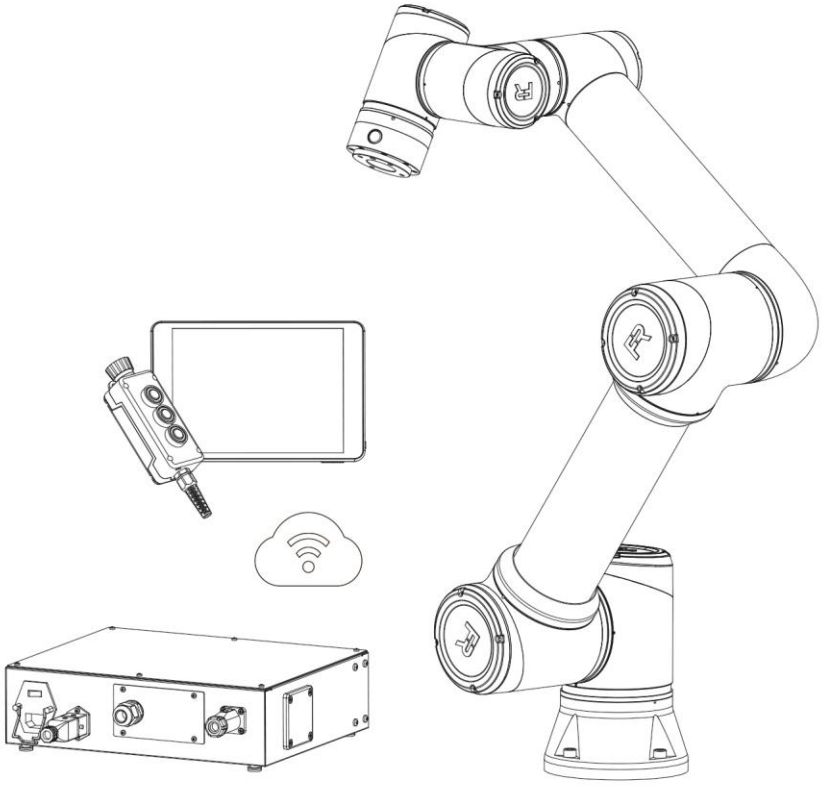
FR5 Collaborative Robot

Product Manual



FAIR Innovation (Suzhou) Robotic System Co.,Ltd.

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Foreword

What's in the box

When you book a robot, you will receive a box. It contains:

- A cooperative robot;
- One button box;
- A control box, including a control box cable;

Important safety instructions

Robot is a kind of equipment that involves personal safety, so it is necessary to perform safety assessment after installing robot every time. You must observe all safety instructions in Chapter 1.

How to use this manual

This manual contains instruction information for robot installation and programming. The manual includes:

- Hardware installation: mechanical and electrical installation of robot.
- Software analysis part of the teaching device: robot teaching and programming.

Robot integrators targeted by this manual should have received basic mechanical and electrical training and be familiar with basic programming concepts.

The first chapter hardware installation

1.1 safety instruction

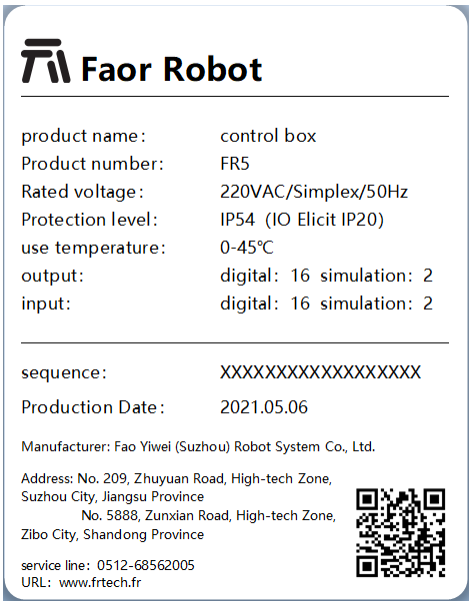
1.1.1 brief introduction

The following warnings will be used in this manual. These warnings are used to ensure the safety of people and equipment. When reading this manual, you must observe and implement all the assembly instructions and guidelines in other chapters of this manual, which is very important. Special attention should be paid to the text related to warning signs.

Note:

If the robot (robot body, control box, teaching box) is damaged, changed or modified due to human reasons, Faao refuses to assume all responsibilities; Faao is not responsible for any damage to robots or any other equipment caused by errors in programs written by customers.

1.1.2 Nameplate information



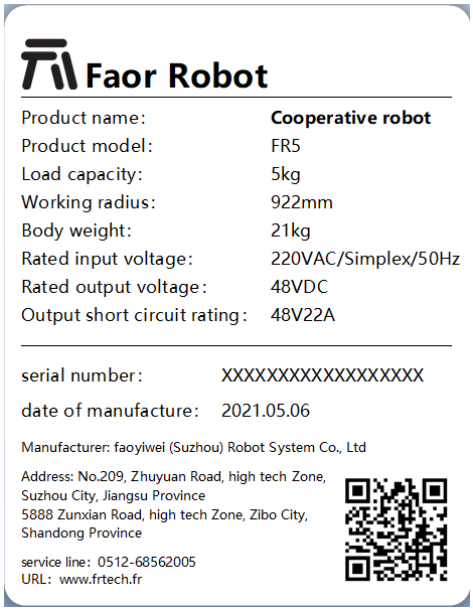


Chart 1.1- Nameplate Information of Robot

1.1.3 Effectiveness and responsibility

The information in this manual does not include the design, installation and operation of a complete robot application, nor does it include all peripheral equipment that may affect the safety of this complete system. The design and installation of the complete system should meet the safety requirements established in the standards and specifications of the country where the robot is installed.

French and Austrian integrators are responsible for ensuring compliance with relevant national laws and regulations, and ensuring that there is no major danger in the complete robot application. This includes but is not limited to the following:

- Make a risk assessment for the complete robot system
- Connect other machinery and additional safety equipment defined by risk assessment
- Establish appropriate security settings in the software
- Ensure that the user will not modify any security measures
- Confirm that the design and installation of the whole robot system are accurate
- Clear instructions for use
- Mark the relevant signs and contact information of the integrator on the robot
- Collect all documents in technical documents, including this manual

1.1.4 Limited liability

Any safety information contained in this manual shall not be regarded as a general robot safety guarantee. Even if all safety instructions are observed, it may still cause personal injury or equipment damage.

1.1.5 Warning signs in this manual

The following signs define the instructions of hazard level regulations contained in this manual. The same warning signs are used on the products.

Hazards:

This refers to the power consumption situation that will cause danger. If it is not avoided, it may lead to death or serious injury.

Risk of electric shock:

This refers to a dangerous electric shock situation. If it is not avoided, it may lead to electric shock death or serious injury.

Danger of scald:

This refers to hot surfaces that may cause danger, which may cause personal injury if contacted.

1.1.6 Evaluation before use

After using the robot for the first time or making any modifications, the default speed of the robot is lower than 250 mm/s. Please do not log in to the administrator to modify the speed and enter the high-speed mode. After that, the following tests must be carried out. Verify that all safety inputs and outputs are correct and connected correctly.Test whether all connected safety inputs and outputs (including equipment shared by multiple machines or robots) function normally. Therefore, you must:

- Test whether the emergency stop button and input can stop the robot and start the brake.
- Test whether the protection input can stop the movement of the robot. If protection reset is configured, check if activation is required before resuming movement.
- Test whether the operation mode can be switched, refer to the icon in the upper right corner of the user interface.
- Test whether the 3rd gear actuating device must be pressed to start the action in manual mode, and the robot is under deceleration control (this function is

not supported before the robot software version V3.0).

- Test whether the system emergency stop output can bring the whole system to a safe state.

1.1.7 urgency stop

The emergency stop button is a class 0 stop. Press the emergency stop button to stop all movements of the robot immediately.

The following table shows the stopping distance and stopping time for triggering a class 0 shutdown. These measurements correspond to the following configurations of the robot:

- Extension: 100% (the robot arm is completely horizontally deployed)
- Speed: 100% (the general speed of the robot is set to 100%, moving at the joint speed of 180/s)
- Payload: maximum payload (5kg)

Joints 1 and 6 test the horizontal movement of the robot, and the rotation axis is perpendicular to the ground. Joint 2, joint 3, joint 4 and joint 5 test robots follow a vertical trajectory, with the rotation axis parallel to the ground and stop when the robots move down.

Table 1.1-1 Stop Time and Stop Distance of Class 0

	Stop distance (rad)	Stop time (ms)
Joint 1	0.51	420
Joint 2	0.63	500
Joint 3	0.60	480
Joint 4	0.33	310
Joint 5	0.16	150
Joint 6	0.10	120

After the emergency stop, turn off the power, turn the emergency stop button, and turn on the power to restart the robot.

Note:

- According to IEC 60204-1 and ISO 13850, emergency stop equipment is not a safety protection device. They are supplementary protective measures and are not used to prevent injuries.

1.1.8 Movement without electric drive

In case of any emergency, such as having to move the robot joints but unable to supply power to the robot, please contact your robot dealer, and if necessary, use violent means to force the robot to move.

1.2 uipment transportation

1.2.1 transport

Robot and control box have been calibrated as a complete set of equipment. Do not separate them, as they will need to be recalibrated.

Robots can only be transported in the original packaging. If you want to transport robots in the future, please keep the packaging materials in a dry place.

When moving the robot from the package to the installation space, support both arms of the robot at the same time. Hold the robot until all mounting bolts of the robot base are fastened.

1.2.2 carry

The total mass (including packaging) of the cooperative robot is about 40kg. When the cooperative robot is transported or transferred by manpower, it needs two people to lift it. It is not recommended to transport it by one person. It must be stable during transportation to avoid the equipment tipping or slipping.

Note:

- If professional equipment is used for handling, the cooperative robot must be transported or handled by a crane or forklift by a professional with corresponding operation qualification, otherwise it may cause personal injury or other accidents.
- If manual handling is used, please pay attention to personal safety during handling;

1.2.3 deposit

Cooperative robots should be stored at -10~60℃ without frost.

1.3 Scrap office

1.3.1 Abandoned disposal

FR robots need to be disposed according to applicable national laws and regulations and national standards.

1.4 Introduction to robot

1.4.1 Basic parameter

Table 1.4-1 Basic Parameters of Robot

name	FR5
load	5kg
Maximum working range	922mm
freedom	6 rotational degrees of freedom
Repeated positioning accuracy	+-0.03mm
Range of joint motion Software limit limit	Axis 1: +175,-175; Axis 2: +85, -265; Axis 3: +160,-160; Axis 4: +85, -265; Axis 5: +175,-175; Axis 6: +175,-175;
Maximum speed of joint	+/-180 degrees /s
the protection grades	IP54
noise	<65dB
Installation direction	In any direction
in-out	Power supply (24V,1.5A), digital IO, Analog IO,485 communication
usage temperature	0-45℃
Whole machine weight	About 20.6kg
Equipment storage	-10~60℃ (no frost)
Mean time to repair failure	2h

1.4.2 Limiting angle

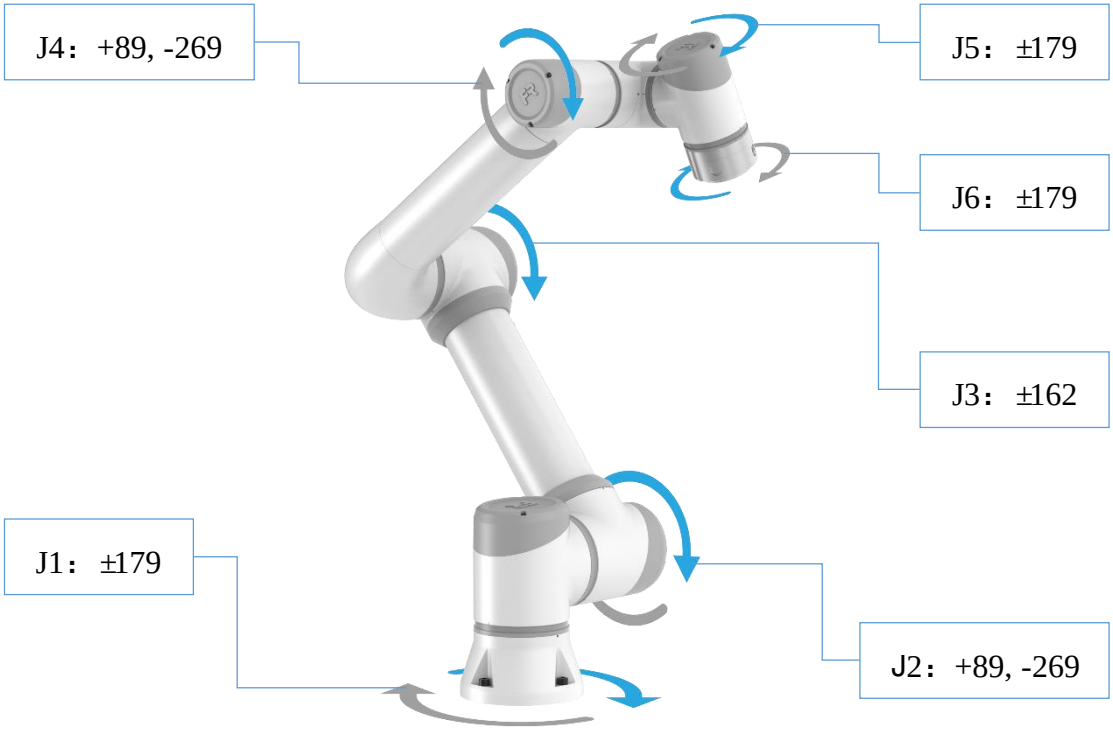


Chart 1.4-1 Mechanical Limit of Robot

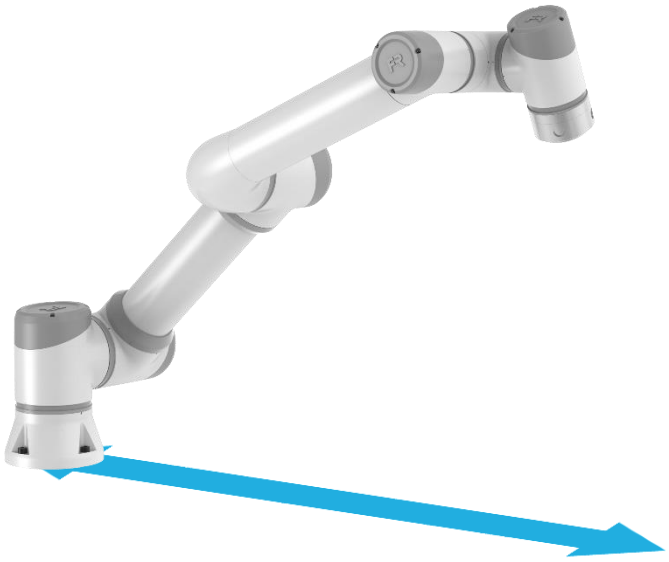


Chart 1.4-2 Working Range of Robot

1.4.3 Range of motion

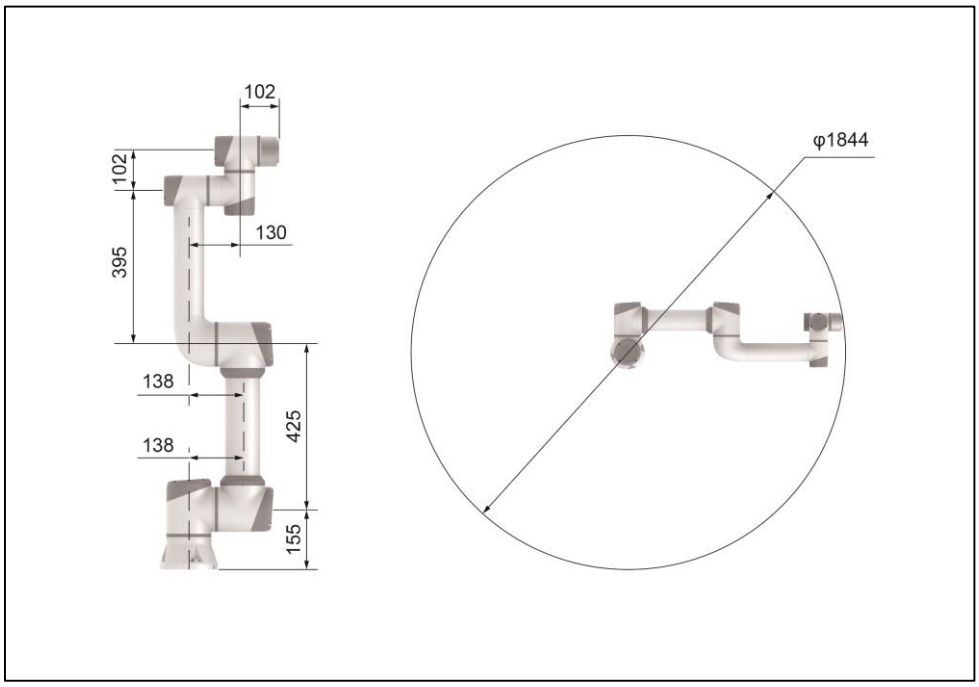


Chart 1.4-3 Motion Range of Robot

1.4.4 Robot coordinate system

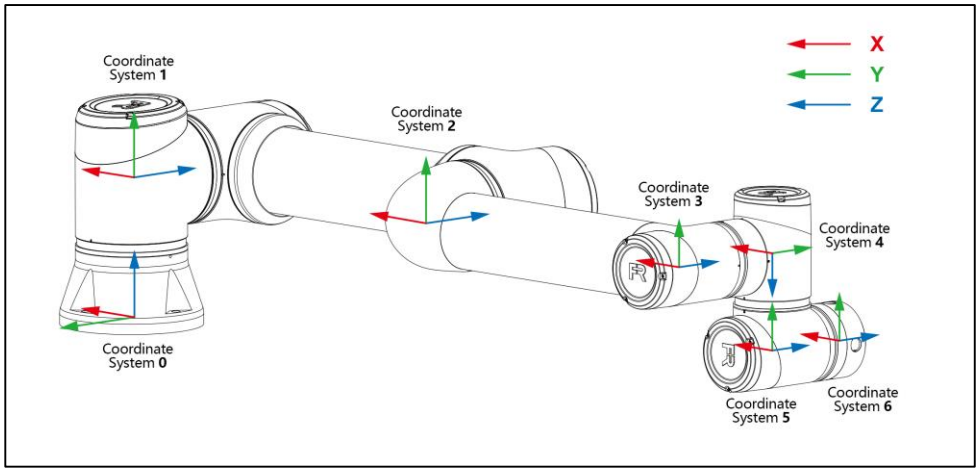


Chart 1.4-4 Robot Coordinate System

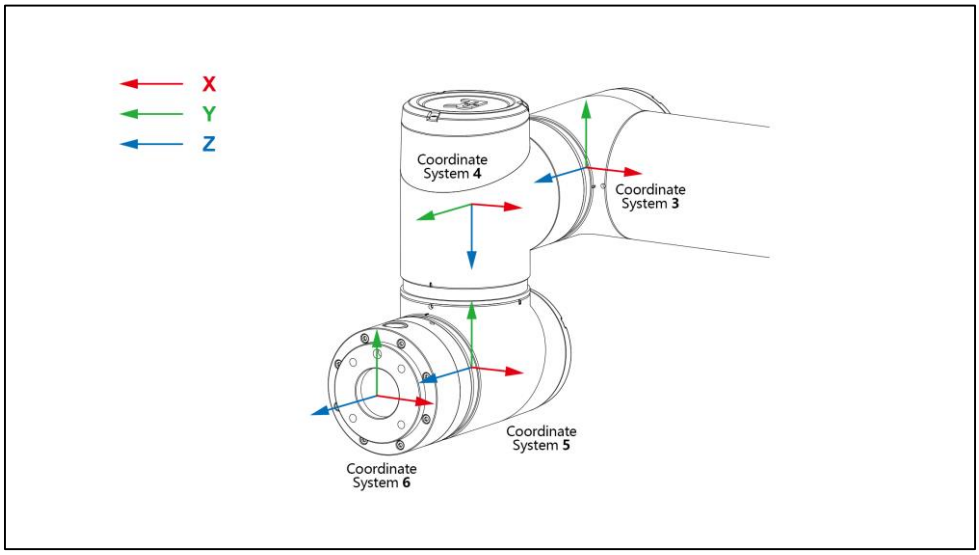


Chart 1.4-5 Robot End Flange Coordinate System

1.5 installation specification

1.5.1 Robot arm installation

Robot arm is installed with four M8 bolts with strength not lower than 8.8. The bolts must be tightened with a torque of 20 n m.

Two reserved 8-pin holes are used to accurately reposition the robot arm. Note: Accurate pedestal can be purchased for use as an accessory. Figure 1.5-1 shows the pin hole position and screw installation position.

Install the robot on a firm, vibration-free surface, which should be able to bear at least 10 times the complete torsional force of the base joint and at least 5 times the weight of the robot arm. If the robot is mounted on a linear axis or a movable platform, the acceleration of the movable mounting base is very low. High acceleration will cause the robot to stop safely.

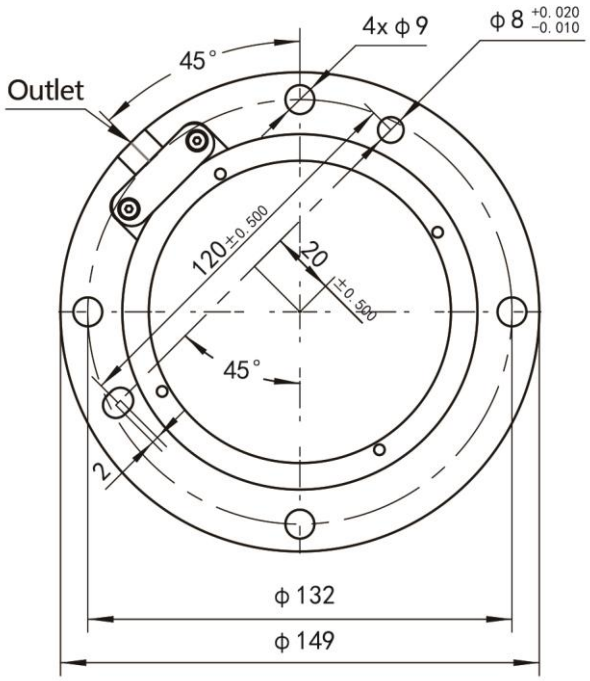


Chart 1.5-1 Installation Dimensions of Robot

Note:

Ensure that the robot arm is correctly and safely installed in place. Instability of installation can lead to accidents.

1.5.2 Tool end installation

The robot tool flange has four M6 threaded holes, which can be used to connect the tool to the robot. M6 bolts must be tightened with a torque of 8 N m, and their strength grade is not lower than 8.8. In order to accurately reposition the tool, please use pins in the reserved 6 pin holes. Figure 1.5-2 shows the drawing of tool flange.

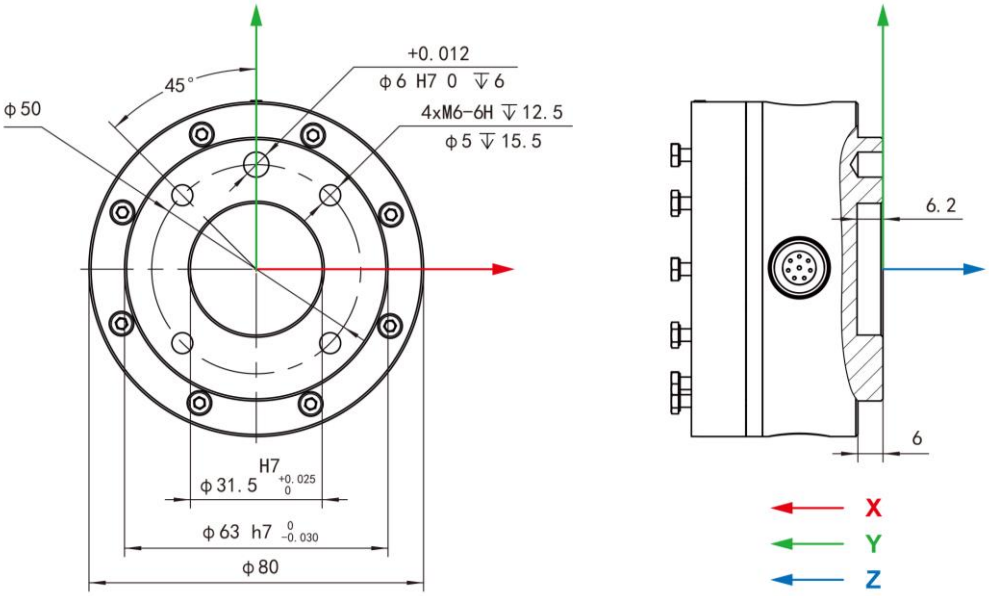


Chart 1.5-2 Dimension of Robot End Flange

Note:

- Ensure that the tool is correctly and safely installed in place.
- Ensure the safe structure of tools, and there will be no danger caused by accidental falling of parts.
- Installing M6 bolts with a length exceeding 8 mm on the upper flange of the robot may damage the tool flange and cause irreparable damage, which leads to the necessity of replacing the tool flange.

1.5.3 Installation environment

When installing and using the cooperative robot, ensure that the following requirements are met:

- The ambient temperature is 0-45℃
- The humidity is 20-80RH without condensation
- No mechanical shock and vibration
- The altitude is required to be below 2000m
- No corrosive gas, liquid, explosive gas, oil stain, salt mist, dust or metal powder, radioactive material, electromagnetic noise and flammable materials
- Avoid equipment working under unstable current conditions

Note:

Please contact us if you want to hoist or install the cooperative robot on a vertical surface.

1.5.4 Floor bearing capacity

Install the robot on a solid surface, which should bear at least 5 times the weight of the robot arm, and the surface should not vibrate.

1.5.5 Maximum payload

The maximum allowable payload of robot arm depends on the offset of gravity center. The maximum load of 5kg is the load value where the center of gravity is 30mm away from the center of the end. When the distance between the center of gravity of the load becomes longer, the load borne by the robot will become smaller.

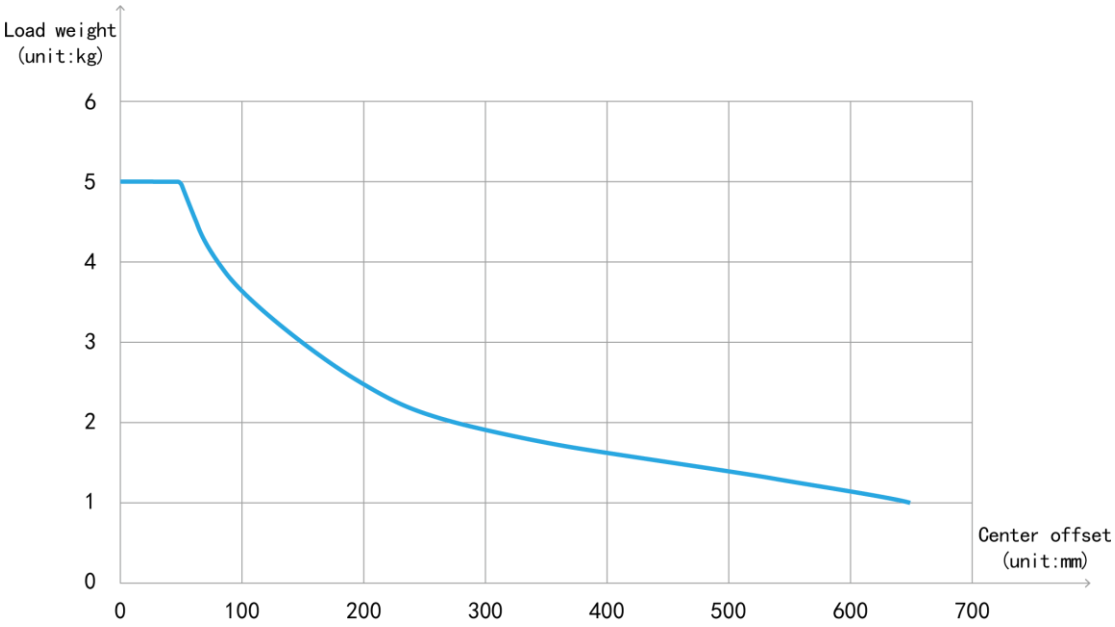


Chart 1.5-3 Schematic diagram of load offset

1.6 Control connection

1.6.1 control unit interface

This series of robots are powered by TN-S single-phase 220V AC power supply. The equipment comes with a 5-meter power cord. The three-pin plug end is inserted into the AC 220V socket provided on site, and the robot is electrically grounded.

- Rated input voltage: 6A/230VAC
- Rated output voltage: 48V/21A
- Number of phases: single phase
- Frequency: 50Hz
- Output short circuit rating: 48V/22A

Warning:

Before wiring, make sure that the power supply is turned off, and hang safety warning signs beside it.

The external connections of this series of manipulator control systems are connected by plugs which can be plugged and installed quickly. The wiring panel of cooperative robot is shown in Figure 1.6-1.

- Ensure that when the power button of the control box is turned off (the button is turned to 0), connect the 220V power cord to the power outlet (the full load input voltage is 6A/230VAC~7A/210VAC);
- Connect the heavy-duty cable of robot body to the heavy-duty interface of control box;
- Plug the aviation plug of the button box into the interface of the teaching device of the control box;
- The heat dissipation ports on both sides of the control box shall be at least 15CM apart;
- At the front of the control box (user sheet metal, switch power key, heavy load

and teaching harness), the interval is not less than 25CM;

- The control box is 0.6-1.5CM away from the ground;
- Users are not allowed to replace the power cable by themselves;

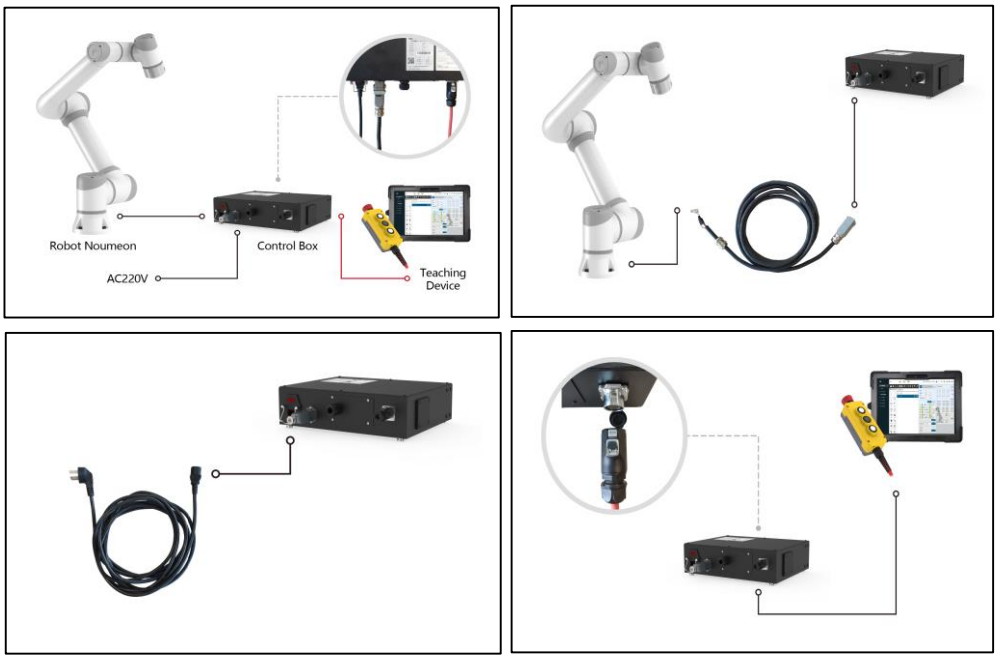


Chart 1.6-1 Wiring Panel of Control Box

1.6.2 I/O panel of controller

You can use the I/O in the control box to control various devices, including pneumatic relay, PLC and emergency stop button. For example, Figure 1.6-2 shows the electrical interface group inside the control box, and the right side of the figure shows the network interface group of the control box.

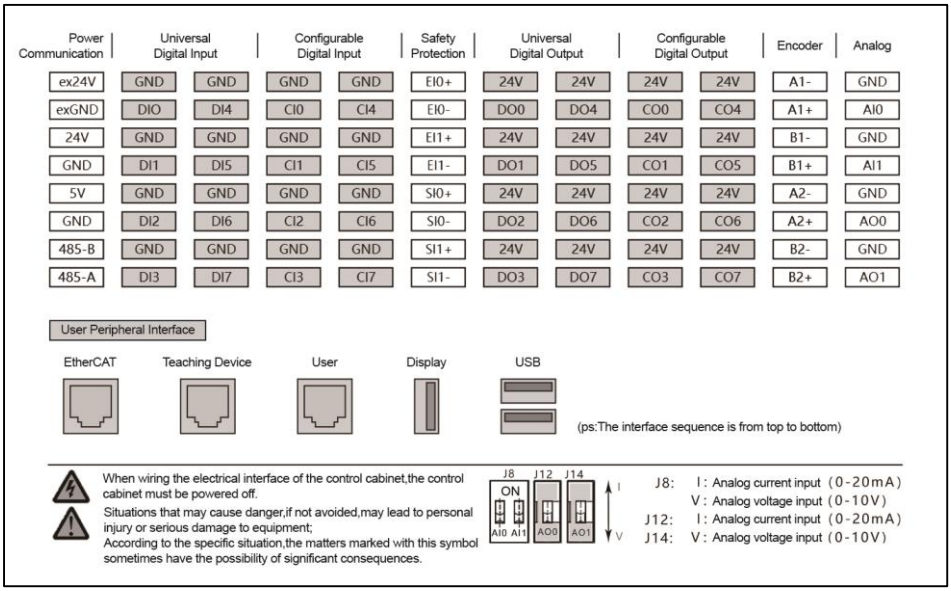


Chart 1.6-2 Schematic diagram of electrical interface of control box

1.6.3 RJ45 network interface group

The network interface group address in the control box is shown in Figure 1.6-3, and the robot default port is prohibited from plugging and unplugging. The user interface can be used to communicate with cameras and other devices, and the IP address is 192.168.57.2. By default, the button box interface is the teaching device control port, with an IP address of 192.168.58.2. Use a network cable to connect the button box interface with the computer. The computer IP address is set to 192.168.58.10 or the same network segment. Open Google browser and enter 192.168.58.2 You can access the Teaching Instructor page.

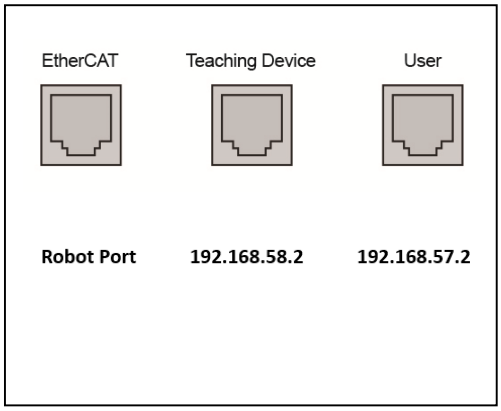


Figure 1.6-3 Schematic diagram of network interface group

1.6.4 End plate

You can control various devices, including pneumatic relay, PLC and emergency stop button, by using the I/O and 485 communication interface of the terminal board. The Pin pin distribution and pin pin pin description are shown in Figure 1.6-4. I/O connector model is M12 connector 8-core female.

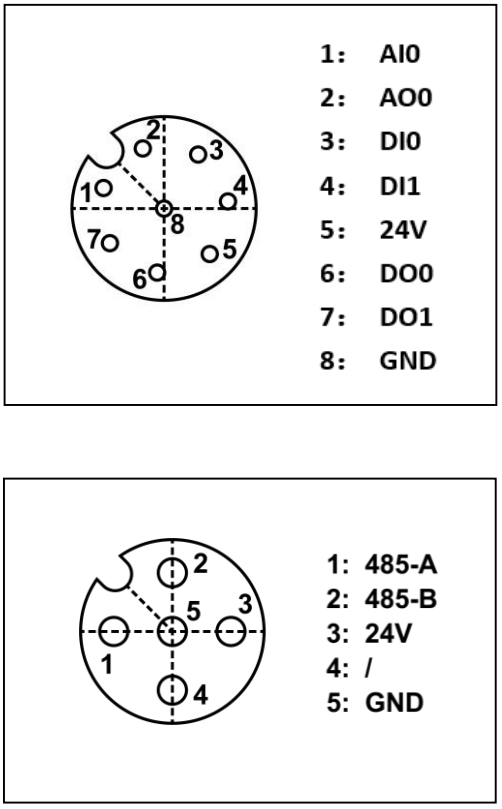


Figure 1.6-4 Schematic diagram of electrical interface of end version

1.6.5 General specification for all digital I/O.

This section specifies the electrical specifications for the 24 volt digital input/output of the following control boxes:

- Secure I/O
- General digital I/O

Robots must be installed in accordance with electrical specifications.

