Collaborative Robot Elfin Series

E5 User Manual

Introduction

How to Use This Manual

This manual is formulated for operators of Elfin robots, who should have some electrical and programming knowledge. The manual will provide instructions for Elfin operators from the following aspects:

- Safety Issue: The operator should keep all safety instructions in mind.
- Mechanical Installation: The operator should follow the instructions when installing the robot.
- Electrical Ports: Open ports of Elfin are introduced to provide convenience for secondary development.
- Software Control: It can guide the operator to install software and run the robot.
- Security Configuration: It introduces the basic safety settings.

Technical Support

Shenzhen Han's Robot Co., Ltd will provide you with long-term technical services. If you have any technical problems or other needs during use, you are welcome to visit our company website: www.hansrobot.com, or directly contact our engineers.

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Chapter 1 Product Introduction

1.1 Introduction to Collaborative Robot Elfin Series

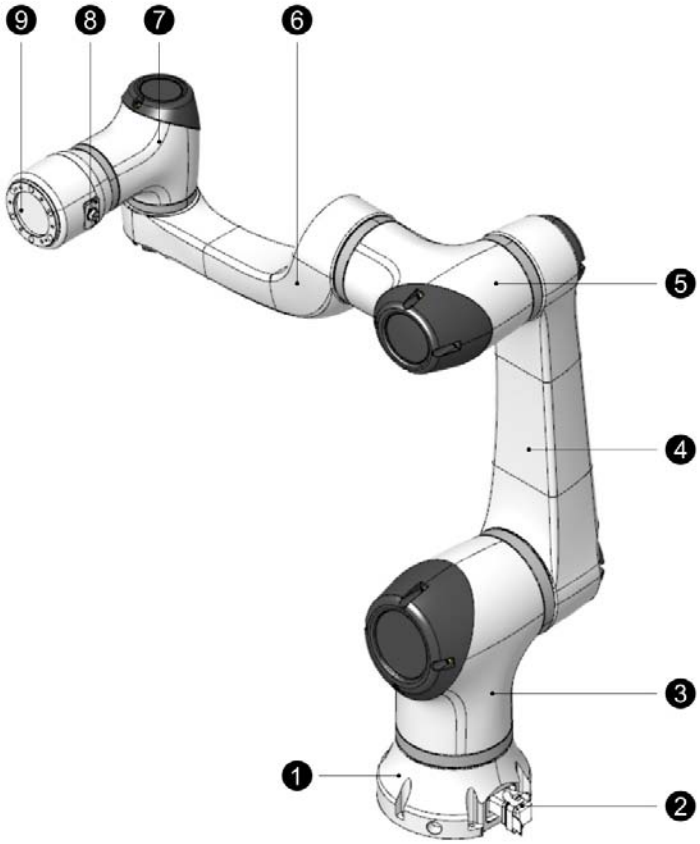
Elfin robot is a new type of human-machine collaborative six-axis robot. Its overall design is lightweight, modular, compact and beautiful, and it can flexibly adapt to all kinds of complicated and varying industrial production environments.

1.2 List of Parts

Robot	Robot body	×1
	End connection line	×1
Electric control box	Electric control box	×1
	Power cable line	×1
	Connecting cable line	×1
Teach pendant	Teach pendant	×1
Instructions	Stored in USB flash disk	×1

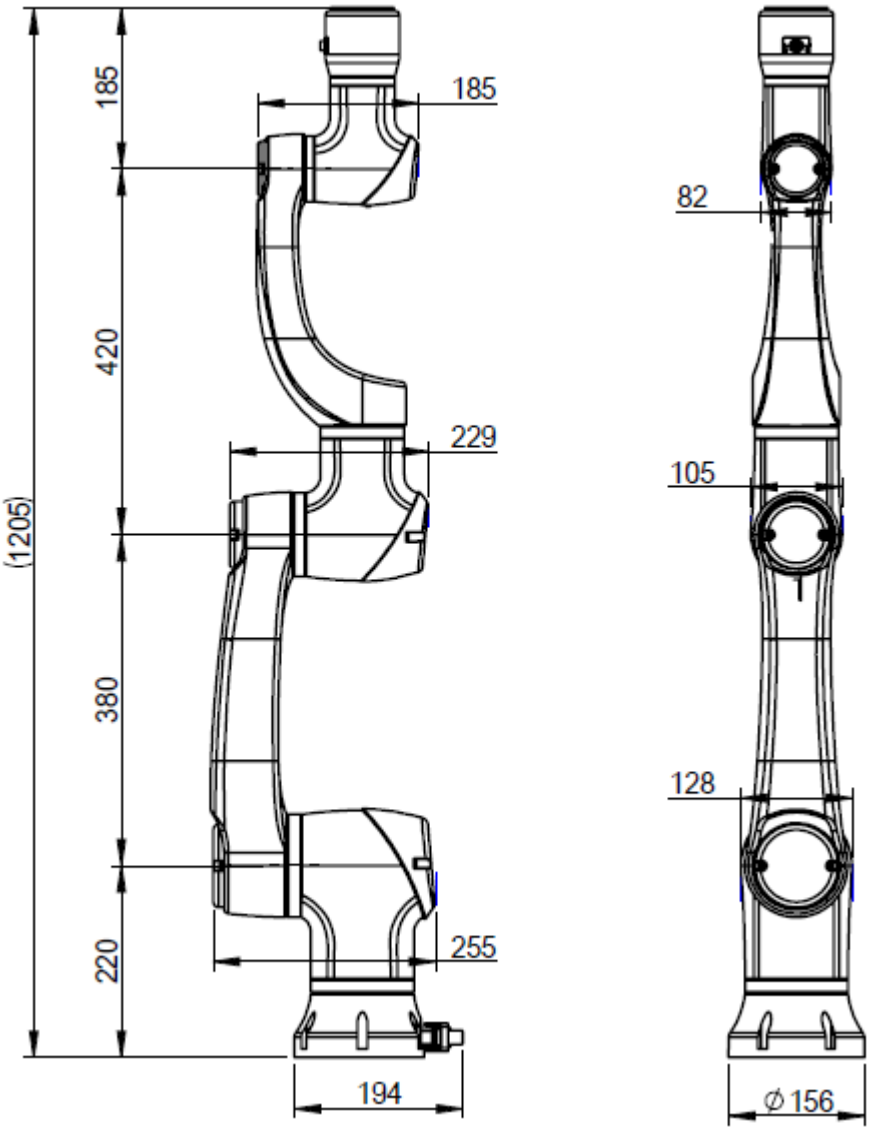
1.3 Robot Body

Name of Each Part



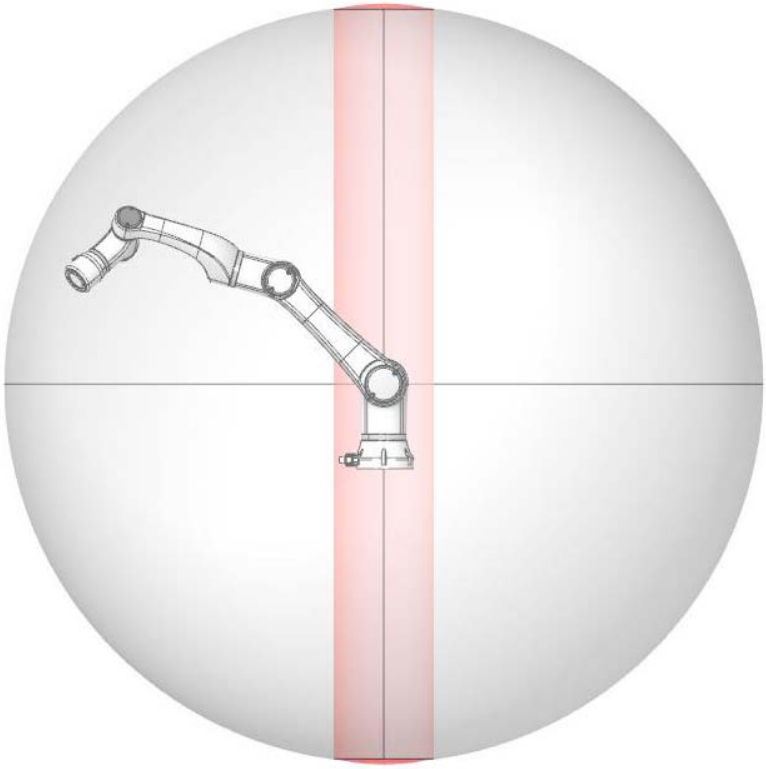
1. Base
2. Communication and power cable
3. Jl-J2 module
4. Lower arm
5. J3-J4 module
6. Upper arm
7. J5-J6 module
8. Tool IO
9. Tool flange

Size and Specification



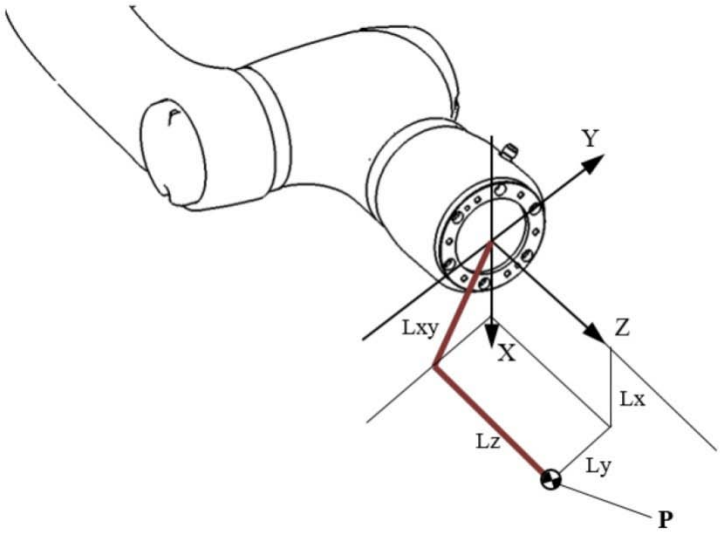
Robot Working Space

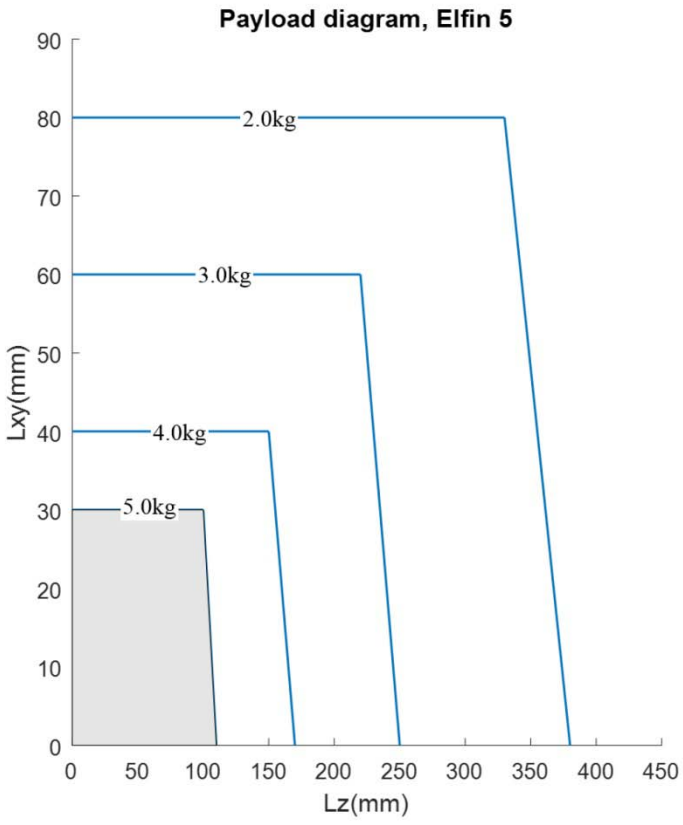
The working space of robot refers to the area within 800 mm around the joint of robot base. When selecting the location to install robot, considerations should be given to the cylinder space above and below the robot. Please try to keep the tool away from the cylindrical space as much as possible, otherwise it will cause the situation where the tool moves slowly and joints move too fast, which leads to the low efficiency of robot and brings difficulties in carrying out risk assessment.



Tool Payload Range

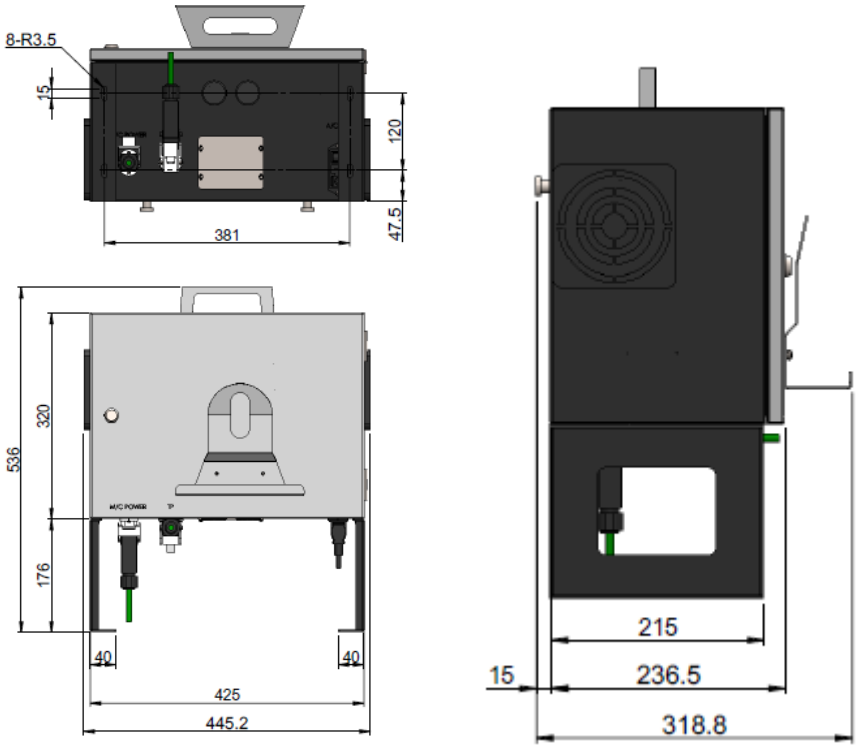
Due to different distances between load center at the end of robot and the center of installed flange, the allowable payload of robot will change accordingly. The relationship between the centroid distance and allowable payload is shown below:

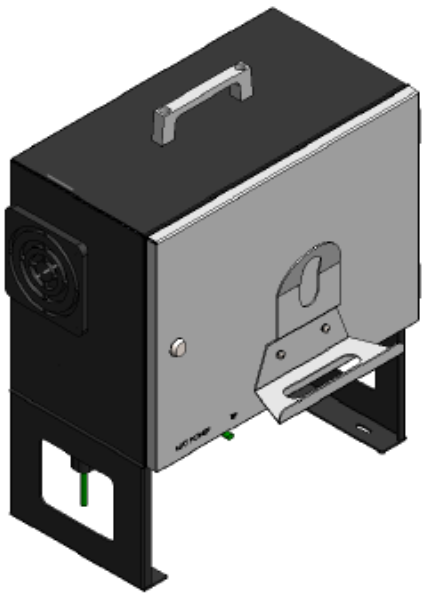




1.4 Electric Control Box

Size and Specification





Specification of electric control box:

Item	Specification
Weight	18.5Kg
Working temperature range	0~50ºC
Electric cabinet size	445.2*236.5*536mm
Paint color	Dark gray + white
External power input	200-240V AC,50-60Hz

Chapter 2 Safety Issue

2.1 Warning Signs

This manual will use the following safety signs at different levels:

Danger:

- Failure to follow the instructions may result in serious injury and even death.

Warning:

- Failure to follow the instructions may result in serious damage to personnel or equipment.

Caution:

- Failure to follow the instructions may result in equipment damage.

2.2 General Safety Reminder

Some situations that may lead to danger are listed according to different safety levels, and others are explained in details in each chapter.

Danger:

- The operatr must check robot and all electrical appliances in accordance with the instructions and warnings in Chapter 3 Mechanical Installation and Chapter 4 Electrical Ports. This operation should be carried out under the situaion of disconnecting power supply.

Warning:

- Make sure that the arms and tools of the robot are installed properly and safely.
- Make sure that there is enough space for robot arms to move freely.
- Make sure that safety measures (such as guardrails, ropes, or protective screens) are taken near the robot operation area to protect the operator and surrounding people.
- Don’t wear loose clothes or jewels when operating the robot. Please be sure to tie your long hairs up and keep them behind your head when operating the robot.
- Don’t use the robot if it is damaged.
- If the software gives out a fatal error message, please activate the emergency stop quickly, write down the situation that causes the error, find out the related error codes on the code page, and contact us.
- Don’t connect the safety device to the normal I/O interface. Only secure interface can be used.
- Make sure that installation settings (such as robot’s installation angle, weight in TCP, TCP offset, safety configuration) are correct. Save the installation file and load it into the program.
- Free drive function (impedance / reverse drive) can only be used in the installation process after passing the risk assessment. Tools and obstacles should not have sharp corners or twists. Please ensure that the head and face of all people are beyond the reach of robot.
- Pay attention to the movement of robot when using Teach Pendant.
- Don’t enter the safety scope of the robot or touch the robot when the system is running.
- Any collision will release a large amount of kinetic energy, which is much stronger than the kinetic energy of high-speed and overloading operations.

- Connecting different machines may pose risks or cause new danger. A comprehensive risk assessment on the whole installation process should always be carried out. When different safety and emergency stop performance levels are required, the highest performance level should always be selected. Always read and understand the user mannual of all the devices used in the installation.

- Don't modify the robot. Any modification of the robot could cause the unpredicable danger for integrators. The authorized reconfiguration of robot should be in accordance with the latest edition of all related service manuals. If the robot is changed or altered in any way, we refuse to take any responsibility.

- Robot and electric control box will produce heat in the operating process. The robot can cool down after cutting off the power and waiting for an hour.

Caution:

- When the robot is connected or work together with other mechine that may damage the robot, it is strongly recommended that all functions of the robot and robot program shall be checked separately. It is recommended to use other temporary road points outside the mechanical workspace to detect the robot program.

- Prevent the robot from being exposed to permanent magnetic fields. A strong magnetic field can damage the robot.

2.3 Other Potential Risks

Please note that certain robot devices may have other major risks:

- Fingers are clamped between the robot foot and base.
- Fingers are clamped between the big arm and small arm.
- Sharp edges and sharp points on the tool or tool connector stab people's skin.
- Sharp edges and sharp points on the obstacle near the robot trail stab people's skin.
- People get hurt after being hit by the robot.
- A sprain or fracture caused by the impact of robot's payload on solid surface.
- The consequences of loosening bolts on fixed robot arm or tool.
- An item falls from a tool, for example, because improper clamping or power off.
- An operation error caused by different e-stop buttons on different machines.

2.4 Risk Assessment

Risk assessment is one of the most important tasks that the integrator must complete. Robot itself is a partially completed machine, and the safety of installed robot depends on how the robot is integrated (such as tool, obstacle and other machinery).

It is recommended that the integrator should use the guidelines of ISO12100 and ISO10218-2 to carry out risk assessment.

The risk assessment needs to consider two situations: the risk of robot installation, robot demonstration and the risk of running robot.

For the non-collaborative installation of robot (e.g. when using dangerous tools), risk assessment may infer that integrators need to connect additional security devices (such as boot device) to protect themselves when programming.

2.5 Emergency Stop Mechanism

All the moving parts of robot will stop when the e-stop is activated. After releasing the e-stop, no action of the robot is started. E-stop cannot be used as a risk reduction measure, but it can be used as a secondary protection device. If multiple e-stop buttons need to be connected, they should be included in the risk assessment of robot application.

2.6 Repair and Maintenance Instructions

All the safety instructions in this manual must be strictly observed when performing maintenance and maintenance work.

Danger:

- The main input cable should be removed from the bottom of electric control box, so as to ensure that it is completely out of power. Other power sources of robot arm or electric control box should be disconnected. Necessary preventive measures should be taken to prevent other people from reconnecting the system's power source during maintenance.
- The grounding lines mut be checked before restarting the system.
- Please follow the ESD regulations when dismantling robot arm or electric control box.

- Don't dismantle the power supply system of electric control box. The power supply system may retain high voltage (up to 600V) after the electric control box is turned off.
- Keep robot arm or electric control box away from water or dust.
- After maintenance, it must be checked to ensure that is meets the service requirements and safety level. It is necessary to observe effective national or local safety laws and regulations. Meanwhile, all safety functions should be checked.

Chapter 3 Mechanical Installation

3.1 Open the Carton

Step 1

Open the carton and check whether the goods inside are consistent with the items on the packing list. If there is any loss or excess, please contact the local sales office in time.

Step 2

Take out the robot, check whether the robot's appearance is intact, whether there is any scratch and other obvious defects. If there is any appearance or quality problem, please contact the local sales office in time.

Step 3

Carry the robot to the specified installation site.

Warning:

- Don't open the carton violently, prevent the robot surface from scratches or impact and collision when opening the carton.
- Please open the carton in a dry and clean external environment.
- When taking the machine out of the carton, please pay attention to protecting the appearance of the robot, and avoid collision and scratches.
- For the matters needing attention in the transportation process, please refer to 3.2 Weight of Parts.

3.2 Weight of Parts

The weight of each main part of the robot is shown in the following table:

Name of Parts	Weight (kg)
Body	23
14 series module	2.8
20 series module	5.8
25 series module	9.6
Terminal IO module	0.5
Upper arm module	1.5
Lower arm module	2.5
Base module	1.5
Electric Control Box	18.5

Warning:

- In the process of packaging and transportation, protective measures should be taken to protect robot against collisions, which many result in scratches on the robot's surface or damage to its internal structure. It is recommended that the original wooden case of the robot or foam should be used in the process of transportation.

- When lifting the robot, please ensure that lifting equipment can withstand the total weight of robot components to prevent it from falling, so as to avoid robot surface scratches, internal structural damage and casualties. When carrying the robot by human labor, please hold the base of the robot, and ensure that at least two people carry the robot together.

- When using other tools to carry the robot, please make sure that the robot is fixed on the handling tool to prevent it from turning over.

3.3 Installation Environment Requirements

The robot should be installed indoors and meet the following requirements:

- Room temperature of 0-50ºC (to prevent excessive temperature change).
- Relative humidity of 10-80% (dew is not allowed).
- Keep it away from direct sunlight.
- Keep it away from dust, soot, salt, metal powder and water.
- Protect it against shock and vibration.
- Keep it away from flammable, explosive and corrosive gas, solid materials and liquids.
- Keep it away from electrical interference sources.
- For the details about the installation space scope of the robot, please refer to the robot dimension chart and the specification table of electric control box.

3.4 Installation Space

Please confirm the installation space according to the Robot Working Space and the Size and Specification of Electric Control Box.

Warning:

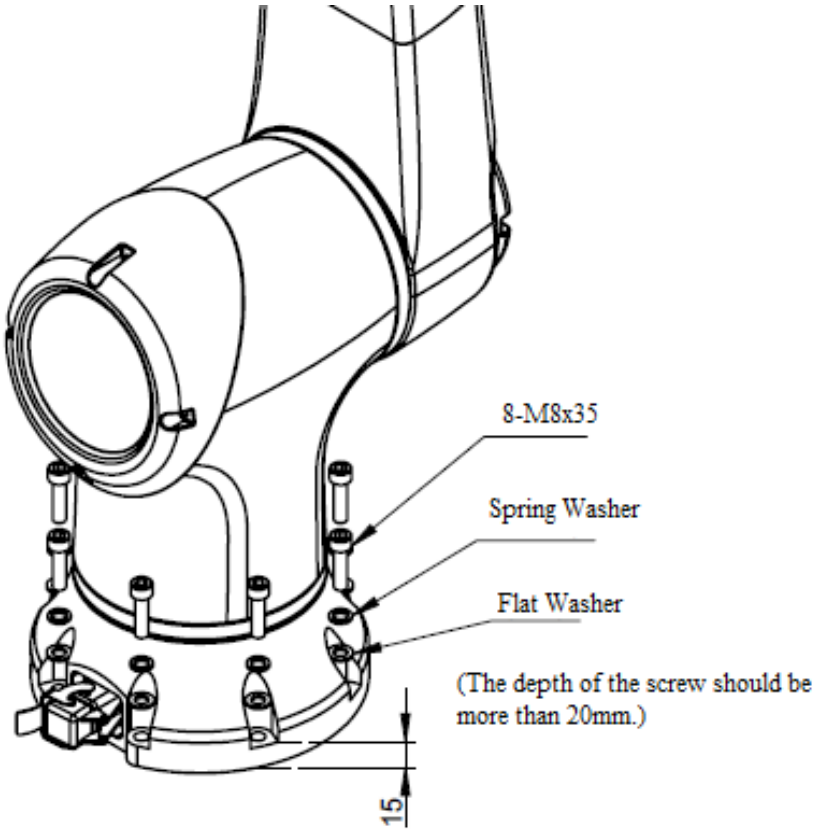
- In addition to the space required for installing the robot and electric control box, please ensure that the following conditions are met: there is enough space to install robot terminal fixture and workspace, enough space for robot teaching, enough space for operator to implement installation, inspection and repair activities, and enough space of gas path.
- The minimum bending radius of the robot power cord is 90mm. When installing the cable, please make sure that there is enough space to install power supply signal line and other cables, so as to prevent the cable from overbending.
- Please make sure that the safety distance is at least 100mm longer than the maximum working space of the robot after installing the jig at the robot terminal.

3.5 Fastening the Robot

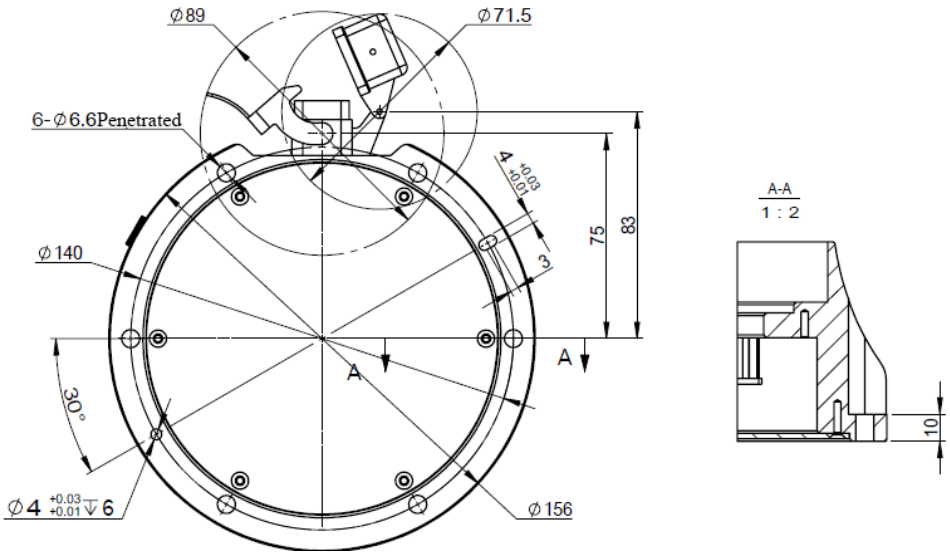
Please use 8 M8 bolts (whose specifications meet ISO898-1 performance level 10.9 or 12.9 mark) to fasten the robot onto the mounting base, and use the torque of 17.6Nm to tighten screws.

No installation platform is provided when you purchase the robot, please make it by yourself or buy a robot installation platform. The size and shape of the installation platform vary greatly due to different robot systems, but the following basic requirements should be met:

- The installation platform should be at least 20mm thick. It is recommended that the steel plate should be used to suppress the vibration.
- It is recommended that the surface roughness of the installation platform should not exceed 25μm.



The installation dimensions of the robot base are shown in the following figure, and the measuring unit is mm.

