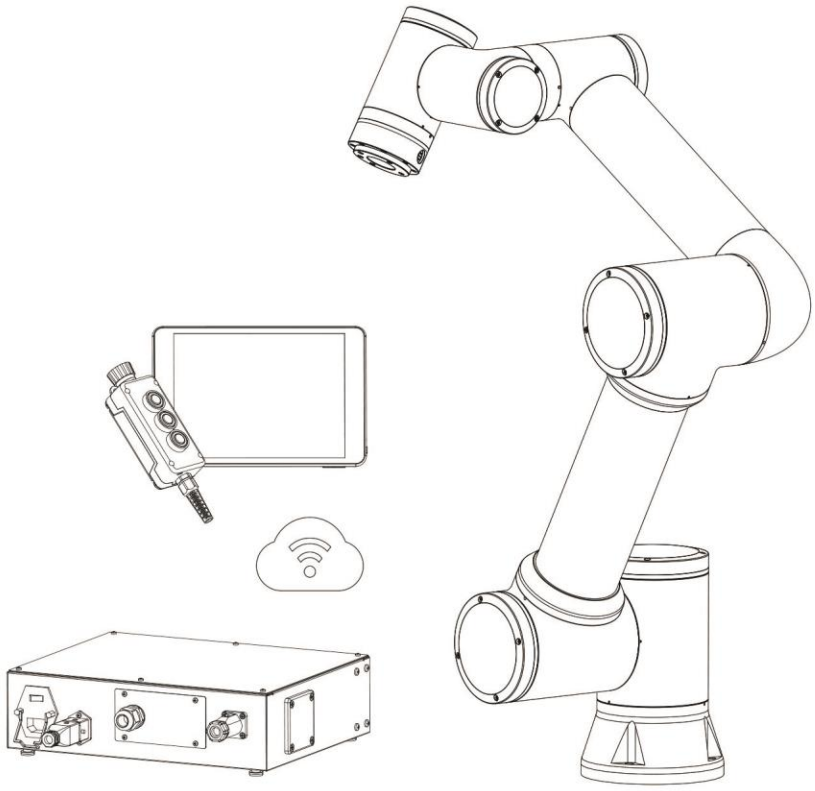
INTELLIGENT COLLABORATIVE ROBOT

User Manual



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preface

What is in the box

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

- One cooperative robot;
- One button box;
- One control box, including one control box cable;

Important safety instructions

Robot is a kind of equipment involving personal safety, so safety assessment must be carried out every time the robot is installed.You must follow all safety instructions in Chapter 1.

How to use this manual

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

- Hardware installation: mechanical installation and electrical installation of the robot.
- Teaching tool software analysis part: robot teaching and programming.

This manual is intended for robot integrators who have received basic mechanical and electrical training and are familiar with primary programming concepts.

Relevant standards followed

standard	definition
2006/42/EC:2006	Machinery Directive: Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive

	95/16/EC(recast)
2004/108/EC:2004	EMC Directive: Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC
EN ISO 13850:2008	Safety of machinery: Emergency stop - Principles for design
EN ISO 13849-1:2008	Safety of machinery: Safety-related parts of control systems - Part 1: General principles of design
EN ISO 13849-2:2012	Safety of machinery: Safety-related parts of control systems - Part 2: Validation
EN ISO 12100:2010	Safety of machinery: General principles of design, risk assessment and risk reduction
EN ISO 10218-1:2011	Industrial robots: Safety Note: Content equivalent to ANSI/RIA R.15.06-2012, Part 1
ISO/TS 15066: 2016	Safety requirements for collaborative industrial robot Robots and robotic devices —Collaborative robots

Chapter I Hardware Installation

1.1 Safety instructions

1.1.1 brief introduction

The following warnings will be used in this manual. These warnings are intended to ensure the safety of personnel and equipment. When reading this manual, it is very important that you follow and implement all assembly instructions and guidelines in other chapters of this manual.Special attention should be paid to the text associated with warning signs.

be careful:

If the robot (robot body, control box, teaching box) is damaged, changed or modified for human reasons, Fair refuses to bear all responsibilities;Fair will not be responsible for any damage to the robot or any other equipment caused by errors in the program written by the customer.

1.1.2 Personnel safety

When running the robot system, you must first ensure the safety of operators. The general precautions are listed below. Please take appropriate measures to ensure the safety of operators.

1. All operators who use the robot system shall receive training through the training course sponsored by FairYiWei (Suzhou) Robot System Co., Ltd.Users need to ensure that they fully grasp the safe and standardized operation process and have the robot operation qualification.For training details, please contact our company atjiling@frtech.fr。

2. All operators using the robot system should not wear loose clothes or jewelry.When operating the robot, make sure that the long hair is tied behind your head.

3. When the equipment is running, even if the robot seems to have stopped, it may be that the robot is waiting for the start signal and is in a state of imminent action.Even in such a state, the robot should also be regarded as in motion.

4. Lines shall be drawn on the floor to mark the action range of the robot, so that the operator can understand the action range of the robot including holding tools (manipulator, tools, etc.).

5. Ensure that safety measures (such as guardrails, ropes, or protective screens) are established near the robot operation area to protect the operator and surrounding people.Locks shall be set as required so that operators other than those responsible for operation cannot contact the power supply of the robot.

6. When using the operation panel and the teaching pendant, because wearing gloves may lead to operational errors, be sure to operate after removing gloves.

7. In emergency and abnormal situations such as people being trapped or surrounded by robots, push or pull the robot arm with force (at least 700 N) to force the joints to move.Manually moving the robot arm without electric drive is limited to emergency situations and may damage joints.

1.1.3 security setting

Under the menu bar of "Security Settings" in "Auxiliary Applications", click "Security Stop Settings" to enter the security stop settings function interface.

Enable the safe stop mode. When the robot reports an error or warns to stop, the robot will automatically be enabled to play the role of safety protection.



Fig 1.1-1 Safety Stop Settings

- **Speed reduction mode:** when this mode is activated, the movement speed of the manipulator in the joint space will be limited, and the value in the corresponding text box is the limit value of the movement speed of each joint. The setting range of joints 1,2,3 is 15~150 °/s, and that of joints 4,5,6 is 15~180 °/s;The movement speed limit of the manipulator in Cartesian space is the TCP speed limit, and the setting range is 0~80mm/s.

1.1.4 Hazard identification

The risk assessment shall consider all potential contacts between the operator and the robot during normal use and foreseeable misoperation.The neck, face and head of the operator shall not be exposed to avoid contact.The use of robots without the use of peripheral safety protection devices requires a risk assessment first to determine whether the relevant hazards will constitute an unacceptable risk, such as

- It may be dangerous to use sharp end actuators or tool connectors;
- It may be dangerous to handle toxic or other harmful substances;
- The operator's fingers may be trapped by the robot base or joints;
- Danger of collision by robot;
- The danger that the robot or the tool connected to the end is not fixed in place;
- The danger caused by the impact between the robot payload and a solid surface.

The integrator must measure such hazards and their related risk levels through risk assessment, and determine and implement corresponding measures to reduce risks to an acceptable level.Please note that there may be other significant hazards associated with specific robotic equipment.

By combining the inherent safety design measures applied by FR robots with the safety specifications or risk assessments implemented by integrators and end users, the risks associated with FR collaborative operations are reduced to a reasonable and feasible level as far as possible.This document can be used to communicate any remaining risks of the robot before installation to the integrator and the end user.If the risk assessment of the integrator determines that there are risks that may pose unacceptable risks to users in its specific applications, the integrator must take appropriate risk reduction measures to eliminate or minimize these risks until the risk is reduced to an acceptable level.It is unsafe to use it before taking appropriate risk reduction measures (if necessary).

If the robot is installed non cooperatively (for example, when using dangerous tools), the risk assessment may infer that the integrator needs to connect additional safety equipment (for example, safety starting equipment) when programming to ensure the safety of personnel and equipment.

1.1.5 Nameplate information

FR3 cooperative robot

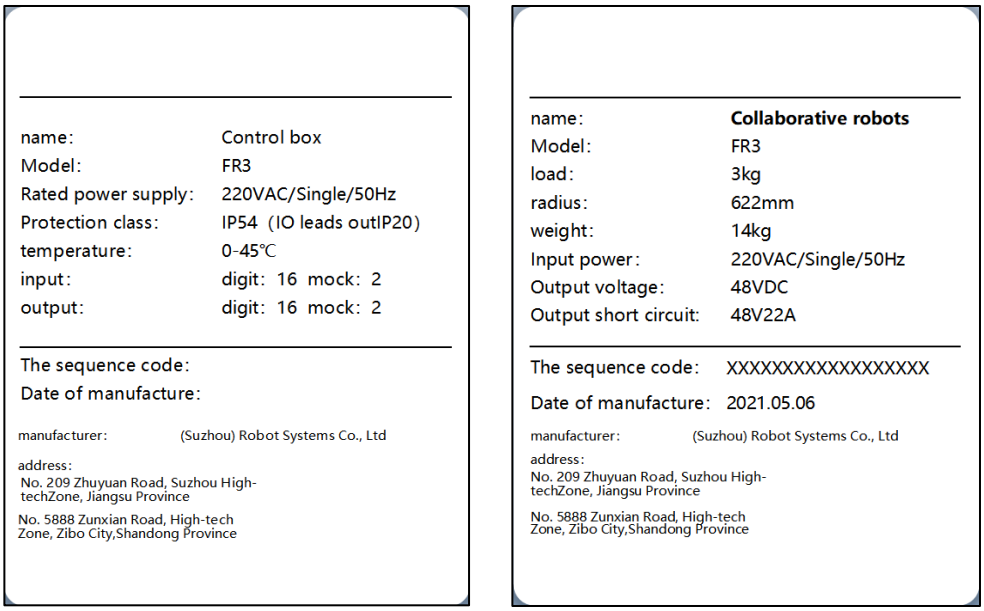


Fig. 1.1-2 FR3 Robot Nameplate Information

FR5 cooperative robot

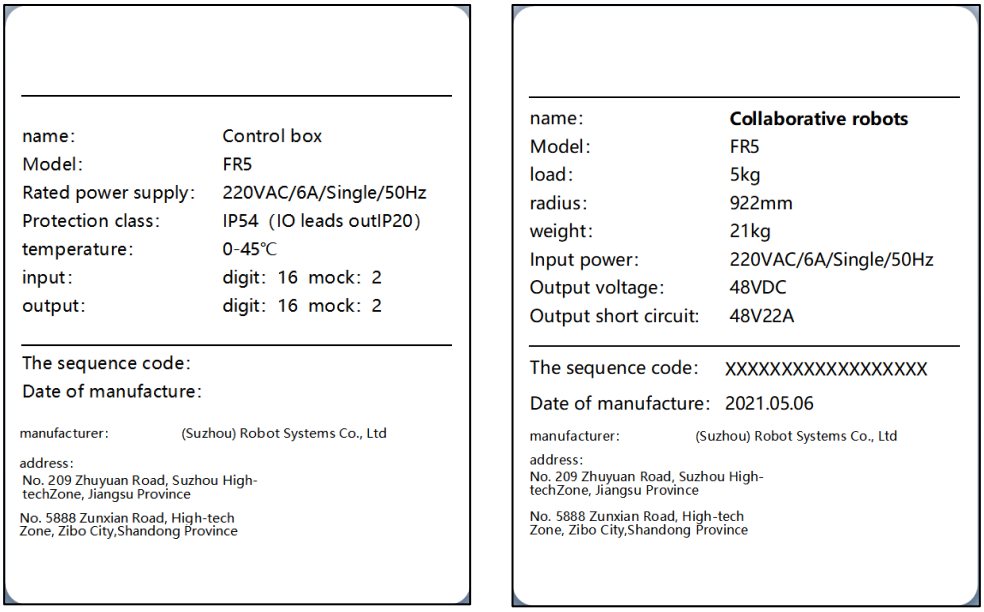


Fig. 1.1-3 FR5 Robot Nameplate Information

FR10 cooperative robot

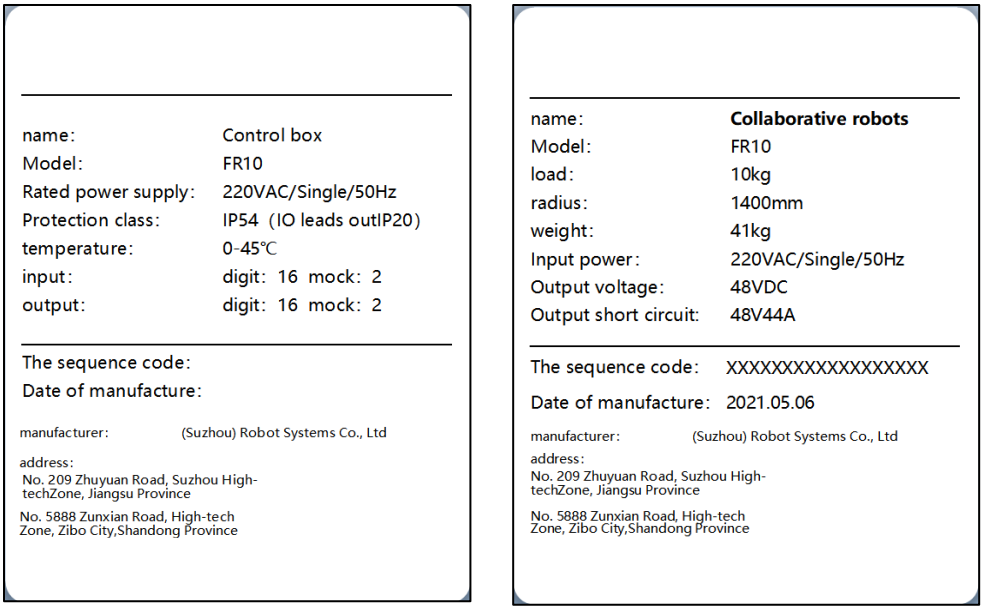


Fig. 1.1-4 FR10 Robot Nameplate Information

FR16 cooperative robot

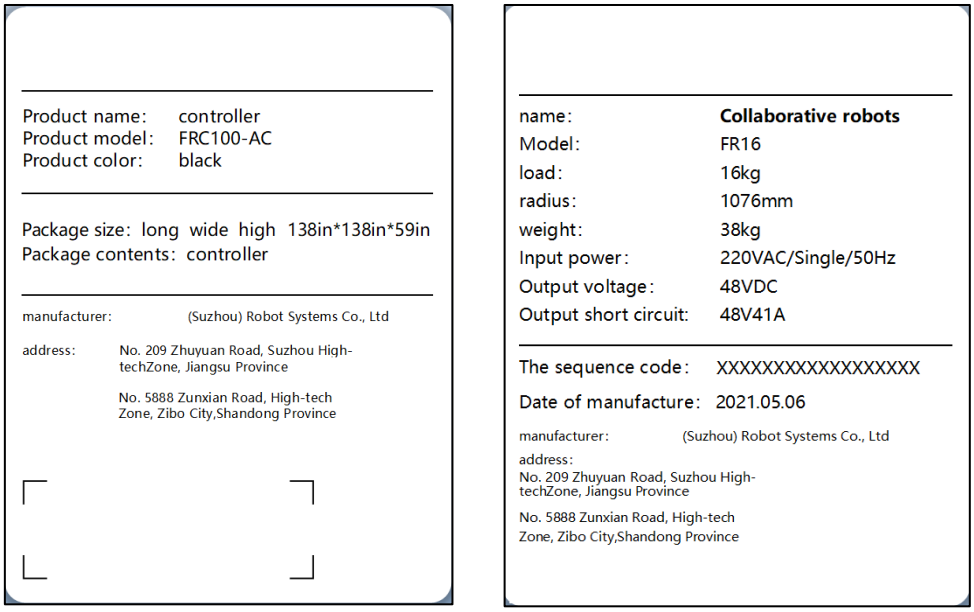


Fig. 1.1-5 FR16 Robot Nameplate Information

FR20 cooperative robot

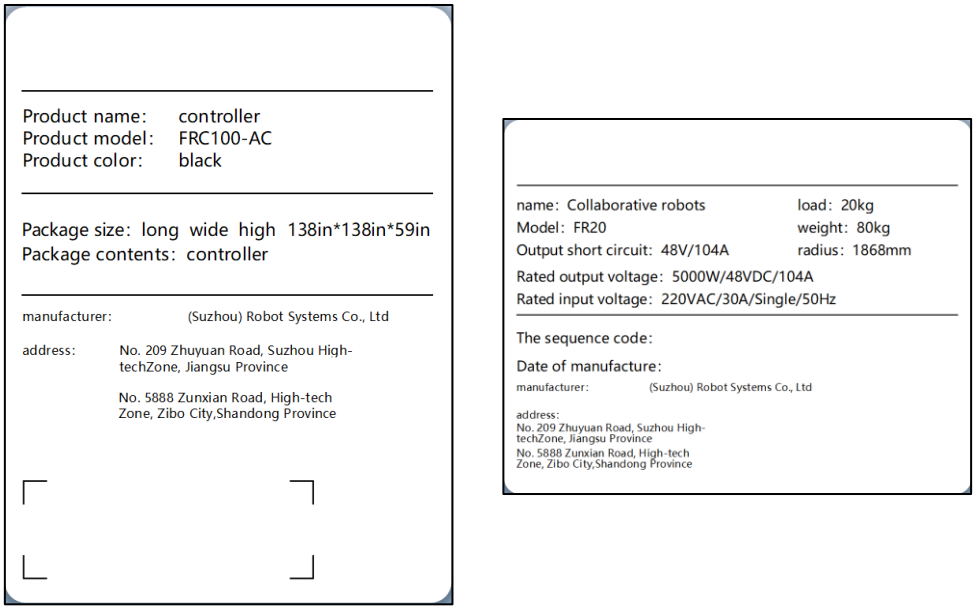


Fig 1.1-6 FR20 Robot Nameplate Information

1.1.6 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 shall meet the safety requirements established in the standards and specifications of the country where the robot is installed.

The integrator of Fair is responsible for ensuring compliance with the laws and regulations of relevant countries 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 of the complete robot system
- Connect other machinery and additional safety equipment defined in the risk assessment
- Establish appropriate security settings in the software
- Ensure that users do not modify any security measures
- Confirm that the design and installation of the entire robot system are correct
- Clear instructions
- Mark the relevant logo and contact information of the integrator on the robot
- Collect all documents in technical documents, including this manual

1.1.7 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 followed, personal injury or equipment damage may still be caused.

1.1.8 Warning signs in this manual

The following signs define the description of hazard class regulations contained in this manual.The same warning signs are used on the product.



DANGER:

This refers to a dangerous power use situation that, if not avoided, could lead to death or serious injury.



Electric shock hazard:

This refers to an electric shock that is about to cause danger. If it is not avoided, it may lead to death or serious injury from electric shock.



Burn hazard:

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

1.1.9 Pre use evaluation

After using the robot for the first time or making any modifications, the default speed of the robot is less than 250mm/s. 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.Confirm 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.So you must:

- Test whether the emergency stop button and input can stop the robot and activate the brake.
- Test whether the protection input can stop the movement of the robot.If a protection reset is configured, check whether activation is required before resuming motion.
- To test whether the operation mode can be switched, see the icon in the upper right corner of the user interface.

- Test whether the 3-gear actuating device must be pressed to start 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.

1.1.10 Emergency stop

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

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

- Extension: 100% (robot arm fully extended horizontally)
- Speed: 100% (generally, the robot speed is set to 100% and moves at the joint speed of 180 °/s)
- Payload: Maximum Payload

Joint 1 and joint 6 test robots move horizontally, and the rotation axis is perpendicular to the ground.The joint 2, joint 3, joint 4, joint 5 test robot follows the vertical trajectory, the rotation axis is parallel to the ground, and stops when the robot moves downward.

Table 1.1-1 Type 0 Stopping Distance (rad)

	Joint 1	Joint 2	Joint 3	Joint 4	Joint 5	Joint 6
FR3	0.47	0.60	0.56	0.29	0.10	0.06
FR5	0.51	0.63	0.60	0.33	0.16	0.10
FR10	0.64	0.70	0.69	0.42	0.25	0.13
FR16	0.60	0.67	0.65	0.39	0.22	0.12
FR20	0.69	0.75	0.80	0.48	0.31	0.22

Table 1.1-2 Type 0 Stop Time (ms)

	Joint 1	Joint 2	Joint 3	Joint 4	Joint 5	Joint 6
FR3	400	470	450	280	120	90
FR5	420	500	480	310	150	120
FR10	460	540	510	330	170	140
FR16	440	530	490	320	160	130
FR20	540	600	700	400	260	170

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

At the same time, the stop time and stop distance for safe stop and soft limit stop of the robot are shown in the table below.These measurements correspond to the following configurations of the robot:

- Extension: 100% (robot arm fully extended horizontally)
- Speed: 100% (generally, the robot speed is set to 100% and moves at the joint speed of 180 °/s)
- Payload: Maximum Payload

Joint 1 and joint 6 test robots move horizontally, and the rotation axis is perpendicular to the ground.The joint 2, joint 3, joint 4, joint 5 test robot follows the vertical trajectory, the rotation axis is parallel to the ground, and stops when the robot moves downward.

Table 1.1-3 Safe Stop Distance (rad)

	Joint 1	Joint 2	Joint 3	Joint 4	Joint 5	Joint 6
FR3	0.49	0.63	0.58	0.32	0.12	0.09
FR5	0.54	0.65	0.63	0.35	0.19	0.12
FR10	0.66	0.73	0.71	0.45	0.27	0.16
FR16	0.63	0.69	0.68	0.41	0.25	0.14
FR20	0.71	0.78	0.82	0.51	0.33	0.25

Table 1.1-4 Safe Stop Time (ms)

	Joint 1	Joint 2	Joint 3	Joint 4	Joint 5	Joint 6
FR3	410	490	410	300	130	110
FR5	450	520	510	330	180	140
FR10	480	570	530	360	190	170
FR16	470	550	520	340	190	150
FR20	560	630	720	430	280	200

Table 1.1-5 Stopping Distance of Soft Limit (rad)

	Joint 1	Joint 2	Joint 3	Joint 4	Joint 5	Joint 6
FR3	0.52	0.65	0.61	0.34	0.15	0.11
FR5	0.56	0.68	0.65	0.38	0.21	0.15
FR10	0.69	0.75	0.74	0.47	0.30	0.18
FR16	0.65	0.72	0.70	0.44	0.27	0.17
FR20	0.74	0.80	0.85	0.53	0.36	0.27

Table 1.1-6 Stop Time of Soft Limit (ms)

	Joint 1	Joint 2	Joint 3	Joint 4	Joint 5	Joint 6
FR3	430	500	430	310	150	120
FR5	460	540	520	350	190s	160
FR10	500	580	550	370	210	180
FR16	480	570	530	360	200	170
FR20	580	640	740	440	300	210

be careful:

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

1.1.11 Movement without electric drive

If the robot joints must be moved but the robot cannot be powered or other emergencies occur, please contact the robot dealer. If necessary, force the mobile robot to rescue the trapped people.

1.2 Equipment transportation

1.2.1 transport

The robot and control box have been calibrated as a complete set of equipment.Do not separate them, as this will require recalibration.

The robot can only be transported in its original packaging.If you want to transport the robot in the future, please store the packaging materials in a dry place.

When the robot is moved from the package to the installation space, the two arms of the robot are held at the same time.Hold the robot until all mounting bolts of the robot base are fastened.

1.2.2 carry

According to different models, the total mass (including packaging) of the cooperative robot ranges from 15kg to 80kg. When carrying or transferring the cooperative robot manually, multiple people are required to assist in lifting. It is not recommended to carry the robot by one person. It must be stable during transportation to prevent the equipment from tipping or sliding.

be careful:

- If professional equipment is used for handling, the cooperative robot must be transported or handled by qualified professionals using cranes or forklifts, otherwise it may cause personal injury or other accidents.
- If manual handling is adopted, please pay attention to personal safety during the handling;
- The cooperative robot contains precision parts. During transportation or handling, severe vibration or shaking should be avoided, or the performance of the equipment may be reduced.

1.2.3 deposit

The cooperative robot shall be stored at - 25~60 ℃ without frost.

1.3 Maintenance and scrapping

1.3.1 Maintenance disposal

Please test the emergency stop and protective stop every 1 month.Judge whether the safety function is effective.

Please refer to the wiring section for emergency stop and protective stop wiring.

1.3.2 Waste disposal

FR robot needs to be disposed according to applicable national laws, regulations and national standards. For details, please contact the manufacturer.

1.4 Introduction to Robot

1.4.1 Basic parameters

Table 1.4-1 Basic Parameters of Robot

	FR3	FR5	FR10	FR16	FR20
load	3kg	5kg	10kg	16kg	20kg
Maximum operating range	622mm	922mm	1400mm	1034mm	1868mm
freedom	6 rotational degrees of freedom				
Repeated positioning accuracy	±0.02mm	±0.02mm	±0.05mm	±0.03mm	±0.1mm
Joint range of motion (soft limit)	1 axis:+175, -175; 2 axis:+85, -265; 3 axes:+150, -150; 4-axis:+85, -265; 5 axis:+175, -175; 6 axis:+175, -175;	1 axis:+175, -175; 2 axis:+85, -265; 3-axis:+160, -160; 4-axis:+85, -265; 5 axis:+175, -175; 6 axis:+175, -175;			
Joint range of motion (hard limit)	1 axis:+179, -179; 2 axis:+89, -269; 3-axis:+152, -152; 4-axis:+89, -269; 5 axis:+179, -179; 6 axis:+179, -179;	1 axis:+179, -179; 2 axis:+89, -269; 3-axis:+162, -162; 4-axis:+89, -269; 5 axis:+179, -179; 6 axis:+179, -179;			
Maximum joint speed	180 degrees/s	180 degrees/s	1,2 joints 120 degrees/s, other joints 180 degrees/s		
Protection grade	IP54				
noise	<65db				
Installation direction	Any direction				
I/O	Power supply (24V, 1.5A), digital IO, analog IO, 485 communication				
Service temperature	0-45℃				
Overall quality	About 15kg	About 20.6kg	About 40kg	About 40kg	About 65kg
Equipment storage	-25~60 ℃ (no frost)				

Mean time to repair	2h

1.4.2 Range of motion

Installation space of mechanical arm:

Installation of robot body requires 3m×3m×2m long×wide×High) space to meet the movement of the robot under the maximum arm extension;If the user increases the end load by himself, please ensure that the installation space has a minimum clearance of 500mm.

Note: The height space is affected by the height of the installation base, where 2m refers to the distance higher than the installation datum plane;

Installation space of control cabinet:

1. The control box shall be placed at 0.6m-1.5m away from the ground for easy operation to prevent electric shock due to flooding.

2. The cabinet must be away from heat sources.

3. One side of the heavy load line of the control box shall be free from obstructions within 150mm, and the other side shall be free from obstructions within 100mm for heat dissipation and easy access.

FR3 cooperative robot

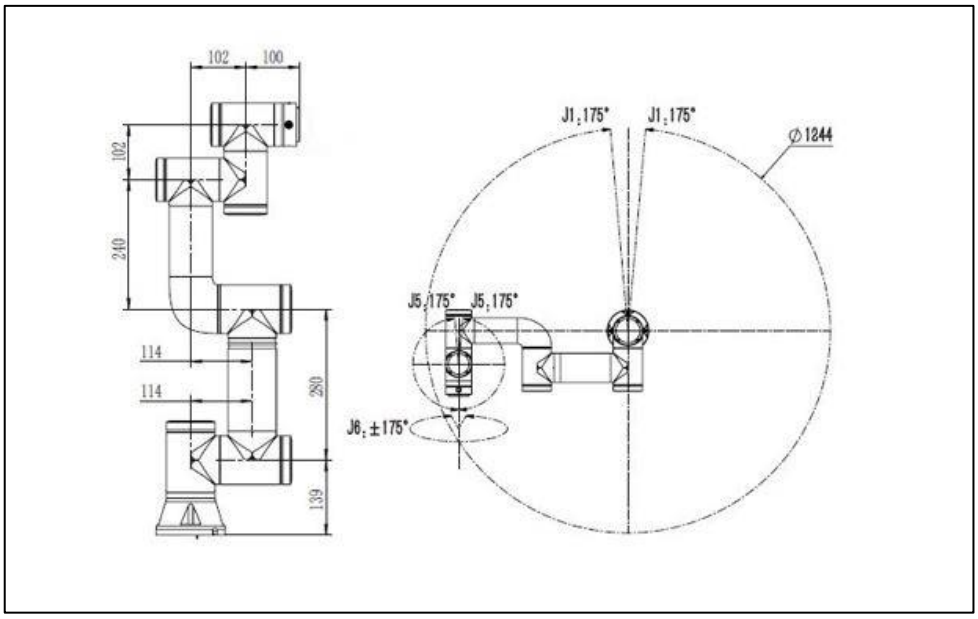


Fig. 1.4-2 FR3 Robot Motion Range

FR5 cooperative robot

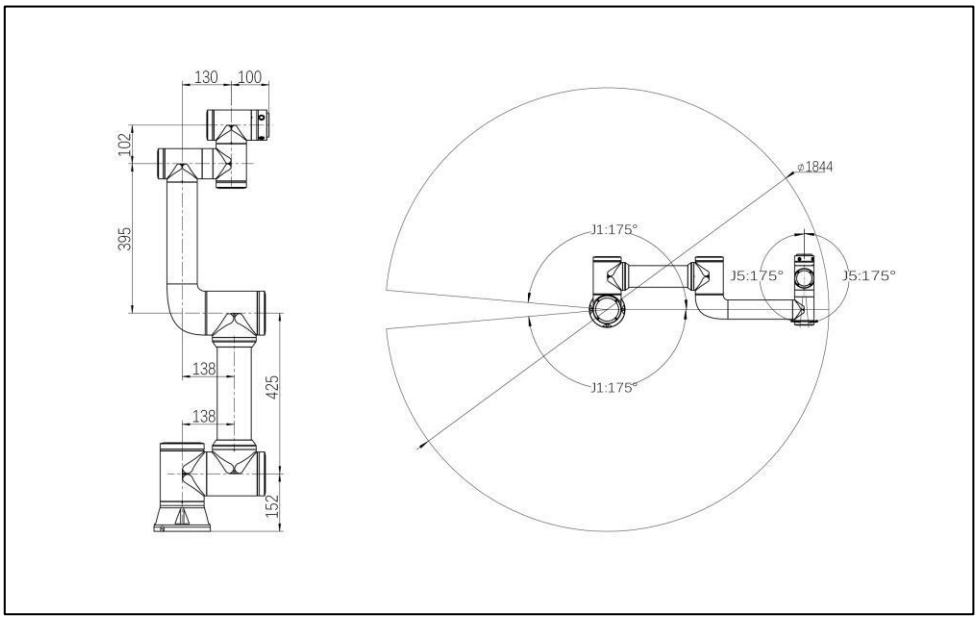


Fig. 1.4-3 FR5 Robot Motion Range

FR10 cooperative robot

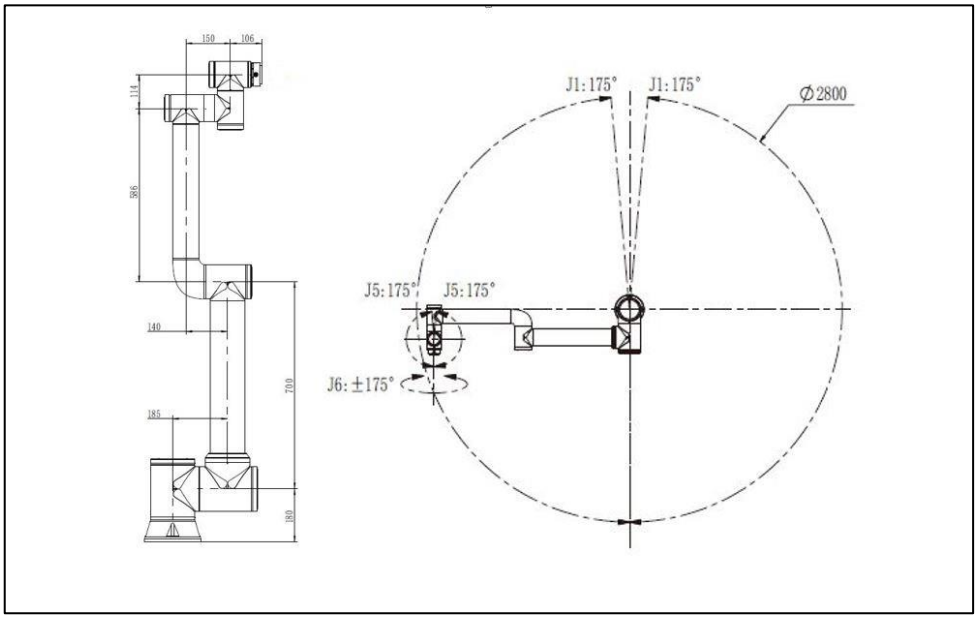


Fig. 1.4-4 FR10 Robot Motion Range

FR16 cooperative robot

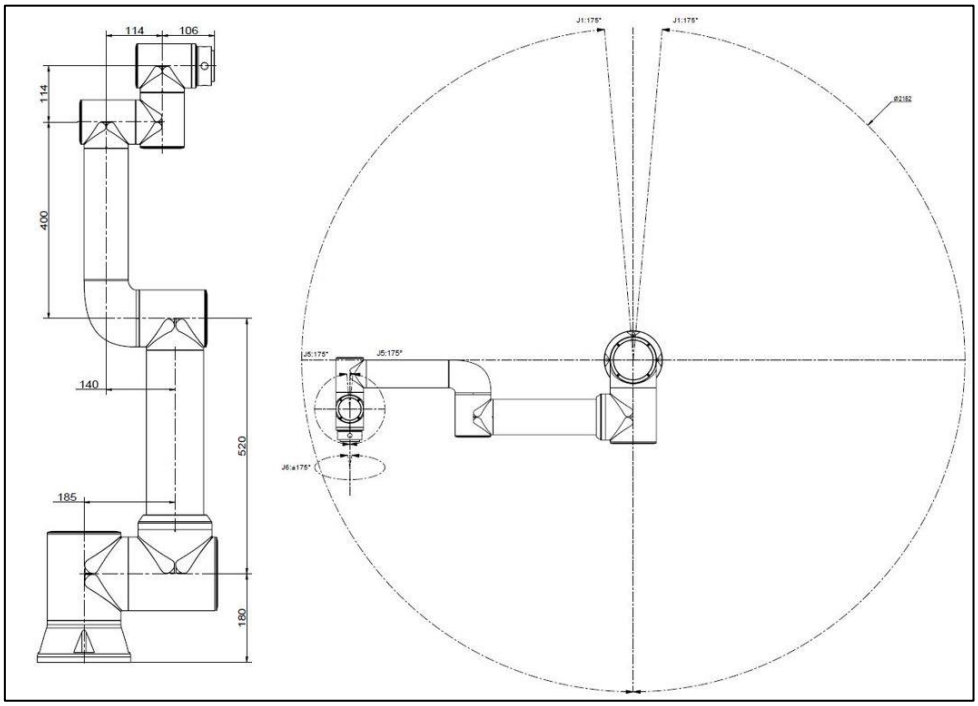


Fig. 1.4-5 FR16 Robot Motion Range

FR20 cooperative robot

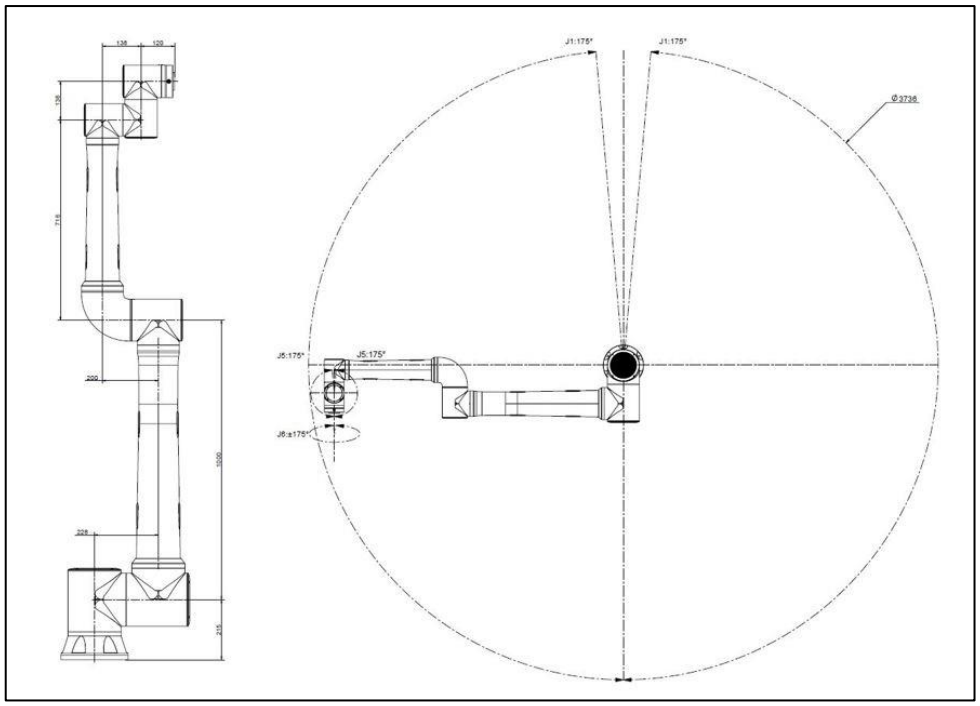


Fig. 1.4-6 FR20 Robot Motion Range

1.4.3 Robot coordinate system

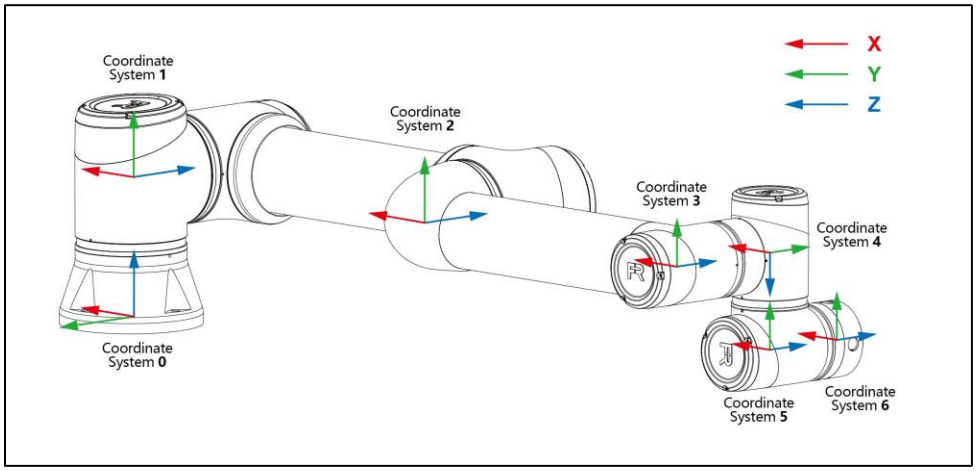


Fig. 1.4-7 Robot Coordinate System

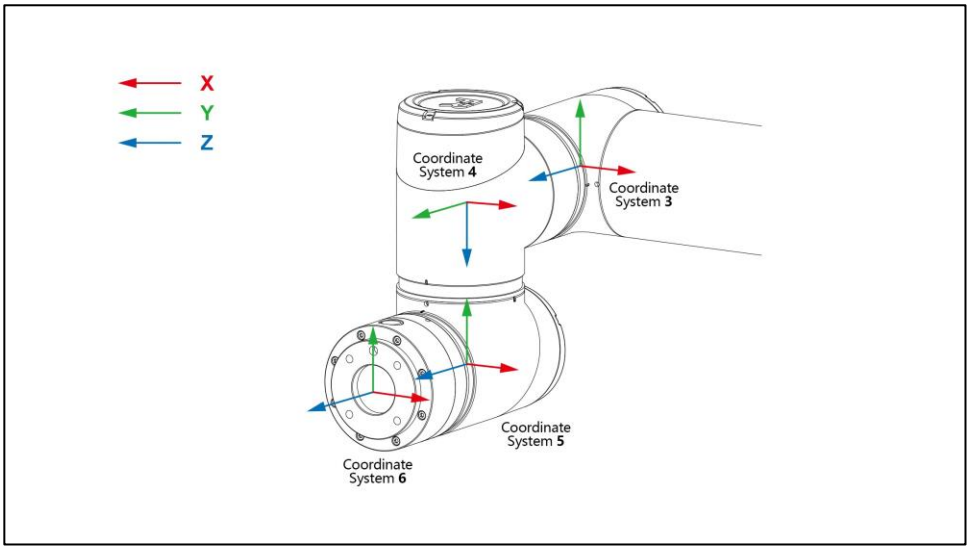


Fig. 1.4-8 Coordinate System of Robot End Flange

1.5 Installation specification

1.5.1 Robot arm installation

The robot arm is installed with 4 M8 bolts with strength no less than 8.8.The bolts must be tightened with a torque of 20 Nm.

Use the two reserved Ø 8 pin holes to accurately reposition the robot arm.Note: Precise bases can be purchased for use as accessories. Fig. 1.5-1 shows the pin hole locations and screw mounting locations.

The robot shall be installed on a solid, vibration free surface, which shall be sufficient to withstand at least 10 times the full torsional force of the base joint and at least 5 times the weight of the robot arm.If the robot is installed on a linear axis or a mobile platform, the acceleration of the mobile mounting base is very low.High acceleration will cause the robot to stop safely.

Installation dimensions of FR3 cooperative robot

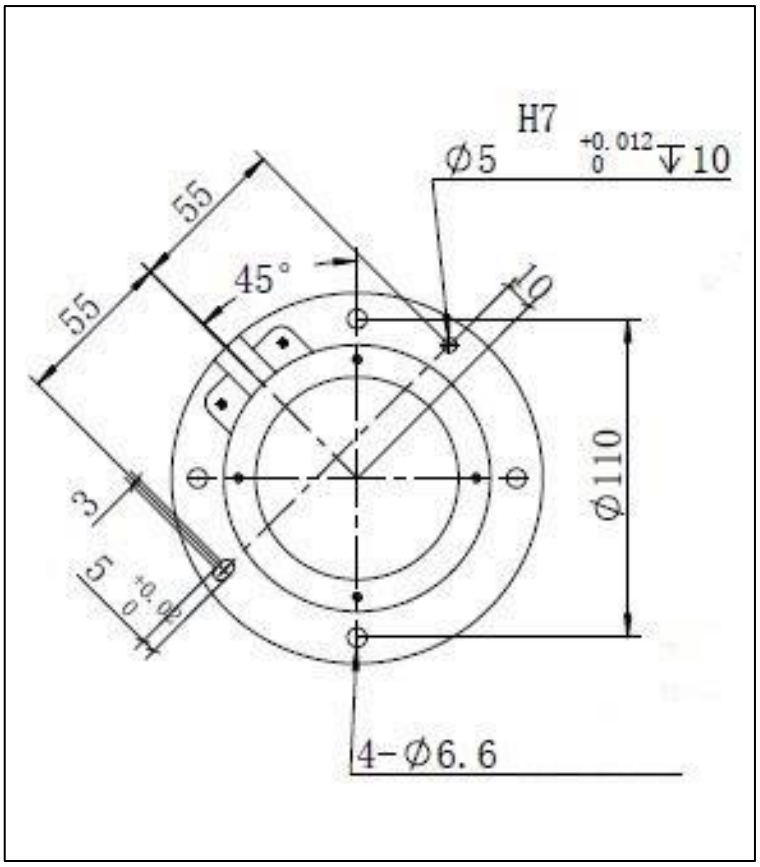


Fig. 1.5-1 Installation Dimensions of FR3 Robot

Installation dimensions of FR5 cooperative robot

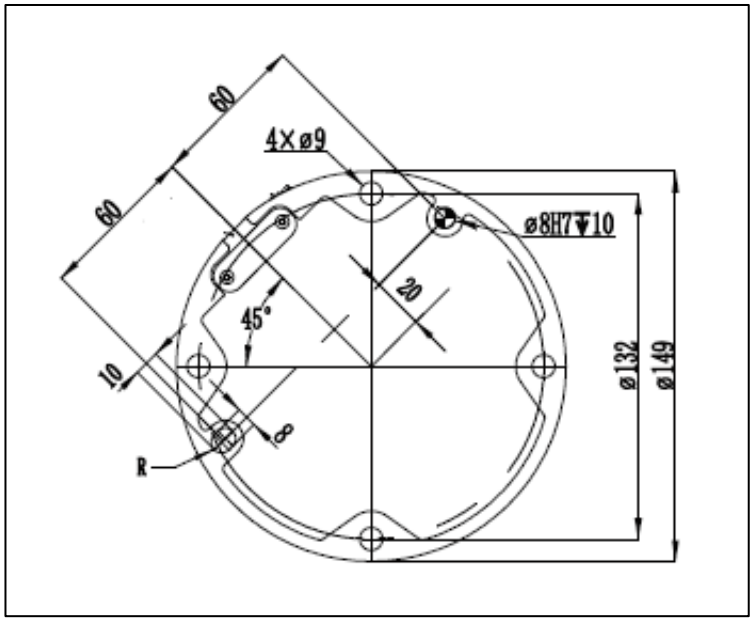


Fig.1.5-2 Installation Dimensions of FR5 Robot

Installation dimensions of FR10 cooperative robot

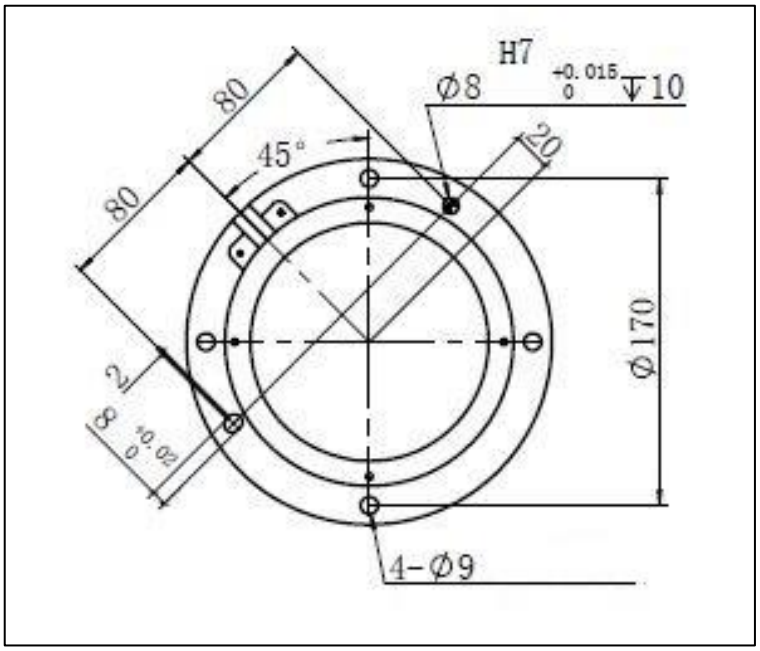


Fig. 1.5-3 Installation Dimensions of FR10 Robot

Installation dimensions of FR16 cooperative robot

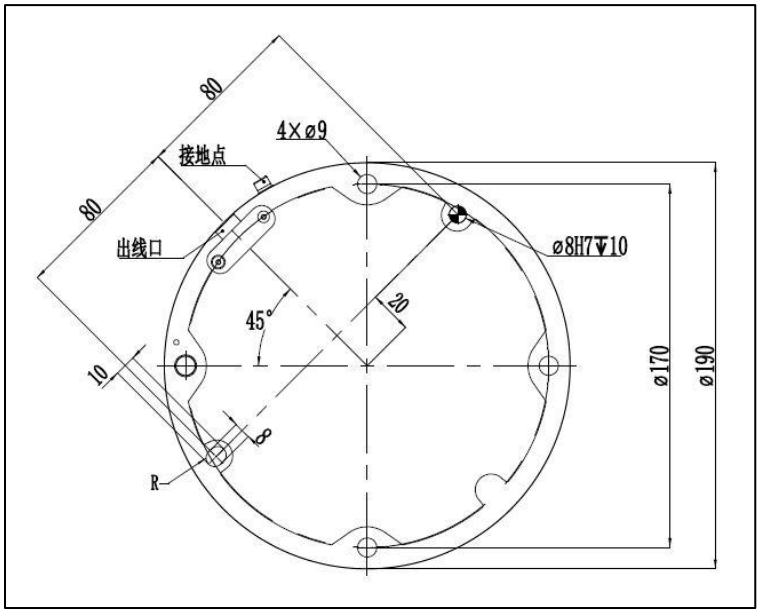


Fig. 1.5-4 Installation Dimensions of FR16 Robot

Installation dimensions of FR20 cooperative robot

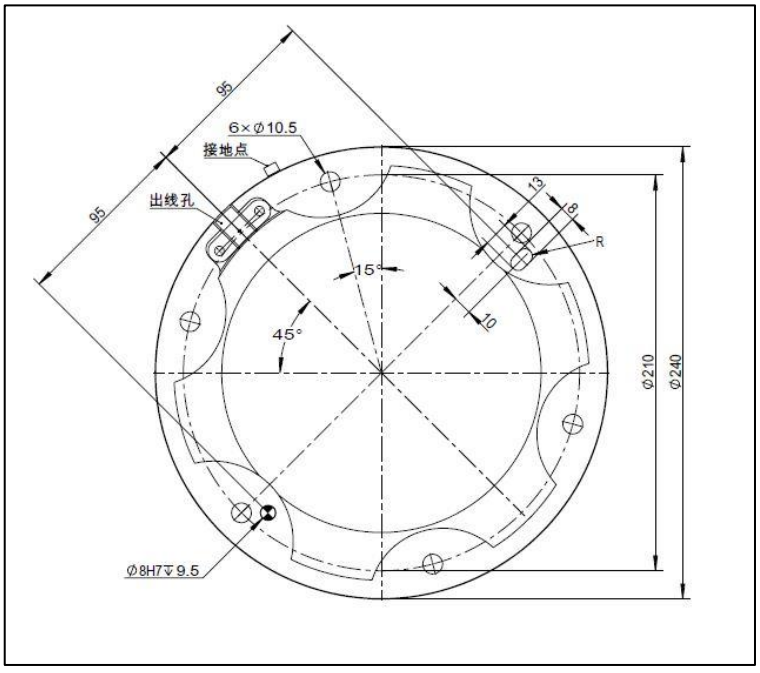


Fig. 1.5-5 Installation Dimensions of FR20 Robot

be careful:

Make sure the robot arm is correctly and safely installed in place. Unstable installation may cause accidents.

1.5.2 Tool end installation

The robot tool flange has four M6 threaded holes for connecting the tool to the robot.M6 bolts must be tightened with a torque of 8 N m, and their strength grade shall not be lower than 8.8.In order to accurately reposition the tool, please use pins in the reserved Ø 6 pin holes.

Chart 1.5-6 shows the drawings of robot tool flanges of FR3, FR5, FR10 and FR16 models.

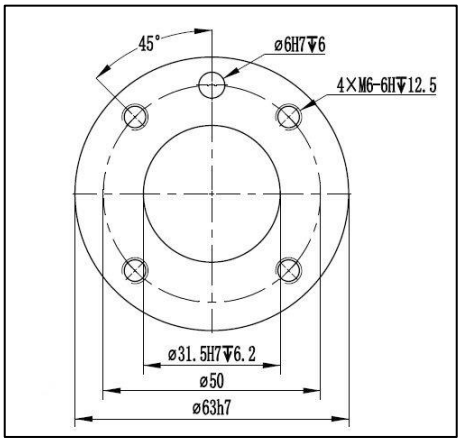


Fig. 1.5-6 Dimensions of Robot End Flange

Fig. 1.5-7 shows the drawing of FR20 robot tool flange.

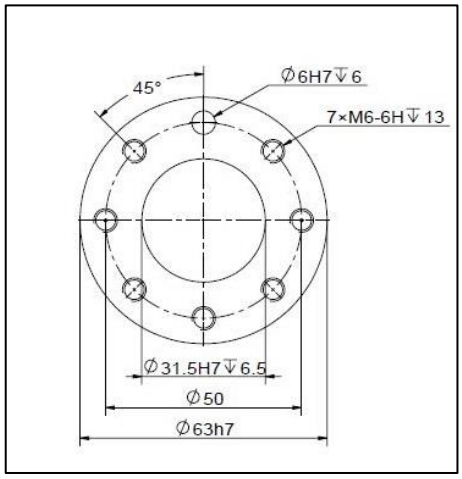


Fig. 1.5-7 Dimensions of FR20 Robot End Flange

be careful:

- Ensure that the tool is correctly and safely installed in place.
- Ensure the safety framework of tools, and there will be no danger caused by accidental falling of parts.
- Installing M6 bolts longer than 8mm on the upper flange of the robot may damage the tool flange and cause irreparable damage, resulting in the need to replace the tool flange.

1.5.3 Installation environment

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

- Ambient temperature 0-45 ℃
- Humidity 20-80RH, no condensation
- No mechanical shock and vibration
- The altitude requirement is below 2000m
- No corrosive gas, no liquid, no explosive gas, no oil stain, no salt mist, no dust or metal powder, no radioactive materials, no electromagnetic noise, and no flammable materials
- Avoid equipment working under unstable current conditions
- The user needs to add an air switch with a turning off capacity of no less than 10A/250V in front of the robot power supply.

be careful:

Please contact us if you want to lift or install the cooperative robot to the vertical surface.

1.5.4 Floor bearing capacity

The robot shall be installed on a solid surface, which shall be enough to bear at least 5 times the weight of the robot arm, and the surface shall be free of vibration.

1.5.5 Maximum payload

The maximum allowable payload of the robot arm depends on the offset of the center of gravity.When the distance between the load center of gravity becomes far, the load borne by the robot will become smaller.