By configuring the "Power Communication" interface, the digital I/O can be powered by internal or external 24V power supply. The upper two terminals (ex24V and exGND) of this interface are 24V of external power supply and ground, and the lower two terminals (24V and GND) are 24V and ground of internal power supply. The default configuration is to use internal power supply, as shown in Figure 1.6-5.

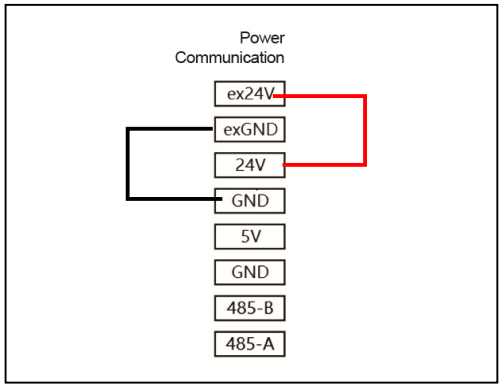


Figure 1.6-5 Schematic diagram of power communication 01

If the load power is large, the external power supply can be connected as shown in Figure 1.6-6.

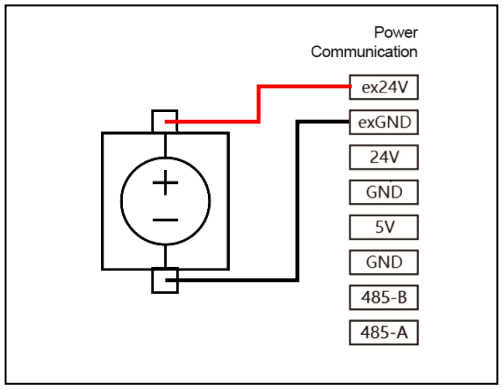


Figure 1.6-6 Schematic diagram of power communication 02

The electrical specifications of internal and external power supplies are shown in Table 1.6-1.

Table 1.6-1 electrical specifications of internal and external power supply

post	parameter	minimum value	typical value	maximum	unit
Internal 24V power supply					
[ex24V – exGND]	voltage	23	24	25	V
[ex24V – exGND]	electric current	0	-	2	A
Internal 24V power supply					
[24V – GND]	voltage	23	24	25	V
[24V – GND]	electric current	0	-	1.5	A

The electrical specifications of digital I/O are shown in table 1.6-2 electrical specifications of digital I/O:

Table 1.6-2 digital I/O electrical specifications

post	parameter	minimum value	typical value	maximum	unit
Digital quantity output					
[COx / DOx]	electric current	0	-	1	A
[COx / DOx]	pressure drop	0	-	0.5	V
[COx / DOx]	drain current	0	-	0.1	mA
[COx / DOx]	function	-	NPN	-	Type
Digital quantity input					
[EIx/SIx/CIx/DIx]	OFF	-3	-	5	V
[EIx/SIx/CIx/DIx]	ON	11	-	30	V
[EIx/SIx/CIx/DIx]	Current (11-30V)	2	-	15	mA
[EIx/SIx/CIx/DIx]	function	-	NPN	-	Type

1.6.6 Secure I/O

This section describes the electrical specifications for safety I/O, which must comply with paragraph1.6.5General electrical specifications in section.

Safety devices and equipment must be installed in accordance with safety instructions and risk assessment, see paragraph1.1. All security I/O are paired (redundant) and must be saved as two independent branches. A single fault should not result in loss of safety function.

Safety I/O includes emergency stop and safety stop. Emergency stop input is only used for emergency stop equipment, and safety stop input is used for various safety-related protection equipment. Functional differences are shown in Table 1.6-3.

Table 1.6-3 Functional Differences

	urgency stop	Safe stop
The robot stops moving	be	be
program execution	stop	pause
Robot power supply	close	open
restart	manual	Automatic or manual
frequency of utilization	Not frequent	often
Need to reinitialize	need	have no use for

Hazards:

- Never connect safety signals to PLCs that do not have the correct safety level. Failure to observe this warning may result in serious injury or death because one of the safety stop functions may be overridden. Safety interface signals must be separated from normal I/O interface signals.
- All I/O related to safety are redundantly constructed (two independent channels). The two channels must be kept separate, so that a single fault will not lead to loss of safety function.
- Before putting the robot into operation, the emergency stop safety function must be verified (the robot is powered on, the emergency stop button is pressed, the robot is powered off, the power is turned off, the emergency stop button is rotated, the power is turned on, and the robot is powered on again). Safety functions must be tested regularly.

The following subsections give some examples of how to use secure I/O ..

Default security configuration

The robot leaves the factory with default configuration, and can be operated without any additional safety equipment. Please refer to Figure 1.6-7.

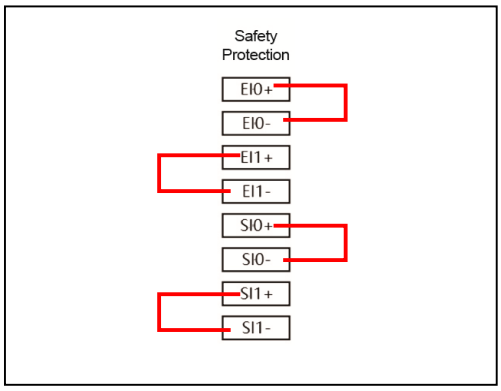


Figure 1.6-7 Schematic diagram of safety protection 01

Connect the emergency stop button

In most applications, it is necessary to use one or more additional emergency stop buttons. See chart 1.6-8.

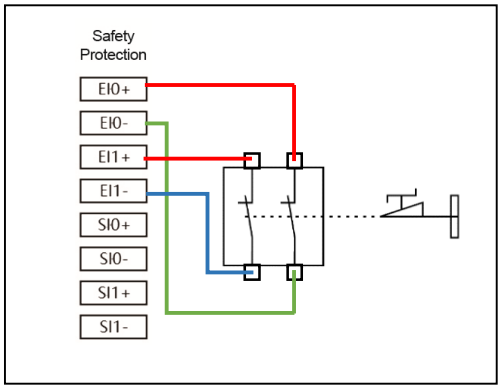


Figure 1.6-8 Schematic diagram of safety protection 02

Connect the safety stop button

An example of a safety stop device is a door switch that stops the robot when the door is opened, as shown in Figure 1.6-9.

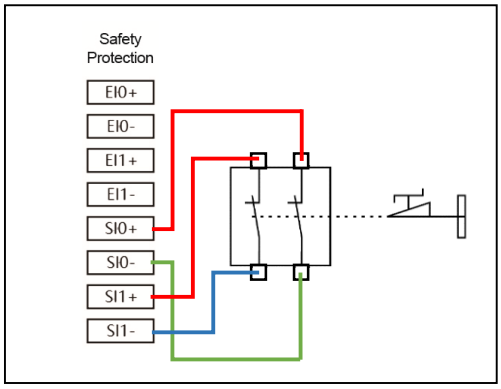


Figure 1.6-9 Schematic diagram of safety protection 03

1.6.7 General digital I/O

This section describes the electrical specifications of general digital I/O, which must comply with the general electrical specifications in Section 1.6.5.

General digital I/O can be used to drive relays, solenoid valves and other devices or interact with other PLCs.

Digital output control load

This example demonstrates how to connect digital output to control load, please refer to Figure 1.6-10.

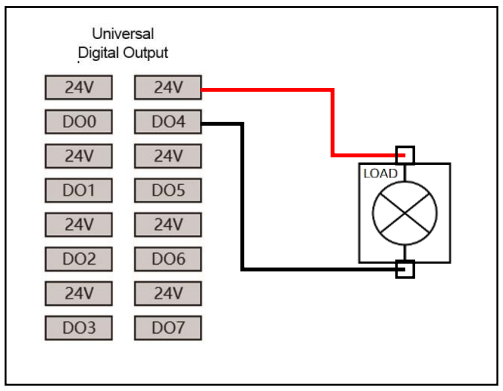


Figure 1.6-10 general digital output diagram 01

1.6.8 Digital input from buttons

The following example demonstrates how to connect a simple button to a numeric input.

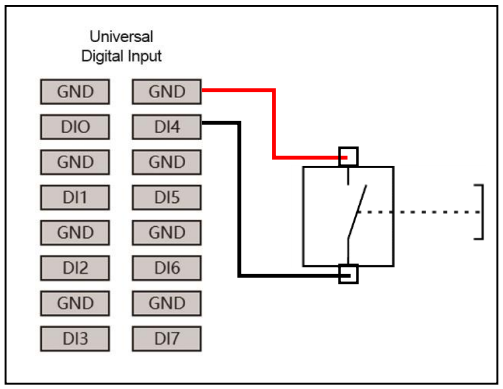


Figure 1.6-11 general digital input diagram 02

1.6.9 Interact with other devices or PLC

The following example demonstrates how to interact with other devices or PLC for digital input and output.

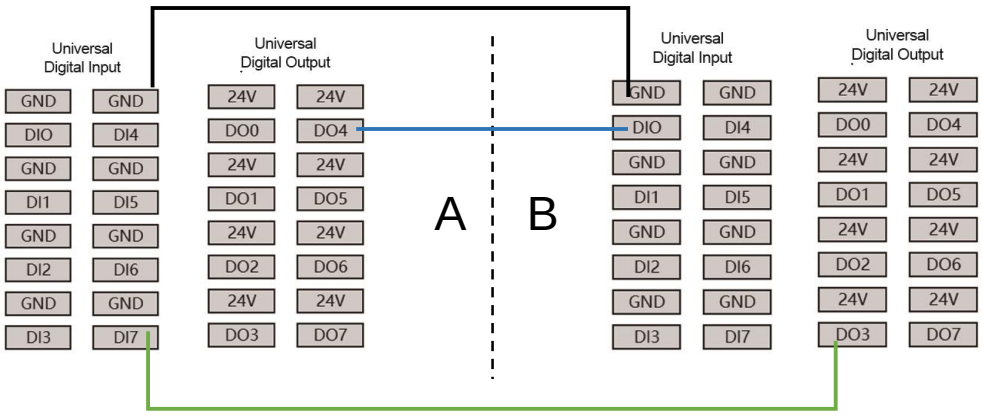


Figure 1.6-12 schematic diagram of interaction with other equipment or PLC

1.6.10 Analog I/O

Table 1.6-4 Analog Current and Voltage

post	parameter	minimum value	typical value	maximum	unit
Analog current input					
[AIx - END]	electric current	0	-	20	mA
[AIx - END]	impedance	-	500	-	ohm
[AIx - END]	Resolution	-	12	-	bit
Analog voltage input					
[Alx - END]	voltage	0	-	10	V
[Alx - END]	impedance	-	510	-	Kohm
[Alx - END]	Resolution	-	12	-	bit
Analog current output					
[AOx - END]	electric current	0	-	20	mA
[AOx - END]	voltage	0	-	10	V
[AOx - END]	Resolution	-	12	-	bit
Analog voltage output					
[AOx - END]	voltage	0	-	10	V
[AOx - END]	electric current	0	-	20	mA
[AOx - END]	impedance	-	100	-	ohm
[AOx - END]	Resolution	-	12	-	bit

The analog I/O is used to set or measure the voltage (0-10V) or current (0-20mA) of other equipment.

In order to achieve high accuracy, the following methods are recommended.

- Equipment and control box use the same ground (GND).
- Use shielded cable or twisted pair.

The following example demonstrates how to use analog I/O .

Use analog output

The following example demonstrates the use of analog output to control the conveyor belt.

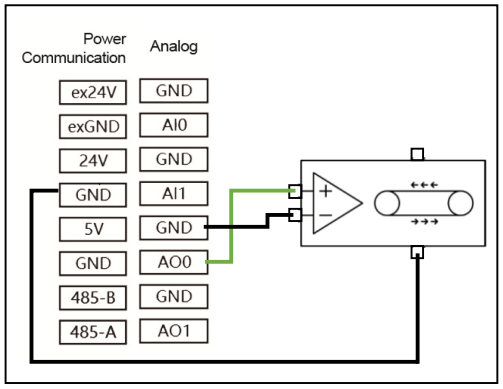


Figure 1.6-13 analog output diagram

Use analog input

The following example demonstrates the use of analog inputs to connect analog sensors.

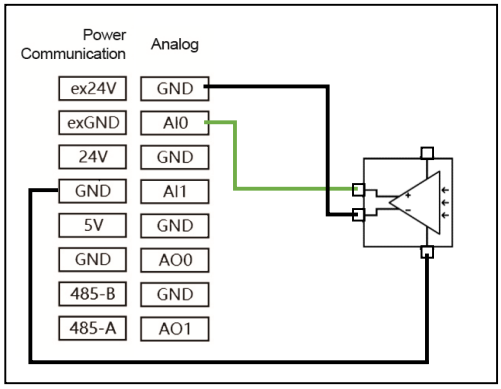


Figure 1.6-154analog input diagram

1.7 Teach and end LED

1.7.1 Introduction to teaching device

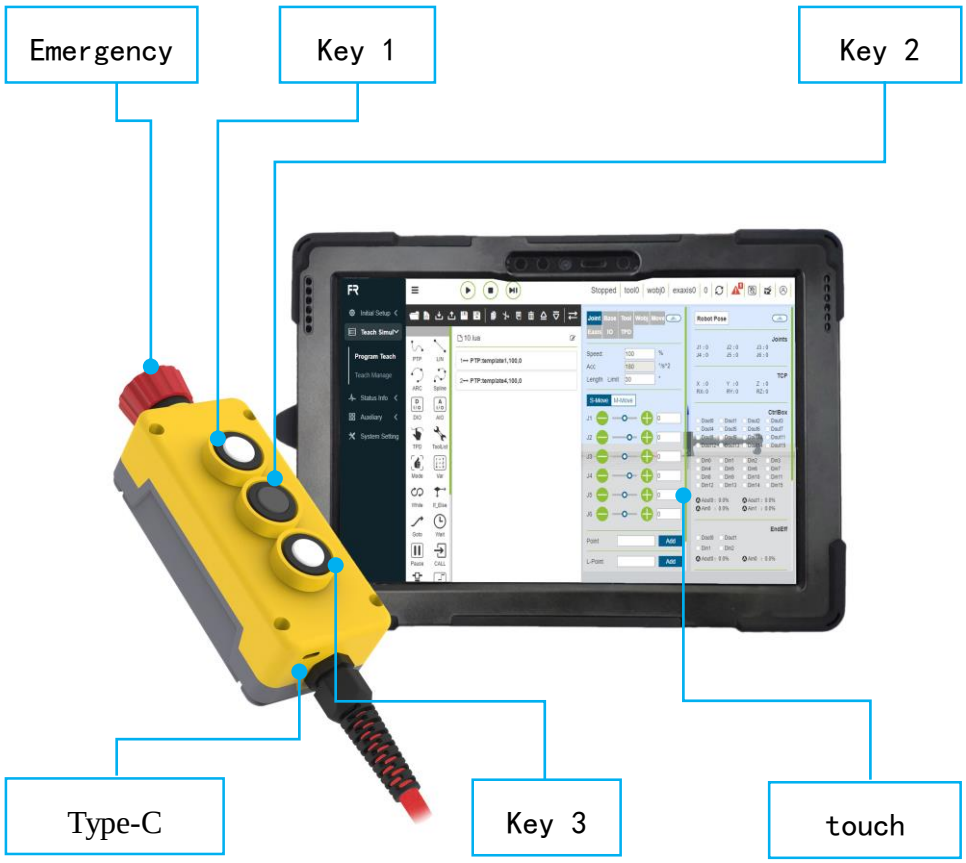


Chart 1.7-1 teaching device and button box

Display screen: the touch operation and display interface of the teaching device.

Emergency stop switch: when the emergency stop switch is pressed, the robot enters an emergency stop state.

Type-c interface: it is connected to the port of the touch panel teaching device.

Press key 1: short press to switch automatic/manual mode, long press to enter/exit drag mode.

Button 2: Press short to record the teaching point, and press long to enter/exit the state of not matching the teaching device.

Button 3: Press short to start/stop running the program, and press long to start/shut down.

1.7.2 End LED definition

Form 1.7-1End LED definition table

function	**LED color**
When communication is not established,	"Extinction", "Red", "Green" and "Blue" alternate
Automatic mode	Blue is bright
Manual mode	Green is always bright
Drag mode	White and blue are always bright
Button box recording point (only when using button box)	Purple flashes twice
Enter the state of not matching the button box (only when using the button box)	Blue flashes twice
Start running (only when using button box)	Yellow flashes twice
Stop running (only when using button box)	Red flashes twice
Error report (only when using button box)	Long red light

Chapter 2 Quick Start Robot

2.1 Install robot arm and control box

According to the first chapter1.5and1.6Install and connect robot arm and control box.

- Unpack the robot arm, and install the robot arm with four M8 bolts with strength not lower than 8.8. Install the robot arm on a solid and shockproof surface. If it is fixed with aluminum plate, the thickness of aluminum plate is not less than 16mm, and if it is fixed with iron plate, the thickness of iron plate is not less than 8mm;
- Place the control box on its legs;
- Connect the heavy load cable of the robot arm body to the heavy load interface of the control box;
- Plug the aviation plug of the button box into the interface of the teaching device of the control box. If the touch screen version of the teaching device is equipped, a data line with both ends being Type-c interfaces should be used to insert the Type-c interfaces of the button box and the teaching device respectively.
- Ensure that the 220V power cord is connected to the power outlet when the power button of the control box is turned off (the button is turned to 0);
- Plug in the power control box.

Hazards:

If the robot is not safely placed on a solid surface, the robot may topple and cause injury.

2.2 Start the robot

The control box connects the physical and electrical input/output terminals of the robot arm, the teaching box and any peripheral equipment. The control box must be opened to power the robot arm.

- Press the power button of the control box to open the control box;
- Open the apocalypse, please refer to the third chapter3.1.2, open chrome browser, visit the website 192.168.58.2, enter the user name and password and click login to enter the system, refer to this chapter.2.3.2To move the robot. If it is not equipped with a teaching device, refer to this section2.3.1To move the robot;
- When the URL cannot be opened normally, please check whether the device is connected normally.

2.3 The button box controls the robot movement

Refer to the first chapter1.7.2End LED definition to control the robot

2.3.1 Without a teaching aid

- **S**tep1: Turn on the power switch of the robot control box, start the robot, and wait for the LED at the end to turn green before operating the robot, as shown in Figure 2.3-1.

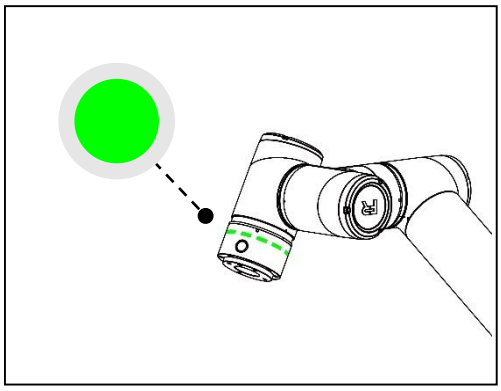


chart 2.3-1Green schematic diagram of end led

- **S**tep2: Press "Button 2" in the button box for a long time to enter the mode of not matching the teaching device, and the LED at the end flashes blue three times, as shown in Figure 2.3-2.

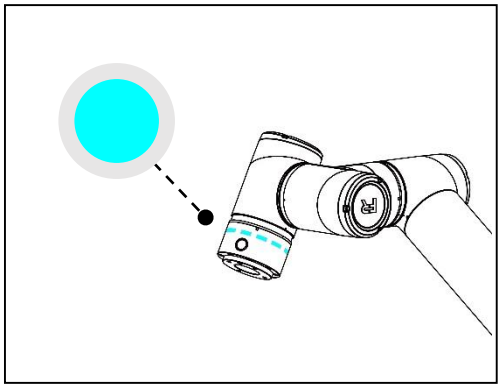


chart 2.3-2Blue blue diagram of end led

- **S**tep3: Long press button 1 in the button box to switch the robot to drag mode, at which time the terminal LED is white and cyan, as shown in Figure 2.3-3. Move the robot to any position, long press button 1 to exit the drag mode, short press button 2 in the button box to record P1 point, and the terminal LED flashes purple three times, as shown in Figure 2.3-4.

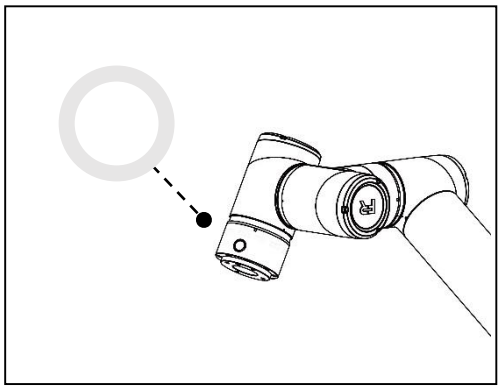


chart 2.3-3White cyan schematic diagram of end led

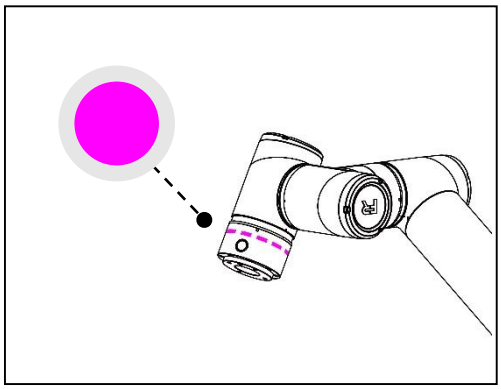


chart 2.3-4Purple schematic diagram of end led

- Step4, move the robot, press the button box "Button 2" briefly to record P2, and the terminal LED flashes purple three times, as shown in Figure 2.3-5.

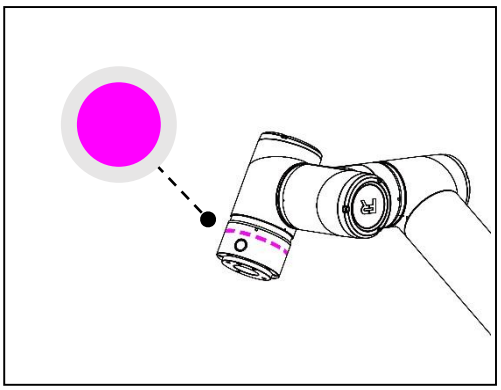


chart 2.3-5Purple schematic diagram of end led

- Step5: Press the button box "Button 1" for a long time to exit the drag mode, which is in manual mode, and the terminal LED is green, as shown in Figure 2.3-6. Press the button 1 briefly to switch the robot to automatic mode, and the terminal LED is blue, as shown in Figure 2.3-7.

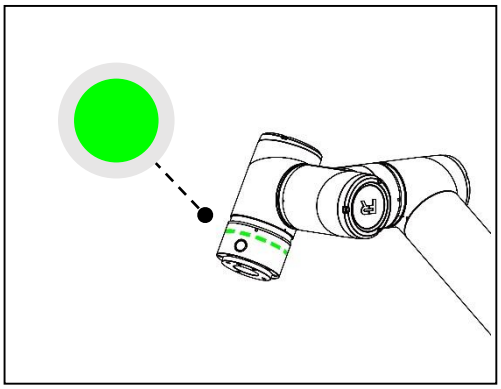


chart 2.3-6Green schematic diagram of end led

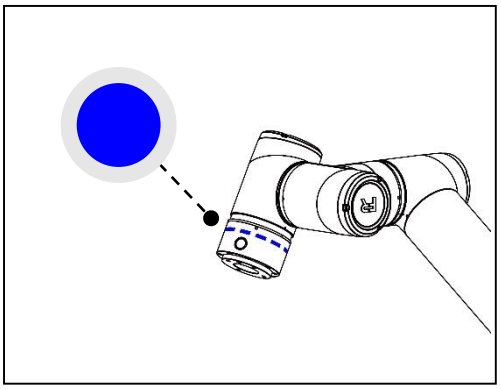


chart 2.3-7Blue schematic diagram of end led

- **S**tep6: Press the button box "Button 3" briefly to run the program, and the LED at the end flashes yellow three times, as shown in Figure 2.3-8.

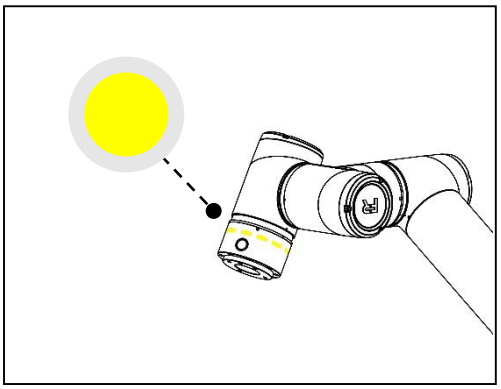


chart 2.3-8Yellow schematic diagram of end led

- **S**tep7: Press the button box "Button 3" briefly to stop running the program, and the LED at the end flashes red three times, as shown in Figure 2.3-9.

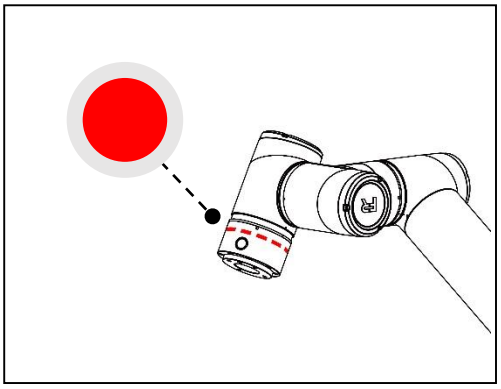


chart 2.3-9Red schematic diagram of end led

2.3.2 Match the teaching device

- **S**tep1, press button 3 of the button box for a long time to start the robot, and wait for the green LED at the end to stop flashing, as shown in Figure 2.3-10, before operating the robot.

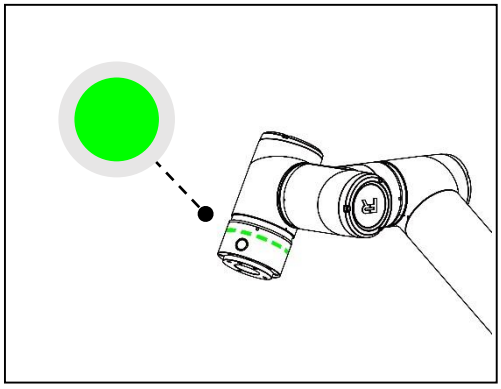


chart 2.3-10Green schematic diagram of end led

- Step2: Open the teaching device and enter the program editing interface.
- Step3, select a blank template to create a new program file.
- Step4, short press button 1 of button box to switch the robot to manual mode, and the LED at the end is green, as shown in Figure 2.3-11.

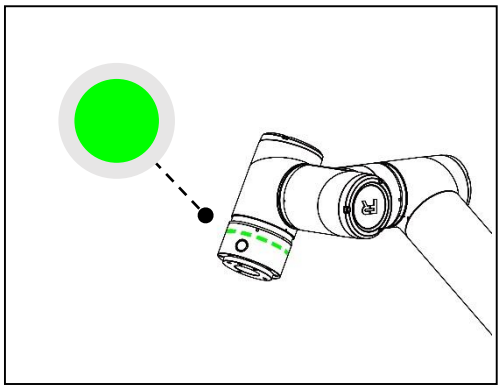


chart 2.3-11Green schematic diagram of end led

- Step5: Long press button box key 1 to switch the robot to drag mode. At this time, the terminal LED is white and cyan, and move the robot to any position. Short press button box key 2 to record P1 point. The terminal LED flashes purple three times, and manually add "PTP:P1" instruction to the program file.

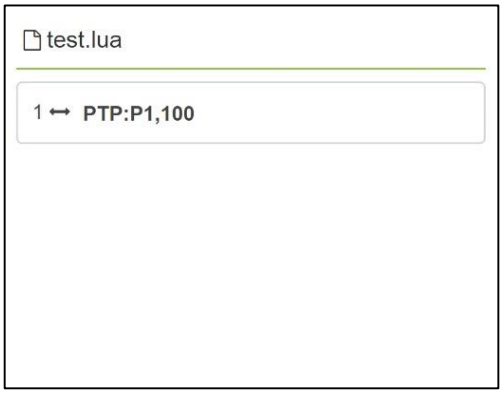


chart 2.3-12Record and add point P1

- Step6, move the robot, press button 2 of the button box briefly to record P2 point, and the LED at the end flashes purple three times, and manually add "PTP:P2" instruction to the program.

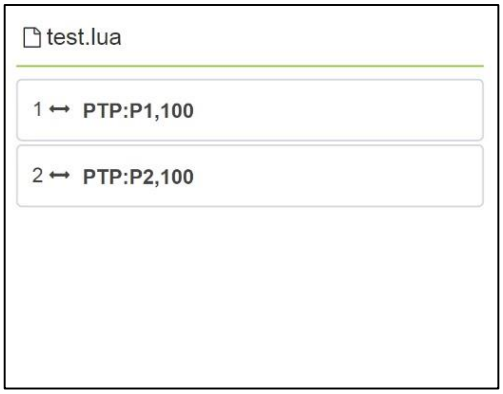


chart 2.3-13Record and add point P2

- Step7, save the program file content.
- Step8: Press button 1 of the button box for a long time to exit the drag mode, which is in manual mode, and the terminal LED is green, as shown in Figure 2.3-14. Press button 1 of the button box for a short time to switch the robot to automatic mode, and the terminal LED is blue, as shown in Figure 2.3-15.

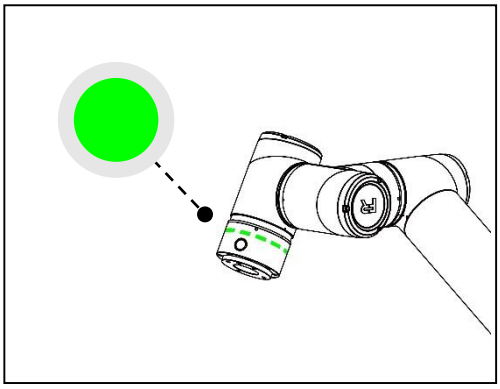


chart 2.3-15Green schematic diagram of end led

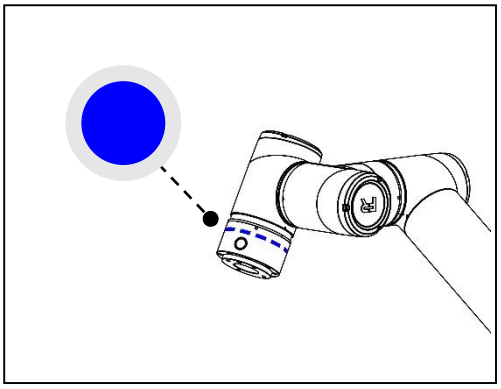


chart 2.3-14Blue schematic diagram of end led

- Step9: Press button 3 of the button box briefly to run the program, and the LED at the end flashes yellow three times, as shown in Figure 2.3-16.

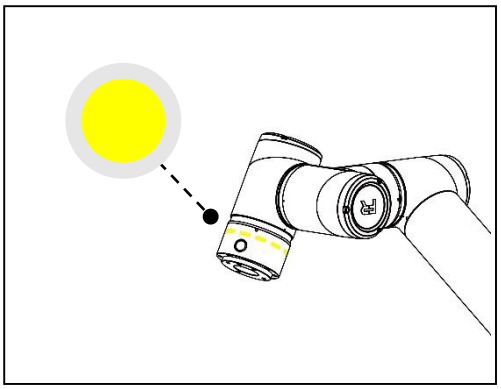


chart 2.3-16Yellow schematic diagram of end led

2.4 Teach controls that movement of the robot

Click the "Teaching Simulation" button in the first-level menu on the left side of the teaching device, and click its submenu "Program Teaching" to enter the program teaching interface, where the robot teaching program is mainly written and modified.

After clicking the "New" icon button, the user names the file, selects a template as the content of the new file, and clicks New to successfully create and open the program file.

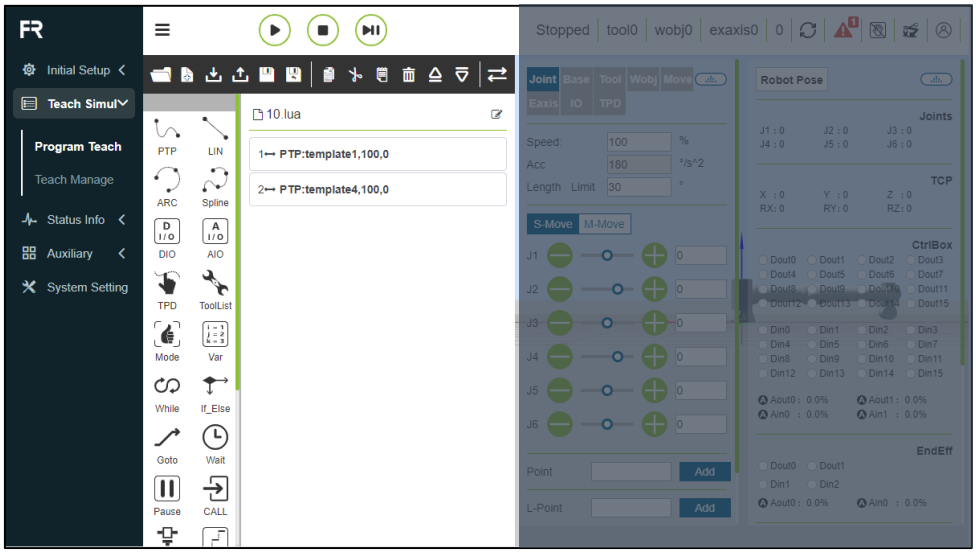


chart 2.4-10peration diagram of teaching program

Warning:

Your head and torso cannot be located within the reach of the robot (work area). Please do not put your fingers where the robot can grasp.

Note:

- Do not allow the robot to move into itself or other objects, as this will cause damage to the robot.
- This is just a quick start guide to how to use the fr robot easily. The premise of the guide is that the environment is safe and harmless, and users are cautious. Please do not increase the speed or acceleration above the default value. Risk assessment is always carried out before the robot is put into operation.

Chapter 3 Software Analysis of Teachers

3.1 Basic information

3.1.1 System introduction

The teaching aid software is developed for robots and runs in the teaching aid operating system. Its main functions and technical characteristics are as follows:

- Ability to write teaching programs for robots;
- It can display the robot position coordinates in real time, simulate the real robot in three dimensions, and control the robot movement.
- It can realize the single-axis inching of the robot and the linkage operation of each axis;
- Ability to view control IO status;
- Users can change passwords, view system information, etc.

3.1.2 Start software

- Power on the control box;
- The instructor opens the browser to access the target website 192.168.58.2;
- Enter the user name and password and click Login to log in to the system.

3.1.3 User login and authority management

- Operator (initial user name: operator password: 123)
- Programmer (initial user name: programmer password: 123)
- Administrator (initial user name: admin password: 123)

User accounts are mainly divided into three levels, and some functions of operators have no permission to use them; Programmers can use all functions except account management, manual high speed and soft limit setting, and administrators have no function restrictions. Specific authority such asTable 3.1-1 authority management

form 3.1-1Authority management

user permission	Permission class	Permission function
Administrator /0	/	unlimited
Programmer /1	/	Except for account setting, manual high speed and soft limit setting, it can be executed
Operator /2	Robot settings	Select the tool coordinate system and apply it
		Select the external tool coordinate system and apply it
		Select the workpiece coordinate system and apply it
		Select the external axis coordinate system and apply it
		Set the robot collision level
		Setting robot soft limit
		Setting robot load and load identification
		Set friction compensation
		Set the robot speed scaling
		Setting IO filtering
		Set DO configuration
		Setting up DI configuration
		Set the robot installation mode
		Configure export
	User peripheral settings	Gripper configuration, reset, activation
		Spray gun configuration and spray gun debugging
		Welding machine configuration, welding machine debugging
		Laser tracking configuration, sensor debugging
		Extended axis configuration, extended axis test
		Conveyor belt configuration
		Tracking attitude configuration
	Teaching simulation	Import and export of teaching files
	Robot operation	Start the teaching program

		Stop executing the teaching program
		Pause execution of teaching program
		Resume execution of teaching program
		Single step
		Robot inching
		Robot Joints application operation
		Teaching point record
	Teaching management	Import and export operation of teaching point information
	status messages	View and export system log
	Auxiliary application	system upgrade
		data backup
		Teach point configuration
		Welding expert database
	system setup	timeset
		Configure export

Login interface such asChart 3.1-1 login interfaceShown.

