufacturer; the robot posture must be close to the origin of the mechanism.

(2) [Zero position] Click this to modify the origin position set by the manufacturer.

distinguish position of origin mastering situation of method to select:

distinguish position of origin mastering situation of method table

Situation (put into Operation)	Method
The value of motor position is lost after maintenance such as replacement of a motor	Execute [Calibration] type
After replacement of gear unit (pulley、belt)	Execute [Calibration] type
After a collision, if robot’s position has offset state.	Execute [Calibration] type
If the absolute position is missing after replacing the battery.	Execute [Zero position] type

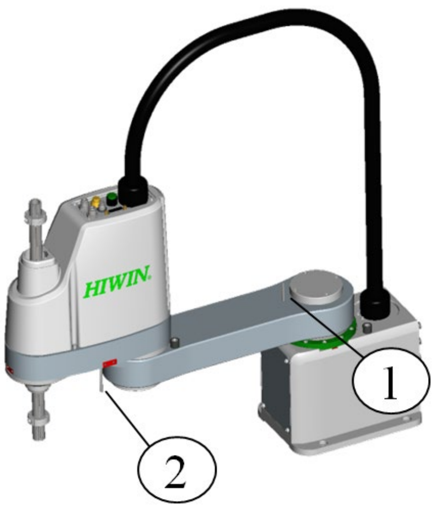
2.3.1 Four Axes Robot Mastering Method

Description

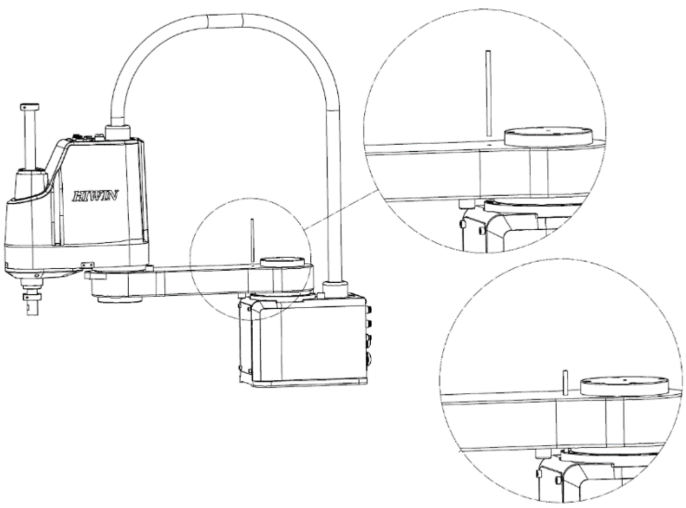
Operate the various axes to make the mechanism adjustment marks overlap and use the calibration function of the software to redefine the origin position.

WARNING

Special note: Performing this operation will lose the origin position originally set for the robot by the manufacturer; improper operations may cause errors to the positions of the corresponding surrounding points and deviation to the absolute accuracy!



Mastering mark of robot



Pin postion of first axis figure

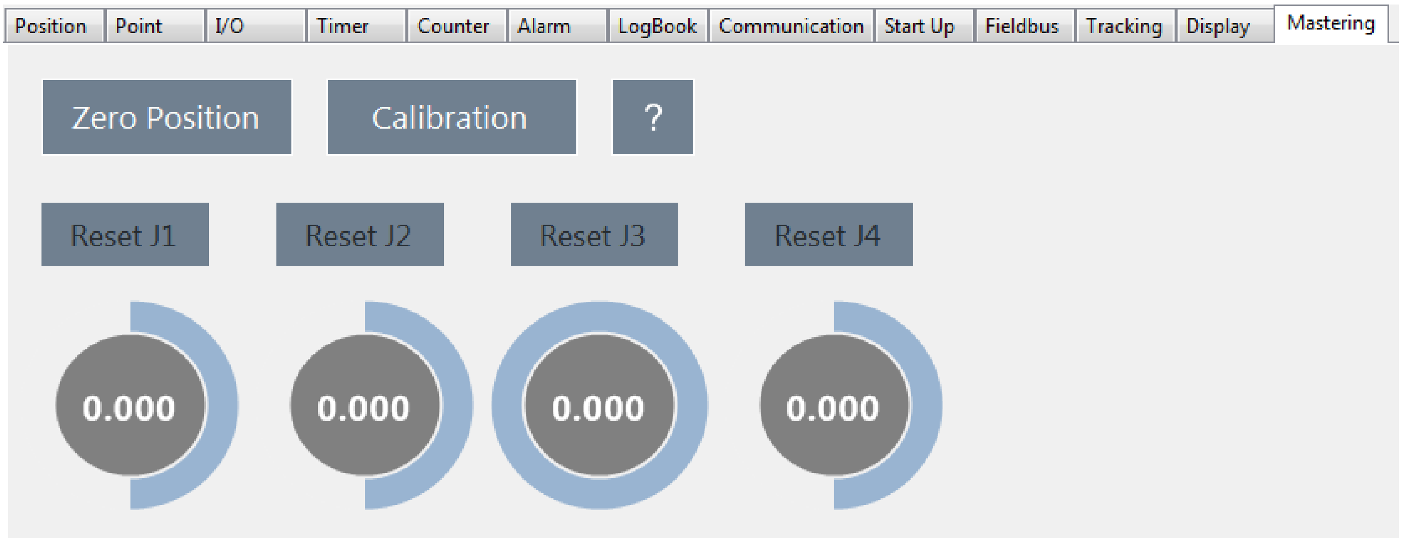
CAUTION

Depending on the model of the robot, the position of the mastering mark may be slightly different from the illustration. For the origin calibration method and image, please refer to the manual of each model.

Prerequisites

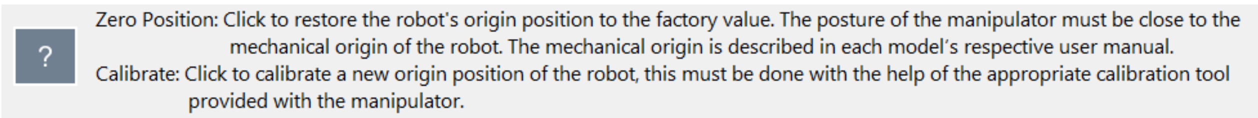
1.Manual mode.

2.Open function tab [Mastering].



Zero position interface

[?] This button shows/hides the description texts; press it once to show the texts, and press it again to hide the texts.



<u>Operator Step</u>

⚠ CAUTION

If the simulated robot position outside the limit and cannot move, please execute Reset first

■Setting origin of first-axis Step:

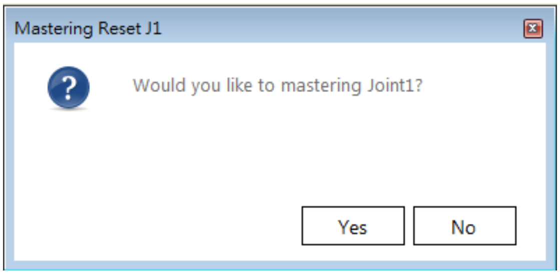
Step1：Press the emergency stop button and push the A arm with your hand until the A arm matches the calibration hole in the base.

Step2：Use the calibration tool (ψ4 bar) and insert it into the calibration hole from top to bottom; if the bar could not be inserted, use the jog screen to slowly adjust the angle until the calibration tool can be inserted into the calibration hole, and make the adjustment marks overlap. This completes the adjustment of the hardware mechanism's origin.

Step 3: Use software positioning calibration (Mastering) → [Positioning calibration Zero Position] button or [Calibration button, click [Reset J1], setting origin. Please refer to the identify origin calibration situation and practice table above for the position calibration or calibration button selection.

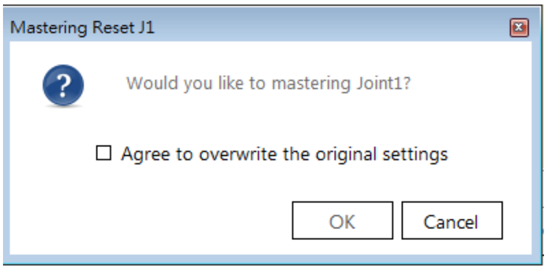
(1) Positioning calibration method: After pressing the [Positioning calibration Zero Position] button, the following figure will appear; perform return to default origin position and then press the [Yes] button to confirm the execution, or press the [No]

button to cancel execution. Press [Yes] to complete the origin position setting for the first axis; the adjustment method for this origin position is based on the origin set by the manufacturer and performing angle conversion. The angle at this time will be closer to the calibration position; for example, the first axis of RS405-400-200-LU should be close to 0 degrees.



[Zero Position] reset interface

(2) Calibration method: After pressing the [Calibration] button, perform modification to the manufacturer’s origin position and a message window will pop up, saying “You want to calibrate Joint1”, and at the bottom of the text, it shows whether to agree to execute the item, as shown in the figure below. Agree must be selected and check the field, then can the [OK] button be pressed. This adjustment method of the origin position saves the robot’s current encoder value, and modifies the origin position set by the manufacturer. The [Cancel] button cancels the execution.



[Calibration] reset interface

Step4：After software the position is determined, remove the calibration tool.

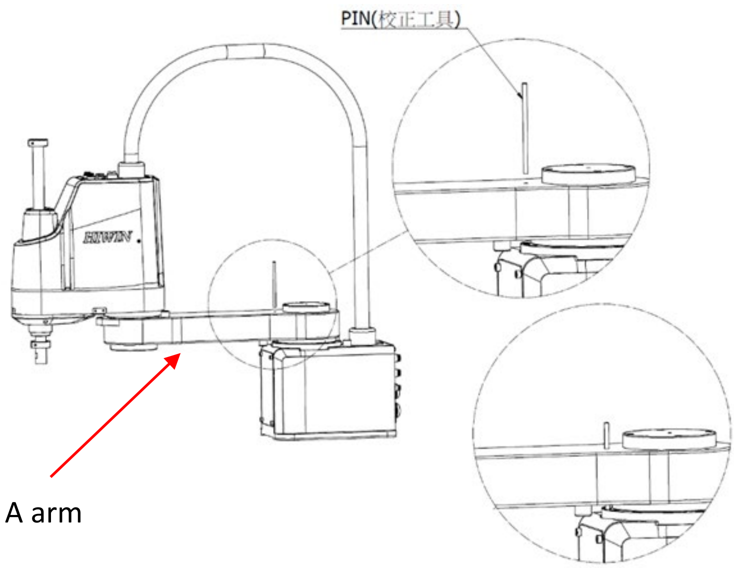


Illustration of first-axis mastering figure

■Setting origin of Second-axis Step:

Step1：Press the emergency stop button and push the B arm with your hand until the B arm matches the calibration hole of the A arm.

Step2：Use the calibration tool (ψ4 bar) and insert it into the calibration hole from bottom to top; if the bar could not be inserted, use the jog screen to slowly adjust the angle until the calibration tool can be inserted into the calibration hole, and make the adjustment marks overlap. This completes the adjustment of the hardware mechanism’s origin.

Step 3: For the software origin calibration method, please refer to the origin setting method for the first axis; click [Reset J2], setting origin.

Step 4: After the software position is determined, remove the calibration tool.

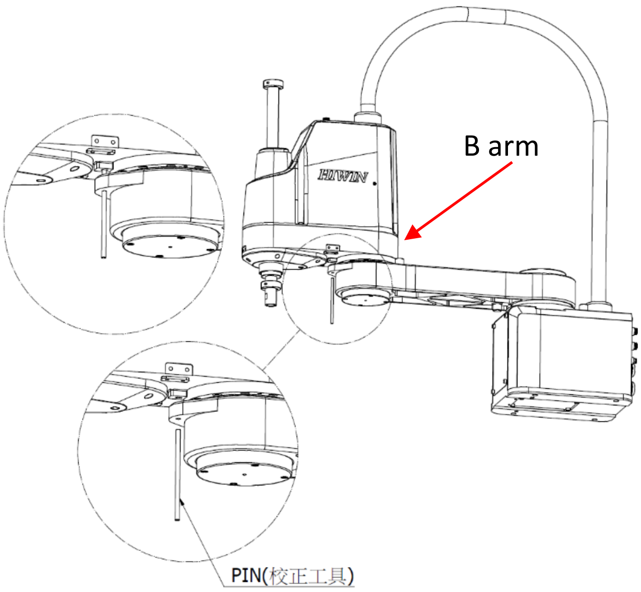


Illustration of Second-axis mastering figure

■Setting origin of third-axis & fourth-axis:

Step1. Confirm that the distance between the stop ring and the spline is 30mm, as shown below。

Step2. After pressing the emergency stop button, hold the brake release button and push the spline by hand until the stop ring contacts the body of the robot arm.

Step3. Turn the spline by hand until the upper surface of the spline is facing directly in front of the B arm, and release the brake release button.

Step4. Make sure that the stop ring is in contact with the body of the robot arm, and the upper surface of the spline is facing directly in front of the B arm.

Step5. Through the software, software calibration refers to the first home position way, after executing origin calibration for the third axis, at this time, the position for the third axis of RS405 will be recorded as +10.9mm, and the position of RS410 will be recorded as +10mm (please note that after calibrating the origin during the initial setting of the software, it will no longer be displayed as 0mm).

Model	RS405	RS410
J3 axis after calibration software display position(mm)	+10.9	+10

Step6.Through the software, select the axis 4 and set the origin position. (software calibrate refer to the first home position way)

Step7.Press the brake release button again and push the spline down about 50mm.

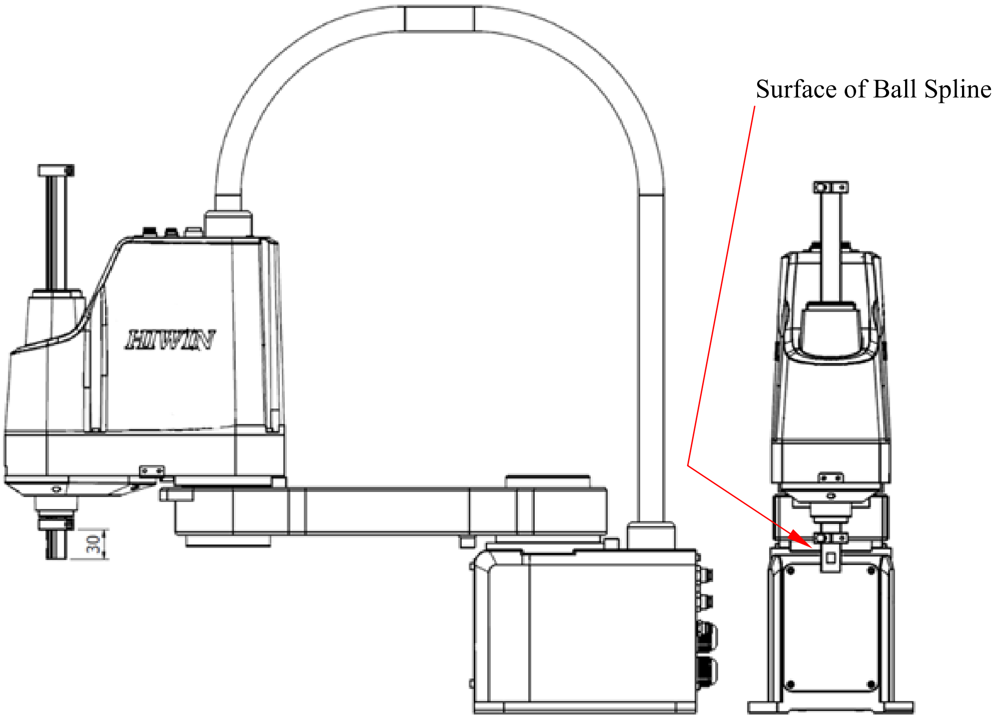


Illustration of third-axis & fourth-axis mastering figure

WARNING

Please read the warning notes before performing the calibration:

Four-axis robot:

When performing motor calibration for the third axis, operators must confirm whether the motor angle of the fourth axis is 0^{o} and the encoder value must be in the odd turn at first; if not, motor calibration must be performed for the fourth axis first.

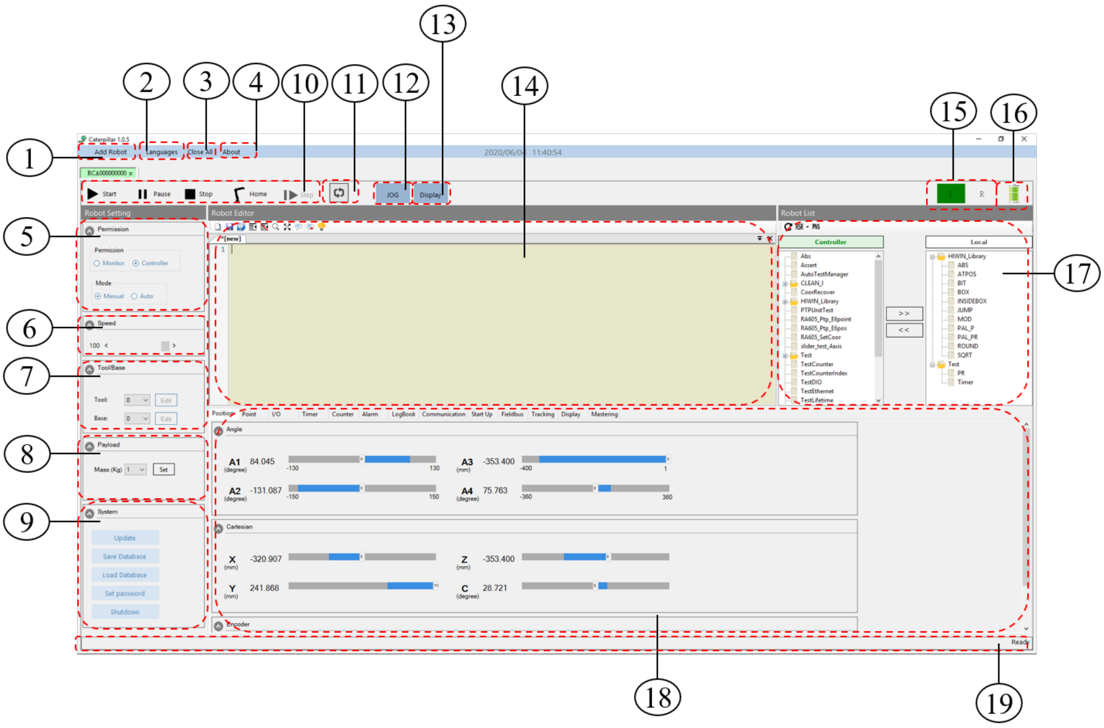
Note: Performing this operation will lose the origin position originally set for the robot by the manufacturer; improper operations may cause errors to the positions of the corresponding surrounding points and deviation to the absolute accuracy!

After calibration is completed, press the Home button and confirm whether the angle is correct. If the actual position of the robot is different from the drawing , please confirm whether the various axes have returned to their default mechanical origins and completed calibration.

3.Interface Operation Setting

3.1 Remote Operation Interface of software

3.1.1 Remote Operation Setting



Remote Operation Interface

No	Function Name	Description
1	Connect Menu	Add robot and close all robot connections.
2	Language Change	Change language to English, Traditional Chinese and Simplified Chinese.
3	Connect Function	Close All connection.
4	About	Display the version of HRSS and robot type. Update HRSS software. IF connect to Robot, will display HRSS Vision.
5	Operation Mode Area	Connection Permission and operation mode setting. Change manual and automation mode.
6	Velocity Ratio	Display by the program to change the ratio.
7	Tool and Base Setting	Display the selected tool and base number. Click to change the tool and base number.
8	Payload	RS405 and RS410 is supported to set acceleration time (ms).
9	System Function	Update software、Save and load database and password Setting.
10	Program Execution Buttons	The buttons are used for start, pause and stop the program. Hold home button to return the robot to the home position. Click motion button to next step.

11	Step Motion	Change step motion and continue motion.
12	Teach button	Display/undisplay teach of operation window.
13	3D Simulation	Display/undisplay 3D simulation of robot.
14	Program Editor	Edit robot program window.
15	Status Bar	Display driver and interpreter status
16	Battery Figure	Display the status of absolute encoder’s battery.
17	Program List	Program files on robot controller and local computer
18	Function Page	Switch the setting function
19	Execution State Bar	Execution state and alarm display.

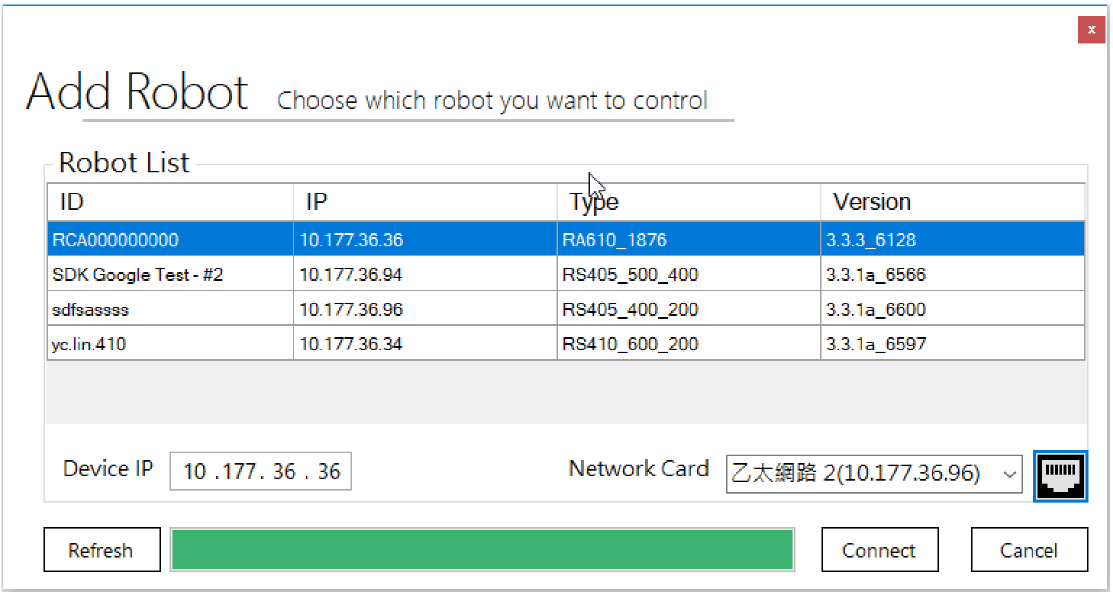
3.1.1.1 Connection Operator Step Description

Operation Steps

1.Wait for controller power switch is on and startup finish. (The robot’s LED light is flashing.)

2.Press “Add Robot” and choose a network card to detect robots.

3. Select to connect robot IP and Type, press “Connect” button.



Connection Interface

Description

1. The default IP is 192.168.0.3 on RC4 robot controller.

2.If failed to detect robot, please check the internet connection to see if it is connected properly.

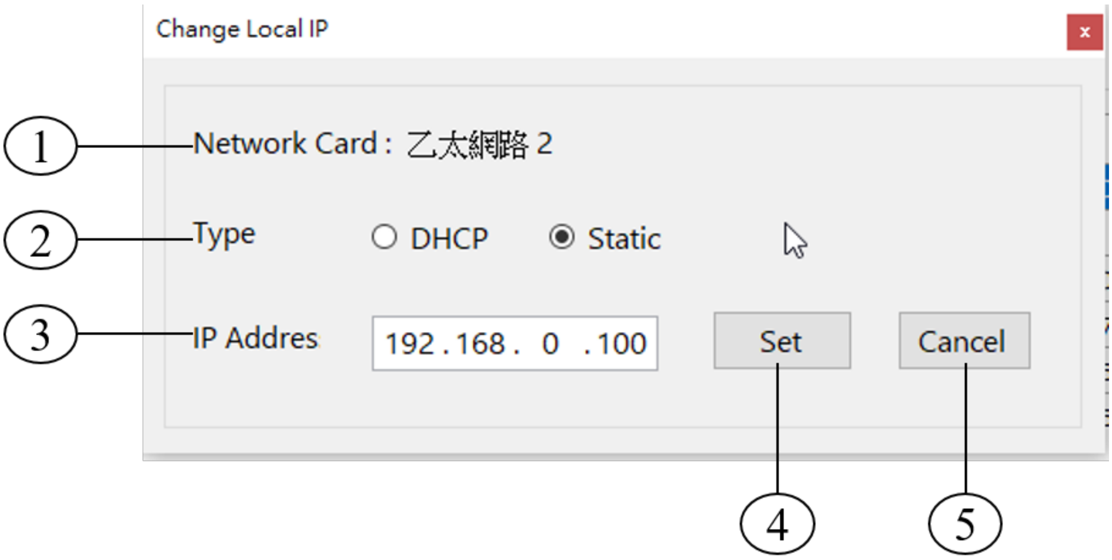
3.1.1.2 Change local PC of IP

Operation Steps

1.Select “Change IP” button。

2.Go to Change local IP interface and Setting IP。

Change IP button



Change local IP Interface

No.	Name	Description
1	Network Card name	Select network card name
2	Change Connect Type	IP Change Connect to DHCP/Static Type
3	IP Address	Want to Change IP Address。
4	Setting	Enter in parameters and save setting.
5	Cancel	Cancel setting, and close the window.

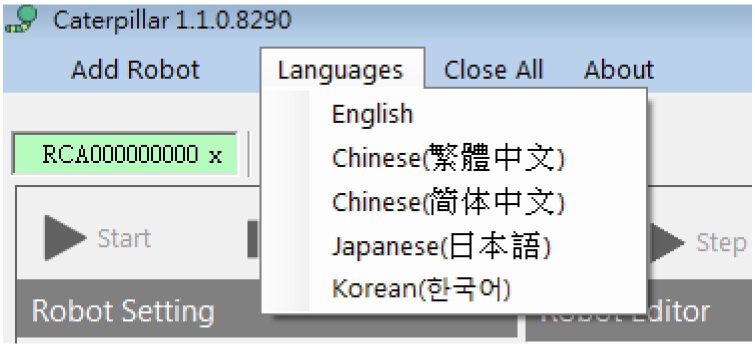
3.1.2 Language Setting

Description

Setting remote operation robot software of language.

The interface enables five different languages to be selected for the setting: English(en-US), Traditional Chinese(zh-TW), Simplified Chinese(zh-CN), Japanese(ja-JP), and Korean(ko_KR).

When setting is completed, Software will close the interface and restart Caterpillar software. The change language is successful。



語言切換設定

Item	Description
English	English. (en-US)
Chinese(繁體中文)	Traditional Chinese.(zh-TW)
Chinese(繁体中文)	Simplified Chinese.(zh-CN)
Japanese(日本語)	Japanese(ja-JP)
Korean(한국어)	Korean(ko_KR)

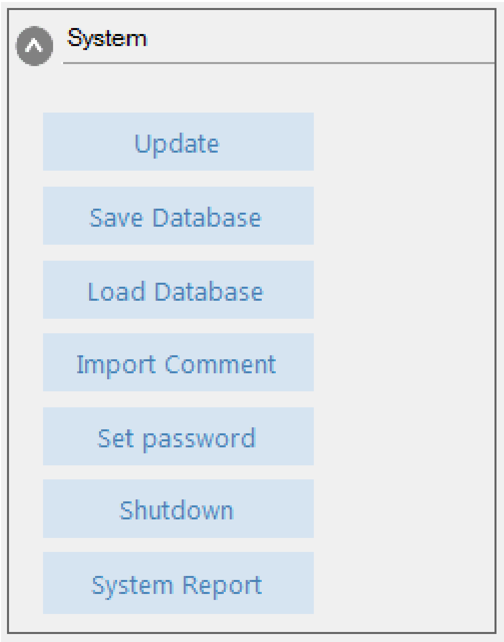
3.1.3 Export system reports

Description

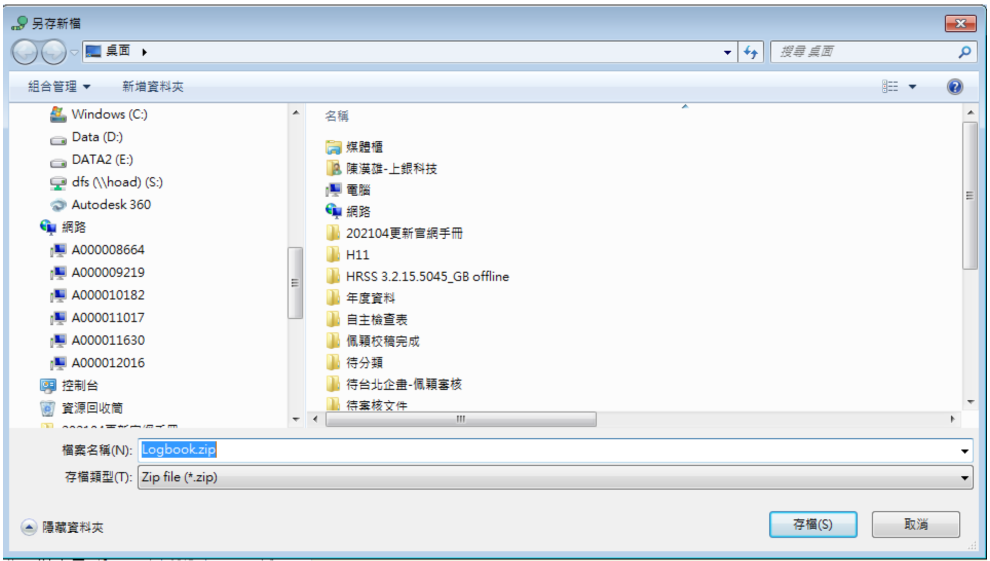
When errors occur on the software system, please use the “System report” button to backup the current logbook of the errors (compressed Zip file). Then send this compressed file back to the manufacturing engineers; the engineers can analyze the cause of the system faults from this file.

Instructions

1. Click the “System Report” button on left side of the system interface as shown below.
2. A file window will pop up; select the storage path and then click the “Save” button.



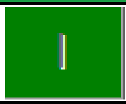
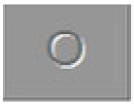
Interface of Export System Report



Saving the system logbook window

3.1.4 Status Bar Display Description

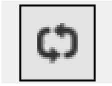
HRSS tatus Block of Driver

Figure	Color	Description
	Green	Driver ready
	Gray	Driver not ready

HRSS status Block of execution

Figure	Color	Description
	Orange	Interpreter running
	Gray	Interpreter failure or stop

Program operation control buttons description.

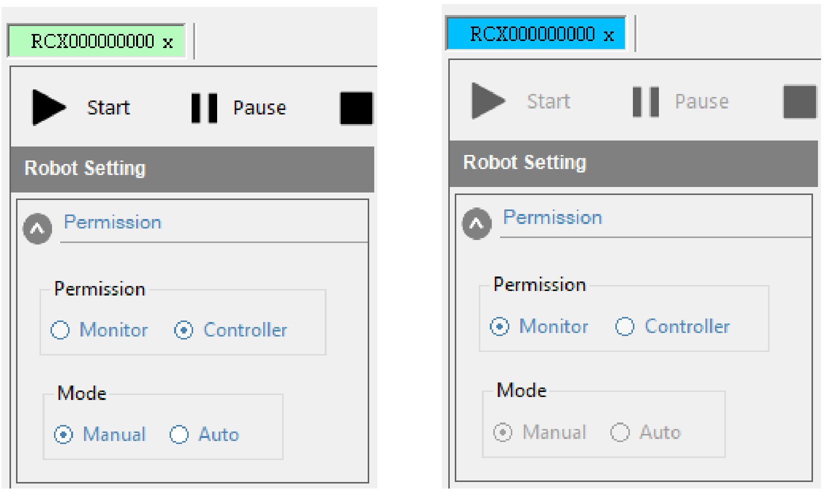
Figure	Description
	Start program. Press F5
	Pause program. Press F6
	Stop program. Press F7
	Return to origin.
	Step execution.
	Program cycle/step execution switch button.

3.1.5 Connection Level and Change Operation Mode

■There are two connection levels: Controller and Monitor. If the Controller's level is green level color, and monitor's level is blue level color

■Single connection with controller level is allowed on a robot.

■The default connection level is Monitor.



Operator mode interface

WARNING

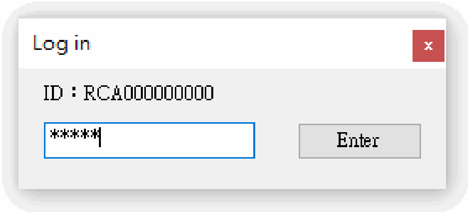
Don’t modify the operation mode during programming period. If it is changed, the robot will stop.

Prerequisite

1.The controller doesn’t process any program.

Operation Steps

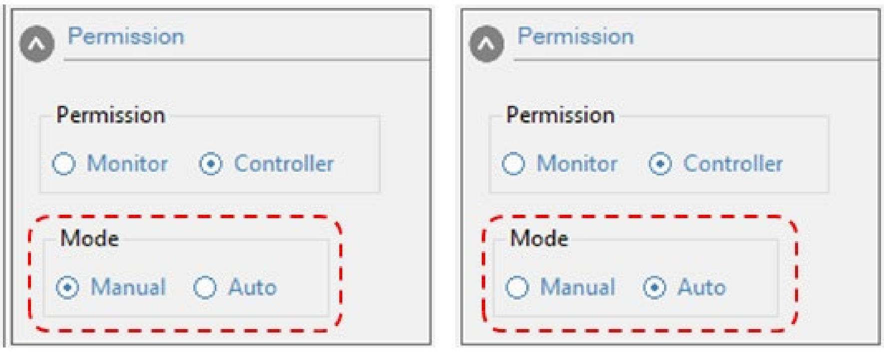
1.Select operation mode，If switch operation mode is needed, enter password (”HIWIN”) and login. Default password is allowed to modify by user self-defined.



Login Window

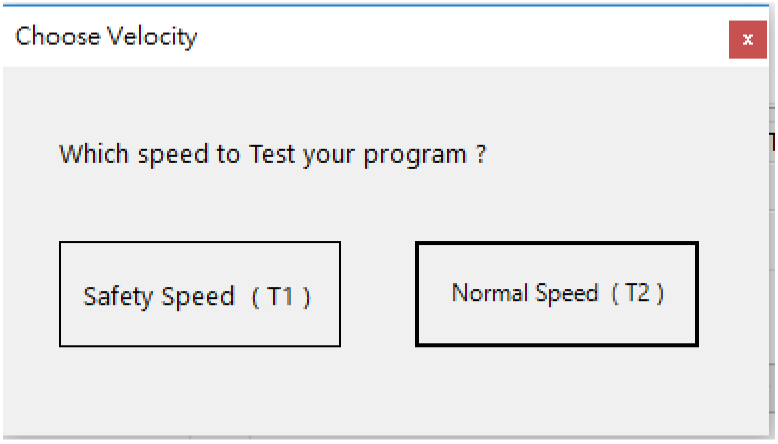
2.Select the operation mode have Manual or Auto mode, change mode don’t need key in password.

3.When operation mode on the Manual mode, select program to run. Choose running velocity if Manual is selected. There are Testing Speed and Normal Speed.



Change operation mode interface

Mode	Application	Running Velocity	JOG Velocity
Manual	Use for test operation, programming and teaching	Safety Speed: maximum 250 mm/s Normal Speed: maximum 2000 mm/s	Maximum 250 mm/s
Auto	Used for the robot with the higher-level controllers (For example, PLC)	maximum 2000 mm/s	Unavailable

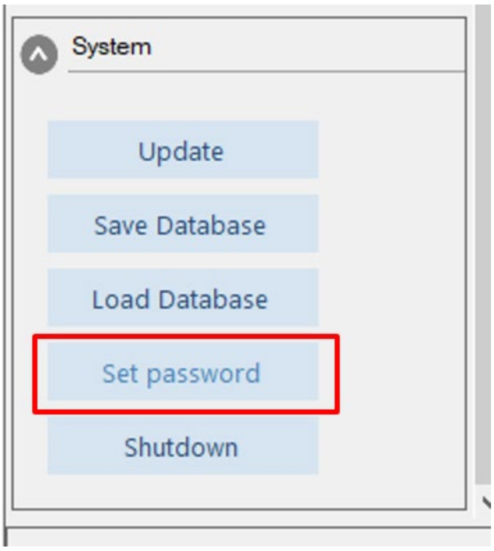


Choose Running Velocity Window

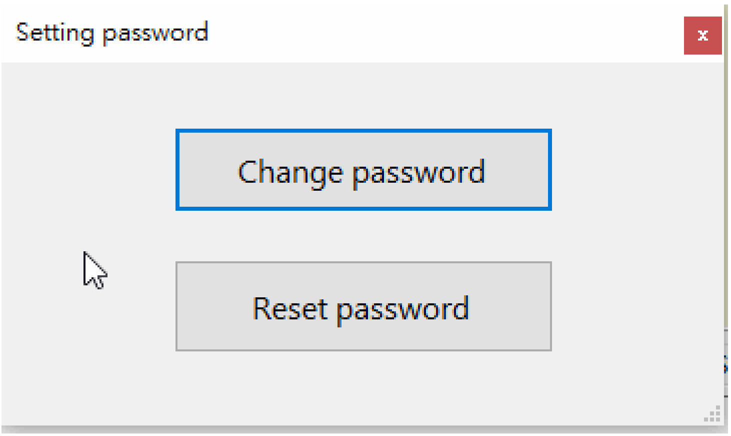
3.1.5.1 Change password

Instructions: -

1. Connect the robot at first.
2. Click Set password button in the left side of “System” interface.



System Interface



Change password window

3. Click change password to change the operation password.
4. If users forgot the operation password; click Reset password to restore the factory password.

3.1.5.2 Changing operation password

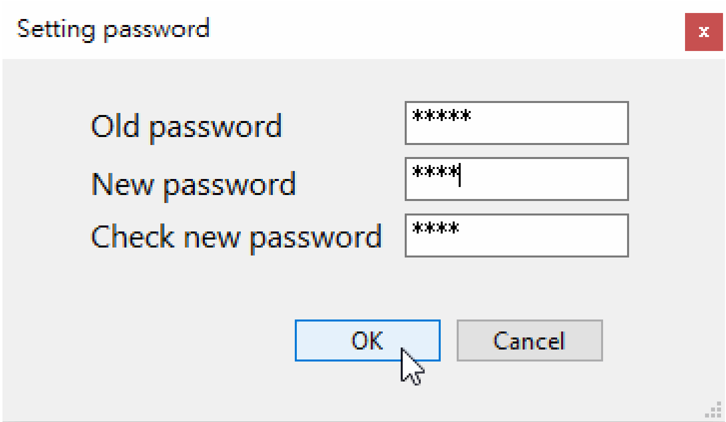
Instructions

1.Select Change password.

2.Users must enter the original password at first, and then enter the new password, confirm the new password, and press OK to set the password.

3.Selecting Cancel will return to the previous Set custom password screen.

※When the incorrect password is entered or the new password and check new password does not match, a prompt window will say failed. When it is match, a prompt window will say password changed successfully.



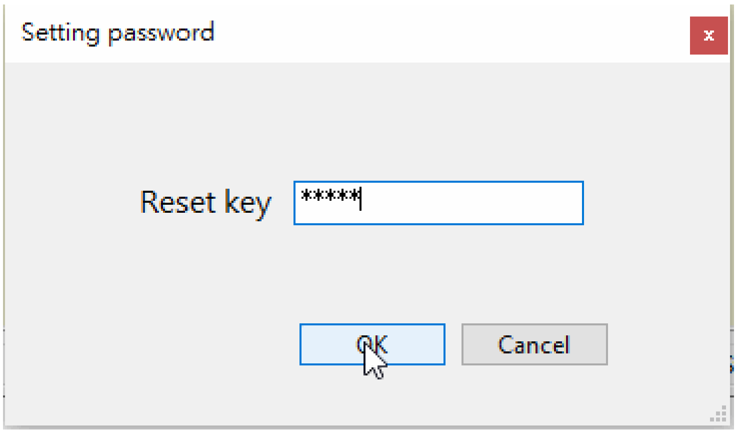
Reset password window

3.1.5.3 Restoring operation password

Instructions

1. Select Reset password.
2. Users must call customer service and provide the Mac serial number (displayed in About section) and the year and month of the robot.

3. Customer service will provide a set of Reset key for the user to enter; setting successful will appear if entered correctly, otherwise setting failed will appear.



Restoring operation password page

3.1.6 Tab display function description

3.1.6.1 Actual Position Display

Operation steps:

1.Click the operating tab of [Position]。

Description:

Display the motor position, the axis and the Cartesian coordinate of current base.

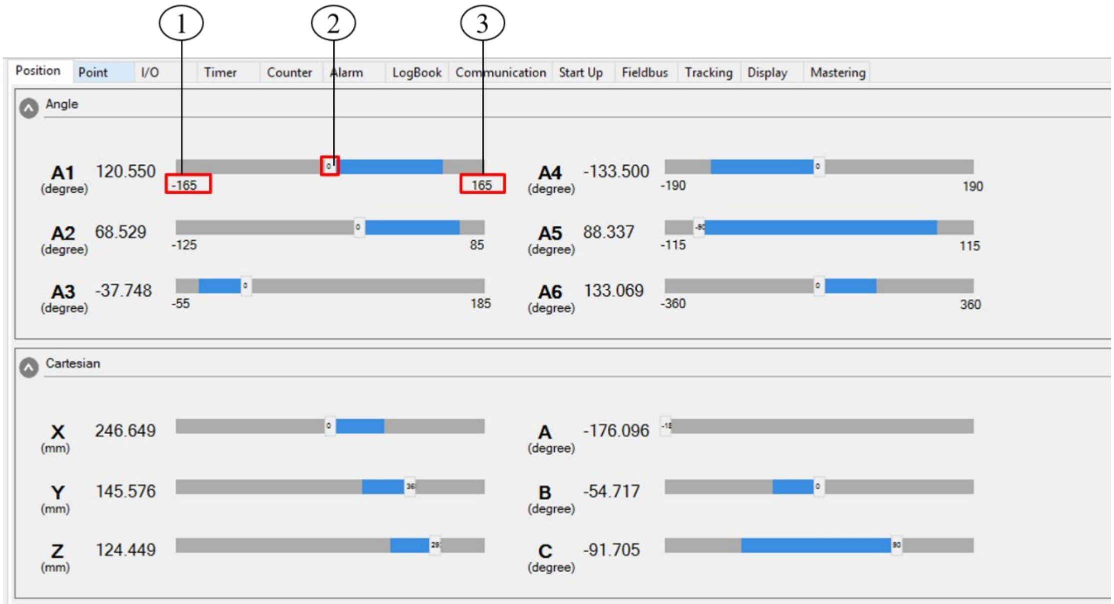
If the 6-axis robot is operated, 6-axis information will be displayed.

If the 4-axis robot is operated, 4-axis information will be displayed.

If the soft limit function is enabled, the limit value on the interface will be updated according to the user setting.

Only when the soft limit function is enabled for the Cartesian coordinates will the upper and lower limit values of the Cartesian coordinates be displayed.

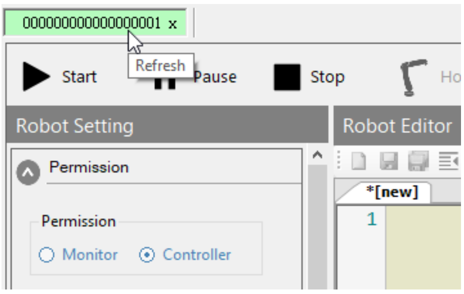
Refer to Chapter 3.6.8: Soft limit function.



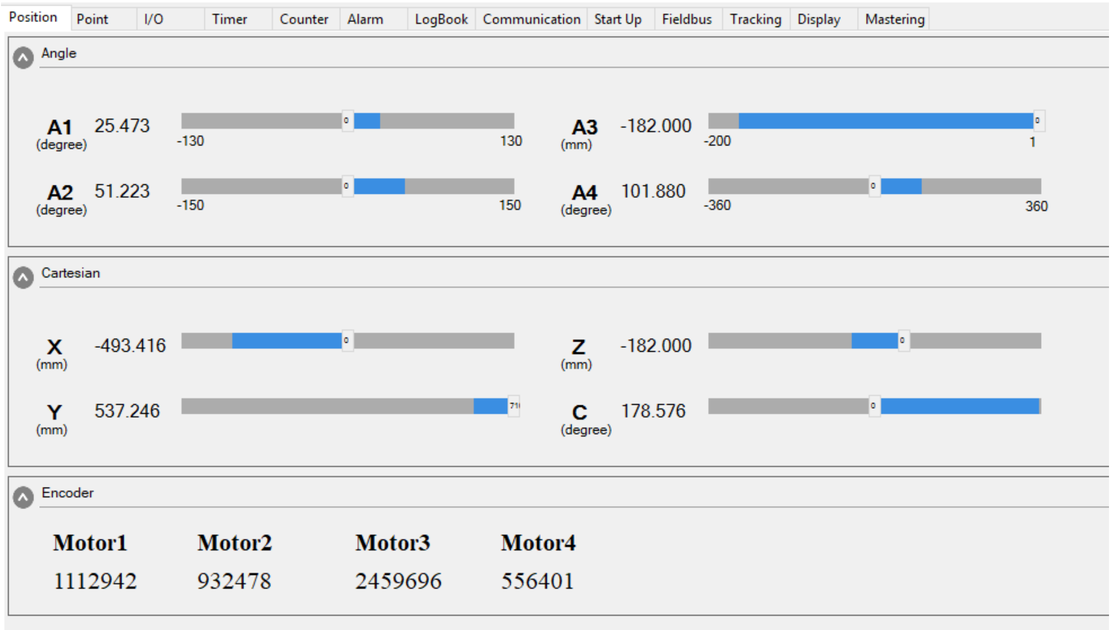
Actual Position Interface

No.	Description
1	Lower limit value on the axis
2	Home point position.
3	Upper limit value on the axis

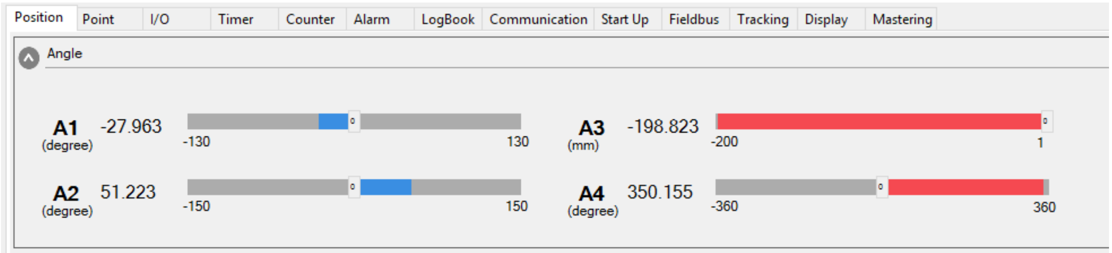
3.1.6.2 Real-time update of the current position



Click the left mouse button on the label of each tab to update the current axis coordinates, Cartesian coordinates and motor encoder information under the Position page in real-time.



The axis coordinates bar will turn red if it reaches ±10 degrees/ ±10mm of the maximum reach.



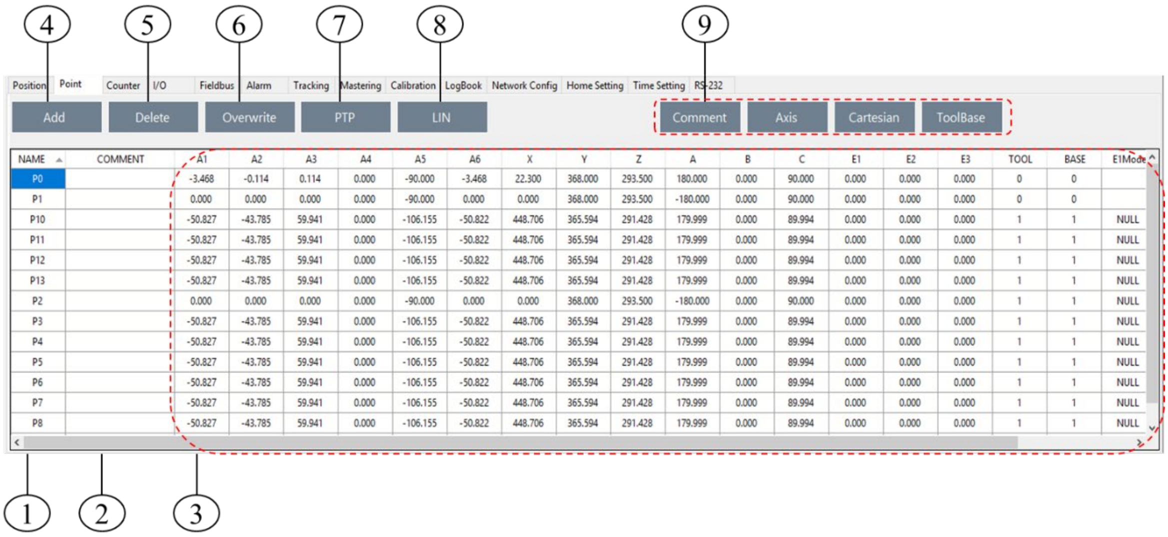
3.1.6.3 Display Point Page

If there is the need to change point coordinates, click on the Cartesian coordinates and modify the values directly; the values of the axis coordinates on the point list will be updated synchronously. If the modified coordinates are connected with external axes, the external axes coordinates will also be updated synchronously.

Operation steps:

■Click the operating tab of [Point].

Description:



Point interface

No.	Description
1	Point name.
2	Point comment. (It can be modified.)
3	Information for points, includes angle of each axis (A1~A6), Cartesian coordinates (X,Y,Z,A,B,C), and number of Tool/Base used.
4	Add a new point with the current information.
5	Delete a selected point.
6	Overwrite a selected point.
7	Move to selected point by PTP.
8	Move to selected point by LINE.
9	Adjust the data arrangement.

Description of adjusting arrangement of data:

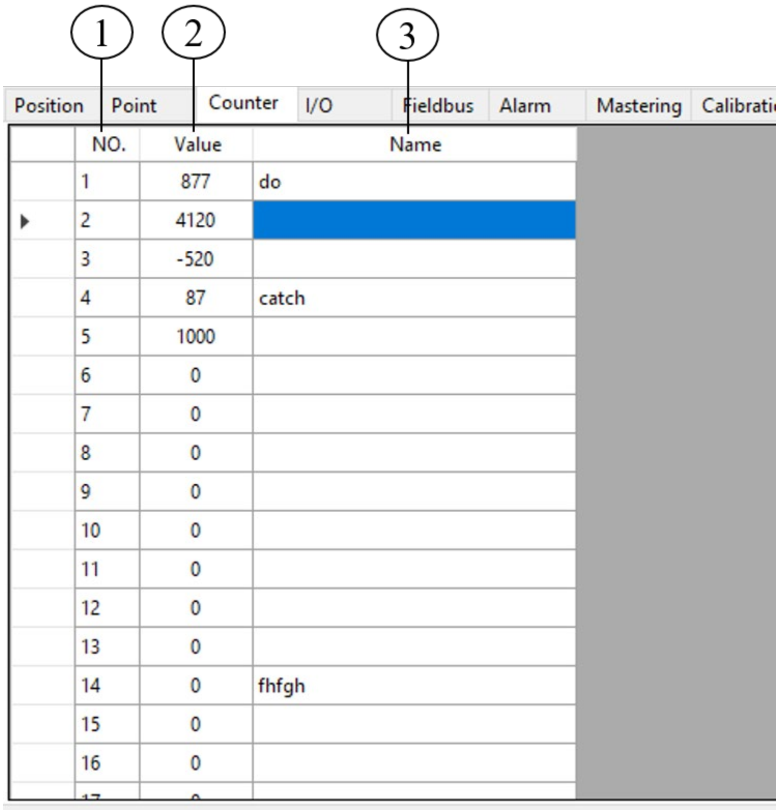
Press the button will hide the corresponding point information, and then display it in the order of clicking.

3.1.6.4 Display Counter Variable Page

Operation steps:

Click the operating tab of [Counter].

Description:



Counter interface

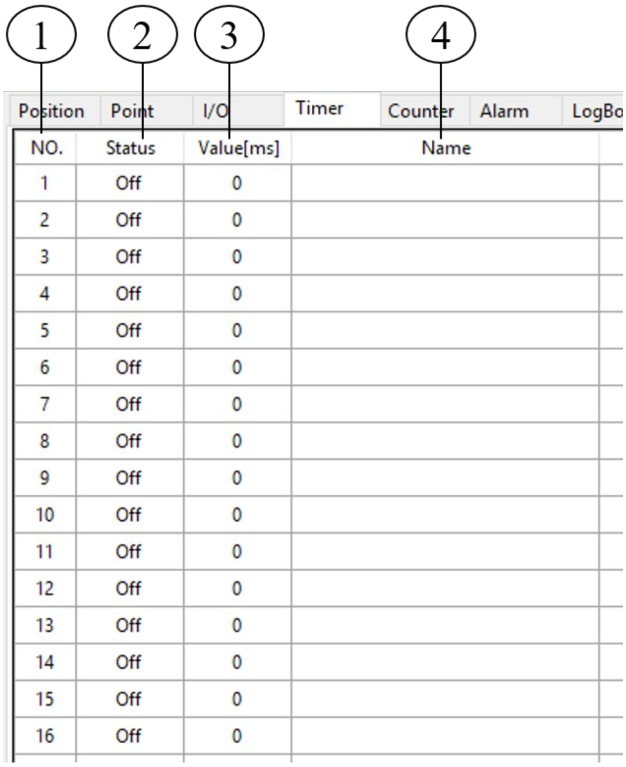
No.	Description
1	Counter No.
2	Counter value.(Double click to modify.)
3	Counter name.(Double click to modify.)

3.1.6.5 Display Timer Variable Page

Operating steps

Click the function tab [Timer].

Description



Timer interface

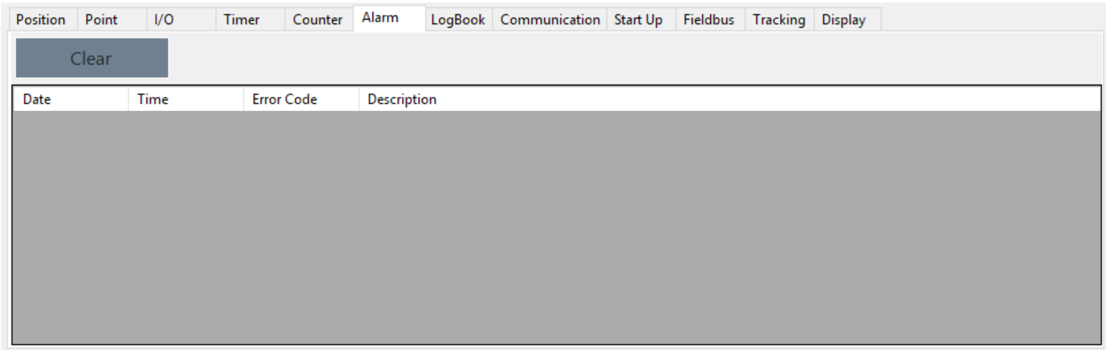
No.	Description
1	Timer number
2	Timer state
3	Timer value (Double click to modify.)
4	Timer name (Double click to modify.)

3.1.6.6 Display Alarm Page

Operating steps

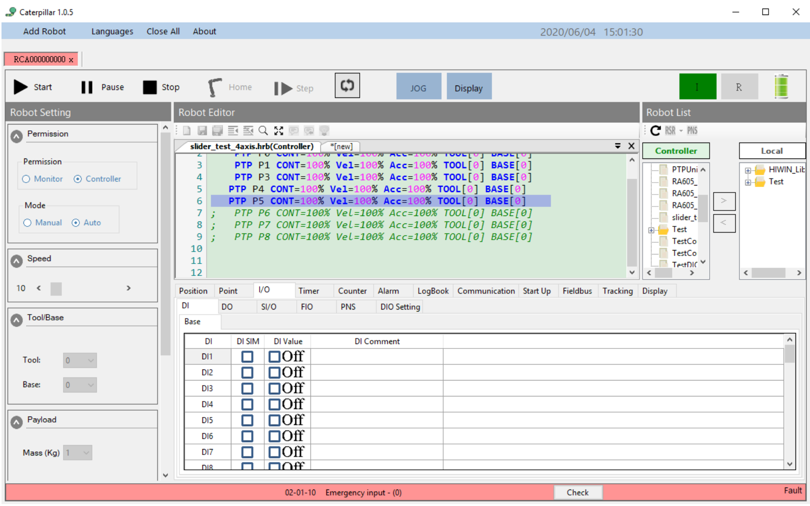
Click the function tab [Alarm]。

Description

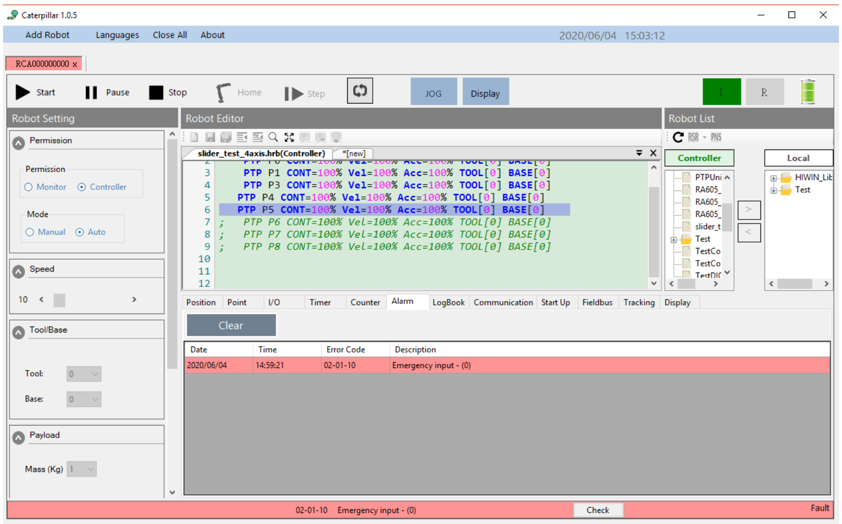


Alarm interface

If the alarm sounds, the alarm information will be displayed permanently on the status bar until it is cleared, as shown in the below figure:



Click “Check” Button，change to “Alarm” tab:


Caterpillar 1.0.5
Add Robot
Languages
Close All
About
2020/06/04 15:03:12
RCA000000000
Start
Pause
Stop
Home
Step
JOG
Display
Robot Setting
Permission
Monitor
Controller
Mode
Manual
Auto
Speed
Tool/Base
Tool:
Base:
Payload
Mass (Kg)
Robot Editor
slider_test_4axis.hrb(Controller)
*[new]
PTP P1 CONT=100% Vel=100% Acc=100% TOOL[0] BASE[0]
PTP P3 CONT=100% Vel=100% Acc=100% TOOL[0] BASE[0]
PTP P4 CONT=100% Vel=100% Acc=100% TOOL[0] BASE[0]
PTP P5 CONT=100% Vel=100% Acc=100% TOOL[0] BASE[0]
; PTP P6 CONT=100% Vel=100% Acc=100% TOOL[0] BASE[0]
; PTP P7 CONT=100% Vel=100% Acc=100% TOOL[0] BASE[0]
; PTP P8 CONT=100% Vel=100% Acc=100% TOOL[0] BASE[0]
Position
Point
I/O
Timer
Counter
Alarm
LogBook
Communication
Start Up
Fieldbus
Tracking
Display
Clear
Date
Time
Error Code
Description
2020/06/04
14:59:21
02-01-10
Emergency input - (0)
Robot List
Controller
Local
HIWIN_Lib
Test
02-01-10 Emergency input - (0)
Check
Fault

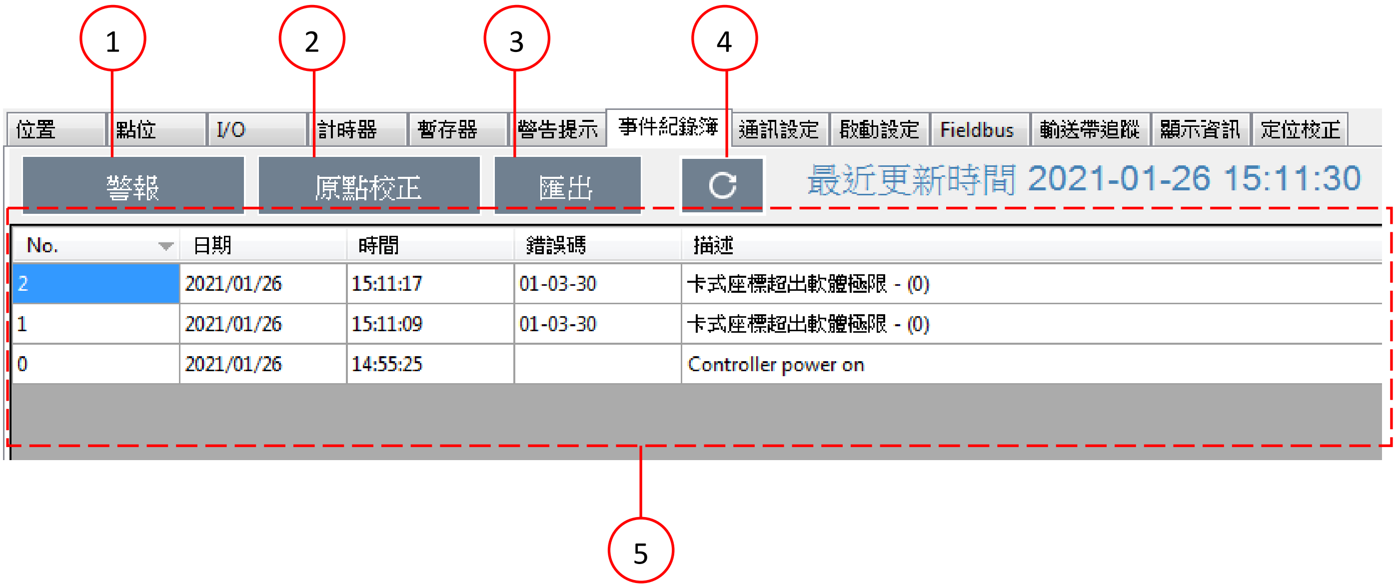
3.1.6.7 Display LogBook and Zero Position History Message

Operating steps

Click the function tab [LogBook]。

Description

Record alarm occurrences and events.



LogBook interface

LogBook description table

No.	name	Description
1	Alarm type of record button	Displays error and event record lists that includes information such as the time, error code and error description.
2	Origin calibration type record button	Displays the mechanism origin adjustment record list that includes information such as time, error code and error description.
3	Export record button	Can Download the record file. This record file will be exported as a compressed file. Entire history records can be viewed from this file. The related files can be sent back to the technical staff of the manufacturer for troubleshooting purpose.
4	Reset button	Refreshes and send the list of information from controller terminal's to the local terminal. The last updated time will be displayed on the screen.
5	Display error list window	Records list; the errors details will be displayed. E.g Home calibration (ZeroPosition).

3.1.7 Update Controller of HRSS Software Version

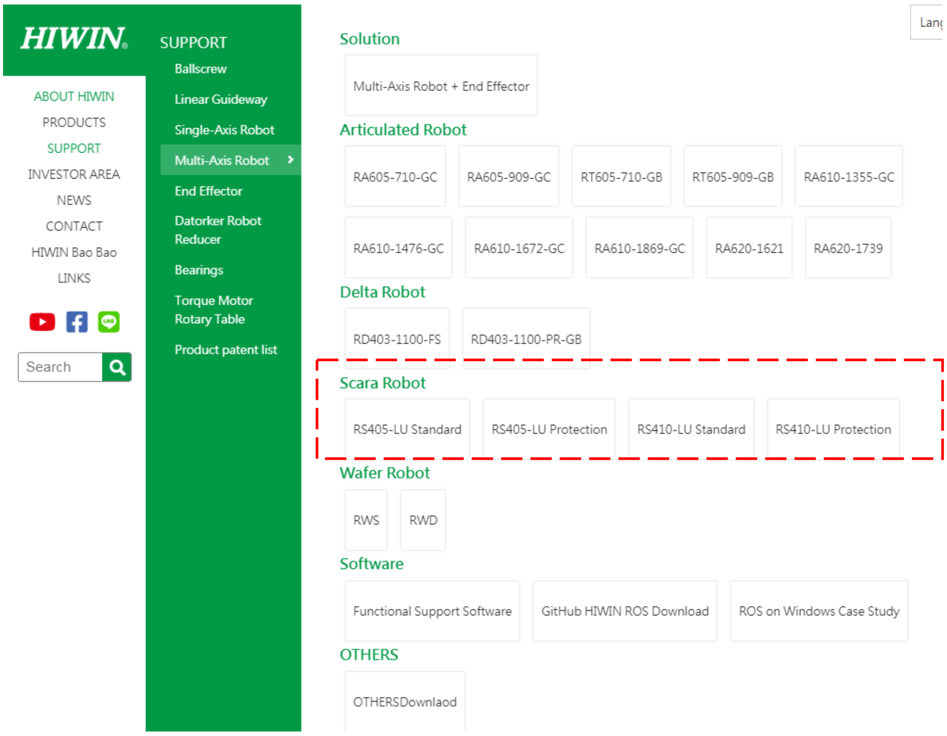
Description

Users can download the HRSS and Caterpillar software update files at the same time from the official HIWIN website, and operate update in Caterpillar interface.

Operation steps

1.Connect to the official website of HIWIN (www.hiwin.tw)

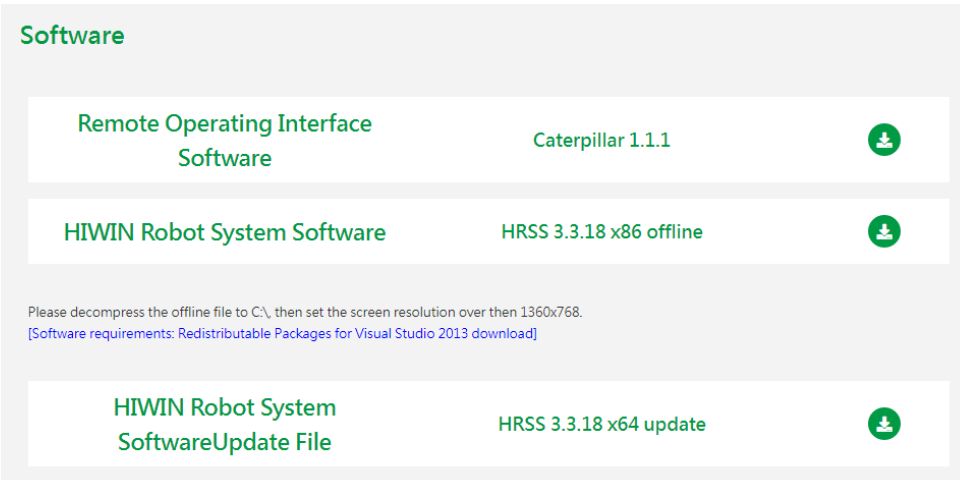
2.On the web page select: Support>Multi axis Robot>SCARA.



official website of HIWIN figure

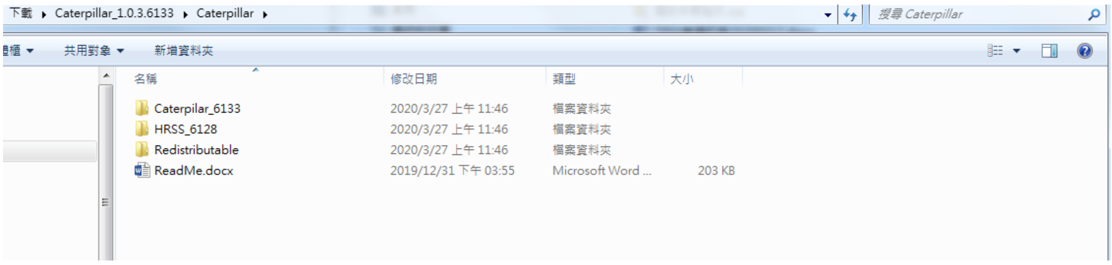
■Choose robot type, enter the website.

■Download Caterpillar and HRSS update file.



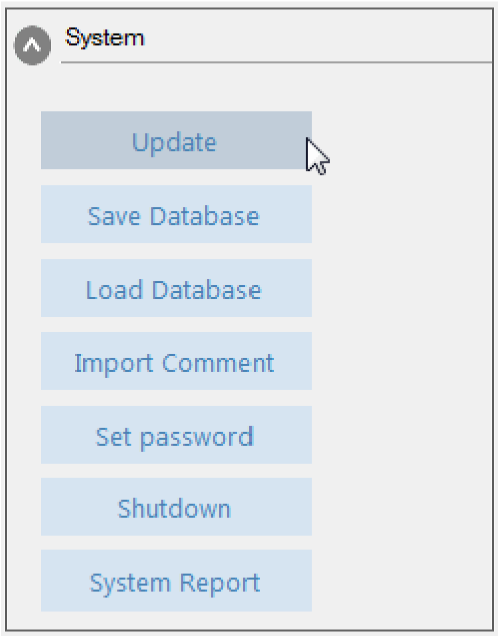
Download update file

After download file, then zip the file.



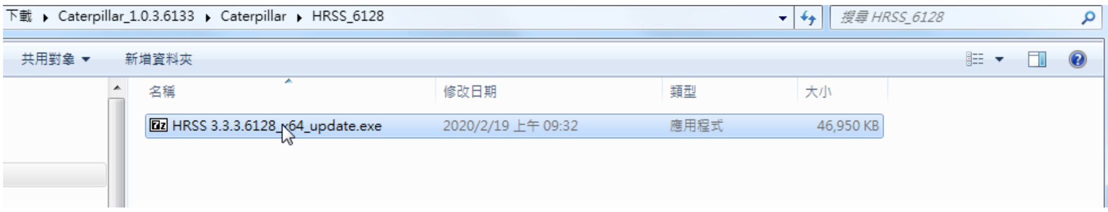
■Read ”ReadMe” document. This folder includes a new version of the HRSS update file and Caterpillar.

■Click left side “System” Interface, Update button.

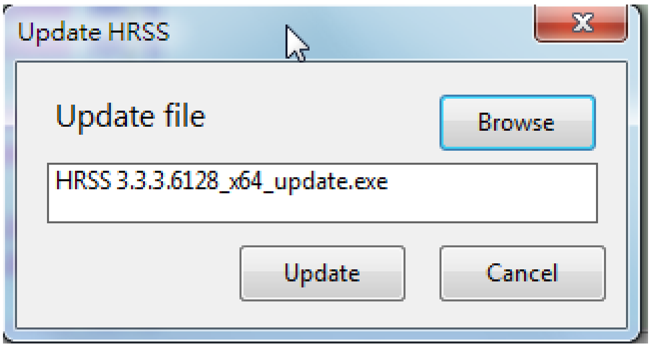


Update HRSS button

■Choose HRSS updatefile (.exe), to do update.



Choose HRSS update file figure



Update file interface

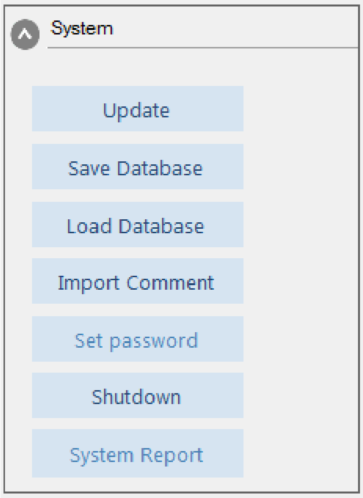
⚠ CAUTION

1. The software update package contains HRSS and Caterpillar. The two versions are dependent and must be downloaded at the same time and updated together.
2. Update the HRSS before you can use the new Caterpillar.
3. Before updating the software, please check current software version, for example: HRSS 3.2.1.2673, please download version with same two number at the front, e.g. HRSS 3.2.2.2775 or HRSS 3.2.4.2925. Do not download version that has two different number at the front, e.g. HRSS 3.3.x.x to avoid incompatible.
4. Download the Caterpillar update package with the HRSS update file.
5. Open the old version of Caterpillar, update the controller software after connecting the robot. Press Update button in the lower left corner, and select the HRSS update package .exe file to do update procedure. (It will be disconnected after the update)
6. Copy the .hrb files from the old Caterpillar directory to the new one.
7. Open the new Caterpillar and connect the robot (Do not use the old version of Caterpillar to connect the robot after updating the controller software.)

3.1.8 Saving and reading of database

Description

Saves and reads the contents of the database; the extension of database files is .db files. The recorded contents in the database the tool/base coordinate systems, comment of the I/O window (DI/O, RI/O, MI/O, SI/O), comment of the counter register, comment of the position register, setting information of the network connection interface and the setting information of the RS-232 communication interface.
There are three options for the database: Save Database, Load Database and Import Comment.



Save Database, Load Database and Import Comment interfaces

■ **Description of Save Database:**

Description

Save Database is used to backup the database file (.db) of the controller terminal. If there is a need to restore database settings, it can be done through the Load Database function.

Operation steps

1.Click the Save Database button on the left side interface of System.

2.A save window will pop up; select the storage path and then click the “Save” button.

■ **Description of Load Database:**

Description

Load (restore) the database to overwrite the database file (.db) of the controller terminal, replacing the contents of the existing database.

(The name of the database file must be “Custom.db”, otherwise it could not load successfully).

⚠ CAUTION

The restoring data & the robot where you would like to load this restoring data must have the same robot model and software version. If you load other database files, the following results may occur:

1. Wrong information.
2. Robot controller cannot operate.
3. Personal injuries and property loss.

Operation steps

1.Click the Load Database button on the left interface of the SYSTEM.

2.A load data window will pop up; after selecting the load path file (.db), press the “Open” button.

3.The power of the controller must be restarted. Only by the restarting; the loading data will become effective.

- **Import comment:** This is only applicable to Caterpillar version 1.1.0 and above

Description

Import comment is importing the text comments of the controller terminal from the database file (.db), overwriting the contents of existing text comments. Users can choose the option to overwrite manually to perform either a single or multiple import operations.

Users can backup the comment files when they want to import them into the different robots.

⇨ Usage scenarios:

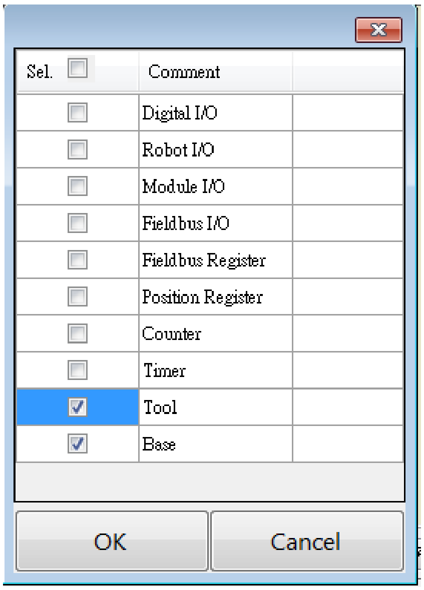
After editing the comments offline, first export them into files through Caterpillar, and then import them into the robot to complete related comments and supplements.

Operating steps

1.Click the Import Comment button under System on the left interface.

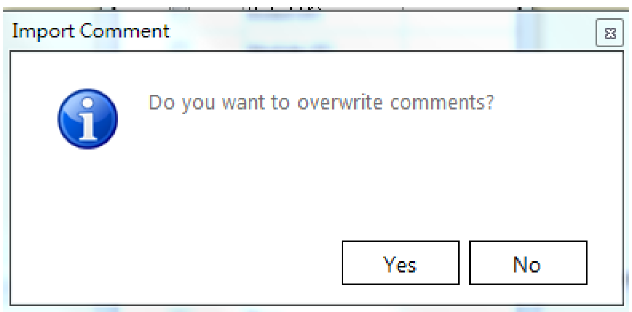
A load data window will pop up; after selecting the database file (.db) to import, press the "Open" button.

2.Below shown Check options window will pop up for the selected database to import; tick the required data base items of the to import, multiple choices can be made. Take the below figure below for example. The Tool and Base databases are ticked simultaneously for import operation. (If Sel. on top of the window is checked, all options will either be checked likewise unchecked).



Import comment selection window

3.Click "OK" button to confirm. The saved database will be imported into the control system of the robot; click the "Clear" button to return to the Load Database screen. Press the "Yes" button for a overwriting message, and confirm that the database text comment is displayed in the window (no need to restart); please note that the existing text comment will be overwritten.



Import Comment overwrite confirmation window

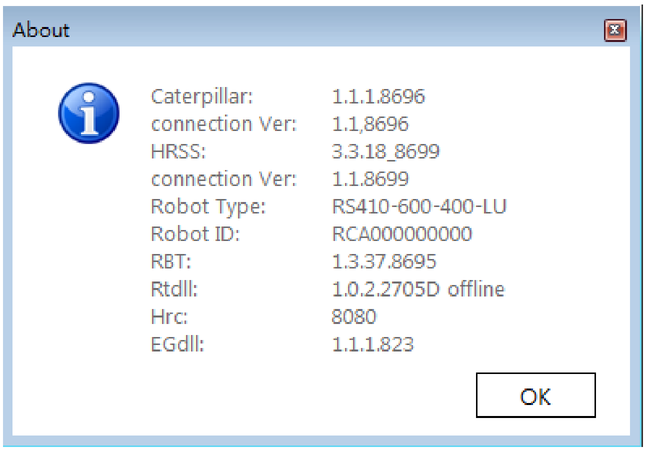
3.1.9 About Robot information display window

<u>Description</u>

Displays the version and model number information of the robot currently connected; it is used for confirming robot information. Take the figure below for example: The model number of the robot is RS405-500-200-LU, the HRSS software version is 3.3.18_8699, the version of the Caterpillar software with the opened remote connection version is 1.1.1_8696.

<u>Operation steps</u>

View the [About] page above the remote interface software.

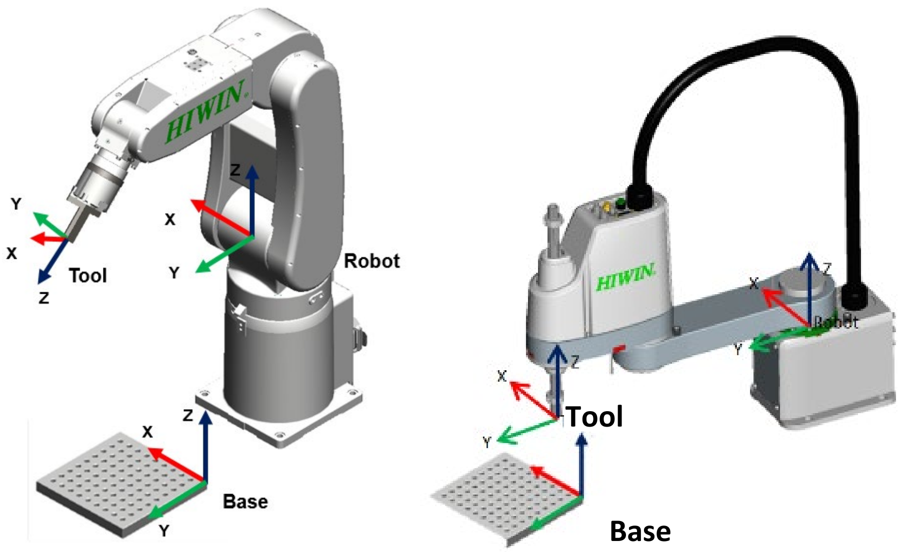


[About] page robot infromation figure

3.2 Coordinate System

Define following Cartesian coordinate system in robot controller system:

☐ ROBOT
☐ BASE
☐ TOOL



Coordinate System Overview

Description

■ ROBOT

The Robot used the Cartesian coordinate system. If it is a 6 axes robot, it will be fixed at the location of the 1st-axis center point and the 2nd-axis center point of the robot. If it is a 4 axes robot, it will be fixed at the robotic foot. This is used as the origin coordinate system of the base coordinate system.

In the default configuration, the coordinate system of ROBOT is consistent with the BASE coordinate system.

■ BASE

The BASE Coordinate System is Cartesian system used to describe the position of the workpiece. It is based on the ROBOT Coordinate System. By default, the Base Coordinate System is consistent with the ROBOT system. A user can move it to the workpiece.

- TOOL

The TOOL Coordinate System is a Cartesian system, located at the tool center point.

By default, the home of the Tool Coordinate System is located at the flange center point (called the Flange Coordinate System). The Tool Coordinate System is offset to the tool center point by the user.

Rotation of the six-axis robot coordinate system

Corner	Rotation around axis
A	Rotate around X axis
B	Rotate around Y axis
C	Rotate around Z axis

Rotation of scara robot coordinate system

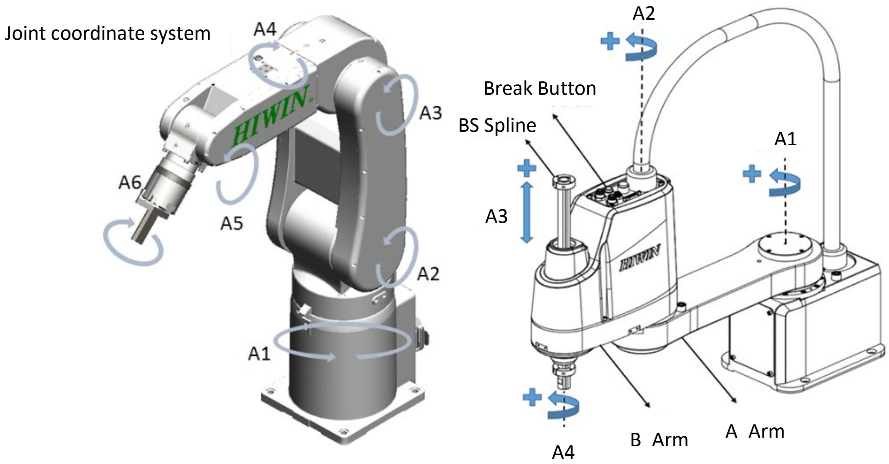
Corner	Rotation around axis
A4	Rotate around Z axis

3.3 JOG Robot

Description:

There are two types of jogging:

- Cartesian jogging,TCP (Tool Center Point) is jogged in the positive or negative direction along an axis of the coordinate system.
- Axis-specific jogging, each axis can independently be moved in a positive or negative direction.



Axis-specific jogging

3.3.1 Manual JOG

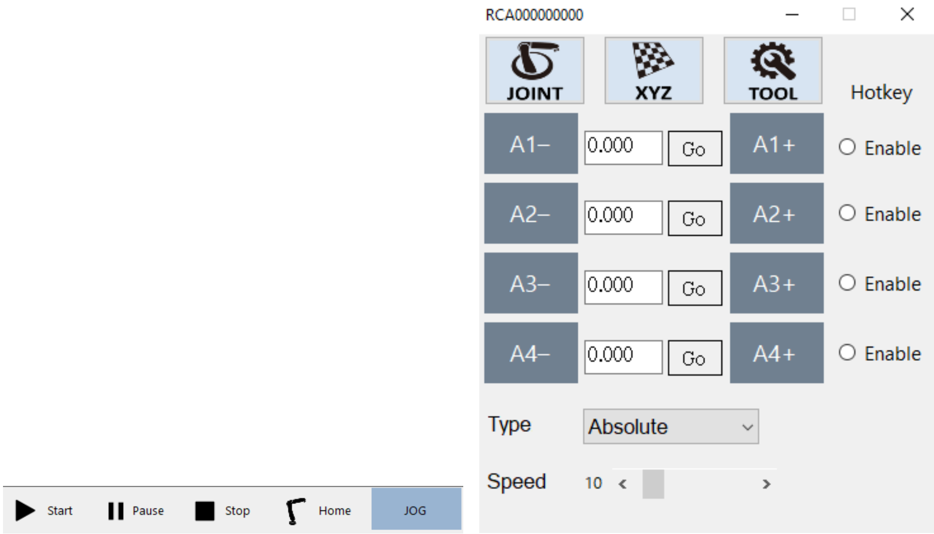
Prerequisite:

1.Connection level need to be Controller.

2.Mode needs to be Manual.

Description:

When connection level is controller and mode is manual, you could jog on TP (Teach Pendant) window.


RCA000000000
JOINT
XYZ
TOOL
Hotkey
A1–
0.000
Go
A1+
Enable
A2–
0.000
Go
A2+
Enable
A3–
0.000
Go
A3+
Enable
A4–
0.000
Go
A4+
Enable
Type
Absolute
Speed
10
Start
Pause
Stop
Home
JOG

TP Window

教導調節視窗

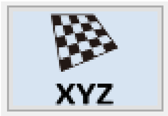
Figure	Coordinates switching shortcuts
	Press Ctrl+Z to switch into the joint coordinates.
	Press Ctrl+X to switch into the Cartesian coordinates.
	Press Ctrl+C to switch into the tool coordinates. .

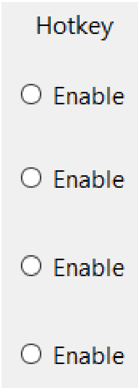
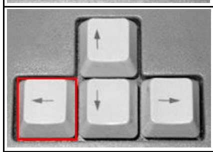
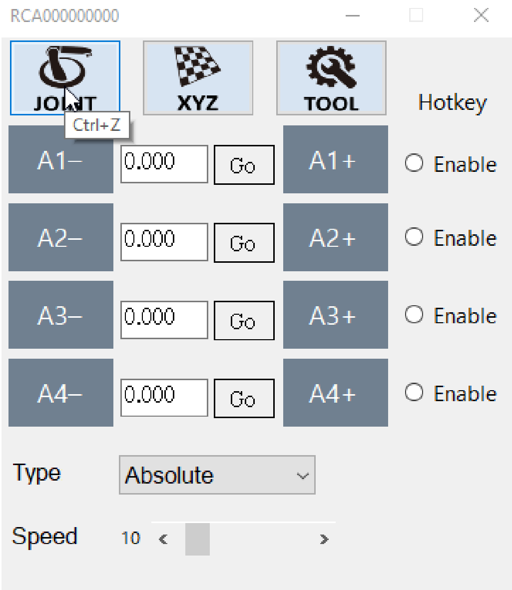
Figure	Axis switching shortcuts
	Press Ctrl+1 to switch into the first axis.
	Press Ctrl+2 to switch into the second axis.
	Press Ctrl+3 to switch into the third axis.
	Press Ctrl+4 to switch into the fourth axis.

Figure	Operation shortcuts
	Press Ctrl + → to move the selected axis in the positive direction.
	Press Ctrl + ← to move the selected axis in the negative direction.



Hot key tip figure

3.3.2 Robot Simulation interface

Operating steps

Click the function tab [Display].

Description

Display the robot simulation figure.

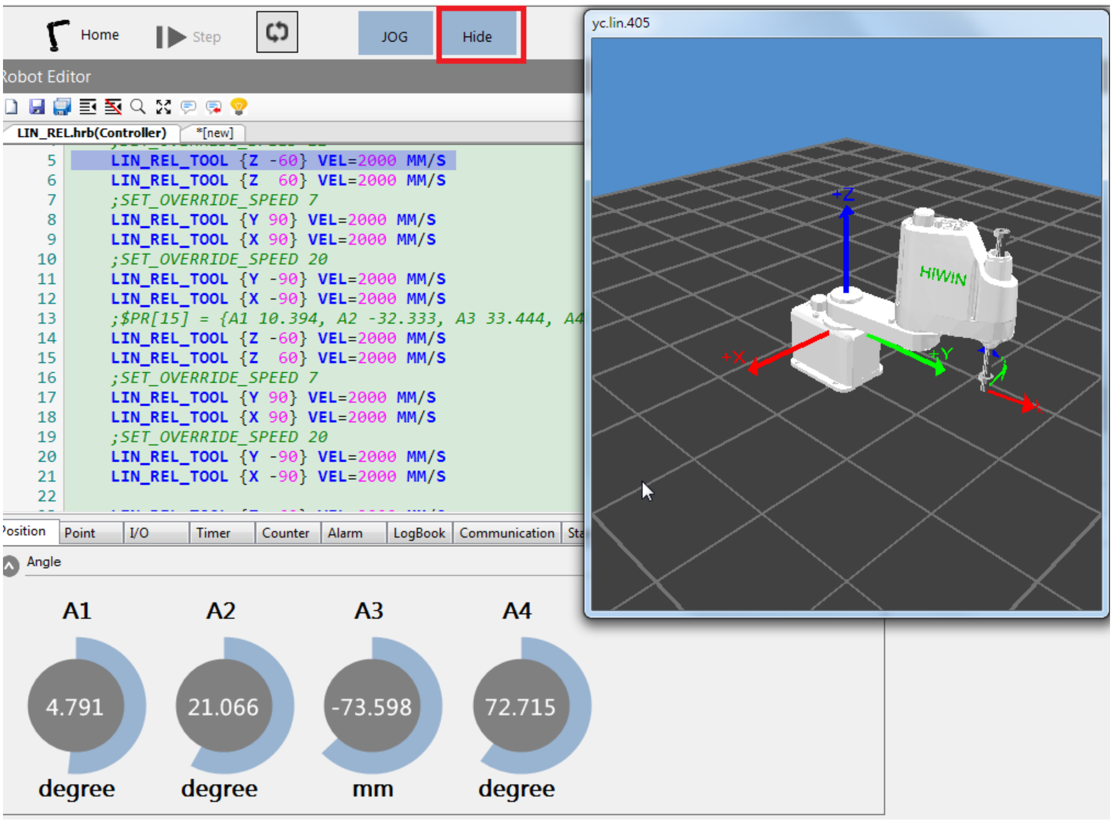
1.Shift : Press the middle wheel of mouse to move.

2.Zoom In/Out: Scroll the middle wheel of mouse.

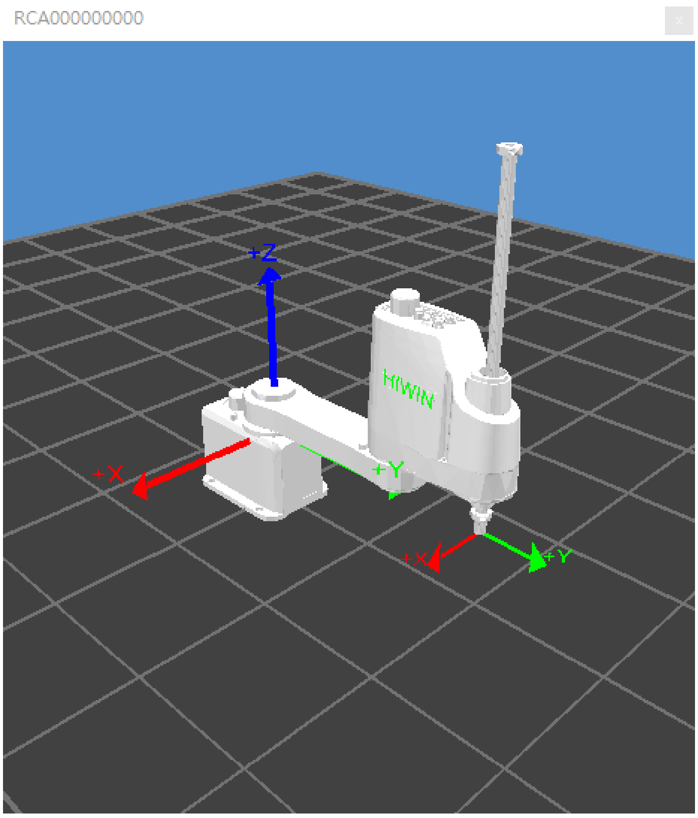
3.Rotation: Press 'shift' and scroll the middle wheel of mouse.

Display robot simulation button figure

Hide robot simulation interface, and display robot simulation interface, use "Display" button to change the Hide/Display state.