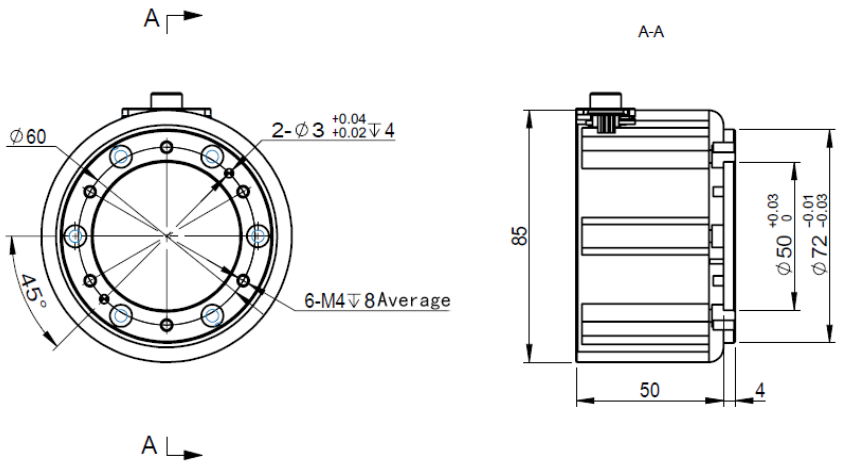


3.6 Installing Tools to the Terminal of ROBOT

No end-effector is provided when you purchase the robot, please make it by yourself or buy an end-effector.

The screw hole for the fixed tool at the robot ends is M4. When fastening the tools, please use the bolts that meet the ISO898-1 performance level 10.9 or 12.9, and use the tightening torque of 5Nm.

The robot end installation dimensions are shown in the following figure, the measurement unit is mm.



Chapter 4 Electrical Ports

4.1 Matters Needing Attention

- Please read the Elfin electric control box interface instructions before installing the electric control box.
- The location of electric control box and distribution cable should be away from the noise source as much as possible. If it is too close to the noise source, there may be position deviation or misoperation.
- Don’t exert too much force on the connector, and don’t overbend the cable. Otherwise, it may lead to bad contact or broken line.
- Please make sure that the equipment is well grounded.
- Please use the accessory nylon clip to fix the cable after connecting the cable.
- Don’t disassemble the electric control box, otherwise it may cause electricity leakage and electric shock.
- The electric control box is equipped with fans at both ends. Don’t block them when installing, and keep good ventilation.

4.2 Connecting cable

As shown below, the line is the power cord of the electric control box, the cable line is 5m long. The control box must be connected to the power supply. This process must be completed using the corresponding IEC C13 wire connected to the standard IEC C14 plug at the bottom of the control box.

Note:

The power supply shall be equipped with at least the following accessories:

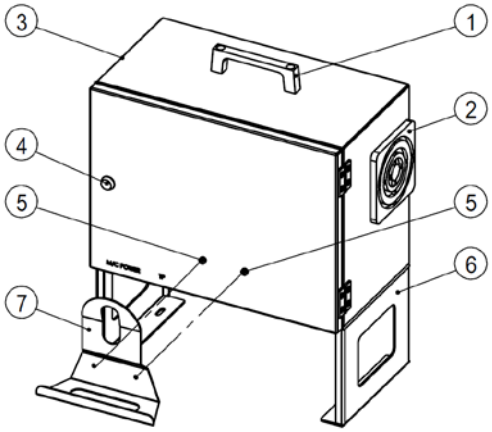
- Grounding;
- Fuse of electric supply;
- Residual current circuit breaker;

It is recommended that all the devices in the robot application should have a power supply switch, so as to lock and post a sign during repair and maintenance.

As shown in the following figure, the line is a cable that connects the robot body and electric control box, with a length of 5m. It connects the machine hand and the electric control box. The gray end connects the plug of robot base, and the black end connects the electric control box's aviation plug.

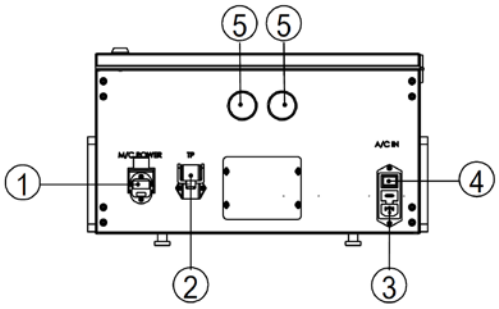
4.3 Peripheral Interface and Connection Instructions

Front:



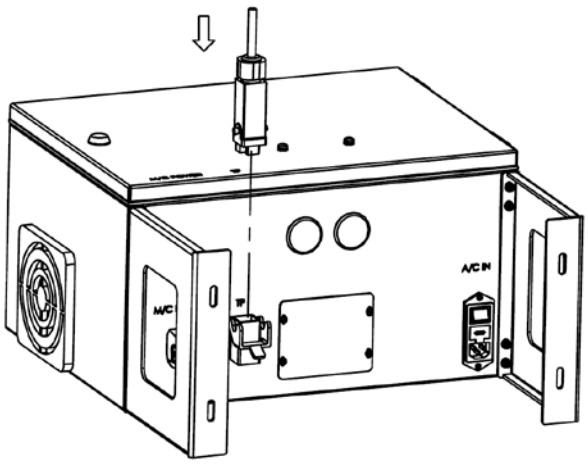
No.	Name
1	Handling handle
2	Air-vent
3	Air intake
4	Cabinet lock
5	Screw
6	fixed foot rack
7	fixed teach pendant plate

Bottom:

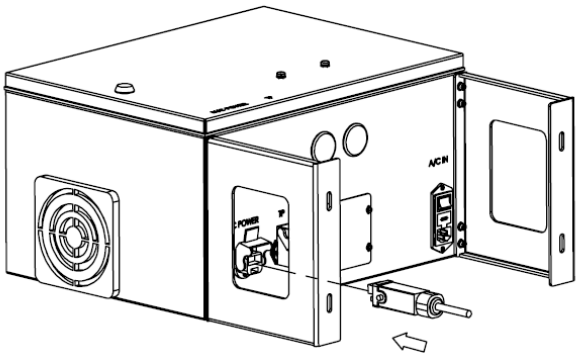


No.	Name
1	Robot connector
2	Teach pendant connector
3	Controller power switch
4	AC power socket
5	grommet

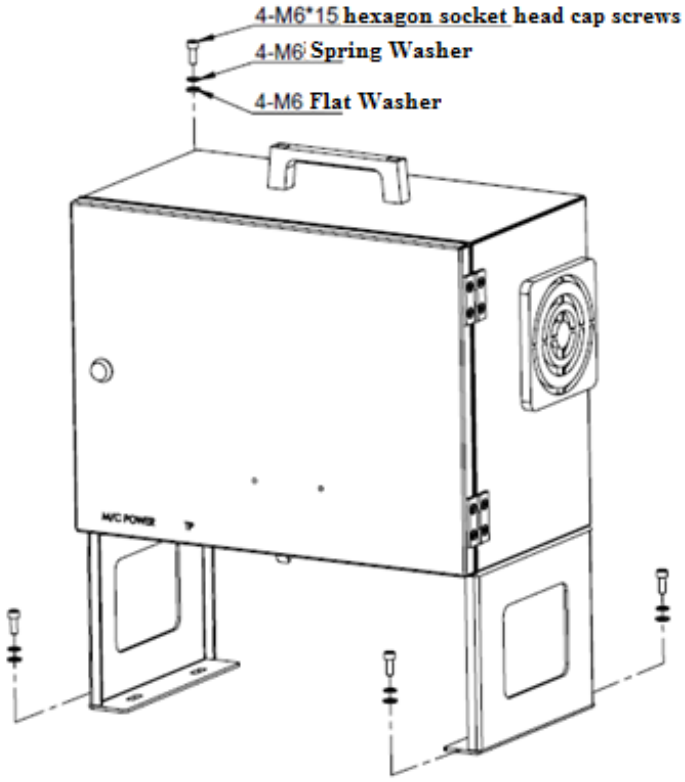
The controller connects the teach pendant.



The controller connects the robot.



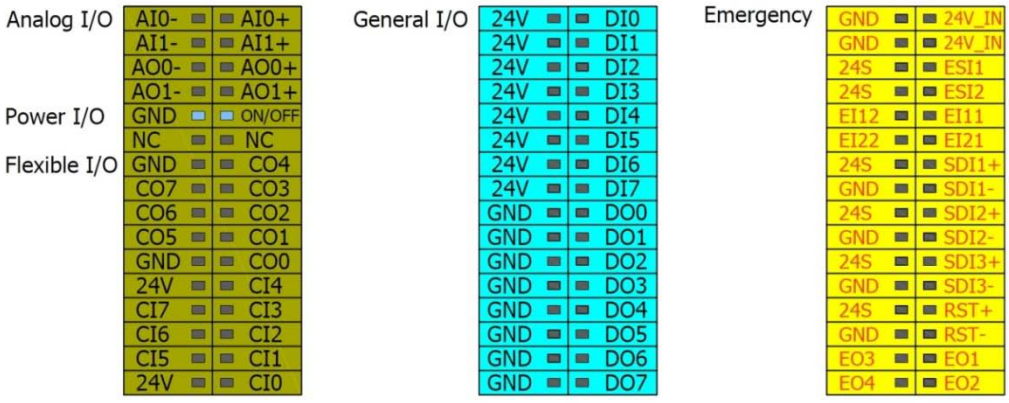
Fasten the controller:



4.4 Introduction to Controller I/O

The controller provides a series of external ports, which can connect controller I/O with various devices such as external relays, PLC, sensors and emergency stop device.

The port layout of the controller panel I/O is shown below:



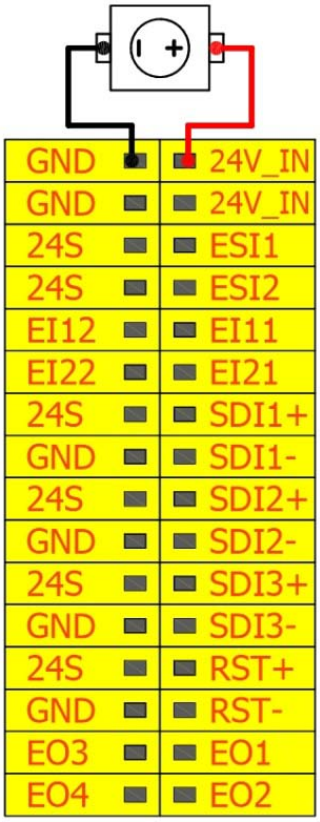
4.5 General specification for all digital I/O

This section describes the electrical specifications of 24V digital I/O provided by the controller.

- General I/O
- Safety I/O
- Configurable I/O

The digital I/O power supply is provided by the controller, and can be supplied externally when needed. The current is limited to 2A when using internal/external power supply.

The digital I/O can connect the external power according to the following diagram. The configurable I/O can be configured into general I/O.



The electrical specifications for internal and external power supply are as follows:

Terminal	Parameter	Minimum Value	Typical Value	Maximum Value	Unit
Internal 24V Power Supply					
INT_24 - INT_GND	Voltage	23	24	25	V
INT_24 - INT_GND	Current	0	-	2	A
External 24V Power Supply					
24D - GND	Voltage	20	24	29	V
24D - GND	Current	0	-	2	A

The digital I/O follows the requirements of IEC61131-2. The electrical specifications are as follows.

Terminal	parameter	minimum value	Tyical value	Maximum value	unit
Digital output					
COx / DOx	Current	0	-	1	A
COx / DOx	Voltage drop	0	-	0.5	V
COx / DOx	Leakage current	0	-	0.1	mA
COx / DOx	Function	-	PNP	-	Type
COx / DOx	IEC 61131-2	-	1A	-	Type
Digital input					
SIx /DIx	Voltage	-3	-	30	V
SIx /DIx	OFF area	-3	-	5	V
SIx/ DIx	ON area	11	-	30	V
SIx/ DIx	Current (11-30V)	2	-	15	mA
SIx/ DIx	Function	-	PNP	-	Type
SIx/ DIx	IEC 61131-2	-	3	-	Type

Safety I/O

This section introduces special safety input (red text font), please follow the 24V digital I/O general specification during use.

The safety inputs include emergency stop and safety protection stop. Emergency stop input is used only for stopping equipment under emergency. The safety protection stop input is used for all types of safety protection devices. Their functional differences are shown in the following table.

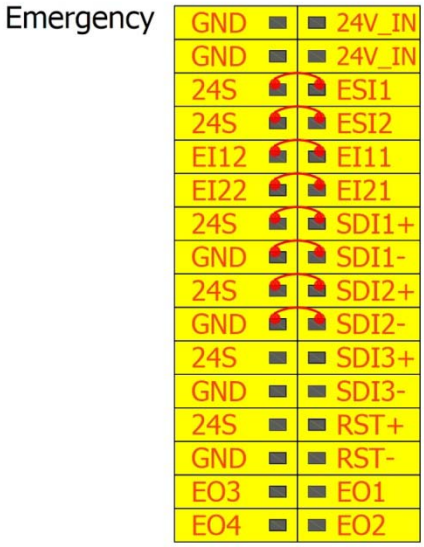
Terminal	Emergency Stop	Safety Protection Stop
Robot stops moving	Yes	Yes
Run program	Stop	Suspend
Robot power supply	Close	open
Initialization	Manual	Automatic or manual
Frequency of use	Low	Ordinary
Need to be re-initialized	Only release the brake	No
Shutdown category (IEC 60204)	1	2
Performance level (ISO 13849-1)	PLd	PLd

Danger:

- Don't connect the safety signal with unsafe PLC. Failure to comply with this warning may lead to casualty accidents caused by failure of safety functions. Be sure to separate safety signals from the ordinary I/O port signal.
- All the Safety I/O have redundancy (two independent channels). Keep two channels independent to ensure that the safety function will not fail when one channel fails.
- The robot's safety functions must be checked before using, and safety functions must be tested on a regular basis.

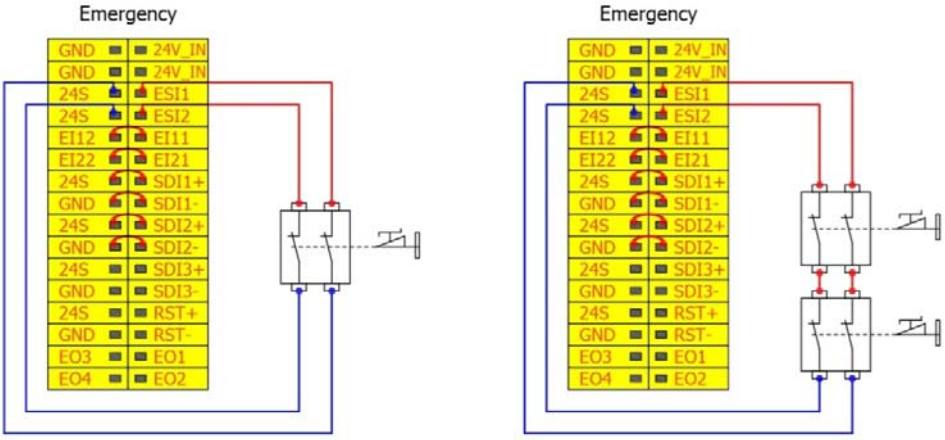
Default Security Configuration

The robot has default security configuration at delivery, and is not connected with other safety devices. Its configuration is as follows:

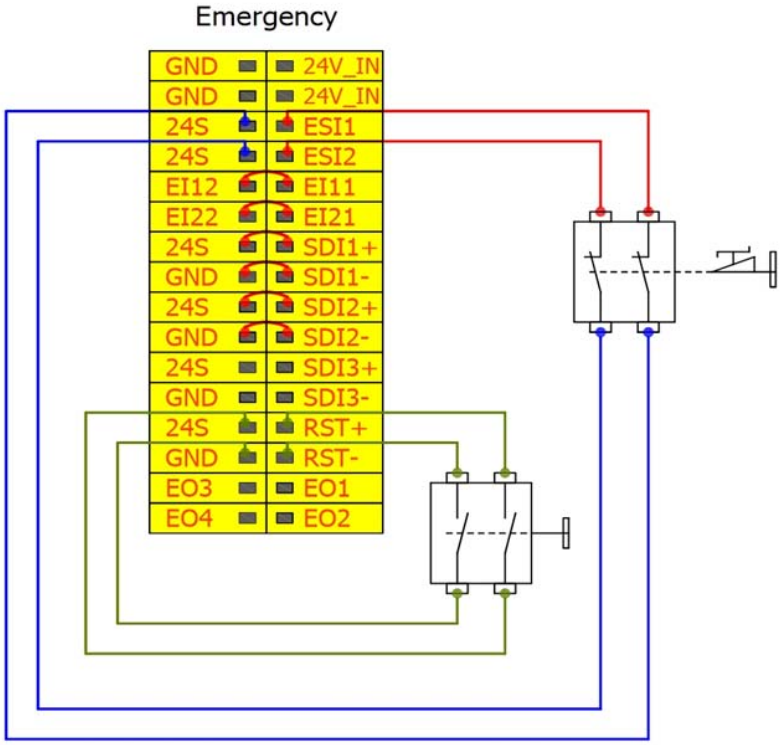


Connect the e-stop button

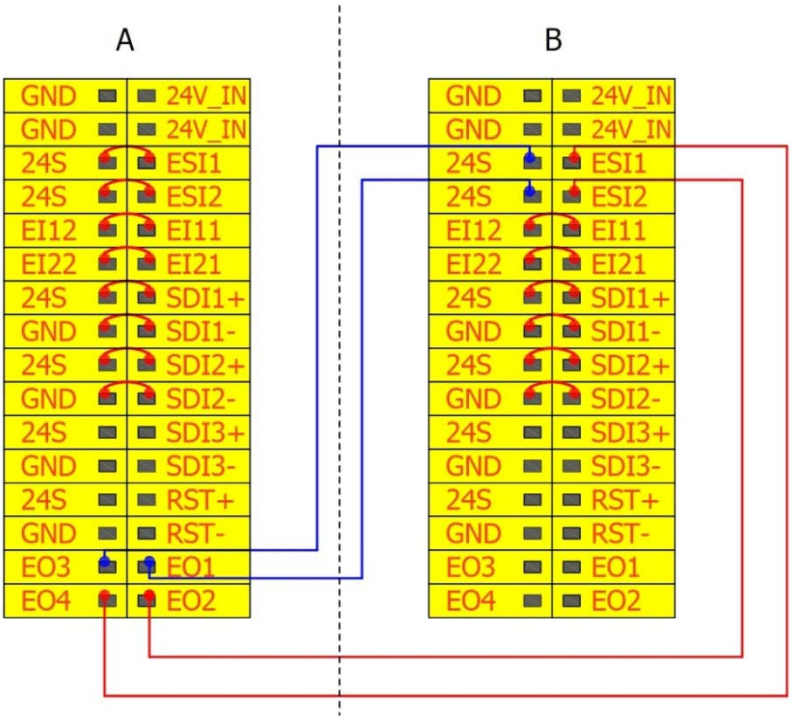
The external connection diagram of one or more e-stops is shown below:



Emergency stop reset function

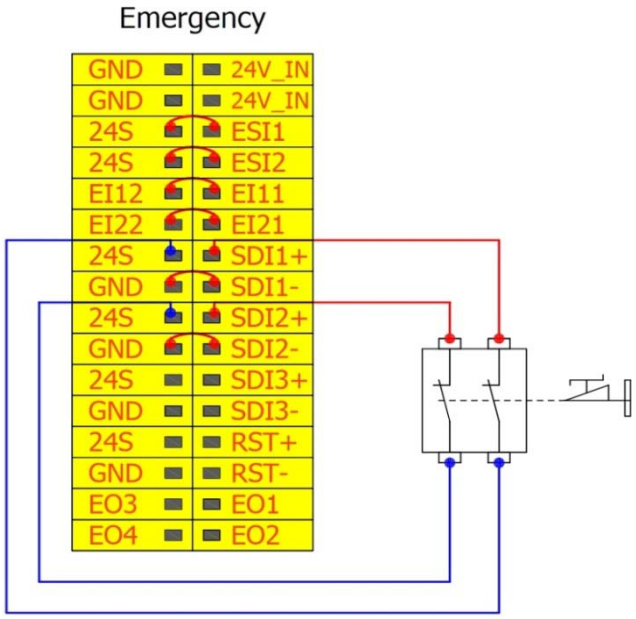


Share emergency stop with other machines



Safety Protection Stop

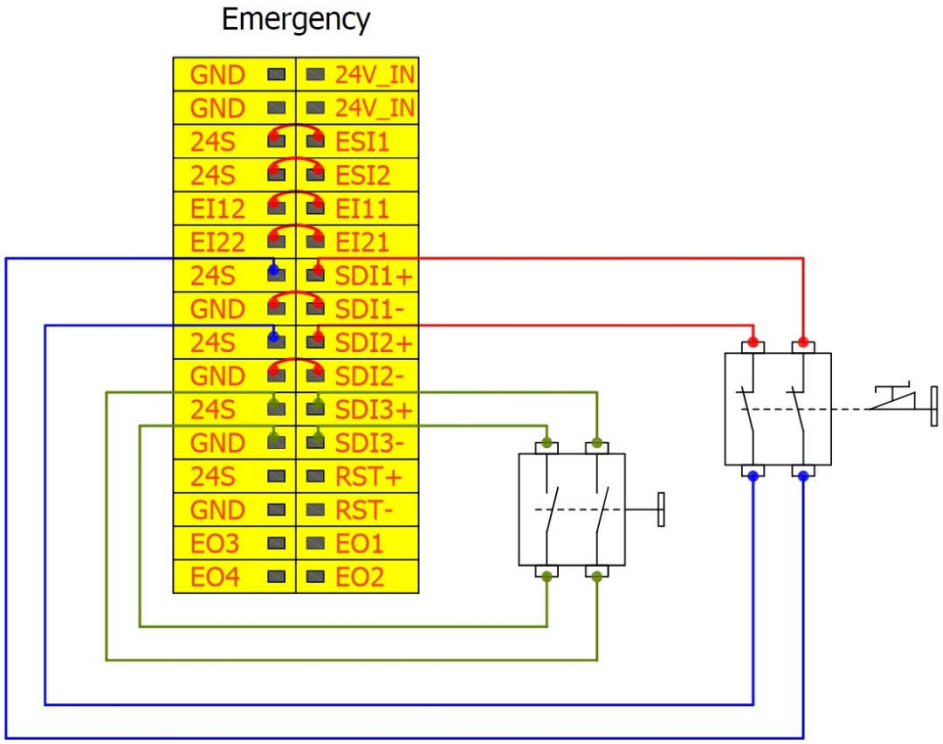
Taking the door switch as an example, the following diagram introduces the construction of basic protection stop function, when the door is opened, robot stops.



Protective stop with reset

When the protective stop is triggered, the following double channel buttons can be reset or reset through the trainer software.

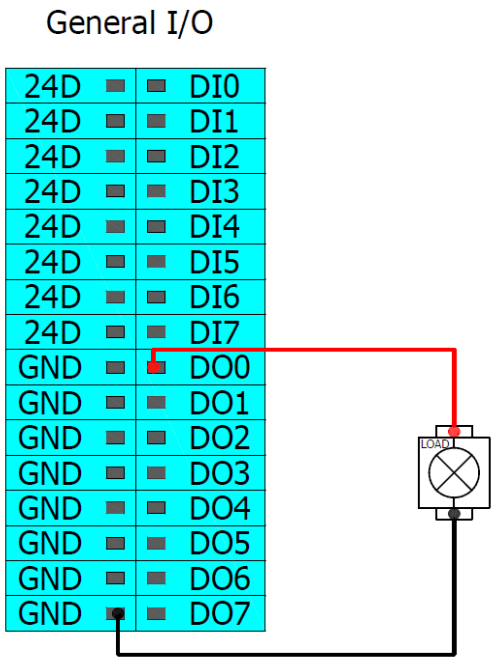
The corresponding construction method is as follows.



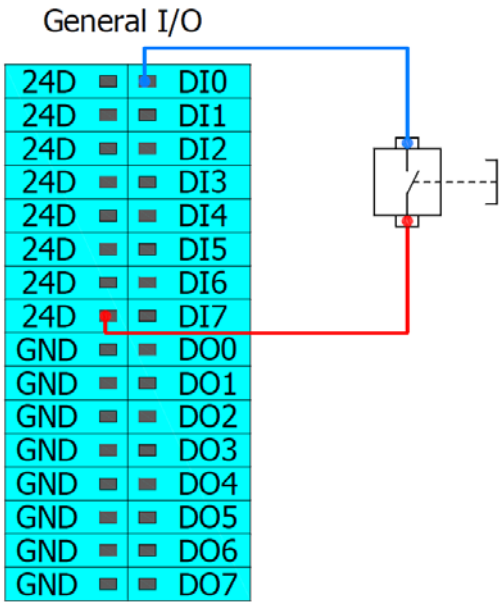
4.6 Build a General Digital I/O

The general digital I/O must follow the general configuration of digital I/O. The flexible I/O, which is not used for safety functions, can be used as general digital I/O.

The use of digital output:



A button is used to control the digital input:



4.7 General Analog I/O

For setting or measuring voltage (0-10v) or current (4-20ma) between devices.

To achieve high precision, please follow the following rules in use:

•Use the closest GND to I/O.

•The measuring equipment and the controller use the same ground (GND), and the simulated I/O is not potential isolated from the controller.

•Use shield wire or twisted pair. Connect the shield line to the "GND" on the common I/O terminal.

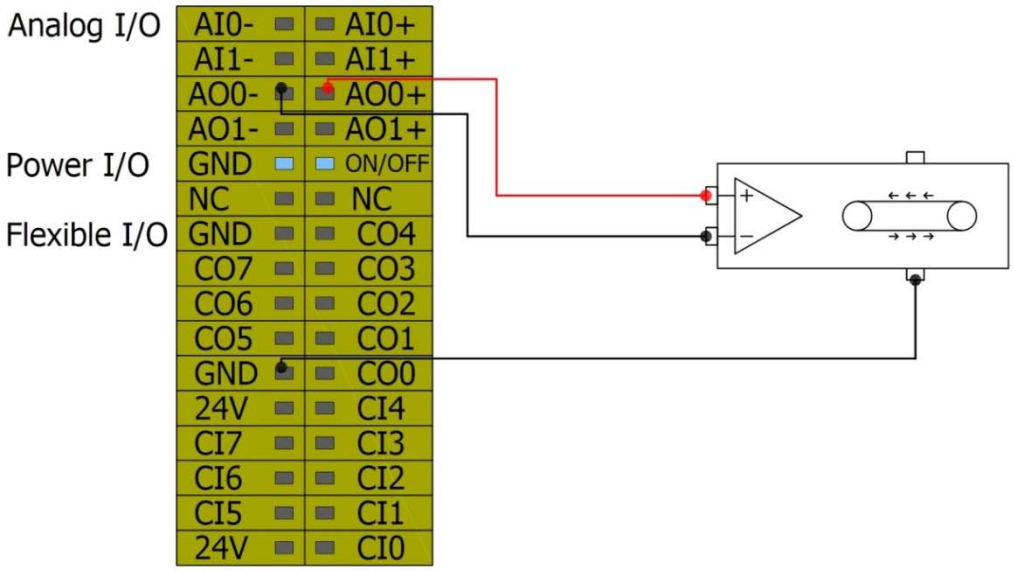
•The current signal is not sensitive to noise. It is preferred to use the equipment in current mode.