FR3 collaborative robot load curve

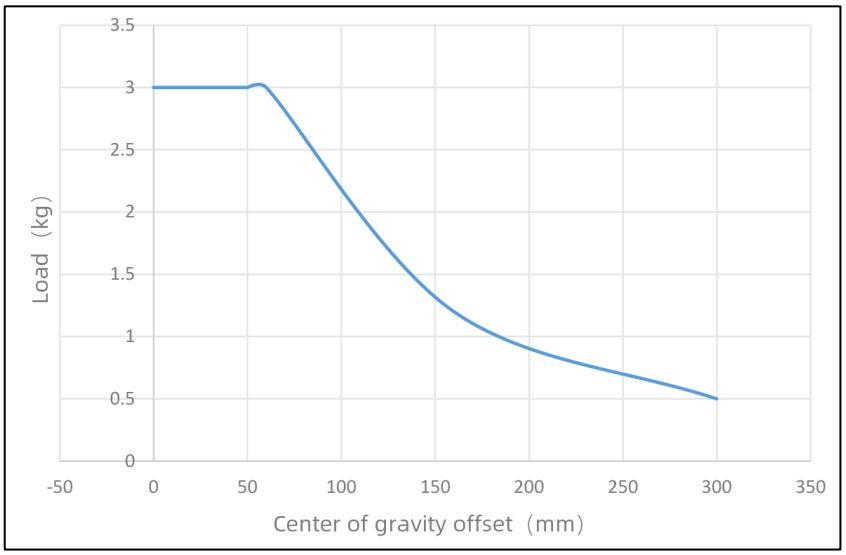


Fig. 1.5-8 Schematic Diagram of FR3 Load Offset

FR5 collaborative robot load curve

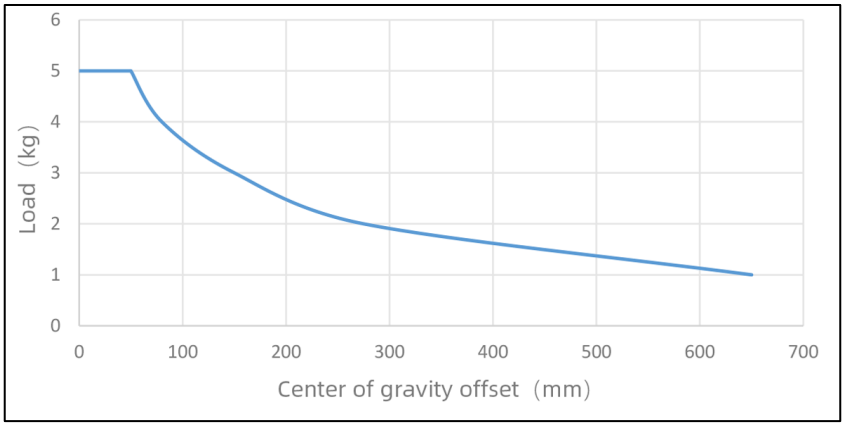


Table 1.5-9 Schematic Diagram of FR5 Load Offset

FR10 collaborative robot load curve

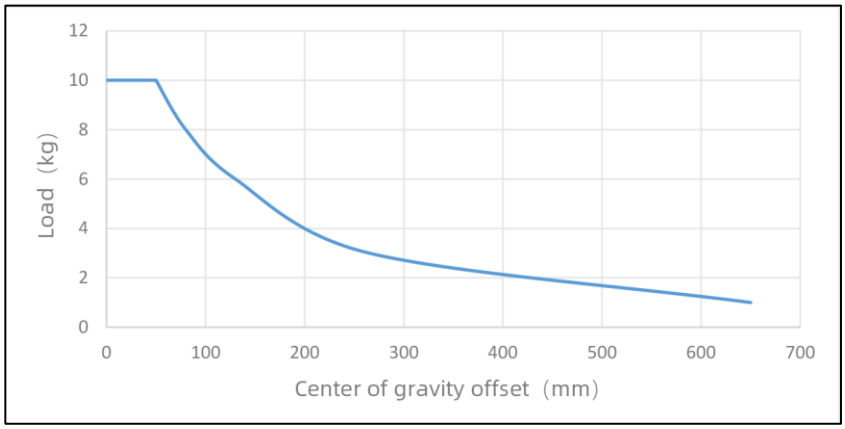


Fig. 1.5-10 Schematic Diagram of FR10 Load Offset

FR16 collaborative robot load curve

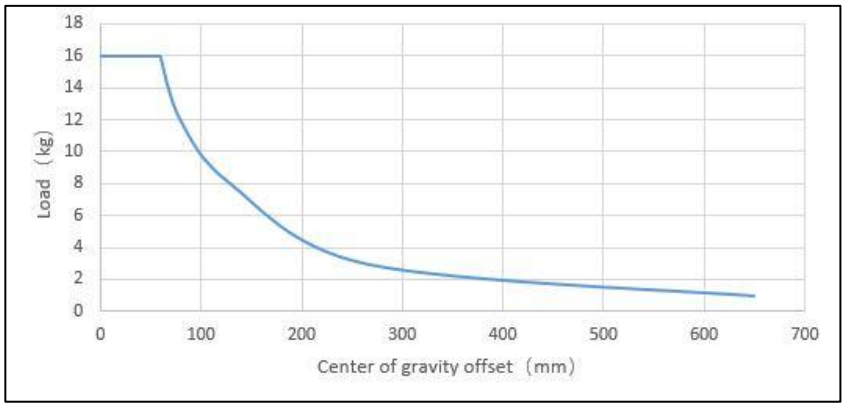


Fig. 1.5-11 Schematic Diagram of FR16 Load Offset

FR20 collaborative robot load curve

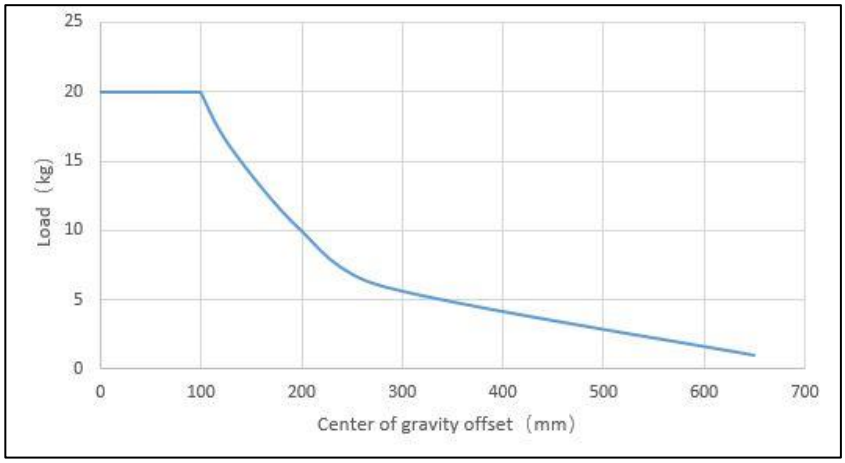


Fig. 1.5-12 Schematic Diagram of FR20 Load Offset

1.6 Control connection

1.6.1 Controller interface

This series of robots use TN-S single-phase 220V AC power supply. The equipment has its own 5m 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/220VAC
- 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 off, and hang a safety warning sign beside it.

The external wires of the control system of this series of manipulators are connected with pluggable plugs that can be quickly installed.The wiring panel of the cooperative robot is shown in Fig. 1.6-1.

- Ensure that the 220V power line is connected to the power socket (the full load input voltage is 6A/220VAC~7A/210VAC) when the power button of the control box is turned off (the button is turned to 0);
- Connect the heavy load cable of the robot body to the heavy load interface of the control box;
- Plug the aviation plug of the button box into the interface of the teaching pendant in the control box;
- The distance between the cooling ports on both sides of the control box shall not be less than 15CM;
- At the front of the control box (user's sheet metal, switch power key,

heavy load and teaching pendant harness), the spacing distance shall not be less than 25CM;

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



Fig. 1.6-1 Control Box Wiring Panel

1.6.2 Controller I/O panel

You can use the I/O in the control box to control various equipment, including pneumatic relay, PLC and stop button of tight limit device.Fig. 1.6-2 shows the electrical interface group of the control box, and Fig. 1.6-3 shows the electrical interface group of the easy to manufacture control box.

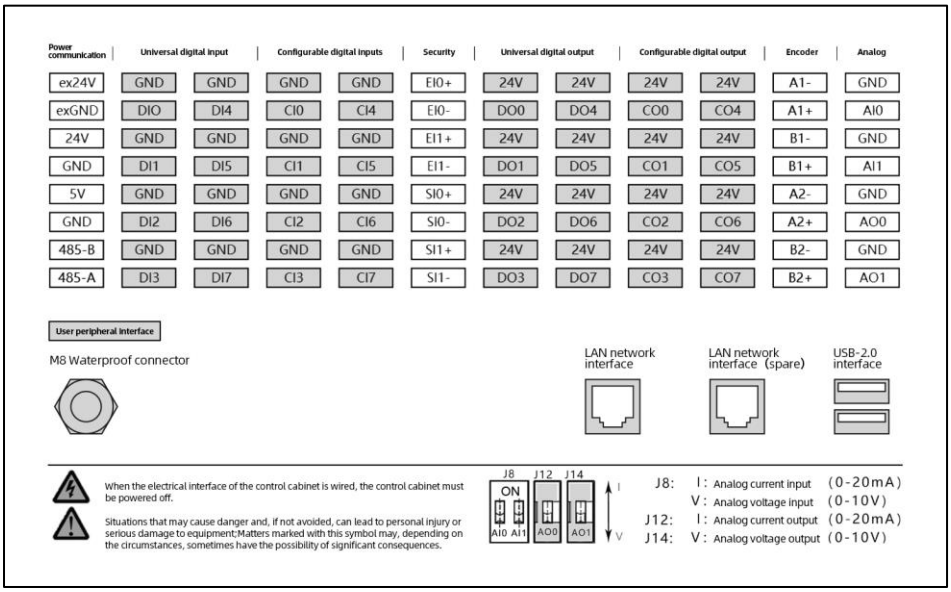


Fig. 1.6-2 Schematic Diagram of Electrical Interface of Control Box

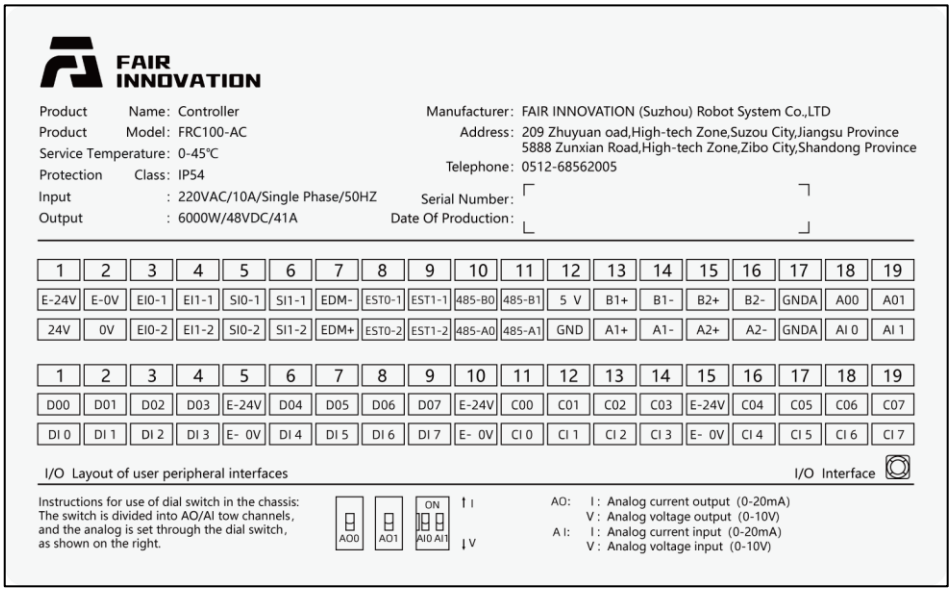
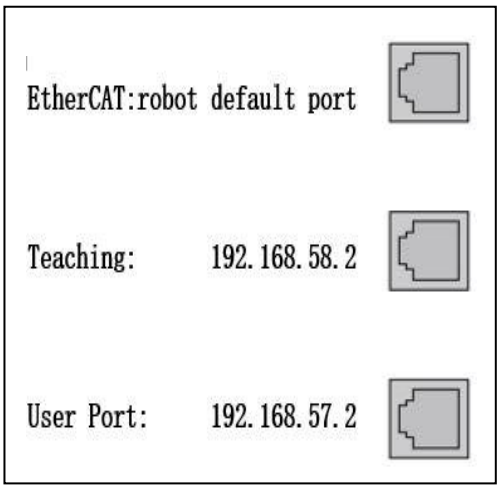


Fig. 1.6-3 Electrical Interface Diagram of Easy to Manufacture Control Box

1.6.3 RJ45 network interface group

The address of the network interface group in the control box is shown in Fig. 1.6-3. Note that this figure corresponds to the order of the address of the internal network interface of the control box, and the robot default port cannot be plugged or unplugged.The user network port can be used to communicate with camera and other devices, and the IP address is 192.168.57.2.The button box interface defaults to the teaching pendant control port, with the 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 to access the teaching pendant page.The easy manufacturing control box accesses the teaching pendant page through the network port connecting the button box.



1.6.4 End plate

You can use the I/O and 485 communication interfaces of the terminal board to control various devices, including pneumatic relays, PLC and emergency stop buttons.Pin pin distribution and pin pin description are shown in Fig. 1.6-4.I/O connector model is M12 connector 8-core female.

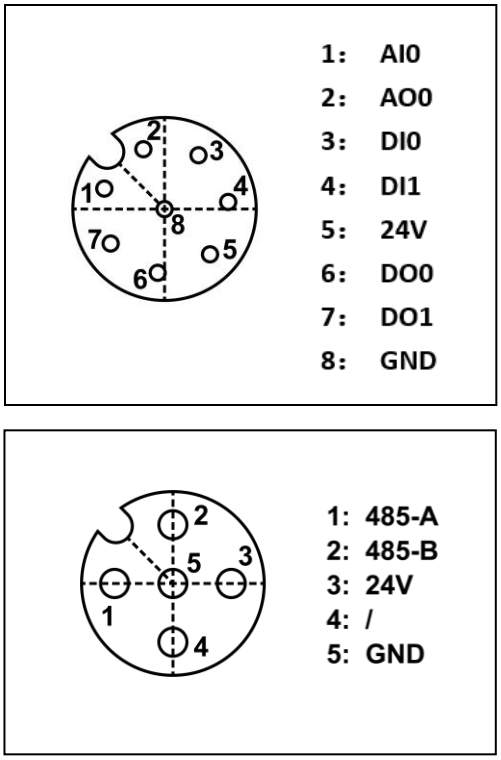


Fig. 1.6-4 Schematic Diagram of Terminal Electrical Interface

1.6.5 Grounding instructions

1. The grounding of the control box is located at the M4 combination screw at the upper left of the power switch, as shown in Fig. 1.6-5.

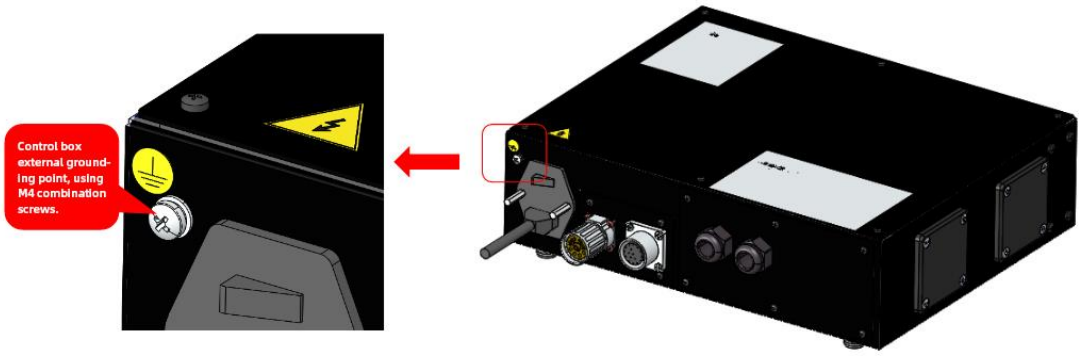


Fig. 1.6-5 Grounding Diagram of Control Box

2. The body grounding is located at the right side of the base outgoing line, as shown in Fig. 1.6-6.

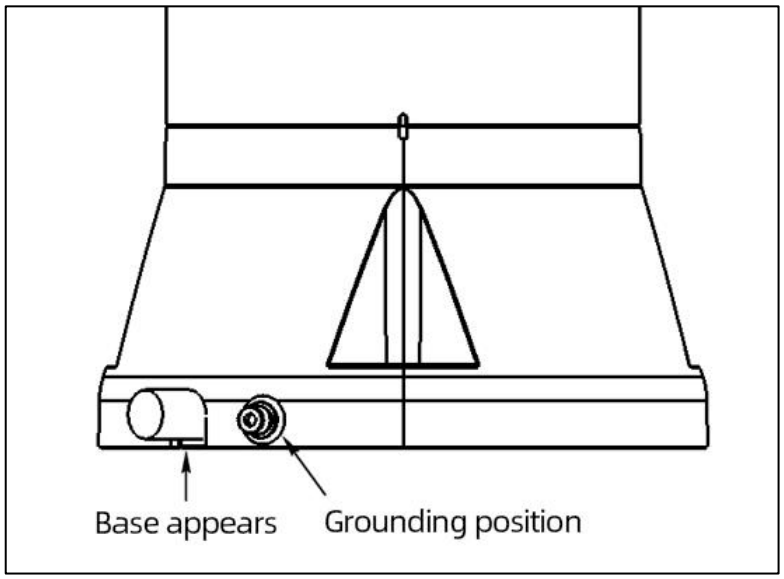


Fig. 1.6-6 Grounding Diagram of Main Body

The sectional area of the separately used protective conductor shall not be less than:

——2.5mm2 copper or 16mm2 aluminum, if mechanical damage protection is provided (conduit, pipe, etc.)

— — 4mm2 copper or 16mm2 aluminum, if no mechanical damage protection is provided

1.6.6 General specification for all digital I/Os

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

- Safety I/O
- General digital I/O

The robot must be installed according to the electrical specifications.

By configuring the "power communication" interface, internal or external 24V power supply can be used to supply power for digital I/O.In this interface, the upper two terminals (ex24V and exon) are 24V and ground of external power supply, and the lower two terminals (24V and GND) are 24V and ground of internal power supply.The default configuration is to use the internal power supply, as shown in Fig. 1.6-7.

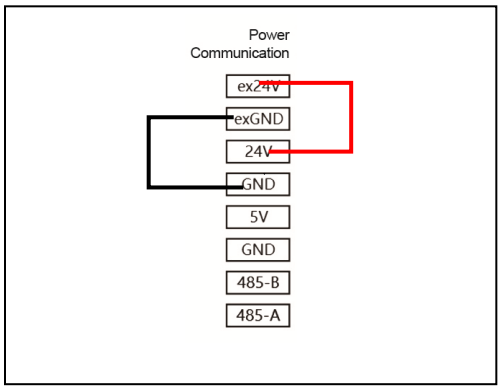


Fig. 1.6-7 Schematic Diagram of Power Communication 01

If the load power is large, the external power supply can be connected as shown in Fig. 1.6-8.

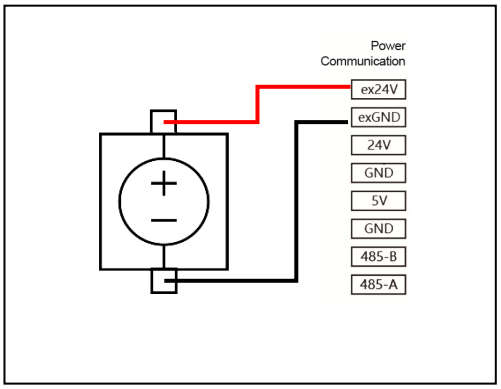


Fig. 1.6-8 Schematic Diagram of Power Communication 02

The electrical specifications of internal and external power supply are shown in Table 1.6-1 Internal and External Electrical Specifications:

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

terminal	parameter	minimum value	Typical value	Maximum	Company
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:

Table 1.6-2 Electrical specifications of digital I/O

terminal	parameter	minimum value	Typical value	Maximum	Company
Digital output					
[COx / DOx]	electric current	0	-	1	A
[COx / DOx]	pressure drop	0	-	0.5	V
[COx / DOx]	Leakage current	0	-	0.1	mA
[COx / DOx]	function	-	NPN	-	Type
Digital 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

1.6.7 Safety I/O

This section describes the electrical specifications for safety I/O, and must comply with section1.6.6General electrical specifications in section.

Safety devices and equipment must be installed in accordance with the safety instructions and risk assessment, see para1.1。All safety I/Os are paired (redundant) and must be saved as two independent branches.A single failure shall not lead to loss of safety function.

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

Table 1.6-3 Functional Differences

	Emergency stop	Safe stop
Robot stops moving	yes	yes
Stop Category	Category 0	Category 1
program execution	stop it	suspend
Robot power supply	close	open
restart	Manual	Automatic or manual
Frequency of use	Infrequent	often
Reinitialization required	need	unwanted

DANGER:

- Never connect safety signals to a PLC that does not have the correct safety level.Failure to observe this warning may result in serious injury or death, as one of the safety stop functions may be overridden.The safety interface signal must be separated from the normal I/O interface signal.
- All safety related I/Os are redundant (two independent channels).The two channels must be kept separate so that a single failure does not result in a loss of safety function.
- Before putting the robot into operation, the emergency stop safety function must be verified (the robot is powered on, press the emergency stop button, the robot is powered off and stopped, the power is turned off, the emergency stop button is rotated, the power is turned on, and the robot is powered on again).The safety function must be tested regularly.
- The robot installation shall comply with these specifications.Otherwise, serious injury or death may be caused because the safety stop function may be bypassed.

The following sections give some examples of how to use safe I/O.

Default Security Configuration

The robot is delivered with default configuration, and can be operated without any additional safety equipment. See Fig. 1.6-9.

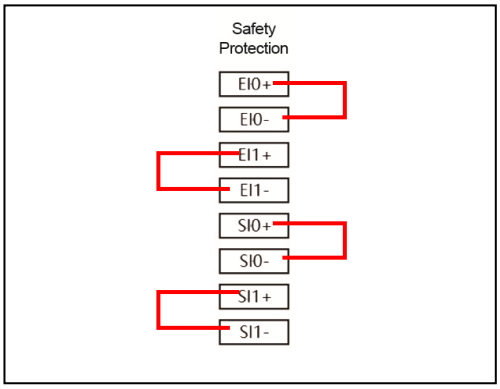


Fig. 1.6-9 Safety Protection Diagram 01

Connect the emergency stop button

In most applications, one or more additional emergency stop buttons are required.See Fig. 1.6-10.

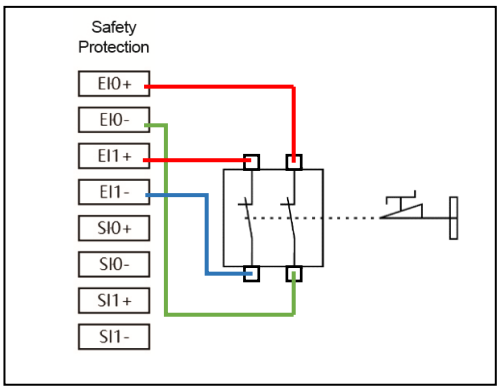


Fig. 1.6-10 Safety Protection Diagram 02

Connect security stop button

An example of a safety stop device is the door switch that stops the robot when the door is open, as shown in Fig. 1.6-11.

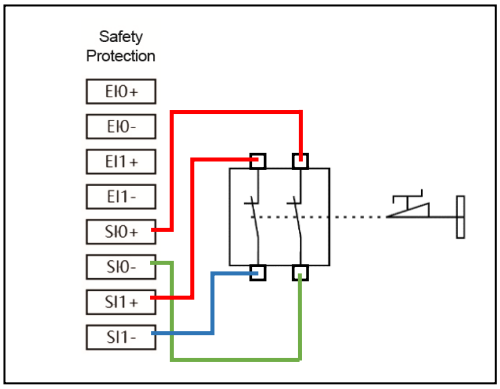


Fig. 1.6-11 Safety Protection Diagram 03

1.6.8 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 1.6.6.

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

Digital output control load

This example demonstrates how to connect the digital output to control the load, see Fig. 1.6-12.

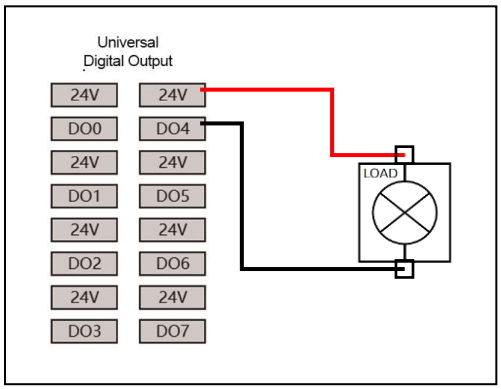


Fig. 1.6-12 Schematic Diagram of Universal Digital Output 01

1.6.9 Digital input from button

The following example shows how to connect a simple button to a digital input.

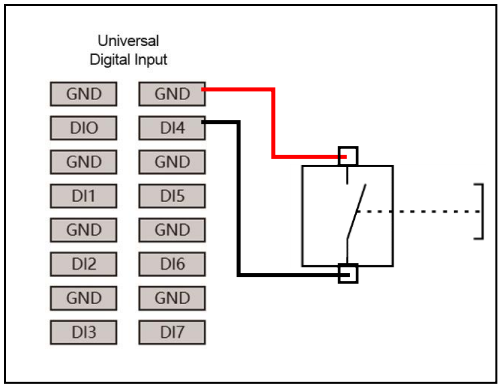


Fig. 1.6-13 Schematic Diagram of Universal Digital Input 02

1.6.10 Interaction with other equipment or PLC

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

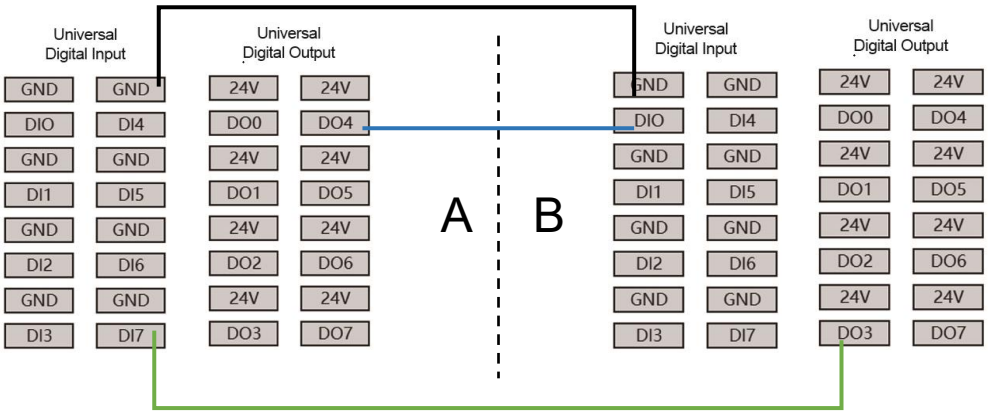


Fig. 1.6-14 Schematic Diagram of Interaction with Other Equipment or PLC

1.6.11 Analog quantity I/O

Table 1.6-4 Analog Current and Voltage

terminal	parameter	minimum value	Typical value	Maximum	Company
Analog current input					
[AIx - END]	electric current	0	-	20	mA
[AIx - END]	impedance	-	500	-	ohm
[AIx - END]	resolving power	-	12	-	bit
Analog quantity voltage input					
[AIx - END]	Voltage	0	-	10	V
[AIx - END]	impedance	-	510	-	Kohm
[AIx - END]	resolving power	-	12	-	bit
Analog current output					
[AOx - END]	electric current	0	-	20	mA
[AOx - END]	Voltage	0	-	10	V
[AOx - END]	resolving power	-	12	-	bit
Analog quantity voltage output					
[AOx - END]	Voltage	0	-	10	V
[AOx - END]	electric current	0	-	20	mA
[AOx - END]	impedance	-	100	-	ohm
[AOx - END]	resolving power	-	12	-	bit

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.

- The 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.

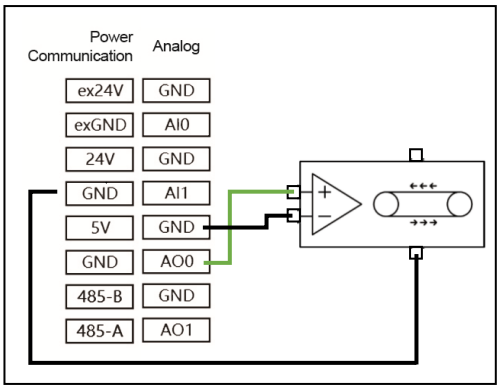


Fig. 1.6-15 Schematic Diagram of Analog Output

Use analog input

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

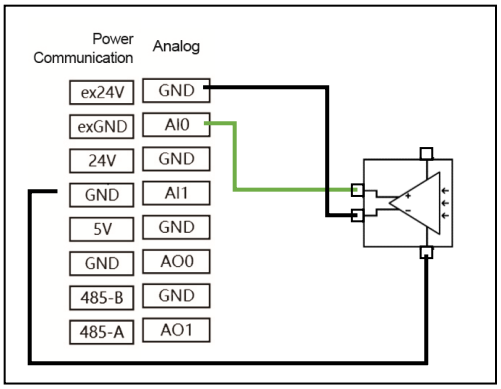


Fig. 1.6-16 Schematic Diagram of Analog Input

1.7 Teaching pendant and end LED

The robot teaching device can use a computer or tablet to access and control the robot. For the connection method, please refer to section 1.6.3. In addition, users can also use our FR-HMI teaching device, which is an optional part.

1.7.1 Introduction to Button Box

The first version of button box

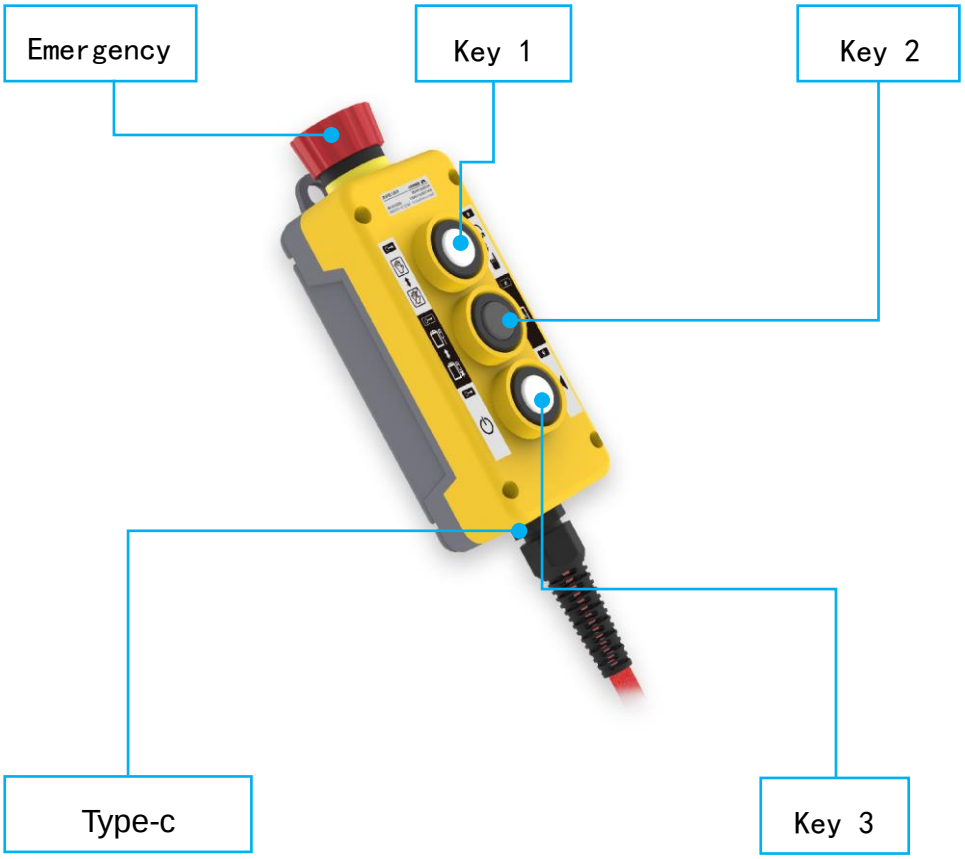


Fig. 1.7-1 The first version of button box

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

Type-c interface: the port to connect the web teaching pendant.

Key 1: Short press to switch between automatic mode and manual

mode, long press to enter/exit drag mode.

Key 2: Short press to record the teaching point, long press to enter/exit the state without teaching device.

Key 3: Short press Start/Stop to run the program.

Version 2 button box

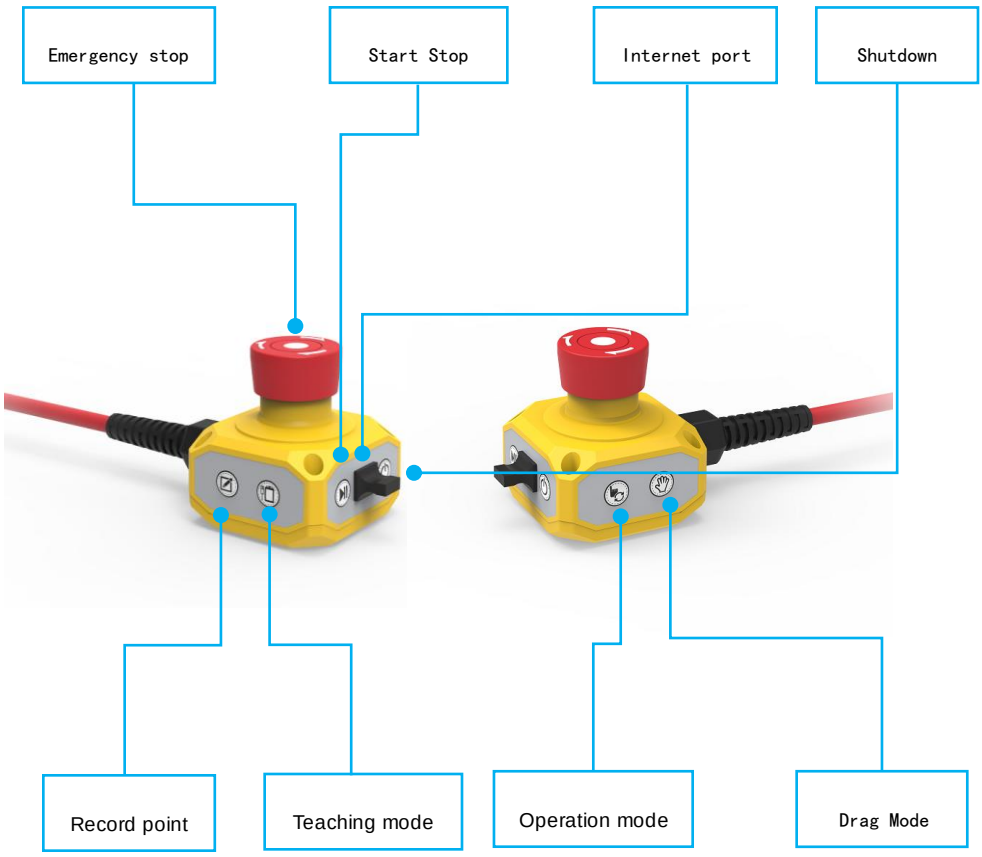


Fig. 1.7-2 Second version button box

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

Start stop: start/stop running the program.

Internet port: connect to the web teaching device.

Shutdown: not enabled temporarily.

Record point: record teaching point.

Teaching mode: enter/exit the state of matching teaching pendant.

Operation mode: automatic/manual mode switching.

Drag mode: enter/exit drag mode.

1.7.2 Introduction to FR-HMI Teaching pendant



Fig. 1.7-3 FR-HMI teaching pendant front

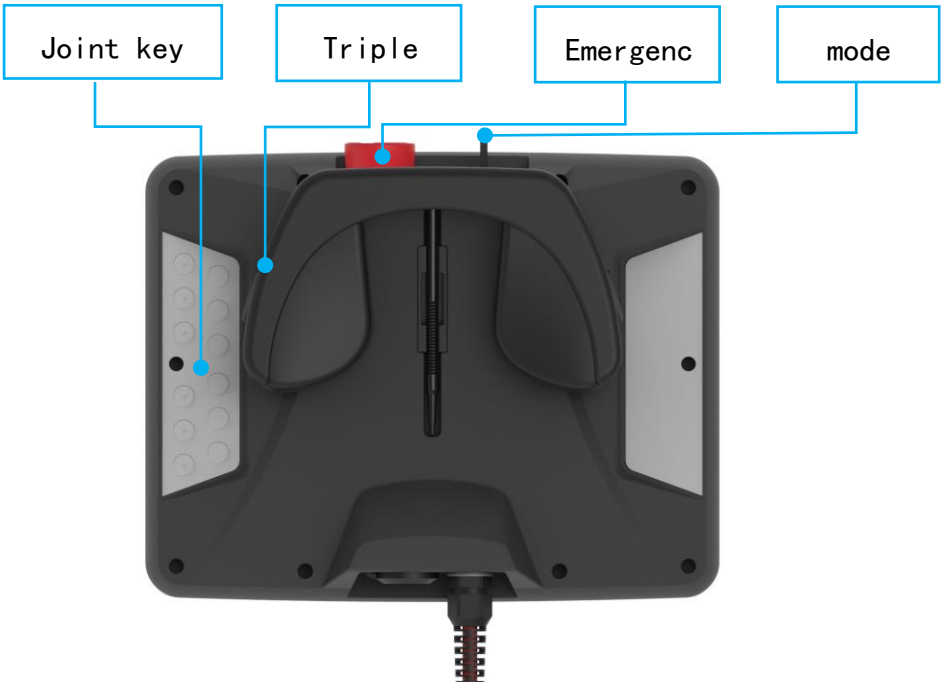


Fig. 1.7-4 FR-HMI teaching pendant back

Display screen: touch operation and display interface of teaching pendant.

Start key: start the program.

Stop key: stop the currently running program.

F4 key: enter the keyboard to call the key.

Joint key: robot joint inching.

Three position enabling: manual mode enabling robot

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

Mode key: rotate the button to switch between manual and automatic mode.

1.7.3 End LED definition

Table 17-1End LED definition table

function	LED color
When communication is not established	Alternating "off", "red", "green" and "blue"
Automatic mode	Long bright blue
Manual mode	Green light
Drag Mode	White cyan is always bright
Button box record point (only when using button box)	Two purple flashes
Enter the state of unmatched button box (only when using the button box)	Twinkle blue
Start running (only when using the button box)	Blinking blue twice
Stop operation (only when using the button box)	Red flashes twice
Error reporting (only when using the button box)	Red long bright
Zero calibration completed	Three flashes of white and cyan
De enable	Twice flashing yellow

Chapter II Quick Start Robot

2.1 Installation of robot arm and control box

According to the1.5and1.6Install and connect the robot arm and the control box.

- Unpack and take out the robot arm, and install the robot arm with 4 M8 bolts with strength no less than 8.8.Install the robot arm on a firm and shockproof surface. If it is fixed with aluminum plate, the thickness of aluminum plate shall not be less than 16mm. If it is fixed with iron plate, the thickness of iron plate shall not be less than 8mm;
- Place the control box on its feet;
- 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 pendant in the control box. If a touch screen teaching pendant is equipped, a data cable with Type-c interfaces at both ends needs to be used to respectively plug into the Type-c interfaces of the button box and the teaching pendant;
- Ensure that the 220V power line is connected to the power socket when the power button of the control box is off (the button is turned to 0);
- Plug in the power control box plug.

DANGER:

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

2.2 Teaching pendant start control robot

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

- Press the power button of the control box to start the control box;
- After starting the robot, the robot is in the manual mode and is not enabled. If you need to operate the robot in the manual mode, you need to press the three position enable switch on the teaching pendant OFF (release) ⇒ ON ⇒ OFF (press). When the switch is in the ON state, drag or control the robot movement.
- If it is not necessary to operate the robot in manual mode, the key switch rotary button on the teaching pendant can be used to switch the working mode of the robot: automatic, manual, user-defined;
- When switching the manual status of the robot, check whether there are abnormalities inside and outside the safety space, and operate the machine carefully;
- When switching the automatic state of the robot, check the safety measures and restore to the normal state, and carefully operate the machine;
- When the teaching pendant cannot be opened normally, please check whether the device connection is normal.

2.3 Button box controls robot movement

Refer to Chapter I1.7.3End LED definition to control the robot

2.3.1 Not equipped with teaching pendant

- Step 1, turn on the power switch of the robot control box, start the robot, wait until the LED at the end turns green, and then operate the robot as shown in Fig. 2.3-1.

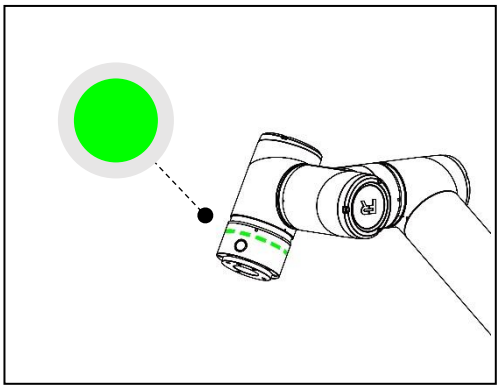


Fig. 2.3-1 Schematic diagram of end LED green

- Step 2, long press the button box "key 2" to enter the mode without teaching pendant, and the end LED flashes blue three times, as shown in Fig. 2.3-2.

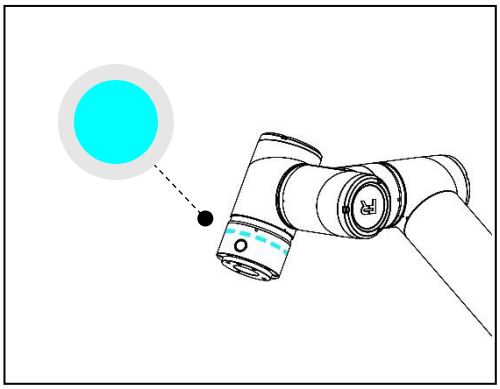


Fig. 2.3-2 Schematic diagram of end LED cyan

- Step 3, long press the button box "key 1" to switch the robot to the drag mode. At this time, the end LED is white cyan, as shown in Fig. 2.3-3. Move the robot to any position, long press the "key 1" to exit the drag mode, short press the button box "key 2" to record P1 points, and the end LED flashes purple three times, as shown in Fig. 2.3-4.

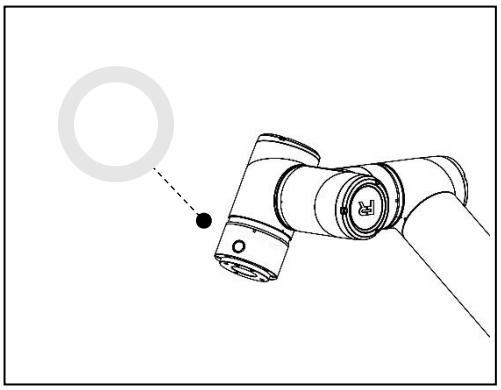


Fig. 2.3-3 Schematic diagram of white cyan LED at the end

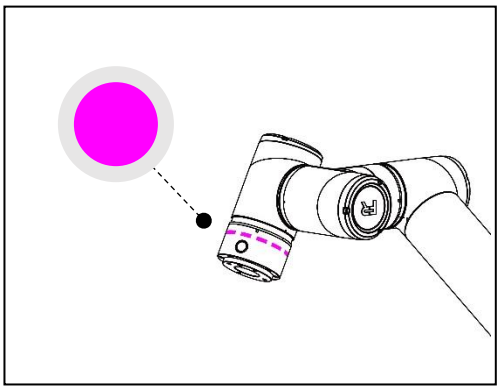


Fig. 2.3-4 Schematic diagram of end LED purple

- Step 4, mobile robot, press the button box "key 2" briefly to record P2 point, and the end LED flashes purple three times, as shown in Fig. 2.3-5.

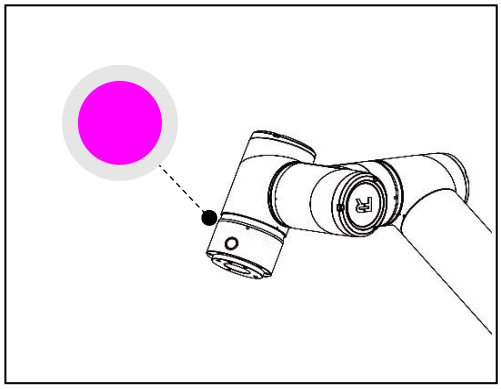


Fig. 2.3-5 Schematic diagram of end LED purple

- Step 5, long press the button box "key 1" to exit the drag mode. At this time, it is the manual mode, and the end LED is green, as shown in Fig. 2.3-6. Shortpress the "key 1" to switch the robot to the automatic mode, and the end LED is blue, as shown in Fig. 2.3-7.

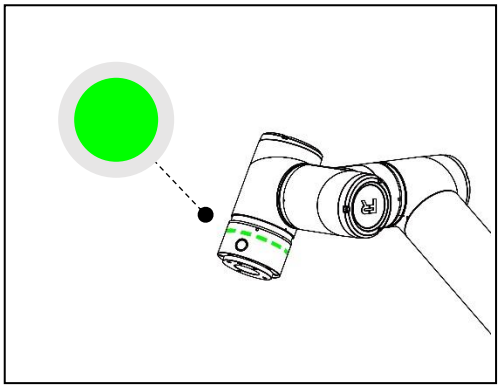


Fig. 2.3-6 Schematic diagram of end LED green

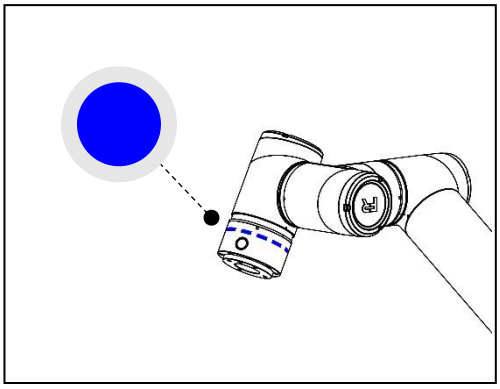


Fig. 2.3-7 Schematic diagram of end LED blue

- Step 6, press the button box "key 3" briefly to run the program, and the LED at the end flashes blue twice, as shown in Fig. 2.3-8.

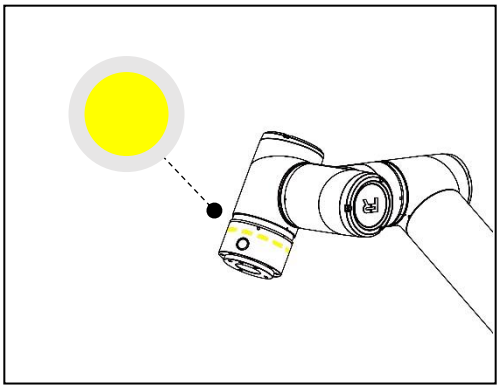


Fig. 2.3-8 Schematic diagram of end LED yellow

- Step 7, briefly press the button box "key 3" to stop the program, and the LED at the end flashes red three times, as shown in Fig. 2.3-9.

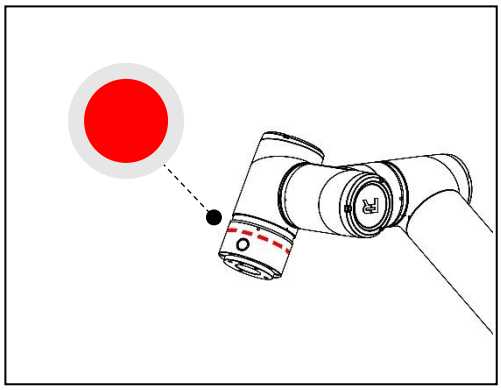


Fig. 2.3-9 Schematic diagram of end LED red

2.3.2 With teaching pendant

- Step 1, start the robot, wait for the end LED to stop flashing green, as shown in Fig. 2.3-10, and then operate the robot.

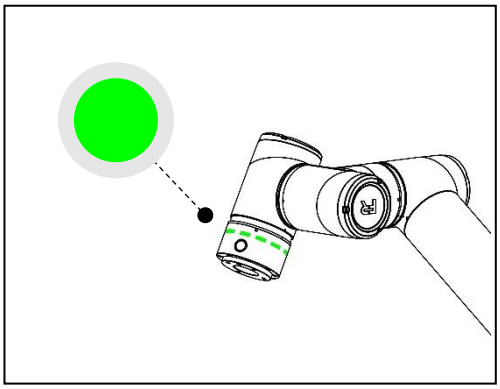


Fig. 2.3-10 Schematic diagram of end LED green

- Step 2, open the teaching pendant to enter the program editing interface.
- Step 3, select a blank template to create a new program file.

- Step 4, briefly press button 1 of the button box to switch the robot to manual mode, and the LED at the end is green, as shown in Fig. 2.3-11.

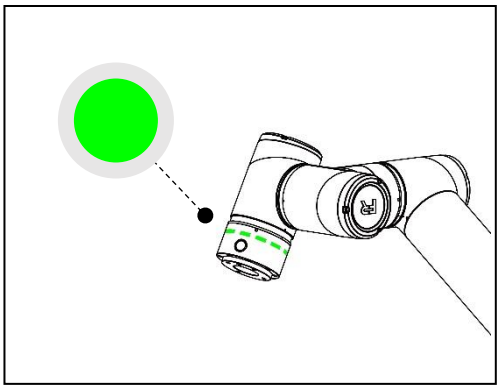


Fig. 2.3-11 Schematic diagram of end LED green

- Step 5, long press button 1 of the button box to switch the robot to the dragging mode. At this time, the LED at the end is white cyan. Move the robot to any position. Press button 2 of the button box briefly to record P1 points. The LED at the end flashes purple three times. Manually add the "PTP: P1" command to the program file.

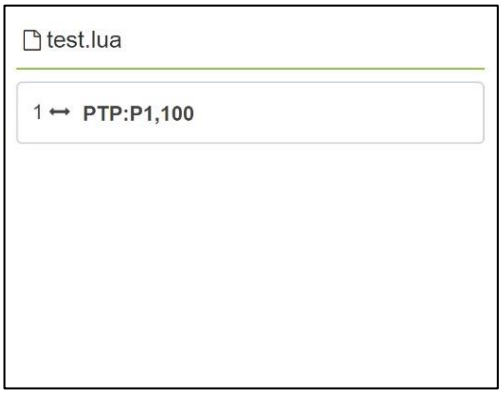


Fig. 2.3-12 Record and add point P1

- Step 6, mobile robot, press button 2 of the button box briefly to record P2 point, the LED at the end flashes purple three times, and manually add "PTP: P2" command to the program.

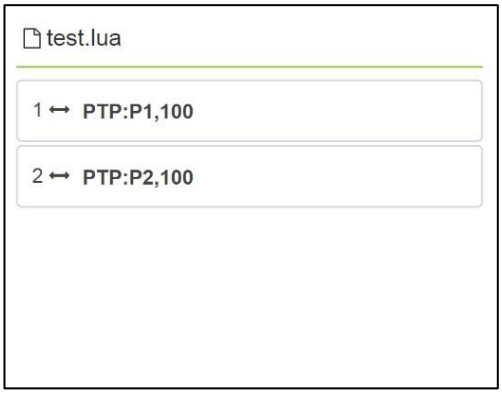


Fig. 2.3-13Record and add point P2

- Step 7, save the contents of the program file.
- Step 8, long press button 1 of the button box to exit the drag mode. At this time, it is manual mode, and the end LED is green, as shown in Fig. 2.3-14. Short press button 1 of the button box to switch the robot to automatic mode, and the end LED is blue, as shown in Fig. 2.3-15.

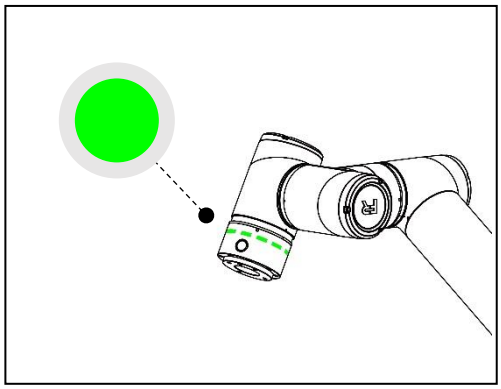


Fig. 2.3-15 Schematic diagram of end LED green

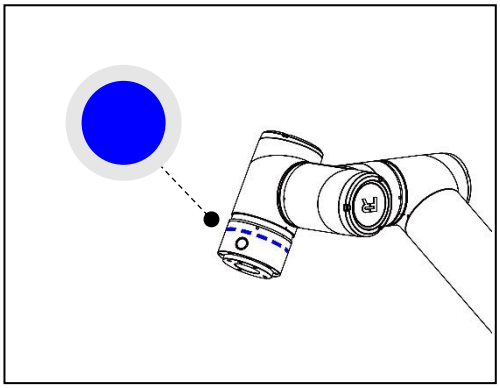


Fig 2.3-14 Schematic diagram of end LED blue

- Step 9, press button 3 of the button box briefly to run the program, and the LED at the end flashes blue twice, as shown in Fig. 2.3-16.

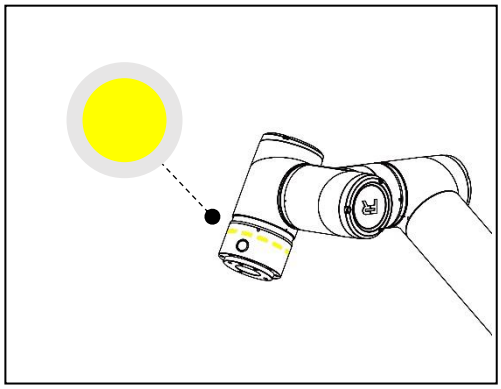


Fig. 2.3-16 Schematic diagram of end LED yellow

2.4 Teaching pendant controls robot movement

Click the "Teaching Simulation" button in the primary menu on the left side of the teaching pendant, 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 and selects a template as the content of the new file. Click New to successfully create and open the program file.

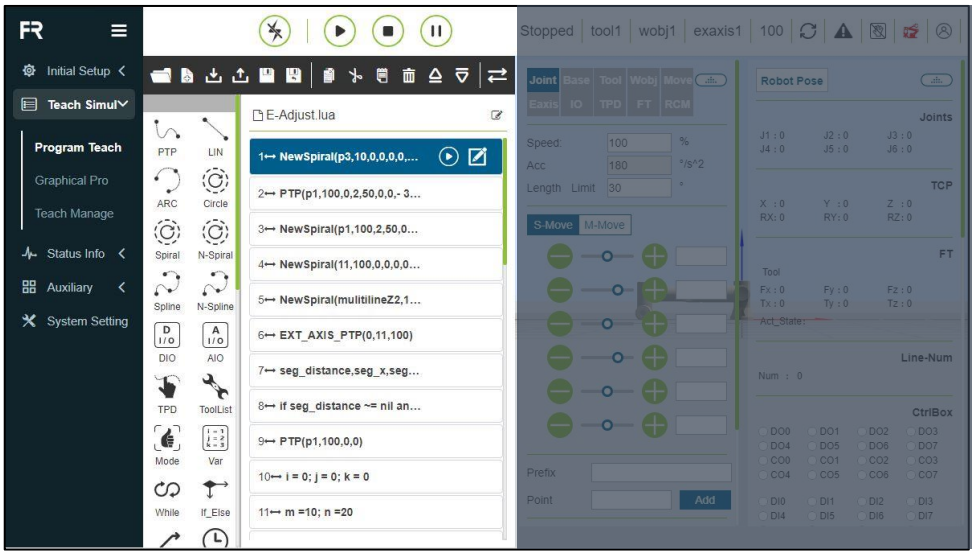


Fig. 2.4-1Schematic diagram of teaching program operation

Warning:

Your head and torso cannot be within the reach of the robot (work area). Please do not put your finger where the robot can hold it.

be careful:

- Do not let the robot move into itself or other objects, as this will cause damage to the robot.
- This is just a quick start guide to teach you how to use FR robot easily. The premise of this guide is that the environment is safe and the user is careful. Please do not increase the speed or acceleration above the default value. Always conduct a risk assessment before putting the robot into operation.

Chapter III Teaching pendant software analysis

3.1 Basic information

3.1.1 System Introduction

The teaching pendant software is a supporting software developed for robots and runs in the teaching pendant operating system. Its main functions and technical features are as follows:

- Be able to write teaching programs for robots;
- Real time display of robot position coordinates, 3D simulation of solid robots, and control of robot movement;
- It can realize single axis inching and linkage operation of each axis of the robot;
- Be able to view the control IO status;
- Users can modify passwords, view system information, etc.

3.1.2 execute

- Power on the control box;
- The teaching pendant 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. The operator can use a few functions, the programmer has some function restrictions, and the administrator has no function restrictions.The manual high-speed function, as

an important safety protection function, can only be used by programmers and administrators. The operator has no manual high-speed function, that is, the operator controls the robot movement in the manual mode, and the maximum speed that the robot can reach is 250 mm/s to play the role of protection. The specific permissions are shown in the table below.

Table 3.1-1Permission management

User permissions	Permission class	Permission function
Administrator/0	/	unlimited
Programmer/1	/	Except for account setting, collision level, soft limit setting, friction compensation coefficient, robot installation mode, zero point setting, encoder type switching, terminal LED setting, system time, system language, custom information configuration, factory value recovery, controller compatibility, network configuration, system upgrade and file import functions, it can be implemented.
Operator/2	Robot settings	Select a tool coordinate system and apply
		Select an external tool coordinate system and apply
		Select the workpiece coordinate system and apply
		Select external axis coordinate system and apply
		Set robot load
		Friction compensation switch
		Set robot speed scaling
	User peripheral settings	Gripper reset, active
		Spray gun commissioning
		Welding machine commissioning
		Sensor commissioning
		Extended axis test
		Belt test
		Tracking attitude test
		Force sensor reset, active
	Teaching simulation	Teaching file export
	Robot operation	Start teaching program

		Stop the teaching program
		Suspend the teaching program
		Resume the teaching program
		Single step execution
		Robot inching
		Robot Joints application operation
		Teaching point record
		Clear controller error
		Change robot mode
	Teaching management	Export of teaching point information
	status information	Viewing and exporting system logs
	Auxiliary application	Data backup export
	System settings	Configure Export

The login interface is as follows Fig. As shown in.