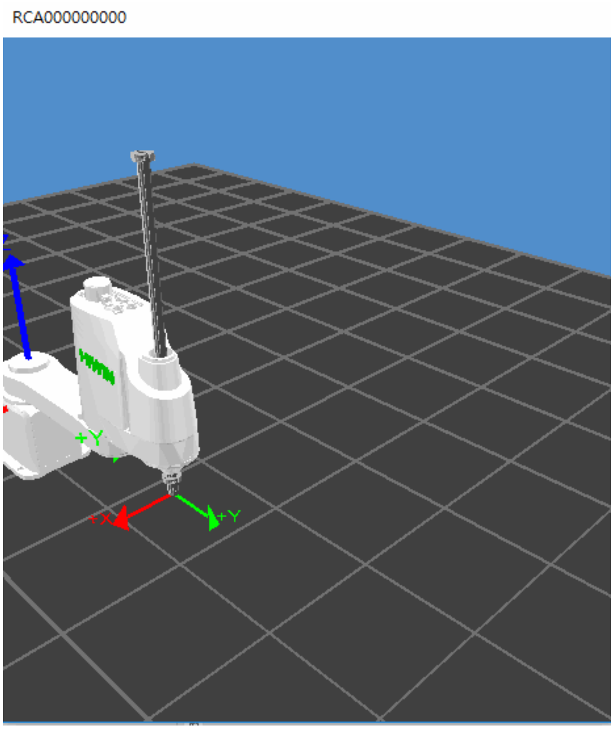


Hide robot simulation button figure



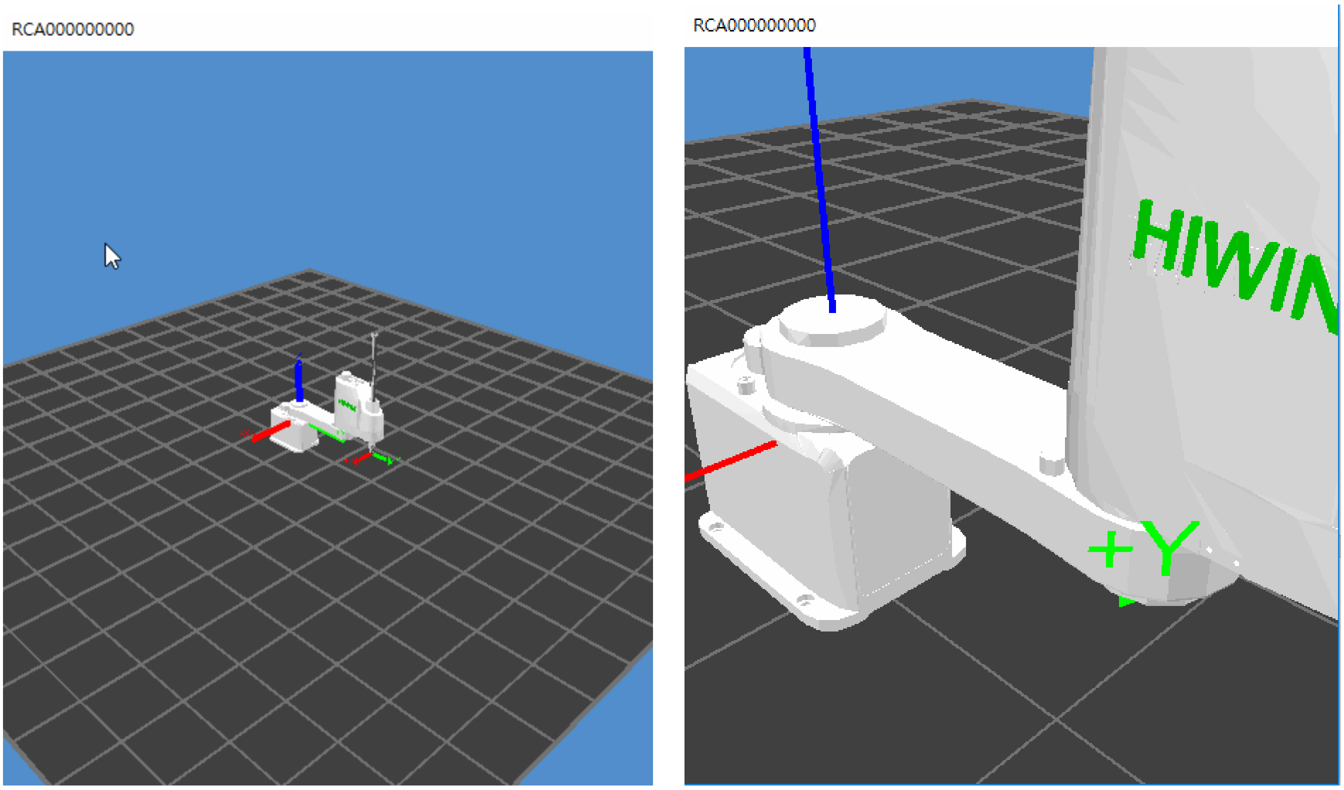
robot simulation button figure

1. Shift : Press the middle wheel of mouse to move.



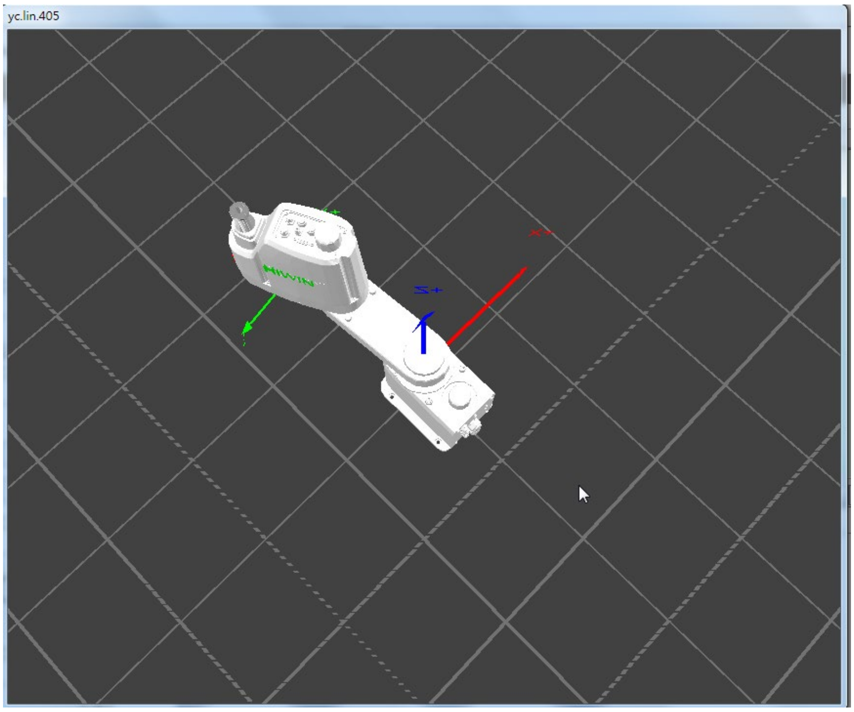
Panning figure

2. Zoom In/Out: Scroll the middle wheel of mouse.



Zoom In/Out figure

Rotation: Press 'shift' and scroll the middle wheel of mouse.



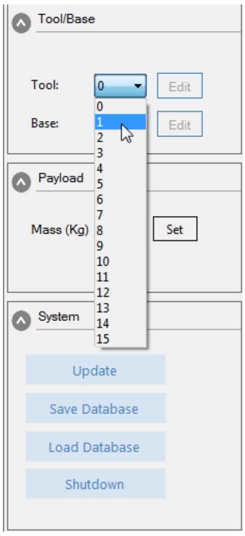
Rotation interface

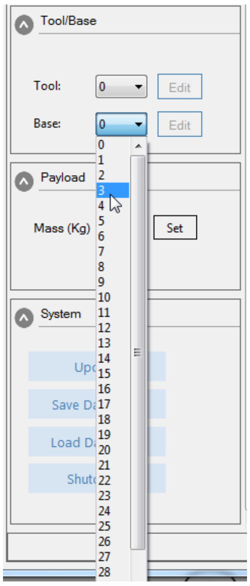
3.3.3 Base/Tool Coordinate

Description:

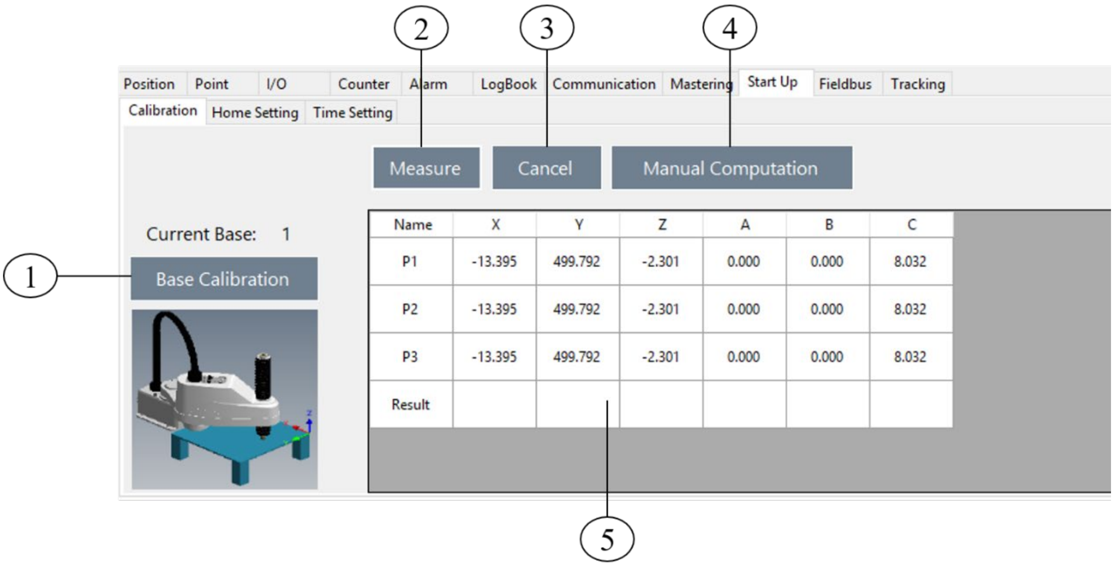
View and modify the base or tool coordinate.

16 tool and 32 base coordinate systems can be saved in the control system at most. When you apply the Cartesian jogging, you must select a tool (Tool Coordinate System) and a base (Base Coordinate System).





Base/Tool interface



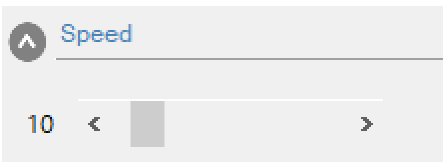
SCARA Robot Base/Tool calibration interface

No.	Description
1	Base/Tool coordinate currently selected.
2	The current position is selected as the calibration point.
3	The current calibration canceled.
4	Enter calculations manually.
5	The information of calibration point.

3.3.4 Jogging Velocity Ratio

Description:

The jogging velocity ratio is robot velocity during jogging. It’s presented by percentage, based on the maximum velocity when the robot is jogging. That value is 250mm/s。



Velocity Ratio Interface

3.4 Input/Output(I/O) Setting

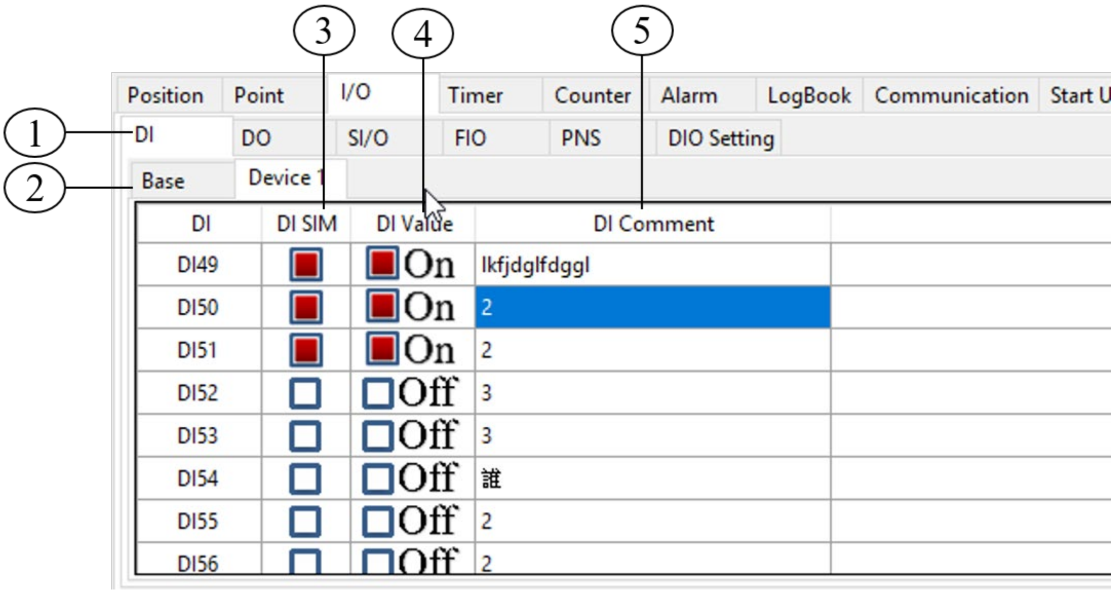
3.4.1 Display Digital Input/Output

Operation steps:

1.Click the operating tab of [I/O].

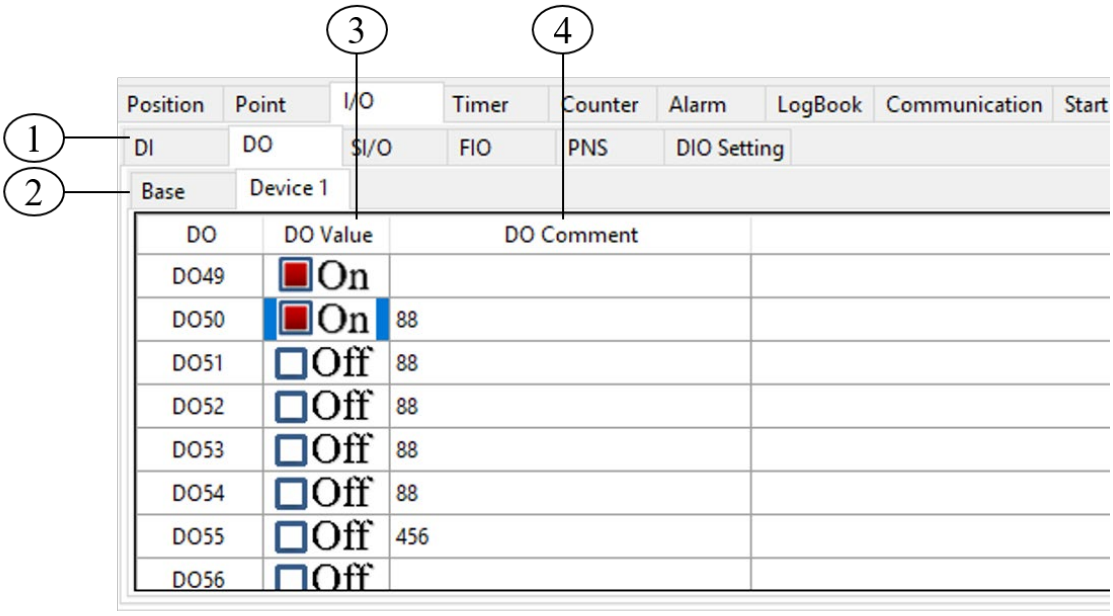
2.Click the [I/O] tab of [DI/O].

Description:



Digital Input Interface

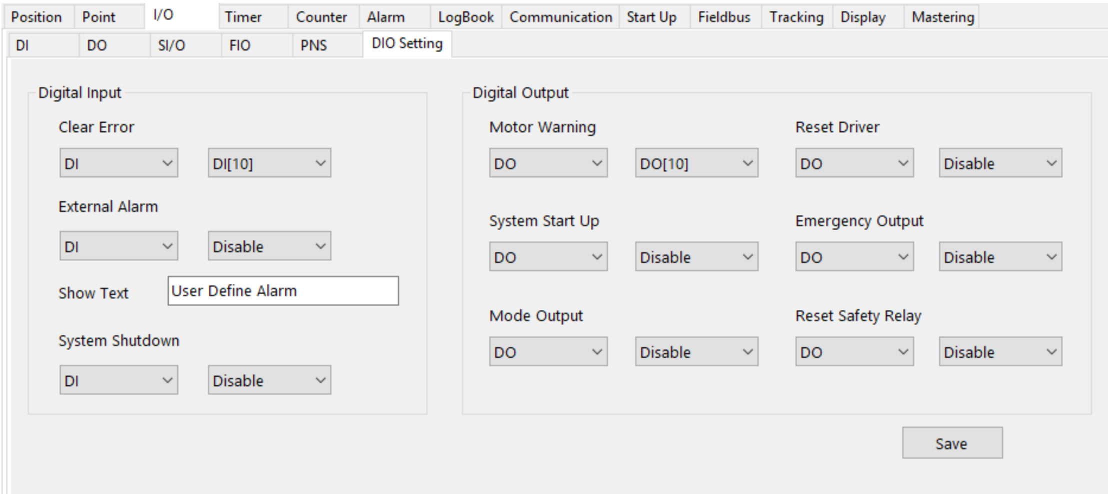
No.	Description
1	Switch I/O page.
2	Switch Basic DI (48) and external DI page.
3	Simulation. opened as red.
4	Digital Input value. (It can be used when the simulation is selected.) ON is displayed red and showed On. OFF is displayed white and showed Off.
5	Digital Input Comment. (Double click to modify.)



Digital Output Interface

No.	Description
1	Switch I/O page.
2	Switch Basic DO and external DO page.
3	Digital Output value. (It can be used when the simulation is selected.) ON is displayed red and showed On. OFF is displayed white and showed Off.
4	Digital Output Comment. (Double click to modify.)

3.4.2 Self-defined Digital Input/Output Function



3.4.2.1 Clear Error Input Signal

Description

User can select the specific D.I./ S.I. to trigger the error clear function.

Operating steps

- Select the specific D.I. / S.I from the Clear Error option, it will be enabled to use as the functional signal of clearing error through the configured D.I. ./ S.I
- If Disable is selected, it indicates that this function is disabled.
- Press [Save] to save the setting.

3.4.2.2 External Alarm Input Signal

Description

User can select the specific D.I. /S.I to trigger the external alarm function.

Operation steps:

1. Select the specific D.I. /S.I from the External Alarm option, it will enable to use as the functional signal of external alarm through the configured D.I. /S.I..
2. If Disable is selected, it indicates that this function is disabled.
3. Set the word to be appeared in Show Text when the alarm is triggered.
4. Press [Save] to save the setting.

3.4.2.3 External Shutdown Input Signal

Description

User can select the specific D.I. /S.I. to trigger the external shutdown function.

Operation steps:

1. Select the specific D.I. /S.I.from the System Shutdown option, it will enable to use as the functional signal of system shutdown through the configured D.I. /S.I..
2. If Disable is selected, it indicates that this function is disabled.
3. Press [Save] to save the setting.

3.4.2.4 Motor Warning Output Signal

Description

User can select the specific D.O. / S.O. to trigger the motor warning function.

Operation steps:

1. Select the specific D.O. / S.O. from the Motor Warning option, it will enable to use as the functional signal of motor warning through the configured D.O. / S.O..
2. If Disable is selected, it indicates that this function is disabled.
3. Press [Save] to save the setting.

3.4.2.5 System Start Up Output Signal

Description

User can select the specific D.O. / S.O. to trigger the system start up function.

Operation steps:

1. Select the specific D.O. / S.O. from the System Start Up option, it will enable to use as the functional signal of starting up through the configured D.O. / S.O..
2. If Disable is selected, it indicates that this function is disabled.
3. Press [Save] to save the setting.

3.4.2.6 Manual/Auto Mode Output Signal

Description

User can select the specific D.O. / S.O. to trigger the mode output function.

Operation steps:

1.Select the specific D.O. / S.O. from the Mode Output option, it will enable to use as the functional signal of mode output through the configured D.O. / S.O. If T1/T2 mode is selected, the specific D.O. / S.O. is OFF. If AUT/EXT mode is selected, the specific D.O. / S.O. is ON. (This function in Caterpillar software only has EXT mode output signal, HRSS software have EXT T1/T2 and AUT/EXT mode output signal)

2.If Disable is selected, it indicates that this function is disabled.

3.Press [Save] to save the setting.

3.4.2.7 Restart driver signal output

Description

Users can set specific D.O. to trigger the function to restart driver signal output.

Operation steps:

1.Select a specific D.O. in the Reset Driver option to use the configured D.O. to restart the signal outputted by the driver.
2.If Disable is selected, it means do not enable this function.
3.When finished selecting, press [Save] to save.

3.4.2.8 Emergency stop signal output signal

Description

Users can set specific D.O. to trigger the function to output emergency stop signals.

Operation steps:

1.Select a specific D.O. in the Emergency Output option to use the configured D.O. as the signal that the emergency stops outputs.
2.If Disable is selected, it means do not enable this function.
3.When finished selecting, press [Save] to save.

3.4.2.9 Restart safety relay output signal

Description

Users can set specific D.O. to trigger the function to restart safety relay output.

Operation steps:

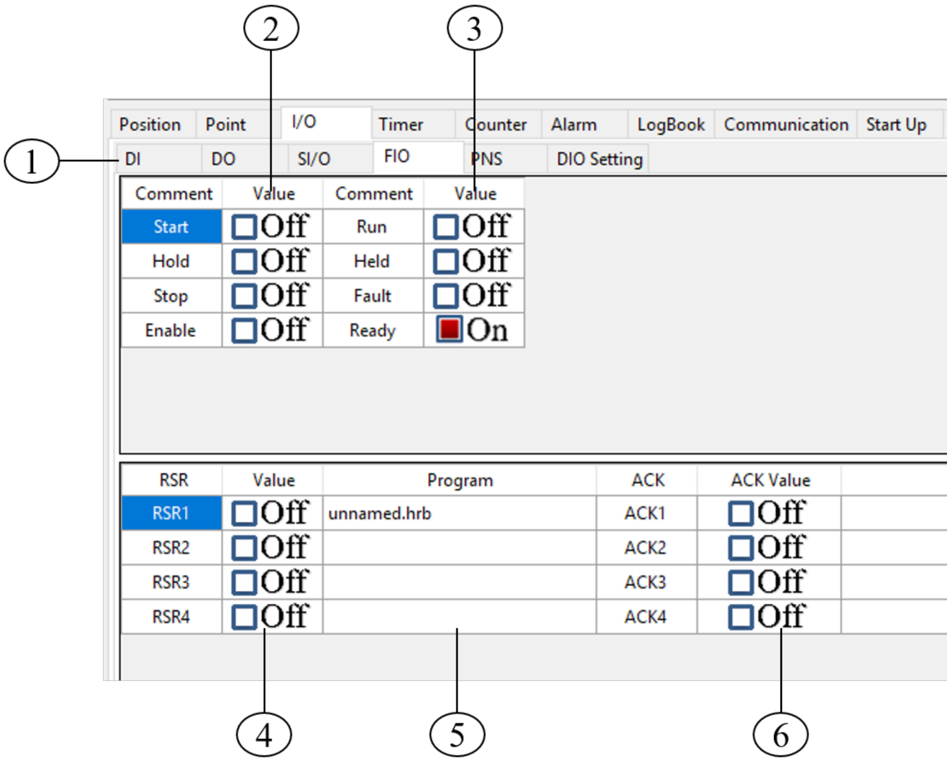
1.Select a specific D.O. in the Safety Relay option to use the configured D.O. to restart the signal outputted by the safety relay.
2.If Disable is selected, it means do not enable this function.
3.When finished selecting, press [Save] to save.

3.4.3 Display External Functional Input/Output

Operation steps:

1.Click the operating tab of [I/O].
2.Click the [I/O] tab of [FIO].

Description:



External Functional Input/Output Interface

No.	Description
1	Switch I/O page.
2	Functional Input value.
3	Functional Output value.
4	RSR value.
5	RSR program name.
6	Functional Output ACK1~ACK4 display corresponding signal.

※ON is displayed in red and showed On. OFF is displayed in white and showed Off.

When programs are executed, press the pause(Hold) button and the Held light will light up while the Run light is still on.

Comment	Value	Comment	Value
Start	Off	Run	On
Hold	Off	Held	On
Stop	Off	Fault	Off
Enable	Off	Ready	On

3.5 Communication Part

3.5.1 TCP/IP Connection

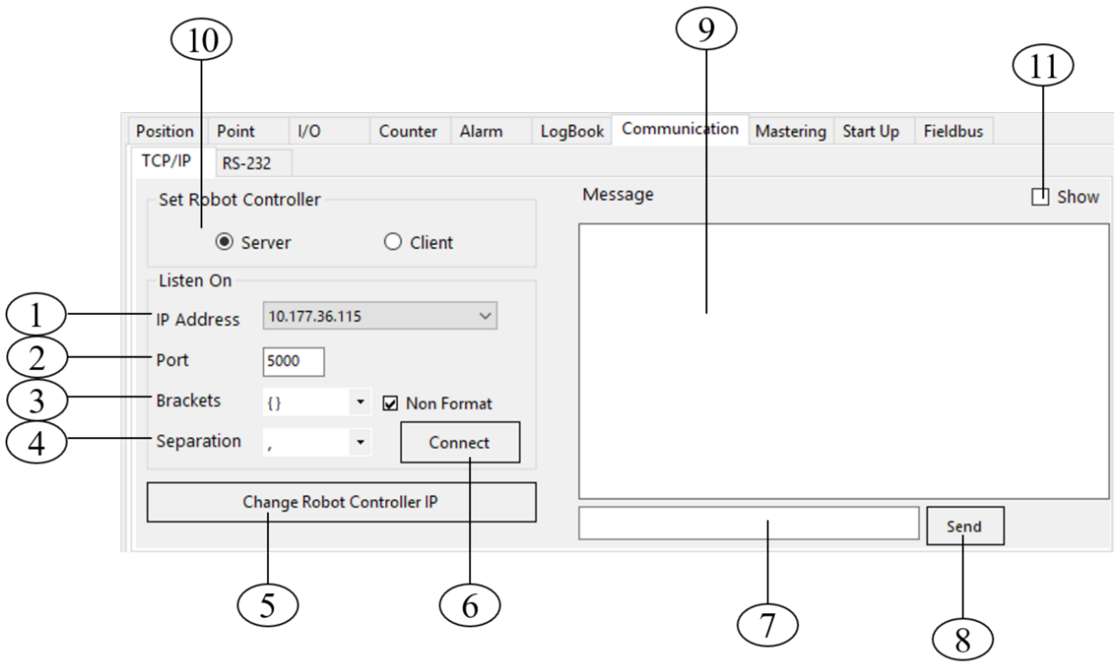
Description

Send and transfer the data by network communication.

You can select RC as Client or Server to connect.

The parameter type is the floating decimal.

The communication format has two parentheses (The type of parenthesis can be selected.), including the value form such “{xxx}” For example, if “{123,456}” is sent, two sets of value “123” and “456” will be received, which there are up to 50 sets of parameters.



TCP/IP interface

No.	Description
1	Target IP to communicate with.
2	Port configuration of TCP/IP connection.
3	Braces / Square brackets / Parenthesis selection.
4	Separation selection.
5	Change the robot controller IP.
6	Connect or Disconnect button.
7	Message sending field
8	Send message
9	Message box to indicate the content which has been transmitted or received.

10	Server/Client configuration of the local robot controller.
11	Display Content of Sending Message and Receiving Message

Operating steps

1.Click the function tab [Communication]

2.Click the sub tab [TCP/IP] in the [Communication] tab.

■Local RC is Client

1.Input the Server's IP and Port.

2.Click [Connect] button.

3."Connection is successful!" means the connection succeeds.

■Local RC is Server

1.Input the TCP/IP Port to be connected.

2.Click [Connect] button.

3."Server is opened!" means the port succeeds in listening.

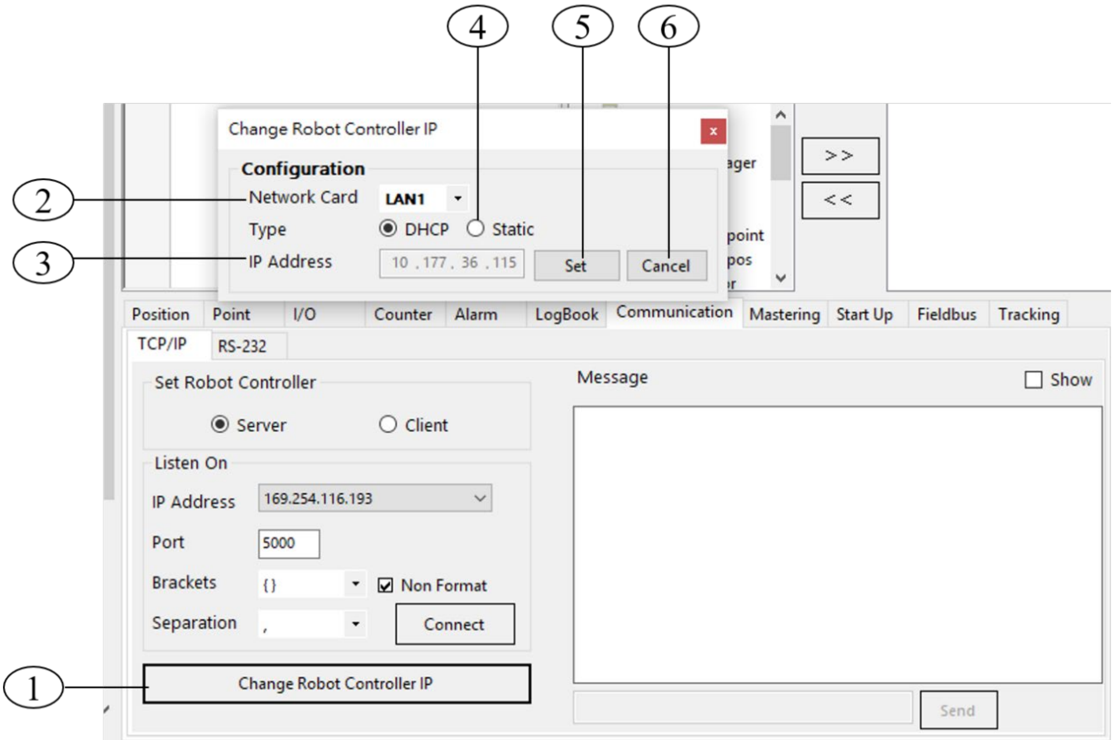
3.5.2 Set up Robot Controller Ip

Description

Configure the IP address in robot controller.

Users can configure the IP address in each Network Card.

It can be configured as DHCP (automatic obtain IP address) or Static (specify specific IP address)。



Change IP interface

No.	Description
1	The button to Change Robot Controller IP.
2	Select to change network card
3	Static IP address, specific IP address
4	DHCP / Static IP mode selection
5	Confirm setting
6	Cancel setting

Operating steps

■Click the [TCP/IP] sub-tab in the [Communication] tab.

■Click Change Robot Controller IP button.

■Select the Network card.

■DHCP

1.Select [DHCP] item.

2.Click the [Set] button.

3.Wait for the bar to finish loading, setting is completed.

■Static IP

1.Select [Static] item.

2.In the [IP Address] column, assign the IP address for robot controller.

3.Click the [Set] button.

4.Wait for the bar to finish loading, setting is completed.

If setting failed message appeared, please check the internet connection to see if it is connected properly or there is a problem in IP setting.

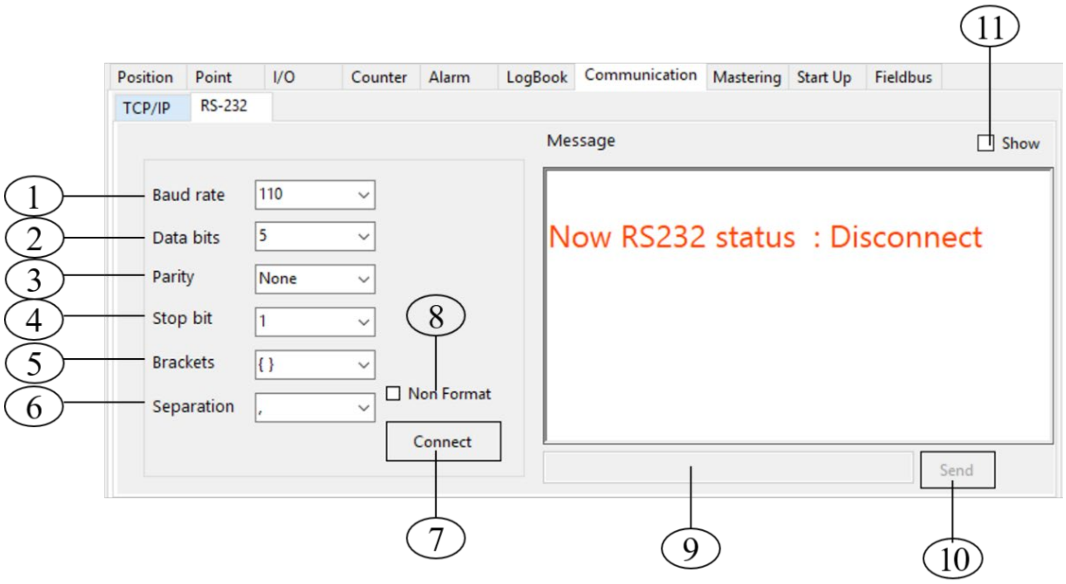
3.5.3 RS232 Connection

Description

Send and transfer the data by serial communication.

The parameter type is the floating decimal.

The communication format has two parentheses (The type of parenthesis can be selected.), including the value form such "{xxx}" For example, if "{123,456}" is sent, two sets of value "123" and "456" will be received, which there are up to 50 sets of parameters.



RS232 interface

No.	Description
1	RS232 Baud rate
2	RS232 Data bit
3	RS232 Parity
4	RS232 Stop bit
5	Braces / Square brackets / Parenthesis selection
6	Separation selection
7	Connect / Disconnect button.
8	Cancel format
9	Messages to be send
10	Send message
11	Display Content of Transmitting Message & Receiving Message

Operating steps

Click the [RS-232] sub tab in the [Communication] tab.

1.Input RS232 paramters.

2.Click [Connect] button.

3.Display "Connection is successful!" to represent the connection success.

3.6 Start-up Function

3.6.1 Six Axes Robot Calibrate Tool/Base Coordinate Way

3.6.1.1 Calibrate Tool Coordinate

Description

When the tool is calibrated, the user will give a set of Cartesian Coordinates (Tool Coordinate System) to the tool mounted on the flange. The tool coordinate system has its origin at a user-defined point. This point is called as TCP (Tool Center Point). Usually, TCP is located at the working point of the tool.

⚠ CAUTION

The calibration method described here must not be used to a fixed tool.

Advantage of tool calibration:

◆The tool can rotate along the TCP. The position of TCP will not change.

◆Program running: The track along TCP keeps the programed velocity.

16 tool coordinates can be saved at most. Variable: TOOL [0…15]).

※TOOL [0] is Default and cannot be changed.

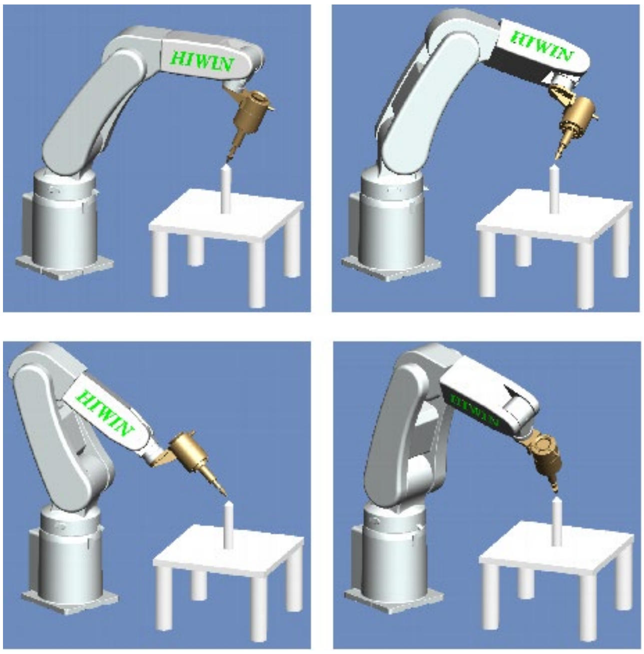
3.6.1.2 Four-Point Calibrate Method of Tool Coordination

Description

The TCP of the tool to be calibrated is moved to a reference point from 4 different directions. The reference point can be freely selected. The robot control system calculates the TCP from the different flange positions.

⚠ CAUTION

The four flange positions at the reference point must be sufficiently apart from one another.



Four-point method

Prerequisite

1.Manual mode.

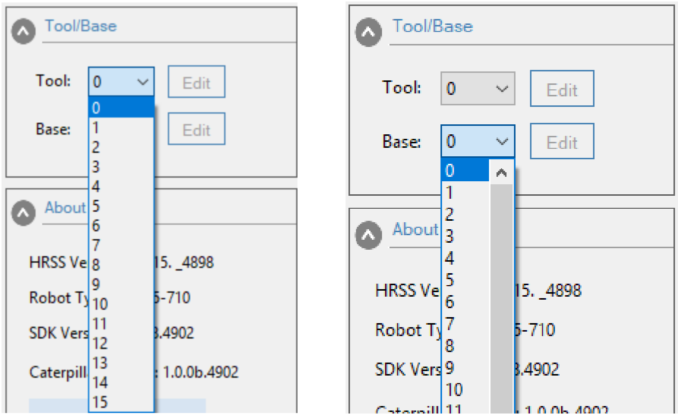
2.Install the tool to be calibrated on the mounting flange.

3. Select a fixed reference point position, it is recommended that this reference point is a shape that is easy to recognize, for example: cuspidal point.

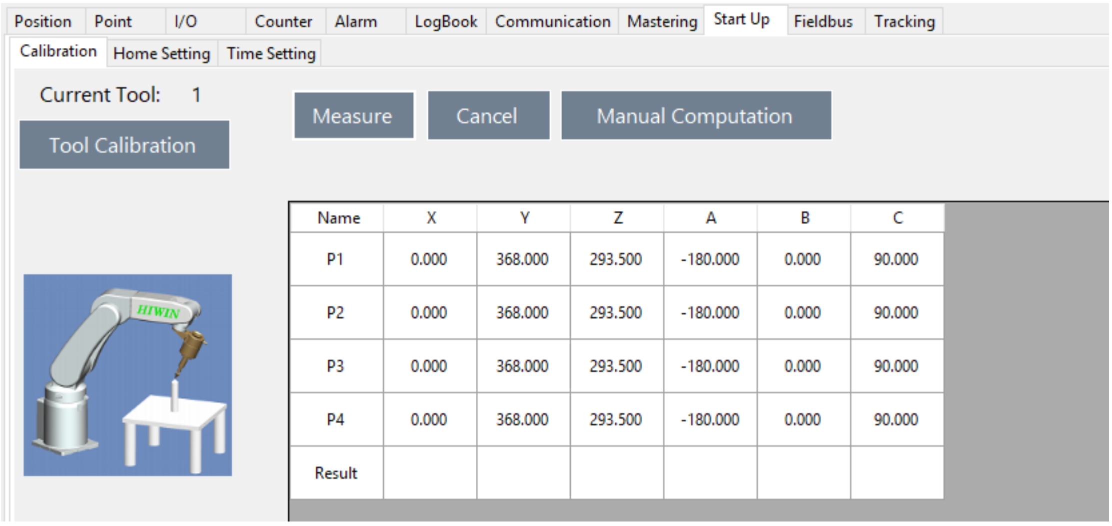
Operation steps

1. Select the tool number of [Tool / Base] on the left side of the remote operation interface.
2. Select the sub-tab [Calibration] of the function tab [Start Up].
3. Click [Tool Calibration].
4. Use TCP to move to the configured reference point. To confirm the reference point, click [Measure].
5. Use TCP to change the position of the other arm and move to the reference point. If you confirm the reference point position, click [Measure].
6. Repeat step 5 twice.

7. After completion, the data shows the new TOOL coordinate system reference position and is saved.



Tool / Base coordinate selection interface



Name	X	Y	Z	A	B	C
P1	0.000	368.000	293.500	-180.000	0.000	90.000
P2	0.000	368.000	293.500	-180.000	0.000	90.000
P3	0.000	368.000	293.500	-180.000	0.000	90.000
P4	0.000	368.000	293.500	-180.000	0.000	90.000
Result						

RA605 robot tool calibration interface

3.6.1.3 Enter Value Way of Tool Coordination

Description

Tool data can be manually entered.

Possible data sources：

- ■In the CAD diagram file, acquire the size information of tool.
- ■Tool size from the measurement of actual object.
- ■Instruction manual of tool manufacturer.

Prerequisite

1. Manual mode.
2. Known X, Y, Z, A, B, C distance and orientation data relative to the flange coordinate system.

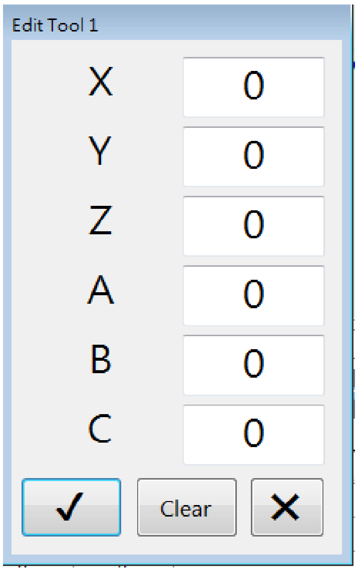
Operation Steps

1. Select the tool number of [Tool / Base] on the left side of the remote operation interface.

2.Click [Edit].

3.Enter the values in the table.

4. Click [✓] button after completed. The data will be saved. Click [Clear] botton, it will delete the coordination parameter. ; Click [X] botton , cancel and exit setting interface.



Numerical input interface

3.6.1.4 Calibrate Base Coordination

Description

During base calibration, the user assigns a Cartesian coordinate system (BASE coordinate system) to a work surface or the work piece. The BASE coordinate system has its origin at a user-defined point. Calibrate base coordinate need to priority calibrate the tool coordination, First.

CAUTION

If a workpiece has been installed on the mounting flange, the calibration described here will not apply.

Advantages of base calibration:

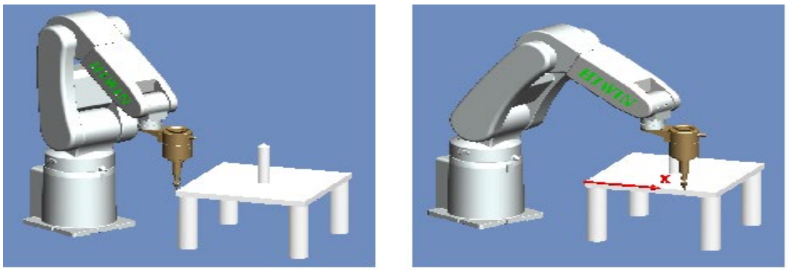
■TCP can be jogged along the work plane or edge of workpiece.

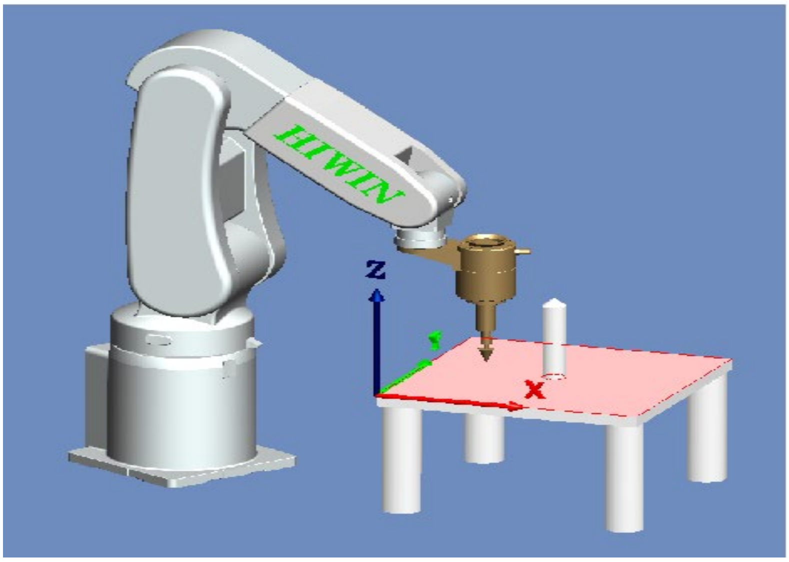
■Points can be taught relative to base. If the base must be moved, for example, because the work plane is moved, the points will be moved as well, and no need to be taught again.

32 base coordinates can be saved at most. Variable: BASE[0…31].

※BASE [0] is Default and cannot be changed.

3.6.1.5 Three-Point Calibrate Method of Base Coordination





Three-Point Calibrate Method

Prerequisite

1.Manual mode.

2.Install a calibrated tool on the mounting flange.

Operation steps

1.Select the base number of [Tools / Base] on the left side of the remote operation interface.

2.Select the sub-tab [Calibration] of the function tab [Start Up].

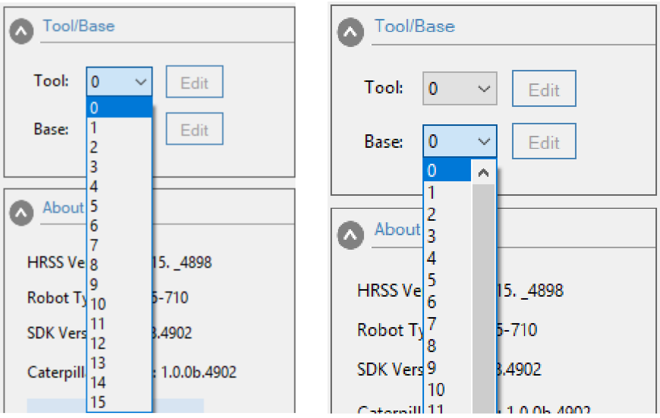
3.Click Base Calibration。

4.Move TCP to the origin of new base coordinate. Click [Measure].

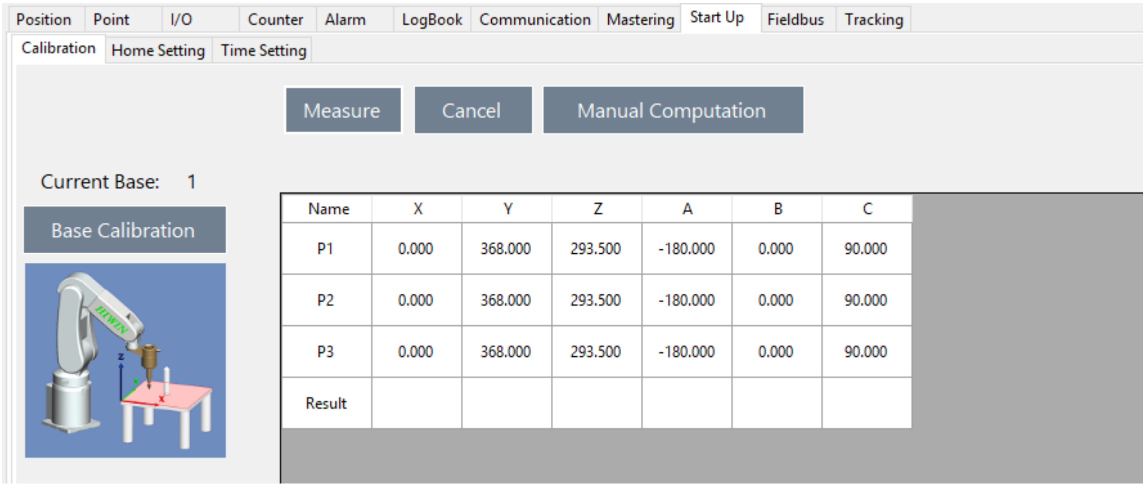
5.Move TCP to a point on positive X axis of new base coordinate. Click [Measure].

6.Move TCP to a point with positive Y on the XY plane. Click [Measure].

7.After completed. The data will be saved.



Tool / Base selection interface



Name	X	Y	Z	A	B	C
P1	0.000	368.000	293.500	-180.000	0.000	90.000
P2	0.000	368.000	293.500	-180.000	0.000	90.000
P3	0.000	368.000	293.500	-180.000	0.000	90.000
Result						

RA605 robot base calibration interface

3.6.1.6 Enter Value Way of Base Coordination

Description

Known the following values, for example, obtain from CAD:

■Distance between the base origin and global origin

■Rotation for base coordinate relative to global coordinate

Prerequisite

1.Manual mode.

2.X, Y, Z, A, B and C relative to the flange coordinate system is known.

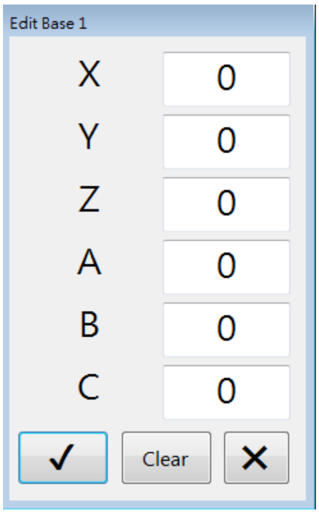
Operation steps

1.Select the base number of the remote operation interface vertical [Tool / Base].

2.Click [Edit].

3.Enter the values in the table.

4. Click [✓] button after completed. The data will be saved. Click [Clear] botton, it will delete the coordination parameter. ; Click [X] botton , cancel and exit setting interface.



Numerical input interface

3.6.2 Four Axes Robot Calibrate Tool/Base Coordinate Way

3.6.2.1 Calibrate Tool Coordination

Description

When the tool is calibrated, the user will give a set of Cartesian Coordinates (Tool Coordinate System) to the tool mounted on the flange. The tool coordinate system has its origin at a user-defined point. This point is called as TCP (Tool Center Point). Usually, TCP is located at the working point of the tool.

⚠ CAUTION

The calibration method described here must not be used for a fixed tool.

Advantage of tool calibration：

1.The tool can rotate along the TCP. The position of TCP will not change.

2.Program running: The track along TCP keeps the programed velocity.

16 tool coordinates can be saved at most. Variable: TOOL [0...15].

※TOOL [0] is default and cannot be changed. The following data will be saved：

X, Y, Z：

The origin of tool coordinate, relative to flange coordinate

A, B, C：

The rotation of tool coordinate, relative to flange coordinate

X：X coordinate

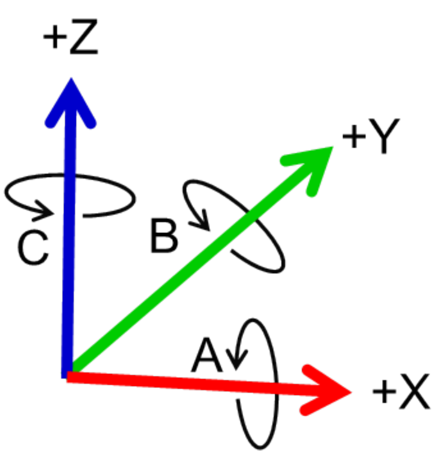
Y：Y coordinate

Z：Z coordinate

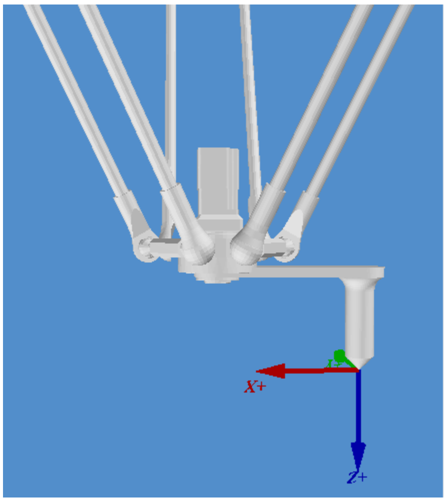
A：Rotate along X coordinate

B：Rotate along Y coordinate

C：Rotate along Z coordinate



Flange coordinates



TCP calibration principle

3.6.2.2 Three-Point Calibrate Method of Tool Coordination

Description

The TCP of the tool to be calibrated is moved to a reference point from 3 different directions. The reference point can be freely selected. The robot control system calculates the TCP from the different flange positions. Achieve the tool coordinates (X, Y, Z, C value, where value of C [J4 rotational angle] is the C value of the first calibrated value).

⚠ CAUTION

The 3 flange positions at the reference point must be sufficiently apart from one another.

Prerequisite

1.Manual mode

2.Install the tool to be calibrated on the mounting flange.

3.Select a fixed reference point position, it is recommended that this reference point is a shape that is easy to recognize, for example: cuspidal point.

Operation steps

1.Select the tool number of [Tool / Base] on the left side of the remote operation interface.

2.Select the sub-tab [Calibration] of the function tab [Start Up].

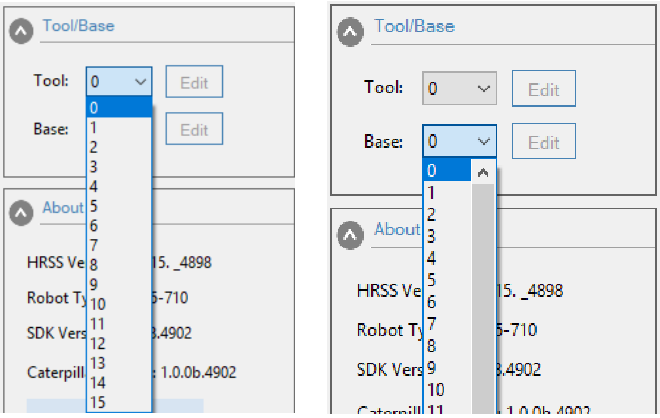
3.Click [Tool Calibration].

4.Use TCP to move to the configured reference point. Click [Measure] to confirm the first calibration point.

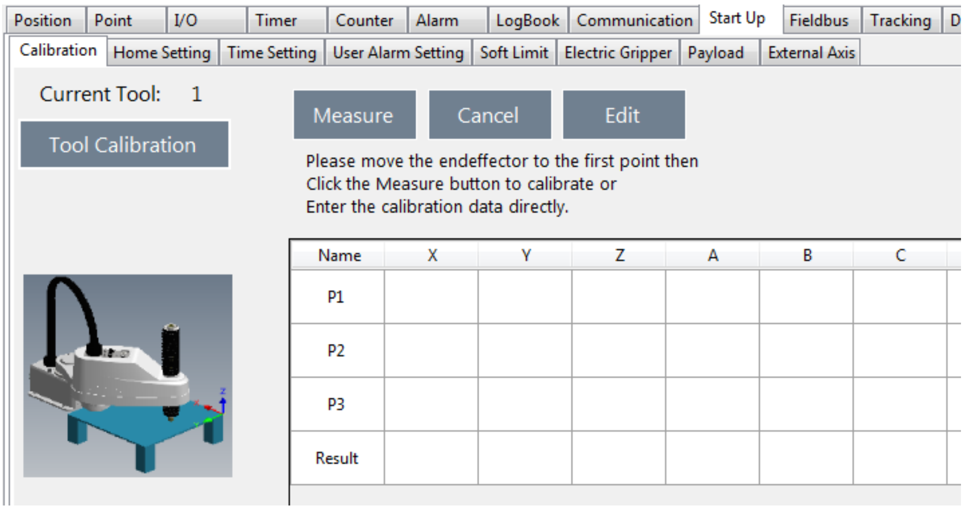
5.Use TCP to replace another posture position of arm, move to the reference point. Click [Measure] to confirm second point，if the position of reference point is to be confirmed, please use OK button for confirmation, otherwise, use No or Cancel to cancel the operation.

6.Repeat Step 5 to confirm third point.

7.After completion, the data will show the new TOOL coordinate system reference position and be saved.



Tool /Base selection interface



SCARA robot tool calibration interface

3.6.2.1 Enter Value Way of Tool Coordination

Description

The tool data can be manually entered.

Possible data source：

■In the CAD diagram file, acquire the size information of tool.

■Tool size from the measurement of actual object.

■Instruction manual of tool manufacturer.

Prerequisite

1.Manual mode

2.Known X, Y, Z, A, B and C relative to flange coordinate

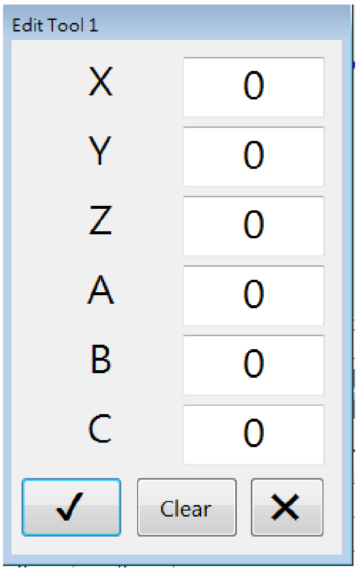
Operating steps

1.Select the tool number of [Tools / Base] on the left side of the remote operation interface.

2.Click [Edit].

3.Enter the values in the table.

4.Click [✓] button after completed. The data will be saved. Click [Clear] botton, it will delete the coordination parameter. ; Click [X] botton , cancel and exit setting interface.



Numerical input interface

3.6.2.1 Calibrate Base Coordination

Description

During base calibration, the user assigns a Cartesian coordinate system (BASE coordinate system) to a work surface or the work piece. The BASE coordinate system has its origin at a user-defined point. Calibrate base coordinate need to priority calibrate the tool coordination, First.

CAUTION

If a workpiece has been installed on the mounting flange, the calibration described here will not apply.

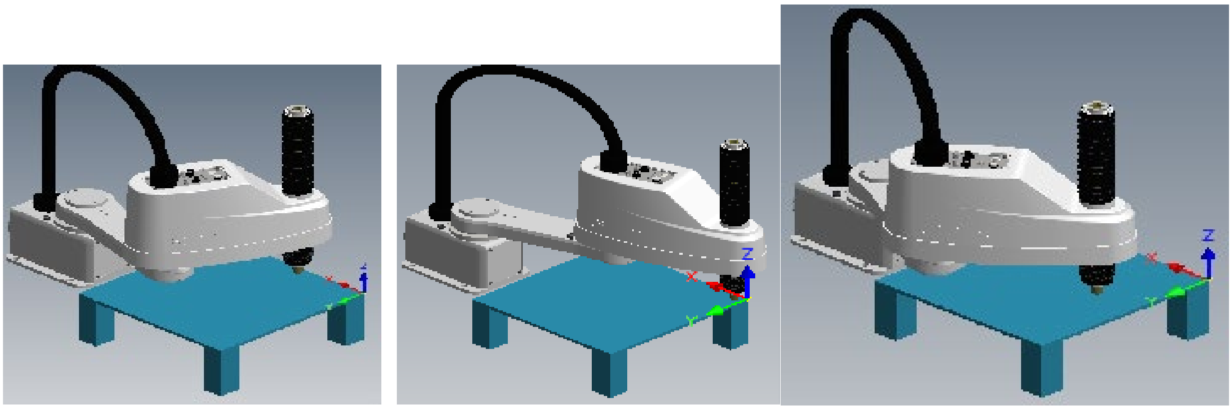
Advantages of base calibration：

■TCP can be jogged along the work plane or edge of workpiece.

■Points can be taught relative to base. If the base must be moved, for example, because the work plane is moved, the points will be moved as well, and no need to be taught again. 32 base coordinates can be saved at most. Variable: BASE[0…31].

※BASE [0] is default and cannot be changed.

3.6.2.2 Three-Point Calibrate Method of Base Coordination



Three-point calibrate method

Prerequisite

1.Manual mode.

2.Install a calibrated tool on the mounting flange.

Operation steps

1.Select the base number of [Tools / Base] on the left side of the remote operation interface.

2.Select the sub-tab [Calibration] of the function tab [Start Up].

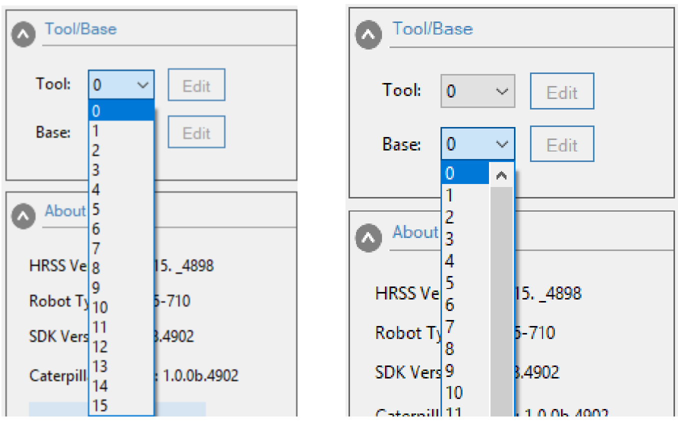
3.Click Base Calibration.

4.Use TCP to move to the origin of the new base frame. Click [Measure].

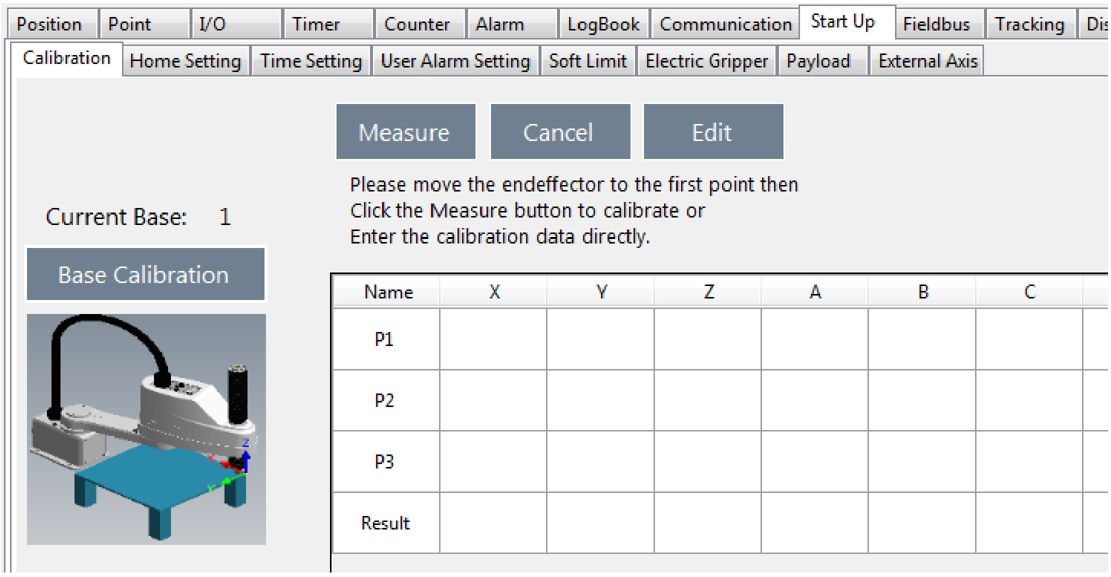
5.Move TCP to a point on the positive X axis of the new base frame. Click [Measure].

6.Move TCP to a point on the XY plane with a positive Y value. Click [Measure].

7.After completion. The data will be saved.



Tool / Base selection interface



SCARA robot base calibration interface

3.6.2.1 Enter Value Way of Base Coordination

Description

Values are known, from CAD, for example：

■Distance between the base origin and global origin

■Rotation for base coordinate relative to global coordinate

Prerequisite

1.Manual mode

2.X, Y, Z, A, B and C relative to the flange coordinate system is known

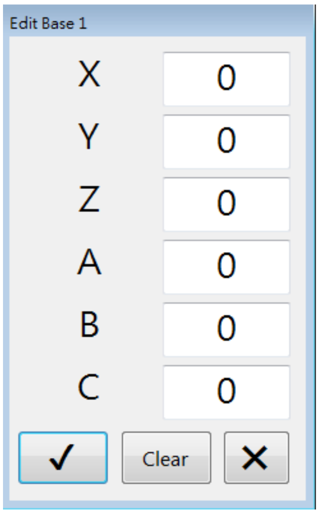
Operation steps

1.Select the base number of [Tools / Base] on the left side of the remote operation interface.

2.Click [Edit].

3.Enter the values in the table.

4. Click [✓] button after completed. The data will be saved. Click [Clear] botton, it will delete the coordination parameter. ; Click [X] botton , cancel and exit setting interface.



Numerical input interface

3.6.3 Home and Position Check Configuration

3.6.3.1 Home Configuration Setting

Description

Self-setting or recover the origin (Home) position.

Prerequisite

1.Manual mode.

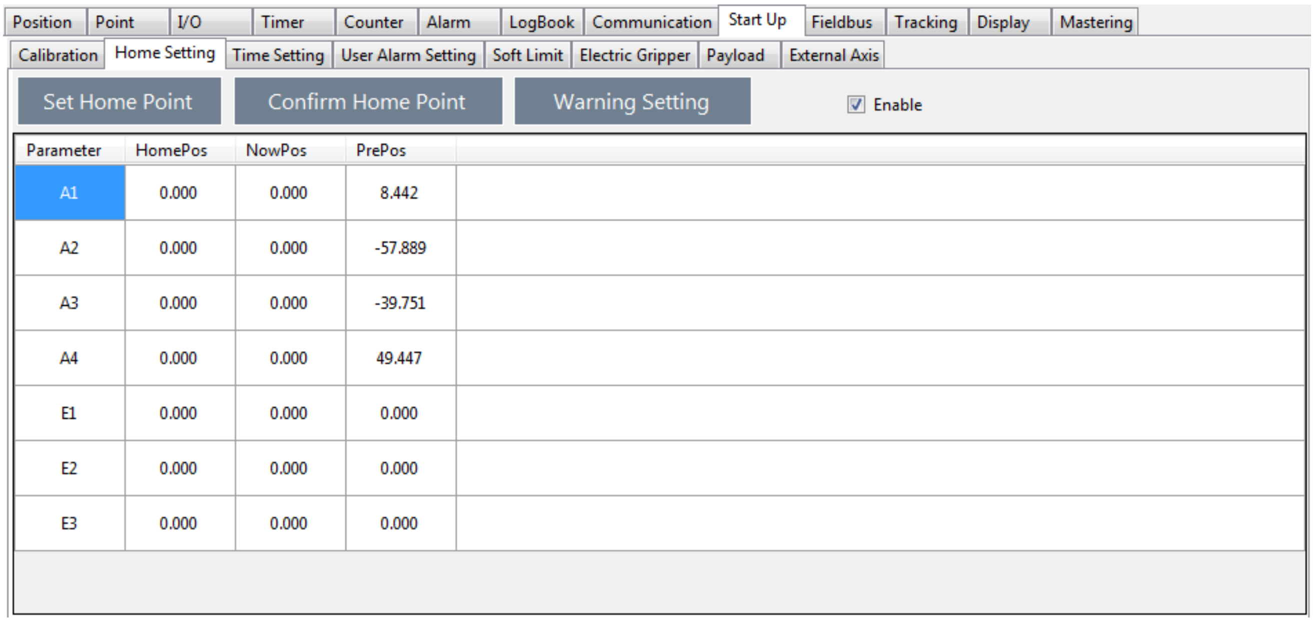
2.Open the adjustment operation interface.

Operation steps

1.Click the sub-tab [Home Setting] of the function tab [Start Up].

2.Move to the self-defined origin position.

3.After moving, click the [Setting Home Point] button to complete the setting.



Parameter	HomePos	NowPos	PrePos
A1	0.000	0.000	8.442
A2	0.000	0.000	-57.889
A3	0.000	0.000	-39.751
A4	0.000	0.000	49.447
E1	0.000	0.000	0.000
E2	0.000	0.000	0.000
E3	0.000	0.000	0.000

Home Setting interface

3.6.3.2 Position Check Setting

Description

The alarm can be removed because of the difference before and after booting "Start pos declination error"

Prerequisite

1.Manual mode

2.Open the adjustment operation interface.

Operation steps

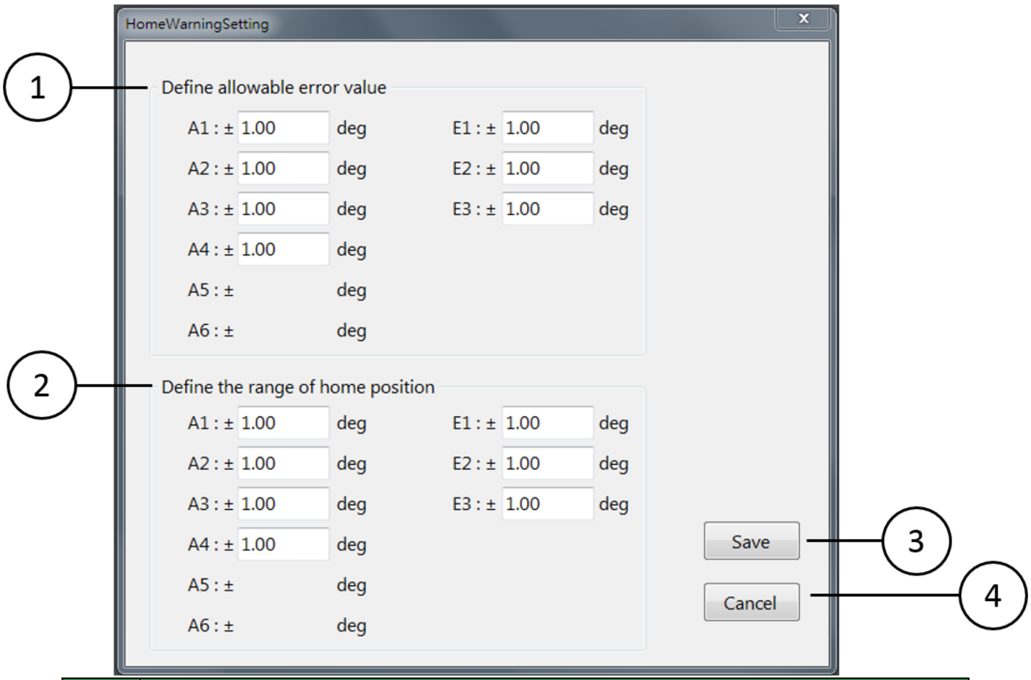
1.Click the sub-tab [Home Setting] of the function tab [Start Up].

2.Click [Warning Setting] button.

3.Enter the define the range of home position parameters.

4.Click "Save" button to save parameters, if setting finish to jump success windows.

5.Click "Cancel" button, no save parameters and exit.



No.	Description
1	When the differences between the angles of each axis before power off and after power on are greater than the set values (A1-A6 & E1-3), "Start pos declination error", error code 01-04-30 will pop up.
2	When the point check alarm appears, the robot must be moved back to the origin manually; When the position is within this set range, Confirm Home Point can be used to release the alarm.
3	Save Setting
4	Cancel and no save parameters.

3.6.3.3 Home Position Power on Check

Description

The alarm can be removed because of the difference before and after booting “Start pos declination error”

Prerequisite

1.Manual mode

2.Open the adjustment operation interface.

Operation steps

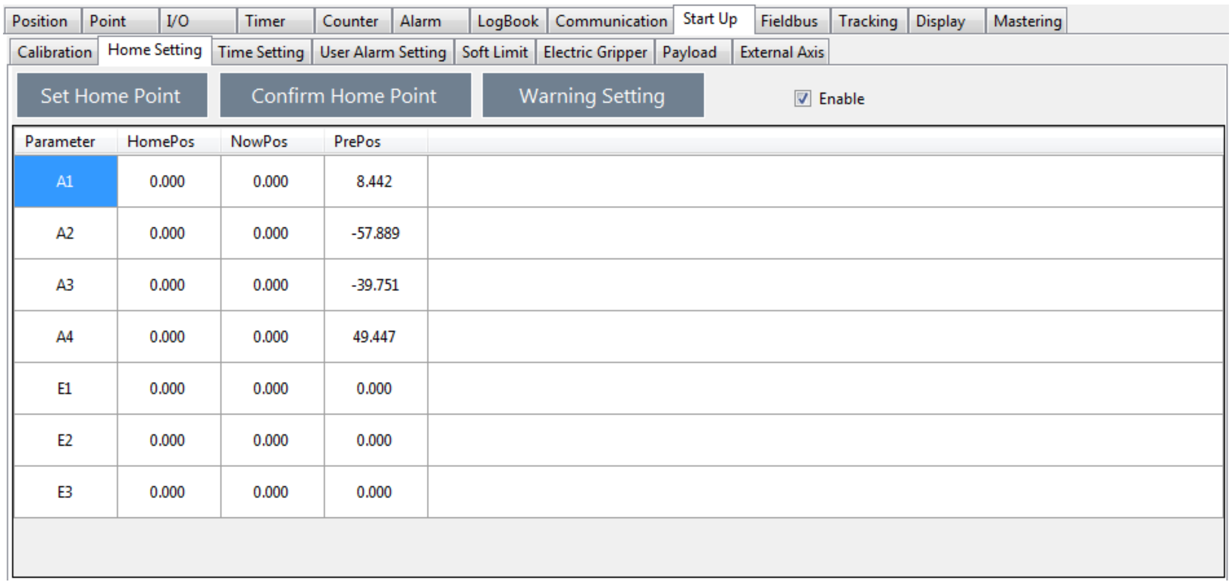
1.Click the sub-tab [Home Setting] of the function tab [Start Up].

2.The NowPos field shows the current axle angle, and the HomePos field shows the setting Home.

3.Using hand to move the robot manually, so that the angle of NowPos moves closer to HomePos.

4.When it is close to Home, even though there is an angle within 1º (Warning Setting of angle) difference, Press [Confirm Home Point]to finish the position check, and remove the alarm.

5.If no need the home position check function, user can cancel the check “Enable” selection, but it will no work on the software of home postioin check.

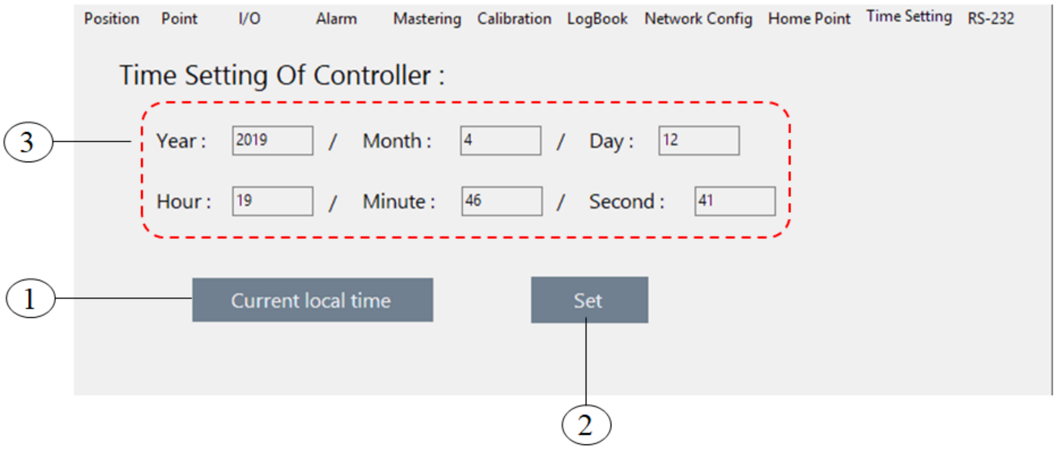


Home Setting interface

3.6.4 Time Setting of Controller

Description

User can use the Time Setting to modify the controller time, in order to sync computer time.



Time Setting of Controller

No.	Description
1	Click to get current local computer time.
2	Click to save time setting into the controller.
3	Required time setting.

Operating steps

■Sync local computer time

1.Click [Start Up] → [Time Setting].

2.Click [Current local time] to get current local computer time.

3.Click [Set] to save time setting into the controller.

■Modify time setting manually

1.Click [Start Up] → [Time Setting].

2.Enter required time setting manually.

3.Click [Set] to save time setting into the controller.

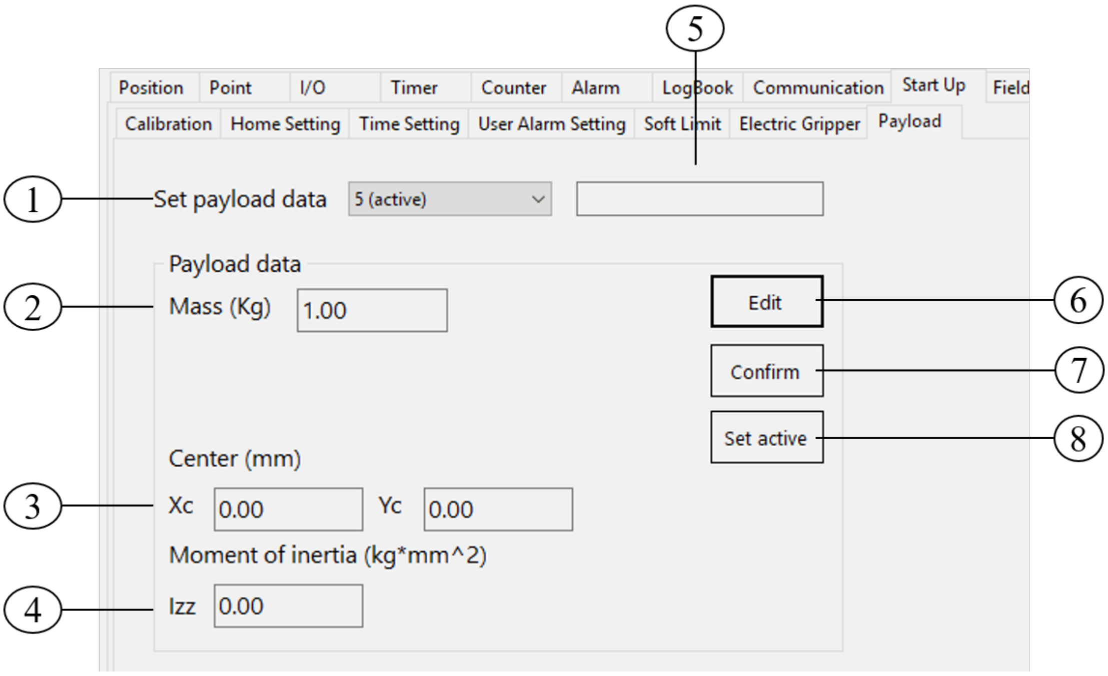
3.6.5 Payload Setting

Description

Set the weight at the end of the robot, which including the tool and the objects are clamped. This function will improve movement performance; also adjust the speed limit of the robot and the accuracy of the collision-detection function of the robot. In terms of load estimation, we can make sure whether the robot will warm-up and how the objects size will affect the accuracy approximately.

Instructions

1.Select the [Start up]->[Payload] page.
2.According to user needs, click [Edit] and enter the various parameters.
3.Once finished changes, click [Confirm] to save.
4.Click [Set active] to set the selected load data。



Payload setting interface

No.	Description
1	1~20 sets of load's data can be saved.
2	Set the load quality; the unit is kilograms.
3	Set the center position of the load; the unit is millimeters.
4	Set the moment of inertia; the unit is kilograms*millimeters^2.
5	Comment on the load data.
6	Manual input parameter changes.
7	Manual input parameter save changes.
8	Seve the load group to use.

3.6.6 User Self-define Alarm

3.6.6.1 Define Alarm Text Content Setting

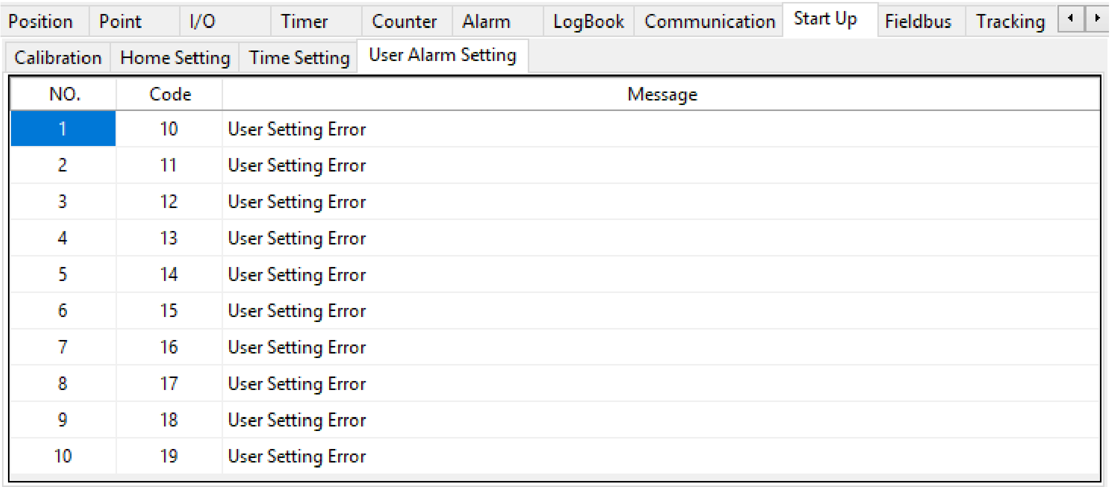
<u>Description</u>

User is able to define 10 sets of alarm text content, issued by program instruction.

<u>Operating Steps</u>

1.Click tab of [Start Up], click subtab of [User Alarm Setting].

2.Click twice on the column of Message, and then edit the alarm text content of that column.



NO.	Code	Message
1	10	User Setting Error
2	11	User Setting Error
3	12	User Setting Error
4	13	User Setting Error
5	14	User Setting Error
6	15	User Setting Error
7	16	User Setting Error
8	17	User Setting Error
9	18	User Setting Error
10	19	User Setting Error

User Alarm Setting interface figure

3.6.7 Electric gripper setting

<u>Description</u>

Users can set a connection with the XEG electric gripper and reset it by HRSS, which allowing users to move the gripper manually, and can use HRL related instructions to controls it.

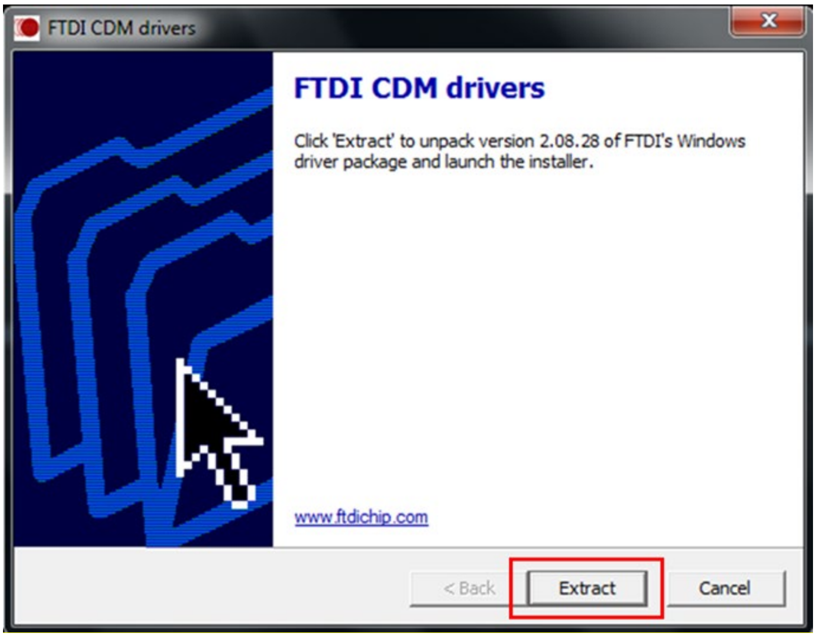
<u>Instructions</u>

Main menu>Start-up>Electric Gripper

1.If no drivers were installed, the driver must be installed at first; descriptions of the steps are as follows:

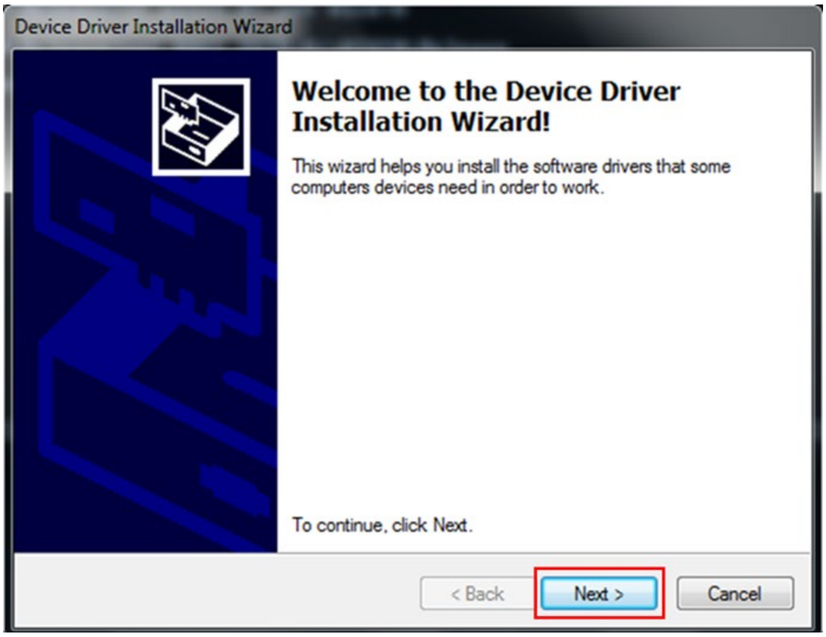
A.The HRSS software version must be updated to at least 3.2.5 or above.

B.Place the Electric Gripper Driver.exe file downloaded from the official website on the controller, and double click on it manually to open the gripper driver installation, and click Extract



Electric Gripper driver installation step 1

C.Click Next to enter the next step



Electric Gripper driver installation step 2

D. Click and finish it after Installation is fully completed; next, restart the controller.

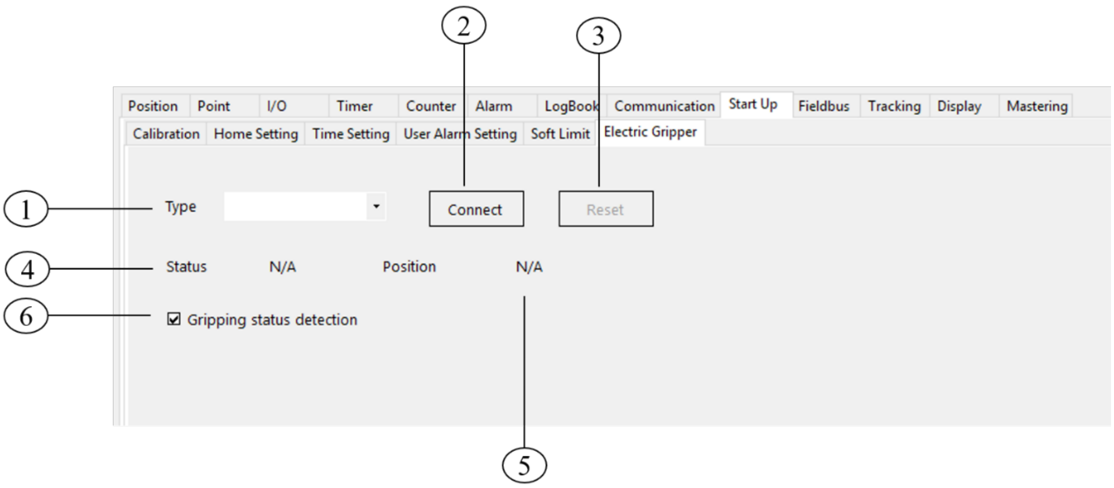
Electric Gripper driver installation step 3

2.Select the gripper model

3.Press the connect button

4.Press the reset button to reset the gripper's setting; please note that this reset is only completed when the gripper status changed from Busy to Idle

5.The detection function of the gripper is enabled by default; this function is used to notify the user when the gripper did not grip any objects. This function can be unselected if the detection function is not required.



Electric Gripper Operation Interface

No.	Description
1	Set the gripper model
2	Connect/disconnect to the gripper
3	Reset the gripper connection settings
4	Displays the current gripper's status

5	Displays the current gripper's position
6	Grip detection status function

3.6.8 Software limit function

Description

The software limit function is provided in HRSS; this function mainly sends out alarms in real-time and stops movements. When the number of movement commands sent to the robot exceeded the limit set, or when the robot exceeded the position of the limit set during the movement process.

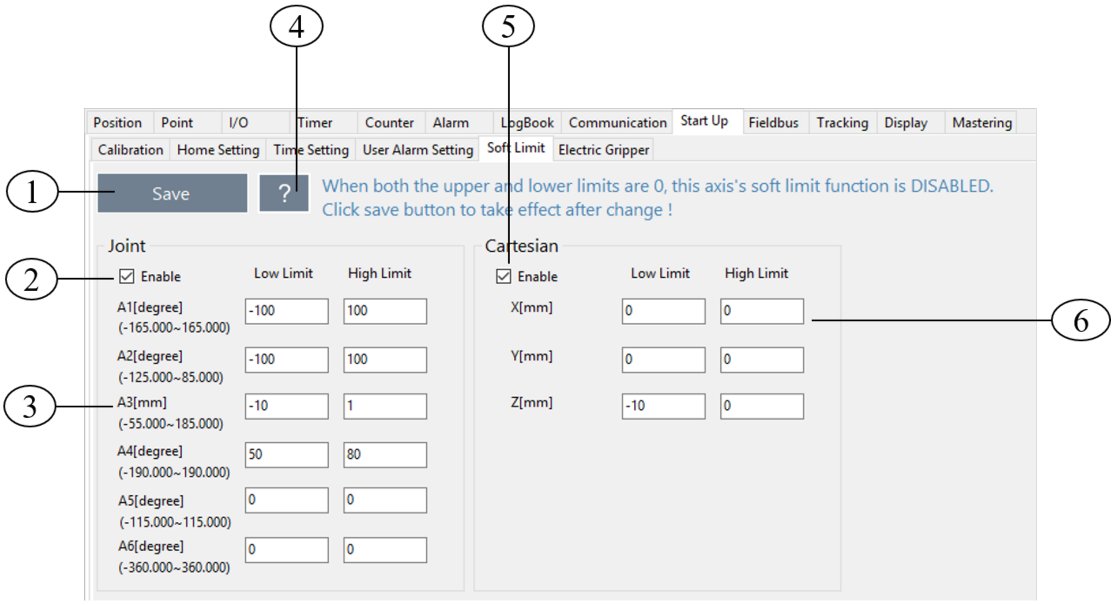
Set the software movement range limit for the various axes and space Cartesian coordinates based on joint, SCARA or parallel robots.

The upper and lower limits of each axis and Cartesian coordinates can be set in the software limit function. The limit range of the Cartesian coordinate is to be set based on the center position of the robot tool (TCP) when the base coordinate is 0 (Base 0). Users can choose whether enable the limit check for each axis or Cartesian coordinate setting (setting interfaces are different according to the different robots). For the limits of each axis for joint robots, upper and lower limits can be set for axes A1~A6. For the Cartesian coordinate limits, upper and lower limits can be set for X, Y and Z. For SCARA robots, upper and lower limits can be set for axes A1~A4. For the limits of each axis for parallel robots, upper and lower limits are set at the same time for axes A1~A3 while the A4 axis is set separately. For the Cartesian coordinate limits, upper and lower limits are set for the radius and Z axis. If the upper and lower limits are both 0, it means that the axis or the X, Y or Z functions are disabled.

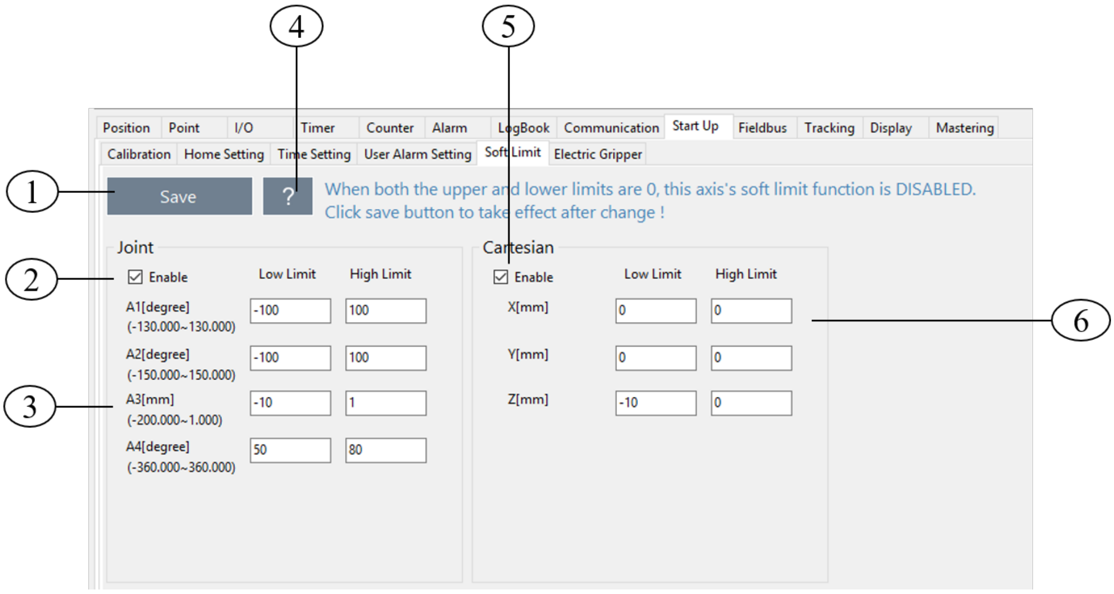
Instructions

1.Save the changes
2.Enable/Disable Soft Limit.
3.Set software limit function for each axis
4.Softlimit note
5.Set the software limit function for space for Cartesian coordinate
6.Set the software limit for each Cartesian coordinates

The movement range on the coordinate display interface will be updated immediately according to the software limit settings.



Joint robot software limit setting interface



SCARA robot software limit setting interface

Item number	Description
1	Save settings
2	Enables/disables the software limit function for each axis
3	Set the software limit for each axis
4	Displays reminder texts. When the upper and lower limits are both set as 0, it is disabled.
5	Enables/disables the software limit function for space Cartesian coordinates
6	Set the software limit for each Cartesian coordinate

3.6.9 External axis functions

Description

HRSS (HIWIN-Software) provides related functions and robotic language (HRL) instructions to operate and control the external axis. After users configured the related external hardware equipment properly, they can use HRSS and it is function. For example, HRSS can be controlling the external axis to execute synchronous and asynchronous movements, or execute synchronous coordinated controls for the external axis. HRSS can currently control a maximum of 3 external axes. In terms of application, it can control linear mobile carriers, end tools and positioners, etc.

3.6.9.1 External axis parameter settings

Description

The connected external axes of the various parameters must set prior to performing operations and controls to the external axes. The parameters for each axis must be set and saved.