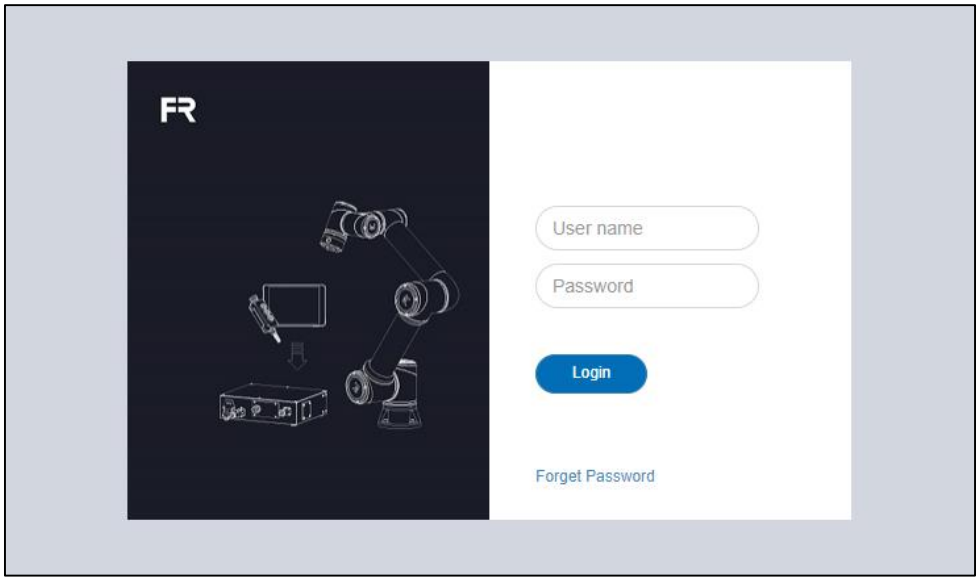


chart 3.1-1Login interface

After successful login, the system will load data such as model, and enter the initial page after loading.

3.2 Initial system interface

After logging in successfully, the system enters the "initial interface", which shows that the teaching device mainly includes Faao LOGO and return to initial page button, menu bar, menu bar zoom button, robot operation area, control area, status area, 3D simulation robot and pose and IO information area. such asChart 3.2-1 schematic diagram of initial system interfaceShown.

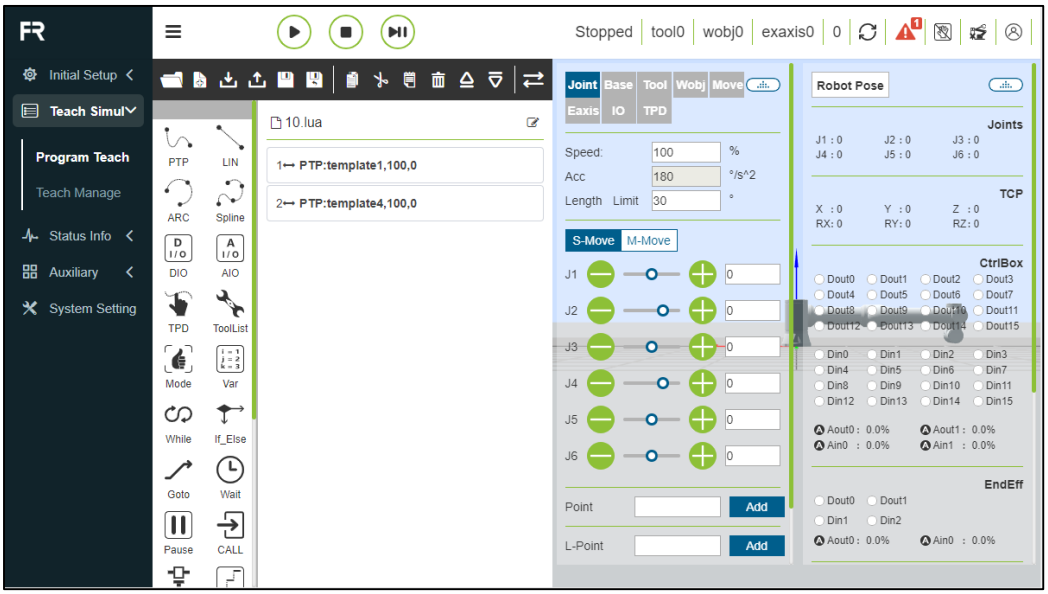


chart 3.2-1Schematic diagram of initial system interface

3.2.1 control area

Start button: upload and start the teaching program

Stop button: stop the current teaching program

Pause / resume button: pause and resume the

3.2.2 status bar

Running	**Robot status:** stopped running pause drag drag
Toolcoord1	**Toolcoord1: the coordinate system of tool 1 is currently applied**
0%	**Percentage of running speed:** speed of robot in current mode
	Normal operation status of robot: the current robot is
	Robot running error status: there is an error in the
	Virtual entity robot: currently it is a solid robot
	Virtual entity robot: currently it is a virtual robot
	Automatic mode: robot automatic operation mode
	Teaching mode: robot teaching operation mode
	Robot dragging status: the current robot can be dragged
	Robot dragging status: the current robot cannot be dragged
	Connection status: robot connected
	Unconnected state: the robot is not connected
	Account information: display user name, authority and login

3.2.3 menu bar

Menu bar likeTable 3.2-1 teach menu column

form 3.2-1Teach menu column

class A	secondary
Initial setup	Robot settings
	User peripheral configuration
Teaching simulation	Program teaching
	Teaching management
status messages	system journal
	Status query
Auxiliary application	Robot body
	Welding expert database
system setup	/

3.2.4 operating space

IO settings can be referred to in 3.5 control box I/O.3.5.1 I/O settings。

The functions such as Joint and Base can be referenced3.6 Robot operation。

3.3 Three-dimensional simulation robot

3.3.1 Virtual/Entity Robot Switching

(This function is not currently enabled)

3.3.2 Three-dimensional virtual track and model shadow

Track drawing: when running the teaching program, turn on the track drawing function, and the robot 3D model will draw the track route of each line of instruction movement.

Model shadow: when it is turned on, there is shadow under the 3D model robot, but when it is turned off, no shadow is displayed.

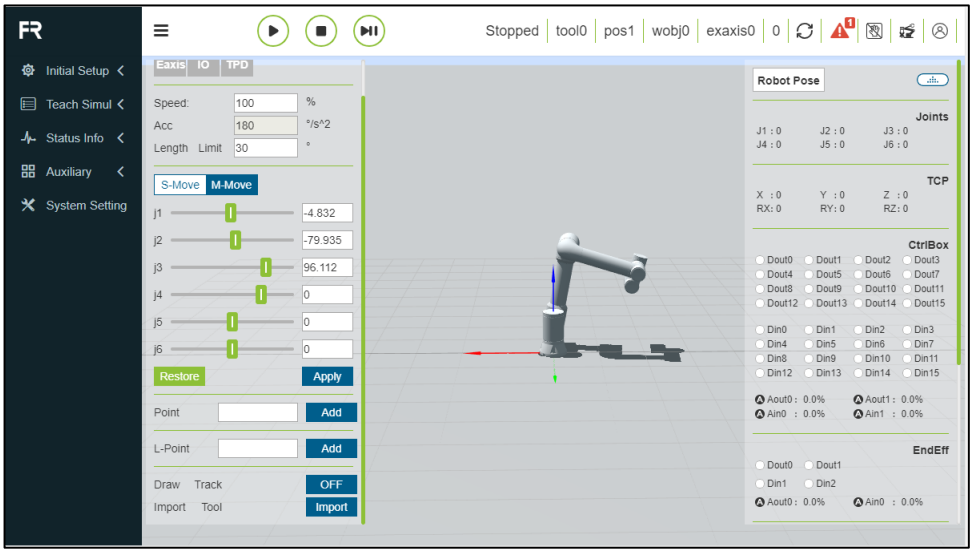


chart 3.3-2Virtual track and model shadow

3.4 Robot settings

3.4.1 Tool coordinates

Under the menu bar of "Robot Settings" in "Initial Settings", click "Tool Coordinates" to enter the tool coordinates interface. Tool coordinates can be used to modify, clear and apply tool coordinates. There are 15 numbers in the drop-down list of the tool coordinate system. After selecting the corresponding coordinate system (toolcoord0~ toolcoord14), the corresponding coordinate values will be displayed below.Click "Apply" after selecting a coordinate system, and the currently used tool coordinate system will become the selected coordinate, as shown in Figure 3.4-1.

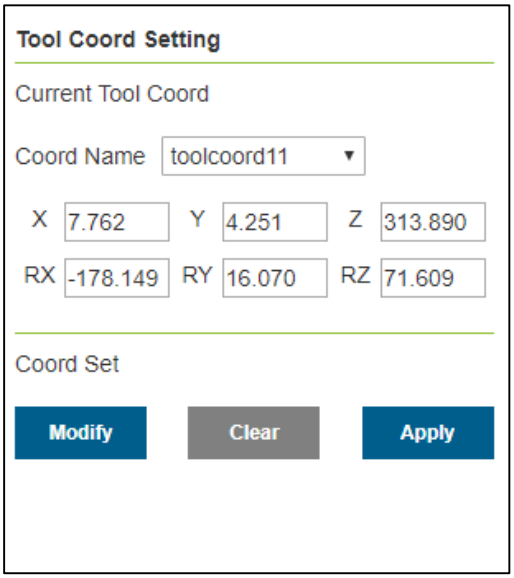


chart 3.4-1Set tool coordinates

Click "Modify" to reset the tool coordinate system of this number according to the prompt. Select a fixed point in the robot space, move the tool to the fixed point in three different postures, and set 1-3 points in turn. As shown in the upper left of Figure 3.4-2. Move the tool vertically to the fixed point set point 4, as shown in the upper right of Figure 3.4-2. Keep the posture unchanged, use the basic coordinates to move,Move a distance in the horizontal direction, and set point 5, which is the set X axis direction of the tool coordinate system. Go back to the fixed point, move vertically upward for a certain distance, and set point 6, which is the tool coordinate

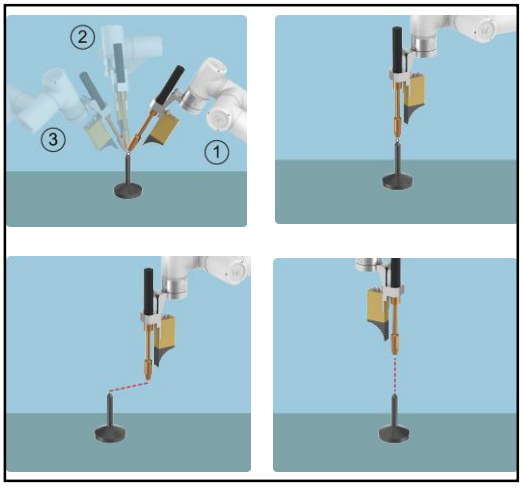


chart 3.4-2Schematic diagram of six-point

Is the z-axis direction. Click the calculate button to calculate the pose of the tool, If you need to reset, click Cancel and press Modify button to start again.

To create a new tool coordinate system.

After finishing the last step, click Finish to return to the tool coordinate interface, and click Save to store the tool coordinate system just created.

3.4.2 External tool coordinates

Click "External Tool Coordinate System" under the menu bar of "Robot Settings" in "Initial Settings" to enter the interface of external tool coordinate system.

The external tool coordinate system setting interface can realize the modification, clearing and application of external tool coordinates.

There are 15 numbers in the drop-down list of external tool coordinate system, from etoolcoord0~ etoolcoord14. After selecting the corresponding coordinate system, the corresponding coordinate values will be displayed at the bottom. After selecting a certain coordinate system, click the "Apply" button, and the currently used tool coordinate system will become the selected coordinate, as shown in Figure 3.4-3.

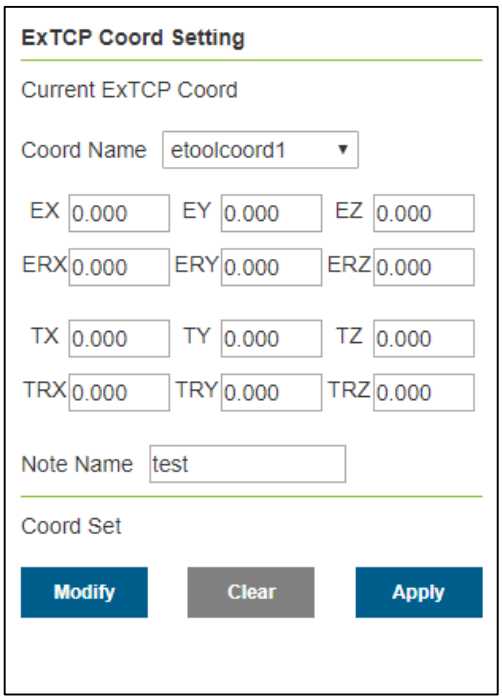


chart 3.4-3External tool coordinates

Click "Modify" to reset the tool coordinate system of this number according to the prompt, as shown in Figure 3.4-4.

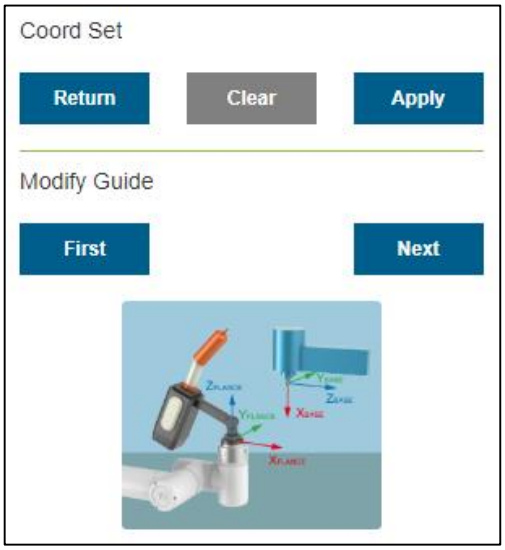


chart 3.4-4 six-point method

1. three points method to determine the external TCP:

Setpoint 1: the TCP of the measured tool is moved to the external TCP, and click the Setpoint 1 button;

Set point 2: move a distance from point 1 along the x axis of external TCF coordinate system, and click the set point 2 button;

Set point 3: return to point 1, move from point 1 along the z axis of external TCF coordinate system for a certain distance, and click the set point 3 button;

Calculation: click the calculation button to get the external TCF;

2. Six-point method to determine the tool TCF:

Set point 1-4: select a fixed point in the robot space, move the tool to the selected point from four different angles, and set 1-4 points in turn;

Set point 5: go back to the fixed point and move a certain distance along the x axis of TCF coordinate system of the tool, and click the set point 5 button;

Set point 6: go back to the fixed point and move a certain distance along the Y axis of the TCF coordinate system of the tool, and click the set point 6 button;

Calculation: click the calculation button to get the tool TCF;

If you need to reset, click the Cancel button to re-enter the new tool coordinate system step.

After finishing the last step, click Finish to return to the tool coordinate interface, and click Save to store the tool coordinate system just created.

3.4.3 Workpiece coordinates

Under the menu bar of "Robot Settings" in "Initial Settings", click "Workpiece Coordinates" to enter the Workpiece Coordinates interface. Workpiece coordinates can be modified, cleared and applied. There are 15 numbers in the drop-down list of workpiece coordinate system. After selecting the corresponding coordinate system (wobjcoord0~ wobjcoord14), the corresponding coordinate values will be displayed in the "Coordinate System Coordinates" below.Click "Apply" after selecting a coordinate system, and the currently used workpiece coordinate system will become the selected coordinate, as shown in Figure 3.4-5.

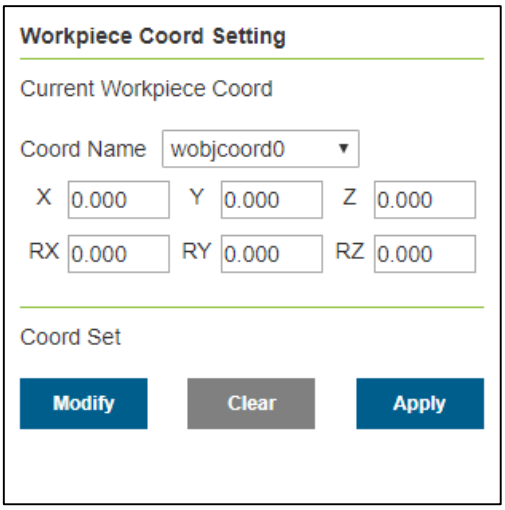


chart 3.4-5Set workpiece coordinates1

Click "Modify" to reset the coordinate system of this numbered workpiece according to the prompt. Fix the workpiece, and select the calibration method "origin -X -Z-axis" or "origin -X -XY+ plane". The first two calibration methods are the same, but the third one is different. The first method is used to calibrate the Z direction of workpiece coordinate system.Choose the second method to calibrate a point on XY+ plane, and calibrate according to the diagram. Click the calculate button to calculate the pose of the workpiece,

If you need to reset, click Cancel and press Modify button to re-create the workpiece coordinate system.

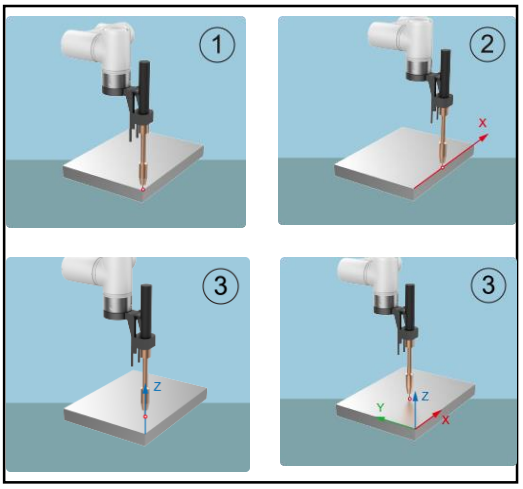


chart 3.4-6Three point method

After finishing the last step, click Finish to return to the workpiece coordinate

interface, and click Save to store the workpiece coordinate system just created.

3.4.4 Extended axis coordinates

Under the menu bar of "Robot Settings" in "Initial Settings", click "Extended Axis Coordinate System" to enter the interface of extended axis coordinate system. You can modify, clear and apply the extended axis coordinates in the extended axis coordinate system setting interface.

There are five numbers in the drop-down list of the extended axis coordinate system. After selecting the corresponding coordinate system from EAXIS 0 to EAXIS 4, the corresponding coordinate values will be displayed at the bottom. After selecting a coordinate system, click the "Apply" button, and the currently used extended axis coordinate system will become the selected coordinate, as shown in Figure 3.4-7.

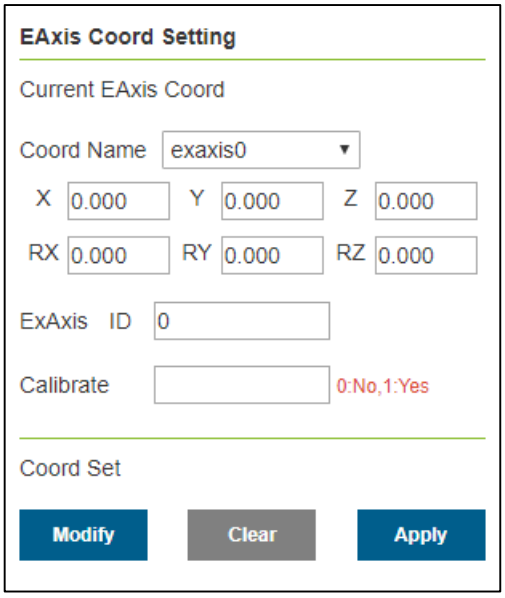


chart 3.4-7Extended axis coordinates

Click "Modify" to reset the extended axis system of this number according to the prompt, as shown in Figure 3.4-8. Empty the extended axis coordinate system to be calibrated before calibration, and apply this extended axis coordinate system. First, look at the first expansion axis scheme-calibration method of linear guide rail. Select the number of the expansion axis, and obtain the information to obtain the driver information of the corresponding expansion axis.We can configure parameters according to this information. DH parameters are set after configuration, and the linear guide scheme defaults to 0. Set the position of the robot relative to the expansion axis, and the linear guide is on the expansion axis. If it is not calibrated, click Save. At this time, the expansion axis can only move asynchronously.

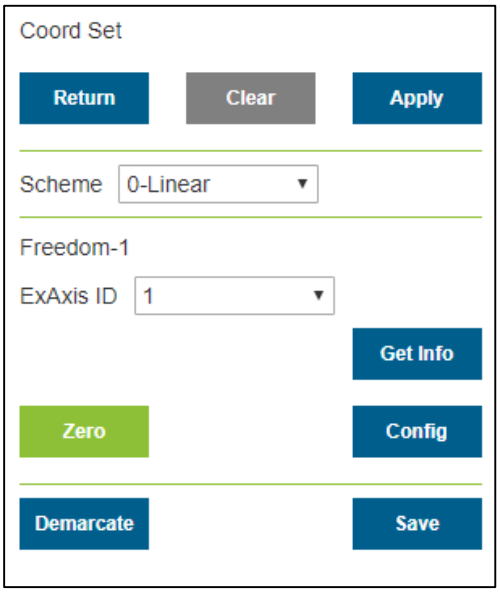


chart 3.4-8Linear guide rail configuration

If you need to move synchronously with the robot, click calibration to enter the calibration interface. At the zero point of the expansion axis, click Eaxis in the operation area to enable the expansion axis, and align the robot end center (the end point of the tool in the application tool coordinate system) with two different postures on the expansion axis, and set points 1 and 2 respectively. Remove the enabling, move the expansion shaft for a certain distance, and after enabling,Also align the center point of the robot end with the previous fixed point, set point 3. Remove the enable, move the expansion axis to zero, and enable the expansion axis. Move the center point at the end of the robot to a point vertically upward from the fixed point, set point 4, calculate the coordinate system and save it.

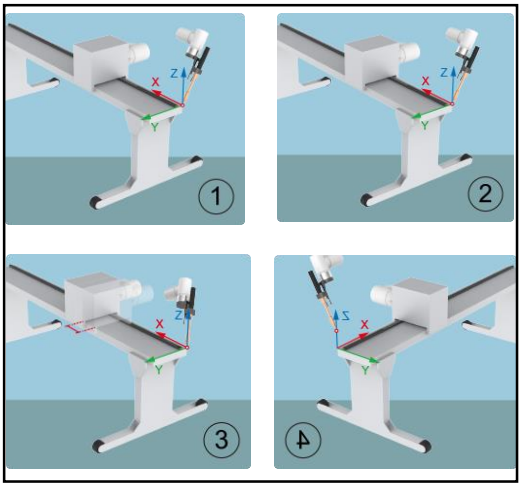


chart 3.4-9Calibration of linear guide rail

Next, we will look at the second scheme of extended shaft-the calibration method of the positioner. The positioner consists of two expansion shafts. Selecting the number of the expansion shaft can obtain the driver information of the corresponding expansion shaft, and we can configure the parameters according to this information. Set DH parameters after configuration, measure DH parameters of the positioner according to the diagram, and input them into the input box.Set the position of the robot relative to the expansion axis, and the positioner is outside the expansion axis. If it is not calibrated, click Save. At this time, the expansion axis can only move asynchronously.

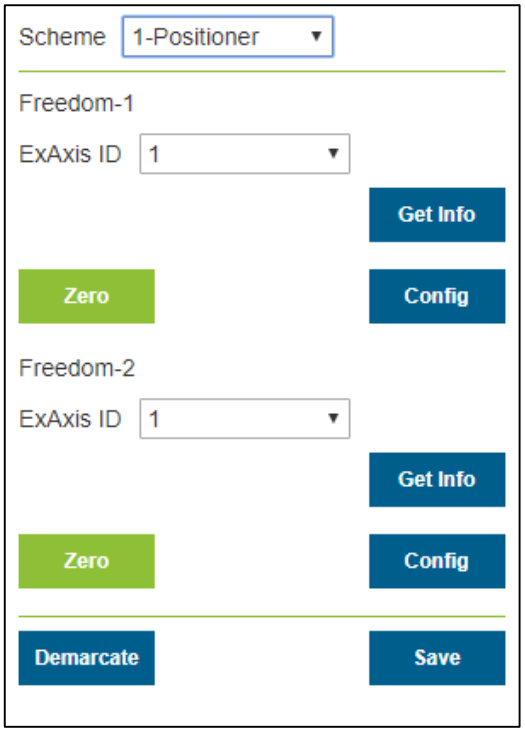


chart 3.4-10Configuration of positioner

If you need to move synchronously with the robot, click calibration to enter the calibration interface. At the zero point of the expansion axis, click Eaxis in the operation area to enable the expansion axis, establish a coordinate system on the positioner, select a point, and enter the Cartesian pose of this point in this coordinate system. For example, select a positive point of Y, and measure that Y is 100mm, then enter the numerical value as shown in the figure, and click the reference point to set the reference point.For the next four calibration points, it is necessary to align the robot end center (the tool end point in the application tool coordinate system) with the reference point.

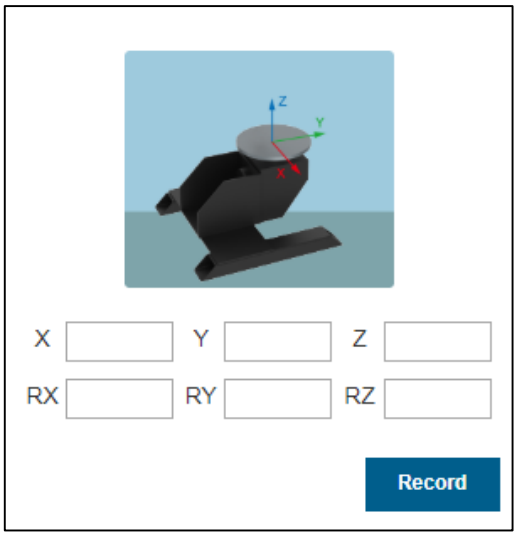


chart 3.4-11Config reference point

Align the robot end center (tool end point in application tool coordinate system) with this reference point, set point 1, click Eaxis in operation area to point two axes a short distance away from the robot end center to align with reference point, set point 2, continue to point two axes, align robot end center with reference point, set point 3, and finally continue to point two axes to align robot end center with reference point.Set point 4, click calculate to get the coordinate system result, click save and apply.

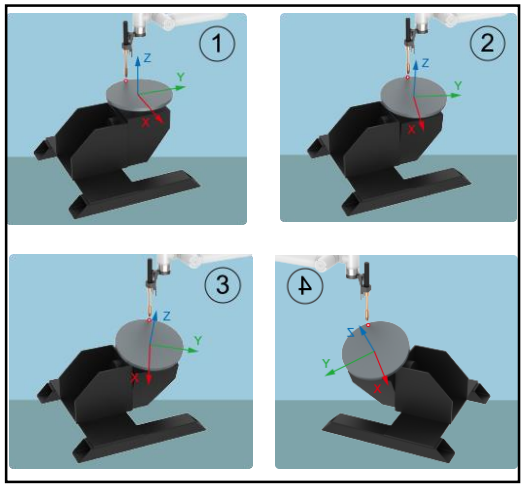


chart 3.4-12Calibration of positioner

3.4.5 Collision grade

Under the menu bar of "Robot Settings" in "Initial Settings", click "Collision Level" to enter the collision level interface.

Collision level can be divided into three parts: level 1, level 2 and level 3. When level 1 is set, the robot is sensitive to collision detection. The sensitivity of collision detection can be set in the user profile, and the user can set the collision level according to the specific use requirements. See figure 3.4-9.

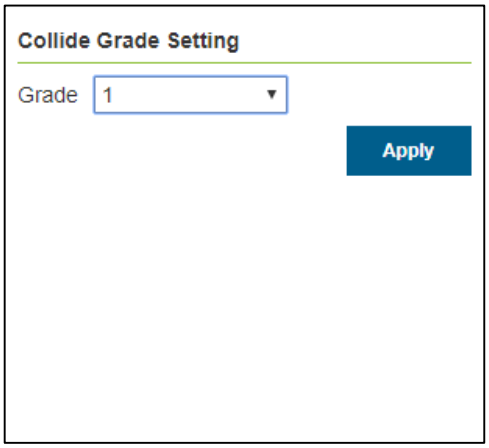


chart 3.4-13Collision level diagram

3.4.6 Soft limit

Under the menu bar of "Robot Settings" in "Initial Settings", click "Soft Limit" to enter the soft limit interface.

There may be other equipment in the robot's travel, and the limit angle can be used to limit the robot, so that the robot's motion does not exceed a certain coordinate value and prevent the robot from colliding. Triggering the soft limit robot to stop is automatically triggered by the robot without stopping distance.

Administrators can use default values or enter angle values. Enter the angle value to limit the positive and negative angles of robot joints respectively. When the input value exceedsTable 1.3-1The soft limit angle values of robot joints listed in section will adjust the limit angle to the maximum value that can be set. When the robot reports that it exceeds the instruction limit, it is necessary to enter the drag mode and drag the robot joint within the limit angle. Interface is shown in 3.4-10.

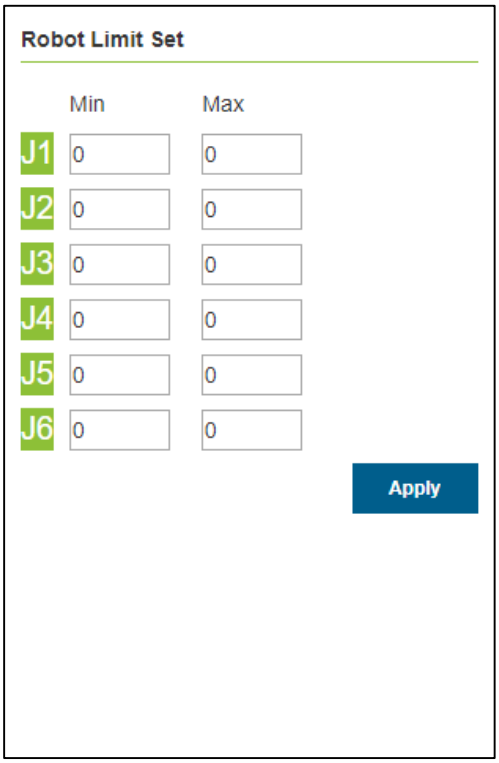


chart 3.4-14Schematic diagram of robot limit

3.4.7 End load

Under the menu bar of "Robot Settings" in "Initial Settings", click "End Load" to enter the end load interface.

The user can set the corresponding parameters according to the parameters of the tool used, with the load weight of 0~5kg and the centroid coordinate range of 0~1000, as shown in 3.4-11.

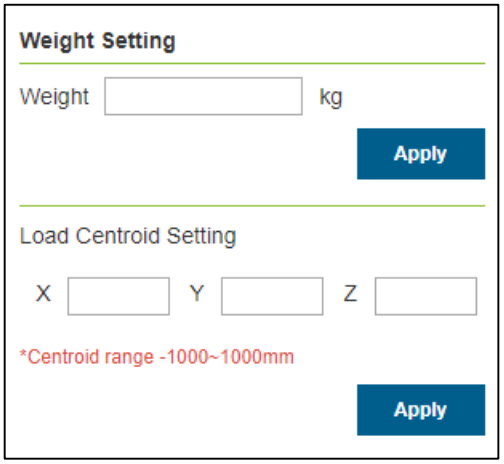


chart 3.4-15Schematic diagram of load setting

When the user is uncertain about the tool quality or centroid, the tool data can be measured through the load identification function.

Make sure that the load is installed before measuring. Click the "Tool Data Measurement" button to enter the load movement test interface.

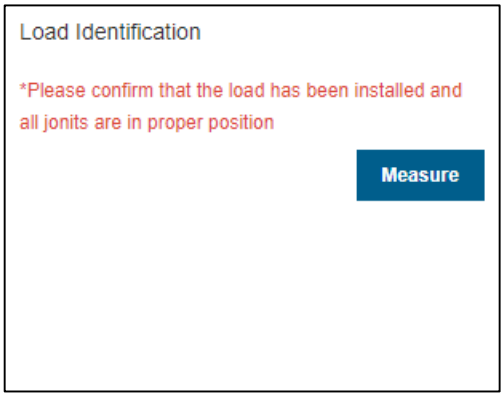


chart 3.4-16Load identification joint setting

Click "Load Identification Start" to test. In case of emergency, please stop moving in time.

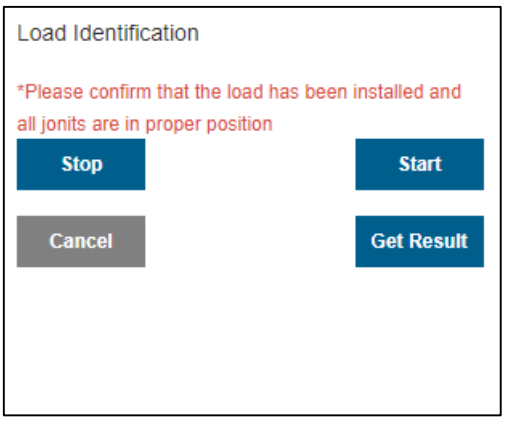


chart 3.4-17Load identification start

After the exercise, click the "Get Identification Result" button to get the calculated tool data and display it on the page. If it needs to be applied to the load data, click Apply.

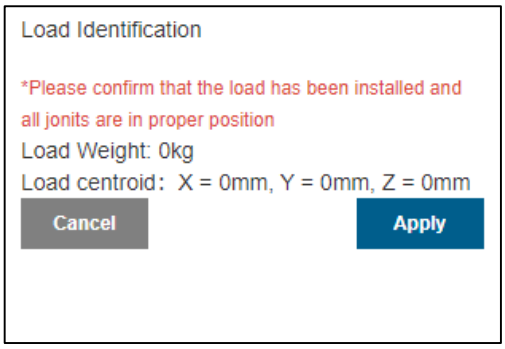
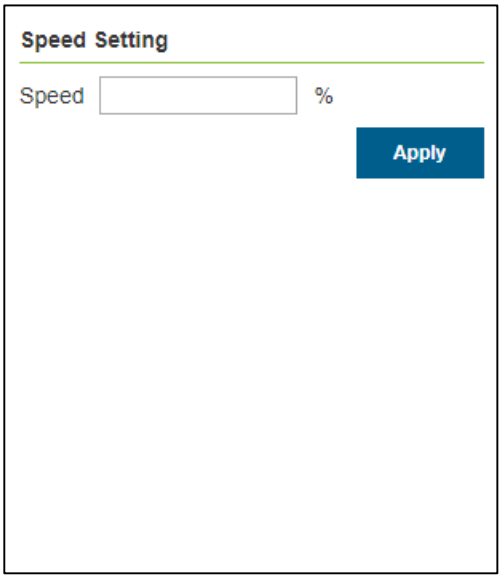


chart 3.4-18Load identification results

3.4.8 Speed scaling

Under the menu bar of "Robot Settings" in "Initial Settings", click "Speed Scaling Settings" to enter the speed scaling settings interface.

This function is to set the running speed of the robot under manual/automatic operation. If the current mode is automatic operation, the set speed is automatic operation speed of the robot; if the current mode is manual operation, the set speed is manual operation speed of the robot. Set the value as the percentage of robot standard speed, if set to 100,That is, 100% of the standard speed (please read the table for the standard speed)1.3-1Robot parameters).



After the speed setting is successful, the corresponding speed status bar will be changed to the set value, and the range of speed value setting is 0~100.

chart 3.4-19Speed zoom settings

3.4.9 Robot installation

Under the menu bar of "Robot Settings" in "Initial Settings", click "Robot Installation" to enter the robot installation mode setting interface.

Robot installation methods are divided into horizontal installation, side installation and upside down installation, and the default installation method is horizontal installation. When the robot installation mode is changed, it is necessary to set the actual installation mode of the robot on this page in time to ensure the normal operation of the robot.

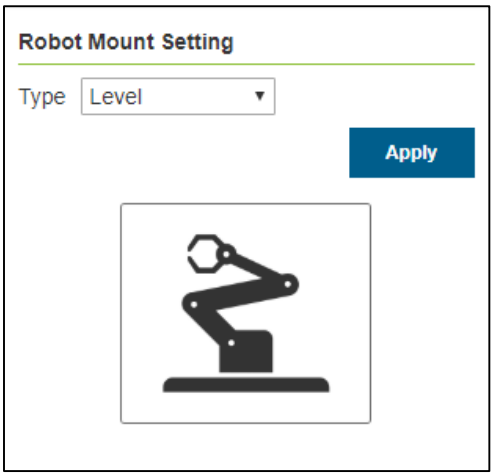


chart 3.4-20Robot installation settings

3.4.10 Friction compensation

Under the menu bar of "Robot Settings" in "Initial Settings", click "Friction Compensation" to enter the interface of friction compensation settings.

Friction compensation coefficient: the use scenario for friction compensation is only in drag mode, and the friction compensation coefficient can be set in the range of 0~1. The higher the value, the greater the compensation force when dragging. The friction compensation coefficient is set separately according to different installation methods.

Friction compensation switch: users can turn on or off friction compensation according to actual robots and usage habits.

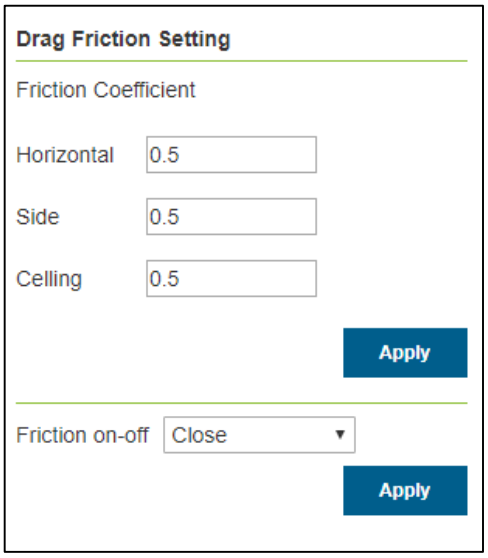


chart 3.4-21Friction compensation settings

3.4.11 Configure import and export

Under the menu bar of "Robot Settings" in "Initial Settings", click "Configuration Import and Export" to enter the configuration import and export interface.