The corresponding I/O configuration is as follows:

Terminal	Parameter	Minimum value	Typical value	Maximum value	Unit
Current mode input					
AIx - AG	current	4	-	20	mA
AIx - AG	resistance	-	20	-	ohm
AIx - AG	Dissociation energy	-	12	-	Bit
Voltage mode input					
AIx - AG	voltage	0	-	10	V
AIx - AG	resistance	-	12	-	Kohm
AIx - AG	dissociation energy	-	12	-	Bit
Current mode output					
AOx - AG	current	4	-	20	mA
AOx - AG	voltage	0	-	10	V
AOx - AG	dissociation energy	-	16	-	Bit
Voltage mode output					
AOx - AG	voltage	0	-	10	V
AOx - AG	electricity	0	-	20	mA
AOx - AG	resistance	-	43	-	ohm
AOx - AG	Dissociation energy	-	16	-	Bit

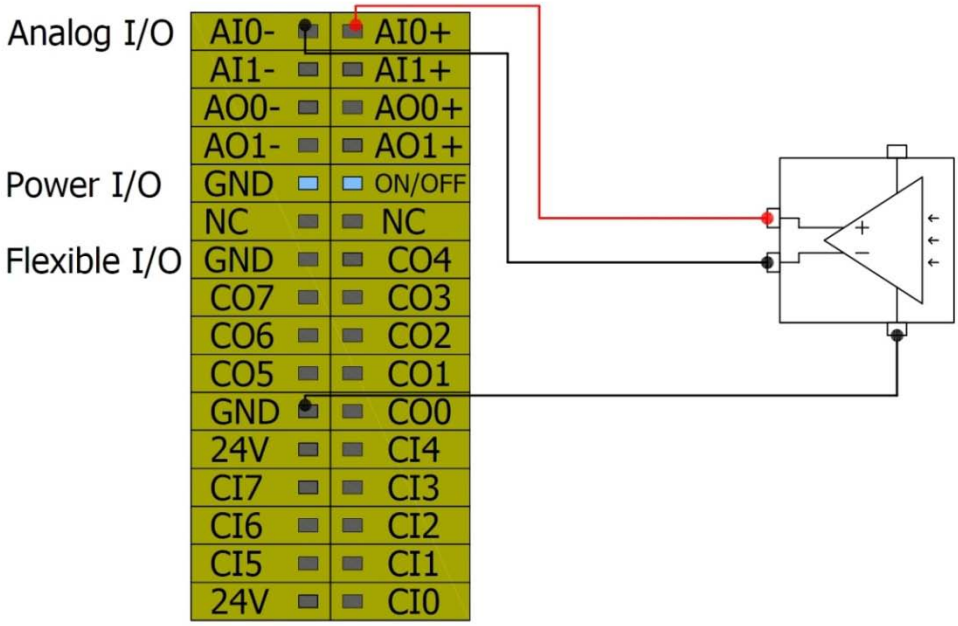
Using analog output

The following example shows how to use analog output to control the speed of conveyor belt.



Using analog input

The diagram below shows how to connect the analog sensors.

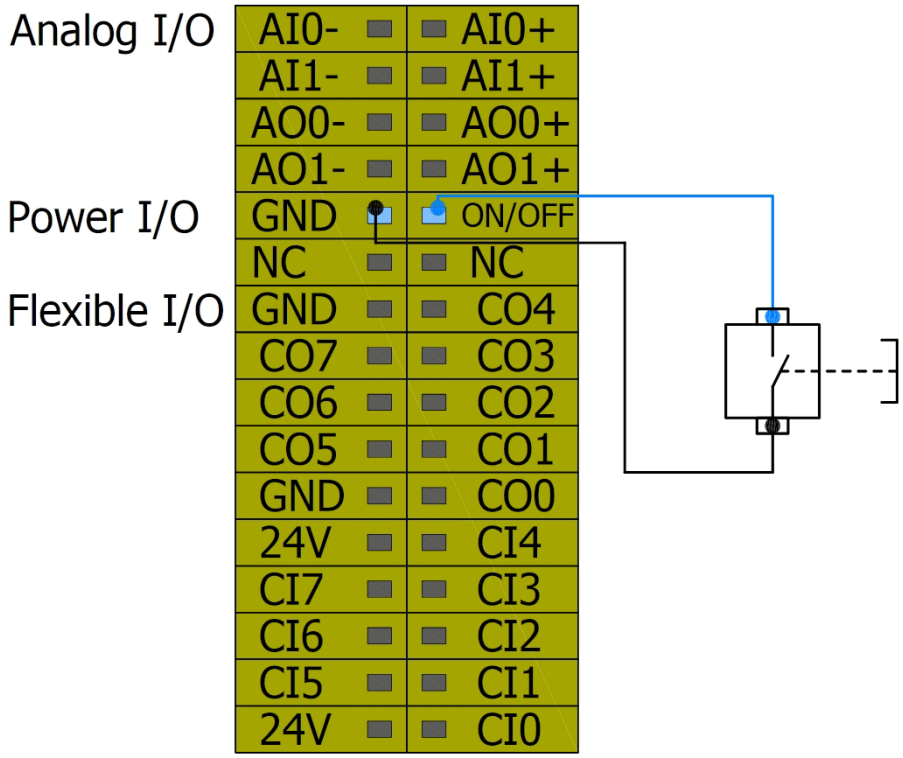


Remote switch machine control

Power IO can be used to open and close the control box without turning on and off the button by the trainer. Build it like this：

Power on: contact trigger;

Power off: keep the short connection at 2.5s-3 S

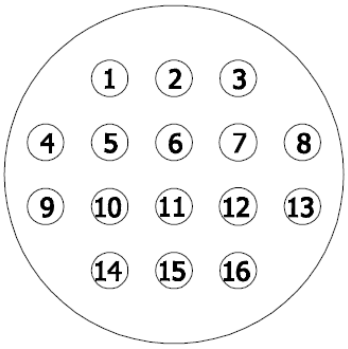


4.8 Safety Guardrail

Users should carry out risk assessment for specific robot applications to determine whether to install security guardrails in the actual operating environment. If a safety guardrail needs to be installed, you should carefully calculate the space of the safety guardrail.

Suggestions: The circle radius of guardrail space> the length of mechanical arm + the length of mechanical arm's terminal fixture.

4.9 Robot Terminal IO Port Description



IO external wiring harness is defined as follows:

connector plug			
PIN	Line color	Definition	Notes
1	Orange	DI8	Digital input8
2	Lampblack	DI9	Digital input9
3	Yellow	DI10	Digital input10
4	Yellow and black	DI11	Digital input11
5	Brown	AI2	Analog input 2
6	Brown and black	AI3	Analog input 3
7	Red	GND	Grounding（0V）
8	Red and white	24V	Power supply（24V）
9	White	DO8	Digital output8
10	White and black	DO9	Digital output 9
11	Green	DO10	Digital output 10
12	Green and black	DO11	Digital output 11
13	Black	RXD	232 reception
14	Black and white	TXD	232 transmission
15	Blue	GND	Grounding（0V）
16	Blue and black	24V	Power supply（24V）

2. Specification of internal power supply

Parameter	Minimum Value	Typical Value	Maximum Value	Unit
24V source voltage		24		V
24V source current		1	1.5	A

If the current exceeds its limit, the software will protect and turn off the output, and the internal control system will generate error messages and display them in the robot log;

The power output of two ports is the output of the same power source.

3. Digital output end

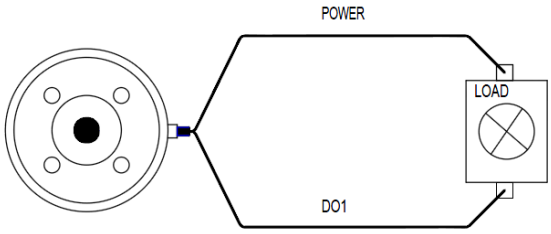
Parameter	Minimum Value	Typical Value	Maximum Value	Unit
Open circuit voltage	0		30	V
Irrigation current flowing through the GND	0		300	Ma
Switching time		1000		us

At the digital output terminal, the current can only be irrigated into the GND (0V), rather than adopting pull current. After the digital output terminal is activated, the corresponding joint will be driven to connect GND; after digital output is disabled, the corresponding joint will be in the open circuit (open set/open drain).

Note: there is no current restriction in the digital output terminal of tools, permanent damage may occur if it exceeds the specified data.

Example of using digital output terminal:

In this diagram, the IO board provides power for the external equipment. If the external system uses its own power supply, grounding treatment is required.

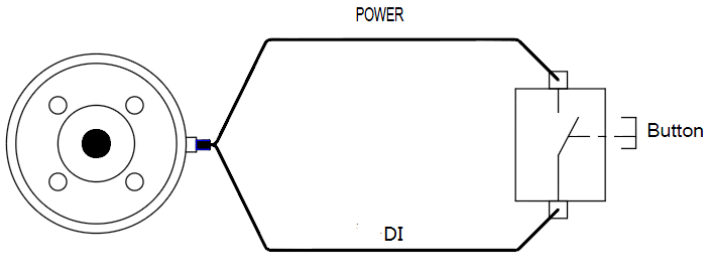


4. Digital input end

Parameter	Minimum Value	Typical Value	Maximum Value	Unit
Input voltage	0		30	V
Logic low voltage			2.8	V
Logic high voltage	6			V
Input resistance		47K		Ω

The digital input is equipped with a weak pull-down resistor. This indicates that the readings of floating input are always low.

Example of using digital input terminal:



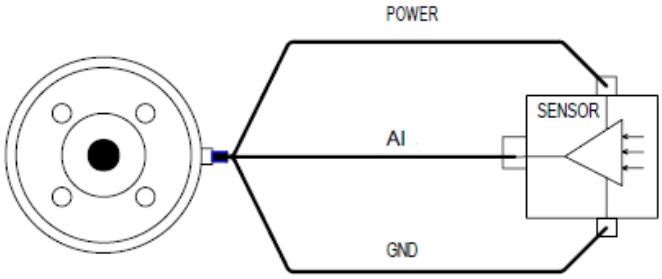
The above diagram shows how to connect simple buttons or switches. In this diagram, the IO board provides power for the external equipment. If the external system uses its own power supply, grounding treatment is required.

5. analog input

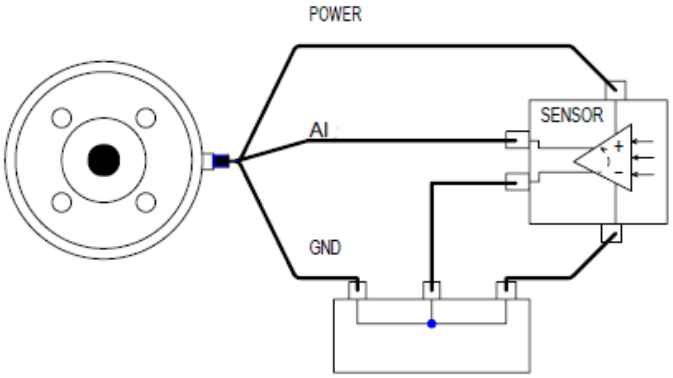
Parameter	Minimum value	Typical value	Maximum value	Unit
input voltage range	0		10	V
input resistance		15K		Ω

The analog input of the tool USES non-differential input. Any change in the current of the common ground connector may lead to interference signal of the analog input, because there will be pressure drop on the ground line and inside the connector, which is very important to understand.

To clearly illustrate the ease of using analog input, here are some simple examples:



The figure above shows the local connection when the user output side is also single-end output analog signal.



In the figure above, the user output end is used as the difference output analog signal, and the use of the differential output sensor is simple and direct. The difference sensor works in the same way as the non-difference sensor, as long as the output negative pole is connected to GND (0V) with the wiring bar.

6. RS232 serial port line

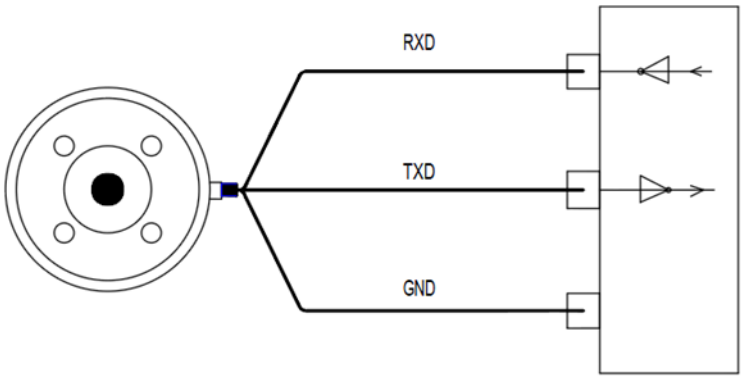
TXD	send data	RS232 data communications, connected to personal computers/industrial cameras/other equipment
RXD	receive data	
GND	ground signal	

The parameters of the serial port are set as follows:

Parameter	value	unit
Baud rate	115200	bps
Data bits	8	bit
Stop bit	1	bit

Example of using a serial port:

This example is that the RS232 of IO communicates with the external device. The power supply can be IO's power supply (24V) or external device power supply, but it should be processed collectively.

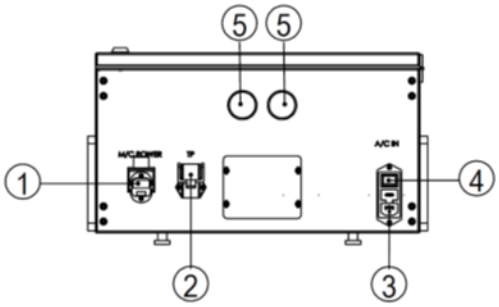


Chapter 5 Hand Teaching Pendant

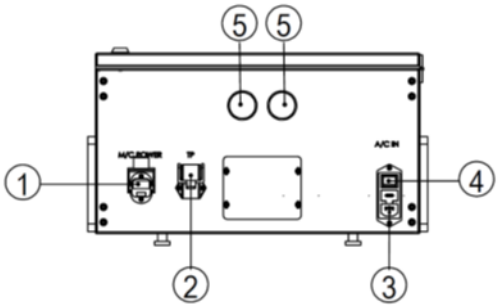
The figure below shows Elfin's hand teaching pendant, the button on the left is the power button of the robot, and the button on the right is the emergency stop button.

Chapter 6 Boot Process

1. Connect the handheld teaching pendant: connect the interface of the handheld teaching pendant to the upper port shown below (under the electric cabinet):



2. Connect the power supply of the electric cabinet: plug the USB interface as shown below into the power cord of the electric cabinet. Connect the other end of the power cord to the 220V power supply.

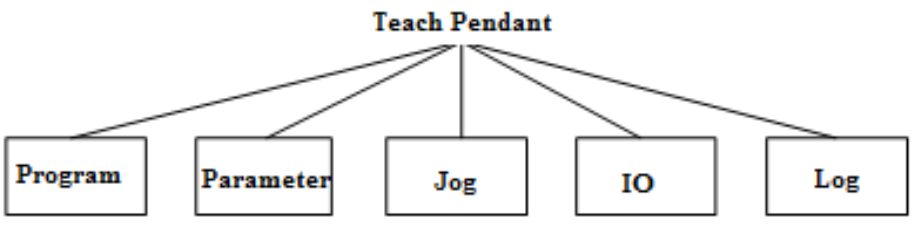


3. Press the switch power button on the electric cabinet, then press the power button on the left side of the handheld indicator to power the electric cabinet. When the electric control box is turned on, the robot is also turned on at the same time. HansRobot software starts automatically.

Chapter 7 HansRobot Software Operation

7.1 Software Introduction

The HansRobot Teach Pendant is interface operation software for manual robot operation, programming, parameter configuration and user monitoring. The user can control the robot to move according to the path specified by the user through the operation interface function button, so that the robot can complete the expected action. It can be said that the teach pendant is the steering wheel for controlling the movement of the robot.
The teach pendant is divided into the following modules:



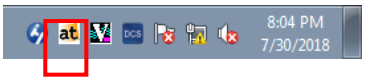
7.2 Software Startup

1) Check if hansEcController, DCS and Teach Pendant are powered on and started successfully.

(1) The flag for the controller to start successfully:

(2) The sign that DCS successfully started:

(3) The sign that the teach pendant is successfully activated:



2) If hansEcController, DCS, and teach pendant are not self-starting, you need to manually start DCS and teach pendant respectively.

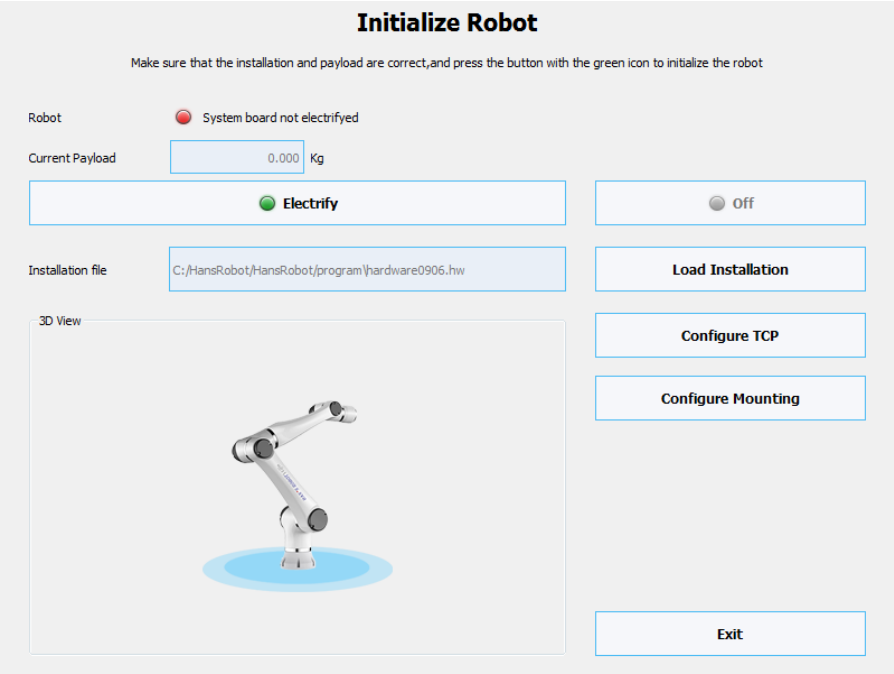
Startup sequence:

(1) Start DCS, double-click “hmRbDCS” to start the software on the desktop of the computer.

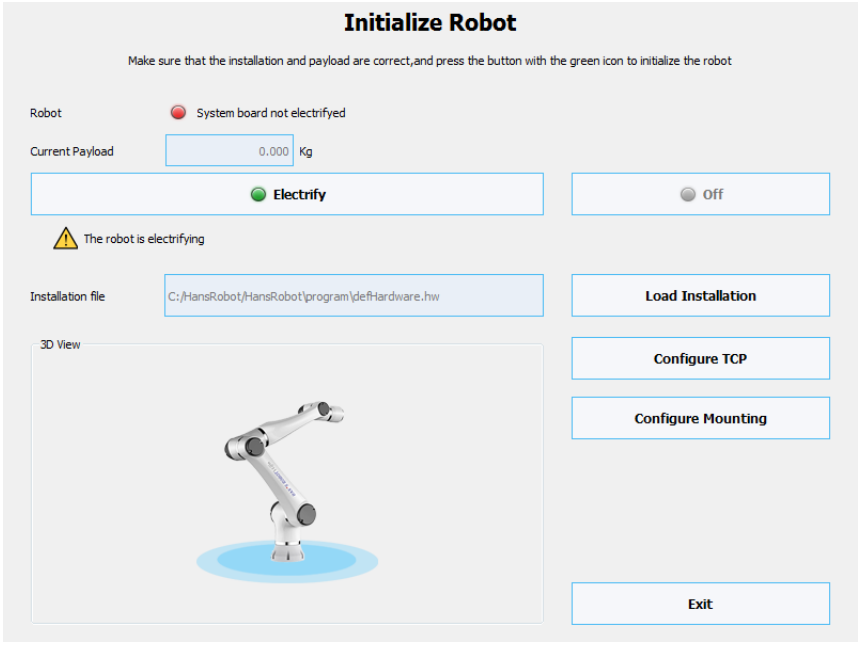
(2) DCS startup success flag.

(3) Start the Teach Pendant Open the Teach Pendant software and double-click the “HansRobot” icon to start the Teach Pendant;

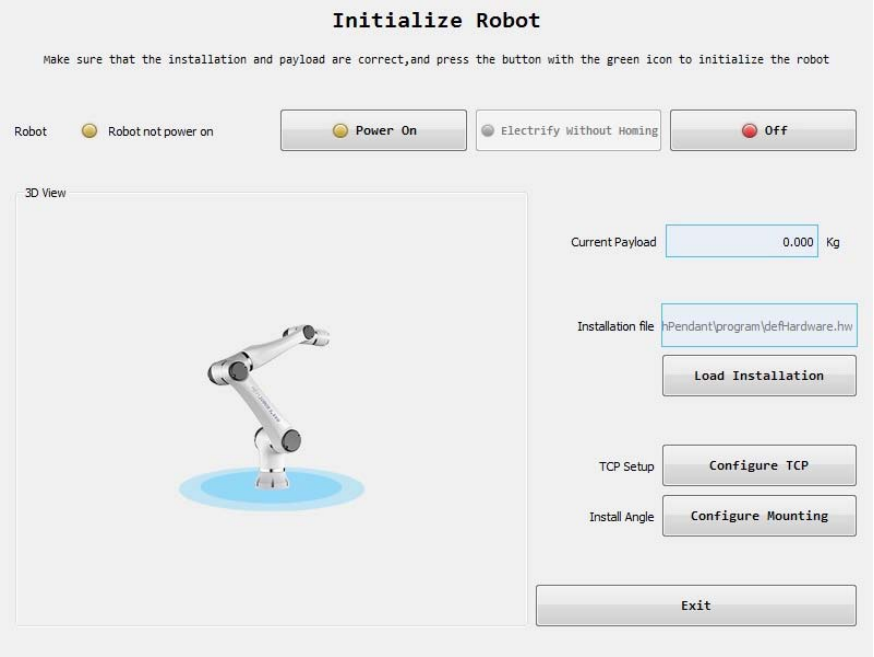
The “Initialization Robot” interface shown in the figure below, the interface prompts, “The system board not electrify”, and the status indicator is red. (Under normal circumstances, if the controller software is started normally, the robot is already powered on, no need to do the following steps);



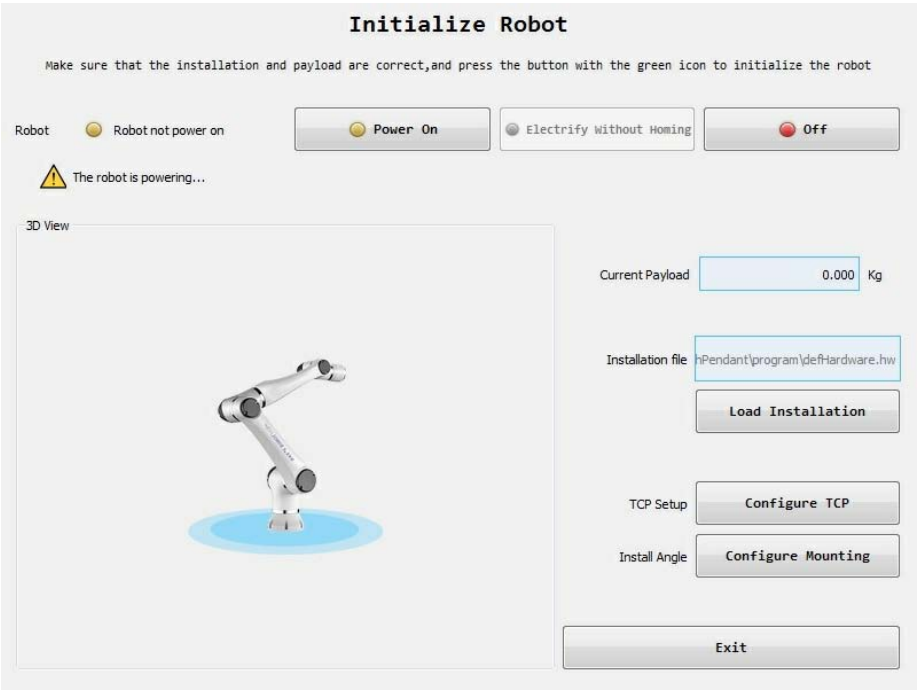
(4) Click the power-on button on the interface shown above to power on the robot. The interface will prompt, “The robot is electrifying”.



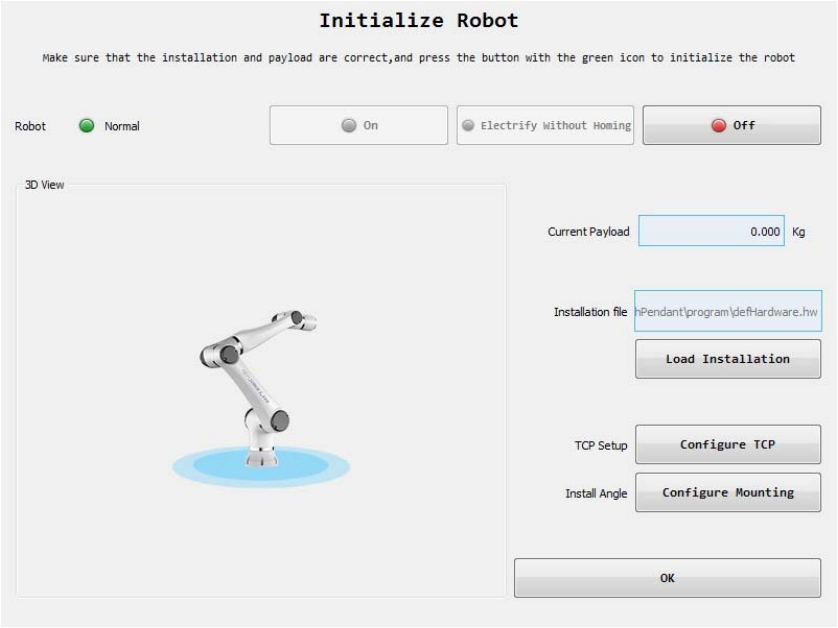
(5) After the power is turned on successfully, the robot is not enabled, and the status indicator is yellow. Please check whether the robot setting information (current payload, installation angle position, TCP, machine origin, etc.) is correct. If it is wrong, please change to the correct parameter settings:



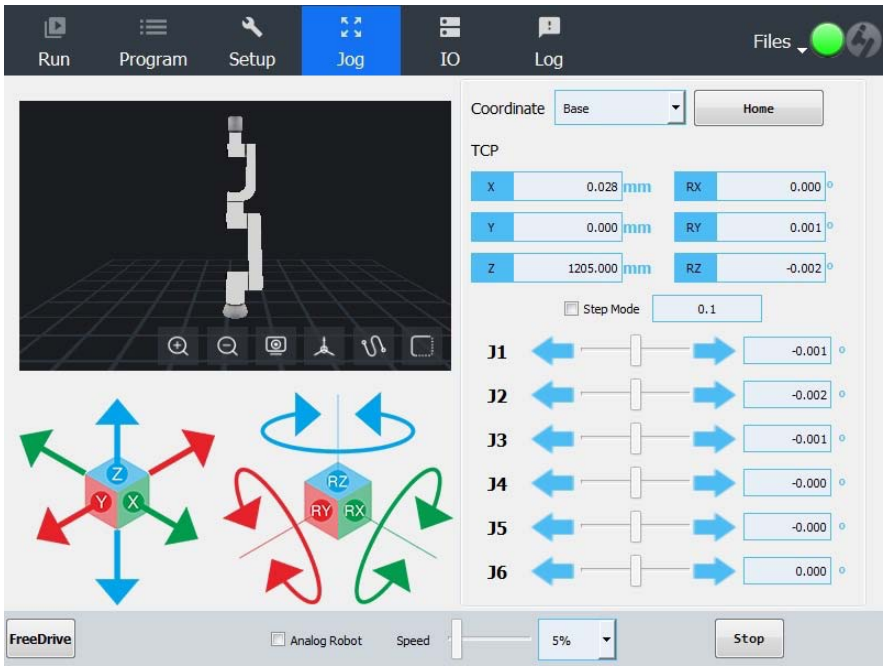
(6) After checking the robot information, click the robot enable button and the interface will prompt the robot to be enabled, as shown below:



(7) The successful interface shown in the figure below. The status indicator is green and the status is normal:



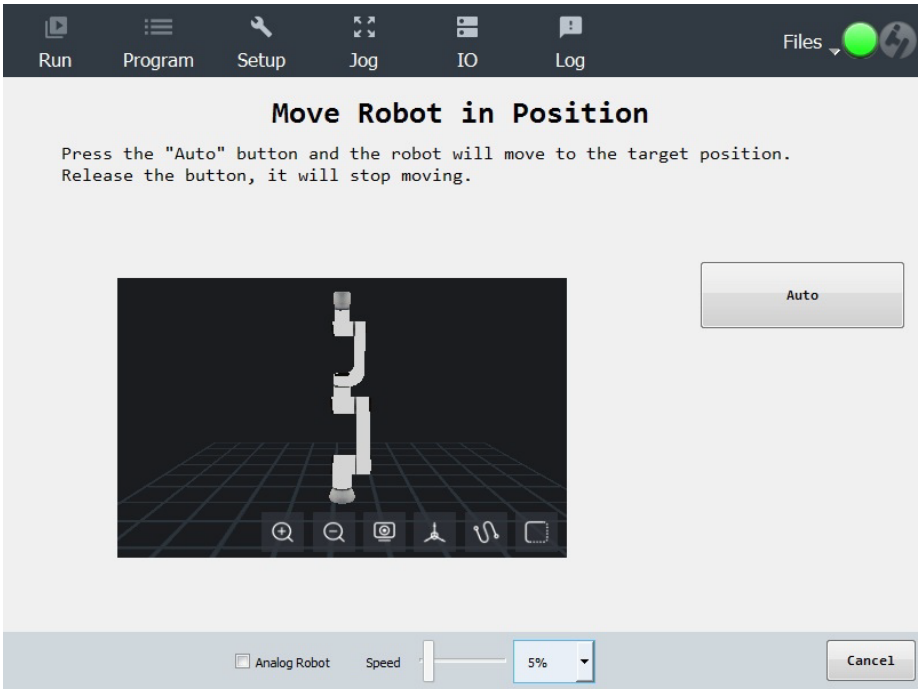
(8) After completing the above steps, click "ok" button to start controlling the robot with the indicator. Click the "return to zero" button as shown below to return the robot to zero. The following figure shows the "point moving interface" of the robot when it normally returns to zero. At this point, the joint Angle coordinate is “0,0,0,0,0,0” and the space coordinates is “0,0,1205,0,0,0” (take 5kg load standard machine as an example).