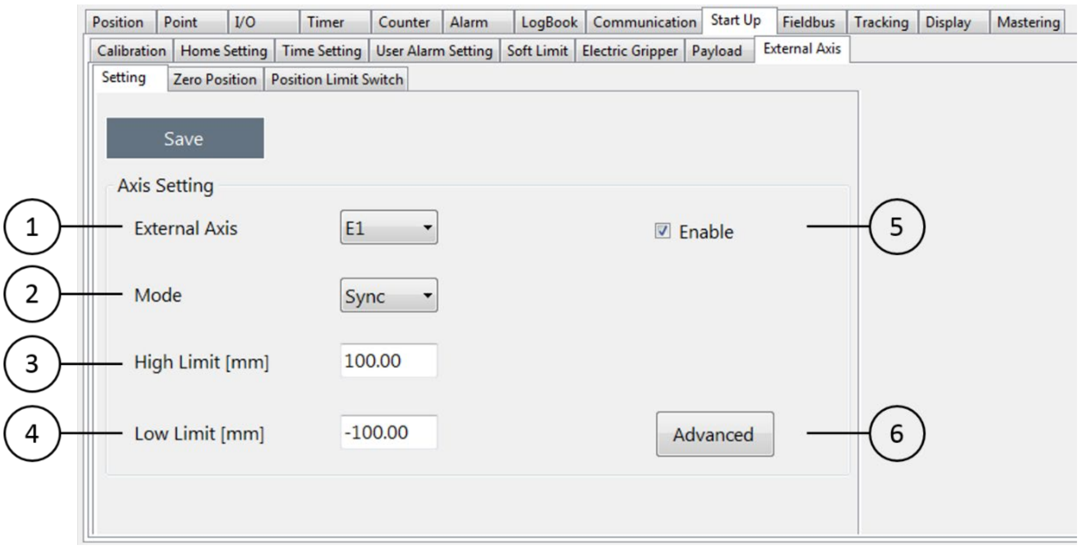
Instructions

1.Click the function page [Start Up] → [External Axis] [Setting].

2.Open the function and set the parameters.

3.Set the advanced page parameters.

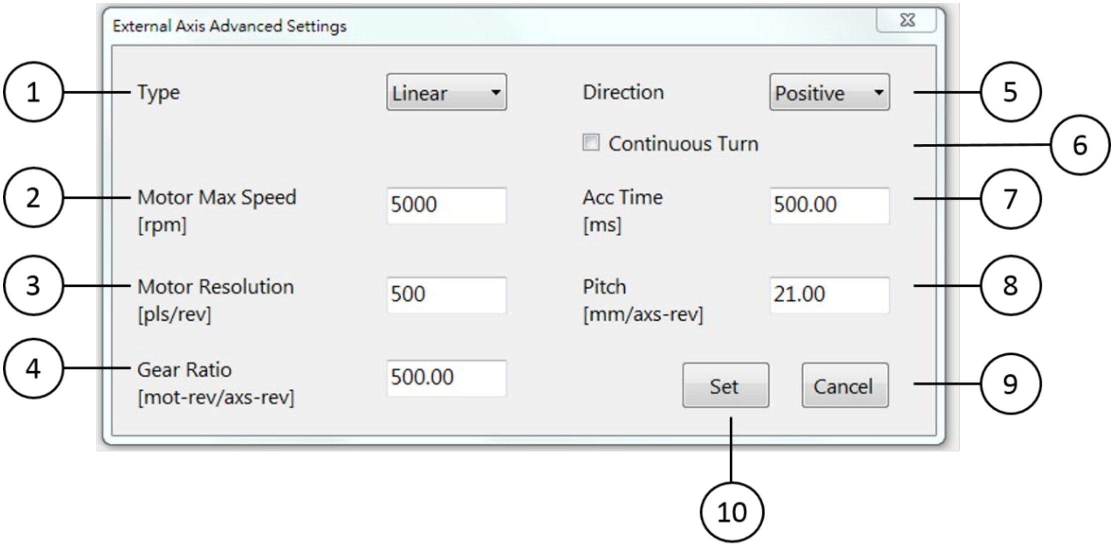
4.Press the [Save] button to save the settings.



External axis parameter settings

Item number	Description
1	Select the external axis
2	Set the movement mode of the external axis as synchronous/asynchronous axis ●Synchronous movement (Sync):

	Synchronous movement means that the movement of all axes, including the robot and external axes, starts and ends at the same time. Calibrate their movement path relationship and set their kinesiology under synchronous movement mode allows the achieving of synchronous coordinated control when controlling external axes. ●Asynchronous movement (Async): Asynchronous movement means that the movements of the robot and external axis do not start or stop at the same time; the movements of the robot and external axes are not dependent on each other
3	Set the upper limit for the movements of the external axis
4	Set the lower limit for the movements of the external axis
5	Enables/disables the selected external axis function
6	Advanced setting page



External axis advanced parameter settings window

Item number	Description
1	Set the external axis type to linear/rotation axis
2	Set the maximum rotation speed of the external axis motor
3	Set the resolution of the external axis motor
4	Set the reduction ratio of the reducer installed on the external axis motor
5	Set the direction of the external axis motor
6	Set the infinite rotation function of the external axis

7	Sets the acceleration and deceleration time for the external axis
8	Sets the lead of the external axis
9	Cancel the changes made at this time
10	Save the settings at this time temporarily; the [Save] button on the home page must be pressed to make changes on this setting

3.6.9.2 Zero point calibration for the external axis

Description

Perform a zero point of the external axis; for safety considerations. Users must do the zero point position calibration after the completion of parameter settings for the external axis.

Instructions

1.Click the function page [Start Up] → [External Axis] [Zero Position].

2.Select the external axis to reset and press the [Reset] button.

3.If set successfully appeared, it means reset has been completed.

Zero point calibration for the external axis

3.6.9.3 External axis positive and negative limit signal monitoring

Description

Caterpillar can set with HRSS to monitor the positive and negative limit status of the external axis driver. When the limit signal trigger is received, the instruction for movements toward the limit direction is stopped to prevent the external axis from bursting or colliding.

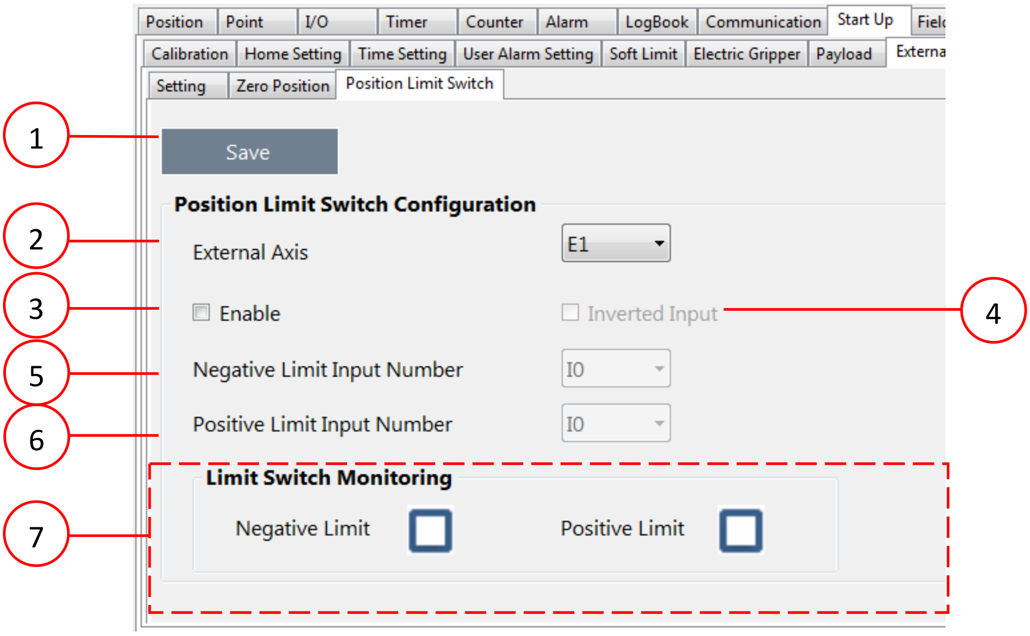
Instructions

1.Click the function page [Start Up] → [External Axis] x [Position Limit Switch].

2.Select the pin and function set.

3.Press the [Save] button to complete the settings.

4.When the sensor or signal source detects the limit, the [Limit Switch Monitoring] light will turn on (invert input not set).



External axis positive and negative limit signal monitoring interface window

External axis positive and negative limit signal monitoring setting table

Item number	Item name	Description
1	Save button	The Save button must be pressed after setting the interface parameters to record the settings.
2	Axis selection	The axis selection button for the external axis; it is in the form of a pull-down menu. Axes E1~E3 can be selected.
3	Enable/Disable monitoring function	To use limit signal monitoring, this function must be enabled
4	Reverse input signal	Reverses the input signal of the positive and negative limits. (If it was originally “normal-open” signal, after being reversed, it would become “normal close” signal)
5	Sets the input pin of the negative limit	Negative limit input pin selection; pins I0~I31 can be selected. (Select based on the external axis driver pin used)
6	Sets the input pin of the positive limit	Positive limit input pin selection; pins I0~I31 can be selected. (Select based on the external axis driver pin used)
7	Limit switch monitoring display	It Shows whether the positive/negative limit is currently the limit position signal; if the frame is red, it is the limit position, and if it is white, it is a non-limit position.

3.6.9.4 Manual operation of external axis

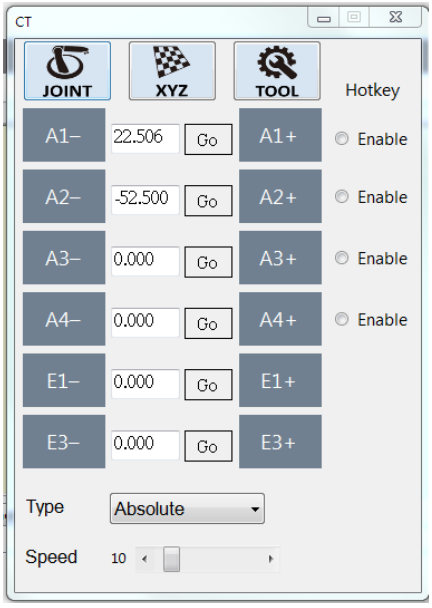
Description

Each of the external axes can be moved manually with a help of JOG mode in the Manual mode; each of the axes can be moved in the positive or negative direction and their speed rates can be adjusted separately.

Instructions

1.Click the [JOG] page.

2.Start moving the external axis.



JOG interface window

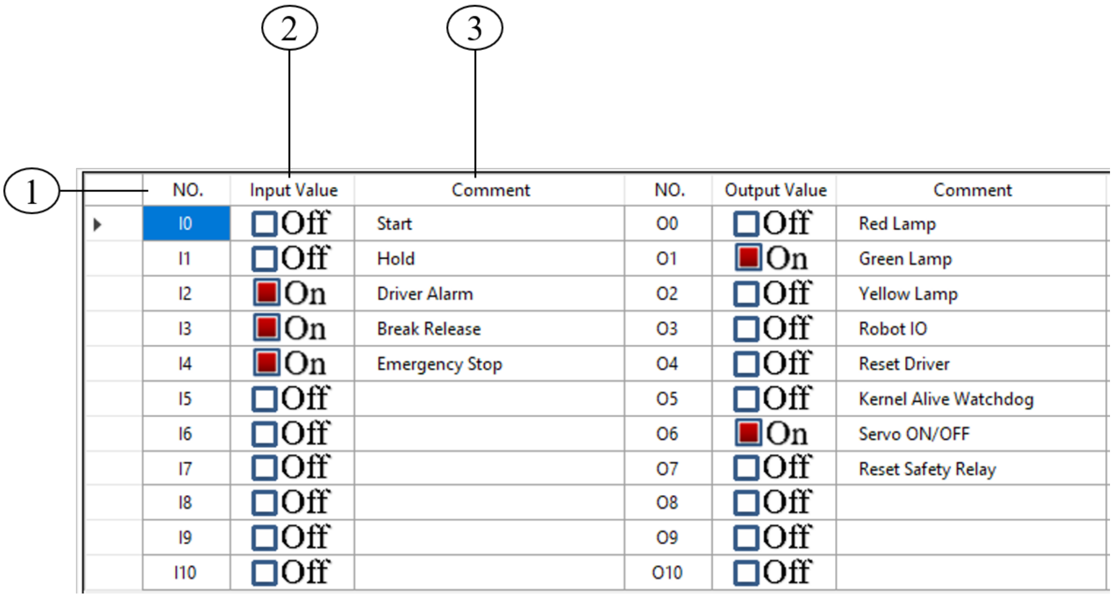
3.7 Display Setting

3.7.1 Display System Status Input/Output

Operation steps

■Click tab of [Display] ,Click subtab of [System I/O].

Description



NO.	Input Value	Comment	NO.	Output Value	Comment
I0	Off	Start	O0	Off	Red Lamp
I1	Off	Hold	O1	On	Green Lamp
I2	On	Driver Alarm	O2	Off	Yellow Lamp
I3	On	Break Release	O3	Off	Robot IO
I4	On	Emergency Stop	O4	Off	Reset Driver
I5	Off		O5	Off	Kernel Alive Watchdog
I6	Off		O6	On	Servo ON/OFF
I7	Off		O7	Off	Reset Safety Relay
I8	Off		O8	Off	
I9	Off		O9	Off	
I10	Off		O10	Off	

System input/output interface

No.	Description
1	Input/Output number
2	The opened input/output signal displays in red and shows On. OFF is displayed in white and showed Off.
3	Input/output name

3.7.2 Module I/O Function

Description

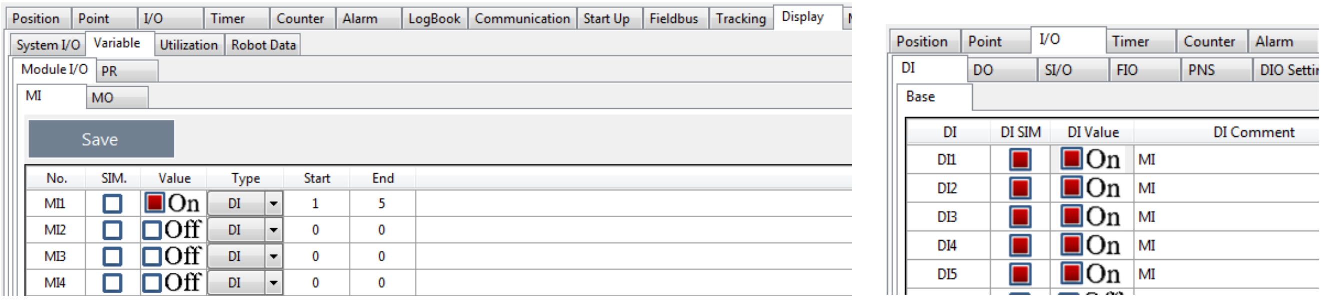
User can use module I/O (DI/DO/SI/SO) to map and control to multiple inputs (DIs) or outputs (DOs).

Operating steps

Click tab of [Display], [Module I/O] tab under [Variable] tab, click tab of [MI]/ [MO].

1. Module Input setting:

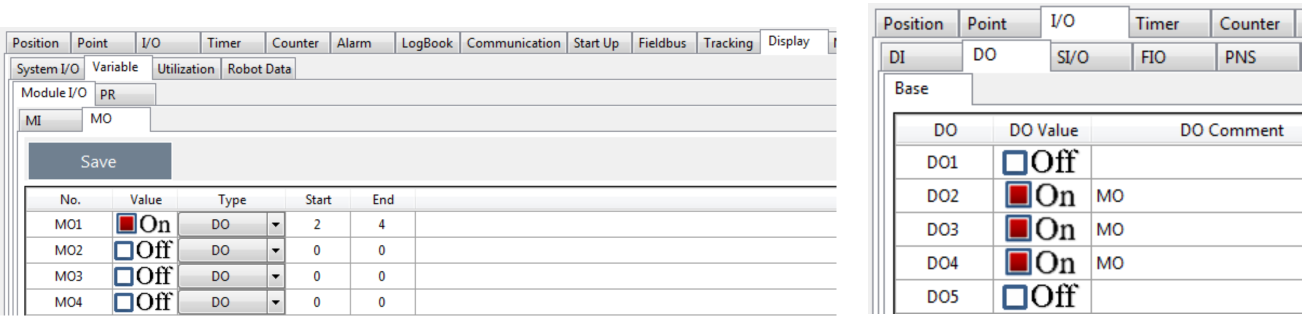
   "Start" is beginning Input number and "End" is the ended Input number. After setting, while the specific Module Input is ON, the mapped Inputs (DIs) will be ON as well.



Module input figure (right figure is DI[1]~ DI[5] ON then MI[1]ON)

2. Module Output setting:

   "Start" is beginning Output number and "End" is the ended Output number. After setting, while the specific Module Output is ON, the mapped Outputs (DOs) will be ON as well.



Module output figure (right figure is DO[2]~ DO[4] ON then MO[1]ON)

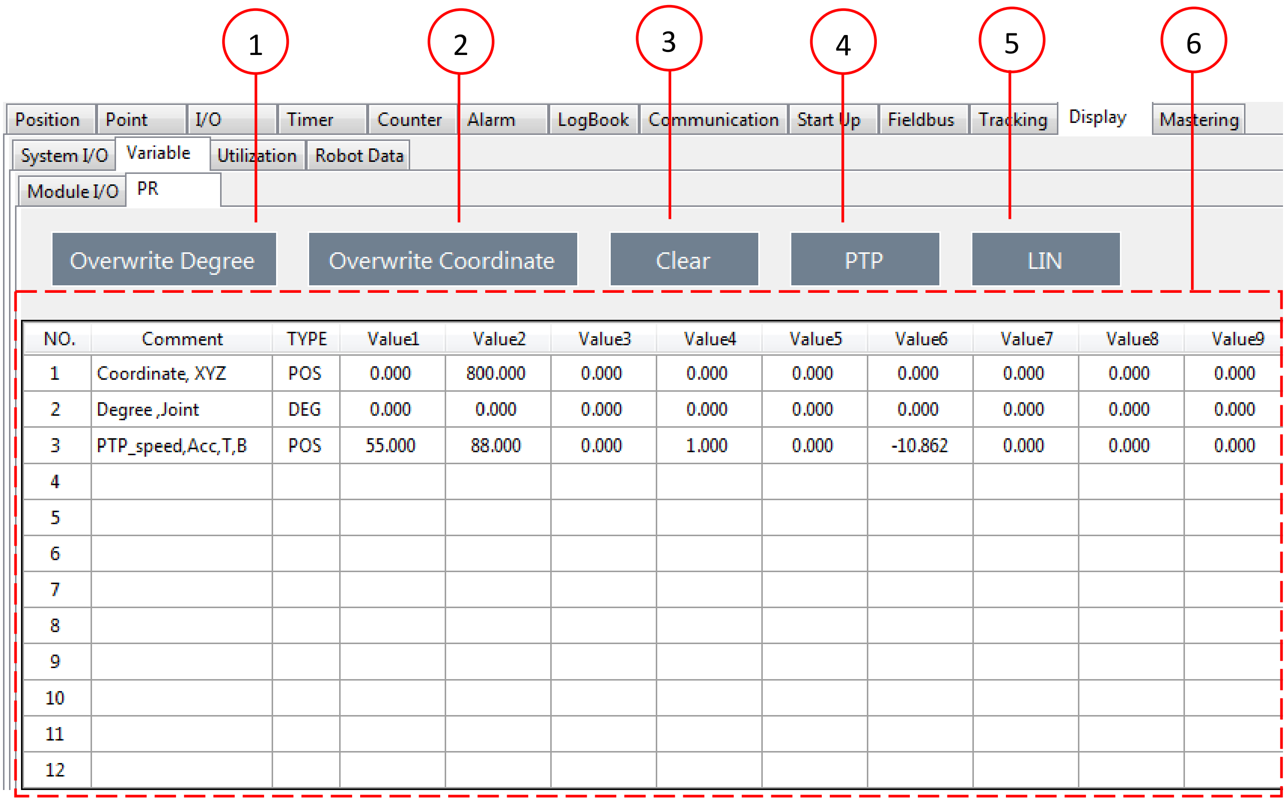
3.7.3 Position Register (PR) Setting

Description

User can set Position Registers. Value1 to Value6 are the angle values or coordinate values; they can be divided into angle DEG and position coordinate value POS. Value7 - Value9 are the external (E1~E3) position values of the external axis.

Operating steps

1. Click tab of [Display], Click subtab of [Variable] , Click subtab of [PR].
2. Select one row of the table of registers.
3. Users can choose and Overwrite Degree of the current axis coordinate position and external axis or Overwrite the current Cartesian coordinate and external axis in the options below.
4. Clicking the [Clear] button will clear all coordinate contents and comments for the respective point.
5. Clicking the [PTP] button will move the robot to this point by using the point to point (PTP) method.
6. Clicking the [LIN] button will move the robot to this point by using the linear (LIN) method.
7. Double-clicking the value in the table allows modifying it directly. While modifying, users must be special attention and enter the correct value in order to prevent the robot from the abnormal positions or collisions.
8. User-defined comments can be entered in the Comment field to identify points during operations.



NO.	Comment	TYPE	Value1	Value2	Value3	Value4	Value5	Value6	Value7	Value8	Value9
1	Coordinate, XYZ	POS	0.000	800.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	Degree ,Joint	DEG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	PTP_speed,Acc,T,B	POS	55.000	88.000	0.000	1.000	0.000	-10.862	0.000	0.000	0.000
4											
5											
6											
7											
8											
9											
10											
11											
12											

Position registers interface

Position registers setting description table

No.	Name	Description
1	Overwrite Degree Overwrite angle button	After selecting the column item (No.) to overwrite, press the button and the angles of the various axes (A1~A4) of the robot will be recorded into the specified table columns (Value1~Value4). They are DEG angle types.
2	Overwrite Coordinate Overwrites the coordinate value angle	After selecting the column item (No.) to overwrite, press the button and the current angles (XYZC) of the various axes of the robot will be recorded into the specified table column (Value1~Value6), in which 0 is recorded into Value4 and Value5. They are POS position coordinate types.
3	Clear button	After selecting the column item (No.) to overwrite, press the button to clear the current values.
4	PTP button	Button used to move to this point using point to point method. After selecting the column item (No.) to move, press this button and the robot will move to the point at this position.
5	LIN button	Button used to move to this point using the linear method. After selecting the column item (No.) to move, press this button and the robot will move to the point at this position.
6	Information display table	Displays the information of the position register currently set; Value1 - Value6 are the angle value or coordinate value, which can be divided into angle DEG and position coordinate value POS, and Value7 - Value9 are the E1~E3 position values of the external axis. A total of PR1 ~ PR4000 position registers can be used, and the writing method of the corresponding program is $PR[1] ~$PR[4000] position register settings. User-defined comments can be entered in the Comment field to identify points during operations. If users want to change the value in PR, simply double-click on it to modify the value. While modifying, users must be special attention and enter the correct value in order to prevent the robot from having abnormal positions or collisions.

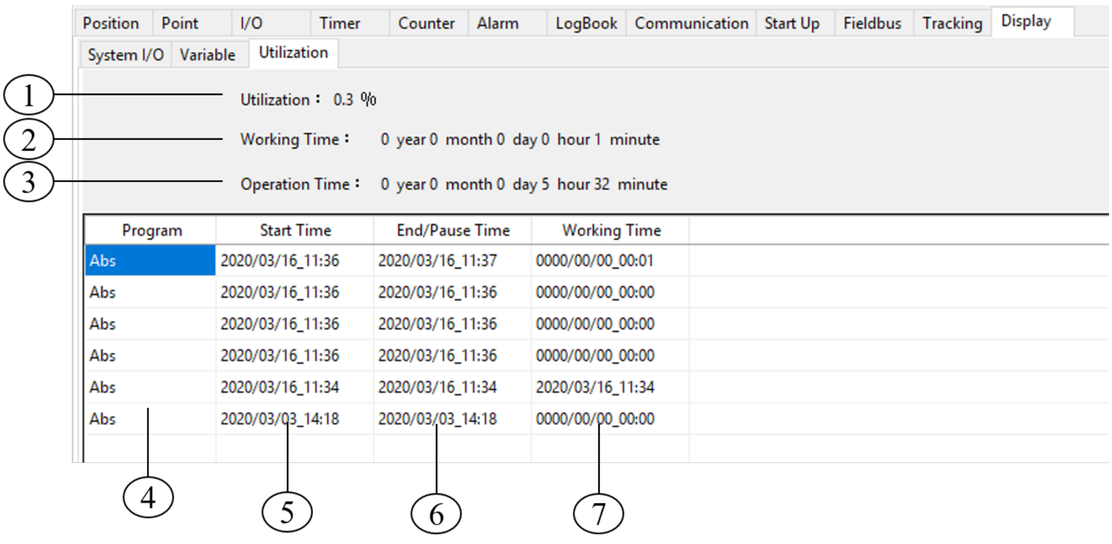
3.7.4 Display Utilization Rate

Operating Steps

Click tab of [Display], click subtab [Utilization].

Description

Display robot utilization 、working time and operation time.



Utilization Interface

No.	Description
1	Utilization rate
2	Total time of executing program
3	Total time of turning on power
4	Name of executing program
5	Start time of executing program
6	End/pause time of executing program
7	Working time of executing program

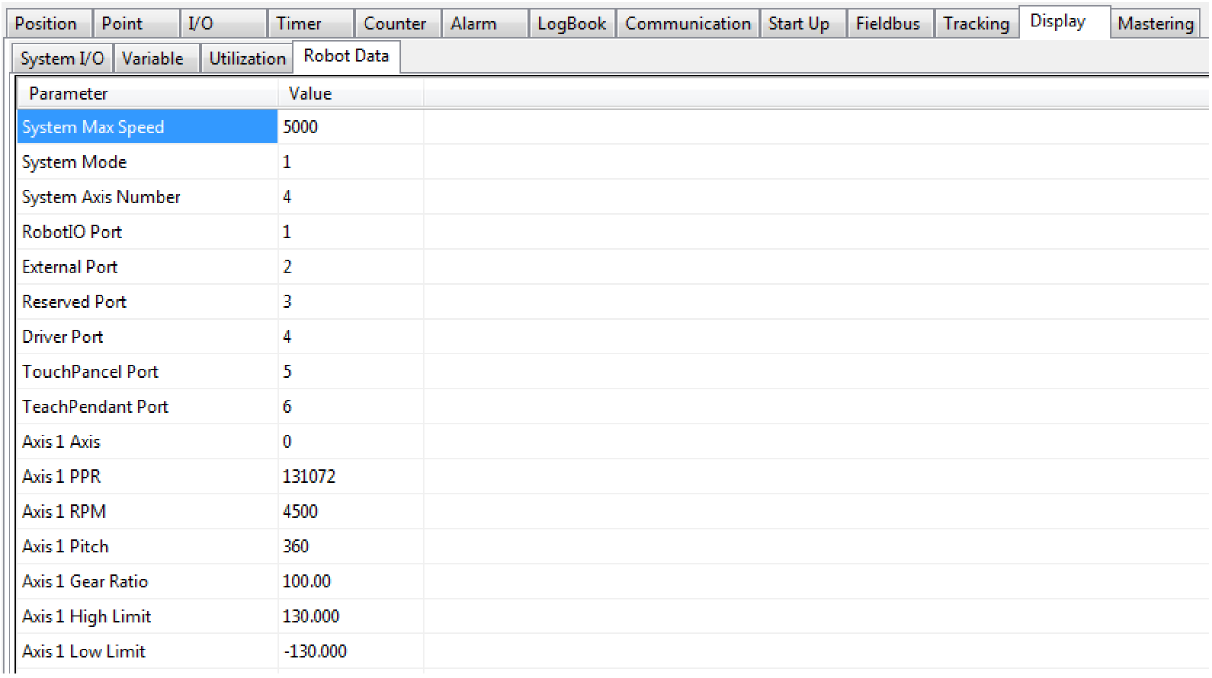
3.7.5 Display Robot Data

Description

Records the robot's parameter's name and parameter values, such as the system's maximum speed, rotation speed set for the first axis, upper and lower limits, gear ratio and other robots' information. It only displays the information and cannot change them; it is only used for confirming parameters and fixing problems.

Operating steps

Click tab of [Display], click subtab of [Robot Data].



Parameter	Value
System Max Speed	5000
System Mode	1
System Axis Number	4
RobotIO Port	1
External Port	2
Reserved Port	3
Driver Port	4
TouchPancel Port	5
TeachPendant Port	6
Axis 1 Axis	0
Axis 1 PPR	131072
Axis 1 RPM	4500
Axis 1 Pitch	360
Axis 1 Gear Ratio	100.00
Axis 1 High Limit	130.000
Axis 1 Low Limit	-130.000

Robot data interface

4. Motion Program Base Design Description

4.1 Motion Overview

Program designed by the following motion:

Point-to-point motion (PTP)

Linear motion (LIN)

Circular motion (CIRC)

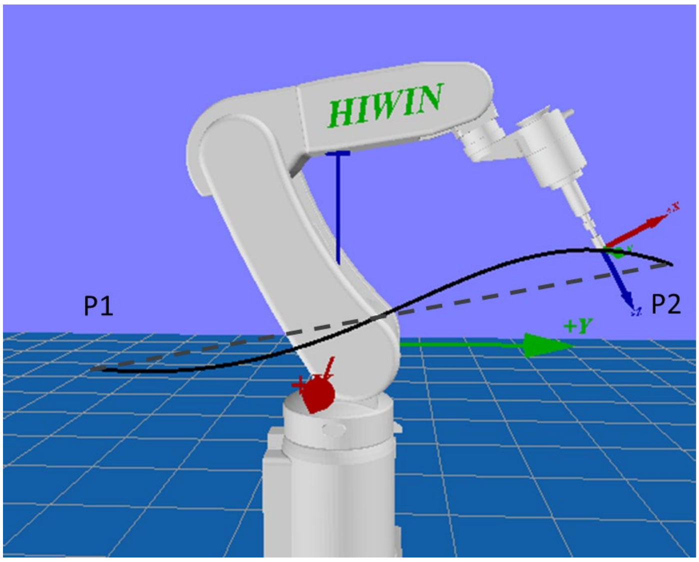
LIN and CIRC Motion is also called as “CP motion” (CP = Continuous Path).

A start point must begin at the end point of the previous motion.

4.2 Point-to-point (PTP) Motion

The robot guides TCP to the target point along the fastest path. Generally, the fastest path is not the shortest one. This means that it is not a straight line. Because the axis performs rotational motion, the curved path is faster than the straight one.

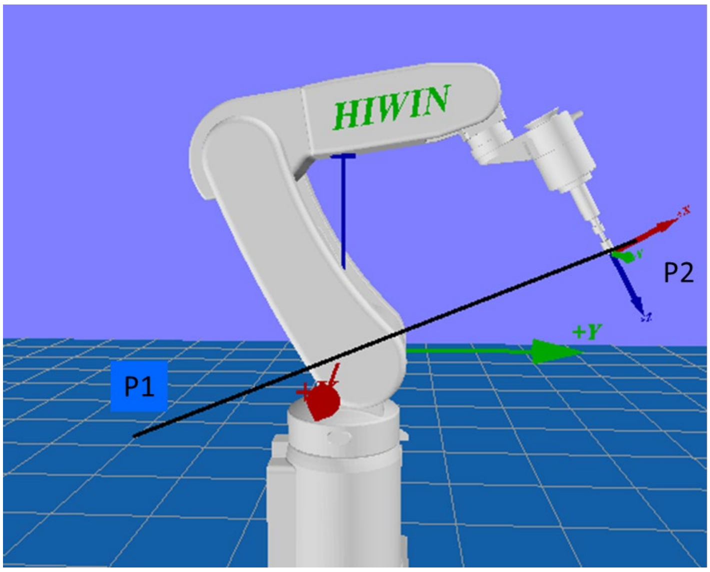
The motion cannot be accurately known in advance.



PTP Motion path figure

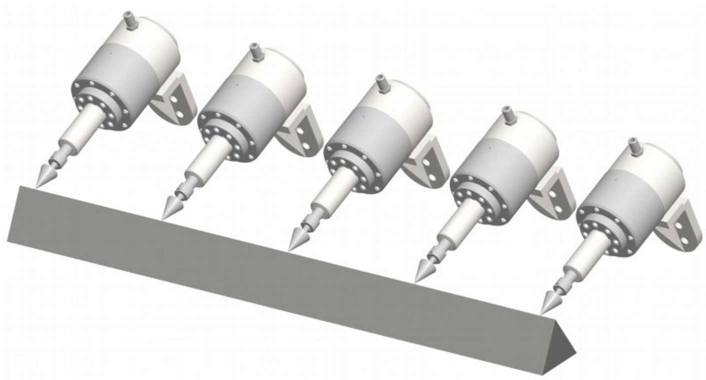
4.3 Liner Motion (LIN)

The velocity defined by the robot along a straight line moves TCP to the target point.

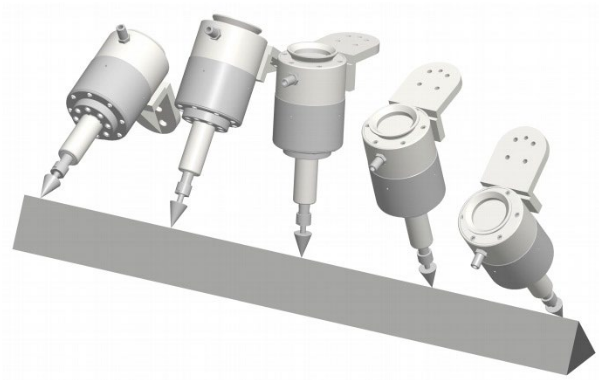


LIN motion path figure

TCP at the start point of motion could be in an orientation different from the target point. The orientation of TCP will gradually change during the motion. When the TCP is at the start point of motion and in the same orientation as the target point, the orientation of TCP will remain the same in the motion.



Start point in same orientation of target point



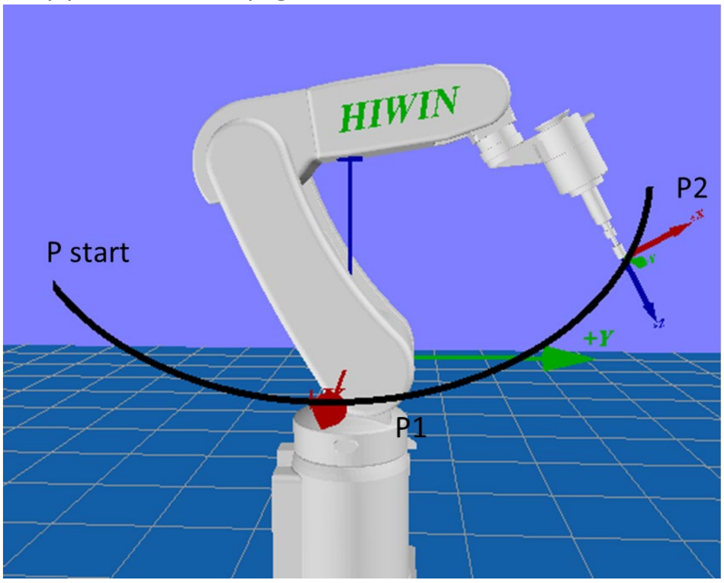
Start point in different orientation of target point

4.4 Circular Motion(CIRC)

The velocity defined by the robot along the circular path moves the TCP to the target point. A circular track is defined by the start point, auxiliary point and target point.

For the CIRC motion, the orientation guide is the same orientation as with LIN motion.

In the CIRC motion, the control system only considers the orientation of the target point. The orientation of auxiliary point is usually ignored.



CIRC motion path figure

4.5 Robot Singular Point Description

The HIWIN's robot with six degrees of freedom has three kinds of singular point.

1.Overhead singular point (Six-Axes robot)

2.Singular point at extended position(Six-Axes robot, SCARA Robot)

3.Singular point at wrist axis(Six-Axes robot)

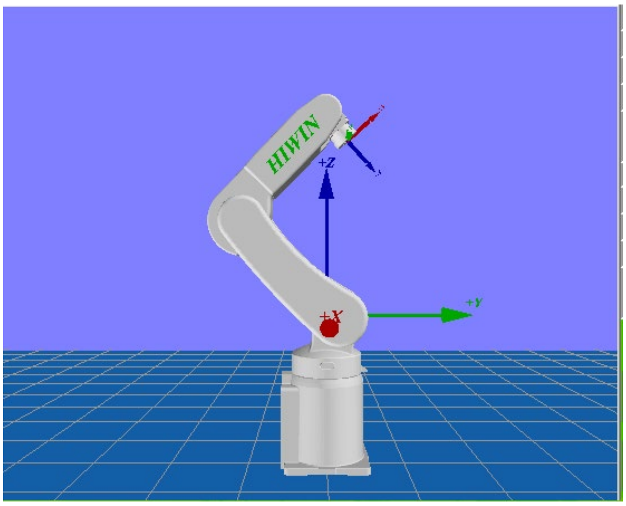
It is considered as a singular point position only when one value can't be obtained by the inverse conversion (converted from Cartesian coordinate to articulated coordinate). In this situation, it is a position of singular point when the minimum Cartesian variation could cause a large change of axis angle.

■Overhead

For the overhead singular point, the wrist point (the middle point of axis A5) is vertical to the axis A1.

The position of the axis A1 cannot be confirmed by the inverse conversion, and it can be any value.

At this point, if the inverse motion is performed, an error will appear.



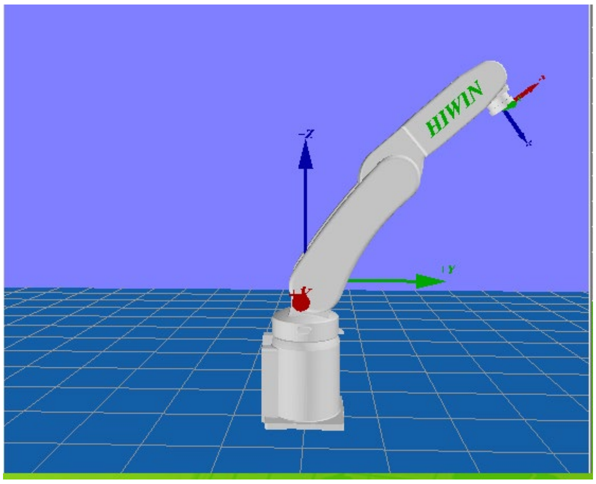
■Extended position

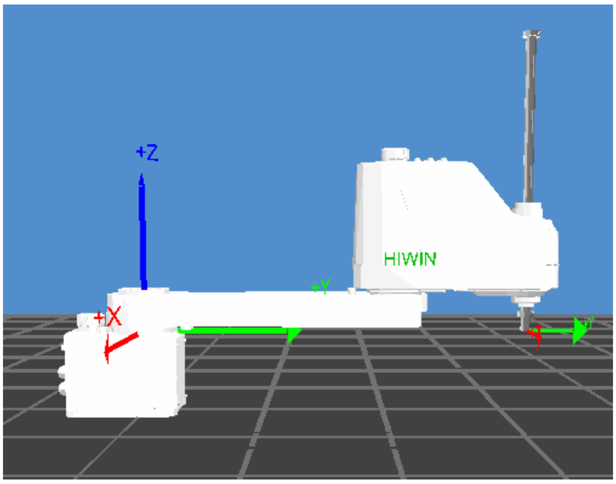
For the singular point at the extended position, the wrist point (the middle point of axis A5) is located in the extension of axis A2 and A3.(SCARA: A1 AND A2)

The robot is located at the edge of the workspace.

Although only one axis angle can be obtained by the inverse conversion, the small Cartesian variation will cause the large velocity of the axis A2 and A3. (SCARA: A1 AND A2)

At this point, if the inverse motion is performed, an error will appear.



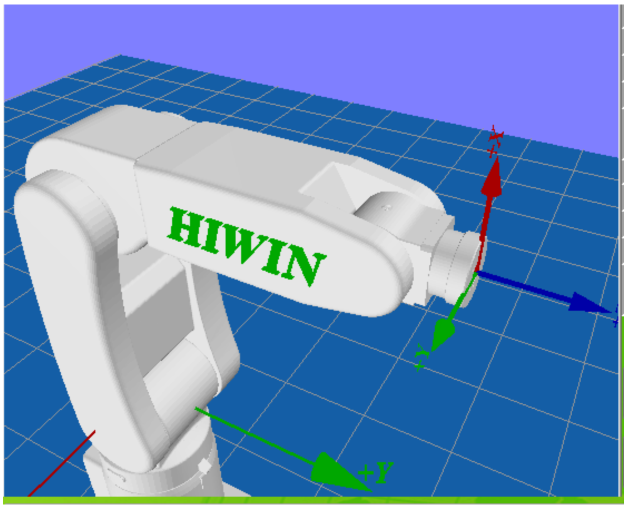


■Wrist axis

For the singular point of the wrist axis, the axis A4 is parallel with A6, and the axis A5 is within the range ±0.1° .

The positions of two axes can't be confirmed by the inverse conversion. Although the axis A4 and A6 can have many positions but the sum of the axis angle is the same.

At this point, if the inverse motion is performed, an error will appear.

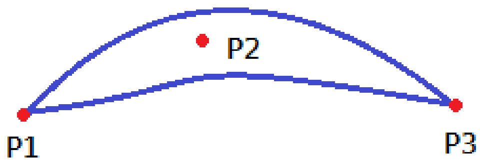


4.6 Blend (Continuous Trajectory)

Blend: Not accurately moved to the point programmed. The over blending is another option that can be selected during the motion program.

■PTP motion

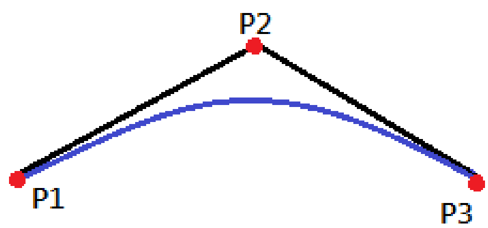
The TCP will leave a track where it can accurately reach the target point, and adopt the faster one. When over blending takes place in a PTP motion, the track change cannot be foreseen. The point through which side on the track cannot be forecasted.



PTP motion and P2 blended

■LIN motion

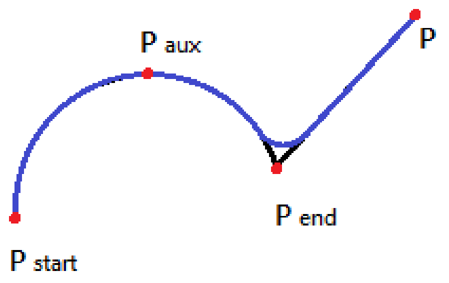
TCP will leave a track where it should accurately move to the target point, and run on a shorter track. The region where the track path runs is not an arc.



LIN motion and P2 blended

■CIRC motion

TCP will leave a track where it should accurately move to the target point, and run on a shorter track. The auxiliary point can reach accurately. The region where the track path runs is not an arc.



CIRC motion and Pend blended

4.7 Continuous/ Discontinuous Trajectory Description

§Continuous Trajectory (CONT, Pre-read) Description:

If the "CONT" command is called, the robot controller will consider the next motion point, and will move in a smoother path. The path smooth level will depend on the motion velocity and acceleration.

There are three kinds of CONT command: CONT, CONT = #%, CONT = #mm. Last two kinds represent the fixed path, like CONT = 50% or CONT = 30mm.

■ **Command Format:**

Format(1)：CONT
Format(2)：CONT = #%
Format(3)：CONT = # mm

⇨**Format(1)：CONT**

If User not define smooth path percentage ratio or smooth path distance, preset parameter is 100%.

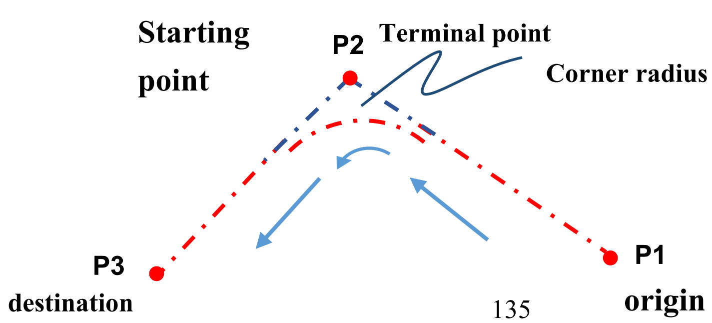
LIN P1 CONT

LIN P2 CONT

LIN P3 CONT

When execute the commands open, there will be the smooth path in "LIN P2 CONT", but there won't move to P1 and P3(because they are the origin and destination).

CONT motion figure



⇨**Format(2)：CONT = #%**

User define smooth path percentage ratio.

LIN P1 CONT

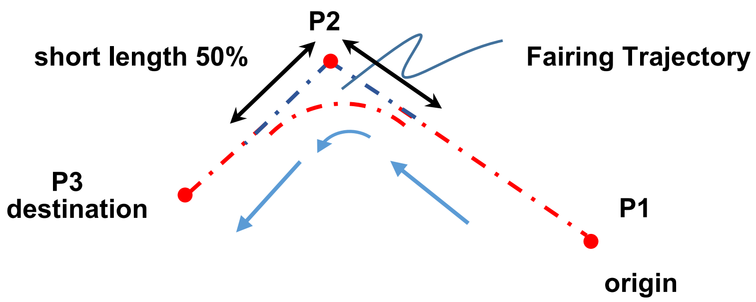
LIN P2 CONT = 50%

LIN P3 CONT

The distance between P2, P3 is shorter than the one between P1, P2, which is called the short length. When execute the open program, the trajectory will start fairing when 50% short length away before P2.

⚠ CAUTION

Because the "CONT= # %" command will create a fixed path, so the velocity of the robot may change.



CONT = 50% figure

⇨**Format(3)：CONT = # mm**

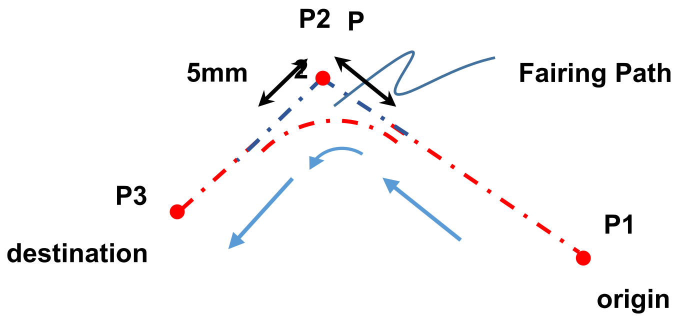
User define smooth path distance.

LIN P1 CONT

LIN P2 CONT = 5mm

LIN P3 CONT

The path will start fairing when 5mm away before P2.



CONT = 5mm figure

⚠ CAUTION

Because the "CONT= # mm" command will create a fixed path, so the velocity of the robot may change.

⚠ CAUTION

When using "CONT= # mm" command, it does not mean that the value specified by the user will be exactly the same. However, the system will attempt at the distance specified by the user.

If there is "DO" command before the "CONT", then the path won't be smoothed.

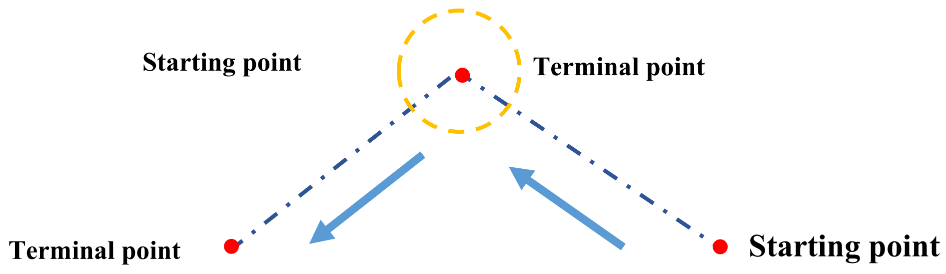
Example：

```
LIN P1 CONT
$DO[1] = TRUE
LIN P2 CONT
LIN P3 CONT
```

Originally, the path moving to P1 should be faired, but in this case, the path won't be smoothed.

Line 2 have one DO signal, to reach P1 position and stop, to output DO[1] signal, then move to P2 position smoothed. CONT not work in Line 2 (not pre-read).

§Discontinuous Trajectory -FINE (Not Pre-read) Description:



FINE motion

"FINE" command make TCP arrive the point without fairing the path.
User choose kind by task state, preset define FINE=1.

■ **Command Format:**

Format(1)：FINE (=0)
Format(2)：FINE = 1
Format(3)：FINE = 2

FINE has three kinds:

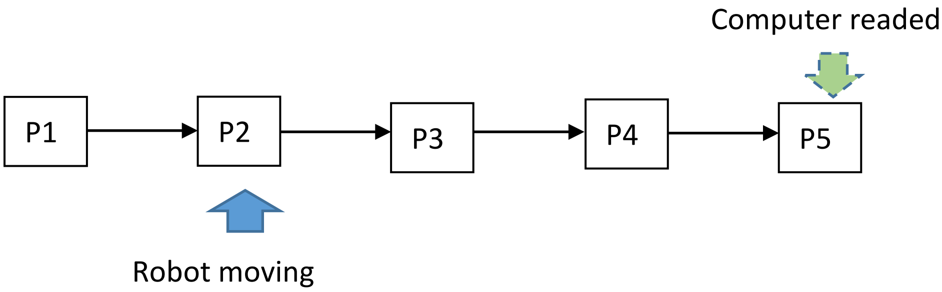
⇨FINE (= 0), pre-read the next command, not check the actual position. Equal CONT commend, can save motion time.

⇨FINE = 1 , not pre-read the next command, not check the actual position.

⇨FINE = 2 , not pre-read the next command, check the actual position.

※Preload function description

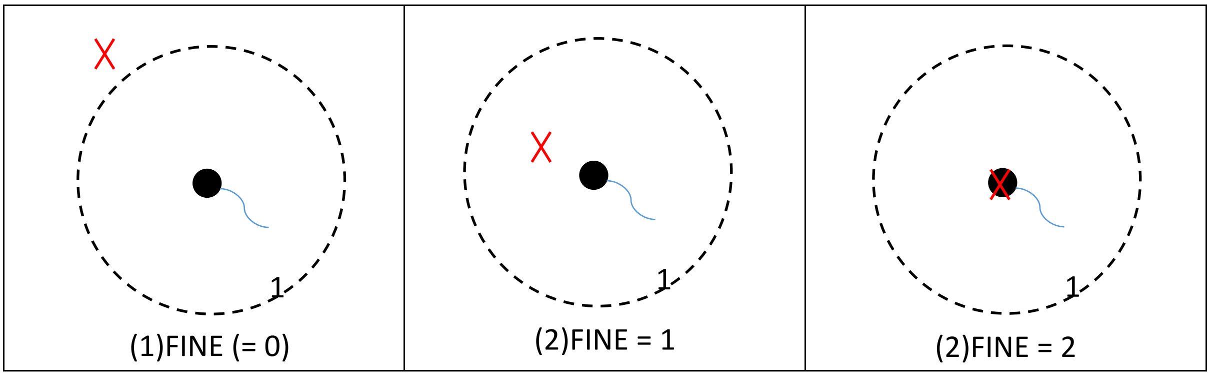
In computer program computations, program codes are preloaded at the bottom layer of the program to be compiled and combined with multiple follow-up actions and then integrated and outputted. We call this the preload function. The benefit of the preload function is to allow the program to know the next step of action in advance, and make adjustments and simplifications to reduce time. But the drawback is that when there might be several types of processes (such as counting, statements and calculation types), that the robot timing may be inaccurate. CONT instructions all have preload functions.
For example: In the figure below, the robot moves to 5th point from P1 to P5; when the robot is moving towards P2, the program already read the P5 point, and the subsequent actions are more certain.



Preload function illustration

※**In-place function description**

The in-place function refers to the accuracy level in which the program determines that the target position was reached. If the error value is extremely low, which means that in-place exits precisely. If the error value is high, which means that in-place exits roughly or not in-place, as shown in the figure below. When the in-place position is enlarged, the area inside the dotted circle is the error range of the point (error of the motor being in-place). When the P1 point position is reached, there are three precision levels: FINE(=0) is the same as the continuous CONT function, it is not in-place and not precise. A better one is FINE=1, which means that it is in-place but not precise. The best one is FINE=2; which means that it is in-place and precise because it takes a longer time to achieve precisely.



In-place function example illustration (1) Not in-place (2) In-place but not precise
(3) In-place and precise

● :Denotes P1 point: X denotes the in-place point of the robot. The area inside the dotted circle is the error range of the point position.

■ **Application program example 1: (explaining using CONT, which is the same as FINE=0)**

```
PTP P1 CONT
LIN P2 CONT
$C[1] = $C[1] + 1
```

■ **Application program example 1 description:**

Execute point to point movement to the P1 point, with continuous trajectory (CONT).
Execute point to point movement to the P2 point, with continuous trajectory (CONT).
The first counter executes the execution plus 1 calculation.

Result description: Successfully moved from P1 point to P2 point in order and complete the counting action; the connection between the actions of P1 and P2 is a continuous trajectory, which can save time. But when the P1 movement just begin, the program already preloaded and completed the counter’s count+1; the count action ran without waiting for P2 to complete executing before performing the count action.

■ **Application program example 2: (explaining using FINE = 1)**

PTP P1 FINE = 1
LIN P2 FINE = 1
$C[1] = $C[1] + 1

- **Application program example 2 description:**

Execute point to point movement to the P1 point, with non-continuous trajectory (FINE=1). .
Execute point to point movement to the P2 point, with non-continuous trajectory (FINE=1).
The first counter executes the execution plus 1 calculation.
Result description: Successfully moved from P1 point to P2 point in order and complete the counting action; the connection between the actions of P1 and P2 is non-continuous trajectory, and the in-place method of P1&P2 is not fully precise positions. The program did not preload, and the counting action was executed after P2 had finished executing.

- **Application program example 3: (explaining using FINE = 2)**

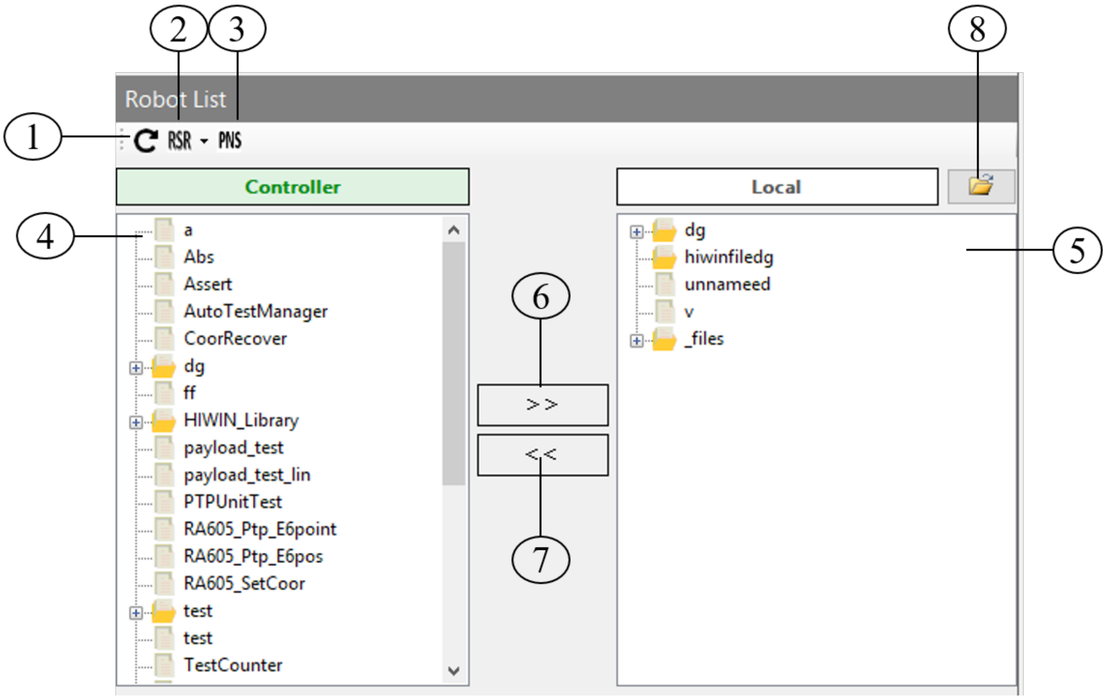
PTP P1 FINE = 1
LIN P2 FINE = 2
$C[1] = $C[1] + 1

- **Application program example 3 description:**

Execute point to point movement to the P1 point, with non-continuous trajectory (FINE=1). .
Execute point to point movement to the P2 point, with non-continuous trajectory (FINE=2).
The first counter executes the execution plus 1 calculation.
Result description: Successfully moved from P1 point to P2 point in order and complete the counting action; the connection between the actions of P1 and P2 is non-continuous trajectory, and the in-place method of P2 is fully precise positions. The program did not preload, and the counting action was executed after P2 had finished executing.

5.Program Editor Setting and Operator

5.1 Manage Program List



Program List

Description

A user can manage the program in the list.

No.	Description
1	Refresh the “Controller” and “Local” program list.
2	Setting designated program, the RSR function.
3	Setting designated program, the PNS function.
4	Controller program list.
5	Local program list.
6	Upload to Local.
7	Download to controller.
8	Change “Local” side folder path (user can select folder).

5.2 Add and Delete File/Folder

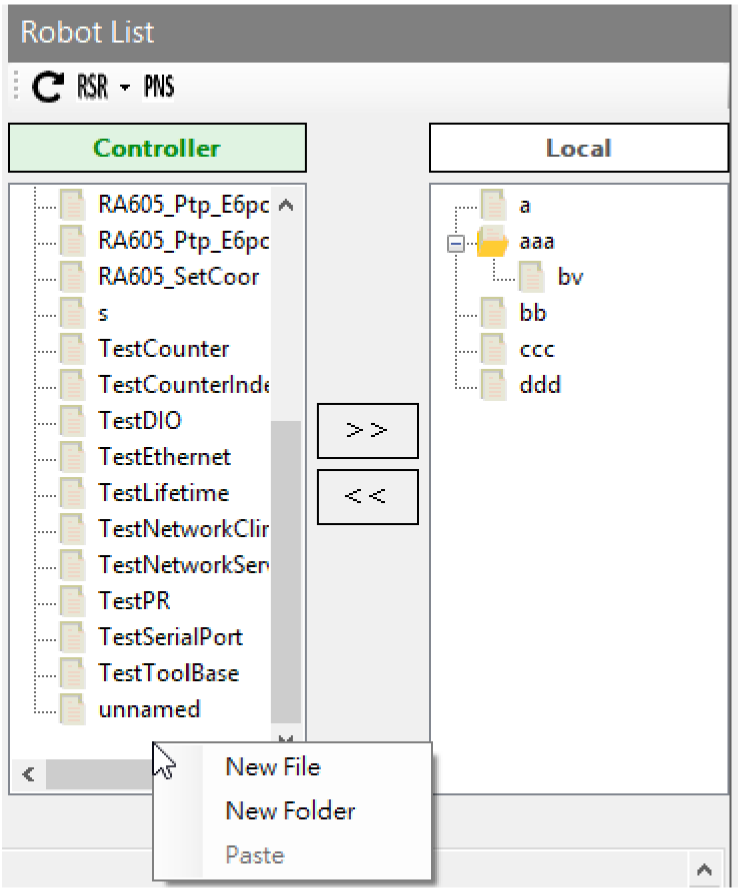
●Add file/folder steps

1.Right-mouse click on empty space of the program list to add file. (New File/New Folder).

2. Enter the name of the new file, make sure it meets the file name specification. Please see section 0.

●Delete file/folder steps

1.Select file/folder and right-mouse click to delete file. (Delete File/Delete Folder).



Add file/folder

5.3 Copy File/Folder

●Copy file steps

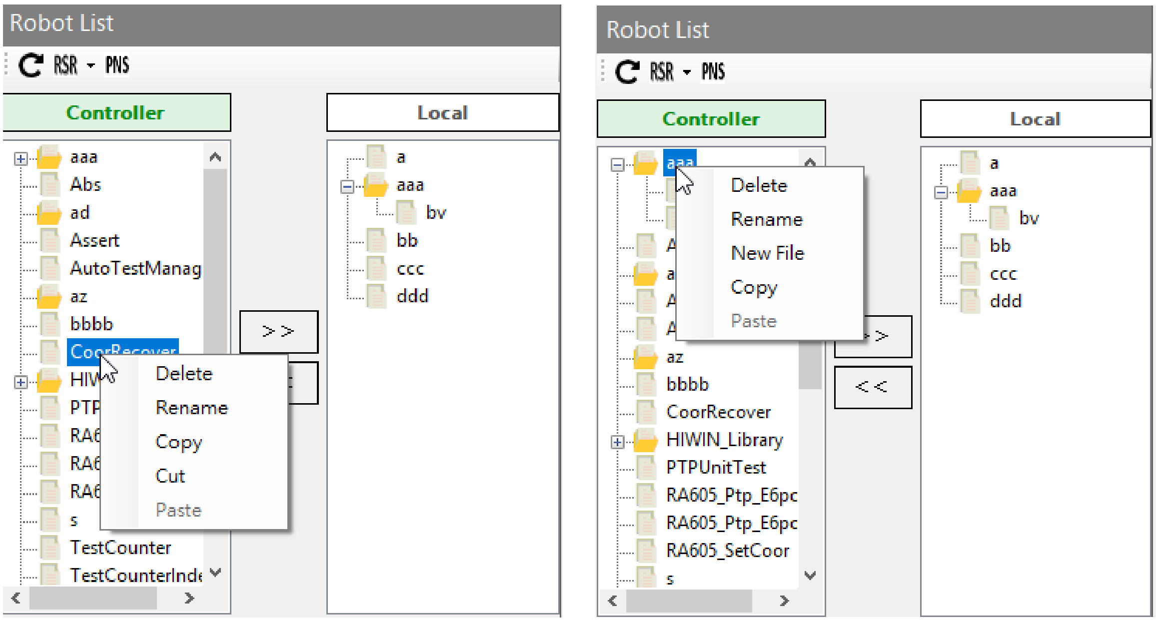
1. Select file, Right-mouse click to copy file, then right-mouse click paste file on any empty space of the program. [Archival name-copy] is the new file name, If file name have [-copy] word, then [-copy(count)] is the new file name.
2. Example: original file name is "test.hrb", first copy file name is "test-copy.hrb". Second copy file name is "test-copy(1).hrb", as above.
3. Hot key use "Ctrl+X" & "Ctrl+V".

●Copy folder steps

4. Select folder, right-mouse click to copy folder, then right-mouse click paste folder on any empty space of the program. [Archival name-copy] is the new folder name, and copy original folder of all files, copy to new folder. If folder name has [-copy] word, then [-copy(count)] is the new folder name.

5. Example: Original file name is “test”, first copy file name is “test-copy”. Second copy file name is “test-copy (1)”, as above.
6. Hot key use “Ctrl+X” & “Ctrl+V”.

※Choose more files：keep push “Ctrl” button and lift-mouse click choose more files/folders.



File/ Folder right-mouse click function figure(left : file; right : folder)

WARNING

When download the local program file to the controller, if the file name does not meet the file name specification, the file will not be opened.

5.4 Cut File/Folder

●Cut file/folder steps

1.Select file/folder, and right-mouse click to cut file/folder, then right-mouse click paste file/folder on any empty space of the program.

2.Hot key use “Ctrl+X” & “Ctrl+V”.

5.5 Rules of name Files

Rules for naming files, the program file has to satisfy this rule to ensure adding or copying of the file successfully.

Content

1. Only Arabic numerals (0-9), English letters (a-z, A-Z) and underscore (_) can be used for naming.

2.Special symbols「~!@#$%^&*()-+={}[]<>,.?/\|」 are not allowed.

3.The first character cannot be a number.

4.Not more than 100 words.

⚠ WARNING

If the name of the program file does not correspond to the rules, follow situation may occur when operating other function:

1.Unable to open the file

2.Unable to copy the file

3.Unable to be added to external startup functions list

4.Unable to use external subroutine functions

5.6 HRSS Program Commend Structure Description

```
...
8 LIN P1 CONT=100% Vel= 200 mm/s Acc=50% Tool [3] Base[4]
...
14 PTP P1 CONT=100% Vel= 100 % Acc=50% Tool [3] Base[4]
...
```

Line	Description
8	LIN motion, the TCP path is liner path.
14	PTP motion, point to point, the TCP path isn't liner path, like as circle path.

User need to selecte robot path way, PTP or LIN or Circ, to finish robot suitable move path.

If the first motion command is not a default home position or that position has changed, one of the following commands must be used:

Complete PTP command

Complete LIN command

Complete motion command must enter all parameter contents about the target points.

WARNING

If you change the home position, all programs will be affected and may cause the injury and property loss.

5.7 Program Operator Description

5.7.1 Set Program Ratio

Description

The program ratio is used to set the robot velocity. It is represented with a percentage, based on the programmed velocity.

⚠ CAUTION

In manual mode, the maximum velocity is 250mm/s, nothing to do with the set value.

Operation steps

1.Adjust in program execution velocity window.

2.Set the program ratio.

5.7.2 Start A Program

Prerequisite

Program selected.

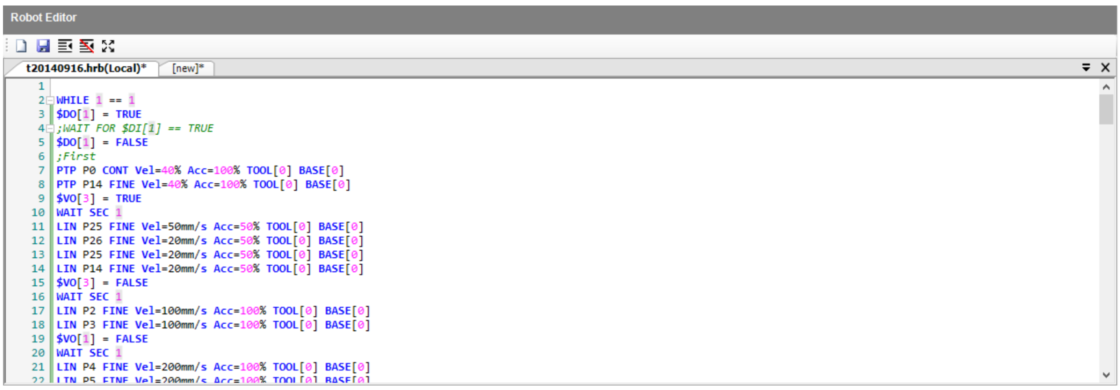
Operation steps

1.Select program opening.

2.Press the Start button.

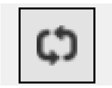
3.The program starts to execute.

4.To stop a program, press the Stop button.

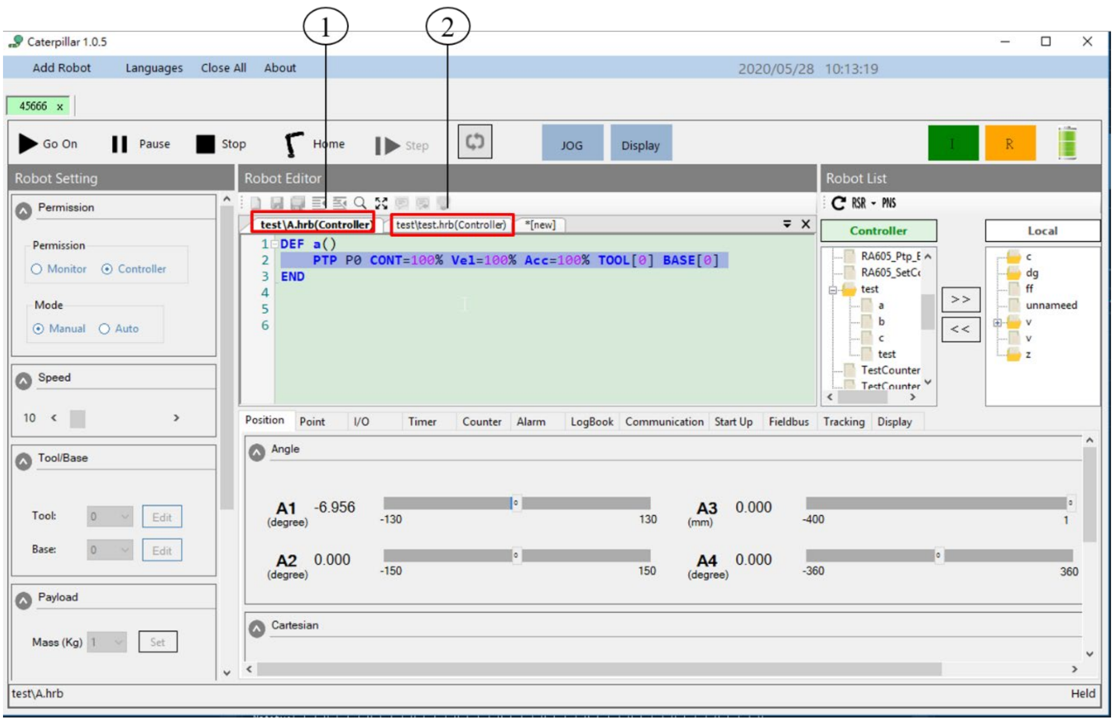


Program editor interface

Program running control button

Figure	Description
Start	Start program, click button or press F5.
Pause	Pause program, click button or press F6.
Stop	Stop program, click button or press F7.
Home	Return Home position, keep press button.
Step	Execute single step.
	Change program cycle or single step button.

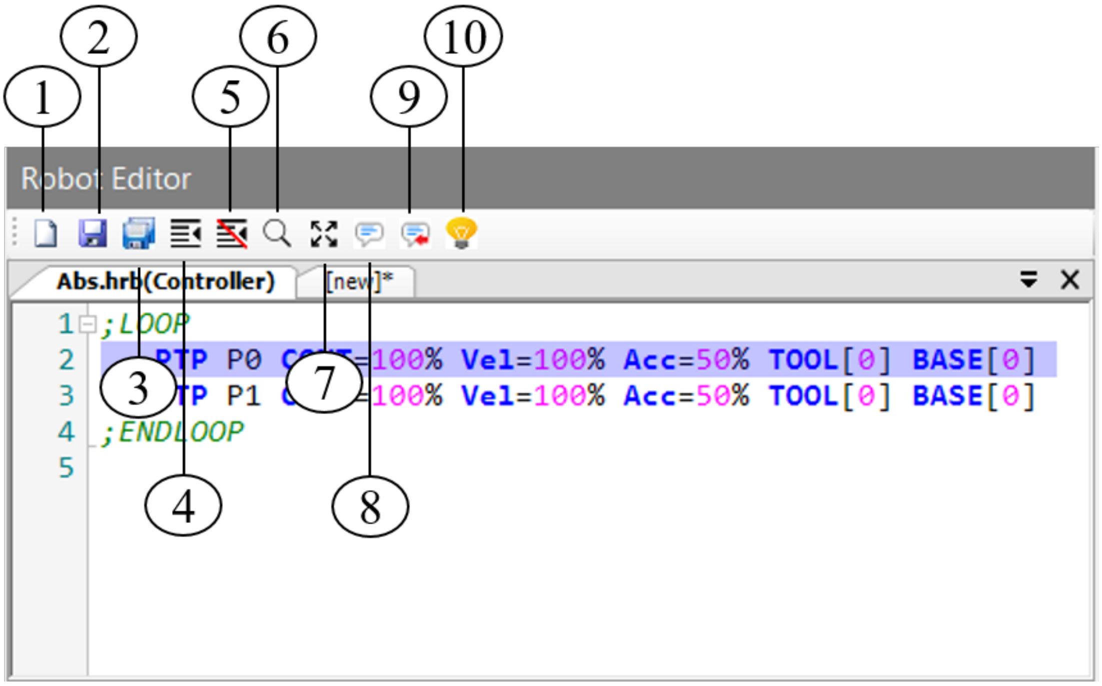
※When executing (2) the program with subroutines(1), the program wiil runs the subroutine (1), it will automatically display or switch to the subroutine. (1 in the figure below is a subroutine. 2 is the main program that is executing subroutine)



Executing and subroutine window

5.8 Edit Program Page Function Description

Description



Program editor interface

No.	Description
1	Create new file.
2	Save file. Hot key: Ctrl+S
3	Save all files.
4	Increase indentation.
5	Decrease indentation.
6	Search a word in the editor. Hot Key: Ctrl+F
7	Zoom in editor interface
8	Command program code, the code is ignored, change to green word, or above the code add “;”(semicolon)
9	Uncommand program code, the code can execute.
10	Keyword tip, Hint(After highlighting the keyword, click on it, and a prompt will pop up), Hot Key: Selection+F1.

CAUTION

A running program can’t be edited.

5.8.1 Editor State Description

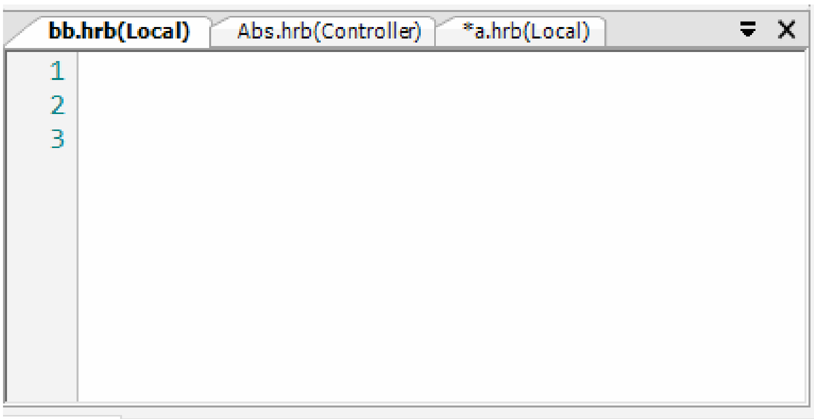
Operating steps

1. Program background different color states:

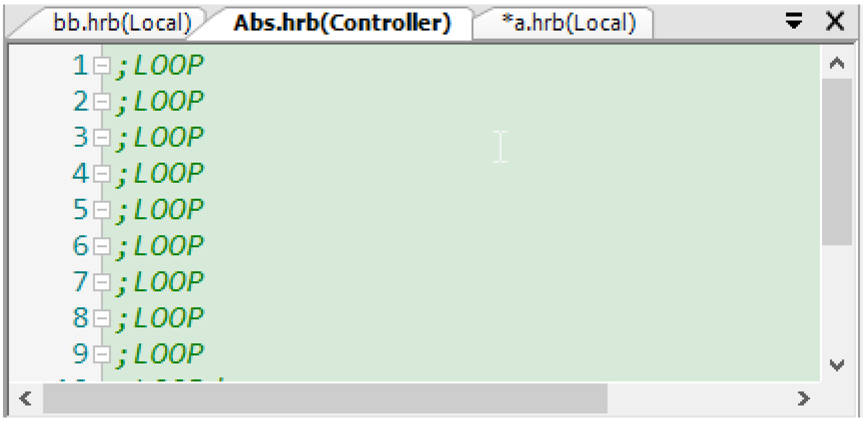
White background color –Local side edit file(s).

green background color –Controller side edit file(s)

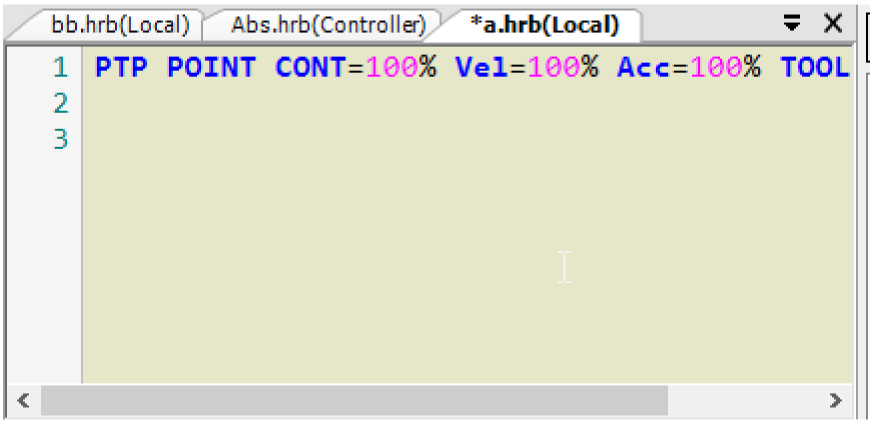
Yellow background color - There are files that have been changed and have not been archived.



Local side interface(White background color)



Controller side interface(green background color)



Edited and have not been archived interface (Yellow background color)

5.8.2 Comment Program Line(s)

Operating steps

1. Selected program codes (after highlighting the keyword), then click “Command” button, to ignore codes , the selected words change to green words.
2. Add semicolon (” ; ”) to the above of program line(s) that is selected to be commented.

5.8.3 Uncommand Program Line(s)

<u>Operating steps</u>

1.Selected program codes (after highlighting the keyword), then click “Uncommand” button, execute codes.

2.Remove semicolon (” ; ”) to the above of program line(s) that is selected to be uncommented.

5.8.4 Indent Program Line(s)

<u>Operating Steps</u>

1.Click [Indent] button.

```
*[new]
LOOP
    PTP P0 FINE=1 Vel=100% Acc=100% TOOL[0] BASE[0]
    PTP P1 FINE=1 Vel=100% Acc=100% TOOL[0] BASE[0]
    PTP P2 FINE=1 Vel=100% Acc=100% TOOL[0] BASE[0]
ENDLOOP
```

5.8.5 Cancel indent Program Line(s)

<u>Operating Steps</u>

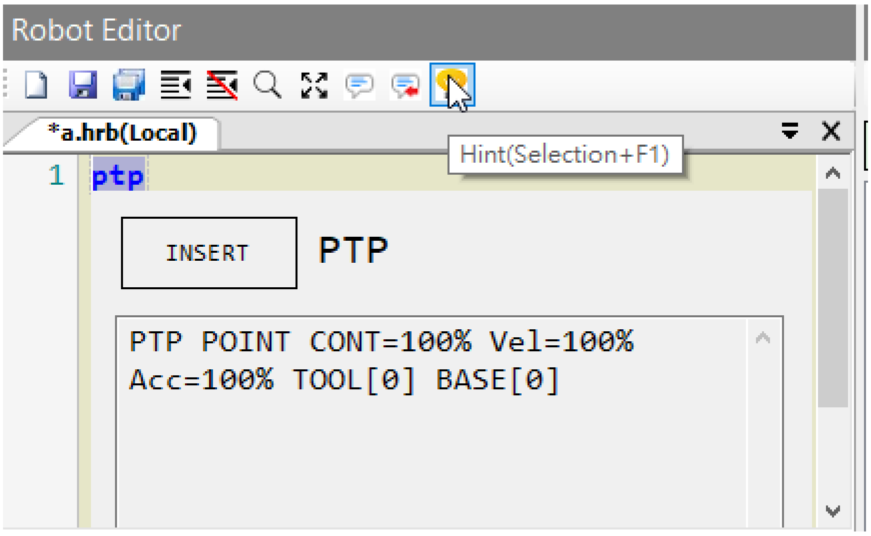
1. Click [Unindent] button.

```
*[new]
LOOP
PTP P0 FINE=1 Vel=100% Acc=100% TOOL[0] BASE[0]
PTP P1 FINE=1 Vel=100% Acc=100% TOOL[0] BASE[0]
PTP P2 FINE=1 Vel=100% Acc=100% TOOL[0] BASE[0]
ENDLOOP
```

5.8.6 Command Tip Button Description

<u>Operating steps</u>

1. Selected program codes(after highlighting the keyword)，Example:PTP、LIN...etc，and click [Hint] button, or hot key:press F1 button, display codes of example, user can click “INSERT” to insert the codes of example.

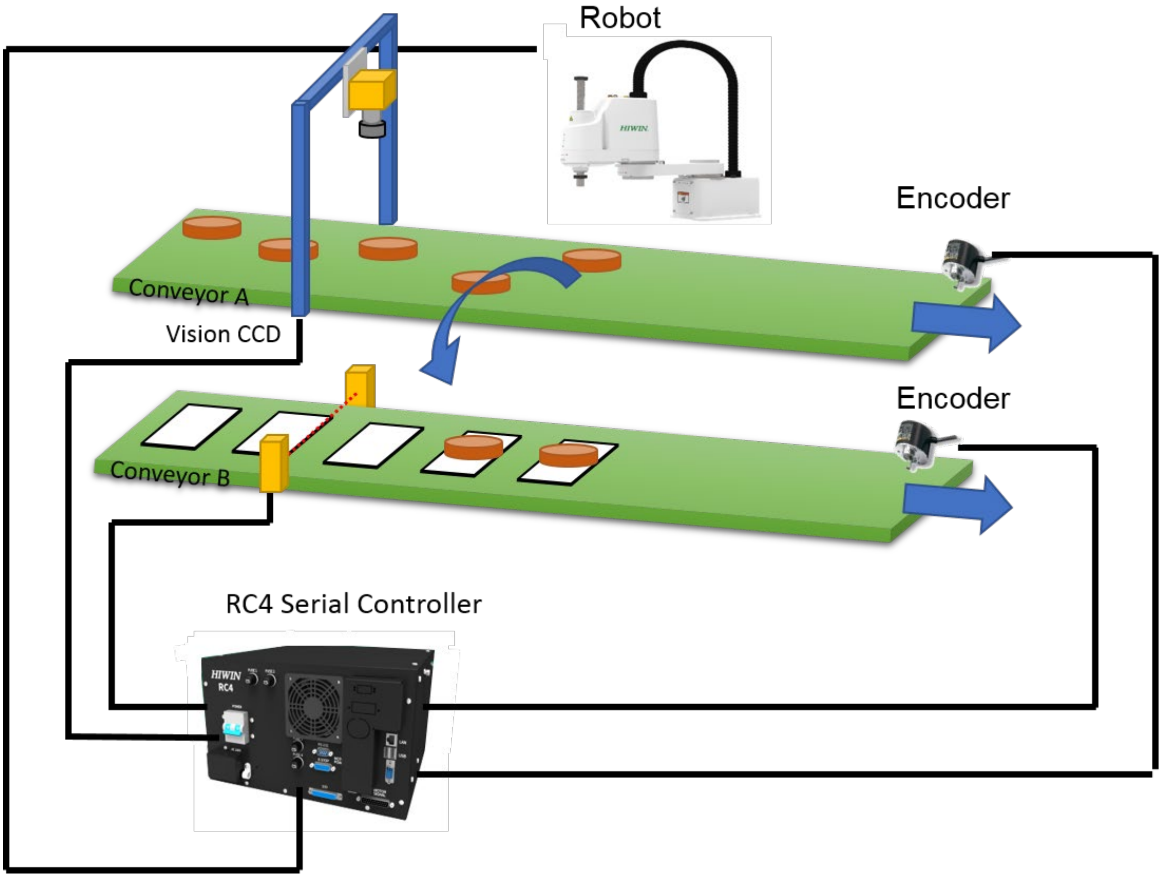


PTP code of example figure

6.Conveyor tracking function application

6.1Overview of the conveyor tracking system

The basic conveyor tracking system' illustration is as shown in the figure below.
The robot uses that the value changes from the encoder, which is installed on the conveyor to calculate the amount of movement of the conveyor. The sensors used to detect the relative position of the targeted workpiece on the conveyor; the sensors could be an optical sensors or vision systems. After receiving the value of the encoder and position information of the targeted workpiece, this info will returned to the robot controller, the robot will run the conveyor tracking function accordingly.

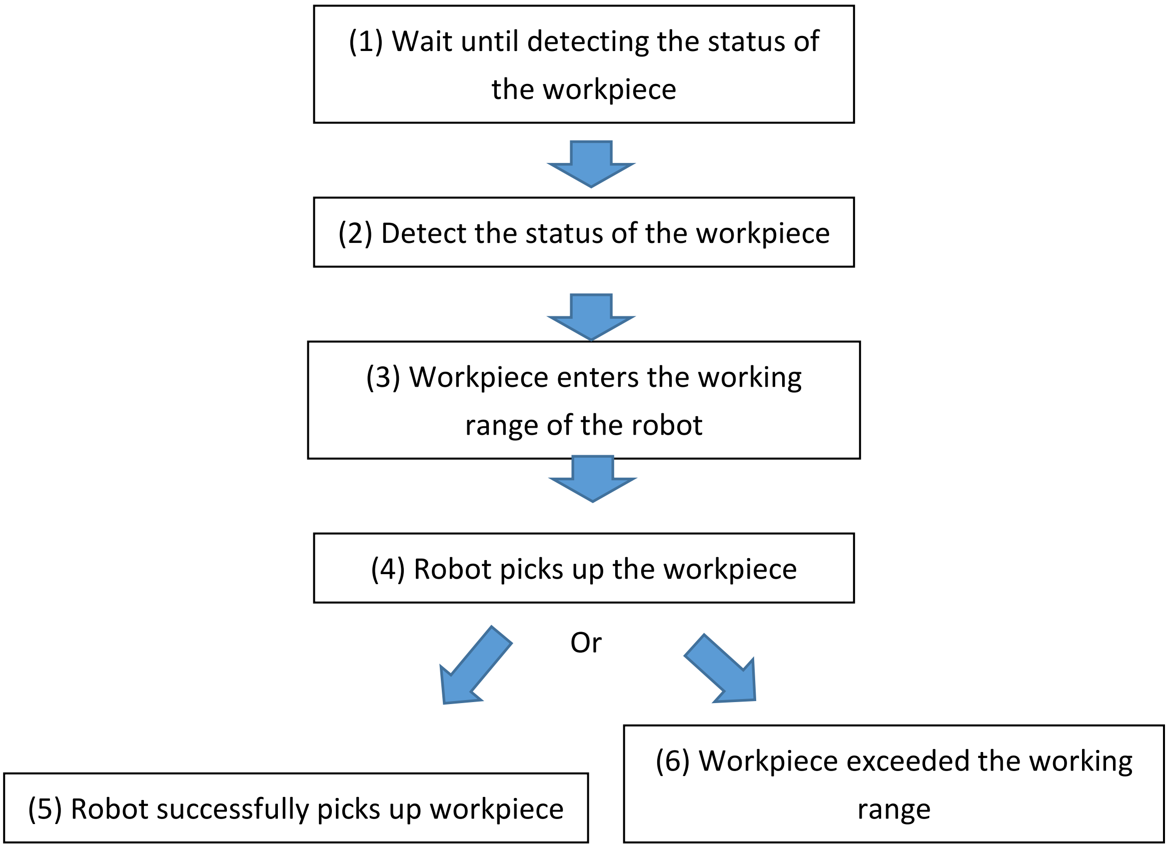


Conveyor system structure figure

6.1.1 Description of the conveyor tracking application process

The robot read the encoder value on the conveyor to detect the displacement of the conveyor, and communicate with vision systems or sensors to trigger signals.
The following uses sensors method for a simple explanation (The visions method is similar).
When the sensor triggers the signal, the robot will get a queue. When the target workpiece enters the selective action range of the robot, the robot will start the conveyor tracking function to execute pick or place actions. If the target workpiece exceeds the selective action range of the robot, the robot will discard the queue.
The overall work process can be divided into several processes, (1). Hold until detecting the status of the

workpiece (2). Detect the status of the workpiece (3). Workpiece enters the working range of the robot (4). Robot pick up the workpiece (5). Robot successfully picks up one workpiece or (6). Workpiece 1 exceeded the working range (robot did not pickup the workpiece).

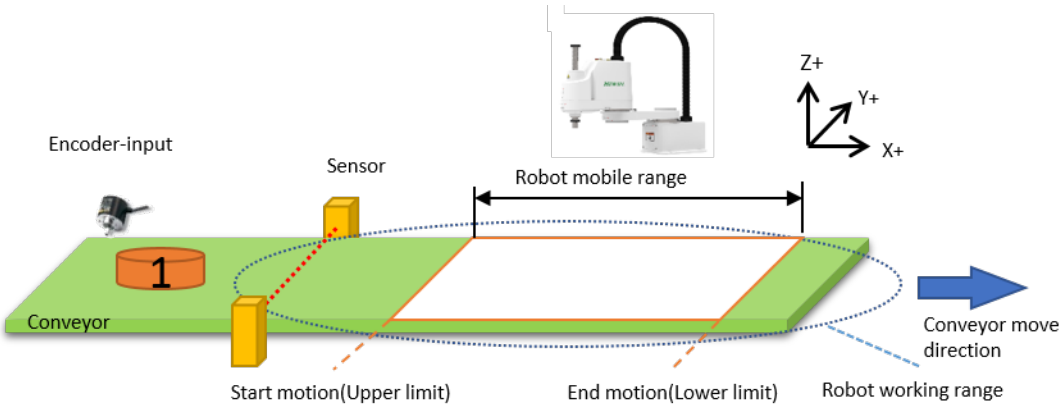


Conveyor pick & place process flow chart

The following chapter will explain the various statuses and corresponding handling processes when the robot executes the conveyor tracking function.