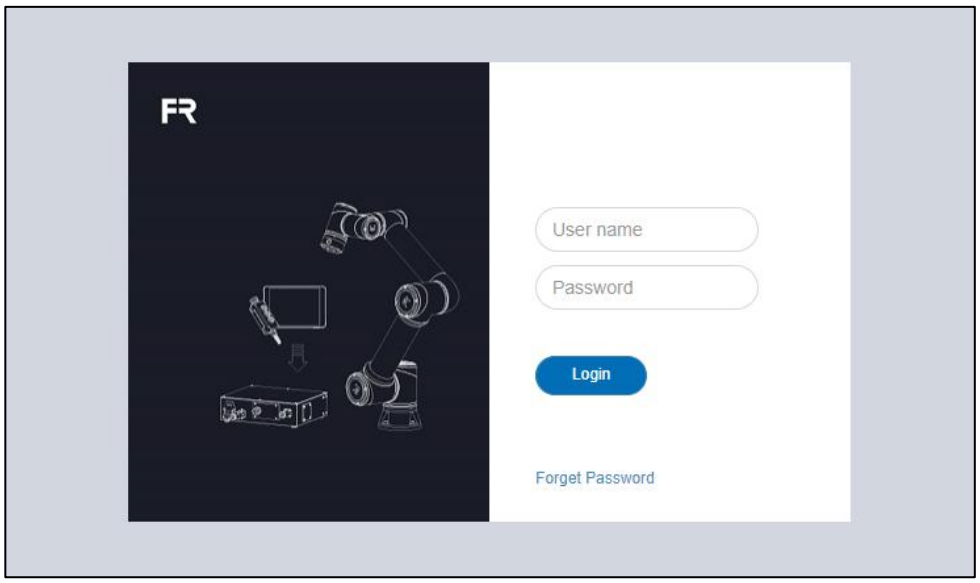


Fig. 3.1-1Login interface

After successful login, the system will load the model and other data, and then enter the initial page.

3.2 Initial system interface

After successful login, the system enters the "initial interface", which shows that the teaching pendant mainly includes eight areas, including Fair LOGO and return to the initial page button, menu bar, menu bar zoom button, robot operation area, control area, status area, 3D simulation robot, position and IO information area.as Fig. As shown in.

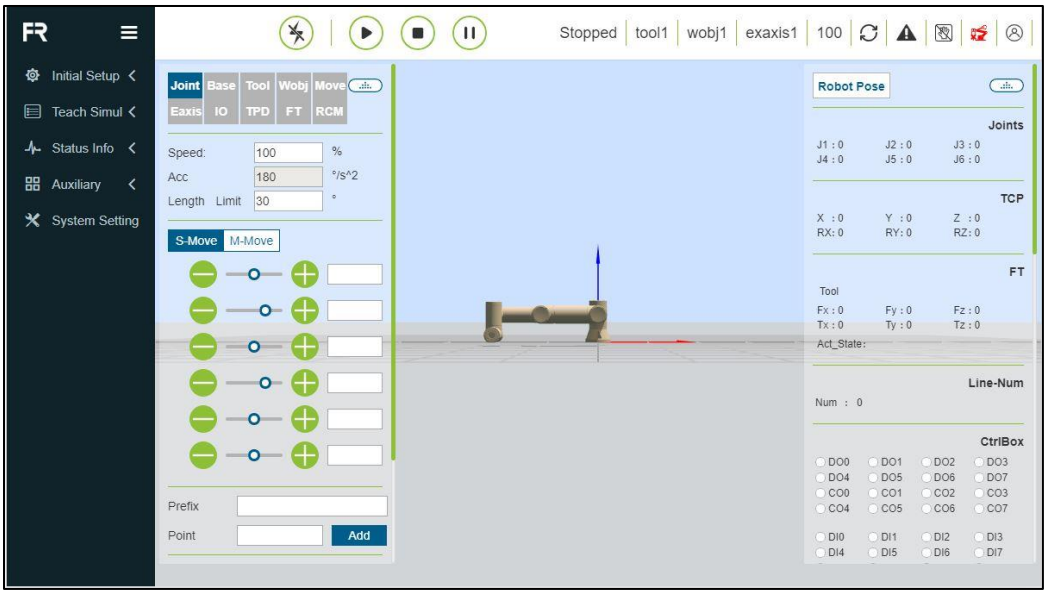


Fig. 3.2-1Schematic diagram of system initial interface

3.2.1 Control area



Enable button: enable robot



Start button: upload and start running the teaching



Stop button: stop the current teaching program



Pause/resume button: pause and resume the current

3.2.2 status bar

Running	**Robot status:** Stopped Running Pause Drag dragging
Toolcoord1	**Toolcoord1:** No. 1 tool coordinate system of current **application**
0%	**Running speed percentage:** the speed when the robot runs in
	**Normal status:** the current robot operates normally
	**Error status:** there is an error in the current robot
	**Virtual solid robot:** currently a solid robot
	**Virtual entity robot:** currently 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:** the robot is connected
	**Unconnected status:** the robot is not connected
	**Account information:** display user name, authority and login

3.2.3 menu bar

Menu bar such asTable

Table 3.2-1Teaching pendant menu bar

class a	second level
Initial settings	Robot settings
	User peripheral configuration
Teaching simulation	Program teaching
	Graphical programming
	Teaching management
status information	system log
	Status Query
Auxiliary application	Robot body
	Welding expert database
	Security Settings
System settings	/

3.2.4 Operation area

For IO settings, refer to3.5.1 I/O settings。

Joint, Base and other functions can be referred to3.6 Robot operation。

3.3 3D simulation robot

3.3.1 Virtual/physical robot switching

(This function is not enabled at present)

3.3.2 3D virtual track and model shadow

Trajectory drawing: When running the teaching program, turn on the trajectory drawing function, and the 3D model of the robot will describe the trajectory of the robot.

Model shadow: in the open state, there is a shadow under the 3D model robot, and when it is closed, no shadow is displayed.

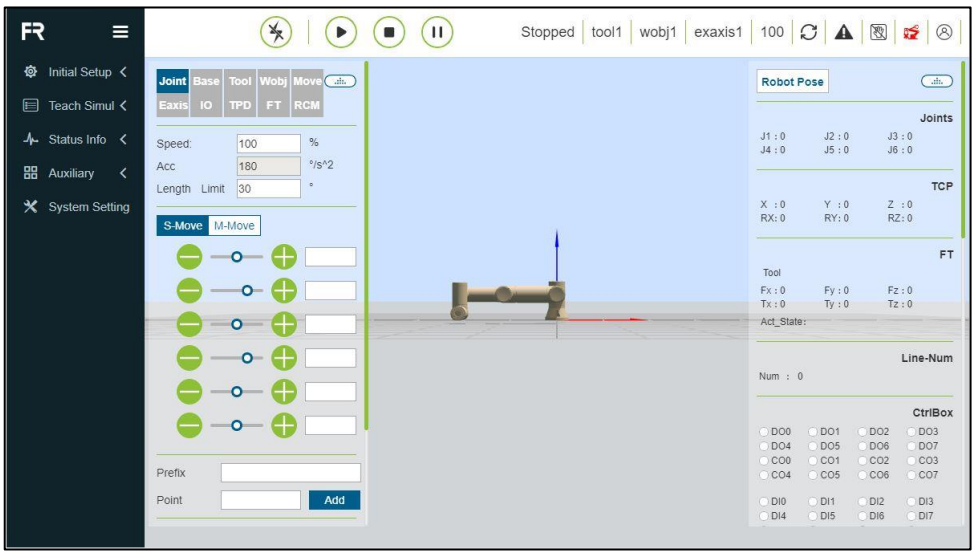


Fig. 3.3-1Virtual track and model shadow

3.3.3 3D visualization of robot coordinate system

Create various 3D virtual coordinate systems in the 3D virtual area of WebAPP robot, take the display of the base coordinate system as an example, as shown in the following figure.The X axis is red, the Y axis is green, and the Z axis is blue.

Base coordinate system: the system robot 3D virtual area in the base coordinate system WebAPP is displayed by default, and the fixed mark is at the bottom center of the robot base.The 3D virtual base coordinate system can be manually closed for display.

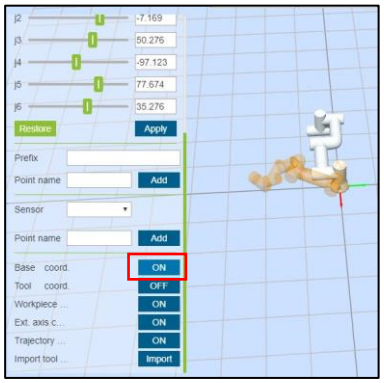


Fig. 3.3-2Base Coordinate System Display Close



Fig. 3.3-3Base Coordinate System Display On

Tool coordinate system: the tool coordinate system is displayed by default.After the WebAPP starts and the user logs in successfully, obtain the name and corresponding parameter data of the tool coordinate system currently applied, and initialize the current tool coordinate system.

When other tool coordinate systems are applied in the process of use, when the command of applying tool coordinate systems is successful, the existing tool coordinate systems in the 3D virtual area of the robot will be cleared first, and then the newly applied tool coordinate system parameter data will be transferred to the 3D coordinate system generation API for tool coordinate system generation. After the generation, the corresponding display will be completed in the 3D virtual area of the robot.

3D virtual tool coordinate system can be displayed manually.

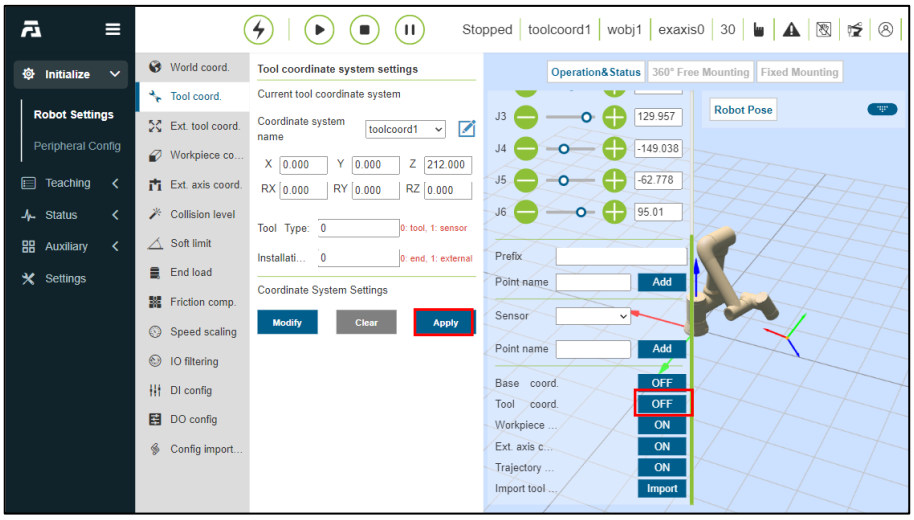


Fig. 3.3-4Tool coordinate system display

Workpiece coordinate system: the workpiece coordinate system is closed by default and can be displayed manually. The process is consistent with the tool coordinate system.

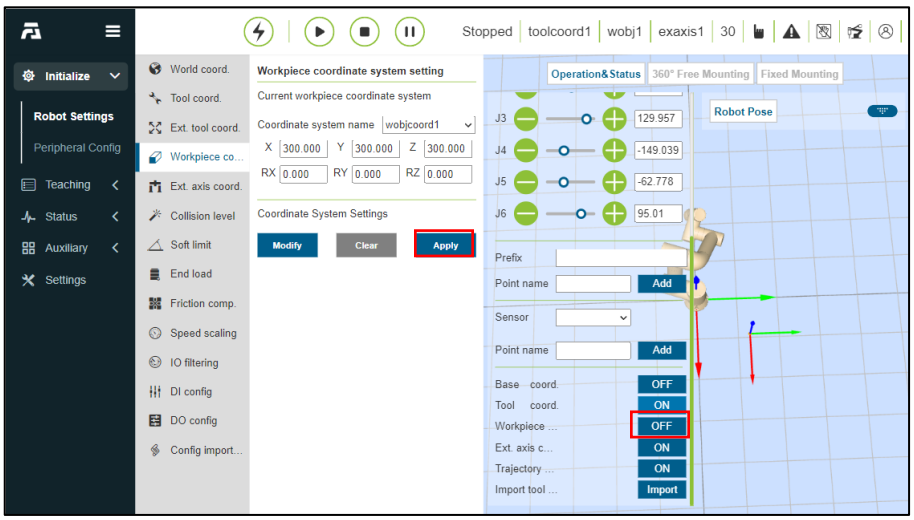


Fig. 3.3-5Display of workpiece coordinate system

External axis coordinate system: the external axis coordinate system is off by default, and you can manually open the display.The process is consistent with the tool coordinate system.

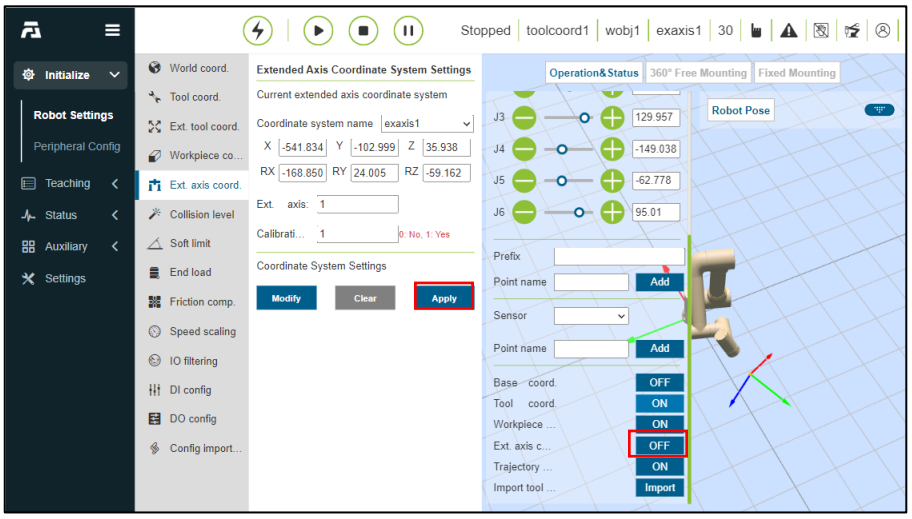


Fig. 3.3-6External axis coordinate system display

3.3.4 Setup and display of robot installation mode

The robot is installed horizontally by default. When the robot installation mode is changed, the actual installation mode of the robot needs to be set on this page in time to ensure the normal operation of the robot.

The user clicks the "Fixed Installation" tab in the 3D virtual display area of the robot, enters the robot fixed installation mode setting page, selects "Front Installation", "Flip Installation" or "Side Installation", and clicks the "Application" button to complete the robot installation mode setting.

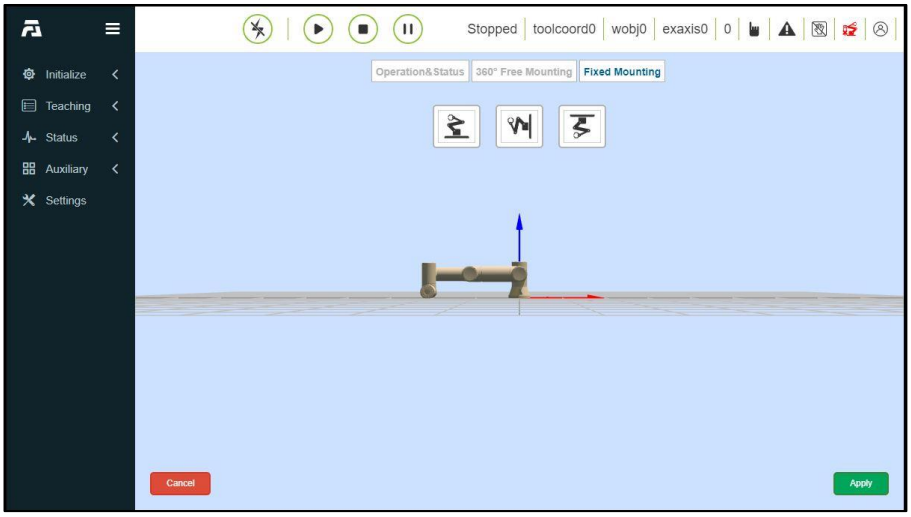


Fig. 3.3-7 Fixed installation

Considering more flexible and rich robot deployment scenarios, we provide free installation function. Users click the "360 ° free installation" tab in the 3D virtual display area of robots to enter the robot free installation mode setting page.Manually adjust the angle of "base tilt" and "base rotation", and the 3D model will display the installation effect accordingly.After modification, click the "Apply" button to complete the robot installation mode setting.

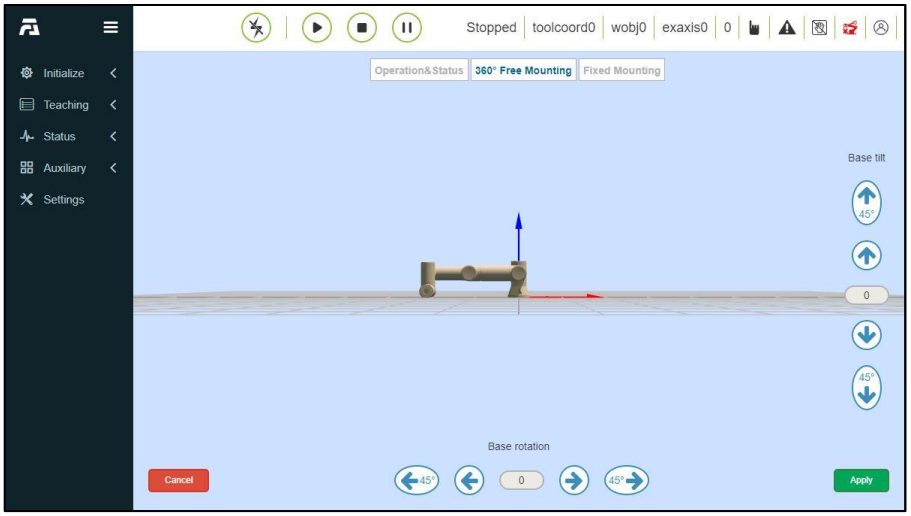


Fig. 3.3-8 360 ° free installation

3.4 Robot settings

3.4.1 Tool coordinates

Click "Tool coordinate" under the menu bar of "Robot setting" in "Initial setting" to enter the tool coordinate interface.Tool coordinates can be modified, emptied and applied.There are 15 numbers in the drop-down list of tool coordinate system. After selecting the corresponding coordinate system (the coordinate system name can be customized), the corresponding coordinate value, tool type and installation position (only displayed under the sensor type tool) will be displayed below. After selecting a coordinate system, click the "Apply" button, and the currently used tool coordinate system will become the selected coordinate, as shown in Fig. 3.4-1.

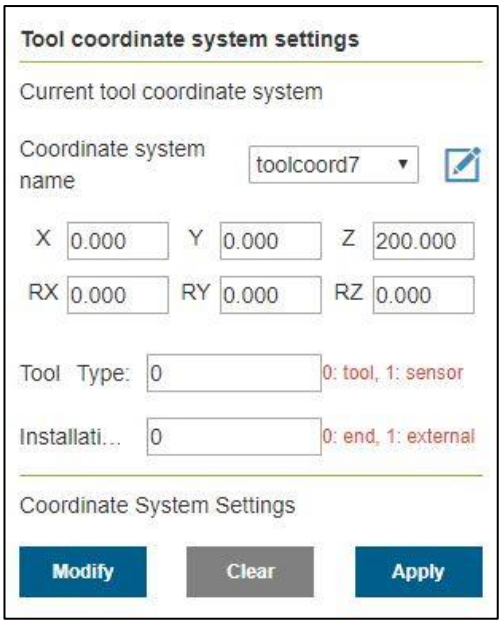


Fig. 3.4-1Set tool coordinates

Click "Modify" to reset the tool coordinate system of this number according to the prompt.The tool calibration method is divided into four point method and six point method. The four point method only calibrates the tool TCP, that is, the position of the center point of the tool. Its attitude is consistent with the end attitude by default. The six point method adds two points on the basis of the four point method to calibrate the attitude of the tool. Here we take the six point method as an example to explain.

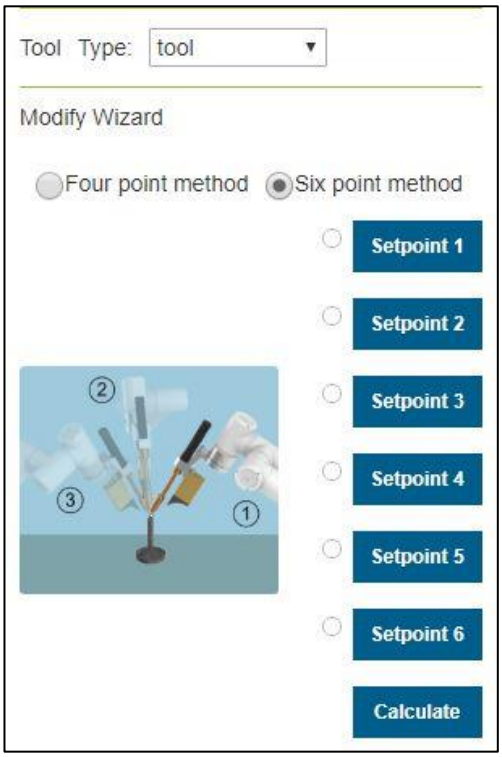


Fig. 3.4-2Set tool coordinates

Select a fixed point in the robot space, move the tool to the fixed point in three different poses, and set 1-3 points in turn.As shown in Fig. 3.4-3 at the top left.Move the tool vertically to the fixed point set point 4, as shown in the upper right of Fig. 3.4-3.Keep the posture unchanged, use the base coordinate to move, move a distance in the horizontal direction, set point 5, and this direction is the X axis direction of the tool coordinate system.Return to the fixed point, move vertically upward for a distance, set point 6, and this direction is the Z axis direction of the tool coordinate system.Click the calculation button to calculate the tool pose, if necessary

To reset, click Cancel and press the Modify button to reset

Steps for creating a tool coordinate system.

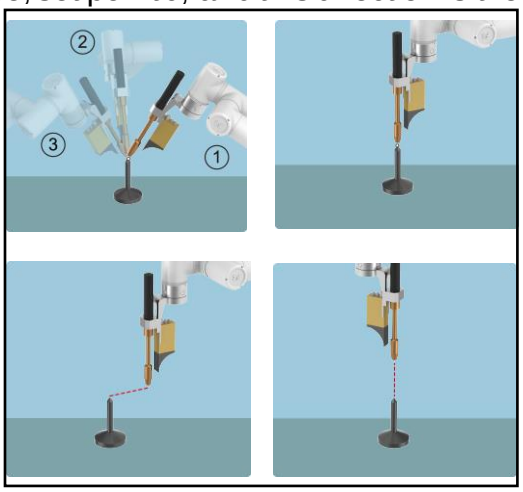


Fig. 3.4-3Schematic diagram of six point method

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

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 coordinates can be modified, cleared and applied in the external tool coordinate system setting interface.

There are 15 numbers in the drop-down list of the external tool coordinate system. Select the corresponding coordinate system from etoolcoord0 to etoolcoord14, and the corresponding coordinate values will be displayed below. Select a coordinate system and click the "Apply" button, and the currently used tool coordinate system will become the selected coordinate, as shown in Fig. 3.4-4.



Fig. 3.4-4External tool coordinates

Click "Modify" to reset the tool coordinate system of this number according to the prompt, as shown in Fig. 3.4-5.

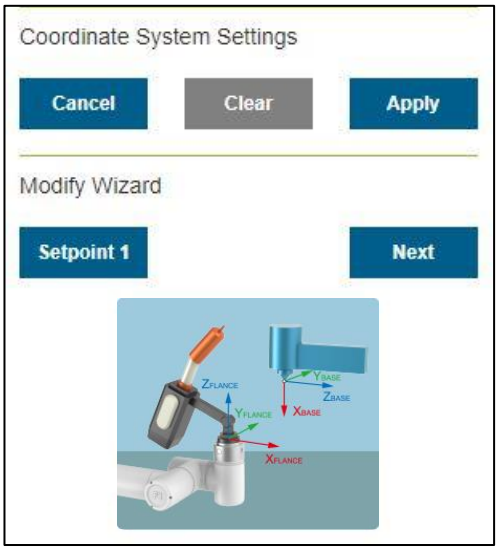


Fig. 3.4-5Schematic diagram of six point method

1. Determine external TCP by three-point method:

Setpoint 1: The TCP of the measured tool moves to the external TCP, and click Setpoint 1;

Setpoint 2: Move a distance from point 1 along the X axis of the external TCF coordinate system, and click Setpoint 2;

Setpoint 3: return to point 1, move a distance from point 1 along the Z axis of the external TCF coordinate system, and click Setpoint 3;

Calculate: click Calculate to get the external TCF;

2. Six point method to determine the tool TCF:

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

Setpoint 5: Return to a fixed point and move a distance along the X axis of the tool TCF coordinate system, click Setpoint 5;

Setpoint 6: Return to a fixed point and move a distance along the Y axis of the tool TCF coordinate system, click Setpoint 6;

Calculate: click Calculate to get the tool TCF;

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

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

3.4.3 Workpiece coordinates

Click "workpiece coordinate" under the menu bar of "robot setting" in "initial setting" to enter the workpiece coordinate interface.The workpiece coordinates can be modified, cleared and applied.There are 15 numbers in the drop-down list of workpiece coordinate system. Select the corresponding coordinate system (wobjcoord0~wobjcoord14), and the corresponding coordinate values will be displayed in the "Coordinate System Coordinates" below. Select a coordinate system and click the "Apply" button, and the currently used workpiece coordinate system will become the selected coordinate, as shown in Fig. 3.4-6.

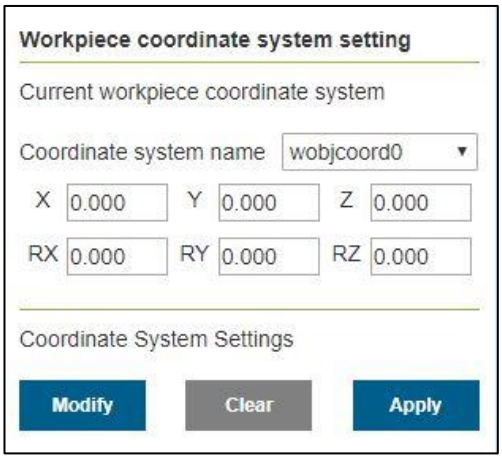


Fig. 3.4-6 workpiece coordinates

The workpiece coordinate system is generally calibrated on the basis of tools, and the workpiece coordinate system needs to be established on the basis of the established tool coordinate system.Click "Modify" to reset the workpiece coordinate system of this number according to the prompt.Fix the workpiece and select the calibration method "origin - X axis - Z axis" or "origin - X axis - XY+plane". The selection of the first two points of the two calibration methods is the same, but the third point is different. The first method is used to calibrate the Z direction of the workpiece coordinate system, and the second method is used to calibrate a point on the XY+plane, which can be calibrated according to the diagram.Click the calculation button to calculate the position and pose of the workpiece,

If it is necessary to reset, click Cancel and press the Modify button to re create the workpiece coordinate system.

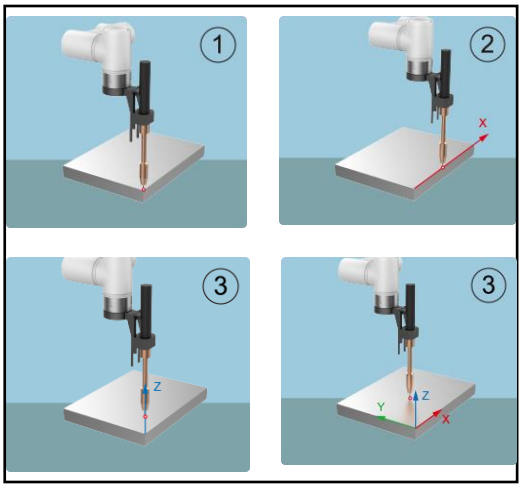


Fig. 3.4-7Schematic diagram of three-point method

After finishing the last step, click "Finish" to return to the workpiece coordinate interface, and click "Save" to store the workpiece coordinate system just established.

3.4.4 Extended axis coordinates

Click "Extended Axis Coordinate System" under the menu bar of "Robot Settings" in "Initial Settings" to enter the interface of extended axis coordinate system.The extended axis coordinates can be modified, cleared and applied in the extended axis coordinate system setting interface.

There are five numbers in the drop-down list of the extended axis coordinate system. Select the corresponding coordinate system from eaxis0 to eaxis4 and the corresponding coordinate values will be displayed below. Select a coordinate system and click the "Apply" button. The currently used extended axis coordinate system will become the selected coordinate, as shown in Fig. 3.4-8.

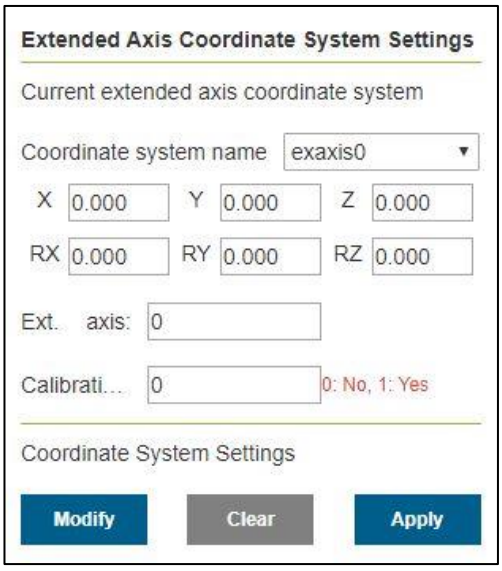


Fig. 3.4-8Extended axis coordinates

Click "Modify" to reset the extended axis system of this number according to the prompt, as shown in Fig. 3.4-9.Clear the extended axis coordinate system to be calibrated before calibration, and apply the extended axis coordinate system.First, let's look at the calibration method of linear guide, the first extended axis scheme.Select the number of the extension axis and obtain the drive information of the corresponding extension axis. We can configure parameters according to this information.Set DH parameters after configuration, and the linear guide scheme defaults to 0.Set the relative extension axis position of the robot, and the linear guide is on the extension axis.If it is not calibrated, click Save. At this time, the extension axis can only move asynchronously.

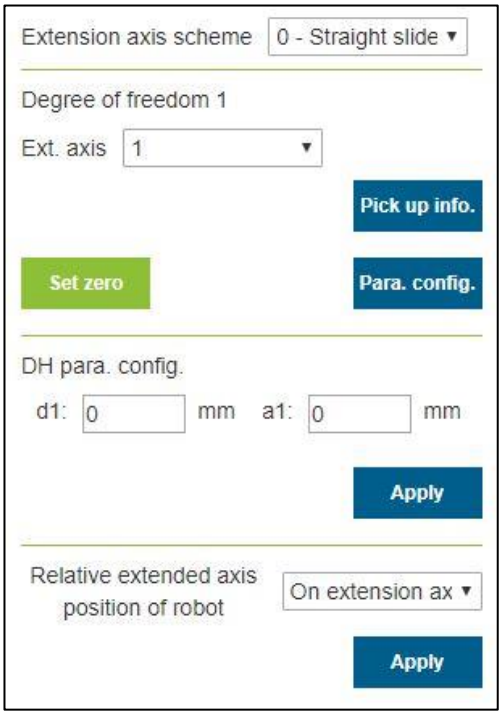


Fig. 3.4-9Linear guide configuration

If it is necessary to move synchronously with the robot, click calibration to enter the calibration interface. At the zero point of the extension axis, click Easis in the operation area to enable the extension axis. Align the center of the robot end (the end point of the tool under the coordinate system of the application tool) with two different poses to fix a point on the extension axis, and set point 1 and point 2 respectively. Remove the enable and move the extension axis for a distance. After enabling, align the center point of the robot end with the previous fixed point, set point 3. Remove the enable and move the extension axis to the zero point to enable the extension axis. Move the center point at the end of the robot to a point vertically upward of the fixed point, set point 4, calculate the coordinate system and save it.

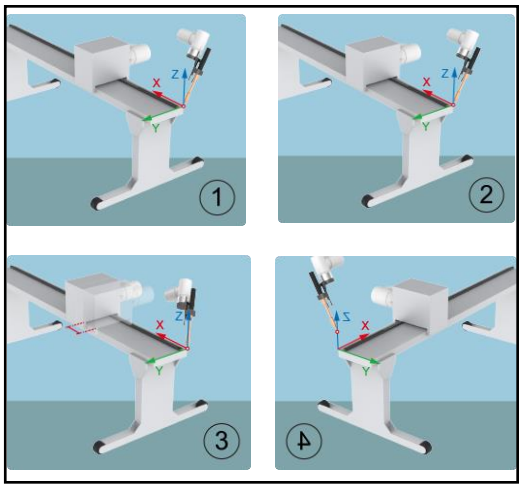


Fig. 3.4-10Linear guide calibration

Next, let's look at the calibration method of the positioner, the second extended axis scheme.The positioner consists of two extension axes. Select the number of the extension axis and obtain the information to obtain the driver information of the corresponding extension axis. We can configure parameters according to this information.After configuration, set DH parameters, measure the DH parameters of the positioner according to the figure, and input them into the input box.Set the relative extension axis position of the robot, and the positioner is outside the extension axis.If it is not calibrated, click Save. At this time, the extension axis can only move asynchronously.

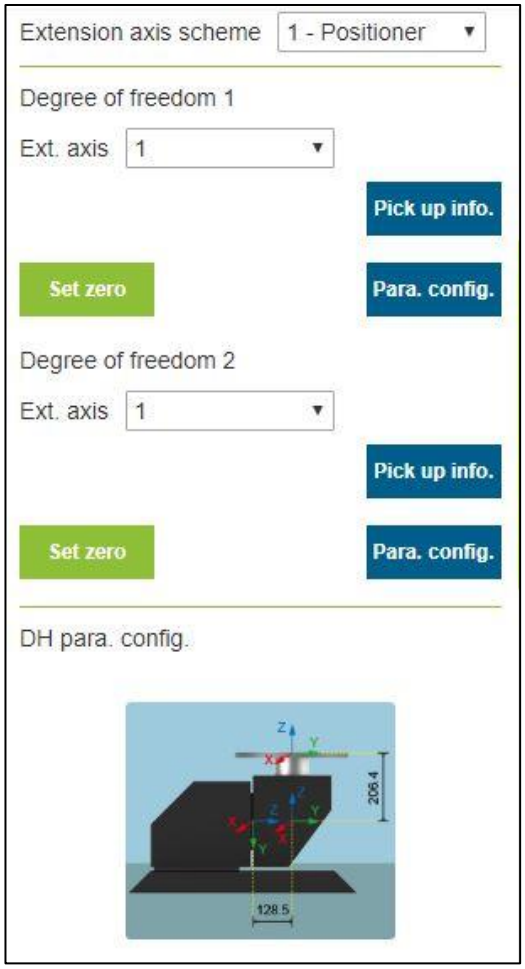


Fig. 3.4-11 Positioner configuration

If it is necessary to move synchronously with the robot, click calibration to enter the calibration interface. At the zero point of the extension axis, click the Easis enable extension axis in the operation area, establish a coordinate system on the positioner, select a point, and input the Cartesian pose of the point under the coordinate system. For example, select a point in the positive direction of Y, and measure that Y is 100mm, then input the value shown in the figure, and click the reference point to set the reference point.The center of the end of the robot (the end point of the tool under the coordinate system of the application tool) shall be aligned with the reference point for the next four calibration points.

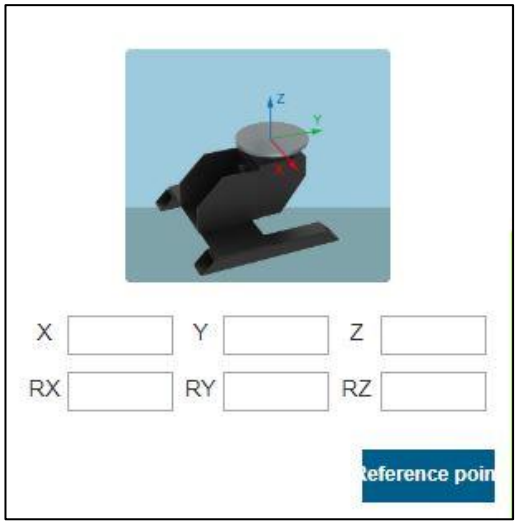


Fig. 3.4-12Reference point configuration of positioner

Align the center of the robot end (the end point of the tool under the application tool coordinate system) with the reference point, set point 1, click Easis in the operation area to jog two axes a short distance, align the center of the robot end with the reference point, set point 2, continue to jog two axes, align the center of the robot end with the reference point, set point 3, and finally continue to jog two axes, align the center of the robot end with the reference point, set point 4,Click Calculate to get the coordinate system result, click Save to apply.

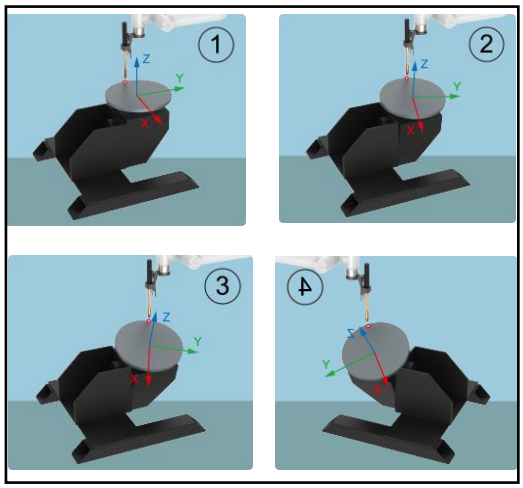


Fig. 3.4-13Calibration of positioner

Next, let's look at the calibration method of the third extended axis scheme - single axis positioner.The positioner consists of a rotating extension axis. Select the number of the extension axis, and obtain the information to obtain the driver information of the corresponding extension axis. We can configure parameters according to this information.DH parameter is set to 0.Set the relative extension axis position of the robot, and the positioner is outside the extension axis.If it is not calibrated, click Save. At this time, the extension axis can only move asynchronously.

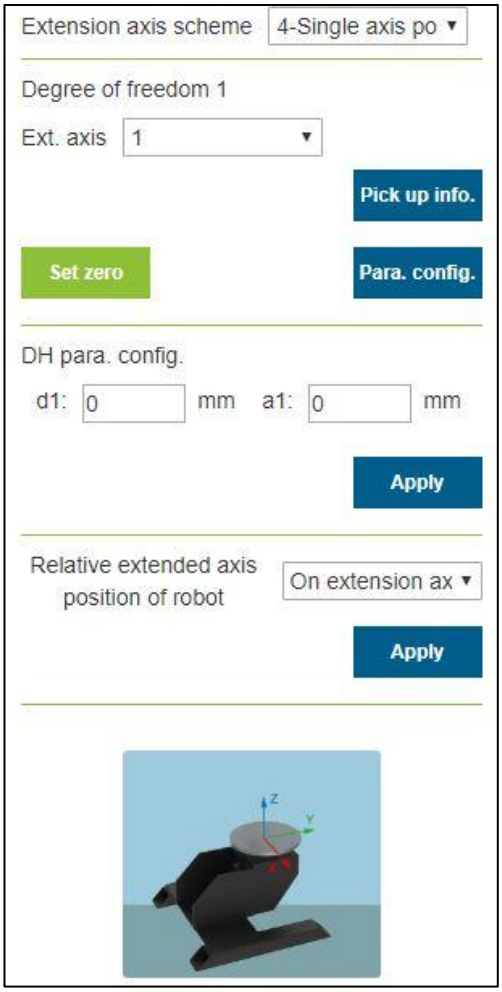


Fig. 3.4-14 Single axis positioner configuration

If it is necessary to move synchronously with the robot, click calibration to enter the calibration interface. At the zero point of the extension axis, click the Easis enable extension axis in the operation area, establish the coordinate system on the positioner, select a point, enter the Cartesian pose of the point under the coordinate system, and click "reference point" to set the reference point.The center of the end of the robot (the end point of the tool under the coordinate system of the application tool) shall be aligned with the reference point for the next four calibration points.Align the center of the end of the robot (the end point of the tool under the application tool coordinate system) with the reference point, set point 1, click Easis in the operation area to jog the rotation axis for a short distance, align the center of the end of the robot with the reference point, set point 2, continue to jog the rotation axis, align the center of the end of the robot with the reference point, set point 3, and finally continue to jog the rotation axis, align the center of the end of the robot with the reference point, set point 4,Click Calculate to get the coordinate system result, click Save to apply.

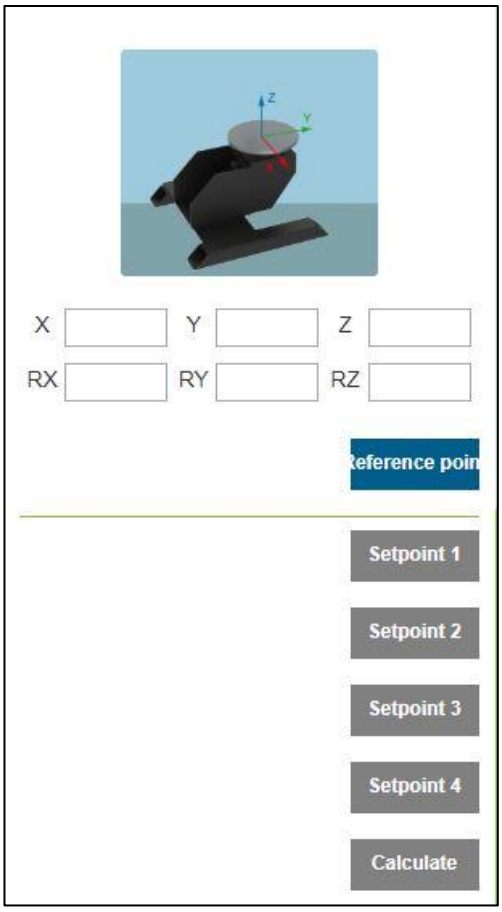


Fig. 3.4-15Calibration of single axis positioner

3.4.5 Collision class

Click "Collision Level" under the menu bar of "Robot Settings" in "Initial Settings" to enter the interface of collision level.

The collision level is divided into one to ten levels. Level one to three detection is relatively sensitive, and the robot needs to run at the recommended speed.At the same time, you can select a custom percentage setting. 100% corresponds to the tenth level.The collision strategy can set the handling mode of the robot after collision, which is divided into error stop and continue movement. Users can set it according to the specific use needs.See Fig. 3.4-16.

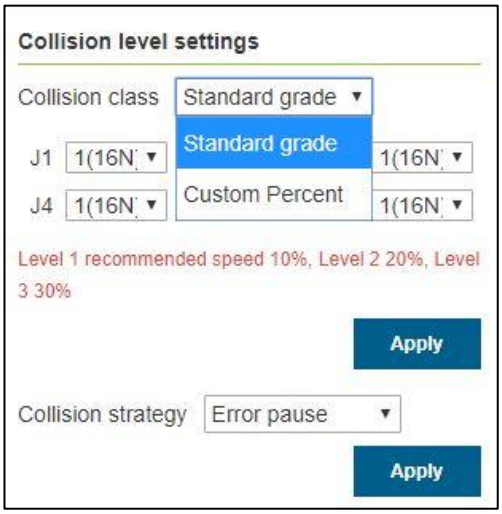


Fig. 3.4-16Schematic diagram of collision level

3.4.6 Soft limit

Click "Soft Limit" under the menu bar of "Robot Setting" in "Initial Setting" to enter the soft limit interface.

There may be other equipment in the robot's travel, and the limit angle can be used to soft limit the robot, so that the robot movement does not exceed a certain coordinate value, and prevent robot collision.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.Input the angle value to limit the positive and negative angles of the robot joints. When the input value exceedsTable 1.3-1The robot joint soft limit angle listed in section will adjust the limit angle to the maximum value that can be set.When the robot reports exceeding the instruction limit, it needs to enter the drag mode and drag the robot joint to within the limit angle.The interface is shown in Fig. 3.4-17.

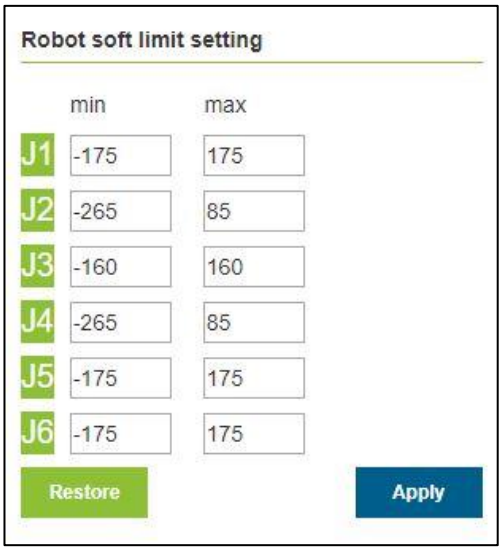


Fig. 3.4-17Schematic diagram of robot limit

3.4.7 End load

Click "End Load" under the menu bar of "Robot Setting" in "Initial Setting" to enter the end load interface.

The user can set corresponding parameters according to the parameters of the tool used. The load weight is 0~5kg, and the range of centroid coordinates is 0~1000, as shown in Fig. 3.4-18.

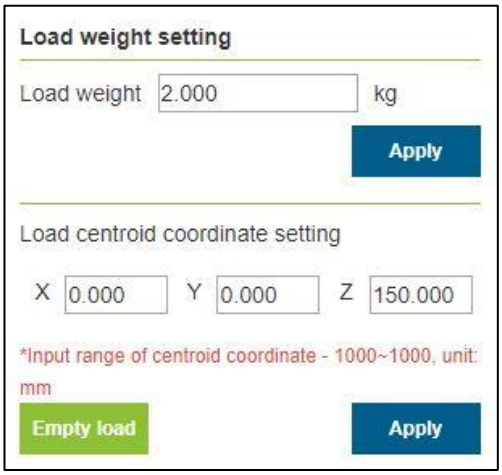


Fig. 3.4-18Schematic diagram of load setting

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

Make sure that the load is installed before carrying out the measurement.Click the "Tool Data Measurement" button to enter the load motion test interface.

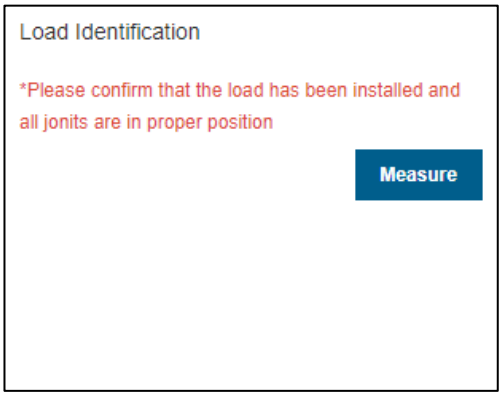


Fig. 3.4-19Load identification joint setting

Click "Load identification start" to test, and stop the movement in case of emergency.

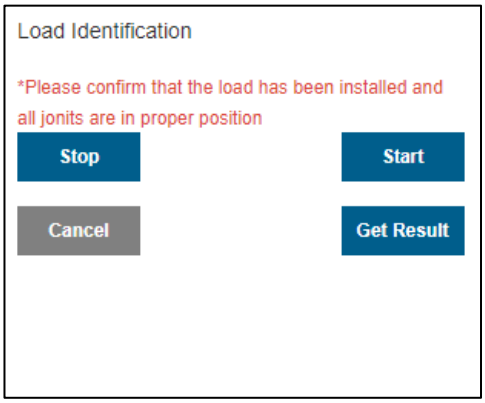


Fig. 3.4-20Load identification start

After the movement, click the "Get Identification Results" 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

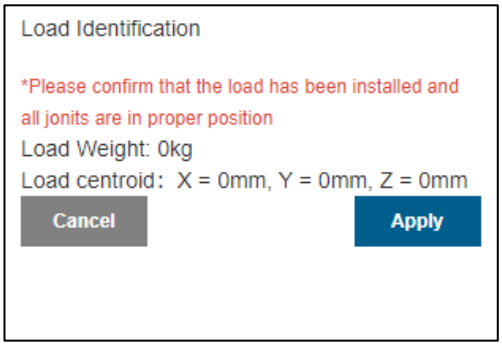


Fig. 3.4-21Load identification results

3.4.8 friction compensation

Click "Friction Compensation" under the menu bar of "Robot Settings" in "Initial Settings" to enter the friction compensation setting interface.

Friction compensation coefficient: the use scenario for friction compensation is only in drag mode. The friction compensation coefficient can be set to 0~1. The higher the value, the greater the force compensated during drag.The friction compensation coefficient is set separately for each shaft according to the different installation methods.

Friction compensation switch: the user can turn on or off the friction compensation according to the actual robot and usage habits.

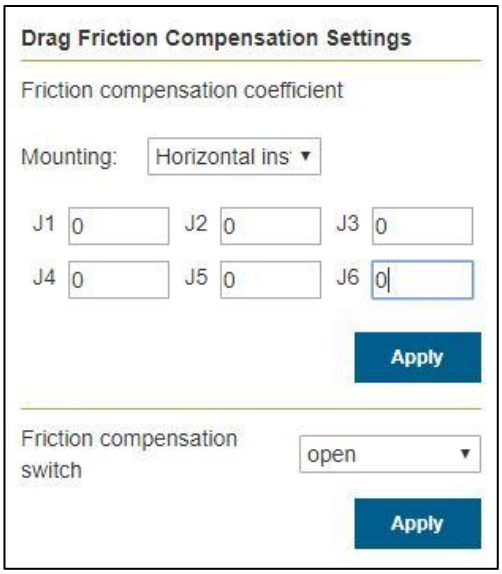


Fig. 3.4-22Friction compensation settings

3.4.9 Speed scaling

Click "Speed scaling setting" under the menu bar of "Robot setting" in "Initial setting" to enter the speed scaling setting interface.

This function is to set the speed of the robot under manual/automatic operation. If the current mode is automatic operation, the set speed is the automatic operation speed of the robot. If the current mode is manual operation, the set speed is the manual operation speed of the robot.The set value is the percentage of the robot's standard speed. If 100 is set, it is 100% of the standard speed (please read the table for standard speed1.3-1Robot parameters).

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

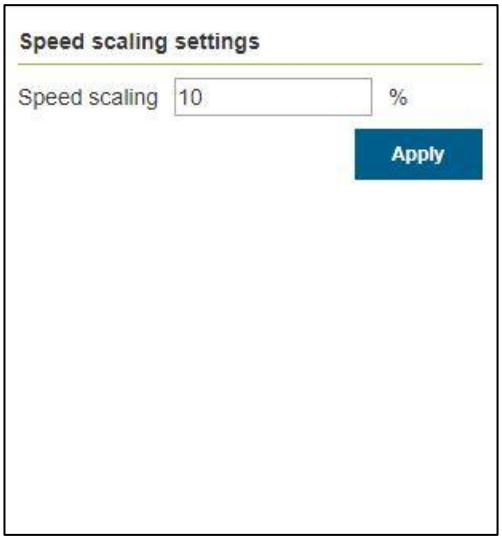


Fig. 3.4-23Speed zoom settings

3.4.10 Configure import and export

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

Import robot configuration file: 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 completion appears, the parameters in the file are successfully set.

Export robot configuration file: click the "Export" button to export the robot configuration file user.config to local.

Import controller database: the user import file name is fr_controller_Controller database file of data.db.Click the "Select File" button, select the modified database file whose content meets the specification, and click the "Import" button. When the prompt of import completion appears, the parameters in the file are successfully set.

Controller database: click the "Export" button to export the robot controller database file to local.



Fig. 3.4-24Configure import and export

3.5 Control box I/O

3.5.1 I/O settings

Click the "IO" button in the operation area on the left side of the 3D model to enter the IO setting interface, as shown in Fig. 3.5-1. The interface can realize manual control of digital output, analog output (0-10v), digital output and analog output (0-10v) of end tools in the robot control box:

- For DO operation, select the port number. If the DO is low level, the operation button on the right displays ON. Click the button to set the DO as high level.

- For AO operation, select the port number, and enter a value (0-100) in the input box on the right. The value is a percentage. Setting 100 means setting the AO port to 10v.

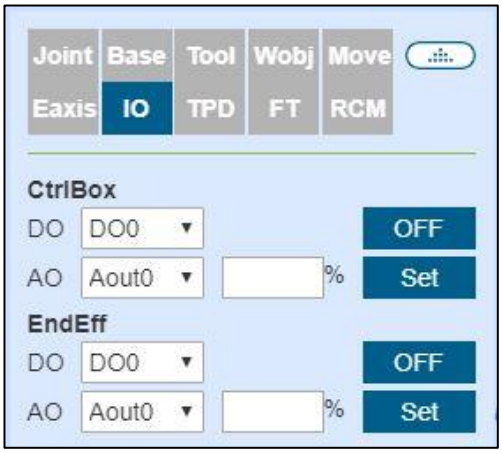


Fig. 3.5-1 I/O setting interface

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 in green; if it is low, the point will be displayed in white;The display value of analog input and analog output is 0-100100, which means 10v.

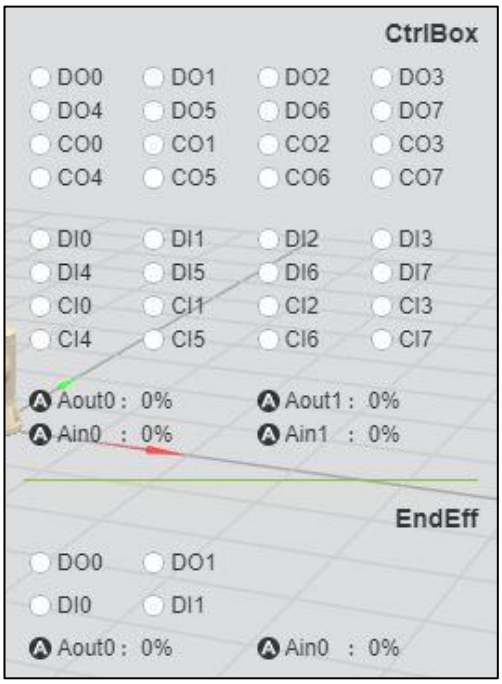


Fig. 3.5-2Status display interface

3.5.3 I/O filtering

Click "Robot Setting" in "Initial Setting" on the left menu bar, and click "IO Filtering" submenu to enter the IO filtering time setting interface. The filtering time setting interface includes: control box DI filtering time, end plate DI filtering time, control box AI0 filtering time, control box AI1 filtering time, and end plate AI0 filtering time, as shown in Fig. 3.5-3.Users can set corresponding parameters according to their own needs, and click the corresponding setting button.

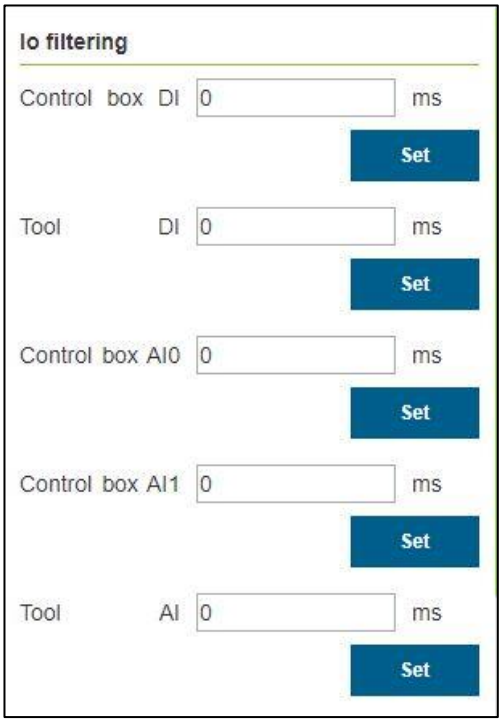


Fig. 3.5-3 I/O filter interface

3.5.4 I/O configuration

Click "Robot Settings" in "Initial Settings" in the left menu bar, and click "DI Configuration" and "DO Configuration" submenus respectively to enter the DI and DO configuration interfaces.The control box CI0-CI7 and CO0-CO7 can be configured, and the terminal DI0 and DI1 can be configured.In production, when the cooperative robot needs to connect peripherals or stops suddenly due to fault or other factors, it needs to output DO signal to realize audible and visual alarm prompt, and input configurable functions such asTable As shown in.

Table 3.5-1Control box input configurable function

Function No	Function name
0	nothing
1	Arcing success signal
2	Welding machine preparation signal
3	Belt detection
4	suspend
5	recovery
6	start-up
7	stop it
8	Pause/Resume
9	Start/Stop
10	Pedal drag switch
11	Move to job origin
12	Manual automatic switching
13	Welding wire position finding succeeded
14	Motion interruption
15	Start main program

16	Start rewind
17	Startup confirmation
18	Laser detection signal X
19	Laser detection signal Y

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

Table 3.5-2Configurable function of control box output

Function No	Function name
0	nothing
1	report errors
2	motion
3	Spraying start and stop
4	Spray gun cleaning
5	Arcing
6	aspiration
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
13	suspend
14	Reaching the job origin
15	Enter the interference zone
16	Start stop control of welding wire positioning
17	Robot startup completed
18	Program start and stop
19	Automatic manual mode

Table 3.5-3Configurable function of terminal input

Function No	Function name
0	nothing
1	Drag Mode
2	Teaching point record
3	Manual automatic switching
4	TPD track recording start/stop
5	suspend
6	recovery
7	start-up
8	stop it
9	Pause/Resume
10	Start/Stop

The default configuration of the control box: CO0 is 1-robot error reporting, CO1 is 2-robot in motion.