After clicking the homing button, the “Move robot in position” interface will be displayed, and the user can press and hold the auto button to return to the origin.

7.3 Moving the robot in place

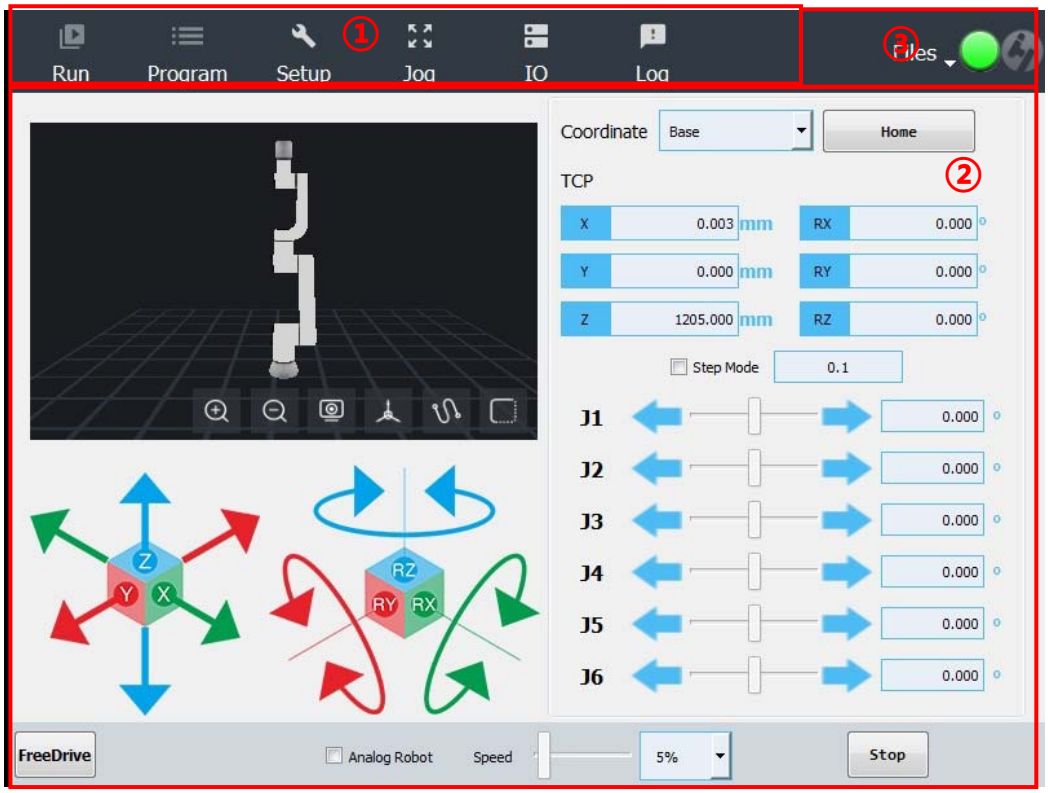
When the robot arm has to be moved to a position in its workspace, the "Move robot in position" is required. For example, if the robot arm needs to move to the start position of the program to start running, or if the robot moves to the origin position as described above, it will switch to the interface, and long press the “Auto” button to move the robot to the target position.



7.4 Operation Interface

The main interface has 3 parts, including:

1. Functions module
2. Functional subpage
3. Control panel

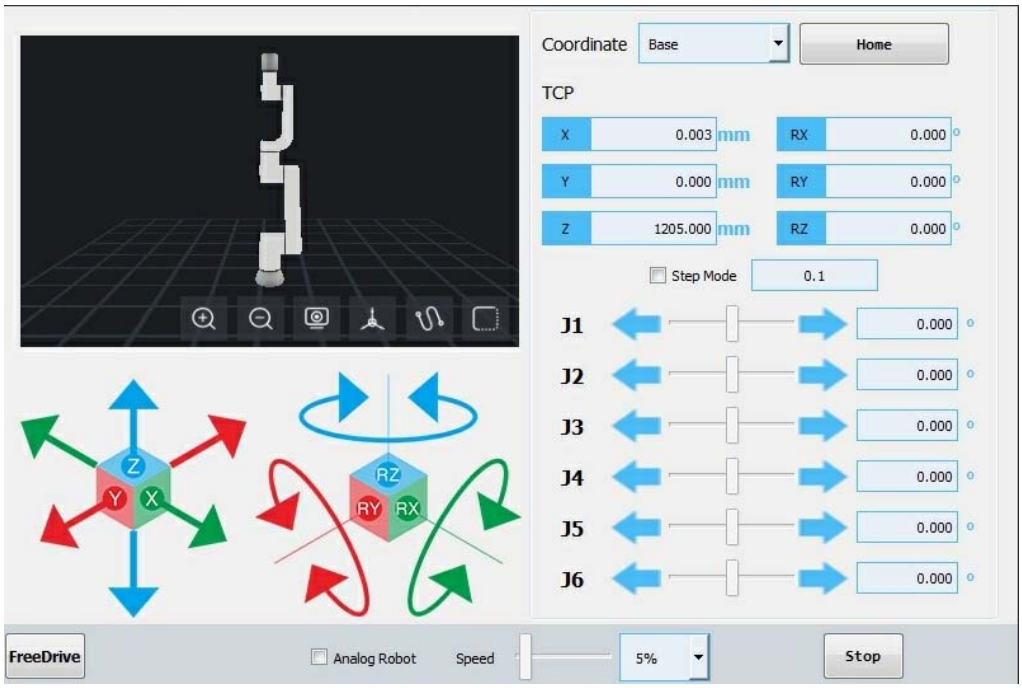


Functions module

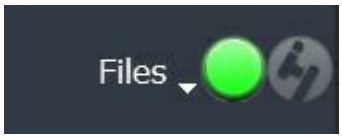
Function module area; click to switch between different function module tabs, dark blue indicates the currently selected tab.

Function sub-page

The function sub-page area is a specific operation interface corresponding to the function module. As shown in the figure below, this function sub-page corresponds to the “Jog” tab of the function module.



Control Panel



Control panel area includes: file menu, status indicator light, and version information.

File menu: click the button to display the following contents:

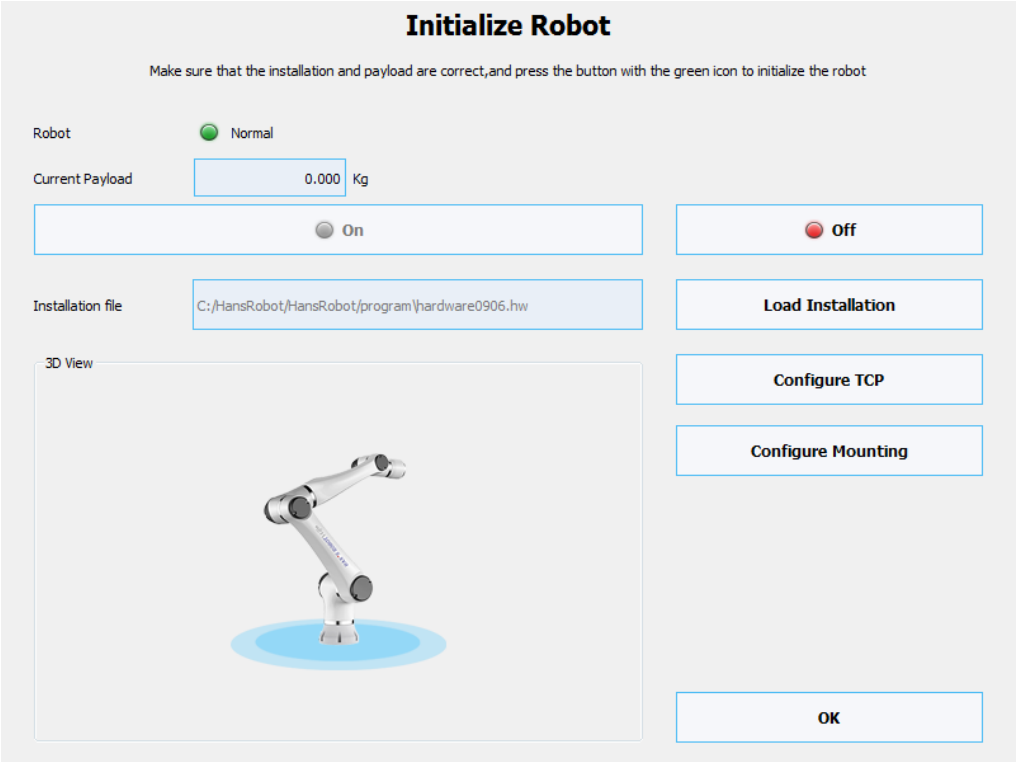
1) New: create a new script program by loading an existing program or creating an empty program.

2) Load: load existing programs.

3) Save: save the currently edited program to the default program folder.

4) Save As: Save the currently edited program to the user-defined location and rename it.

5) Initialize:



Initialize the screen as shown below. On this screen, you can control the initialization of the robot arm: power on/power off, enable, set the payload, load and installation Settings file (.hw), configure tool TCP coordinates (see section 1.6 TCP configuration for details), and configure the installation position (see section 1.6 installation for details).

6) Language: can switch between Chinese, English and Spanish.

7) Minimize: minimize the software interface.

8) Exit: close the teach pendant software.

Status indicator: LED status indicator indicates the current status of the robot arm:

•The red highlighted LED indicates that the robot arm is currently in a stop state for a variety of reasons.

•The yellow highlight LED indicates that the robot arm is not enabled and cannot be moved.

•The green highlighted LED indicates that the robot arm is powered and enabled, and is ready for normal operation, such as motion.

The text next to the LED light further illustrates the current state of the robot arm.

1) If the robot is not powered, click the power on button (the master station will be

automatically activated during power-on).

2) If the master station is not started, click the start master button.

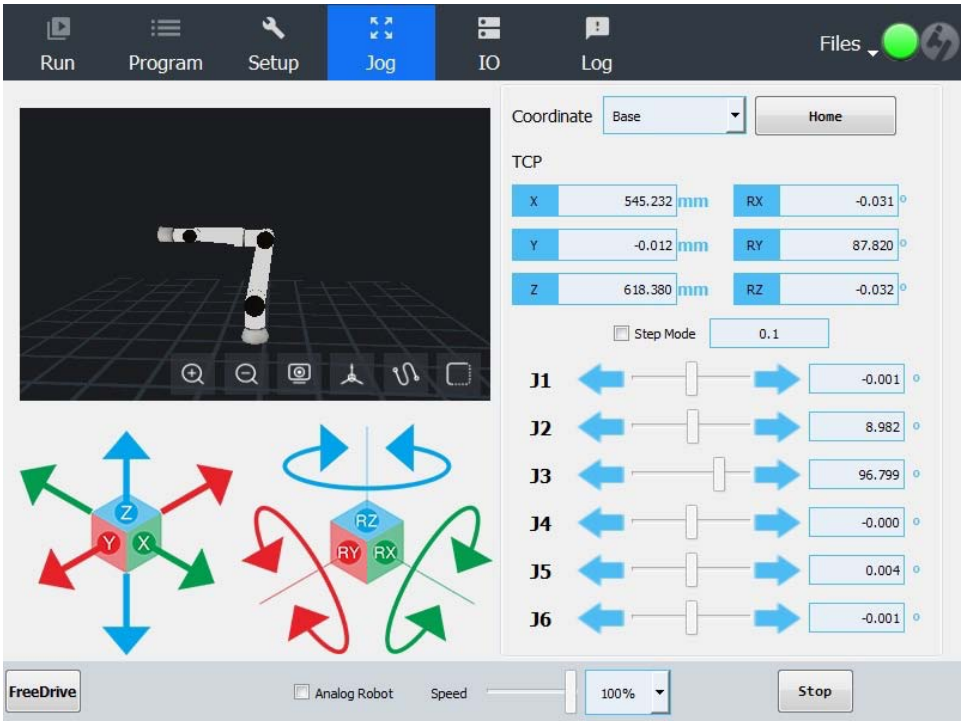
3) If the robot is not enabled, click the enable button.

4) If the robot is out of the safe space, clear the error and restore the robot according to the operation instructions.

Version information:  display current software version information.

7.5 Manually Controlling the Robot

This section describes how to manually control the robot to move to the target position in an expected posture. This part of the content can be found in the Jog teaching interface. The Jog teaching interface is mainly used for the basic operation of robot motion, which enables the robot to carry out angular motion, spatial motion and traction teaching function.



1) **Step mode:** The motion offset, in mm or °, is only enabled when the check box is selected. The user can jog at the set step offset.

2) **Speed ratio bar**: The display bar shows the current rate ratio of the robot; Drag the square drag block on the display bar to adjust the speed ratio; Click the drop-down button in the options box to select the robot rate ratio.

The speed ratio adjustment range is 1%-100%.

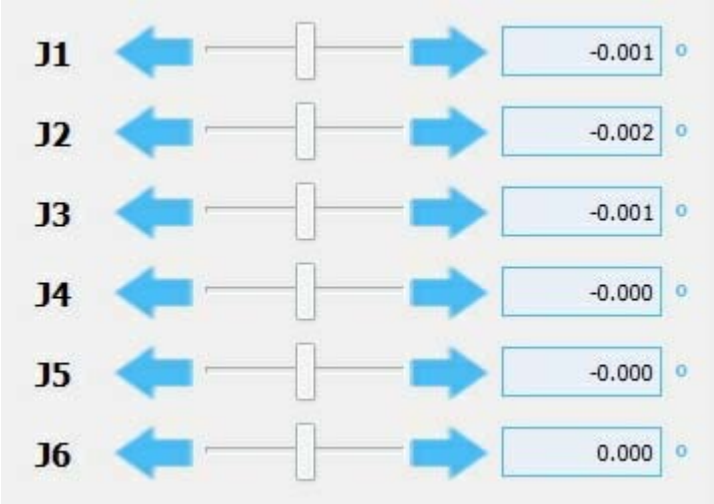
3) **Analog robot**: see section 1.7 -> debugging -> (10).

4) **Coordinate system:** Defines the coordinate system currently used to control the robot. It can be switched in the following coordinate system modes: base coordinates, user coordinates, tool coordinates. If you do not choose the correct coordinate system, the robot may appear to be inconsistent with the expected action, creating an unpredictable danger.

5) **Home**: After clicking this button, enter the “Move robot in position” tab, and press and hold the “Auto” button, the body will move from the current posture to the origin position by the joint angle motion (vertical state).

Two modes of motion, one is joint angle motion and the other is space coordinate motion.

Joint Angular Motion



J1 to J6 sequentially indicate the first axis to the sixth axis of the robot.

The text boxes display the current angle coordinate values of corresponding axis positions of the robot, in the unit of ° (degree).

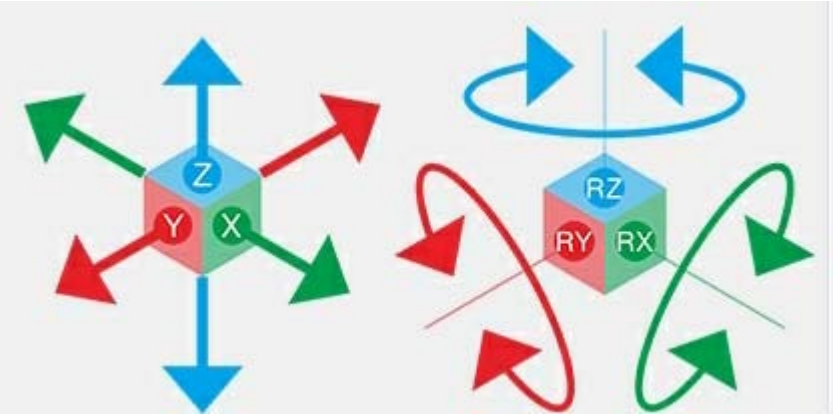
1) **Buttons corresponding to J1–, J2–, J3–, J4–, J5–, and J6–**:  In the safe space, the robot moves in the negative direction corresponding to the axis, and the text box displays the current position of the corresponding axis. Each time the button is clicked, it moves 2° in the corresponding negative direction of the axis. Press and hold the button, the corresponding axis moves continuously in the negative direction, release the button to stop the movement. If the relative movement of the step is selected, the step distance of the user input corresponding to the axial negative direction is moved.

2) **Buttons corresponding to J1+, J2+, J3+, J4+, J5+, and J6+**:  In the safe space, the robot moves the corresponding axis in the forward direction, and the text box displays the current position of the corresponding axis. Each time the button is clicked, it moves 2° in the positive direction of the axis. Press and hold the button, the corresponding axis will move continuously in the positive direction, release the button to stop the movement. If the relative movement of the step is selected, the step distance of the user input

corresponding to the axial positive direction will be moved.

Note: The joint angle motion here corresponds to the MoveJ, MoveRelJ, and ACS motion modes in scripting.

Space coordinate motion



1) **Buttons corresponding to X–, Y–, and Z–**:In the safe space, the robot end TCP moves in the negative direction of this component. Each time the button is clicked, the robot end TCP moves 2 mm in the negative direction. Press and hold the button, the end of the robot TCP moves continuously in the negative direction, release the button to stop the movement. If the starting step relative motion is checked, the robot end TCP moves the step distance input by the user in the negative direction.

2) **Buttons corresponding to X+, Y+, and Z+**:In the safe space, the robot end TCP moves in the forward direction of this component. Each time the button is clicked, the robot end TCP moves 2 mm in the forward direction. Press and hold the button, the end of the robot TCP moves continuously in the forward direction, release the button to stop the movement. If the starting step relative motion is checked, the robot end TCP moves the step distance input by the user in the forward direction.

3) **Buttons corresponding to RX–, RY–, and RZ–**:RX- indicates that the robot end TCP rotates in the negative direction of the X axis; RY- indicates that the robot end TCP rotates in the negative direction of the Y axis; RZ- indicates that the robot end TCP rotates in the negative direction of the Z axis. Within the safe space, each time the button is clicked, the robot end TCP rotates 2° in the negative direction of the corresponding axis. Press and hold the button, the end of the robot TCP continues to rotate in the negative direction of the corresponding axis, and the button is released to stop the movement. If the starting

step relative motion is checked, the robot end TCP rotates the user input step distance in the negative direction of the corresponding axis.

4) **Buttons corresponding to RX+, RY+, and RZ+**:RX- indicates that the robot end TCP rotates in the forward direction of the X axis; RY- indicates that the robot end TCP rotates in the forward direction of the Y axis; RZ- indicates that the robot end TCP rotates in the forward direction of the Z axis. Within the safe space, each time the button is clicked, the robot end TCP rotates 2° in the forward direction of the corresponding axis. Press and hold the button, the end of the robot TCP continues to rotate in the forward direction of the corresponding axis, and the button is released to stop the movement. If the starting step relative motion is checked, the robot end TCP rotates the user input step distance in the forward direction of the corresponding axis.

TCP indicates the cutter coordinate names currently used.

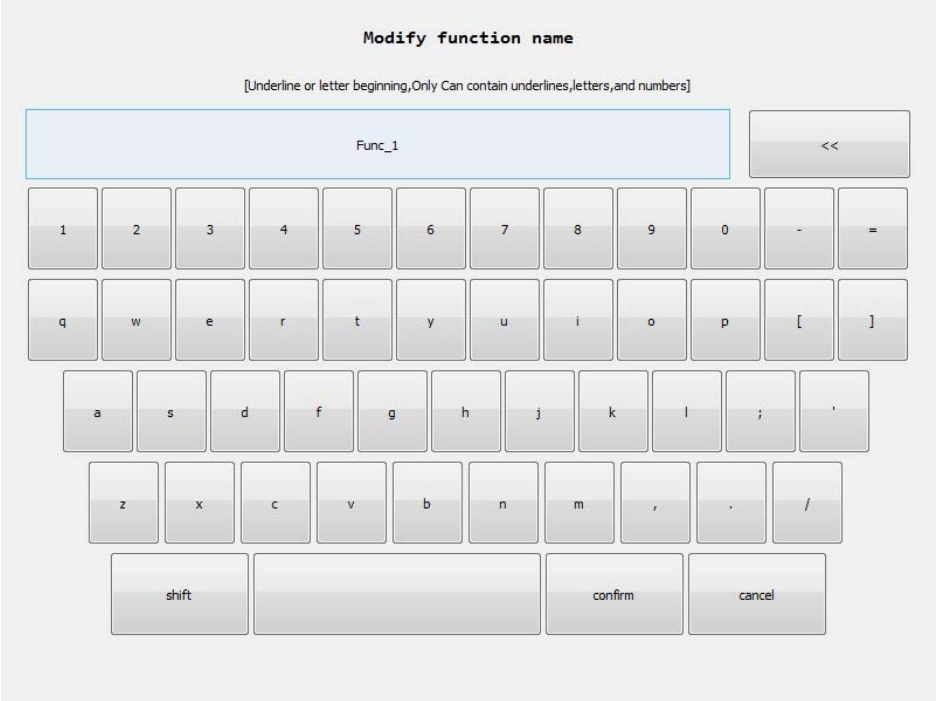
X, Y, Z, RX, RY, and RZ indicate the current spatial coordinate position vectors of the robot. As shown in the above figure, the text boxes display the spatial coordinate values of the current the current robot terminal TCP relative to the selected characteristics. X, Y, and Z are in the unit of mm. RX, RY, and RZ are in the unit of °.

Note: The spatial coordinate motion on the Point Motion interface is corresponding to the MoveJ and MoveRelJ instructions and the ACS motion mode in Script Programming.

Homing

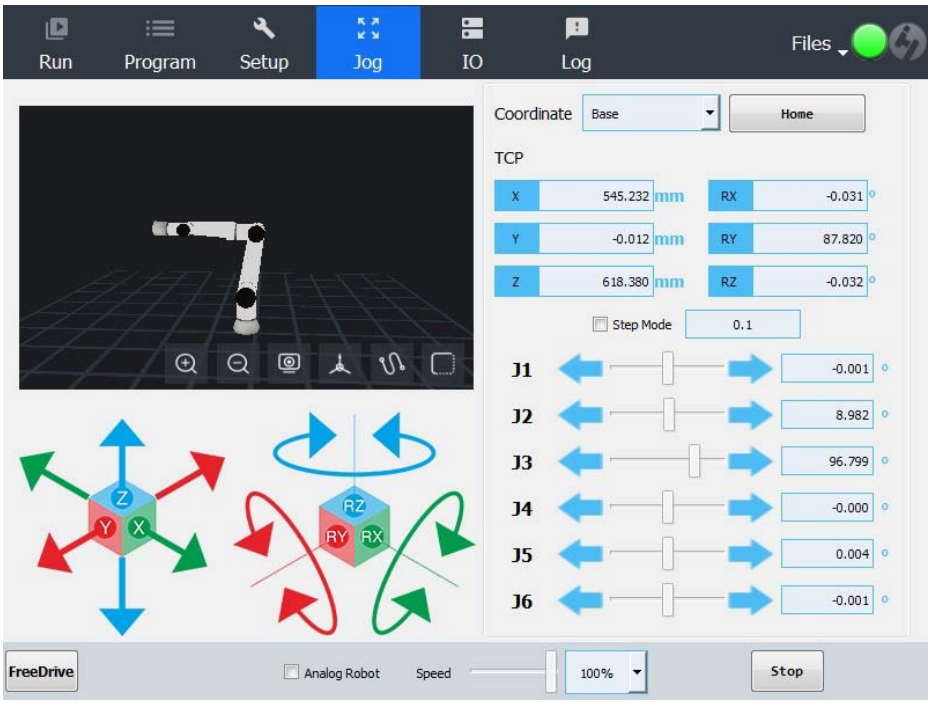
Click the button of "Home" to move the robot to origin position. See section 1.2 (7) for the specific operation.

On Screen Keyboard

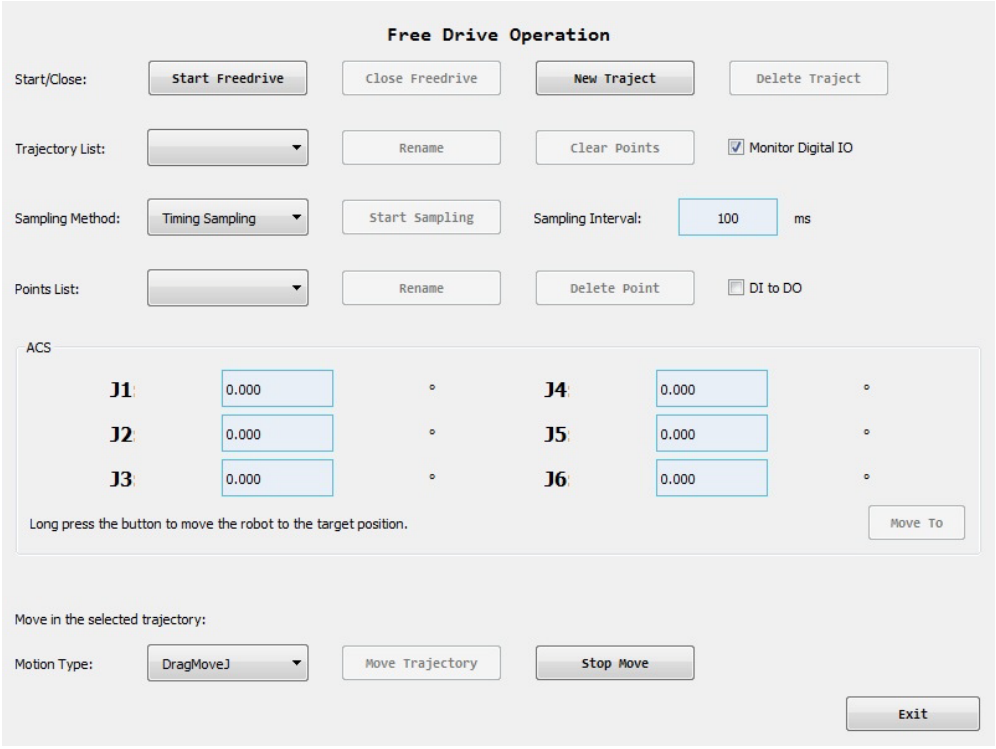


Click the input fields in the software interface and the input keyboard as shown above will appear. Please use "shift" to change case and "<<" to delete.