6.1.1.1 Sensor waits to detect the status of the workpiece:

Robot status (1), as shown in the figure below, workpiece 1 (orange color object) is placed on the conveyor, and is moving through the conveyor. At this time, the encoder value is 50 pulses. When the sensor has not yet detected workpiece 1, the robot did not receive the trigger signal. Therefore, there are no queues and the robot is in stand-by status. The statuses are as shown in the list below:

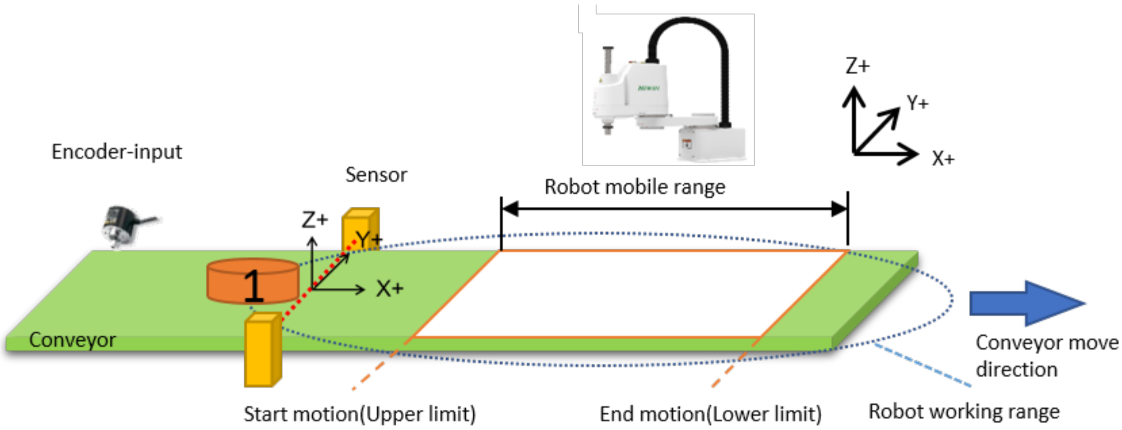


Sensor waiting to detect workpiece illustration

Robot status (1) list	
Encoder tracking signal	pulse=50
Encoder pick workpiece signal	pulse=0
Queue	None
Robot execution status	Ready

6.1.1.2 Sensor detects the status of the workpiece:

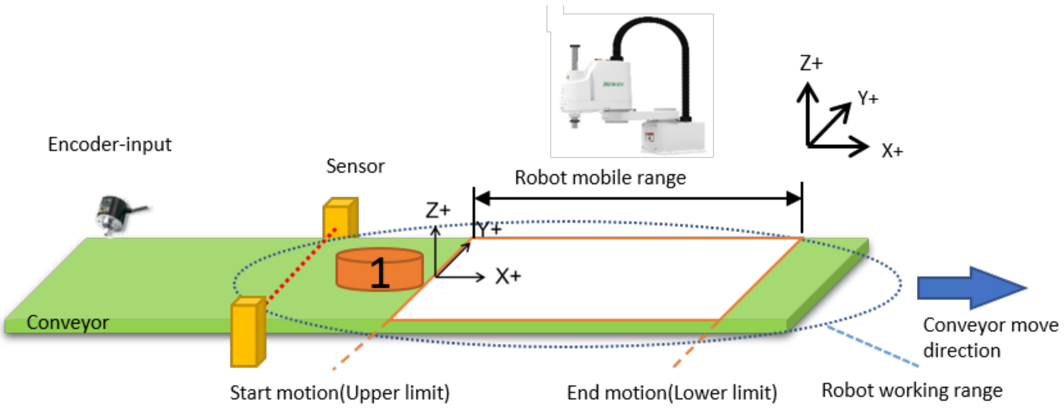
Robot status (2), workpiece 1 is placed on the conveyor and is moving through the conveyor. At this time, the encoder value is 100 pulses. When the sensor detects workpiece 1, the robot will receive the trigger signal. At this time, the robot will record the encoder value, and the queue count will increase by one. But since the workpiece has not yet entered in between the upper and lower limit action range of the robot, therefore, the robot is in stand-by status; the statuses are as shown in the list below:



Sensor detects the workpiece illustration

Robot status (2) list	
Encoder tracking signal	pulse=100
Encoder pick workpiece signal	pulse=100
Queue	Queue1
Robot execution status	Ready

6.1.1.3 Workpiece enters the working range of the robot:



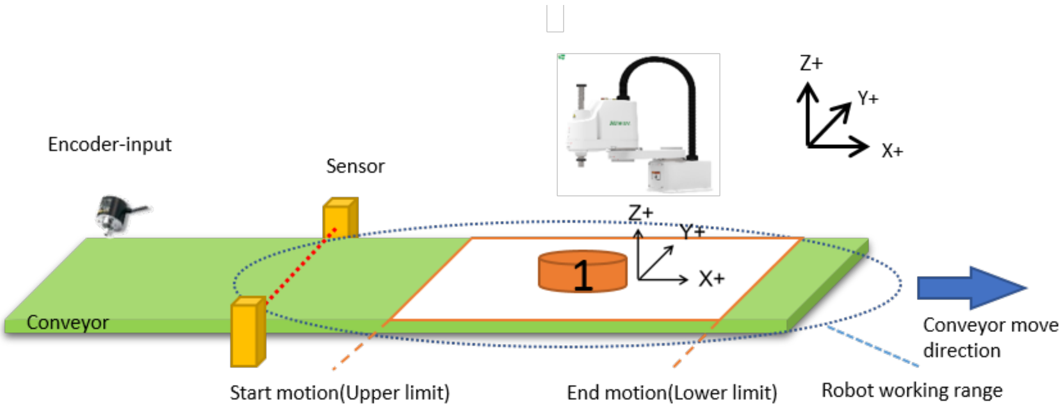
Workpiece enters the working range of the robot illustration

Robot status (3), workpiece 1 is placed on the conveyor and is transported through the conveyor. At this time, the encoder value is 150 pulses. When the workpiece enters upper limits of action range of the robot, the robot starts executing actions; the statuses are as shown in the list below:

Robot status (3) list	
Encoder tracking signal	pulse=150
Encoder pick workpiece signal	Queue1 pulse=100+50
Queue	Queue1
Robot execution status	Ready

6.1.1.4 Robot executes pick workpiece:

Robot status (4), workpiece 1 is placed on the conveyor and is transported through the conveyor. At this time, the encoder value is 200 pulses. Parallelly, the robot is executing the pick action; since the robot already picked up workpiece 1, therefore, the encoder stops recording the value temporarily; the statuses are as shown in the list below:

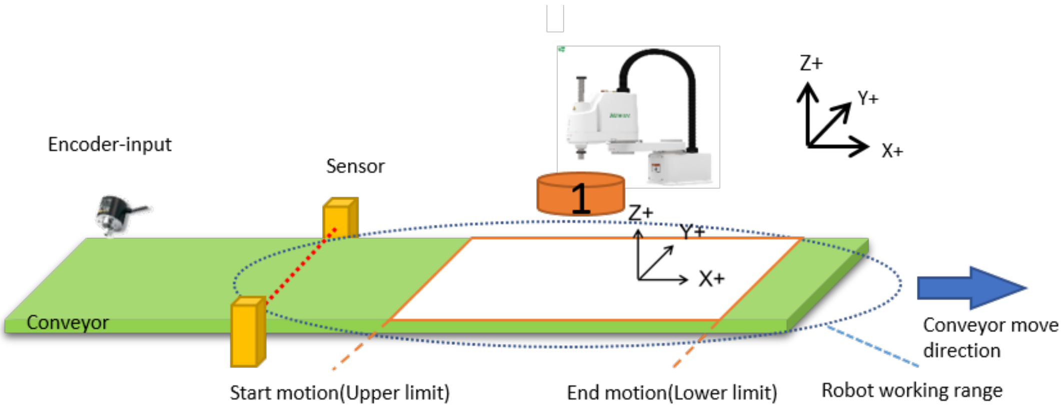


Robot executes pick workpiece illustration

Robot status (4) list	
Encoder tracking signal	pulse=200
Encoder pick workpiece signal	Queue1 pulse=100+100
Queue	Queue1
Robot execution status	Pick

6.1.1.5 Robot successfully picked up workpiece:

Robot status (5), workpiece 1 is placed on the conveyor and is transported through the conveyor. At this time, the encoder value is 215 pulses. Since the robot already finished executing the action, therefore, the queue has ended, and the count subtracts one; the statuses are as shown in the list below:

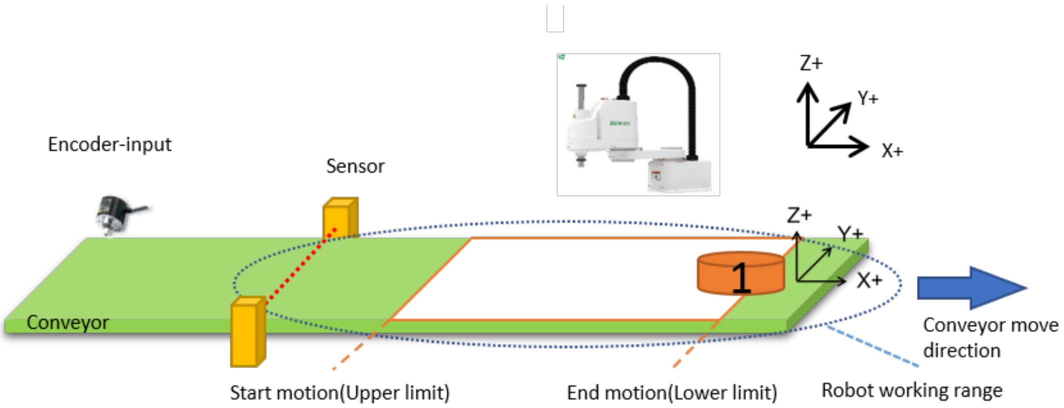


Robot successfully picked up workpiece illustration

Robot status (5) list	
Encoder tracking signal	pulse=215
Encoder pick workpiece signal	Queue1 pulse=100+100
Queue	Remove
Robot execution status	Place

6.1.1.6 Workpiece exceeded the working range of the robot:

Robot status (6), workpiece 1 is placed on the conveyor and is transported through the conveyor. At this time, the encoder value is 425 pulses. Since workpiece 1 already exceeded the lower limit of action range of the robot, therefore, the queue was discarded, and the count subtracts one; the statuses are as shown in the list below:



Workpiece exceeded the working range of the robot illustration

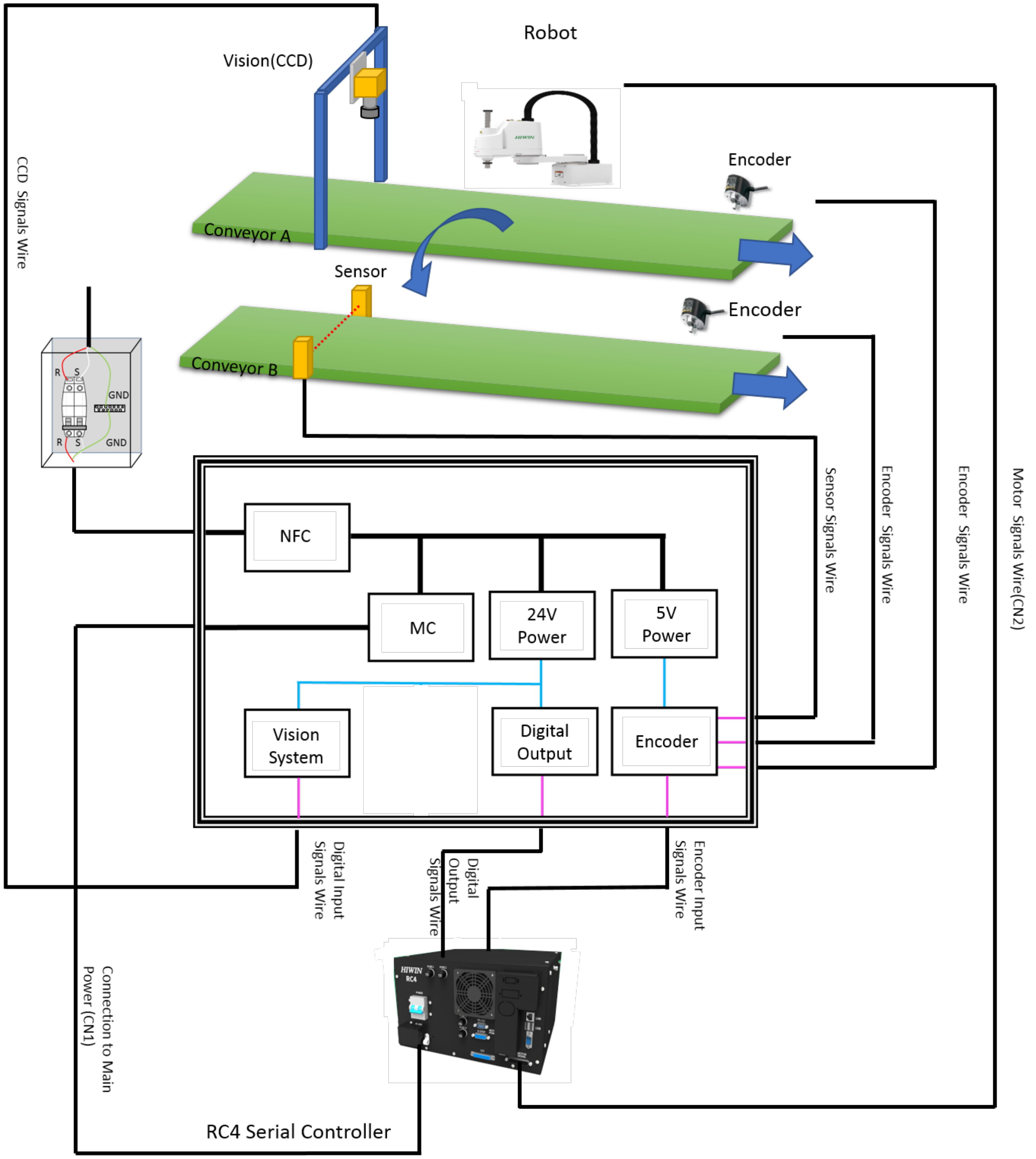
Robot status (6) list	
Encoder tracking signal	pulse=425
Encoder pick workpiece signal	Queue1 pulse=100+315
Queue	Queue1 remove
Robot execution status	Queue1 discarded

This example is used to explain the possible statuses before picking with conveyor tracking; operators must first understand the situation of each status and their relationships with the corresponding queues in order to know the content of the tasks that need to be processed later.

6.2 Layout of the conveyor tracking system configuration

6.2.1 Description of the system configurations/specifications

The basic system configuration is as shown in the figure below:



Conveyor tracking (pick-on-the-fly) system configuration architecture diagram

Peripheral equipment specifications sheet

Robot & Controller	The conveyor pick-on-the-fly function can be used on the SCARA LU series robots and parallel robots. Refer to the conveyor's manual for if there are problems with the conveyor, and refer to RC4 or GB/GC controller for problems with the controller.
Conveyor	Conveyors with linear movements, such as **roller conveyors, flat belt conveyors,** and timing synchronous conveyors, can be used.
Encoder	Differential output rotary incremental type encoders can be used. Example: Omron incremental type with an outer diameter of ϕ50 E6C2-C and 2,000P/R resolution.
Sensor	Contrast, reflective, retroreflective and limited reflective sensors can be used; laser sensors can be used for high-precision measurements. Example: Omron contrast type E3T-ST31 2M
Vision system	The communication arrangement of the vision system must meet the communication arrangement defined by HIWIN Technologies Corp.; please refer to Chapter 6.3 Description of communication formats.

Note 1: Please select the above specification based on the physical requirements.

Note 2: The speed which is selected for the conveyor specification must be constant.

Note 3: For the installation of the encoder, the axis must be parallel to the surface of the conveyor, and cannot be inclined with the surface of the conveyor (a small amount of downforce is recommended).

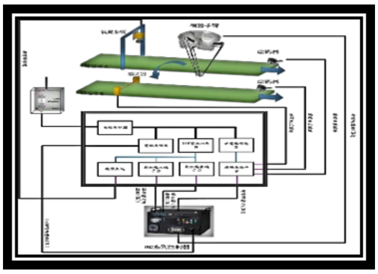
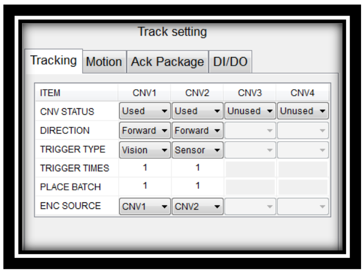
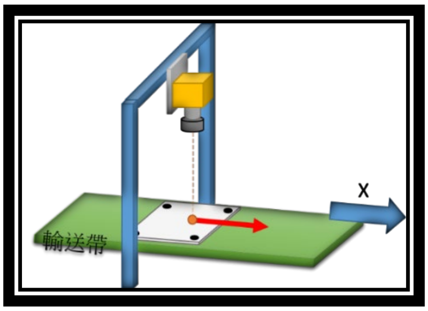
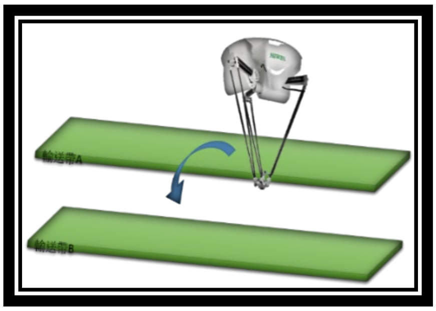
6.2.2 Basic installation process

1.System configuration: Perform hardware settings such as system configuration, robot installation, conveyor configuration, vision system installation, and system power distribution. There all are done according to the different work applications.

2.Function setting: Set the conveyor tracking related parameters; the main ones include selecting the trigger method (sensor or vision system), set the workpiece height and IP setting for the vision system, etc.

3.Conveyor and coordinate system calibration: This mainly includes coordinate system calibration, work range calibration and conveyor ratio calibration. If vision systems are used, then coordinate system calibration must be performed for the robot and vision system.

4.Program writing: Based on the system configuration and setting, write the conveyor tracking instruction and plan the actions of the robot.

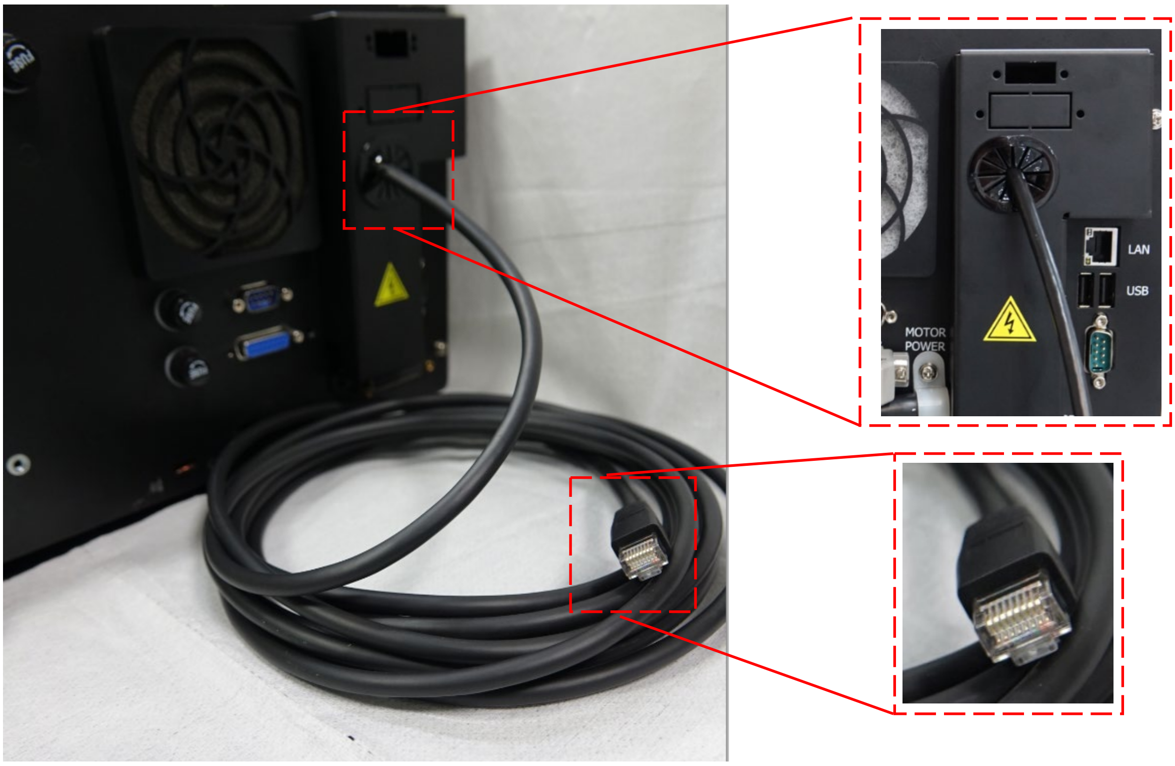
(1) System configuration	(2) Function setting
	
(3) Conveyor and coordinate system calibration	(4) Program writing
	

6.2.3 Description of electrical wiring connection

This chapter explains the wiring of the robot controller and encoder.

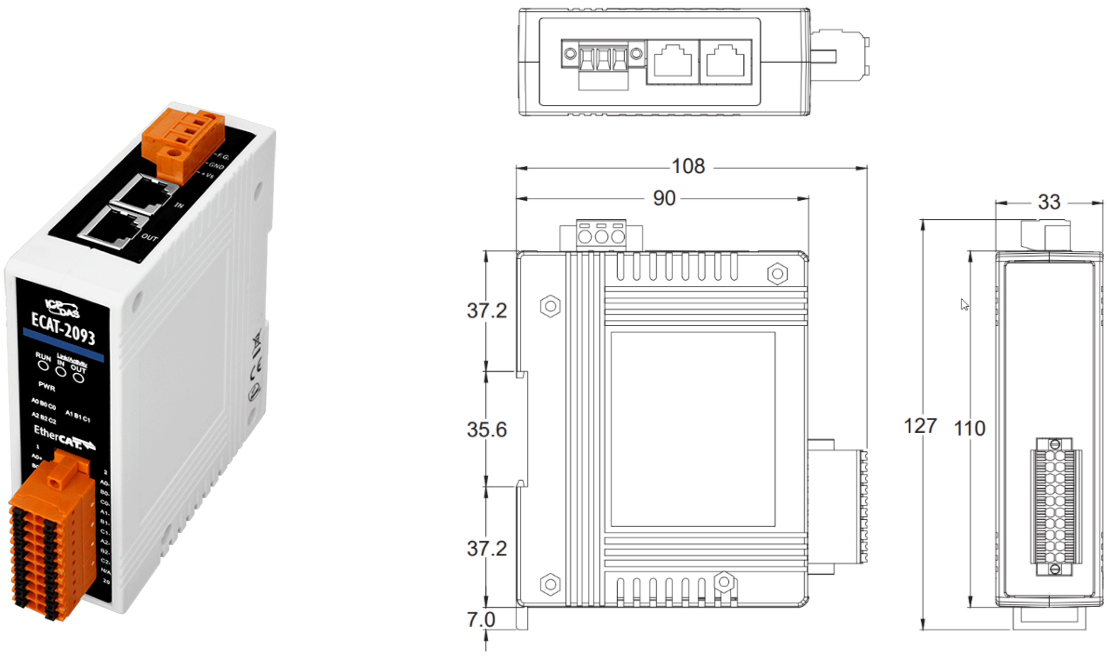
6.2.3.1 Description of the encoder module input terminal (Encoder Socket)

The EtherCAT encoder module is an optional purchase accessory; when users specified that they need an encoder modules before the product are shipped, the optionally purchased network cable will be installed with the RC4 controller. The other end of the network cable will be exposed outside the RC4 controller. An additional expansion module will also be shipped for users to install in their electronic control panel equipment (module can be fixed in-place using aluminum extrusions that are commonly used industrially).



Encoder network roadmap after the optionally purchased encoder module is shipped

There are 3 set of channels for the encoder input terminal, which are CNV1~CNV3; each phase signal is a differential signal. Therefore, each phase signal has two types of signals + and -. Each set of channel has its own input trigger (latch) contact; the signal specification is DC24V, which are IDI1~IDI4 respectively. The IDICOM type can be changed to NPN or PNP based on its usage method. The figure below is an overview of the encoder input pins.



Encoder module appearance diagram

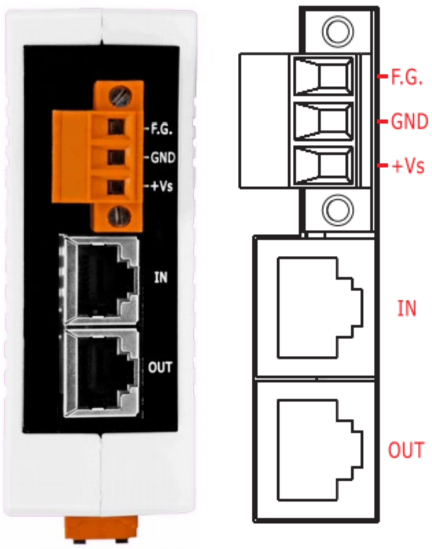
Note: For related information, refer to the ICP DAS official website:https://www.icpdas.com

Description:

The encoder data capture module is used with the encoder, and its power pin definitions are as shown in the below figure.

⚠ 注意

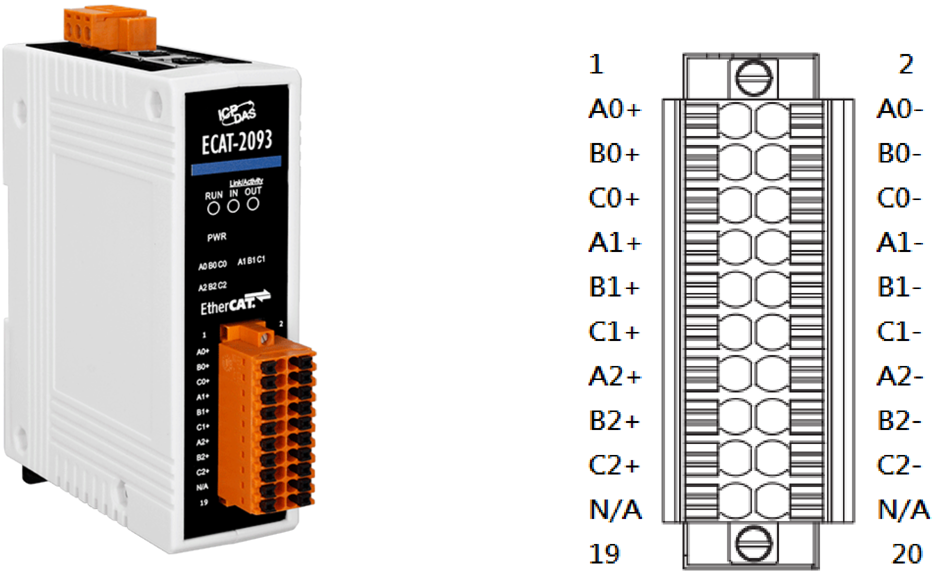
❖Please use differential output of rotary incremental type encoders (optional purchase).



Signal pins	Pin definitions
F.G	Frame Ground (ground)
GND	Power supply: Ground 0V (From the negative charge contact)
+Vs	Power supply: $+24V_{DC}$(from the positive charge contact)
IN	EtherCAT signal input (signal input)
OUT	EtherCAT signal output (signal output)

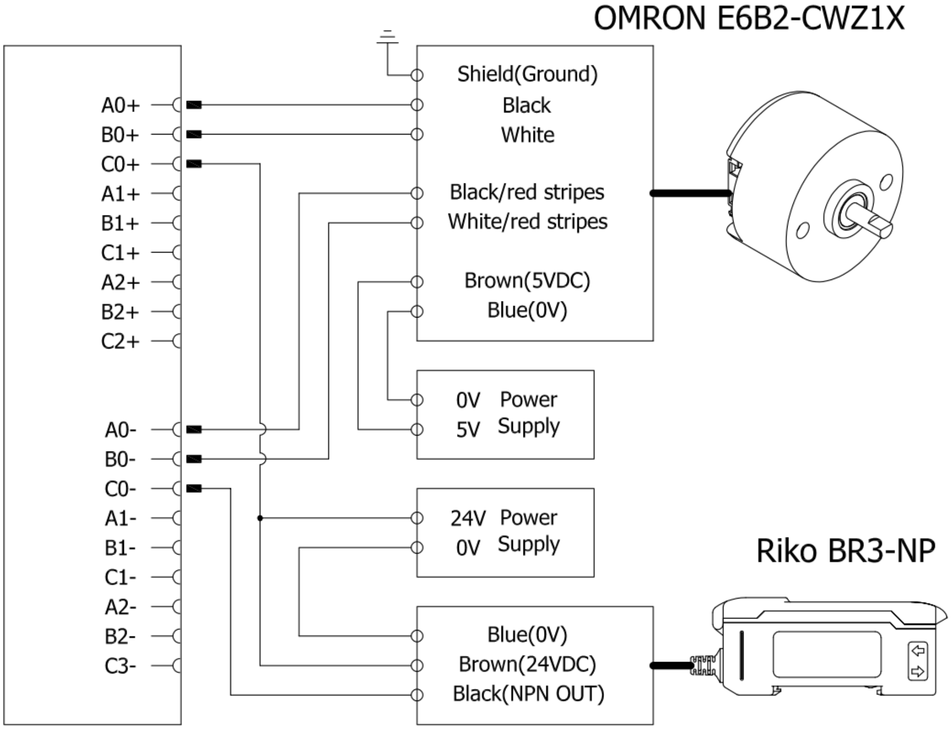
Encoder module connection sockets and wiring diagram

Encoder input overview:



Encoder input pin diagram

Encoder capture module usage range is as shown in the figure below.



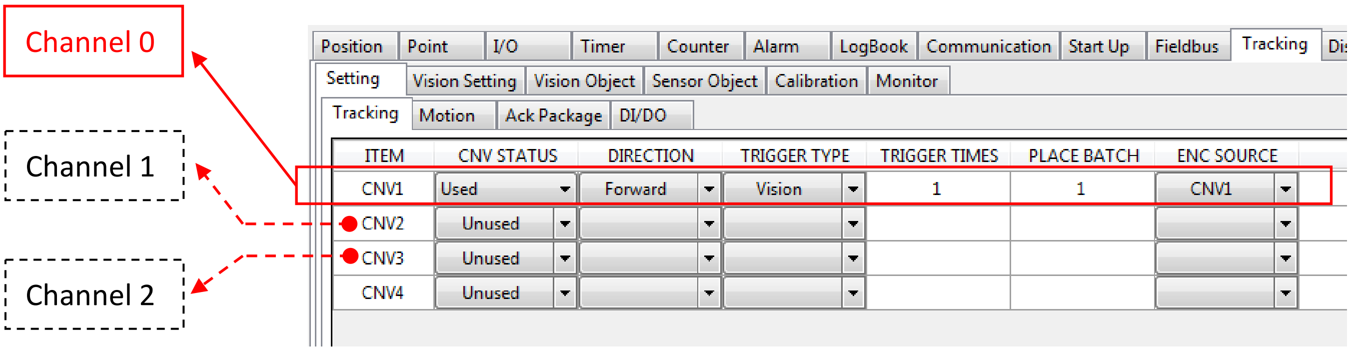
Usage example diagram using one encoder and one sensor

Encoder capture module pin description table

Pin signal	Pin definitions	Description
A0+	Encoder input A0+	Channel 0 (Encoder channel 0)
A0-	Encoder input A0-	
B0+	Encoder input B0+	
B0-	Encoder input B0-	
C0+	24 VDC	
C0-	Latch NPN out	
A1+	Encoder input A1+	Channel 1 (Encoder channel 1)
A1-	Encoder input A1-	
B1+	Encoder input B1+	
B1-	Encoder input B1-	
C1+	24 VDC	
C1-	Latch NPN out	
A2+	Encoder input A2+	Channel 2 (Encoder channel 2)
A2-	Encoder input A2-	
B2+	Encoder input B2+	
B2-	Encoder input B2+	
C2+	24 VDC	
C2-	Latch NPN out	

Note: Encoder input is encoder input, Latch NPN out is the NPN trigger signal of the sensor.

Refer to the below figure for the encoder setting relationship in the conveyor tracking setting interface, Interface path: Conveyor tracking>> Setting>>Tracking.



Encoder channel and software setting interface relationship window

Note 1: **Cable specifications & extension features recommendations:**

Recommended cable specifications: PW15-W48-A017, CAT 6, 26AWG (Refer to the controller manual optional accessories)

The rising time of the waveform output will change according to the cable length, load resistance and cable type.

If the cable is extended, the rising time of the waveform output will increase, affecting the phase difference features of phases A and B; they will differ according to conditions such as frequency and noise.

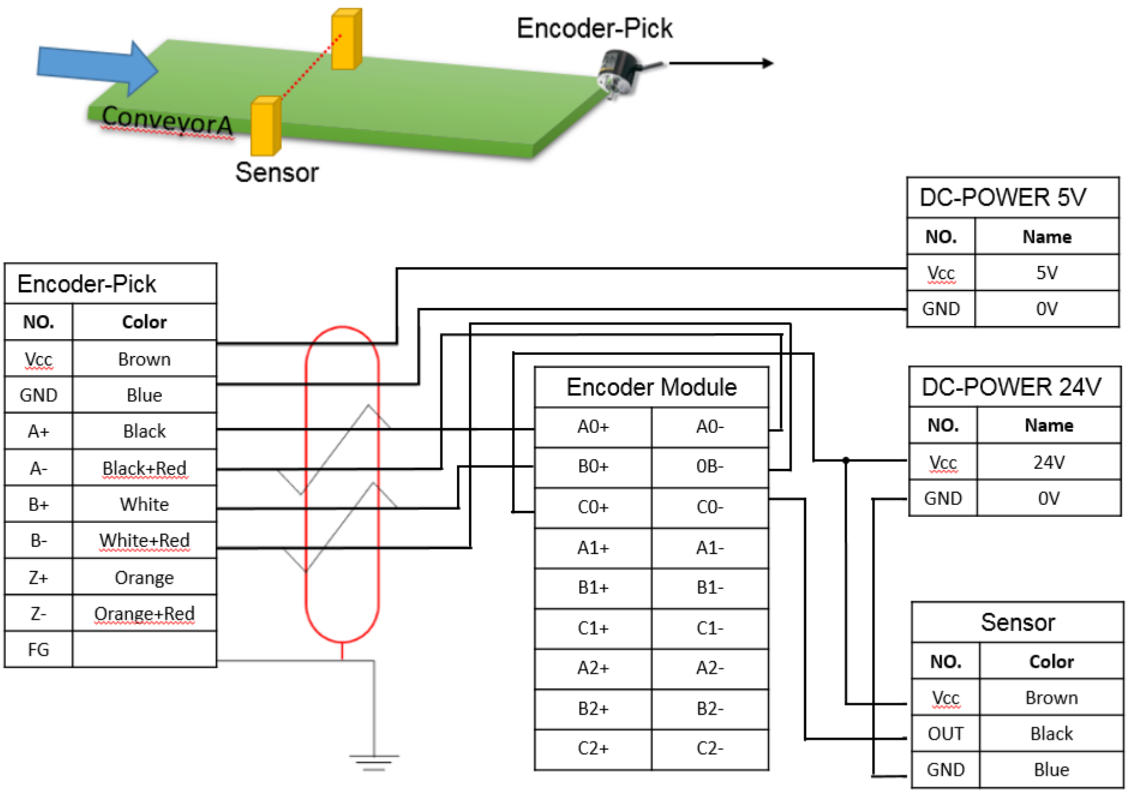
Note 2: Encoder only need to connect phases A and B; phase C is used for the input signal of external sensors.

Note 3: Encoder input; Latch NPN out is the NPN trigger signal of the sensor.

Note 3: For related information of the encoder module, refer to the ICP DAS official website:https://www.icpdas.com.

6.2.3.2 Encoder connection method for single pick tasks

Refer to the external devices connection method, as shown in the figure below:

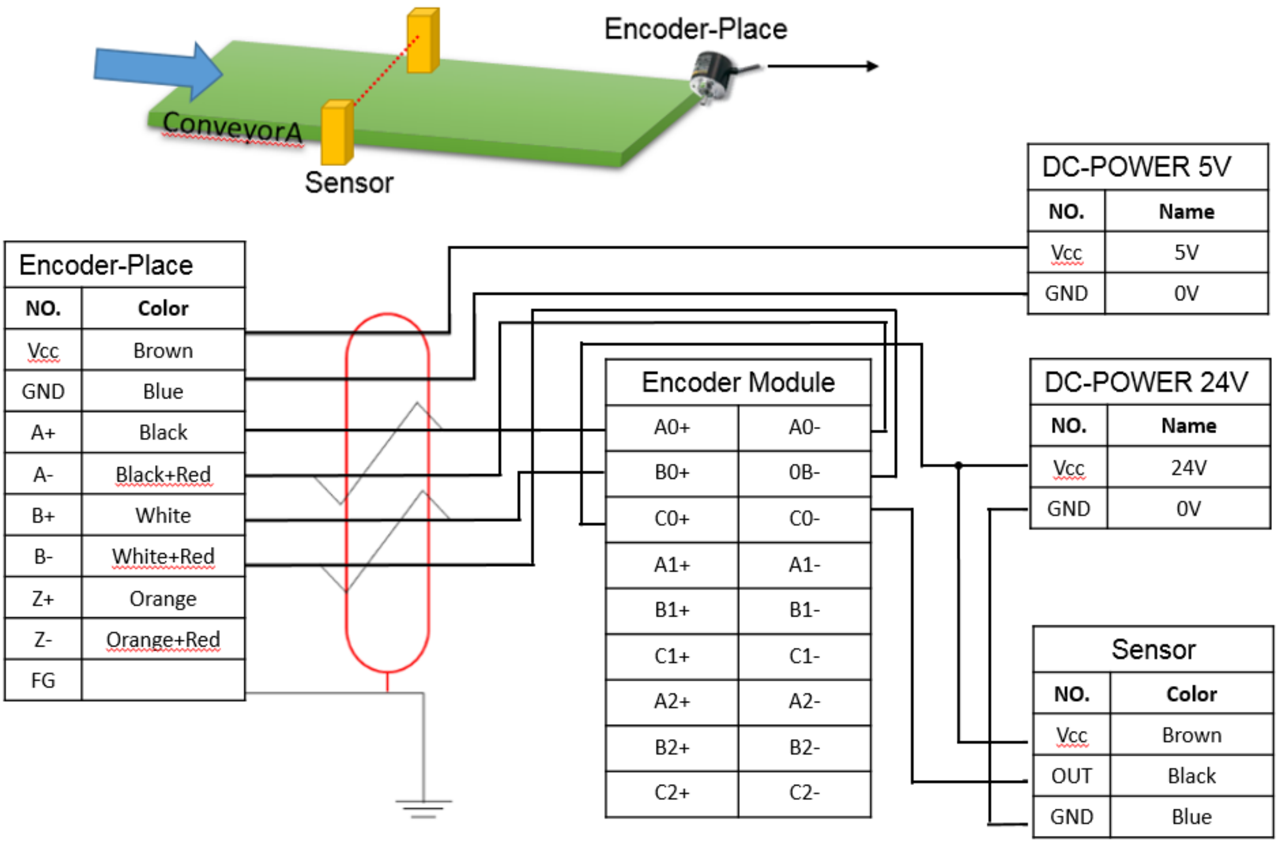


Encoder connection-pick illustration

Note 1: The configuration in the figure above is a NPN type.

6.2.3.3 Encoder connection method for single placement tasks

Refer to the external devices connection method, as shown in the figure below:

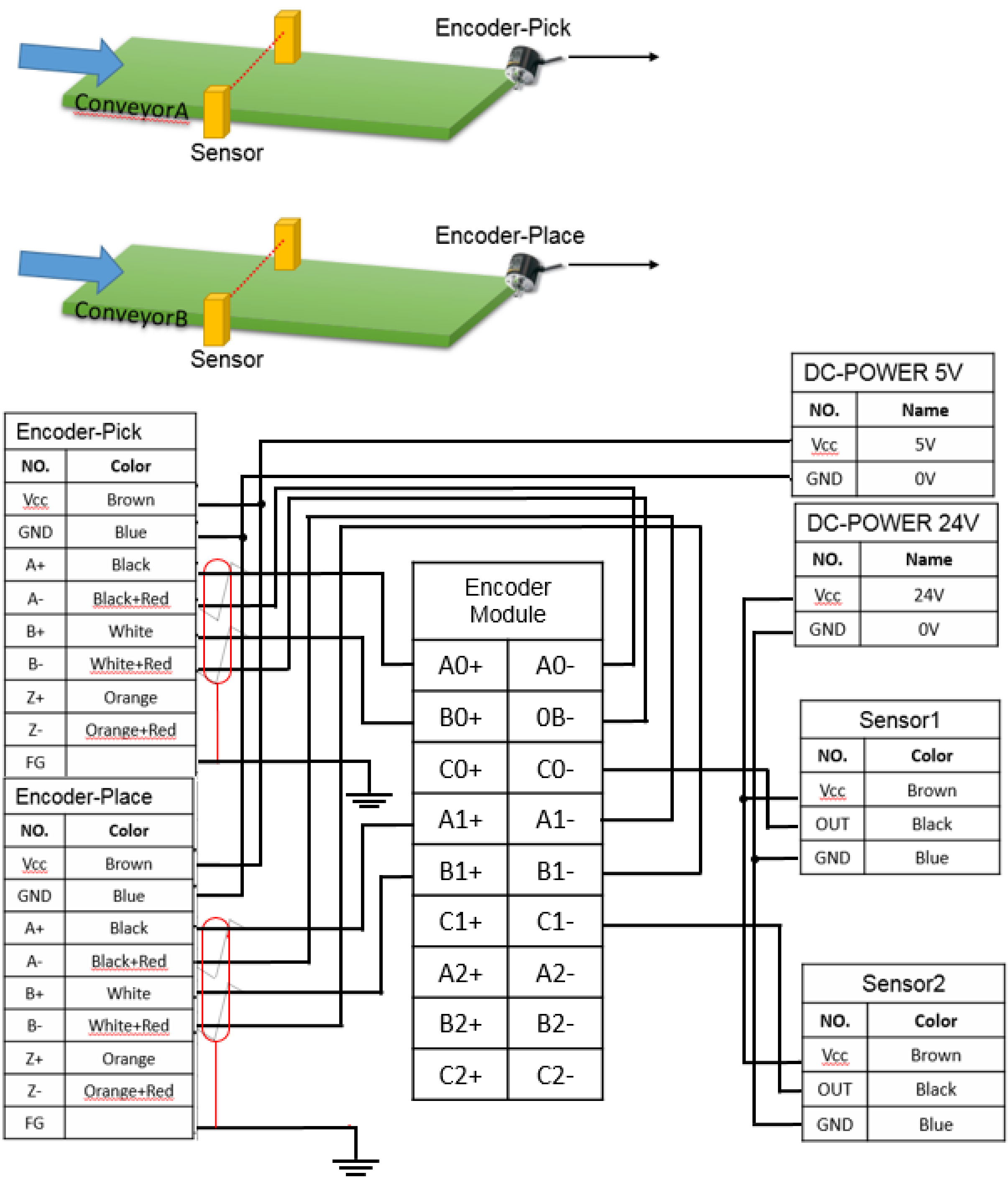


Encoder connection-place illustration

Note 1: The configuration in the figure above is a NPN type.

6.2.3.4 Encoder connection method for the combination of pick and place tasks

Refer to the external devices connection method, as shown in the figure below:



Encoder connection-pick & place coexistence illustration

Note 1: The configuration in the figure above is NPN a type.

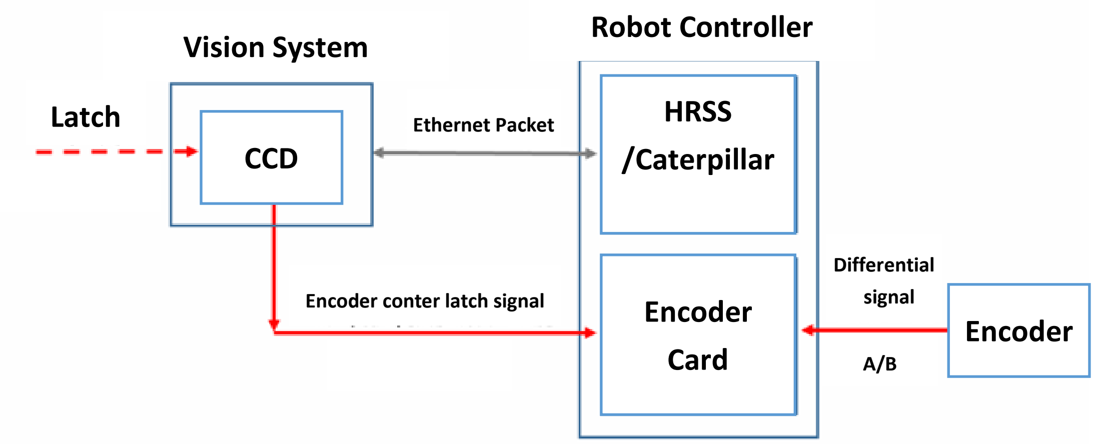
6.3Explanation of conveyor tracking system communication format

6.3.1 Description of HRSS conveyor tracking and machine vision communication timing

This chapter explains the series of actions of the robot and machine's vision communication and input/output trigger sequence by using the below communication networking diagram and communication sequence diagram.

■**Communication network diagram**

The contents of this communication network case explain the integration of the robot controller, machine vision system and encoder. In which the robot controller includes the encoder capture card and HIWIN's robot software system (hereafter referred as HRSS), and the remote connection system (hereafter referred as Caterpillar). The machine vision system includes cameras.

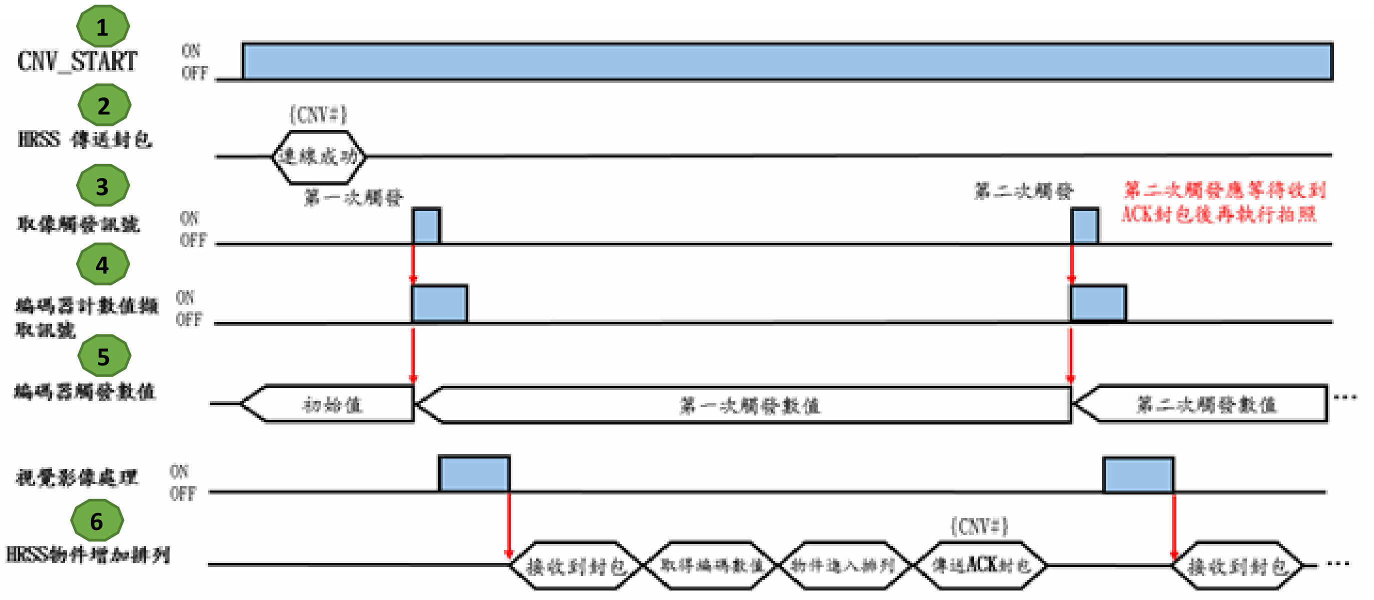


Conveyor tracking vision and encoder communication network diagram

In the above encode communication network , the communication method between the machine vision and robot is network transmission (TCP/IP), and in terms of the definition of the connect, the vision system must be the server (slave terminal) and HRSS/Caterpillar is the client (master terminal).
The encoder capture cards in the encoder and robot controller are connected using physical networks; the transmission signal is a differential signal. The encoder count value capturing action of the robot controller's encoder capture card is triggered by the encoder count value capture signal sent by the camera; it is triggered by physical circuits. Users must confirm that the encoder capture signal and the time the cameras take photos are triggered simultaneously; prevent delays from occurring when triggering. Confirm that the conveyor tracking action is accurate. In this case, the encoder capture signal uses the physical signal of the camera's exposure trigger signal as the encoder count value capture signal.

■**Communication sequence diagram**

This contents of this communication sequence diagram for conveyor tracking explains the integration of the robot controller, machine visions and encoder. Sensors can be added according to different usage needs to be used as the trigger signal source for taking photos, or add vision exposure signals. There is a total of six steps to explain; the explanations are as below:



Communication sequence diagram for conveyor tracking

The communication sequence diagram for conveyor tracking explained in six steps as follows:

➪**Step 1: Execute the conveyor tracking instruction (CNV_START)**

When the robot executes the conveyor tracking function, the CNV_START instruction must be executed at first. This instruction used to enable the setting and communication of conveyor tracking related functions. CNV_START might stop by three ways, which are: when the CNV_STOP instruction is executed, when the error signal is triggered or when the process was actively stopped.

➪**Step 2: Connect HRSS and machine vision**

When the robot and machine vision are connected successfully, HRSS/Caterpillar will send the packet {CNV#}, which means it can now accept the packet transmission from the vision system. This packet will only be sent once when connection was successful. In which the CNV# in the large bracket is the conveyor number selected for tracking.

For example, the conveyor number that the user selected for tracking is 2 (CNV=2), therefore, when the robot and machine vision are connected successfully, the robot will return the packet {2} to the machine vision.

➪**Step 3: Encoder count value capturing and camera imaging**

Since the machine vision itself has no installed encoder capture card, therefore, the timing for camera imaging and the encoder count value capture triggering must be done simultaneously. If there were delays between the imaging timing and encoder count value capture trigger signal, when the robot is performing tracking, the conveyor direction will fall behind.
In this case, the camera imaging and exposure time are almost simultaneous, therefore, the exposure signal is used as the trigger signal for the robot controller's encoder count capture value.

⇨**Step 4: Encoder count value capture signal and encoder trigger value**

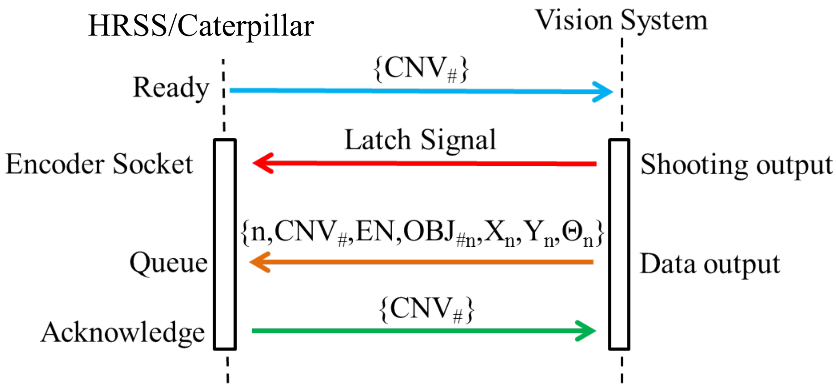
When the encoder count value trigger signal is triggered, the encoder trigger value will update the encoder value. The maximum processing time for the encoder trigger value is approximately 0.8 milliseconds (ms).

⇨**Step 5: Machine vision transmission packet and encoder value reading**

After the machine vision processed the image, packet transmission should be performed according to the communication format. After HRSS/Caterpillar receives the packet, it will read the current encoder value and queue the object information in the packet and encoder value.
If HRSS/Caterpillar received the wrong packet, HRSS/Caterpillar will ignore the wrong packet.
If the machine vision takes photos at fixed times, when the shooting frequency is faster than the machine vision's processing time, or the encoder value was updated before HRSS obtained the encoder value, the reasons above will all cause incorrect alignment between the packet and the encoder value.

⇨**Step 6: Object enters queue and ACK packet is returned**

After HRSS/Caterpillar received the correct packet and finished queuing the object, it will return the ACK packet to the machine vision. The content of the ACK packet is {CNV#}, in which the CNV# in the large bracket is the conveyor number selected for tracking.
If the conveyor number that the user selected for tracking is 1 (CNV=1), when the robot and machine vision are connected successfully, the robot will return the packet {1} to the machine vision.
After the machine vision receives the ACK packet, it should continue to trigger photo-taking and encoder value capture signal.
Refer to the message flow illustration in the figure below.



Communication architecture message flow illustration

6.3.2 Communication format and example description

Packet format that the vision system sends to HRTS:

Packet format = { n, $CNV_{\#}$, EN, $OBJ_{\#}$, X_n, Y_n, Θ_n }
= { [total number of packets], [conveyor number], [encoder value], [object type number], [X coordinate of the n object number], [Y coordinate of the n object number] , [Θ_n angle of the n object number] }

- **Format/parameter description:**

⇨The packet format begins and ends using large brackets "{ }", and the comma "," is used as the separator.

⇨n: The total number of dispatched objects in this packet data must be a positive integer, n = 1,2,3,...,50; 1 packet dispatched object includes 1 set of [X, Y, Θ] coordinate information. Similarly, n packet dispatched objects include n sets of [X_n, Y_n, Θ_n] coordinate information.

⇨$CNV_{\#}$: The conveyor number that corresponds to this packet data, #=1,2,3,4.

⇨EN: The encoder value that corresponds to the image; it must be a positive integer.

⇨$OBJ_{\#}$: Object type number, #=1~8.

⇨X_n: X coordinate of the object number n.

⇨Y_n: Y coordinate of the object number n.

⇨Θ_n: Θ rotation angle of the object number n. (This rotation axis is$\overrightarrow{U_Z} = \overrightarrow{U_X} \times \overrightarrow{U_Y}$, which is the fourth axis rotation angle).

⇨The maximum number of objects in a single packet is 50; the string length of the packet can contain a maximum of$2^{12} = 4096$characters.

⇨If the contents of the packet data sent by the vision system did not include EN encoder value, it will be represented by "NA".

⇨Positive values can be expressed as "X_n" or "+ X_n", negative values can be expressed as "-X_n"; numbers can contain a maximum of 14 characters.

Example Communication format & its explanation:

- **Example 1 description: (A single conveyor tracking, 1 object and 1 set of coordinate values.)**

⇨The packet data is: { 1, 1, 3000, 1, X_1, Y_1, Θ_1 }

Total number of objects	Conveyor number	Encoder value	Object type	X coordinate	Y coordinate	Rotation angle
1	1	3000	1	X_1	Y_1	Θ_1

Description: Total number of objects in this packet is 1, the corresponding conveyor number is 1, the corresponding encoder value is 3000 pulses, the object type of the 1st object is type 1, and its coordinates and angle are expressed as X1, Y1, Θ1.

■ **Example 2: (A single conveyor tracking, no corresponding encoder, 2 objects and 2 coordinate values.)**

⇨The packet data should be: { 2, 1, NA, 1, X_1, Y_1, Θ_1, 2, X_2, Y_2, Θ_2 }

Total number of objects	Conveyor number	Encoder value	Object type	X coordinate	Y coordinate	Rotation angle
2	1	NA	1	X_1	Y_1	Θ_1
			2	X_2	Y_2	Θ_2

Description: The total number of objects in this packet is 2, the corresponding conveyor number is 1, there is no corresponding encoder and is expressed as NA, the object type of the 1st object is type 1, and its coordinates and angle are expressed as X1,Y1,Θ1; the object type for the 2nd object is type 2, and its coordinates and angle are expressed as X2,Y2,Θ2.

■ **Example 3: (A single conveyor tracking, 4 objects and 4 sets of coordinate values.)**

⇨The packet data should be: { 4, 1, 3000, 1, X_1, Y_1, Θ_1, 1, X_2, Y_2, Θ_2, 2, X_3, Y_3, Θ_3, 3, X_4, Y_4, Θ_4 }

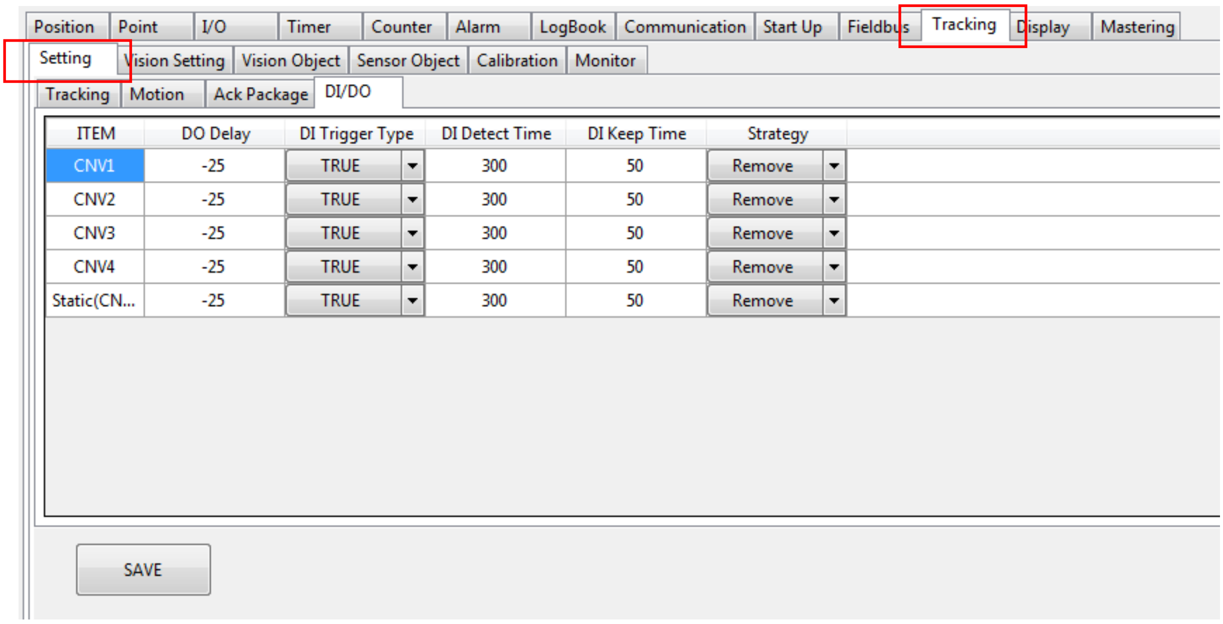
Total number of objects	Conveyor number	Encoder value	Object type	X coordinate	Y coordinate	Rotation angle
4	1	3000	1	X_1	Y_1	Θ_1
			1	X_2	Y_2	Θ_2
			2	X_3	Y_3	Θ_3
			3	X_4	Y_4	Θ_4

Description: The total number of objects in this packet is 4, the corresponding conveyor number is 1, the corresponding encoder value is 3000 pulse, the object type of the 1st object is type 1, and its coordinates and angle are expressed as X1,Y1,Θ1; the object type for the 2nd object is type 1 (the same object type can be repeated), and its coordinates and angle are expressed as X2,Y2,Θ2; the object type of the 3rd object is type 2, and its coordinates and angle are expressed as X3,Y3,Θ3; the object type for the 4th object is type 3, and its coordinates and angle are expressed as X4,Y4,Θ4.

6.4Conveyor tracking object parameter setting

This chapter will start explaining the interface parameter settings of the conveyor tracking function; refer to Track Setting

Interface path: From the tab window at the bottom, select Tracking >> Setting; it is then divided into 4 tabs, tracking interface (Tracking), motion interface (Motion), custom packet interface (Ack Package) and the conveyor's digital input/output interface (DI/DO). The following chapter will describe these using different sections:

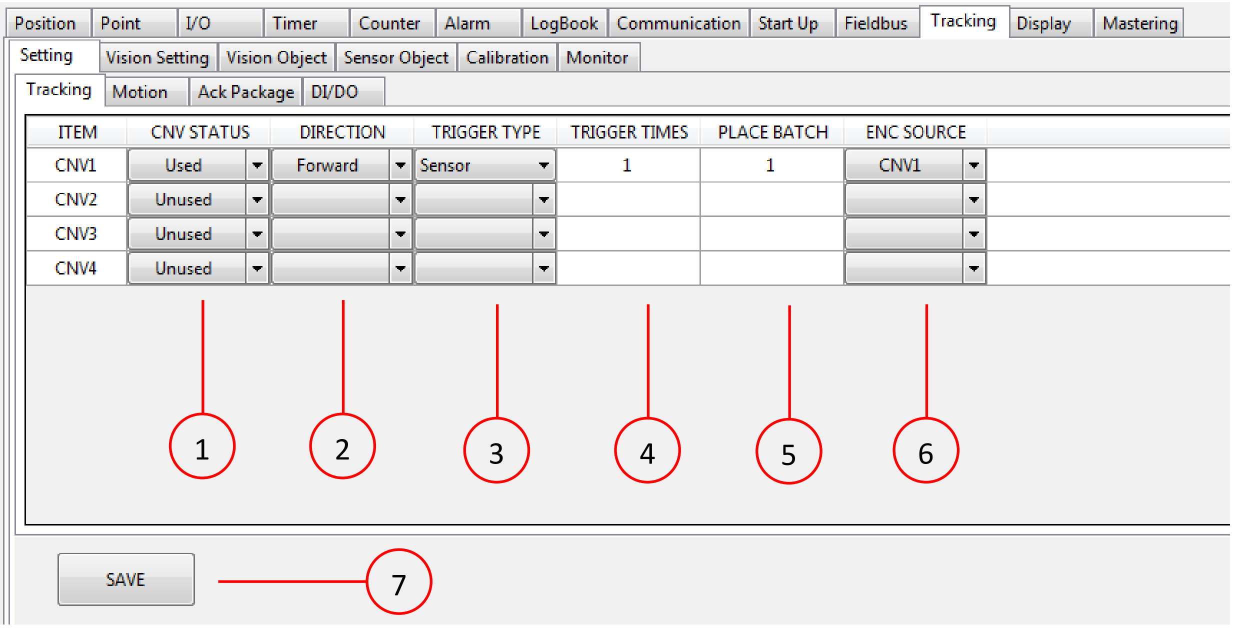


Conveyor tracking setting interface

6.4.1 Description of conveyor tracking interface settings

This chapter explains the various parameter settings for conveyor tracking; please refer to the descriptions in the below figure and table.

Path: select Tracking >> Setting >> Tracking.



Conveyor tracking setting interface illustration window

Conveyor tracking setting interface illustration table

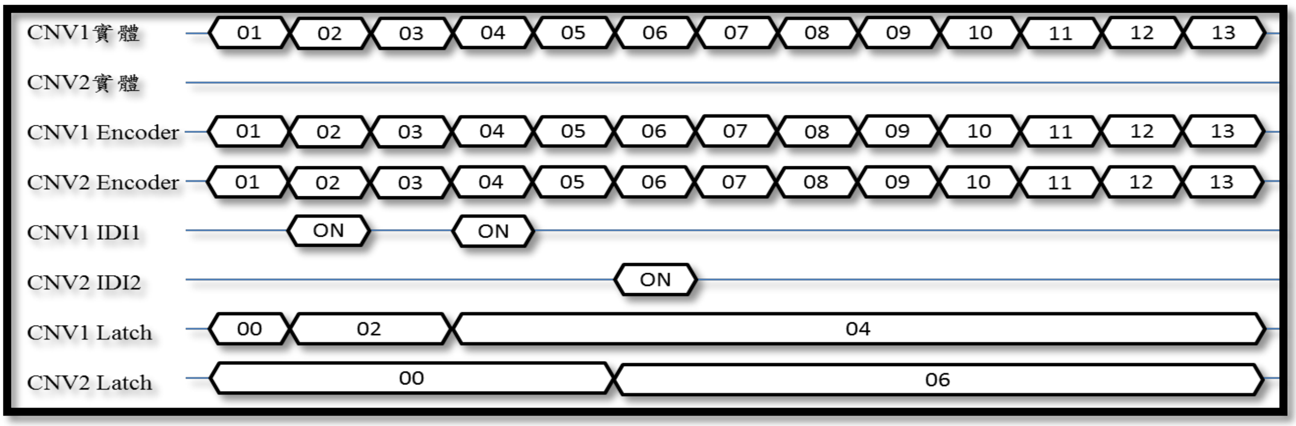
NO.	Name	Description
1	**CNV STATE** Conveyor usage status	Selecting "Used" enables to use this conveyor and selecting "Not Used" disables this conveyor.
2	**DIRECTION** Conveyor count direction	Selecting "Forward" will lead the conveyor in the positive direction ; selecting "Reverse" will lead the conveyor in the reverse direction.
3	**TRIGGER TYPE** Trigger tracking type	Selecting "Vision" uses image trigger methods, selecting "Sensor" uses sensor trigger methods.
4	**TRIGGER TIMES** Trigger tracking times	Conveyor tracking status variable, **only applicable for sensor trigger methods**. When the sensor on the conveyor is triggered, the robot will receive a pick-on-the-fly or place-on-the-fly queue. This variable can set the number of times the sensor must be triggered before the queue will increase by one. It is a positive integer type, and the setting input range is 1 to 100 times; the default value is 1 time.
5	**PLACE BATCH** Place times	Place-on-the-fly status variable; it is used when several objects need to be placed-on-the-fly in the same queue position. When the sensor on the release object conveyor is triggered, the robot will receive a queue position where place-on-the-fly can be executed, and the maximum number of place-on-the-fly times for the robot at this queue position can be set by this variable. It is a positive integer type and the setting input range is 1 to 100 times; the default value is 1 time.

NO.	Name	Description
6	**ENC SOURCE** Encoder source selection	The conveyor encoder copy function is used for shared reference of conveyor encoder value; the IDI status or trigger latch value will not be copied, and the default value is the conveyor encoder number itself.
7	**Save button**	Saves setting parameters.

Example description:

⇨<u>Description of encoder source selection (ENC SOURCE):</u>

The conveyor encoder copy function only copies the encoder value, it will not copy the IDI status or trigger (latch) value; the default value is the numbering itself, and it can be adjusted so that two entities can share and refer to the same encoder value. As shown in the example below: CNV1 is connected to a physical encoder signal, CNV2 copies the encoder signal of CNV1, and they triggered IDI1 and IDI2 respectively and received the queues Queue02, Queue04 and Queue06. The timing diagram is as shown below.

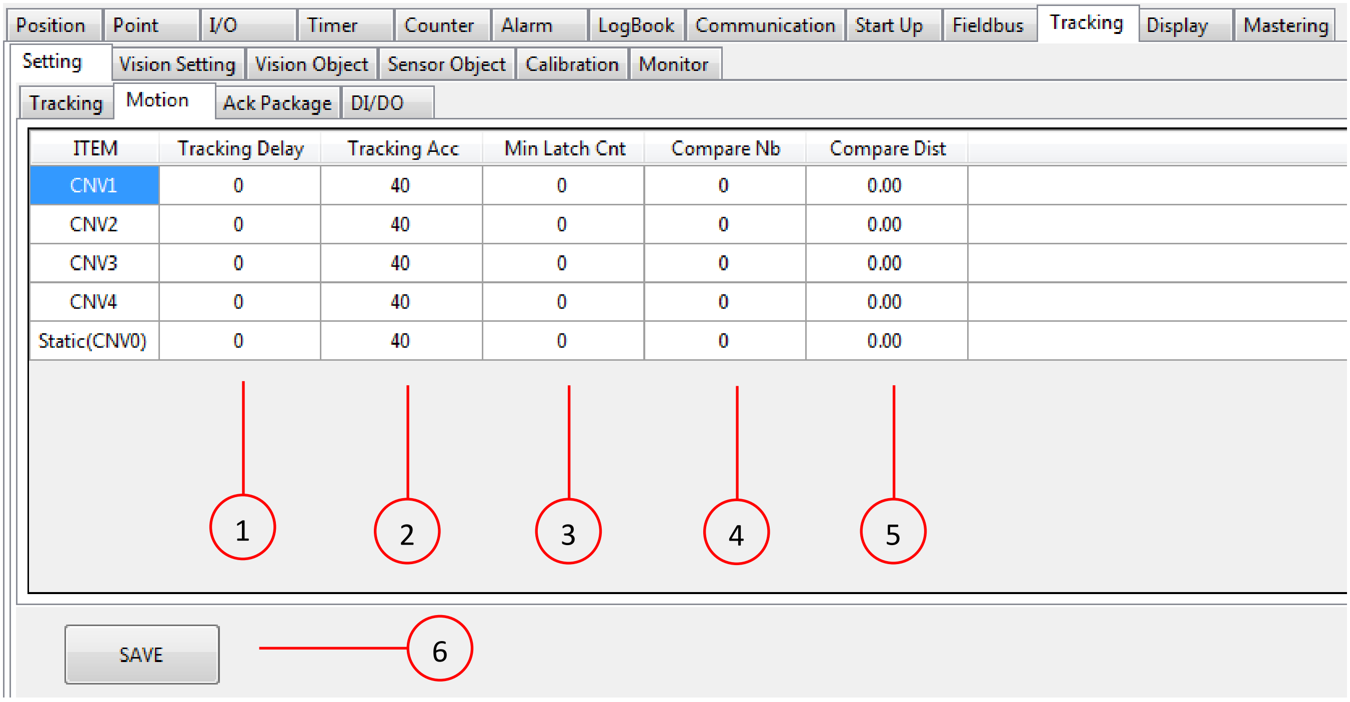


Encoder source selection timing diagram

6.4.2 Description of conveyor motion interface settings

This chapter explains the various parameter settings for conveyor motions; please refer to the descriptions in the figure and table below.

Path: In the tab window below, select Tracking >> Setting >> Motion.



ITEM	Tracking Delay	Tracking Acc	Min Latch Cnt	Compare Nb	Compare Dist
CNV1	0	40	0	0	0.00
CNV2	0	40	0	0	0.00
CNV3	0	40	0	0	0.00
CNV4	0	40	0	0	0.00
Static(CNV0)	0	40	0	0	0.00

Conveyor motion setting interface illustration window

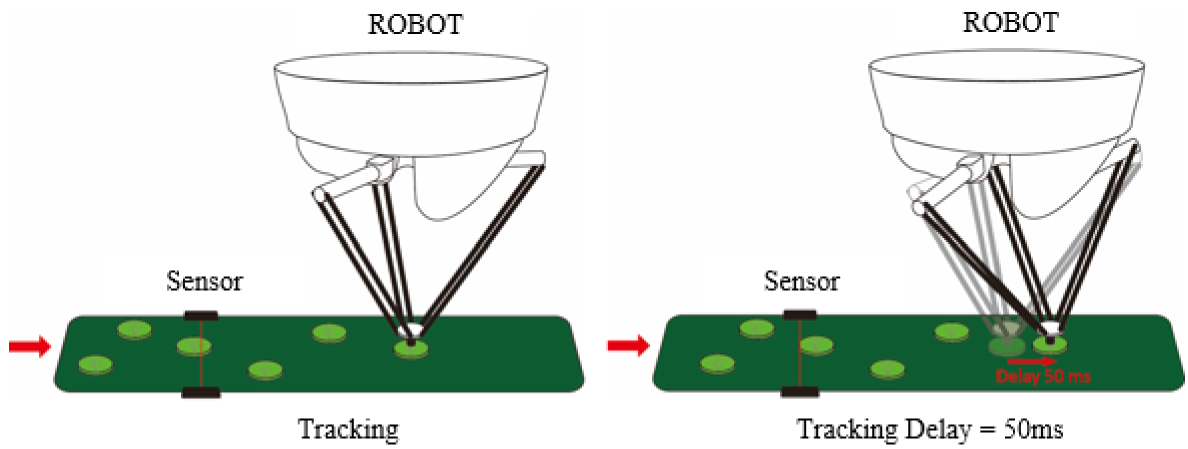
Conveyor motion setting interface illustration table

NO.	Name	Description
1	**Tracking Delay**	This sets how long the object should be followed before the pick-up action. The unit is milliseconds (ms) and the setting range is 0~1500 ms; the default value is 0 ms. (Please refer the diagram below)
2	**Tracking Acc** Tracking acceleration	The acceleration and deceleration time used to synchronize with the conveyor. The unit is millisecond (ms), the setting input range is 4 ~ 1000 ms and the default value is 40 ms. The smaller the value, the faster the acceleration or deceleration. (Please refer the diagram below)
3	**Min latch Cnt** Minimum trigger interval	Only applicable to sensor triggered filter function, the minimum trigger interval is that delaying (masking) the next signal receipt after the signal is triggered (Latch). Mainly used to prevent false triggering caused by signal interference and resulting into the robot malfunctions. The unit is pulse, and users can adjust and set the minimum trigger interval according to actual operation situations; the default value is 0. (Please refer the example below)
4	**Compare Nb** Compare object settings	Only applicable to Vision triggered filter functions; this setting value denotes the number of matching data with a repeated identified

NO.	Name	Description
		objects. The setting input range is 0 ~ 20, and the default value is 0, which means disable this function. The recommended setting is to set the maximum number of objects shot in a single image; it must be set with the comparison distance (Compare Dist) in order to this function to be effective. Set the filter buffer size; this size affects the comparison distance with the multiple previously confirmed triggered objects when the vision receives information on new objects, and then determines whether to trigger the object
5	**Compare Dist** Comparison distance setting	Only application to Vision triggered filter function, this setting value determines the threshold for the comparison distance length; the unit is millimeters (mm) and the default value is 0.00mm. The recommended setting is to set as the inscribed circle diameter length of the smallest object in a single image; it must be set with compare object settings (Compare Nb) in order for this function to be effective.
6	**Save button**	Saves setting parameters.

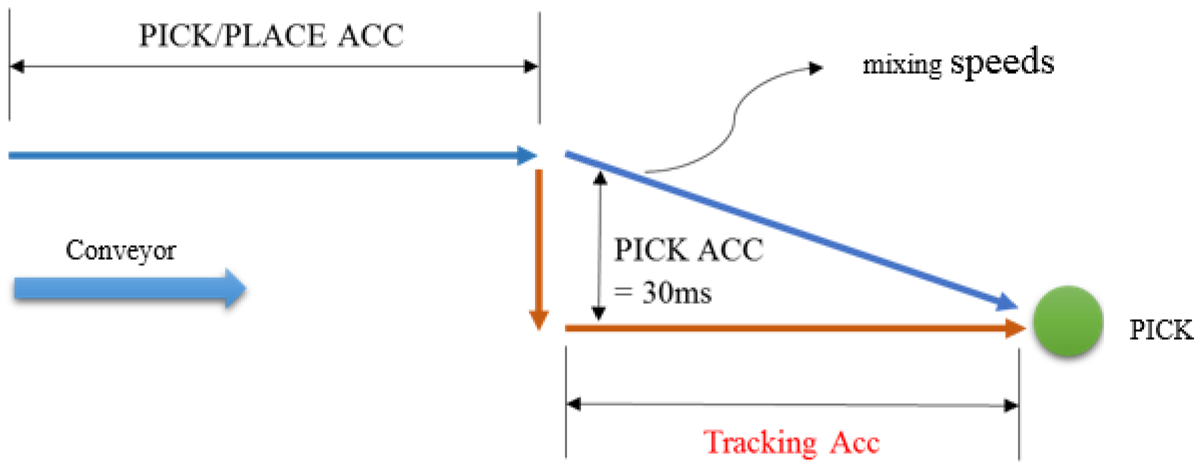
Example description:

⇨Description of Tracking Delay, example with delay set to 50ms:



Conveyor tracking delay time setting illustration diagram

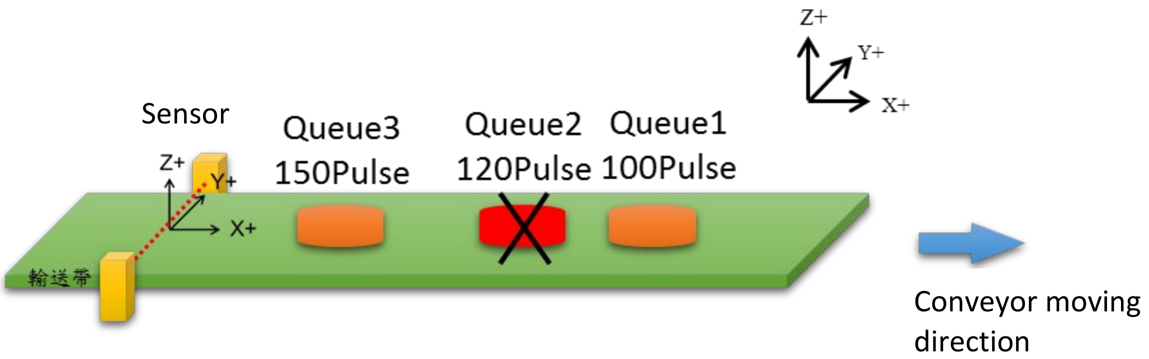
⇨Tacking acceleration time setting Tracking Acc illustration, the default value is 30ms:



Conveyor tracking acceleration time setting illustration diagram

⇨Minimum trigger interval count setting (Min Latch Cnt) example:

For example: The difference between the previous latch object and the current latch object pulse (20) is smaller than the threshold value set for count (25); therefore, the current triggered object (Queue 2) will be ignored. The default value is 0 (which means this function is disabled). As shown in the figure below, there are three objects on the conveyor, and the minimum trigger interval counties set to 25; therefore, Queue2 (task 2) will be ignored while Queue 1 and Queue3 have normal pick intervals.

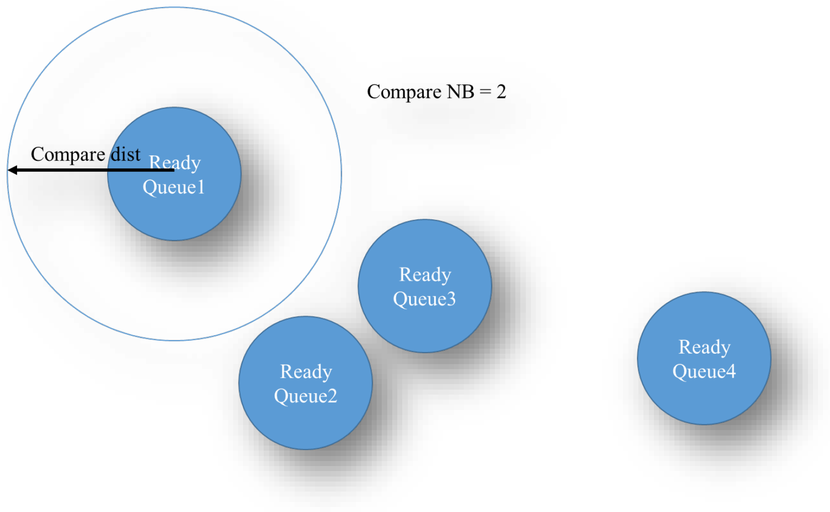


Conveyor tracking minimum trigger interval count setting illustration diagram

⇨Description of <u>compare object setting (Compare Nb) and compare distance setting (Compare Dist.)</u>:

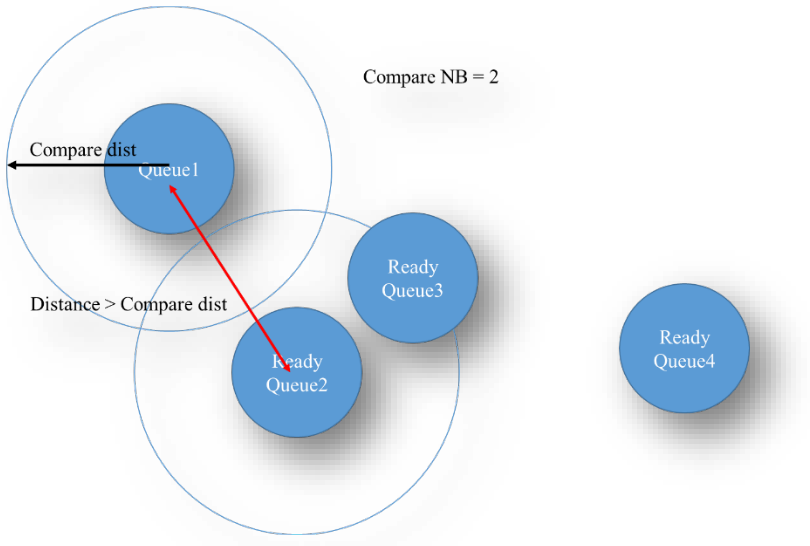
Description of 4 different filter examples by setting compare object setting (Compare Nb) as 2 with different comparison distance (Compare Dist.) settings.

Filter example 1: Ready Queue1 (Queue1 that is prepared and ready) is the first data entry and has no previous data entry that can be compared to; therefore, Ready Queue1 will be successfully kept as Queue1. This is when the workpiece is more independent and distributed.



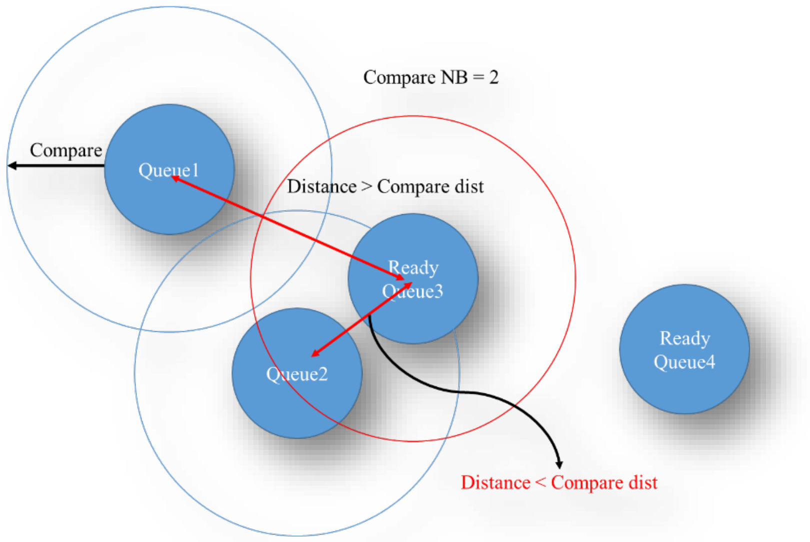
Compare Nb and Compare Dist. example 1

Filter example 2: Relative distance comparison will be performed for Ready Queue2 with the Queue1; if it is greater than the value set for Compare Dist., Ready Queue2 will be successfully kept as Queue2. This is when the workpiece is more concentrated and is outside the distance range.



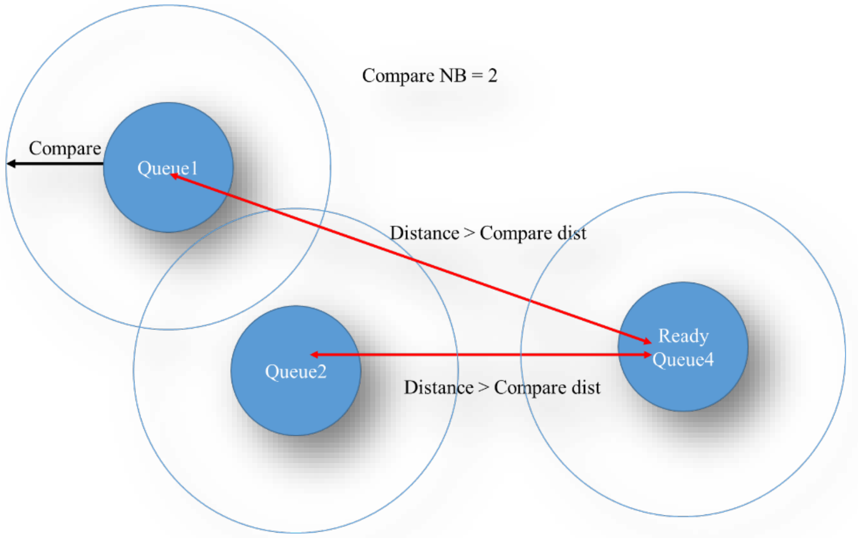
Compare Nb and Compare Dist. example 2

Filter example 3: Relative distance comparison will be performed for Ready Queue3 with the data of Queue1 and Queue2. If one of the data entries is smaller than the value set for Compare Dist., the Ready Queue3 data will be filtered out. This is when the workpiece is more concentrated and is within the distance range.



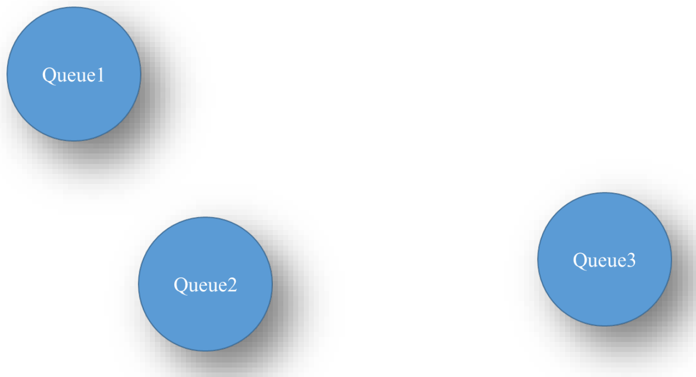
Compare Nb and Compare Dist. example 3

Filter example 4: Relative distance comparison will be performed for Ready Queue4 with the data of Queue1 and Queue2. If it is greater than the value set for Compare Dist., Ready Queue4 will be successfully kept as Queue3 (at the Ready Queue4 position). This is when the workpiece is more distributed and is outside of the distance range.



Compare Nb and Compare Dist. example 4

From the filter results of these four workpiece examples, the sequence of what was finally received is 3 queue entries (Queue1 ~ 3).

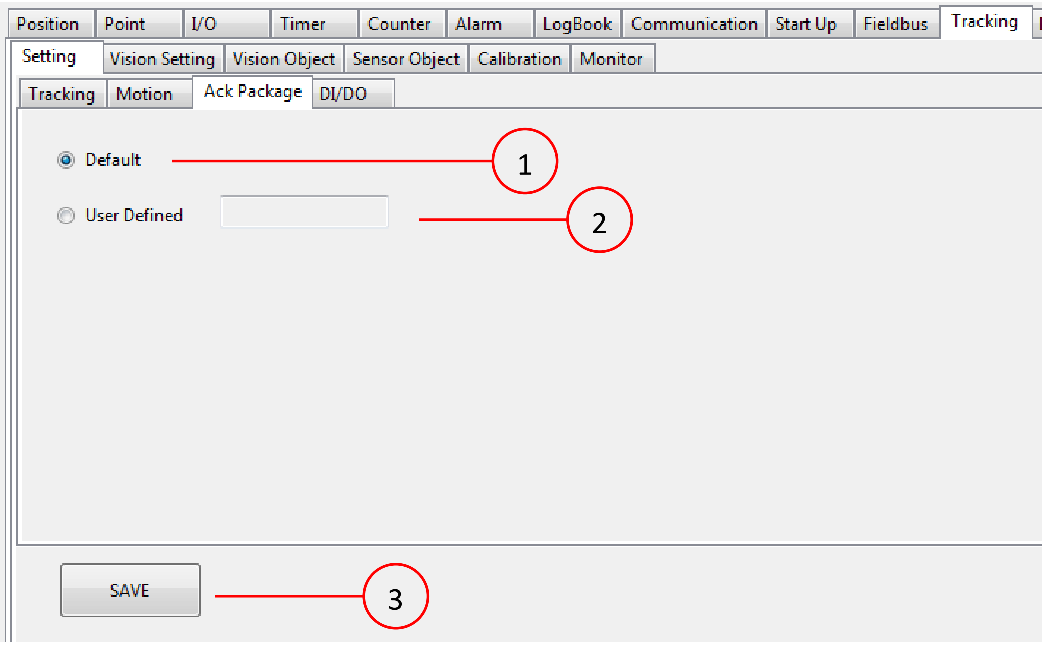


Compare Nb and Compare Dist. example filter results

6.4.3 Description of conveyor custom packet interface settings

Allows users to customize the contents of the signal packet returned by vision; it is applicable to the packet setting of different vision brands. The initial default is to return the "{conveyor number}".

Path: In the tab window below, select Tracking >> Setting >> Ack Package.



Interface diagram for customizing packet format

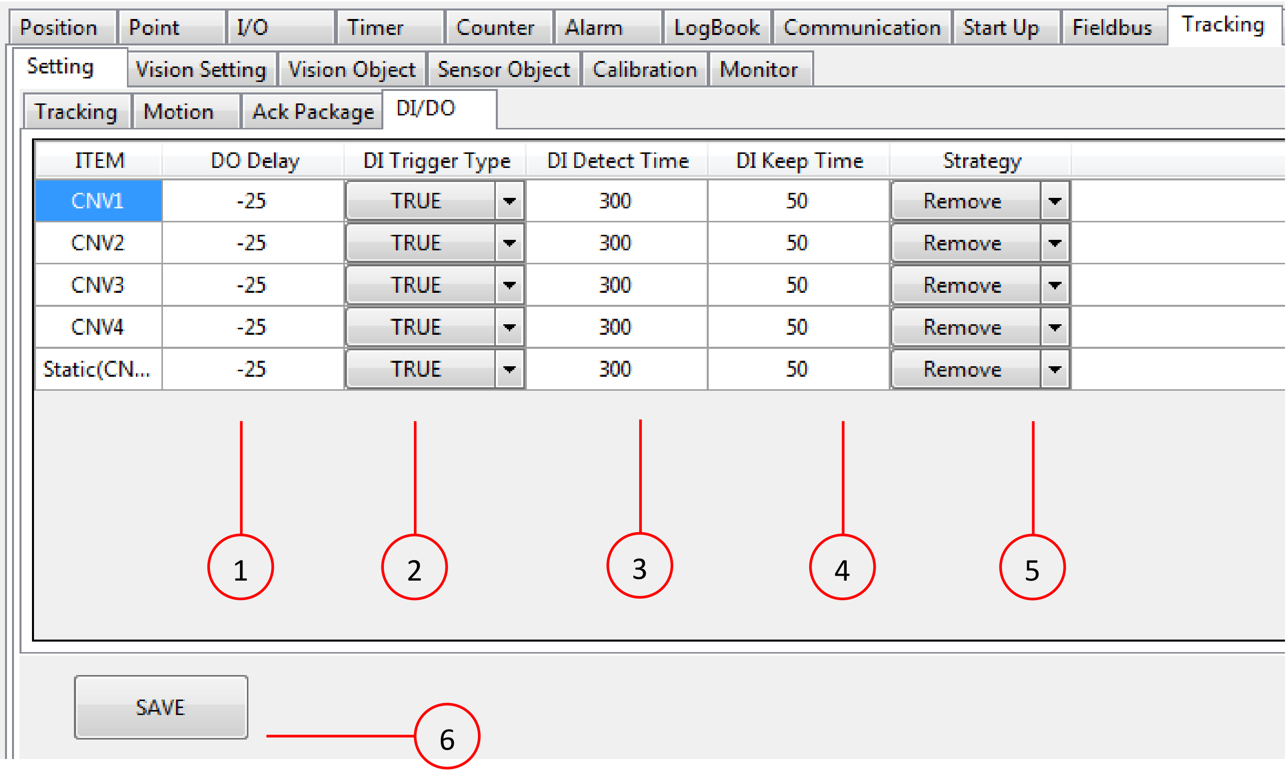
Illustration table for customizing packet format returned by vision

NO.	Name	Description
1	Default value options	The initial default is to return the "{conveyor number}"
2	User-defined options	Customize the signal packet content returned by the vision; it is applicable for different vision camera packet settings.
3	Save button	Saves setting parameters.

6.4.4 Description of conveyor digital input/output interface settings

The advancing or delaying of digital input and output signals can be controlled in conveyor tracking system; the following are the settings' descriptions.

Path: In the tab window below, select Tracking >> Setting >> Ack Package.



Conveyor digital input/output interface window

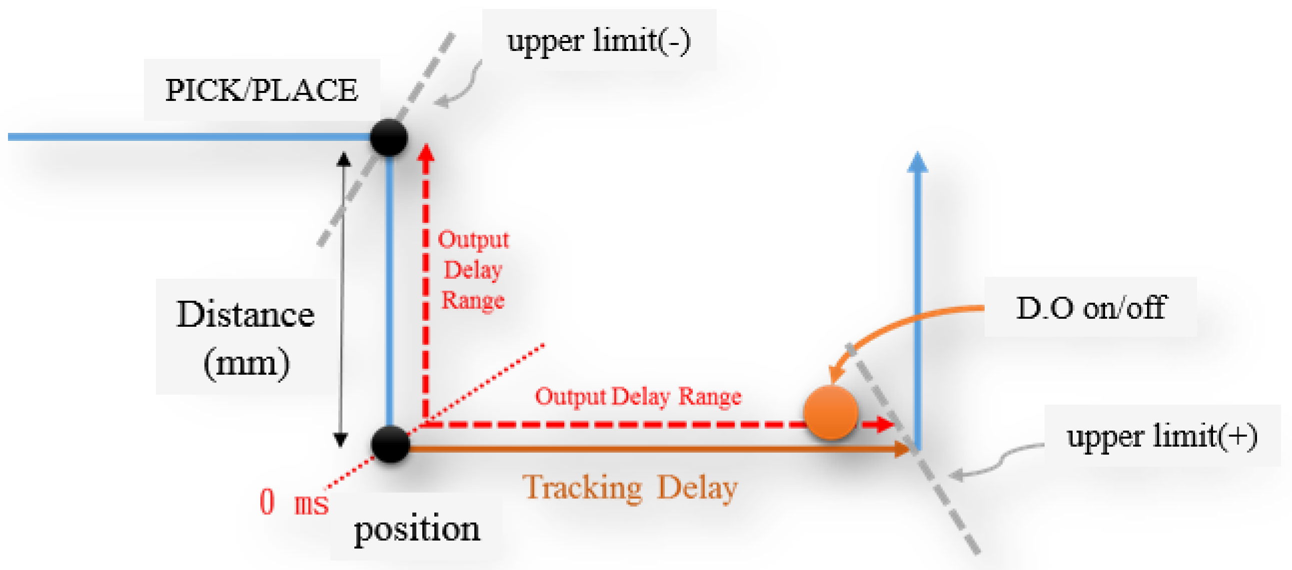
Conveyor digital input/output setting illustration table

NO.	Name	Description
1	**DO Delay** Digital output delay	Sets the digital output ($DO[]) time to open when robot tracking is in-place; positive and negative values can be used to move up or delay the action time. The allowed input range is -1500 to 1500, and the unit is millisecond (ms).
2	**DI Trigger Type** Digital input trigger types	On/Off status setting when the robot picked up an object; the menu includes two options “TRUE” or “FALSE”, and the default value is TRUE.
3	**DI Detect Time** Digital input detection time	The time to maintain digital input ($DI[]) detection after the digital output ($DO[]) signal is sent. The default value is 300; allowed input range is from 1 to 1500 and the unit is millisecond (ms).
4	**DI Keep Time** Digital input duration	The duration to detect digital input ($DI[]); only when this time is exceeded will the detection of digital input ($DI[]) be determined. The default value is 50; the allowed input range is 1 to 1500, and the unit is millisecond (ms).
5	**Strategy** Response strategy	During picking, when the response strategy is detected for the digital input ($DI[]), the menu includes two options “Retry” or “Remove”; the default value is Remove.
6	**Save button**	Saves setting parameters.

Example description:

⇨Description of digital output delay (DO Delay):

The parameters must be set as integer type, and the time count begins from the downforce position. If the quantity was not specified, the default value is -25ms, and the allowed input range is -1500 to 1500 ms. A positive value represents delay time and a negative value represents move up advancing time. The default value of output digital signal is 25 ms earlier.



Digital output delay (DO Delay) illustration diagram

⇨Digital input (DI) trigger type:

On/Off status setting of the digital input signal when the robot picked up an object; the default value is TRUE.

⇨Digital input (DI) detection time:

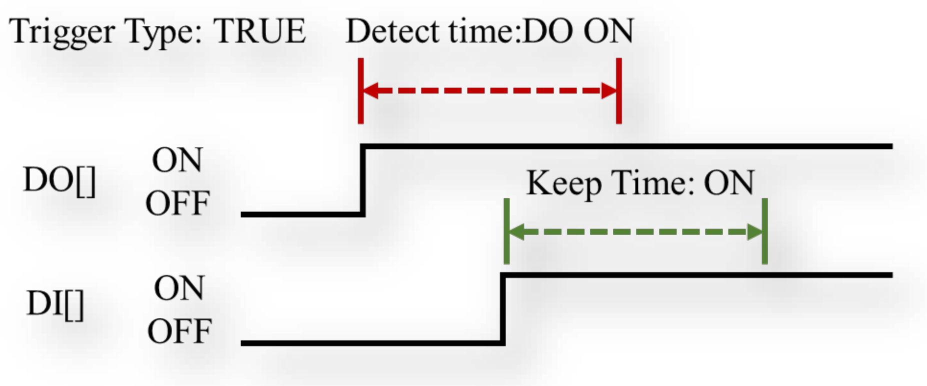
The time to detect digital input signals after the robot has picked up an object and the digital output ($DO[]) signal was sent. The parameter setting is in floating-point number type, and the default value is 300 ms. The allowed input range is from 1 ms to 1500 ms.