Configuration import: the user imports the robot configuration file named user.config, which contains various parameters in the robot setting function. Click the "Select File" button, select the modified configuration file whose content meets the specification, and click the "Import" button. When the prompt of import is displayed, the parameters in the file are successfully set.

Configuration export: Click the "Export" button to export the robot configuration file user.config to the local area.

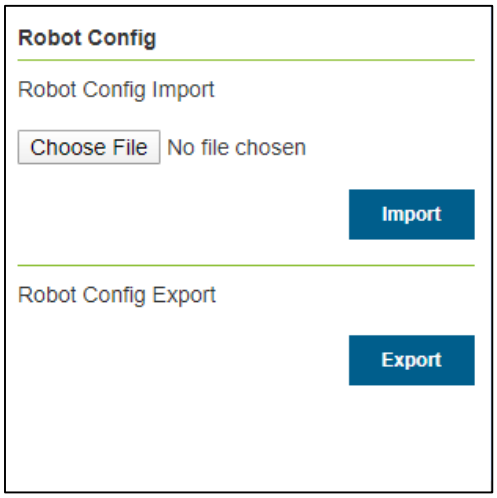


chart 3.4-22Configure import and export

3.5 I/O of control box

3.5.1 I/O settings

Click the "IO" button in the left operatIOn area of the 3d model to enter the io setting interface, as shown in figure 3.5-1. in this interface, the digital output and analog output (0-10v) in the robot control box and the digital output and analog output (0-10v) of the end tool can be manually controlled:

- DO operatiON, select the port number. If the DO is low level, the operation button on the right side displays ON, and click the button to set the DO to high level.
- AO operation, select the port number, and enter a value (0-100) in the right input box, which is a percentage. Setting 100 means setting the AO port to 10v.

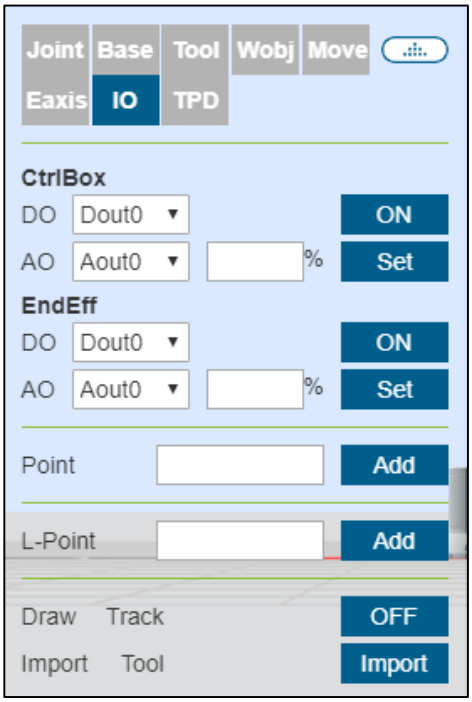


chart 3.5-1 I/O setup interface

3.5.2 I/O status display

The status display area on the right side of the 3D model will display the current IO status. In digital input and digital output, if the port level is high, the point will be displayed as green, and if it is low, it will be displayed as white. The analog input and output display values are 0-100, and 100 means 10v.

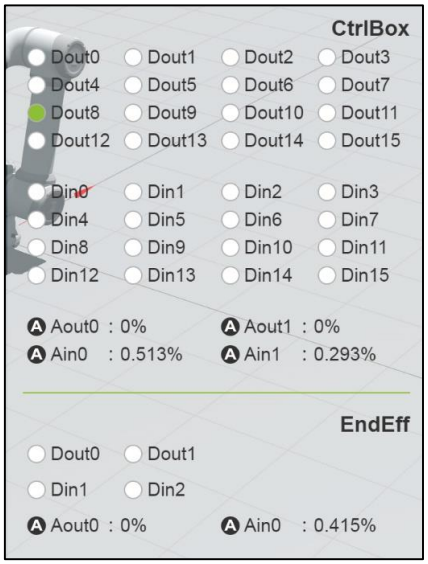


chart 3.5-2Status display interface

3.5.3 I/O filtering

Click "Robot Setting" in "Initial Setup" in the left menu bar, and click "IO Filter" submenu to enter the IO filter time setting interface, which includes control box DI filter time, terminal board DI filter time, control box AI0 filter time, control box AI1 filter time and terminal board AI0 filter time, as shown in Figure 3.5-3.Users can set the corresponding parameters according to their own needs, and click the corresponding setting button.

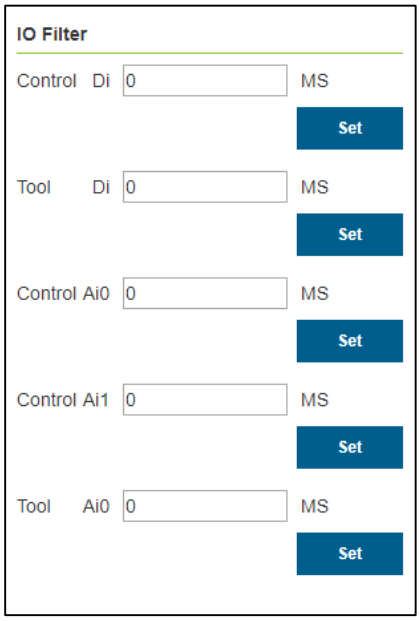


chart 3.5-3 I / O filter interface

3.5.4 I/O configuration

Click "Robot Setting" in "initial Setup" in the left menu bar, and click "DI config" and "DO config" submenu to enter DI and DO configuration interface. In which control boxes DI8-DI15 and DO8-DO15 are configurable, and terminals DI1 and DI2 are configurable. In the production, when the cooperative robot needs to connect with peripherals or suddenly stops due to faults or other factors, it needs to output DO signals to realize audible and visual alarm prompt.Enter configurable functions such asTable 3. 5-1 control box input configurable function.

form 3.5-1Control box input configurable function

Function number	**Function name**
0	without
1	Successful arcing signal
2	Welding machine preparation signal
3	Conveyor detection
4	pause
5	recover
6	start
7	stop
8	Pedal drag switch

Output configurable functions are shown in Table 3.5-2 and Table 3.5-3.

form 3.5-2Output configurable function of control box

Function number	**Function name**
0	without
1	Error reporting
2	sports
3	Spray start and stop

4	Spraying gun
5	arcing
6	aspirate
7	Forward wire feeding
8	Reverse wire feeding
9	JOB input port 1
10	JOB input port 2
11	JOB input port 3
12	Start and stop of conveyor belt

form 3.5-3End output configurable function

Function number	**Function name**
0	without
1	Drag mode
2	Teaching point record

The default configuration of the control box: DO8 is 1- the robot reports an error, DO9 is 2- the robot is in motion.

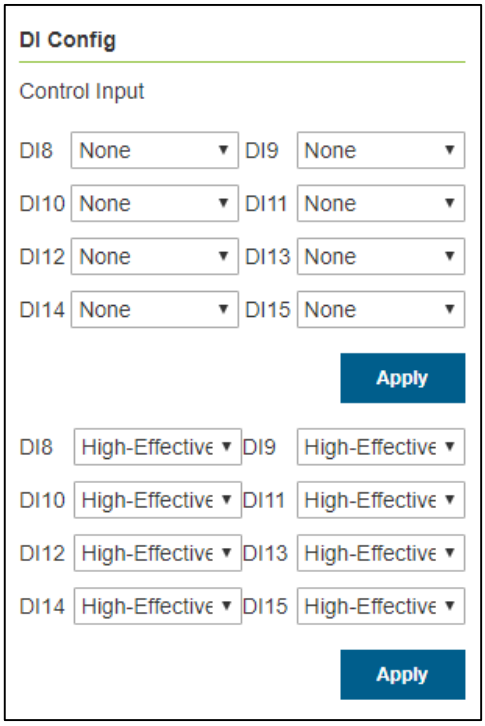


chart 3.5-4 Control box DI configuration

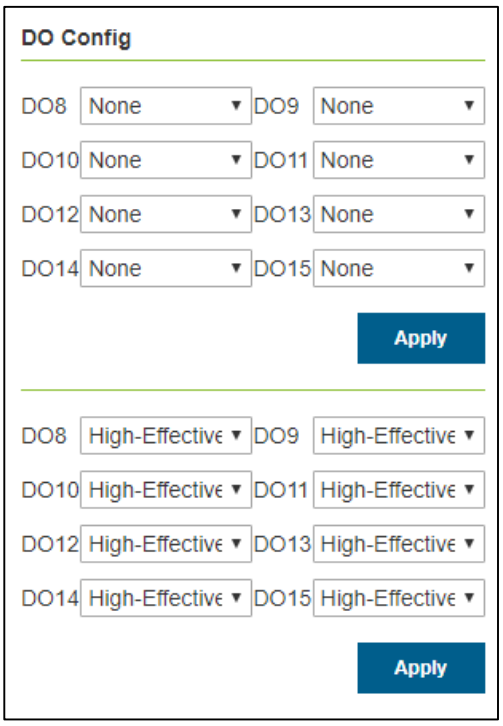


chart 3.5-5Control box DO configuration

Default configuration of terminal DI: DI1 drag teaching, DI2 teaching point recording.

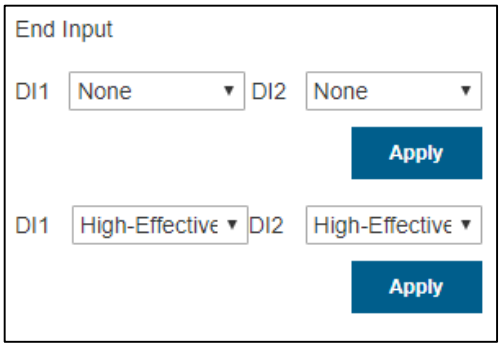


chart 3.5-6End DI configuration

After the configuration is completed, the corresponding output DO status can be viewed in the I/O page of the control box under the corresponding status. (Note: configured DI and DO cannot appear on the teaching and programming page)

3.6 Robot operation

3.6.1 Teaching point record

The manual teaching control area mainly sets the test coordinate system in the teaching mode, displays the angles and coordinate values of each axis of the robot in real time, and can name and save the teaching points.

When saving a teaching point, the coordinate system of the teaching point is the coordinate system applied by the current robot. Above the operation area, you can set the speed and acceleration of the teaching point as a percentage of the robot's standard speed. If 100 is set, it is 100% of the standard speed (please read the standard speed)Table 1.3-1Robot parameters).

Laser teaching point, the saved point position is the point position identified by laser.

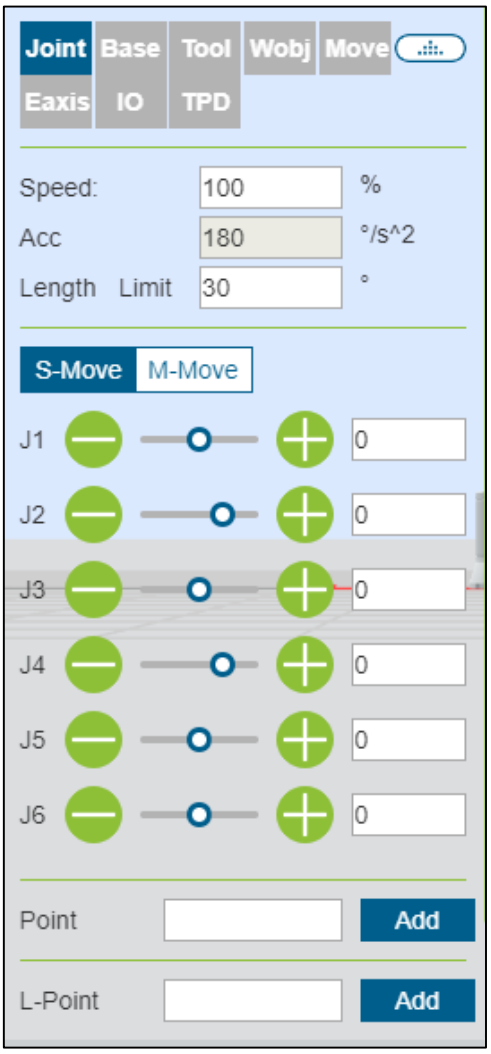


chart 3.6-1Schematic diagram of manual operation

Note:

When using the robot for the first time, please set the speed value of 30 so as to be familiar with the robot movement, so as to avoid accidents.

3.6.2 Joint motion

Under the operation of Joint, the middle six slider bars respectively represent the angles of the corresponding axes, and the joint motion is divided into single-axis inching and multi-axis linkage

Uniaxial inching: the user can control the robot movement by operating the left and right round buttons, as shown in Figure 3.6-2. In the manual mode and joint coordinate system, a joint of the robot is rotated. When the robot stops beyond the motion range (soft limit), it can be manually operated by single-axis inching to move the robot out of the overrun position.Single-axis inching is faster and more convenient than other operation modes in rough positioning and large-scale movement.

Set the parameter of "Length Limit" (the maximum distance for the robot to run when long press the button, the input value range is 0~300), and long press the round button to control the robot to run. If the button is released while the robot is running, the robot will stop moving immediately; if the button is kept pressed, the robot will stop moving after long press the set value of the motion threshold.

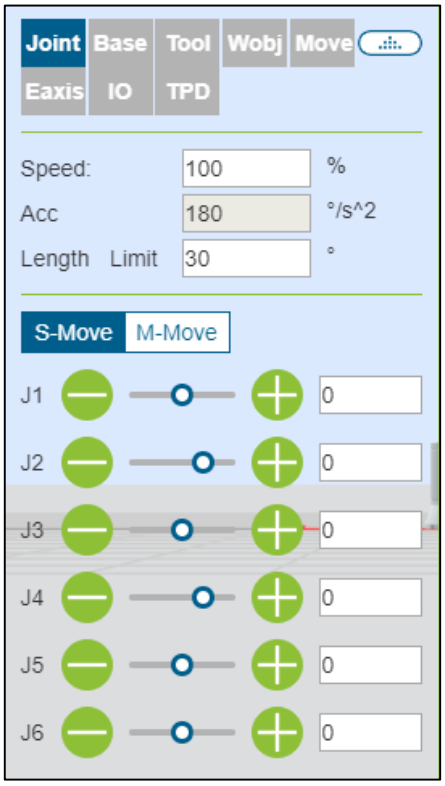


chart 3.6-3 Joint single axis inching diagram

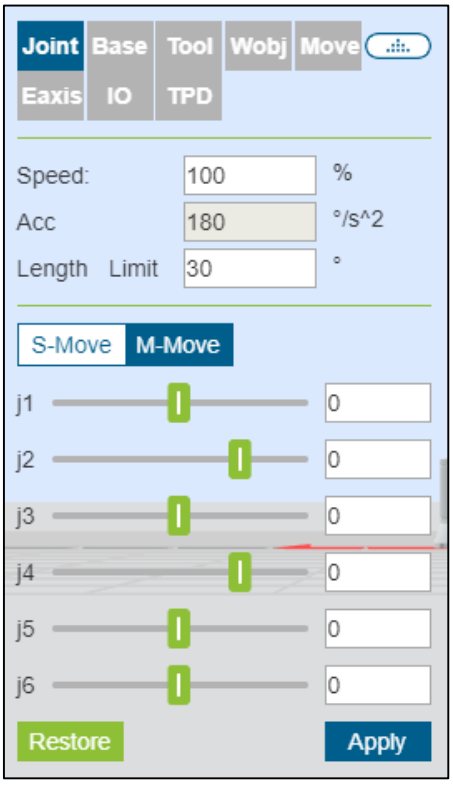


chart 3.6-2 Joint multi axis linkage diagram

Multi-axis linkage: the user can adjust the corresponding target position of the robot by operating the middle six sliders, as shown in Figure 3.6-3. The target position can be determined by observing the 3D virtual robot. If the adjusted position does not meet his expectations, click the "Restore" button to make the 3D virtual robot return to its original position. When the user determines the target position,Click the "Apply" button, and the real robot will move accordingly.

3.6.3 Base inching

In the base coordinate system, the left and right circular buttons can be operated to control the robot, which can move linearly on X,Y,Z Y and Z axes or rotate around RX, Ry and RZ. The middle six slider bars respectively indicate the position and movement range on the corresponding coordinate axes, as shown in Figure 3.6-4. The function of Base inching is similar to that of uniaxial inching in Joint motion.

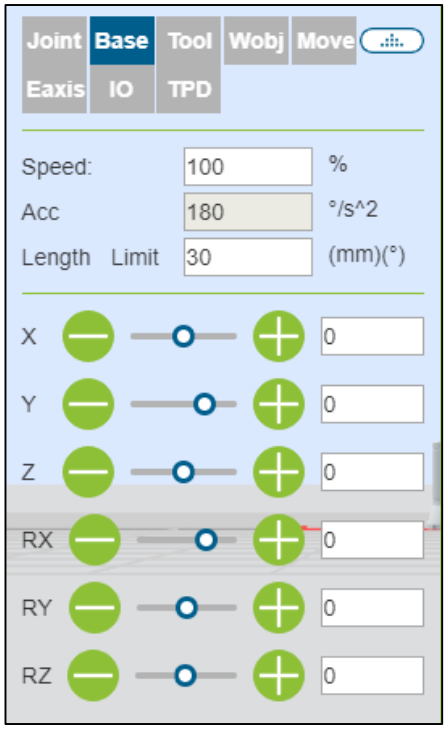


chart 3.6-4 Schematic diagram of base inching

Note:

The button can be released at any time to stop the robot. If necessary, press the emergency stop button to stop the robot.

3.6.4 Tool inching

Select the tool coordinate system, and you can operate the left and right circular buttons to control the robot to move in a straight line on the X,Y,Z y and z axes or rotate around rx, ry and rz. the six slider bars in the middle respectively indicate the position and movement range on the corresponding coordinate axes, as shown in figure 3.6-5. The function of Tool inching is similar to that of uniaxial inching in Joint motion.

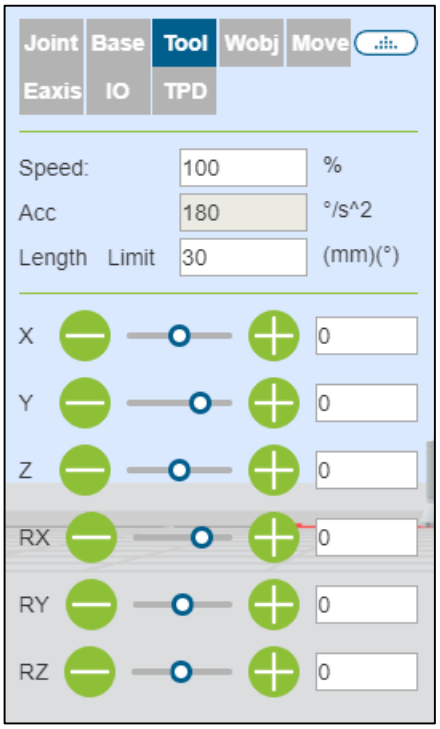


chart 3.6-5 Tool inching diagram

3.6.5 Wobj inching

Select the workpiece inching, and you can operate the left and right circular buttons to control the robot. Under the workpiece coordinate system, it can move straight along the X,Y,Z Y and Z axes or rotate around RX, Ry and RZ. The middle six slider bars respectively indicate the position and movement range on the corresponding coordinate axes, as shown in Figure 3.6-6. The function of Wobj inching is similar to that of uniaxial inching in Joint motion.

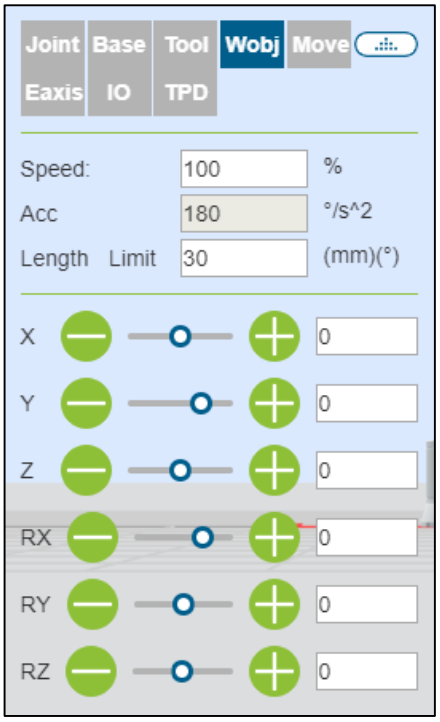


chart 3.6-6 Wobj inching diagram

3.6.6 Move move

Select Move to move, you can directly input cartesian coordinate values, click "Calc Joint", the joint position will be displayed as the calculated result, and it is confirmed that there is no danger. you can click "To Point" to control the robot to move to the input cartesian pose.

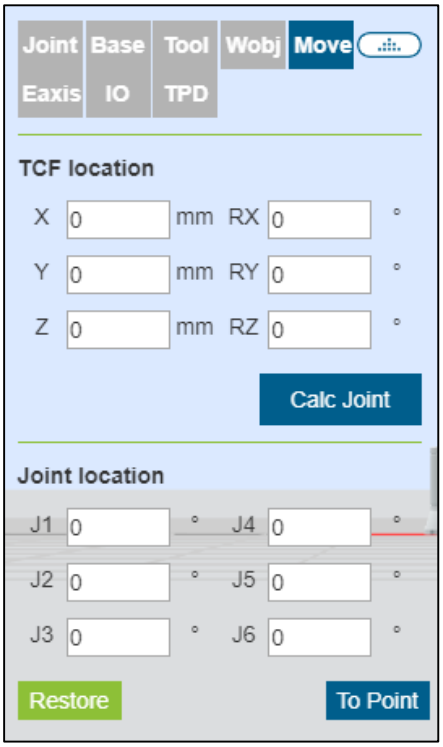


chart 3.6-7 Move movement diagram

3.6.7 Eaxis mobile

Select Eaxis movement. this function is the inching function of the expansion shaft. it is necessary to use this inching function to control the expansion shaft on the premise of configuring the expansion shaft. for details, refer to chapter 4 machine-robot peripherals-configuration of expansion shaft peripherals.

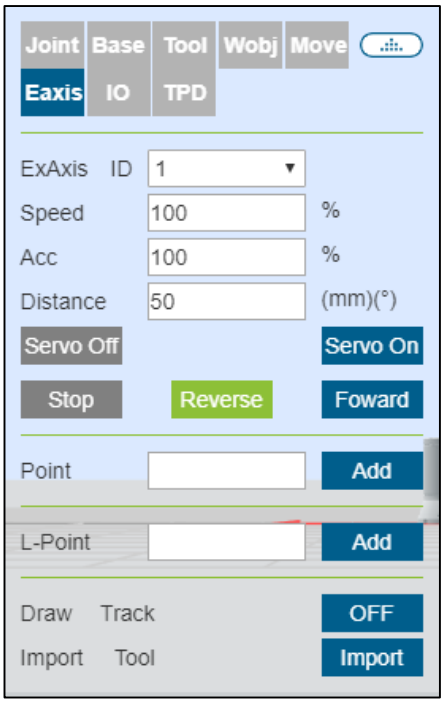


chart 3.6-8 Movement diagram of eaxis

3.6.8 TPD (teaching programming)

Operation steps of teaching programming (TPD) function are as follows:

Step1 Record the initial position: enter the left operation area of the 3D model and record the current position of the robot. Set the name of the point in the edit box, and click the "Add" button. If the save is successful, it will prompt "Save the point successfully";

Step2 Configure trajectory recording parameters: Click TPD to enter the "TPD" function item to configure trajectory recording parameters, and set the name, pose type and sampling period of trajectory file, as shown in Figure 3.6-9;

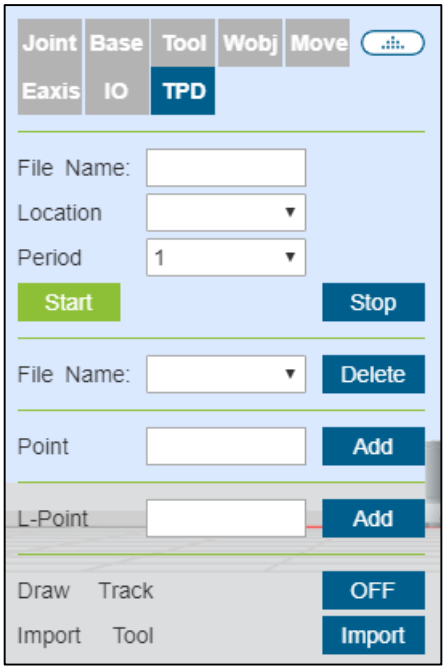


chart 3.6-9 TPD track record

Step3 Check the robot mode: Check whether the robot mode is in manual mode, if not, switch to manual mode. In manual mode, you can switch to the supporting teaching mode in two ways, one is to press the end button for a long time, and the other is to drag the interface mode switch button. In TPD records, it is recommended to switch the robot from the interface to enter the supporting teaching mode. As shown in Figure 3.6-10;

chart 3.6-10Robot mode

Step4 Start recording: Click the "Start" button to start track recording, and drag the robot to teach actions.

Step5 Stop recording: After the action teaching is completed, click the "Stop" button to stop track recording, and then drag the teaching switch button to make the robot exit the drag teaching mode. When the teach pendant receives "Stop track recording successfully", it means track recording is successful.

Step6 Teaching programming: Click New, select a blank template, click Enter PTP function programming item, select the initial position point just saved, click Add button, and a PTP instruction will be displayed in the program file after the application is completed; Then click to enter the TPD function programming item, select the track just recorded, set whether it is smooth and speed scaling, and click the "Add" button.After the application is completed, a MoveTPD command will be displayed in the program file, as shown in Figure 3.6-9.

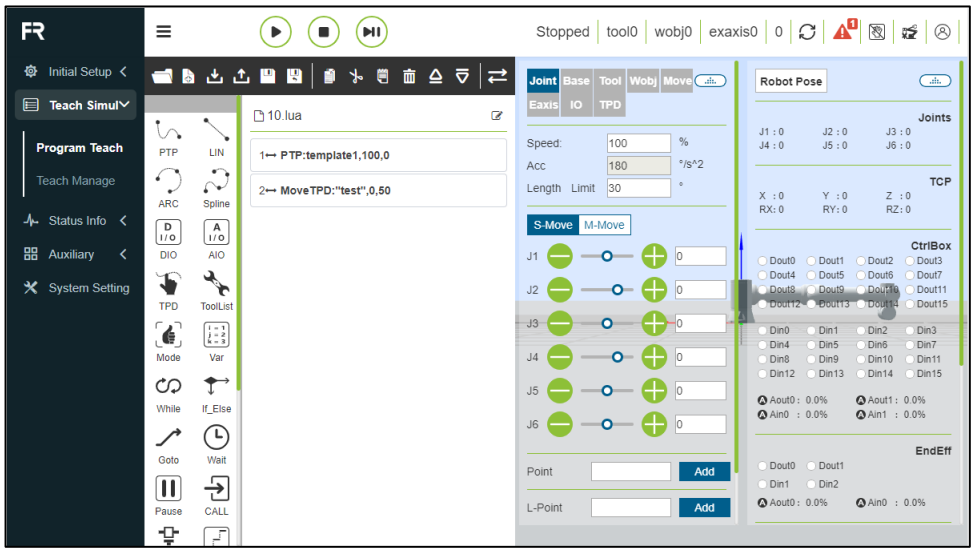


chart 3.6-11 TPD programming

Step7 Track Reproduction: After editing the teaching program, switch to automatic running mode, click the "Start Running" icon at the top of the interface to start running the program, and the robot begins to reproduce the taught action.

TPD file deletion and exception handling:

Trajectory file deletion: click to enter the TPD function item, select the track file to be deleted, and click the "Delete Track" button. If the deletion is successful, you will receive a prompt of successful deletion.

Exception handling:

- **Over-limit of command points:** a track can record up to 20,000 points. When it exceeds 20,000 points, the controller will no longer record the exceeded points, and send an alarm prompt of "over-limit of command points" to the teaching device. At this time, click to stop recording;
- **TPD instruction interval is too large:** if the teaching device reports that

the TPD instruction interval is too large, check whether the robot has returned to the initial position before recording. if the robot returns to the initial position and still reports that the TPD instruction interval is too large, delete the current track and re-record a new track;

- In case of other abnormal situations during TPD operation, the robot operation should be stopped immediately through the teaching device or emergency stop button, and the causes should be checked.

Note:

During the operation of TPD function, the corresponding prompts on the teaching device should be strictly followed.

3.7 Teaching simulation

3.7.1 brief introduction

Click the command on the left to add a program node to the program tree.

When the program is running, the currently executed program node is highlighted in blue.

In manual mode, click the first icon on the right side of the node to make the robot execute the instruction independently, and the second icon is to edit the content of the node.

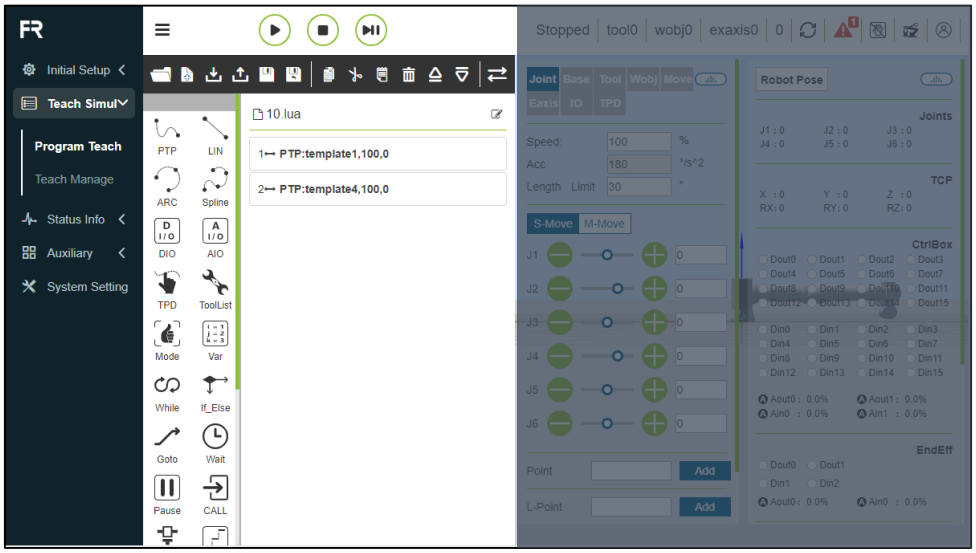


chart 3.7-1Program tree interface

3.7.2 Toolbar

Use the toolbar at the bottom of the program tree to modify the program tree.

Open: opens the user program file

New: select a template to create a new program file

Import: import the file into the user program folder

Export: export user program files to the local location.

Save: saves the editing contents of the file

Save as: rename the file to the user program or template

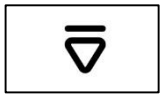
Copy: copies a node and allows it to be used for other operations, such as pasting it to another

Paste: allows you to paste previously cut or copied

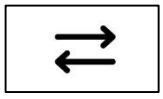
Cut: cuts a node and allows it to be used for other operations, such as pasting it to another

Delete: removes a node from the program tree.

Move up: move the node up.



Move down: moves the node down.



Switch editing mode: program tree mode and text editing

3.7.3 Program command

The left side is mainly the addition of program commands. Click the icon above each keyword to enter the detailed interface. There are two main operations for adding program commands to the file. One way is to open the relevant commands and click the Apply button to add the commands to the program, and the other way is to click the "Add" button first, when the commands are not saved in the program file.You need to click "Apply" again to save the command to the file. In the second way, more than one instruction of the same type is issued. We add the functions of adding button and displaying the content of the added instruction to this type of command. Click Add button to add an instruction, and the added instruction displays all the added instructions.Click "Apply" to save the added instruction to the opened file on the right.

PTP command: Click the "PTP" icon to enter the PTP command editing interface

You can select the point to be reached, and set whether it is offset or not. if you select offset, the offset settings of x, y, z, rx, ry and rz will pop up. the PTP specific path is the optimal path automatically planned by the motion controller. click "Add"and "Apply" to save this instruction.

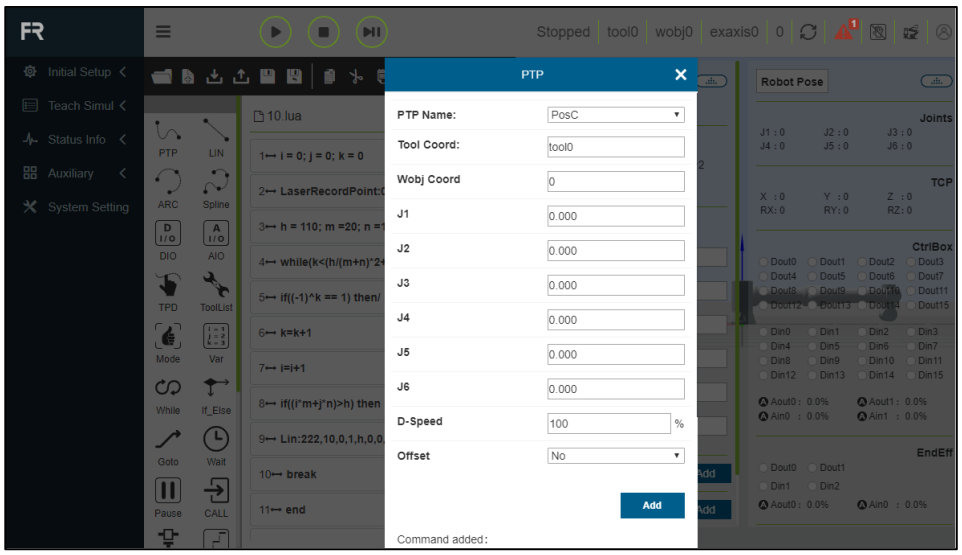


chart 3.7-2 PTP instruction interface

Lin command: click the "LIN" icon to enter the Lin command editing interface

The function of this instruction is similar to that of "PTP", but the path of the point reached by this instruction is a straight line.

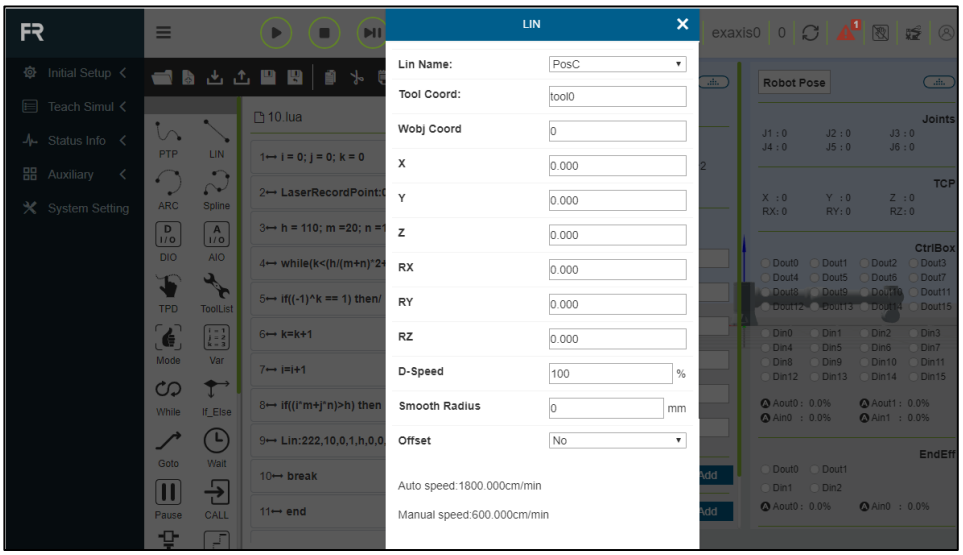


chart 3.7-3 Lin command interface

Arc command: click the "ARC" icon to enter the Arc command editing interface

The "Arc" command is an arc movement, which includes two points, the first point is the transition point in the middle of the arc, and the second point is the end point.