Fig. 3.5-4 Control box DI configuration



Fig. 3.5-5Control box DO configuration

Default configuration of end DI: DI0 drag teaching, DI1 teaching point record.

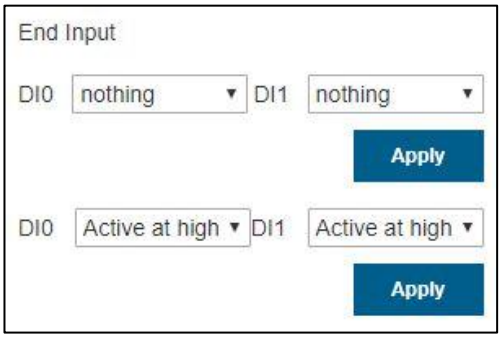


Fig. 3.5-6End DI configuration

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

3.6 Robot operation

3.6.1 Teaching point record

The manual teaching control area is mainly used to set the examination coordinate system in the teaching mode, display the angles and coordinate values of each axis of the robot in real time, and name and save the teaching points.

When saving the teaching point, the coordinate system of the teaching point is the coordinate system applied by the current robot.The speed and acceleration of the teaching point can be set above the operation area. The set value is the percentage of the robot's standard speed. If 100 is set, it is 100% of the standard speed (please read the standard speedTable 1.4-1Robot parameters).

Sensor teaching point, select the calibrated sensor type tool, enter the point name, click Add, and the saved point position is the position of the point recognized by the sensor.

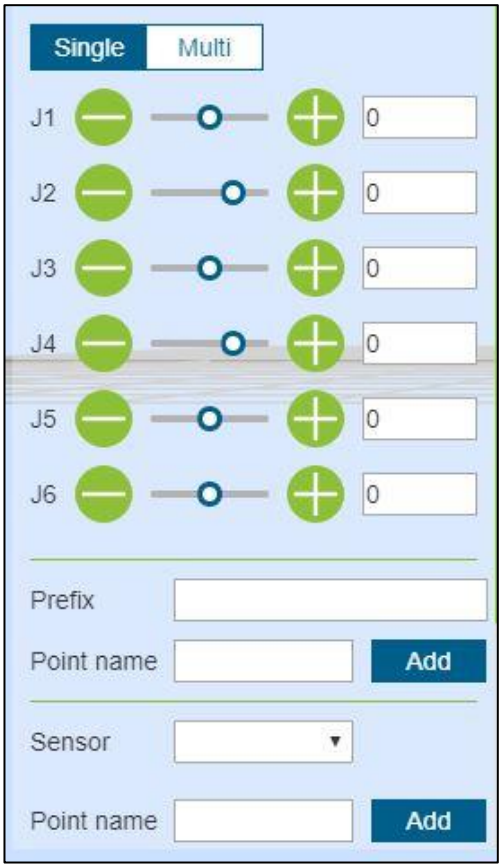


Fig. 3.6-1Schematic diagram of manual operation

be careful:

When you use it for the first time, please set a speed value as low as 30 to be familiar with the robot movement to avoid accidents.

3.6.2 Joint

Under the joint operation, the six slider bars in the middle represent the angles of the corresponding axes respectively. The joint movement is divided into single axis inching and multi axis linkage

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

Set the "Long press motion threshold" (when the button is pressed for a long time, the maximum distance the robot runs, the value range is 0~300) parameter, long press the round button to control the robot operation, if the button is released during the robot operation, the robot will immediately stop moving, if the button is kept pressed, the robot will run and long press the value set by the motion threshold to stop moving.

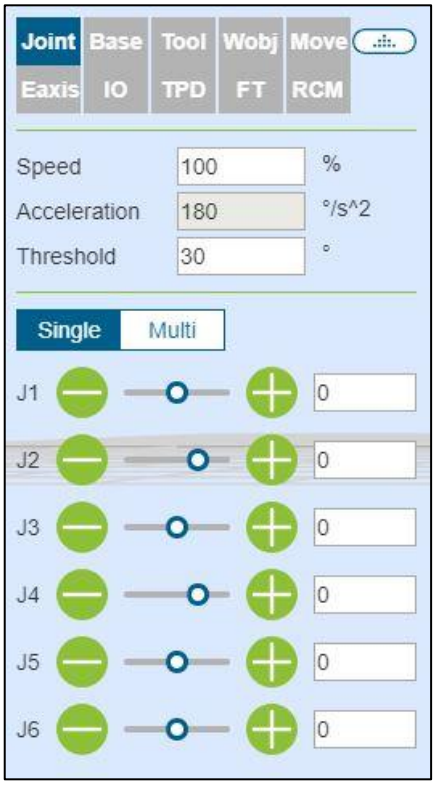


Fig. 3.6-3 Joint Single Axis Jog Diagram

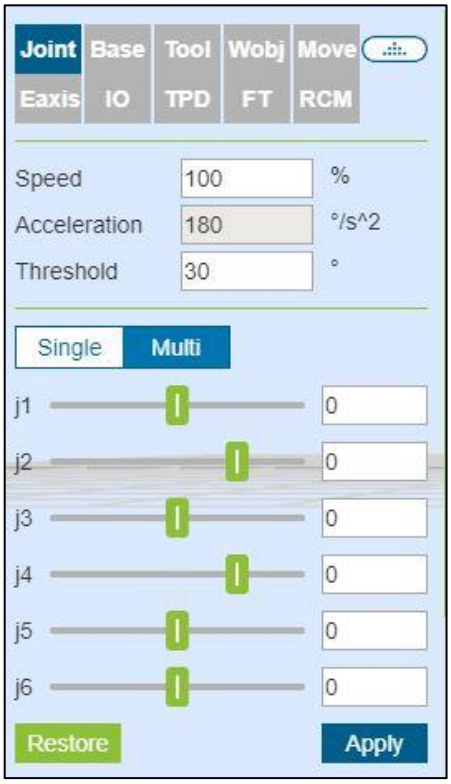


Fig. 3.6-2 Joint Multi axis Linkage Diagram

Multi axis linkage: the user can operate the middle six sliders to adjust the corresponding target position of the robot, as shown in Fig. 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 return the 3D virtual robot to its original position.After the user determines the target position, he can click the "Apply" button, and the solid robot will move accordingly.

3.6.3 Base inching

In the base coordinate system, the robot can be controlled by operating the round buttons on the left and right sides to move in a straight line on the X, Y, Z axis or rotate around RX, RY, RZ. The six slider bars in the middle represent the position and range of motion on the corresponding coordinate axis, as shown in Fig. 3.6-4.The function of Base inching is similar to that of single axis inching in Joint motion.

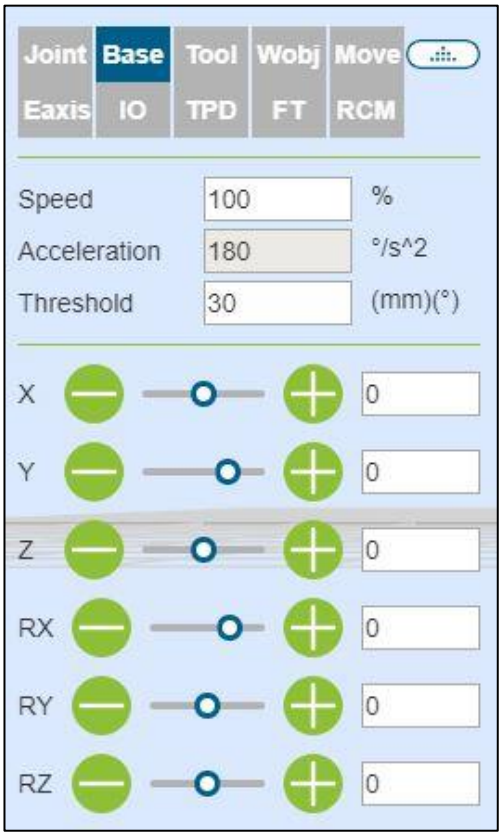


Fig. 3.6-4 Schematic diagram of base inching

be careful:

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, you can operate the round buttons on the left and right sides to control the robot, move in a straight line on the X, Y, Z axis or rotate around RX, RY, RZ, and the six slider bars in the middle represent the position and range of motion on the corresponding coordinate axis, as shown in Fig. 3.6-5.The function of tool inching is similar to that of single axis inching in joint motion.

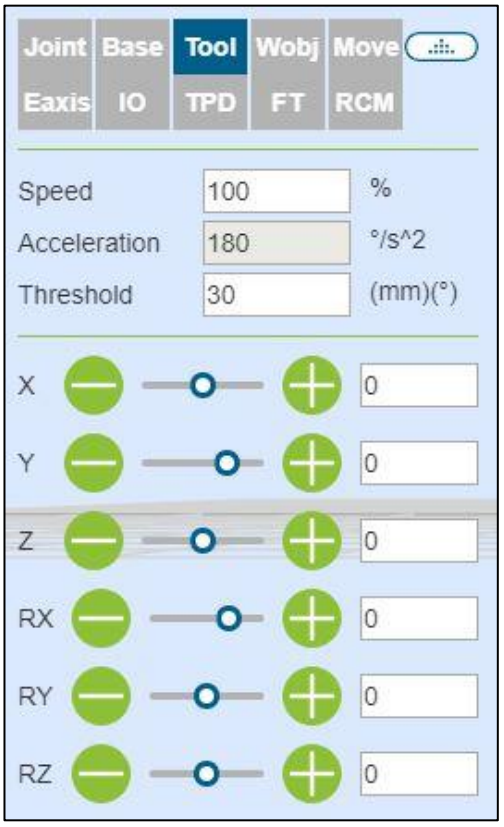


Fig. 3.6-5 Schematic diagram of tool inching

3.6.5 Wobj inching

Select the workpiece inching, you can operate the left and right round buttons to control the robot. Under the workpiece coordinate system, the robot moves along the X, Y, Z axes in a straight line or rotates around RX, RY, RZ. The six slider bars in the middle represent the position and range of motion on the corresponding coordinate axis, as shown in Fig. 3.6-6.The function of Wobj inching is similar to that of single axis inching in Joint motion.

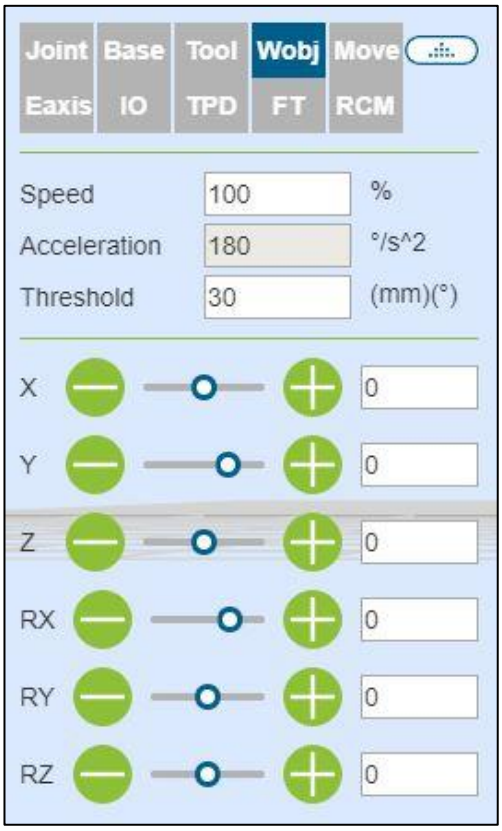


Fig. 3.6-6 Schematic diagram of Wobj inching

3.6.6 Move

If you select Move, you can directly input Cartesian coordinate values. Click "Calculate joint position", and the joint position will be displayed as the result of calculation. After confirming that there is no danger, you can click "Move to this point" to control the robot to move to the input Cartesian position and pose.

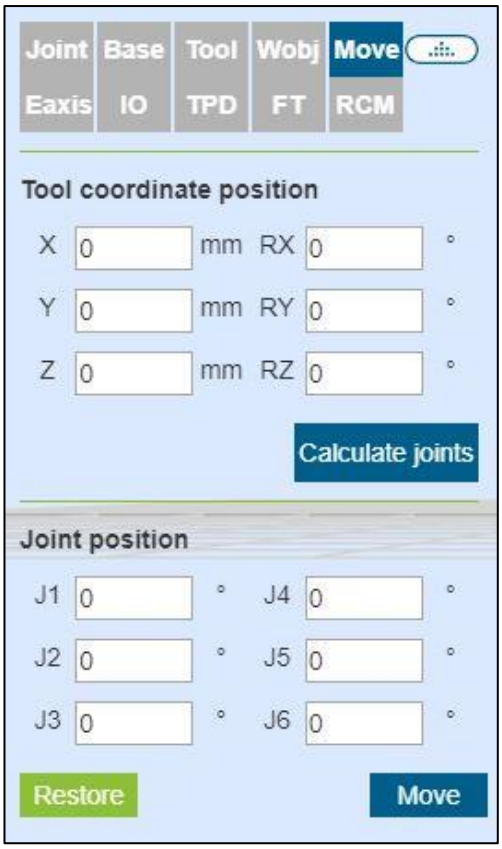


Fig. 3.6-7 Move Schematic Diagram

3.6.7 Easis Mobile

Select Easis to move. This function is the inching function of the extension axis. You need to use this inching function to control the extension axis on the premise of configuring the extension axis. For details, see "Chapter 4 Machine - Operator Peripherals - Extension Axis Peripheral Configuration".



Fig. 3.6-8 Schematic diagram of Easis movement

3.6.8 TPD

The operation steps of TPD function are as follows:

Step 1 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 "Save" button. If the point is saved successfully, you will be prompted with "Saved successfully";

Step 2 Configure the track recording parameters: click TPD to enter the "TPD" function item to configure the track recording parameters, set the name, pose type and sampling period of the track file, and configure DI and DO. In the process of recording the TPD track, you can trigger DI to record the corresponding DO that needs to be output, as shown in Fig. 3.6-9;



Fig. 3.6-9 TPD track record

Step 3 Check the robot mode: check whether the robot mode is in the manual mode. If not, switch to the manual mode. In the manual mode, you can switch to the supporting teaching mode by two ways, one is long pressing the end button, the other is the interface drag mode switch button. In the TPD record, it is recommended to switch the robot from the interface to the supporting teaching mode.As shown in Fig. 3.6-10;

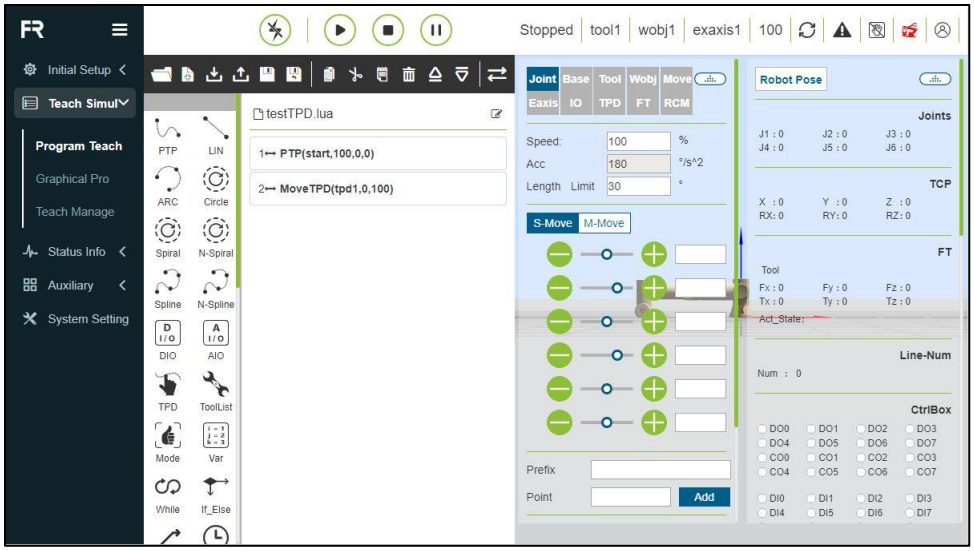


Fig. 3.6-10Robot mode

Step 4 Start recording: click the "Start recording" button to start track recording, and drag the robot for action teaching.In addition, there is a "TPD record start/stop" function configuration item in the terminal DI configuration. By configuring this function, the user can trigger the "start recording" track function through an external signal. It should be noted that to start recording tracks through an external signal, first configure the TPD track information on the page.

Step 5 Stop recording: After the action teaching is completed, click the "Stop recording" button to stop the track recording, and then drag the teaching switch button to make the robot quit the dragging teaching mode.When the teaching pendant receives the "Stop track recording successfully", it means that the track recording is successful.Synchronizing step 4, after the "TPD record start/stop" function is configured, the recording can be stopped by an external signal.

Step 6 Teaching programming: click New, select a blank template, click to enter the PTP function programming item, select the initial location point just saved, click the "Add" button, and after the application is completed, a PTP command will be displayed in the program file;Then click to enter the TPD function programming item, select the track just recorded, set whether it is smooth and the speed scaling ratio, click the "Add" button, and after the application is completed, a MoveTPD command will be displayed in the program file, as shown in Figure 3.6-11;



Step 7 Track reappearance: After the teaching program is edited, switch to the automatic operation mode, click the "Start running" icon on the top of the interface to start running the program, and the robot starts to reappear the teaching action.

Step8 Track editing: The TPD track editing area can visually display and edit tracks to achieve TPD track pre analysis and simplification.Select the corresponding track to obtain the points, then the track points recorded by the user will be displayed in the three-dimensional space of the robot. Next, the user can drag the "Start" and "End" scroll bars to simulate and reproduce and clip the start and end points of the track.

TPD file deletion and exception handling:

Track 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 indicating that the deletion is successful.

Exception handling:

- **The number of command points exceeds the limit:** a track can record up to 20000 points. When the number exceeds 20000 points, the controller will no longer record the number of points exceeded, and will send an alarm prompt of "command points exceed the limit" to the teaching pendant. At this time, click to stop recording;
- **Too large TPD command interval:** if the teaching pendant reports an error and the TPD command 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 an error and the TPD command interval is too large, delete the current track and record a new track again;
- In case of other abnormalities during TPD operation, the robot operation shall be stopped immediately through the teaching pendant or emergency stop button to check the causes.

be careful:

During the operation of TPD function, the corresponding prompts on the teaching pendant shall 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 executing program node is highlighted in gray.

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

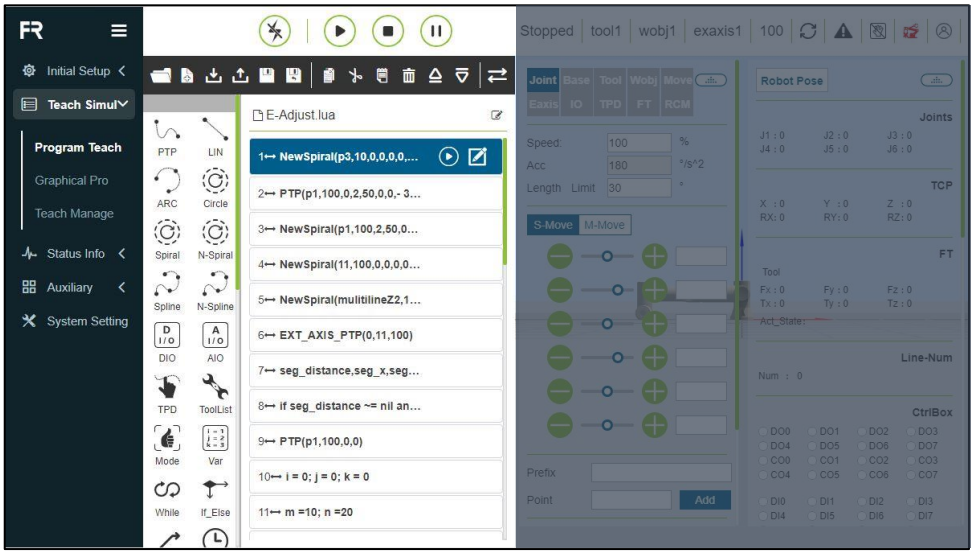


Fig. 3.7-1Program Tree Interface

3.7.2 toolbar

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



Open: Open the user program file



New: Select a template to create a new program file



Import: import a file into the user program folder



Export: export the user program file to the local



Save: save file edits



Save As: Rename and save the file to the user program



Copy: Copy a node and allow it to be used for other operations (for example, paste it to another



Paste: Allows you to paste a previously cut or copied



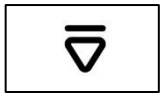
Cut: Cut a node and allow it to be used for other operations (for example, paste it to another



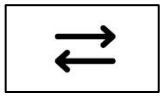
Delete: Deletes a node from the program tree.



Move Up: moves the node up.



Move Down: move the node down.



Switch editing mode: program tree mode and lua editing

3.7.3 Program command

The left side is mainly for adding program commands. Click the icon above each keyword to enter the detailed interface. There are two operations for adding program commands to the file. One is to open the relevant command and click the application button to add the command to the program. The other is to click the "Add" button first. At this time, the command is not saved to the program file,You need to click "Apply" again to save the command to the file.The second method mostly occurs when multiple commands of the same type are issued. We add the function of adding key and displaying the added command content to this type of command. Click the add key to add a command, and the added command displays all the added commands. Click "Apply" to save the added commands to the open file on the right.

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

You can select the point you want to reach, and the smooth transition time setting can realize that the movement from this point to the next point is continuous. Whether to set the offset, you can select the offset based on the base coordinate system and the tool coordinate, and pop up the x, y, z, rx, ry, rz offset settings. The PTP specific path is the optimal path automatically planned by the motion controller. Click "Add"The command can be saved after "Apply".

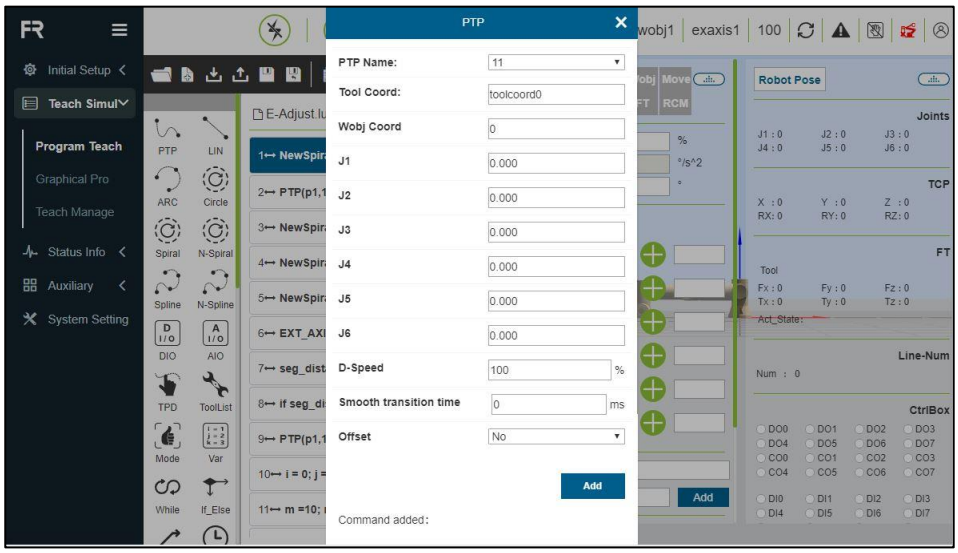


Fig. 3.7-2 PTP command interface

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

The function of this command is similar to that of the "PTP" command, but the path of the point where the command arrives is a straight line.

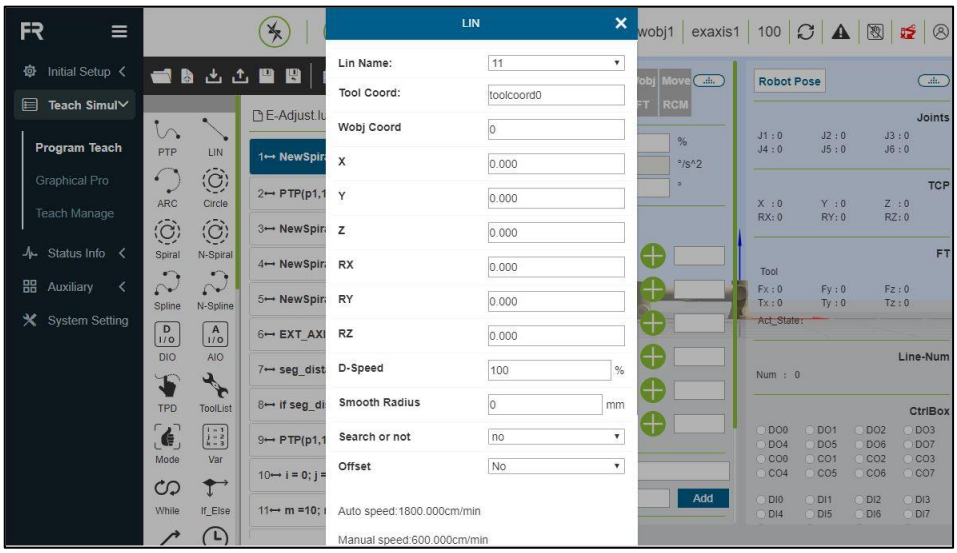


Fig. 3.7-3 Lin command interface

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

The "Arc" command is an arc motion, including two points. The first point is the middle transition point of the arc, and the second point is the end point. Both the transition point and the end point can set whether to offset. You can choose to offset based on the base coordinate system and tool coordinates, and pop up the x, y, z, rx, ry, and rz offset settings. The end point can set a smooth transition radius to achieve continuous motion effects.

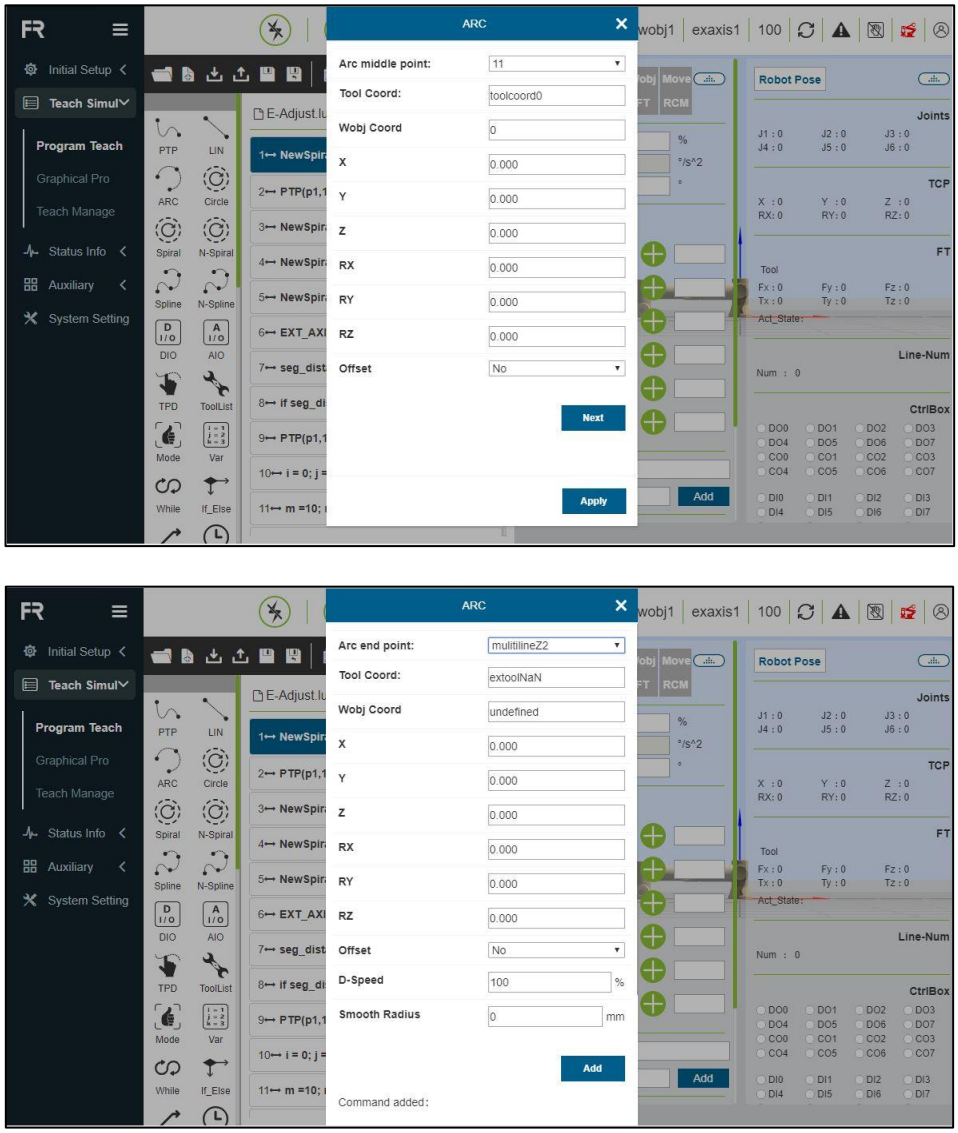


Fig. 3.7-4 Arc command interface

Circle command: click the "Circle" icon to enter the circle command editing interface

The "Circle" command is a whole circle movement, including two points. The first point is the middle transition point 1 of the whole circle, and the second point is the middle transition point 2 of the whole circle. The transition point 2 can set whether to offset. The offset is effective at both transition point 1 and transition point 2.

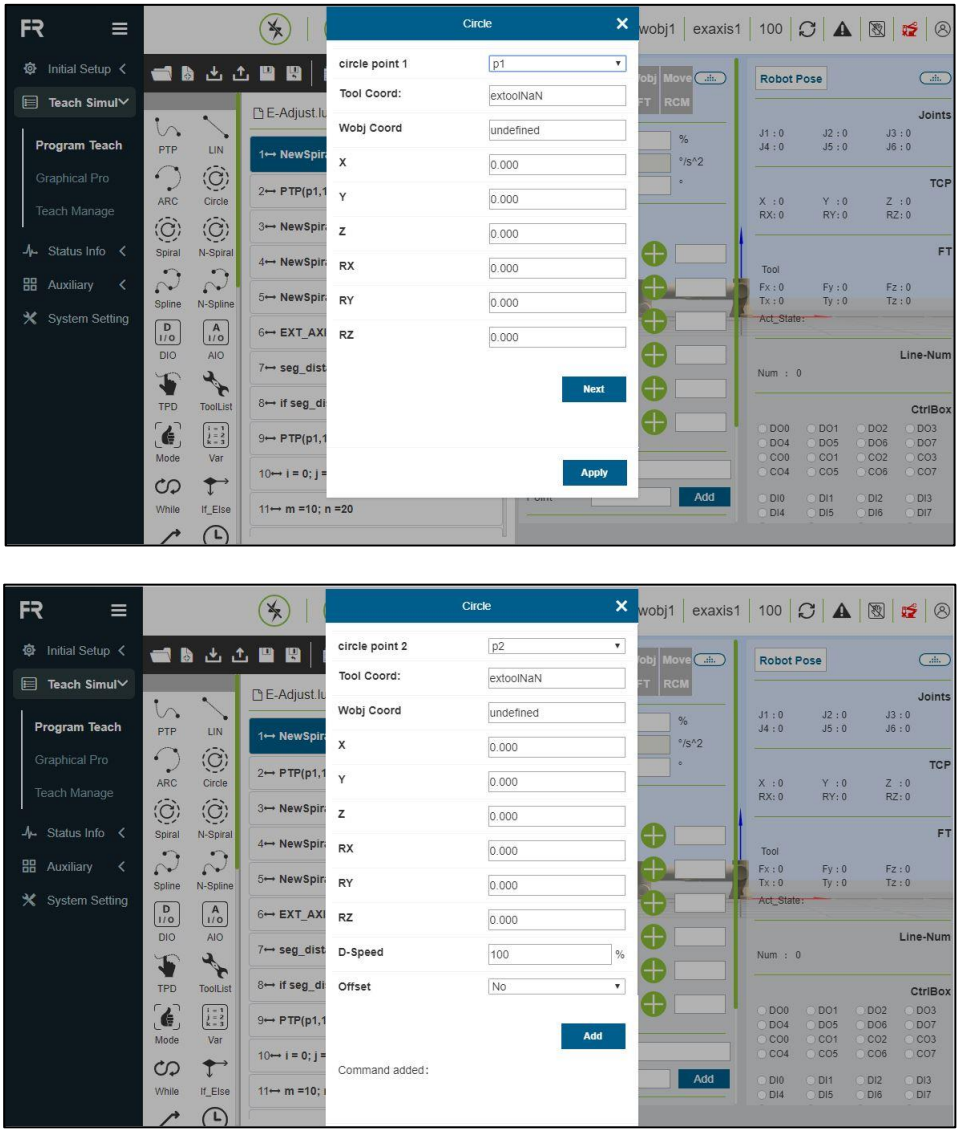


Fig. 3.7-5 Circle command interface

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

The "Spiral" command is a spiral movement, which contains three points. The three points form a circle. On the third point setting page, there are several parameter settings, including the number of spiral turns, attitude correction angle, radius increment and axis direction increment. The number of spiral turns is the number of motion cycles of the spiral. The attitude correction angle corrects the attitude at the end of the spiral and the attitude of the first point of the spiral,The radius increment is the increment of the radius of each circle, and the increment of the rotation axis direction is the increment of the spiral axis direction.Sets whether to offset, which is effective for the trajectory of the entire helix.

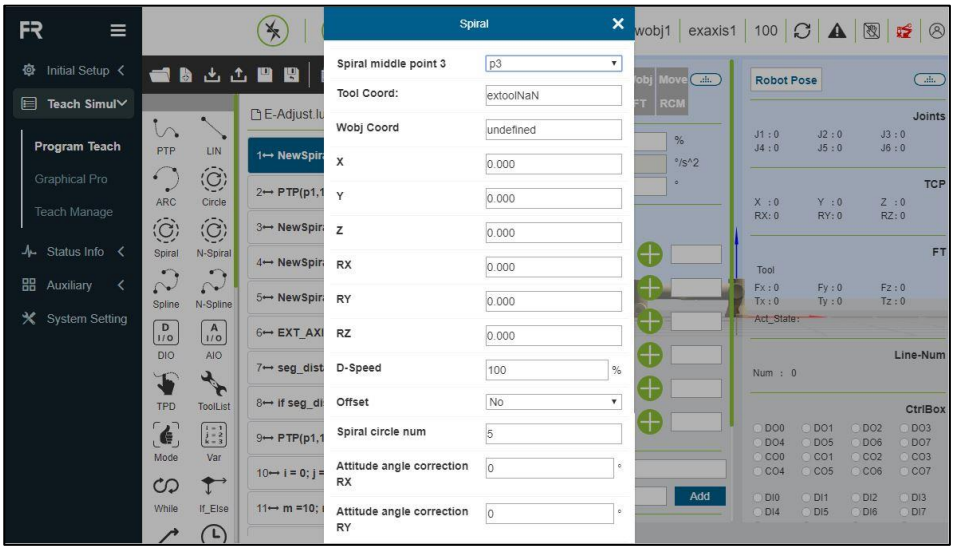


Fig. 3.7-6 Spiral command interface

N-Spiral command: click the "N-Spiral" icon to enter the N-Spiral command editing interface

The "N-Spiral" command is an optimized version of spiral movement, which requires only one point plus the configuration of parameters to achieve spiral movement.The robot takes the current position as the starting point, and the user sets the debugging speed, whether to offset, the number of spiral coils, the spiral inclination, the initial radius, the radius increment, the axis direction increment and the rotation direction. The number of spiral coils is the number of motion coils of the spiral line, and the spiral inclination is the angle between the Z axis of the tool and the horizontal direction,The attitude correction angle corrects the attitude at the end of the spiral and the attitude at the first point of the spiral. The initial radius is the size of the radius of the first circle, the radius increment is the increment of the radius of each circle, and the rotation axis direction increment is the increment of the spiral axis direction, and the rotation direction is clockwise and counterclockwise.

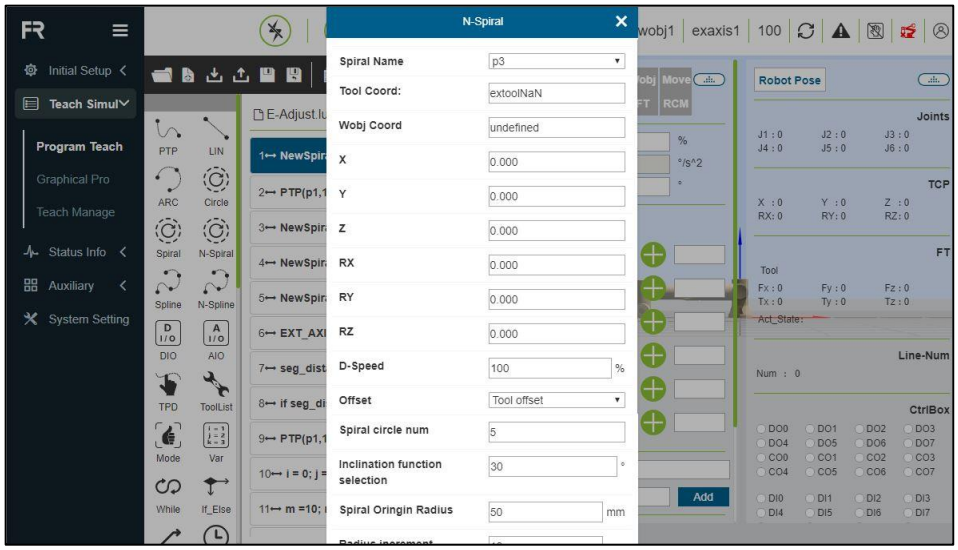


Fig. 3.7-7 N-Spiral command interface

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

This command is divided into three parts: the start of the spline group, the end of the spline segment and the end of the spline group. The start of the spline group is the start sign of the spline movement. The spline segment contains SPL, SLIN and SCIRC segments. Click the corresponding icon to enter the command adding interface. The end of the spline group is the end sign of the spline movement.

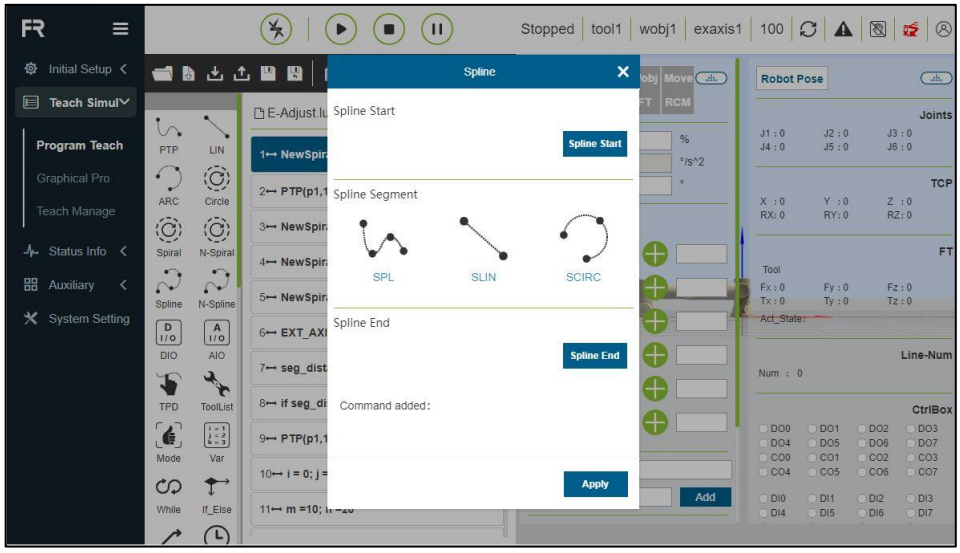


Fig. 3.7-8 Spline command interface

N-Spline command: click the "N-Spline" icon to enter the N-Spline command editing interface

This instruction is a Spline instruction algorithm optimization instruction, which will replace the existing Spline instruction later. This instruction is divided into three parts: multi-point track start, multi-point track segment and multi-point track end. The multi-point track start is the start sign of multi-point track movement, and the multi-point track segment is to set each track point. Click the icon to enter the point adding interface. The multi-point track end is the end sign of multi-point track movement,Control mode and debugging speed can be set here. Control mode is divided into given control point and given path point.

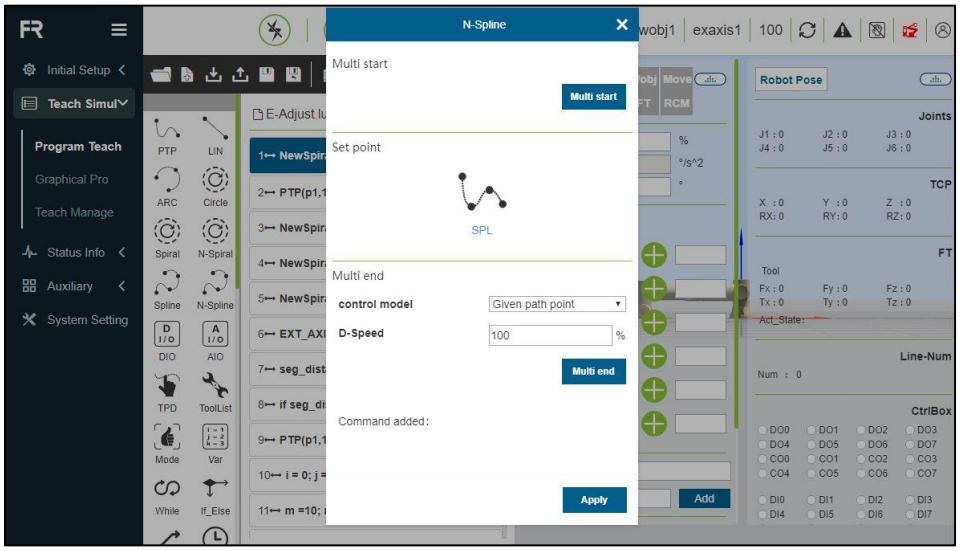


Fig. 3.7-9 N-Spline command interface

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

The "IO" instruction is divided into two parts: setting IO (SetDO/SPLCSetDO) and obtaining IO (GetDI/SPLCGetDI).

"SetDO/SPLCSetDO" This command can set the specified output DO status, including 16 channels of control box digital output and 2 channels of tool digital output. The status option "False" is closed, "True" is on, whether to block the option "Blocking" means to set the DO status after the movement stops, and the option "Non blocking" means to set the DO status during the last movement.In the smooth track option, selecting Break means to set the DO state after the smooth transition radius ends, and selecting Serial means to set the DO state during the smooth transition radius movement.When the instruction is added to the worker thread, you need to select Yes to apply the thread, or No to use the instruction elsewhere.Click Add and Apply.

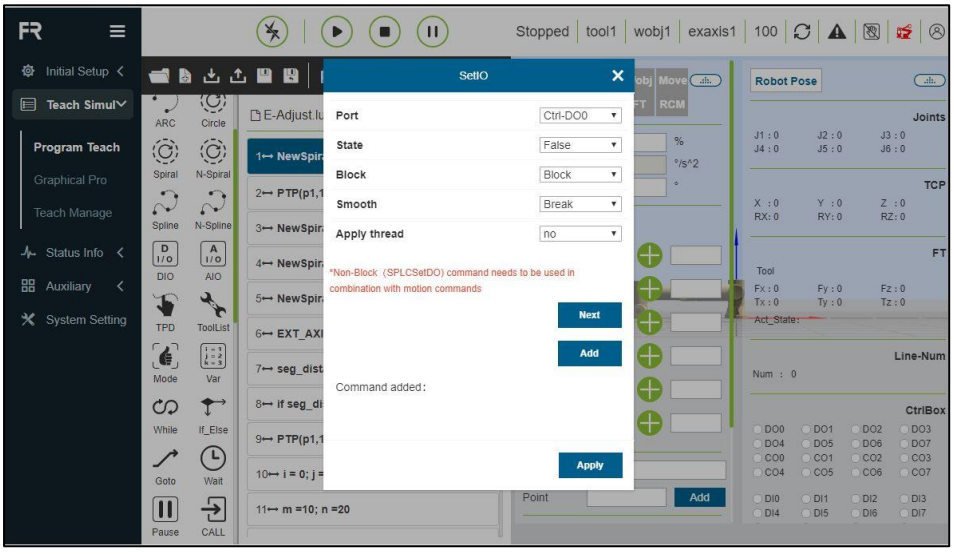


Fig. 3.7-10 SetDO command interface

In the "GetDI/SPLCGetDI" command, select the value of the port number you want to obtain. Select the "Blocking" option to obtain the DI status after the motion stops. Select the "Non Blocking" option to obtain the DI status during the last motion.When the instruction is added to the worker thread, you need to select Yes to apply the thread, or No to use the instruction elsewhere.Click Add and Apply after selection.

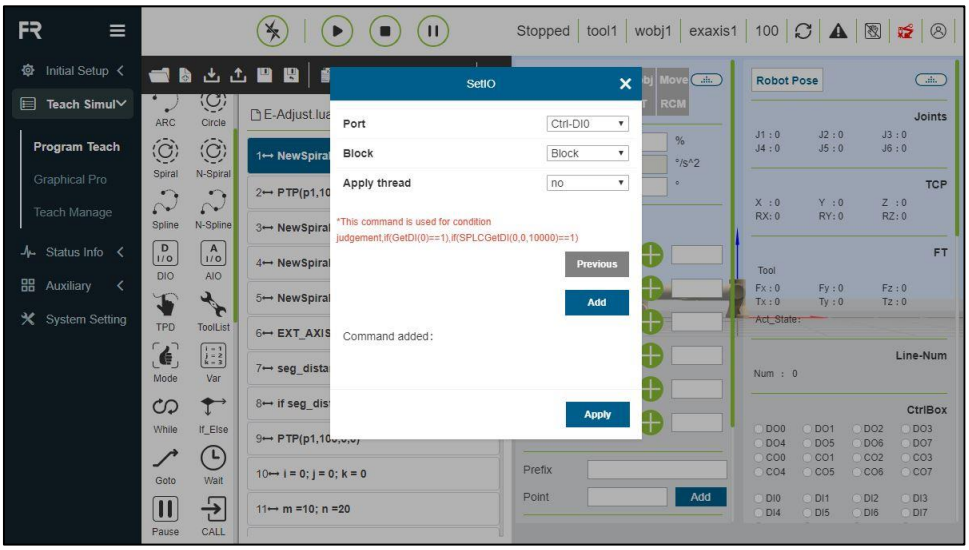


Fig. 3.7-11 GetDI command interface

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

In this instruction, there are two functions: setting analog output (SetAO/SPLCSetAO) and acquiring analog input (GetAI/SPLCGetAI).

"SetAO/SPLCSetAO" selects the analog output to be set, inputs the value to be set, the range is 0-10, whether to block the option "Blocking" means to set the AO state after the motion stops, and "Non blocking" means to set the AO state during the last motion.When the instruction is added to the worker thread, you need to select Yes to apply the thread, or No to use the instruction elsewhere.Click Add and Apply.

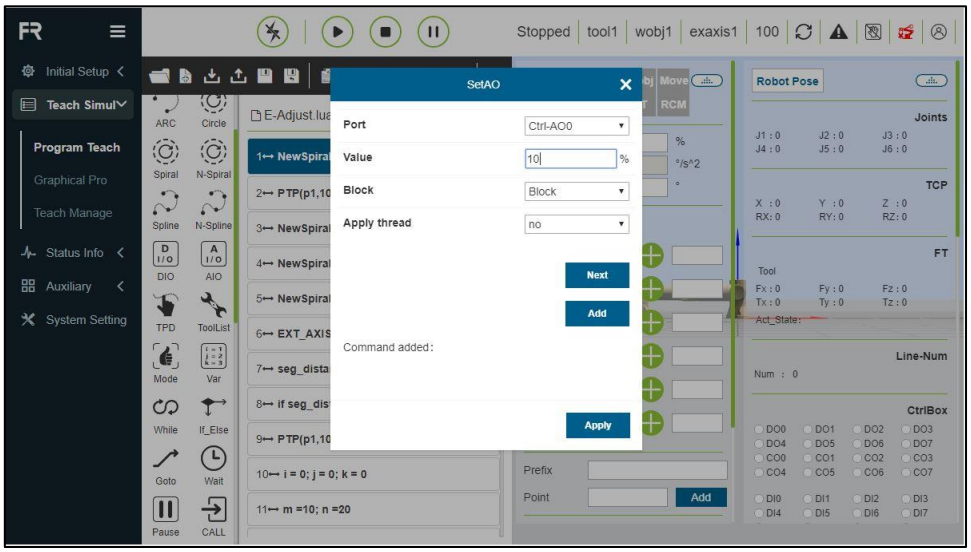


Fig. 3.7-12 SetAO command interface

"GetAI/SPLCGetAI" selects the analog input to be acquired. Choosing "Blocking" means acquiring AI status after the motion stops. Choosing "Non Blocking" means acquiring AI status during the last motion.When the instruction is added to the worker thread, you need to select Yes to apply the thread, or No to use the instruction elsewhere.Click Add and Apply.

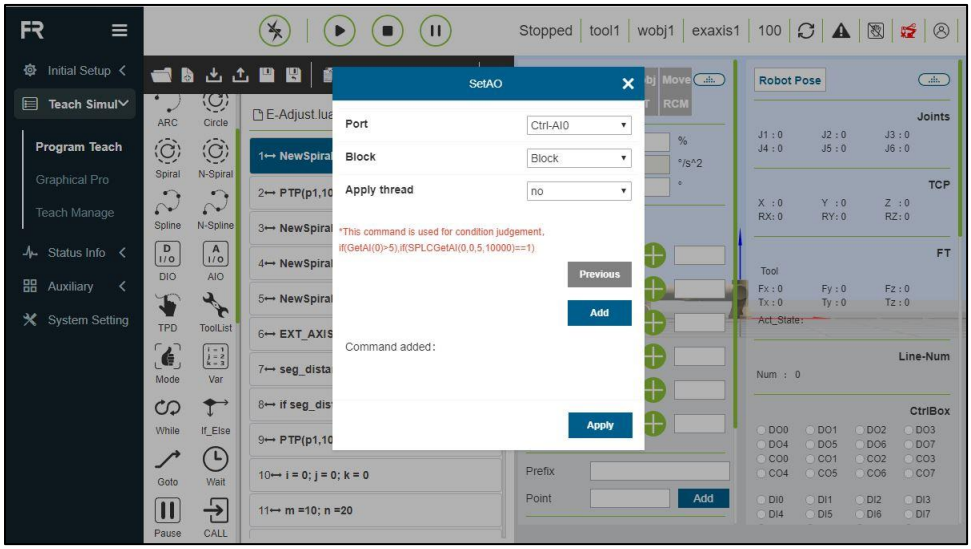


Fig. 3.7-13 GetAI command interface

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

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

About track recording: save the starting point of the next track before preparing to record the track.When the robot is in drag mode, enter the file name, select the cycle (assuming the value is x, that is, a point is recorded every x milliseconds, and it is recommended to record a point every 4 milliseconds), and click to start recording. The user can drag the robot to carry out the specified movement as required. After the recording is completed, click to stop recording, and then the previous robot's motion track can be saved.When a movement cannot be fully recorded, the system will prompt that the number of record points exceeds the limit, and the user needs to record the movement in several times.

When programming, first use the PTP command to reach the start point of the corresponding track, then select the track in the TPD track reproduction command, select whether it is smooth, set the debugging speed, click "Add" and "Application" in order to insert the program.The trajectory loading command is mainly used to read the trajectory file in advance and extract the trajectory command, which is better applied to the conveyor belt tracking scene.

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

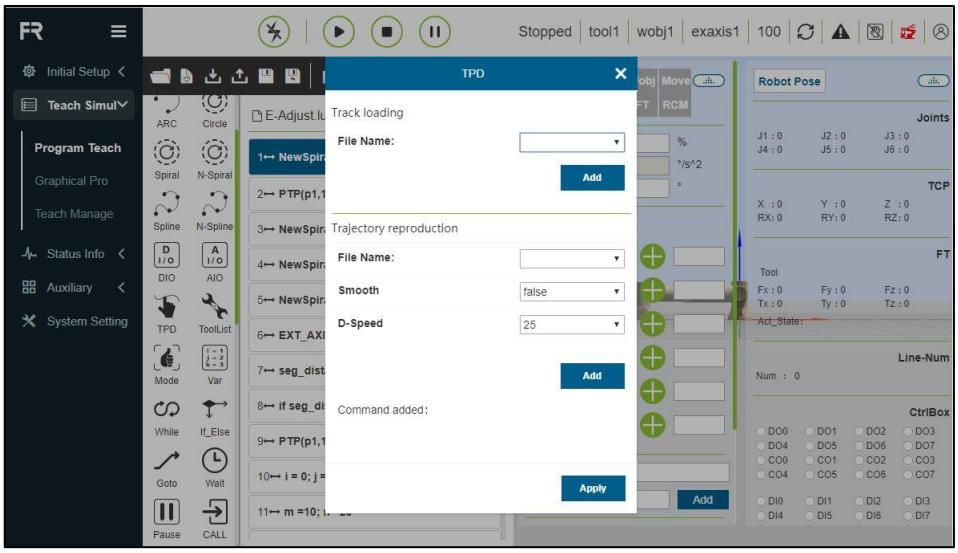


Fig. 3.7-14 TPD command interface

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

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

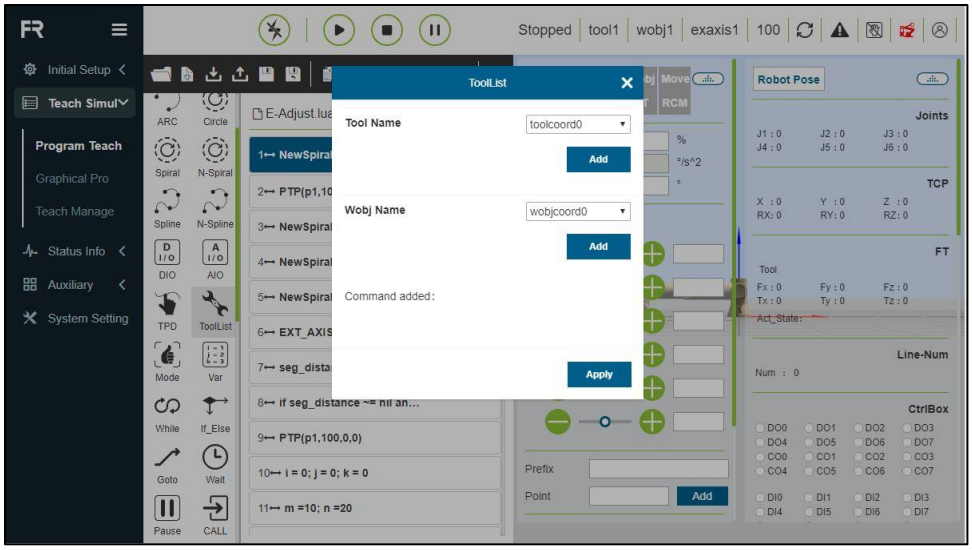


Fig. 3.7-15 ToolList command interface

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

This command can switch the robot to manual mode, 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.

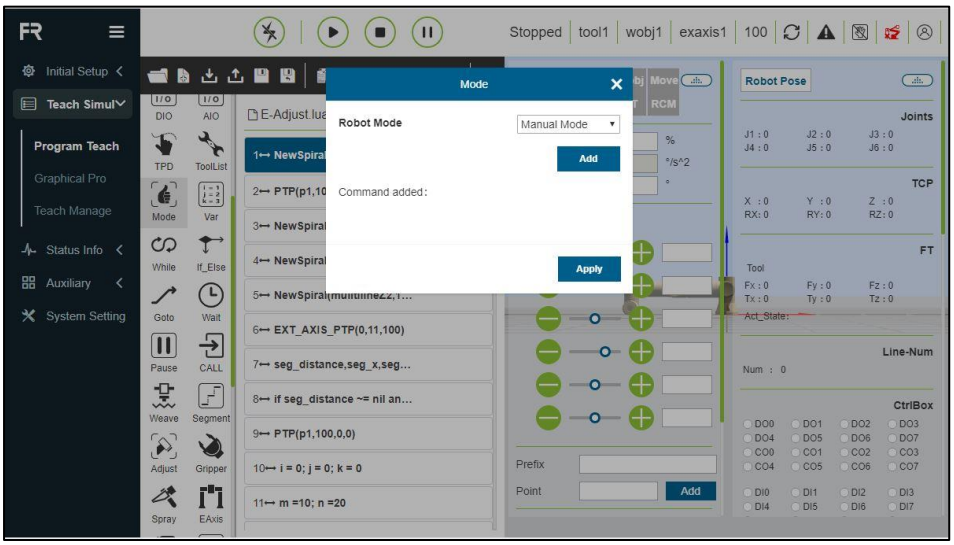


Fig. 3.7-16 Mode command interface

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

This instruction is a variable system instruction, which is divided into two parts: Lua variable definition, variable query and Sys variable renaming, obtaining value and setting value. Lua variable definition can declare a variable and assign an initial value, which can be used together with while, if else and other instructions. Lua variable query instruction can query the value of the entered variable name in real time and display it in the status bar.The number of Sys variables is fixed. You can rename them, obtain variable values, and set variable values. The value saved by the variable is not reset with the system shutdown.