⇨Digital input (DI) duration Keep Time:

This the duration of the digital input signal. The parameter setting is in floating-point number type, and the default value is 50 ms. The allowed input range is from 1 ms to 1500 ms.

⇨Response strategy:

When response strategy of the digital input DI signal is detected during pick up, the default value is the Remove strategy.



Digital input trigger, detection and duration signal of the conveyor illustration diagram

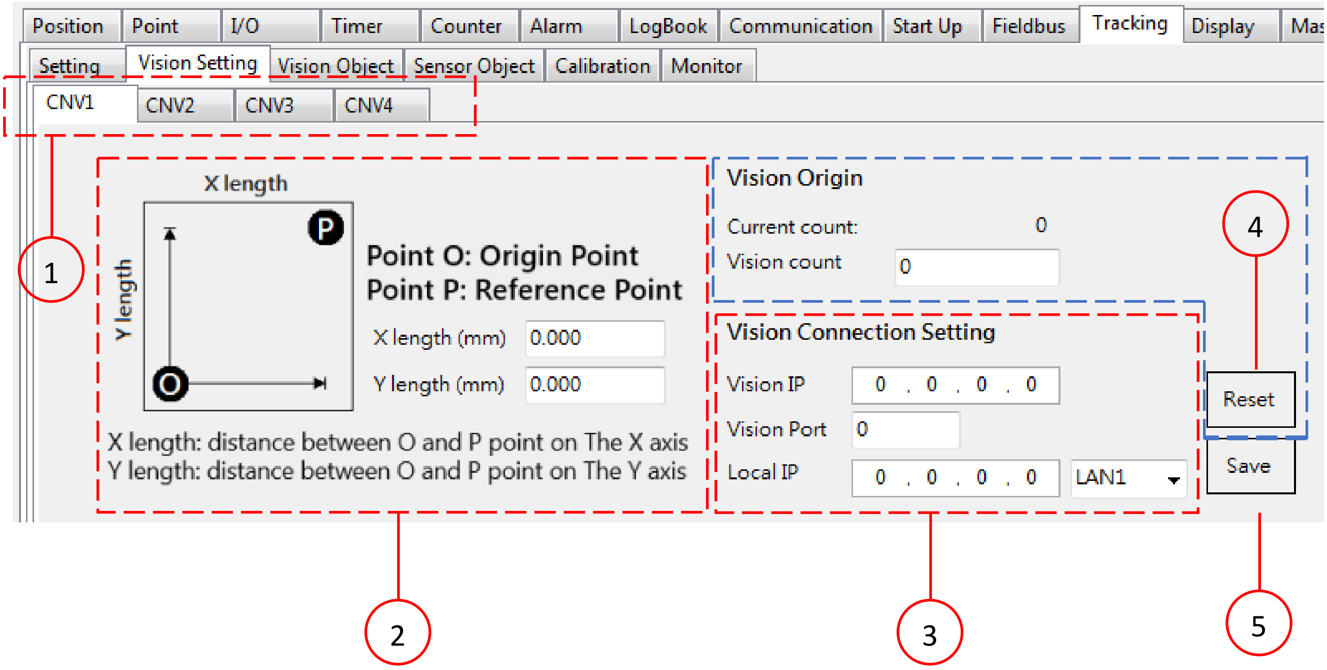
After completing the basic settings for the parameters of the conveyor tracking object, the following is the description related to calibration.

6.5Conveyor tracking vision image parameters

This chapter will explain how to use the conveyor tracking vision image parameter settings. This chapter can be skipped if the sensor trigger function is used.

Path: In the tab window below, select Tracking >> Setting >> Vision Setting.

Image parameter setting interface



Conveyor image parameter setting interface diagram

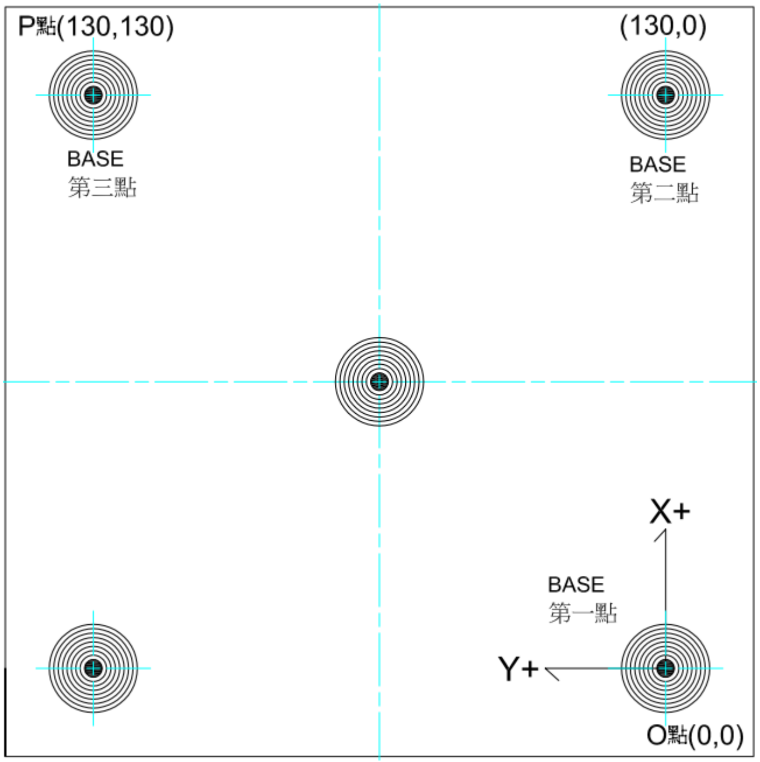
Conveyor image parameter setting table

NO.	Name	Description
1	Conveyor number tab	Select the conveyor number tab to set; there is a total of 4 tabs, CN1 ~ CN4.
2	Calibration template distance setting	Calibration template distance setting; the X and Y length value of the O point and P point in the template must be set. The unit is millimeter (mm).
3	Vision connection setting	The IP and port of the vision must be set; its vision IP and local IP must have the same network domain settings (the first 3 digits of the IP must be the same).
4	Reset button	Clears the conveyor encoder count value and resets it to zero; the current position of the vision origin position setting will be 0. After resetting, users can go to the monitor page to confirm that the encoder value has been reset to zero. The reset to zero action must be performed before vision calibration.
5	Save button	Saves setting parameters.

⇨Instructions:

1.Select the conveyor number (CNV1~CNV4) to track, and record the setting information on the image parameter page according to the conveyor number separately. Therefore, please select the number first when setting parameters, then press Save after setting is completed. .

2.Before using the conveyor tracking function, the corresponding coordinate position (mm) of the calibration point in the image system must first be set; this is the distance from the origin of the calibration template to the calibration point. Set the values of POINT X Y as the straight-line distance between X and Y of P point and O point (the value is a positive integer). As shown in the diagram below, O point is the origin, and the distance between P point at the top-left and O point at the bottom-right is 130X130mm; therefore, enter the value 130 for the X distance length and enter the value 130 for the Y distance length.



Calibration template sample diagram

3.Vision Connection Setting:

1)Vision IP: Must be set as the same as the vision system IP.

2)Vision port: Must be set as the same as the vision system port.

3)Local IP:Click menu and select IP1 (top network socket) or IP2 (bottom network socket), and set the local IP address. The first 3 value of the IP must be the same as the vision system IP; the 4th byte can be compiled by the user, but cannot be the same as the vision IP.

Note 1: The coordinate system of the robot must be the same as vision calibration; the coordinate system is based on the right-hand rule.

Note 2: IP1 and IP2 cannot be used as sockets simultaneously (COPEN(ETH,…instruction cannot be used twice).

4.Vision origin position setting:

1)The encoder value must be zero; reset the encoder count value on the conveyor to zero when vision calibration is performed for the calibration template.

→Click the "Reset" button and confirm that the Now value is zero.

2)Vision Count: Relative offset value setting must be set for the encoder value corresponding to vision recognition; unit: pulse count. It can be changed from here. If it doesn't need to be used, the value must be set as zero.

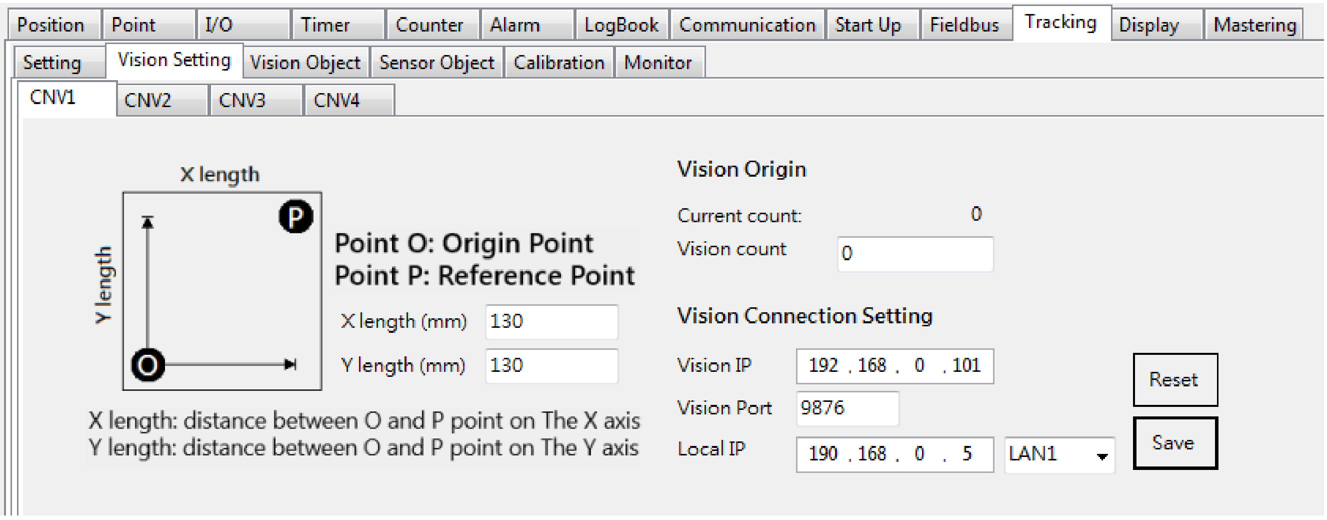
5.Once the above settings are completed, click the "Save" button to save the parameters set. Remember to press Save before changing/switching to another tabs.

⇨Example description for setting vision image parameters:

Example:

Set the conveyor as CNV1, set the X axis length as 130mm, set the Y axis length as 130 mm, and set the vision count as 0

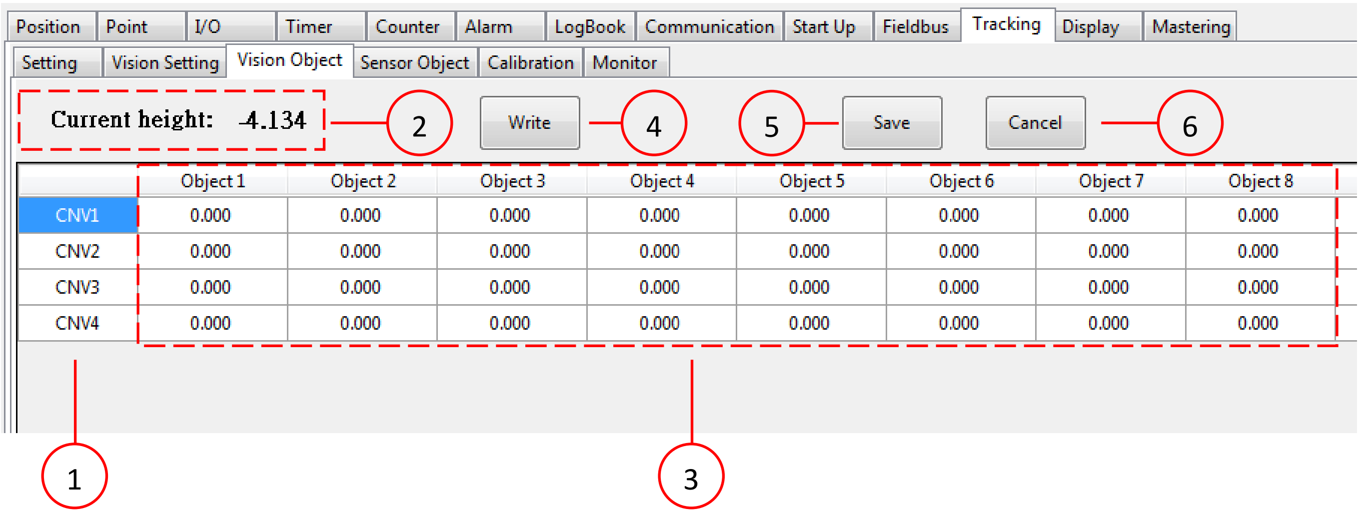
Set the vision IP as 192.168.0.101, set the vision port as 9876 and set the local IP as 192.168.0.5.



Calibration template sample data’s window

6.6 Vision triggered object setting

Before performing conveyor tracking, related parameters for conveyor tracking must be adjusted; related settings of objects can be applied directly to the conveyor’s pick-on-the-fly program instructions.
Path: In the tab window below, select Tracking >> Setting >> Vision Setting.



Conveyor vision triggered object setting interface diagram

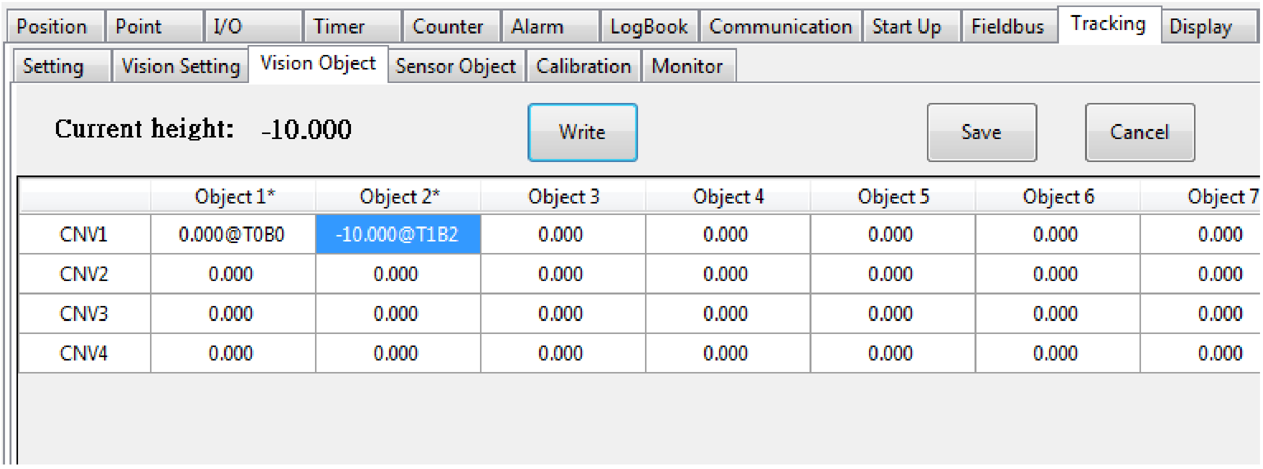
Conveyor vision triggered object settings illustration table

NO.	Name	Description
1	Conveyor number	Select the conveyor number to set; there are total of 4 conveyor settings that correspond to CN1 ~ CN4.
2	Robot height value	Displays the Z axis height value of the current robot; unit: millimeter (mm).
3	Object height record table	Displays the height for each work object in accordance to the height value of the tool coordinates and base coordinates; a total of 8 objects; Object from 1 to 8, can be used. Not only the current recorded height value is displaying, the tool coordinates and base coordinates also will be recorded; number height value@T#B#. There is a “*” symbol next to the object numbers above, which means that the value was changed but not yet saved.
4	Write button	Click the “Write” button for the object height that needs to be set to write the current height plus the tool coordinates and base coordinates into the fields of this object.
5	Save button	Saves the setting parameters. After saving, the “*” symbol next to Object# on the top will disappear.
6	Cancel button	Cancels the height value written and restores the previous height value entry. Since the object’s height record table cannot be edited directly, to restore objects with the “*” symbol, the Cancel button must be pressed to restore the previous entry of height value. If the Save button was already pressed, the current value can only be replaced by overwriting.

⇨Description of the object height record table & write button:

Example:

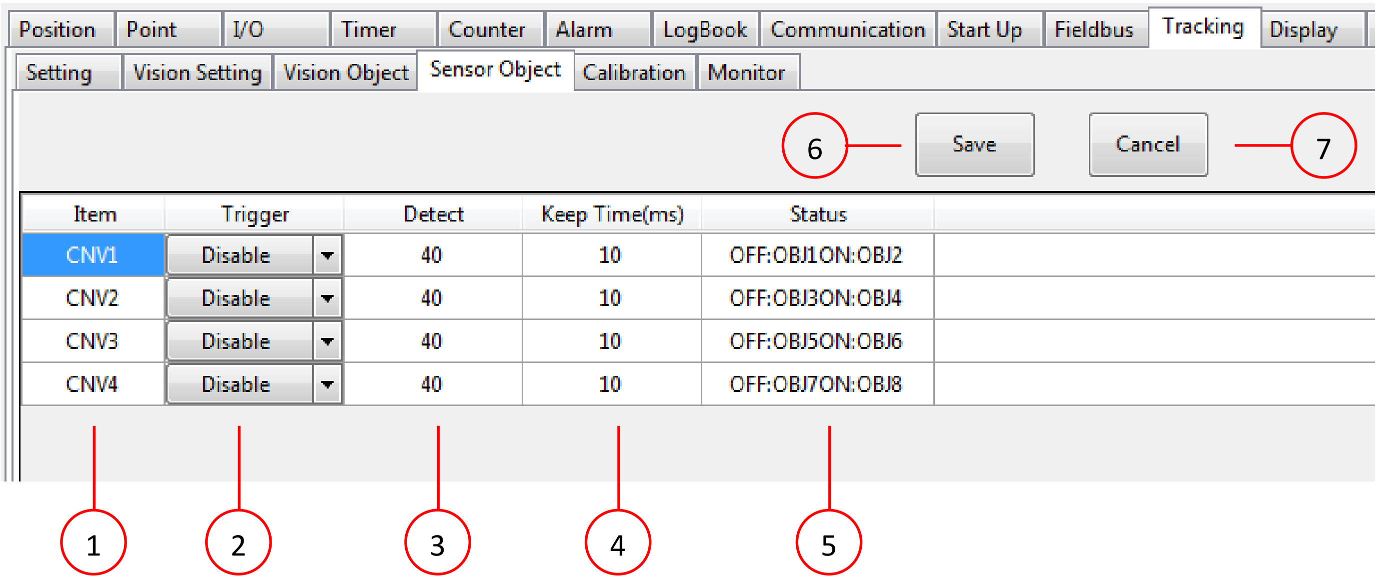
Select the 2nd object (Object2) recorded values on the CN1 conveyor; the current (Z axis) height is 10.000 mm. After pressing the "Write" button for the TOOL[1] coordinates and BASE[2] coordinates, "10.000@T1B2" will be displayed in the object height record table. There will be a "*" symbol next to the object number, which means that it has not yet been saved. Remember to press the "Save" button; "*" will only disappear after the record is saved.



Example Vision triggered object setting write values window

6.7 Sensor triggered object setting

Before performing conveyor tracking, related parameters for conveyor tracking must be adjusted; related settings of objects can be applied directly to the conveyor’s pick-on-the-fly program instructions.
Path: In the tab window below, select Tracking >> Setting >> Sensor Setting.



Conveyor sensor triggered object setting interface window

Conveyor vision triggered object settings illustration table

NO.	Name	Description
1	**Conveyor number**	Select the conveyor number to set; there is a total of 4 conveyor settings that correspond to CN1 ~ CN4.
2	**Trigger signal setting**	Users can select the digital input $DI if they want to perform sensor triggered object signal setting. The default setting is Disable. It is a pull-down menu and the available setting is $DI[1] ~ $DI[48].
3	**Detect Time** Detection time	The time to maintain digital input ($DI[]) detection after the digital output ($DO[]) signal is being sent. The default value is 40 and the unit is millisecond (ms).
4	**Keep Time** Duration	The object tracking duration after detecting digital input ($DI[]); the default value is 10 and the unit is millisecond (ms).
5	**Object status** Status	Status of the detected object. Two types of objects are distinguished based on the ON/OFF status of the digital input ($DI[]) selected. Take CN1 for an example, if the signal of CN1 is OFF, it can be considered Object1; if the signal of CN1 is ON, it can be considered Object2. The same goes for CN2 ~ 4.
6	**Save button**	Saves the setting parameters. After saving, the “*” symbol next to Object# on the top will disappear.
7	**Cancel button**	Cancels the height value written and restores the previous height value. Since the object height record table cannot be edited directly, to restore

NO.	Name	Description
		objects with the "*" symbol, the Cancel button must be pressed to restore the previous entry of height value. If the Save button was already pressed, the current value can only be replaced by overwriting.

6.8 Conveyor and trigger device calibration setting

This chapter explains the calibration setting between the conveyor and trigger device. Before performing conveyor tracking operation, calibration must be performed to synchronize the setting of the conveyor and trigger device; the trigger device refers to image vision or sensor trigger devices. Users can perform calibration settings based on the trigger device being used. The following are two sections used to describe the calibration methods separately.

6.8.1 Calibration for sensor triggered method

In addition to installing the electronic controls such as sensor and encoder; parameter settings (refer to Chapter 6.4) must also be completed for conveyor tracking objects. Sensor triggered calibration requires the following steps:

1.Select the calibration template.

2.Install calibration fixtures at the end of the robot, and calibrate the tool coordinates (refer to Chapter 3.3.3).

3.Base coordinate (user coordinate) calibration.

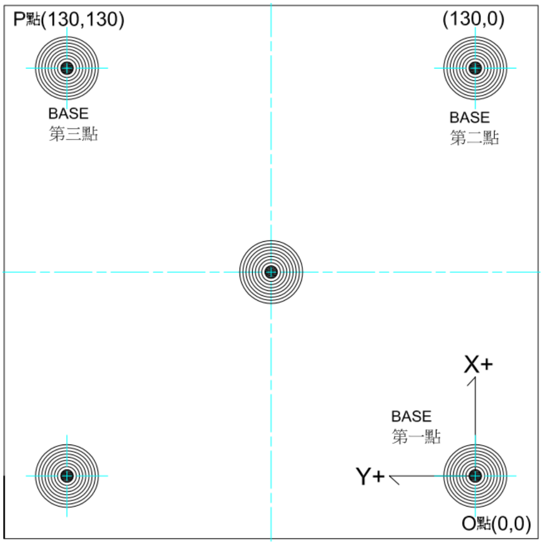
4.Conveyor motion ratio calibration.

5.Robot working range calibration.

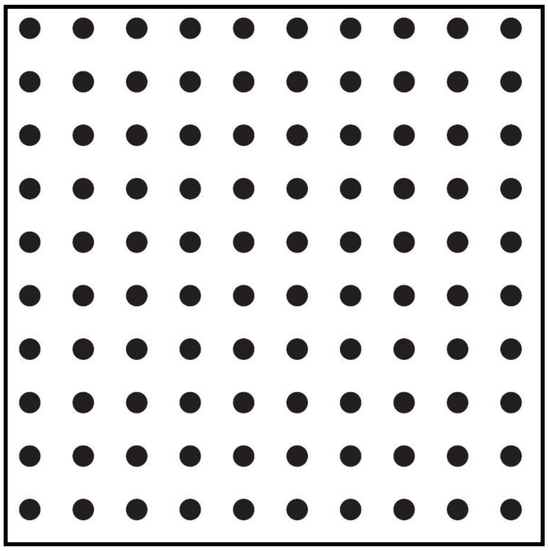
The manual calibration process steps must be performed in order to allow the robot coordinates, conveyor encoder value and sensor position to have corresponding relationships, and to accurately perform pick-on-the-fly tasks for workpieces on the conveyor. Each of the following sections will explain them separately.

6.8.1.1 Sensor triggered-select the calibration template

Select a calibration template; this calibration template must have the same specifications as the end calibration fixtures in order to compare (point) positions. Refer the calibration template in the figure below, for example, the end calibration fixture can use the following circle diameter for the operator to compare the calibrated positions; operators can refer to the image below or design their own calibration template (the calibration template is used for measuring, therefore, it is recommended that its point positions and sizes must be tested to prevent errors occurring).



(This figure is just an example description and does not have correct distance ratios)

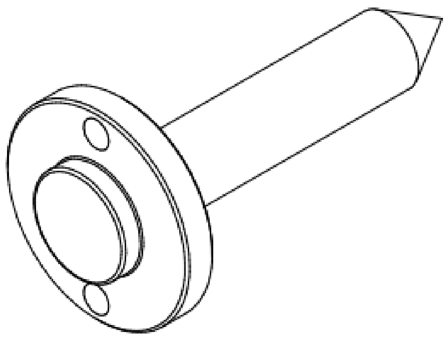


(This figure is just an example description and does not have correct distance ratios)

Sample Calibration template diagram (left figure 130mm square five-point figure, right figure: 10mm matrix dot plot)

6.8.1.2 Sensor triggered-install calibration fixture and tool coordinate calibration

Before starting the following sensor calibration, the calibration fixture mechanism device that corresponds to the calibration template must be installed at the end of the robot (due to the different sizes and specifications requirements, users must design the fixture mechanism themselves); this calibration fixture must be the same as the pick TCP (Tool Center Point), as this will be the most accurate method. After installing the end fixtures, corresponding tool coordinate calibration must be performed for the end fixture (calibration rod) (If base coordinate calibration cannot be performed first, then change to the tool coordinates, this is the order need to be followed).



Refer to the end fixture (calibration rod) figure

Refer to the installing end fixture to the robot end figure

Refer to the illustration diagram for using end fixture (calibration rod) with the calibration template

Description of entering the tool coordinate values using value input:

The distance of the tool can be entered manually to adjust the tool coordinate.

Possible data source:

■Obtain the tool size information from the CAD file.

■Physical measurement of the tool size.

■User manual from the tool manufacturer.

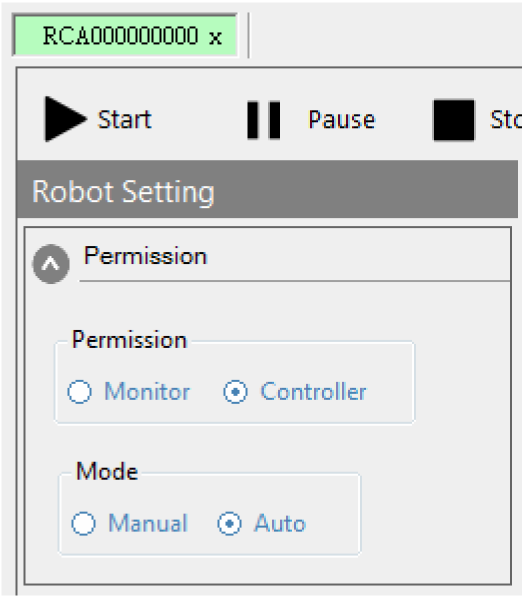
Prerequisites

1. Manual operation mode.

2. Known X, Y, Z, A, B and C distance sizes relative to the flange coordinates.

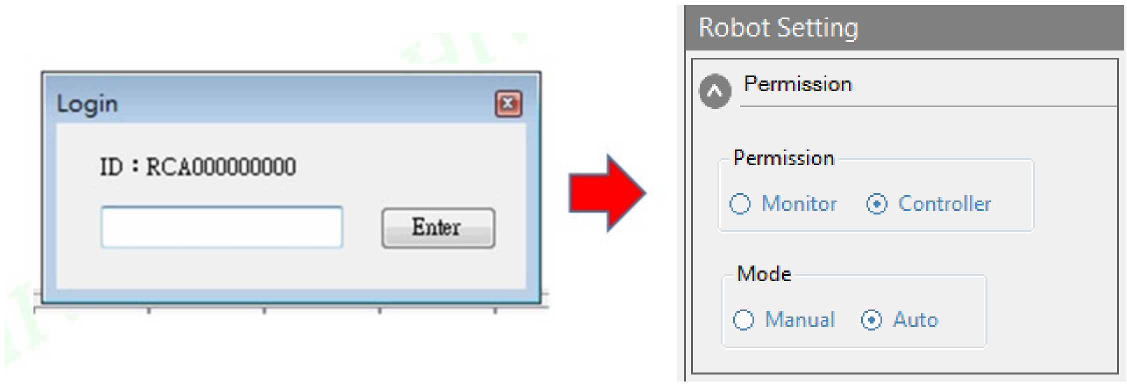
Instructions:

1.)Switch the mode into controller permissions.



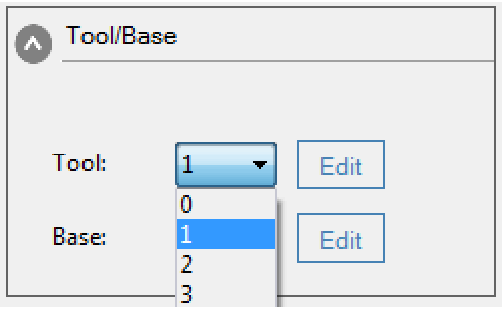
Switching to controller permission diagram

2.)Enter the password (HIWIN) to switch into the manual mode.



Enter the password to switch to manual mode figure

3.)Select the tool coordinate number from the tool/base interface on the left; for example TOOL[1].



Selecting the tool coordinate number from the tool/base interface window

1.)Then click the Edit button and the input value page will appear. .

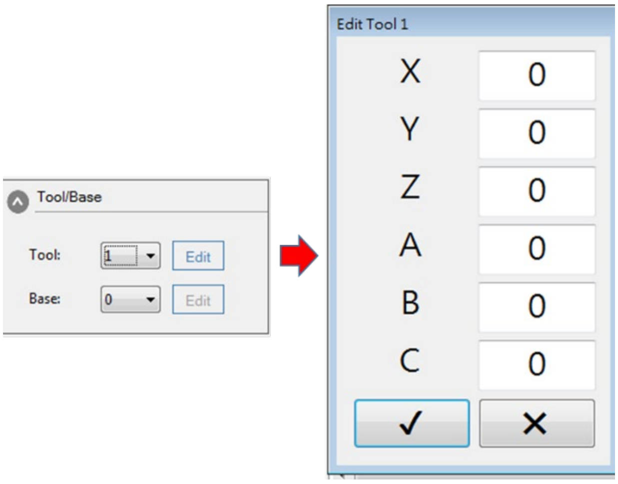
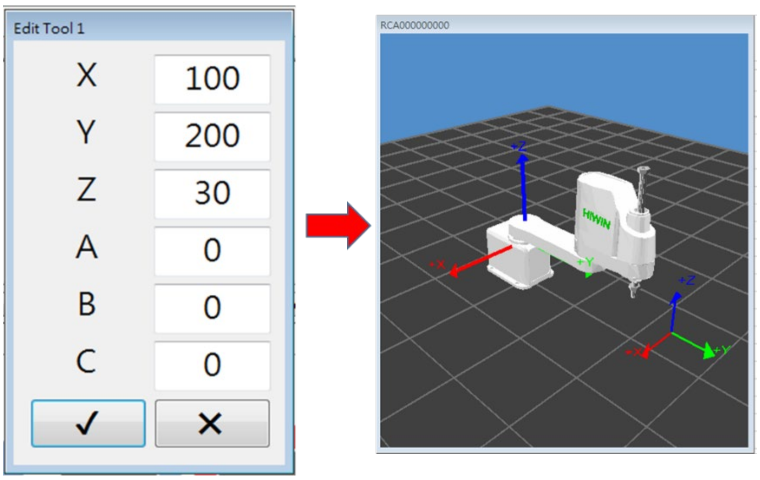


Figure1, Click the Edit button and enter the input values

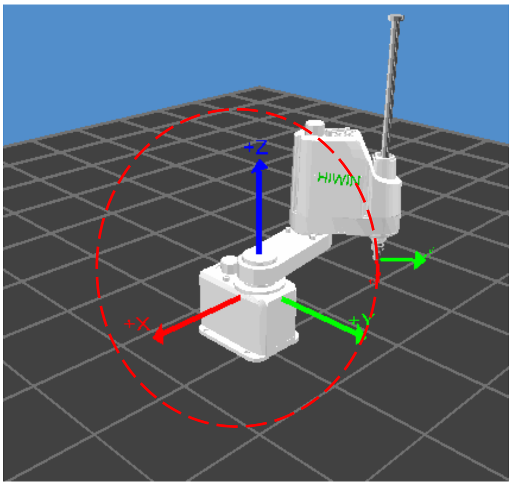
2.)Enter the values for the X, Y, Z, A, B and C distance sizes of each axis in the table and tick [V];data will be saved. It can be seen from the simulated robot display of below screen; that the TOOL coordinates have shifted successfully.



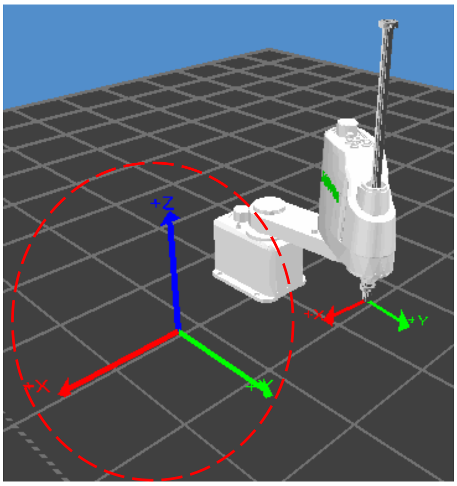
Tool coordinate TOOL[1] value input interface window

6.8.1.3 Sensor triggered-base coordinate calibration

Purpose for base coordinate calibration: To rotate and shift the origin of the robot coordinates to the user's desired reference point. As shown below, the left figure is the original base coordinate figure; after user base coordinate calibration, the left figure's coordinates are shifted to the new base coordinate (right figure).



Original base coordinate BASE[0] diagram



Shifted to the new base coordinate diagram

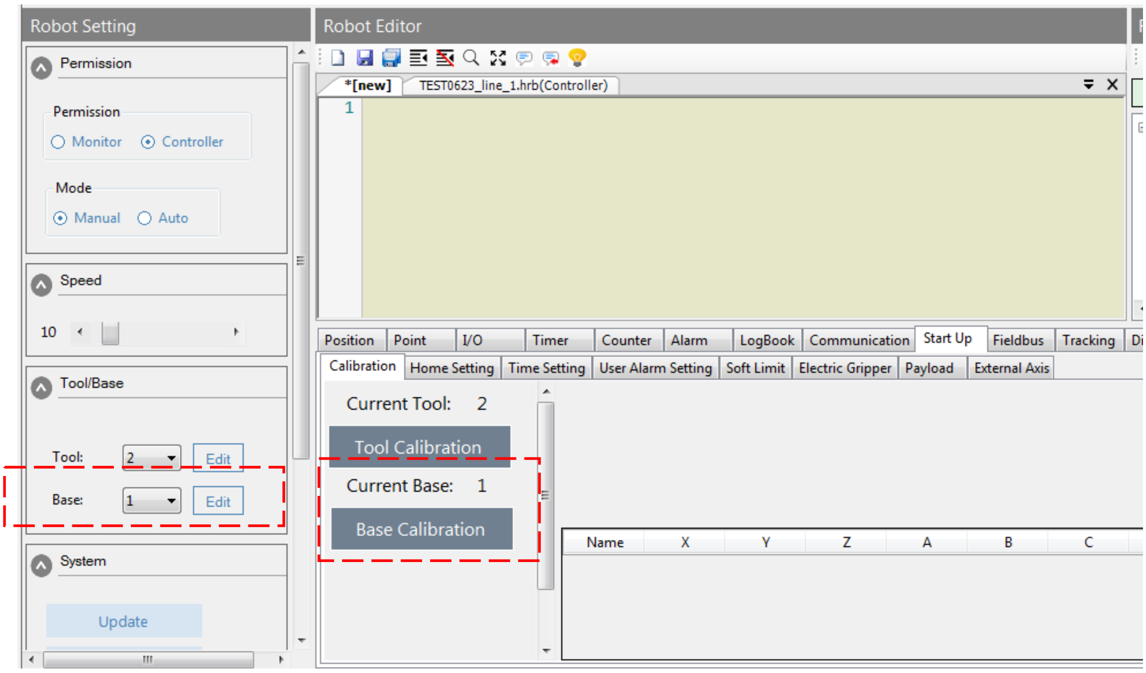
After completing tool coordinate calibration, next is to perform base coordinate calibration. The purpose of base coordinate calibration is to move the robot coordinate onto the conveyor, and have relevant definitions for the direction. In order to make the base coordinate of the robot the same as the base coordinate of the conveyor, and to make it easier to identify, this process defines the conveying direction of the conveyor uniformly to positive X axis (+ X_Axis) and positive Z axis upwards (+ Z_Axis).

Sensor triggered base coordinate calibration includes the following 4 steps:
Step (one) Open the base coordinate setting page.
Step (two) Set the first point of the base coordinate.
Step (three) Set the second point of the base coordinate.
Step (four) Set the third point of the base coordinate.
The following are detailed introductions of the steps.

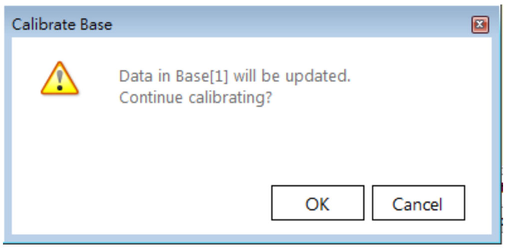
■**Step (one) Open the base coordinate setting page**

From Tool/Base in the left interface , first select the base calibration/coordinate to set from Base (Base[1] is used as the example here), then switch to the coordinate calibration page and start the three steps for base calibration.

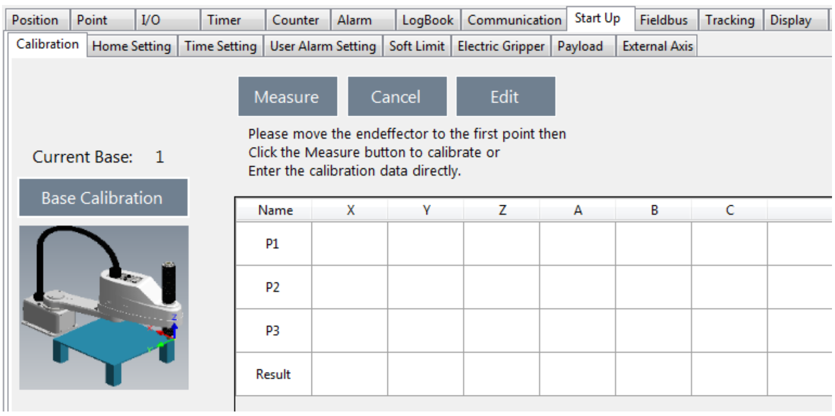
Path: From the tab window below, select Tracking >> Start Up >> Calibration > Base Calibration button.



Base coordinate BASE[2] interface diagram



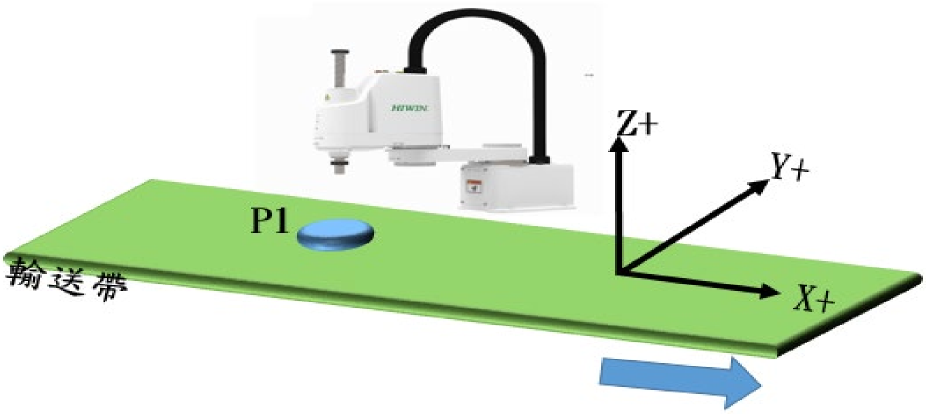
Confirm the update of the Base confirmation window



Base calibration setting window

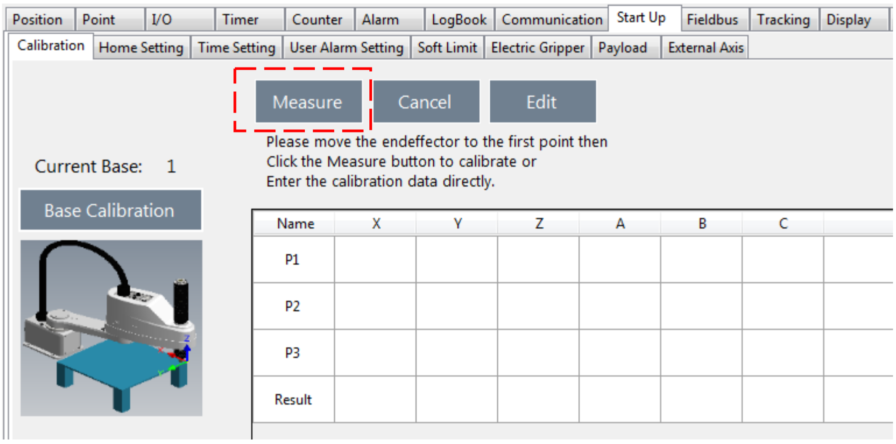
■**Step (two) Set the first point of the base coordinate**

Place the calibration template/workpiece on the conveyor, and the workpiece must be within the range where the robot can reach, and then move the end of the robot to the position point P1 of that workpiece (the blue workpiece is used to represent this in the figure below). This position is the first point, and is the calibration origin. Press the “Measure” button to confirm it is the first point for base coordinate calibration.



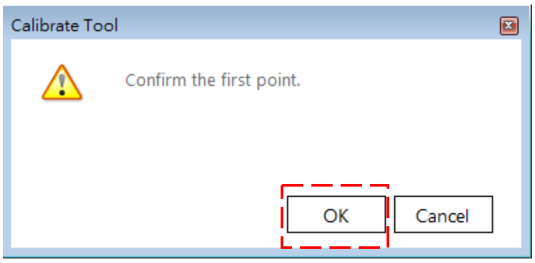
First point (P1) for base coordinate calibration illustration diagram

Note 1: Point (P1) must be within the robot range; the blue workpiece can also be replaced by the calibration template.

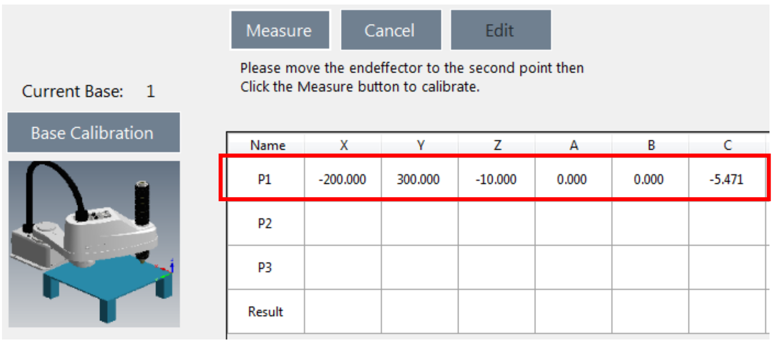


Base calibration; press the measure button to set P1.

Press the “OK” button after the robot moved to the P1 point to confirm the calibration of the first point; the position information is displayed in the calibration table. The calibration of the first point has been completed.



Confirm it is the first point of the calibration

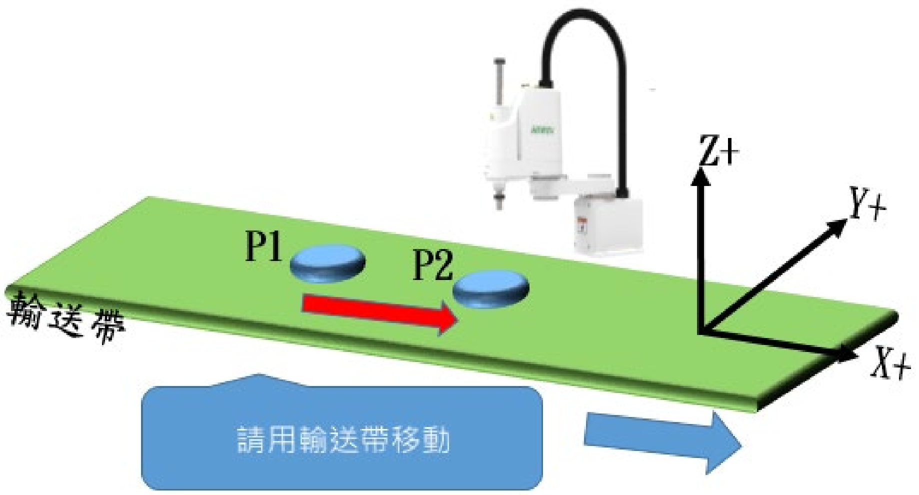


Record the position information of the first point

■**Step (three) Set the second point of the base coordinate**

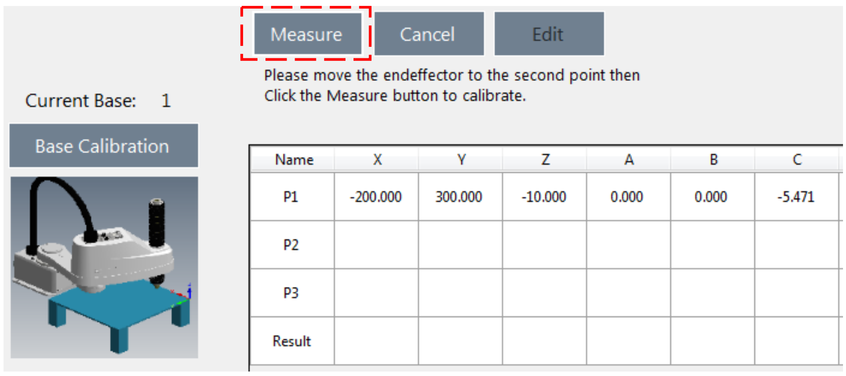
Place the calibration workpiece on the conveyor, then start the operation of the conveyor and move the conveyor downstream for some distance (must be within a reachable range of the robot), then move the robot arm end to this point (P2). This position is the second point. This action allows the robot to obtain the conveyor coordinates in the positive X axis direction (+X_Axis).

Press the “Measure” button to confirm it is the second point for base coordinate calibration.



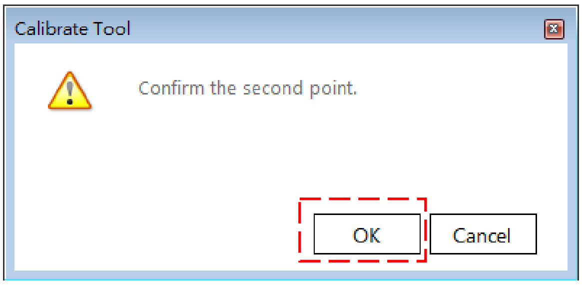
Second point (P2) for base coordinate calibration illustration diagram

Note: Point (P2) must be within the robot range, and the positioning point of the workpiece must not move randomly on the conveyor in order to prevent distortion.

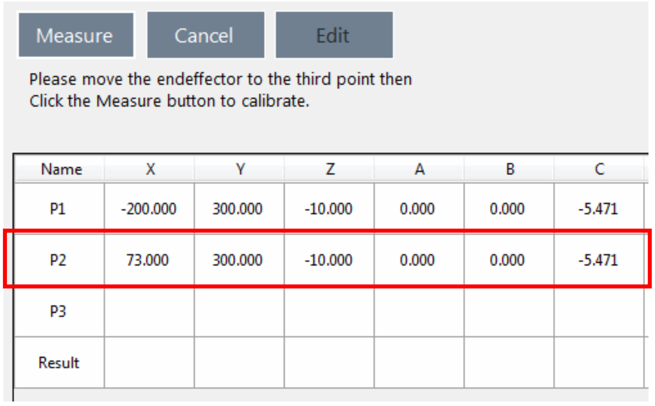


Go to base calibration and press the measure button to set P2.

After the robot moved to the P2 point, press the “OK” button to confirm the calibration of the second point. Calibration for the second point is completed.



Confirming the second point of the calibration

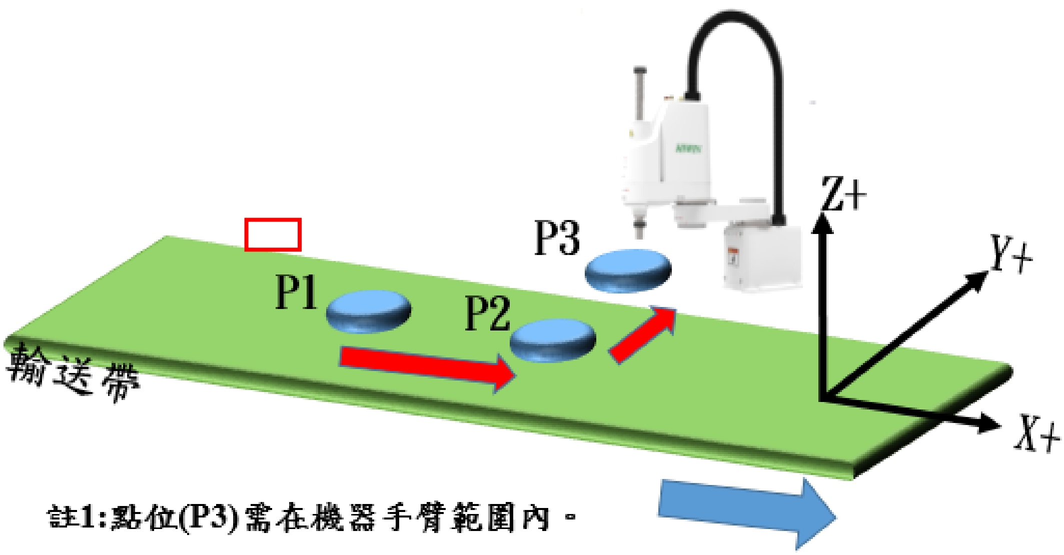


Name	X	Y	Z	A	B	C
P1	-200.000	300.000	-10.000	0.000	0.000	-5.471
P2	73.000	300.000	-10.000	0.000	0.000	-5.471
P3						
Result						

Record the position information of the second point

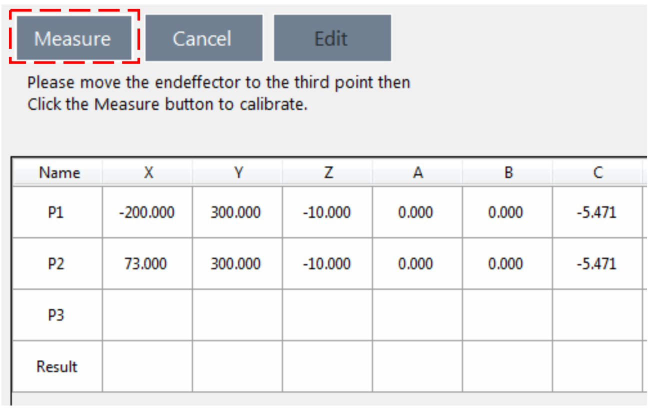
■Step (four) Set the third point of the base coordinate

Based on the right-hand rule direction, move the robot to any position in the Y axis positive direction (Y+) (P3), and this position will be the third point. This action allows the robot to obtain the conveyor coordinates in the positive Y axis direction (+Y_Axis).



Third point (P3) for base coordinate calibration illustration diagram

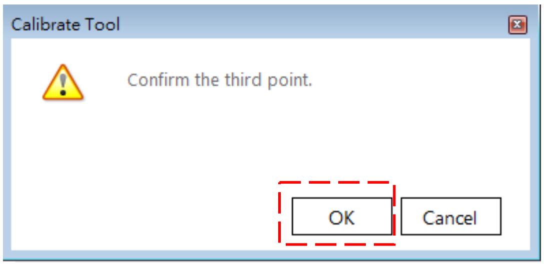
Press the “Measure” button to confirm it is the third point for base coordinate calibration.



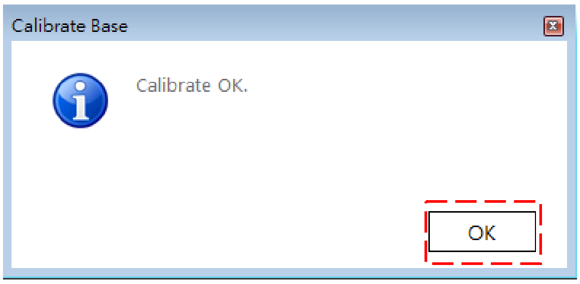
Name	X	Y	Z	A	B	C
P1	-200.000	300.000	-10.000	0.000	0.000	-5.471
P2	73.000	300.000	-10.000	0.000	0.000	-5.471
P3						
Result						

Go to base calibration and press the measure button for the third point P3.

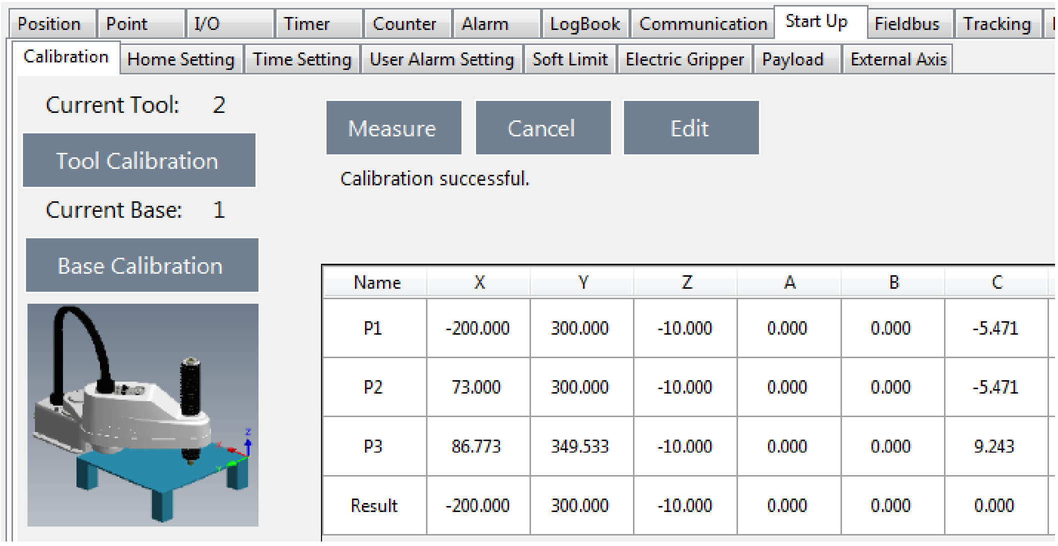
After the robot moved to the P3 point, press the “OK” button to confirm the calibration of the third point. Calibration for the third point is completed. After the calculation result is completed, a calibration completed window prompt will appear. After pressing the “OK” button, base coordinate calibration is completed. After pressing the “OK” button, base coordinate calibration is completed. If the three points are not on the same point or calculation could not be completed, robot calculation will fail.



Confirm it is the second point diagram



Confirm calibration completed diagram



Record the position information of the third point and calculate the resulting diagram

After completing the four steps above, calibration for the base coordinate is completed. After calibration is completed, next is to perform the conveyor motion ratio calibration.

6.8.1.4 Sensor triggered-conveyor motion ratio calibration

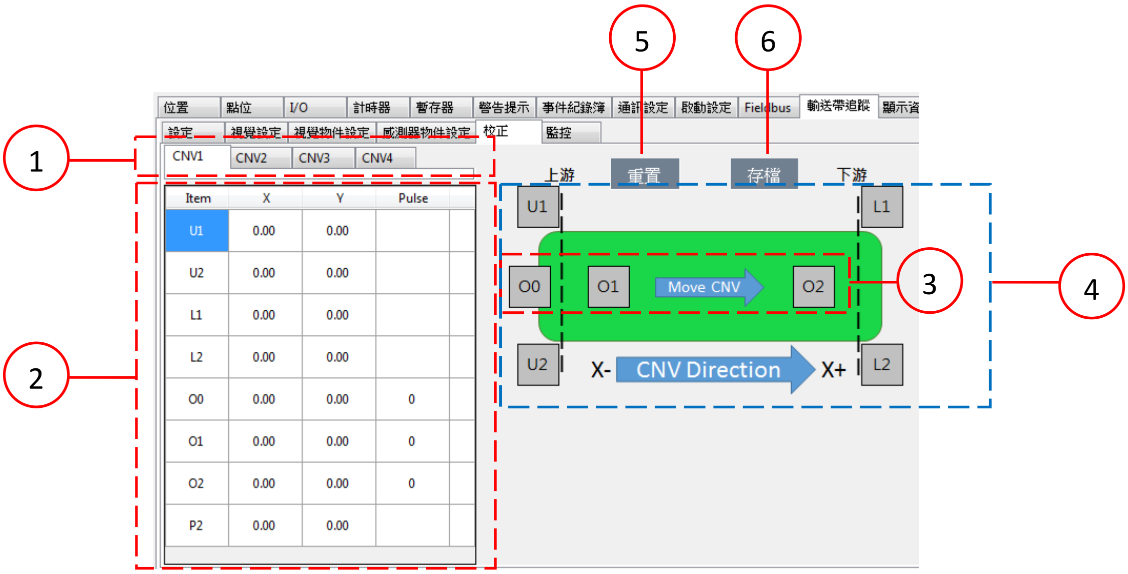
This chapter explains the conveyor motion ratio calibration; this is to make the coordinates of the robot have the same ratio as the encoder motion of the conveyor,

Take the figure below for example, where the circumference is πD and the diameter (D) is 50mm, the circumference is approximately 157mm. When the encoder rotates one round, the encoder value is 2000 pulse, and the conveyor can move 157mm. Now divide the round into 4 equal parts, situation 1: The encoder value is 0, and the conveyor position is at 0mm; situation 2: The encoder value is 500, and the conveyor position is at 39.25mm; situation 3: The encoder value is 1000 and the conveyor position is at 78.5mm, and situation 4: The encoder value is 1500 and the conveyor position is at 117.75mm. It can be seen that the conveyor position has a certain motion ratio relationship with the encoder value.

Record the position information of the third point and calculate the resulting diagram

Through the relationship described above, by using the position of the conveyor and the value of the encoder, we can get the parameters of the two for over 3 points in order to obtain the ratio relationship, which are the conveyor motion ratio calibration steps that are going to be performed below (the three points O0, O1 and O2 will be used below for calibration).

Calibration operation is required, the conveyor tracking object parameter setting must first be completed (refer to Chapter 6.4), and set the tool coordinate and base coordinate settings (refer to Chapter 6.8.1.2~6.8.1.3) where the end fixture (calibration rod) is installed.
Path: In the tab window below, select Tracking >> Setting >> Calibration.



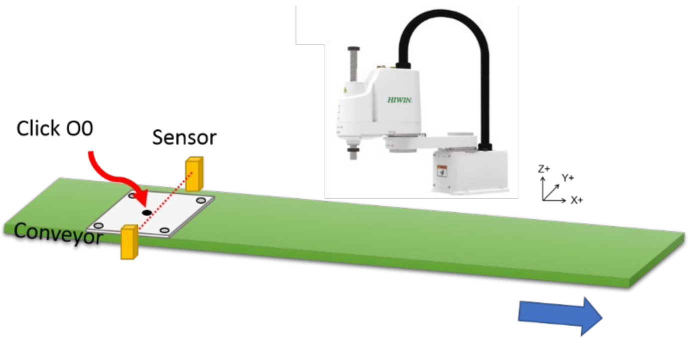
Conveyor motion ratio calibration interface window (sensor triggered)

Note: Based on sensor triggered or vision triggered selected on the Tracking page, the calibration interface is different.

Illustration table for customizing packet format returned by vision

Item number	Item name	Description
1	Conveyor number tab	Select the conveyor number to set; there is a total of 4 tabs, CN1 ~ CN4.
2	Calibration setting display table	Displays the setting value table for conveyor settings, including the X axis, Y axis and conveyor encoder setting values.
3	Encoder setting buttons	The three buttons O0, O1 and O2 are input buttons for 3 different encoder positions.
4	Upstream/downstream setting button	Sets the working range calibration setting when the conveyor is used with robots; there is a total of four buttons, U1, U2, L1 and L2. U1 and U2 are used for upstream range setting; L1 and L2 are used for downstream range setting.
5	Reset button	Clears the current conveyor calibration setting, and used for recalibration setting.
6	Save button	Saves setting parameters.

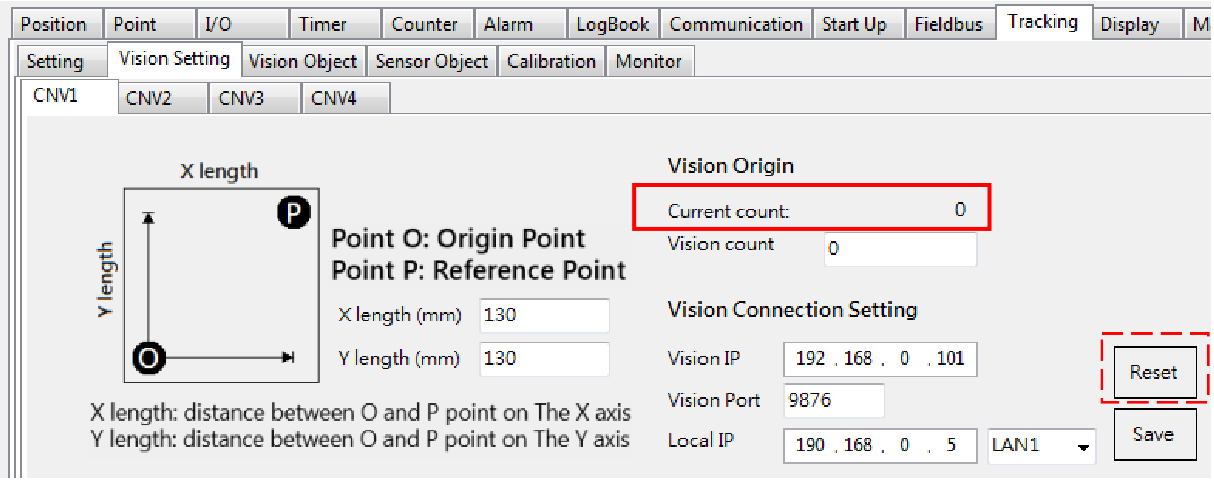
Place the calibration template/workpiece on the conveyor, and move the conveyor to the sensor trigger point.



Calibration template placed on conveyor and conveyor moves to the sensor trigger point illustration

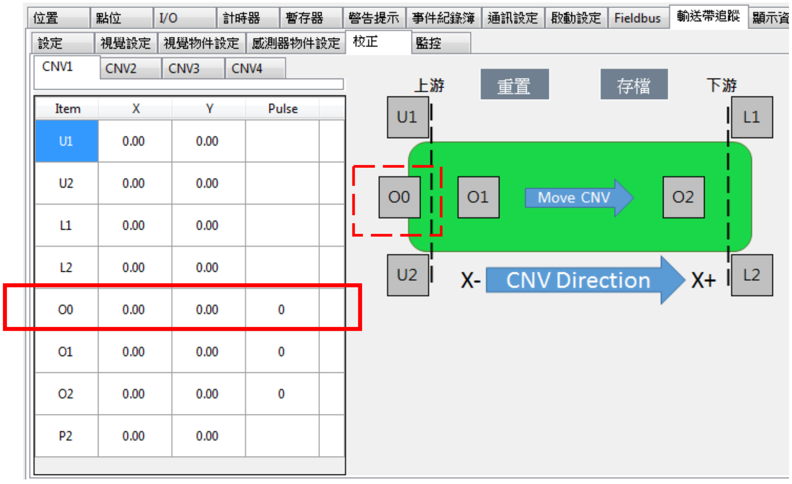
Note: O0, O1 and O2 are all the same point (the black dot position on the calibration template).

Select the conveyor tab to use (CN1 ~ CN4), and place the calibration template/workpiece on the conveyor. After moving the conveyor to the sensor trigger point (black dot at the center of the calibration template), switch to the Vision Setting page and press the “Reset” button. It can be seen that the current value of the vision (encoder) origin position is 0 pulse (or go to the Monitor page and confirm the encoder value is 0 pulse).



Vision setting interface reset encoder window

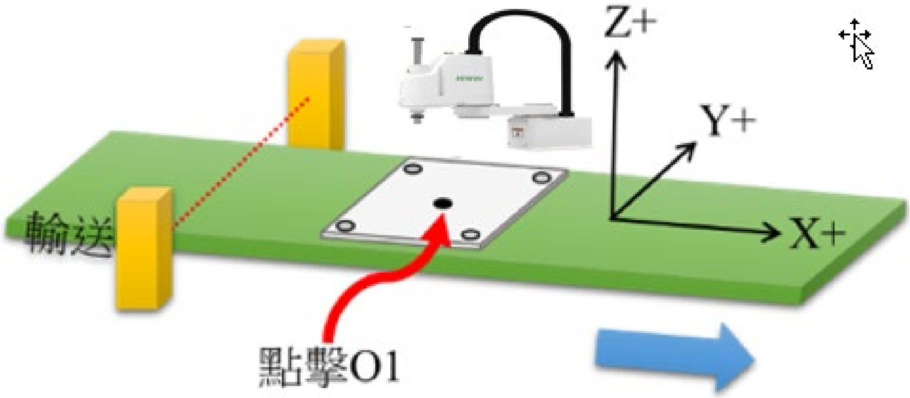
Return to the (sensor) calibration page and click on the “O0” function button on the image; check whether the value of O0 is 0 pulse in the left side table.



Conveyor motion ratio calibration O0 point interface diagram

Note: After moving the conveyor encoder value, switch to the Monitor page to confirm the changes of the encoder value. If it was discovered that the count of the encoder value (CNT) is decreasing when the conveyor is moving, open the Tracking page and select the Reverse field function to reverse the count of this conveyor, and change the encoder value to increasing count.

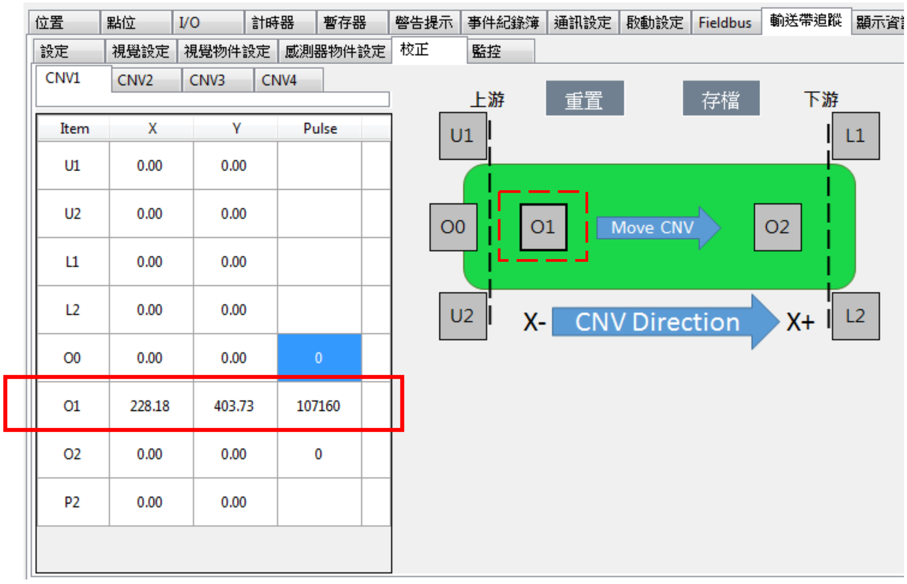
Slowly move the conveyor either automatically or manually to move the calibration fixture to the upstream position (reachable range of the robot, and towards the upstream end of the range); at this time, the conveyor will obtain the encoder value for the new position.



Calibration template moves to the upstream point within the robot range illustration diagram

Note: The point must be within the robot range; O0, O1 and O2 are all the same point (the black dot position on the calibration template).

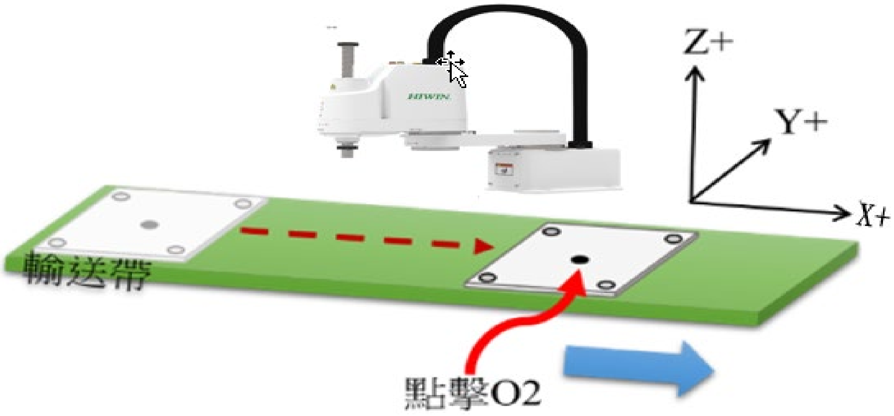
Move the end of the robot to where the calibration fixture (calibration rod) corresponds to the black dot on the calibration template (which is the same point position for sensor trigger). Set this point as the O1 point, and click the “O1” function button; check whether the value of O1 changed, and has X axis and Y axis coordinate values.



Item	X	Y	Pulse
U1	0.00	0.00	
U2	0.00	0.00	
L1	0.00	0.00	
L2	0.00	0.00	
O0	0.00	0.00	0
O1	228.18	403.73	107160
O2	0.00	0.00	0
P2	0.00	0.00	

Conveyor motion ratio calibration O1 point interface diagram

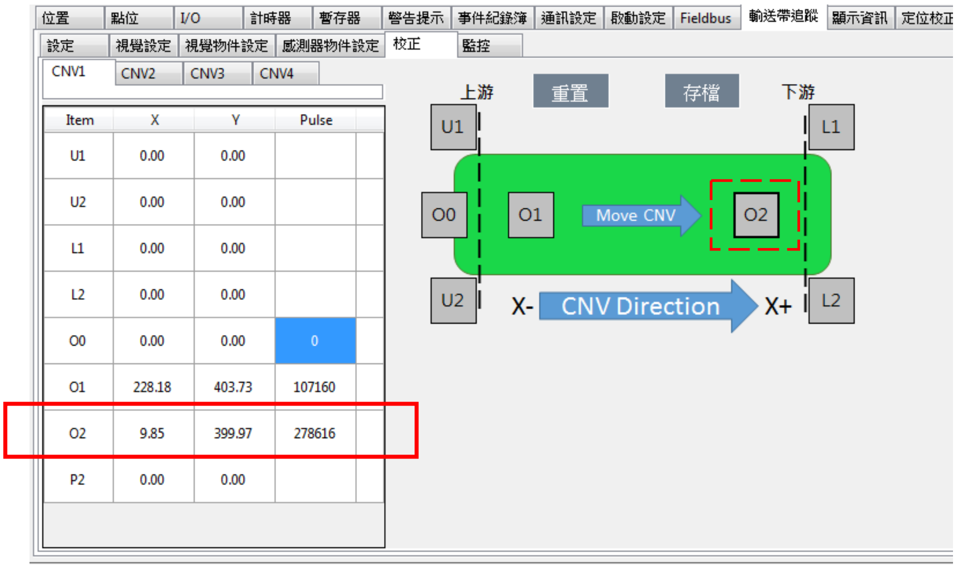
Move the calibration fixture to the downstream position by moving the conveyor,



Calibration template moves to the downstream point within the robot range illustration diagram

Note: The point must be within the robot range; O0, O1 and O2 are all the same point (the black dot position on the calibration template).

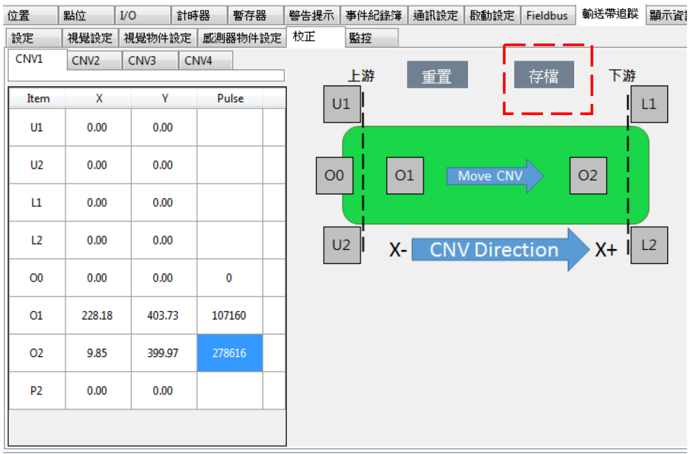
Move the end of the robot to the calibration fixture, and set this point as the O2 point. Click the “O2” function button and check whether the value of O2 changed, and has X axis and Y axis coordinate values.



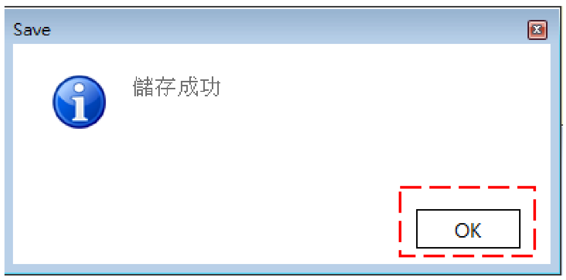
Item	X	Y	Pulse
U1	0.00	0.00	
U2	0.00	0.00	
L1	0.00	0.00	
L2	0.00	0.00	
O0	0.00	0.00	0
O1	228.18	403.73	107160
O2	9.85	399.97	278616
P2	0.00	0.00	

Conveyor motion ratio calibration O2 point interface diagram

When the steps above are completed, click the “Save” button to save the setting parameters. This completes the conveyor motion ratio calibration.



Item	X	Y	Pulse
U1	0.00	0.00	
U2	0.00	0.00	
L1	0.00	0.00	
L2	0.00	0.00	
O0	0.00	0.00	0
O1	228.18	403.73	107160
O2	9.85	399.97	278616
P2	0.00	0.00	

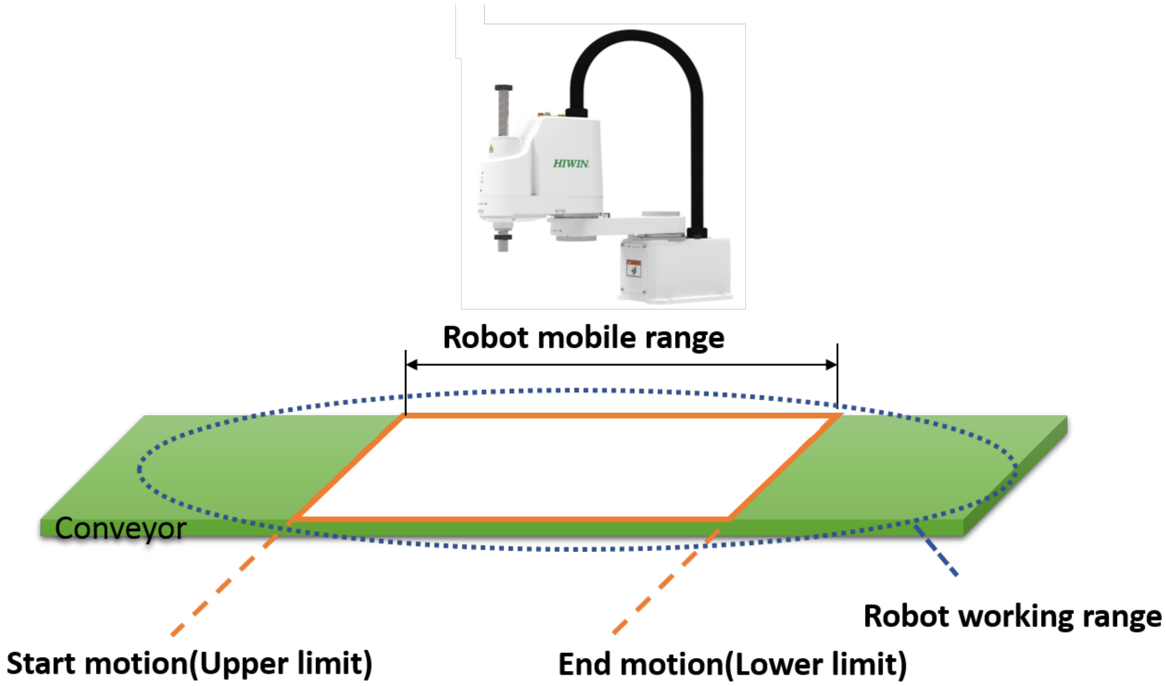


Conveyor motion ratio calibration save interface window Save successful screen window

The next section explains the calibration of the downstream position within the work range.

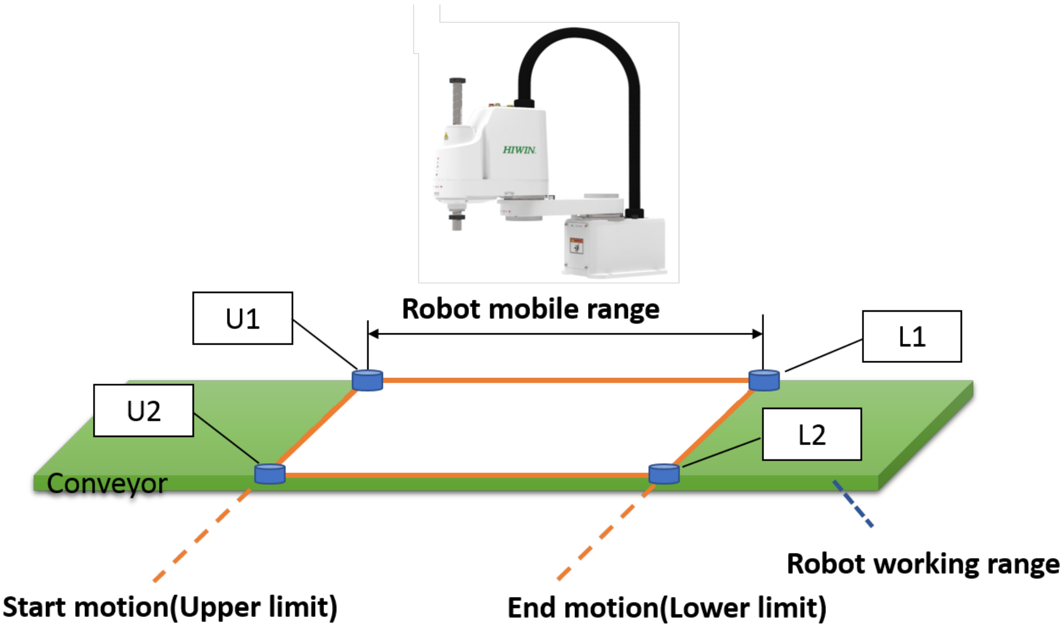
6.8.1.5 Sensor triggered-calibration of the conveyor and robot work ranges

This chapter defines the calibration settings for the work range when the conveyor is used with the robot. After defining the safety range, when the robot is executing conveyor tracking tasks, the robot will only execute the task within this work range, and will not act when exceeded this range. The monitoring screen will display exceeded range (Over_stream).



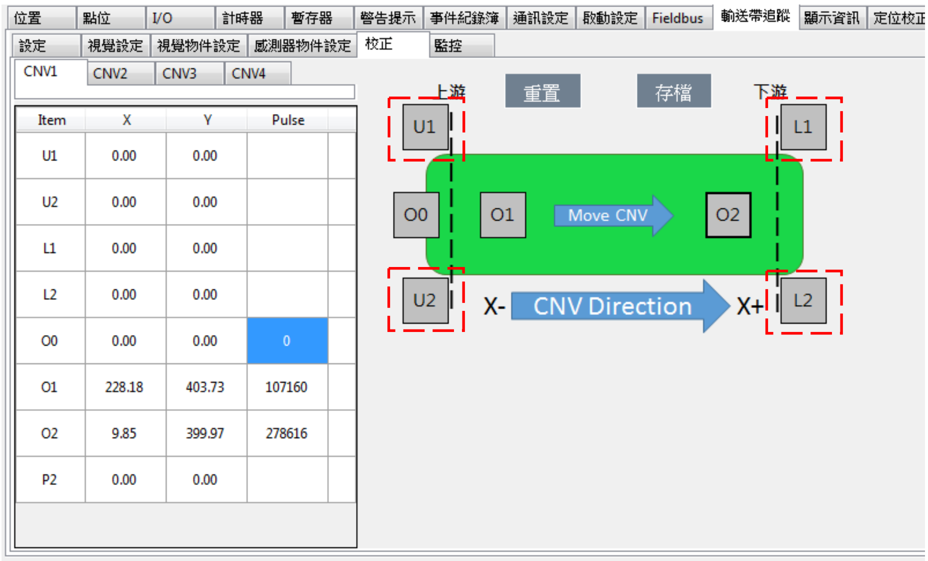
Robot and conveyor work range illustration diagram

When setting the work range for the robot and conveyor, it is set using the 4 points of a rectangle. The 2 upstream points settings are U1 and U2; when the workpiece enters this range, tracking begins (upper limit point). The 2 downstream points settings are L1 and L2; when the workpiece leaves this range, tracking is discarded (lower limit point), as illustrated in the figure below.



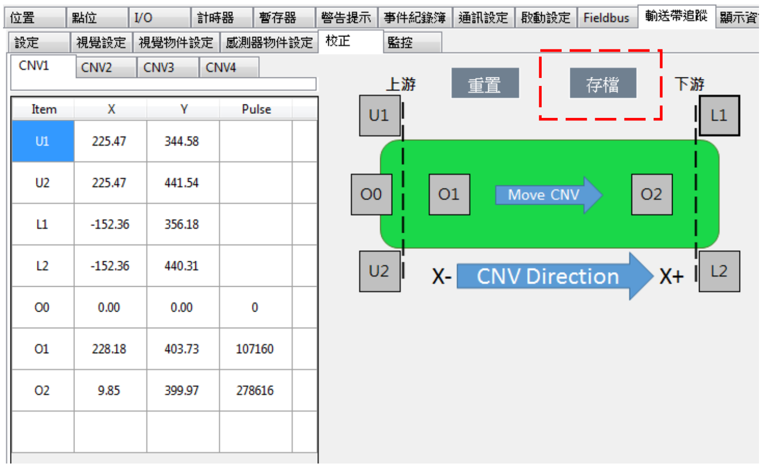
Robot and conveyor work range corresponding setting illustration diagram

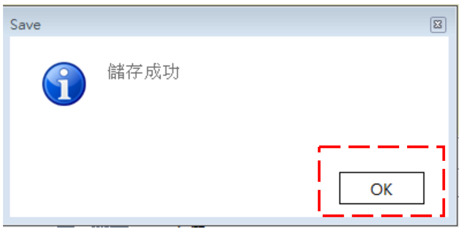
Move the robot upstream to any two points close to the upper limit range, and press U1 and U2. Move downstream to any two points close to the upper limit range, and click L1 and L2. Check whether the values of U1, U2, L1 and L2 changed.



Conveyor upstream/downstream range calibration U1, U2, L1, L2 point interface diagram

After the settings above are completed, click the “SAVE” function button to save the upstream/downstream range, and calibration is completed.





Conveyor upstream/downstream setting completed save interface window

Save successful screen window

Note 1: Points U1, U2, L1 and L2 must be within the robot range.

Note 2: Points U1, U2 and L1, L2 will each form an infinite line segment.

After completion of the calibration for the sensor triggered method; next is to be performed the programming for conveyor tracking. (Please refer to Chapters 9.12, 10.9)

6.8.2 Calibration for vision triggered method

In addition to installing the vision system, vision system input/output configuration and the electronic controls for the encoder, parameter settings (refer to Chapter 6.4) must also be completed for conveyor tracking objects. Vision triggered calibration requires the following steps:

1.Select the calibration template.

2.Install calibration fixtures at the end of the robot, and calibrate the tool coordinates (refer to Chapters 3.3.3 and 6.8.1.2).

3.Vision system calibration

4.Vision system and base coordinate (user coordinate) calibration.

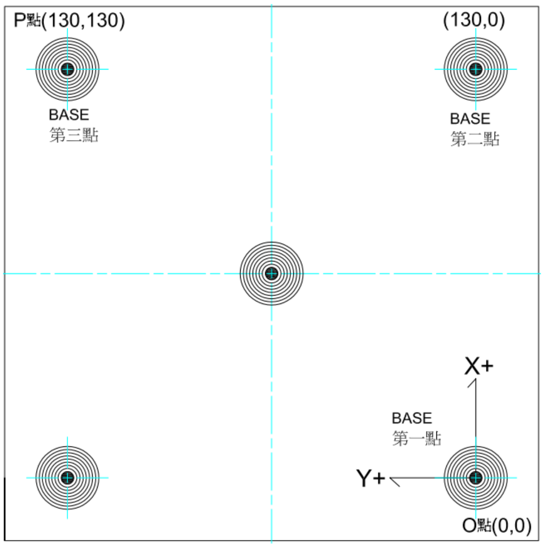
5.Conveyor motion ratio calibration.

6.Robot working range calibration.

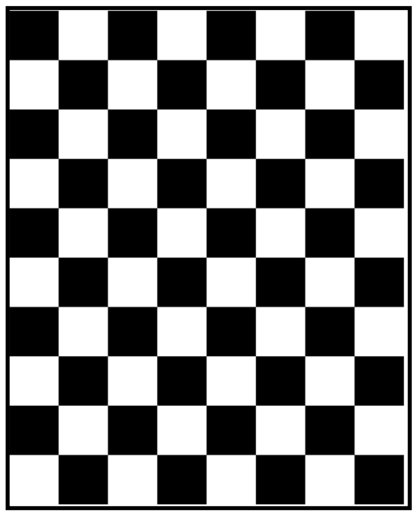
The manual calibration process steps must be performed in order to allow the robot coordinates, conveyor encoder value and vision system coordinate position to have corresponding relationships, and to accurately perform pick-on-the-fly tasks for workpieces on the conveyor. Each of the following sections will explain them separately.

6.8.2.1 Vision triggered-select the calibration template

Select a calibration template; this calibration template must have the same specifications as the end calibration fixtures in order to compare (point) positions. Refer the calibration template in the figure below, for example, the end calibration fixture can use the following circle diameter for the operator to compare the calibrated positions; operators can refer to the image below or design their own calibration template (the calibration template is used for measuring, therefore, it is recommended that its point positions and sizes must be tested to prevent errors occurring).



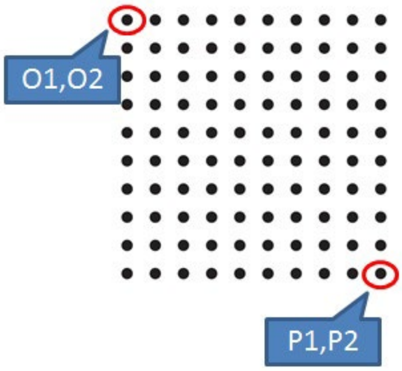
(This figure is just an example description and does not have correct distance ratios)



(This figure is just an example description and does not have correct distance ratios)

Sample Calibration template diagram (left figure 130mm square five-point figure, right figure: 10mm matrix grid)

Rectangular point calibration template can also be used to set the O point and P point screen diagram.



Using rectangular point calibration template to set the O point and P point

6.8.2.2 Vision triggered-install calibration fixture and tool coordinate calibration

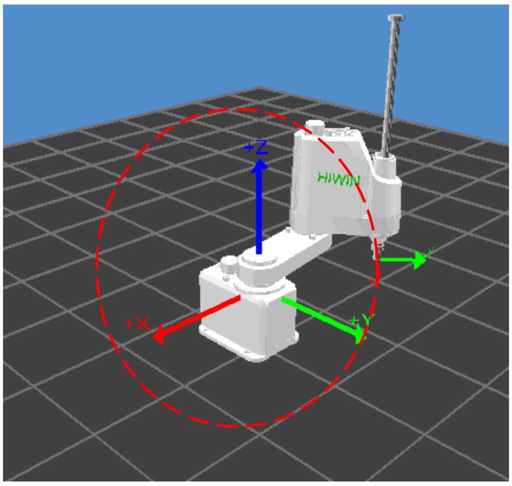
Before starting the following vision calibration, the calibration fixture mechanism device that corresponds to the calibration template must be installed at the end of the robot (due to the different sizes and specifications requirements, users must design the fixture mechanism themselves); this calibration fixture must be the same as the pick TCP (Tool Center Point), as this will be the most accurate method. After installing the end fixtures, corresponding tool coordinate calibration must be performed for the end fixture (calibration rod) (if base coordinate calibration cannot be performed first, then change the tool coordinates, this order need to be followed)
The setting is the same as 6.8.1.2 Sensor triggered-install calibration fixture and tool coordinate calibration; please refer to the descriptions in 196(it will not be repeated here).

6.8.2.3 Vision triggered-vision system calibration & adjustment

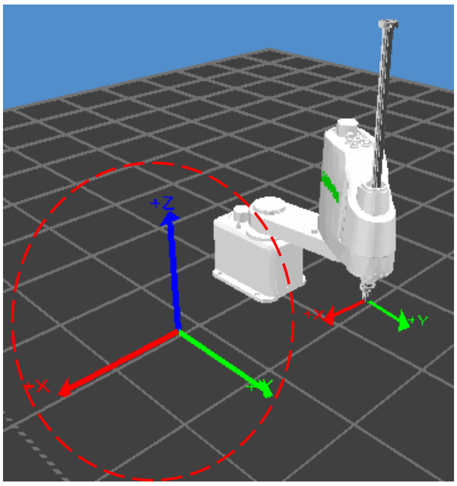
Perform vision system calibration based on the vision system used by the user. For example, adjust the camera positions, light source, focal distance, adjust the parameters for recognition methods, and visual image curve compensation calibration. The calibration method is different for the different vision systems or brands; users must make adjustments according to the vision system will be used. This chapter will not give further explanations. After calibration is completed, the calibrated parameters can be used for follow-up adjustments.

6.8.2.4 Vision triggered-vision and base coordinate calibration

Purpose for base coordinate calibration: To rotate and shift the origin of the robot coordinates to the user's desired reference point. As shown below, the left figure is the original base coordinate figure; after user base coordinate calibration, the left figure's coordinate is shifted to the new base coordinate (Right figure).



Original base coordinate BASE[0] diagram



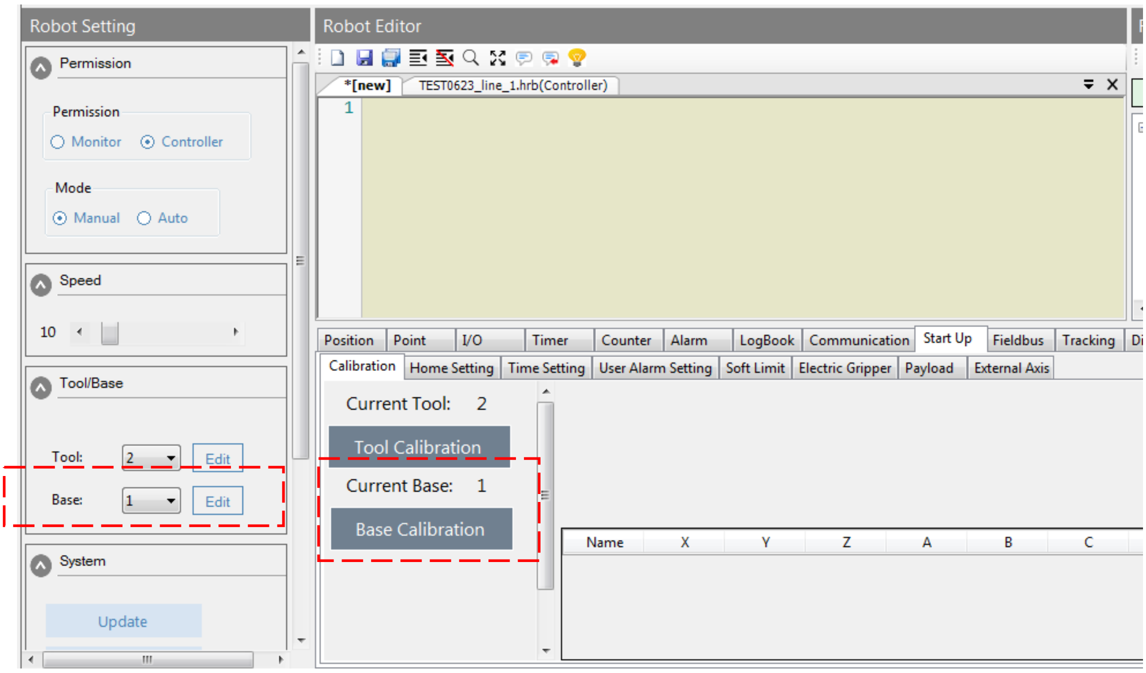
Shifted to the new base coordinate diagram

After completing tool coordinate calibration, next is to perform base coordinate calibration. The purpose of base coordinate calibration is to move the robot coordinate onto the conveyor, and have relevant definitions for the direction. In order to make the base coordinate of the robot the same as the base coordinate of the conveyor, and to make it easier to identify, this process defines the conveying direction of the conveyor uniformly to positive X axis (+ X_Axis) and positive Z axis upwards (+ Z_Axis).