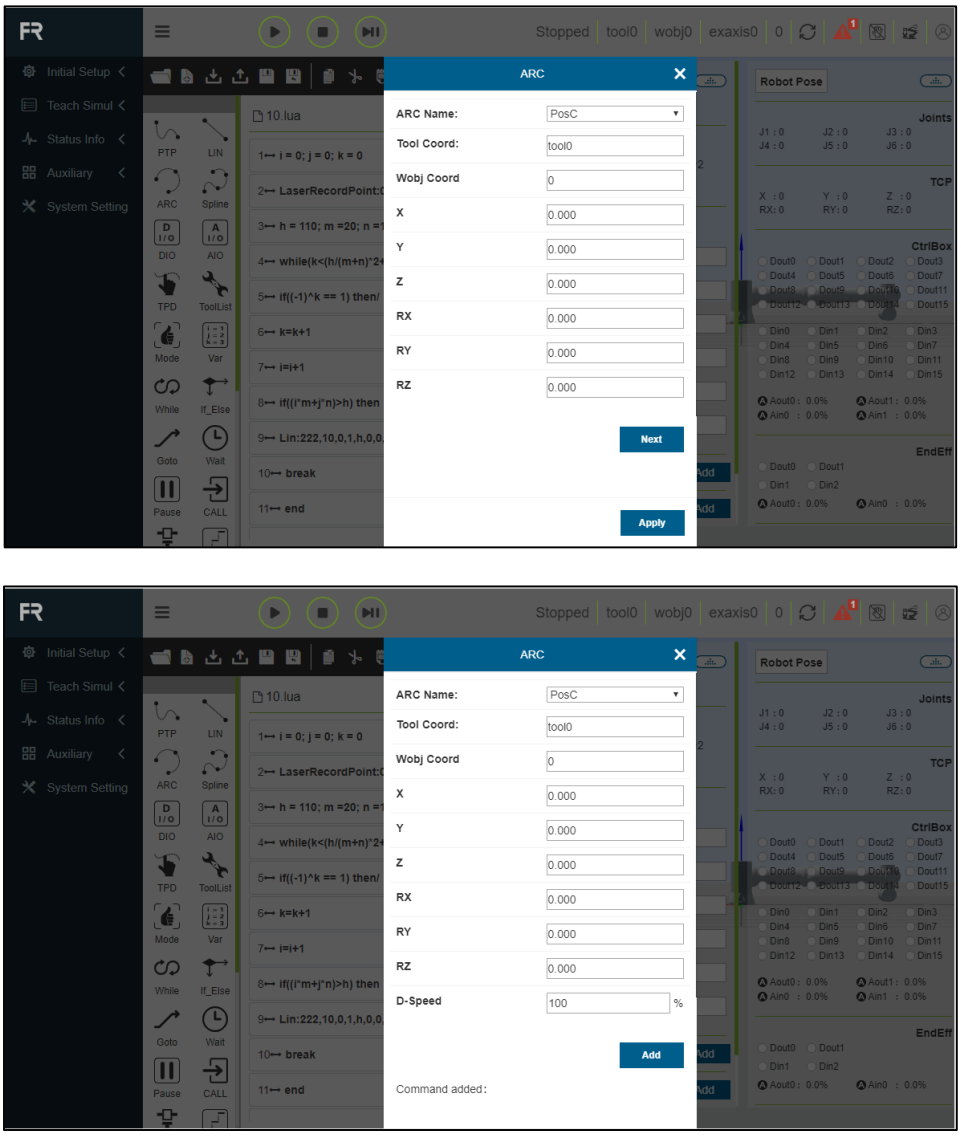


chart 3.7-4 Arc command interface

Spline command: Click the "Spline" icon to enter the Spline command editing interface

This instruction is divided into three parts: spline group start, spline section and spline group end. Spline section includes SPL, SLIN and SCIRC sections. Click the corresponding icon to enter the instruction adding interface. Spline group end is the end sign of spline movement.

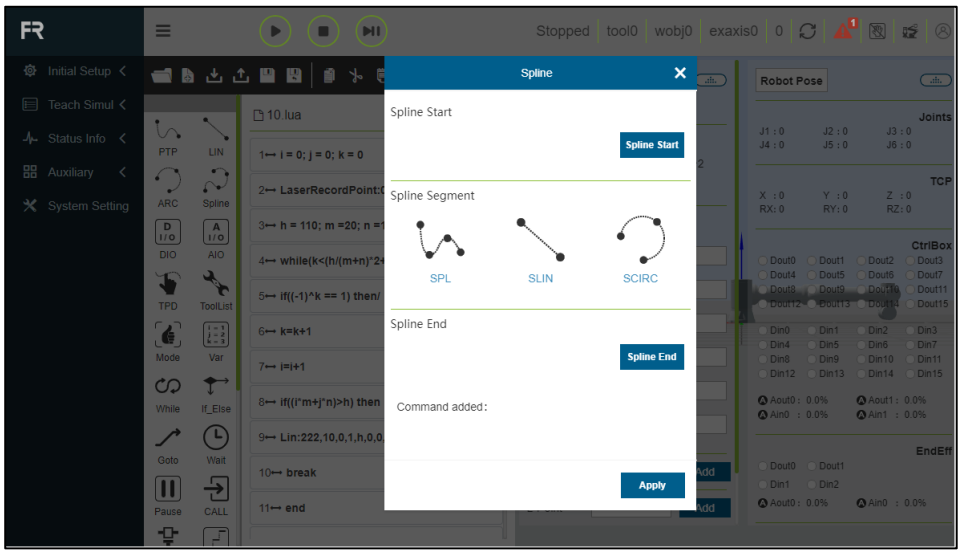


chart 3.7-5 Spline command interface

IO command: click the "IO" icon to enter the editing interface of IO command

"IO" instruction is divided into two parts: set IO(SetDO) and get IO(GetDI).

"SetDO" this instruction can set the specified output DO status, including 16 control box digital outputs and 2 tool digital outputs. the status option "False" is closed and "True" is open. if it is blocked, select "Block" to set the DO status after the movement stops, and select "Non-Blocking" to set the DO status during the last movement.Select "Break" to set the DO state after the smooth transition radius ends, and select "Serious" to set the DO state during the smooth transition radius movement. Click "Add" and "Apply".

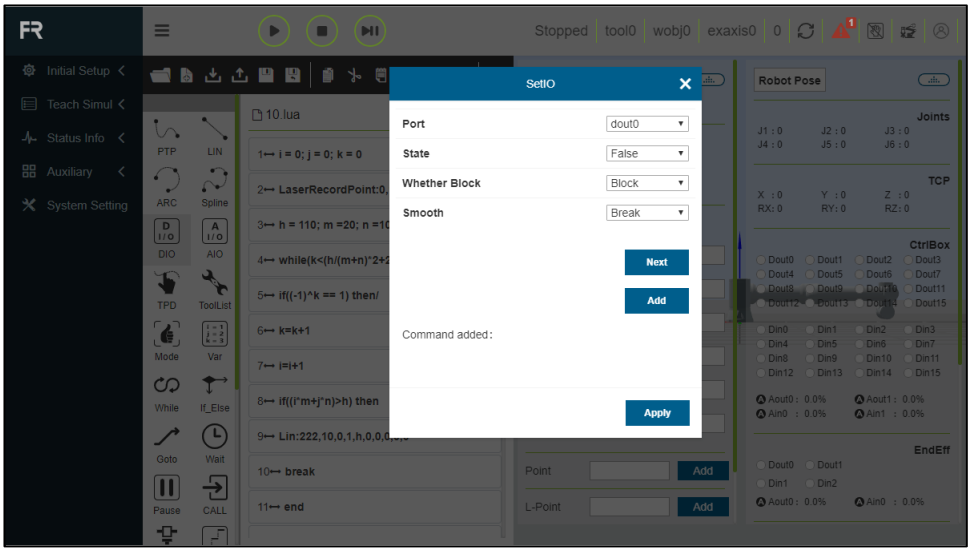


chart 3.7-6 SetDO command interface

In the "GetDI" command, select the value of the port number you want to obtain. If it is blocked, select "Block" to obtain the DI status after the movement stops, and select "Non-Blocking" to obtain the DI status during the previous movement. Click "Add" and "Apply" after selection.

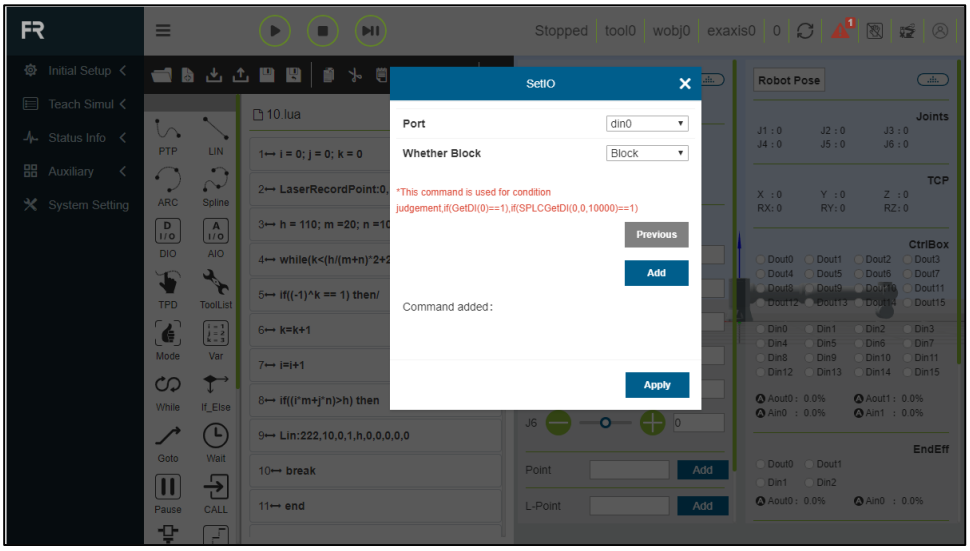


chart 3.7-7 GetDI instruction interface

AI command: Click the "AI" icon to enter the AI command editing interface

In this instruction, there are two functions: setting analog output (SetAO) and obtaining analog input (GetAI).

"SetAO" selects the analog output to be set, and enters the value to be set in the range of 0-10. if it is blocked, select "Block" to set the AO state after the movement stops, and select "Non-Blocking" to set the AO state during the previous movement. click "Add" and "Apply".

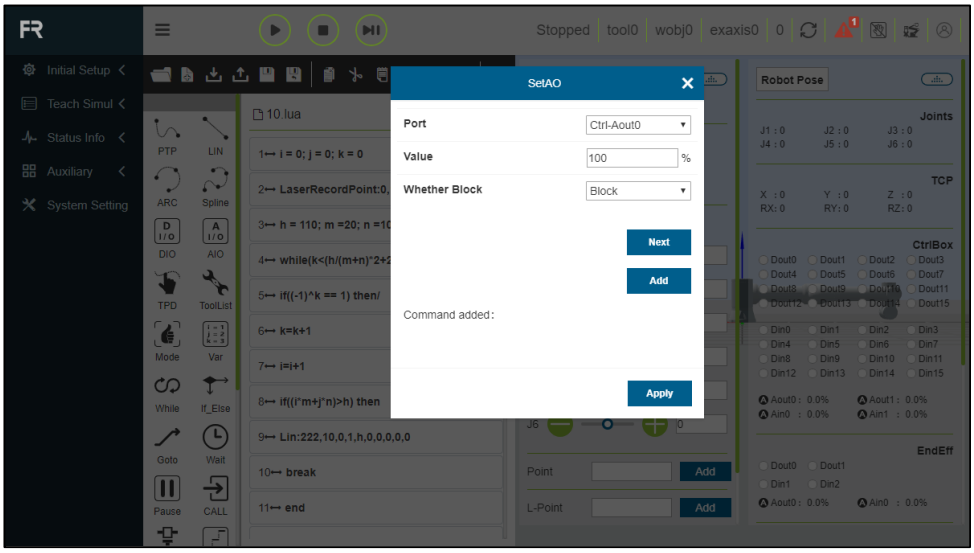


chart 3.7-8 SetAO command interface

"GetAI" selects the analog input to be acquired. if it is blocked, select "Block" to acquire the AI state after the movement stops, and select "Non-Block" to acquire the AI state during the previous movement. click "Add" and "Apply".

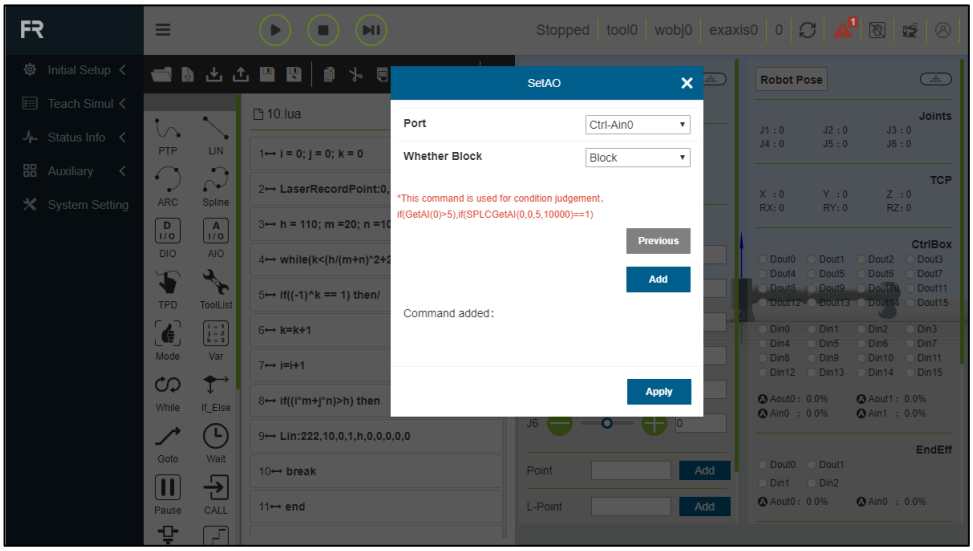


chart 3.7-9AI command interface

TPD command: click "TPD" button to enter TPD command editing interface

In this instruction, the user first needs to have a recorded track.

About track recording: before preparing to record the track, save the starting point of the track. When the robot is in drag mode, enter the file name and select the pose type, which includes the end pose (record the end tool flange pose), the joint pose (record the joint angle), the tool TCF (record the tool center point pose), and the selection period (assuming the value is x,That is to say, one point is recorded every x milliseconds, and it is recommended to record one point every 4 milliseconds), and the user can drag the robot for specified movement according to the requirements. After the recording is completed, click Stop Recording to save the previous robot movement track. When a movement cannot be completely recorded, it will prompt that the number of recording points exceeds the limit, and the user needs to record the movement several times.

When programming, first use PTP instruction to reach the starting point of the corresponding track, and then select the track in TPD instruction. Choose whether it is smooth or not, select the track to be reproduced from the existing tracks, and click "Add" and "Apply" in turn to insert the program. Long-term useless tracks can be deleted through the Delete Track button.

(Note: For detailed operation of TPD, see the instruction module of TPD function.)

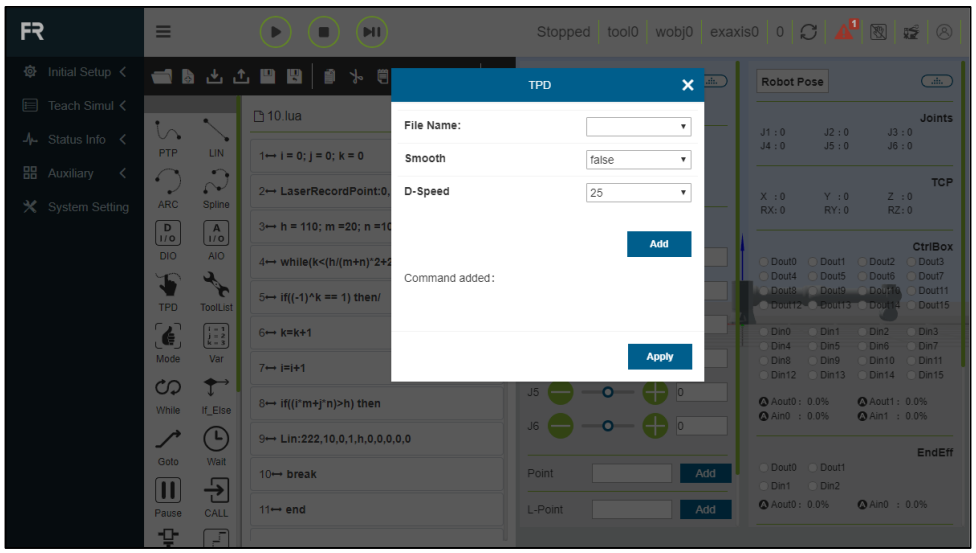


chart 3.7-10 TPD command interface

ToolList command: click the "ToolList" icon to enter the ToolList command editing interface

Select the name of the tool coordinate system and click "Apply" to add the instruction to the program. When the program runs the statement, the tool coordinate system of the robot will be set.

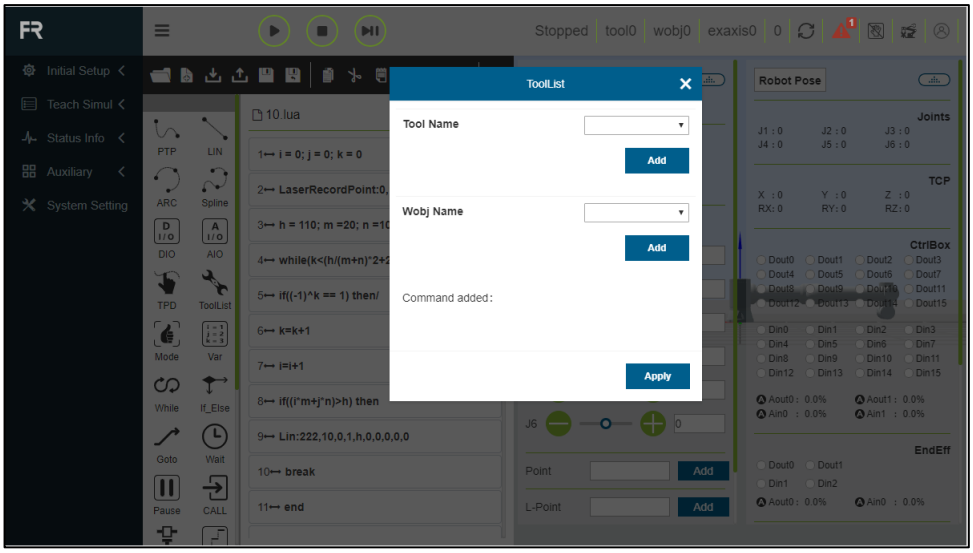


chart 3.7-11 ToolList command interface

Mode command: click the "Mode" icon to enter the Mode command editing interface

This instruction can switch the robot to manual mode, which is usually added at the end of a program, so that the user can automatically switch the robot to manual mode and drag the robot after the program runs.

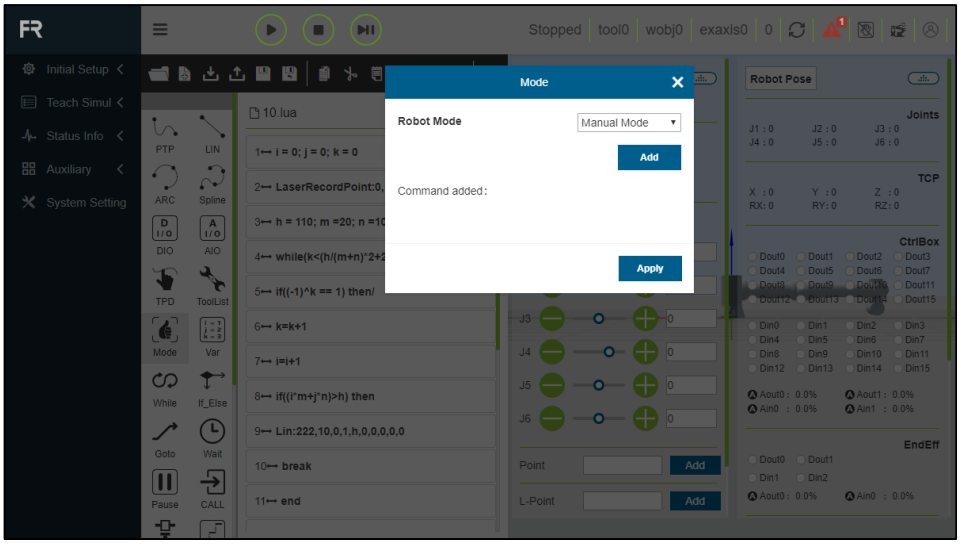


chart 3.7-12 Mode command interface

Var command: click the "Var" icon to enter the editing interface of Var command

This instruction is a variable system instruction, which is divided into two parts: variable definition and variable query. The variable definition can declare a variable and give an initial value, which can be used in conjunction with while and if-else instructions. The variable query instruction can query the value of the input variable name in real time and display it in the status bar. (This instruction requires a certain programming foundation, please contact us if you need help)

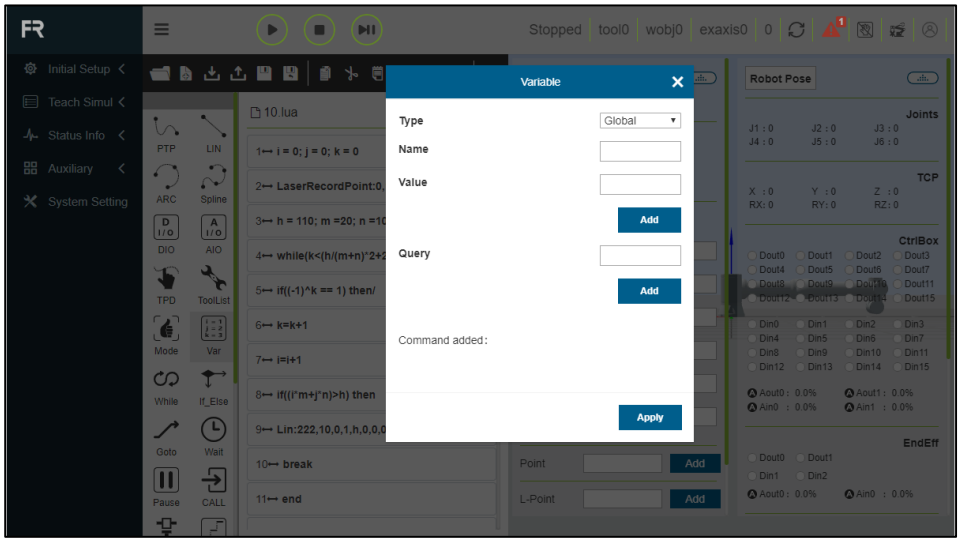


chart 3.7-13 Var command interface

While command: click the "While" icon to enter the While command editing interface

Enter the waiting condition in the input box behind While, enter the action instruction during the cycle in the input box behind do, and click save. (For convenience of operation, you can arbitrarily input do content and edit other instructions in the program to insert instead)

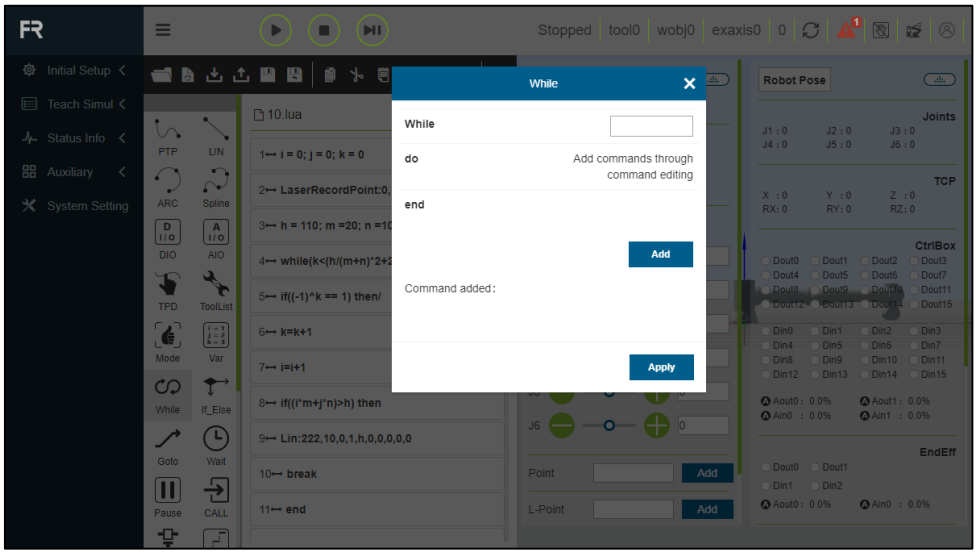


chart 3.7-14 While command interface

If…else command: click the "if…else" button to enter the editing interface of if…else command

Enter the statement in the right input box, and click Add and Apply after editing. (This instruction requires a certain programming foundation, please contact us if you need help)

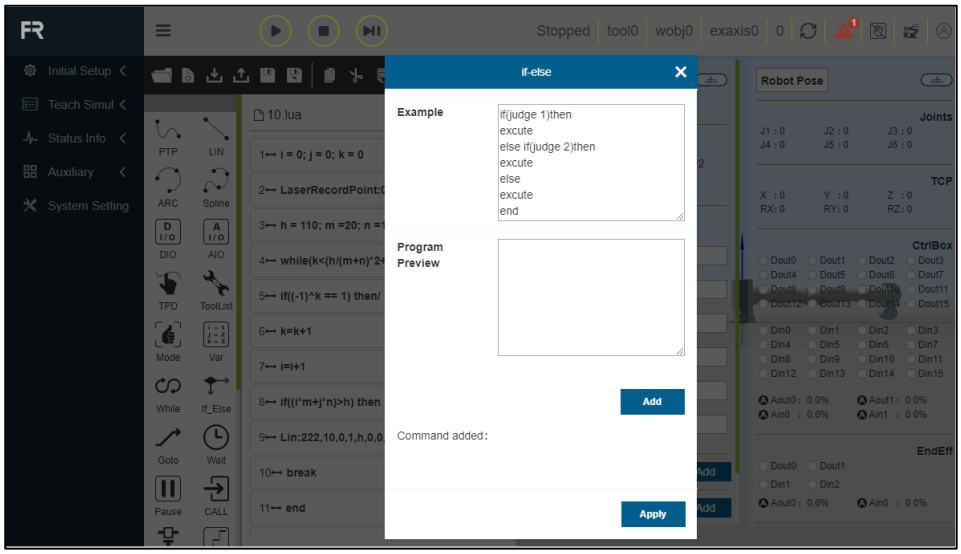


chart 3.7-15 If…else command interface

Goto command: click the "Goto" button to enter the editing interface of Goto command

Goto instruction is a jump instruction. Enter a statement in the right input box, and click Add and Apply after editing. (This instruction requires a certain programming foundation, please contact us if you need help)

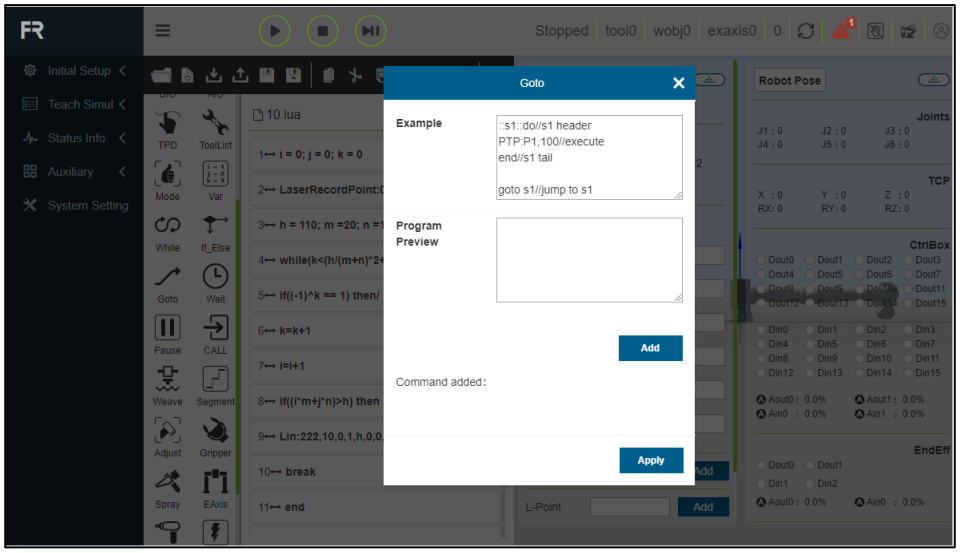


chart 3.7-16 Goto command interface

Wait command: click the "Wait" icon to enter the edit interface of Wait command

This instruction is a delay instruction, which is divided into three parts: "WaitMs", "WaitDI" and "WaitAI".

The unit of "WaitTime" instruction is milliseconds. Enter the number of milliseconds to wait, and click "Add" and "Apply".

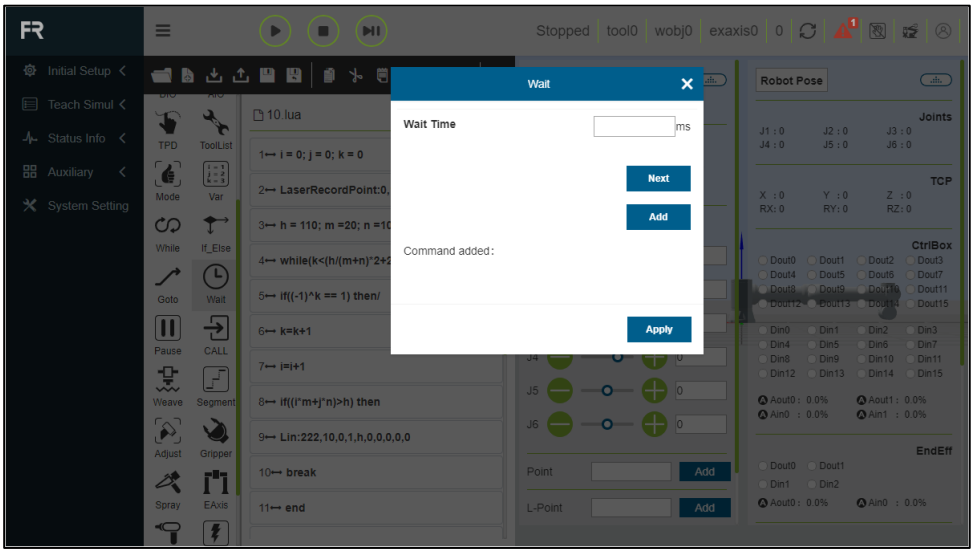


chart 3.7-17 WaitTime instruction interface

"WaitDI" instructIOn, select the io port number, waiting status, waiting maximum time and waiting timeout processing method to be waited, and click "Add" and "Apply".

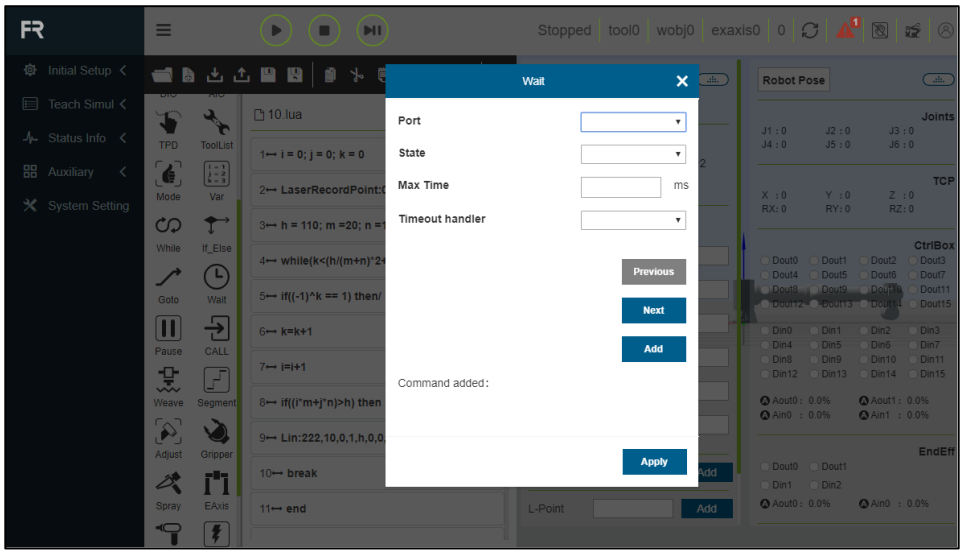


chart 3.7-18 WaitDI instruction interface

"WaitAI" command, select the analog quantity and value to be waited, the maximum waiting time and the waiting timeout processing method, and click "Add" and "Apply".

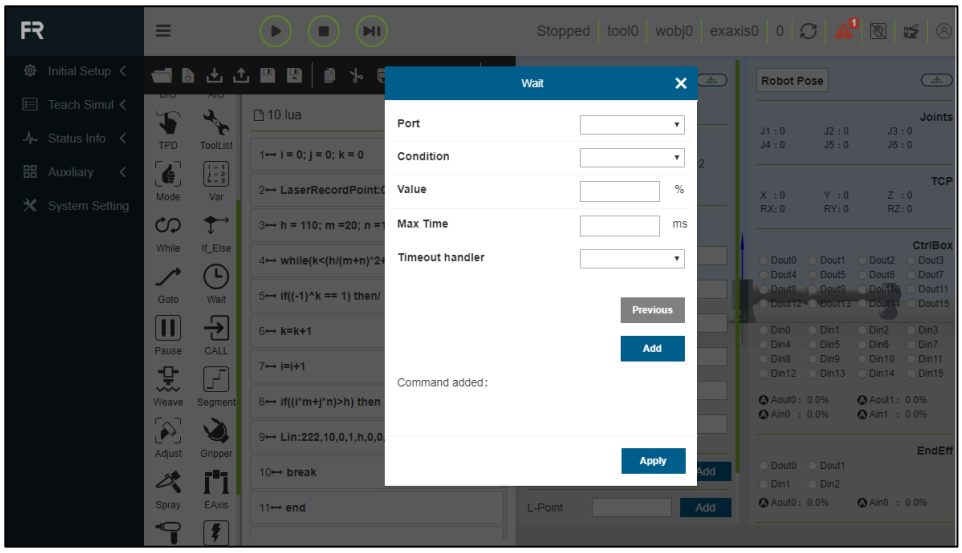


chart 3.7-19 WaitAI command interface

Pause command: click the "Pause" icon to enter the Pause command editing interface

This instruction is a pause instruction. Insert this instruction into the program. When the program executes this instruction, the robot will be in a pause state. If you want to continue running, click the "Pause/Resume" button in the control area.

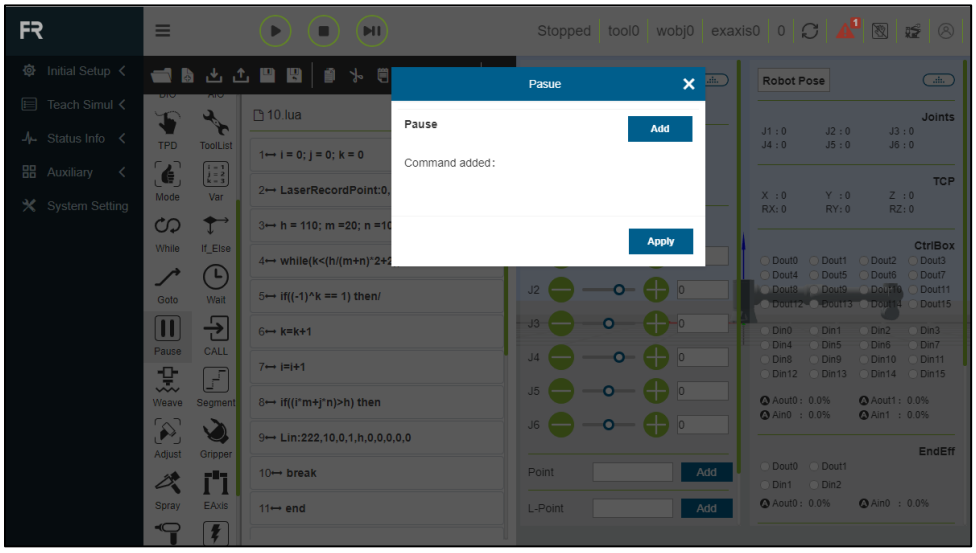


chart 3.7-20 Pause command interface

CALL command: click the "CALL" icon to enter the CALL command editing interface

Click the file name selection box to select the subprogram to insert. After the selection, the subprogram content will be displayed in the lower display box. If there is no problem, click Insert. (Note that the call command cannot appear in the call file.)

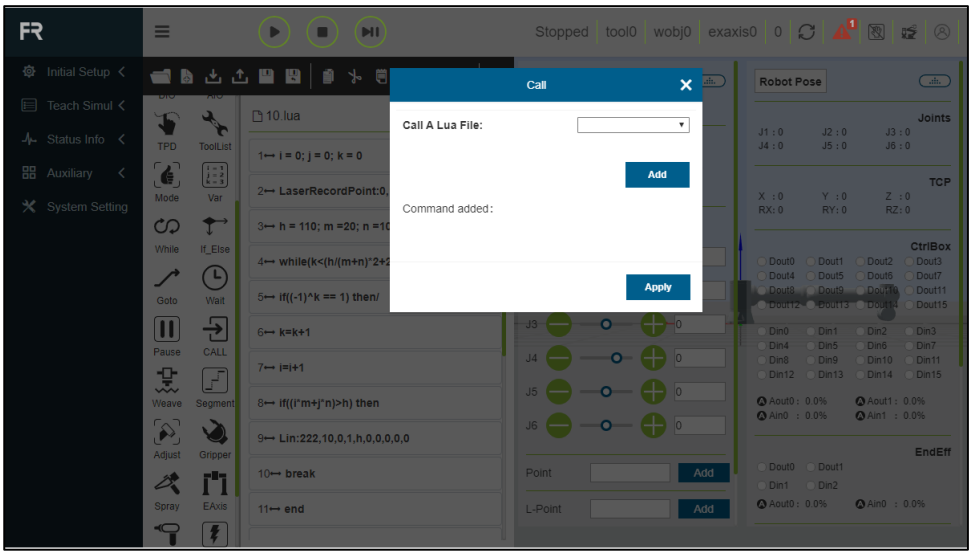


chart 3.7-21 Call instruction interface

Weave command: click the "Weave" icon to enter the edit interface of Weave command

The "Weave" command consists of two parts. In the first part, select the pendulum welding number with configured parameters, and click "Start" and "Stop " and apply to add relevant commands to the program.