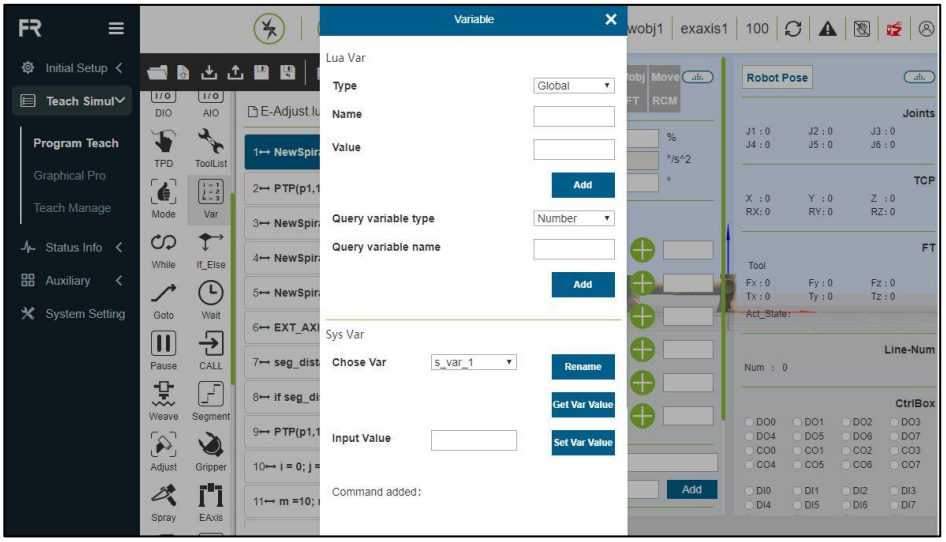


Fig. 3.7-17 Var command interface

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

Enter the waiting conditions in the input box behind While, and the action instructions during the cycle in the input box behind Do, and then click Save.(For the convenience of operation, you can input the do content at will and edit other instructions in the program instead)

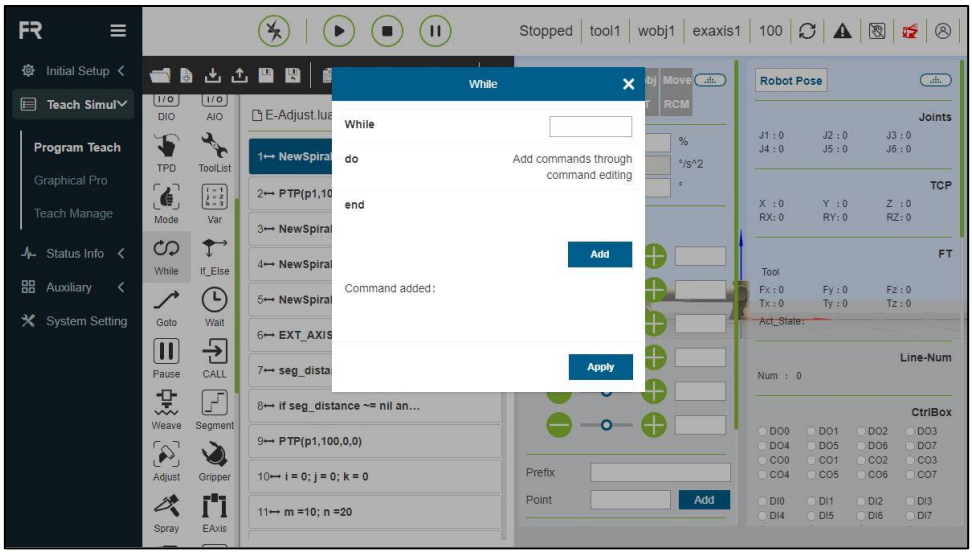


Fig. 3.7-18 While command interface

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

Enter the statement in the right input box, and click "Add" and "Apply" after editing.(This instruction needs some programming foundation, please contact us for help)

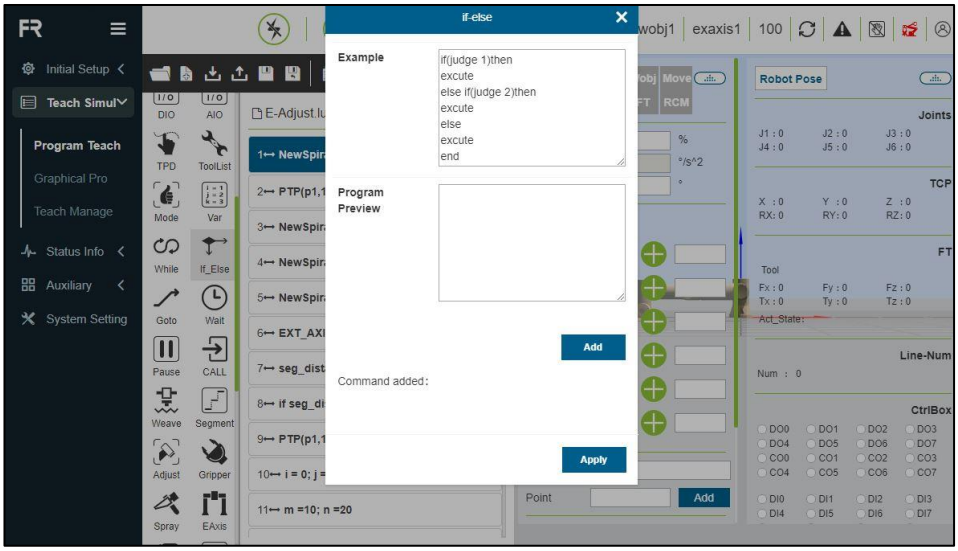


Fig. 3.7-19 If. else command interface

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

Goto instruction is a jump instruction. Enter a statement in the inputbox on the right, and click "Add" and "Apply" after editing.(This instruction needs some programming foundation, please contact us for help)

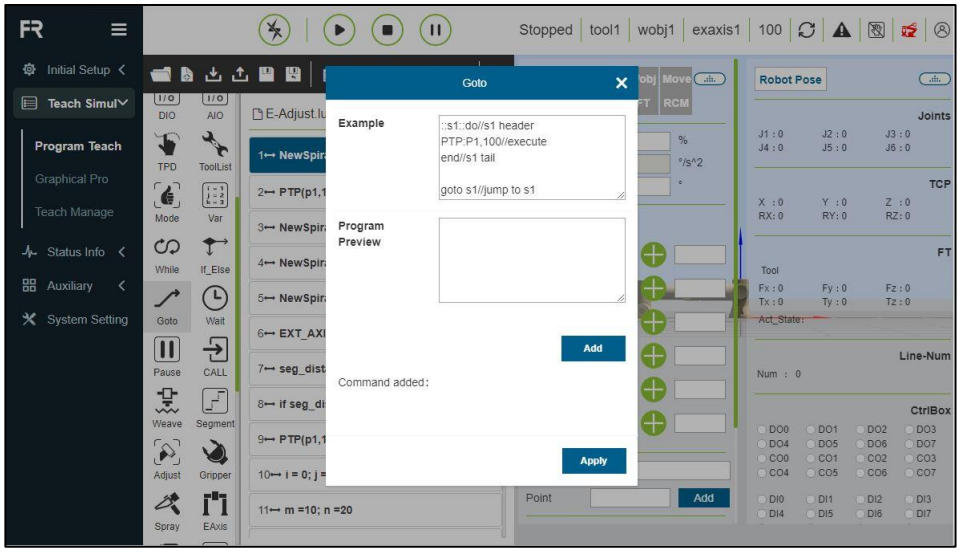


Fig. 3.7-20 Goto command interface

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

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

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

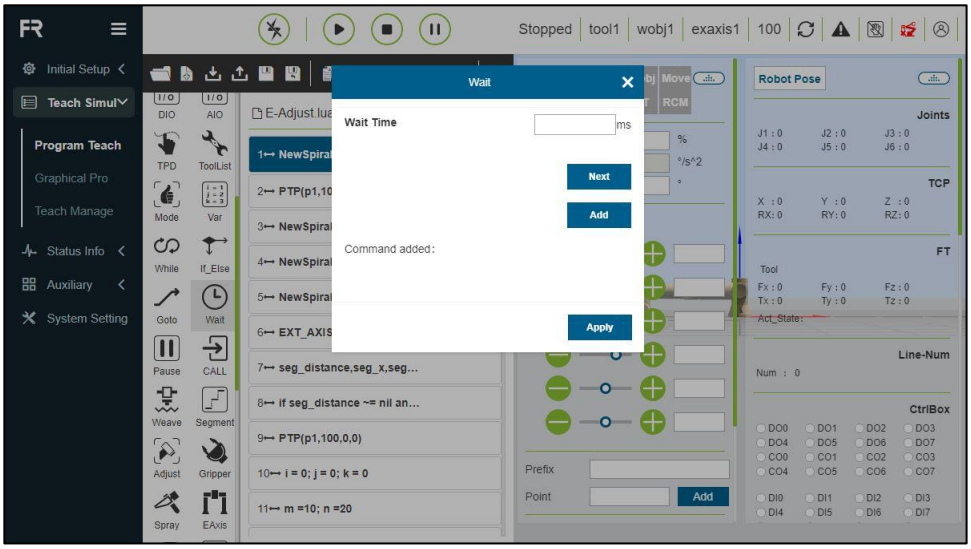


Fig. 3.7-21 WaitTime command interface

The "WaitDI" command, that is, single DI wait, selects the IO port number, wait status, maximum wait time and wait timeout processing method to wait, and then click "Add" and "Apply".

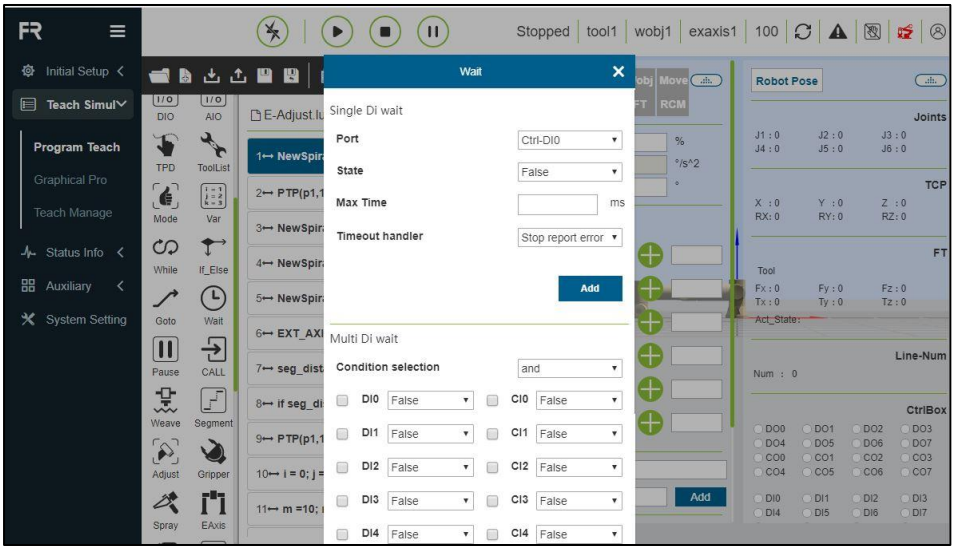


Fig. 3.7-22 WaitDI command interface

The "WaitMultiDI" instruction, that is, multi DI waiting, first selects the conditions for multi DI to hold, then checks the DI port and status to wait, finally sets the maximum waiting time and the waiting timeout processing method, and then clicks "Add" and "Apply".

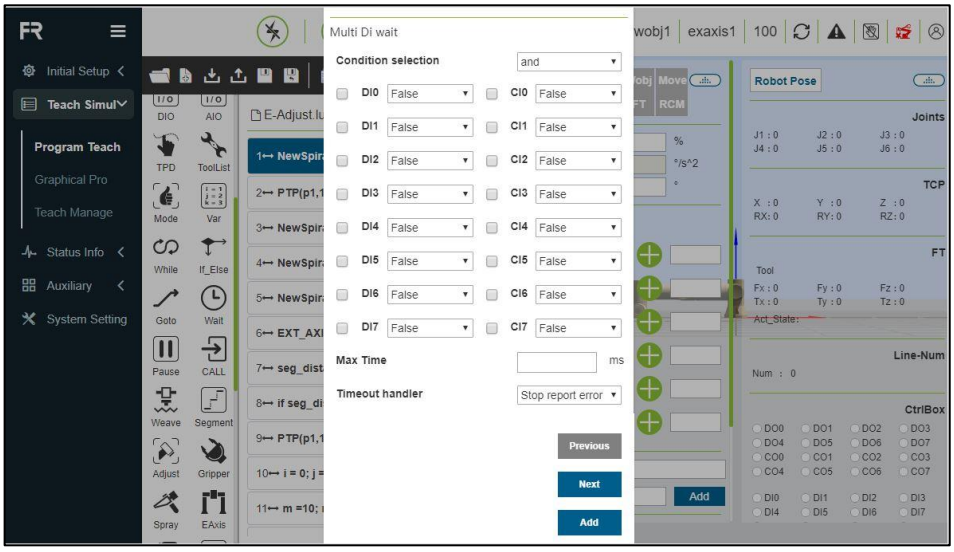


Fig. 3.7-23 WaitMultiDI command interface

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

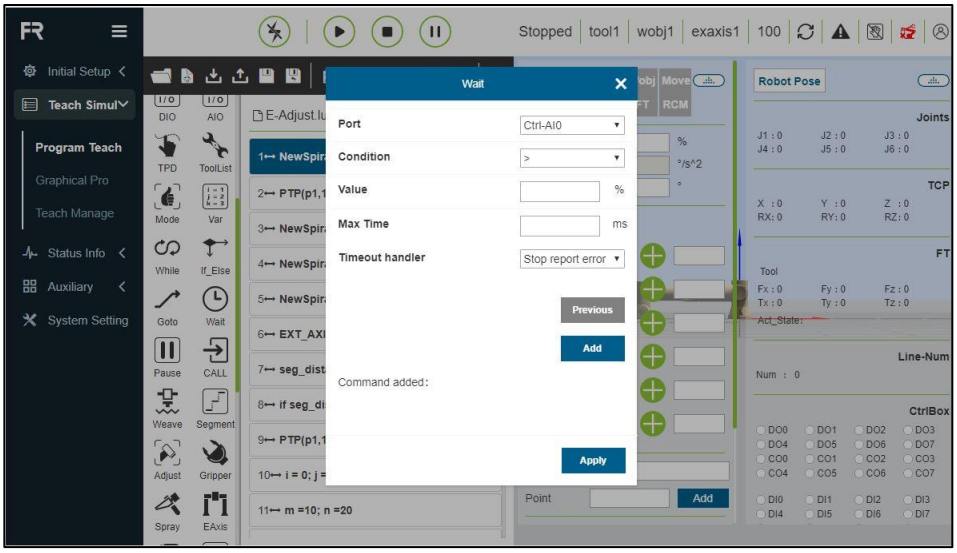


Fig. 3.7-24 WaitAI command interface

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

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

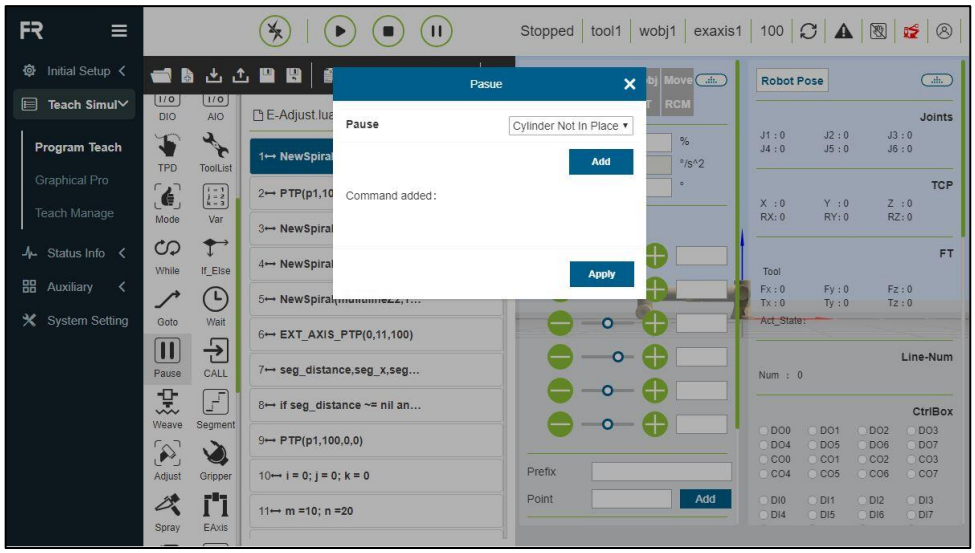


Fig. 3.7-25 Pause command interface

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

The Dofile instruction calls the internal program of the controller. When using the Dofile instruction, the called subprogram needs to be saved. If the main program is not changed, it can not be saved again.The Dofile instruction supports two-level calls. Two parameter settings should be paid attention to. One is the level of the call, and the other is the ID number of the call. In principle, the same ID cannot appear in the same program.

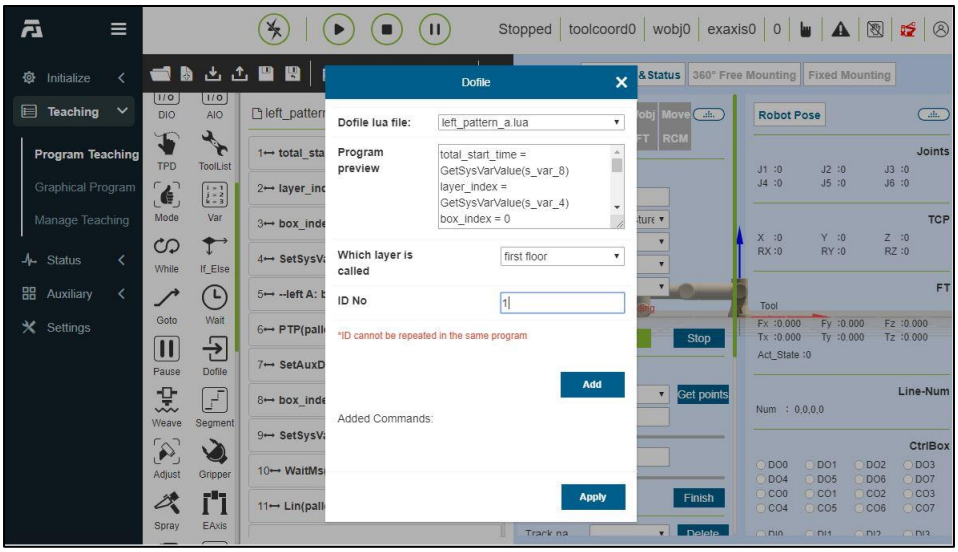


Fig. 3.7-26 Dofile command interface

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

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

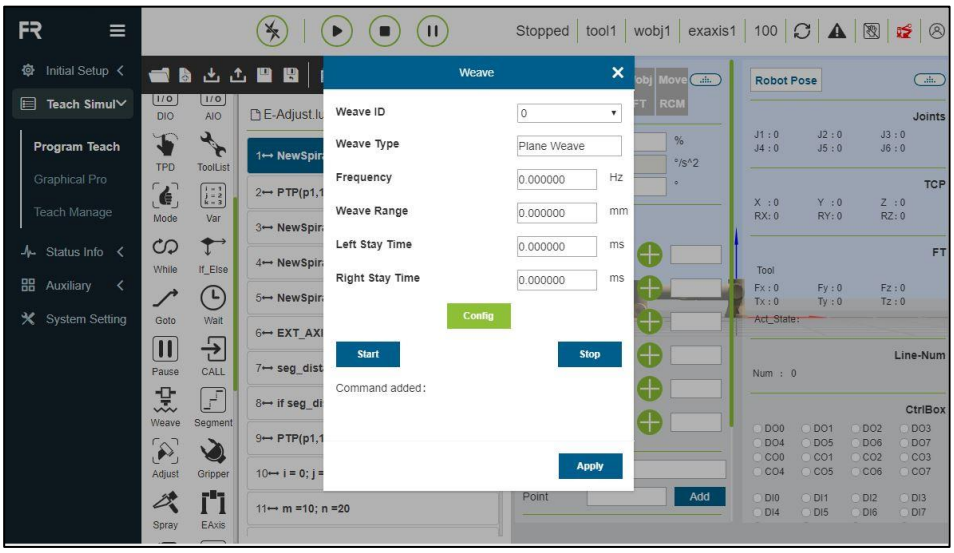


Fig. 3.7-27 Weave command interface

Click "Configuration and Test" to configure the parameters of swing welding. After the configuration is completed, the swing welding track can be tested by pressing the Start and Stop test buttons.

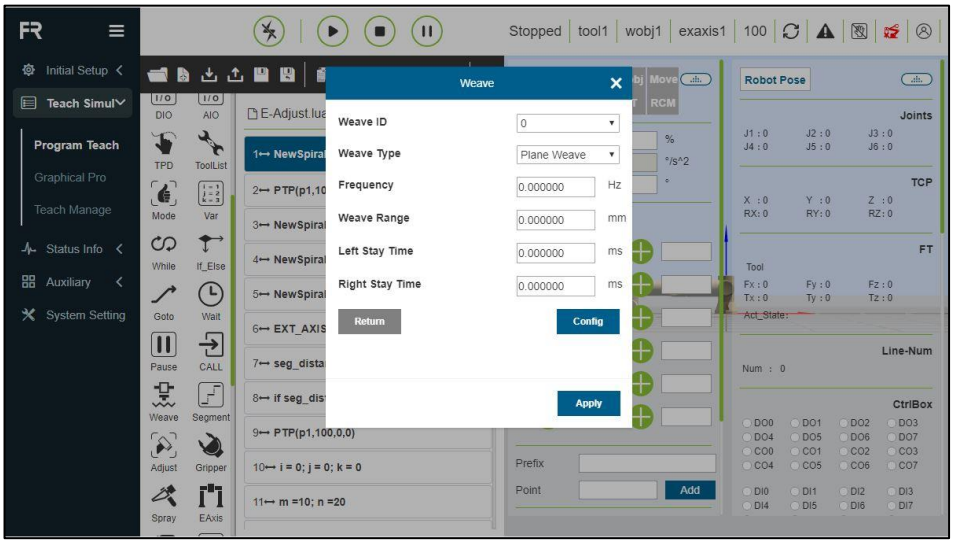


Fig. 3.7-28 Weave configuration and test instruction interface

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

This instruction is a special instruction for welding. It is mainly used in the cyclic intermittent welding scene of one section of welding and one section of no welding.Between the starting point and the end point, use this command to select the starting point and the end point, set the debugging speed, set the DO port for arc starting, the execution length, and the non execution length. According to the actual application scenario, set the function mode, swing selection, and rounding rules to achieve the segment welding function.

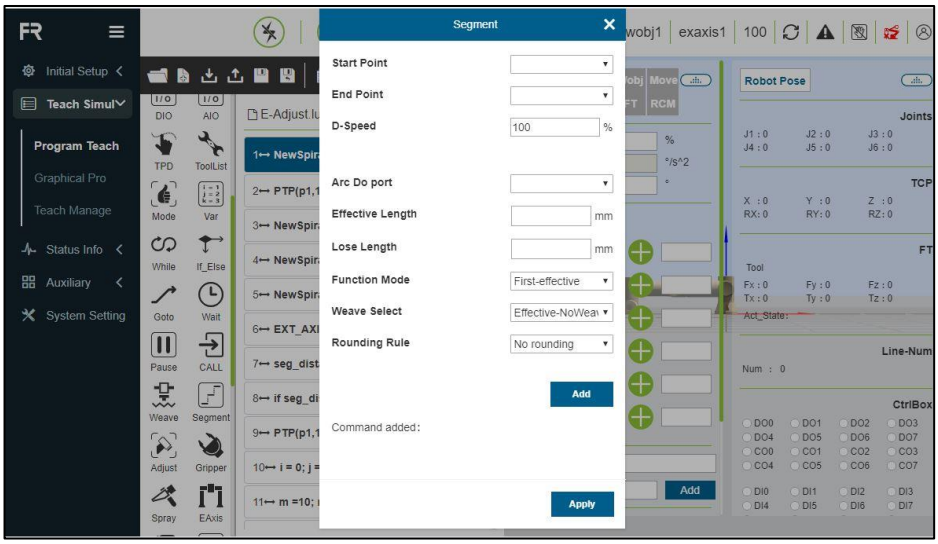


Fig. 3.7-29 Segment command interface

Adjust command: click the "Adjust" icon to enter the adjust command editing interface

This command is used to adaptively adjust the welding gun posture for welding tracking. After recording the three corresponding posture points, add an adaptive posture adjustment command according to the actual movement direction of the robot.See the robot peripheral chapter for details.

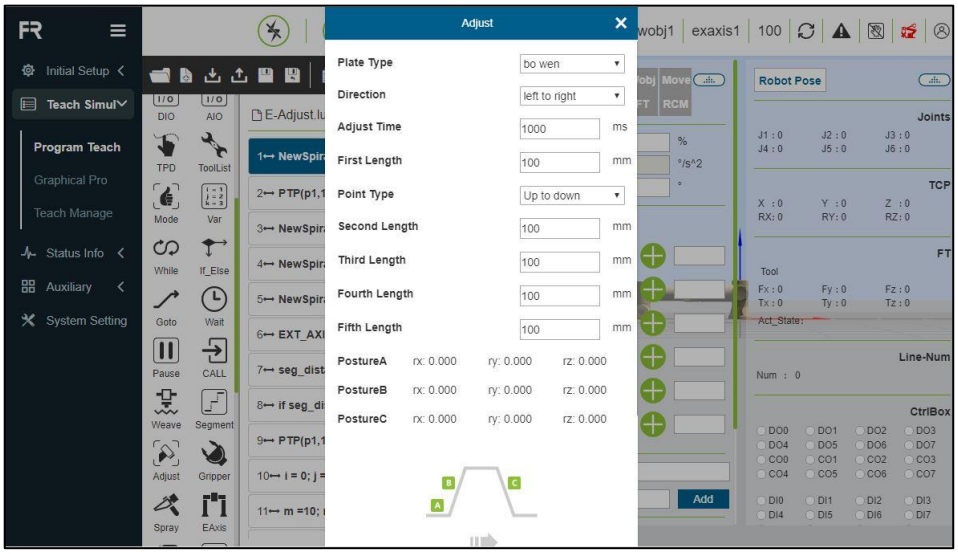


Fig. 3.7-30 Adjust command interface

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

This command is divided into gripper movement control command and gripper activation/reset command. In the gripper control command, the number of gripper that has been configured and activated is displayed. The user can edit it through the edit box or slide the slider bar to the required value to complete the setting of gripper opening/closing, opening/closing speed and opening/closing torque. The value is a percentage. Whether to block the function option,When blocking is selected, the gripper movement needs to wait until the last movement command is executed. When non blocking is selected, the gripper movement is parallel to the last movement command.Click the "Add" and "Apply" buttons to save the set values to the teaching file.Clamping jaw reset/activation command displays the configured clamping jaw number, and reset/activation command can be added to the program.

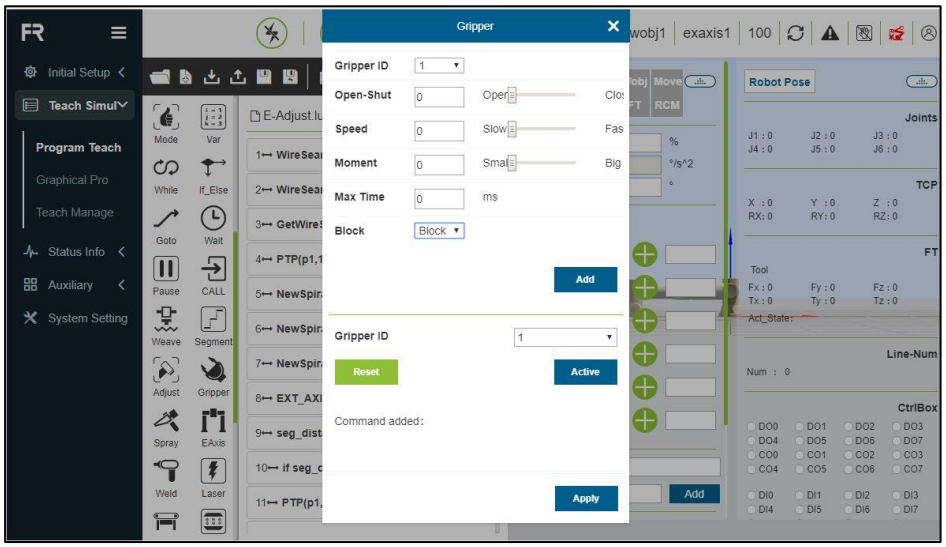


Fig. 3.7-31 Gripper command interface

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

This instruction is related to spraying, which controls the spray gun "start spraying", "stop spraying", "start cleaning" and "stop light gun".When editing the program command, it is necessary to confirm that the spray gun peripherals have been configured. See the robot peripherals section for details.

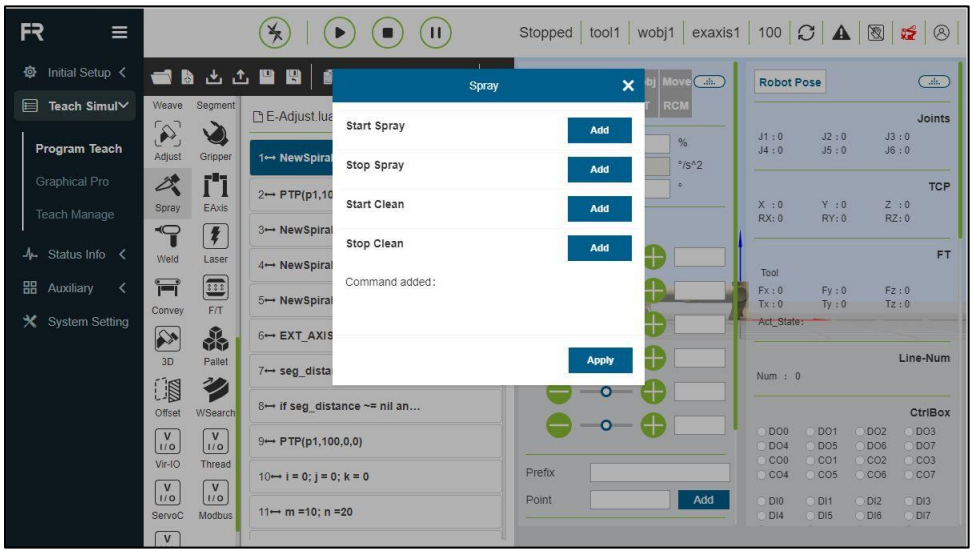


Fig. 3.7-32 Spray command interface

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

This command is aimed at the scene where the external axis is used, and can be used in combination with the PTP command to decompose the movement of a point in space in the X axis direction to the external axis movement.Select the external axis number, select the motion mode to synchronize, select the point to be reached, click "Add" and "Apply" to save this command

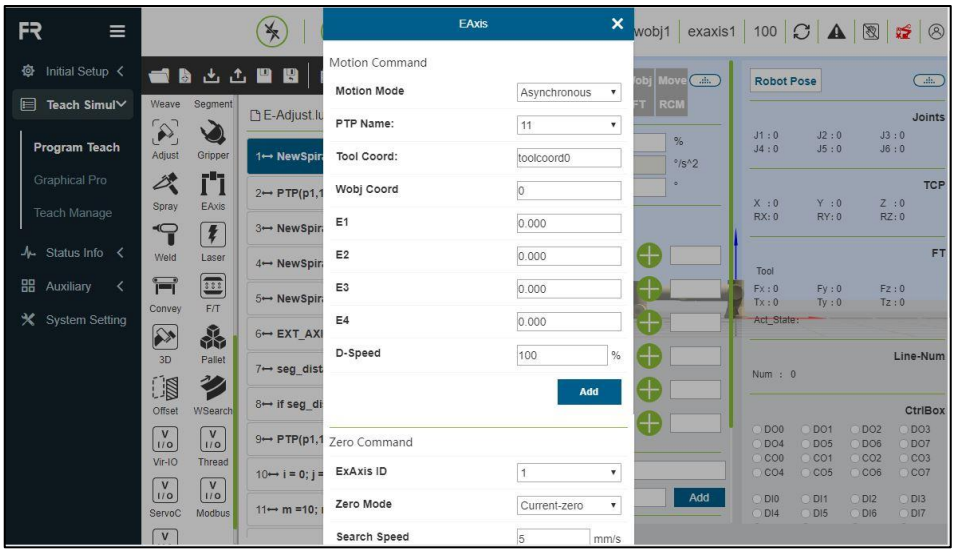


Fig. 3.7-33 EAxis command interface

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

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

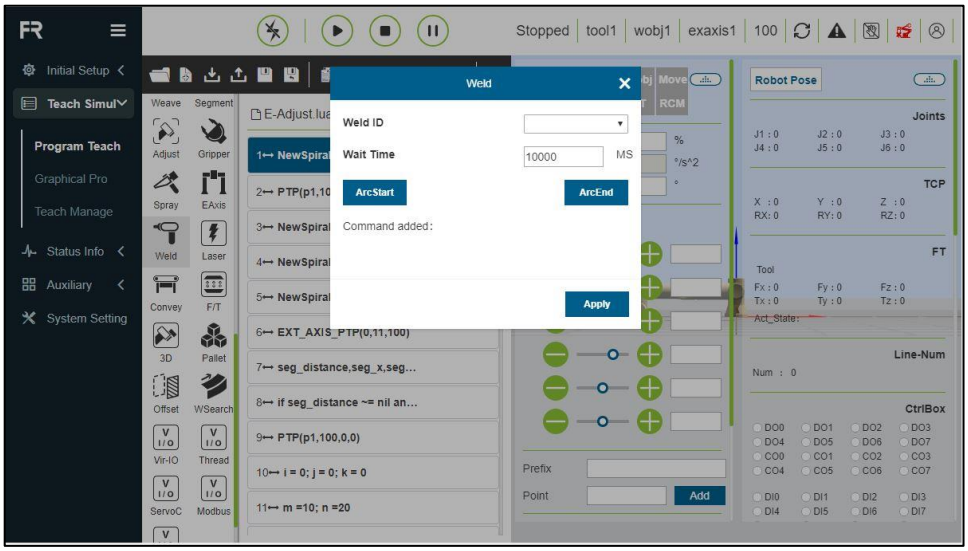


Fig. 3.7-34 Weld command interface

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

This command includes three parts: laser command, tracking command and location search command. Before adding this command, please confirm whether the laser tracking sensor in the outdoor device has been successfully configured.See the robot peripheral chapter for details.

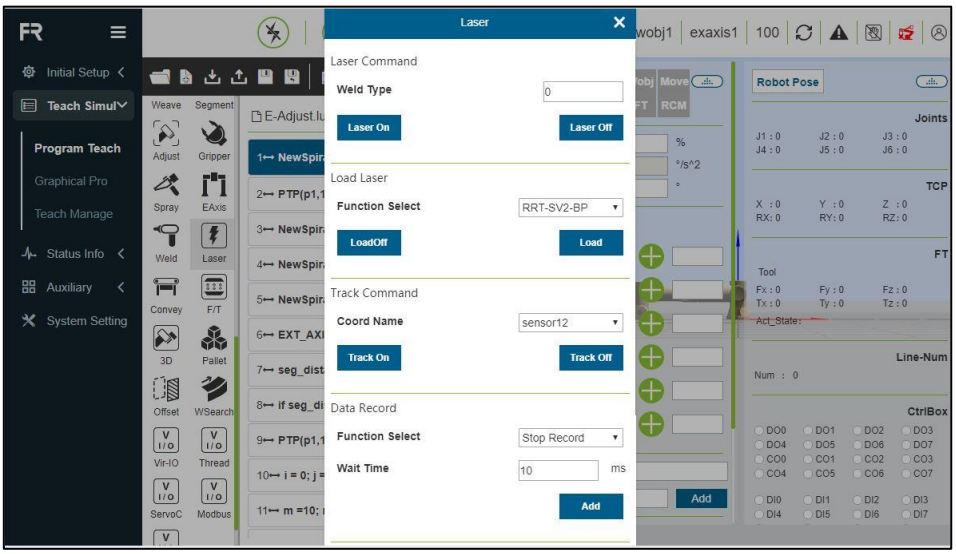


Fig. 3.7-35 Laser command interface

Conveyor command: click the "Conveyor" icon to enter the edit interface of the Carry command

This command includes four commands: position real-time detection, IO real-time detection, tracking on and tracking off.See the robot peripheral chapter for details.

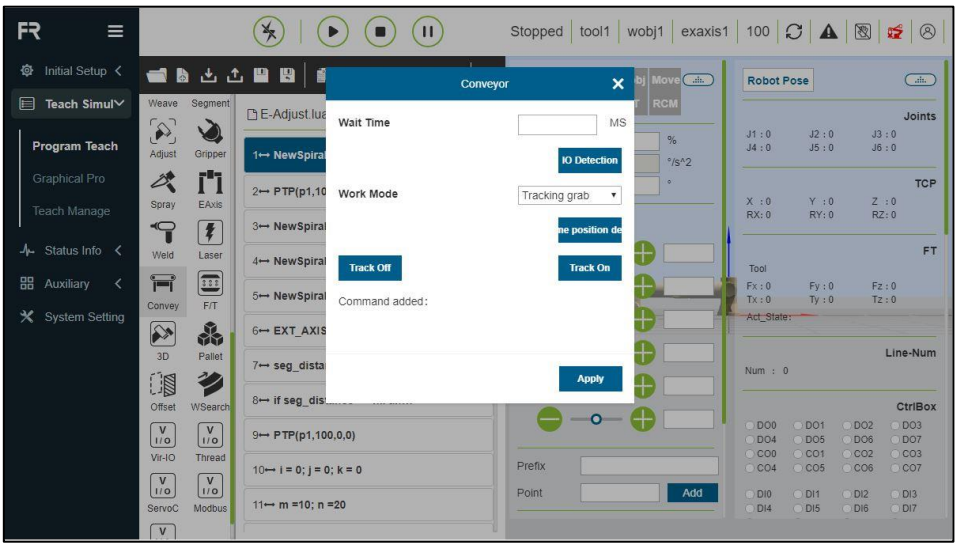


Fig. 3.7-36 Conveyor command interface

F/T command: click the "F/T" icon to enter the F/T command editing interface

This command contains FT_Guard, FT_Control, FT_Spiral, FT_Rot, FT_Lin, FT_FindSurface, FT_CalCenter (center positioning) seven commands, see the robot peripheral chapter for details.

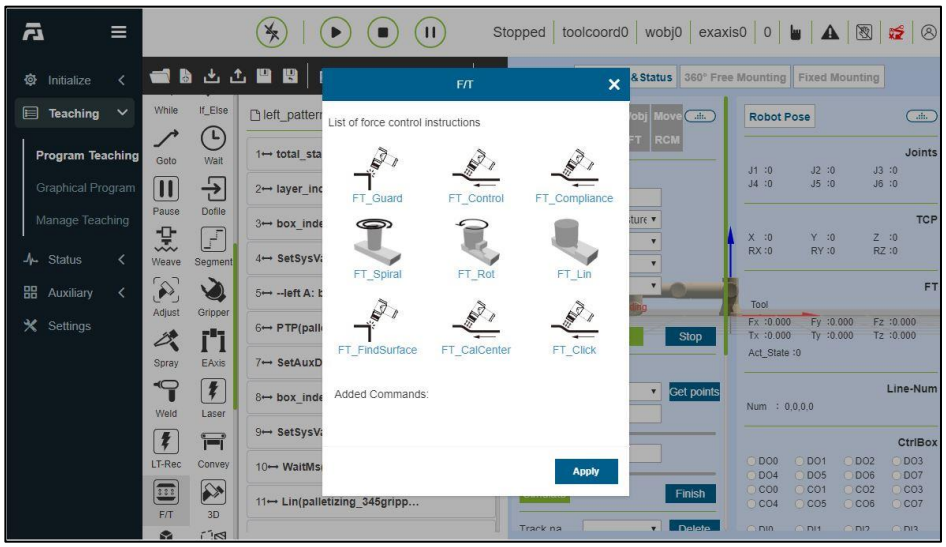


Fig. 3.7-37 F/T command interface

3D command: click the "3D" icon to enter the 3D command editing interface

This command generates instructions for 3D visual program instances. Users can refer to the generated program and communicate with other visual devices, including camera calibration and camera capture.

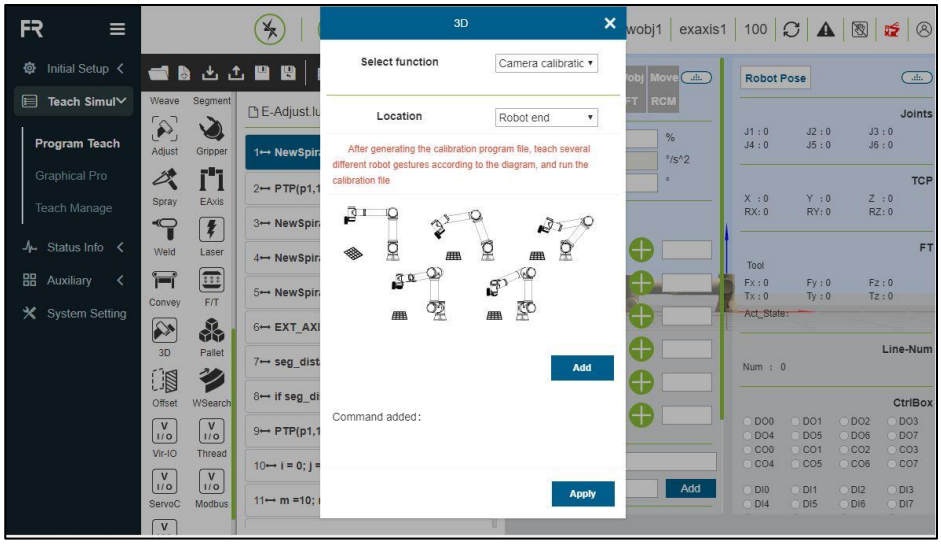


Fig. 3.7-38 3D command interface

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

This instruction is the instruction generated by the stacking program, which is consistent with the matrix movement function in Section 3.9.6. Refer to that section for details.

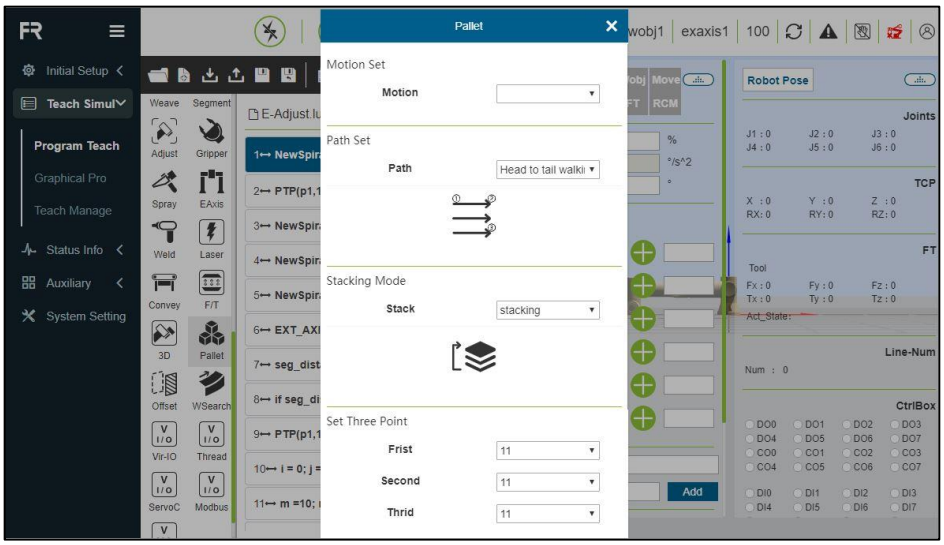


Fig. 3.7-39 Pallet command interface

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

This command is an overall offset command. Input each offset, add the open command and close command to the program, and the motion command between the start and close will offset based on the base coordinate (or workpiece coordinate).

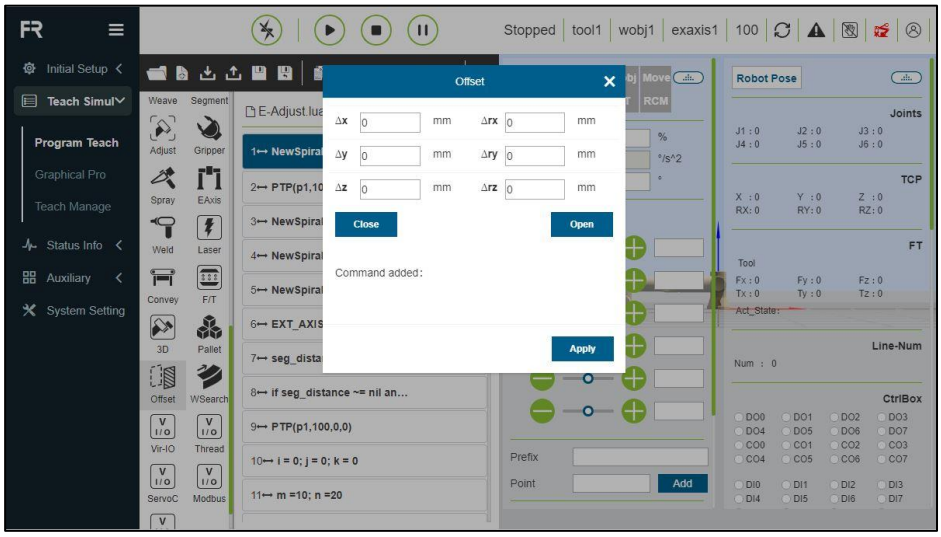


Fig. 3.7-40 Offset command interface

W-Search command: click the "W-Search" icon to enter the W-Search command editing interface

This command is a welding wire location search command, including three commands: location search start, location search end, and offset calculation. This command is generally used in welding scenes, and needs to be used in combination with robot IO and motion commands.

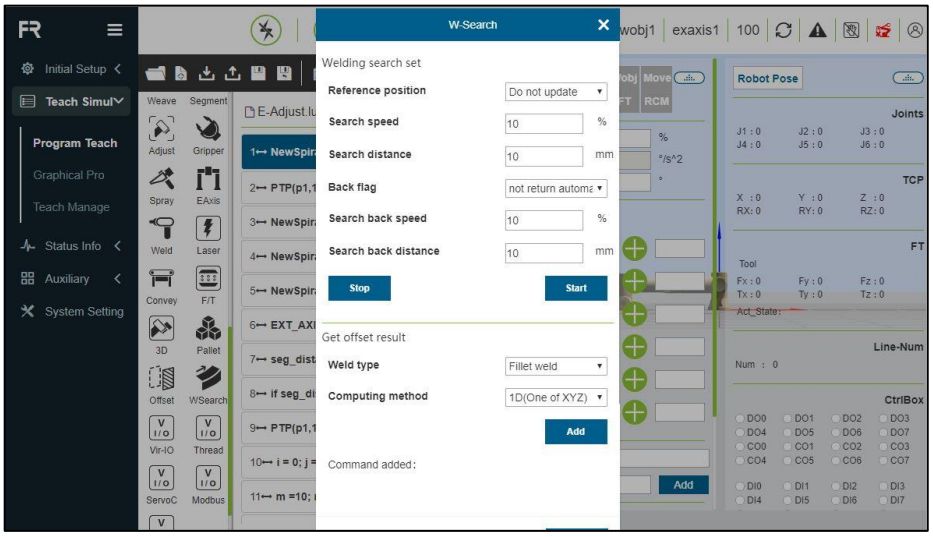


Fig. 3.7-41 W-Search command interface

In the process of programming, it is usually to set the start command of position finding first, and then add two LIN commands to determine the direction of position finding. After the successful position finding, the calculated offset is obtained, and the offset is put into the actual welding movement command through the overall offset command, as shown below.

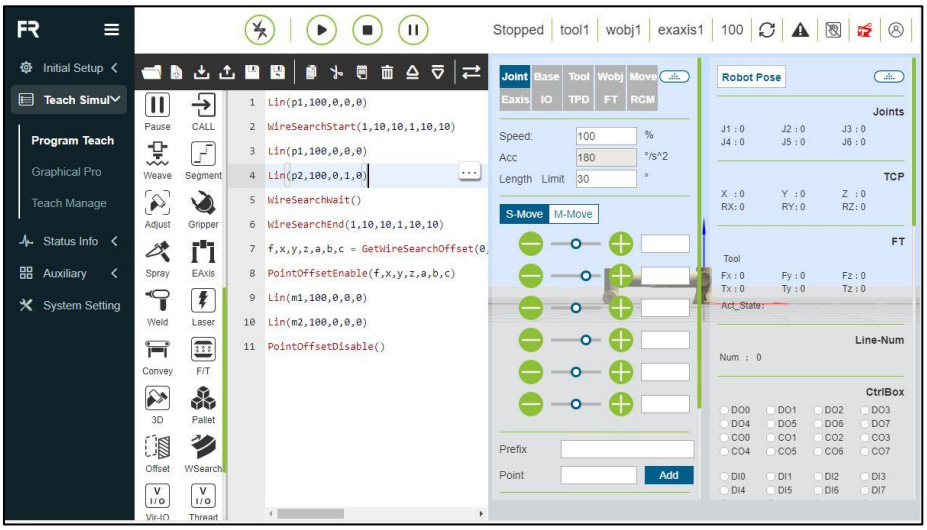


Fig. 3.7-42 W-Search example (1D)

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

This instruction is a virtual IO control instruction, which can set analog external DI and AI status and obtain analog DI and AI status.

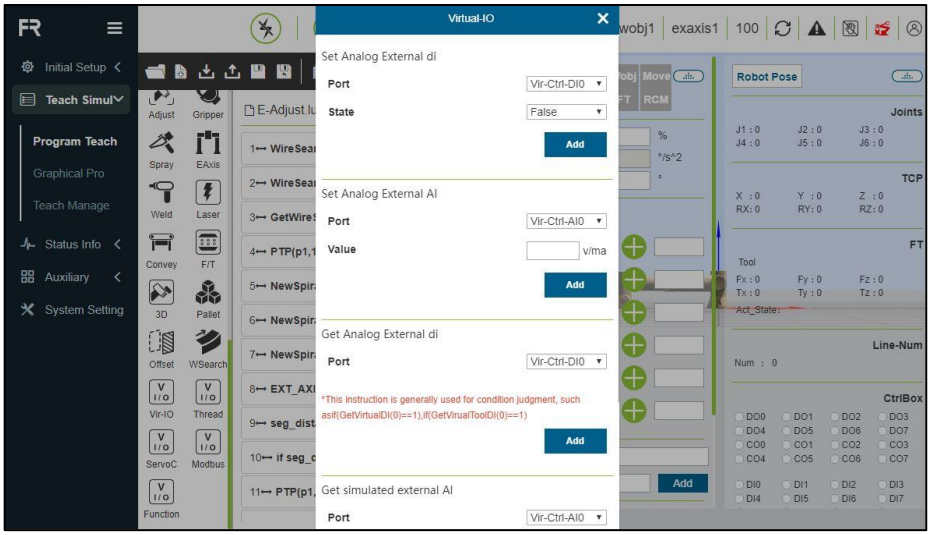


Fig. 3.7-43 Vir IO command interface

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

The Thread command is a worker thread function. Users can define a worker thread to run simultaneously with the main thread. The worker thread mainly interacts with external devices, supports socket communication, robot DI status acquisition, robot DO status setting, robot status information acquisition, and data interaction with the main thread,The data obtained by the main thread through the auxiliary thread is used to control the judgment of the robot's motion logic. The screenshot of the user program example is:

```
1  --auxThread function definition
2  function auxThread_TCPCom(ip, port)
3      local flag = 0
4      while 1 do
5          if flag == 0 then
6              flag = SocketOpen(ip,port, "socket_0")
7          elseif flag == 1 then
8              SocketSendString("hello world","socket_0",1)
9              n,svar = SocketReadAsciiFloat(1,"socket_0",0)
10             if n == 1 then
11                 SetSysNumber(1, svar)
12             end
13         end
14         WaitMs(10)
15     end
16 end
17 --Create auxThread
18 NewAuxThread(auxThread_TCPCom, {"127.0.0.1",8010})
19 WaitMs(10)
20 while 1 do
21     v  = GetSysNumber(1)
22     if v == 100 then
23         PTP(p1,100,0,0)
24     end
25     PTP(p2,100,0,0)
26 end
27
```

Fig. 3.7-44 Thread Program Example

ServoCart command: click the "ServoC" icon to enter the ServoCart command editing interface

ServoCart servo control (Cartesian space motion) command, which can control the robot motion through absolute pose control or based on the current pose offset.

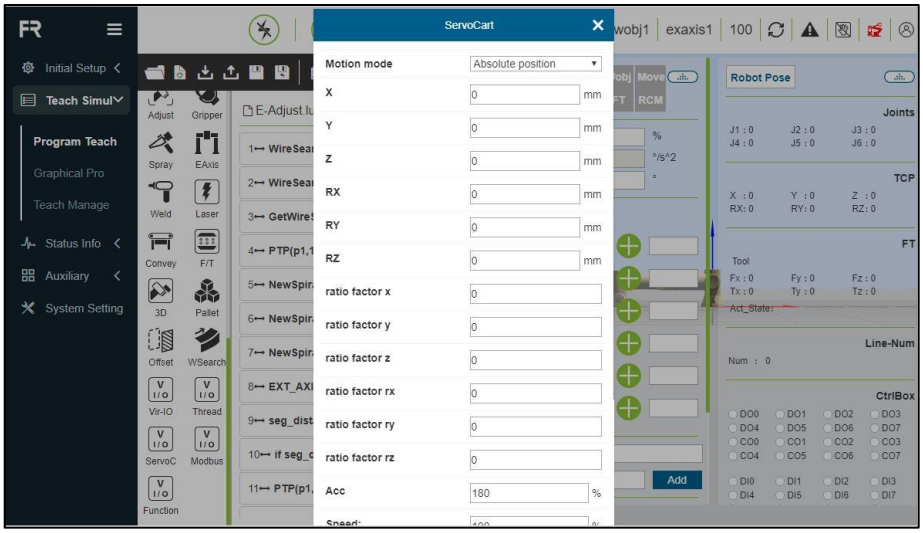


Fig. 3.7-45 ServoCart command interface

Example of absolute pose control program:

```
PTP(p1,100,0,0)
x,y,z,rx,ry,rz = GetActualTCPPose()
while 1 do
    if type(x) == "number" then
        x = x+1
        WaitMs(8)
        ServoCart(0,x,y,z,rx,ry,rz,0,0,0,0,0,0,180,100,0.008,0,0)
    end
end
```

In this example, x, y, z, rx, ry, rz (Cartesian position) is the current position of the robot obtained. In addition, the user can control the robot movement by reading the trajectory data file, socket communication and sending the trajectory data.