Enable FreeDrive



After clicking the "FreeDrive" button of the jog interface, it will enter the "Free Drive operation" interface.



The meaning of the button in the interface is as follows:

Start FreeDrive teaching: Turn on the FreeDrive teaching mode. Warning: Before turning on the FreeDrive teaching function, be sure to check whether the mechanical origin, installation angle, actual load and other parameters are correct.

Close the FreeDrive teaching: end the FreeDrive teaching state.

New track: a new track name will be created in the track list. When the FreeDrive teaching is turned on, the track can be obtained by manual sampling or timed sampling.

Delete track: deletes the track (containing the track name and the track bit) in the current track list.

Track list drop-down box: display all current track names.

Rename (track) : rename the track name in the current track list.

Clear track points: dismiss all points in the current track list.

Monitoring digital IO: when checked, the sampling phase will record the change of digital IO at the end of the robot.

DI reflects DO: When checked, in the sampling phase, the software interface will show the changes of the terminal output signal corresponding to the terminal input signal.

Sampling method: two sampling methods, one is manual sampling; the other is timed sampling.

Sampling interval: set the sampling interval under timed sampling mode.

Start sampling: after the timed sampling is selected and the sampling interval is set, click the start sampling button to start timing sampling.

Sampling current point: set the manual sampling mode, drag the robot to the point, and click "sampling current point".

List of sampling points: display all points recorded under the current trajectory

Rename (bit): modify the default bit name in the current sample point list.

Delete bit: delete the bit in the current sampling point list.

Move to: move to the spot in the current sampling point list.

Motion mode: currently only joint Angle motion mode, namely DragMoveJ is supported.

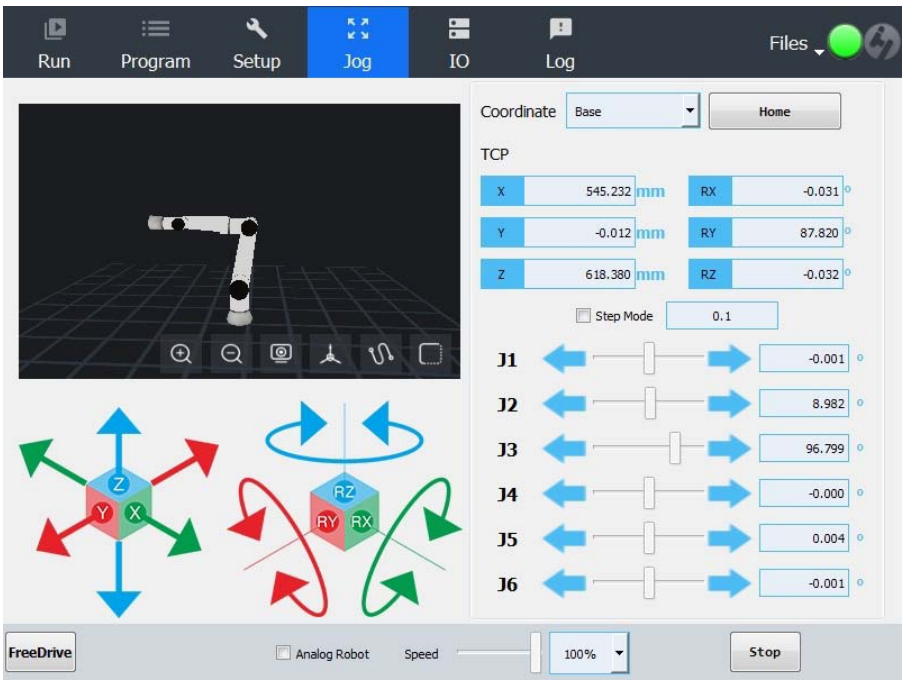
Trajectory: when the FreeDrive teaching state is closed, click the button to make the robot reproduce the teaching trajectory.

Stop motion: when the robot reproduces the track, click the button to stop motion.

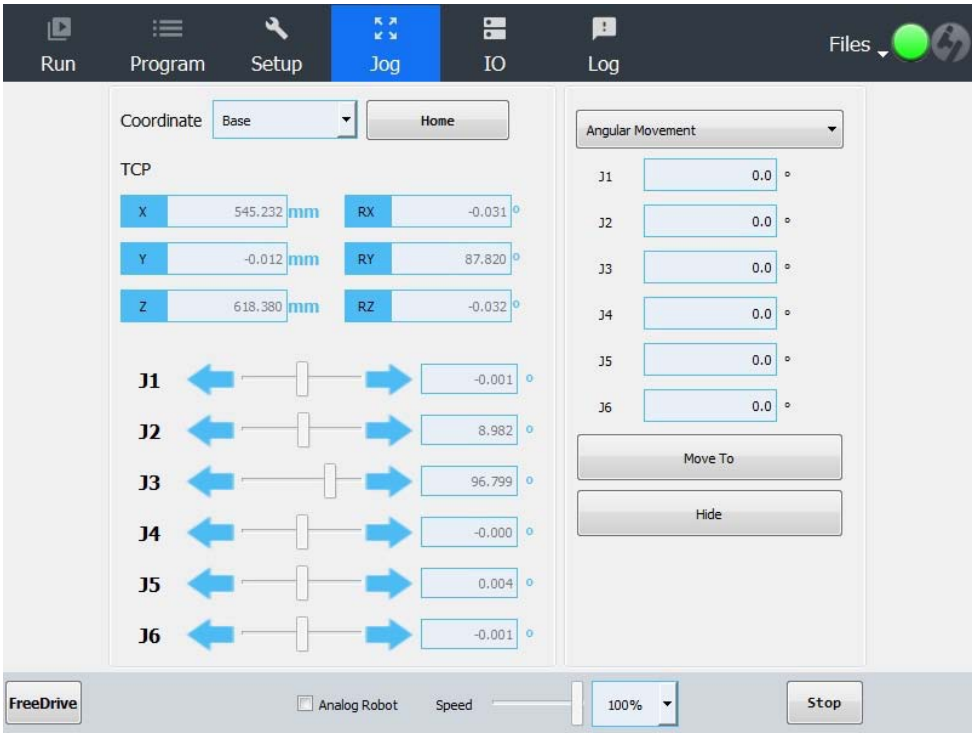
Exit: exit the FreeDrive teaching interface.

Jog Editing

You can switch to the jog-editing interface by clicking the "Coordinates" in the "Jog" interface or the data display box under the "TCP" area.



The jog-editing interface is shown in the following figure:



The jog editing function interface is used for the user to manually input the known spatial coordinate point coordinate value or the joint angle point angle value, and then click the “Move to” button to directly move to the target point:

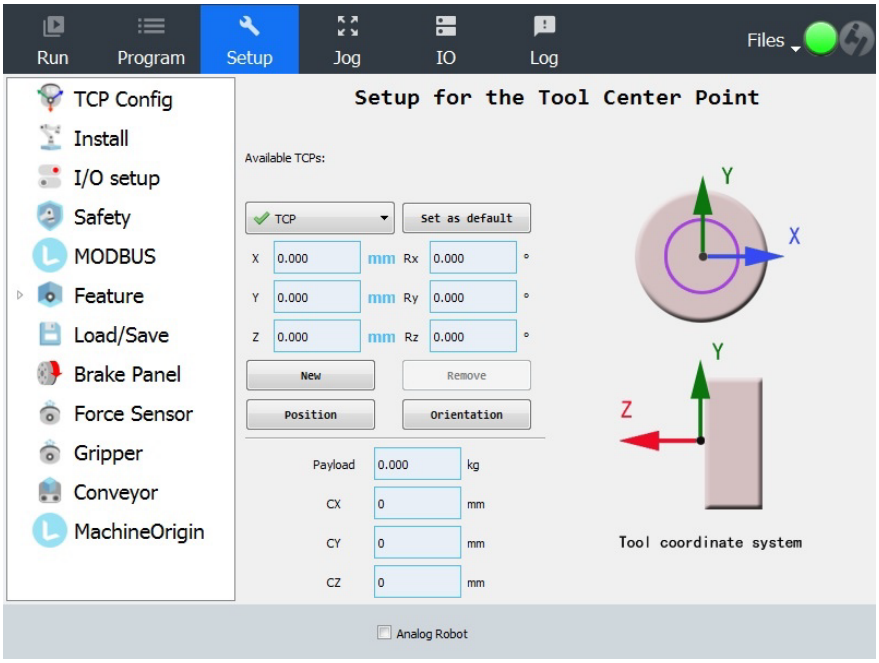
1) **Angular motion**: select the angular motion or click the data box under Joint area to edit the data value of angular motion;

2) **Spatial motion**: select the spatial motion or click the data box under TCP region to edit the data value of spatial motion;

3) **Hidden**: Click this button to exit the jog editing interface and return to the jog interface.

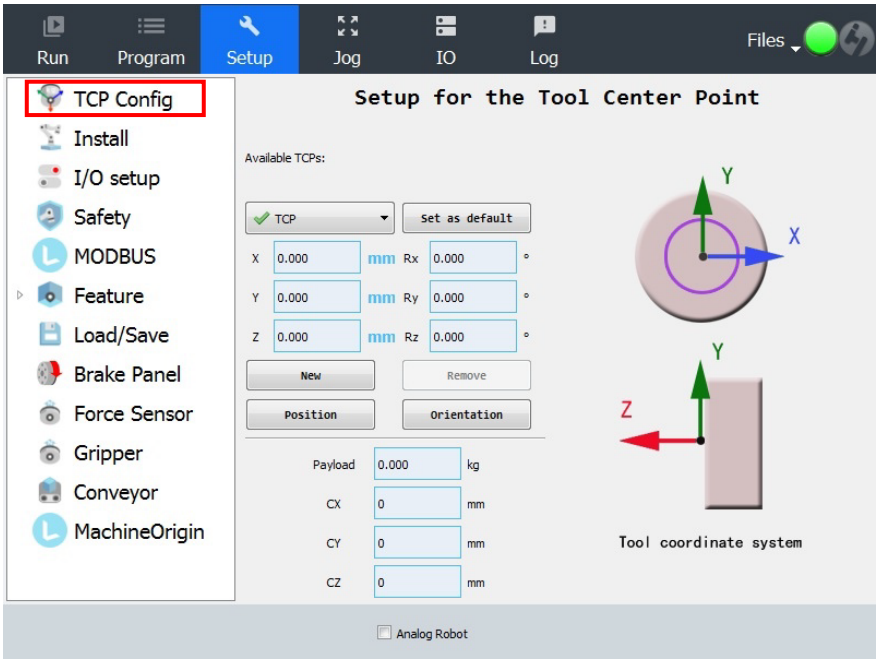
Parameter Configuration

This area is used to set parameters such as TCP coordinate system, installation Angle, safe space, safe stop and gripper.



TCP Configuration

Set the tool coordinate system, you can use the manual input tool coordinate parameter value or manually teach the tool coordinate system.



Buttons on the interface are defined as follows:

1) **New**: This button is used to create cutter coordinates.

2) **Delete**: This button is used to delete selected cutter coordinates.

3) **Edit**: You can manually enter a parameter value to modify the tool coordinate system if you have obtained the offset of the new TCP relative to the flange center.

4) **Set as Default**: One and only one of the configured TCPs is the default TCP. In the TCP drop-down menu, there is a green circle icon to the left of the name that is set to the default TCP. The default TCP name is displayed at the TCP interface of the jog interface. To set the currently selected tool coordinate as the default TCP, click the Set as default button.

5) **Position**: This button is used to demonstrate four point positions to determine the origin position of the new cutter coordinate system.

6) **Direction:** the TCP direction can be calculated automatically through the following steps:

- Click the new button.
- Click the direction button.
- According to the prompt, from the drop-down list to select a coordinate system.
- Click teaching points, teaching a point to make tool direction same as the

selected coordinate system Z axis direction, can complete the teaching of TCP direction.

- Calculated to verify the TCP direction, and use the set button to set it to the selected TCP.

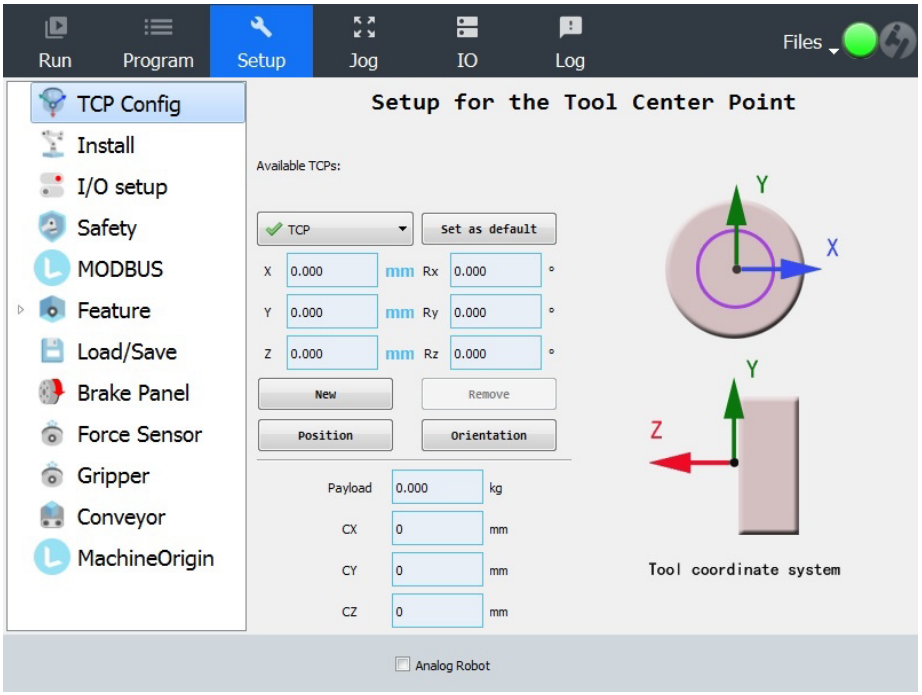
The teaching principle of four-point method: the end point of the cutter should be moved from four different angles to the same position for teaching;

➔ TCP Demonstration Example

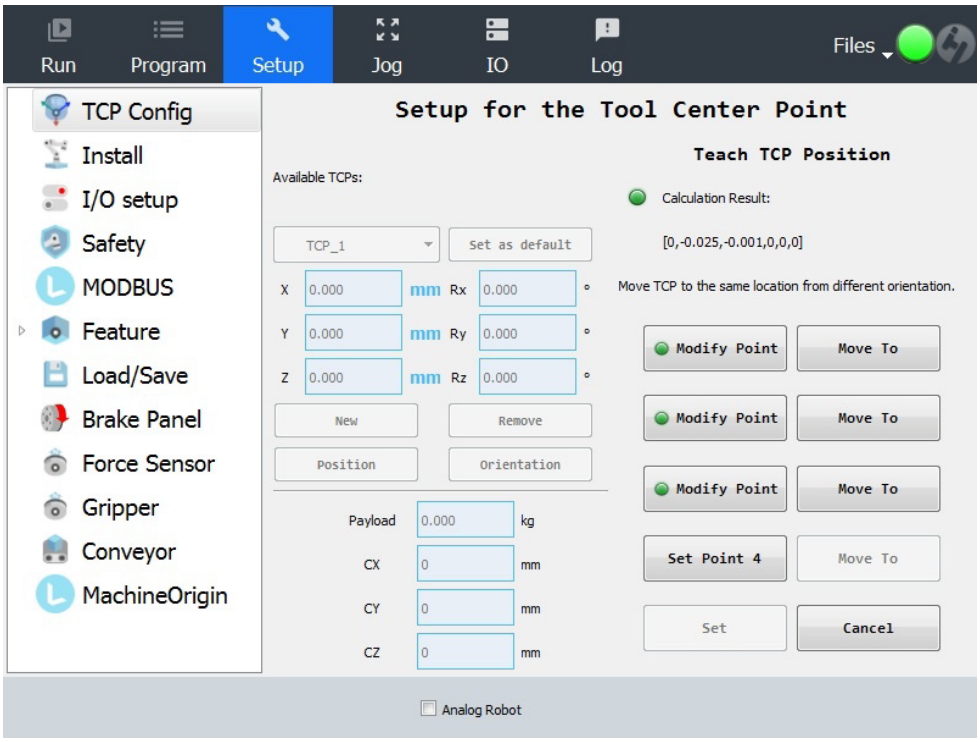
Create a cutter coordinate system TCP_1.

(1) Click New. A new cutter coordinate system TCP_1 is automatically generated.

(2) Click Position. The four-point demonstration interface is displayed.



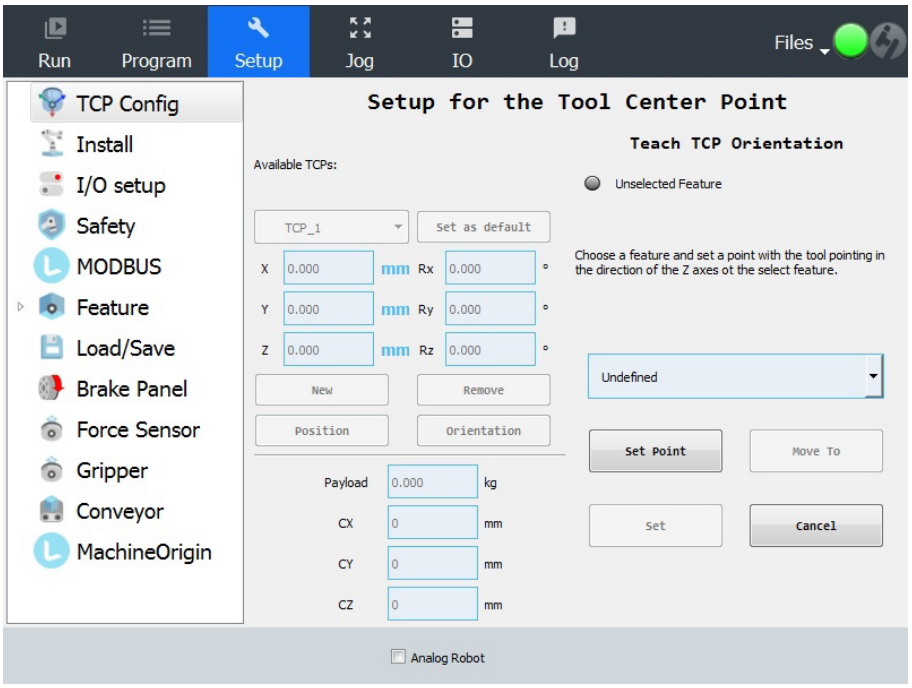
Check the interface after the demonstration for the first three point positions is completed. If a green indicator is displayed in front of a point position, the point position meets the requirement.



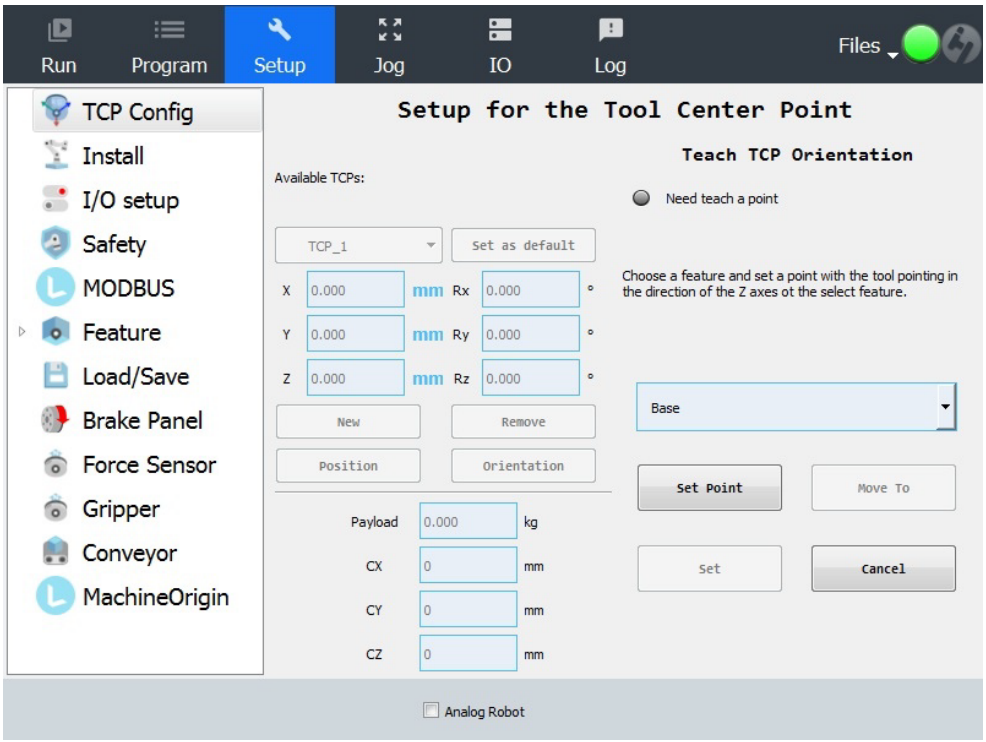
After the demonstration for the fourth point position is completed, click **Set** shown in the above figure.

Note: Teaching points must be diversified enough to ensure correct calculations. Otherwise the indicator light above the button will turn red. The light of the corresponding button reflects the quality of each taught point. Green = excellent, yellow = normal, red = unqualified.

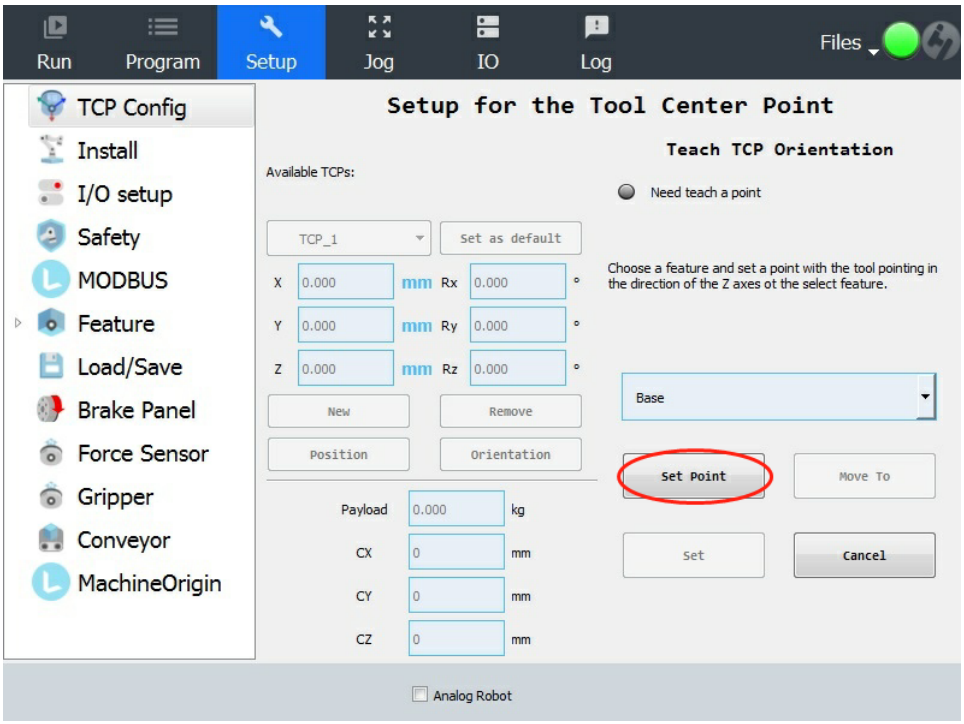
③ **Direction**: Click the "Orientation" button in the interface to enter the TCP 1 direction teaching interface.



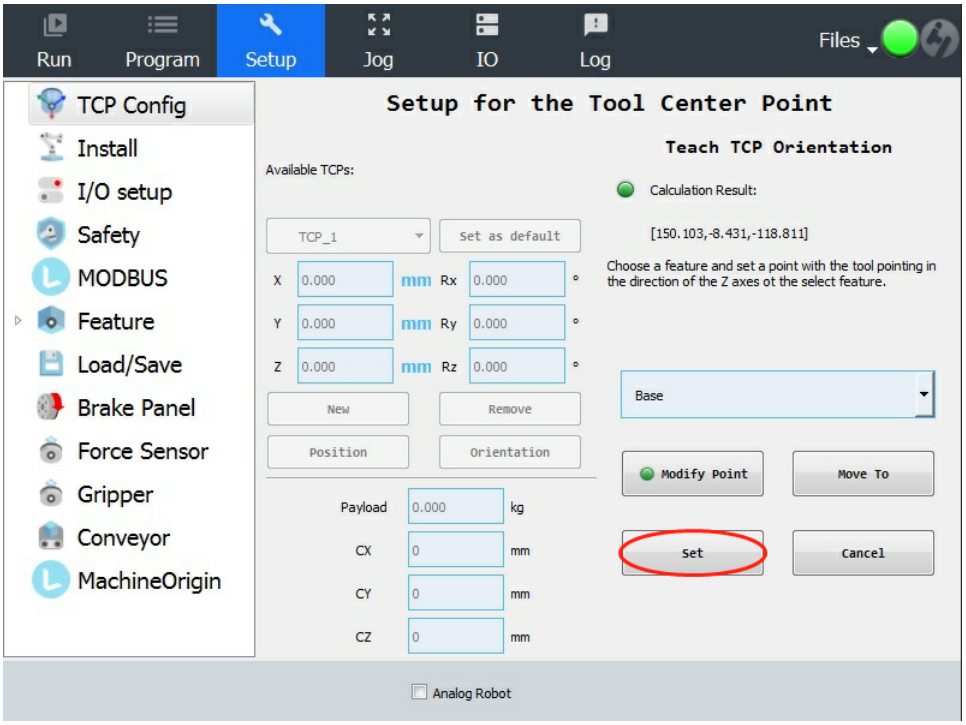
According to the prompt, select a coordinate system from the drop-down list, such as the "Base" coordinate system; the direction of the newly created TCP_ is the same as the direction of the "Base" coordinate system;



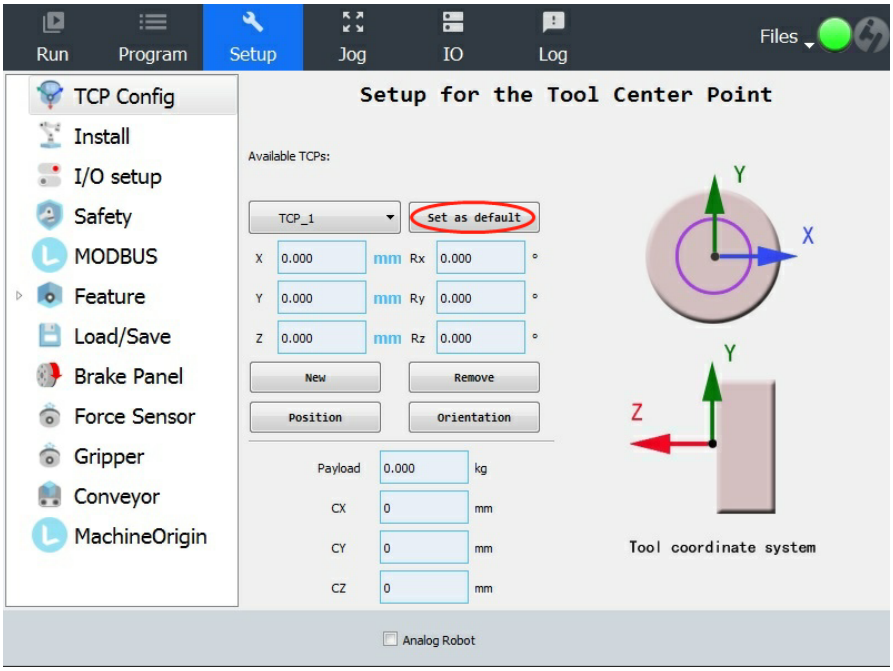
Click Set Point: Teach a point so that the tool direction is the same as the Z coordinate of the selected coordinate system.