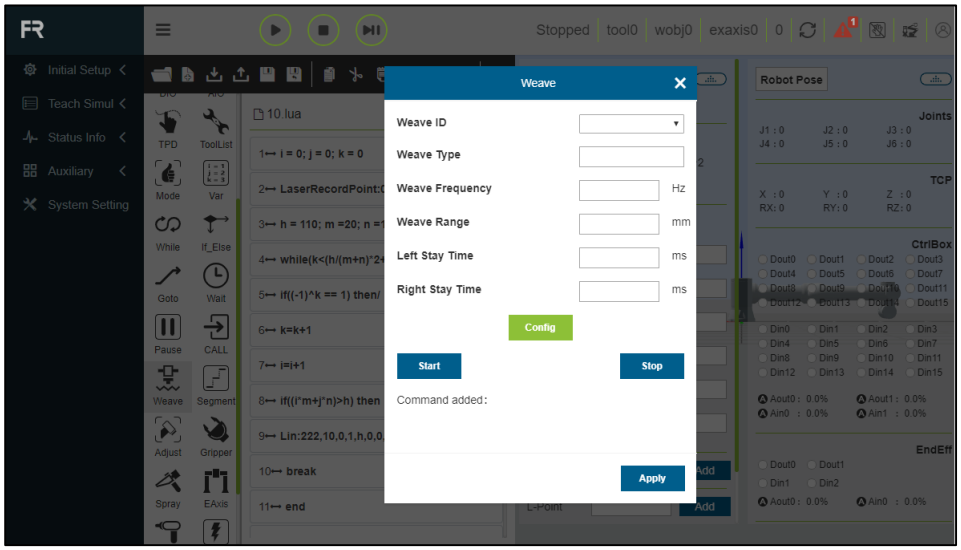


chart 3.7-22 Weave command interface

Click "Config" to configure the parameters of pendulum welding.

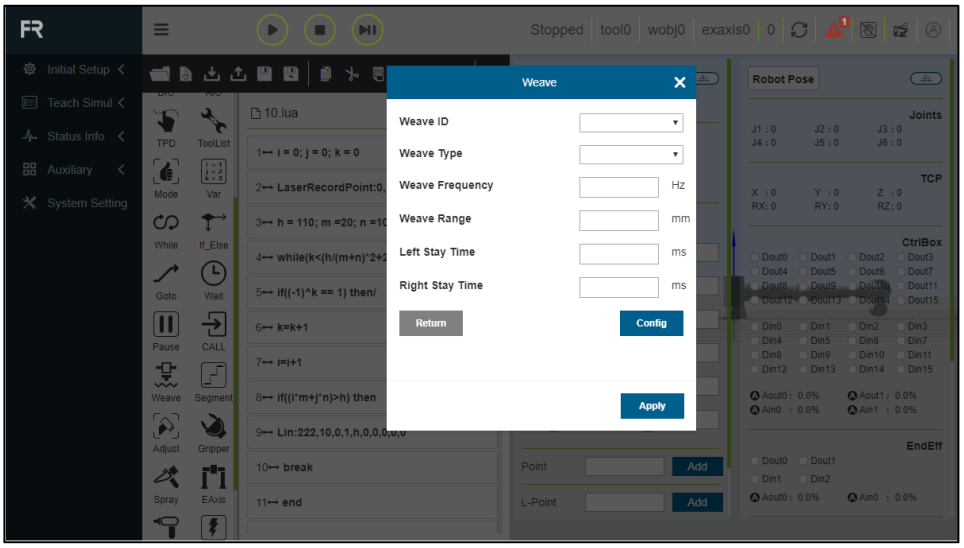


chart 3.7-23 Weave configuration and test instruction interface

Segment command: click the "Segment" icon to enter the Segment command editing interface

This instruction is a special instruction for welding, and it is mainly used for one-stage welding and one-stage intermittent welding without welding. Between the starting point and the end point, use this instruction to select the starting point, set the debugging speed, total length, execution length and non-execution length, set the function mode, swing selection and rounding rules according to the actual application scenario, and use the workpiece coordinate system function.Calibrate the straight line to be welded as X positive direction.

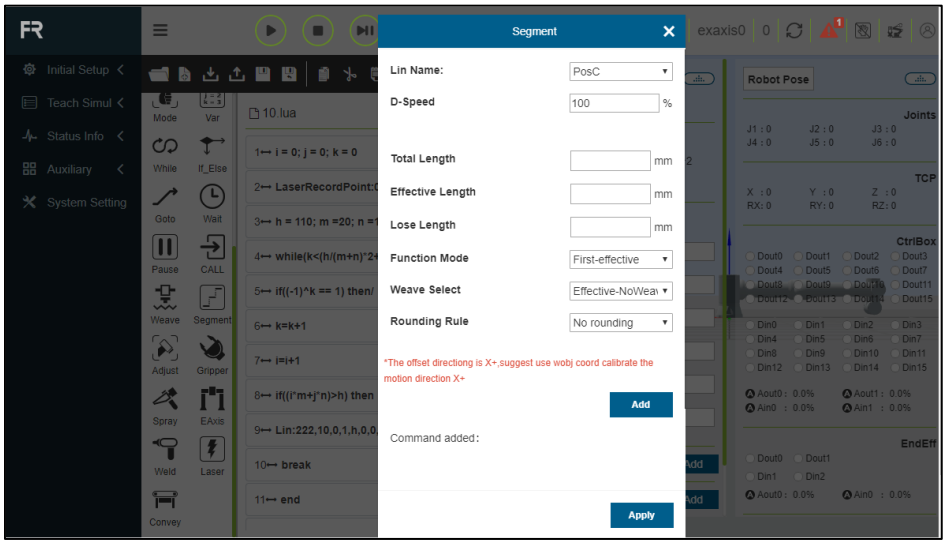


chart 3.7-24 Segment instruction interface

Adjust command: click the "Adjust" icon to enter the edit interface of Adjust command

This instruction adaptively adjusts the welding gun posture scene for welding tracking. After recording three corresponding posture points, it adds a posture adaptive adjustment instruction according to the actual movement direction of the robot. See robot peripherals chapter for details.

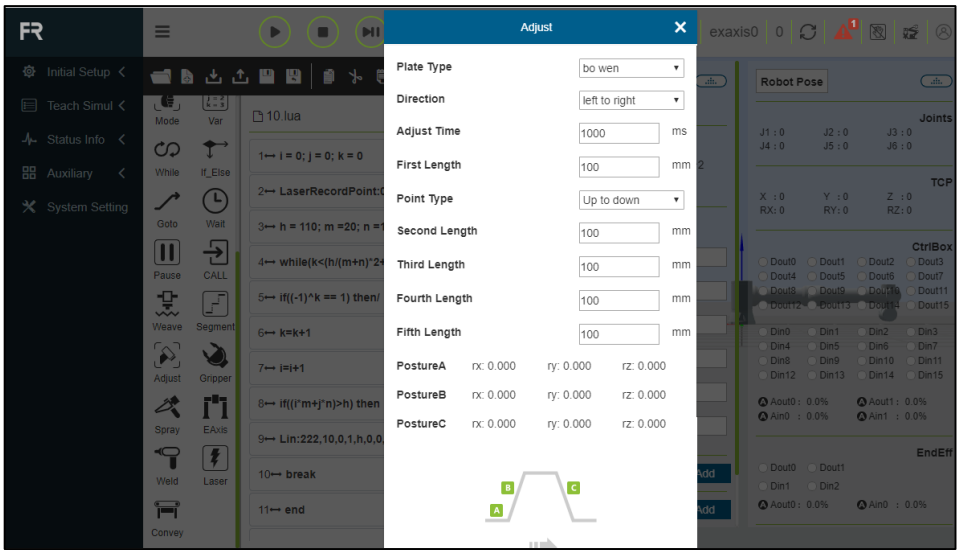


chart 3.7-25 Adjust command interface

Gripper command: click the "Gripper" icon to enter the Gripper command editing interface

In this instruction, the selection box of gripper number will display the configured and activated gripper number. The user can edit it through the edit box or slide the slider to the required value to complete the setting of gripper opening and closing, opening and closing speed and opening and closing moment. Click the "Add" and "Apply" buttons to save the set values in the teaching file.

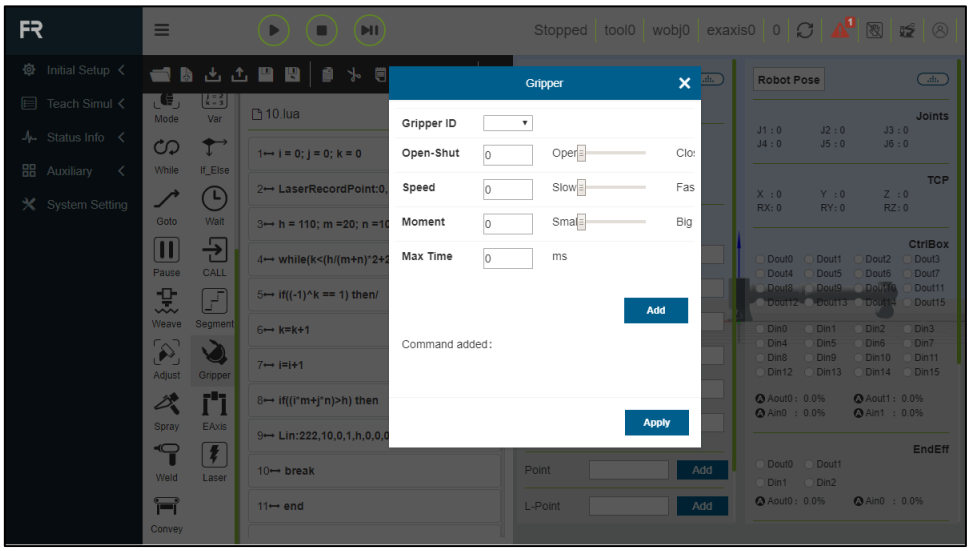


chart 3.7-26 Gripper command interface

Spray command: click the "Spray" icon to enter the Spray command editing interface

This instruction is related to spraying, and controls the spray gun to "Start Spray", "Stop Spray", "Start Clean" and "Stop Clean ". When editing the program command, it is necessary to confirm that the spray gun peripherals have been configured. See the robot peripherals chapter for details.

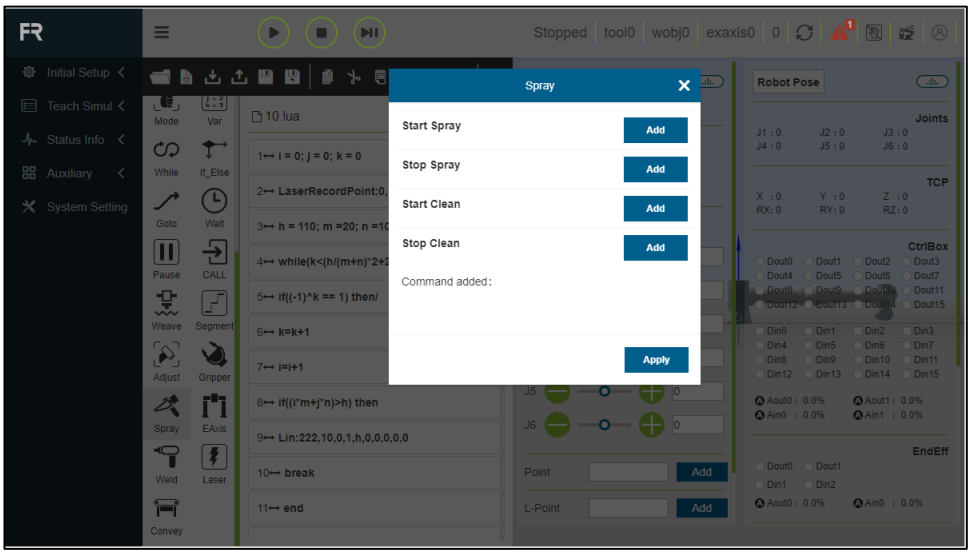


chart 3.7-27 Spray command interface

EAxis command: click the "EAxis" icon to enter the editing interface of EAxis command

Combined with PTP instruction, this instruction can decompose the movement in the x-axis direction of a point in space into the movement of the external axis. Select the number of external axis, select synchronization in motion mode, select the point to be reached, and click "Add" and "Apply" to save this instruction. .

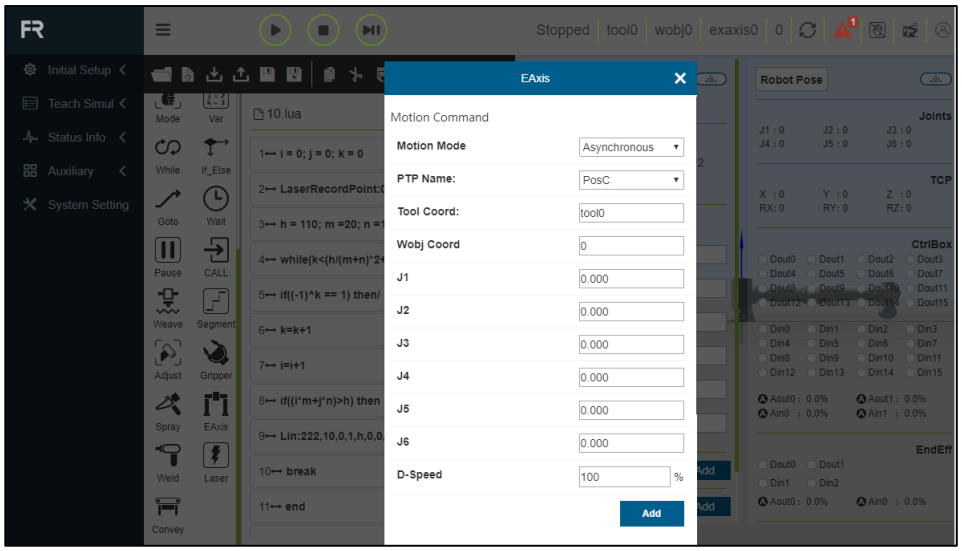


chart 3.7-28 EAxis command interface

Weld command: click the "Weld" icon to enter the edit interface of Weld command

This instruction is mainly used for welding machine peripherals. Before adding this instruction, please confirm whether the welding machine configuration is completed in the user peripherals. See the robot peripherals chapter for details.

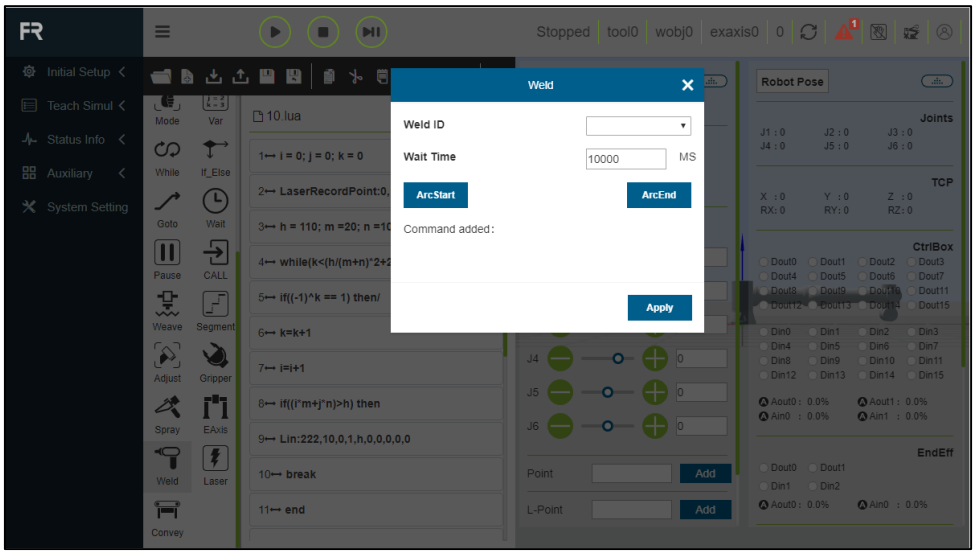


chart 3.7-29 Weld command interface

Laser command: click the "Laser" icon to enter the Laser command editing interface

This instruction includes three parts: laser command, tracking command and locating command. Before adding this instruction, please confirm whether the laser tracking sensor in the user's peripheral has been successfully configured. See robot peripherals chapter for details.

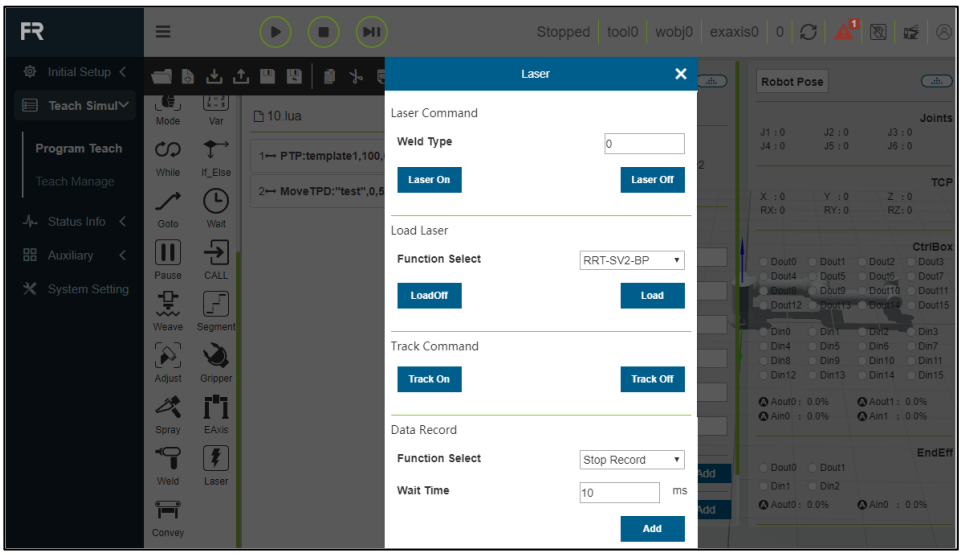


chart 3.7-30 Laser command interface

Communicate command: click the "communicate" icon to enter the communicate command editing interface

This instruction includes four commands: Pose Detection, IO Detection, Track On and Track Off.

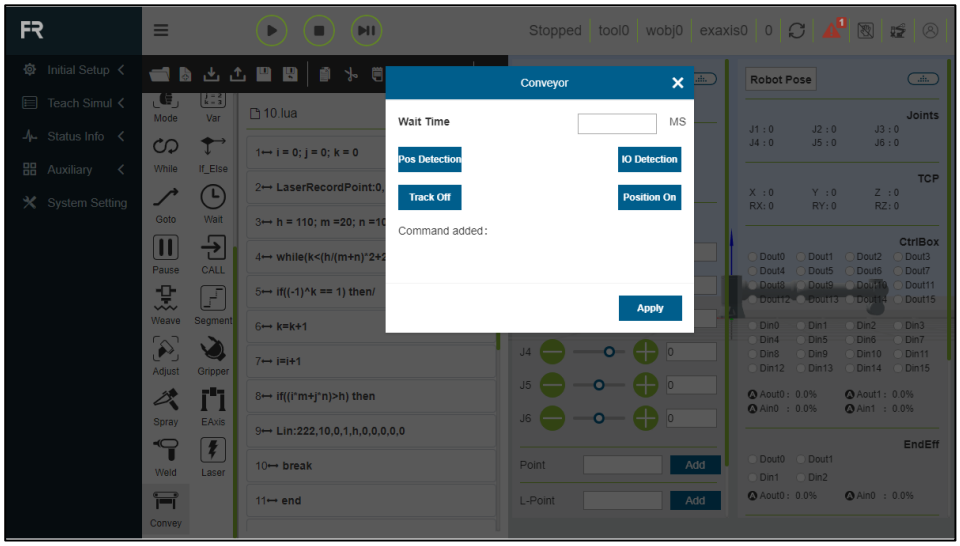
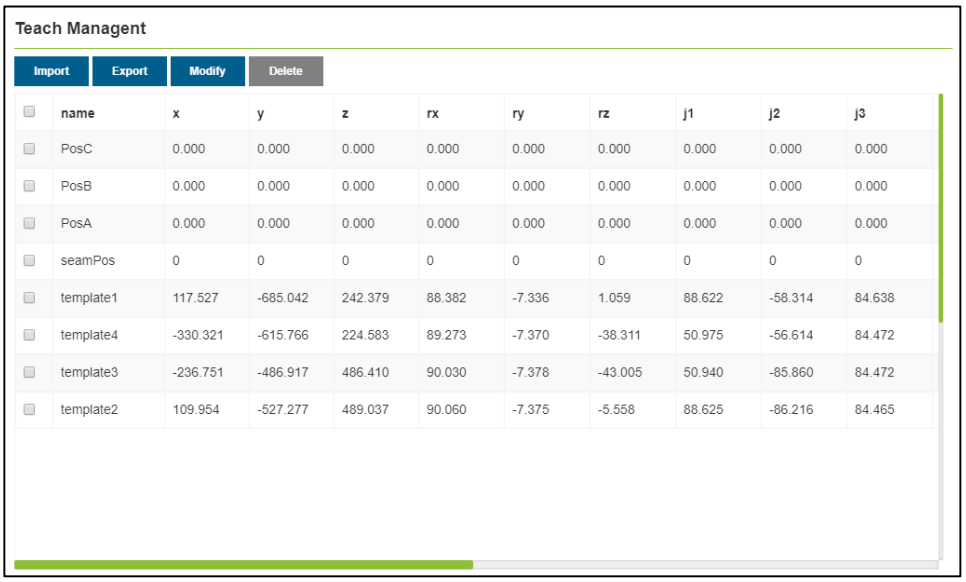


chart 3.7-31 Conductor command interface

3.7.4 Teaching management

Click "Teach Manage" to display all saved teaching point information. In this interface, you can import and export teaching point files. After selecting a teaching point, click "Delete" button to delete this point information. The values of teaching points x,y,z,rx,ry,rz and V can be modified. Enter the modified value, check the left check box, and click Modify above to modify the teaching point information.



	name	x	y	z	rx	ry	rz	j1	j2	j3
	PosC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	PosB	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	PosA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	seamPos	0	0	0	0	0	0	0	0	0
	template1	117.527	-685.042	242.379	88.382	-7.336	1.059	88.622	-58.314	84.638
	template4	-330.321	-615.766	224.583	89.273	-7.370	-38.311	50.975	-56.614	84.472
	template3	-236.751	-486.917	486.410	90.030	-7.378	-43.005	50.940	-85.860	84.472
	template2	109.954	-527.277	489.037	90.060	-7.375	-5.558	88.625	-86.216	84.465

chart 3.7-32Teaching management interface

3.8 status messages

3.8.1 system journal

Click the "System Log" button in "Status Info" in the left menu bar to enter the log display interface. Some important operation records of the teaching device are recorded in the log, such as the registrant, increase or decrease of teaching points, etc. After clicking, the log records of the current day will be displayed by default. To query the previous records, select the target date in "Date Selection".The daily log records will be displayed in real time at the bottom, and the number of log records can be found in the system settings for details. When there is too much user log information, users can find relevant log information according to the type.

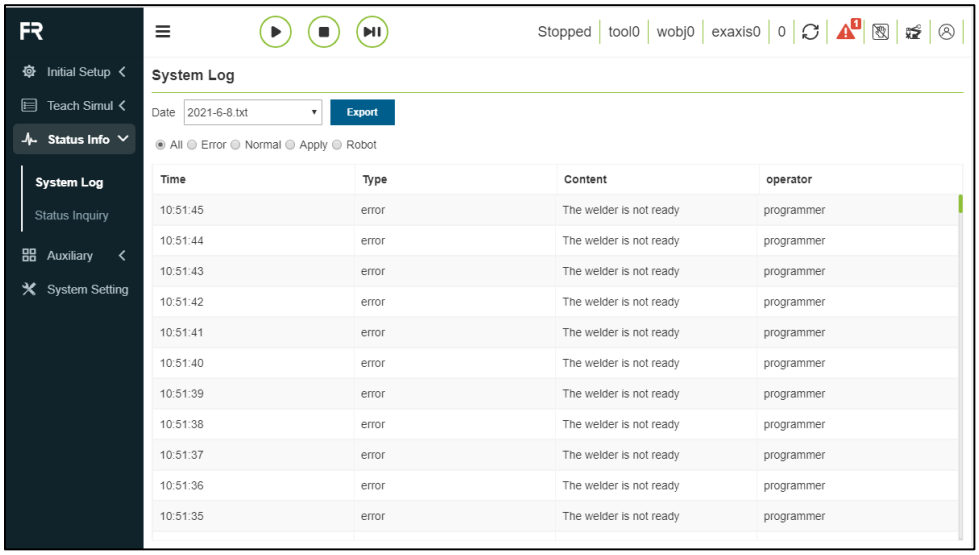


chart 3.8-1System log interface

3.8.2 Status query

Click the "Status Inquiry" menu in the "Status Info" menu bar on the left to enter the status query interface, as shown in the following figureChart 3.8-2 status query。

chart 3.8-2Status query

Operation steps of status query:

Step1: Click the "Chart" button to pop up the chart setting pop-up box, such asChart 3.8-3 chart settingsAs shown in the figure, select the chart display query as the query type, select the parameters to be queried and the chart in which the parameters are put in the chart settings, and click the "Move Right" button to configure the parameters into the chart. Click "Set" to issue the instruction of setting chart. At present, only one table can contain up to four parameters to be checked and at most one chart can be set.

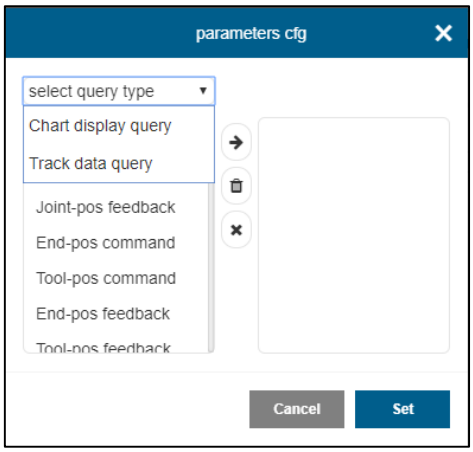


chart 3.8-3Chart settings

Step 2: the trigger function does not need to be set temporarily. Click the "Query" button to query the data.

3.9 Auxiliary application

3.9.1 Robot calibration

Under the menu bar of "Robot Moumenon" in "Auxiliary", click"Robot Correct", enter the robot calibration interface, this function is mainly to correct the zero position of the robot.Click the "Enable" button, drag each axis of the robot to the zero position of the robot on the machine, and click the "Zero Set" button to set the robot zero point.

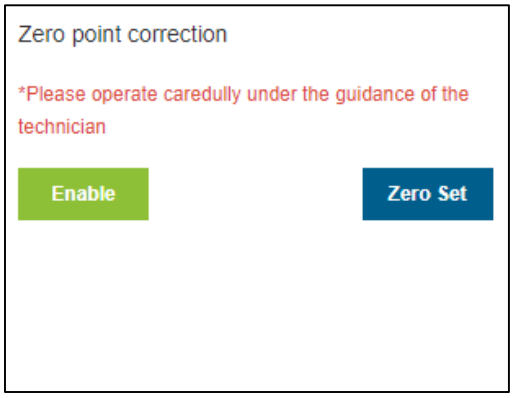


chart 3.9-1Robot calibration diagram

Zero setting: when the robot leaves the factory, it will preset an initial posture, in which the angle of each joint is 0.When the zero point is set, the robot posture corresponding to each joint moving to a specific position.Zero point is the reference of robot coordinate system. Without zero point, the robot can not judge its own position. Therefore, in order to obtain the highest absolute positioning accuracy as possible,It is necessary to calibrate the robot zero point.

In general, it is necessary to calibrate the zero point of the robot under the following conditions:

- After replacing the parts of robot mechanical system;
- After violent collision with workpiece or environment;
- When there is a big difference between the actual position and the operation such as establishing the coordinate system;
- After the whole system is re installed;
- After the encoder battery is replaced;
- After the long-distance transportation of the robot.

Note:

When the robot leaves the factory, the zero point will be set. If you need to set the zero point again, please contact us for technical support.

3.9.2 system upgrade

Under the menu bar of "Robot Moumenon" in "Auxiliary", click the "Sys Upgrade" button to enter the system upgrade interface.System upgrade includes software upgrade, drive upgrade and system shutdown.

Software upgrade: click "Choose file" under software upgrade, select software.tar.gz upgrade package in U disk, click upload upgrade package, and "upload percentage... Upload" will be displayed next to the upgrade button.After the background file download is completed, the interface displays "upload completed, upgrading in progress", check the file MD5 and version number, decrypt and decompress the upgrade file, and prompt "upgrade succeeded,Please restart the control box! ",If it detects, decompresses, or has other errors, the "upgrade failed" is displayed next to the upgrade button.

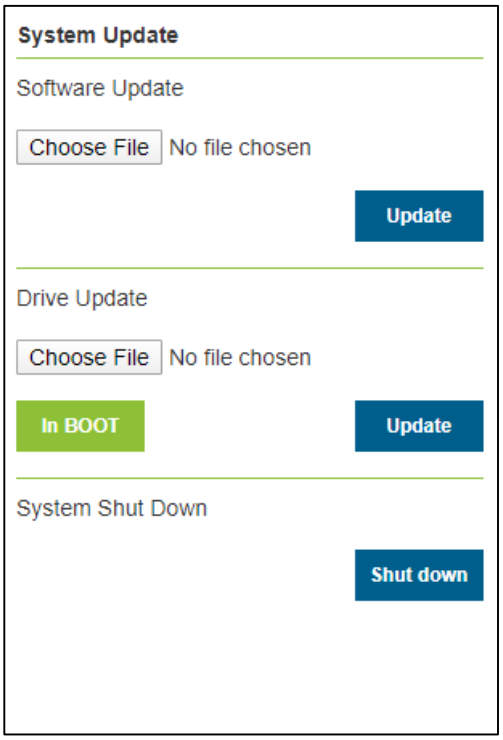


chart 3.9-2system upgrade

Drive upgrade: function reservation.

System shutdown: function reservation.

3.9.3 data backup

Under the menu bar of "Robot Moumenon" in "Auxiliary", click "Data Backup" enters the data backup interface, as shown in 3.9-3.

The backup package data contains tool coordinate system data, system configuration file, teaching point data, user program, template program and user configuration file. When the user needs to move the robot related data to another robot for use, this function can be realized quickly.

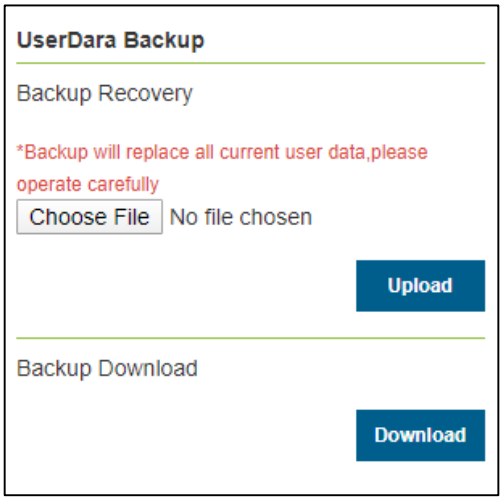


chart 3.9-3Data backup interface

3.9.4 10s data record

Under the menu bar of "Robot Moumenon" in "Auxiliary", click "10s Record" to enter the 10s data record function interface.

First, select the record type, which is divided into default parameter record and optional parameter record. The default parameter record is the data automatically set by the system, and the optional parameter record user can choose the parameter data to be recorded by himself, and the maximum number of parameters is 15. After selecting the parameter list, select the record parameter, and click the "Move Right" button to configure the parameter into the parameter list.Click "Start" for the robot to start recording data, click "Stop" for the robot to stop recording data, and click "Download" to download the last 10s of data.

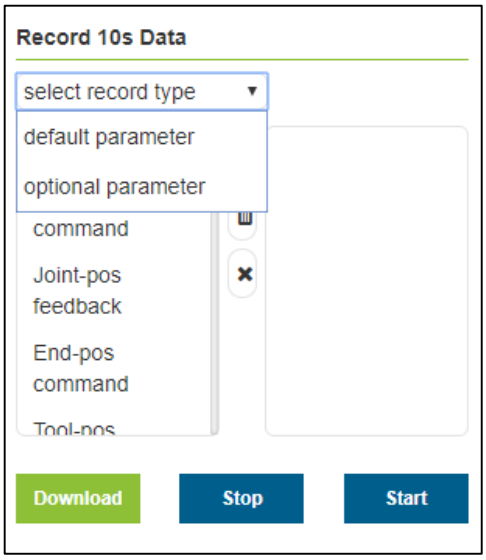


chart 3.9-4 10s data record

3.9.5 Teach point configuration

Under the menu bar of "Robot Moumenon" in "Auxiliary", click "Point Cfg" to enter the teaching point configuration function interface.

The user is using a button box or somethingBefore the IO signal records the teaching point function, first configure the name prefix, upper limit number and teaching method of the teaching point, for example, the name prefix "P", upper limit number "3", and the teaching method "Robot Teaching". The current end (tool) points of the recording robot are P1, P2 and P3 in turn. Re-recording will overwrite the previous recording points. If the laser teaching point is selected,The points identified by the laser are recorded.

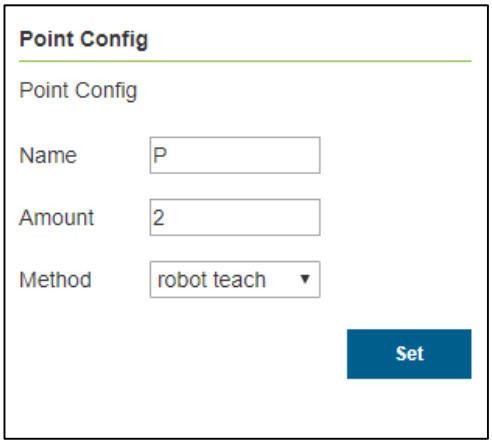


chart 3.9-5 Teach point configuration

3.9.6 Matrix movement

Under the menu bar of "Robot Moumenon" in "Auxiliary", click "Pallet" to enter the interface of matrix mobile configuration function.

This function controls the regular movement of the robot by setting three-point coordinates, row, column and floor height, which is suitable for common palletizing applications. The first step is to select the robot motion mode, "PTP" or "Line"; the second step is to set the robot motion path, "head-to-tail" or "l-shape"; the third step is to set the stacking mode, "stacke" or "tacke off".

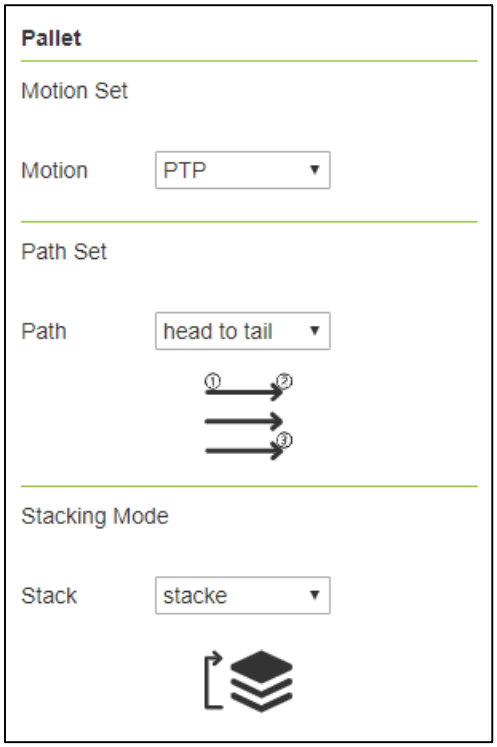


chart 3.9-6 Matrix movement

The fourth step is to teach three points according to the path. The first point is the starting point of the first row, and the arm posture in the whole movement process is determined by this point. The second point is the end point of the first row and the third point is the end point of the last row. The fifth step is to set the number of rows and columns, the sixth step is to set the number of layers and the height of each layer, and the last step is to name the matrix movement program file, and a matrix movement program is successfully generated.