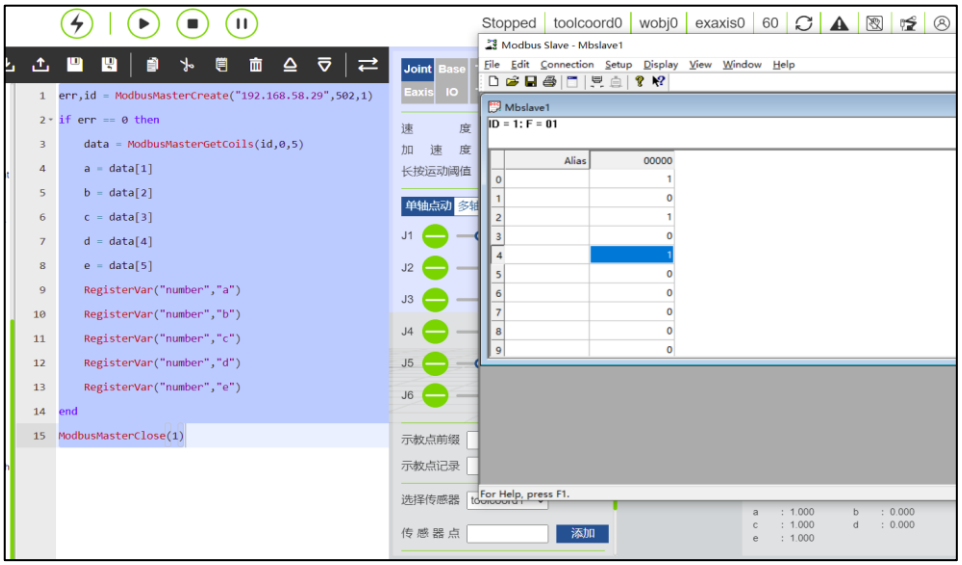
Example of control program based on current pose offset (base coordinate offset):

```
1 PTP(p1,100,0,0)
2 while 1 do
3     WaitMs(8)
4     ServoCart(1,0,1,-1,0,0,0,0.4,0.4,0.4,0.2,0.2,0.2,180,100,0.008,0,0)
5 end
```

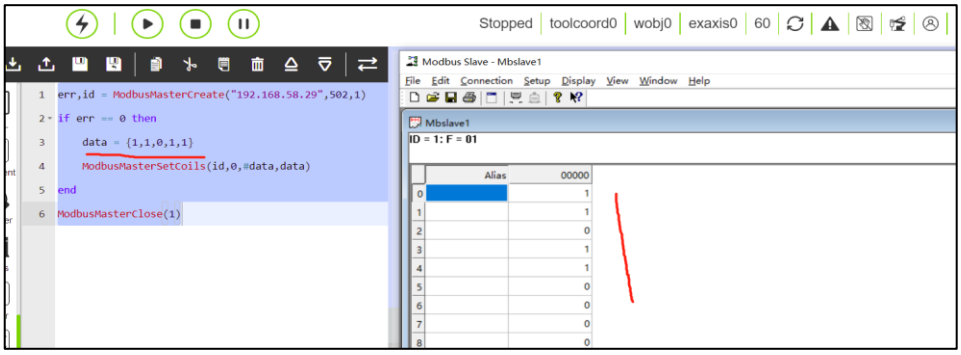
Modbus command: click the "Mobus" icon to enter the Modbus command editing interface

The command function is a bus function based on the ModbusTCP protocol. The user can control the robot to communicate with the ModbusTCP client or server (master and slave communication) through relevant commands, and read and write the coil, discrete quantity and register.

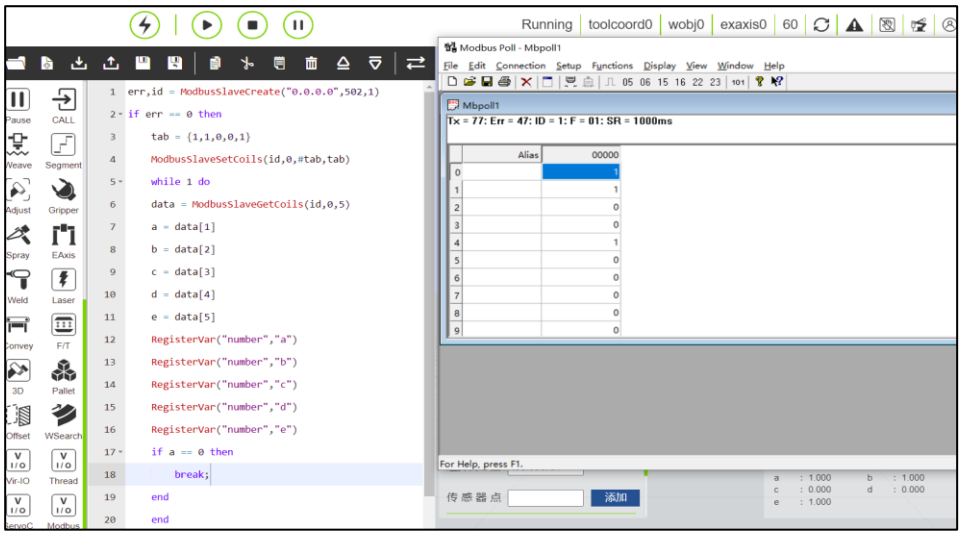
Example of modbus master station reading coil:



Example of modbus master station writing coil:



Example of Modbus slave reading and writing coil:



Please contact us for more operation functions of ModbusTCP.

Function command: click the "Function" icon to enter the function command editing interface

This instruction is to call the function interface function, provide the robot interface function to the customer for selection, and prompt the customer for the parameters required by the function, so that the customer can write script instructions. More functions are being added in succession.

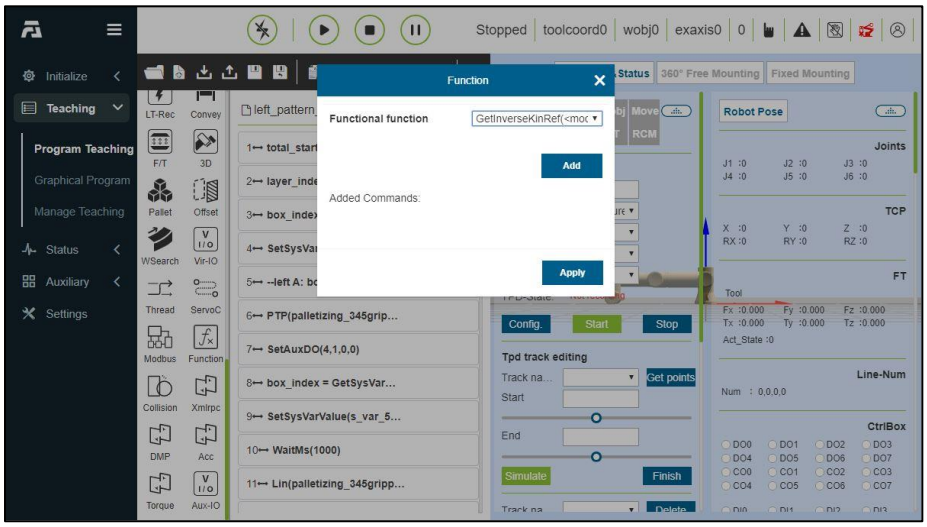


Fig. 3.7-46 Function command interface

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

This instruction sets the collision level. Through this instruction, the collision level of each axis can be adjusted in real time during program operation, and the application scenarios can be deployed more flexibly.

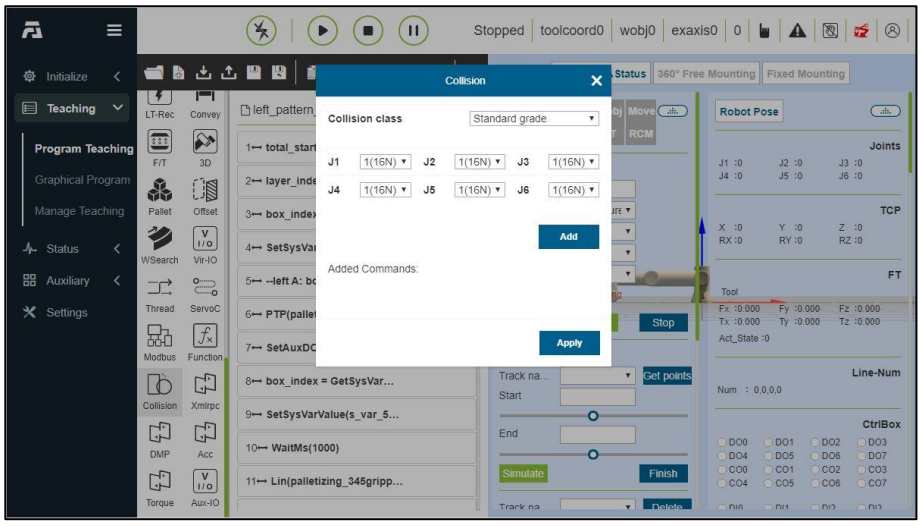


Fig. 3.7-47 Collision command interface

Xmlrpc command: click the "Xmlroc" icon to enter the Xmlrpc command editing interface

XML-RPC is a remote procedure call method that uses xml to transfer data between programs through sockets.In this way, the robot controller can call the function function (with parameters) at the remote program/service and obtain the returned structural data.The robot controller is responsible for handling all the details of writing XML-RPC client messages and handling the conversion between data types and XML.

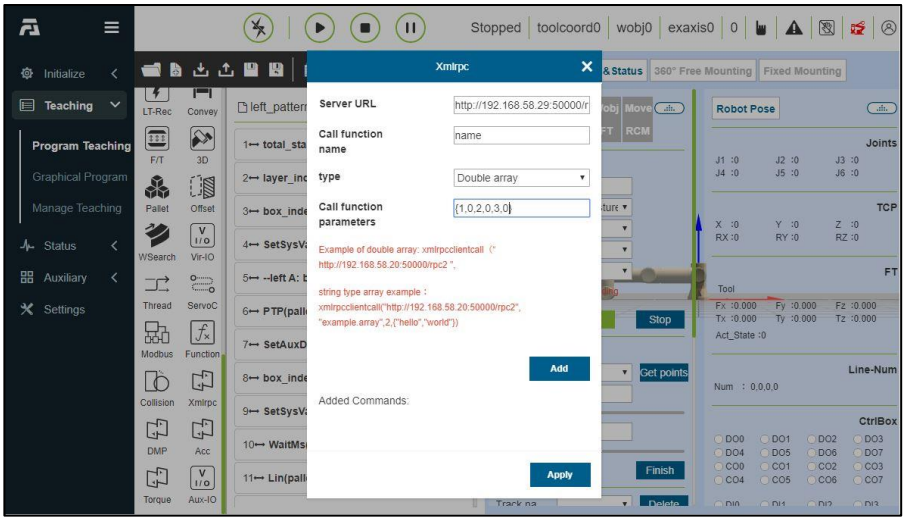


Fig. 3.7-48 Xmlrpc Instruction Interface

1) The controller connects to the remote user-defined port as a client;
2) The controller calls remote function functions as a client;
3) Support calling different remote function functions;
4) Support the input of string array parameters and the return of character array results. The number of array elements can be customized;

Support the input of double array parameters and the return of double array results. The number of array elements can be customized;

XmlrpcClientCall (serverUrl, methodName, tableType, param)

detailed parameters

serverUrl The server url, for example:“http://192.168.58.29:50000/RPC2"

methodName Call function name, "example. add"

tableType 1-double array, 2-string array



param Call function parameters

XmlrpcClientCall (error, result) return value

error 0 - No error, 1 - Error

result If the parameter is passed in as a double array, the result is a double array,

If the parameter is passed in as a string array, the result is a string array

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

Acc command is the function that the robot acceleration can be set separately. By adjusting the acceleration scaling factor of the motion command, the acceleration and deceleration time can be increased or decreased, and the robot action beat time can be adjusted.

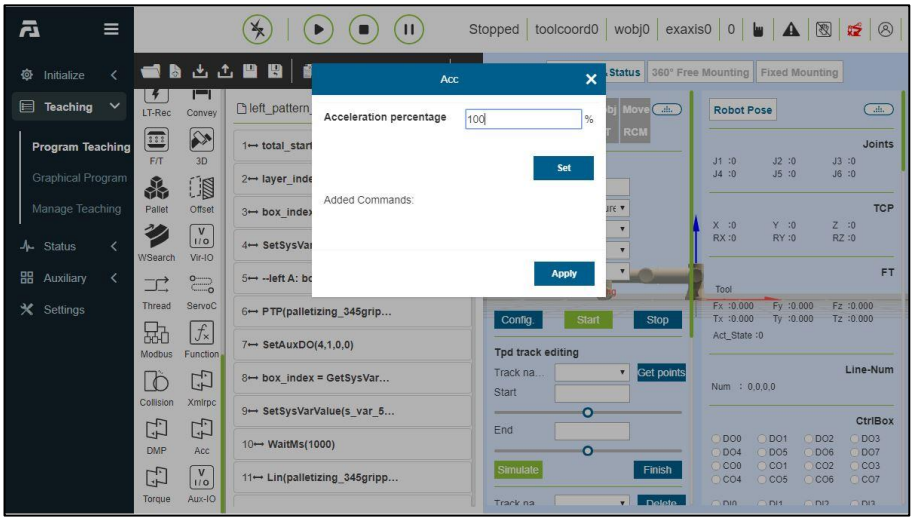


Fig. 3.7-49 Acc command interface

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

This command is a force compliance control command, through which the robot can adjust its trajectory to reduce the force when the force is greater than a certain value during force control training;When the force is less than a certain value, return to the original track and continue to move along the original track.

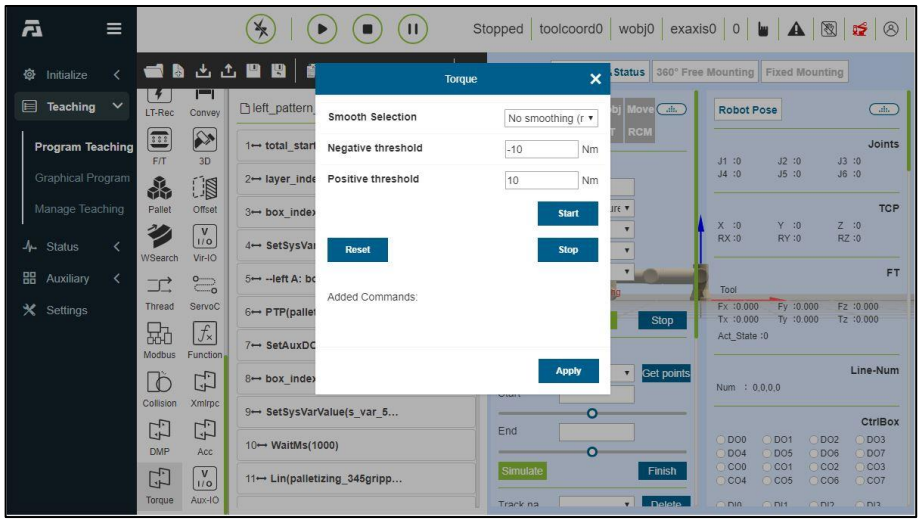


Fig. 3.7-50 Torque command interface

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

Aux IO is an instruction function for the robot and PLC to communicate and control the external expansion of IO. It requires the robot and PLC to establish UDP communication. On the basis of the original 16 channel I/O, 128 channel I/O can be expanded. The instruction usage is similar to the general IO usage mentioned above.It is technically difficult to use this function. Please contact us for consultation before using this function.

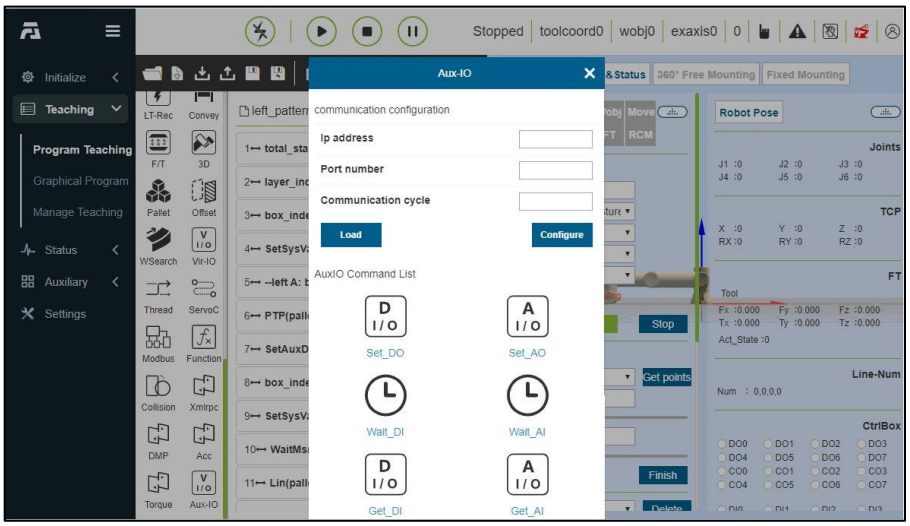


Fig. 3.7-51 Aux IO command interface

3.7.4 Teaching management

Click "Teaching Management" to display all saved teaching point information. In this interface, you can import and export teaching point files. Select a teaching point and click the "Delete" button to delete the point information. The values of teaching point x, y, z, rx, ry, rz and v can be modified. Enter the modified value, check the check box on the left, and click the above to modify the teaching point information. In addition, users can search teaching points by name.

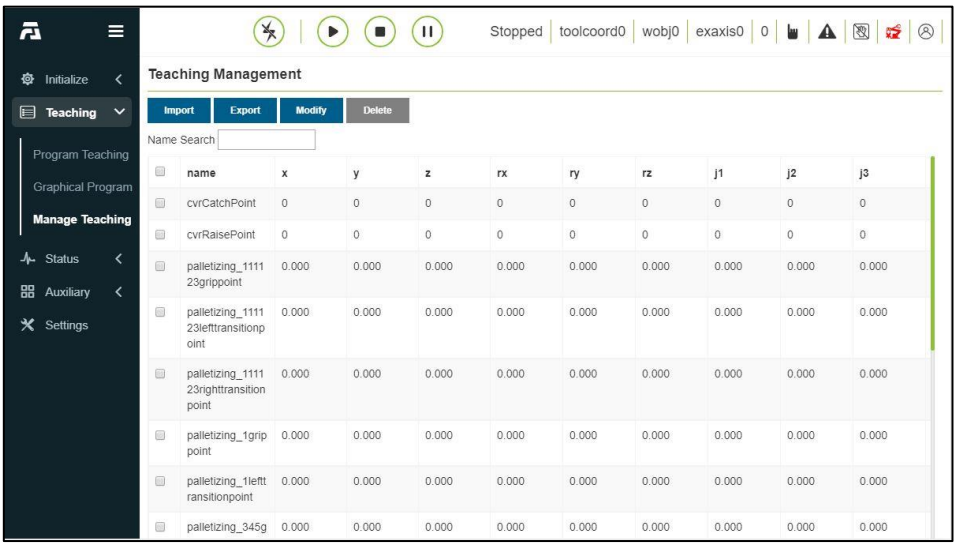


Fig. 3.7-52Teaching management interface

3.8 status information

3.8.1 system log

Click the "System Log" button in the "Status Information" of the left menu bar to enter the log display interface.Some important operation records of the teaching pendant are recorded in the log, such as the increase or decrease of the login person, teaching point, etc. Click to enter, and the log record of the current day will be displayed by default. If you want to query the previous record, select the target date in the "date selection", and the log record of the current day will be displayed in real time below. See the system settings for details of the number of log records.When there is too much user log information, users can search for relevant log information according to the type.

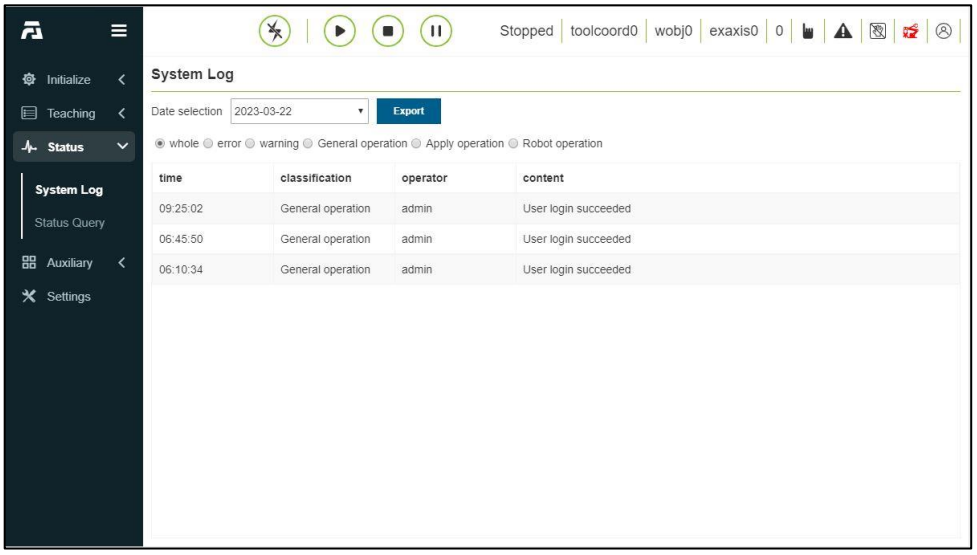


Fig. 3.8-1System log interface

3.8.2 Status Query

Click the "Status Query" menu in the "Status Information" of the left menu bar to enter the status query interface, as shown in Fig. 。

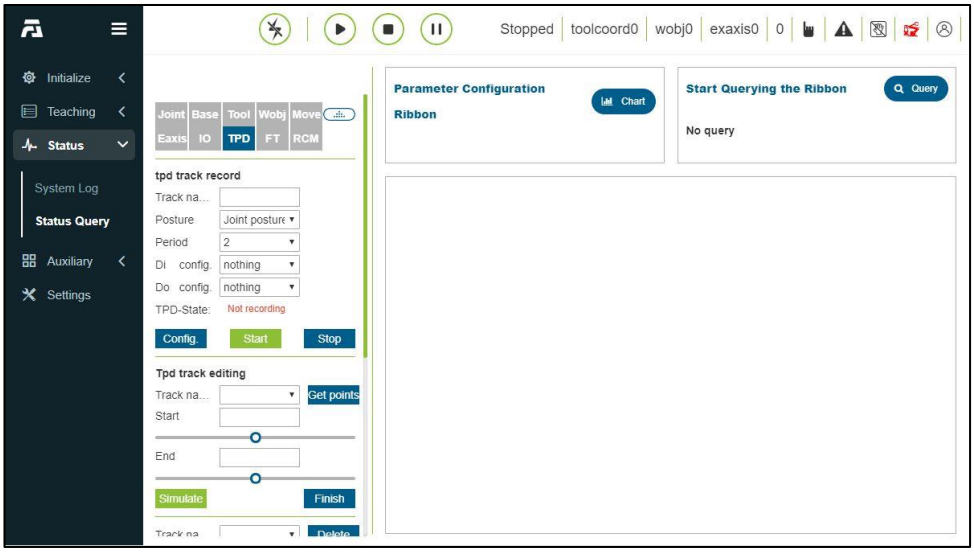


Fig. 3.8-2Status Query

Operating steps for status query:

Step 1: Click the "Chart" button to pop up the chart setting pop-up box, as shown in

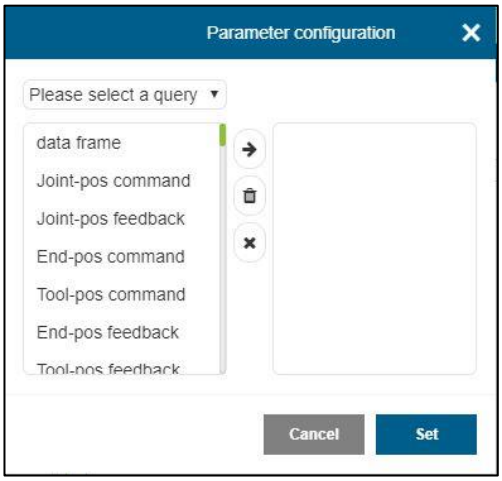


Fig. As shown in Fig. 3, select a chart as the query type to display the query, select the parameters to be queried and the chart into which the parameters are placed in the chart settings, and click the "Move Right" button to configure the parameters to the chart.Click "Set" to issue the chart setting instruction.Currently, only one table can contain up to four parameters to be queried and at most one chart can be set;

Fig. 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 body" in "auxiliary application", click"Robot calibration ", enter the robot calibration interface, this function is mainly used to calibrate the robot's zero position.Click the "Disable" button, drag each axis of the robot, move the robot to the zero point position on the machine, click the "Zero point setting" button, and set the robot zero point.

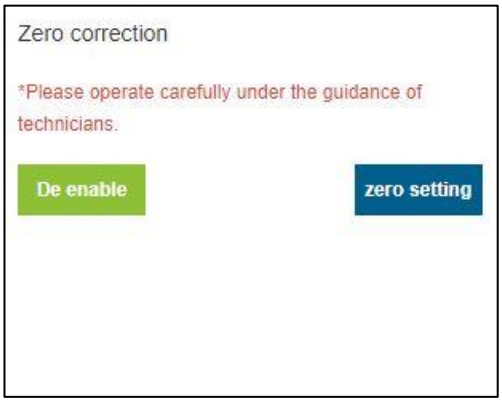


Fig. 3.9-1Schematic diagram of robot calibration

Zero setting: the robot will preset an initial pose when leaving the factory, and the angle of each joint in this pose is 0.The corresponding robot posture when each joint of the robot moves to a specific position when the zero point is set.The zero point is the reference of the robot coordinate system. Without the zero point, the robot cannot judge its own position. Therefore, in order to obtain the highest absolute positioning accuracy, it is necessary to calibrate the zero point of the robot.

In general, the robot needs to be zero calibrated under the following circumstances:

- After replacing the mechanical system parts of the robot;
- After severe collision with workpiece or environment;
- When the operations such as establishing coordinate system differ greatly from the actual position;
- After the whole system is reinstalled;
- After the encoder battery is replaced;
- After long-distance transportation and handling robot.

be careful:

The zero point will be set when the robot leaves the factory. 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 Body" in "Auxiliary Application", click the "System Upgrade" button to enter the system upgrade interface.System upgrade includes software upgrade, drive upgrade and system shutdown.

Software upgrade: under software upgrade, click "Upload File", select the software.tar.gz upgrade package in the USB flash drive, click to upload the upgrade package, and "Uploading. Upload Percentage" will be displayed next to the upgrade button.When the stage file download is completed, the interface displays "Upload completed, upgrading in progress", performs file MD5 and version number detection, decrypts and decompresses the upgraded file after passing, and prompts "Upgrade succeeded, please restart the control box!". If it detects, decompresses or other errors occur, "Upgrade failed" is displayed next to the upgrade button.

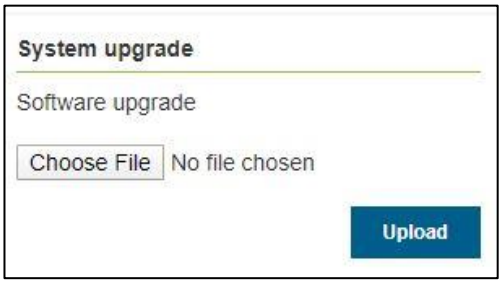


Fig. 3.9-2System upgrade

Firmware upgrade: after the robot enters the BOOT mode, upload the upgrade package, select the slave station to be upgraded (control box slave station, body drive slave station 1~6, and end slave station), perform the upgrade operation, and display the upgrade status.

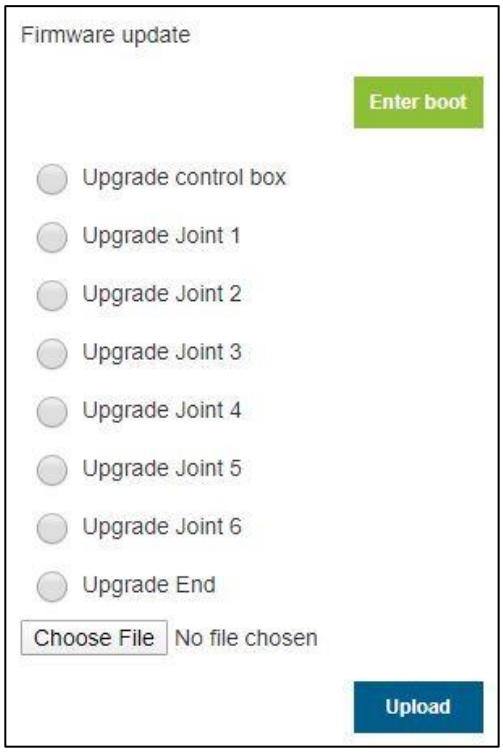


Fig. 3.9-3Firmware update

Slave configuration file upgrade: after the robot is enabled, upload the upgrade file, select the slave station to be upgraded (control box slave station, body drive slave station 1~6, end slave station), perform the upgrade operation, and display the upgrade status.

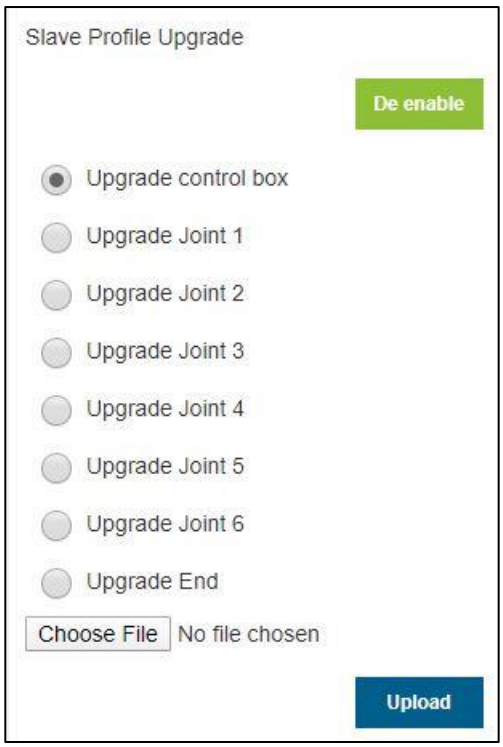


Fig. 3.9-4Slave configuration file upgrade

System shutdown: function reservation.

3.9.3 Data backup

Under the menu bar of "robot body" in "auxiliary application", click "Data backup" enters the data backup interface, as shown in 3.9-5.

The backup package data includes 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 quickly realized.



Fig. 3.9-5Data backup interface

3.9.4 10s data record

Click "10s data record" under the menu bar of "robot body" in "auxiliary application" 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 and recorded by the system. The optional parameter record user can select the parameter data to record by himself. The number of parameters can be up to 15.After selecting the parameter list, select the record parameter, and click the "Move Right" button to configure the parameter to the parameter list.Click "Start Recording" to start recording data, click "Stop Recording" to stop recording data, and click "Download Data" to download data for the last 10 seconds.

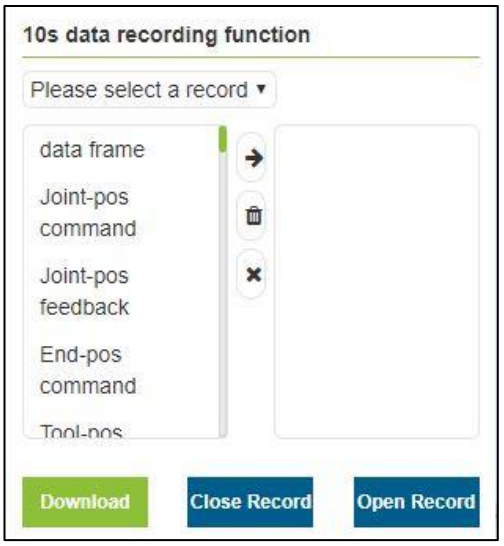


Fig. 3.9-6 10s data record

3.9.5 Teaching point configuration

Under the menu bar of "Robot Body" in "Auxiliary Application", click "Teaching Point Configuration" to enter the function interface of teaching point configuration.

Before using the button box or other IO signal recording teaching point function, the user first configures the teaching point name prefix, number upper limit and teaching method. The name prefix supports two modes: user-defined prefix and using the current program name as the prefix.For example, the user-defined name prefix "P", the upper limit of the number "3", the teaching method "robot teaching", and the current end (tool) points of the recording robot are P1, P2, and P3 in sequence. Recording again will cover the previous recorded points.

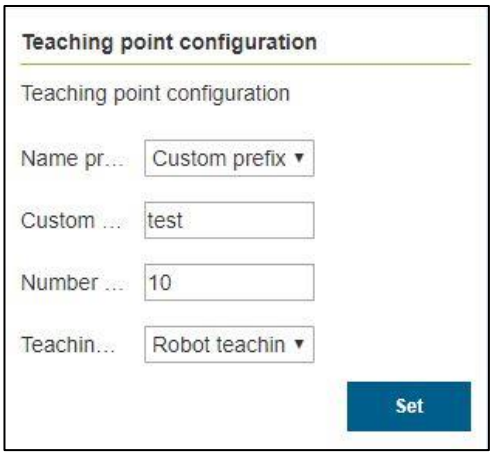


Fig. 3.9-7 Teaching point configuration

3.9.6 Matrix shift

Under the menu bar of "robot body" in "auxiliary application", click "matrix movement" to enter the matrix movement configuration function interface.

This function controls the regular movement of the manipulator by setting the three-point coordinates and the row row layer and layer height values. It is suitable for common stacking 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 walking" or "bow walking", the third step is to set the stacking mode, "stacking" or "unloading".

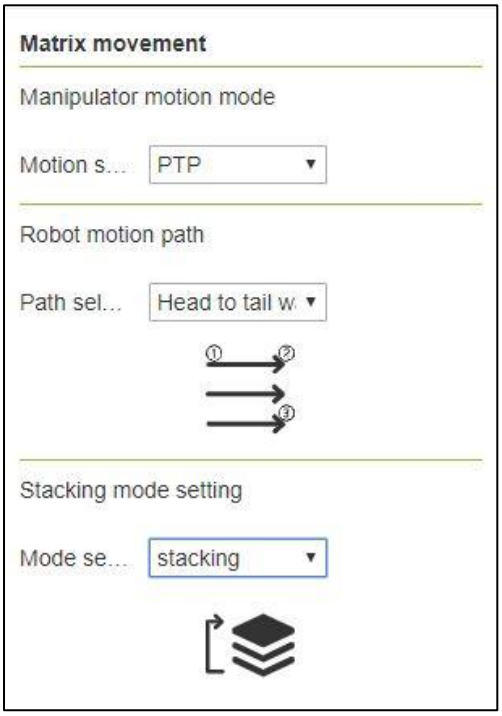


Fig. 3.9-8 Matrix shift

Step 4: Teach three points according to the path. The first point is the starting point of the first row. The arm posture during 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.Step 5: set the number of rows and columns, step 6: set the number of layers and the height of each layer, and finally, name the matrix motion program file. A matrix motion program is generated successfully.

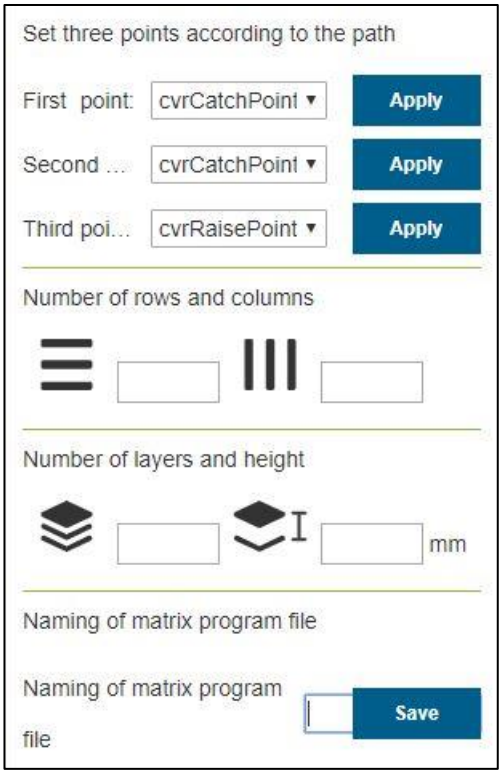


Fig. 3.9-9 Matrix shift

3.9.7 Job origin

Under the menu bar of "robot body" in "auxiliary application", click "job origin" to enter the job origin configuration function interface.

This page displays the name and joint position information of the operation origin. The operation origin is named as pHome. Click "Set" to take the current robot pose as the operation origin. Click "Move to this point" to move the robot to the operation origin.In addition, the configurable option of moving to the job origin is added in DI configuration, and the configurable option of reaching the job origin is added in DO configuration.

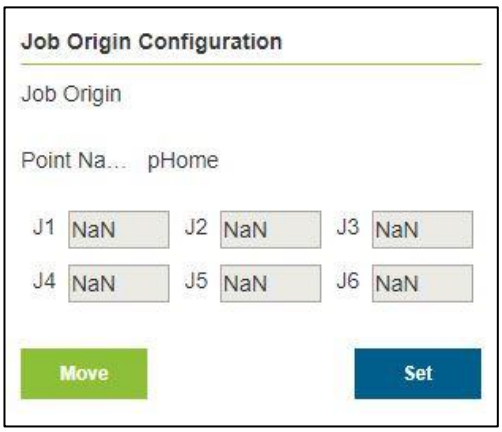


Fig. 3.9-10 Job origin

3.9.8 Interference zone configuration

Under the menu bar of "robot body" in "auxiliary application", click "interference zone configuration" to enter the interference zone configuration function interface.

First, we need to configure the interference mode and the operation of entering the interference zone. The interference mode is divided into "axis interference" and "cube interference". When it is enabled, the activation flag will be displayed.First, configure "Continue Motion" or "Stop" when entering the interference zone.

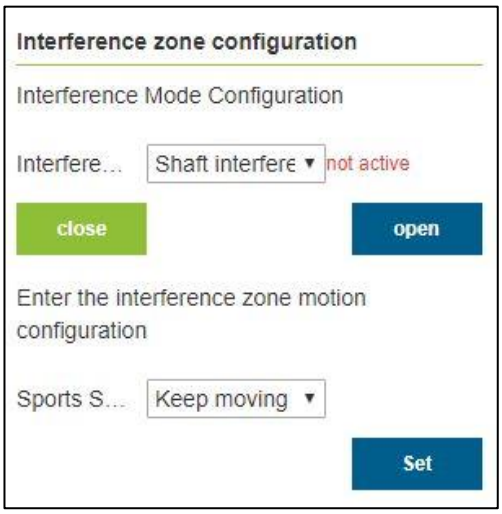


Fig. 3.9-11 Interference zone configuration

Next, set the drag configuration for entering the interference zone. The user can set the strategy for entering the interference zone in the drag mode according to the requirements. There is no restriction on drag, impedance callback and switching back to manual mode。

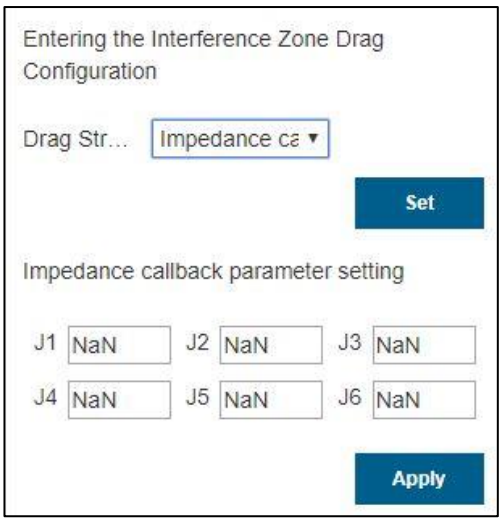


Fig. 3.9-12 Interference Zone Drag Configuration

To select axis interference, you need to configure the parameters of axis interference. The detection methods are divided into "command position" and "feedback position". The interference area mode is divided into "interference within the range" and "interference outside the range". Next, you can set the range of each joint and whether each joint range is enabled. You can enter values,You can also record the position of the current robot through the "Robot Teaching" button, and then click Apply.

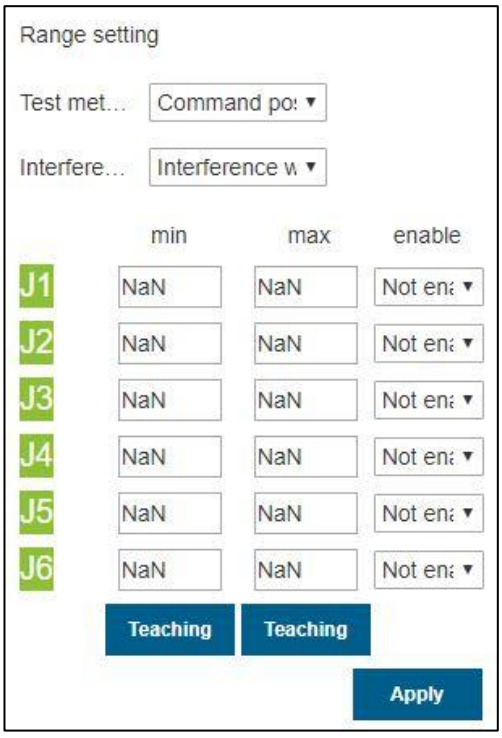


Fig. 3.9-13 Axis Interference Configuration

To select cube interference, you need to configure the parameters of cube interference. The detection methods are divided into "command position" and "feedback position". The interference area mode is divided into "interference within the range" and "interference outside the range". The reference coordinate system is divided into "base coordinate" and "workpiece coordinate". Select settings according to the actual use.Next, set the range. The range setting is divided into two methods. First, look at the first method "two-point method", which is composed of two diagonal vertices of the cube. We can record the position by inputting or robot teaching.Finally, click Apply.

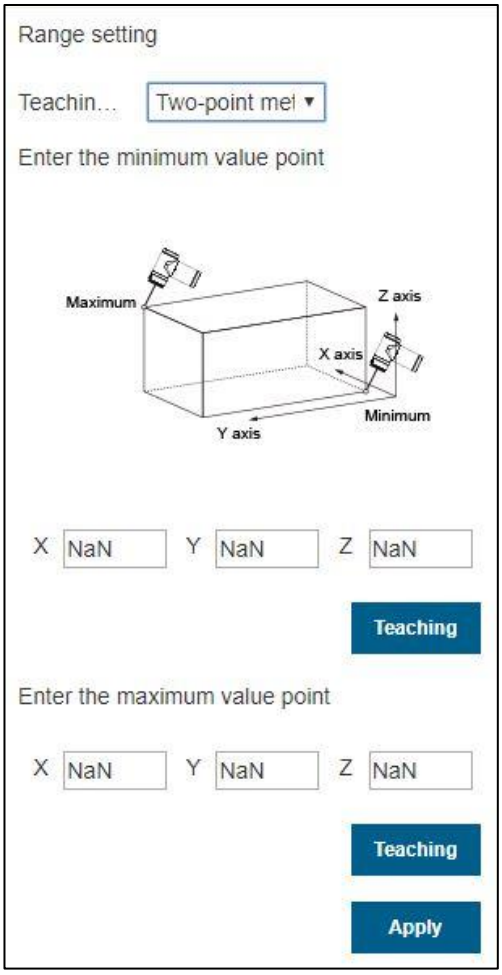


Fig. 3.9-14 Cube Interference Configuration

Next, let's look at the second method "center point+side length", that is, the center position point of the cube and the side length of the cube form the interference zone. We can record the position by inputting or robot teaching.Finally, click Apply.

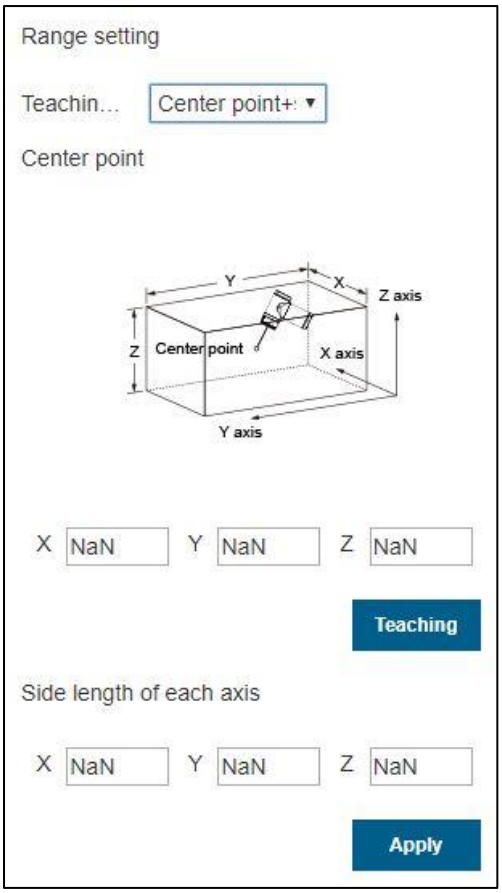


Fig. 3.9-15 Cube Interference Configuration

3.9.9 End LED configuration

Under the menu bar of "Robot Body" in "Auxiliary Application", click "End LED Configuration" to enter the end LED color configuration function interface.

ConfigurableThe LED colors are green, blue and white cyan. Users can configure the LED colors of automatic mode, manual mode and drag mode according to their needs. Different modes cannotbe configured with the same color.



Fig. 3.9-16End LED configuration

3.9.10 Peripheral agreement

Under the menu bar of "Robot Body" in "Auxiliary Application", click "Peripheral Protocol" to enter the peripheral protocol configuration function interface.

This is the configuration page of external protocols. Users can configure protocols according to the currently used peripherals.

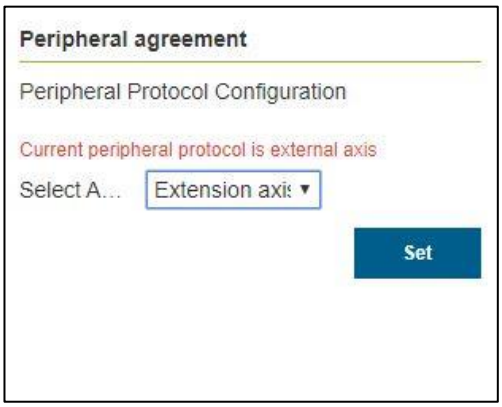


Fig. 3.9-17Peripheral Protocol Configuration

Add a lua interface for reading and writing registers based on Modbus rtu communication in the program teaching, input register address 0x1000, the number of registers is 50, a total of 100 bytes of data content;The address of the holding register is 0x2000, the number of registers is 50, and the total data content is 100 bytes.

1) ModbusRegRead (fun_code, reg_add, reg_num): read register;

fun_Code: function code, 0x03 holding register, 0x04 input register

reg_Add: register address

reg_Num: number of registers

2) ModbusRegWrite (fun_code, reg_add, reg_num, reg_value): write register;

fun_code Function code, 0x06 single register, 0x10 multiple registers

reg_Add: register address

reg_Num: number of registers

reg_Value: byte array

3) ModbusRegGetData (reg_num): obtain register data;

reg_Num: number of registers

Return value description:

reg_Value: array variable

Screenshot of program example:

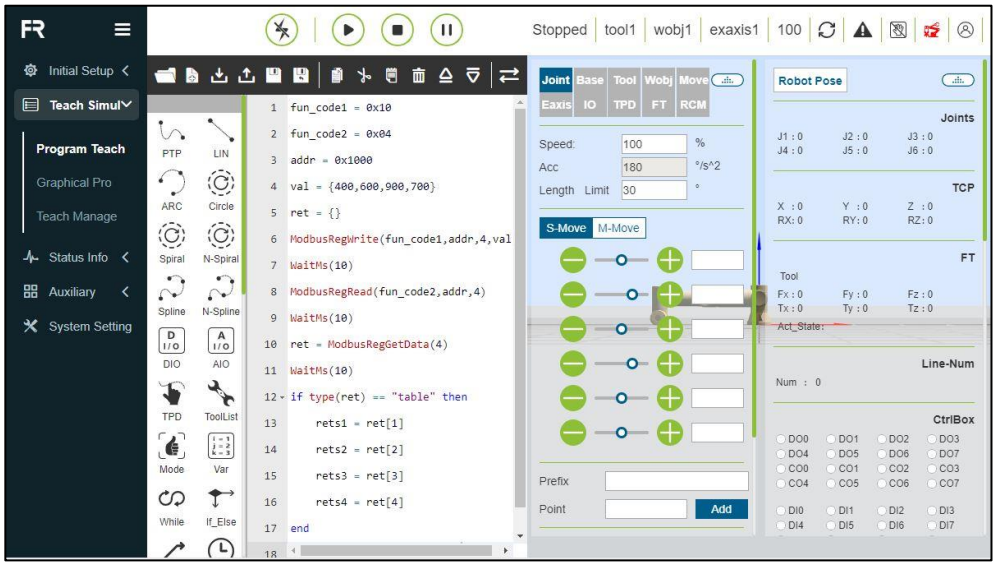


Fig. 3.9-18 Modbus rtu communication lua program example

3.9.11 Main program configuration

Under the menu bar of "robot body" in "auxiliary application", click "main program configuration" to enter into the main program configuration function interface.

The configuration main program can communicate withThe DI configuration main program is started and used together. The configured main program needs to be trial run first to ensure safety. After the corresponding DI is configured as the signal function of starting the main program in the robot settings, the user can control the DI signal to run the main program.

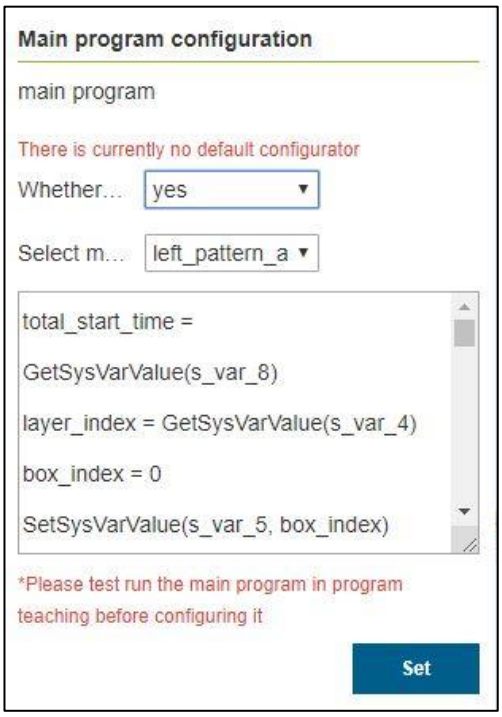


Fig. 3.9-19Main program configuration

3.9.12 Drag Lock

Under the menu bar of "robot body" in "auxiliary application", click "drag locking" to enter the drag teaching locking configuration function interface.

The function of locking degrees of freedom is added for dragging teaching. When the dragging teaching function switch is set to enable status, the parameters of each degree of freedom will take effect when the user drags the robot.For example, when the parameters are set to X: 10, Y: 0, Z: 10, RX: 10, RY: 10, RZ: 10, dragging the robot in the drag mode can limit the robot to move only in the Y direction. If it is necessary to keep the robot's posture unchanged during dragging and move only in the X, Y, Z directions, you can set X, Y, Z to 0, RX, RY, RZ to 10.

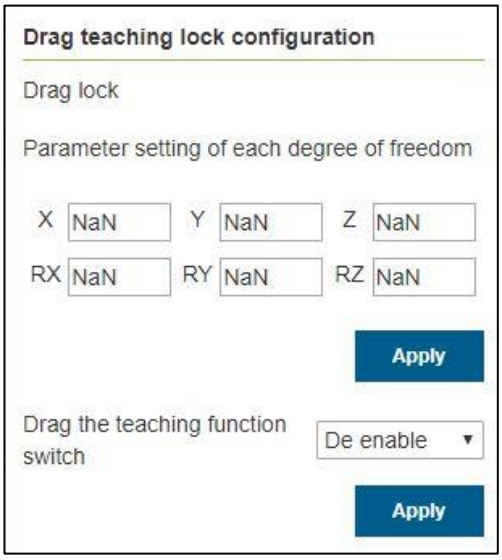


Fig. 3.9-20Drag teaching lock configuration

3.9.13 Welding expert database

Click the menu bar of "Welding Expert Database" in "Auxiliary Application" to enter the function interface of welding expert database.The welding expert database is divided into four parts: weldment shape, part design, fixture structure and configuration.

Click "Direct welding" under "Weldment shape" to enter the direct welding guidance interface.On the basis of the completion of various basic robot settings, we can quickly generate welding teaching programs through several simple steps.It mainly includes the following five steps. Due to the mutual exclusion between functions, the actual steps to generate a welding teaching program are less than five steps.

Step 1, whether to use the extension axis. If you use the extension axis, you need to configure the relevant coordinate system of the extension axis and enable the extension axis.

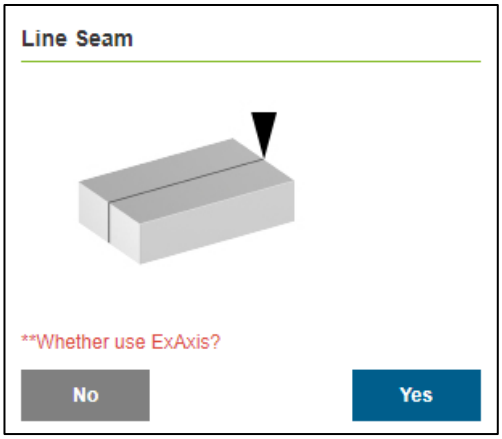


Fig. 3.9-21 Extended axis configuration

Step 2: Calibrate the starting point, starting point safety point, ending point and ending point safety point.If the extended axis is selected in the first step, the extended axis movement function will be loaded to coordinate with the calibration of relevant points.

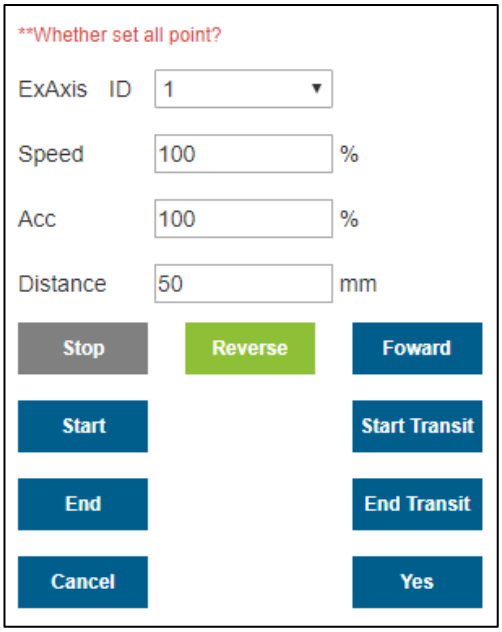


Fig. 3.9-22 Calibrate relevant points

Step 3, select whether to need laser. If yes, you need to edit the parameters of the laser locating command.

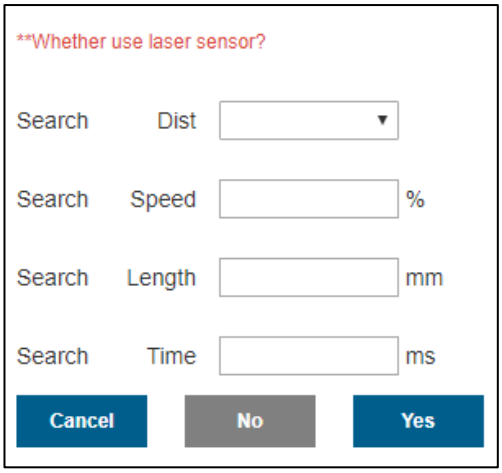


Fig. 3.9-23 Laser location finding configuration

Step 4, select whether swing welding is required. If swing welding is required, edit the parameters related to swing welding.



Fig. 3.9-24 Swing welding configuration

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

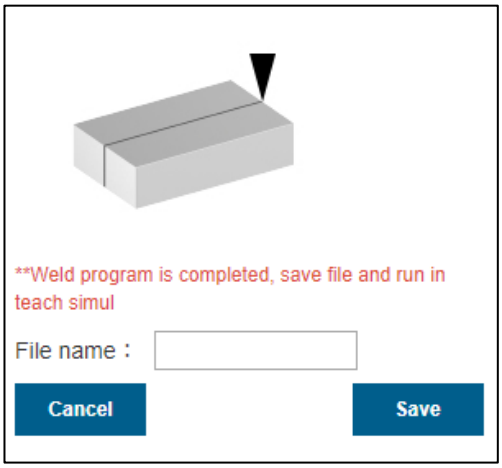


Fig. 3.9-25 Save program

Click "circular arc welding" under "weldment shape" to enter the circular arc welding guidance interface.On the basis of the completion of various basic robot settings, we can quickly generate the welding teaching program through two simple steps.It mainly includes the following two steps.

Step 1: Calibrate the starting point, starting point safety point, arc transition point, end point and end point safety point.



Fig. 3.9-26 Calibration point

Step 2, name the program and automatically open the program in the program teaching interface.



Fig. 3.9-27 Save program

Click "Multi layer and multi pass welding" under "Weldment shape" to enter the multi layer and multi pass welding guidance interface.On the basis of the completion of various basic robot settings, we can quickly generate the welding teaching program through four simple steps.It mainly includes the following five steps.

Step 1: Set the first group of points according to the prompt, namely, welding point, X+point, Z+point and safety point.