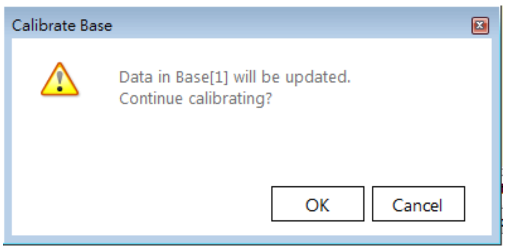
Vision triggered base coordinate calibration includes the following 4 steps:
Step (one) Open the base coordinate setting page.
Step (two) Set the first point of the base coordinate.
Step (three) Set the second point of the base coordinate.
Step (four) Set the third point of the base coordinate.
The following are detailed introductions of the steps.

■**Step (one) Open the base coordinate setting page**

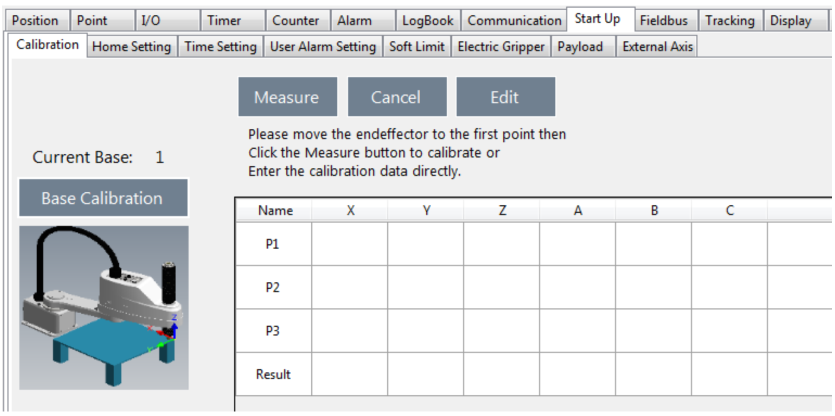
From Tool/Base in the left interface, first select the base coordinate to set from Base (Base[1] is used as the example here), then switch to the coordinate calibration page and start the three steps for base calibration. Path: From the tab window below, select Tracking >> Start Up >> Calibration > Base Calibration button.



Base coordinate BASE[2] interface diagram



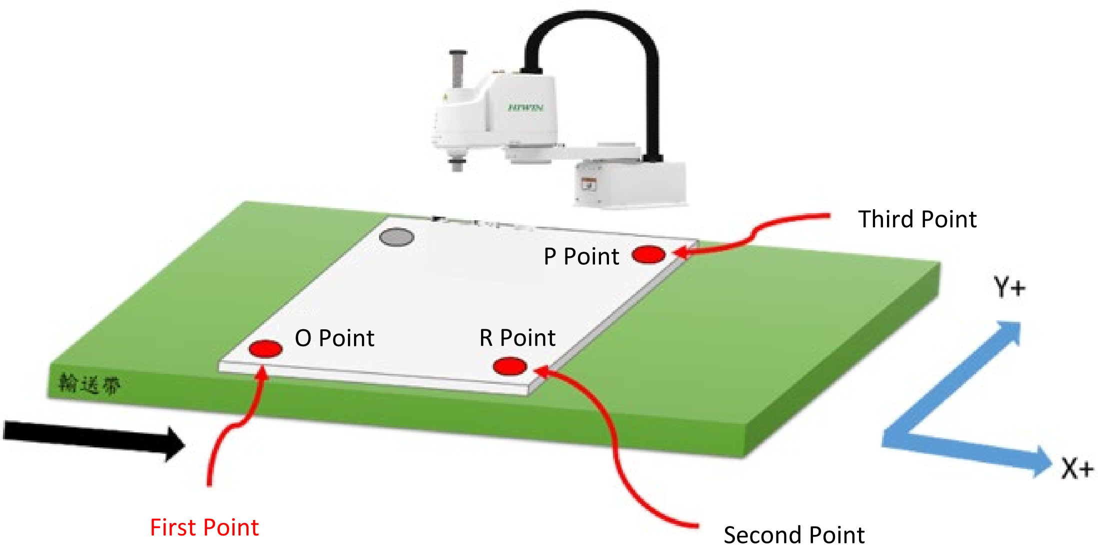
Confirm the update of the Base confirmation window



Base calibration setting window

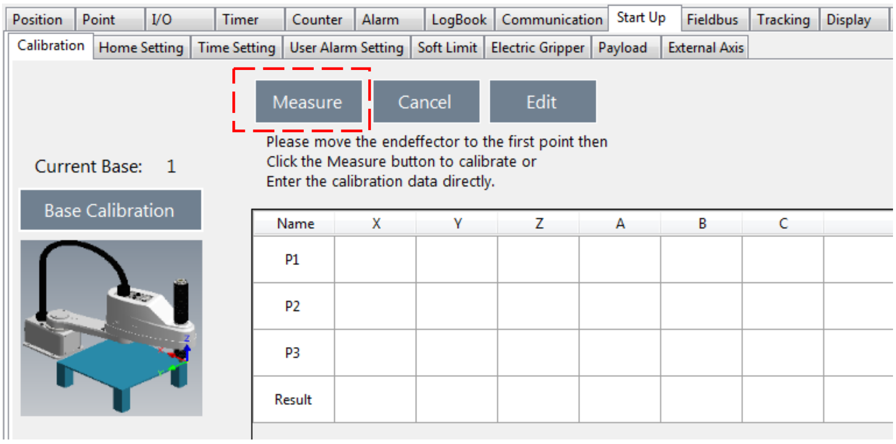
■**Step (two) Set the first point of the base coordinate**

Place the calibration template on the conveyor; there must be information on 3 points on the calibration template, and they must have vertical angle relationships. The workpiece must also be within the reachable range of the robot (it would be best to try to place it at the center of the robot range), and move the end of the robot to the O point on the calibration template. This position is the first point, and is the calibration origin. Press the “Measure” button to confirm it as a first point for base coordinate calibration.



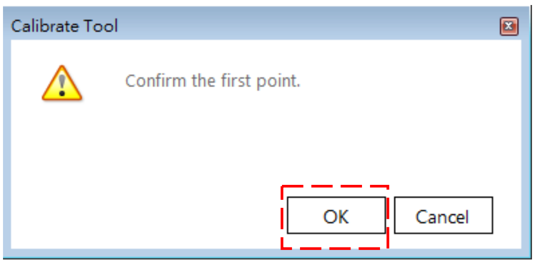
First point (P1) for base coordinate calibration illustration diagram

Note 1: The points (O and P points) on the calibration template must be within the robot range.

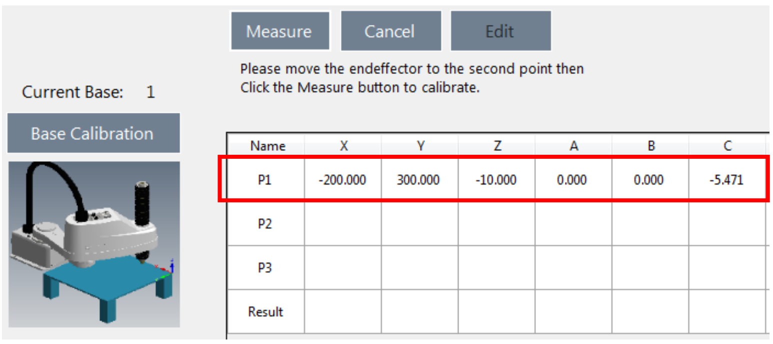


Base calibration presses the measurement button to set P1.

Press the “OK” button after the robot moved to the O point to confirm the calibration of the first point (P1); the position information is displayed in the calibration table. The calibration of the first point has been completed.



Confirm it is the first point of the calibration

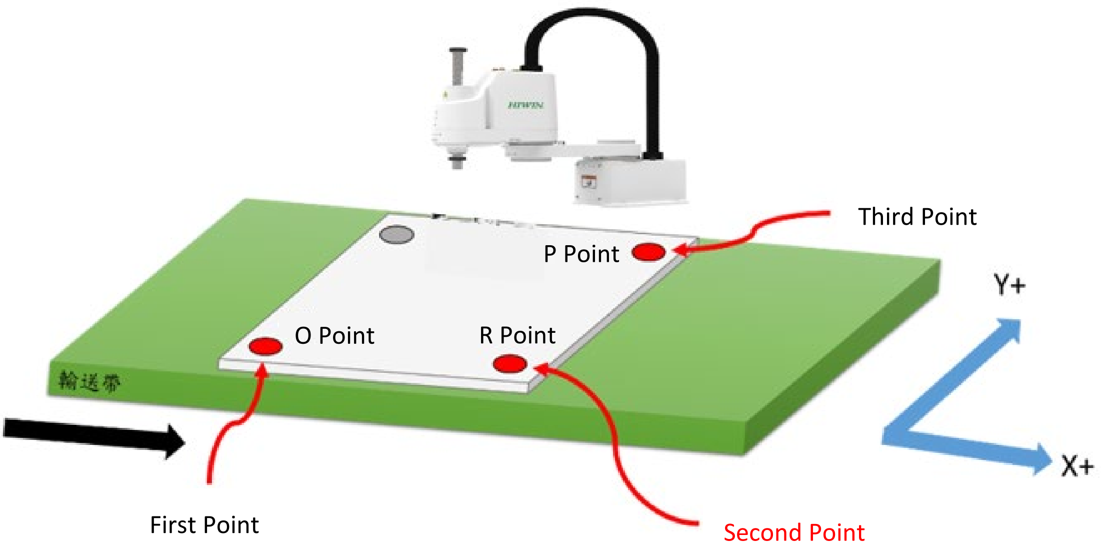


Record the position information of the first point

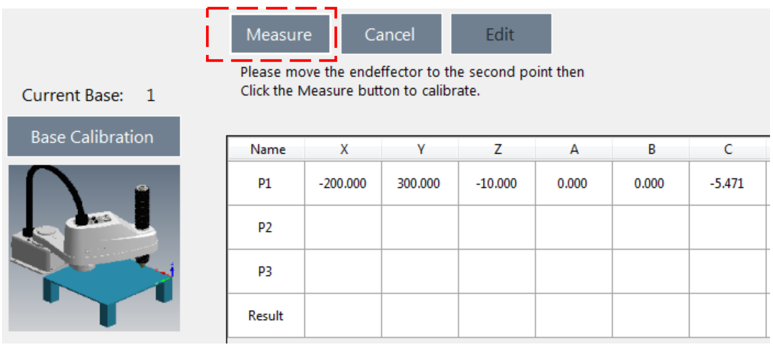
■**Step (three) Set the second point of the base coordinate**

Place the calibration workpiece on the conveyor, and then move the end of the robot to the R point. This position is the second point. This action allows the robot to obtain the conveyor coordinates in the positive X axis direction (+X_Axis).

Press the “Measure” button to confirm it is the second point for base coordinate calibration.

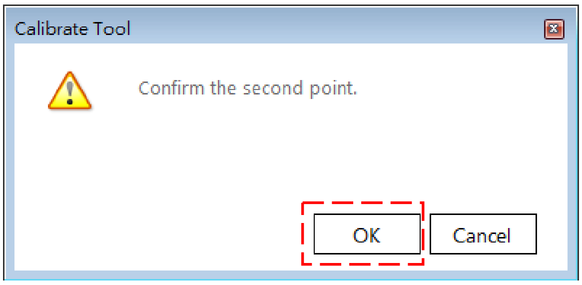


Third point (P2) for base coordinate calibration illustration diagram

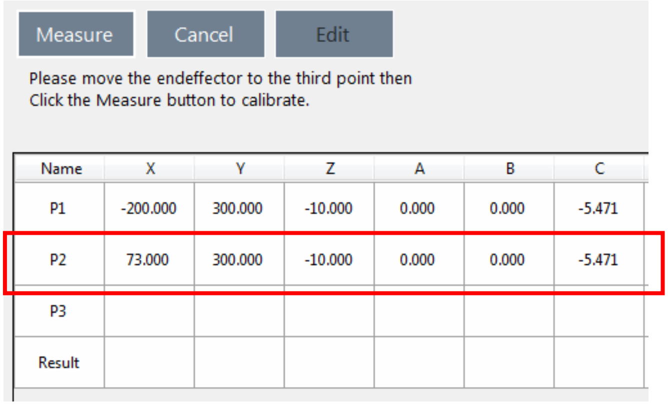


Go to base calibration and press the measurement button to set P2.

After the robot moved to the R point, press the “OK” button to confirm the calibration of the second point. Calibration for the second point is completed.



Confirming it is the second point of the calibration

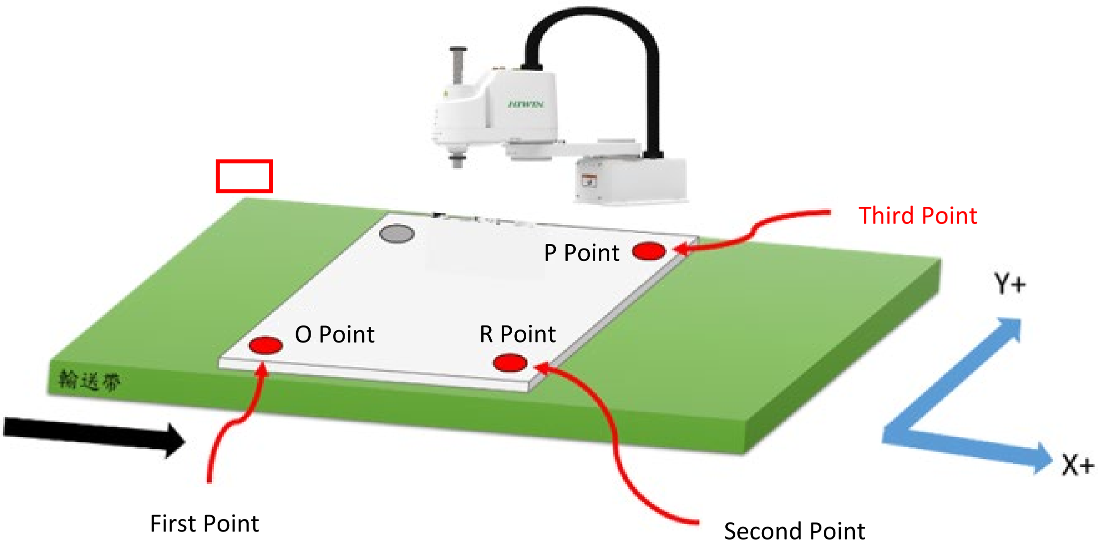


Name	X	Y	Z	A	B	C
P1	-200.000	300.000	-10.000	0.000	0.000	-5.471
P2	73.000	300.000	-10.000	0.000	0.000	-5.471
P3						
Result						

Record the position information of the second point

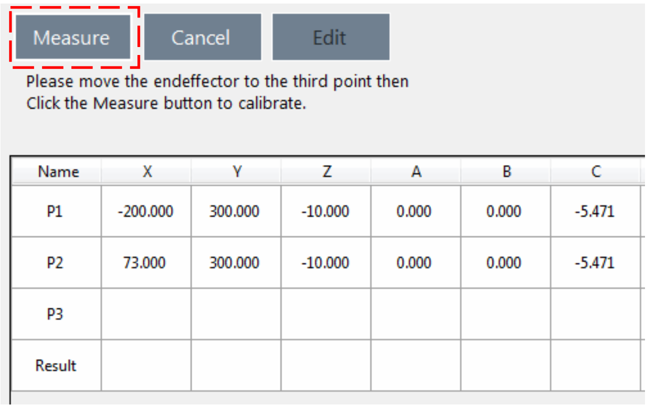
■Step (four) Set the third point of the base coordinate

Based on the right-hand rule direction, move the robot to the P point; this position is the third point. This action allows the robot to obtain the conveyor coordinates in the positive Y axis direction (+Y_Axis).



Third point (P3) for base coordinate calibration illustration diagram

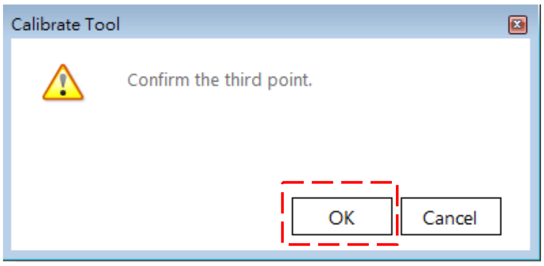
Press the "Measure" button to confirm it as a third point for base coordinate calibration.

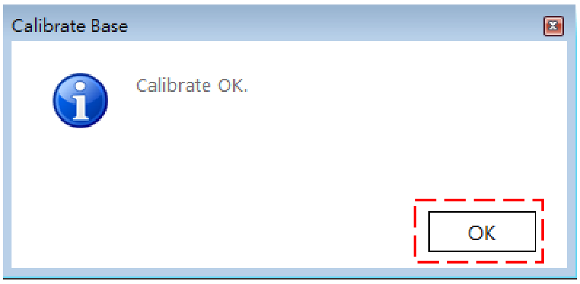


Name	X	Y	Z	A	B	C
P1	-200.000	300.000	-10.000	0.000	0.000	-5.471
P2	73.000	300.000	-10.000	0.000	0.000	-5.471
P3						
Result						

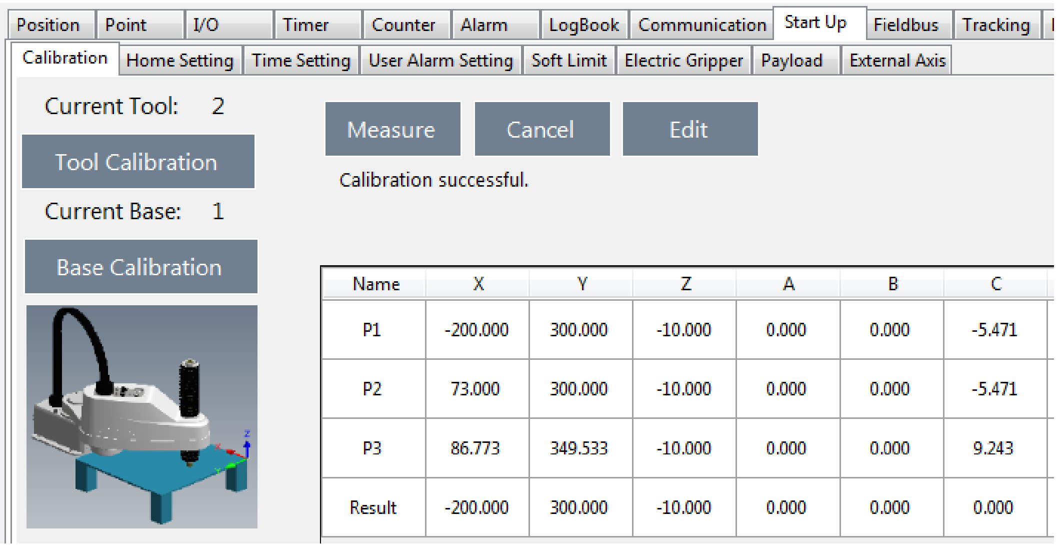
Go to base calibration and press the measure button for the third point P3

After the robot moved to the P point, press the “OK” button to confirm the calibration of the third point. Calibration for the third point is completed. After pressing the “OK” button, base coordinate calibration is completed. After the calculation result is completed, a calibration completed window prompt will appear. If the three points are not on the same point or calculation could not be completed, robot calculation will fail.





Confirming the second point of the calibration   Confirm calibration completed diagram



Record the position information of the third point and calculate the resulting window

After completing the above four steps, calibration for the base coordinate is completed. After calibration is completed, next is to perform the conveyor motion ratio calibration.

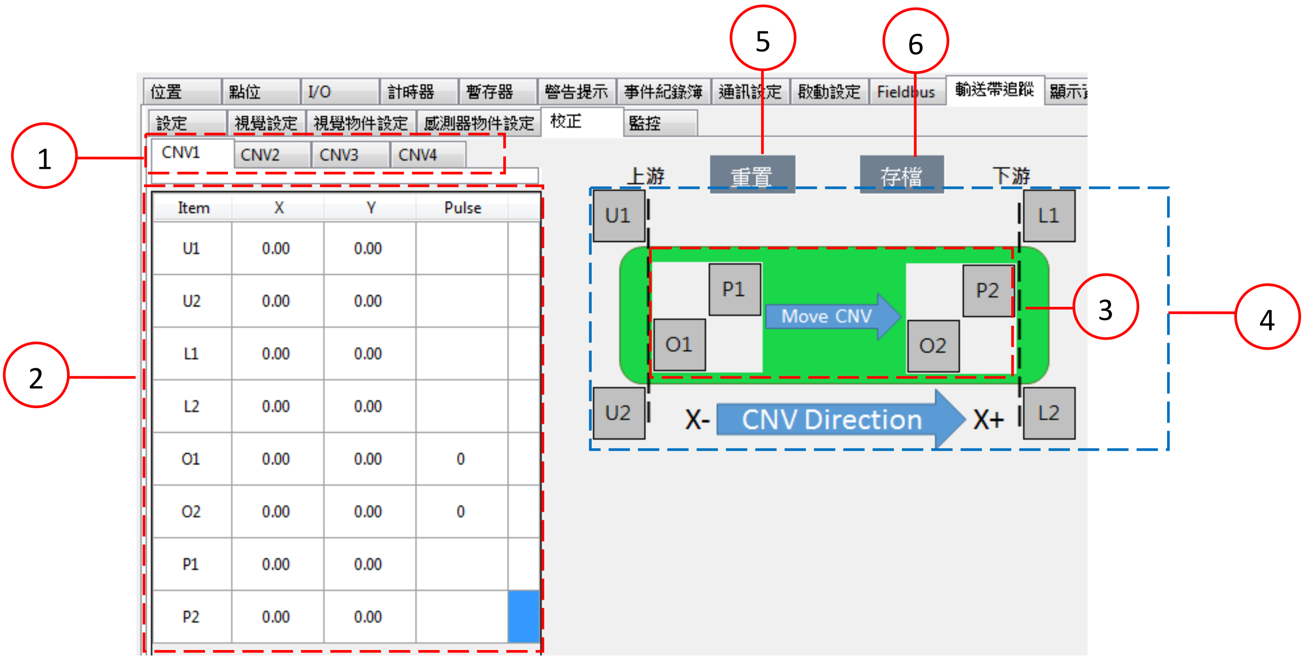
6.8.2.5 Vision triggered-conveyor motion ratio calibration

This chapter explains the conveyor motion ratio calibration; this is to make the coordinates of the robot have the same ratio as the encoder motion of the conveyor,

Refer to Chapter 6.8.1.4 for related explanations (it will not be repeated here). By using the position of the conveyor and the value of the encoder, we can get the two parameters for over 4 points in order to obtain the ratio relationship, which are the conveyor motion ratio calibration steps that are going to be performed below (the 4 points O1, P1, O2 and P2 will be used for calibration below).

Calibration operation is required, the conveyor tracking object parameter setting must be completed (refer to Chapter 6.4) at first, and set the tool coordinate and base coordinate settings (refer to Chapter 6.8.1.2~6.8.1.3) where the end fixture (calibration rod) is installed.

Path: In the tab window below, select Tracking >> Setting >> Calibration.



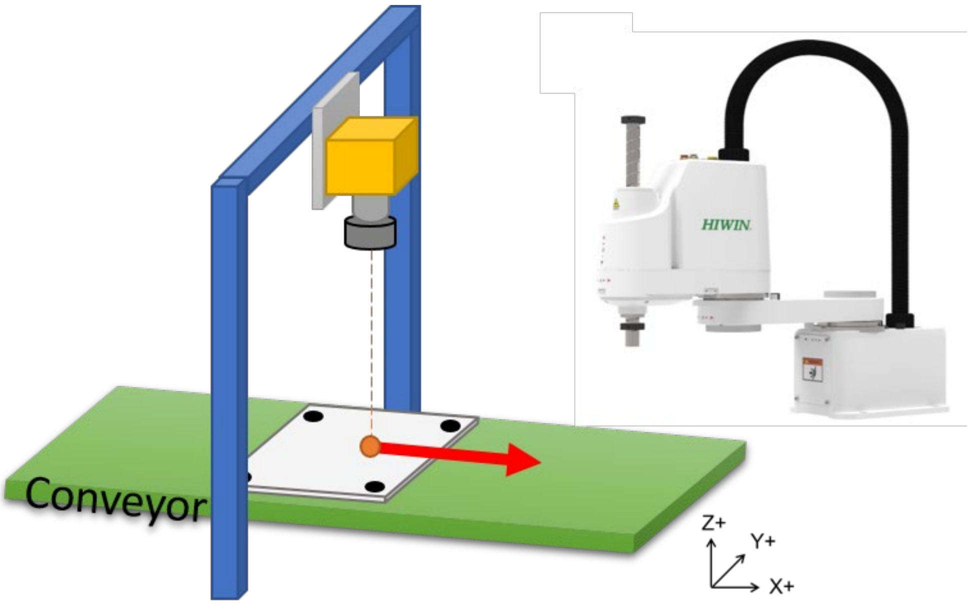
Conveyor motion ratio calibration interface window (vision triggered)

Note: Based on sensor triggered or vision triggered selected on the Tracking page, the calibration interface is different.

Illustration table for customizing packet format returned by vision

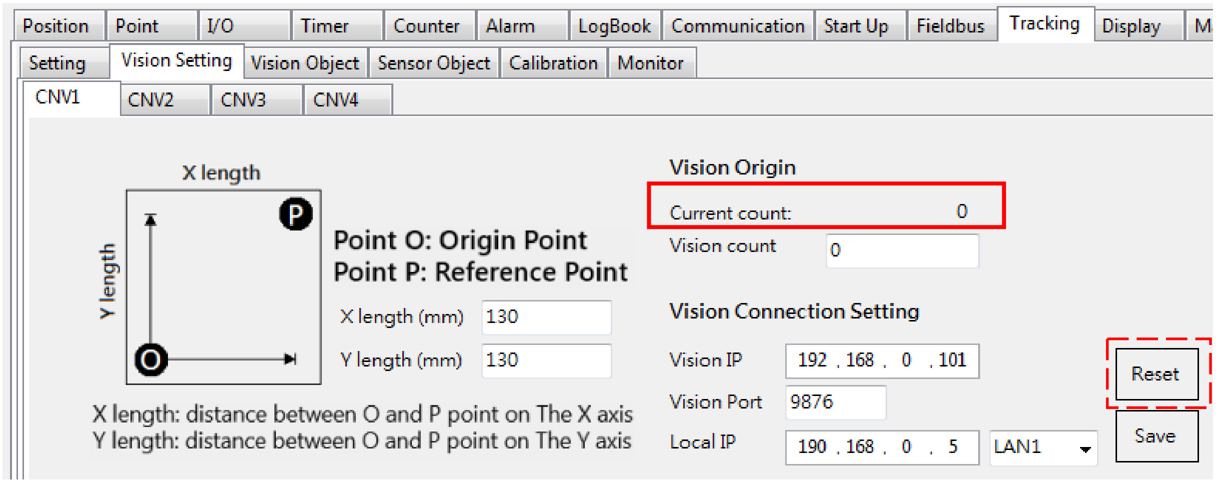
NO.	Name	Description
1	Conveyor number tab	Select the conveyor number to set; there is a total of 4 tabs, CN1 ~ CN4.
2	Calibration setting display table	Displays the setting value table for conveyor, including the X axis, Y axis and conveyor encoder setting values.
3	Encoder setting buttons	The four buttons O1, P1, O2 and P2 are input buttons for 4 different encoder positions.
4	Upstream/downstream setting button	Sets the working range calibration setting when the conveyor is used with robots; there is a total of four buttons, U1, U2, L1 and L2. U1 and U2 are used for upstream range setting; L1 and L2 are used for downstream range setting.
5	Reset button	Clears the current conveyor calibration settings, and use it for recalibration.
6	Save button	Saves setting parameters.

Place the calibration template on the conveyor, and move the conveyor to the trigger point for vision photo-taking.



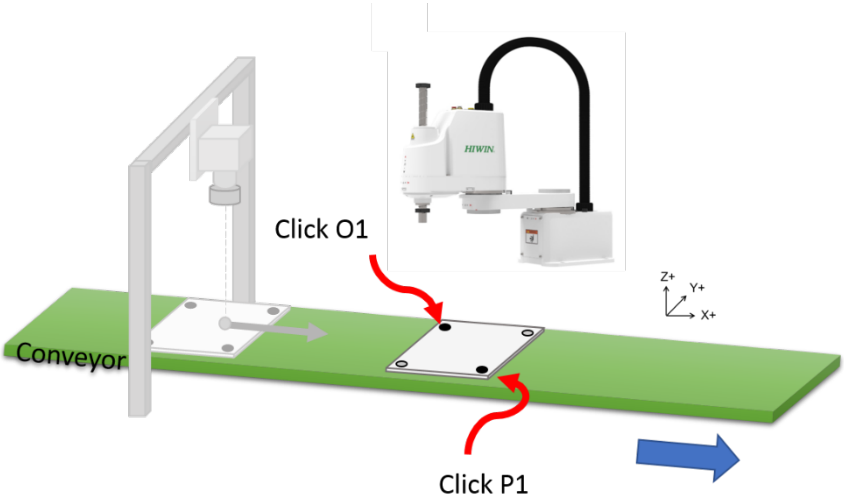
Calibration template placed on conveyor and conveyor moves to the vision trigger point illustration

Select the conveyor tab to use (CN1 ~ CN4), and place the calibration template on the conveyor. After moving the conveyor to the vision calibration photo-taking trigger point, switch to the Vision Setting page and press the “Reset” button. It can be seen that the current value of the vision (encoder) origin position is 0 pulse (or go to the Monitor page and confirm the encoder value is 0 pulse).



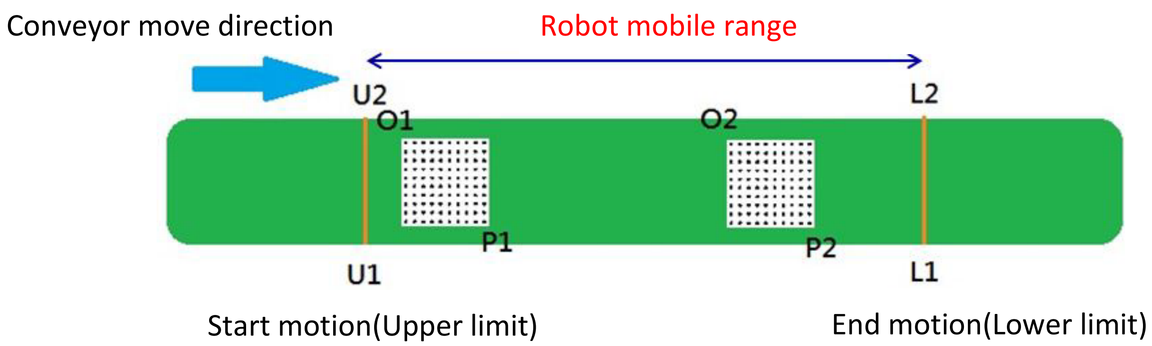
Vision setting interface reset encoder window

After the encoder is reset to zero, do not move the calibration template; instead, move the conveyor automatically/manually to where the O point and P point on the calibration template are all within the robot range (it is best to try to have them close to the upstream position of the robot), and the point that reset the calibration template to zero cannot be the same as the encoder value of O point (O1 or P1 point) (this means that the encoder value of O1 cannot be 0).



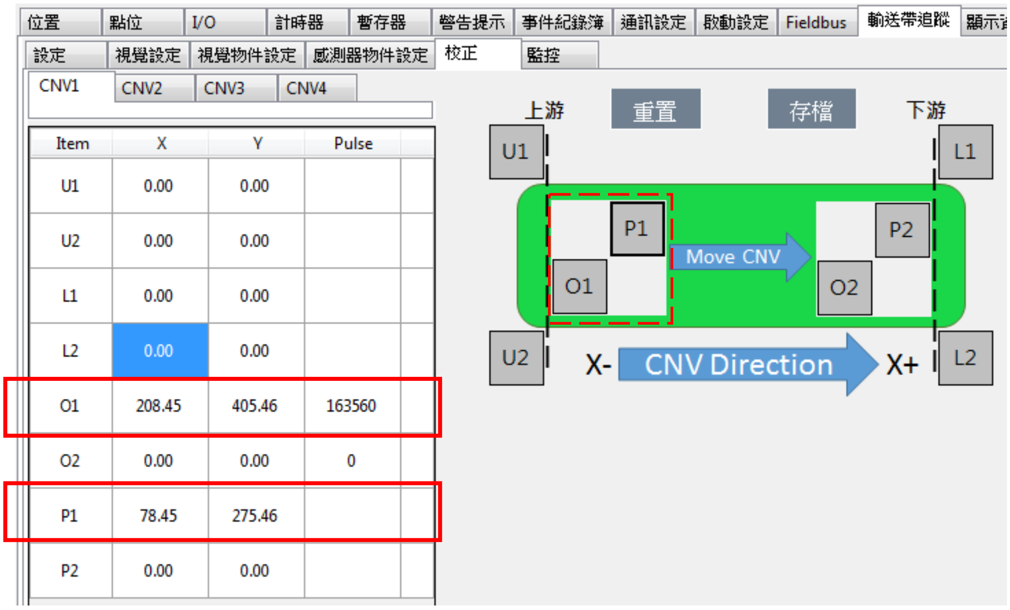
Move the conveyor within the robot range and click O1 and P1 illustration diagram

After moving the conveyor encoder value, switch to the Monitor page to confirm the changes of the encoder value. If it was discovered that the count of the encoder value (CNT) is decreasing when the conveyor is moving, open the Tracking page and select the Reverse field function to reverse the count of this conveyor, and change the encoder value to increasing count.



Robot and conveyor work range corresponding setting illustration diagram

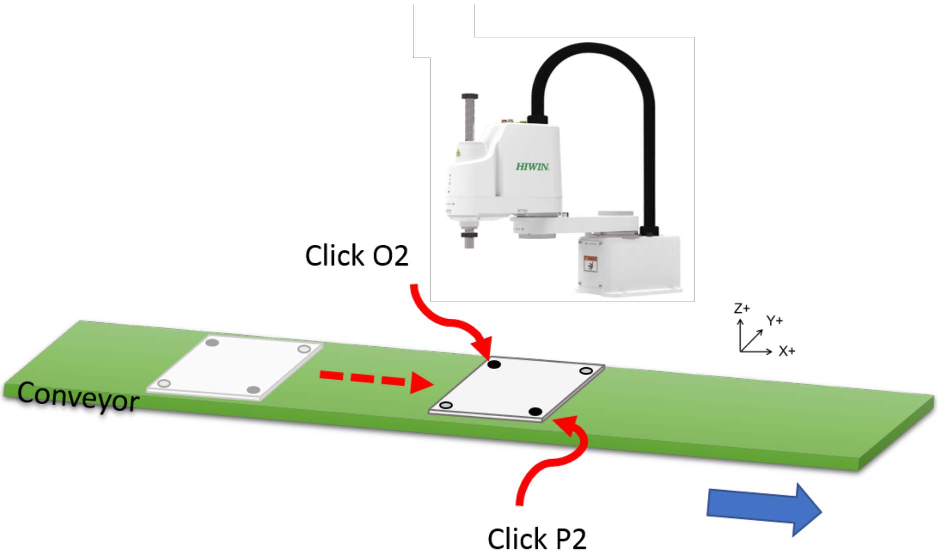
Return to the (vision triggered) calibration page, and move the end of the robot to the O point and P point of the calibration fixture respectively; then press the O1 and P1 function buttons and check whether the values of O1 and P1 have changed.



Move the conveyor to within the robot range and click the O1 and P1 buttons interface diagram

Note: The points must be within the robot range.

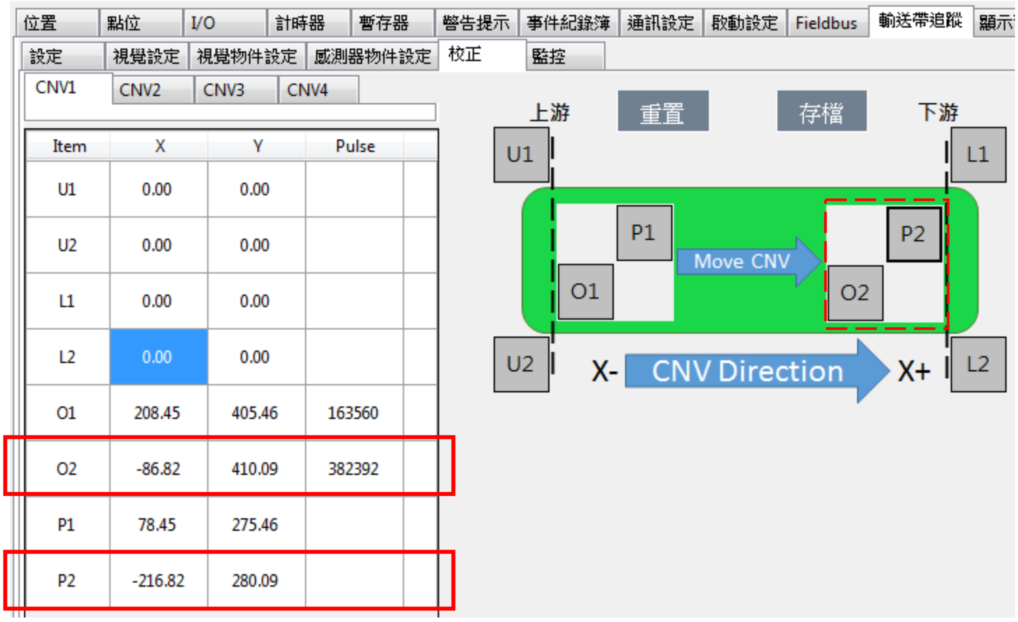
Move the conveyor either automatically or manually for some distance downstream (the closer the distance is to the downstream position, the better it is), and the calibration template must be within the moving range of the robot.



Move the conveyor downstream for some distance and click O2 and P2 illustration diagram

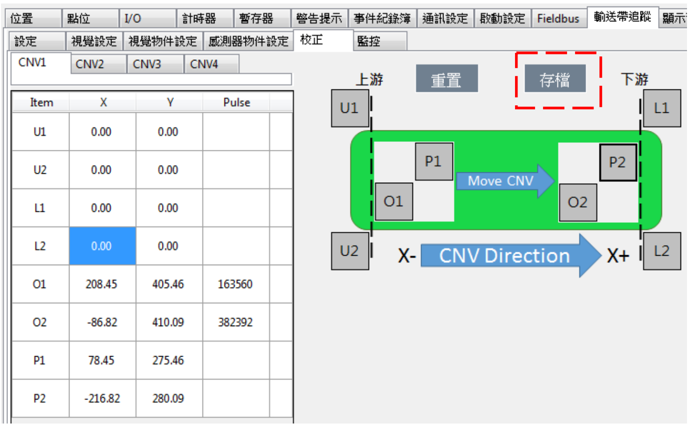
Note: O1 and O2 are the same point (the O point position on the calibration template); P1 and P2 are the same point (the P point position on the calibration template); and the points must be within the robot range.

Move the calibration fixture (calibration rod) at the end of the robot to the O2 point and P2 point of the calibration fixture respectively, then press the O2 and P2 function buttons and check whether the values of O2 and P2 have changed.

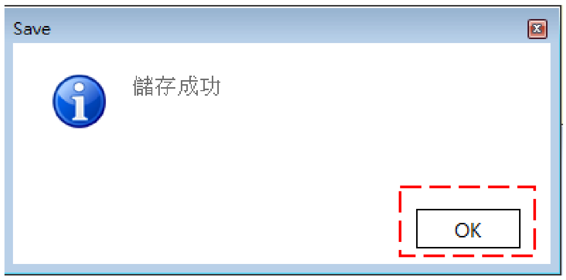


Move the conveyor to within the robot range and click the O2 and P2 buttons interface diagram

When the settings above are completed, click the “SAVE” function button to save the completed calibration; if settings were done poorly or need to recalibrate, please press the “Reset” button.



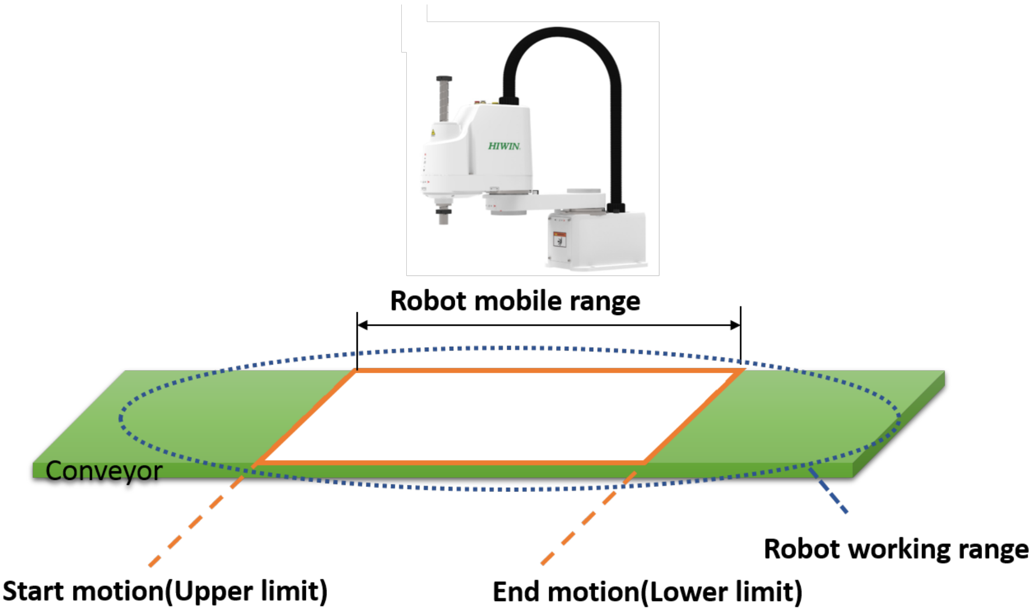
Conveyor motion ratio calibration save interface diagram



Save successful screen window

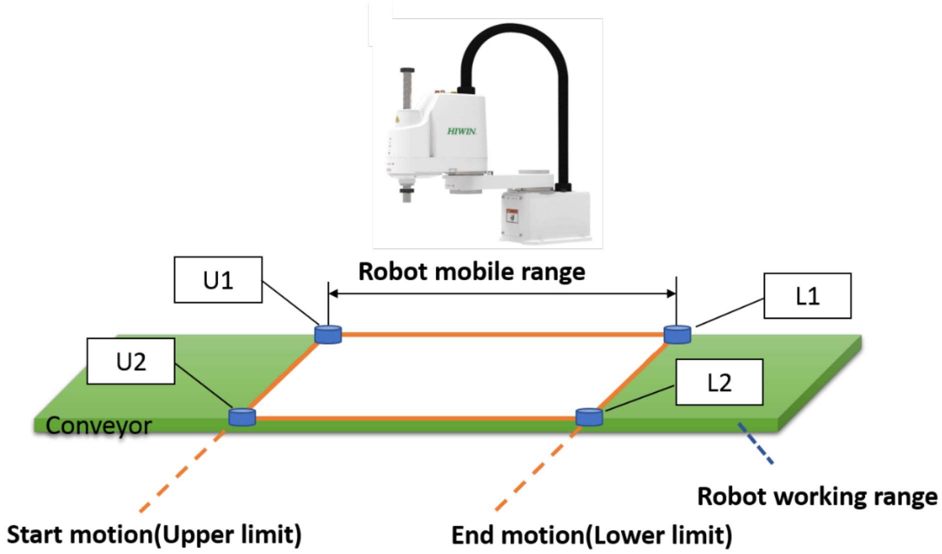
6.8.2.6 Vision triggered-calibration of the conveyor and robot work ranges

This chapter defines the calibration settings for the work range when the conveyor is used with the robot. After defining the safety range, when the robot is executing conveyor tracking tasks, the robot will only execute the task within this work range, and will not act when exceeded this range. The monitoring screen will display exceeded range (Over_stream).



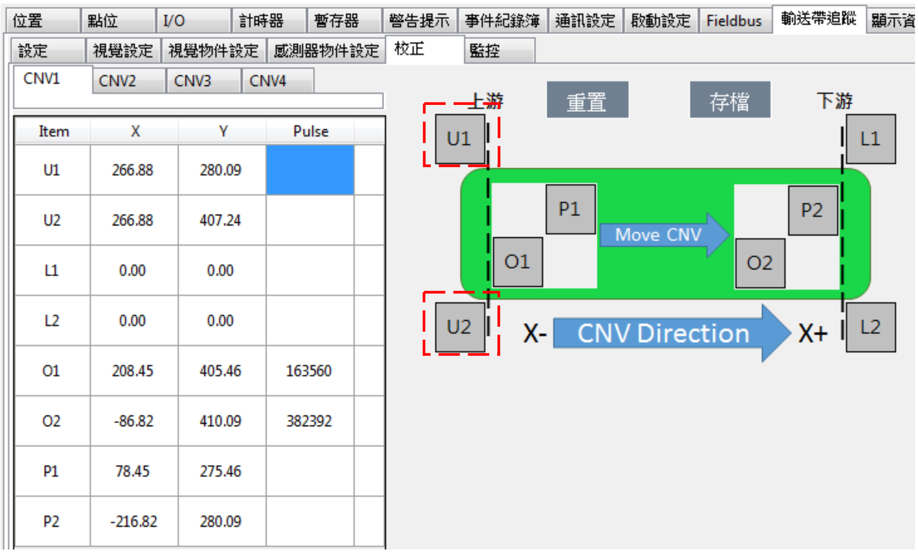
Robot and conveyor work range illustration diagram

When setting the work range for the robot and conveyor, it is set using the 4 points of a rectangle. The 2 upstream points settings are U1 and U2; when the workpiece enters this range, tracking begins (upper limit point). The 2 downstream points settings are L1 and L2; when the workpiece leaves this range, tracking is discarded (lower limit point), as illustrated in the figure below.



Robot and conveyor work range corresponding setting illustration diagram

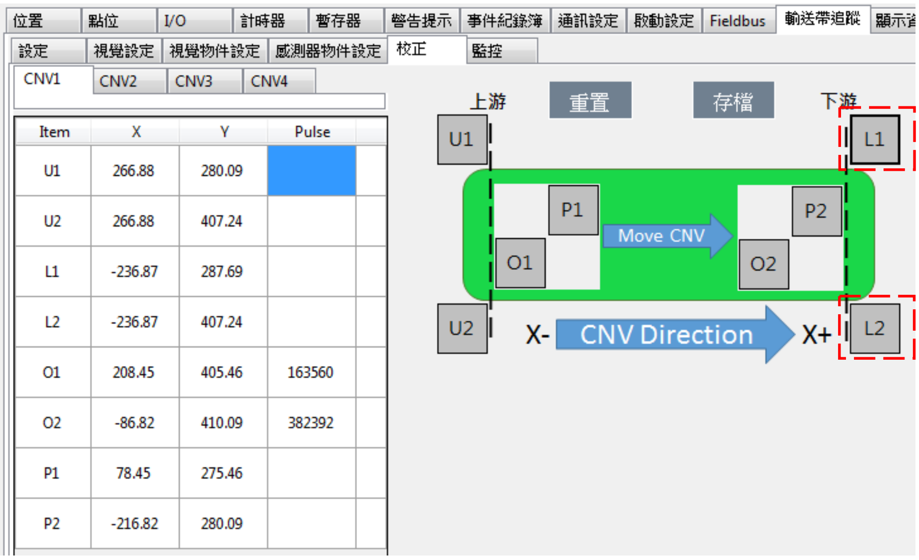
Move the robot upstream to any two points close to the upper limit range, and click the U1 and U2 buttons. Check whether the values of U1 and U2 were recorded.



Item	X	Y	Pulse
U1	266.88	280.09	
U2	266.88	407.24	
L1	0.00	0.00	
L2	0.00	0.00	
O1	208.45	405.46	163560
O2	-86.82	410.09	382392
P1	78.45	275.46	
P2	-216.82	280.09	

Conveyor upstream range calibration U1, U2 point interface diagram

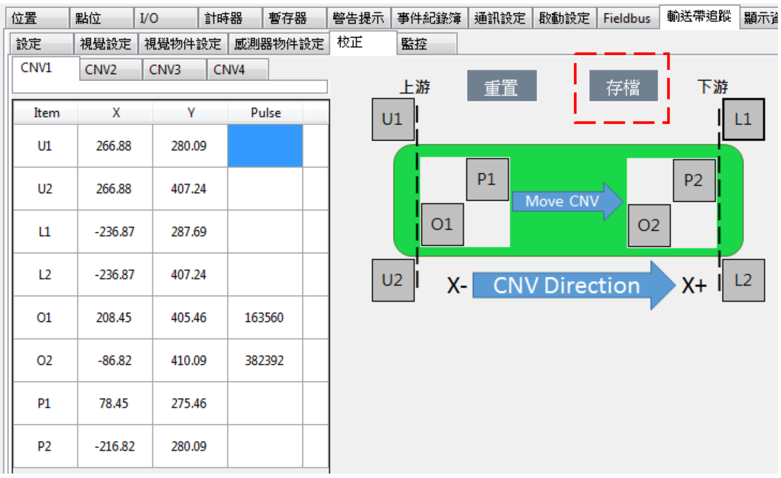
Move the robot downstream to any two points close to the lower limit range, and click the L1 and L2 buttons. Check whether the values of L1 and L2 were recorded.

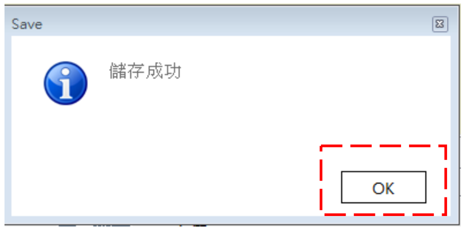


Item	X	Y	Pulse
U1	266.88	280.09	
U2	266.88	407.24	
L1	-236.87	287.69	
L2	-236.87	407.24	
O1	208.45	405.46	163560
O2	-86.82	410.09	382392
P1	78.45	275.46	
P2	-216.82	280.09	

Conveyor downstream range calibration for L1 andL2 points interface window

After the settings above are completed, click the “SAVE” button to save the upstream/downstream range. The calibrationhas been completed.





Conveyor upstream/downstream setting completed save interface window

Save successful screen window

Note 1: Points U1, U2, L1 and L2 must be within the robot range.

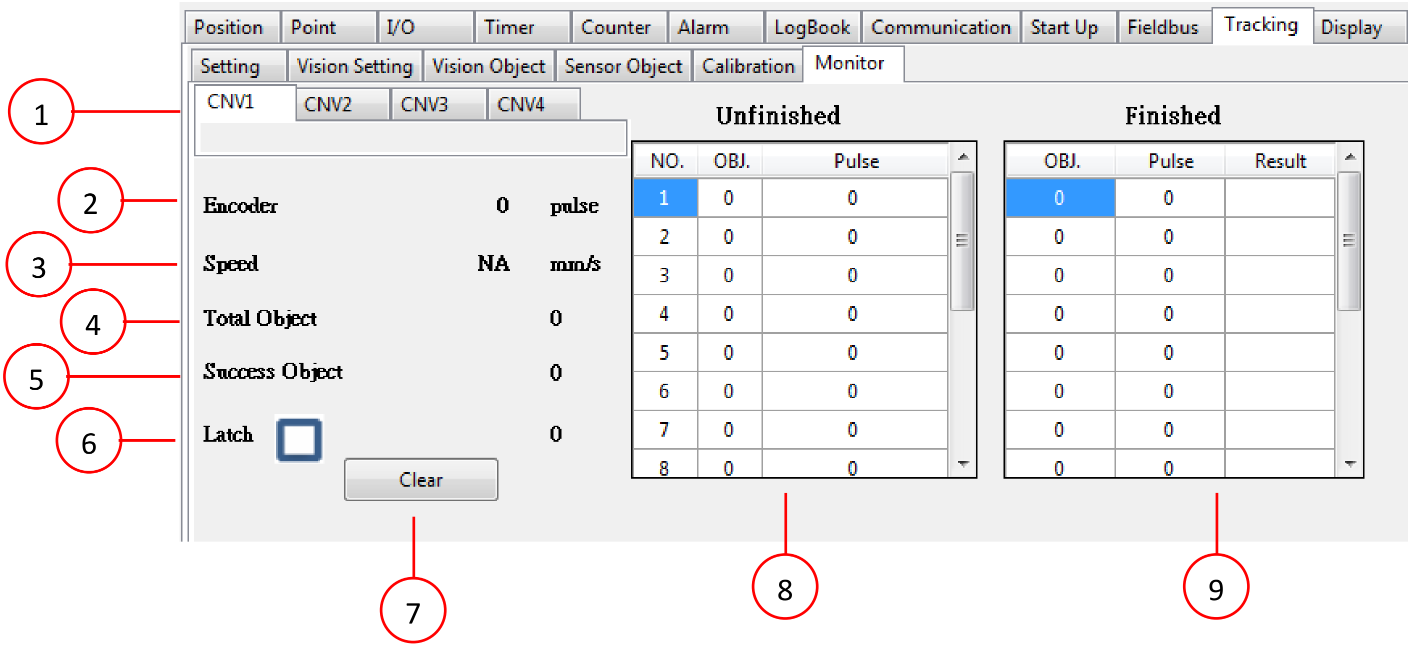
Note 2: Points U1, U2 and L1, L2 will each form an infinite line segment.

After completion of the calibration for the vision triggered method; next is to be perform the programming for conveyor tracking. (Please refer to Chapters 9.12, 10.9)

6.9 Conveyor tracking function status monitor

Performing conveyor tracking operations.

Path: In the tab window below, select Tracking >> Setting >> Monitor.



Conveyor monitor interface window

Conveyor monitor setting instruction table

NO.	Name	Description
1	**Conveyor number**	Select the conveyor number; there is a total of 4 conveyor tabs that correspond to CN1 ~ CN4.
2	**Encoder**	Displays the current encoder value that the robot received.
3	**Speed**	Displays the current conveyor speed; the unit is millimeters/second (mm/s).
4	**Total Object** Total number of objects	Displays the total number of queue data received by the robot.
5	**Success Object** Number of successful objects	Displays the accumulated number of queues that the robot successfully picked up.
6	**Latch**	Trigger signal status display; the white part within the frame is not triggered, and the red is triggering.
7	**Clear button**	Clears the current queues that are not executed.
8	**Information on incomplete queues**	When the robot receives unprocessed queue data, it will display how many objects and encoder pulses are in the queue.
9	**Information on completed queues**	When the robot receives processed queue data, it will display the number of completed queues, the encoder pulses and the pick-up results. When the robot picked-up successfully, Success will be

NO.	Name	Description
		displayed; and when it failed, Over_stream (range exceeded) will be displayed.

7. FieldBus Communication (SI/O) Application

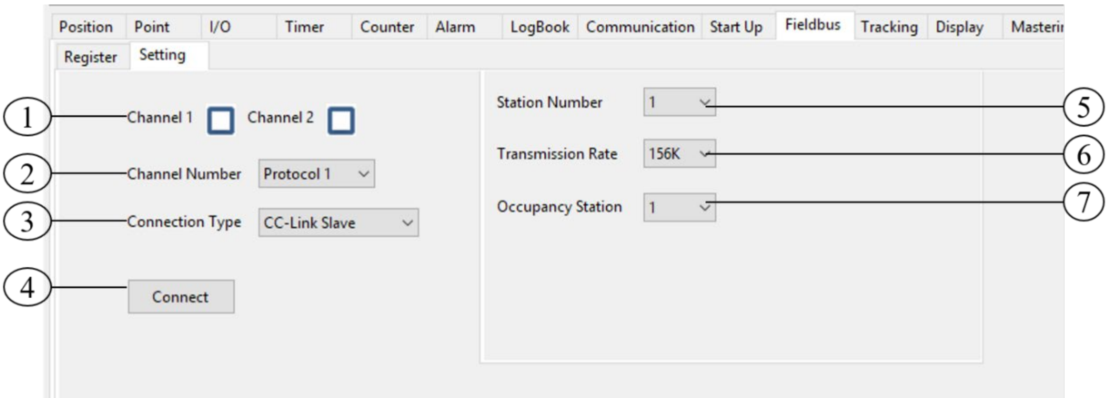
7.1 Setup CC-Link connection parameters

<u>Operating steps</u>

1.Click the [FieldBus] sub tab.

2.Click the [Setting] sub tab.

<u>Description</u>



FieldBus CC-Link Setting interface

No.	Description
1	Display Protocol connection status. If connection is successful, it will show red block. If failed or disable, it will show white block.
2	Protocol selection. It can be Protocol1 or Protocol2.
3	Connection type, please select [CC-Link Slave].
4	Connect or Disconnect.
5	Station number in this CC-Link network. The range is 1~64。
6	Transmission Rate for data transfer.
7	Occupancy station number for this equipment. The range is 1~4.

After finishing above, Click [Connect] buttont to proceed this connection and click [Save] button to save this configuration. Next time to start this system, it will use this configration to make connection.

7.2 Setup Profinet Connection Parameters

Operating steps

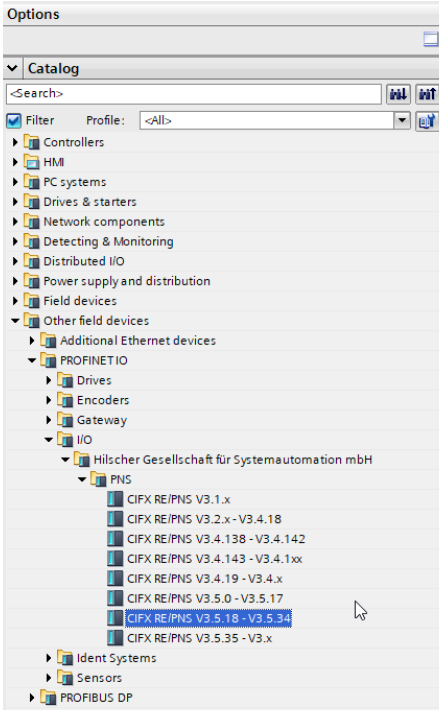
1.Siemens PLC need to install PROFINET IO descripted file of GSDML(download form HIWIN Website).

2.Click the [FieldBus] sub tab.

3.Click the [Setting] sub tab.

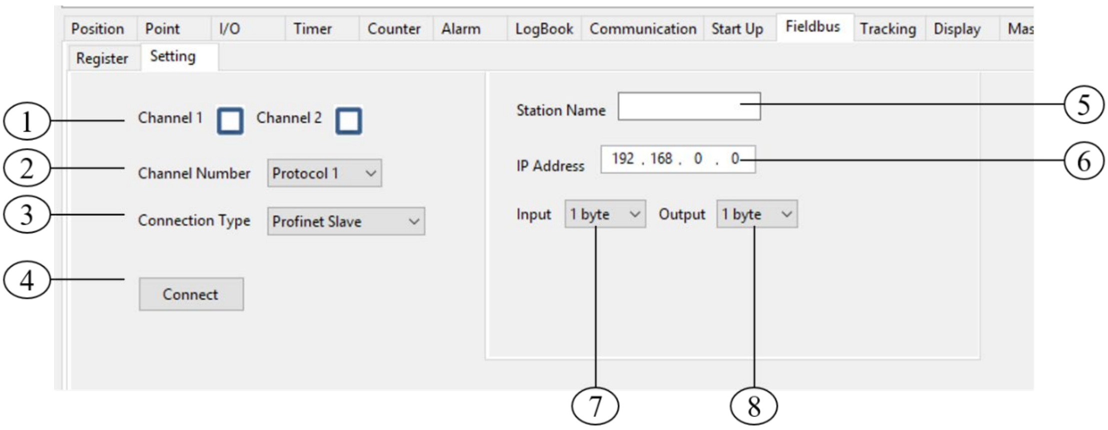
Description

1. After PROFINET IO descripted file of GSDML installed, on Siemens TIA Portal Software Options menu to select Other field devices->PROFINET IO->I/O->Hilscher Gesellschaft für System automation mbH ->PNS->CIFX RE/PNS V3.5.18–V3.5.34。



Siemens TIA Portal software Setting figure

2. Open Caterpillar，click FieldBus → Setting , open FieldBus Profinet setting parameters interface.



FieldBus Profinet Setting interface

No.	Description
1	Display Protocol connection status. If connection is successful, it will show red block. If failed or disable, it will show white block.
2	Protocol selection. It can be Protocol1 or Protocol2.
3	Connection type, please select [Profinet Slave].
4	Reconnect or Disconnect.
5	Station name. Require to set up the same name with the Master’s.
6	IP address corresponding to the Master’s.
7	Input bytes number corresponding to the Master’s. The IO maximum number support 16 Bytes.
8	Output bytes number corresponding to the Master’s. The IO maximum number support 16 Bytes.

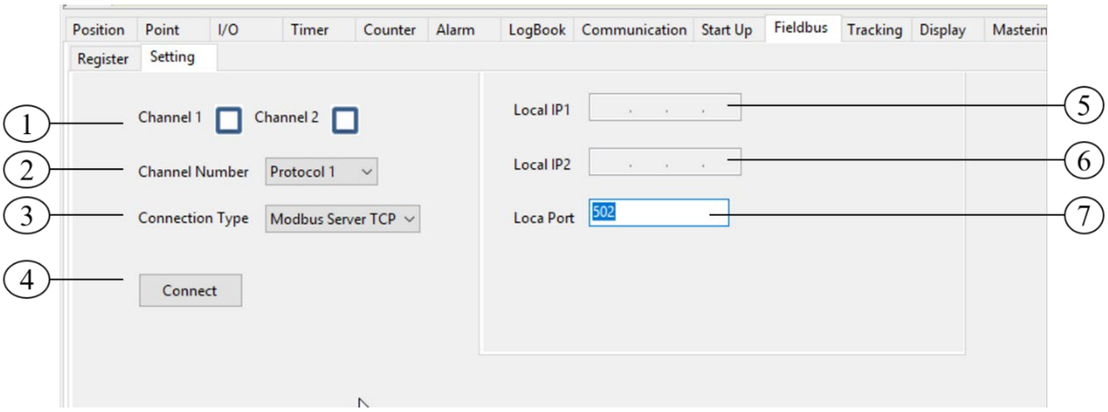
After finishing above, Click [Connect] buttont to proceed this connection and click [Save] button to save this configuration. Next time to start this system, it will use this configuration to make connection.

7.3 Setting ModbusTCP Server Connection Parameters

Operating steps

1. Click [Fieldbus] tab.
2. Click [Setting] tab.

Description



FieldBus ModbusTCP Server Setting interface

FieldBus Modbus TCP Server interface parameters description table

No.	Name	Description
1	Protocol Connection Status	Confirmation of protocol connection status. If connection is successful, the box will appear red, if connection is failed or setting is not switched on, the box will appear white.
2	Protocol Number	Protocol Number, can select the protocol of connection. When select protocol 1, SI/O[1]~[128] can be used. When select protocol 2, SI/O[129]~[256] can be used.
3	Connection Type	Connection Type, please select「Modbus Server」.
4	Connection Button	Click to connect or disconnect.
5	Local IP1 Setting	Local IP1, setting of the local IP1address.
6	Local IP2 Setting	Local IP2, setting of the local IP2address.
7	Local Port	Local Port, setting of the local communication port.

The Modbus function codes(1,2,3,15,16) are available.

Once setting is complete, click [Connect] to connect and store the setting, next reboot would use current setting for connection.

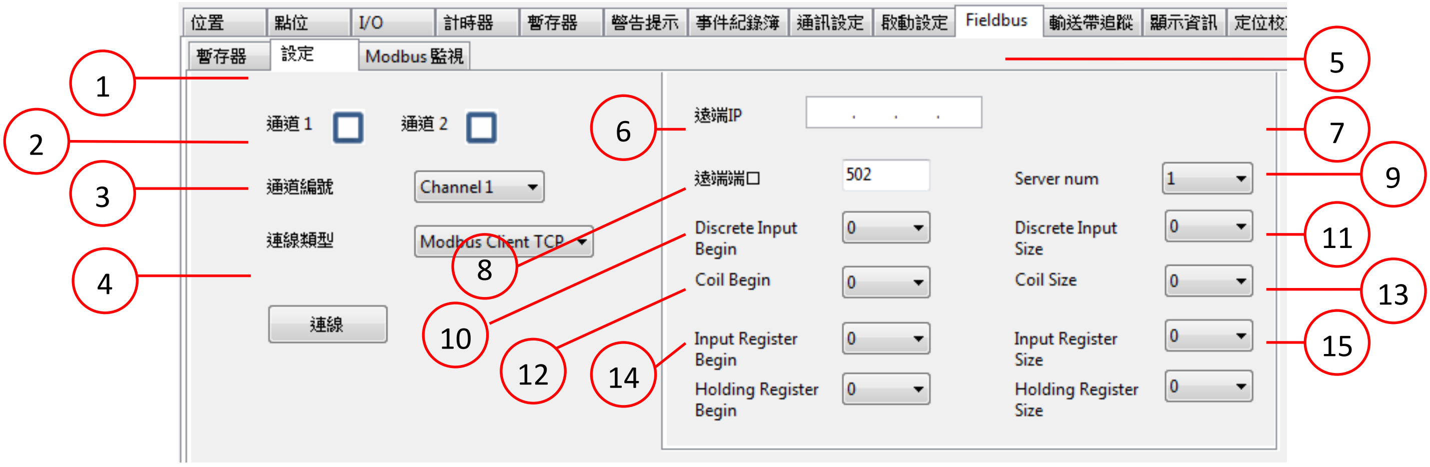
7.4 Setting ModbusTCP Client Connection Paramedics

Operating steps

1.Click the [FieldBus] sub tab.

2.Click the [Setting] sub tab.

Description



FieldBus ModbusTCP Client setting interface figure

FieldBus Modbus TCP Client interface parametic description table

No.	Name	Description
1	Protocol Connection Status	Confirmation of protocol connection status. If connection is successful, the box will appear red, if connection is failed or setting is not switched on, the box will appear white.
2	Protocol Number	Protocol Number, can select the protocol of connection. When select Channel 1, SI/O[1]~[128] can be used. When select Channel 2, SI/O[129]~[256] can be used.
3	Connection Type	Connection Type, please select「Modbus Client」.
4	Connect button	Click to connect or disconnect.
5	Remote IP	Remote IP, set corresponding to remote device.
6	Remote Port	Remote Port, set corresponding to remote device.
7	Server number	Server number setting, setting range is 1 ~ 4.
8	Discrete Input Begin	the setting of remote device SI start number, setting range is 0 ~ 256.
9	Discrete Input size	setting of SI quantity should correspond to the setting of remote device, setting range is 0 ~ 128。If data size is 0, then disable.
10	Coil Begin	the setting of remote device SO start number, setting range is 0 ~ 256。
11	Coil Size	the setting of remote device SO write number, setting range is 0 ~ 128。If data size is 0, then disable.

No.	Name	Description
12	Input Register Begin	the setting of remote device SRR register start number, setting range is 0 ~ 999 。
13	Input Register Size	the setting of remote device SRR read quantity, setting range is 0 ~ 128 。 If data size is 0, then disable.
14	Holding Register Begin	the setting of remote device SRW register start number, setting range is 0 ~ 999 。
15	Holding Register Size	the setting of remote device SRW write quantity, setting range is 0 ~ 16 。 If data size is 0, then disable.

Once setting is complete, click [Connect] to connect and store the setting, next reboot would use current setting for connection.

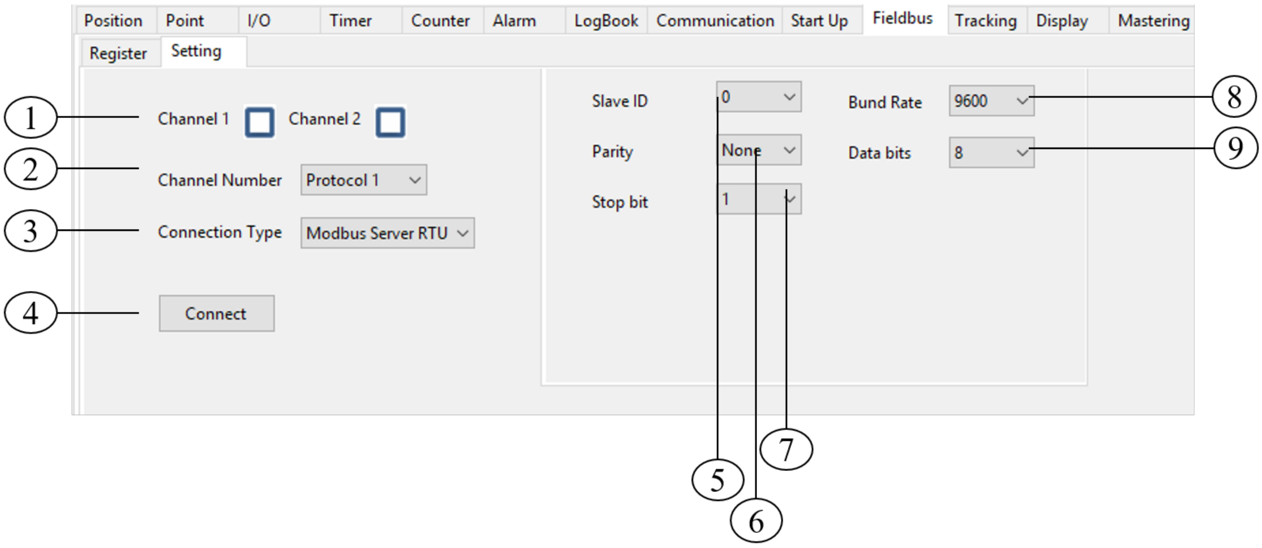
7.5 Setting ModbusRTU Server Connection Parameters

Operating steps

1. Click the [FieldBus] sub tab.

   2.Click the [Setting] sub tab.

Description



FieldBus Modbus RTU Server Setting interface

FieldBus Modbus RTU Client interface parameter description table

No.	Name	Description
1	Protocol Connection Status	Confirmation of protocol connection status. If connection is successful, the box will appear red, if connection is failed or setting is not switched on, the box will appear white
2	Protocol Number	Protocol selection. It can be Protocol1 or Protocol2.
3	Connection Type	Connection type, please select「Modbus Server RTU」。
4	Connect button	Connect or Disconnect.
5	Slave ID	Setting local Slave ID, setting range is 0 ~ 256。
6	Parity Check	Setting COMPORT parity parameter，「Even」:Even check,「Odd」:Odd check, 「None」: null check.
7	Stop bits	Setting Stop bit , select 1 or 2.
8	Baud rate	Setting Baud rate(bit/s), setting range is 110 ~ 115200。
9	Data bits	Setting Data bits, setting range is 5 ~ 8。

Once setting is complete, click [Connect] to connect and store the setting, next reboot would use current setting for connection.

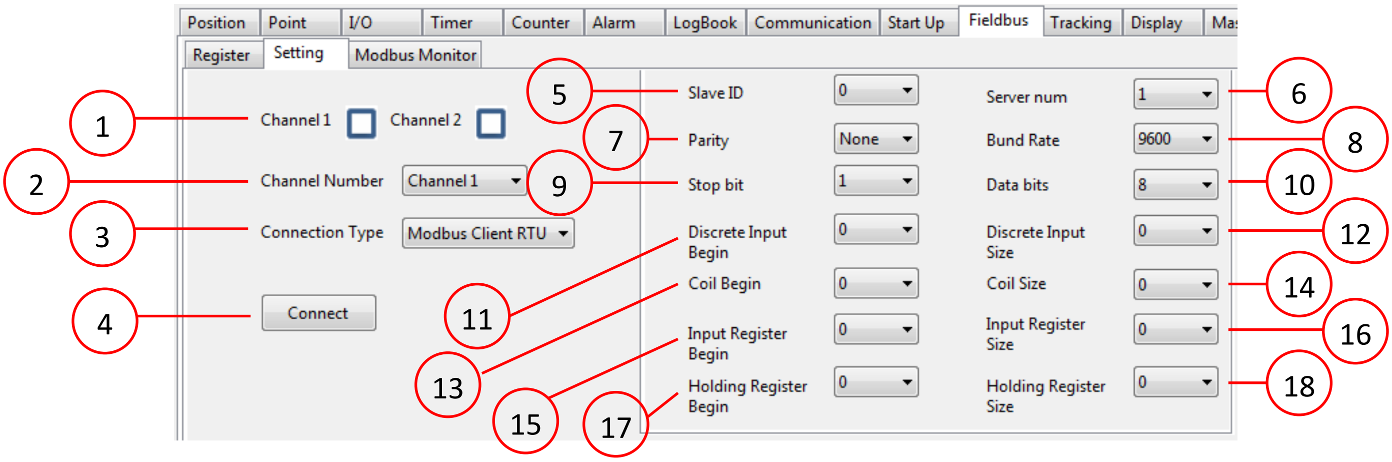
7.6 ModbusRTU Client connection parameter settings

Instructions

1.Click the FieldBus tab in the function tab.

2.Click the Setting tab.

Description



FieldBus Modbus RTU Client setting interface window

FieldBus Modbus RTU Client interface parameter description table

No.	Name	Description
1	Protocol Connection Status	Confirmation of protocol connection status. If connection is successful, the box will appear red, if connection is failed or setting is not switched on, the box will appear white
2	Protocol Number	Protocol selection. It can be Channel1 or Channel2.
3	Connection Type	Connection type, please select「Modbus Client RTU」。
4	Connect button	Connect or Disconnect.
5	Slave ID	Setting local Slave ID, setting range is 0 ~ 256。
6	Server number	Server number Setting, setting range is 1 ~ 4.
7	Parity Check	Setting COMPORT parity parameter，「Even」:Even check,「Odd」:Odd check, 「None」: null check.
8	Stop bits	Setting Stop bit , select 1 or 2.
9	Baud rate	Setting Baud rate(bit/s), setting range is 110 ~ 115200。
10	Data bits	Setting Data bits, setting range is 5 ~ 8。
11	Discrete Input Begin	the setting of remote device SI start number, setting range is 0 ~ 256.
12	Discrete Input size	setting of SI quantity should correspond to the setting of remote device, setting range is 0 ~ 128。If data size is 0, then disable.

No.	Name	Description
13	Coil Begin	the setting of remote device SO start number, setting range is 0 ~ 256。
14	Coil Size	the setting of remote device SO write number, setting range is 0 ~ 128。If data size is 0, then disable.
15	Input Register Begin	the setting of remote device SRR register start number, setting range is 0 ~ 999。
16	Input Register Size	the setting of remote device SRR read quantity, setting range is 0 ~ 128。If data size is 0, then disable.
17	Holding Register Begin	the setting of remote device SRW register start number, setting range is 0 ~ 999。
18	Holding Register Size	the setting of remote device SRW write quantity, setting range is 0 ~ 16。If data size is 0, then disable.

Once setting is complete, click [Connect] to connect and store the setting, next reboot would use current setting for connection.

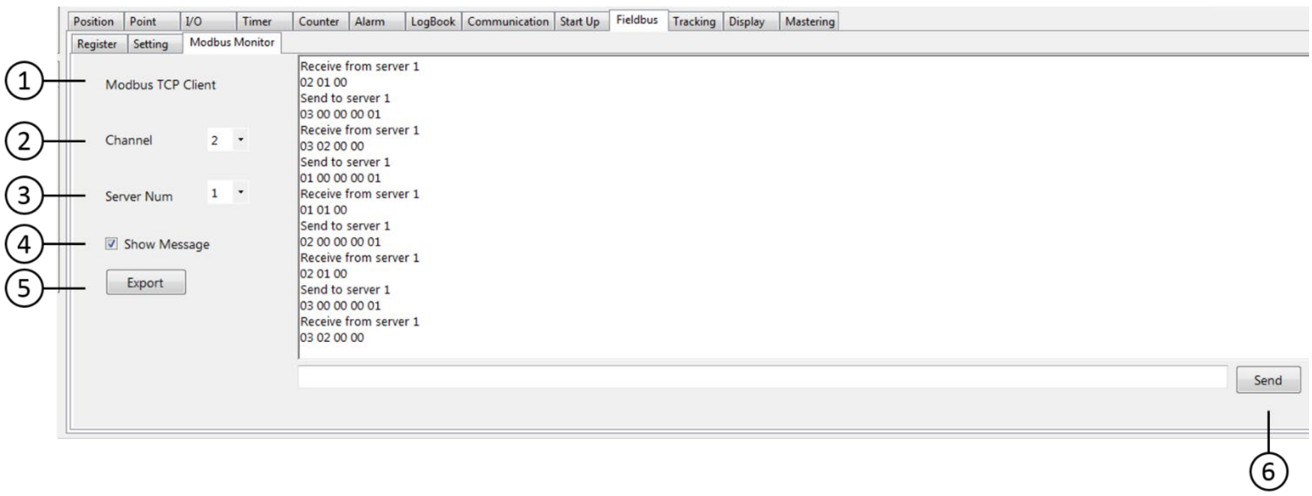
7.7 Modbus Monitor Page

Instructions:

1.On the Function tab, click the FieldBus tab → click the Modbus Monitortab.

Description:

This interface is used to display Modbus communication messages.



ModBus Monitor interface window (e.g., using Modbus TCP Client)

Modbus monitor setting description table

No.	Name	Description
1	Fieldbus mode display	Displays the connection mode for the current channel.
2	Channel selection	Protocol selection. It can be Channel1 or Channel2.
3	Corresponding server number	The message sending server number selected for client mode.
4	Message display selection	Check tickbox to display/hide the transmission messages.
5	Export button	Requires connecting a USB hard drive and export output messages
6	Send message button	Users enter the message to send into the message field, then click the message to send test manually.

7.8 FieldBus Application Description

7.8.1 Field Bus Input(SI[n])

Operating steps

1. Click the [I/O] sub tab.
2. Click the [SI/O] sub tab.

Description

A. When using Protocol1, SI[1]~SI[128] can be used.
    a. When Occupancy is 1, SI[1]~SI[32] can be used.
    b. When Occupancy is 2, SI[1]~SI[64] and so on.

B. When using Protocol 2, SI[129]~SI[256] can be used.
    a. When Occupancy is 1, SI[129]~SI[160] can be used.
    b. When Occupancy is 2, SI[129]~SI[192] and so on.

C. SI[1]~SI[8] are reserved and have similar function as FI[1]~FI[8].

D. Interface can be used directly for selection.
    a. SI[1]~SI[8] cannot be set directly.
    b. Comment for SI[1]~SI[8] is unmodifiable, the reset will be stored.

E. Can be controlled by command.
    a. The command $SI[n] can be used to read Input status.
    b. Other instruction can be used such as IF、WAIT FOR.

7.8.2 Field Bus Output(SO[n])

<u>Operating steps</u>

1. Click the [I/O] sub tab.
2. Click the [SI/O] sub tab.

<u>Description</u>

A.When using Protocol1, SO[1]~SO[128] can be used.

a. When Occupancy is 1, SO[1]~SO[32] can be used.

b. When Occupancy is 2, SO[1]~SO[64] and so on.

B.When using Protocol2, SO[129]~SO[256] can be used.

a. When Occupancy is 1, SO[129]~SO[160] can be used.

b. When Occupancy is 2, SO[129]~SO[192] and so on.

C.SO[1]~SO[8] are reserved and have similar function as FO[1]~FO[8].

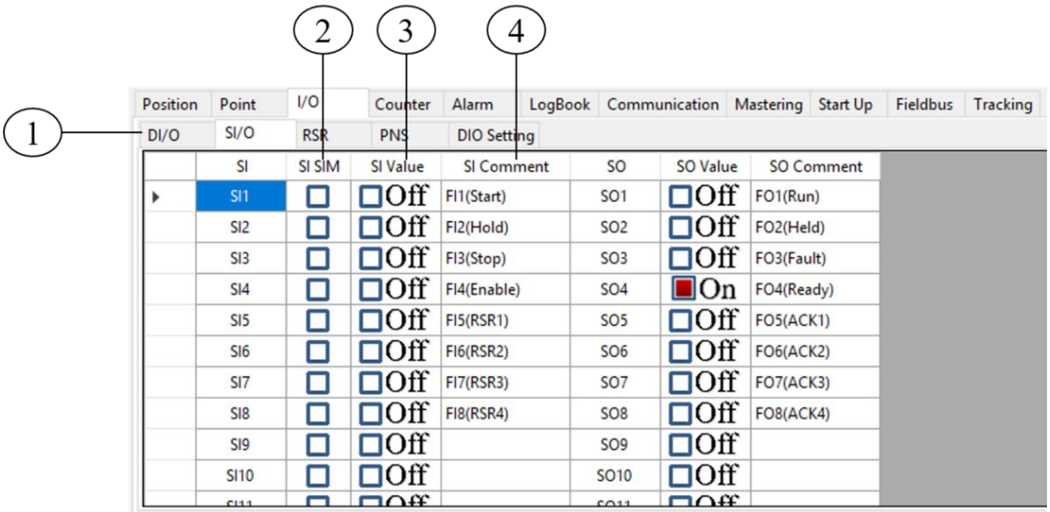
D.Interface can be used directly for selection.

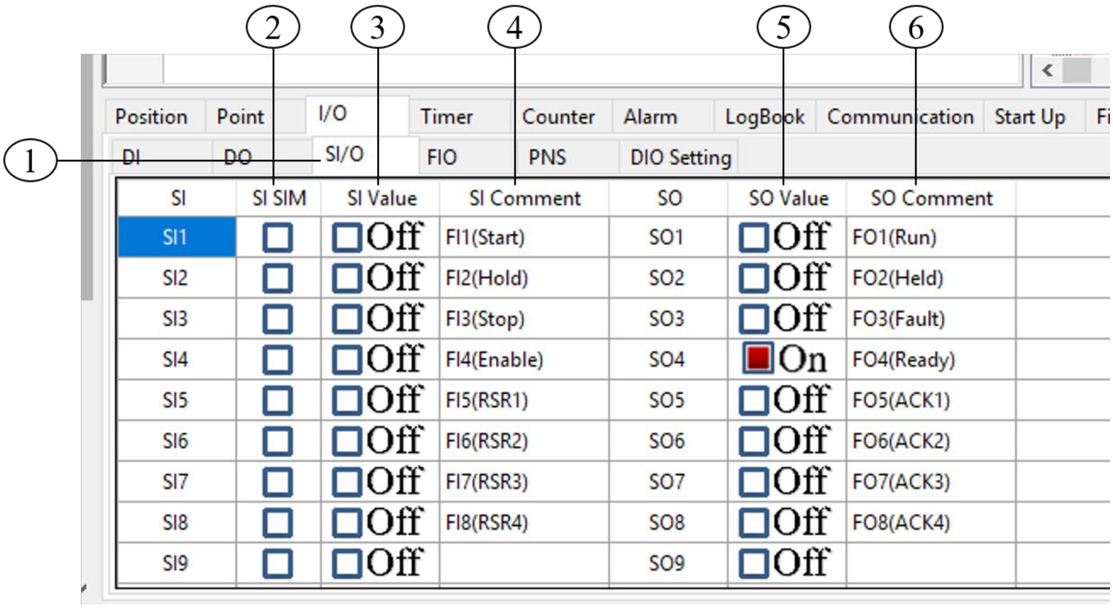
a. SO[1]~SO[8] cannot be set directly.

b. Comment for SO[1]~SO[8] is unmodifiable, the reset will be stored.

E.Can be controlled by command.

c. Then command $SO[n] can be used to write Output status.



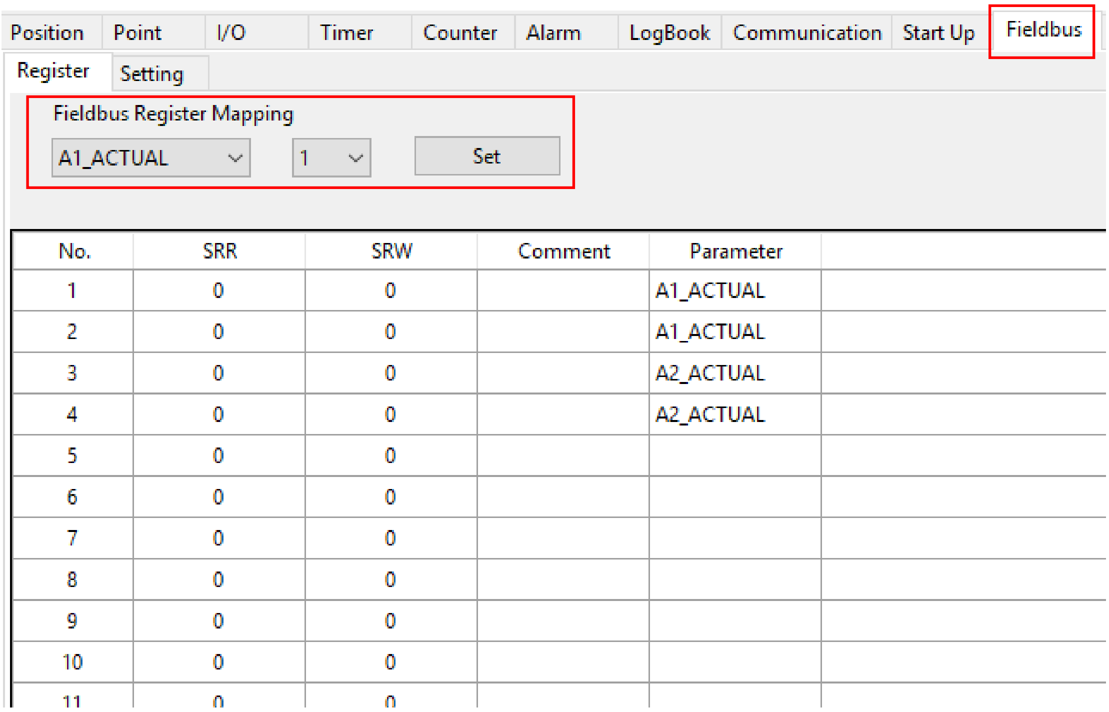


FieldBus I/O Interface

No.	Description
1	SI/O tab page.
2	SI SIM, If simulation is enabled, the box will appear red, otherwise it will appear white.
3	SI Value.(It only can be set when enable simulation.) If input signal is ON, the box will appear red, if input signal is OFF, the box will appear white.
4	SI Comment.(Double click to modify.)
5	SO Value. If output signal is ON, the box will appear red, if output signal is OFF, the box will appear white.
6	SO Comment.(Double click to modify.)

7.8.3 FieldBus Register Mapping

A.Click Fieldbus → Register, Open Fieldbus Register Mapping Setting interface.



No.	SRR	SRW	Comment	Parameter
1	0	0		A1_ACTUAL
2	0	0		A1_ACTUAL
3	0	0		A2_ACTUAL
4	0	0		A2_ACTUAL
5	0	0		
6	0	0		
7	0	0		
8	0	0		
9	0	0		
10	0	0		
11	0	0		

Fieldbus Register Mapping Setting interface

B.Select system parameters that user required.

Parameter Name:

A1_ACTUAL: Actual angle of 1st axis

A2_ACTUAL: Actual angle of 2nd axis

A3_ACTUAL: Actual angle of 3rd axis

A4_ACTUAL: Actual angle of 4th axis

A5_ACTUAL: Actual angle of 5th axis

A6_ACTUAL: Actual angle of 6th axis

X_ACTUAL: Actual X coordinate of TCP

Y_ACTUAL: Actual Y coordinate of TCP

Z_ACTUAL: Actual Z coordinate of TCP

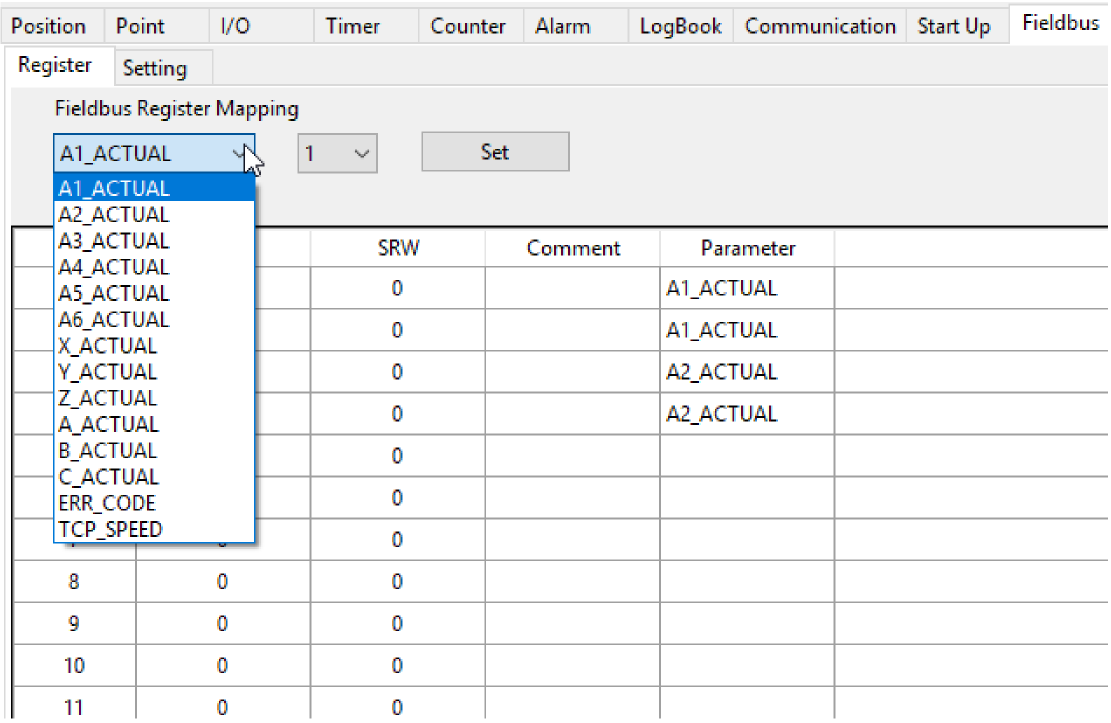
A_ACTUAL: Actual A coordinate of TCP

B_ACTUAL: Actual B coordinate of TCP

C_ACTUAL: Actual C coordinate of TCP

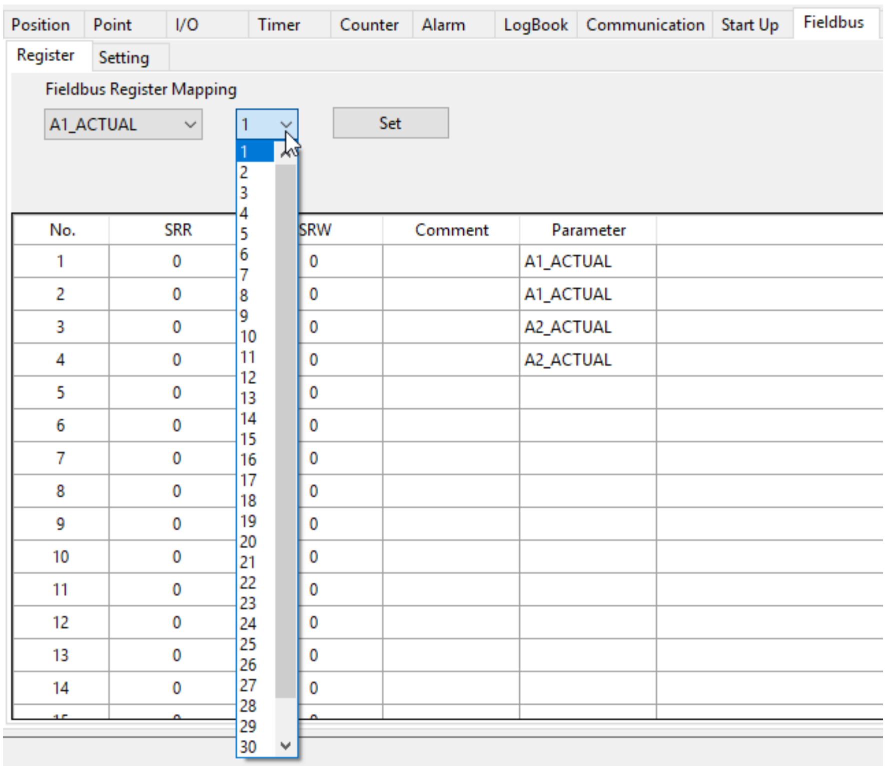
ERR_CODE: Error code

TCP_SPEED: Actual speed of TCP



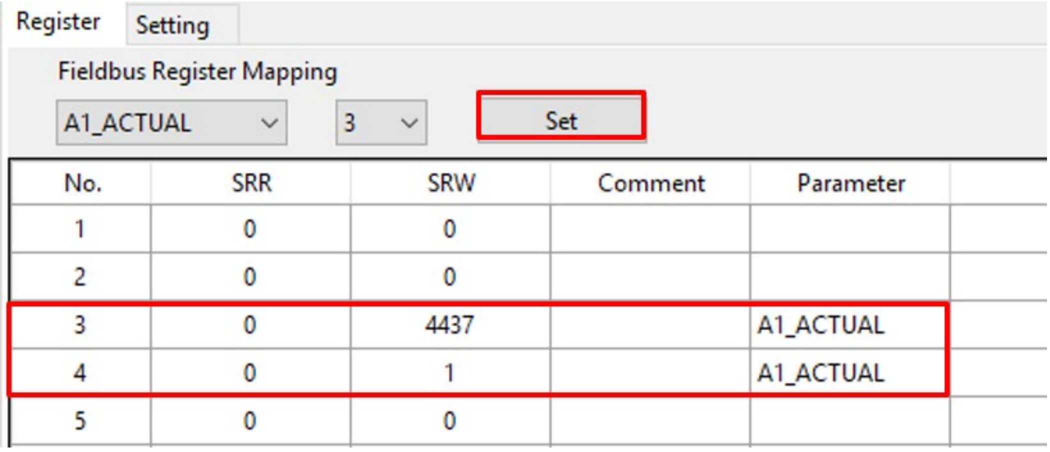
Select system parameter interface

C.Select saving register number storage for parameter interface.