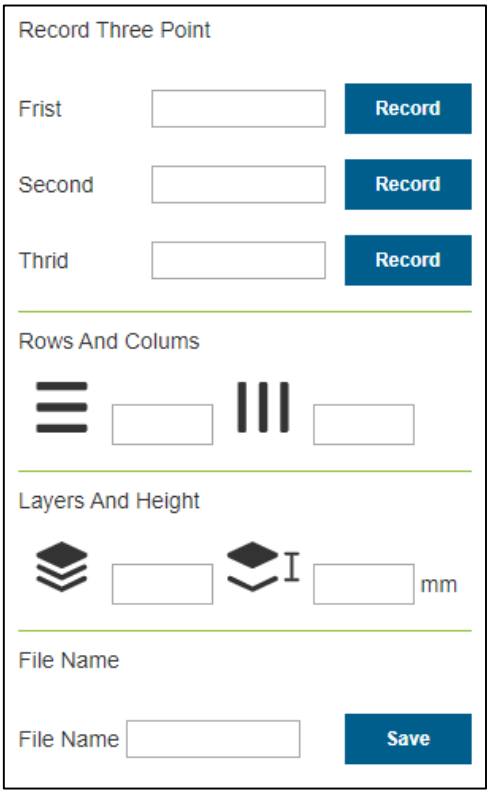


chart 3.9-7 Matrix movement

3.9.7 Welding expert database

Click the menu bar of "Professional Weld" in "Auxiliary" to enter the function interface of welding expert database. Welding expert database is divided into four functions: shape of weldment, part design, fixture structure and configuration.

Click "Line Seam" under "Part Shape" to enter the direct welding guidance interface. On the basis of the configuration of basic robot settings, we can quickly generate welding teaching program through several simple steps. It mainly includes the following five steps. Because there are mutual exclusion among functions, there are fewer than five steps to actually generate a welding teaching program.

Step 1: Whether to use the expansion axis, if so, it is necessary to configure the related coordinate system of the expansion axis and enable the expansion axis.

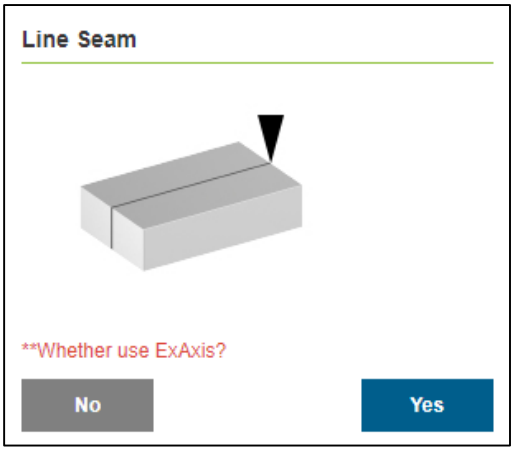


chart 3.9-8 Expansion axis configuration

Step 2: calibrate the start point, start transit point, end point and end transit point. If the expansion axis is selected in the first step, the expansion axis movement function will be loaded to coordinate with the calibration of relevant points.

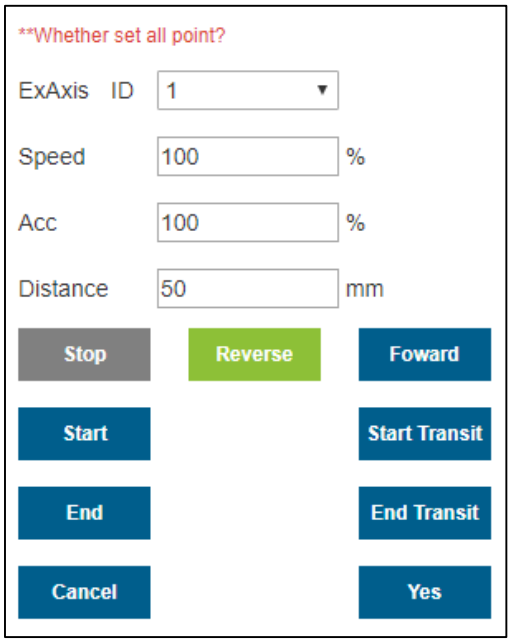


chart 3.9-9 Calibration of correlation points

Step 3: Choose whether laser is needed, and if so, edit the parameters of laser locating instruction.

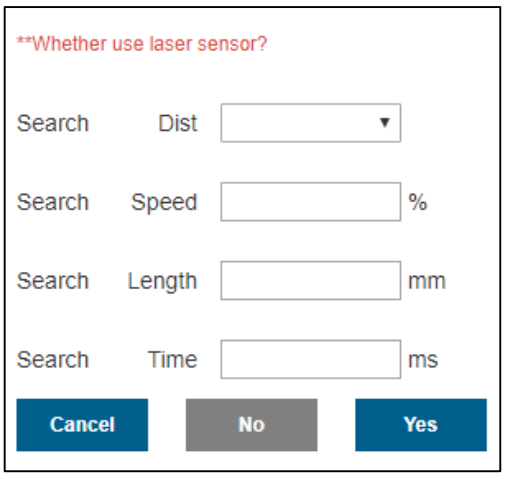


chart 3.9-10 Laser locating configuration

Step 4: Choose whether pendulum welding is needed, and if pendulum welding is needed, edit relevant parameters of pendulum welding.

chart 3.9-11 Pendulum welding configuration

Step 5, name the program and automatically open the program in the program teaching interface.

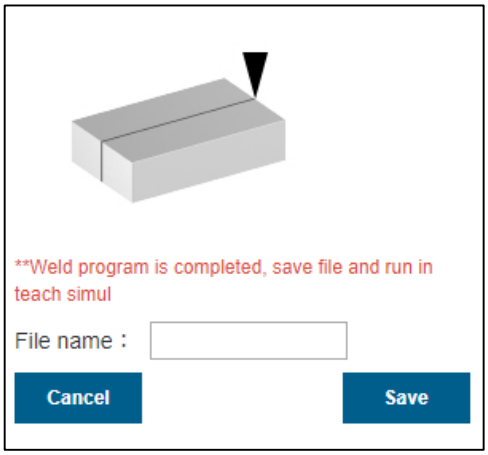


chart 3.9-12 save routine

Click "Arc Seam" under "Part Shape" to enter the arc welding instruction interface. On the basis of the configuration of basic robot settings, we can quickly generate welding teaching program by two simple steps. Mainly comprises the following two steps.

Step one, calibrate the start point, start transit point, arc between point, end point and end transit point.

chart 3.9-13 aiming

Step 2: Name the program and open it automatically in the program teaching interface.

chart 3.9-14 save routine

3.10 system setup

3.10.1 General settings

Click "System Settings" in the left menu bar and "General Set" in the secondary menu bar to enter the general settings interface. General settings can update the robot system time according to the current computer time, so as to record the log content accurately. Customers can choose the language of the teaching instrument as noon, English or Japanese according to their requirements.In addition, you can set the log retention number and import and export the system configuration file. The maximum log retention number is 30, and the system configuration file records the set value. Restoring factory settings under system recovery can clear user data and restore the robot to factory configuration.The export function of the controller log is to download some important state or error record files of the controller, which is convenient for troubleshooting robot problems.

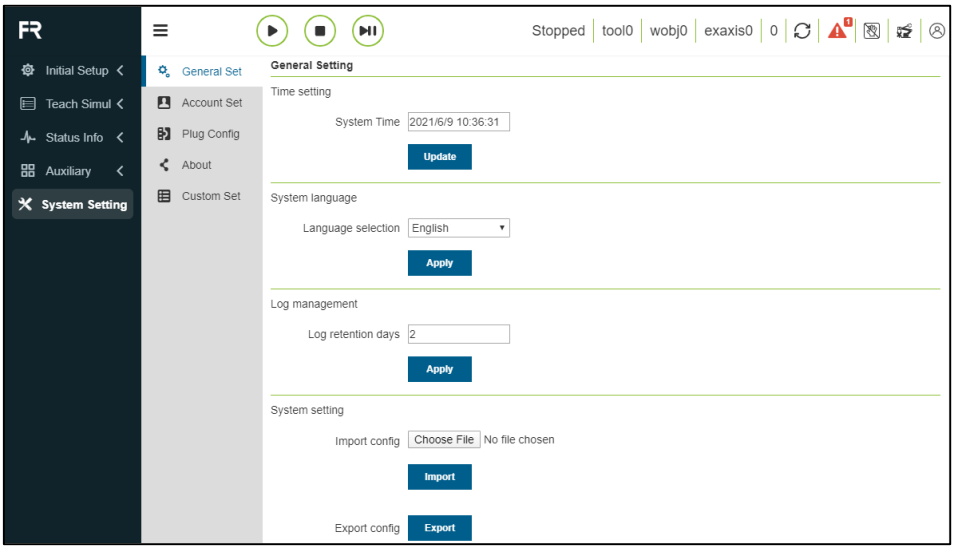


chart 3.10-1General setting diagram

3.10.2 Account settings

Click account setting in the secondary menu bar to enter the account setting interface. The account management function can only be used by administrators. The default administrator account cannot be deleted, and the administrator's user name and authority cannot be modified.

- **M**odify user name, password and user authority: select the selection box of the data line to be modified (that is, the white selection box at the head of the line), then select the data to be modified and modify it. After modification, click "Save-Logout", and the system will enter the login interface and log in with the modified user name and password.
- **Add user:** click "New" and a new line will appear at the bottom of the account management pop-up box. Select the selection box at the beginning of this line, then click "Modify" enter the new user information, select the user authority, and click "Save-Logout", and the system will re-enter the login interface and log in with the new user.
- **Delete user:** select the selection box of the line you want to delete, click "Delete" and finally click "Save-Logout".

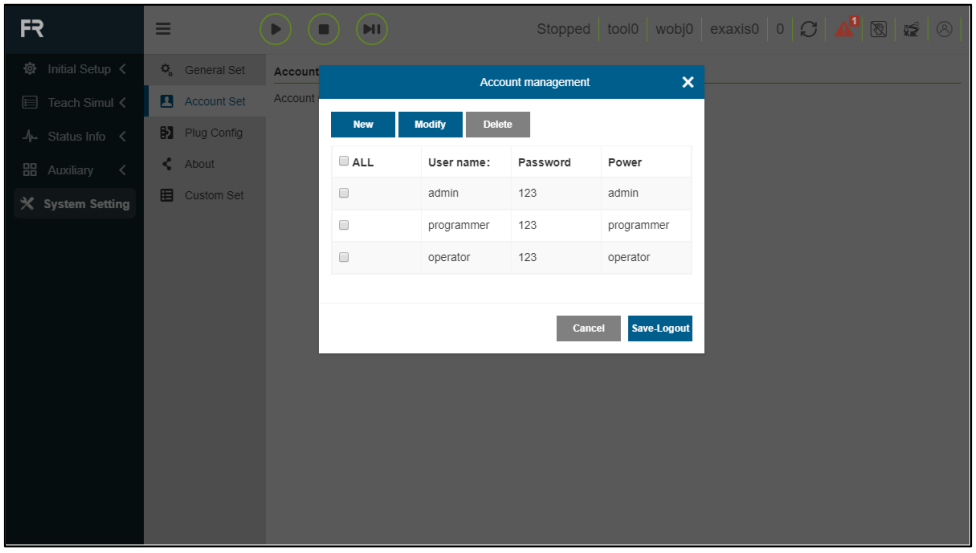


chart 3.10-2Account setting diagram

3.10.3 about

Click about in the secondary menu bar to enter about interface. This page shows the model and serial number of the robot, the Web version and control box version, hardware version and firmware version used by the robot.

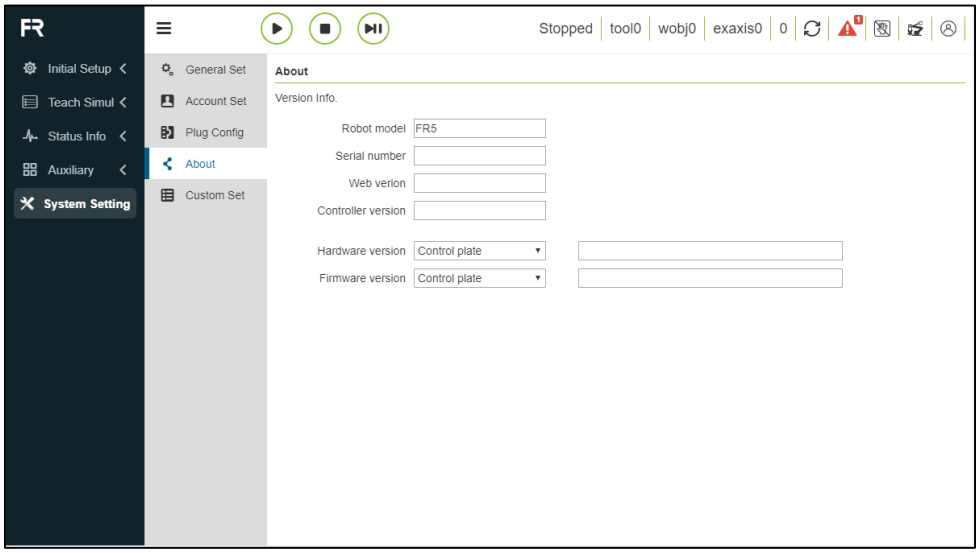


chart 3.10-3About diagrams

The fourth chapter robot peripherals

4.1 Clam peripheral configuration

4.1.1 Teaching steps of gripper program

Step1: Select the "Gripper Cfg" button in the user peripheral configuration interface. The configuration information of gripper is divided into gripper id, gripper firm, gripper type, software version and mounting position. Users can configure corresponding gripper information according to specific production requirements. If the user needs to change the configuration, he can first select the corresponding gripper number and click the "Clear" button.To clear the corresponding buttons and reconfigure them according to the requirements;

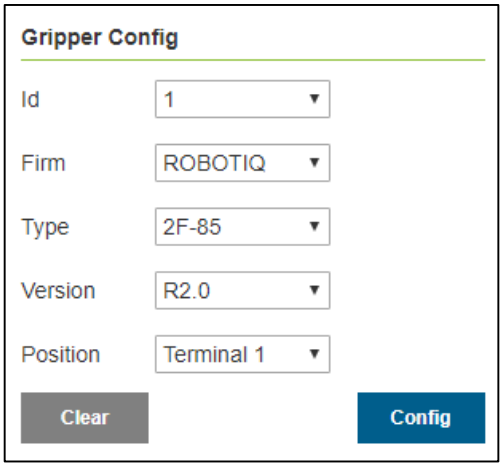


chart 4.1-1Clam configuration

Note:

Before clicking clear configuration, the corresponding gripper should be inactive.

Step2: After the gripper configuration is completed, the user can view the corresponding gripper information in the gripper information table at the bottom of the page. If the configuration error is found, click the "Clear" button to reconfigure the gripper;

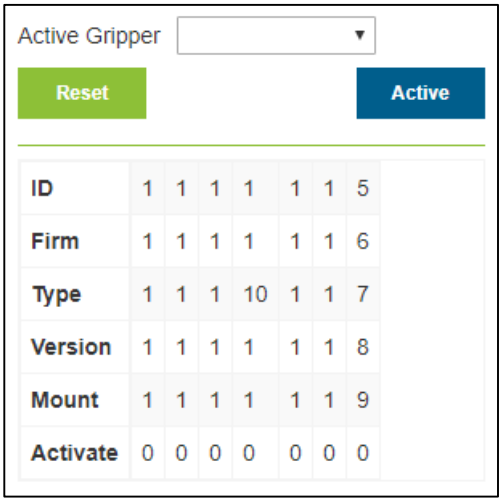


chart 4.1-2Gripper configuration information

Step3: Select the configured gripper, click the "Reset" button, click the "Activ" button after the page pop-up command is sent successfully, and check the activation status in the gripper information table to judge whether the activation is successful;

Note:

When the gripper is activated, the gripper must not have a clamping object

Step4: Select the "Gripper" command in the program teaching command interface. In the gripper command interface, the user can select the gripper number to be controlled (the gripper that has been configured and activated), and set the corresponding opening and closing state, opening and closing speed, and the maximum time when the opening and closing moment has waited for the action of the gripper. Click add application after setting.

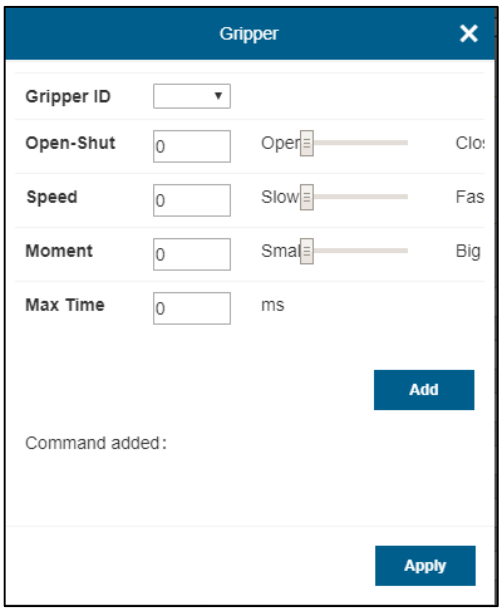


chart 4.1-3Gripper command editing

4.1.2 Teaching of gripper program

serial number	instruction format	annotate
1	PTP:template2,100,0	# Wait for the pinch point
2	PTP:template1,100,0	# Clamping point
3	MoveGripper:1,255,255,0,1000	# jaws closed
4	PTP:template2,100,0	/
5	PTP:template3,100,0	# Wait for the drop point
6	PTP:template3,100,0	# Put something away
7	MoveGripper:1,0,255,0,1000	# jaws open

4.2 Spray gun peripheral configuration

4.2.1 Configuration steps of spray gun peripherals

Step1: Select the "Spray Cfg" button in the user's peripheral configuration interface, and the user can quickly configure the DO required for spraying through the one-key configuration button of spraying function (default configuration DO10 is spraying start and stop, and DO11 is spraying gun cleaning). Users can also customize and configure DO on the IO Configuration interface according to their own needs;

Step2: After the configuration is completed, click four buttons: "Start Spray", "Stop Spray", "Start Clean" and "Stop Clean" to debug the spray gun;

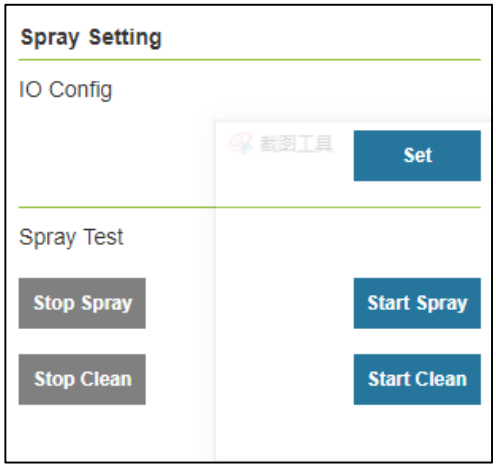


chart 4.2-1Spray gun configuration

Note:

Before using the spraying function, it is necessary to establish the corresponding tool coordinate system

Step3: Select the "spray" command in the program teaching command interface. According to the specific program teaching requirements, add and apply four instructions of "start spray", "stop spray", "start clean" and "stop clean" in corresponding places.

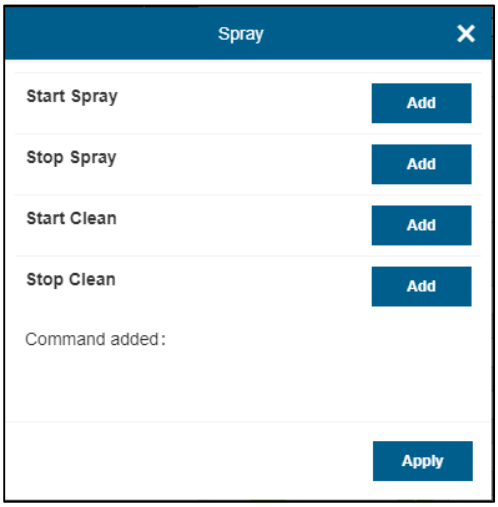


chart 4.2-2Gun command editing

4.2.2 Painting program teaching

serial number	instruction format	annotate
1	Lin:template1,100,0,0	# Start spraying point
2	SprayStart()	# Start spraying
3	Lin:template2,100,0,0	# spraying path
4	Lin:template3,100,0,0	# Stop spraying point
5	SprayStop()	# Stop spraying
6	Lin:template4,100,0,0	# Gun clearance point
7	PowerCleanStart()	# Start clearing guns
8	WaitTime:5000	# gun clearance time ms
9	PowerCleanStop()	# Stop clearing guns

4.3 Welding machine peripheral configuration

4.3.1 Welding machine peripheral configuration steps

Step1: Select the "Weld Cfg" button in the user peripheral configuration interface, and the user can quickly configure the DI and DO required by the welding machine by configuring the IO button of the welding machine (the default configuration is DI12 arc starting success signal, DO9 air supply signal, DO10 arc starting signal, DO11 point feeding, DO12 reverse feeding, DO13 JOB selection 1,DO14 JOB selection 2, and 2,DO15 JOB selection 3). Users can also use the "IO configuration" interface according to their own requirements,Custom configuration;

Note:

Before using the welding machine function, it is necessary to establish the corresponding tool coordinate system and apply the established tool coordinate system in the program teaching.The welder function is usually used in conjunction with a laser tracking sensor.

Step2: After the configuration is completed, select the number, set the waiting time, and click the eight buttons of "ArcEnd", "ArcStart", "Closehale", "Aspirated", "Forward Wire" , "Stop Forward Wire" , "Opposite Wire" and "Stop Opposite Wire" to debug the welding machine;

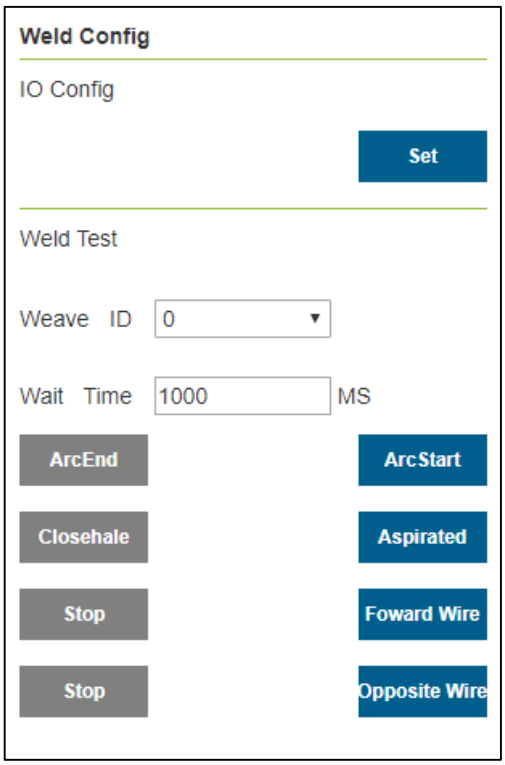


chart 4.3-1Welding machine configuration

Step3: Select the "Weld" command in the program teaching command interface. Add and apply "Arc Start" and "Arc End" instructions at the corresponding places according to the specific program teaching requirements.

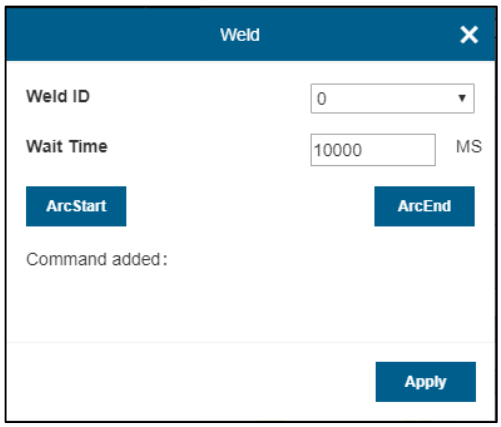


chart 4.3-2Welding machine instruction editing

4.3.2 Welding machine program teaching

serial number	instruction format	annotate
1	Lin:template1,100,0,0	# Start arc point
2	ARCStart:0,1000	# Start arcing
3	Lin:template2,100,0,0	# Stop arc starting point
4	ARCEnd:0,1000	# Stop arcing

4.4 Peripheral configuration of laser tracking sensor

4.4.1 Configuration steps of laser tracking sensor peripherals

Step1: Select the "Laser Cfg" button in the user peripheral configuration interface, and the user first sets the sensor location, which is divided into robot terminal and robot exterior. In this section, taking the robot end as an example, it is suggested that the D-value of sensor scanning deviation points should be set to 4 by default. The controller IP defaults to 192.168.58.2, and the Laser IP is configured as the same network segment.The port is 5020, and the sampling period is recommended to be 25. Select Ruiniu communication protocol and load laser. After loading, the sensor can be tested by using the " Laser Off" and "Laser On" buttons.

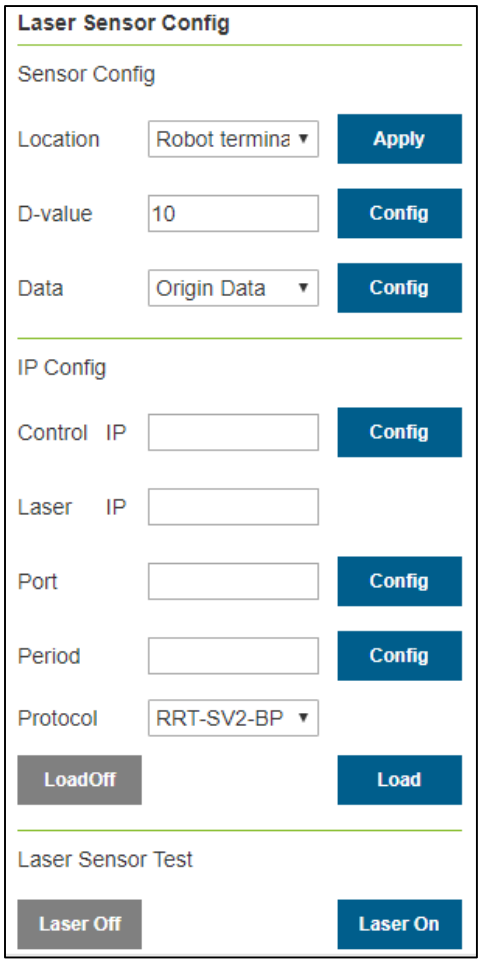


chart 4.4-1IP configuration of laser tracking sensor

Note:

Before using the laser tracking sensor function, it is necessary to establish the corresponding tool coordinate system, and use the established tool coordinate system in the program teaching. The welder function is usually used in conjunction with a laser tracking sensor.

Step2: Calibrate the reference point of the sensor.

Use the six-point method to configure the reference point of the sensor, click Modify, select a fixed point in the workspace of the robot, move the center point of the sensor from three different angles to the selected point, and set points 1, 2 and 3 respectively. Move the center point of the sensor vertically above the selected point, and record point 4.Move the center point of the sensor from a fixed point to a point in the X-axis direction of the sensor coordinate system, and set point 5. Back to the fixed point, move vertically upward, and move the center point of the sensor from the fixed point to a point in the z-axis direction of the sensor coordinate system, and set it as point 6. Click calculate to get the pose of the laser sensor, and click apply to finish it.

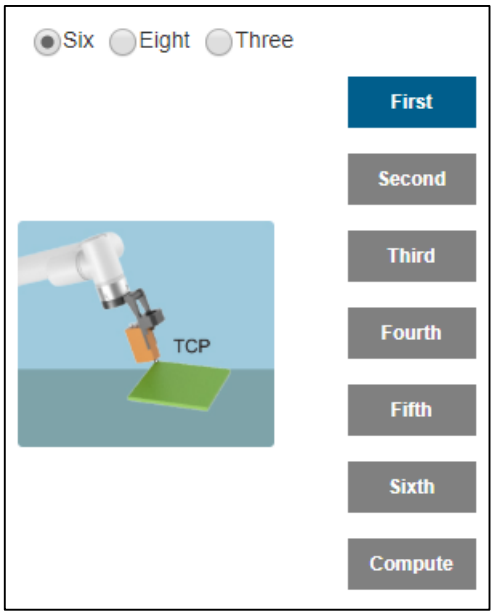


chart 4.4-2Reference point configuration-six-point method

Use the eight-point method to configure the sensor reference point, click modify, select the eight-point method, move the laser line of the sensor to coincide with the calibration line on the calibration board, try to keep the laser sensor close to the calibration line and identify the calibration point, record point 1, move about -y/+y 20mm, adjust the robot to make the laser identify the calibration point, record point 2, move about -x/+x 20mm,Adjust the robot to make the laser recognize the calibration point, record point 3 and move by -y/+y 20mm; adjust the robot to make the laser recognize the calibration point, record point 4 and move by -rx 5mm; adjust the robot to make the laser recognize the calibration point and record point 5. Move about -ry 5mm, adjust the robot to make the laser recognize the calibration point and record point 6, move about -rz 5mm, adjust the robot to make the laser recognize the calibration point and record point 7,Move-rz about 5 mm, adjust the robot to make the laser recognize the calibration point and record point 8. Click calculate to get the pose of the laser sensor, and click apply to finish it.

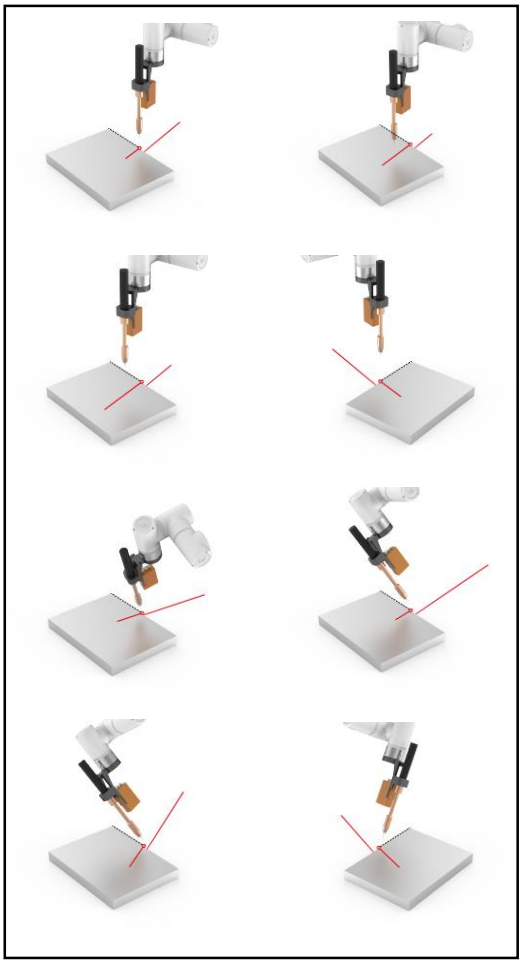


chart 4.4-3Reference point configuration-eight-point method

Step3: Select the "Laser" command in the program teaching command interface. According to the specific program teaching requirements, add instructions at the corresponding places.

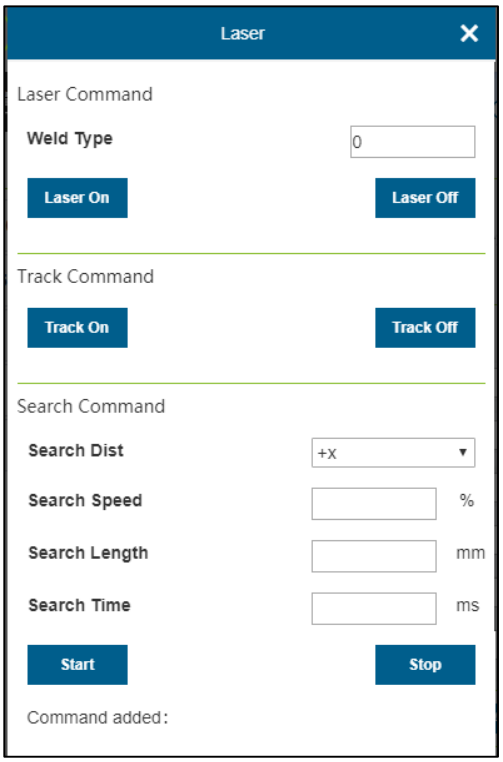


chart 4.4-4Command editing of laser tracking sensor

4.4.2 Program teaching of laser tracking sensor

serial number	instruction format	annotate
1	PTP:template1,100,0	# Starting point of laser sensor
2	LTSearchStart:1,20,100,10000	# Start looking for a position
3	LTSearchStop()	# Stop locating
4	Lin:seamPos,20,0,0,0,0	# weld starting point
5	LTTrackOn()	# Laser tracking
6	ARCStart:0,10000	# welding machine arcing
7	Lin:SeamEnd11,10,0	# weld end point
8	ARCEnd:0,10000	# welding machine arc closing
9	LTTrackOff	# Laser tracking off

4.5 Expansion axis peripheral configuration

4.5.1 Expansion axis peripheral configuration steps

Step1: Select the "ExAxis Cfg" button in the user peripheral configuration interface to enter the extension axis interface, select the extension axis number 1, and click the " Config" button to enter the right interface. Set shaft type, shaft direction, running speed, acceleration, Negative Limit, Positive Limit, Lead, encoder Resolution, starting point Offset, Company, Model and Entype, and click Config to finish the configuration.

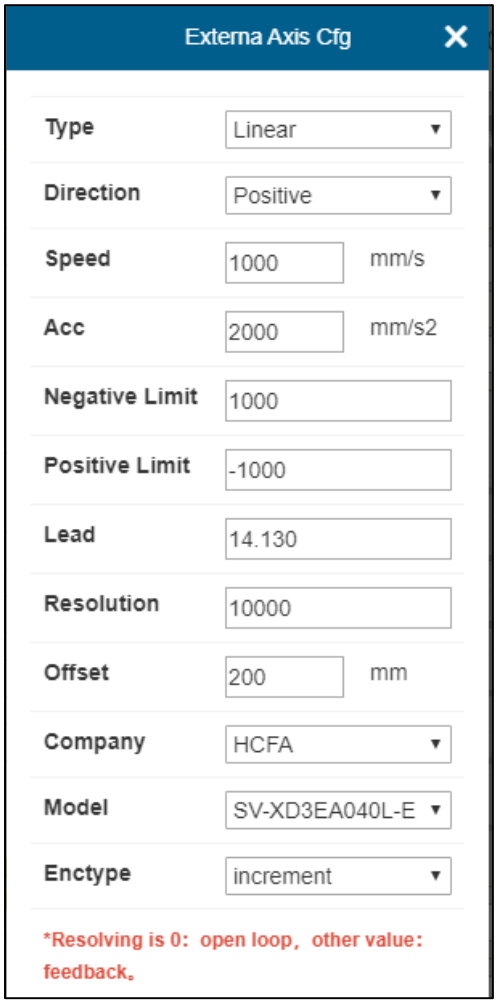


chart 4.5-1Parameter configuration of expansion axis

Note:

Before using the extended axis function, it is necessary to establish the corresponding extended axis coordinate system and apply the established tool coordinate system in the program teaching. The extended axis function is mainly used with welding machine function and laser tracking sensor function.

Step2: Click the "Zero" button to enter the zero setting pop-up window, as shown in the picture on the right. Set the zeroing mode, zeroing speed, zero hoop speed and axis direction, click the "Set" button, and the zeroing status will be displayed in the blank below the axis direction. When the prompt "Zeroing completed" appears, it indicates that the zero setting of the extended axis is successful.

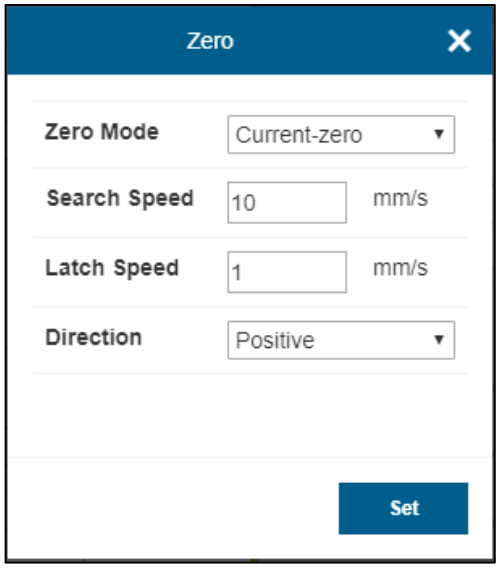


chart 4.5-2Expansion axis zero point setting

Step3: Select the extension shaft number with configured parameters, click "Servo On", and set the running speed, acceleration and maximum distance of single run, so that the extension shaft can be tested by forward rotation and reverse rotation.