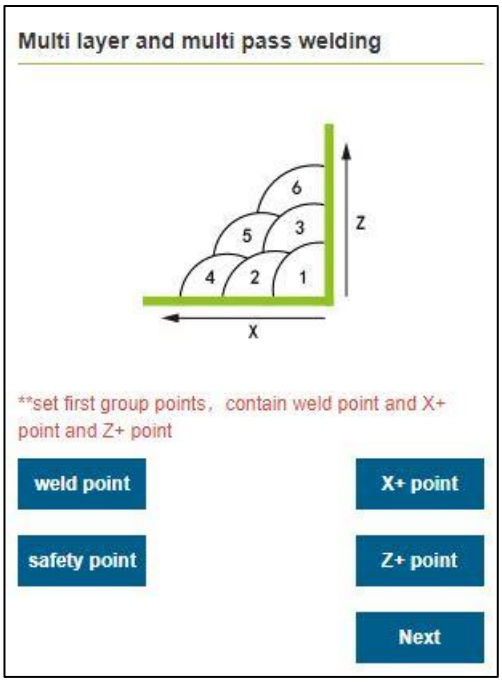


Fig. 3.9-28 Set the first group of points

Step 2: Set the second set of points. You can set the type of path points. It supports straight line and arc paths, including welding points, X+points and Z+points.

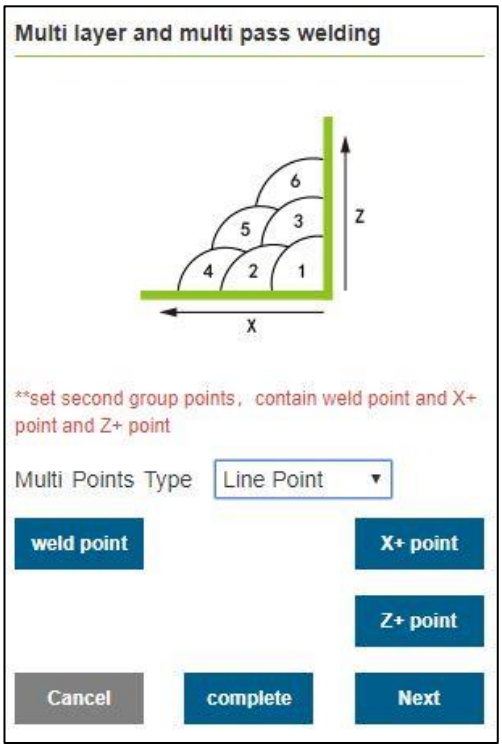


Fig. 3.9-29 Set the second group of points

Step 3: After all the assembly points are set, click "Finish" to enter the function page of each weld bead offset setting, and set the offset of the required weld bead in turn, as shown in the following figure.

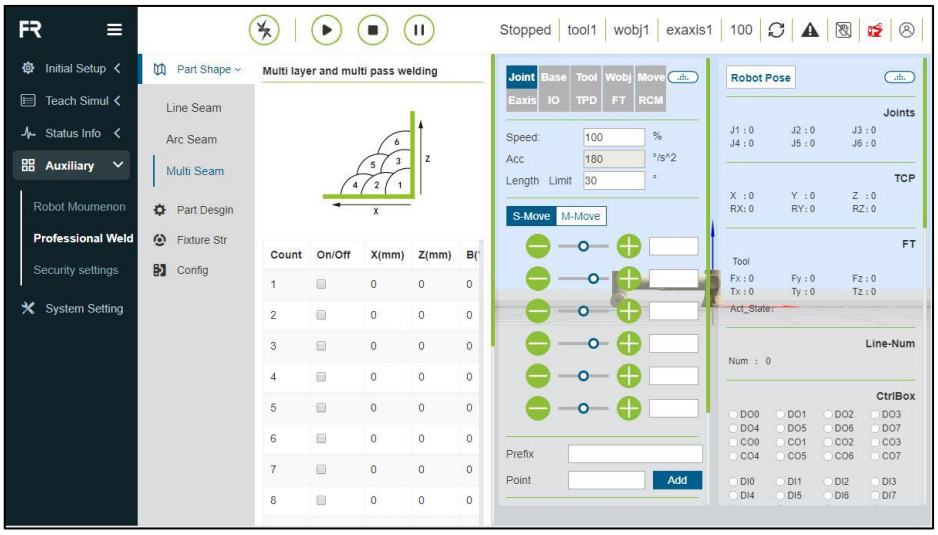


Fig. 3.9-30 Weld bead offset setting

Step 4: After all the required weld bead parameters are set, click "Finish"

to jump to the program generation page, and enter the file name to generate the multi-layer and multi pass welding program. After that, the user can open the program in program teaching for debugging. The interface is shown in the following figure.

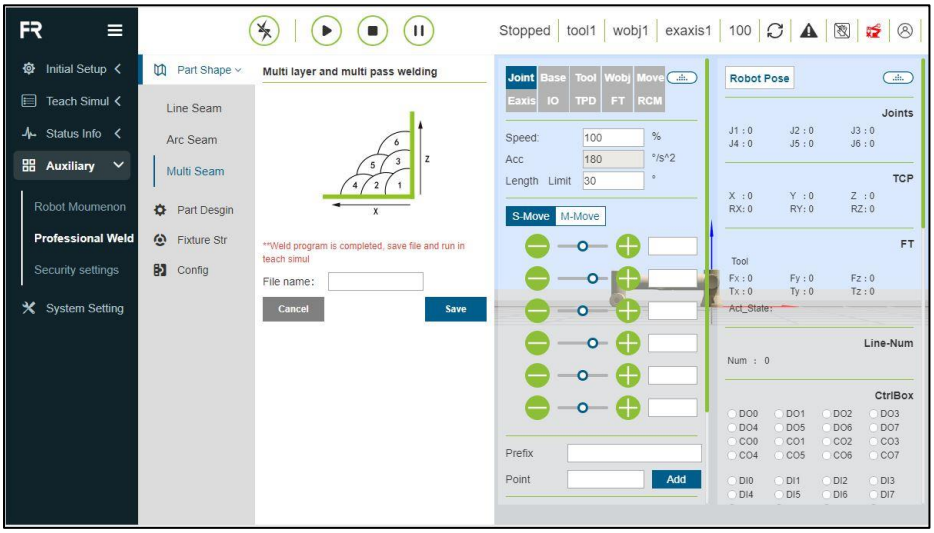


Fig. 3.9-31 Save program

3.9.14 Safe speed setting

Under the menu bar of "Security Settings" in "Auxiliary Applications", click "Safe Speed Settings" to enter the safe speed setting function interface.

Enable the safe speed and set the speed limit value. When the user debugs the robot in the manual mode or drags the robot in the drag mode and the speed exceeds the set threshold value, the robot will stop and warn the user to play the role of safety protection。

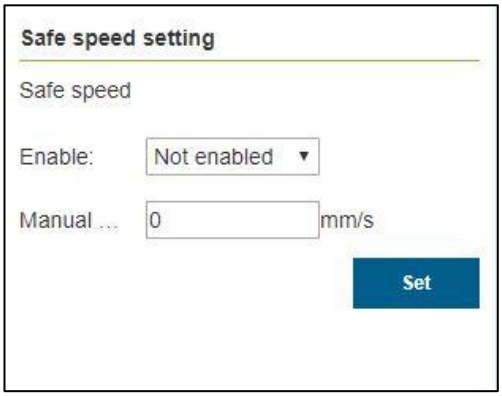


Fig. 3.9-32Safe speed setting

3.10 System settings

3.10.1 General settings

Click "System Setting" in the left menu bar, and click "General Setting" in the secondary menu bar to enter the general setting interface.The general setting can update the robot system time according to the current computer time, so as to record the log content accurately.

The network settings can set the controller IP, subnet mask, default gateway, DNS server, and teaching pendant IP (this IP is valid when using our FR-HMI teaching pendant, and you need to configure the teaching pendant enabling status to enable when using the FR-HMI teaching pendant) to facilitate the use of scenarios by customers.

Customers can choose Chinese, English, French or Japanese as the language of the teaching pendant according to their needs.In addition, the language can be customized by users. Users can translate the exported Chinese language files, import the translated language files, and then select to use the imported language files.

The user can set the number of log reservations and import and export the system configuration file. The maximum number of log reservations is 30. The system configuration file records the set value.

Restoring factory settings after system recovery can clear user data and restore the robot to factory configuration.

The slave station log generation and controller log export function is to download some important status or error reporting record files of the controller, which is convenient for troubleshooting robot problems.

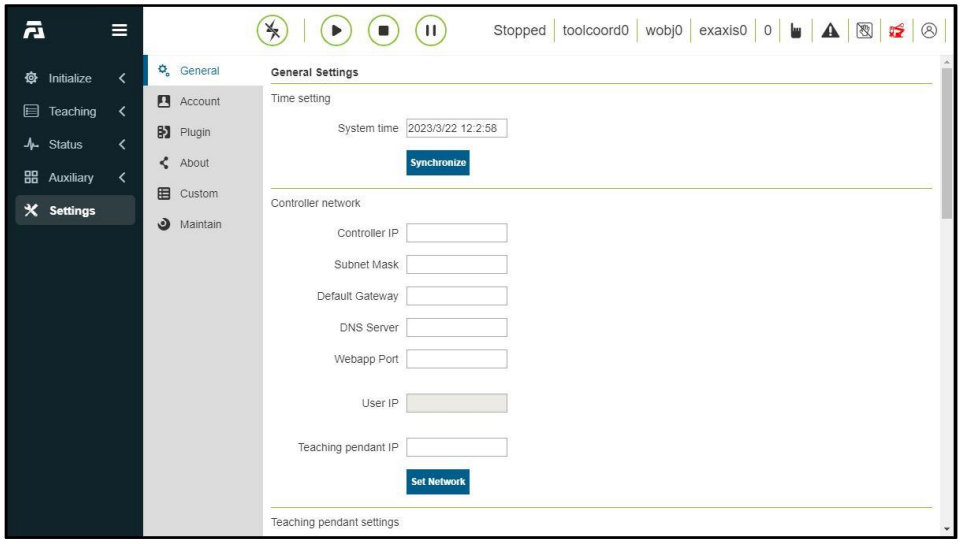


Fig. 3.10-1Schematic diagram of general settings

3.10.2 Account settings

Click Account Setting in the secondary menu bar to enter the account setting interface.The account management function is only available to administrators.The default administrator account cannot be deleted, and the administrator's user name and permissions cannot be modified.

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

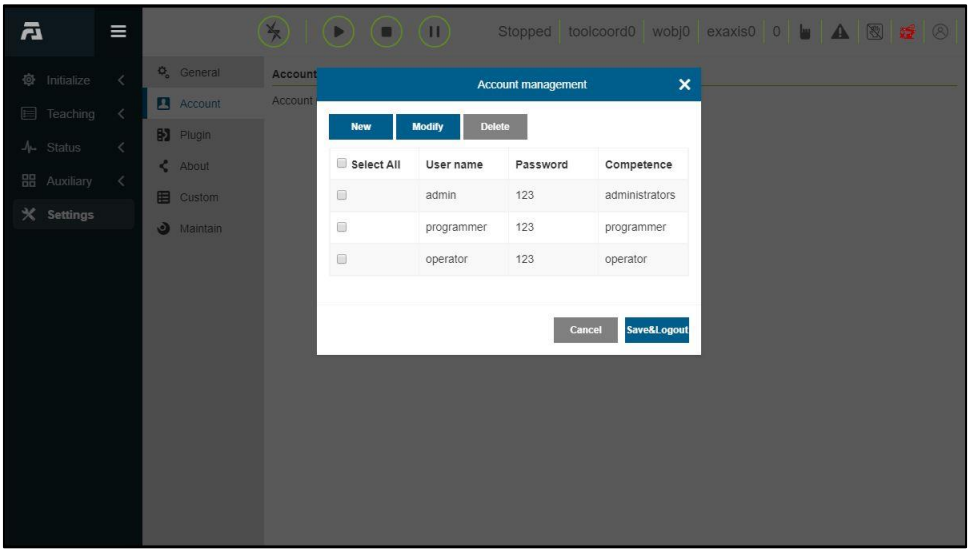


Fig. 3.10-2Schematic diagram of account setting

3.10.3 about

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

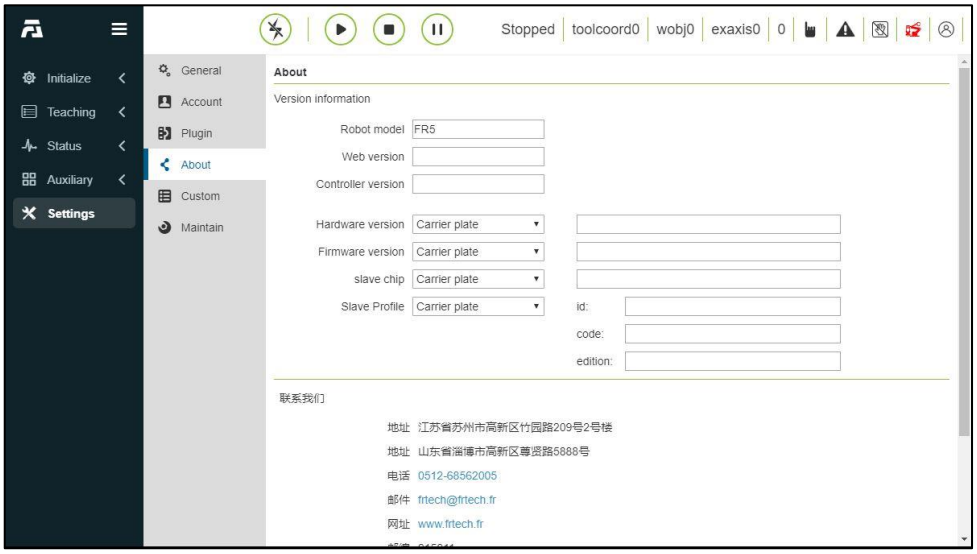


Fig. 3.10-3About Schematics

Chapter IV Robot Peripherals

4.1 Clamping jaw peripheral configuration

4.1.1 Teaching steps of gripper program

Step 1: Select the "End Peripheral Configuration" button in the user peripheral configuration interface, and select the "Clamping Jaw Device" as the device type. The configuration information of the clamping jaw is divided into the clamping jaw manufacturer, clamping jaw type, software version and mounting position. The user can configure the corresponding clamping jaw information according to the specific production requirements.If the user needs to change the configuration, first select the corresponding gripper number, click the "Clear" button to clear the corresponding button, and re configure according to the demand;

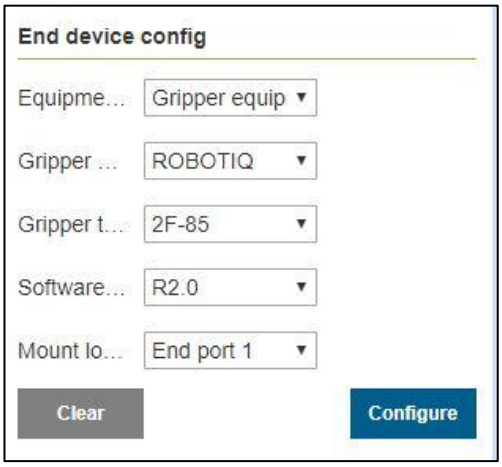


Fig. 4.1-1Jaw configuration

be careful:

Before clicking Clear Configuration, the corresponding gripper should be inactive.

Step 2: After the jaw configuration is completed, the user can view the corresponding jaw information in the jaw information table at the bottom of the page. If a configuration error is found, click the "Clear" button to reconfigure the jaw;

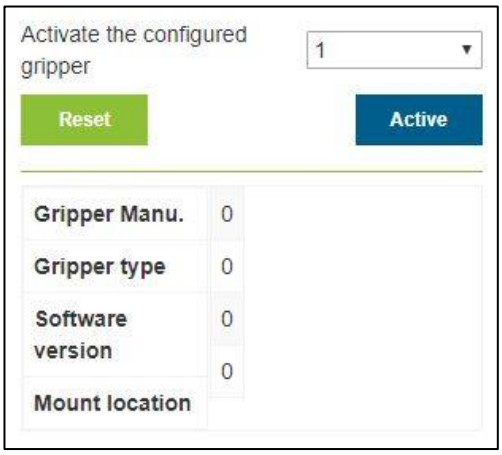


Fig. 4.1-2Jaw configuration information

Step 3: Select the configured gripper and click the "Reset" button. After the page pops up and the command is sent successfully, click the "Activate" button to check the activation status in the gripper information table to determine whether the activation is successful;

be careful:

When the gripper is activated, the gripper shall be free of clamping objects

Step4: Select the "Gripper" command in the program teaching command interface.In the jaw command interface, the user can select the number of jaw to be controlled (the jaw that has been configured and activated), and set the corresponding opening/closing status, opening/closing speed, opening/closing torque, and the maximum time that the jaw action has been waiting for.Click Add Application after setting.In addition, the gripper activation and reset commands can be added to deactivate/reset the gripper when running the program.

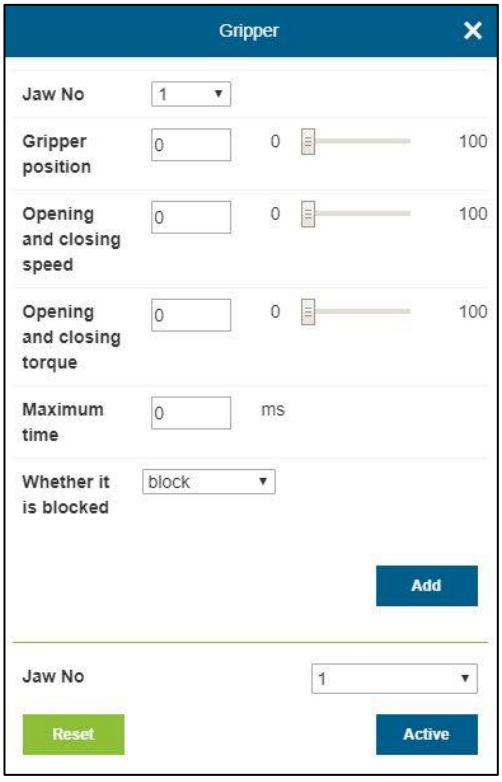


Fig. 4.1-3Jaw command editing

4.1.2 Clamping program teaching

S/N	Instruction format	notes
1	PTP(template2,100,-1,0)	#Waiting for pinch point
2	PTP(template1,100,-1,0)	#Pinch point
3	MoveGripper(1,255,255,0,1000,0)	#Clamping jaws closed
4	PTP(template2,100, -1,0)	/
5	PTP(template3,100, -1,0)	#Waiting for placement point
6	PTP(template3,100, -1,0)	#Placement point
7	MoveGripper(1,0,255,0,1000,0)	#Clamping jaws open

4.2 Configuration of spray gun peripherals

4.2.1 Configuration steps of spray gun peripherals

Step 1: Select the "Spray Gun Configuration" 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 the spraying function (the default configuration is DO10 for spraying start and stop, and DO11 for spraying gun cleaning).Users can also customize the configuration of DO in the IO Configuration interface according to their own needs;

be careful:

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

Step 2: After the configuration is completed, click the four buttons "Start spraying", "Stop spraying", "Start cleaning" and "Stop cleaning" to debug the spray gun;



Fig. 4.2-1Spray gun configuration

Step3: Select the "spray" command in the program teaching command interface.According to the specific program teaching needs, add four commands "start spraying", "stop spraying", "start gun cleaning" and "stop gun cleaning" in the corresponding places.

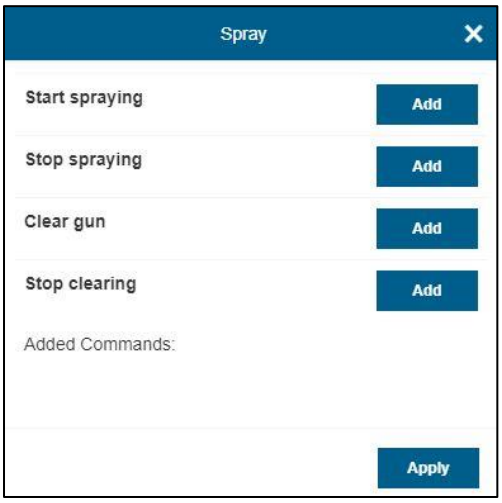


Fig. 4.2-2Spray gun command editing

4.2.2 Painting program teaching

S/N	Instruction format	notes
1	Lin(template1,100,-1,0,0)	#Start spraying point
2	SprayStart()	#Start painting
3	Lin(template2,100,-1,0,0)	#Spray path
4	Lin(template3,100,-1,0,0)	#Stop spraying point
5	SprayStop()	#Stop spraying
6	Lin(template4,100,-1,0,0)	#Gun cleaning point
7	PowerCleanStart()	#Start to clean the gun
8	WaitTime(5000)	#Cleaning time ms
9	PowerCleanStop()	#Stop gun cleaning

4.3 Configuration of welding machine peripherals

4.3.1 Configuration steps of welding machine peripherals

Step 1: Select the "welding machine configuration" button in the user's 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 arcing success signal, DO9 air supply signal, DO10 arcing signal, DO11 inching wire feed, DO12 reverse wire feed, DO13 JOB select 1, DO14 JOB select 2, DO15 JOB select 3).Users can also customize the configuration in the IO Configuration interface according to their own needs;

be careful:

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

Step 2: After the configuration is completed, select the number, set the waiting time, click the six buttons of "arc stopping", "arc starting", "air supply", "air off", "forward wire feed" and "reverse wire feed" to debug the welding machine;



Fig. 4.3-1Welding machine configuration

Step3: Select the "Weld" command in the program teaching command interface.According to the specific program teaching requirements, add and apply "arc starting" and "arc stopping" commands in the corresponding places.

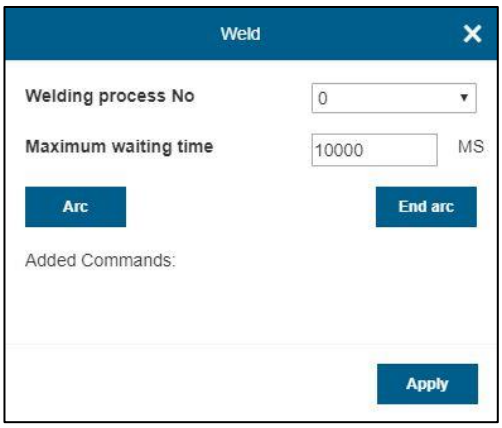


Fig. 4.3-2Welding machine instruction editing

4.3.2 Welding machine program teaching

S/N	Instruction format	notes
1	Lin(template1,100,-1,0,0)	#Start arc starting point
2	ARCStart(0,1000)	#Start arcing
3	Lin(template2,100,-1,0,0)	#Stop arc starting point
4	ARCEnd(0,1000)	#Stop arcing

4.4 Sensor peripheral configuration

4.4.1 Configuration steps of sensor peripherals

Step 1: Select the "Sensor Configuration" button in the user's peripheral configuration interface. This section takes the robot end as an example. The user first sets the maximum difference value. It is recommended that the maximum difference value of sensor scanning deviation points be set to 4 by default. Data processing selects the original data or YZ data according to the actual use scene.The controller IP is 192.168.57.2 by default, and the sensor IP can be configured to the same network segment. The port is 5020, and the recommended sampling period is 25. The communication protocol is currently adapted to Ruiniu communication protocol, and the corresponding protocol can be loaded.After loading, the sensor can be tested by pressing the "Open Sensor" and "Close Sensor" keys.

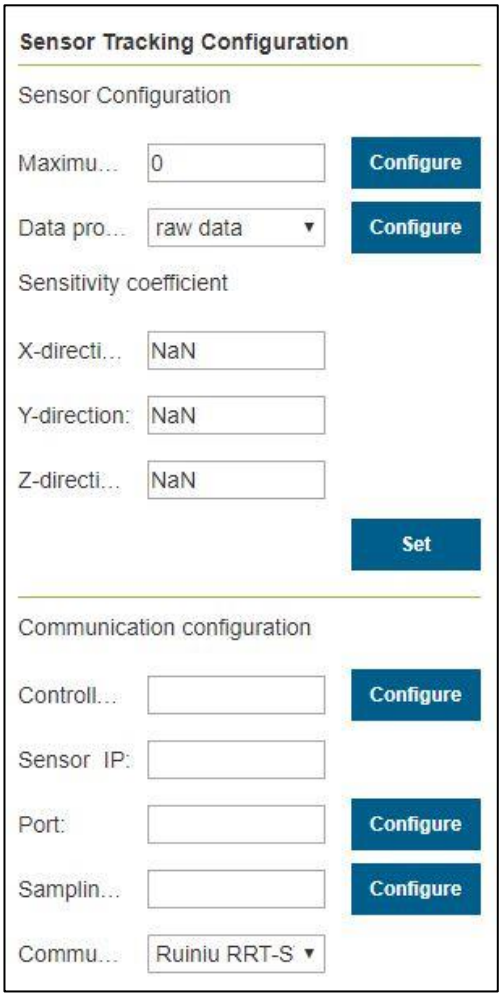


Fig. 4.4-1IP configuration of laser tracking sensor

be careful:

Before using the sensor function, it is necessary to establish the corresponding tool coordinate system, and apply the established tool coordinate system during program teaching. The welder function is usually used with the sensor.

Step 2: Calibrate the sensor reference point.

In the tool coordinate system setting function, we calibrate the sensor type tool and use the six point method to configure the sensor coordinate system.Select a fixed point in the robot workspace, move the sensor center point to the selected point from three different angles, and set points 1,2,3 respectively.Move the center point of the sensor vertically above the selected point and record Point 4.Move the sensor center point from the fixed point to a point in the X axis direction of the sensor coordinate system, and set point 5.Return to the fixed point, move it vertically upward, move the sensor center point 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 position and attitude of the sensor tool, and click Apply to complete it.

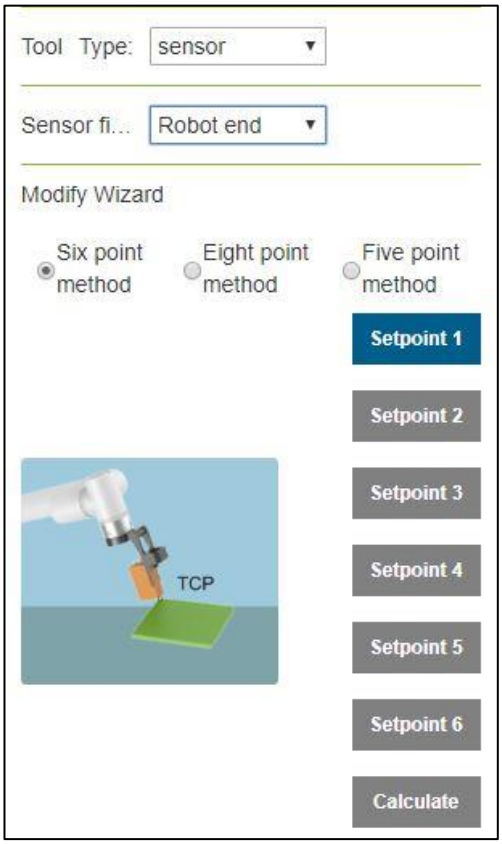


Fig. 4.4-2Reference point configuration - six point method

Eight point method: in the tool coordinate system setting function, we calibrate the sensor type tool and use the eight point method to configure the sensor coordinate systemSelect the eight point method, move the laser line of the sensor to make it coincide with the calibration line on the calibration board, try to keep the sensor close to the calibration line and recognize the calibration point, record point 1, move about - y/+y 20mm, adjust the robot to make the laser recognize 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, move about - y/+y 20mm,Adjust the robot to make the laser recognize the calibration point, record point 4, move about - rx 5mm, and adjust the robot to make the laser recognize the calibration point, record point 5.Move - ry about 5mm, adjust the robot to make the laser recognize the calibration point, record point 6, move - rz about 5mm, adjust the robot to make the sensor recognize the calibration point, record point 7, move - rz about 5mm, adjust the robot to make the laser recognize the calibration point, record point 8.Click Calculate to get the position and attitude of the sensor, and click Apply to complete it.

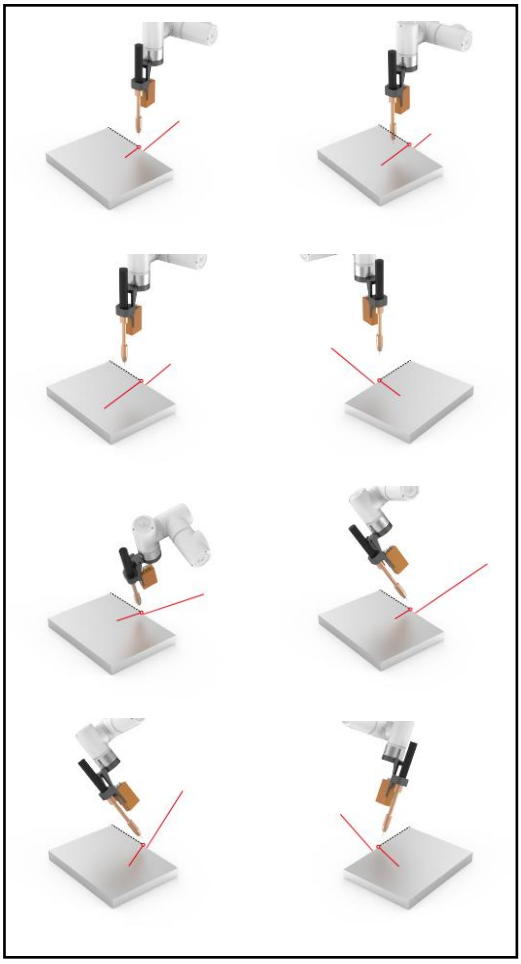


Fig. 4.4-3Reference point configuration - eight point method

Five point method: in the tool coordinate system setting function, we calibrate the sensor type tool and use the five point method to configure the sensorCoordinate systemFirst, determine a fixed point, align the end of the tool with this point, record point 1, and then adjust the robot attitude so that the laser can recognize the recorded fixed points, record points 2 to 5 respectively, and pay attention to the attitude change needs to be as large as possible.Click Calculate to get the position and attitude of the sensor, and click Apply to complete it.

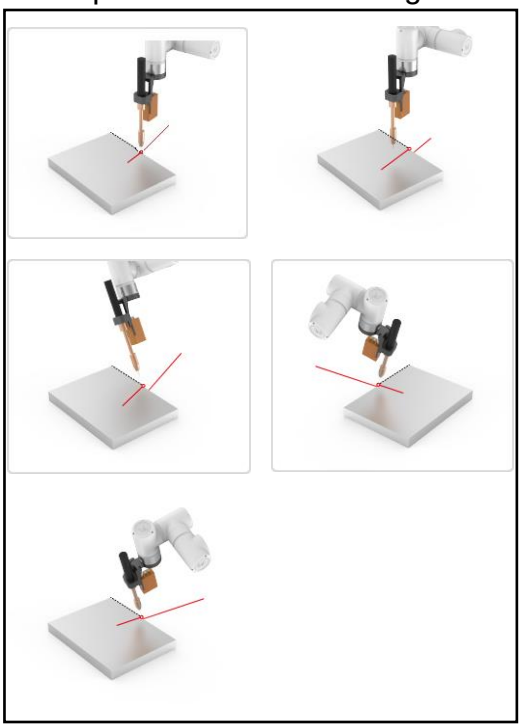


Fig. 4.4-4Reference point configuration - five point method

4.4.2 Laser sensor tracking function

Instruction description: select the "Laser" command in the program teaching command interface.It integrates laser related instructions. According to the specific program teaching requirements, add instructions in the corresponding places. Refer to the following program examples.

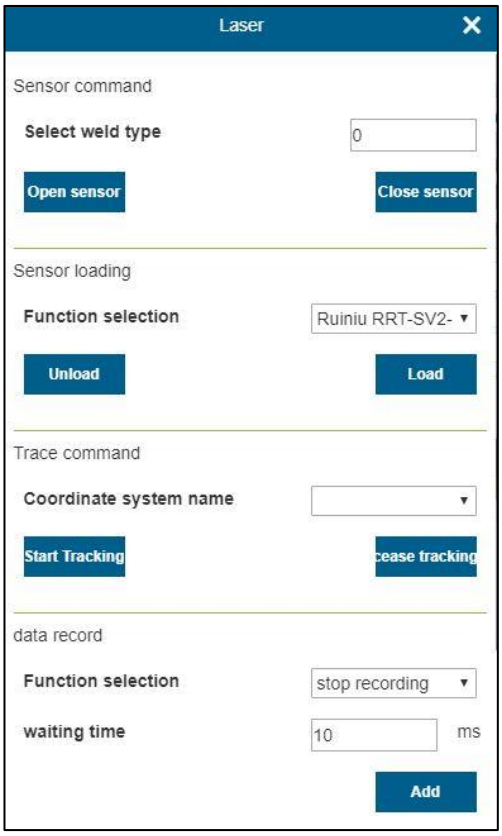


Fig. 4.4-5 Laser tracking command editing

Program example:

S/N	Instruction format	notes
1	LTLaserOn(2)	#Turn on the sensor
2	PTP(template1,100,-1,0)	#Sensor starting point
3	LTSearchStart(1,20,100,10000,2)	#Start searching
4	LTSearchStop()	#Stop searching
5	Lin(seamPos,20,-1,0,0,0)	#Start of weld
6	LTTrackOn(2)	#Laser tracking
7	ARCStart(0,10000)	#Arc striking of welder
8	Lin(SeamEnd11,10-1,0,0)	#End of weld
9	ARCEnd(0,10000)	#Arc extinguishing of welder
10	LTTrackOff()	#Sensor tracking off
11	LTLaserOff()	#Turn off the sensor

4.4.3 Laser sensor track reproduction function

Instruction description: select the "LT Rec" command in the program teaching command interface.This command is mainly used to obtain the starting point and ending point of the laser identification path and to reproduce the track. According to the specific program teaching needs, add the command at the corresponding place. Refer to the following program example.

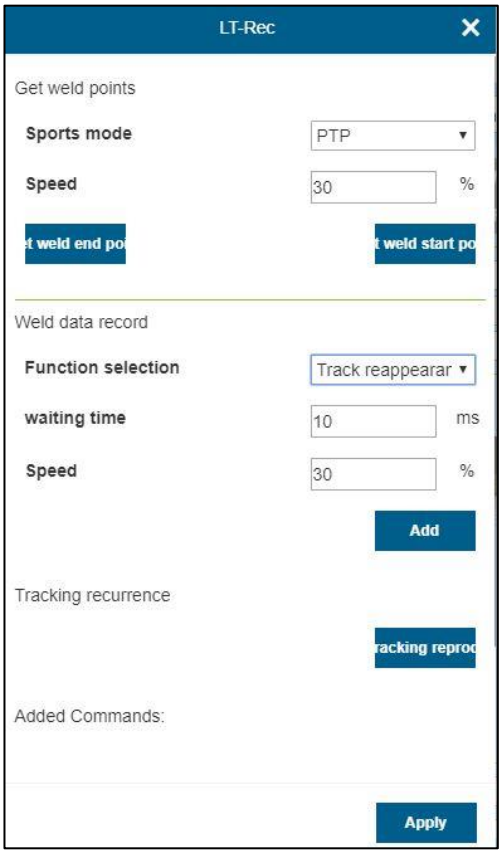


Fig. 4.4-6 Track reproduction instruction editing

Program example:

S/N	Instruction format	notes
1	PTP(template1,100,-1,0)	#Move to starting point
2	LaserSensorRecord(2,0,30)	#Sensor start recording
3	Lin(template2,100,-1,0,0)	#Move to the end
4	LaserSensorRecord(0,0,30)	#Stop recording
5	pos={}	#Initialize array
6	pos=GetWeldTrackingRecordStartPos(0,30)	#Start point for obtaining laser record
7	If type(pos) == “table” then	#Judge data type
8	LaserPTP(#pos,pos)	#Move to the starting point of the laser track
9	end	
10	LaserSensorRecord(3,0,30)	#Set Recurrence Track
11	MoveLTR()	#Start reproducing track
12	LaserSensorRecord(0,0,30)	#End

4.5 Peripheral configuration of extension axis

4.5.1 Configuration steps of peripheral equipment of extension axis

Step 1: Select the "Extended Axis" button in the user peripheral configuration interface to enter the extended axis interface, select the number 1 of the extended axis, and click the "Parameter Configuration" button to enter the right interface.Set the shaft type, shaft direction, running speed, acceleration, positive direction limit, reverse direction limit, lead, encoder resolution, starting point offset, manufacturer, model and mode, and click Configure to complete the configuration.

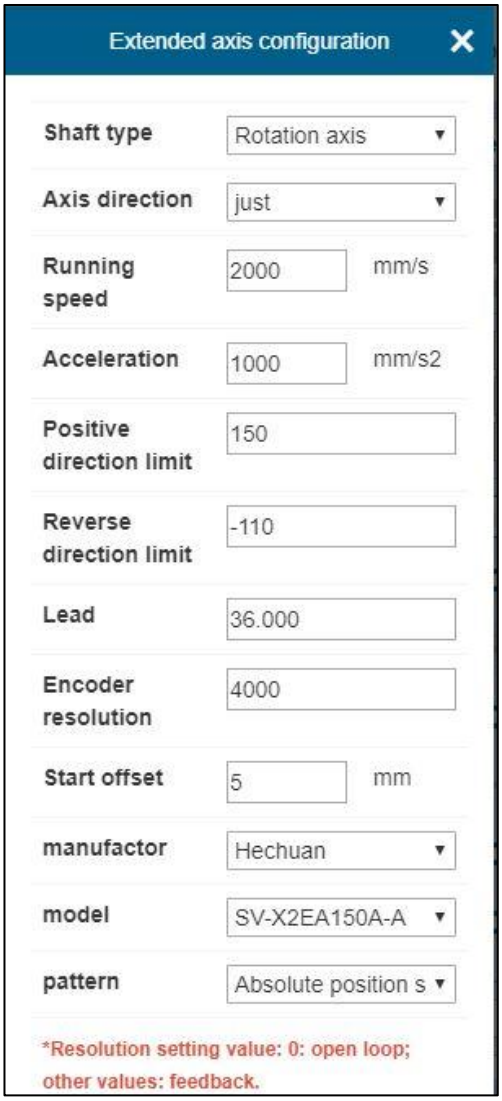


Fig. 4.5-1Extended axis parameter configuration

be careful:

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

Step 2: Click the "Zero Setting" button to enter the zero setting pop-up window, as shown in the picture on the right.Set the homing mode, homing speed, zero clamping speed and axis direction, click the "Set" button, and the extended axis will start homing. The homing status will be displayed in the space below the axis direction. When the prompt "homing completed" appears, it indicates that the extended axis zero point is set successfully.

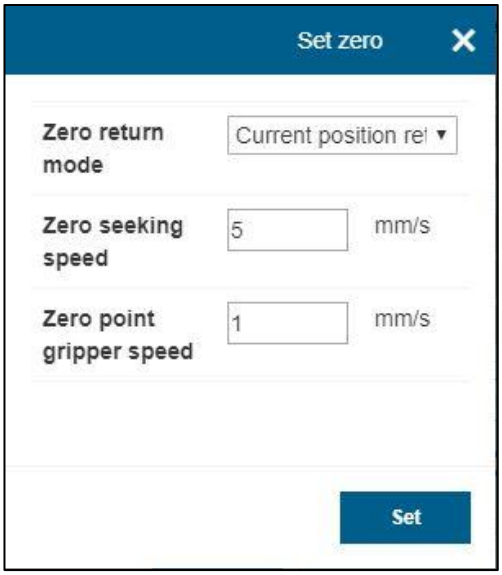


Fig. 4.5-2Extension axis zero point setting

Step 3: Select the extension axis number with configured parameters, click "Servo Enable", set the operating speed, acceleration and maximum distance of single operation, and test the extension axis with forward rotation and reverse rotation.

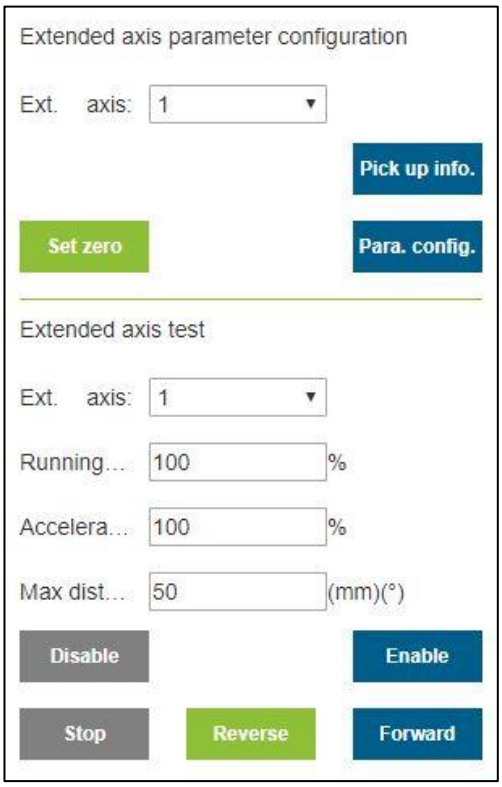


Fig. 4.5-3Extended axis test

Step 4: The extension axis is usually used together with the laser sensor. At this time, the laser sensor is usually installed externally. The sensor reference point configuration needs to be calibrated using the three-point method instead of the six point method previously used.Align the tool center with the middle point at the bottom of the right cross section (the side close to the camera), set point 1, align the tool center point with the middle point at the bottom of the left cross section, set point 2, move the tool center point 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 three-point calibration.



Fig. 4.5-4Sensor three-point calibration

Step5: Select the "EAxis" command in the program teaching command interface.Add instructions in corresponding places according to specific program teaching requirements.

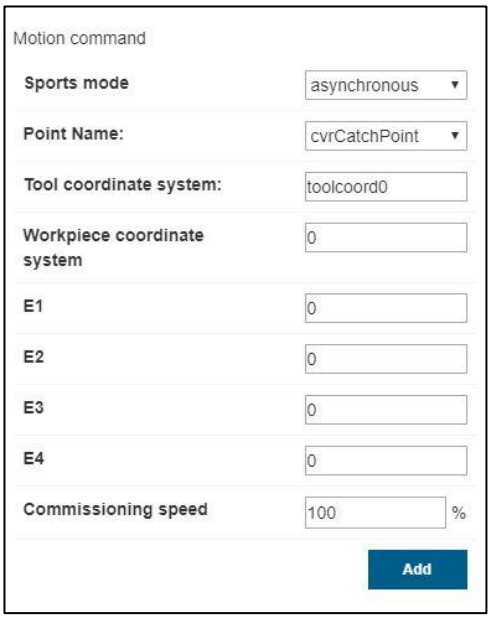


Fig. 4.5-5Extended axis command editing

4.5.2 Extension axis matching laser tracking welding program teaching

S/N	Instruction format	notes
1	EXT_AXIS_PTP(1,1,laserstart)	#External axis movement laser sensor starting point
2	PTP(laserstart,10,-1,0)	#Starting point of robot motion laser sensor
3	LTSearchStart(3,20,10,10000)	#Start searching
4	LTSearchStop()	#Stop searching
5	EXT_AXIS_PTP(1,1,seamPos)	#Start point of external axis movement weld
6	Lin(seamPos,20,-1,0,0,0)	#Start point of robot moving weld
7	LTTrackOn()	#Laser tracking
8	ARCStart(0,10000)	#Arc striking of welder
9	EXT_AXIS_PTP(1,1,laserend)	#End point of external axis movement weld
10	Lin(laserend,10,-1,0,0)	#End point of robot moving weld
11	ARCEnd(0,10000)	#Arc extinguishing of welder
12	LTTrackOff	#Laser tracking off

4.6 Conveyor tracking configuration

4.6.1 Conveyor tracking configuration steps

Step 1: Select the "Conveyor Tracking" button in the user peripheral configuration interface to enter the conveyor tracking configuration interface, click the "Configure Conveyor IO" button to quickly configure the IO required for the conveyor function, and then configure the corresponding parameters according to the actual use of the function. Here, taking the no visual tracking capture function as an example, it is necessary to configure the conveyor encoder channel, resolution, lead,Select No for visual matching, and click Configure.

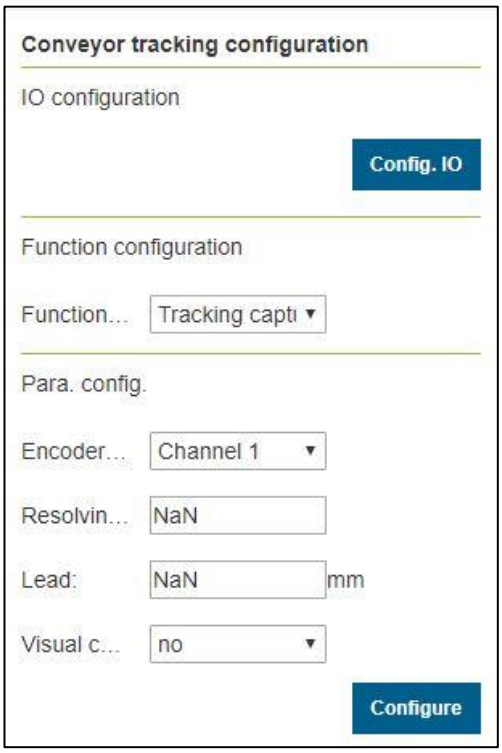


Fig. 4.6-1Conveyor configuration

Step 1: Select the "Conveyor Tracking" button in the user peripheral configuration interface to enter the conveyor tracking configuration interface, click the "Configure Conveyor IO" button to quickly configure the IO required for the conveyor function, and then configure the corresponding parameters according to the actual use of the function. Here, taking the no visual tracking capture function as an example, it is necessary to configure the conveyor encoder channel, resolution, lead,Select No for visual matching, and click Configure.



Fig. 4.6-2Conveyor configuration

Step 2: Next, set the grab point compensation value, which is the compensation distance in X, Y, Z directions, and can be set according to the actual situation during debugging.

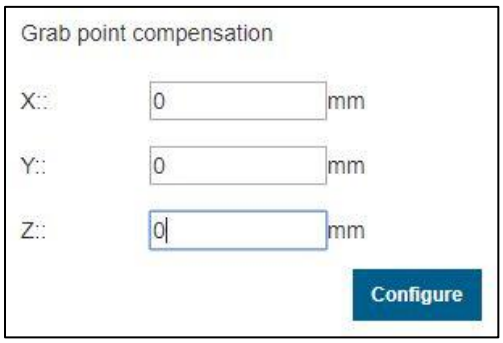


Fig. 4.6-3Conveyor Grab Point Compensation Configuration

Step 3: Start the conveyor belt, move the calibrated object to the defined point A position, and stop the conveyor belt.Move the robot, align the calibration rod tip at the end of the robot with the calibrated object tip, click the start point A button, pop up the dialog box, display the current encoder value and robot pose, and click calibration to complete the calibration of start point A.

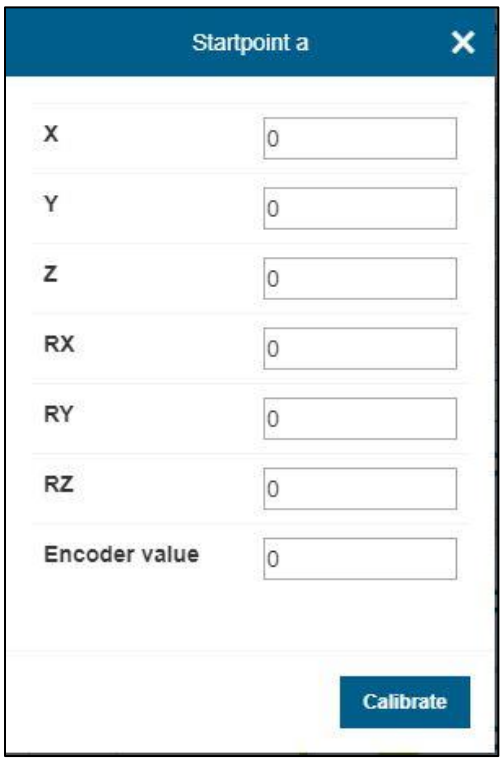


Fig. 4.6-4Start point A configuration

Step 4: Click the reference point button to enter the reference point calibration. When recording the reference point, record the height and attitude of the robot when it grabs. Each time when tracking, it will track and capture the height and attitude area of the reference point. It can not be at the same height as the AB point. Click calibration to complete the reference point calibration.

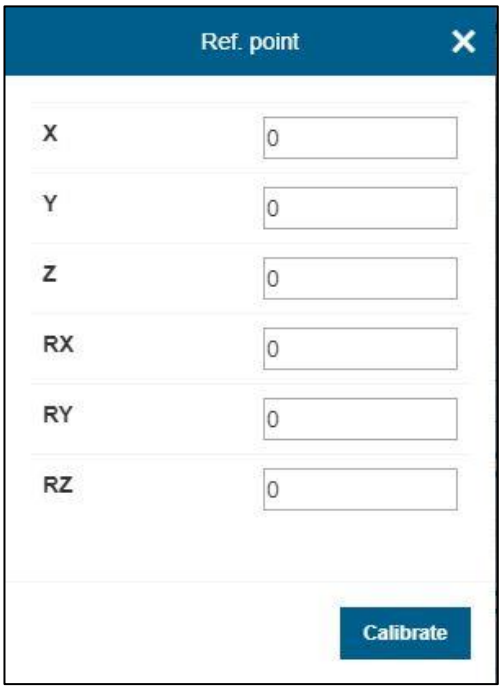


Fig. 4.6-5Reference point configuration

Step5: Start the conveyor belt, move the calibrated object to the defined B point position, and stop the conveyor belt.Move the robot, align the calibration rod tip at the end of the robot with the calibrated object tip, click the endpoint B button, and a dialog box will pop up, displaying the current encoder value and robot posture. Click calibration to complete endpoint B calibration.

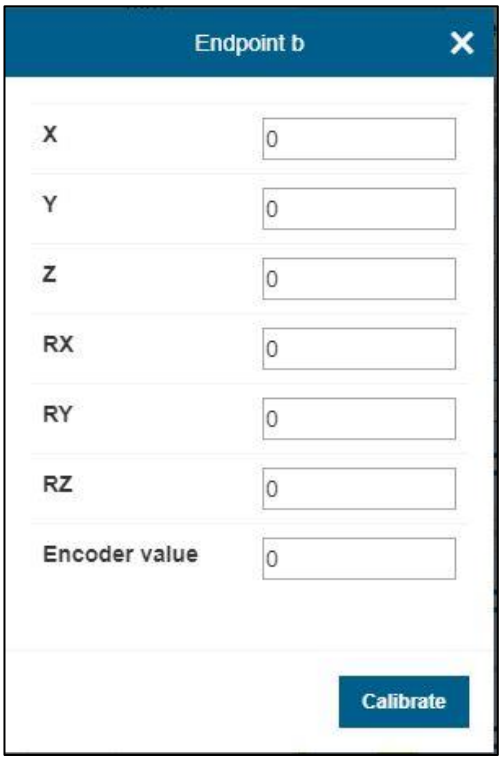


Fig. 4.6-6End point B configuration

4.6.2 Teaching of conveyor tracking program

S/N	Instruction format	notes
1	PTP(conveyorstart,30,-1,0)	#Robot grabbing starting point
2	While(1) do	#Loop Grab
3	ConveyorIODetect(10000)	#IO real-time detection of objects
4	ConveyorGetTrackData(1)	#Object position acquisition
5	ConveyorTrackStart(1)	#Conveyor tracking start
6	Lin(cvrCatchPoint,10,-1,0,0)	#Robot reaches the grab point
7	MoveGripper(1,255,255,0,10000)	#Gripper claw grabs objects
8	Lin(cvrRaisePoint,10,-1,0,0)	#Robot lifting
9	ConveyorTrackEnd()	#End of belt tracking
10	PTP(conveyorraise,30,-1,0)	#Robot arrives at holding point
11	PTP(conveyorend,30,-1,0)	#Robot reaches the placement point
12	MoveGripper(1,0,255,0,10000)	#Gripper release
13	PTP(conveyorstart,50,-1,0)	#The robot returns to the starting point again and waits for the next capture
14	end	#End

4.7 Attitude adaptive configuration

4.7.1 Attitude adaptive configuration steps

Step 1: Select the "Tracking Attitude Configuration" button in the user peripheral configuration interface to enter the attitude adjustment configuration interface, select the plate type and the actual working direction of the robot, adjust the robot attitude, set attitude point A, attitude point B and attitude point C respectively, usually A is the plane attitude point, B is the rising edge attitude point, and C is the falling edge attitude point.

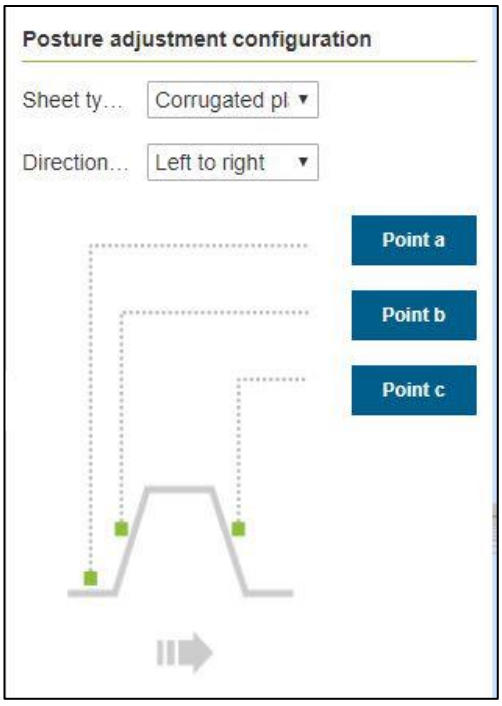


Fig. 4.7-1Attitude adjustment configuration

be careful:

A attitude and B attitude, the smaller the attitude change between A attitude and C attitude, the better. Attitude adaptive function is an auxiliary application function, which is usually used with seam tracking.

Step 2: Select the "Adjust" command in the program teaching command interface.Add instructions in corresponding places according to specific program teaching requirements.

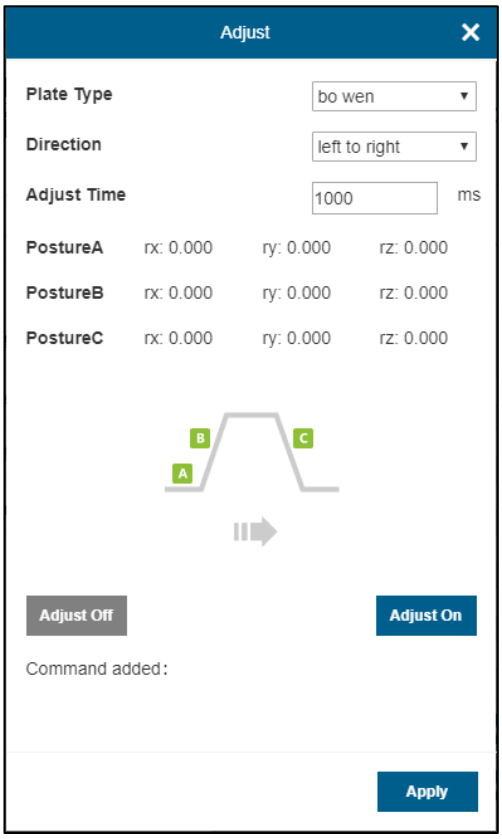


Fig. 4.7-2Attitude adjustment command editing

4.7.2 Attitude adaptive fit extension axis and laser tracking welding program teaching

S/N	Instruction format	notes
1	EXT_AXIS_PTP(1,1,laserstart)	#External axis movement laser sensor starting point
2	PTP(laserstart,10,-1,0)	#Starting point of robot motion laser sensor
3	LTSearchStart(3,20,10,10000)	#Start searching
4	LTSearchStop()	#Stop searching
5	EXT_AXIS_PTP(1,1,seamPos)	#Start point of external axis movement weld
6	Lin(seamPos,20,-1,0,0,0)	#Start point of robot moving weld
7	LTTrackOn()	#Laser tracking
8	ARCStart(0,10000)	#Arc striking of welder
9	PostureAdjustOn(0,PosA,PosC,PosB,1000)	#Attitude adaptive adjustment on
10	EXT_AXIS_PTP(1,1,laserend)	#End point of external axis movement weld
11	Lin(laserend,10,-1,0,0)	#End point of robot moving weld
12	ARCEnd(0,10000)	#Arc extinguishing of welder
13	PostureAdjustOff(0)	#Attitude adaptive adjustment off
14	LTTrackOff	#Laser tracking off

4.8 Force/torque sensor peripheral configuration

4.8.1 Force/torque sensor configuration steps

Step 1: Select the "End Peripheral Configuration" button in the user's peripheral configuration interface, and select the "Force Sensor Device" as the device type. The force sensor configuration information is divided into manufacturer, type, software version and mounting location. The user can configure the corresponding force sensor information according to the specific production requirements.If the user needs to change the configuration, he can first select the corresponding number, click the "Clear" button to clear the corresponding information, and re configure as required;

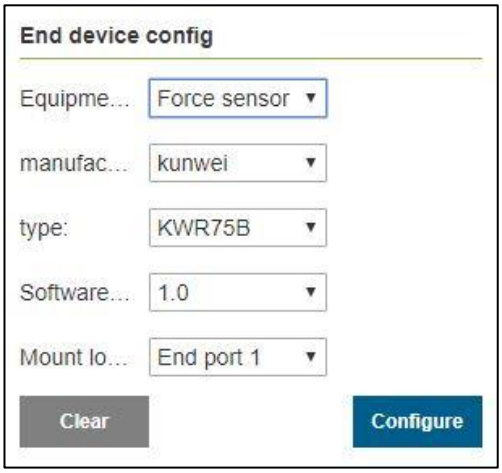


Fig. 4.8-1Force/torque sensor configuration

be careful:

Before clicking Clear Configuration, the corresponding sensor should be inactive.