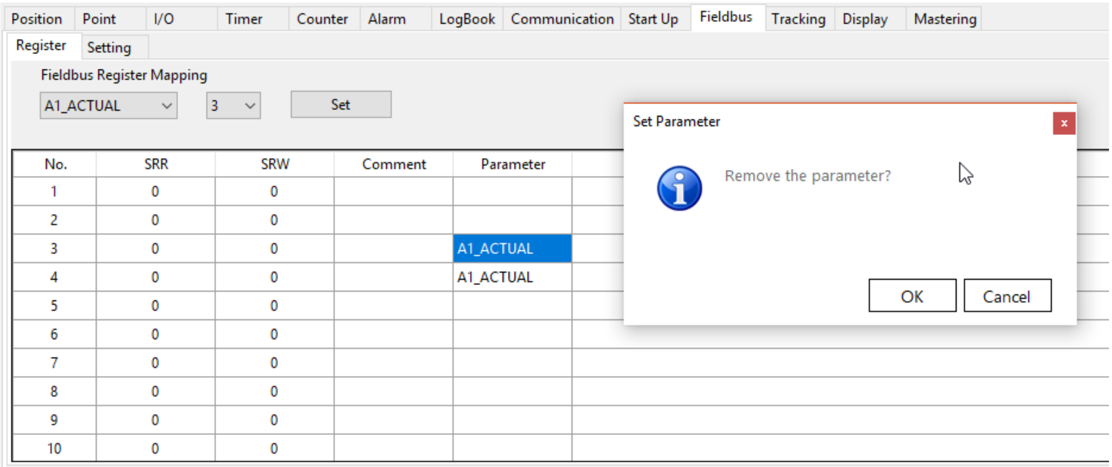
選擇系統參數儲存在哪個暫存器編號的介面

D. Click [Set] to save the setting.



Click [Set] button to save parameters interface

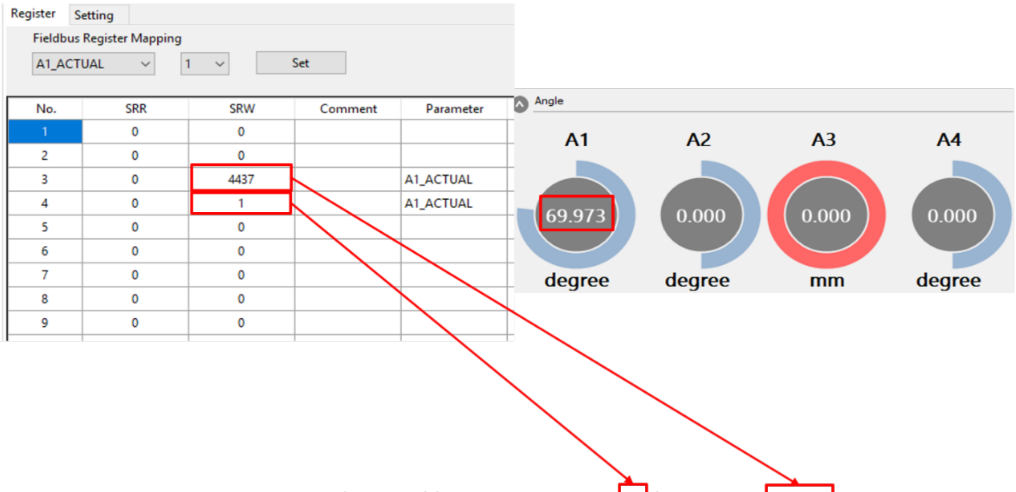
E.Click parameter column to remove the stored parameter from register.



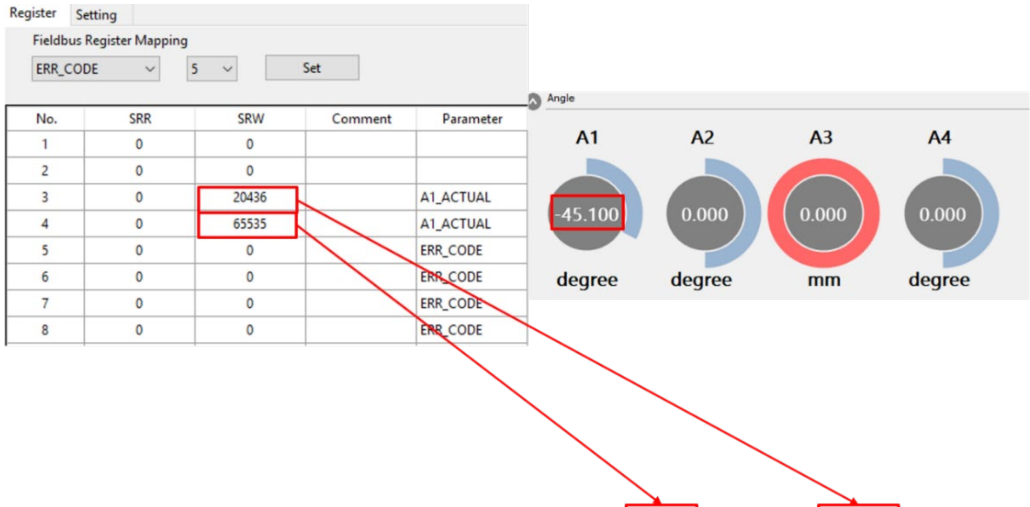
Remove the parameters in the register interface

F.Register parameters explanation:

A1_ACTUAL:

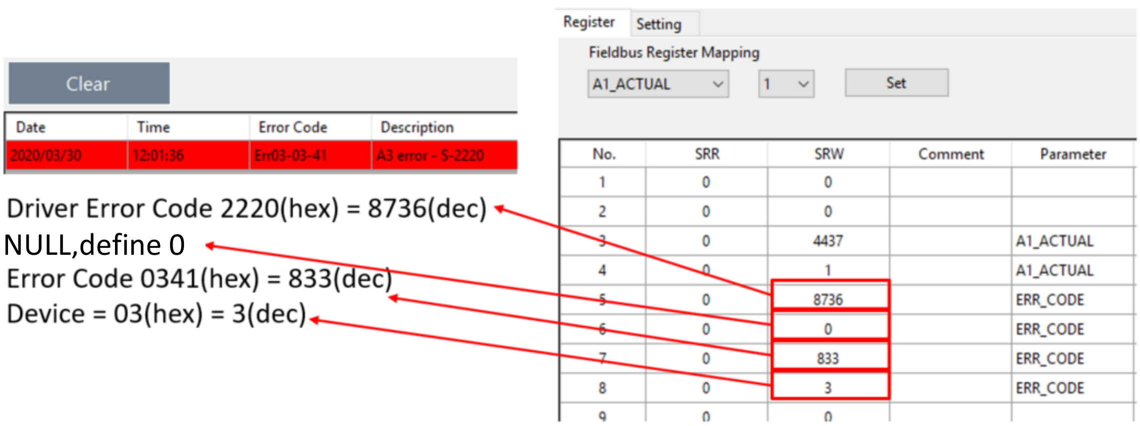


A1(69.973)*1000 = 69973 = $\boxed{1}$ * 65536 + $\boxed{4437}$



(65536 * 65536 + A1*1000 = $\boxed{65535}$ * 65536 + $\boxed{20436}$

Error Code:



7.8.4 Field Bus Register(SRR、SRW)

<u>Operating steps</u>

3. Click the tab of [FieldBus].
4. Click the sub tab of [Register].

<u>Description</u>

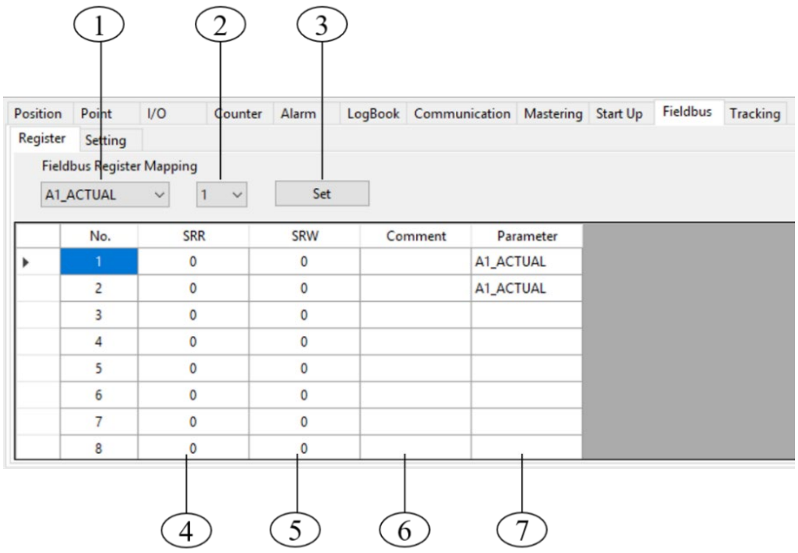
A. SRR (Register for Read) and SRW (Register for Write).

B. When using Protocol1, SRR[1]~SRR[16]、SRW[1]~SRW[16] can be used.
   a. When Occupancy is 1, SRR[1]~SRR[4]、SRW[1]~SRW[4] can be used.
   b. When Occupancy is 2, SRR[1]~SRR[8]、SRW[1]~SRW[8] and so on.

C. When using Protocol2, SRR[17]~SRR[32]、SRW[17]~SRW[32] can be used.
   a. When Occupancy is 1, SRR[17]~SRR[20]、SRW[17]~SRW[20] can be used.
   b. When Occupancy is 2, SRR[17]~SRR[24]、SRW[17]~SRW[24] and so on.

D. Value can be written or read directly through interface.
   a. SRR column can be read but not modify.
   b. SRW column can modify when clicked.
   c. Range of input value is -32767~-32767.
   d. Comment after modified will be saved.

E. Can be controlled by command.
   a. Command $SRW[n] can be used to set SRW status.
   b. Command $SRR[n] can be used to set SRR status.



FieldBus RS interface

項號	說明
1	Select system parameters that user required. Parameter Name: A1_ACTUAL: Actual angle of 1st axis A2_ACTUAL: Actual angle of 2nd axis A3_ACTUAL: Actual angle of 3rd axis A4_ACTUAL: Actual angle of 4th axis A5_ACTUAL: Actual angle of 5th axis A6_ACTUAL: Actual angle of 6th axis X_ACTUAL: Actual X coordinate of TCP Y_ACTUAL: Actual Y coordinate of TCP Z_ACTUAL: Actual Z coordinate of TCP A_ACTUAL: Actual A coordinate of TCP B_ACTUAL: Actual B coordinate of TCP C_ACTUAL: Actual C coordinate of TCP ERR_CODE: Error code TCP_SPEED: Actual speed of TCP
2	Register number storage for parameter interface.
3	Click [Set] to save the setting.
4	The value of SRR for the specific register.
5	The value of SRW for the specific register.
6	The comment of the specific register.
7	System parameter name for the specific register. Click parameter column to remove the stored parameter from register.

7.8.5 Fieldbus EtherNet IP

Description

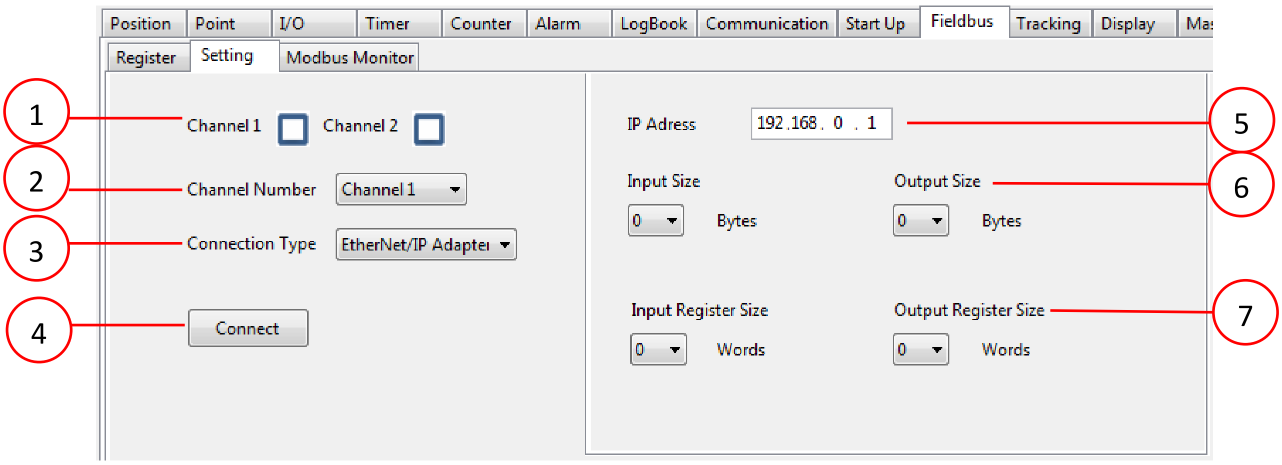
Adding EtherNet\IP Adapter communication into the current Fieldbus function; this is mainly used for hidden message communication (Implicit Message). It provides IO and Register data transmission, which means SI, SO, SRR and SRW data transmissions.

Instructions

1.Click the FieldBus tab in the function tab.

2.Click the Setting tab.

3.Set the EtherNet\IP Adapter parameters; refer to the table below for parameter descriptions.



FieldBus EtherNet IP interface window

FieldBus EtherNet IP parameter description table

No.	Name	Description
1	Protocol Status Display	Displays the connection status of the protocol. If connected successfully, a red block will be displayed; if connection failed or it is not set as enabled, a white block will be displayed.
2	Protocol number	Select the protocol to connect; either Channel 1 or Channel 2 can be selected.
3	Connection type	Select the connection type; please select [EtherNet/IP Adapter].
4	Connect button	Performs connection or disconnection.
5	Remote IP setting	The IP address of the IP Adapter must be set.
6	Length setting	Input/output length must be set; allowed ranges are 0~83 Bytes.
7	Register length setting	Input/output register length must be set; allowed ranges are 0~83 Words.

4.When selection is completed, click the “Connect” button to connect and save settings. Next time it restarts, this setting will be used to perform in this connection.

8. Inquire Error Message And Solution Description

The error message with * symbol, on behalf of this error does not stop robot.

8.1 Robot system software,01-XX-XX)

8.1.1 System Error Message(01-01-XX)

Error Code	Error Name	Message	Reason	Solution
01-01-10	System initialization failure	System initialization failure	Software damaged or lost	Need to re-install software. Please contact the engineer from manufacturer.
01-01-11	Motion library load failure	Motion library load failure	Motion library damaged or lost	
01-01-12	Motion library initialization failure	Motion library initialization failure		
01-01-13	Motion library memory initialization failure			
01-01-14	Motion library start failure	Motion library start failure		
01-01-20	EtherCAT library loading failure	EtherCAT library loading failure	Software damaged	
01-01-21	EtherCAT disconnection	EtherCAT anomalies	EtherCAT connection anomalies	1.Check the drive EtherCAT connection status. 2.Please turn off the power and then restart. 3.Please contact the engineer from manufacturer.
01-01-22	EtherCAT initialization failure			
01-01-23	EtherCAT line crossing alarm			
01-01-24	EtherCAT none slave alarm			
01-01-25	EtherCAT can't check slave			
01-01-26	EtherCAT slave none response			
01-01-27	EtherCAT cycle alarm			

Error Code	Error Name	Message	Reason	Solution
01-01-28	EtherCAT cycle jitter	EtherCAT anomalies	EtherCAT connection anomalies	1.Check the drive EtherCAT connection status. 2.Please turn off the power and then restart. 3.Please contact the engineer from manufacturer.
01-01-29	EtherCAT cycle counter error			
01-01-2A	EtherCAT cycle watchdog error			
01-01-2B	EtherCAT INIT switching error			
01-01-2C	EtherCAT PREOP switching error			
01-01-2D	EtherCAT SAFEOP switching error			
01-01-2E	EtherCAT OP switching error			
01-01-2F	EtherCAT master none response			
01-01-30	EtherCAT master initialization error			
01-01-31	EtherCAT busbar scan error			
01-01-32	EtherCAT frame response error	EtherCAT anomalies	EtherCAT connection anomalies	1.Check the drive EtherCAT connection status. 2.Please turn off the power and then restart. 3.Please contact the engineer from manufacturer.
01-01-33	EtherCAT frame lost			
01-01-34	EtherCAT master counter error of initialization command			
01-01-35	EtherCAT master response error of initialization command			
01-01-36	EtherCAT slave counter error of initialization command	EtherCAT anomalies	EtherCAT connection anomalies	1.Check the drive EtherCAT connection status. 2.Please turn off the power and then restart.
01-01-37	EtherCAT slave response error of			

Error Code	Error Name	Message	Reason	Solution
	initialization command			3.Please contact the engineer from manufacturer.
01-01-38	EtherCAT mailbox time out			
01-01-39	EtherCAT mailbox SDO cancel			
01-01-3A	EtherCAT mailbox COE counter receive error			
01-01-3B	EtherCAT mailbox COE counter send error			
01-01-3C	EtherCAT mailbox receive invalid data			
01-01-3D	EtherCAT master alarm			
01-01-40	Axis 1 parameter setting fail	System anomalies	Software damaged or lost	If reinstall software is required, please contact engineer from the original equipment manufacturer.
01-01-41	Axis 2 parameter setting fail			
01-01-42	Axis 3 parameter setting fail			
01-01-43	Axis 4 parameter setting fail			
01-01-44	Axis 5 parameter setting fail			
01-01-45	Axis 6 parameter setting fail			
01-01-50	Conveyor 1 encoder initial fail			
01-01-51	Conveyor 2 encoder initial fail			

Error Code	Error Name	Message	Reason	Solution
01-01-52	Conveyor 3 encoder initial fail	System anomalies	Software damaged or lost	If reinstall software is required, please contact engineer from the original equipment manufacturer.
01-01-53	Conveyor 4 encoder initial fail			
01-01-54	External parameter initial fail			
01-01-55	HRSS Loading fail			
01-01-58	FBWF memory consumption 128MB	FBWF memory consumption 128MB	FBWF anti-write memory is full to 128 MB	User needs to reboot
01-01-59	FBWF memory consumption 512MB	FBWF memory consumption 512MB	FBWF anti-write memory is full to 512 MB	User needs to reboot
01-01-60	FBWF file failed to open	FBWF file failed to open	File damage	Confirm that the file is damaged
01-01-80	Set infinite rotation for the external axis failed	Set infinite rotation for the external axis failed	The external axis is set to enable coupled coordinated movement, and cannot be set as an infinite rotation function.	Please disable the coordinated movement of the external axis first and then set the infinite rotation function.
01-01-81	The external axis must be set to synchronous mode	The external axis must be set to synchronous mode	It Was not set as synchronous mode correctly; movement abnormal.	Please set the external axis as synchronous mode.
01-01-82	The external axis must be set to asynchronous mode	The external axis must be set to asynchronous mode	It Was not set as asynchronous mode correctly; movement abnormal.	Please set the external axis as asynchronous mode.
01-01-83	External axis movement type error	External axis movement type error	External axis movement type setting error.	If it was originally set as linear axis, please change it to rotation axis; if it was

Error Code	Error Name	Message	Reason	Solution
				originally set as rotation axis, please change it to linear axis.
01-01-84	External axis tracking number error	External axis tracking number error	External axis tracking currently only supports E2 axis tracking E1; tracking number setting error.	The correct setting is to set the E2 axis to track the E1 axis.
01-01-85	External axis motion base error	External axis motion base error	Motion base of the external axis could not be correctly set.	Please confirm whether the calibration point for the coordinated coupling of the external axis is correct.

8.1.2 Program Error(01-02-XX)

Error Code	Error Name	Message	Reason	Solution
01-02-10	Program code incorrect	Program code format incorrect	Syntax error.	Check robot language. Please refer to 8.1.11Message modification.
	Program syntax error. Start Symbol should less than two	More than two starting symbol characters are set	More than two starting symbol characters are set	Set the correct starting symbol
	Program syntax error. Split Symbol should less than two	More than two delimiter characters are set	More than two delimiter characters are set	Set the starting symbol for the delimiter
	Program syntax error. End Symbol should less than two	More than two end symbol characters are set	More than two end symbol characters are set	Set the starting symbol for the end
	Format error	Argument format error	1.It is set as both the starting symbol and ending symbol simultaneously 2.Delimiter not set Set the symbol as matching format	1.Set the start symbol and end symbol 2.Set the delimiter Confirm that the symbol input conforms to the hexadecimal ASCII CODE
01-02-11	Try to repair the corrupted file. Please confirm the program content is correct before execute.	Program file open failure.	Files are damaged or lost.	Use backup file or create new file.
01-02-12	Program copy error	Program file copy error	Program file copy error	Please export the history record and send it back to original factory for analysis.

8.1.3 Motion Error(01-03-XX)

Error Code	Error Name	Message	Reason	Solution
01-03-10	Axis 1 following error too big	Axis 1 position over deviation	Axis 1 motion command or actual position exceeded deviation too big.	1. Reduce speed。 2. Reduce load. 3. Reduce acceleration.
01-03-11	Axis 2 following error too big	Axis 2 position over deviation	Axis 2 motion command or actual position exceeded deviation too big.	
01-03-12	Axis 3 following error too big	Axis 3 position over deviation	Axis 3 motion command or actual position exceeded deviation too big.	
01-03-13	01-03-13	Axis 4 following error too big	Axis 4 motion command or actual position exceeded deviation too big.	
01-03-14	01-03-14	Axis 5 following error too big	Axis 5 motion command or actual position exceeded deviation too big.	1. Reduce speed。 2. Reduce load. 3. Reduce acceleration.。
01-03-15	01-03-15	Axis 6 following error too big	Axis 6 motion command or actual position exceeded deviation too big.	
01-03-16	Axis 1 position overlimit of positive	Axis 1 exceeded positive rotation limit	Motion to Axis 1 reach positive limit	Axis 1 move negative
01-03-17	Axis 1 position overlimit of negative	Axis 1 exceeded negative rotation limit	Motion to Axis 1 reach negative limit	Axis 1 move positive

Error Code	Error Name	Message	Reason	Solution
01-03-18	Axis 2 position overlimit of positive	Axis 2 exceeded positive rotation limit	Motion to Axis 2 reach positive limit	Axis 2 move negative
01-03-19	Axis 2 position overlimit of negative	Axis 2 exceeded negative rotation limit	Motion to Axis 2 reach negative limit	Axis 2 move positive
01-03-1A	Axis 3 position overlimit of positive	Axis 3 exceeded positive rotation limit	Motion to Axis 3 reach positive limit	Axis 3 move negative
01-03-1B	Axis 3 position overlimit of negative	Axis 3 exceeded negative rotation limit	Motion to Axis 3 reach negative limit	Axis 3 move positive
01-03-1C	Axis 4 position overlimit of positive	Axis 4 exceeded positive rotation limit	Motion to Axis 4 reach positive limit Motion to	Axis 4 move negative
01-03-1D	Axis 4 position overlimit of negative	Axis 4 exceeded negative rotation limit	Axis 4 reach negative limit Motion to Axis 5 reach	Axis 4 move positive
01-03-1E	Axis 5 position overlimit of positive	Axis 5 exceeded positive rotation limit	positive limit	Axis 5 move negative
01-03-1F	Axis 5 position overlimit of negative	Axis 5 exceeded negative rotation limit	Motion to Axis 5 reach negative limit	Axis 5 move positive
01-03-20	Axis 6 position overlimit of positive	Axis 6 exceeded positive rotation limit	Motion to Axis 6 reach positive limit	Axis 6 move negative
01-03-21	Axis 6 position overlimit of negative	Axis 6 exceeded negative rotation limit	Motion to Axis 6 reach negative limit	Axis 6 move positive
01-03-30	XY coordinate overlimit of software	XY coordinates reached the limit	Motion to XY coordinate limit	Clear error and move in opposite limit direction
01-03-31	Joint overspeed	Shaft over speed	Reverse solution to determine a	Clear error and use PTP motion

Error Code	Error Name	Message	Reason	Solution
			shaft speed too fast.	
01-03-32	Wrist singularity	Near wrist singular point	Near wrist singular point	Try to avoid the singular point of motion
01-03-33	Shoulder singularity	Near shoulder singular point	Near shoulder singular point	
01-03-34	Elbow singularity	Near elbow singular point	Near elbow singular point	
01-03-40	Circle command 3 reference points on the same line	Circle command on the same line	Command setting error.	Check CIRC description.
01-03-41	Circle comm can't found center point	Unable to calculate center of circle in two point space		
01-03-42	Circle comm can't calculate transpose matrix	Circle command parameter error, unable to calculate transpose matrix		
01-03-50	Synchronize output queue overflow	Synchronize output command buffer overflow	Synchronize output command too much, causing buffer overflow	1. Please check if the connecting line is correctly connected, and turn off the power and then re-start. 2. Please contact engineer from the original equipment manufacturer.
01-03-51	Synchronize output overlimit	Synchronize output control command overlimit	Synchronize activate output command too much	
01-03-52	Found motion command when compliance teaching	During compliance tuning, send motion command	Motion command cannot be performed during compliance tuning.	Clear error and stop sending motion command
(next page)				

Error Code	Error Name	Message	Reason	Solution
01-03-53	Collision behavior occurred to axis 1	Collision behavior occurred to robot	1. Collision occurred 2. False alarm occurred	1. Clear the alarm and check whether the movement caused collision behaviors. 2. Please contact the engineer from the manufacturer.
01-03-54	Collision behavior occurred to axis 2			
01-03-55	Collision behavior occurred to axis 3			
01-03-56	Collision behavior occurred to axis 4			
01-03-57	Collision behavior occurred to axis 5			
01-03-58	Collision behavior occurred to axis 6			
01-03-59	Collision behavior occurred to axis E1			
01-03-5A	Collision behavior occurred to axis E2			
01-03-5B	Collision behavior occurred to axis E3			

Error Code	Error Name	Message	Reason	Solution
01-03-60	Load estimation file processing abnormal	File error	1. Missing file 2. File data error	1. Execute the load estimation function again. 2. Please contact the engineer from the manufacturer.
01-03-61	Load identification file abnormal		1. Missing file 2. File open error	
01-03-62	Identification parameter abnormal			
01-03-70	Axis 1 exceeded software lower limit	Position of axis 1 exceeded the setting value of the software lower limit	1. The end position command issued exceeded the setting value for the software lower limit of axis 1 2. The position of the robot while moving exceeded the setting value for the software lower limit of axis 1	1. Adjust the movement instruction position and avoid issuing commands that exceed the software limit movement direction. 2. Adjust the software limit setting value so that the robot movement range does not exceed the setting value.
01-03-71	Axis 1 exceeded software upper limit	Position of axis 1 exceeded the setting value of the software upper limit	1. The end position command issued exceeded the setting value for the software upper limit of axis 1 2. The position of the robot while moving exceeded the setting value for the software upper limit of axis 1	1. Adjust the movement instruction position and avoid issuing commands that exceed the software limit movement direction. 2. Adjust the software limit setting value so that the robot movement range does not exceed the setting value.

Error Code	Error Name	Message	Reason	Solution
01-03-72	Axis 2 exceeded software lower limit	Position of axis 2 exceeded the setting value of the software lower limit	1. The end position command issued exceeded the setting value for the software lower limit of axis 2 2. The position of the robot while moving exceeded the setting value for the software lower limit of axis 2	
01-03-73	Axis 2 exceeded software upper limit	Position of axis 2 exceeded the setting value of the software upper limit	1. The end position command issued exceeded the setting value for the software upper limit of axis 2 2. The position of the robot while moving exceeded the setting value for the software upper limit of axis 2	
01-03-74	Axis 3 exceeded software lower limit	Position of axis 3 exceeded the setting value of the software lower limit	1. The end position command issued exceeded the setting value for the software lower limit of axis 3	

Error Code	Error Name	Message	Reason	Solution
			2. The position of the robot while moving exceeded the setting value for the software lower limit of axis 3	
01-03-75	Axis 3 exceeded software upper limit	Position of axis 3 exceeded the setting value of the software upper limit	1. The end position command issued exceeded the setting value for the software upper limit of axis 3 2. The position of the robot while moving exceeded the setting value for the software upper limit of axis 3	1. Adjust the movement instruction position and avoid issuing commands that exceed the software limit movement direction. 2. Adjust the software limit setting value so that the robot movement range does not exceed the setting value.
01-03-76	Axis 4 exceeded software lower limit	Position of axis 4 exceeded the setting value of the software lower limit	1. The end position command issued exceeded the setting value for the software lower limit of axis 4 2. The position of the robot while moving exceeded the setting value for the software lower limit of axis 4	

Error Code	Error Name	Message	Reason	Solution
01-03-77	Axis 4 exceeded software upper limit	Position of axis 4 exceeded the setting value of the software upper limit	1. The end position command issued exceeded the setting value for the software upper limit of axis 4 2. The position of the robot while moving exceeded the setting value for the software upper limit of axis 4	
01-03-78	Axis 5 exceeded software lower limit	Position of axis 5 exceeded the setting value of the software lower limit	1. The end position command issued exceeded the setting value for the software lower limit of axis 5 2. The position of the robot while moving exceeded the setting value for the software lower limit of axis 5	
01-03-79	Axis 5 exceeded software upper limit	Position of axis 5 exceeded the setting value of the software upper limit	1. The end position command issued exceeded the setting value for the software lower limit of axis 5	1. Adjust the movement instruction position and avoid issuing commands that exceed the software limit movement direction. 2. Adjust the software limit setting value so that the robot

Error Code	Error Name	Message	Reason	Solution
			2. The position of the robot while moving exceeded the setting value for the software lower limit of axis 5	movement range does not exceed the setting value.
01-03-7A	Axis 6 exceeded software lower limit	Position of axis 6 exceeded the setting value of the software lower limit	1. The end position command issued exceeded the setting value for the software lower limit of axis 6 2. The position of the robot while moving exceeded the setting value for the software lower limit of axis 6	
01-03-7B	Axis 6 exceeded software upper limit	Position of axis 6 exceeded the setting value of the software upper limit	1. The end position command issued exceeded the setting value for the software upper limit of axis 6 2. The position of the robot while moving exceeded the setting value for the software upper limit of axis 6	
01-03-7C	Tool center exceeded the	Position of tool center exceeded	1. The end position	

<table>
<tr><th>Error Code</th><th>Error Name</th><th>Message</th><th>Reason</th><th>Solution</th></tr>
<tr><td></td><td>software lower limit of X</td><td>the setting value for the software lower limit of X</td><td>command issued exceeded the setting value for the software lower limit of X
2. The position of the robot while moving exceeded the setting value for the software lower limit of X</td><td></td></tr>
<tr><td>01-03-7D</td><td>Tool center exceeded the software upper limit of X</td><td>Position of tool center exceeded the setting value for the software upper limit of X</td><td>1. The end position command issued exceeded the setting value for the software upper limit of X
2. The position of the robot while moving exceeded the setting value for the software upper limit of X</td><td rowspan="3">1. Adjust the movement instruction position and avoid issuing commands that exceed the software limit movement direction.
2. Adjust the software limit setting value so that the robot movement range does not exceed the setting value.</td></tr>
<tr><td>01-03-7E</td><td>Tool center exceeded the software lower limit of Y</td><td>Position of tool center exceeded the setting value for the software lower limit of Y</td><td>1. The end position command issued exceeded the setting value for the software lower limit of X
2. The position of the robot while moving exceeded the setting value for the software lower limit of X</td></tr>
<tr><td>01-03-7F</td><td>Tool center exceeded the</td><td>Position of tool center exceeded</td><td>1. The end position</td></tr>
</table>

Error Code	Error Name	Message	Reason	Solution
	software upper limit of Y	the setting value for the software upper limit of Y	command issued exceeded the setting value for the software upper limit of X 2. The position of the robot while moving exceeded the setting value for the software upper limit of X	
01-03-80	Tool center exceeded the software lower limit of Z	Position of tool center exceeded the setting value for the software lower limit of Z	1. The end position command issued exceeded the setting value for the software lower limit of X 2. The position of the robot while moving exceeded the setting value for the software lower limit of X	
01-03-81	Tool center exceeded the software upper limit of Z	Position of tool center exceeded the setting value for the software upper limit of Z	1. The end position command issued exceeded the setting value for the software upper limit of Z 2. The position of the robot while moving exceeded the setting value for the software upper limit of Z	1. Adjust the movement instruction position and avoid issuing commands that exceed the software limit movement direction. 2. Adjust the software limit setting value so that the robot movement range does not exceed the setting value.
01-03-82	Tool center exceeded the	Position of tool center exceeded	1. The end position	

Error Code	Error Name	Message	Reason	Solution
	software lower limit of the radius	the setting value for the software lower limit of the radius	command issued exceeded the setting value for the software lower limit of the radius 2. The position of the robot while moving exceeded the setting value for the software lower limit of the radius	
01-03-83	Tool center exceeded the software upper limit of the radius	Position of tool center exceeded the setting value for the software upper limit of the radius	1. The end position command issued exceeded the setting value for the software upper limit of the radius 2. The position of the robot while moving exceeded the setting value for the software upper limit of the radius	
01-03-84	Instruction TL_SET execution error	Instruction TL_SET execution error	1.Torque limit detection limit range setting error 2.Setting limit parameter issued while stopping the execution of torque limit detection	Refer to the software manual and follow the instructions carefully.

Error Code	Error Name	Message	Reason	Solution
01-03-85	Instruction TL_START execution error	Instruction TL_START execution error	Start instruction issued while torque limit parameters not set	Refer to the software manual and follow the instructions arefully.
01-03-87	Axis 1 torque over max setting value.	Axis 1 overload, excessive torque.	Axis 1 overload.	1. Reduce the operating speed. 2. Reduce the payload.
01-03-88	Axis 2 torque over max setting value.	Axis 2 overload, excessive torque.	Axis 2 overload.	
01-03-89	Axis 3 torque over max setting value.	Axis 3 overload, excessive torque.	Axis 3 overload.	
01-03-8A	Axis 4 torque over max setting value.	Axis 4 overload, excessive torque.	Axis 4 overload.	
01-03-8B	Axis 5 torque over max setting value.	Axis 5 overload, excessive torque.	Axis 5 overload.	
01-03-8C	Axis 6 torque over max setting value.	Axis 6 overload, excessive torque.	Axis 6 overload.	

8.1.4 Operation Erro(01-04-XX)

Error Code	Error Name	Message	Reason	Solution
01-04-10	Read driver 1 encoder is abnormality	Axis 1 absolute encoder position error	Read axis 1 encoder under moving status	Please confirm whether the brake shaft is falling.
01-04-11	Read driver 2 encoder is abnormality	Axis 2 absolute encoder position error	Read axis 5 encoder under moving status	
01-04-12	Read driver 3 encoder is abnormality	Axis 3 absolute encoder position error	Read axis 3 encoder under moving status	
01-04-13	Read driver 4 encoder is abnormality	Axis 4 absolute encoder position error	Read axis 4 encoder under moving status	
01-04-14	Read driver 5 encoder is abnormality	Axis 5 absolute encoder position error	Read axis 5 encoder under moving status	
01-04-15	Read driver 6 encoder is abnormality	Axis 6 absolute encoder position error	Read axis 6 encoder under moving status	
01-04-16	Write data to driver 1 is abnormality	Axis 1 driver parameter write back failed	Driver 1 connection is abnormality	Check driver 1 connection.
01-04-17	Write data to driver 2 is abnormality	Axis 2 driver parameter write back failed	Driver 2 connection is abnormality	Check driver 2 connection.
01-04-18	Write data to driver 3 is abnormality	Axis 3 driver parameter write back failed	Driver 3 connection is abnormality	Check driver 3 connection.
01-04-19	Write data to driver 4 is abnormality	Axis 4 driver parameter write back failed	Driver 4 connection is abnormality	Check driver 4 connection.
01-04-1A	Write data to driver 5 is abnormality	Axis 5 driver parameter write back failed	Driver 5 connection is abnormality	Check driver 5 connection.
01-04-1B	Write data to driver 6 is abnormality	Axis 6 driver parameter write back failed	Driver 6 connection is abnormality	Check driver 6 connection.

Error Code	Error Name	Message	Reason	Solution
01-04-1C	Clear driver 1 encoder is abnormality	Clear Axis 1 driver encoder failed	Driver 1 connect is abnormality. 2. The command is forbidden	1.Check driver 1 connected. 2.Check driver 1 status.
01-04-1D	Clear driver 2 encoder is abnormality	Clear Axis 2 driver encoder failed	Driver 2 connect is abnormality. 2. The command is forbidden	1.Check driver 2 connected. 2.Check driver 2 status.
01-04-1E	Clear driver 3 encoder is abnormality	Clear Axis 3 driver encoder failed	Driver 3 connect is abnormality. 2. The command is forbidden	1.Check driver 3 connected. 2.Check driver 3 status.
01-04-1F	Clear driver 4 encoder is abnormality	Clear Axis 4 driver encoder failed	Driver 4 connect is abnormality. 2. The command is forbidden	1.Check driver 4 connected. 2.Check driver 4 status.
01-04-20	Clear driver 5 encoder is abnormality	Clear Axis 5 driver encoder failed	Driver 5 connect is abnormality. 2. The command is forbidden	1.Check driver 5 connected. 2.Check driver 5 status.
01-04-21	Clear driver 6 encoder is abnormality	Clear Axis 6 driver encoder failed	Driver 6 connect is abnormality. 2. The command is forbidden	1.Check driver 6 connected. 2.Check driver 6 status.
01-04-30	Start position declination is abnormality	Robot position declination	The robot's position is different from when it was last powered off.	Please move to the origin and confirm that the angle is correct. Refer 3.6
01-04-31	A1 declination is abnormality			
01-04-32	A2 declination is abnormality			
01-04-33	A3 declination is abnormality			
01-04-34	A4 declination is abnormality			
01-04-35	A5 declination is abnormality			

Error Code	Error Name	Message	Reason	Solution
01-04-36	A6 declination is abnormality			
01-04-37	Axis E1 position exceeded deviation			
01-04-38	Axis E2 position exceeded deviation			
01-04-39	Axis E3 position exceeded deviation			
01-04-40	RSR(&NUM) no file	RSR file not set	RSR execution file not set	Confirm that the execution file is set.
01-04-41	PNS(&NUM) no file	PNS file not set	PNS execution file not set	
01-04-50	ISR delay stack overflow	ISR delay buffer overflow	ISR delay buffer overflow	1. Please turn off the power and then re-start. 2. please contact engineer from the original equipment manufacturer.
01-04-51	Motion command queue overflow	Motion command buffer overflow	Motion command too much, causing buffer overflow	1. Please turn off the power and then re-start. 2. If it is still unable to resolve,please contact engineer from the original equipment manufacturer.
01-04-52	Jog queue overflow	Jog command buffer overflow	Jog command too much, causing buffer overflow	
01-04-53	Interpolation buffer overflow	Interpolation command buffer overflow	Interpolation command too much, causing buffer overflow	
01-04-60	Modify Time Setting	* Time is modified, will not shutdown.	Time Setting is modified, will not shutdown	Inform user time setting is modified, will not shutdown
01-04-61	Modify NTP Setting	*NTP is modified, will not shutdown.	NTP Setting is modified, will not shutdown	Inform user NTP is modified, will not shutdown
01-04-70	Infinite rotation is not turned on.	Infinite rotation is not turned on.	User operates infinite rotation in	After the user turns on the infinite rotation function in

Error Code	Error Name	Message	Reason	Solution
			infinite rotation function interface, and executes the CT_A6 command.	the interface, the user executes the CT_A6 command.

8.1.5 IO & Communication(01-05-XX)

Error Code	Error Name	Message	Reason	Solution
01-05-10	Teach Pendant connection error	TP connection error	1.TP destroy. 2.TP connection port is abnormal.	1.Change TP. 2.Check connect port.
01-05-20	ROBOT IO connection error	Robot IO connection error	Interference	Confirm RIO wire.
01-05-21	ROBOT IO disconnection	Robot IO disconnection	1.Robot IO destroy 2.Robot IO port is abnormal.	1. Change Robot IO. 2. Confirm RIO port.
01-05-30	Network disconnection	Network disconnection	Network is abnormal.	Check network connection.
01-05-31	Network connect failure	Network connect failure	Network server is abnormal.	1.Check network connection server. 2.Check network domain. 3.Check connection IP and PORT setting
01-05-32	Server opened failure	Server opened failure	Server opened failure	Check connection IP and PORT setting
01-05-33	Server closed the connection	Sever connection closed	Sever automatically closed connection	Prevent sever automatically disconnect from client
01-05-34	Network port setting error	Network port setting error	Network port setting error	Check port setting.
01-05-35	Network client disconnect time out	Network client disconnect time out	Network client disconnect time out	Check sever whether interact with client disconnect message
01-05-42	Serial IO disconnected	Serial IO disconnected	Cause of disconnection	Reconnect serial IO

8.1.6 Operator Error(01-06-XX)

Error Code	Error Name	Message	Reason	Solution
01-06-10	Motion delay command abnormality	Parameter cannot be set	Parameter is not within the range to be set	Check parameter.
01-06-11	Acceleration setting command abnormality	Parameter cannot be set		
01-06-12	PTP motion command abnormality	PTP motion failed	1.Command format error. 2.Unable to give motion command instruction	1. Confirm the command format. 2. Confirm the motion function status。
01-06-13	Circle motion command abnormality	CIRC motion failed		
01-06-14	Line motion command abnormality	LIN motion failed		
01-06-15	Feedspeed setting command abnormality	Parameter cannot be set	Parameter cannot be set.	Check parameter.
01-06-16	Path abnormality	Moving path abnormality	The moving path is out of working range.	Re-design the position of point and the action instruction, or check if the setting of Tool and Base has any error.
01-06-17	Setting conveyor tracking acceleration error	Parameter setting error	Parameter out of the range	Check the parameter setting is correct.
01-06-18	Setting conveyor pick acceleration error			
01-06-19	Enable smooth motion error			

Error Code	Error Name	Message	Reason	Solution
01-06-1A	Disable smooth motion error			
01-06-20	Counter index abnormality	Parameter cannot be set	Index not within setting range	Confirm Index No.
01-06-21	Timer index abnormality			
01-06-22	Counter stop number abnormality			
01-06-23	DI index abnormality			
01-06-24	DO index abnormality			
01-06-25	RI index abnormality			
01-06-26	RO index abnormality			
01-06-27	VI index abnormality			
01-06-28	VO index abnormality			
01-06-29	SI index abnormality			
01-06-2A	SO index abnormality			
01-06-2B	SR index abnormality			
01-06-2C	SRW index abnormality			
01-06-30	DI can't be setting		DI setting unavailable	DI not set
01-06-31	RI can't be setting		RI setting unavailable	RI not set
01-06-32	SI can't be setting		SI setting unavailable	SI not set
01-06-33	SO can't be setting		Specific SO setting not available	Specific SO not set

<table>
<tr><th>Error Code</th><th>Error Name</th><th>Message</th><th>Reason</th><th>Solution</th></tr>
<tr><td>01-06-34</td><td>SRR can't be setting</td><td></td><td>SRR setting not available</td><td>SRR not set</td></tr>
<tr><td>01-06-35</td><td>SRW value abnormality</td><td>SRW value is abnormal.</td><td>Parameter error.</td><td>Check setting command.</td></tr>
<tr><td>01-06-36</td><td>Fieldbus Slot1 abnormality</td><td>Fieldbus Slot1 abnormality</td><td rowspan="2">1.Parameter setting error.
2.Driver is not installed.
3. Fieldbus connection abnormal.</td><td rowspan="2">1.Set the correct parameters.
2.Confirm that the driver installation is completed.
3Check the hardware wiring.</td></tr>
<tr><td>01-06-37</td><td>Fieldbus Slot2 abnormality</td><td>Fieldbus Slot2 abnormality</td></tr>
</table>

8.1.7 External Axis Error(01-07-XX)

Error Code	Error Name	Message	Reason	Solution
01-07-10	E1 axis following error overlimit	E1 axis position over deviation	E1 axis motion command and actual position exceeded deviation	1. Reduce the speed 2. Reduce the load weight 3.Reduce acceleration in percentage
01-07-11	E2 axis following error overlimit	E2 axis position over deviation	E2 axis motion command and actual position exceeded deviation	
01-07-12	E3 axis following error overlimit	E3 axis position over deviation	E3 axis motion command and actual position exceeded deviation	
01-07-13	E1 axis position overlimit of positive	E1 axis exceeded positive rotation limit	Over the positive limit.	E1 axis move towards negative
01-07-14	E1 axis position overlimit of negative	E1 axis exceeded negative rotation limit	Over the negative limit.	E1 axis move towards positive
01-07-15	E2 axis position overlimit of positive	E2 axis exceeded positive rotation limit	Over the positive limit.	E2 axis move towards negative
01-07-16	E2 axis position overlimit of negative	E2 axis exceeded negative rotation limit	Over the negative limit.	E2 axis move towards positive
01-07-17	E3 axis position overlimit of positive	E3 axis exceeded positive rotation limit	Over the positive limit.	E3 axis move towards negative
01-07-18	E3 axis position overlimit of negative	E3 axis exceeded negative rotation limit	Over the negative limit.	E3 axis move towards positive

01-07-19	E1 axis clear encoder error	E1 axis driver clear encoder failed	1.Connection with axis E1 is abnormal. 2.Axis E1 prohibits this command.	1.Check Axis E1 is connected. 2.Check Axis E1 status.
01-07-1A	E2 axis clear encoder error	E2 axis driver clear encoder failed	1.Connection with axis E2 is abnormal. 2.Axis E2 prohibits this command.	1.Check Axis E2 is connected. 2.Check Axis E2 status.
01-07-1B	E3 axis clear encoder error	E3 axis driver clear encoder failed	1.Connection with axis E3 is abnormal. 2.Axis E3 prohibits this command.	1.Check Axis E3 is connected. 2.Check Axis E3 status.
01-07-1F	Axis E1 torque over max setting value	Axis E1 overload, excessive torque.	Axis E1 overload.	
01-07-20	Axis E2 torque over max setting value	Axis E2 overload, excessive torque.	Axis E2 overload.	1. Reduce the operating speed. 2. Reduce the payload.
01-07-21	Axis E3 torque over max setting value	Axis E3 overload, excessive torque.	Axis E3 overload.	

8.1.8 Conveyor Tracking Error(01-08-XX)

Error Code	Error Name	Message	Reason	Solution
01-08-10	Camera connection failure	Connection with the vision system is failed.	1.IP setting error. 2.PORT setting error.	1.Check IP setting. 2.Check Port setting.
01-08-11	Camera connection abnormality	Connection with the vision system is failed.	Vision system no response.	Confirm the connection with the vision system.
01-08-12	Camera disconnect fail	Connection with the vision system is failed.		
01-08-13	Pick command error	Execution instruction is failed.	Point setting error.	Please confirm if the information of point position is entered into the instruction.
01-08-14	Place command error			
01-08-15	Conveyor encoder clear error	Encoder clear failed.	Encoder clear failed.	Check the conveyor wiring is correct
01-08-16	Setting latch source error	Setting latch source error	Setting latch failed	
01-08-17	Start conveyor command error	Start conveyor failed	Conveyor setting failed	Check conveyor setting is correct.
01-08-18	Read encoder count error	Read encoder error	Encoder fault	Check encoder and wiring.

Error Code	Error Name	Message	Reason	Solution
01-08-19	Clear place data error	Data clearing failed	Place clearing failed	Contact an engineer from the original equipment manufacturer.
01-08-1A	CNV_OBJECT can't be setting	Unavailable to set parameters	Unavailable to set parameters	Check Robot Language.
01-08-1B	CNV_FULL can't be setting			
01-08-1C	CNV_EMPTY can't be setting			
01-08-1E	Encoder latch value inconsistent	Encoder latch value inconsistent	Trigger sensor or encoder error.	Check the trigger sensor and the encoder is normal.

8.1.9 User-Defined Error(01-09-XX)

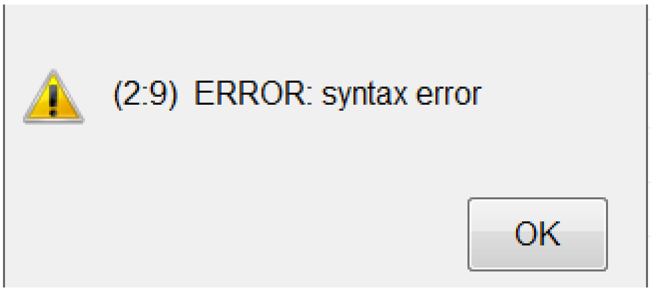
Error Code	Error Name	Message	Reason	Solution
01-09-10	User-defined error 1	User-defined error 1	User-defined error 1	User-defined error 1
01-09-11	User-defined error 2	User-defined error 2	User-defined error 2	User-defined error 2
01-09-12	User-defined error 3	User-defined error 3	User-defined error 3	User-defined error 3
01-09-13	User-defined error 4	User-defined error 4	User-defined error 4	User-defined error 4
01-09-14	User-defined error 5	User-defined error 5	User-defined error 5	User-defined error 5
01-09-15	User-defined error 6	User-defined error 6	User-defined error 6	User-defined error 6
01-09-16	User-defined error 7	User-defined error 7	User-defined error 7	User-defined error 7
01-09-17	User-defined error 8	User-defined error 8	User-defined error 8	User-defined error 8
01-09-18	User-defined error 9	User-defined error 9	User-defined error 9	User-defined error 9
01-09-19	User-defined error 10	User-defined error 10	User-defined error 10	User-defined error 10

8.1.10Authorization Error(01-0B-XX)

Error Code	Error Name	Message	Reason	Solution
01-0B-10	You have no license of HRSDK	You have no license of HRSDK	1. . SDK is not enabled. 2. Function is not authorized.	1.With the original purchase authorization. 2. Check whether the authorized device is connected normally.
01-0B-11	You have no license of Fieldbus	You have no license of Fieldbus		
01-0B-12	You have no license of External Axis	You have no license of External Axis		
01-0B-13	You have no license of External TCP	You have no license of External TCP		
01-0B-14	You have no license of Continuous Turn	You have no license of Continuous Turn		

8.1.11 Windows Information

When the program is executed, if the program syntax is wrong, the following window will appear



1.The above figure as an example, the message is divided into two main parts:

1. Error location: (2: 9), on behalf of 9^{th} words on line 2 is wrong.
2. Error message: syntax error

Error message description:

Error Code	Error Name	Message	Reason	Solution
01-02-10	syntax error	Syntax error	Command spelling error. Wrong space.	Check spelling and spaces.
01-02-10	ID not exist	Variable not exist	Variable not declared.	Declare variable before use.
01-02-10	Unknown character	Character cannot be recognized	Use special symbols.	Change variable name.
01-02-10	… is not declared	Variable not declared	Variable not declared.	Declare variable before use.
01-02-10	Invalid value	Invalid value	Value out of range	Modify value according to instruction
01-02-10	Index of … is out of range	Index is out of range	Array index out of range	Modify array index
01-02-10	Type should be …	Type error	Type error.	Change to the correct type.
01-02-10	Fail in handling STRUC member expression	Structure member variable expression error	Struct member not declared.	Check the declaration of structure variables.

8.2 HIWIN robot controller(02-XX-XX)

8.2.1 Safety Input(02-01-XX)

Error Code	Error Name	Message	Reason	Solution
02-01-10	Emergency input	Emergency stop signal disconnect	Emergency stop trigger.	Release the emergency stop and clear the error.
02-01-11	Enable switch down	Enable switch down	Enable switch is pressed to the third paragraph.	Release enable switch.

8.2.2 Hardware Error(02-02-XX)

Error Code	Error Name	Message	Reason	Solution
02-02-11	No motor brake signal	Do not receive motor brake signal	1. Hardware abnormalities. 2. The emergency stop status is excluded within 500 milliseconds.	1. Contact with the engineer from the original equipment manufacturer. 2. Press emergency stop again, over 500 millisecond.

8.3 Axis amplifier(03-XX-XX)

8.3.1 Function Name and Number Description

Error Code	Error Name	Message
Axis number(m)	0m	m: axis umber. ex 03-01-21：axis 1 alarm, 03-02-21：axis 2 alarm, and so on.
Ext axis number (n)	En	n: external axis number ex：03-E1-21-> external axis 1 alarm, 03-E2-21->external axis 2 alarm, and so on.

8.3.2 Driver Alart Number

Error Code	Error Name	Message	Reason	Solution
03-0m(En)-21	overcurrent	Current exceeds the specified value	1.Driver is abnormal. 2. Motor U, V, W is short circuit. 3.Motor is broken.	1. Check the servomotor main circuit cable connection. 2. Replace the driver. 3. Replace the motor.
03-0m(En)-25	STO	Safety input protection.	Safety input signal.	Check the safety input signal status.
03-0m(En)-26	Safe torque off abnormal	Safe torque off abnormal.	Safety input signal.	Check the safety input signal status.
03-0m(En)-27	Single circuit STO	Safe input protection.	Safety input signal.	Check the safety input signal status.
03-0m(En)-30	Current control error	Current control error	1. Servo malfunction. 2. Motor malfunction.	1. Check the parameter id_pwr_board, write 100W: manufacture_data =2 I2CEE.Sate=11 400W: manufacture_data =3 I2CEE.Sate=11 2. Change the motor.
03-0m(En)-32	HFLT inconsistent	HFLT inconsistent	1. Servo malfunction.	1. Change the DA module of that axis.

Error Code	Error Name	Message	Reason	Solution
			2. Electrical interference.	2. Keep away and remove interference sources, or implement EMC countermeasures of magnetic rings.
03-0m(En)-34	DC bus voltage abnormal	DC bus voltage abnormal	1. Servo malfunction 2. Insufficient capacitance for the driver.	1. Change the DA/DP module. 2. Change the HCV1 module.
03-0m(En)-35	ECAT interface cannot be detected	ECAT interface cannot be detected	1. Firmware version error. 2. EtherCAT communication interface of driver malfunctioned.	1. Confirm that the firmware version is 8.197 or above. 2. Check whether the connector pins of the DA module are short-circuited, and replace the DA module.
03-0m(En)-36	CiA-402 reset error	CiA-402 reset error	This process cannot be completed.	Reconnect the power and execute (reload the DA module parameters).
03-0m(En)-37	Fan error	Fan error	1. Fan cable disconnected, fan stuck or too dirty. 2. Continuous alarm from the DA module of a specific axis.	1. Change the fan. 2. Change the HCV1 backboard or DA module.
03-0m(En)-38	Absolute encoder error	Absolute encoder error	1. Power of encoder in robot abnormal. 2. Battery has no voltage or low voltage. 3. Parallel battery failure or reversed polarity 4. Battery wiring installation abnormal. 5. Did the upper position send the	1. Change the power supply. 2. Change the battery. 3. Confirm the battery life or change the battery. 4. Adjust the wiring. 5. Send the correct clear instruction (enter the value 7 for SDO object number: 0x2060).

Error Code	Error Name	Message	Reason	Solution
			correct clear instruction?	
03-0m(En)-41	overload	Torque is too large.	1.The effective torque exceeds the rated torque. 2. The motor's hold brake is not released. 3. Power supply wiring is incorrect	1. Change the motion plan, or reduce load. 2. Check that the wiring and the driver voltage are correct.
03-0m(En)-43	regenerative resistor overload	Regenerative load rate is too large.	1. Insufficient external regeneration resistor capacity. 2. Amplifier failed.	1.Replace the external regeneration resistor capacity 2. Replace amplifier
03-0m(En)-45	overspeed	Exceeded average rotational speed	The servomotor speed is above the maximum rotational speed	Change operating conditions.
03-0m(En)-51	amplifier thermal abnormality	The amplifier temperature is too high.	1. Regenerative power is too large. 2. The surrounding air temperature is too high. 3. Built-in Fan in amplifier Stopped.	1. Change the amplifier installation conditions. 2. Check whether the cooling fan is running.
03-0m(En)-52	Anti-surge resistor overheat	Anti-Surge resistor overheated.	1.Power switch frequency is too high. 2.Ambient temperature is too high.	1.Reduce the power switch frequency. 2-1.Check the cooling fan is running. 2-2. Change the amplifier installation conditions.
03-0m(En)-53	dynamic brake resistor overheat	Dynamic brake resistor overheated.	Dynamic brake action frequency is too high.	Used within the allowable operating frequency range
03-0m(En)-58	Drive temperature overheat	Drive temperature overheat	1. Drive environment is overheated. 2. Motor overload.	1. Confirm drive cooling mode is normal. 2. Confirm electrical control box is in a ventilated condition

Error Code	Error Name	Message	Reason	Solution
			3. Motor speed too fast.	3. Reduce the load weight. 4. Reduce arm speed.
03-0m(En)-61	overvoltage	Main circuit DC voltage is excessively high.	1. The power supply exceeded the allowable range. 2. The moment of inertia ratio exceeded the allowable value.	1. Measure the power supply voltage 2. Confirm that the moment of inertia ratio is within the allowable range.
03-0m(En)-62	undervoltage	Main circuit DC voltage is excessively low.	1. Input supply voltage is below the allowable range. 2. The power supply is unstable, or was influenced by a lightning surge.	Set AC power supply voltage within the specified range.
03-0m(En)-71	control power source voltage shortage	The voltage of the control power is too low.	1. Input supply voltage is below the allowable range. 2. The power supply is unstable, or was influenced by a lightning surge.	1. Set AC power supply voltage within the specified range.
03-0m(En)-72	control circuit voltage shortage	The control circuit voltage is insufficient	1. Contact fault of connector or incorrect wiring for encoder cable. 2.The amplifier internal circuit is bad.	1. Re-insert the connector and confirm that the encoder is correctly wired. 2.Replace amplifier.
03-0m(En)-81	encoder disconnect	Encoder signal is disconnected.	1. Wrong connection. 2. Connector off. 3. Poor connection	1.Check the encoder cable. 2. Check the power supply voltage(5VDC) on the motor side.
03-0m(En)-84	encoder communication abnormality	Encoder Communications Error	1. Malfunction caused by noise interference.	1. Correct the wiring around the encoder by separating the encoder

Error Code	Error Name	Message	Reason	Solution
			2. Contact fault of connector or incorrect wiring for encoder cable.	cable from the servomotor main circuit cable or by checking the grounding and other wiring. 2. Check the encoder cable.
03-0m(En)-85	encoder initial error(5V abnormality)	Encoder initial error	1. Wrong connection. 2. Connector off. 3. Poor connection.	1.Check the encoder cable. 2. Check the power supply voltage(5VDC) on the motor side.
03-0m(En)-87	encoder CS abnormality	Encoder CS signal disconnect.	1. Wrong connection. 2. Connector off. 3. Poor connection.	1.Check the encoder cable. 2. Check the power supply voltage(5VDC) on the motor side.
03-0m(En)-A1	encoder multi-turn data error (battery abnormality)	Encoder Backup Error	1. The encoder cable disconnected, and connected again. 2. The battery voltage is low.	1. Check the encoder connector battery or the connect or contact status. 2. Measure the battery voltage.
03-0m(En)-A3	encoder overspeed	overspeed	Servomotor speed is too high.	Motor acceleration exceeds allowable acceleration range.
03-0m(En)-A5	encoder single turn error	Detected encoder single turn error	1. Excessive noise to the encoder cable. 2. The amplifier internal circuit is bad.	1. Check noise in the cable between the SERVOPACK and the host controller. 2. Re-insert the connector and confirm that the encoder is correctly wired.
03-0m(En)-A6	encoder multi-turn error	Detected encoder single turn error		
03-0m(En)-A9	encoder overheat	The amplifier temperature is too high.	1. The surrounding air temperature is too high. 2. Motor is overheated.	Change motor installation method.
03-0m(En)-AB	encoder error	An encoder error was detected.	1. Excessive noise to the encoder cable. 2. The amplifier internal circuit is bad.	1. Check noise in the cable between 2. If the restart cannot be solved, please replace the motor.

Error Code	Error Name	Message	Reason	Solution
03-0m(En)-C1	speed overlimit	The speed of the motor exceeds 120% of the maximum speed.	Overshoot too big.	1. Adjust the servo parameters. 2. Slow command acceleration and deceleration mode.
03-0m(En)-D1	position error too big	Position deviation exceeded the set value	1. Load inertia is too large. 2. The brake is not released. 3. The position command frequency is too high.	1. Change the load conditions, or replace a larger capacity motor. 2. Check the encoder cable. 3. Change the controller's position command.
03-0m(En)-E1	EEPROM abnormality	EEPROM abnormality	The driver internal circuit is bad.	Replace the driver.
03-0m(En)-E2	EEPROM check is abnormality	EEPROM check is abnormality	The CPU cannot read the correct data from the driver's built-in EEPROM.	
03-0m(En)-EF	Motor not matching	The amplifier does not match the motor.	Use the wrong driver or motor.	Replace the correct driver or motor.
03-0m(En)-F3	amplifier error	amplifier error	amplifier error	According to the driver brand, compare the driver Error code.
03-0m(En)-F4	software thermal reach limit	Motor reaches temperature limit.	Motor temperature is too high.	Reduce speed or reduce load.
03-0m(En)-F5	motor disconnect	Motor cannot connect.	Motor disconnect.	Check the motor cable.
03-0m(En)-F6	amplifier phase initial error	amplifier phase initial error	Phase initialization failed.	1. Replace motor or driver. 2. Check the cable.
03-0m(En)-F7	Hall sensor error	Hall sensor error.	Hall sensor error.	
03-0m(En)-F8	Hall phase error	Hall phase error.	Hall phase check error.	
03-0m(En)-F9	overload warning	* Overload warning. Robot will not stop	The effective torque exceeds the set torque.	Relax the conditions of use.

Error Code	Error Name	Message	Reason	Solution
03-0m(En)-FA	amplifier overheating warning	*Amplifier overheated warning. Robot will not stop.	The temperature around the amplifier is greater than the preset temperature range.	Reduce the ambient temperature.
03-0m(En)-FB	regenerated overload warning	* Regenerative overload warning. Robot will not stop	Regenerated resistance overload.	Relax the conditions of use.
03-0m(En)-FC	detecting power failure	* Detecting power failure. Robot will not stop.	Detected control power input voltage is insufficient.	1. Check if the input power supply has momentary or low voltage status. 2. Maybe the internal circuit of the amplifier is abnormal. If this alarm occurs for a long time, replace an amplifier.
03-0m(En)-FD	main circuit is abnormal	* Main voltage is abnormal. Robot will not stop.	Main power voltage exceeds DC 105V.	1. Check input mains voltage is within specifications. (Three-phase：AC200～230V+10，－15%，50/60Hz±3Hz) 2. The inertia of the load may be too large, reducing the load inertia. 3. For regenerative resistors, the wiring may not be correct or the impedance does not match the cause of the problem. Check that the impedance of the wiring or external resistor meets the specifications in this manual.

Error Code	Error Name	Message	Reason	Solution
03-0m(En)-FE	battery insufficient	* The battery voltage is low.	Measure the battery voltage.	Replace the battery.
03-0m(En)-FF	battery empty	The battery voltage is empty.	Battery is empty	User should replace with a new battery immediately.

8.3.3 DAC - Y Driver Alarm Code(Y-XXX)

Error Code	Error Name	Message	Reason	Solution
Y-020	Parameters and check abnormal.	Servo unit is abnormal	Data of internal parameter of SERVOPACK is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-021	Parameters format abnormal.	Servo unit is abnormal	Data format of internal parameter of SERVOPACK is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-022	System and calibration abnormal.	Servo unit is abnormal	Data of internal parameter of SERVOPACK is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-030	Main loop detected abnormal.	Servo unit is abnormal	Servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-040	Parameters setting abnormal.	Servo unit is abnormal.	Data of internal parameter of SERVOPACK is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-041	Division pulse output setting abnormal.	Parameter setting abnormal.	Parameter setting is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-042	Parameters combinatio n abnormal.	Parameter setting abnormal.	Parameter setting is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.

Error Code	Error Name	Message	Reason	Solution
Y-044	Semi/closed loop/ Full close loop parameters.	Parameter setting abnormal.	Parameter setting is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-050	Combinatio n error.	Servo unit is abnormal.	Servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-051	Product is not supported.	Servo unit is abnormal.	Servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-0B0	Servo ON command is invalid.	Servo unit is abnormal.	Servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-100	Overcurrent detection	Servo unit is abnormal.	Servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-300	Abnormal regeneratio n	Servo unit is abnormal.	Servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-320	Regenerativ e overload	Regeneration overload alarm.	Regenerative resistor capacity is insufficient or it is in a continuous regeneration state.	1. Please turn off the power and restart. 2. Review the operating conditions. 3. Please contact the engineer from manufacturer.
Y-330	Main circuit power	Servo unit is abnormal.	Servo unit is abnormal.	1. Please turn off the power and restart.

Error Code	Error Name	Message	Reason	Solution
	wiring error.			2. Please contact the engineer from manufacturer.
Y-400	Overvoltage	Servo unit is abnormal.	Servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-410	Insufficient voltage	Servo unit is abnormal.	Servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-450	Main circuit capacitor overvoltage.	Servo unit is abnormal.	Servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-510	Overspeed	Motor speed is above maximum speed.	Command input value is too high or the servo unit is abnormal.	1. Adjust the operating conditions. 2. Please turn off the power and restart. 3. Please contact the engineer from manufacturer.
Y-511	Division pulse output overspeed.	Servo unit is abnormal.	Servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-520	Vibration alarm	Abnormal vibration of motor speed is detected.	Command input value is too high or the servo unit is abnormal.	1. Adjust the operating conditions. 2. Please turn off the power and restart. 3. Please contact the engineer from manufacturer.

Error Code	Error Name	Message	Reason	Solution
Y-521	Advanced auto-tune alert.	The vibration was detected in the adjustment-free function.	When the adjustment function is executed, the motor vibrates greatly.	1. Adjust the operating conditions. 2. Please turn off the power and restart. 3. Please contact the engineer from manufacturer.
Y-710 (moment) Y-720 (continuous)	Overload	Exceeded the maximum payload.	The motor runs beyond the overload protection feature.	1. Adjust the operating conditions. 2. Please turn off the power and restart. 3. Please contact the engineer from manufacturer.
Y-730 Y-731	DB overload.	The power consumption of the detected DB is too large.	The motor is driven by an external force or the servo unit is abnormal.	1. Do not drive the motor by external force. 2. Please turn off the power and restart. 3. Please contact the engineer from manufacturer.
Y-740	The surge current limit resistor is overloaded.	Main circuit is energized too high.	Servo unit is abnormal.	1. Adjust the operating conditions. 2. Please turn off the power and restart. 3. Please contact the engineer from manufacturer.
Y-7A0	Heat sink is overheated.	The heat sink temperature exceeds 100 °C.	The ambient temperature is too high or the servo unit is abnormal.	1. Adjust the operating conditions. 2. Please turn off the power and restart. 3. Please contact the engineer from manufacturer.

Error Code	Error Name	Message	Reason	Solution
Y-7AB	Built-in fan stopped.	The internal fan of the SERVOPACK stopped.	There is a foreign object entering, or the servo unit is abnormal.	1. Remove foreign objects. 2. Please turn off the power and restart. 3. Please contact the engineer from manufacturer.
Y-810	Encoder backup alert.	The encoder data is abnormal.	The power is turned on for the first time, or the servo unit is abnormal.	1. Make the settings of the encoder. 2. Please turn off the power and restart. 3. Please contact the engineer from manufacturer.
Y-820	Encoder and number alarm.	Encoder and number verification errors.	Servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-830	Encoder battery alarm.	The battery voltage of the absolute encoder is lower than the specified value.	The battery voltage is insufficient or the servo unit is abnormal.	1. Replace the battery. 2. Please turn off the power and restart. 3. Please contact the engineer from manufacturer.
Y-840	Encoder data alert.	The encoder is malfunctioning.	The servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-850	Encoder overspeed.	When the control power is turned on, the encoder overspeed is detected.	The servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-860	The encoder is overheated.	The encoder exceeds the upper	The ambient temperature is too high or the servo unit is abnormal.	1. Adjust the ambient temperature to below 40 °C.

Error Code	Error Name	Message	Reason	Solution
		temperature limit.		2. Please turn off the power and restart. 3. Please contact the engineer from manufacturer.
Y-B10	The speed command A/D is abnormal.	When the servo is turned ON, the speed command input is incorrectly operated.	The servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-B11	The speed command A/D conversion data is abnormal.	The speed command input is incorrectly operated.	The servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-B20	The torque command A/D is abnormal.	When the servo is turned ON, the torque command input is incorrectly operated.	The servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-B31	Current detection error 1	U phase current detection loop is abnormal.	The servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-B32	Current detection error 2	V phase current detection loop is abnormal.	The servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.

Error Code	Error Name	Message	Reason	Solution
Y-B33	Current detection error 3	The current detection loop is abnormal.	The servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-BF0 Y-BF1 Y-BF2 Y-BF3 Y-BF4	System alarm 0~4	The servo unit is abnormal.	The servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-C10	Detected out of control.	When the servo is turned ON, the detected motor is out of control.	The motor wiring is incorrect or the servo unit is abnormal.	1. Confirm that there is no problem with the motor wiring. 2. Please turn off the power and restart. 3. Please contact the engineer from manufacturer.
Y-C80	The clearing of encoder is abnormal.	The upper limit of the number of revolutions setting is abnormally.	The servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-C90	The encoder communication is abnormal.	The encoder is malfunctioning.	The servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-C91	The encoder communication position data acceleration is abnormal.	The encoder is malfunctioning.	The servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.

Error Code	Error Name	Message	Reason	Solution
Y-C92	The encoder communication timer is abnormal.	The encoder is malfunctioning.	The servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-CA0	The encoder parameters are abnormal.	The encoder is malfunctioning.	The servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-CB0	Encoder calibration returned abnormal.	The encoder is malfunctioning.	The servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-CC0	The upper limit of the number of revolutions is inconsistent.	The encoder is malfunctioning.	The servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-D00	The position deviation is too large.	In the state of servo ON, the position deviation exceeds the upper limit.	The position command is too fast, or the servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-D01	The position deviation is too large when the servo is turned ON.	When the servo is OFF and the position deviation is too large, the servo is directly turned ON.	The servo unit is abnormal.	1. Please turn off the power and restart. 2. Please contact the engineer from manufacturer.
Y-D02	The positional deviation caused by	In the accumulated position deviation state,	The servo unit is abnormal.	1. Please turn off the power and restart.

Error Code	Error Name	Message	Reason	Solution
	the speed limit at servo ON is too large.	the servo is ON, and the position command is input in this state, and the position deviation excessive alarm value is exceeded.		2. Please contact the engineer from manufacturer.
Y-F10	The power cable is out of phase.	When the main circuit power is ON, the low voltage state of one of the R, S, and T phases lasts for more than 1 second.	The three-phase power supply wiring is defective, or the servo unit is abnormal.	1. Confirm that there is no problem with the power wiring. 2. Please turn off the power and restart. 3. Please contact the engineer from manufacturer.

8.3.4 DAC – S Driver Alarm Code(S-XXXX)

Error Code	Error Name	Message	Reason	Solution
S-3110	Power supply overvoltage	Power supply overvoltage	Main circuit AC voltage is out of range.	Check if the power supply voltage is within the specified range or install an external regenerative resistor.
S-3130	Main power phase error	Main power phase error	One of the phases is disconnected from three-phase main power supply.	Check wiring or replace the drive.
S-3211	Overvoltage	Overvoltage	Mains DC overvoltage.	Replace the drive. Reduce the power supply voltage to the specified range. Reduce the load rate.
S-3212	Regenerative resistor overload.	Regenerative resistor overload.	Regenerative resistance load is too large.	Confirm that the operating conditions are correct.
S-3220	Main circuit low voltage.	Main circuit low voltage.	Main circuit DC low voltage.	Check if the power supply voltage is within the specified range. Replace the drive.
S-4110	Drive temperature error.	Drive temperature is abnormal.	Ambient temperature is too high or the drive is damaged.	Confirm that the drive ambient temperature does not exceed 55°C. Replace the drive.
S-4210	Anti-surge resistor overheating.	Anti-surge resistor overheating.	Drive failure or ambient temperature is too high.	Replace the drive. Confirm that the ambient temperature does not exceed 55°C.
S-5113	Control power supply low voltage 2.	Control power supply low voltage 2.	Undervoltage ±5V control switching power supply.	Replace the drive or Confirm external circuit.
S-5114	Control power supply low voltage.	Control power supply low voltage.	Control power supply voltage is too low.	Replace the drive Check if the power supply voltage is within the specified range.

Error Code	Error Name	Message	Reason	Solution
S-5115	Control power supply low voltage 1.	Control power supply low voltage 1.	Undervoltage ±12V control switching power supply.	Replace the drive or Confirm external circuit.
S-5210	Abnormal current detection.	Abnormal current.	Drive damage or motor damage.	Replace the motor or drive.
S-5220	System error.	System error.	Setting mismatch.	Replace the drive.
S-5400	Main power supply equipment error.	Abnormal power supply.	Abnormal power supply, over-current or overheating of the servo module.	Confirm wiring, replace servo motor or drive. Confirm that the environment does not exceed 55°C.
S-5510	Memory error.	Memory error.	CPU access error of CPU built-in memory.	Replace the drive.
S-5530	EEPROM error	EEPROM error	Drive built-in EEPROM abnormal.	Replace the drive.
S-6010	Initialization thread timeout.	Initialization thread timeout.	The initialization thread was not completed within the initialization time.	Replace the drive. Confirm that the drive is properly grounded.
S-6310	EEPROM calibration code error.	EEPROM calibration code error.	CPU access error of CPU built-in EEPROM.	Replace the drive.
S-6320	System parameter error.	System parameter error.	System parameter abnormal.	Replace the drive.
S-7120	Motor temperatur e error.	Abnormal motor temperature.	Motor damage, high ambient temperature, short circuit.	Replace the servo motor. Confirm that the ambient temperature does not exceed 55°C. Confirmation cable.

Error Code	Error Name	Message	Reason	Solution
S-7122	Speed feedback error.	Speed feedback error.	Motor power cable disconnection.	Confirm wiring. Replace the drive or motor.
S-7300	Encoder initialization failed.	Encoder initialization failed.	Cable break.	Confirm wiring. Check if the encoder power supply is higher than 4.75V Replace the motor or drive.
S-7305	Encoder connector 1 is broken.	Encoder connector 1 is broken.	Power supply cable disconnection.	Confirm wiring. Check if the encoder power supply is higher than 4.75V or replace the motor
S-7510	Communication error.	Communication error.	Abnormal communication.	Check if the communication format is correct.
S-7520	Link lost.	Communication disconnects.	Communication cable is damaged or not connected.	Confirm that the communication cable is connected or normal.
S-8311	Overload	Overload	Motor load is too large.	Reduce load or slow down.
S-8312	STO safe torque off abnormal.	STO safe torque off abnormal.	STO input is abnormal.	Confirm stop.
S-8400	Average continuous speed overspeed.	Average continuous speed overspeed.	Motor speed overspeed.	Reduce operating speed.
S-8500	Position command error.	Position command error.	Position command is out of setting range.	Reduce the amount of input movement command.
S-8611	Position deviation is too large.	Position deviation is too large.	Position deviation exceeds the set value.	Confirm wiring. Confirm the power supply voltage. Replace the drive or motor.
S-8700	Task thread error.	Task thread error.	CPU interrupt error.	Replace the drive.

8.4 Electric gripper(04-XX-XX)

8.4.1 Hardware Error(04-01-1X)

Error Code	Error Name	Message	Reason	Solution
04-01-11	Electric gripper data return error.	Electric gripper data return error.	Electric gripper connection failed, and no data was returned.	Check that the 24V power supply is properly connected. Check that the USB cable is properly connected, Check that the serial port is set correctly. Refer to the manual to install the gripper driver.
04-01-12	Number of gripper serial port exceeds the upper limit.	Number of gripper serial port exceeds the upper limit.	Exceeded the connection port name limit.	Modify the connection port setting is less than or equal to COM99.
04-01-13	Gripper hardware is not connected.	Gripper hardware is not connected.	Connection port is disconnected.	Re-plug the USB cable and reconnect it.
04-01-14	Gripper serial port are closed.	Gripper serial port are closed.	Gripper serial port is not turned on.	Close this serial port and reconnect.
04-01-15	Gripper serial port not available.	Gripper serial port not available.	Unable to achieve serial port.	Re-plug the USB cable and reconnect it. Replace the USB cable.
04-01-16	Gripper reconnection failed.	Gripper reconnection failed.	Connection port is interrupt and an attempt to reconnect failed.	Re-plug the USB cable and reconnect it. Replace the USB cable.
04-01-17	Gripper serial port is repeatedly connected.	Gripper serial port is repeatedly connected.	When a duplicate connection port is detected, the connection is automatically disconnected.	Check if the gripper is repeatedly connected.

8.4.2 Operation Error(04-01-2X、04-01-8X)

Error Code	Error Name	Message	Reason	Solution
04-01-20	Gripper model setting error.	Gripper model setting error.	Gripper type setting is incorrect.	Check that the gripper type setting is correct.
04-01-21	Repeat gripper command.	Repeat gripper command.	Repeat the instructions in succession.	Wait for the gripper Busy to end, and then issue a new order.
04-01-22	Repeat gripper command.	Repeat gripper command.	Repeat the instructions in succession.	Wait gripper end “Busy” signal, then give new commend.
04-01-23	Gripper position setting error.	Gripper position setting error.	Gripper position setting is greater than the total stroke.	Check that the gripper movement position input is correct.
04-01-24			Gripper position setting is less than zero	
04-01-25	Gripper speed setting error.	Gripper speed setting error.	Gripper moving speed setting is greater than the preset range.	Check if the gripper moving speed input is correct.
04-01-26			Gripper moving speed setting is less than the preset range.	
04-01-27	Gripper position direction setting error.	Gripper position direction setting error.	Gripper movement direction setting is incorrect.	Check that the gripper movement direction input is correct.
04-01-28	The gripping displacement setting is incorrect.	The gripping displacement setting is incorrect.	Gripping displacement setting is greater than the range of motion.	Check that the gripping displacement input is correct.
04-01-29			Gripping displacement setting is smaller	

Error Code	Error Name	Message	Reason	Solution
			than the range of motion.	
04-01-2A	Gripping speed setting is incorrect.	Gripping speed setting is incorrect.	Gripping speed is greater than the preset range.	Check that the gripping speed input is correct.
04-01-2B			Gripping speed is smaller than the preset range.	
04-01-2C	Gripping force setting is incorrect.	Gripping force setting is incorrect.	Gripping force is greater than the preset range.	Check that gripping force input is correct.
04-01-2D			Gripping force is smaller than the preset range.	
04-01-2E	Gripping failed.	Gripper failed to grip.	After the user turns on the grip detection function, the gripping action is performed and the electric gripper detects the unwound object.	This alarm is used to detect if the jaws are clamped to the object. If you do not need to send this detection alarm, you can cancel this function in the setting interface.
04-01-2F	Gripper is set incorrectly with respect to the total stroke.	Gripper is set incorrectly with respect to the total stroke.	Gripper exceeds the movable range with respect to the total stroke.	Check if the gripper moving distance and the total gripping displacement are correct.
04-01-80			Gripper is less than the movable range relative to the total stroke	
04-01-81	Gripper speed setting error.	Gripper speed setting error.	Gripper moving speed is less than the gripping speed.	Check that the gripper moving speed input is correct.

8.4.3 Electric Gripper Controller Alarm Signal Error(04-01-3X)

Error Code	Error Name	Message	Reason	Solution
04-01-30	Gripper reset error	Gripper reset error	Some workpieces have not been removed during the route. Finger design interferes with the stroke	Check that there are no foreign objects in the itinerary. Modify the finger design.
04-01-31	Gripper position error	Gripper position error	Obstacles in the movement of the gripper.	Check and eliminate obstacles in the route.
04-01-32	Gripper overtravel	Gripper overtravel	Gripper displacement setting is greater than the range of motion.	Check that the gripper displacement input is correct.
04-01-33	Gripper return home position error	Gripper return home position error	Gripper didn’t connect power. Gripper obstacles in the itinerary.	Check that gripper power is correct. Check and exclude obstacles in the itinerary.

8.4.4 Electric Gripper Commend Communication Timeout(04-01-4X)

Error Code	Error Name	Message	Reason	Solution
04-01-41	Gripper connection timeout	Gripper connection timeout	Electric gripper command communication failed and data returned timeout.	Check that the 24V power supply is properly connected. Check that the USB cable is properly connected, Check that the serial port is set correctly. Refer to the manual to install the jaw driver. Replace the controller unit.
04-01-42	Gripper firmware communicatio n timeout	Gripper firmware communication timeout		
04-01-43	Gripper stop action timeout	Gripper stop action timeout		
04-01-44	Gripper reset timeout	Gripper reset timeout		
04-01-45	Gripper movement timeout	Gripper movement timeout.		
04-01-46	Gripping timeout	Gripping timeout		
04-01-47	Gripper expert mode action timeout	Gripper expert mode action timeout		
04-01-48	Gripper state reading timeout	Gripper state reading timeout		

9. Program Examples

9.1 Register Class

9.1.1 COUNTER Register

Program:

```
$C [1] = 10
```

Description:

The constant 10 is saved into COUNTER 1. After the program is closed, the number of the variable definition still registered.

Hint:

There are 20 COUNTERs from 1 to 20. The saved number is integer. The storage capacity is 32bit, which is -2147483648(2^{16})~ 2147483647(2^{16}-1)..

9.1.2 TIMER Register

Program:

```
$T[1] = 0
WAIT SEC 0
$T_STOP[1] = FALSE
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
WAIT SEC 0
$T_STOP[1] = TRUE
```

Description:

Calculate the period when the robot moves from the original position to P0. After the program is closed, the number of the variable definition still registered.

Parameter explanation:

Start counting when $T_STOP[n]=FALSE. And stop when $T_STOP[n]=TRUE.

Hint:

There are 20 TIMERs, from 1 to 20. $T[n] represents the TIMER n. Before starting and ending $T_Stop, "WAIT SEC 0" command which can stop pre-read is necessary. Every TIMER is 32bit, the display range is from -2147483648(2^{16})~ 2147483647(2^{16}-1). (ms).

9.2 Variable Type Class

9.2.1 REAL (Floating Point)

Program:

REAL One

One = 1

Description:

The format is similar to the data type of the decimal data. This variable will disappear after the program is closed.

Hint: The storage capacity is 32bit about 10^{-37}~10^{38}, effective to 6 digits after the decimal point.

9.2.2 INT (Integer)

Program:

INT Two = 2

Description:

Which is a format of the integer-type data, and will disappear after the program is closed.

Hint: The storage capacity is 32bit, which are -2147483648(2^{16})~ 2147483647(2^{16}-1).

9.2.3 UINT (Unsigned Integer)

Program:

UINT Three = 3

Description:

Format is unsigned type integer, and will disappear after the program is closed.

Hint:The storage capacity is 32bit, which are 0 ~ 4294967295(2^{32}-1)。可輸入十進位整數或使用 0x 開頭表示十六進位整數。

9.2.4 BOOL

Program:

BOOL K = TRUE

Description:

Which means “Boolean”, is a logically variable. Will disappear after the program is closed.

Hint: Used to declare the variable represents TRUE or FALSE.

9.2.5 CHAR (Character)

Program:

```
CHAR COLOR = 'R'
```

Description:

Which represents the character variable. Will disappear after the program is closed.

Hint: Used to declare the variable represents the specific characters.

9.2.6 E6POS Point (Cartesian Coordinate Point)

Program:

```
E6POS POINT = {X 0,Y 300,Z 200}
PTP POINT CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
```

Description:

Define POINT in Cartesian coordinate, and move the robot to POINT.

Hint:

If the parameter is not set, its value will not changed(A, B, C in this case). This point doesn't define E6AXIS (A1~A6) values.

9.2.7 E6AXIS Point(Joint Coordinate Point)

Program:

```
E6AXIS POINT = {A1 90}
PTP POINT CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
```

Description:

Define POINT in the joint coordinate, and move the robot to POINT.

Hint:

Parameter A2, A3, A4 are not set, and will remain the original value. This point doesn't define E6POS (X, Y, Z, A, B, C) value.

9.2.8 E6POINT (Cartesian Coordinate Point and Joint Coordinate Point)

Program:

```
E6POINT HOME = {Y 200,Z -1000,A 90}
PTP HOME CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
```

or you change the definition of HOME like this:

```
E6POINT HOME = {A1 90}
```

Description:

The first definition of HOME is in Cartesian coordinate, and then move the robot to HOME. The second definition is in Joint coordinate.

Hint:
If there is parameter not defined, it will remain the current value.

9.3 Logical Operator Class

9.3.1 Arithmetic Operator

Program:

```
INT a, b, e
REAL c, d, f
a= 3
b= 5
c= 0.6
d= 12.2
e= 10
f= 10.0
a= a*b; a= 3*5= 15
b= b+d; b= 5+12.2= 17.2 → round off, b= 17
c= c*d; c= 0.6*12.2= 7.32
d= b+d; d= 17+12.2= 29.2
e= e/2; e= 5
e= 10/4; e= 2(round down)
e= f/4; e= 2(round down)
f= f/4; f= 2.5
```

Hint: If the format is INT and there are decimals after operation, decimals will be removed. After INT and REAL are operated by "+", "-", or "*", the result format will be REAL.

9.3.2 Logical Operator

Logic Operator		A AND B	A OR B
A=TRUE	B=TRUE	TRUE	TRUE
A=TRUE	B=FALSE	FALSE	TRUE
A=FALSE	B=TRUE	FALSE	TRUE
A=FALSE	B=FALSE	FALSE	FALSE

9.3.3 Relation Operator

Relation Operator	A > B	A >= B	A < B	A <= B	A == B	A != B
A = 2,B = 1	TRUE	TRUE	FALSE	FALSE	FALSE	TRUE
A = 1,B = 1	FALSE	TRUE	FALSE	TRUE	TRUE	FALSE
A = 1,B = 2	FALSE	FALSE	TRUE	TRUE	FALSE	TRUE

9.4 Input / Output Class

9.4.1 Digital Input

Program:

WAIT FOR $DI[1] == TRUE

Parameter explanation:

The Digital Channel 1 inputs TRUE.

9.4.2 Digital Output

Program:

$DO[1] = TRUE

Parameter explanation:

The Digital Channel 1 outputs TRUE.

9.4.3 Robot Input

Program:

WAIT FOR $RI[1] == TRUE

Parameter explanation:

The Channel 1 of Robot signal inputs TRUE.

9.4.4 Robot Output

Program:

$RO[1] = TRUE

Parameter explanation:

The Channel 1 of Robot signal outputs TRUE.

9.4.5 Valve Input

Program:

$VO [1] = TRUE

Parameter explanation:

The Channel 1 of Solenoid Valve outputs TRUE.

9.5 Motion Function Class

The way to define the point can be:

1. Establish the point with the software frame.
2. Establish the point of E6POS or E6AXIS.
3. Define the point parameter directly. The coordinates not defined will remain the same, for example, PTP {X 200}.
4. Define the joint angle directly, and the parameter not defined will be the current value, like PTP {A1 90, A3 60}.

9.5.1 PTP (Point-to-point Absolute Motion)

Point Definition 1

Program:

```
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
```

Description:

Only require the position of the starting point and the terminal point. There is no limit for the middle process. TCP will be guided with the fastest trace of the robot to the target point. P0 is additionally established for TCP except for the Home status. TCP will move point-to-point from Home to P0.

Parameter explanation:

PTP; name of point-to-point command, the shortest trace for the robot

P0; any point except for Home

CONT; smooth extent

Vel; moving velocity relative to maximum velocity

Acc; moving acceleration relative to maximum acceleration

Point Definition 2

Program:

```
E6POS POINT = {X 0,Y 300,Z 200}
PTP POINT CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
```

Description:

Move to POINT.

Hint: The same way to establish points with E6AXIS.

Point Definition 3

Program:

```
PTP {X 100} CONT=100% Vel=2000mm/s Acc=50% TOOL[0] BASE[0]
```

Description:

The TCP moves to this coordinate (refer to the base coordinate). The parameters not defined will remain the same.

Point Definition 4

Program:

```
PTP {A1 45} CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
```

Description:

The A1 axis of TCP moves to +45° (refer to the base coordinate). For the axis not defined, the angle will not change.

9.5.2 PTP_REL (Point-to-point Relative Motion)

Point Definition 1

Program:

```
PTP_REL {X 100 } CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
```

Description:

The TCP moves to this coordinate (refer to the base coordinate). The coordinates not defined will remain the same.

Point Definition 2

Program:

```
PTP_REL {A1 45} CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
```

Description:

The A1 axis of TCP moves at +45° relative to the original A1 axis (refer to the base coordinate). For the axis not defined, the angle will not change.

9.5.3 LIN (Linear, Absolute Motion)

Point Definition 1

Program:

LIN P0 CONT=100% Vel=2000mm/s Acc=50% TOOL[0] BASE[0]

Description:

P0 is additionally established for TCP except for the Home status. TCP will move point-to-point from Home via P0 to P1. The robot will guide TCP to the target point along the linear trace with the defined velocity.

Parameter explanation:

LIN; name of point-to-point command, linear trace connecting two points

P0; any point except for Home

CONT; smooth extent

Vel; velocity moving on linear trace

Acc; acceleration moving on linear trace

Point Definition 2

Program:

E6POS POINT = {X 0,Y 368,Z 293}

LIN POINT CONT=100% Vel=2000mm/s Acc=50% TOOL[0] BASE[0]

Description: move to POINT

Hint: Same method to establish points with E6AXIS

Point Definition 3

Program:

LIN {X 100} CONT=100% Vel=2000mm/s Acc=50% TOOL[0] BASE[0]

Description:

The TCP moves to this coordinate (refer to the base coordinate). The coordinates not defined will remain the same.

Point Definition 4

Program:

LIN {A1 45} CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]

Description:

The A1 axis of TCP moves at +45° relative to the original A1 axis (refer to the base coordinate). For the axis not defined, the angle will not change.

9.5.4 LIN_REL (Linear, Relative Motion)

Point Definition 1

Program:

LIN_REL {X 100 } CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]

Description:

The coordinates of TCP move in relative to this coordinate (refer to the base coordinate). For the direction not defined, the coordinates will not change.

Point Definition 2

Program:

LIN_REL {A1 45} CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]

Description:

The A1 axis of TCP moves at +45° relative to the original A1 axis (refer to the base coordinate). For the axis not defined, the angle will not change.

Program:

LIN_REL {X 100 } CONT=100% Vel=2000mm/s Acc=50% TOOL[0] BASE[0]

9.5.5 LIN_REL_TOOL (Linear, Relative Motion for Tool coordinate)

Point Definition 1

Program:

LIN_REL_TOOL {X 100 } CONT=100% Vel=2000mm/s Acc=50% TOOL[0] BASE[0]

Description:

The TCP of the robot will move along the axis of the command(“X” in this case) by increasing the value(“100” in this case).

Point Definition 2

Program:

LIN_REL_TOOL {A 45} CONT=100% Vel=2000mm/s Acc=50% TOOL[0] BASE[0]

Description:

In this case, the TCP will rotate +45° along the X axis of the TCP coordinate. And the command “B”(“C”) means to rotate along “Y”(“Z”) axis.

9.5.6 CIRC (Arc, Absolute Motion)

Point Definition 1

Program:

CIRC P0 P1 CONT=100% Vel=2000mm/s Acc=50% TOOL[0] BASE[0]

Description:

P0 and P1 are additionally established for TCP except for the Home status. TCP will move with circular trace from Home via P0 to P1. The robot will guide TCP to the target point along the circular trace with the defined velocity.