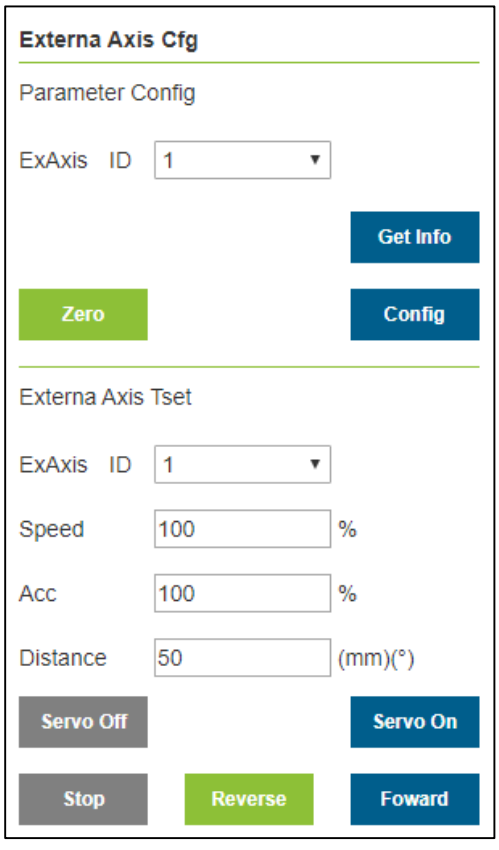


chart 4.5-3Extended axis test

Step4: The extended shaft is usually used in conjunction with the laser sensor. At this time, the laser sensor is usually installed externally, and the reference point configuration of the sensor needs to be calibrated by the three-point method instead of the six-point method used before. Align the center of the tool with the set point 1 at the middle point of the bottom of the right cross section (the side close to the camera).Align the center point of the tool with the middle point at the bottom of another cross section, i.e. the left cross section, set point 2, move the center point of the tool to the middle point of the upper edge of the right cross section of the sensor, set point 3, calculate and save, and click Apply to complete the calibration by three-point method.

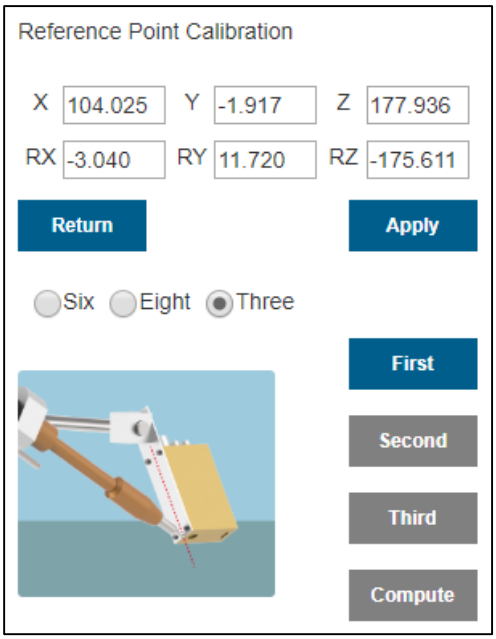


chart 4.5-4Sensor calibration by three-point method

Step5: select "EAxis" command in the program teaching command interface. According to the specific program teaching requirements, add instructions at the corresponding places.

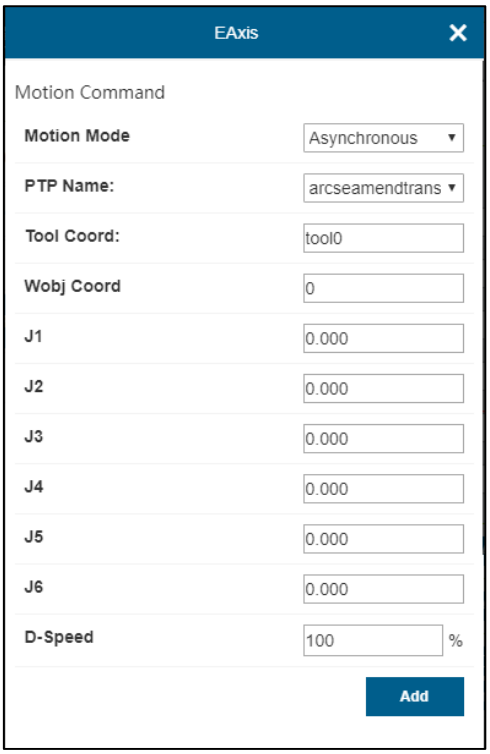


chart 4.5-5Expand axis command editing

4.5.2 Teaching of extended shaft with laser tracking welding program

serial number	instruction format	annotate
1	EXT_AXIS_PTP:1,1,laserstart	# Starting point of external axis motion laser sensor
2	PTP:laserstart,10,0	# Starting point of robot motion laser sensor
3	LTSearchStart:3,20,10,10000	# Start looking for a position
4	LTSearchStop()	# Stop locating
5	EXT_AXIS_PTP:1,1,seamPos	# Start point of external shaft moving weld
6	Lin:seamPos,20,0,0,0,0	# Robot moving weld starting point
7	LTTrackOn()	# Laser tracking
8	ARCStart:0,10000	# welding machine arcing
9	EXT_AXIS_PTP:1,1,laserend	# External axis moves weld end point
10	Lin: laserend,10,0,0	# Robot moves weld end point
11	ARCEnd:0,10000	# welding machine arc closing
12	LTTrackOff	# Laser tracking off

4.6 Conveyor tracking configuration

4.6.1 Conveyor tracking configuration steps

Step1: Select the "Conveyor Cfg" button in the user peripheral configuration interface to enter the belt tracking configuration interface, click the "Set" button to quickly configure the IO required by the belt function, and then configure the resolution, transmission ratio and wheel circumference of the belt according to the actual usage.

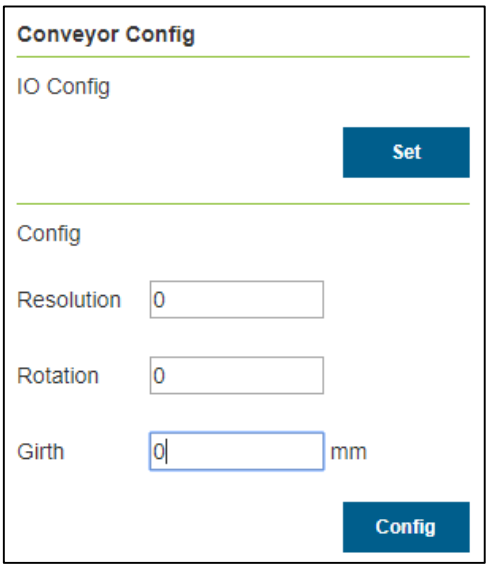


chart 4.6-1Conveyor belt configuration

Step2: Put the object on the conveyor belt, click the conveyor belt start button, turn on the conveyor belt, click the conveyor belt to stop closing the conveyor belt when the object moves to the proximity switch position, click the IO cut-in point, pop up the pop-up box, display the current encoder value, and click the calibration button to end the IO trigger calibration.

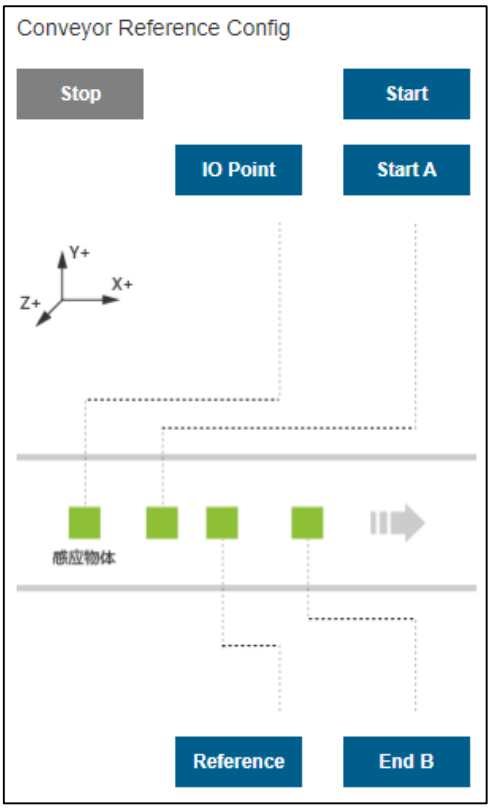


chart 4.6-2Conveyor reference point configuration

Step3: Turn on the conveyor belt, move the calibrated object to the defined point A, and stop the conveyor belt. Move the robot, align the sharp point of the calibration rod at the end of the robot with the sharp point of the calibrated object, click the starting point A button, pop up the dialog box, display the current encoder value and robot pose, and click Calibration to complete the calibration of starting point A..

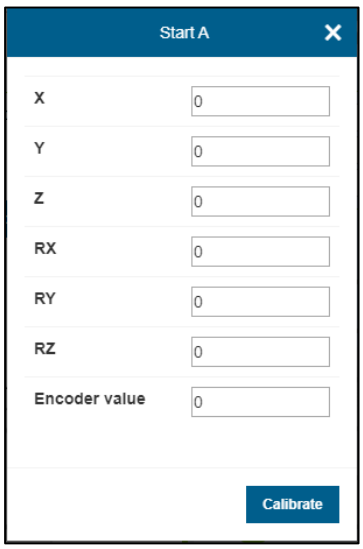


chart 4.6-3Starting point a configuration

Step4: Click the reference point button to enter the reference point calibration. When recording the reference point, record the robot's height and attitude during grabbing. When tracking each time, it will track and grab by recording the height and attitude area of the reference point, which may not be at the same height as AB point. Click Calibration to complete the reference point calibration.

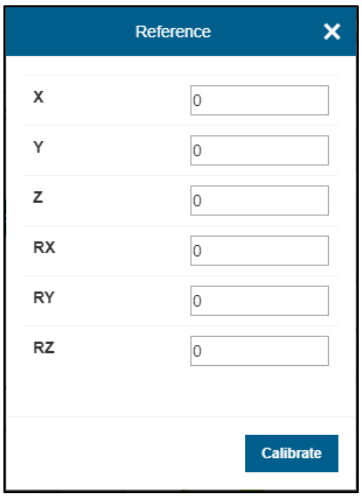


chart 4.6-4Reference point configuration

Step5: Turn on the conveyor belt, move the calibrated object to the defined point B, and stop the conveyor belt. Move the robot, align the sharp point of the calibration rod at the end of the robot with the sharp point of the calibrated object, click the end point B button, pop up a dialog box, display the current encoder value and robot pose, and click Calibration to complete the end point B calibration.

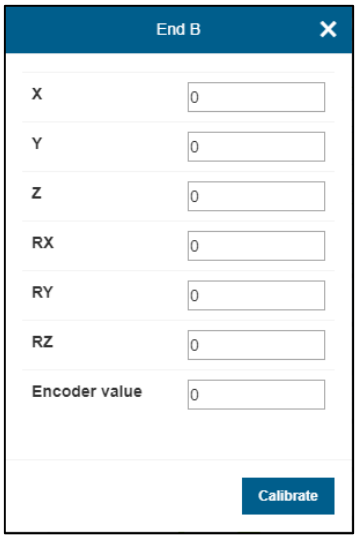


chart 4.6-5End point b configuration

4.6.2 Conveyor tracking program teaching

serial number	instruction format	annotate
1	PTP:conveyorstart,30,0	# Robot grab starting point
2	While(1) do	# Loop grab
3	ConveyorIODetect:10000	#IO real-time detection of objects
4	ConveyorGetTrackData()	# Object position acquisition
5	ConveyorTrackStart()	# Conveyor tracking starts
6	Lin:cvrCatchPoint,10,0,0,0	# Robot reaches grab point
7	MoveGripper:1,255,255,0,10000	# Grippers grab objects
8	Lin:cvrRaisePoint,10,0,0,0	# Robot lift
9	ConveyorTrackEnd()	# End of conveyor tracking
10	PTP:conveyorraise,30,0	# Robot arrives at the waiting point
11	PTP:conveyorend,30,0	# Robot reaches the placement point
12	MoveGripper:1,0,255,0,10000	# Grippers released
13	PTP:conveyorstart,50,0	# The robot returns to the starting point of grabbing again and waits for the next grab
14	end	# End

4.7 Attitude adaptive configuration

4.7.1 Attitude adaptive configuration steps

Step1: Select the "Adjust Cfg" button in the user peripheral configuration interface, enter the attitude adjustment configuration interface, select the plate type and the actual working movement direction of the robot, adjust the robot attitude, and set attitude point A, attitude point B and attitude point C respectively, usually A is a plane attitude point, B is a rising edge attitude point, and C is a falling edge attitude point.

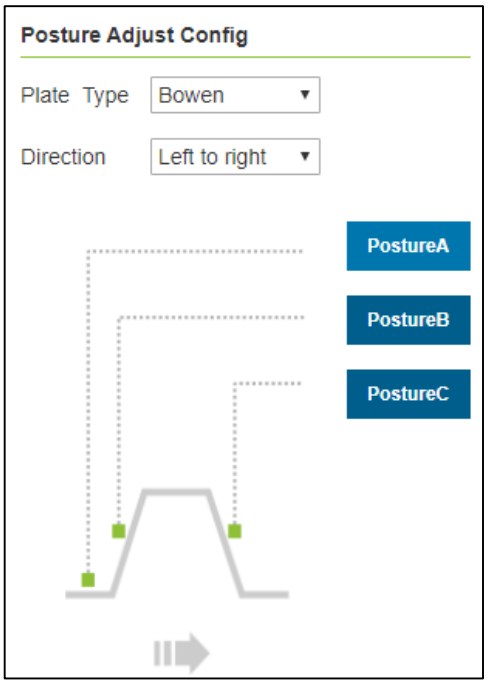


chart 4.7-1Configuration of attitude adjustment

Note:

The smaller the attitude change between a-attitude and b-attitude, and between a-attitude and c-attitude, the better. Attitude adaptive function is an auxiliary application function, which is usually used with seam tracking.

Step2: Select the "Adjust" command in the program teaching command interface. According to the specific program teaching requirements, add instructions at the corresponding places.

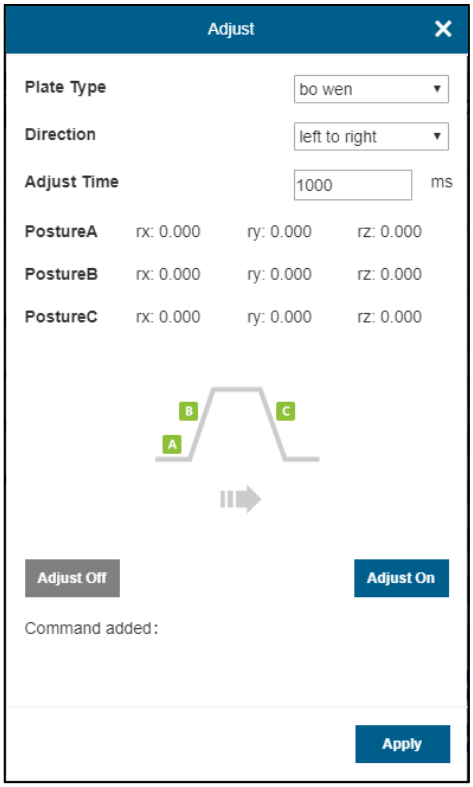


chart 4.7-2Attitude adjustment instruction editing

4.7.2 Self-adaptive attitude matching extended axis and laser tracking welding program teaching

serial number	instruction format	annotate
1	EXT_AXIS_PTP:1,1,laserstart	# Starting point of external axis motion laser sensor
2	PTP:laserstart,10,0	# Starting point of robot motion laser sensor
3	LTSearchStart:3,20,10,10000	# Start looking for a position
4	LTSearchStop()	# Stop locating
5	EXT_AXIS_PTP:1,1,seamPos	# Start point of external shaft moving weld
6	Lin:seamPos,20,0,0,0,0	# Robot moving weld starting point
7	LTTrackOn()	# Laser tracking
8	ARCStart:0,10000	# welding machine arcing
9	PostureAdjustOn:0,PosA,PosC,PosB,1000	# Attitude adaptive adjustment on
10	EXT_AXIS_PTP:1,1,laserend	# External axis moves weld end point
11	Lin: laserend,10,0,0	# Robot moves weld end point
12	ARCEnd:0,10000	# welding machine arc closing
13	PostureAdjustOff:0	# Attitude adaptive adjustment turned off
14	LTTrackOff	# Laser tracking off

appendix

Appendix 1: Motion Controller Errors and Handling Methods

Error classification	Error name (displayed by the teach pendant)	processing mode	Post-processing operation
Command point error	Joint command point error	1. Check whether the command point is wrong; 2. Check whether the tool is consistent with the record of command points; 3. Re-record the instruction points and modify the teaching program;	Check and confirm. After modifying the program, click the START button again to execute the new program.
	Straight line target point error		
	Midpoint of arc error		
	Arc target point error		
	TPD point error		
	TPD the current instruction deviates too much from the starting point of the next instruction	1. Check whether the starting point of TPD track is recorded and whether there is a motion command (PTP / LIN) moving to the starting point of TPD track before TPD instruction in teaching program; 2. Modify the teaching program;	
	The next command changes the joint configuration	1. Modify the teaching program. When the movement stops, the next line of the current line is changed to PTP	

		instruction;	
	The current instruction joint configuration has changed	1. In the automatic mode, the teaching program is modified, and the current program is changed to PTP instruction when the movement stops; 2. In manual mode, switch the joint coordinates after power on again and then jog;	
	PTP joint instruction out of limit	1. When the command of motion process exceeds the soft limit, the program needs to be modified;	Reverse inching makes the robot leave the soft limit area or switch to the drag mode, and drag the robot to leave the soft limit area; After modifying the program, click the start button again to execute the new program;
	TPD joint instruction out of limit	1. When the command of motion process exceeds the soft limit, the program needs to be modified;	
	LIN/ARC offering joint command out of limit	1. When the command of motion process exceeds the soft limit, the program needs to be modified;	
	JOG joint instruction out of limit	1. The command of motion process exceeds the soft limit;	Reverse inching makes the robot leave the soft limit area or switch to the drag mode, and drag the robot to leave

			the soft limit area;
	Axis 1 - Axis 6 overrun command velocity in joint space	1. There are problems in the instruction;	Contact developers;
	Overspeed command in Cartesian space		
	Excessive torque command in joint space		
Drive failure	1 axis drive failure	1. If the driver fails, check the driver fault table and check the cause of the driver failure;	Power on again;
	2 axis drive failure		
	3 axis drive failure		
	4 axis drive failure		
	5 axis drive failure		
	6 axis drive failure		
Soft limit exceeded	1 axis out of soft limit fault	1. The movement process exceeds the soft limit;	Switch to drag mode and drag the robot to leave the soft limit area;
	2 axis out of soft limit fault		
	3 axis out of soft limit fault		
	4 axis out of soft limit fault		
	5 axis out of soft limit fault		
	6 axis out of soft limit fault		
Collision failure	1 axis impact fault	1. Collision occurs in the	Check the cause

	2 axis impact fault	process of motion;	of the collision and click the resume button in the teaching programming interface when the movement needs to be started again;
	3 axis impact fault		
	4 axis impact fault		
	5 axis impact fault		
	6 axis impact fault		
Slave error	Number of active slave stations is wrong	1. If there is an error in the slave station, check whether the EtherCAT cable is normal;	Power on again, if not solved, contact after-sales personnel;
	Salve offline		
	Slave status is not consistent with the set value		
	Slave is not configured		
	Slave configure error		
	Slave initialize error		
	Slave mailbox communication initialize error		
IO error	The channel error	1. Check whether the IO instruction channel in the program is set incorrectly;	Check and confirm. After modifying the program, click the START button again to execute the new program.
	Numerical fault	1. Check whether the IO instruction value in the program is set incorrectly;	
	WaitDI wait for a timeout	1. Check whether there is effective input signal;	
	WaitAI wait for a		

	timeout		
	WaitToolDI wait for a timeout		
	WaitToolAI wait for a timeout		
	The channel has been configured functionally wrong	1. The function of the current channel has been configured, which cannot be used in teaching programming, so it needs to be replaced with other channels;	The current channel has been configured with functions, which cannot be used in teaching programming and needs to be replaced with other channels;
Gripper error	Claw movement timeout error	1. Waiting for the gripper movement completion signal to time out;	Contact developers;
File error	Zbt incorrect configuration file version	1. wrong version of zbt.config configuration file;	Contact after-sales personnel;
	User incorrect configuration file version	1. wrong version of user.config configuration file;	
	Zbt the configuration file failed to load	1. error in loading zbt.config configuration file;	Check whether there is zbt.config configuration file; Re-power on and contact after-sales personnel if you still report an error;

	User the configuration file failed to load	1. the user.config configuration file is loaded incorrectly;	Check whether there is zbt.config configuration file; Re-power on and contact after-sales personnel if you still report an error;
parameter error	Error with tool number overrun	1. The tool number is beyond the allowable range;	Check and confirm. After modifying the program, click the START button again to execute the new program.
warn	Shoulder joint configuration changes	Not yet realized;	
	Elbow joint configuration changes		
	Wrist joint configuration changes		
	RPY initialization failure	1. RX, RY and RZ failed to initialize, so the robot was moved so that RY was not equal to 90;	After moving the robot, power on again;

Appendix 2: Servo Driver Fault Code Table

Fault code	Fault name	processing method
1	Software over current fault	1. Check for increased or abnormal joint load or resistance 2. If the fault is not eliminated, repair or replace the drive plate
2	Over voltage fault	Reduce the speed or acceleration of the robot
3	Under voltage fault	1. Check whether the 48V power supply voltage output of the control box is abnormal 2. Check the drive plate and joint housing for short circuit 3. If the fault is not eliminated, repair or replace the drive plate
4	Overheating fault	Reduce the load or speed of the robot
5	Overload fault	Reduce the load or speed of the robot
6	Overspeed fault	1. Check whether the fixing screw of magnetic braid assembly and motor shaft is loose 2. Re zero the encoder 3. If the fault is not eliminated, repair or replace the magnetic braid assembly
7	Abnormal parameter fault	Repair or replace the drive plate
8	Runaway fault	1. Check whether the fixing screw of magnetic braid assembly and motor shaft is loose 2. Re zero the encoder 3. If the fault is not eliminated, repair or replace the magnetic braid assembly
9	Position error fault	1. Check for increased or abnormal joint load or

		resistance 2. If the fault is not eliminated, repair or replace the drive plate
10	Position overflow fault	1, check whether the hard limit is loose 2. Re-zero the robot
11	Hardware overcurrent fault	Repair or replace the drive plate
12	Drive inhibit fault	Not enabled
13	Motor locked-rotor fault	1. Check whether the brake electromagnet is attracted. 2. Check whether it hits the hard limit 3. If the fault is not eliminated, repair or replace the drive plate
14	Power supply failure	Not enabled
15	STO fault	Not enabled
16	Phase current AD zero failure	Repair or replace the drive plate
17	EEPROM fault	Repair or replace the drive plate
18	Hall fault	1. Check whether Hall harness is plugged firmly, short circuit or open circuit. 2. If the fault has not been eliminated, repair or replace the joint
19	Encoder failure	Repair or replace the magnetic braid assembly
20	Encoder zero failure adjustment	1. reset the encoder to zero 2. If the fault has not been eliminated, repair or replace the magnetic braided component
21	Encoder z-phase signal loss fault	Not enabled
22	Encoder count failure	Not enabled

23	Encoder multi-turn data overflow fault	Not enabled
24	External clock failure	Repair or replace the drive plate
25	Uww phase sequence fault	Not enabled
26	FPGA fault	Not enabled
27	Back to zero failure	Not enabled
28	Magnetic encoder failure	1. Check whether the fixing screw of magnetic braid assembly and motor shaft is loose 2. If the fault has not been eliminated, repair or replace the magnetic braided component
29	Breakage fault of motor power line	1, check whether the motor power line plug is firm, with or without short circuit, open circuit 2. If the fault is not eliminated, repair or replace the drive plate
30	EtherCAT fault	1, check whether the cable plug is firm, short circuit, open circuit 2. If the fault is not eliminated, repair or replace the drive plate
31	EtherCAT_SM_DOG fault	1, check whether the cable plug is firm, short circuit, open circuit 2. If the fault is not eliminated, repair or replace the drive plate
32	EtherCAT_FATALSYNC fault	1, check whether the cable plug is firm, short circuit, open circuit 2. If the fault is not eliminated, repair or replace the drive plate
33	EtherCAT_SYNC fault	1, check whether the cable plug is firm, short circuit, open circuit

		2. If the fault is not eliminated, repair or replace the drive plate
34	EtherCAT_RFT fault	1, check whether the cable plug is firm, short circuit, open circuit 2. If the fault is not eliminated, repair or replace the drive plate
35	Drive shaft address failure	1. Re-configure the address of the drive shaft 2. If the fault is not eliminated, repair or replace the drive plate
36	Robot school zero failure	1、 Re-zero the robot 2、 Erase FLASH with JLINK first, then download the program again and zero it 3. If the fault is not eliminated, repair or replace the drive plate
37	Encoder communication failure	1. Check whether the encoder harness is plugged firmly and whether there is short circuit or open circuit. 2. If the fault has not been eliminated, repair or replace the magnetic braided component
40	Malfunction of magnetic encoder module-calibration of zero failure	1、 Re-zero the magnetic braiding assembly 2、 If the fault is still not eliminated, repair or replace the magnetic braid assembly
41	Magnetic braid module failure-multi-turn failure	1、 Check whether the magnet assembly and motor shaft fixing top wire are loose. 2、 If the fault is still not eliminated, repair or replace the magnetic braid assembly
42	Magnetic braid module failure-multi-turn small magnetic braid failure	1、 Check whether the multi-turn small magnetic braided chip is abnormal 2、 If the fault is still not eliminated, repair or replace the magnetic braid assembly

43	Magnetic braid module failure-multi-turn large magnetic braid failure	1、Check whether the multi-turn large magnetic braided chip is abnormal 2、If the fault is still not eliminated, repair or replace the magnetic braid assembly
44	Magnetic braiding module failure-single-loop magnetic braiding failure	1、Check whether the single-turn magnetic braided chip is abnormal 2、If the fault is still not eliminated, repair or replace the magnetic braid assembly
45	Magnetic coding module failure-optical coding failure	1、Check whether the optical encoder disc is contaminated or not stuck firmly 2、If the fault is still not eliminated, repair or replace the magnetic braid assembly

Appendix 3: Upgrade of End Plate 485

In field use, it is possible to update the firmware to meet the new requirements, provide a new upgrade file (XX_XX_MAIN.bin), and upgrade the terminal board through the 485 interface (it is necessary to transfer the USB to the 485 module). Upgrade steps are as follows:

At Step1:485, there is a 5Pin communication aviation connector at the end of the robot. The Pin pin pin distribution and pin pin pin description of the aviation connector are shown in Figure 1. The 485-A and 485-B at the end of the robot are connected by twisted pair.

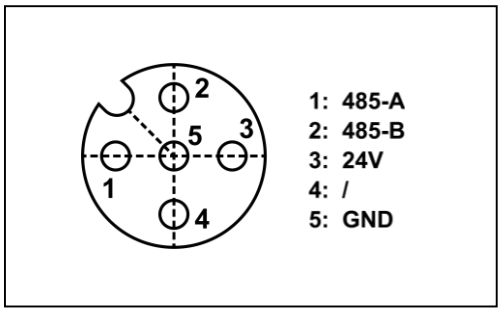


Figure 1 pin pin pin distribution of aviation joint

Step2: Hardware connection: connect the USB end of the USB-to-485 tool to the PC. If the USB&485 tool is recognized in the PC device manager, the following interface will appear.

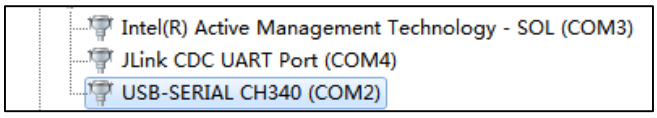


Figure 2 USB & 485 port identification

Step2: Upgrade the tool. After completing the wiring, open the "French-Austrian serial port debugging assistant", click the "end board" button, and select the above-mentioned identified serial port in the "serial port parameter setting" function, with baud rate of 115200, 8 data bits, no check bit, stop bit 1, and then open the serial port. After success, the prompt of "serial port opened successfully" will appear.

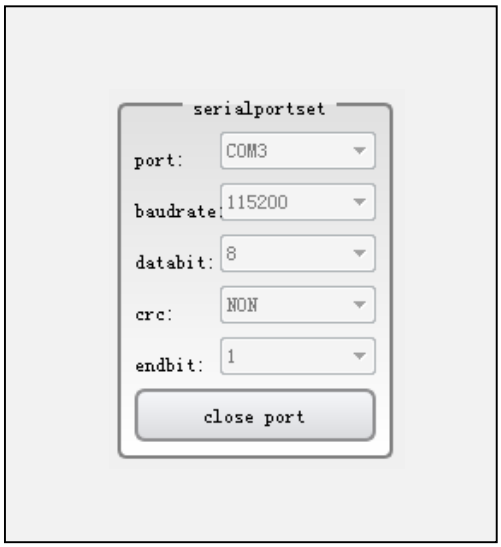


Figure 3 serial port parameter setting

Step3: Firmware upgrade, select "End Board" and click "Firmware Upgrade", as shown in the chart:

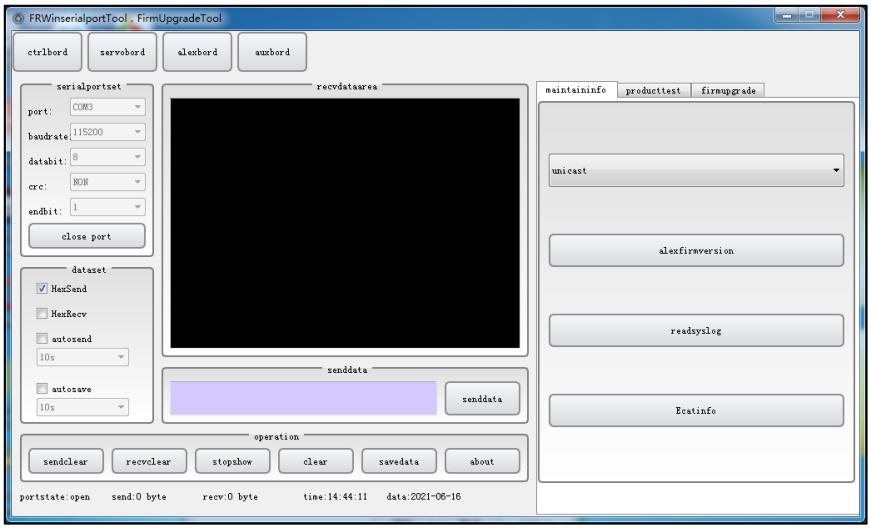


Figure 4 end plate firmware upgrade

- Click "Flash Erase" first. After successful erasure, you will be prompted to erase successfully in the receiving data area.

- Open the file (file to be upgraded) and select the storage path, as shown below. After the selection is completed, the file name to be upgraded will appear in the file name display box.

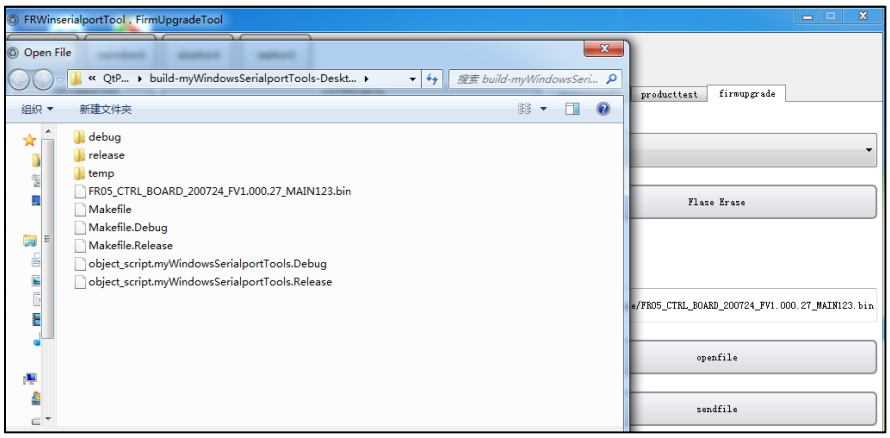


Figure 5 select upgrade file

- Click "Send File". When the progress bar shows 100%, it means that the upgrade file has been sent.

Step4: Upgrade verification, restart and power up the system. In the column of "Maintenance Information", select "Query the firmware version information of the terminal board", and the firmware version information will be displayed in the "Receiving Data Area". If it is consistent with the upgraded file version information, the upgrade is successful, otherwise the upgrade fails.

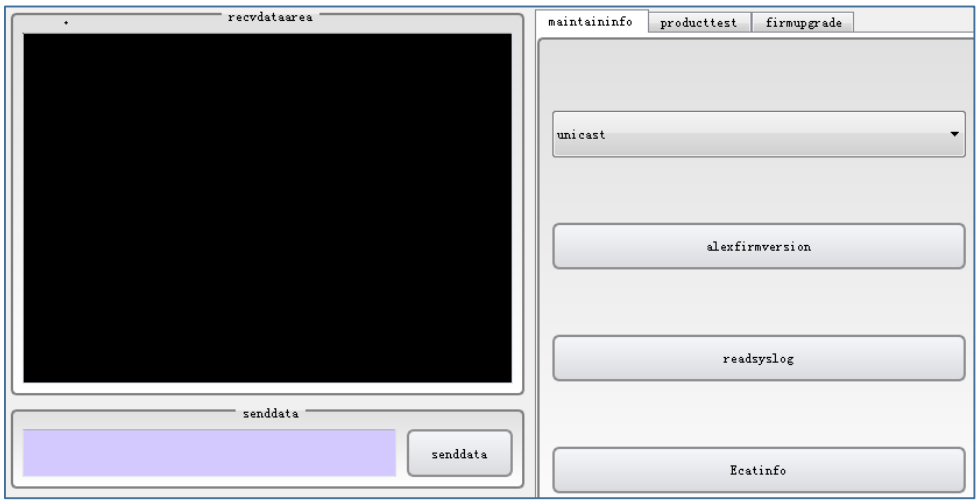


Figure 6 query firmware version information

Appendix 4: Upgrade of Control Box 485

There is a "power communication" interface on the robot control panel, and USB&485 tools A and B are connected to "485-A" and "485-B" of their interfaces respectively.

The upgrade process is the same as the terminal board, and the software can be selected accordingly, so it is not repeated here.

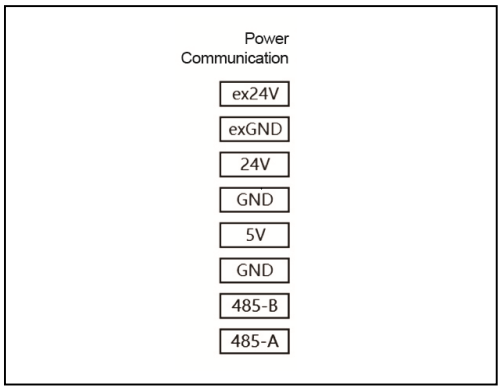


Figure 1 power communication interface

Surgical language

Connecting flange: a structure used to connect external tools, generally called flange.

Robot end: the center point of the last shaft or connecting flange of the robot.

Tool center point (TCP): the tool center point is the characteristic point of the robot tool, which is the control point of the robot system. It defaults to the center of the last motion axis or connecting flange when leaving the factory. The tool center point of each tool contains the transformation and rotation set relative to the center of the tool output flange. The location coordinates x, y and z determine the position of the center point of the tool,RX, RY and RZ determine the direction of the tool center. When the values are all zero, the center of the tool coincides with the center point of the connecting flange.

Tool pose point (TCF): based on the tool center point TCP, it reflects the pose of the tool coordinate system relative to the end connecting rod coordinate system.

Base coordinate system: the origin of the base coordinate system is generally defined at the center point between the first axis of the robot and the mounting surface, with the X axis forward and the Y axis determined according to the right-hand rule in the axial direction.

World coordinate system: a fixed coordinate system established in a work unit or workstation. When there is only one robot, the coordinate system can be considered to coincide with the base coordinate system; When there are multiple robots or external devices, the world coordinate system can provide a unique reference system for these devices. On the premise of convenient calibration of coordinate systems of other devices,Its specific location can be arbitrarily specified.

Joint coordinate system: the joint coordinate system is the coordinate system in the robot joint, under which each axis of the robot can move forward or backward independently within the limit range. It is suitable for the robot to move in a large range and does not require the robot TCP posture. Uniaxial inching of robot in manual mode is carried out in joint coordinate system.

Tool coordinate system: it is used to define the position of tool center point and

tool posture. If it is not defined, the tool coordinate system defaults to the center of connecting flange. After installing the tool, TCP will change and become the center at the end of the tool.

External tool coordinate system: the coordinate system used to define the pose of the tool fixed outside the robot.

Expansion axis: the axis on the robot body is removed, and an additional axis is needed for working. The expansion axis mainly includes slide rails, turnover tables and additional servo equipment.

Manual mode: in this mode, all movements of the robot are manually controlled by the user, and the external safety facilities such as safety grating and safety door are ineffective for short-distance debugging.

Automatic mode: this mode is generally used for robots to run teaching programs, when external safety facilities are enabled.

Repetition positioning accuracy: the consistency between the position and attitude measured by repeated n times when the robot is operated by the same method under the same conditions.

Teach: a hand-held unit that programs or moves the robot and is connected with the control system.