Click the “Settings” button in the figure below to complete the teaching in the TCP_1 direction.



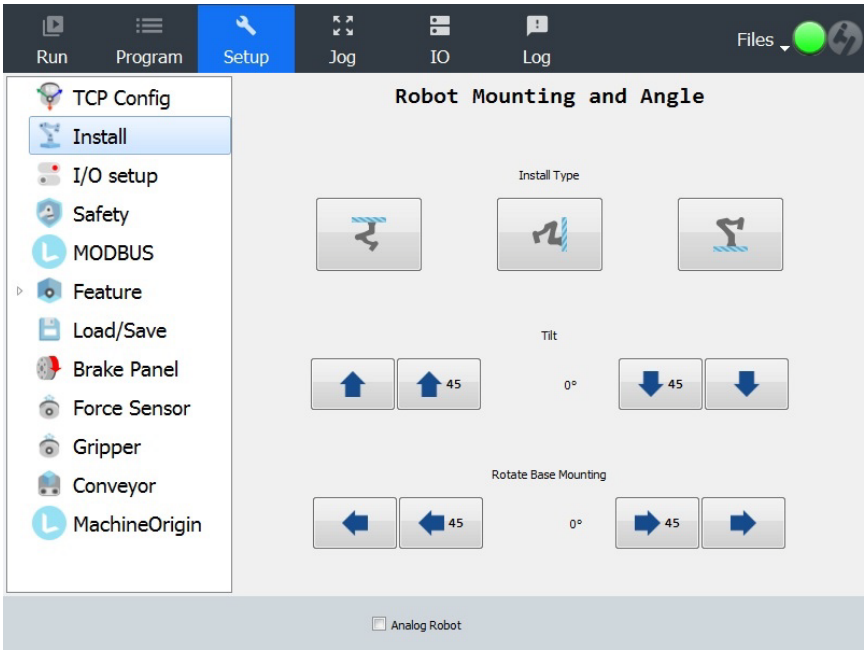
④If you want to set the new TCP as the default TCP coordinate system, you need to click the "set as default" button in the interface. As shown in the figure below, set TCP 1 as the default TCP:



7) **Payload**

The user can set the load based on the actual Elfin end load and its offset from the center of the flange in the X, Y, Z directions. Click the corresponding input box, the virtual keyboard will pop up, enter the correct value, click the setting button, the permission verification dialog box will pop up, enter the corresponding password in the verification box to complete the setting;

Installation



The system default robot arm is mounted on a smooth parallel floor or on the ground, in which case no changes to this screen are required. However, if the robot arm is mounted ceiling-mounted, wall-mounted or angled, it needs to be adjusted using the buttons on the screen. The buttons on the right side of the screen can be used to set the mounting angle of the robot arm. The first three buttons on the right side set the angle to ceiling (180◦), wall (90◦), floor(0◦). The tilt button can be used to set any angle. The rotary button at the bottom of the screen is used to rotate the mounting angle of the robot arm to match the actual mounting angle.

Tilt Angle: rotation around the Y-axis of Base coordinate, positive counterclockwise;

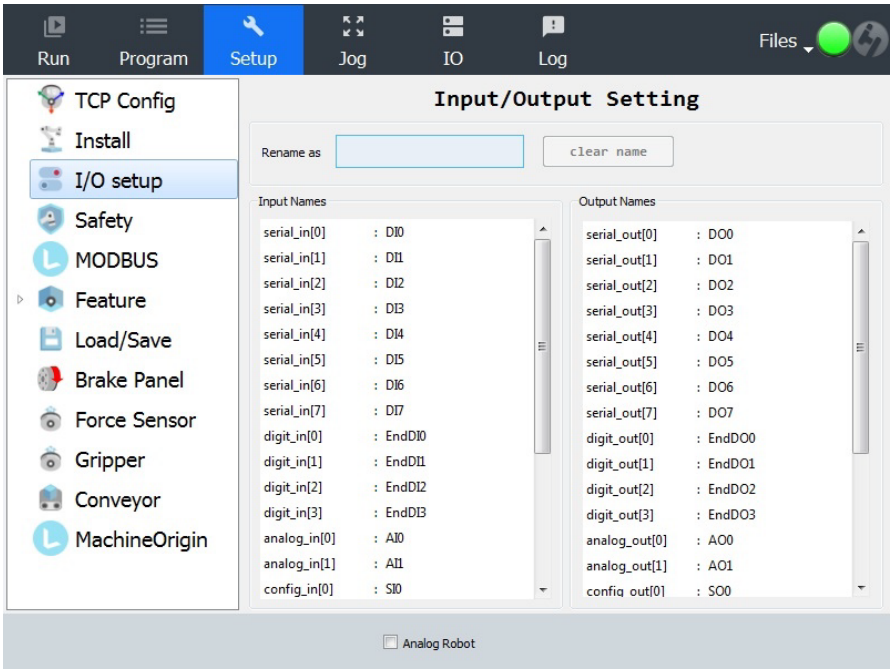
Rotation Angle: rotation around the Z-axis of the Base coordinate is positive counterclockwise.

WARNING: Be sure to use the correct installation settings. Save and load the installation settings file with the program.

The controller USES an advanced dynamic model to ensure that the robot arm moves smoothly and accurately, and that the robot arm can support itself when it is in free driving mode. To do this, it is essential that the Angle and position of the robot arm be set correctly.

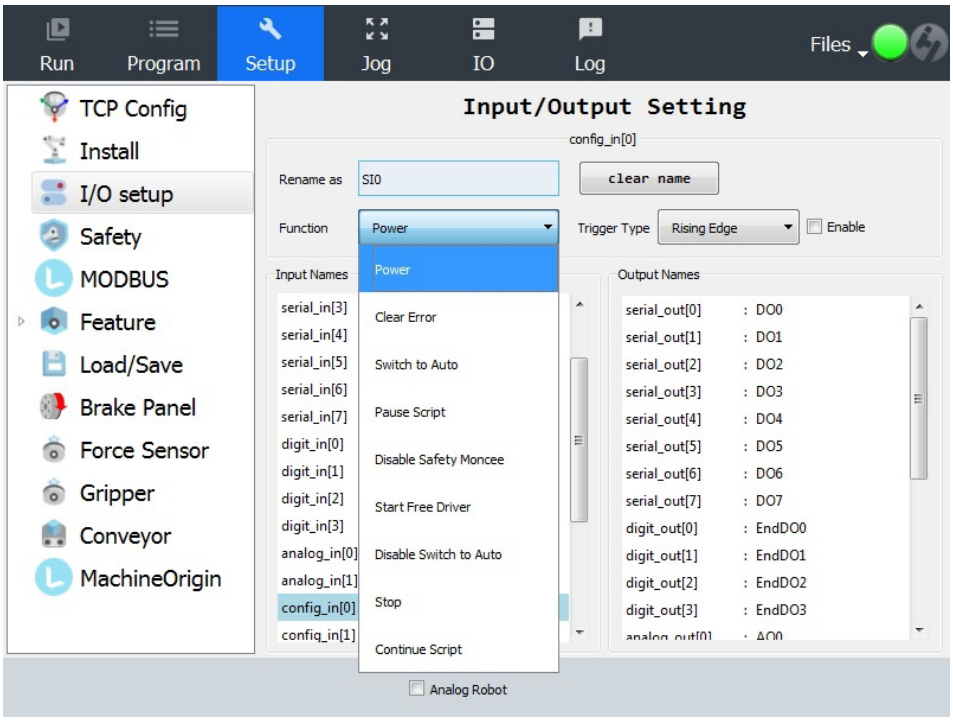
WARNING: if the robot arm installation information is not properly set, this will result in frequent safety stops, or the possibility that the robot arm will fall weightless immediately after the zero force demonstration button is pressed.

I/O Setting

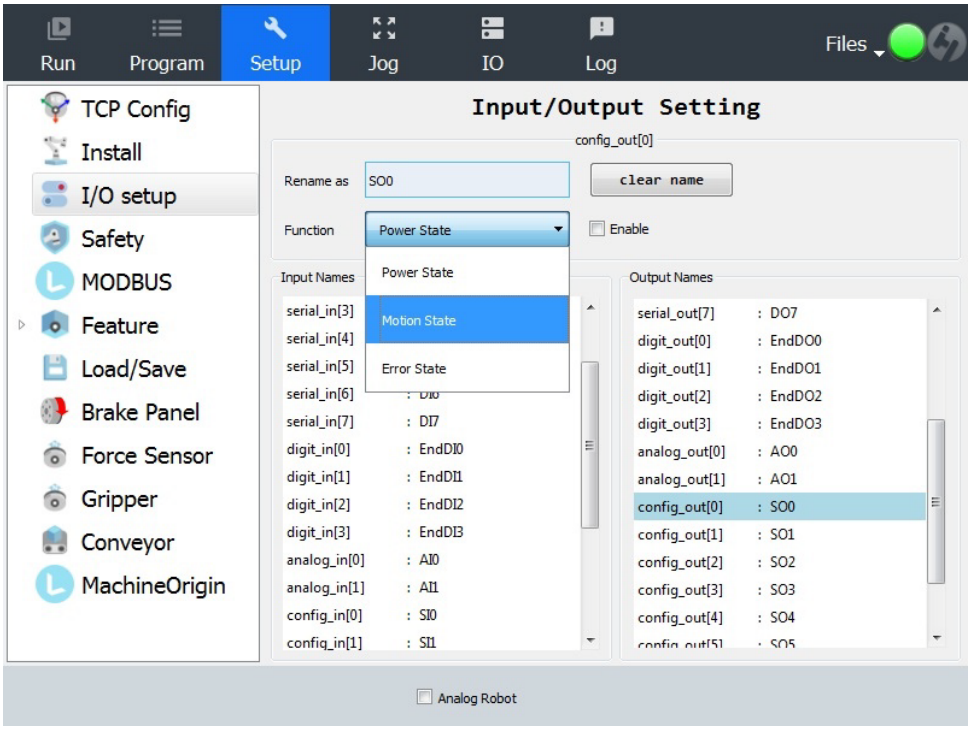


1) Names can be assigned to the input and output signals, making it easier to remember the individual signals when operating the robot. Click to select the appropriate I/O and use the on-screen keyboard to set the signal name. Setting the name to an empty string can restore the name.

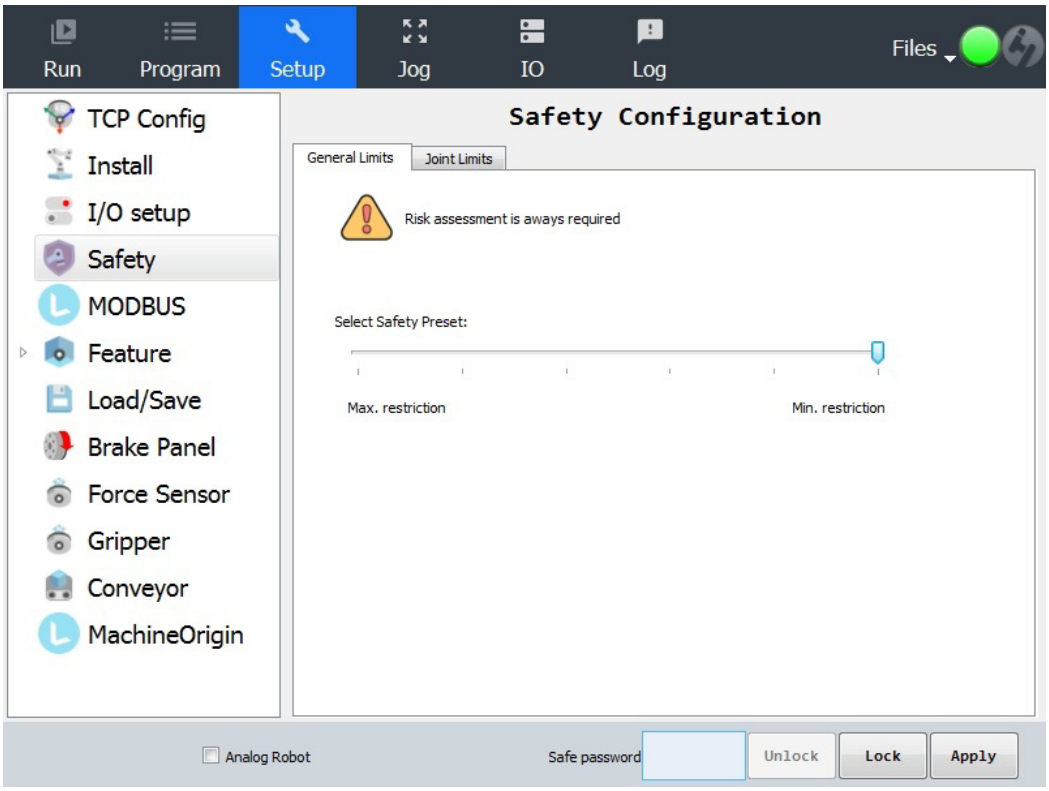
2) Eight configurable number input IO signals can be configured to trigger corresponding actions. Available actions include "enable", "error clearance", "switch to automatic mode", "pause script", "shield safe light screen", "open zero force demonstration", "cut off switch to automatic mode", "stop" and "continue script".



3) In addition, eight configurable digital output IO signals can be configured to reflect the current state of the robot. Such as "enable state", "motion state", "error state". When the “Start” option is checked, the IO's function settings will be enabled; if this option is unchecked, then Configurable IO and Universal IO are indistinguishable. It is also possible to rename these eight configurable digital output IO signals.



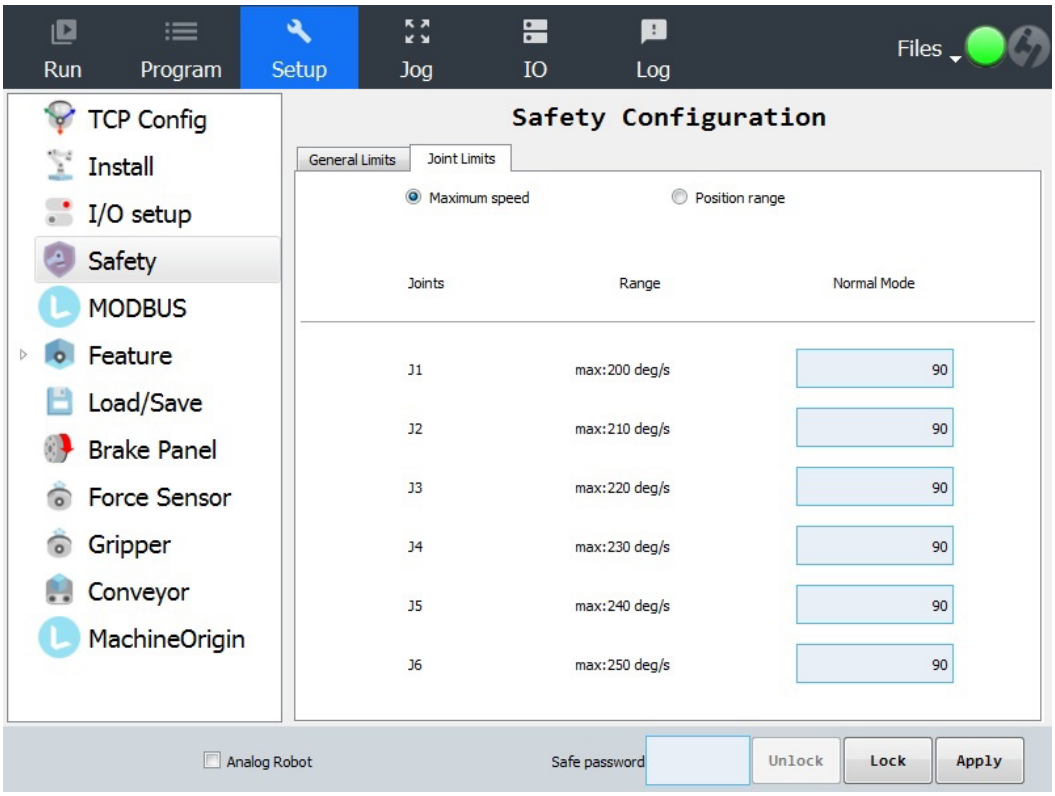
Safety



General limitation: As shown in the figure above, pull the Select Safety Preset box to adjust the collision speed of the safe stop during the operation of the robot. The “strict limit” sets a small collision force, and the “minimum limit” sets a large collision force. A total of 6 gears are selected on the safety-preset axis, and the required collision force is gradually increased from left to right.

5kg	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
J1	25	30	35	40	45	300
J2	30	35	50	65	75	300
J3	20	25	30	35	45	300
J4	15	18	20	15	20	300
J5	8	10	10	15	20	300
J6	8	10	10	15	20	300

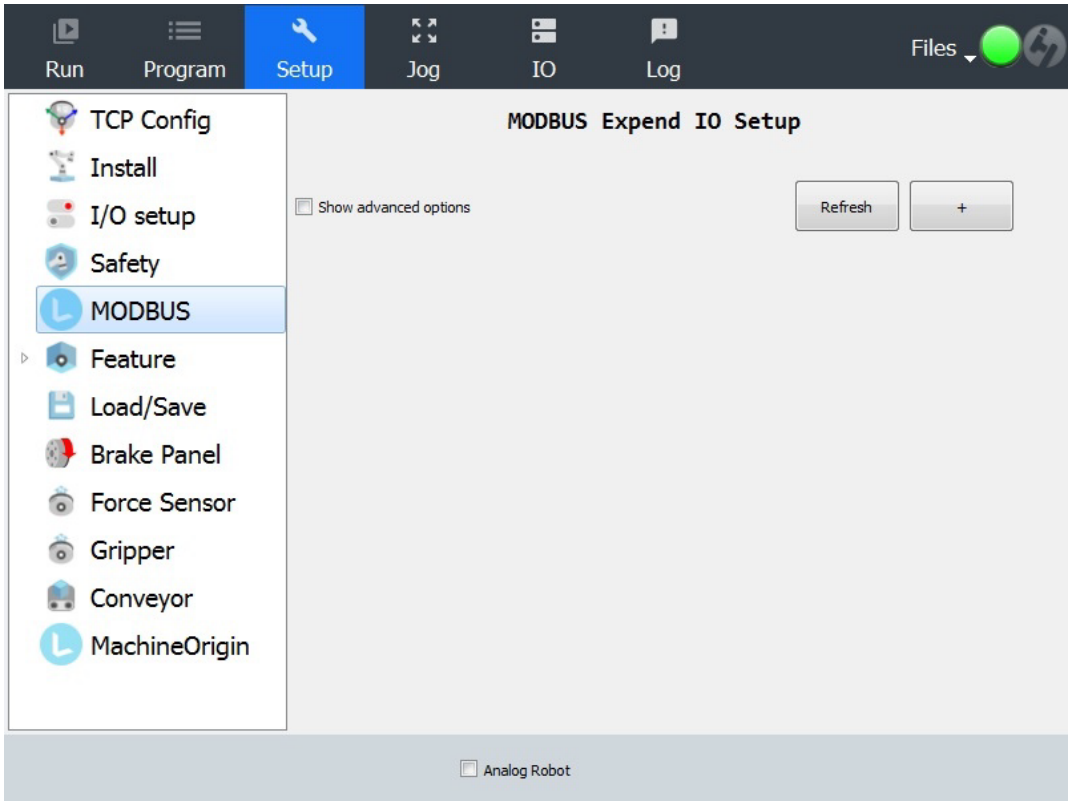
Joint limits: As shown in the figure below, select “Maximum Speed”, enter the four-digit security code, click Unlock to set the maximum speed of each joint (Elfin's maximum joint speed is 90°/s, the setting value cannot exceed this limit), and the setting is completed. Click Apply, Lock.



Similarly, the location range can be set.

Elfin joint angular motion range is: J1axis：±360°；J2axis：±135°；J3axis：±153°；J4axis：±360°；J5axis：±360°；J6axis：±360°。

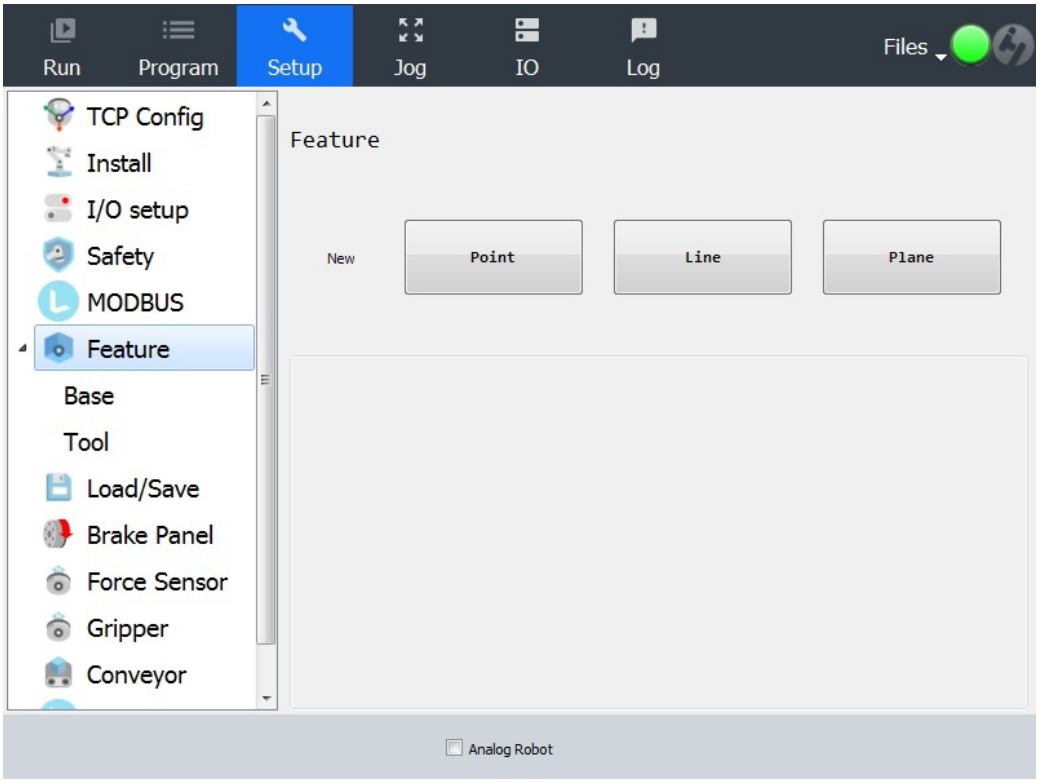
MODBUS（This function is temporarily unavailable.）



MODBUS client (host) signals can be set here. A connection to a MODBUS server (or slave) with the specified IP address can be created by an input/output signal (register or digital). Each signal has a unique name and can therefore be used in the program.

Characteristic

Setting feature is to set user coordinate system (point, line, surface) and set user coordinate system through teaching.

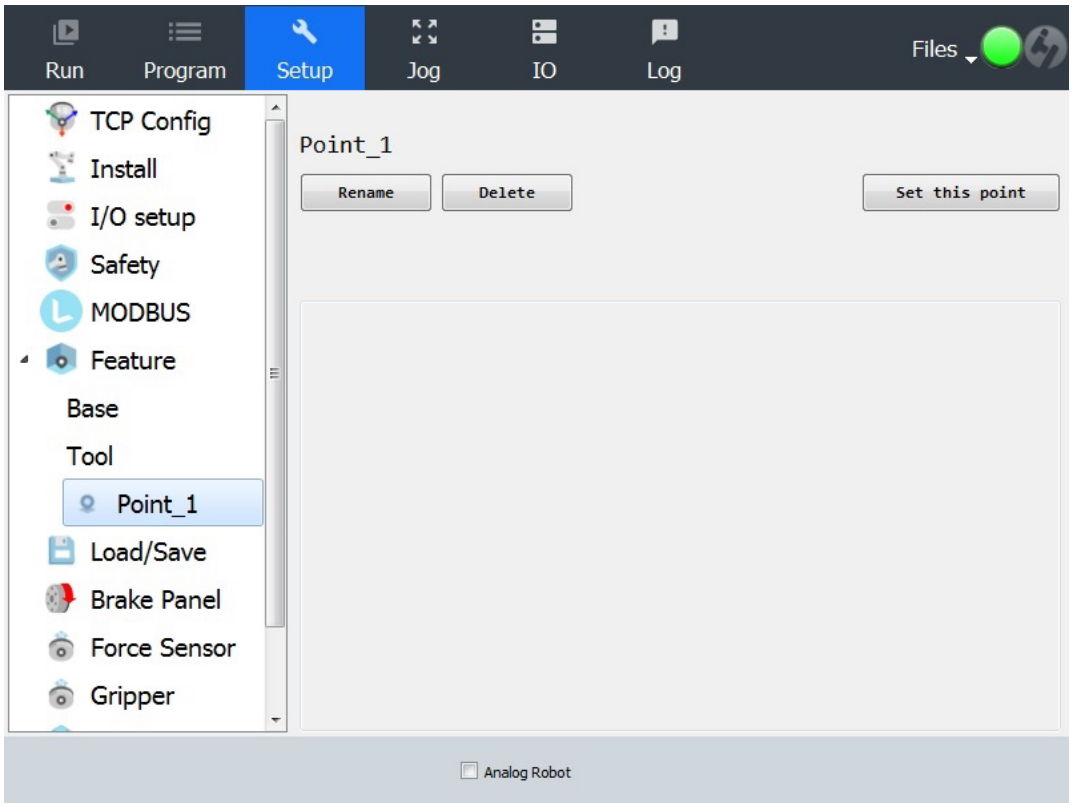


1) Point coordinates

Click the "Point" button; the "Point N" point coordinate system will be automatically generated, as shown in the following figure "Point_1":

Click the "Set this point" button to set the point coordinate system.

The position and orientation of the point coordinate system are the same as the position and orientation of the TCP at the teach point.



(1) **Rename**: use this button to rename features.

(2) **Delete**: use this button to remove selected features.

(3) **Display coordinate axis**: select the coordinate axis to display the selected feature in the 3D simulation robot. This option applies to this screen and the "move" screen. (This function is temporarily unavailable)

(4) **Wake up**: Select whether the selected feature will wake up. This determines if the feature will be displayed in the feature menu of the "Mobile" screen. (This feature is temporarily unavailable)

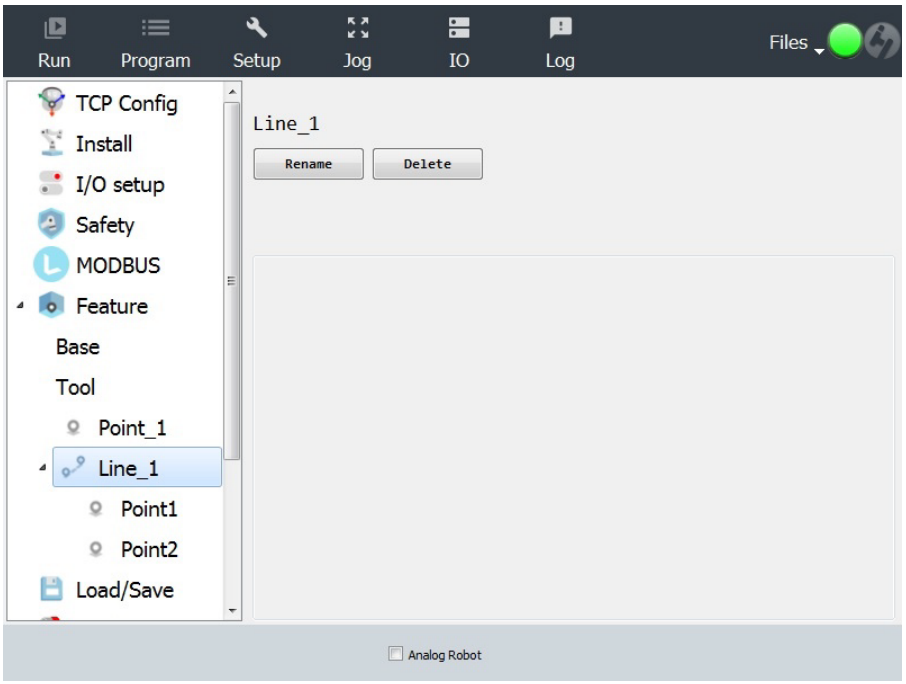
(5) **Variable**: Select whether the selected feature can be used as a variable. If this option is selected, the variable named after the feature name followed by "var" can be used when editing the bot, and a new value can be assigned to the variable in the program, which can then be used to control the waypoints that depend on the eigenvalue. (This feature is temporarily unavailable)

(6) **Move the robot here**: Press this button to move the robot arm to the selected feature. After the move is over, the coordinate system of the feature and the coordinate system of TCP will coincide. The difference is that the x-axis has a rotation of 180 degrees.