Step 2: After the force sensor configuration is completed, the user can view the corresponding force sensor information in the information table at the bottom of the page. If the configuration error is found, click the "Clear" button to reconfigure.

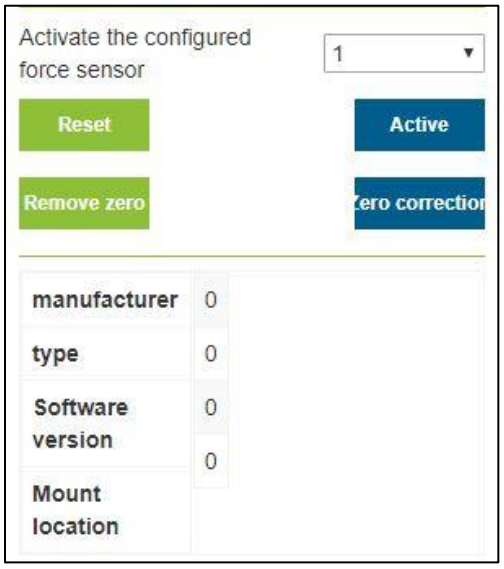


Fig. 4.8-2Force/torque sensor configuration information

Step 3: Select the configured force sensor number, click the "Reset" button, and then click the "Activate" button after the pop-up command is sent successfully. You can check the activation status in the force sensor information table to determine whether the activation is successful;In addition, the force sensor will have an initial value, and the user can select "zero correction" and "zero removal" according to the use demand.The zero point correction of the force sensor needs to ensure that the force sensor is horizontal and vertical downward, and the robot is not configured with a load.

Step 4: After the force sensor is configured, the sensor type tool coordinate system needs to be configured. The sensor tool coordinate system value can be directly input and applied according to the distance between the sensor and the end tool center.

4.8.2 Load identification of force/torque sensor

Specific attitude identification: clear the end load data, configure the force sensor, establish the sensor coordinate system, adjust the robot end attitude to vertical downward, and install the end load after "zero point correction".First, select the corresponding sensor tool coordinate system, adjust the robot to make the sensor and tool vertically downward, record the data, and calculate the mass.Then, adjust three different poses of the robot, record three groups of data respectively, calculate the center of mass, and click Apply after confirmation.

Dynamic identification: after clearing the end load data and configuring the force sensor, establish the sensor coordinate system, adjust the robot end attitude to vertical downward, and install the end load after "zero point correction".Click "Identification On", drag the robot to move, and then click "Identification Off" to automatically apply the load results to the robot.

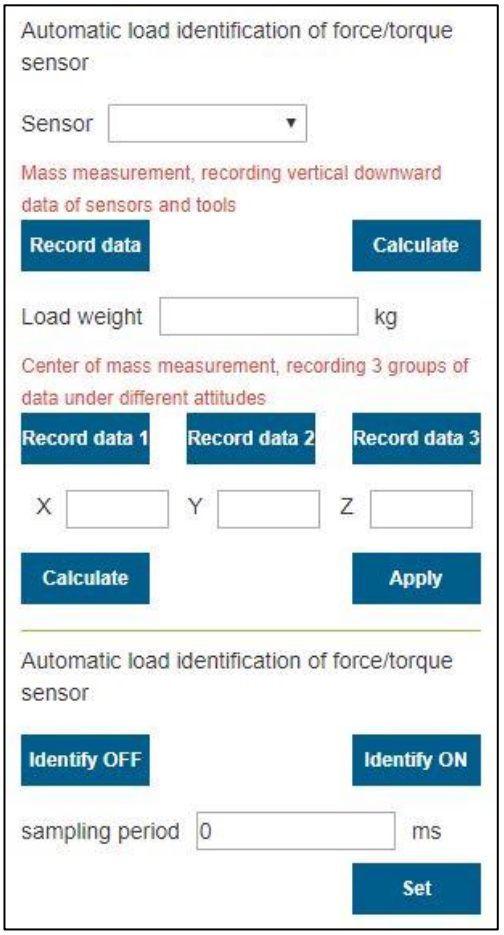


Fig. 4.8-3 Load identification of force/torque sensor

4.8.3 Force/torque sensor auxiliary drive

After the sensor is configured, it can be used together with the sensor to better assist the dragging robot.The first use can be configured according to the data in the picture on the right. After the application is completed, the robot can be controlled to move in a fixed posture by dragging the end force sensor directly without entering the drag mode.

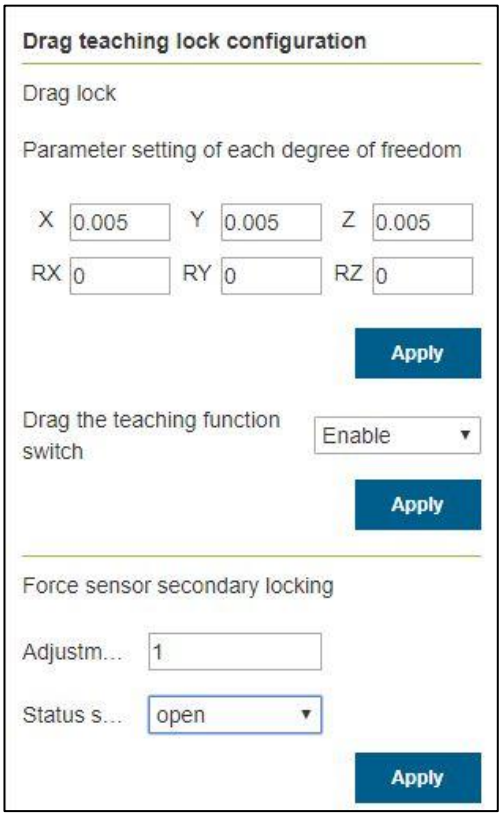


Fig. 4.8-4 Force/torque sensor drag lock

4.8.4 Force/torque sensor collision detection

Instruction description: "FT_ Guard" instruction is collision detection instruction.Select the corresponding sensor coordinate system, check the effective torque direction detection, set the current value, maximum collision threshold and minimum collision threshold. The normal range of collision detection conditions is (current value - minimum threshold, current value+maximum threshold), and add the "ON" and "OFF" commands to the program.

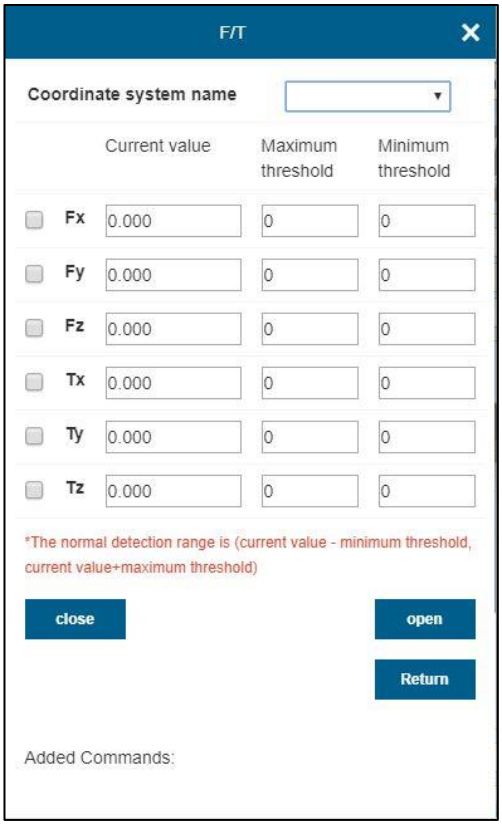


Fig. 4.8-5 FT_Guard command editing

Program example:

S/N	Instruction format	notes
1	FT_Guard(1,1,1,1,1,0,0,0,5,0,0,0,0,0,1 0,0,0,0,0,0,5,0,0,0,0,0)	#Force/moment collision detection on
2	PTP(template1,100,-1,0)	#Motion command
3	FT_Guard(0,1,1,1,1,0,0,0,5,0,0,0,0,0,1 0,0,0,0,0,0,5,0,0,0,0,0)	#Force/moment collision detection off

4.8.5 Force/torque sensor force controlled movement

Instruction description: "FT_Control" command is a force control motion command, which can make the robot move near the set force, and is often used in polishing scenes.Select the corresponding sensor coordinate system, tick the effective torque direction detection, set the detection threshold, PID proportional coefficient in each direction (generally set p as 0.001), set the maximum adjustment distance (corresponding to X, Y, Z) and the maximum adjustment angle (corresponding to RX, RY, RZ), and add the "ON" and "OFF" commands to the program.

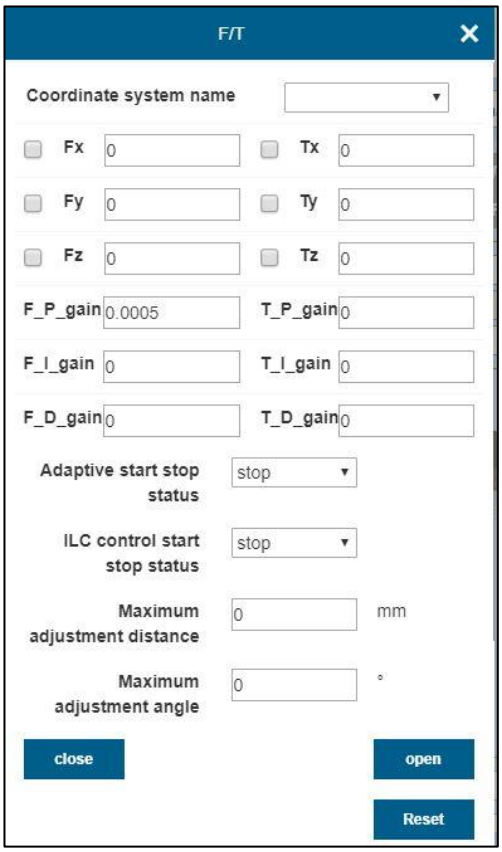


Fig. 4.8-6 FT_Control command editing

Program example:

S/N	Instruction format	notes
1	FT_Control(1,11,1,0,1,0,0,0,10,0,5,0,0,0,0.001,0,0,0,0,0,0,0,0,10,5)	#Force/torque motion control ON
2	Lin(template3,100,-1,0,0)	#Motion command
3	FT_Control(0,11,1,0,1,0,0,0,10,0,5,0,0,0,0.001,0,0,0,0,0,0,0,0,10,5)	#Force/torque motion control off

4.8.6 Force/torque sensor screw insertion

Instruction description: "FT_Spiral" instruction is a spiral exploration insertion, which is generally used for the shaft hole assembly of cylindrical shafts.Before running the action, it is necessary to drag the end of the robot to the approximate position of the hole location. According to the current scene, set the parameters of the command and add them to the program. After running, the robot will explore in a spiral motion.

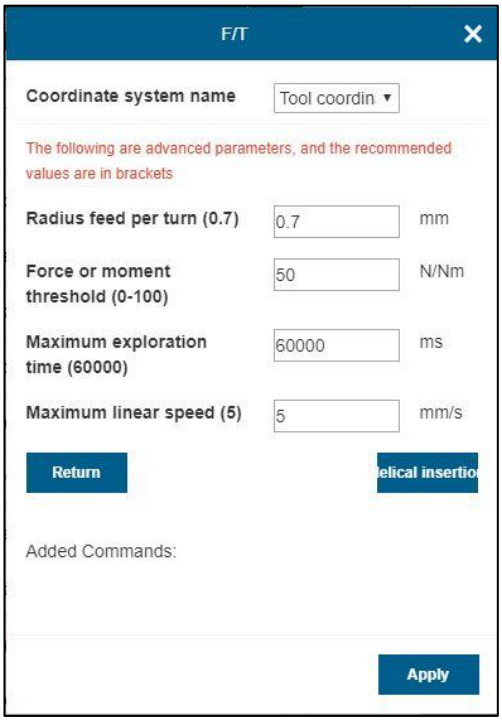


Fig. 4.8-7 FT_Spiral Command Editing

Program example:

S/N	Instruction format	notes
1	FT_Control(1,10,0,0,1,0,0,0,0,0,5,0,0,0,0.0005,0,0,0,0,0,0,10,0)	#Force/torque motion control ON
2	FT_SpiralSearch(0,0.7,0,60000,5)	#Spiral insertion
3	FT_Control(0,10,0,0,1,0,0,0,0,0,5,0,0,0,0.0005,0,0,0,0,0,0,10,0)	#Force/torque motion control off

4.8.7 Force/torque sensor rotation insertion

Instruction description: The "FT_Rot" instruction is a rotary exploration insertion, which is generally used to undertake the spiral insertion action, and is used for the shaft hole assembly of the key shaft.Before running the action, it is necessary to move the end of the robot to the hole position found by spiral exploration or the fully aligned teaching hole position. According to the current scene, set the parameters of the command and add them to the program. After running, the robot will slowly rotate to explore.

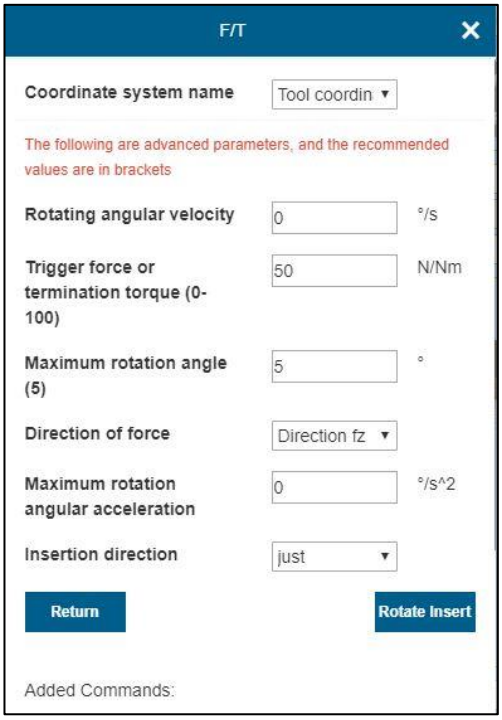


Fig. 4.8-8 FT_Rot command editing

Program example:

S/N	Instruction format	notes
1	FT_Control(1,10,0,0,1,0,0,0,0,0,5,0,0,0,0,0.0005,0,0,0,0,0,0,10,0)	#Force/torque motion control ON
2	FT_RotInsertion(0,3,0,5,1,0,1)	#Rotate Insert
3	FT_Control(0,10,0,0,1,0,0,0,0,0,5,0,0,0,0,0.0005,0,0,0,0,0,0,10,0)	#Force/torque motion control off

4.8.8 Linear insertion of force/torque sensor

Instruction description: "FT_Lin" instruction is a rotation exploration insertion, which is generally used to undertake the spiral insertion action or rotation insertion action, and is used for the shaft hole assembly of the key shaft.Before running the action, it is necessary to move the end of the robot to the hole position found by the spiral line exploration, rotate the position where the insertion action ends or the fully aligned teaching hole position, set the parameters of the command according to the current scene, add them to the program, and after running, the robot will move in a straight line in the set direction.

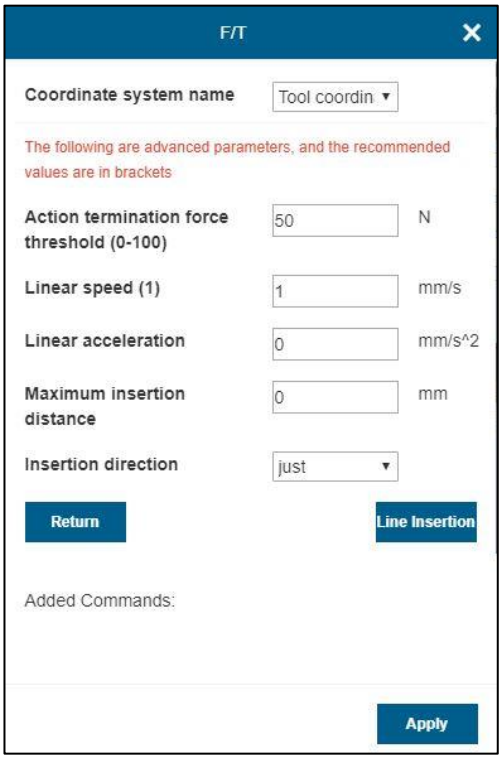


Fig. 4.8-9 FT_Lin command editing

Program example:

S/N	Instruction format	notes
1	FT_Control(1,10,0,0,1,0,0,0,0,0,5,0,0,0,0,0.0005,0,0,0,0,0,0,10,0)	#Force/torque motion control ON
2	FT_LinInsertion(0,50,1,0,100,1)	#Line insertion
3	FT_Control(0,10,0,0,1,0,0,0,0,0,5,0,0,0,0,0.0005,0,0,0,0,0,0,10,0)	#Force/torque motion control off

4.8.9 Force/torque sensor surface positioning

Instruction description: The "FT_FindSurface" instruction is for surface positioning, which is generally used to find the object surface.According to the current scene, set the corresponding coordinate system, movement direction, movement axis, exploration linear speed, exploration linear acceleration, maximum exploration distance, action termination force threshold and other parameters, add them to the program, run the program, the action starts to execute, and the robot end starts to move slowly to the direction of the surface.

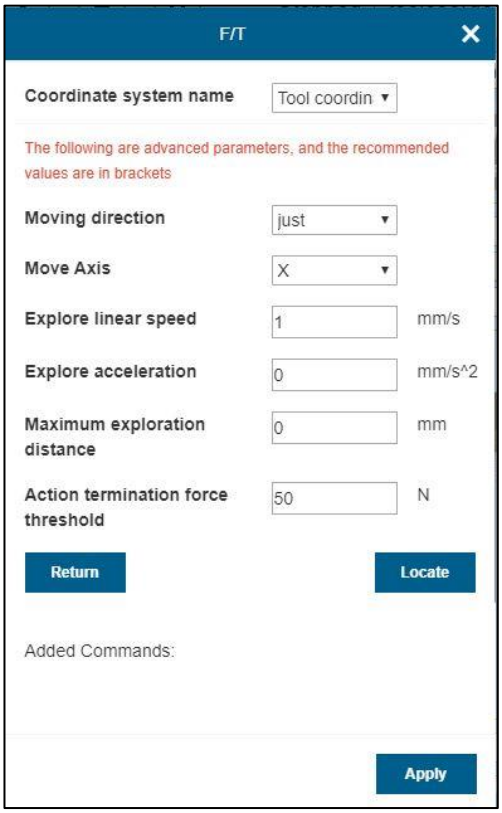


Fig. 4.8-10 FT_FindSurface command editing

Program example:

S/N	Instruction format	notes
1	PTP(1,30,-1,0)	#Initial position
2	FT_FindSurface(0,1,3,1,0,100,5)	#Plane positioning

4.8.10 Center positioning of force/torque sensor

Instruction description: "FT_CalCenter" instruction is for center positioning, which is generally used to find the middle plane surface of two surfaces.According to the current scene, set the corresponding coordinate system, moving direction, moving axis, exploring linear speed, exploring linear acceleration, maximum exploring distance, action termination force threshold and other parameters, respectively find plane A and plane B, add them to the program, run the program, and the action starts to execute. The robot slowly moves to the direction of surface A, and after positioning to plane A,The robot slowly moves to the direction of surface B, and after positioning to surface B, the center plane position can be calculated.

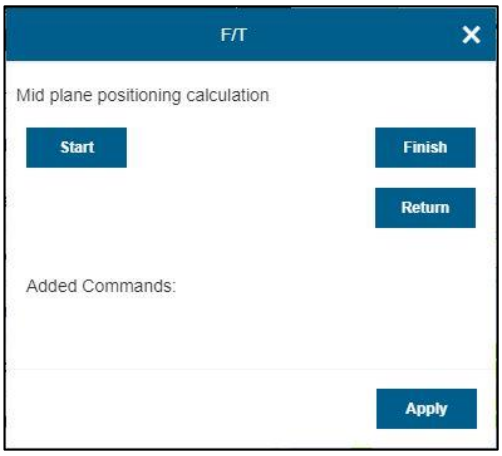


Fig.4.8-11 FT_CalCenter Command Editing

Program example:

S/N	Instruction format	notes
1	PTP(1,30,-1,0)	#Initial position
2	FT_CalCenterStart()	#Surface positioning start
3	FT_Control(1,10,0,0,1,0,0,0,0,0,-10,0,0,0,0.00001,0,0,0,0,0,0,100,0)	#Force/torque motion control ON
4	FT_FindSurface(1,2,2,10,0,200,5)	#Positioning plane A
5	FT_Control(0,10,0,0,1,0,0,0,0,0,-10,0,0,0,0.00001,0,0,0,0,0,0,100,0)	#Force/torque motion control off

6	PTP (1,30, - 1,0) -- initial position	#Initial position
7	FT_Control(1,10,0,0,1,0,0,0,0,0,-10,0,0,0,0.00001,0,0,0,0,0,0,100,0)	#Force/torque motion control ON
8	FT_FindSurface(1,1,2,20,0,200,5)	#Positioning plane B
9	FT_Control(0,10,0,0,1,0,0,0,0,0,-10,0,0,0,0.00001,0,0,0,0,0,0,100,0)	#Force/torque motion control off
10	pos = {}	#Define array pos
11	pos = FT_CalCenterEnd()	#Acquire Cartesian pose of positioning center
12	MoveCart(pos,GetActualTCPNum(), GetActualWObjNum(),30,10,100,-1,0)	#Move to the center of positioning

4.8.11 Spot force detection of force/torque sensor

Instruction description: "FT_Click" instruction is point by force detection, which is used to detect a point by force and is usually used together with surface positioning action.After setting the parameters, add them to the program, run the program, and the end starts to move towards the target along the Z direction of the tool coordinate system. When the force in the positive Z direction reaches the point force value, the point force detection is completed.

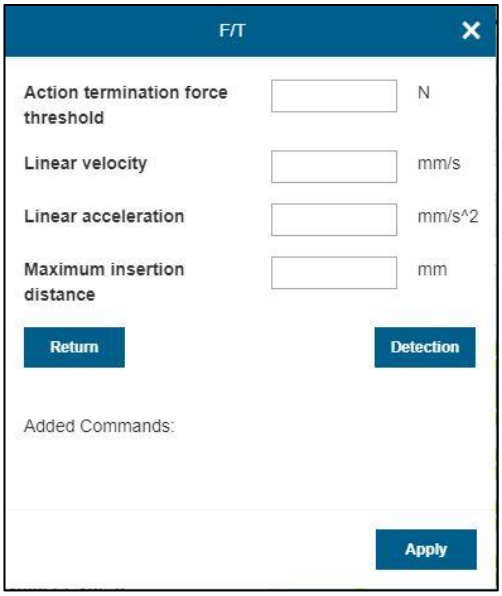


Fig. 4.8-12 FT_Click command editing

Program example:

S/N	Instruction format	notes
1	PTP(1,30,-1,0)	#Initial position
2	FT_Click(0,5,5,0,100,0)	#Spot force detection

4.9 Extended IO device peripheral configuration

4.9.1 Extended IO device configuration steps

Step 1: Select the "End Peripheral Configuration" button in the user peripheral configuration interface, and select "Extended IO Device" for the device type. The extended IO device configuration information is divided into manufacturer, type, software version and mount location. The user can configure the corresponding device information according to the specific production requirements.If the user needs to change the configuration, he can first select the corresponding number, click the "Clear" button to clear the corresponding information, and re configure as required;

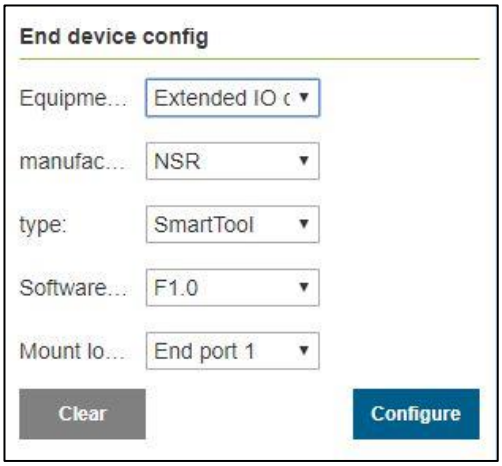


Fig. 4.9-1Extended IO device configuration

be careful:

Before clicking Clear Configuration, the corresponding device should be inactive.

Step 2: After the configuration of the extended IO device is completed, the user can click the "Smart Tool" function menu in the auxiliary application to enter this function configuration page. The user can customize the functions of each key on the end handle, including (new program, hold program, PTP, Lin, ARC, swing welding start, swing welding end, IO port).

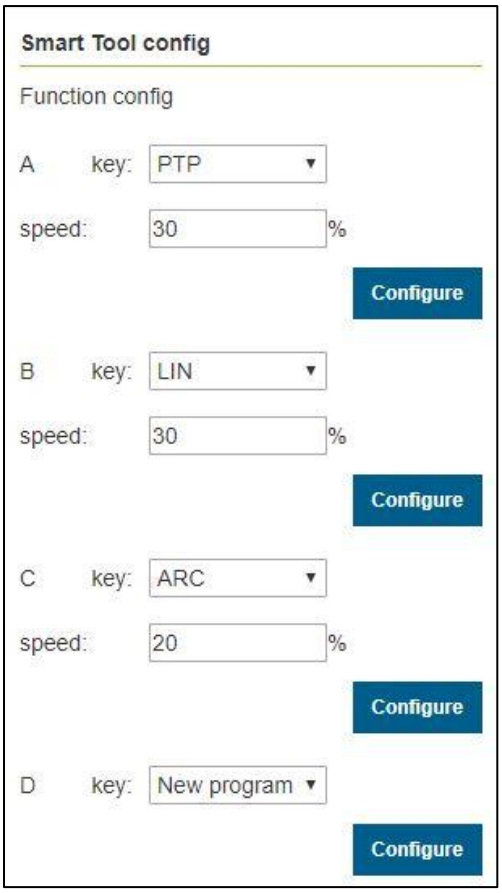


Fig. 4.9-2Extended IO device function configuration

4.10 Stacking system configuration

4.10.1 Stacking system configuration steps

Step 1: Select the "Stacking System Configuration" button in the user's peripheral configuration interface. For the first use, you need to create a formula first. Click "Formula Creation", enter the name of the formula, click "Creation", and then click "Start Configuration" to enter the stacking configuration page.



Fig. 4.10-1Stacking formula configuration

Step 2: Click "Configuration" in the workpiece configuration bar to enter the workpiece configuration pop-up window, set the "length", "width", "height" of the workpiece and the workpiece grabbing point, and click "Confirm Configuration" to complete the workpiece information setting.

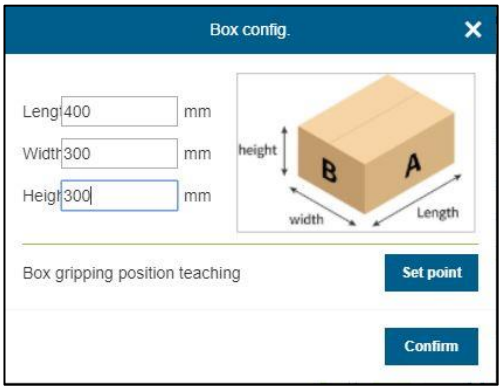


Fig. 4.10-2Stacking workpiece configuration

Step 3: Click "Configuration" in the tray configuration bar to enter the tray configuration pop-up window, set the tray "front", "side" and "height", then set the station and station transition point, click "Confirm Configuration" to complete the tray information setting.

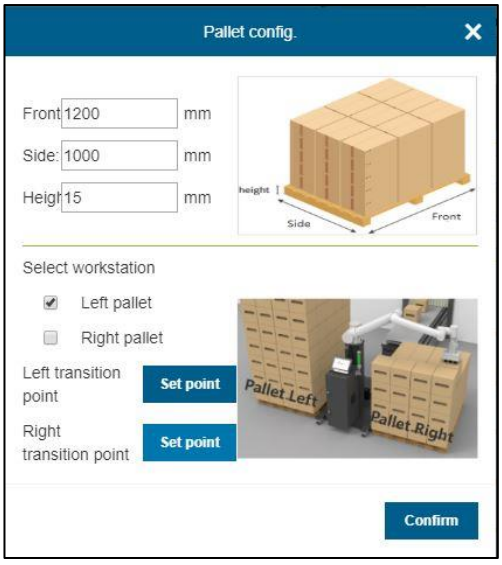


Fig. 4.10-3Stacking tray configuration

Step4: Click "Configuration" in the mode configuration bar to enter the mode configuration pop-up window and set the workpiece interval. The right box is the simulated workpiece placement mode, which can be added individually or in batches.Then set the number of stacking layers and the mode of each layer, and click "Confirm Configuration" to complete the mode information setting.

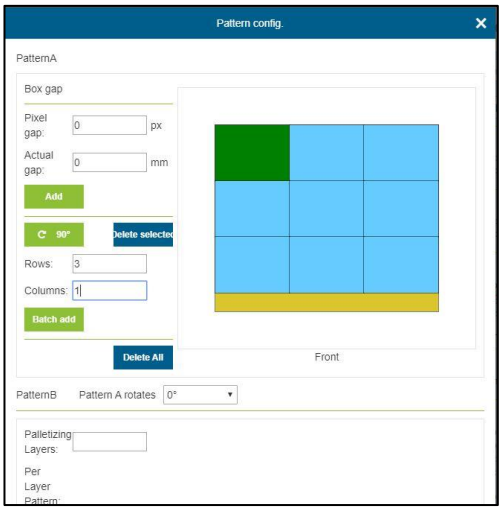


Fig. 4.10-4Stacking mode configuration

Step4: Click "Generate program" to open the "Stacking monitoring page", where you can display and view "Generate information", "Alarm information" and "Stacking program".

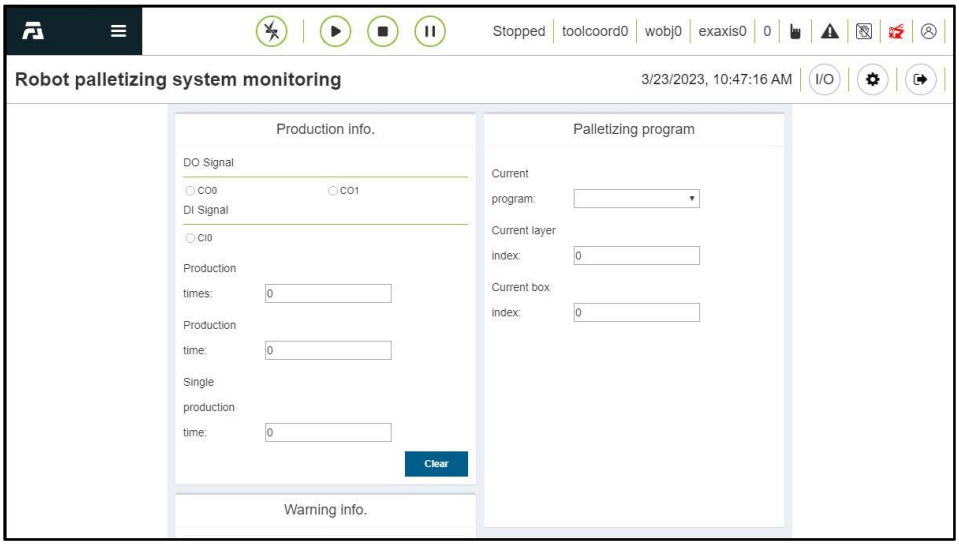


Fig. 4.10-5Stacking system monitoring

appendix

Appendix 1: Motion controller errors and handling methods

Error classification	Error name (teaching pendant display)	Handling method	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 recording of instruction points; 3. Record the instruction points again 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		
	Arc middle point error		
	Arc target point error		
	The arc command point spacing is too small		
	Error in middle point 1 of whole circle/spiral line (including tool discrepancy)		
	Error in the middle point 2 of the whole circle/helix (including tool discrepancy)		
	Error in middle point 3 of whole circle/spiral line (including tool discrepancy)		
	The command point spacing of the whole circle/helix is too small		
	TPD command point		

	error		
	The TPD command tool does not match the current tool		
	TPD The deviation between the current instruction and the starting point of the next instruction is too large	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 the TPD command in the teaching program; 2. Modify the teaching program;	
	Internal/external tool switching error	1. Record the instruction points again and modify the teaching program;	
	PTP joint command overrun	1. The movement process command exceeds the soft limit, and the program needs to be modified;	Reverse inching to make the robot leave the soft limit area or switch to the dragging mode to drag the robot out of the soft limit area; After modifying the program,
	TPD joint command overrun	1. The movement process command exceeds the soft limit, and the program needs to be modified;	
	LIN ARC issued joint command overrun	1. The movement process command	

		exceeds the soft limit, and the program needs to be modified;	click the START button again to execute the new program;
	JOG joint command overrun	1. The movement process command exceeds the soft limit;	Reverse inching to make the robot leave the soft limit area or switch to the dragging mode to drag the robot out of the soft limit area;
	Command overspeed in Cartesian space	1. The instruction has problems;	Contact after-sales personnel;
	Torque command overrun in joint space		
	Command speed in joint space of axis 1-axis 6 exceeds the limit		
	The joint configuration of the next command changes (there are singular positions in the next command)	1. Modify the teaching program. When the movement stops, the next program of the current line is modified to PTP command;	
	The joint configuration of the current command has changed (there is a singular pose in the current command)	1. In the automatic mode, modify the teaching program. When the movement stops, the current	

		program is modified to PTP command; 2. In the manual mode, switch the joint coordinates after power on again and then jog;	
	Instruction error, only LIN and ARC instructions are allowed between ARCSTART and ARCEND	1. Check the instruction and modify the teaching program;	
	Instruction error, only LIN instruction is allowed between WEAVESTART and WEAVEEND		
	Swing welding parameter error	1. Check the swing welding parameters and modify the teaching program;	
	Laser sensor command deviation is too large	1. Use the laser sensor supporting software to check whether the laser sensor data has jumps;	
	The laser sensor command is interrupted, and the seam tracking ends in advance	1. Use the laser sensor supporting software to check whether the laser sensor data is interrupted;	
	External axis command speed overrun	1. The instruction has problems;	Contact after-sales personnel;
	Excessive deviation		

	between external axis command and feedback		
	Belt tracking - excessive attitude change between starting point and reference point	1. Recalibrate the position and attitude points of the conveyor belt;	
	Constant force control - (X, Y, Z, RX, RY, RZ) direction exceeds the maximum adjustment distance	1. Adjust the constant force control PID value and modify the teaching program;	
Drive failure	1-6 axis driver fault	1. If the drive fails, check the drive failure table and check the cause of the drive failure;	Power on again;
Out of soft limit	1-6 axis out of soft limit fault	1. The movement exceeds the soft limit;	Switch to the dragging mode and drag the robot away from the soft limit area;
Collision fault	1-6 axle collision fault	1. Collision during movement;	Check the cause of collision, and click the RESUME button on the teaching programming interface when it is necessary to start

			movement again;
file error	Wrong version of zbt configuration file	1. The version of the zbt.config configuration file is incorrect;	Contact after-sales personnel;
	The zbt configuration file failed to load	1. Error loading the zbt.config configuration file;	Power on again, and contact after-sales personnel if the error is still reported;
	User profile version error	1. The version of the user.config configuration file is incorrect;	Contact after-sales personnel;
	User profile loading failed	1. Error loading the user.config configuration file;	Power on again, and contact after-sales personnel if the error is still reported;
	Incorrect version of exaxis configuration file	1. The exaxis.config configuration file version is incorrect;	Contact after-sales personnel;
	Failed to load exaxis configuration file	1. Error loading exaxis.config configuration file;	Power on again, and contact after-sales personnel if the error is still reported;
	The robot model is inconsistent and needs		Contact after-sales

	to be reset		personnel;
IO error	Channel error	1. Check whether the IO command channel in the program is set incorrectly;	Check and confirm. After modifying the program, click the START button again to execute the new program;
	Value error	1. Check whether the IO command value in the program is set incorrectly;	
	WaitDI wait timeout	1. Check whether there is effective input signal;	
	WaitAI waiting timeout		
	WaitToolDI wait timeout		
	WaitToolAI wait timeout		
	Channel configured function error	1. The function of the current channel has been configured, which cannot be used in teaching and programming. It needs to be replaced with another channel;	The function of the current channel has been configured and cannot be used in teaching programming, so it needs to be replaced with another channel;
	Arc striking timeout	1. Check the successful arcing signal;	
	Arc extinguishing timeout	1. Check the successful arc extinguishing signal;	
	Location finding timeout	1. Adjust the locating parameters and modify	

		the teaching program;	
	IO detection timeout of conveyor belt, resettable	1. Check IO trigger signal;	
	Successful arc striking DI not configured	1. Check the DI configuration;	
Jaw error	Jaw movement timeout error	1. Waiting for the signal of gripper movement completion timeout;	Contact after-sales personnel;
	485 timeout		
	Command format error		
	Movement delay, must be activated before movement		
	When moving, the active bit must be active		
	Temperature too high		
	Voltage too low		
	Automatically releasing		
	internal fault		
	Activation failed		
	Overcurrent		
	Automatic release end		
warning	Changes in shoulder joint configuration	Not yet implemented;	
	Changes in elbow joint configuration		
	Wrist joint configuration		

	changes		
	RPY initialization failed	1. Initialization of RX, RY and RZ fails, and the mobile robot makes RY not equal to ± 90 °;	After moving the robot, power on again;
	After 1 min, switch to the general teaching mode warning		
Wrong number of active slave stations	Wrong number of active slave stations	1. If the slave station has an error, check whether the EtherCAT cable is normal;	Power on again, if not solved, contact after-sales personnel;
Slave error	Drop line from station		
	Slave status is inconsistent with the set value		
	Slave is not configured		
	Slave configuration error		
	Slave initialization error		
	Slave mailbox communication initialization error		
Safety door warning	Safety door triggered		
Motion Warning	LIN command attitude changes too much	Not yet implemented;	
Interference zone warning	Enter the interference zone		
Parameter error	Tool number overrun error	1. Export the backup package;	Contact after-sales personnel

	Positioning completion threshold error		
	Crash level error		
	Load weight error		
	Load centroid (X, Y, Z) error		
	DI filter time error		
	AxleDI filter time error		
	AI filtering time error		
	AxleAI filtering time error		
	DI high and low level range error		
	DO high and low level range error		
	Workpiece number overrun error		
	External axis number overrun error		
	Conveyor tracking - encoder channel error		
	Conveyor tracking - workpiece axis number error		
Eight point method	The attitude change of the first group of data is too large	1. Recalibrate;	
	Data error, calculation failed		

Button box status feedback	Recording point signal		
	Start running		
	Stop operation		
External axis out of soft limit fault	External axis 1-4 axis out of soft limit fault	1. The movement exceeds the soft limit;	Inch the external shaft in reverse direction to leave the soft limit area;
Teaching pendant (raspberry pie) communication	Communication between Webapp and teaching pendant (Raspberry Pie) failed	1. Check whether the teaching pendant (raspberry pie) needs to be enabled. If not, enter the Web page, system settings - general settings - teaching pendant settings, and turn off the teaching pendant to enable; 2. Check whether the teaching pendant (raspberry pie) is connected to the controller network cable normally;	
Origin error	The origin has changed and needs to be reset	1. Enter the Web page, assist the application - robot body - operation origin, and reset the operation origin;	

Appendix 2: Servo driver fault code table

Fault code	Fault name	processing method
1	Software overcurrent fault	1. Check whether the joint load or resistance becomes larger or abnormal 2. If the fault is still not eliminated, repair or replace the drive board
2	Overvoltage 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 still not eliminated, repair or replace the drive board
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 magnetic braiding assembly and the motor shaft fixing jackscrew are loose 2. Re perform encoder zero calibration 3. If the fault is still not eliminated, repair or replace the magnetic editor assembly
7	Parameter abnormal fault	Repair or replace the drive plate
8	Runaway fault	1. Check whether the magnetic braiding assembly and the motor shaft fixing jackscrew are loose 2. Re perform encoder zero calibration 3. If the fault is still not eliminated, repair or replace the magnetic editor assembly

9	Position error fault	1. Check whether the joint load or resistance becomes larger or abnormal 2. If the fault is still not eliminated, repair or replace the drive board
10	Position overflow fault	1. Check whether the hard limit is loose 2. Re perform robot zero calibration
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 engaged 2. Check whether the hard limit is hit 3. If the fault is still not eliminated, repair or replace the drive board
14	Power supply failure	not enabled
15	STO fault	not enabled
16	Phase current AD zero setting fault	Repair or replace the drive plate
17	EEPROM fault	Repair or replace the drive plate
18	Hall fault	1. Check whether the hall harness is inserted firmly and whether there is short circuit or open circuit 2. If the fault is still not eliminated, repair or replace the joint
19	encoder failed	Repair or replace the magnetic braid assembly
20	Encoder zero setting fault	1. Re perform encoder zero calibration 2. If the fault is still not eliminated, repair or replace the magnetic editor assembly
21	Encoder Z-phase signal	not enabled

	loss fault	
22	Encoder count fault	not enabled
23	Encoder multi turn data overflow fault	not enabled
24	External clock fault	Repair or replace the drive plate
25	UVW phase sequence fault	not enabled
26	FPGA fault	not enabled
27	Zero return fault	not enabled
28	Magnetic encoder fault	1. Check whether the magnetic braiding assembly and the motor shaft fixing jackscrew are loose 2. If the fault is still not eliminated, repair or replace the magnetic editor assembly
29	Motor power line disconnection fault	1. Check whether the power line of the motor is firmly inserted, and whether there is short circuit or open circuit 2. If the fault is still not eliminated, repair or replace the drive board
30	EtherCAT fault	1. Check whether the network cable is firmly plugged, and whether there is short circuit or open circuit 2. If the fault is still not eliminated, repair or replace the drive board
31	EtherCAT_SM_DOG fault	1. Check whether the network cable is firmly plugged, and whether there is short circuit or open circuit 2. If the fault is still not eliminated, repair or replace the drive board
32	EtherCAT_FATALSYNC	1. Check whether the network cable is firmly

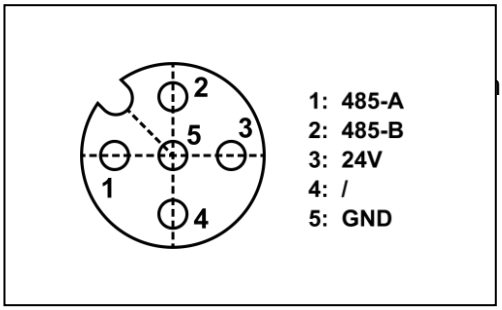
	failure	plugged, and whether there is short circuit or open circuit 2. If the fault is still not eliminated, repair or replace the drive board
33	EtherCAT_SYNC fault	1. Check whether the network cable is firmly plugged, and whether there is short circuit or open circuit 2. If the fault is still not eliminated, repair or replace the drive board
34	EtherCAT_RFT failure	1. Check whether the network cable is firmly plugged, and whether there is short circuit or open circuit 2. If the fault is still not eliminated, repair or replace the drive board
35	Drive shaft address fault	1. Re configure the drive axis address 2. If the fault is still not eliminated, repair or replace the drive board
36	Robot zero calibration fault	1、Re perform robot zero calibration 2、First use JLINK to erase FLASH, then download the program again and zero 3. If the fault is still not eliminated, repair or replace the drive board
37	Encoder communication failure	1. Check whether the encoder harness is inserted firmly and whether there is short circuit or open circuit 2. If the fault is still not eliminated, repair or replace the magnetic editor assembly
40	Magnetic encoder module failure - zero calibration failure	1、Re zero the magnetic braiding assembly 2、If the fault is still not eliminated, repair or replace the magnetic editor assembly

41	Magnetic encoder module fault - multi turn fault	1、Check whether the magnetic braiding assembly and the motor shaft fixing jackscrew are loose 2、If the fault is still not eliminated, repair or replace the magnetic editor assembly
42	Magnetic encoder module failure - multi turn small magnetic encoder failure	1、Check whether the multi turn small magnetic braiding chip is abnormal 2、If the fault is still not eliminated, repair or replace the magnetic editor assembly
43	Magnetic encoder module failure - multi turn large magnetic encoder failure	1、Check whether the multi turn magnetic braiding chip is abnormal 2、If the fault is still not eliminated, repair or replace the magnetic editor assembly
44	Magnetic braiding module fault - single turn magnetic braiding fault	1、Check whether the single turn magnetic braiding chip is abnormal 2、If the fault is still not eliminated, repair or replace the magnetic editor assembly
45	Magnetic encoder module failure - optical encoder failure	1、Check whether the optical coding disc is polluted or not stuck 2、If the fault is still not eliminated, repair or replace the magnetic editor assembly

Appendix 3: End plate 485 upgrade

During field use, it is possible to update the firmware to meet the new requirements. A new upgrade file (XX_XX_MAIN. bin) will be provided to upgrade the terminal board through the 485 interface (USB to 485 module is required).The upgrade steps are as follows:

Step 1: 485 wiring. There is a 5Pin communication aviation connector at the end of the robot. The pin pin distribution and pin pin description of the aviation connector are shown in Fig. 1.Connect the 485 - A and 485 - B at the end of the robot with A and B of the USB to 485 tool using twisted pair cables.



Step 2, hardware connection, connect the USB end of the USB to 485 tool to the PC, and in the PC device manager, if the USB&485 tool is identified, the following interface will appear.

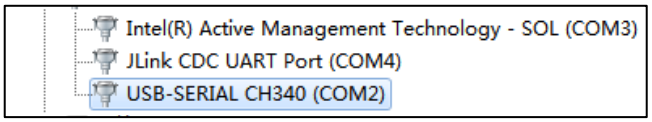
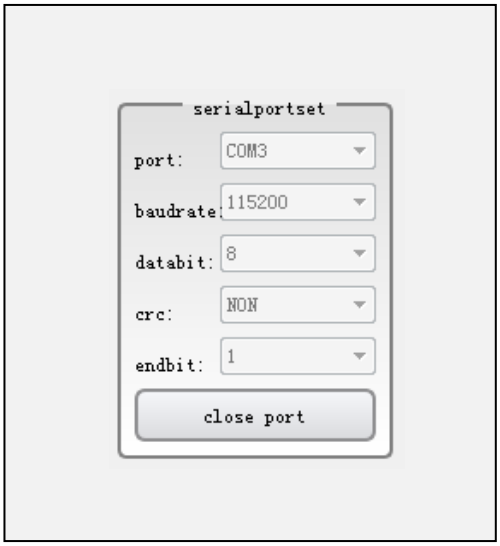


Fig. 2 USB&485 Port Identification Description

Step 2: Upgrade the tool. After the wiring is completed, open the "Fair Serial Port Debugging Assistant", click the "Terminal Board" button, and select the above identified serial port in the "Serial Port Parameter Setting" function. The baud rate is 115200, the data bit is 8, the check bit is none, and the stop bit is 1. Then open the serial port. After success, the prompt "Serial port opened successfully" will appear.



Step 3: Firmware upgrade, select "End plate" and click "Firmware upgrade", as shown in the fig.:

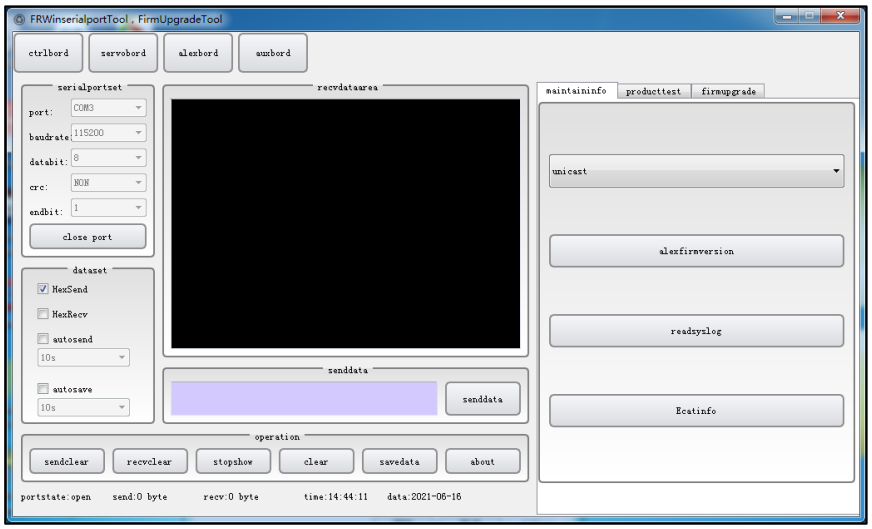


Fig. 4 End Plate Firmware Upgrade

- First, click "Flash Erase". After the erasure is successful, you will be prompted in the receiving data area that the erasure is successful.
- Open the file (the file to be upgraded), select the path to store it, as shown below. After the selection, the file name to be upgraded will appear in the file name display box.

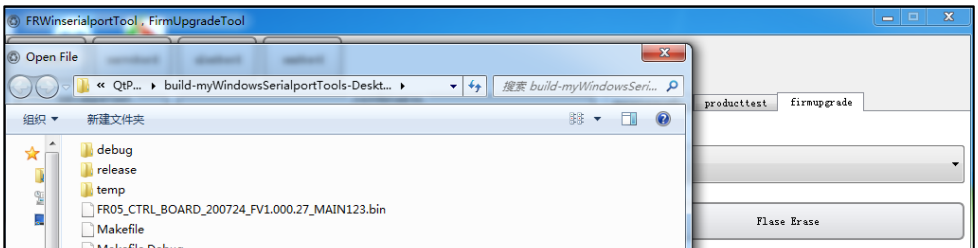


Fig. 5 Select Upgrade File

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

Step 4: Upgrade verification. The system is restarted and powered on. In the "Maintenance Information" column, select "Query terminal board firmware version information", and the firmware version information will be displayed in the "Receive Data Area". If it is consistent with the upgraded file version information, the upgrade is successful, otherwise the upgrade fails

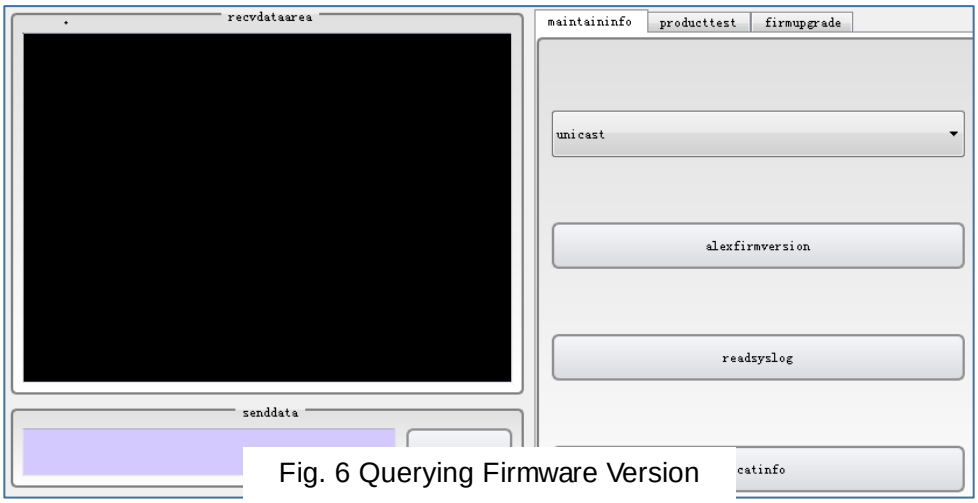


Fig. 6 Querying Firmware Version Information

Appendix 4: Control Box 485 Upgrade

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

The upgrade process is the same as that of the terminal board, and the software can be selected accordingly, which will not be repeated here.

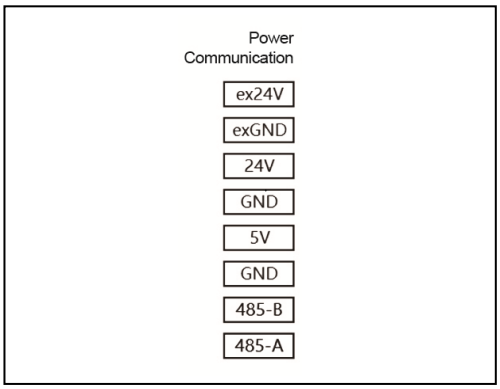


Fig. 1 Power Communication Interface

Appendix 5: List of Spare Parts and Vulnerable Parts

spare parts	number	number
M8 * 30 screw	4.0.08.2006185	4
Straight pin A type 8 * 20	4.5.00.2013076	2
Fuse 5x20 6A		1

term

Stop Category:

Class 0 shutdown: when the power supply of the robot is cut off, the robot stops working immediately.This is an uncontrollable stop. Since each joint will brake at the fastest speed, the robot may deviate from the path set by the program.This protective stop can be used when the safety assessment limit is exceeded, or when an error occurs in the safety assessment part of the control system.For more information, refer to ENISO13850:2008 or IEC60204-1:2006.

Class 1 shutdown: when the robot is powered to stop, the robot will stop. When the robot stops, the power will be cut off.This is a controllable stop, and the robot will follow the programmed path.Cut off the power supply after one second or once the robot stops stably.For more information, refer to ENISO13850:2008 or IEC60204-1:2006.

Class 2 shutdown: controllable stop when the robot is powered on.The robot stops all movements within one second.The operation of the safety assessment control system can make the robot stay at the stop position.For more information, refer to IEC60204-1:2006.

Diagnostic coverage rate (DC): used to measure the effectiveness of the diagnosis implemented to achieve the assessed performance level.For more information, see ENISO13849-1:2008.

Integrator: The integrator is the mechanism that designs the final installation of the robot.The integrator is responsible for the final risk assessment and must ensure that the final installation complies with local laws and regulations.

Mean time to dangerous failure (MTTFd): The mean time to dangerous

failure (MTTFd) refers to the value calculated and detected to reach the assessed performance level.For more information, see ENISO13849-1:2008.

Risk assessment: risk assessment is the whole process of identifying all risks and reducing them to an appropriate level.The risk assessment shall be recorded and archived.For details, please refer to ISO12100.

Performance Level: Performance Level (PL) is a separate level, which is used to describe the ability of each safety related part of the control system to perform safety functions under predictable conditions.PLd is the second highest reliability category, which means that the security function is quite trustworthy.For more information, refer to EN ISO13849-1:2008.

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

Robot end: the center point of the last axis 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 moving axis or connecting flange when leaving the factory.The tool center point of each tool contains transformations and rotations set relative to the center of the tool output flange.The position coordinates X, Y, Z determine the position of the tool center point, and RX, RY, RZ determine the direction of the tool center.When the values are all zero, the center of the tool coincides with the center of the connecting flange.

Tool position and attitude point (TCF): reflect the attitude of the tool coordinate system relative to the end link coordinate system on the basis of the tool center point TCP.

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. The x-axis is forward, and the y-axis is 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 satisfying the coordinate system for convenient calibration of other devices, its specific position can be arbitrarily specified.

Joint coordinate system: the joint coordinate system is the coordinate system in the robot joint. Under the joint coordinate system, each axis of the robot can achieve independent forward or reverse movement within the limit range.It is applicable to the robot that needs to move in a large range and does not require the TCP posture of the robot.The single axis inching of the robot in manual mode is carried out in the joint coordinate system.

Tool coordinate system: the coordinate system used to define the position of the tool center point and the tool attitude. If not defined, the tool coordinate system defaults to the center of the connecting flange.After installing the tool, TCP will change and become the center of the end of the tool.

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

Extension axis: remove the axis on the robot body, and add additional axis for work. The extension axis mainly includes slide rail, turntable and external servo equipment.

Manual mode: in this mode, all movements of the robot are manually controlled by the user, and external safety facilities such as safety gratings and safety doors do not work, so as to facilitate close debugging.

Automatic mode: This mode is generally used for the robot to run the teaching program. At this time, the external safety facilities are enabled.

Repetitive positioning accuracy: the consistency of the position and attitude measured by the robot in the same condition and the same method for n times.

Teaching pendant: a hand-held unit that programs or moves the robot and is connected to the control system.