Parameter explanation:

CIRC; name of point-to-point command, the starting point arrives the target point via the auxiliary point along the circular trace

P0; any point except for Home as auxiliary point

P1; any point except for Home as target point

CONT; smooth extent

Vel; velocity moving on circular trace

Acc; acceleration moving on circular trace

Hint:

P0 and P1 should be established first.

Point Definition 2

Program:

E6POS POINT1 = {X 0,Y 300,Z 200}

E6POS POINT2= {X 20,Y 320,Z 220}

CIRC POINT1 POINT2 CONT=100% Vel=2000mm/s Acc=50% TOOL[0] BASE[0]

Description: Move to POINT2 via POINT1.

Hint: The points are established the same method as E6AXIS.

Point Definition 3

Program:

CIRC {X 0, Y 450} {X -150, Y 300} CONT=100% Vel=2000mm/s Acc=50% TOOL[0] BASE[0]

Description:

TCP based on the starting point as the original coordinate moves to the auxiliary point and then arrives the destination point (refer to the base coordinates).

Point Definition 4

Program:

CIRC {A1 5.0, A2 5.0, A3 5.0, A4 5.0} {A1 10.0, A2 10.0, A3 10.0, A4 10.0} CONT=100% Vel=2000mm/s Acc=50% TOOL[0] BASE[0]

Description:

TCP based on the starting point as the original coordinate moves to the auxiliary point and then arrives at the destination point (refer to the base coordinates).

9.5.7 CIRC_REL (Arc, Relative Motion)

Point Definition 1

Program:

CIRC_REL {X -150, Y 150} {X -150, Y -150} CONT=100% Vel=2000mm/s Acc=50% TOOL[0] BASE[0]

Description:

TCP based on the starting point as the original coordinate moves to the auxiliary point and then arrives the destination point (refer to the base coordinates).

Point Definition 2

Program:

CIRC_REL {A1 5.0, A2 5.0, A3 5.0, A4 5.0} {A1 10.0, A2 10.0, A3 10.0, A4 10.0} CONT=100% Vel=2000mm/s Acc=50% TOOL[0] BASE[0]

Description:

TCP based on the starting point as the original coordinate moves to the auxiliary point and then arrives at the destination point (refer to the base coordinates).

9.5.8 SPLINE (Spline Motion)

Point Definition 1

Program:

```
E6POINT P1 ={ X 95 , Y 0 , Z -500 }
E6POINT P2 ={ X 94.63849632 , Y 3.922008424 , Z -500 }
.....
E6POINT P54 ={ X -8.279795561 , Y -44.82876141 , Z -500 }
E6POINT P55 ={ X 0 , Y -45 , Z -500 }
E6POINT P56 ={ X 8.279795561 , Y -44.82876141 , Z -500 }
.....
E6POINT P73 ={ X 95 , Y 0 , Z -500 }
SPLINE
SPL P1
SPL P2
.....
SPL P54
SPL P55
SPL P56
.....
SPL P73
ENDSPLINE
```

Description:

Start from P1 point and move to P73 point with B-Spline curvilinear motion.

9.5.9 Array Accumulation

Program:

```
PTP P0 CONT=100% Vel=100% Acc=100% TOOL[0] BASE[1]
P0.A1 = P0.A1 + 10
PTP P0
P0.A1 = P0.A1 + 10
PTP P0
```

Description:

The A1 coordinate of P0 accumulates 10 degrees every time, and the other coordinates will not change.

9.5.10CT_A6 (Axis 6 Continuous Turning)

Program:

```
LIN P0 FINE=1 Vel=100mm/s Acc=100% TOOL[0] BASE[0]
CT_A6 100
WHILE $C[1] <2
$C[1] = $C[1]+1
LIN P1 FINE=1 Vel=100mm/s Acc=100% TOOL[0] BASE[0]
LIN P2 FINE=1 Vel=100mm/s Acc=100% TOOL[0] BASE[0]
ENDWHILE
$C[1] = 0
CT_A6 -50
WHILE $C[2] <2
$C[2] = $C[2]+1
LIN P1 FINE=1 Vel=100mm/s Acc=100% TOOL[0] BASE[0]
LIN P2 FINE=1 Vel=100mm/s Acc=100% TOOL[0] BASE[0]
ENDWHILE
$C[2] = 0
CT_A6 0
WAIT SEC 1
LIN P0 FINE=1 Vel=100mm/s Acc=100% TOOL[0] BASE[0]
```

Description:

The sixth axis of the robot first reciprocates between P1 and P2 at a speed of 100% in the positive direction, and then reciprocates between P1 and P2 at a speed of 50% in the negative direction, and then ends infinite rotation and returns to the P0 point.

9.5.11 BRAKE

Program:

```
LIN P0 FINE=1 Vel=3000mm/s Acc=100% TOOL[0] BASE[0]
LIN_REL {Z -200}
LOOP
IF $DI[1] == TRUE THEN
BRAKE
EXIT
ENDIF
ENDLOOP
LIN P1 FINE=1 Vel=3000mm/s Acc=100% TOOL[0] BASE[0]
```

Description:

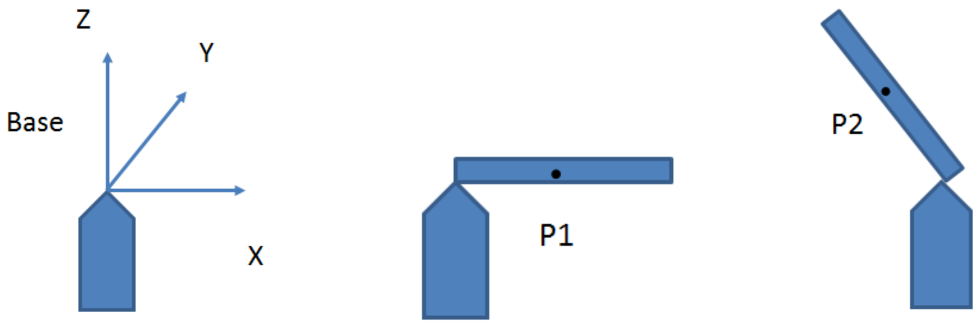
The robot moves to P0, it moves 200mm down along Z axis. The sensor of DI[1] is triggered on the way, the robot stops the motion and moves linearly from the stop point to P1.

9.5.12EXT_TCP(Option)

Front work:

At the external tool point, teach a Base coordinate system, and the origin of the Base coordinate system is at the tool processing point.

Teaching starting point is at point P1 and ending point at P2



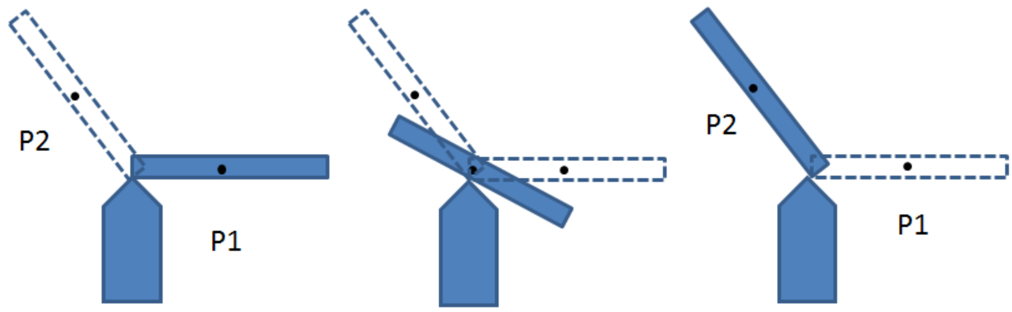
Teach Base Starting Point Ending Point

Program:

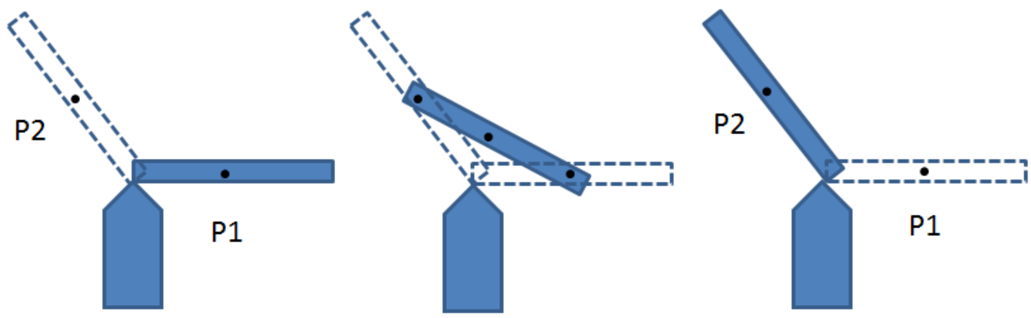
```
EXT_TCP_START
LIN P1 FINE=1 Vel=1000mm/s Acc=100% TOOL[0] BASE[1]
LIN P2 FINE=1 Vel=1000mm/s Acc=100% TOOL[0] BASE[1]
EXT_TCP_END
```

Description:

After the robot moves to P1, it is processed (polished) along the straight line of the workpiece and moved to P2. During the process, the workpiece remains in contact with the tool. If EXT_TCP is not used, the workpiece and tool will only be in contact at the start and end points



Using EXT_TCP



Not using EXT_TCP

9.6 Contol Flow Function Class

9.6.1 IF

■Format 1 of IF

IF *condition* THEN

………………

ENDIF

Program:

```
INT n = 1
IF n > 0 THEN
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
ENDIF
```

Description:

Because the *condition* is true, TCP will move to P0.

Parameter description:

Condition; condition

Because the condition is true, the statement in IF will be executed.

■Format 2 of IF

IF *condition* THEN

………………

ELSE

………………

ENDIF

Program:

```
INT n = 0
IF n > 0 THEN
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
ELSE
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
ENDIF
```

Description:

Because the condition is false, TCP will execute ELSE and move to P0.

■**Application for determining IF condition**

IF ((TRUE) AND (TRUE)) THEN

………………

ENDIF

Program:

```
INT n, m
n = 1
m = 2
IF ((n == 1) AND (m ==2)) THEN
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
ENDIF
```

Description:

Because the condition is true, TCP will move to P0.

IF ((TRUE) OR (FALSE)) THEN

………………

ENDIF

Program:

```
INT n,m
n =1
m = 3
IF    ((n == 1) OR (m == 2)) THEN
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
ENDIF
```

Description:

Because the condition is true, TCP will move to P0.

IF *condition* THEN

………………

ENDIF

Program:

```
IF $DI[1] == TRUE THEN
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
ENDIF
```

Description:

If DI[1] is true, the condition will be true. TCP will move to P0.

9.6.2 FOR

FOR *start* TO *last* STEP *increment*

………………

ENDFOR

Program:

```
INT n
FOR n = 0 TO 2 STEP 1
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
ENDFOR
```

Description:

TCP moves to and fro between P0 and P1 three times.

Parameter explanation:

start ; start

last ; condition

increment ; increment

After FOR is executed from the start to the condition, FOR will end.

If the STEP increment is omitted, the increment default is 1.

■**FOR application**

Program:

```
INT n
FOR n = 0 TO 20 STEP 10
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
ENDFOR
```

Description:

TCP moves to and fro between P0 and P1 three times.

Program:

```
INT n
FOR n = 2 TO 0 STEP 1
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
ENDFOR
```

Description:

TCP moves to and fro between P0 and P1 three times.

Program:

```
INT n
FOR n = -1 TO 3 STEP 2
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
ENDFOR
```

Description:

TCP moves to and fro between P0 and P1 three times.

9.6.3 LOOP

■LOOP ENDLOOP

LOOP

………………

ENDLOOP

Program:

```
LOOP
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
ENDLOOP
```

Description:

TCP repeatedly moves to and fro between P0 and P1.

Parameter explanation:

LOOP is an infinite loop.

■LOOP EXIT ENDLOOP

LOOP

………………

EXIT

………………

ENDLOOP

Program:

```
INT n =0
LOOP
IF n == 1 THEN
EXIT
ELSE
n = n + 1
ENDIF
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
ENDLOOP
```

Description:

TCP will move to P0.

Parameter explanation:

LOOP execute to EXIT and end LOOP.

9.6.4 WHILE

■WHILE ENDLOOP

WHILE *condition*

………………

ENDWHILE

Program:

```
INT n = 2
WHILE n > 0
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
n = n - 1
ENDWHILE
```

Description:

TCP moves to and fro between P0 and P1 twice.

Parameter explanation:

condition ; condition

When the condition of WHILE is true, repeatedly execute the statement in WHILE until the condition is false and ends.

■Application for determining WHILE condition

WHILE ((TRUE) AND (TRUE))

………………

ENDWHILE

Program:

```
INT n,m
n = 1
m = 2
WHILE ((n == 1) AND (m == 2))
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
n = n + 1
ENDWHILE
```

Description:

TCP moves to and fro between P0 and P1 once.

WHILE ((TRUE) OR (FALSE))

………………

ENDWHILE

Program:

```
INT n,m
n = 1
m = 2
WHILE ((n == 1) OR (m == 3))
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
ENDWHILE
```

Description:

TCP moves to and fro between P0 and P1 once.

9.6.5 REPEAT

■REPEAT UNTIL

REPEAT

………………

UNTIL *condition*

Program:

```
INT n =0
REPEAT
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
n = n + 1
UNTIL n > 2
```

Description:

TCP will move to P0 and P1 as well as repeatedly execute twice.

Parameter explanation:

Condition; condition

Repeatedly execute the statement in REPEAT until the condition is true, and end REPEAT.

■Application for determining REPEAT condition

REPEAT

………………

UNTIL((FALSE) OR (TRUE))

Program:

```
INT n =0
INT k =1
REPEAT
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
n = n + 1
UNTIL (k ==2) OR (n > 2)
```

Description:

TCP will move to P0 and P1 as well as repeatedly execute twice.

REPEAT

………………

UNTIL((TRUE) AND (TRUE))

Program:

```
INT n =0
INT k =1
REPEAT
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
n = n + 1
UNTIL(k ==1) AND (n > 2)
```

Description:

TCP will move to P0 and P1 as well as repeatedly execute twice.

9.6.6 GOTO

IF *condition* THEN
GOTO *LABEL1*
ENDIF
IF *condition* THEN
GOTO *LABEL 2*
ENDIF
IF *condition* THEN
GOTO *LABEL 3*
ENDIF

LABEL 1:
………………
LABEL 2:
………………
LABEL 3:
………………

Program:

```
INT n =0
LOOP
IF n == 0 THEN
GOTO STEP0
ENDIF
IF n == 1 THEN
GOTO STEP1
ENDIF
IF n == 2 THEN
GOTO STEP2
ENDIF

PRO:
n = n + 1
ENDLOOP

STEP0:
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
GOTO PRO
STEP1:
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
```

GOTO PRO
STEP2:

Description:
TCP moves from P0 to P1, and then ends LOOP.

Parameter explanation:
LABEL ; label
The label of GOTO corresponds to the following statement of the label. If the label doesn't have the statement, it will end program.

9.6.7 SWITCH

■**SWITCH without default**

SWITCH *number*

………………

CASE *number1*

………………

CASE *number2*

………………

ENDSWITCH

Program:

```
INT n =0
LOOP
SWITCH n
CASE 0
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
CASE 1
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
CASE 2
EXIT
ENDSWITCH
n = n + 1
ENDLOOP
```

Description:

TCP moves from P0 to P1, and then executes EXIT to end LOOP.

Parameter explanation:

number ; argument

The argument of SWITCH corresponds to the statement of CASE.

When the argument of SWITCH doesn't correspond to CASE, it will directly correspond to ENDSWITCH.

■**SWITCH with default**

SWITCH *number*

………………

CASE *number1*

………………

CASE *number2*

………………

DEFAULT

EXIT

ENDSWITCH

Program:

```
INT n =0
LOOP
SWITCH n
CASE 0
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
CASE 1
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
DEFAULT
EXIT
ENDSWITCH
n = n + 1
ENDLOOP
```

Description:

TCP moves from P0 to P1, and then executes EXIT to end LOOP.

Parameter explanation:

The argument of SWITCH corresponds to CASE. If there is no correspondence, the statement of DEFAULT will be executed.

When the argument of SWITCH doesn't correspond to CASE, the statement with DEFAULT will jump to the statement of DEFAULT.

■**SWITCH Extension 1**

SWITCH *number*

………………

CASE *number1, number3, number5*

………………

CASE *number2, number4*

………………

DEFAULT

EXIT

ENDSWITCH

Program:

```
INT n =0
LOOP
SWITCH n
CASE 0,2,4
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
CASE 1,3
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
CASE 5
EXIT
ENDSWITCH
n = n + 1
ENDLOOP
```

Description:

TCP moves to and fro between P0 and P1, moves to P0, and then executes EXIT to end LOOP.

■SWITCH Extension 2

SWITCH *character*

………………

CASE *character1*

………………

CASE *character2*

………………

DEFAULT

EXIT

ENDSWITCH

Program:

```
CHAR COLOR = 'R'
LOOP
SWITCH COLOR
CASE 'R'
```

```
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
CASE 'G'
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
DEFAULT
EXIT
ENDSWITCH
IF COLOR =='G' THEN
COLOR ='Y'
ENDIF
IF COLOR =='R' THEN
COLOR ='G'
ENDIF
ENDLOOP
```

Description:

TCP moves from P0 to P1, and then executes EXIT to end LOOP.

9.6.8 WAIT

■WAIT SEC

Program:

```
WAIT SEC 3
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
```

Description:

After the program waits for three second, TCP will move to P0.

■WAIT INPUT

Program:

```
WAIT FOR $DI[1] == TRUE
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
```

Description:

When the program waits the Digital INPUT Channel 1 is TRUE, TCP will move to P0.

Program:

```
WAIT FOR $RI[1] == TRUE
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
```

Description:

When the program waits the INPUT Channel 1 for the robot is TRUE, TCP will move to P0.

9.6.9 QUIT

Program:

```
LOOP
IF $DI[1] == TRUE THEN
QUIT
ENDIF
ENDLOOP
```

Description:

The program will be closed when executing “QUIT” command(when DI[1] == TRUE in this case).

9.7 Definition of Structure Class

STRUC *LABEL* INT *PARAMETER1*, REAL *PARAMETER2*
DECL *LABEL* PART1 ,PART2, ……. , …….
PART1 = { *PARAMETER1* 10, *PARAMETER2* 500 }
PART2 = { *PARAMETER1* 20, *PARAMETER2* 100 }
………………
………………

Program:

```
STRUC CASTING_TYPE INT MASS, REAL VOLUME
DECL CASTING_TYPE PART1 ,PART2
PART1 = {MASS 10, VOLUME 500 }
PART2 = {MASS 20, VOLUME 100 }
```

Description:

For the different objects in the specific type, the different parameters can be assigned in the same variable.

Parameter explanation:

STRUC *LABEL* ; define the type name
INT *PARAMETER1* ; define the format of object parameter
REAL *PARAMETER2* ; define the format of object parameter
PART1 ; define the object
PART2 ; define the object

Hint:

PART1. *PARAMETER1* = K, which can obtain the parameter.

9.8 Function and Subprogram Class

9.8.1 Definition & Using Method of Function

Function is a program code which allows the user to execute the specific task or specific motion. User may write the frequently repeated program code in the function, and may also decide to write the program code with any length in the function. Usually, one function only performs one task.

The declaration of function tells the compiler with respect to the function name, post back value and parameters.

Definition of Function:

```
DEFFCT return_type function_name ( parameter list )

statement body of the function
RETURN…

ENDFCT
```

The declaration of function includes the function header and function body. The description of each part is shown as follows:

return_type: Data type returns from function.

function_name: Function name.

parameter list: Function parameters. User may deliver the parameters into the function. The data type of parameter will refer to the data type and support point type declared in the function field. If the parameter is input, then use "parameter: IN" for indication, use as the input parameter, it will not affect the incoming variable even it is modified in the function. If it is used as the output variable and modified in the function, then use "parameter: OUT". As the output variable, if it is modified in the function, the originally incoming variable will also be changed accordingly. One function may have no function parameters, and up to five (5) parameters as the maximum.

statement body: Function body. If the function has parameter, then the user needs to declare the type of parameter in order to undertake.

Example of program 1:

```
INT iFUN
iFUN = FCT_1(2,3)
DEFFCT INT FCT_1(num1:IN,num2:IN)
INT num1
INT num2
RETURN num1+num2
```

```
ENDFCT
```

Description:

Declare one function named as FCT_1, income two (2) INT parameters i.e. num1 and num2 respectively, and then post back after adding these two parameters.

Example of program 2:

```
E6POINT RE_E6,OUT_E6
INT iX
OUT_E6 = P1
RE_E6 = FCT_2(P0,OUT_E6)

DEFFCT E6POINT FCT_2(A:IN,B:OUT)
E6POINT A
E6POINT B
A.X = B.X
B.X = 100
PTP A
RETURN A
ENDFCT

iX = OUT_E6.X
```

Description:

Declare one function named as FCT_2, income one parameter of E6POINT and one output parameter B of E6POINT, the function assigns the X value of B to X of A first, and then configures X of B to 100, and then executes the point to point moving to A, and finally post back A, and B is taken as output returning to the calling procedure.

9.8.2 Definition & Using Method of Subprogram

The difference between the defined subprogram and function are: the subprogram has no post back value and the declaration are different.

Definition of subprogram:

```
DEF subprogram_name ( parameter list )

statement body of the subprogram

END
```

The declaration of function includes the subprogram header and subprogram body. Description of each part is shown as follows:

subprogram_name: Subprogram name.

parameter list: Subprogram parameter and up to five (5) parameters as the maximum.

statement body: Subprogram body.

Example of program 1:

```
INT iNUM
iNUM = 4
$C[4] = 0
PROG_1(3,iNUM)
$C[4] = iNUM

DEF PROG_1(num1:IN,num2:OUT)
INT num1
INT num2
num2= num1+num2
END
```

Description:

Declare one subprogram named as PROG_1, income one parameter num1 of INT and one output parameter num2 of INT, and then add these two parameters, and assign to num2 as the output.

Example of program 2:

```
E6POINT E6_OUT_A,E6_OUT_B
E6_OUT_A = P0
E6_OUT_B = P1
```

```
PROG_2(E6_OUT_A,E6_OUT_B)

DEF PROG_2(A:OUT,B:OUT)
E6POINT A
E6POINT B
A.X = B.X
B.X = 100
PTP A
END
```

Description:

Declare one subprogram named as PROG_2, income two (2) output parameters of E6POINT i.e. A and B respectively, the subprogram assigns X of B to X of A first, and then configures X of B to 100, and then executes the pint to point moving A, takes the modified A and B as the output returning to the calling procedure.

9.9 External Function & Subprogram Class

9.9.1 Definition & Using Method of External Function(EXTFCT)

Declare the external function which indicates that the user writes this function into a separate independent file, and the name of this independent file shall be the same as the function name, and call this function outside this independent file. The external function locates on the first line of program code and must begin with the keyword of DEFFCT, one file can only define one external function. If it desires to call the external function, it will have to declare the external function at the calling program. The declaration of external function must use the keyword of EXTFCT. After declaration, it will be the same as the calling of general function.

Definition of declaration for external function:
EXTFCT return_type function_name (parameter list)

Description of each part of external function is shown as follows:
return_type: Type of post back value, structure of supporting point position.
function_name: Function name.
parameter list: Function parameters. Please be aware that the declaration of function parameter name (located in the procedure desired to call) must be consistent with the definition (located at the procedure being called) and up to five (5) parameters as the maximum, support the type of point position.

Example of program:

The program content of file named as FCT_1:
```
DEFFCT INT FCT_1 ( num1:IN,num2:IN)
INT num1
INT num2
RETURN num1+num2
ENDFCT
```
Content of external program:
```
EXTFCT INT FCT_1(num1:IN,num2:IN)
INT iNum

iNum = 10
iNum = FCT_1(6,8)
```

Description:

In the program with the file name of FCT_1, declare one function named as FCT_1, income two (2) parameters of INT i.e. num1 and num2 respectively, and then add these two parameters, and post back to the calling procedure, in addition, in another external file program, use EXTFCT to declare the external function of FCT_1, and then perform the calling by using the function mode directly, please be aware that the calling of external function can be up to eight (8) layers as the deepest, the compiler will report error if exceeded.

9.9.2 Definition & Using Method of External Subprogram(EXT)

Declare the external subprogram which indicates that the user writes this subprogram into a separate independent file, and the name of this independent file shall be the same as the subprogram name, and call this program outside this independent file. The external subprogram locates on the first line of program code and must begin with the keyword of DEF, one file can only define one external function. If it desires to call the external subprogram, it will have to declare the external subprogram at the calling program. The declaration of external subprogram must use the keyword of EXT. After declaration, it will be the same as the calling of general subprogram.

Definition of declaration for external subprogram:
EXT subprogram_name (parameter list)

Description of each part of external subprogram is shown as follows:
subprogram_name: Subprogram name.
parameter list: Subprogram parameters. The declaration of subprogram parameter name (located in the procedure desired to call) must be consistent with the definition (located at the procedure being called) and up to five (5) parameters as the maximum, support the type of point position.

Example of program:

The program content of file named as PROG_1:

```
DEF PROG_1 ( num1:IN,num2:OUT )
INT num1
INT num2
num2 = num1+num2
END
```

Content of external program:

```
EXT PROG_1( num1:IN,num2:OUT )
INT iNum

iNum = 7
PROG_1(4,iNum)
```

Description:

In the program with the file name of PROG_1, declare one function named as PROG_1, income one (1) parameter num1 of INT and one output parameter num2 of INT, and then add these two parameters, and assign to num2 as the output returning to the calling procedure, in addition, in another external file program, use EXT to declare the external function of PROG_1, and then perform the calling by using the subprogram mode directly, please be aware that the calling of external subprogram can be up to eight (8) layers as the deepest, the compiler will report error if exceeded.

9.10 RS232 Communication Configuration Class

Program:

```
INT HANDLE
INT NUM
REAL SERDATA
COPEN ( SER , HANDLE)
LOOP
IF HANDLE > -1 THEN
CINQUIRE(HANDLE,NUM)
If NUM>0 THEN
CREAD (HANDLE, SERDATA)
ENDIF
CCLEAR (HANDLE)
SERDATA = SERDATA + 1
CWRITE (HANDLE, SERDATA)
ENDIF
WAIT SEC 0.3
ENDLOOP
```

Description:
Program writing and reading the number via RS232.

Parameter explanation:
SER; RS232
HANDEL; target folder

CWRITE (HANDLE, SERDATA)	; write the number of SERDATA into HANDLE
CREAD (HANDLE, SERDATA)	; give the number of HANDLE to SERDATA
CCLEAR (HANDLE)	; clear the number of HANDLE
CINQUIRE(HANDLE,NUM)	; read the received quantity

9.11 NET(Network) Communication Configuration Class

Program:

```
INT HANDLE
INT NUM
REAL ETHDATR
COPEN ( ETH , HANDLE)
LOOP
IF HANDLE > -1 THEN
CINQUIRE(HANDLE,NUM)
If NUM>0 THEN
CREAD (HANDLE, ETHDATR)
ENDIF
CCLEAR (HANDLE)
ETHDATR = ETHDATR + 1
CWRITE (HANDLE, ETHDATR)
ENDIF
WAIT SEC 0.3
ENDLOOP
```

Description:

Program writing and reading the number via network

Parameter explanation:

ETH	; Internet
HANDLE	; target folder
CWRITE (HANDLE, ETHDATR)	; write the number of ETHDATR into HANDLE
CREAD (HANDLE, ETHDATR)	; give the number of HANDLE to ETHDATR
CCLEAR (HANDLE)	; clear the number of HANDLE
CINQUIRE(HANDLE,NUM)	; read the received quantity

9.12 Conveyor Configuration Class

9.12.1 CNV_START

Description:

Start conveyor procedures, and connect with the system. The command for other conveyor can be executed after this command, used for the start of the conveyor program.

Format:

CNV_START CNV=1

…

CNV_END CNV=1

Format description:

CNV is the parameter for the conveyor number, which can be input from 1 to 4.

9.12.2 CNV_END

Description:

End the conveyor and the connection with the system, used for the end of the conveyor program.

Format:

CNV_START CNV=1

…

CNV_END CNV=1

Format description:

CNV is the parameter for the conveyor number, which can be input from 1 to 4.

9.12.3CNV_PICK_QUANTITY

Description:

The variables for the conveyor are used to set the maximum quantity of the object that the robot can pick every time. When the quantity reaches this value, the following pick commands will not be executed. This variable will simultaneously affect CNV_FULL and CNV_EMPTY.

Format:

CNV_PICK_QUANTITY = 1

Format description:

The variable type is positive integer. The default is 1, which can be input from 1 to 8.

9.12.4CNV_TRIGGER_TIMES[NUM]

Description:

This is a variable for the conveyor, used when the conveyor is set as a sensor trigger. When the conveyor sensor is triggered, the robot will receive a task to pick or place. This variable can be set to increase the speed of a task after the sensor is triggered several times, require to specify a conveyor number, # as the conveyor number.

Format:

CNV_TRIGGER_TIMES[NUM] = 1

Format description:

This variable type is positive integer from 1 to 100. If no quantity is assigned, the default is 1. NUM is the number of the conveyor. Input can be from 1 to 4, and represented by CNV1 to CNV4.

9.12.5CNV_PICK

Description:

Pick the object. Automatically waits for messages from the system when the command is given that it can pick the object. After a successful pick, the robot will return to the height that the pick started from. If the pick fails, the robot will return to the starting position.

Format:

CNV_PICK CNV=1 OBJ=1 $DO[1] P1 Down=5.000mm CONT=50% Vel=2000mm/s Acc=50% TOOL[0] BASE[0]

Format description:

■CNV is the parameter for the conveyor number. When it is necessary to track the object, the CNV number will be set. If the number is obmitted, it will not track. The input range 1 to 4.

■OBJ is the object parameter, used to assign a number to the object. When it is omitted, no number is assigned to the object. All objects will be picked. The input range input is 1 to 8.

■$DO[] is the parameter for the number O, which represents the Digital Output position to pick the object. The input range input is 1 to 48.

■P is the position parameter. The number for this position is the coordinate when the object triggers the sensor signal; if the image trigger is employed, it can be omitted.

■Down is the height that pressed downwardly to pick the object. During picking, the robot will stop a distance over the object and move downwardly. This parameter is used to assign this distance. The input range is a positive integer.

■FINE and CONT are the paramaters for the discontinuous and continuous motion. The percentage behind the paramter is the smooth extent. For the description of CONT, please see the Appendix at Chapter 4.7.

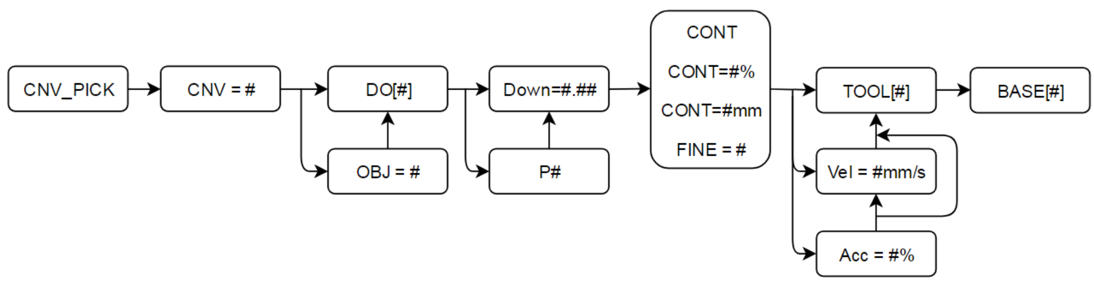
■Vel is the velocity parameter. The default is 2000mm/s.

■Acc is the acceleration. The default is 100%.

■TOOL is the parameter for the tool coordinates, which can be used to set the position of different end tools, input is from 0 to 15.

BASE is the parameters for base coordinate, which can be used to set the base number that the conveyor is calibrated, input is from 0 to 31.

Command flowchart:



PICK flowchart

Flowchart description:

■# is the number.

■CNV, OBJ, P, Vel and Acc can be omitted to input.

■Please select either CONT, CONT = #%, CONT = #mm or FINE.

9.12.6 CNV_PLACE

Description:

The objects can be picked and placed or selected according to the object number or O (chosen object); the object will return the safety height after successfully placed. When the place fails, the conveyor will return to the starting position.

Format:

CNV_PLACE CNV=1 OBJ=1 $DO[1] P1 Down=5.000mm CONT=100% Vel=2000mm/s Acc=50% TOOL[0] BASE[0]

Format description:

■CNV is the parameter for the conveyor number. When it is necessary to track the object, the CNV number will be entered. If the number is omitted, it will not track. The input range is from 1 to 4.

■OBJ is the object parameter, which can be used to assign the picked object number. If it is omitted, the object number is not assigned. All objects are placed. The input range is 1 to 8.

■$DO[] is the parameter for the number O, which represents the position to place the object in this time. If it is omitted, it will represent to place according to the object number.

■P is the position parameter, which represents the position to place the object.

■Down is the height that pressed downwardly to pick the object. During picking, the robot will stop a distance over the object and move downwardly. This parameter is used to assign this distance, which should be positive integer or 0.

■FINE and CONT are the paramaters for the discontinuous and continuous motion. The percentage behind the paramter is the smooth extent. For the description of CONT, please see the Appendix at Chapter 4.7.

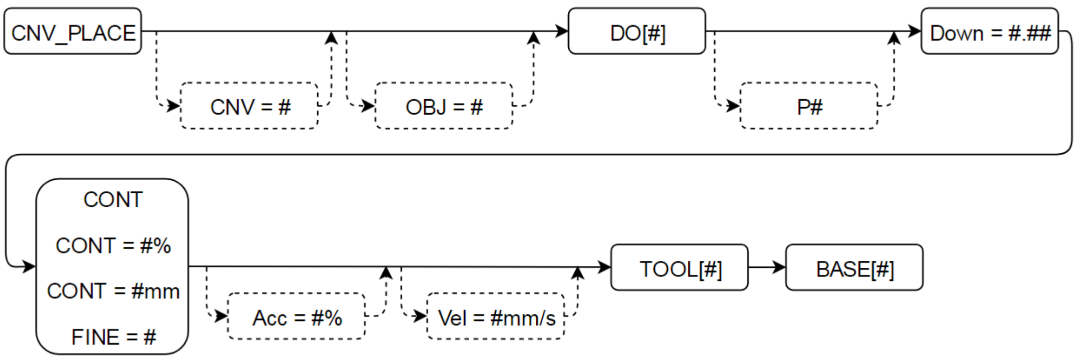
■Vel is the velocity parameter. The defaut is 2000mm/s.

■Acc is the acceleration parameter. The default is 100%.

■TOOL is the parameter for tool coordinate.

BASE is the parameter for the base coordinate.

Command flowchart:



PLACE flowchart

Flowchart description:

■# is the number.

■CNV, OBJ, P, Vel and Acc can be omitted to input.
■Please select either CONT, CONT = #%, CONT = #mm or FINE.

9.12.7 CNV_OBJECT

Description:

The variable for picking represents the latest object number picked. After the object is placed, the number will be automatically reset, which can be used to determine the current object and perform the specific action. (ATTENTION: CNV_OBJECT can be used only after CNV_PICK)

Format:

```
CNV_PICK CNV=1 $DO[1] P1 Down=5.000mm CONT=50% Vel=2000mm/s Acc=50% TOOL[0] BASE[0]
IF CNV_OBJECT == 1 THEN
CNV_PLACE CNV=1 $DO[1] P3 Down=5.000mm CONT=100% Vel=2000mm/s Acc=50% TOOL[0] BASE[0]
ENDIF
CNV_PLACE CNV=1 $DO[1] P2 Down=5.000mm CONT=100% Vel=2000mm/s Acc=50% TOOL[0] BASE[0]
```

Format description:

The variable type is integer, which can be used for WHILE or IF.

9.12.8CNV_FULL

Description:

The Boolean variable for picking (For the description of Boolean, please see chapter 9.2.4) represents when the quantity of objects that have been picked by the robot reaches the upper limit. When the picking quantity has reached the value set by CNV_PICK_QUANTITY, this variable is TRUE; if the quantity doesn’t reach the setting value, it will be FALSE.

Format:

```
CNV_PICK_QUANTITY = 2
WHILE CNV_FULL == FALSE
…
ENDWHILE
```

Format description:

The variable type is Boolean, which can be used for WHILE or IF.

9.12.9 CNV_EMPTY

Description:

The Boolean variable for picking (For the description of Boolean, please see the chapter 9.2.4) represents the quantity of the objects that have been picked by the robot. When no object is picked, this variable is TRUE; if one or more object is picked, this variable is FALSE.

Format:

WHILE CNV_EMPTY == FALSE

…

ENDWHILE

Format description:

The variable type is Boolean, and can be used for WHILE or IF.

9.12.10 CNV_SET_DELAY_TIME[NUM]

Description:

This parameter is used to set the delay time for the conveyor. By setting this variable, the robot can continue to move with the object in the specific time and leave after reaching the position to pick or place.

As shown in below, the robot will move with the object in 50ms and leave after picking or placing.

Format:

CNV_SET_DELAY_TIME[NUM] = 50

Format description:

NUM is the number of the conveyor. Input can be from 1 to 4, and represented by CNV1 to CNV4.

The variable type is positive integer. The default is 0, which can be input from 0 to 1500 with a unit of ms.

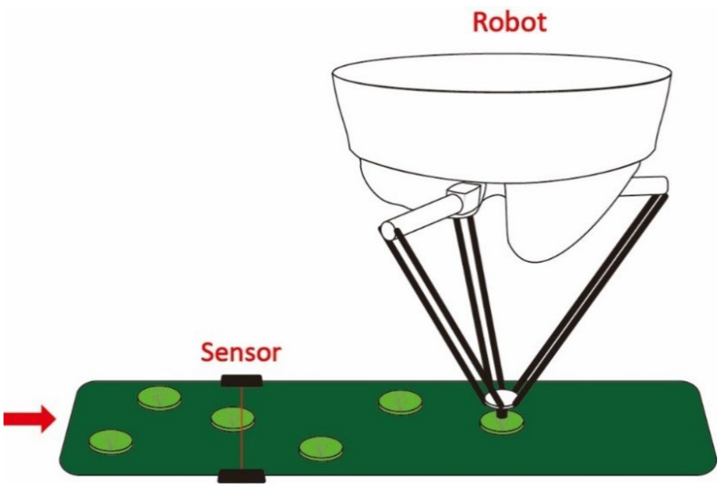


Illustration of Delta positioning

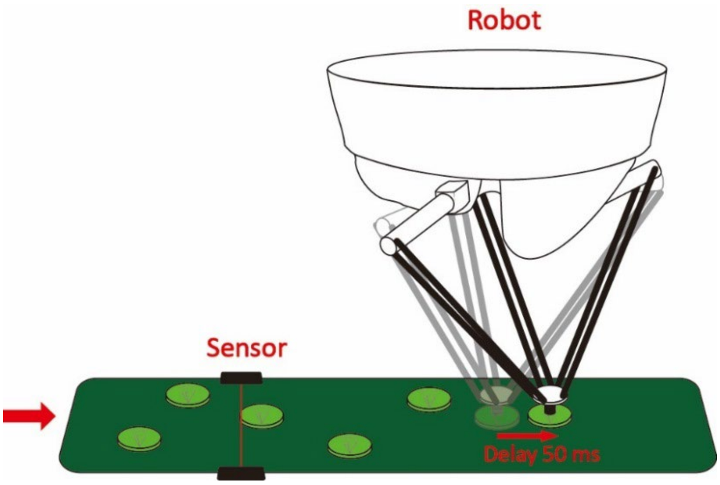


Illustration of Delta delay 50 ms

9.12.11 CNV_QUEUE_SIZE[NUM]

Description:

This is the pick variable. This variable shows the sensor has been triggered on the conveyor, but there is a quantity of object not picked.

As shown in below, the sensor for the Conveyor 2 has triggered three objects, but the robot has not picked them. Therefore, this variable is 3.

Format:

```
IF CNV_QUEUE_SIZE[NUM] > 0 THEN
…
ENDIF
```

Format description:

NUM is the number of the conveyor. Input can be from 1 to 4, and represented by CNV1 to CNV4.

The variable type is a positive integer, and can be used for WHILE or IF.

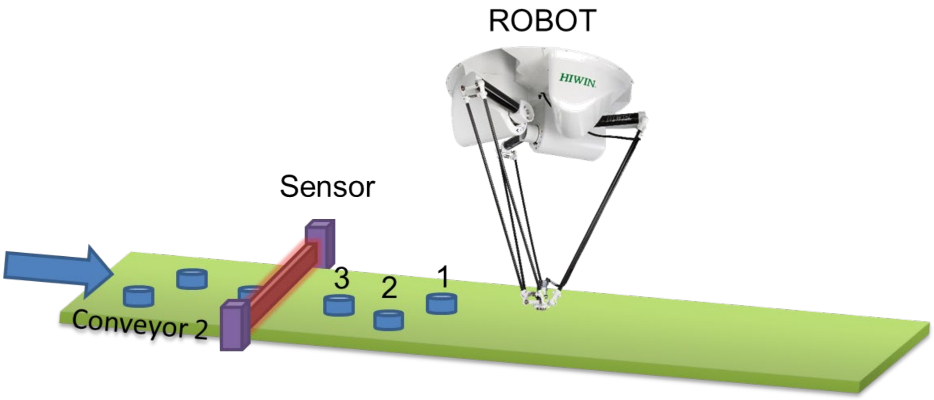


Illustration of CNV_QUEUE_SIZE

9.12.12 CNV_OBJ_CNT_DIST[NUM]

Description:

This is the conveyor variable. When the variable CNV_QUEUE_SIZE[NUM] is greater than or equal to 2 (Two or more objects on the conveyor have been triggered.) can be used immediately.

This variable can display the difference between the position of the first object and the second object triggered by the sensor from the difference in Encoder value. It is usually used to determine if the triggered objects are continuous.

Format:

```
IF CNV_QUEUE_SIZE[NUM] > 1 THEN
IF CNV_OBJ_CNT_DIST[NUM] < 2600 THEN
…
ELSE
…
ENDIF
ENDIF
```

Format description:

NUM is the number of the conveyor. Input can be from 1 to 4, and represented by CNV1 to CNV4.

The variable type is positive integer, and can be used for WHILE or IF.

9.12.13 CNV_PLACE_BATCH[NUM]

Description:

The place variable is used when many objects are placed in the same work space.

When the senor that releases an object is triggered, the robot will obtain a position where the object can be placed. The maximum number of times that the robot can place an object in this position can be set by this variable.

Format:

```
CNV_PLACE_BATCH[NUM] = 1
```

Format description:

The variable type is a positive integer. If no quantity is assigned, the default is 1. The input range is 1 to 100 and represented by CNV1 to CNV4.

9.12.14 CNV_RESET_ENC

Description:

Conveyor Tracking Instruction. The user can use this instruction to clear the counting value of the external encoder when writing program.

The effect of using this instruction is same as the effect of pressing “CLEAR” on the conveyor calibration interface.

Format:

CNV_RESET_ENC

Format description:

No need to enter parameter.

9.12.15 CNV_QUEUE_REMOVE[NUM]

Description:

Flying pick/flying place state variable. The user is able to remove the temporary value placed at the forefront of the waiting queue by using this instruction during the process of writing the program.

Format:

CNV_QUEUE_REMOVE[NUM]

Format description:

NUM is the number of the conveyor. Input can be from 1 to 4, and represented by CNV1 to CNV4.

9.12.16 CNV_PICK_ACC[NUM]

Description:

Flying pick state variable. The user is able to configure the acceleration time of tracking push-down by using this instruction when writing program.

Format:

CNV_PICK_ACC[NUM]

Format description:

NUM is the number of the conveyor. Input can be from 1 to 4, and represented by CNV1 to CNV4. The default value is 30, range from 10 to 100.

9.12.17 CNV_OFFSET_X[NUM]

Description:

Flying pick/flying place state variable. The user is able to configure the offset value of X by using this instruction when writing program.

Format:

CNV_OFFSET_X[NUM] = 10

Format description:

NUM is the number of the conveyor. Input can be from 1 to 4, the offset value of X is configured as 10mm.

9.12.18 CNV_OFFSET_Y[NUM]

Description:

Flying pick/flying place state variable. The user is able to configure the offset value of Y by using this instruction when writing program.

Format:

CNV_OFFSET_Y[NUM] = 10

Format description:

NUM is the number of the conveyor. Input can be from 1 to 4, the offset value of Y is configured as 10mm.

9.12.19 CNV_OFFSET_Z[NUM]

Description:

Flying pick/flying place state variable. The user is able to configure the offset value of Z by using this instruction when writing program.

Format:

CNV_OFFSET_Z[NUM] = 10

Format description:

NUM is the number of the conveyor. Input can be from 1 to 4, the offset value of Z is configured as 10mm.

9.12.20 CNV_SPEED[NUM]

Description:

Conveyor state variable, user is able to read the current speed of conveyor.

Format:

```
INT ISpeed
ISpeed = CNV_SPEED[NUM]
```

Format description:

NUM is the number of the conveyor. Input can be from 1 to 4, and represented by CNV1 to CNV4.

9.13 Do Switching on the Path(SYN Out) Class

9.13.1 Program Example 1 of SYN

Program:

```
LIN P1 FINE Vel=100% Acc=50% TOOL[0] BASE[0]
SYN $DO[1] = TRUE START DELAY = 50 ms
SYN $DO[2] = TRUE END DELAY = -50 ms
LIN P2 FINE Vel=100% Acc=50% TOOL[0] BASE[0]
```

Description:

As shown in below, the command for SYN is given when moving from P1 to P2. P1 and P2 are not in the smooth circumstance. The range of START is from the position of the accurate position for P1 to P2. The range for END is from P2 to P1; the command for START Delay in SYN is given to 50ms, which executes the command for DO[1]=True after the time elapses 50ms. The command for END Delay in SYN is given to -50ms, which backwards 50ms from P2 to execute DO[2]=True.

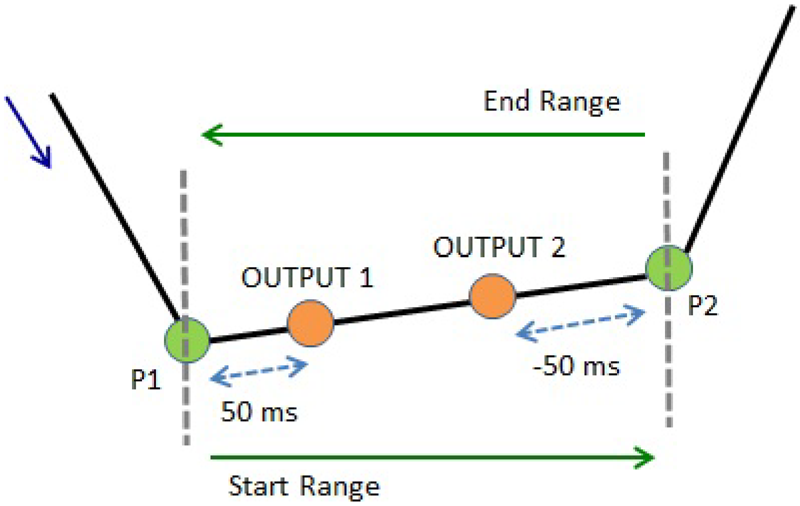


Illustration of Example 1

9.13.2 Program Example 2 of SYN

Program:

LIN P1 FINE Vel=100% Acc=50% TOOL[0] BASE[0]

SYN $DO[1] = TRUE START DELAY = 50 ms

SYN $DO[2] = TRUE END DELAY = -50 ms

LIN P2 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]

Description:

As shown in below, the command for SYN is given when moving from P1 to P2. P2 is in the smooth circumstance. The range of START is from the position of the smooth termination for P1 to the smooth start for P2. The range for END is from the position of the smooth start for P2 to the smooth termination for P2; the command for START Delay in SYN is given to 50ms, which executes the command for DO[1]=True after the time elapses 50ms from the position of the smooth termination for P1. The command for END Delay in SYN is given to -50ms, which executes the command for DO[2]=True after the time elapses 50ms forward from the central point of the Bezier curve in the smooth range of P2. For the description of CONT, please see the Appendix at Chap. 4.7

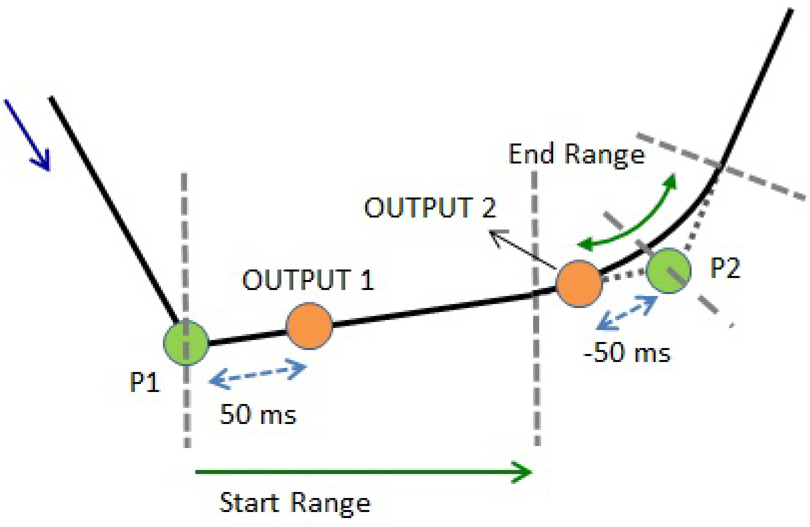


Illustration of Example 2

9.13.3 Program Example 3 of SYN

Program:

```
LIN P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
SYN $DO[1] = TRUE START DELAY = 50 ms
SYN $DO[2] = TRUE END DELAY = -50 ms
LIN P2 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
```

Description:

As shown in below, the command for SYN is given when moving from P1 to P2. P1 and P2 are in the smooth circumstance. The range of START is from the position of the smooth termination for P1 to the smooth start for P2. The range for END is from the position of the smooth start for P2 to the smooth termination for P2; the command for START Delay in SYN is given to 50ms, which executes the command for DO[1]=True after the time elapses 50ms from the position of the smooth termination for P1. The command for END Delay in SYN is given to -50ms, which executes the command for DO[2]=True after the time elapses 50ms forward from the central point of the Bezier curve in the smooth range of P2. For the description of CONT, please see the Appendix at Chap. 4.7.

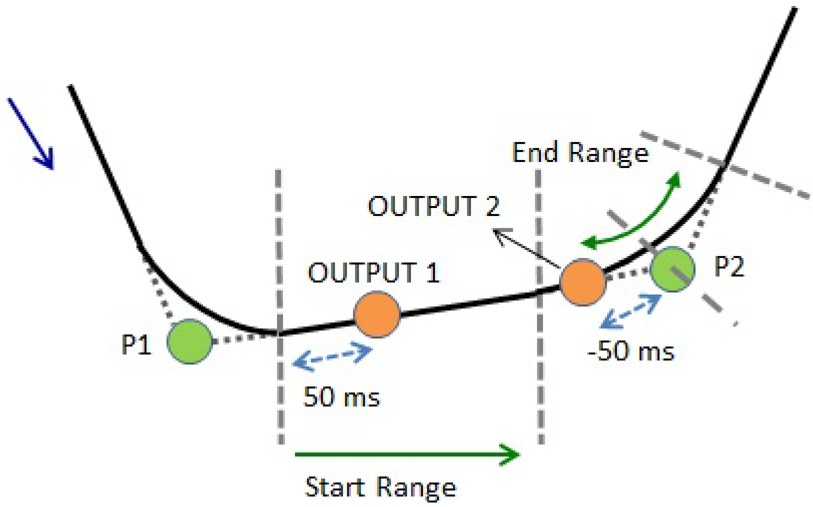


Illustration of Example 3

9.13.4 Program Example 4 of SYN

Program:

LIN P1 FINE Vel=100% Acc=50% TOOL[0] BASE[0]

SYN $DO[1] = FALSE START PATH = 50 mm DELAY = -50 ms

LIN P2 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]

LIN P3 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]

LIN P4 FINE Vel=100% Acc=50% TOOL[0] BASE[0]

Description:

As shown in below, the command for SYN is given when moving from P1 to P2. The path is used, as well as P2 and P3 are in the smooth circumstance. The range of START is from the position of the smooth start for P1 to P4; PATH=50mm and DELAY = -50ms are in SYN, counting 50mm from the start of P1, moving to 50ms and executing DO[1] = False; if P3 is the accurate position, the range of START is from the smooth start of P1 to P3. For the description of CONT, please see the Appendix at Chap 4.7.

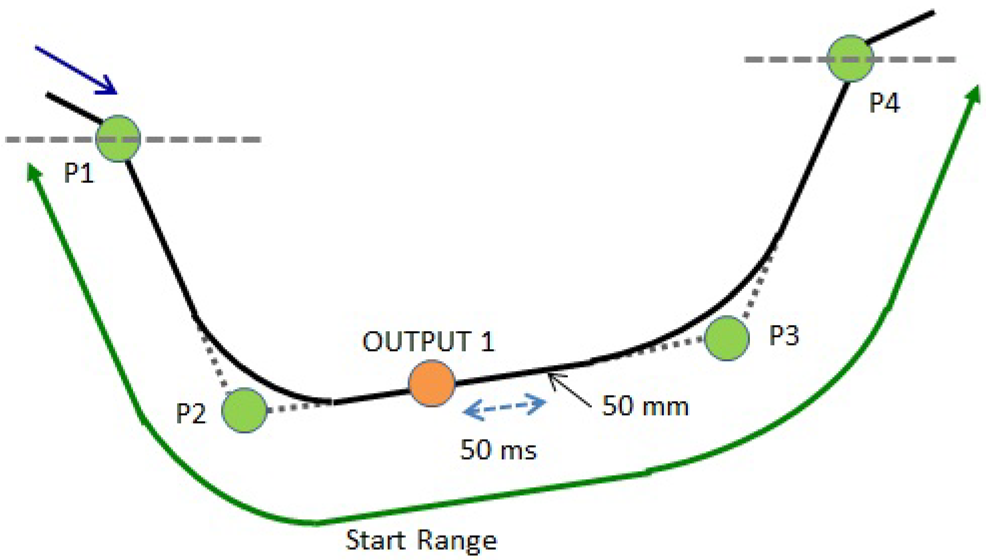


Illustration of Example 4

9.13.5 Program Example 5 of SYN

Program:

```
LIN P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
SYN $DO[1] = FALSE START PATH = 50 mm DELAY = -50 ms
LIN P2 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
LIN P3 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
LIN P4 FINE Vel=100% Acc=50% TOOL[0] BASE[0]
```

Description:

As shown in below, the command for SYN is given when moving from P1 to P2. The path is used, as well as P1, P2 and P3 are in the smooth circumstance. The range of START is from the position of the smooth start for P1 to P4; PATH=50mm and DELAY = -50ms are in SYN, counting 50mm from the smooth start of P1, moving to 50ms and executing DO[1] = False; if P3 is the accurate position, the range of START is from the smooth start of P1 to P3. For the description of CONT, please see the Appendix at Chap 4.7.

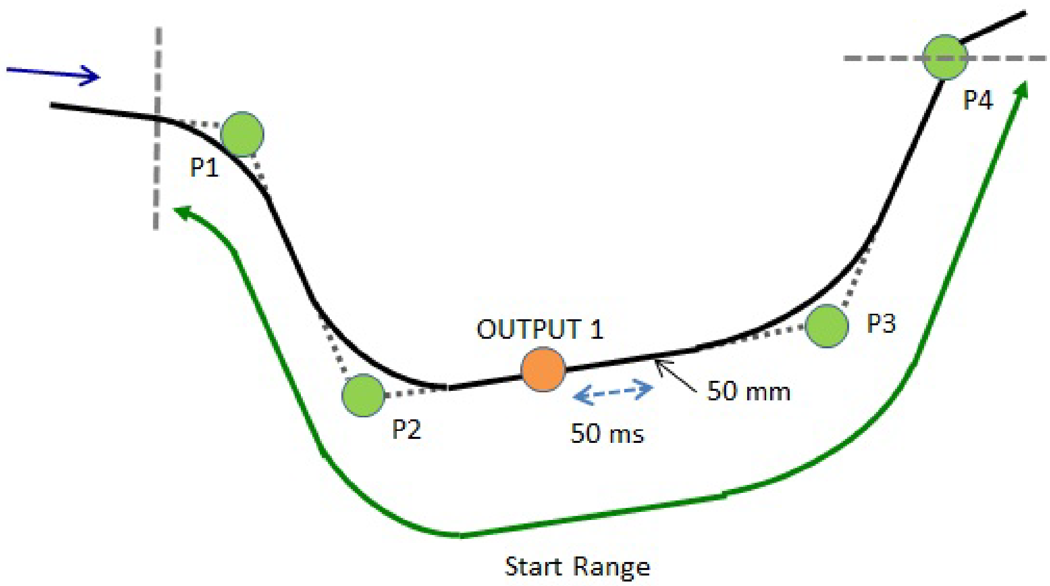


Illustration of Example 5

9.14 Issue Self-defined Alarm Text Command

Description

If the user requires an alarm based on the self-determined condition during the execution of program, it is possible to use this instruction function to issue an alarm while the program is running.

When using this instruction to issue the alarm, it has the function as temporary motion stop, the "Start" button will be used to continue executing the operation.

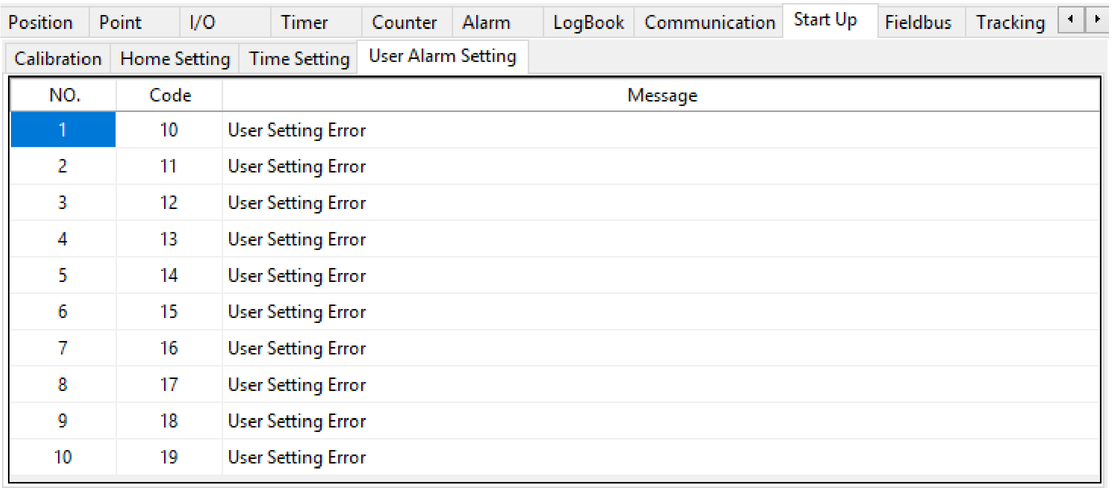
Setting alarm text refer to chapter 3.6.6.

Format

USER_ALARM [n]

Format description

The variable type is a positive integer, from 1 to 10 and cannot be 0.



NO.	Code	Message
1	10	User Setting Error
2	11	User Setting Error
3	12	User Setting Error
4	13	User Setting Error
5	14	User Setting Error
6	15	User Setting Error
7	16	User Setting Error
8	17	User Setting Error
9	18	User Setting Error
10	19	User Setting Error

User Alarm Setting interface

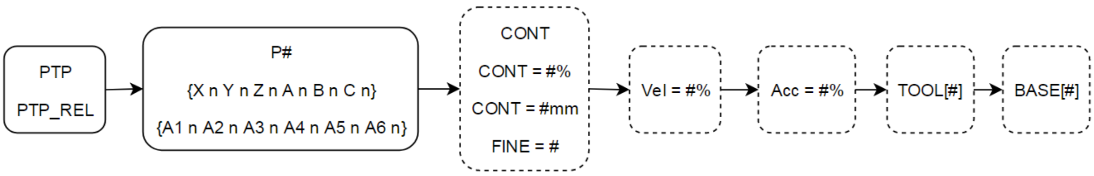
10. Functional Program Application Example

10.1 Motion Commands Description

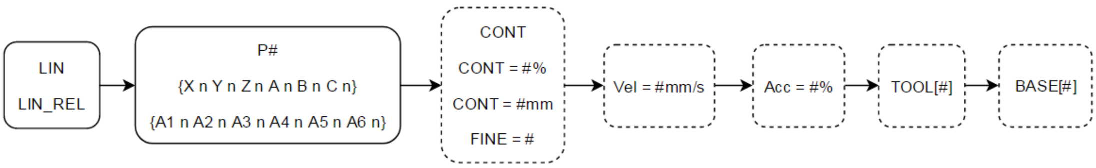
Motion commands:

Commands	Description
PTP	Point to point motion
PTP_REL	Point to point relative motion
LIN	Linear motion
LIN_REL	Linear relative motion
LIN_REL_TOOL	Circular motion
CIRC	Circular relative motion
CIRC_REL	B-Spline curvilinear motion
SPLINE…SPL…ENDSPLINE	Point to point motion

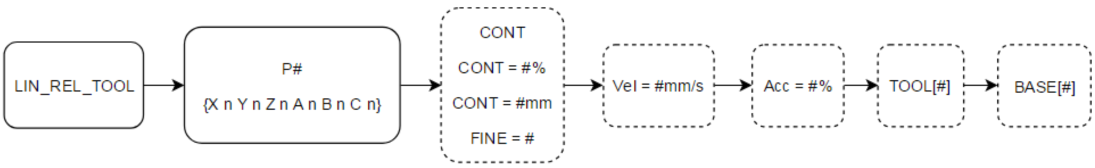
PTP&PTP_REL flowchart:



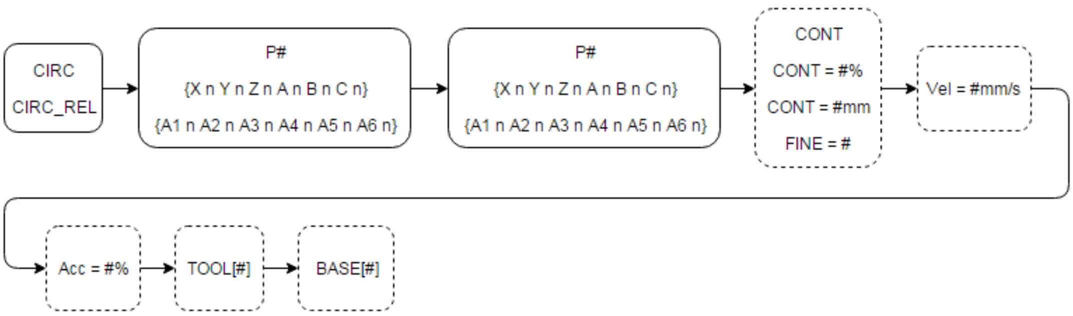
LIN&LIN_REL flowchart:



LIN_REL_TOOL flowchart:



CIRC&CIRC_REL flowchart:



SPLINE instructions:

SPLINE

SPL P1
.....
SPL P73
ENDSPLINE

10.2 Register Commands Description

暫存器指令：

Commands	Description
$C[#]	Counter register
$DI[#]	Digital input point register
$DO[#]	Digital output point register
$PR[#]	Robot input point register
$RI[#]	Robot output point register
$RO[#]	Timer register
$T[#]	Start timer register
$T_STOP[#]	Valve output register
$VO[#]	Counter register

Example:

```
$C[1] = 0
$DO[1] = TRUE
WAIT FOR $DI[1] == TRUE
$RO[1] = TRUE
WAIT FOR $RI[1] == TRUE
$VO[1] = TRUE
$T_STOP[1] = TRUE
$T[1] = 0
```

PR Example 1:

```
$PR[1] = {A1 1 , A2 2 , A3 3 , A4 4 ,A5 5 , A6 6}
$PR[2] = {X 7 ,Y 8 , Z 9 , A 10 ,B 11 , C 12}
$PR[3] = {A1 1 , A2 2 , A3 3 , A4 4 ,A5 5 , A6 6, X 7 ,Y 8 , Z 9 , A 0,B 0, C 0}
```

PR Example 2:

```
E6POS A = {X 10 ,Y 10 ,Z 10 ,A 10 ,B 10 ,C 10}
E6AXIS B = {A1 20 , A2 20 , A3 20 , A4 50 ,A5 10 , A6 20}
E6POINT C = {X 5 ,Y 15 ,Z 25 ,A 35 ,B 45 ,C 55}}
$PR[1] = A
$PR[2] = B
$PR[3] = C
```

PR Example 3:

```
$PR[1] = GETPOINT
```

10.3 Variable Type Commands Description

Variable types:

Commands	Description
BOOL	Boolean variable type
CHAR	Character variable type
E6AXIS	Angular variable value type
E6POINT	Coordinates or angular variable type
E6POS	Coordinates variable type
FRAME	BASE or TOOL coordinate system
INT	Integer variable type
REAL	Real point variable type

Example:

```
BOOL K = TRUE
CHAR COLOR = 'R'
INT I = 0
REAL R = 0
```

FRAME：

```
FRAME POINT = {A1 90}
```

E6POS/E6AXIS：

```
E6POS POINT = {X 0,Y 300,Z 200}
E6AXIS POINT = {A1 90}
PTP POINT CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
```

E6POINT：

```
E6POINT HOME = {Y 200,Z -1000,A 90}
```

10.4 Trigonometric Function of Math Calculation Commands Description

Math Calculation:

Commands	Description
ACOS	Arc cosine(X)
ASIN	Arc sine(X)
ATAN	Arc tangent(X)
ATAN2	Arc tangent(X, Y)
COS	Cosine(X)
SIN	Sine(X)
TAN	Tangent(X)

X,Y is angle degree.

Example:

```
REAL TESTA
TESTA=ACOS(0)
TESTA=ASIN(0)
TESTA=ATAN(0)
TESTA=ATAN2(0,1)
TESTA=COS(0)
TESTA=SIN(0)
TESTA=TAN(0)
```

10.5 Control Flow Function Commands Description

Control function

Commands	Description
FOR…ENDFOR	For loop
GOTO	Go to label position
IF…ENDIF	IF statement
LOOP…ENDLOOP	LOOP
REPEAT…UNTIL	Repeat loop
SWITCH…ENDSWITCH	Switch statement
WHILE…ENDWHILE	While loop

Example:

FOR…ENDFOR：

```
INT n
FOR n = 0 TO 2 STEP 1
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
```

```
ENDFOR
```

GOTO：

```
FOUND:
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
GOTO FOUND
```

IF...ENDIF：

```
INT n = 1
IF n > 0 THEN
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
ENDIF
```

LOOP...ENDLOOP：

```
LOOP
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
ENDLOOP
```

REPEAT...UNTIL：

```
INT n =0
REPEAT
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
n = n + 1
UNTIL n > 2
```

SWITCH...ENDSWITCH：

```
INT n =0
LOOP
SWITCH n
CASE 0
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
CASE 1
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
CASE 2
EXIT
ENDSWITCH
n = n + 1
ENDLOOP
```

WHILE...ENDWHILE：

```
INT n = 2
WHILE n > 0
PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0]
```

```
n = n - 1
ENDWHILE
```

10.6 Other Function Commands Description

Other Commands:

Commands	Description	Program Example
ADDTOOL	Add tool	ADDTOOL ee
ADDOBJECT	Add object	ADDTOOL table P:500,200 C:200,50
SET_TOOL	Set tool coordinate system	FRAME T_ONE T_ONE.X = 100 SET_TOOL 1 SET_TOOL T_ONE
SET_BASE	Set base coordinate system	FRAME B_ONE B_ONE.Y = 100 SET_BASE 1 SET_BASE B_ONE
SET_OVERRIDE_SPEED	Set override speed ratio	SET_OVERRIDE_SPEED 100
SET_SPEED	Set line speed, Uint:mm/s	SET_SPEED 2000
SET_ROTATION_SPEED	Set rotation speed, Uint:deg/sec	SET_ROTATION_SPEED 100
SET_ACC	Set acceleration	SET_ ACC 250
TRUE_PATH	Open or close trajectory accuracy control	TRUE_PATH = TRUE
USER_ALARM	Configure user alarm	USER_ALARM[1]
SYN	Synchronous switch O pint in motion path	LIN P1 FINE Vel=100% Acc=50% TOOL[0] BASE[0] SYN $DO[1] = TRUE START DELAY = 50 ms SYN $DO[2] = TRUE END DELAY = -50 ms LIN P2 FINE Vel=100% Acc=50% TOOL[0] BASE[0]
MOVEFLOOR	Move floor position	MOVEFLOOR 100
DEFFCT…ENDFCT	Define subprogram	PTP P0 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0] MY()

		DEFFCT INT MY() PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0] BASE[0] RETURN 100 ENDFCT
GETPOINT	Get coordinates or angular value	E6POINT E6TEST E6TEST = GETPOINT
AXISON	Axis coordinates on	AXISON
AXISOFF	Axis coordinates off	AXISOFF
GET_MOTION_STATUS	Get motion status	INT Istatus Istatus = GET_MOTION_STATUS
WAIT SEC	Wait second	WAIT SEC 10
WAIT FOR $DI[#]	Wait digital input	WAIT FOR $DI[1] == TRUE
STRUC	Define structure	STRUC CASTING_TYPE INT MASS, REAL VOLUME

10.7 External Axis Commands Description

External Axis Commands：

Commands	Description	Program Example
EX_AX	Turns on or off the connected external axis	EX_AX[1] = TRUE ... EX_AX[1] = FALSE
EX_AX_ASYNC	Sets the external axis as synchronous axis or asynchronous axis	EX_AX_ASYNC[1] = TRUE EX_AX_ASYNC[2] = FALSE
EX_AX_SYNC_COUPLE	Turns on or off the coordinated control function of the external axis	EX_AX_SYNC_COUPLE[1] = TRUE
EX_AX_SET_ACC	Sets the acceleration and deceleration time for the external axis	EX_AX_SET_ACC[1] 250
EX_AX_SET_SPEED	Sets the speed of the specified external axis	EX_AX_SET_SPEED[1] 1000
EX_AX_CT	Executes infinite rotation for the external axis	EX_AX_CT[1] 100
ASYPTP	Performs point to point movement control for the asynchronous external axis	ASYPTP{E1 60, E2 100} CONT=100% Vel=100% Acc=50%

PTP	Performs synchronous point to point movement control for the robot and synchronous external axis	E6POINT P1{A1 50, E1 60} PTP P1 CONT=100% Vel=100% Acc=50% TOOL[0]BASE[0] PTP{A1 40, E1 50} CONT=100% Vel=100% Acc=50% TOOL[0]BASE[0] PTP{X 100, E1 50} CONT=100% Vel=100% Acc=50% TOOL[0]BASE[0]
LIN	Performs synchronous linear movement control for the robot and synchronous external axis	E6POINT P1{A1 50, E1 60} LIN P1 CONT=100% Vel=2000mm/s Acc=50% TOOL[0]BASE[0] LIN{A1 40, E1 50} CONT=100% Vel=2000mm/s Acc=50% TOOL[0]BASE[0] LIN{X 100, E1 50} CONT=100% Vel=2000mm/s Acc=50% TOOL[0]BASE[0]
CIRC	Performs synchronous arc movement control for the robot and synchronous external axis	E6POINT P1{A1 50, E1 60} E6POINT P2{X 100, E1 0} CIRC P1 P2 CONT=100% Vel=2000mm/s Acc=50% TOOL[0]BASE[0] CIRC{A1 50, E1 60} {X 100, E1 0}CONT=100% Vel=2000mm/s Acc=50% TOOL[0]BASE[0] CIRC{A1 50, E1 60} {X 100, E1 0} CONT=100% Vel=2000mm/s Acc=50% TOOL[0]BASE[0]

10.8 Network and RS232 Communication Application Example

RS232 or EtherNet Commands:

Commands	Description
COPEN	Open RS232 or EtherNet
CCLOSE	Close RS232 or EtherNet
CCLEAR	Delete RS232 or EtherNet data
CREAD	Read received data from RS232 or EtherNet
CWRITE	Write RS232 or EtherNet data
CINQUIRE	Inquire RS232 or EtherNet package numbers

ETH Example:

```
INT HANDLE
INT NUM
REAL SERDATA
COPEN ( ETH , HANDLE)
LOOP
    IF HANDLE > -1 THEN
        CINQUIRE(HANDLE,NUM)
        If NUM>0 THEN
CREAD (HANDLE, SERDATA)
        ENDIF
        CCLEAR (HANDLE)
        SERDATA = SERDATA + 1
        CWRITE (HANDLE, SERDATA)
    ENDIF
    WAIT SEC 0.3
ENDLOOP
CCLOSE (HANDLE)
```

RS232 Example:

```
INT HANDLE
INT NUM
REAL SERDATA
COPEN ( SER , HANDLE)
LOOP
      IF HANDLE > -1 THEN
            CINQUIRE(HANDLE,NUM)
            If NUM>0 THEN
CREAD (HANDLE, SERDATA)
            ENDIF
            CCLEAR (HANDLE)
            SERDATA = SERDATA + 1
            CWRITE (HANDLE, SERDATA)
      ENDIF
      WAIT SEC 0.3
ENDLOOP
CCLOSE (HANDLE)
```

10.9 Conveyor Tracking Application Example

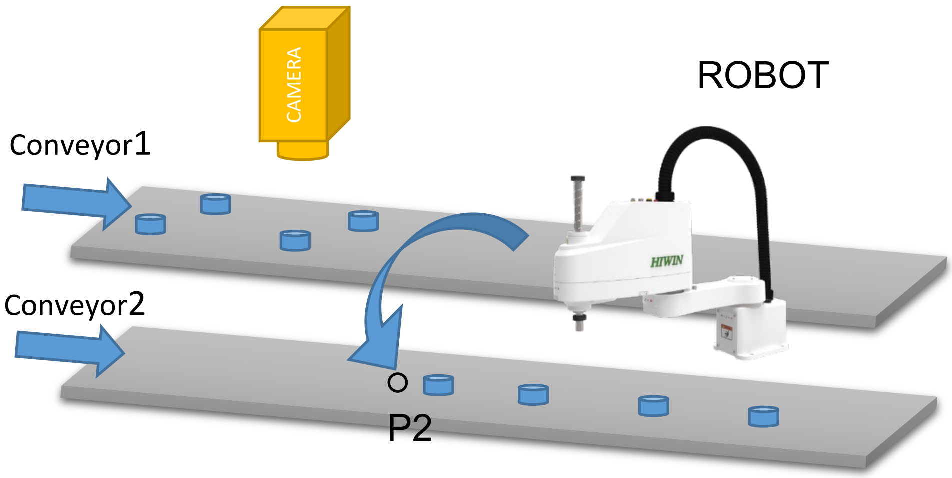
This chapter explains the programming application example for conveyor tracking; please refer to Chapter 6-Conveyor tracking function application to perform conveyor pick-on-the-fly setting first, and then refer to the conveyor tracking type instructions in Chapter 9.12, and use it with the application sample program in this chapter.

10.9.1 Visual Way A Conveyor Pick/Place Object to B Conveyer Example(A)

Program description:

This is a visual example.

The robot picks the object from the Conveyor 1 to place on te Conveyor 2. The position is visually picked, and place P2 on the Conveyor 2.



Visual trigger way A conveyor pick/place object to B conveyer figure

■**Program example:**

Correspond to line, robot program commands, robot program simple description.

LINE	Robot Program Command:	Robot Program Simple Description:
1	CNV_START CNV=1	;Start pick&place
2	CNV_PICK_QUANTITY = 2	;Set the maximum quantity to pick object,2
3	WHILE CNV_FULL == FALSE	;Go to loop when the quantity on the robot doesn't reach the upper limit..
4	CNV_PICK CNV=1 OBJ=1 $DO[1] Down=5.000mm FINE Vel=2000mm/s Acc=50% TOOL[0] BASE[0]	; Execute pick(object) motion; Setting conveyor 1, object number 1, digital output signal$DO[1], down distance 5mm
5	ENDWHILE	
6	WHILE CNV_EMPTY == FALSE	;Go to loop when the quantity on the robot is not empty.
7	CNV_PLACE $DO[1] P2 FINE Vel=2000mm/s Acc=50% TOOL[0] BASE[0]	; Execute place(object) motion; Digital output signal$DO[1], place on P2 position
8	ENDWHILE	
9	CNV_END CNV=1	; End pick&place

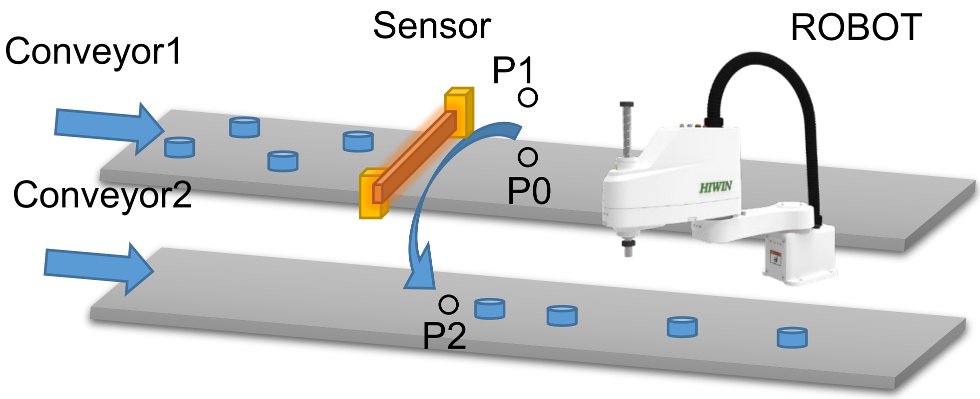
10.9.2 Sensor Way A Conveyor Pick/Place Object to B Conveyer Example(B)

Program description:

When the position to trigger a sensor is within the picking range, P can be directly set as the pick and place position.

The robot picks and places the object from the Conveyor 1 to the Conveyor 2. When the object is triggered by the sensor, the robot will move to P0 and pick, and then move to P1 and finally place P2.

Program:



Sensor trigger way A conveyor pick/place object to B conveyer example figure

■**Program example:**

Correspond to line, robot program commands, robot program simple description.

LINE	Robot Program Command:	Robot Program Simple Description:
1	CNV_START CNV=1	;Start pick&place
2	CNV_PICK_QUANTITY = 2	;Set the maximum quantity to pick object,2
3	WHILE CNV_FULL == FALSE	;Go to loop when the quantity on the robot doesn't reach the upper limit..
4	CNV_PICK CNV=1 $DO[1] P0 Down=5.000mm FINE Vel=2000mm/s Acc=50% TOOL[0] BASE[0]	Execute pick(object) motion; Setting conveyor 1, object number 1, digital output signal$DO[1], pick on P0 position, down distance 5mm.
5	ENDWHILE	
6	PTP P1 CONT Vel=100% Acc=50% TOOL[0] BASE[0]	; Move to P1 position
7	WHILE CNV_EMPTY == FALSE	; go to loop when the quantity on the robot is not empty.
8	CNV_PLACE CNV=2 $DO[1] P2 FINE Vel=2000mm/s Acc=50% TOOL[0] BASE[0]	; Execute place(object) motion; Setting conveyor 2, Digital output signal$DO[1], place on P2 position
9	ENDWHILE	
10	CNV_END CNV=1	; End pick&place

10.9.3 Sensor Way A Conveyor Pick/Place Objects to B Conveyer Example(C)

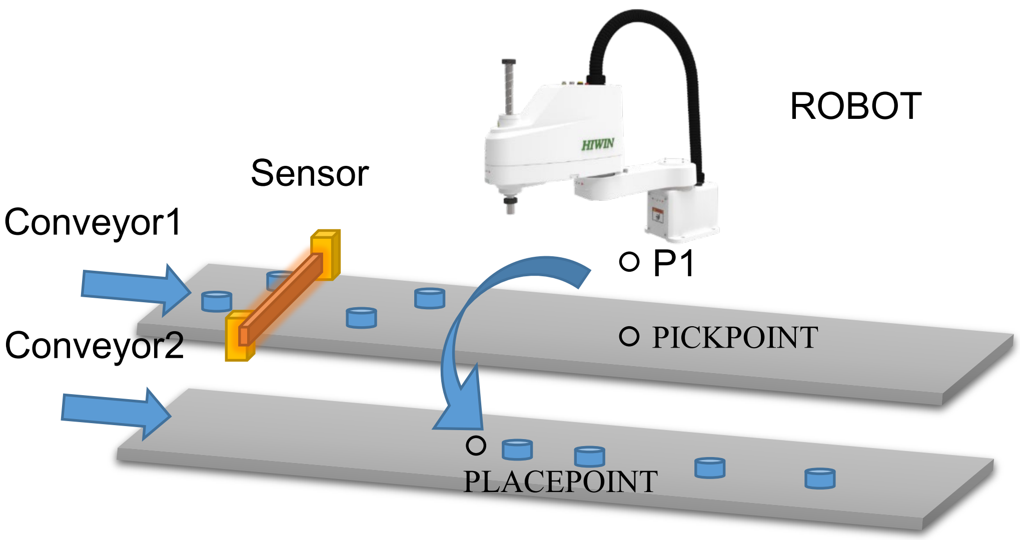
Program description:

This example will release two objects after they are simultaneously picked.

When the position to trigger a sensor is beyond the picking range, the command E6POINT can be used to set the pick and place position.

(Before using the command E6POINT, please ensure the ToolBase coordinates have been parallel with those for the conveyor. So, you just need to adjust X coordinate or Y coordinate following P is adjusted).

The robot picks from the Conveyor 1 to the Conveyor 2, waits for the object to move to PICKPOINT, and then place to PLACEPOINT after moving to P1.



Sensor trigger way A conveyor pick/place two objects to B conveyer example figure
(self-define point name)

■**Program example:**

Correspond to line, robot program commands, robot program simple description.

LINE	Robot Program Command:	Robot Program Simple Description:
1	CNV_START CNV=1	;Start pick&place
2	CNV_PICK_QUANTITY = 2	;Set the maximum quantity to pick object,2
3	E6POINT PICKPOINT = P0	;Set the pick point of E6POINT, P0
4	PICKPOINT.X = PICKPOINT.X – 200	; If our Tool/Base coordinate is parallel with the conveyor coordinate, X for PICKPOINT will be needed. ; the coordinate position minus 200, no change for Y coordinate
5	E6POINT PLACEPOINT = P2	; Set the place point of E6POINT ,P2
6	PLACEPOINT.X = PLACEPOINT.X – 50	; If our ToolBase coordinate is parallel with the conveyor coordinate, X for PLACEPOINT will need to minus 50 and there is no change for Y coordinate.
7	WHILE CNV_FULL == FALSE	; go to loop when the quantity on the conveyor doesn't reach the upper limit.
8	CNV_PICK CNV=1 $DO[1] PICKPOINT Down=0.000mm FINE Vel=2000mm/s Acc=50% TOOL[0] BASE[0]	; Pick the first object ; Setting conveyor 1, digital output signal$DO[1], pick on PICKPOINT position, down distance 0mm.
9	CNV_PICK CNV=1 $DO[2] PICKPOINT Down=0.000mm FINE Vel=2000mm/s Acc=50% TOOL[0] BASE[0]	; Pick the second object; Setting conveyor 1, digital output signal$DO[2], pick on PICKPOINT position, down distance 0mm.
10	ENDWHILE	
11	PTP P1 CONT Vel=100% Acc=50% TOOL[0] BASE[0]	;Move to P1 position.
12	WHILE CNV_EMPTY == FALSE	; go to loop when the quantity on the conveyor is not empty.
13	CNV_PLACE CNV=2 $DO[1] PLACEPOINT FINE Vel=2000mm/s Acc=50% TOOL[0] BASE[0]	; Execute place motion. ; Setting conveyor 2, digital output signal$DO[1], pick on PLACEPOINT position
14	ENDWHILE	
15	CNV_END CNV=1	; End pick&place

10.10 External Axis Application Example

The following is a sample program for using external axis related instructions; after setting the external axis parameters correctly, related instructions can be used to execute functions, including turning on the external axis, switching axis modes, infinite rotation, enabling synchronous coordination, etc.

LINE	Robot Program Command:	Robot Program Simple Description:
1	EX_AX[1] =TRUE EX_AX[2] =TRUE EX_AX[3] =TRUE	;Trun on external axis 1~3
2	EX_AX_ASYNC[2] =TRUE	;Sets the external axis as asynchronous axis
3	LIN P0 FINE=1 Vel=100mm/s Acc=100% TOOL[1] BASE[1]	;Move Robot and external axis to P0 (asynchronous)
4	ASYPTP{E2 90} FINE=1 Vel=100% Acc=100% TOOL[1] BASE[1]	; Move Robot and external axis of E2 to 90 mm position.(asynchronous)
5	EX_AX_SYNC_COUPLE[1] = TRUE EX_AX_SYNC_COUPLE[3] = TRUE	; Turns on or off the coordinated control function of the external axis of 1&3.
6	EX_AX_CT [2] 100	;Executes infinite rotation for the external axis of second external axis.
7	LIN P1 FINE=1 Vel=100mm/s Acc=100% TOOL[1] BASE[1]	;Move Robot and external axis to P0 (asynchronous)

10.11 Gripper Commands Description

Gripper commands：

Commands	Description	Example
EG_OPEN	Connect with XEG series electric gripper	EG_OPEN(Type)
EG_CLOSE	Disconnect current XEG series electric gripper connection	EG_CLOSE
EG_RESET	Reset XEG series electric gripper	EG_RESET

EG_GET_STATUS	Get XEG series electric gripper status	IF EG_GET_STATUS == 2 THEN
		…
		ENDIF

EG_RUN_MOVE	Move XEG series electric gripper	EG_RUN_MOVE(10,20)
EG_RUN_GRIP	Grip action of XEG series electric gripper	EG_RUN_GRIP(C,5,L,M)
EG_RUN_EXPERT	Grip action and movement of XEG series electric gripper	EG_RUN_EXPERT(C,10,20,5,10,100)

EG_GET_POS	Get XEG series electric gripper position	IF EG_GET_POS > 5.00 THEN
		…
		ENDIF

There is a sample program below. First of all, set the parameter “Wait Idle” to “ON”. This sample will be using all commands of XEG (a kind of electric gripper), including “pick”, “place”, and changing to expert mode to recognize different items by picking status. Users can refer to this sample to develop their own programs.

LINE	Robot Program Command:	Robot Program Simple Description:
1	PTP P1 FINE Vel=100% Acc=100% TOOL[0] BASE[0]	;Initialize: move the robot to the original position, connect to the XEG, and reset the XEG.
2	EG_OPEN(X32)	;try to connect to the XEG
3	EG_RESET	;reset the XEG
4	$C[1]=0	
5	WHILE $C[1] <= 100	;The major part of the program: recognize two different objects by pick and place.
6	$C[1] = $C[1]+1	
7	IF EG_GET_STATUS <0 THEN	;move XEG to a specific position
8	ENDIF	;TO DO the handling commands if XEG gets errors
9	EG_RUN_MOVE(26.5,80)	
10	PTP P6 FINE Vel=100% Acc=100% TOOL[0] BASE[0]	
11	PTP P3 FINE Vel=100% Acc=100% TOOL[0] BASE[0]	;execute the picking command
12	IF EG_GET_STATUS <0 THEN	;TO DO the handling commands if XEG gets errors
13	ENDIF	
14	EG_RUN_GRIP(C,25,H,M)	
15	IF SelectObject(EG_GET_POS, EG_GET_STATUS) ==2 THEN	;recognize the objects by the position and status of XEG
16	PTP P6 FINE Vel=100% Acc=100% TOOL[0] BASE[0]	
17	PTP P2 FINE Vel=100% Acc=100% TOOL[0] BASE[0]	
18	ENDIF	
19	IF EG_GET_STATUS <0 THEN	;move XEG to a known position
20	ENDIF	;TO DO the handling commands if XEG gets errors
21	EG_RUN_MOVE(26.5,80)	
22	PTP P7 FINE Vel=100% Acc=100% TOOL[0] BASE[0]	
23	PTP P8 FINE Vel=100% Acc=100% TOOL[0] BASE[0]	

```
PTP P9 FINE Vel=100% Acc=100% TOOL[0] BASE[0]
PTP P4 FINE Vel=100% Acc=100% TOOL[0] BASE[0]
IF EG_GET_STATUS <0 THEN
ENDIF                                                ;change to expert mode to move XEG to pick
EG_RUN_EXPERT(C,3.5,60,20.5,20,50)                   ;TO DO the handling commands if XEG gets
IF SelectObject(EG_GET_POS, EG_GET_STATUS) ==1       errors
THEN
PTP P9 FINE Vel=100% Acc=100% TOOL[0] BASE[0]
PTP P11 FINE Vel=100% Acc=100% TOOL[0] BASE[0]
PTP P5 FINE Vel=100% Acc=100% TOOL[0] BASE[0]
ENDIF                                                ; move XEG to a known position
IF EG_GET_STATUS <0 THEN                             ;TO DO the handling commands if XEG gets
                                                     errors
ENDIF
EG_RUN_MOVE(26.5,80)
PTP P10 FINE Vel=100% Acc=100% TOOL[0] BASE[0]
PTP P5 FINE Vel=100% Acc=100% TOOL[0] BASE[0]
IF EG_GET_STATUS <0 THEN                             ;pick
ENDIF                                                ;TO DO the handling commands if XEG gets
                                                     errors
EG_RUN_GRIP(C,25,H,M)
IF SelectObject(EG_GET_POS, EG_GET_STATUS) ==1       ; recognize the objects by the position and
THEN                                                 status of XEG
PTP P10 FINE Vel=100% Acc=100% TOOL[0] BASE[0]
PTP P8 FINE Vel=100% Acc=100% TOOL[0] BASE[0]
PTP P4 FINE Vel=100% Acc=100% TOOL[0] BASE[0]
ENDIF
IF EG_GET_STATUS <0 THEN                             ; move XEG to a known position
ENDIF                                                ;TO DO the handling commands if XEG gets
                                                     errors
EG_RUN_MOVE(26.5,80)
PTP P8 FINE Vel=100% Acc=100% TOOL[0] BASE[0]
PTP P7 FINE Vel=100% Acc=100% TOOL[0] BASE[0]
PTP P2 FINE Vel=100% Acc=100% TOOL[0] BASE[0]
IF EG_GET_STATUS <0 THEN                             ; change to expert mode to move XEG to
                                                     pick
ENDIF                                                ;TO DO the handling commands if XEG gets
                                                     errors
EG_RUN_EXPERT(C,3.5,60,20.5,20,50)
IF SelectObject(EG_GET_POS, EG_GET_STATUS) ==2       ; recognize the objects by the position and
```

```
THEN                                                  status of XEG
PTP P7 FINE Vel=100% Acc=100% TOOL[0] BASE[0]
PTP P6 FINE Vel=100% Acc=100% TOOL[0] BASE[0]
PTP P3 FINE Vel=100% Acc=100% TOOL[0] BASE[0]         ; move XEG to a known position
ENDIF                                                 ;TO DO the handling commands if XEG gets
                                                      errors
IF EG_GET_STATUS <0 THEN
ENDIF
EG_RUN_MOVE(26.5,80)
PTP P6 FINE Vel=100% Acc=100% TOOL[0] BASE[0]
PTP P1 FINE Vel=100% Acc=100% TOOL[0] BASE[0]
ENDWHILE                                              ;disconnect from XEG
EG_CLOSE                                              ;Subprogram: the function to recognize
                                                      different objects
DEFFCT INT SelectObject(POSITION:IN,STATUS:IN)
REAL POSITION
INT STATUS
IF POSITION>=18.5 AND POSITION<=20.5 AND
STATUS==2 THEN
RETURN 1
ELSE
IF POSITION>=3 AND POSITION<=4 AND STATUS==2
THEN
RETURN 2
ELSE
RETURN 0
ENDIF
ENDIF
ENDFCT
```

11. Safety Certification

RS405-LU、RS410-LU have CE marking and it fulfill related Directive and ISO standards.

CE Compliance		
Machinery Directives(MD)	**2006/42/EC**	
	Safety of machinery — General principles for design — Risk assessment and risk reduction	EN ISO12100:2010
	Robots and robotic devices — Safety requirements for industrial robots — Part 1: Robots	EN ISO 10218-1:2011
Low Voltage Directives (LVD)	**2014/35/EU**	
	Safety of Machinery - Electrical equipment of machines - Part 1: General requirements	EN 60204-1:2018
Electromagnetic Compatibility Directives (EMC)	**2014/30/EU**	
	Generic standards - Immunity for industrial environments	EN 61000-6-2
	Generic standards. Emission standard for industrial environments	EN 61000-6-4
Restriction of Hazardous Substances Directive(RoHS)	**2011/65/EU+(EU)/2015/863**	
	Cd(100 ppm↓) Pb,Hg,Cr^{6+},PBB,PBDE,DEHP,DBP,BBP,DIBP(1000 ppm↓)	

Remote Operating Interface Software (Caterpillar)

(Original Instruction) User Manual

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