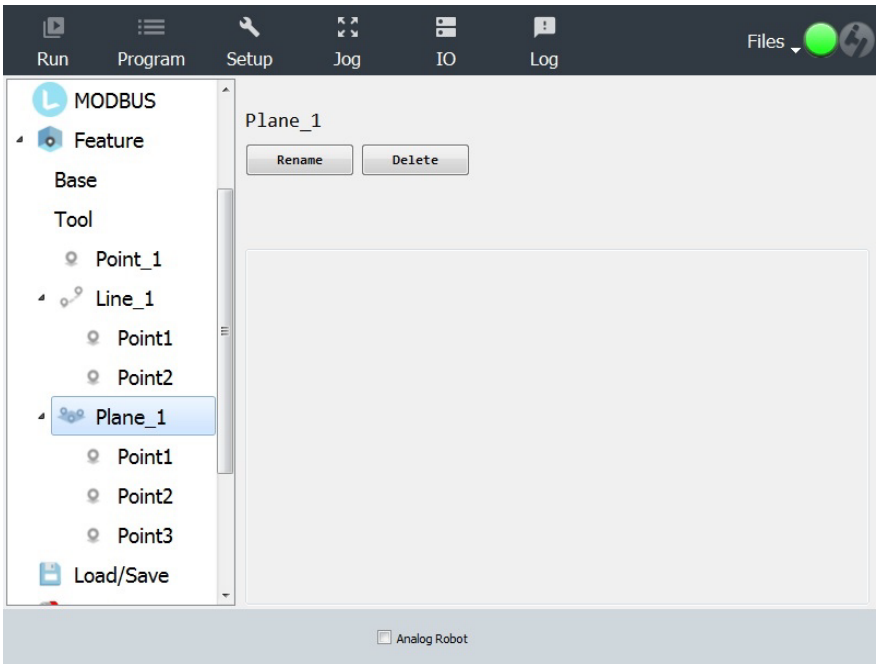
(7) **Re-teach**: Change this point: When it is found that the "point coordinate system" of the original teaching completion does not meet the requirements, you can click this button to re-teach the point coordinate system.

2) System of linear coordinates

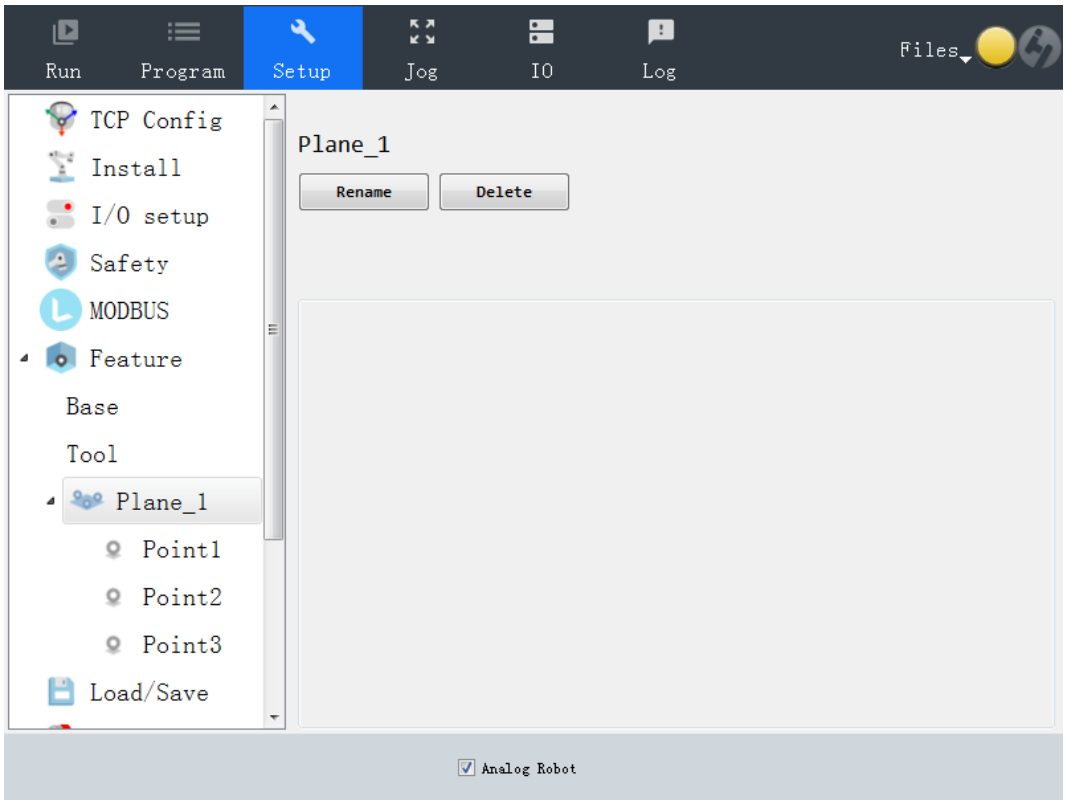
Add lines: add line features as shown in the figure below. The direction of the first point to the second point will form the forward and reverse of the y-axis of the linear coordinate system. The z-axis of the linear coordinate system is the same as the projection direction of the vertical plane of the Z-axis of the first point. The origin of the linear coordinate system is the same as the position of the first point.



3) Plane coordinate system



Add a planar feature to the installation settings as shown below. The plane is defined by three sub-point features. The position of the coordinate system is the same as the position of the first sub-point. The z-axis is the plane normal, and the axis from the first point to the second point is the Y-axis forward and reverse. The positive direction of the z-axis is set so that the angle between the z-axis of the plane and the z-axis of the first point is less than 180 degrees.



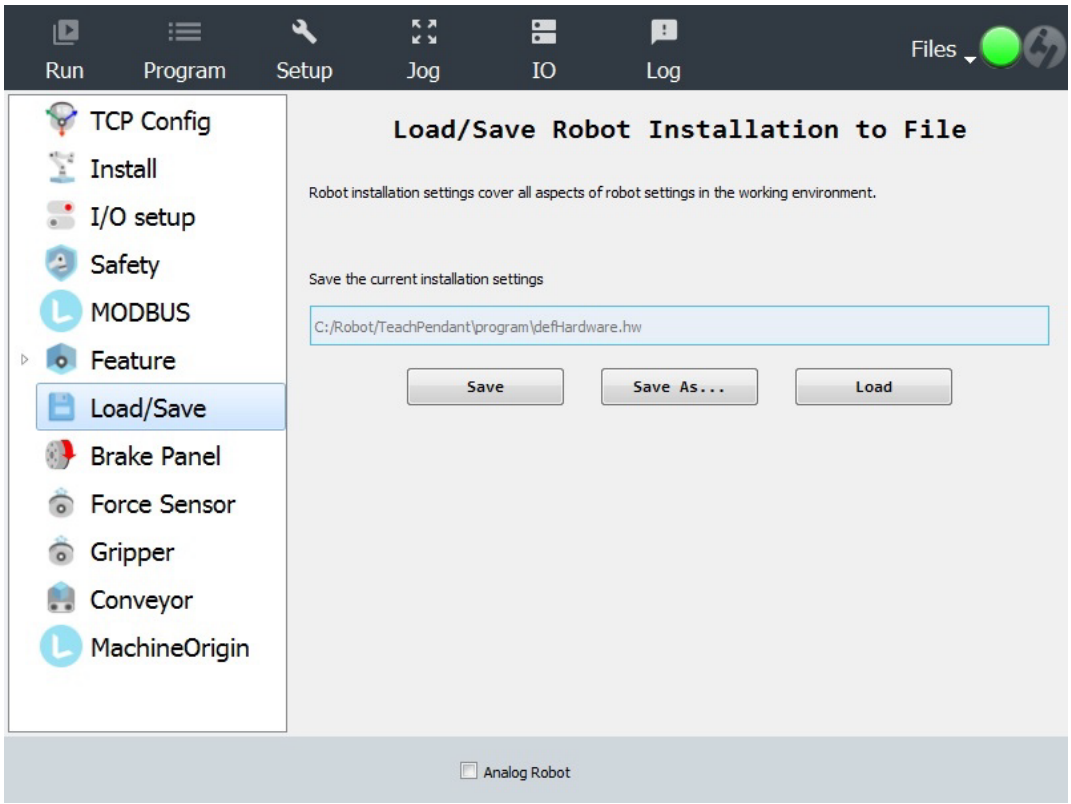
Load/save

Used to load or save the robot's installation settings file (.hw file type). The installation information includes the machine origin, dynamic parameters, and so on. The meaning of the interface button is as follows:

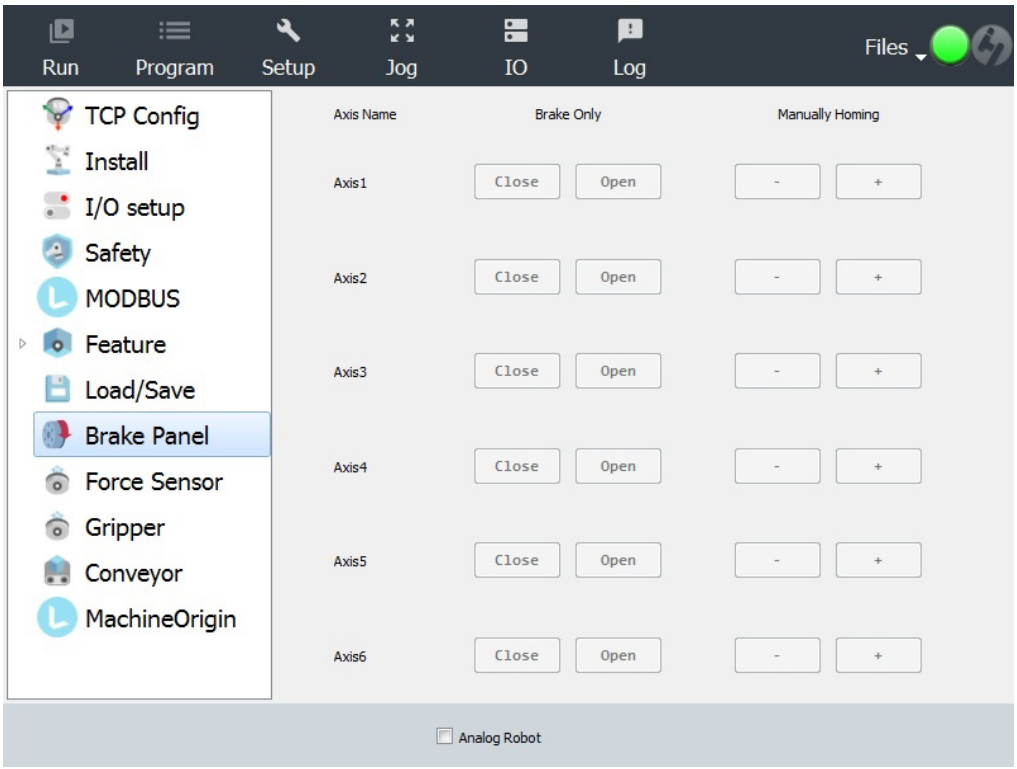
(1) **Save**: saves the current installation Settings to the path shown in the path box.

(2) **Save as**: saves the current installation Settings to a custom path.

(3) **Load**: load (under /program path) the setup file.

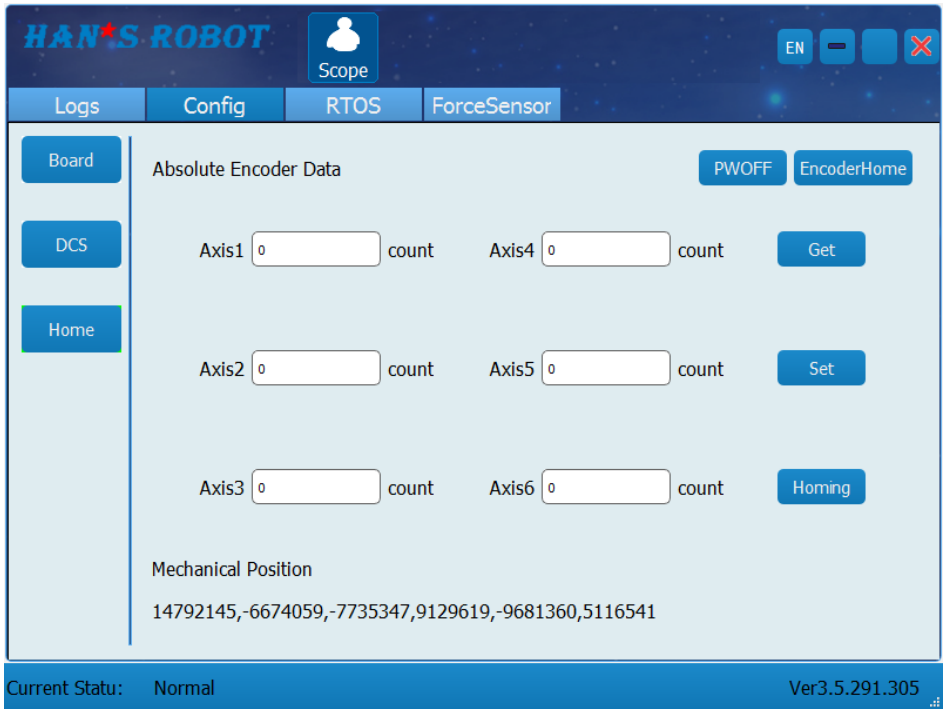


The brake operation

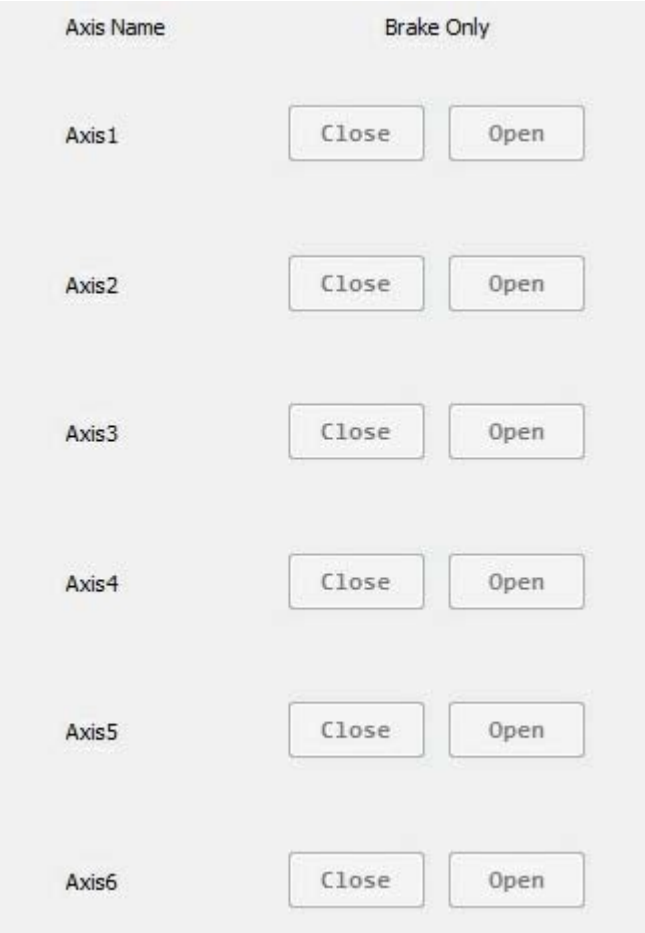


The interface can be used to open and close the single axis and perform HomeStep2 and other operations, but these two operations can only be carried out when the robot is in the state of PWOFF.

(1) PWOFF: switch to the "mechanical origin" interface in the DCS interface, click the "PWOFF" button in the upper right corner to enable the robot, as shown in the figure below:



(2) Open or close the lock of a single shaft: this function can be used in some special cases when the lock of a single shaft needs to be opened for debugging.



▸application scenarios:

The brake setting function is mainly in the case that the robot can not clear the wrong position after collision or self-collision.

① Axis 2 collision with external objects

② Axis 3 collision with external objects

③ Robot self-collision (Axis 2 collision with Axis 3)

How to manually open (close) a brake:

Step 1: In the event that the robot is disabled, let one person lift a corresponding axis.

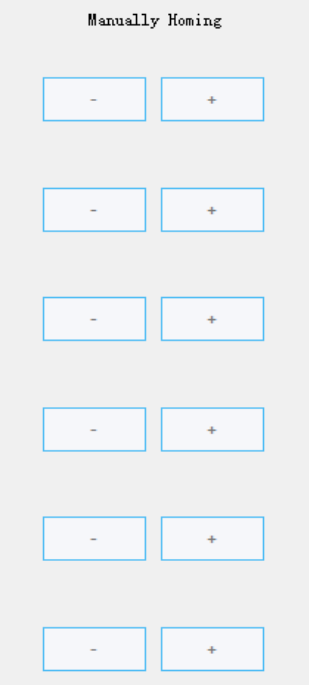
① In the case of Axis 2 collision with external objects, manually lift Axis 2, and you will hear a click sound from the brake when Axis J2 is lifted. Please move a little in the opposite direction and then Switch to the Brake interface of the software (you must always lift Axis 2). Click Open of Axis2 to open the brake of Axis J2. Manually lift Axis J2 to

a safe position. Click Close of Axis2 to close the brake;

② In the case of Axis 3 collision with external objects, manually lift Axis 3, and you will hear a click sound from the brake when Axis J3 is lifted. Switch to the **Brake** interface of the software (you must always lift Axis 3). Click **Open** of Axis3 to open the brake of Axis J3. Manually lift Axis J3 to a safe position. Click **Close** of Axis3 to close the brake;

③ In the case of robot self-collision (Axis 2 collision with Axis 3), manually lift Axis 3, and you will hear a click sound from the brake when Axis J3 is lifted. Switch to the **Brake** interface of the software (you must always lift Axis 3). Click **Open** of Axis3 to open the brake of Axis J3. Manually lift Axes J3 and J2 to a normal gap. Click **Close** of Axis3 to close the brake;

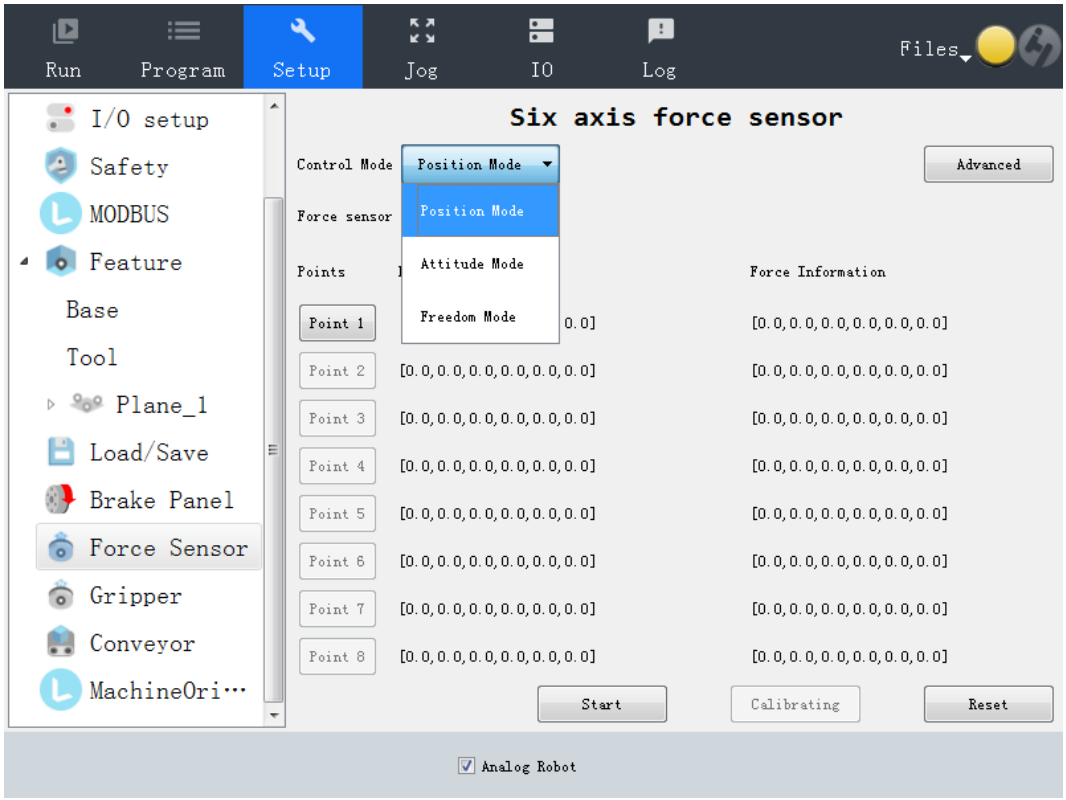
(3)single axis is executed to retrieve the origin(Manually Homing): When "home point loss" occurs, the robot is first removed to PWOFF, and then switched to the interface. Clicking "-" or "+" will perform the algorithm of retrieving the origin.



Performed Manually "Home" after the operation, please make the robot, and then to slow (about 10%) will the robot back to home position, check if the home position be right back.

Force sensor

The interface is applied to calibrate the six - dimensional force sensor, and selecting the control mode completes the application of force sensor.

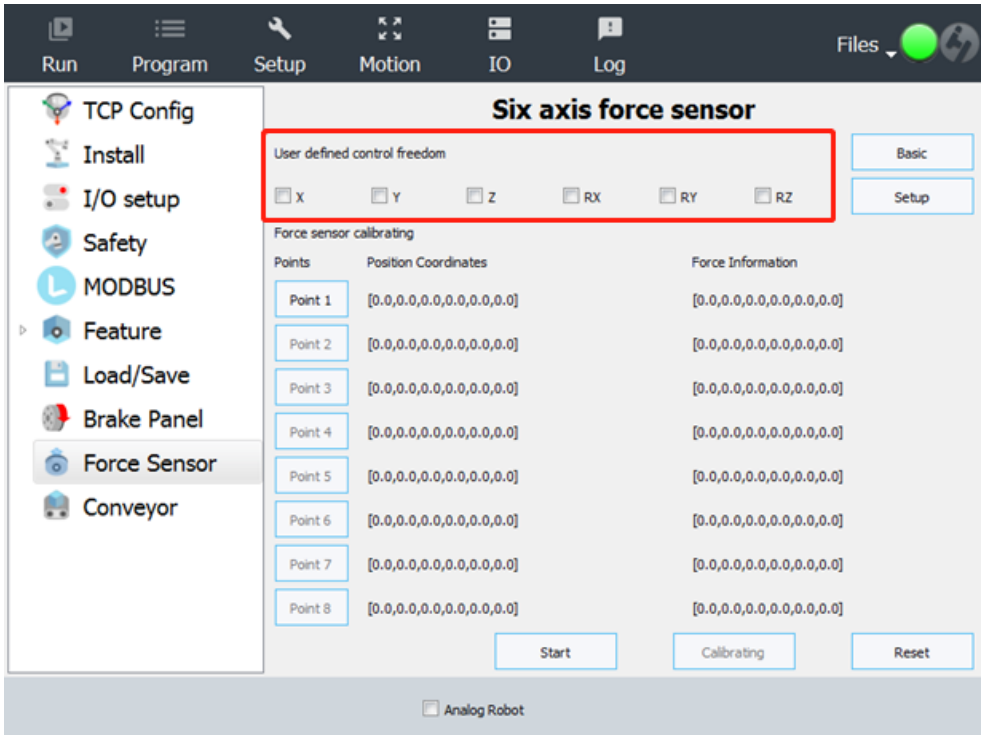


Position mode: the motion space based on force sensor is set in the X, Y and Z directions in the Cartesian space coordinate system.

Attitude mode: the motion space based on force sensor is set in the RX, RY and RZ directions in the Cartesian space coordinate system.

Free mode: the motion space based on force sensor is set in the X, Y, Z, RX, RY and RZ directions in the Cartesian space coordinate system.

Advanced Settings: users customize the selection of elements under the Cartesian coordinate system, select the corresponding mode and click the "Settings" button to complete the setting, as shown in the figure below.



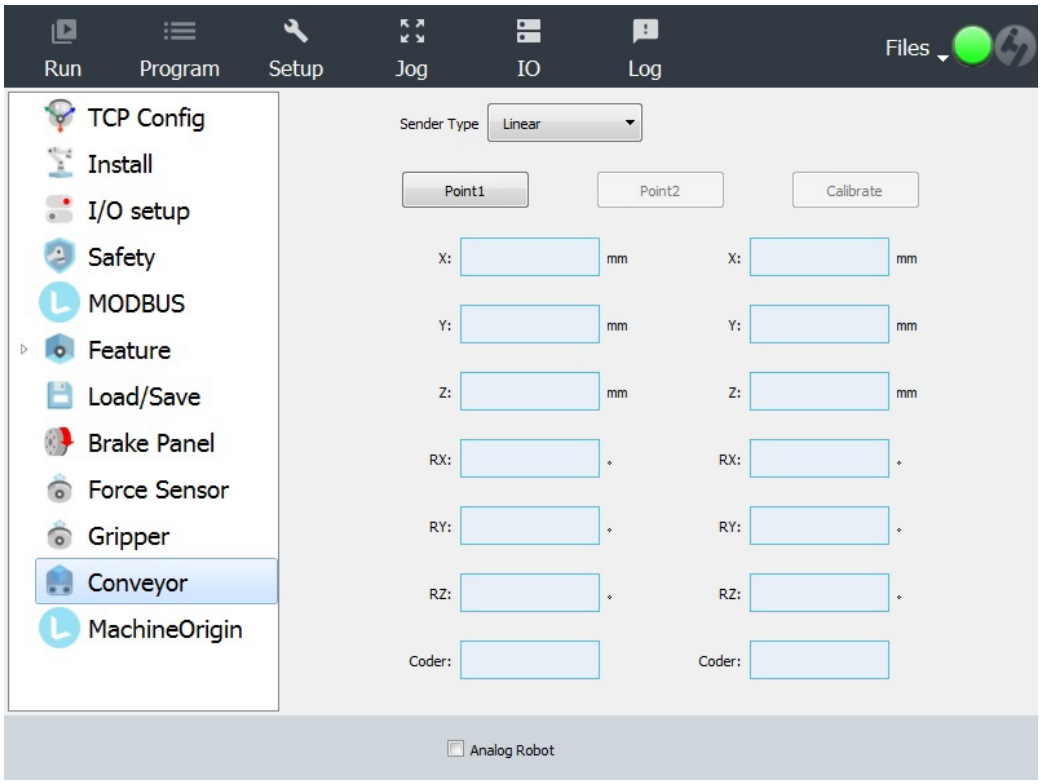
Calibration: calibrate the sensor by teaching 8 different positions and positions.

Reset: resets the marking point.

start: start using force sensor.

Conveyor

When using a conveyor, the robot can be configured to track the movement and speed of the conveyor relative to the "tool center point." Conveyor Tracking Setup provides configuration options that allow the robot to work with multiple common conveyors.



Conveyor type: optional type is liner.

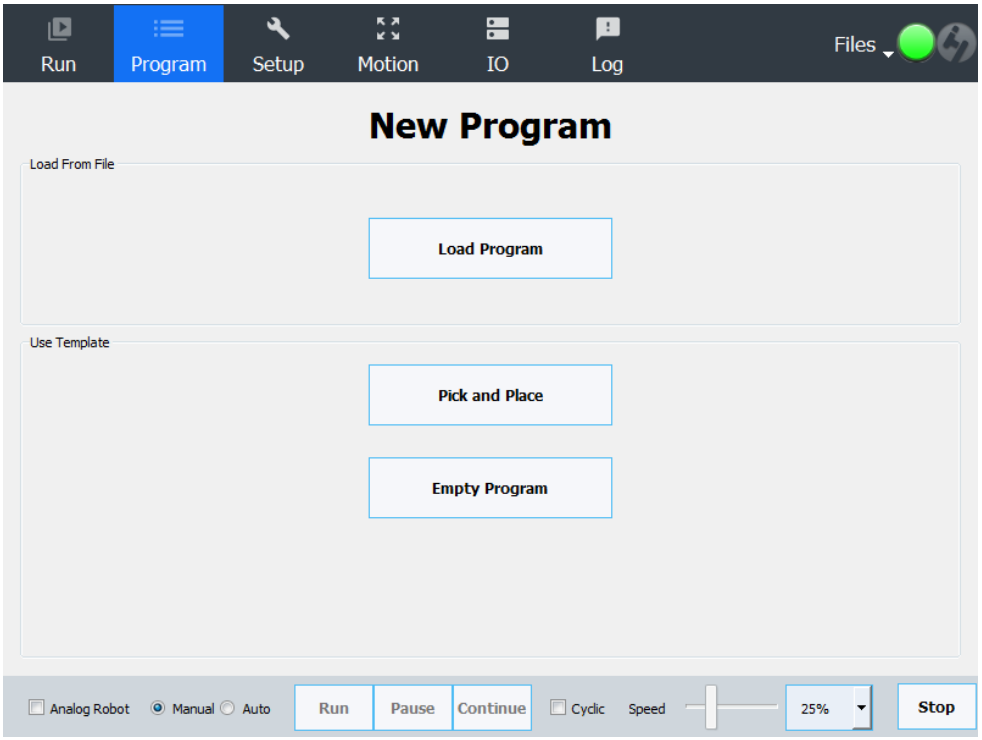
Marking points: teach two marking points according to the direction of belt movement.

Calibration: commence calibration.

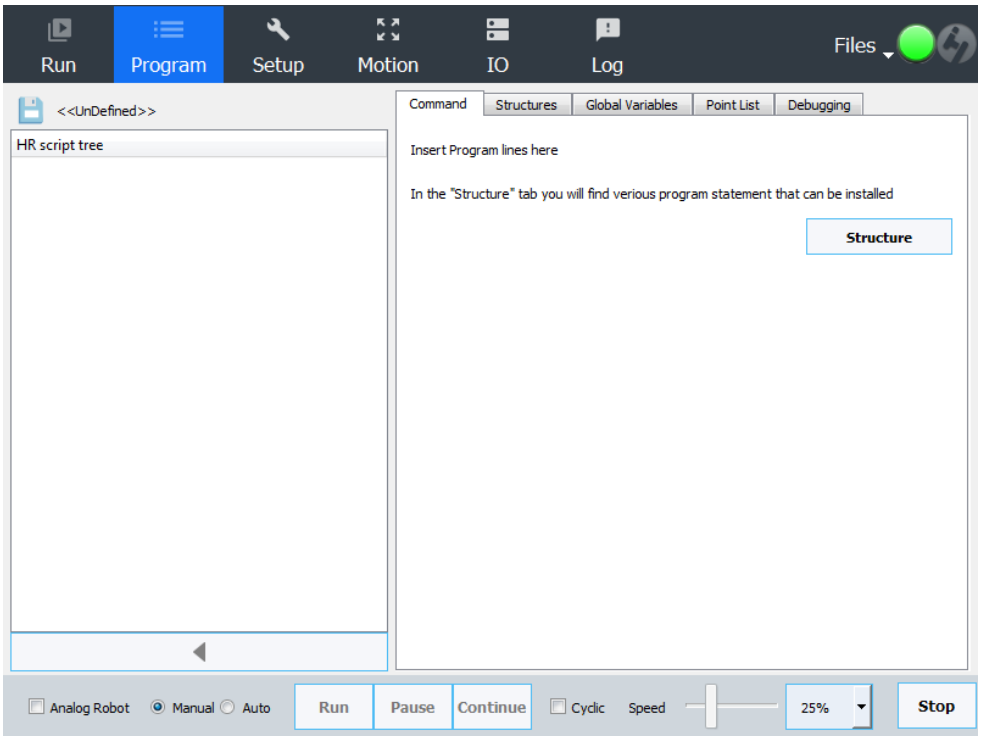
7.6 Program

New Program

New programs can be created by either an empty program or by referring to an existing (saved) robot program. Click the drop-down menu of "file" in the upper right corner and select "new" to enter the following interface. Click "empty program" to create an empty program and "loader" to load the script saved by the user.

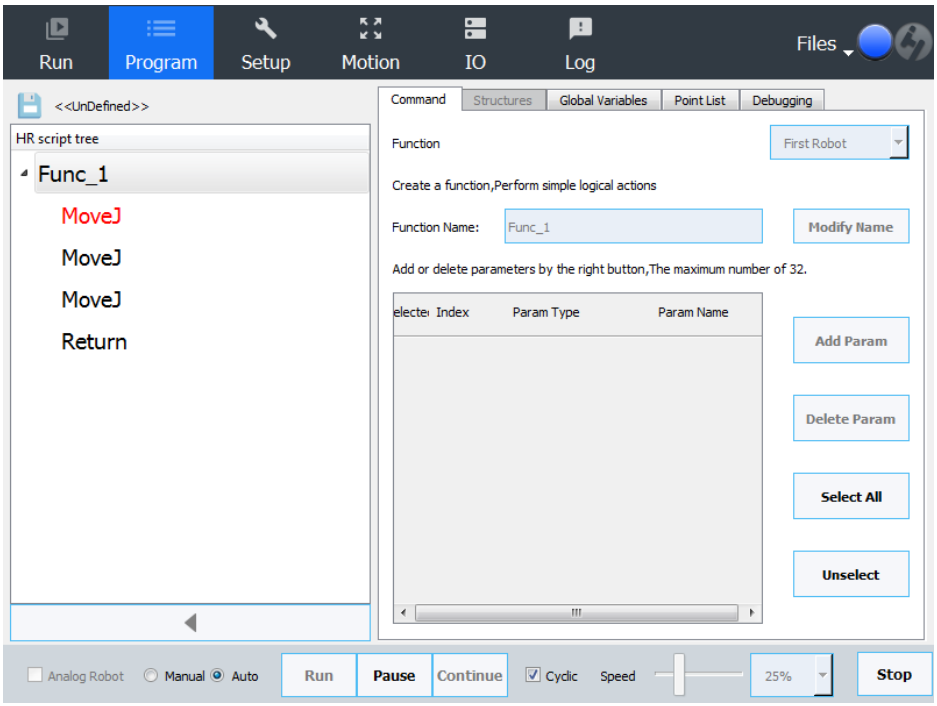


Program TAB

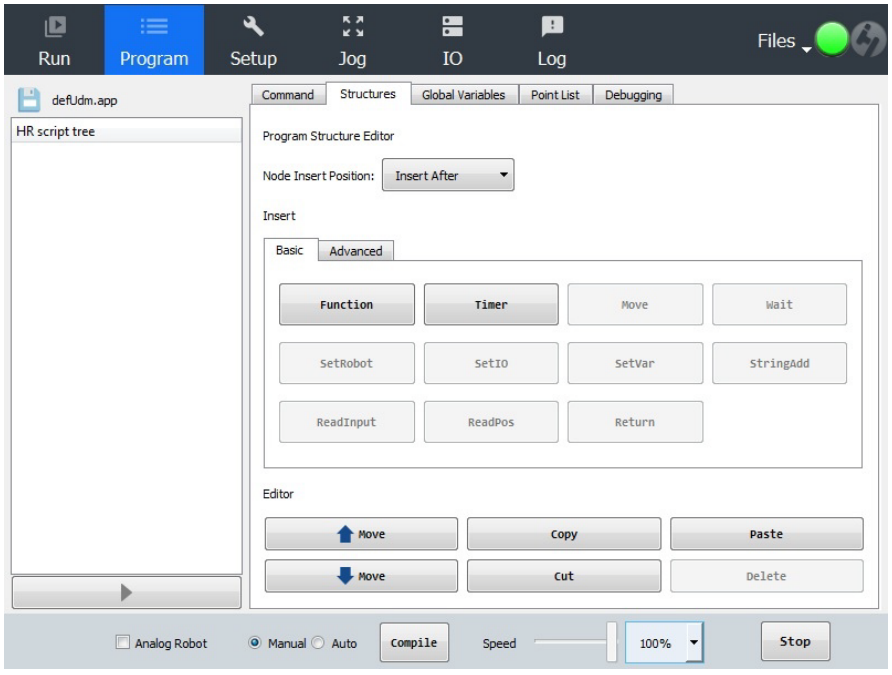


Program tree: The program tree on the left side of the screen displays the program as a command list, and the right area of the screen displays information related to the current command. The current command can be selected by clicking on the command list. You can use the Structure tab to insert or remove commands. The arrow button below the program tree, click this button to widen the display of the program tree. The program name is displayed directly above the program tree with a small disk icon next to it. Click this icon to quickly save the program.

In the program tree, the currently executing command is shown in red, as shown in the figure below.



Click the structure button to go to the "structure" TAB, where you can find a variety of optional commands. The commands in the program tree need to be inserted. After all program lines are specified and defined, switch to automatic mode, and the program can run after successful compilation.



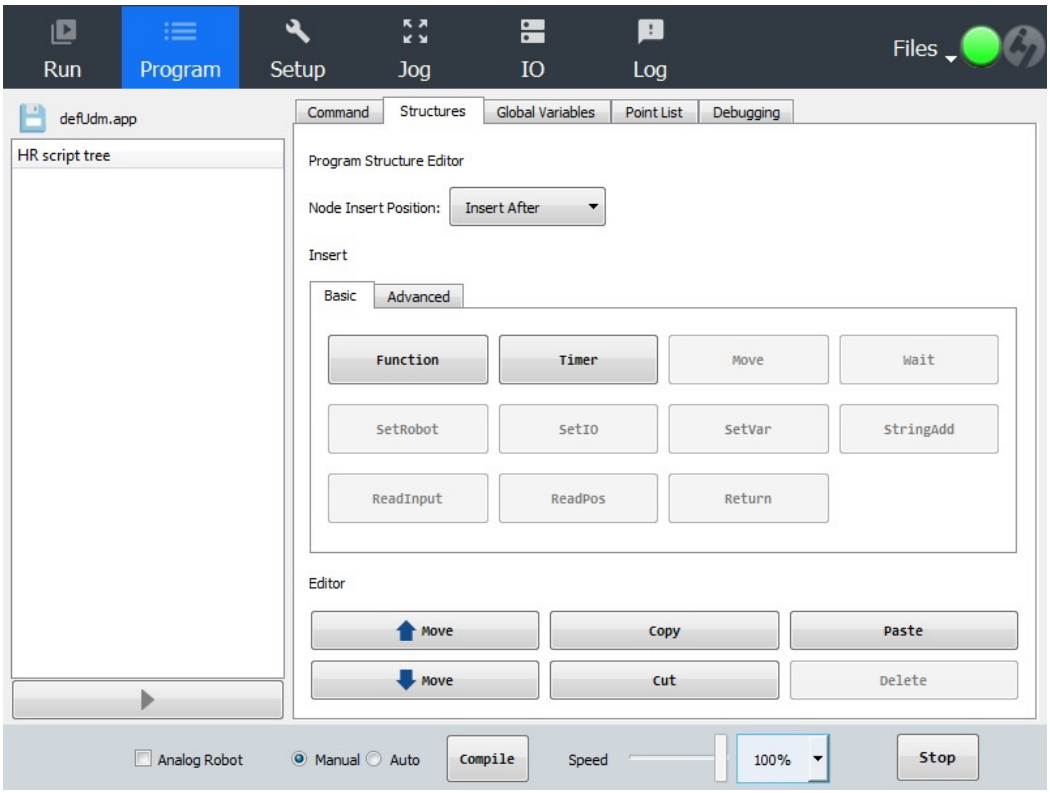
Program-structure

In the "Structure" column of the "Programs" tab, the user can insert multiple commands into the program tree, and the user can freely edit the custom application script. You can also use the copy, delete, cut, paste, and move to operate the command line accordingly.

As shown in the figure above, the following instructions can be added to the program tree by clicking the required instruction button in the "structure" column. After adding the instruction, the details of the instruction content need to be edited in the "command" column. The meaning of the button and instruction in the "structure" bar is as follows:

Node insertion location: "before selection" will insert the instruction above the currently selected command line, and "after selection" will insert the instruction below the currently selected command line.

General instruction



(1) Function: Create a new function that adds an instruction to the function

(2) Timer: adds a Timer to the script root directory. The Timer Function can run in parallel with the Function instruction (up to five Timer functions can run simultaneously).

(3) Move: Add a spatial linear motion command (MoveL), joint motion command (MoveJ), circular motion command (MoveC), Z-motion command (MoveZ), and position offset command (MoveRelL, MoveRelJ) by teaching.

(4) Wait: Add a wait instruction to the function, wait for the end of the waiting time when running the program, or wait until the set condition is met before the program can continue to execute.

(5) SetRobot: Add this command to the program to control the robot's power on, PWOFF, error reset and robot stop command; set the robot's user coordinates, tool coordinates; set the speed ratio during the movement; set the robot payload; set to turn on conveyor follow.

(6) SetIO : add the instruction to set the serial digital output IO, bus digital output IO state, and set the corresponding IO signal to high or low.

(7) SetVar : an instruction that can assign values to both global and local variables.

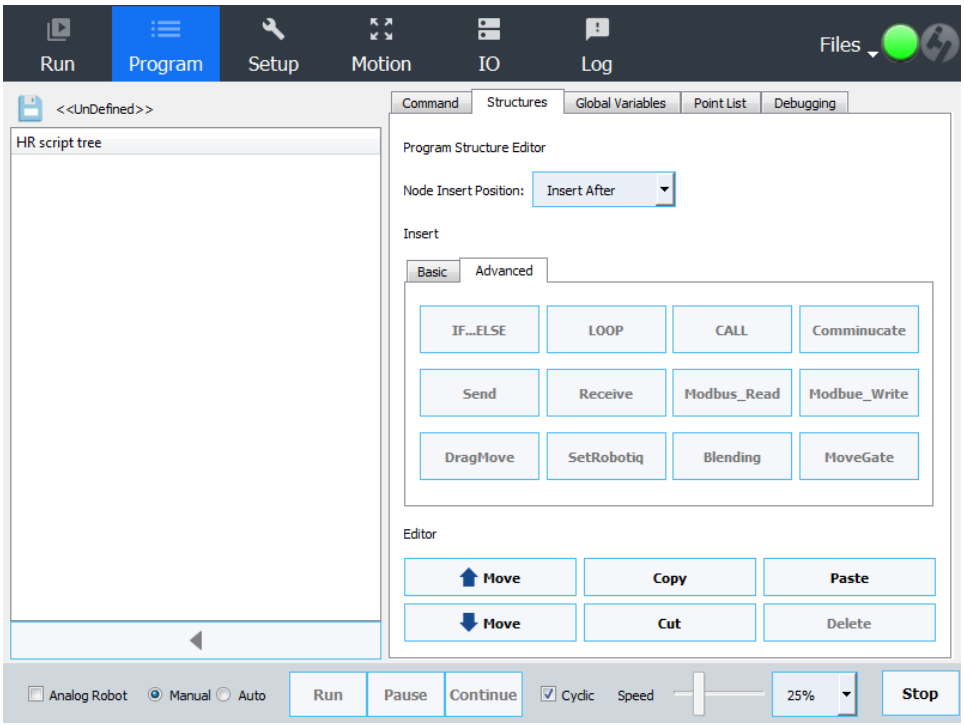
(8) StringAdd : The result of adding two string variables to a new string variable is usually used with the ReadInput and Call instructions.

(9) ReadInput: Reads the status of one or more serial input IOs and stores their status in the integer variable.

(10) ReadPos: Get the joint angle value or spaces coordinate value of the current robot and assign these values to the Double variable.

(11) Function Return: this logic is used at the end of the function to end the program.

Advanced Order



(1) IF...ELSE: Adds a regular judgment instruction, and the "if...else" structure can instruct the robot to change its behavior according to whether the IO input status or the set judgment condition is satisfied or not. If the condition is true, the command line for this If will be executed. Each If command can contain multiple ElseIf and one Else commands. If the result of the expression is False during the execution of the If section, then it will go to the next ElseIf or Else.

(2) LOOP: Adds a loop instruction that is used in the internal loop of the program until the condition judged by LOOP is false, and then jumps out of the loop.

(3) CALL: Add the call instruction, which is the logic to call other functions in the function.

(4) Communicate: Add network client to communicate with server.

(5) Send: Add client send TCP/IP data instruction.

(6) Receive: Add client to receive TCP/IP data instruction.

(7) Modbus_Read: Add client to receive Modbus data instruction.

(8) Modbus_Write: Add client send Modbus data instruction.

(9) DragMove: Add the user's drag instruction. The user can select the existing FreeDrive instruction through the track list or track variable, or create or edit the track through the "track edit" button.

(10) SetRobotiq: The Robotiq gripper is supported, and the application method is detailed

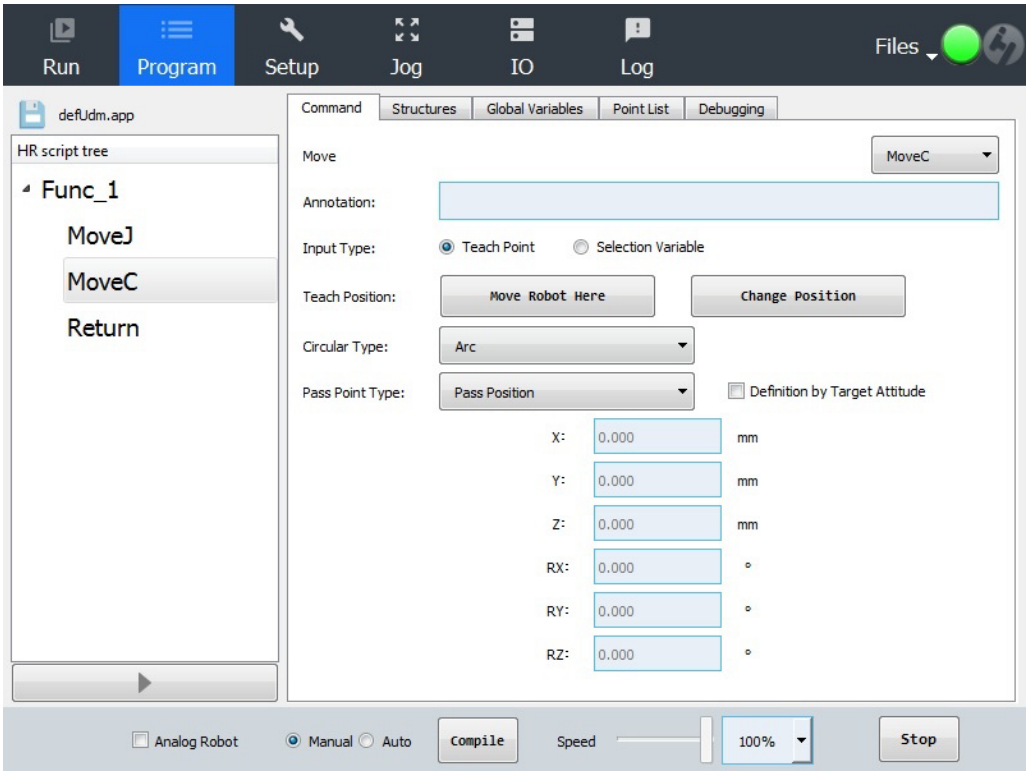
in the following SetRobotiq instruction.

(11) Blending: In the Blending command, the MoveL and MoveC movements will be added to the blend, and there will be no pause between the motion instructions. The blending motion will show better fluency in time.

(12) MoveGate: The trajectory of the robot is the arch trajectory.

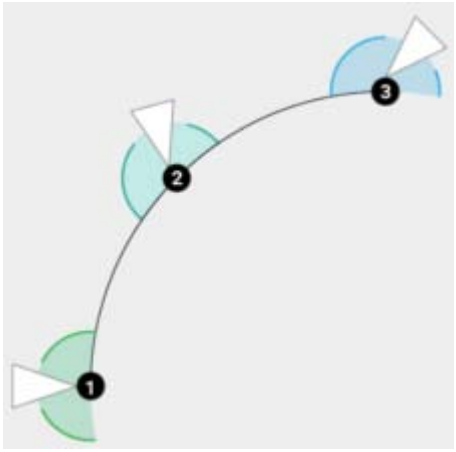
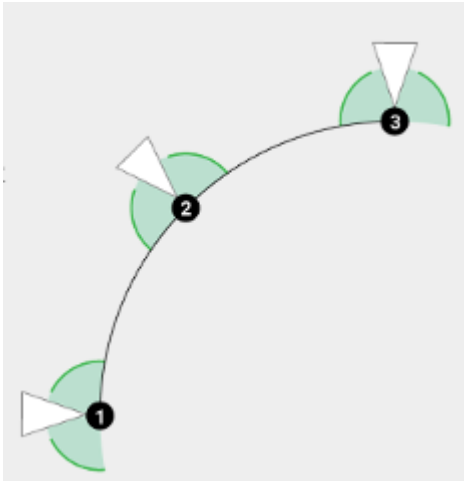
Partial instruction details

➔ 1、MoveC Command：



The MoveC command realizes the circular path motion, and the interface determines a circular path (full circle or arc) according to the method of determining the circle by three points. Three points cannot be in the same position; otherwise a circular trajectory cannot be determined. The function description is shown in the table below:

Button	Description
Circular arc type	The following two types can be selected: Arc or round
Initial position	The current position of the robot, the starting point of the arc
Passing position	A point through which a circular path passes can be used to "manually teach" PCS coordinate values, or to "select variables" to pass in coordinate values.

Target position	The target point of a circular trajectory, if it is a full circle, is also considered as a passing point. Can be taught as PCS coordinate values, or can be passed in via variables.
Number of circular	If the selection type is an arc, the number of circles is the number of times the robot repeats the track.
Profile type	There are two types of profiles ①When "Definition by Target Attitude" is not checked, the posture from the starting point to the ending point has nothing to do with the second point. The effect is as follows, 1 point is the starting point, and 2 and 3 points are the passing point of the arc and the target point.  ②When "Definition by Target Attitude" is selected, 1 point is the starting point, and 2 and 3 points are the passing point of the arc and the target point. Based on the tool attitude of the initial point, the motion starts from the starting point to the end point. The effect is as shown below: 

➔ 2、MoveZ Command

The MoveZ instruction is used to realize the z-type trajectory between two points, and its schematic diagram is shown below. The red track is z-type trajectory. (Note: at the peak of the z-type trajectory, the actual trajectory is more rounded than the indicated peak)

3-points teaching:

①starting point：p1

②Ending point: p2 (The connection line between p1 and p2 is the middle line of the z-track width line)

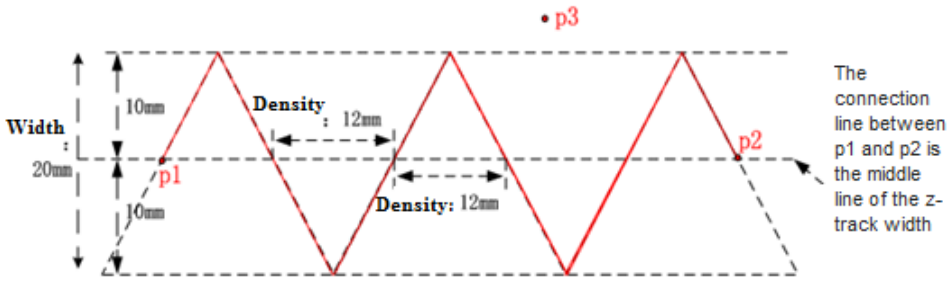
③Planar point: p3 (Used to determine the MoveZ trajectory plane.)

④Z type Width: as shown in the figure below, is the vertical distance between the two peaks of the z-type trajectory;

⑤Z type density: The density of the Z-shaped trajectory is determined linearly by the speed of the robot. The ratio can be set in the configuration file (the faster the speed, the denser the density; the slower the speed, the more dense the density):

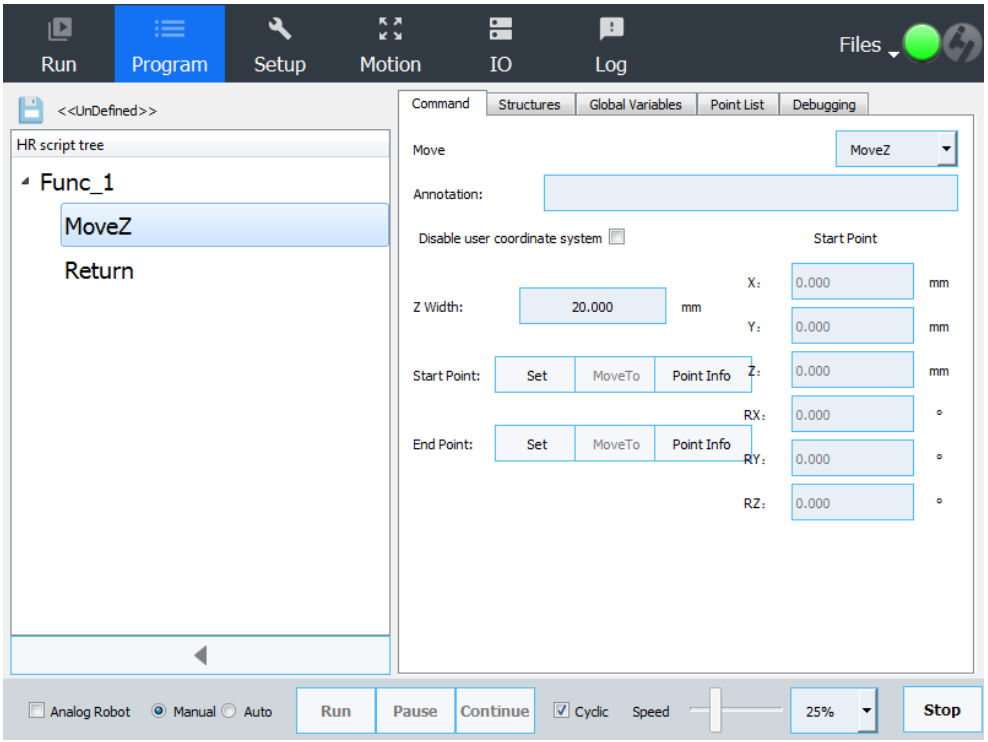
The following table shows the relationship between speed and density by setting the density parameter to 0.02cm as an example:

	Robot Speed	Z type density
2^1	2%	8mm
2^2	4%	4mm
2^3	8%	2mm
2^4	16%	1mm



There are two ways to edit the MoveZ command, which is to distinguish whether the user coordinate system is checked.

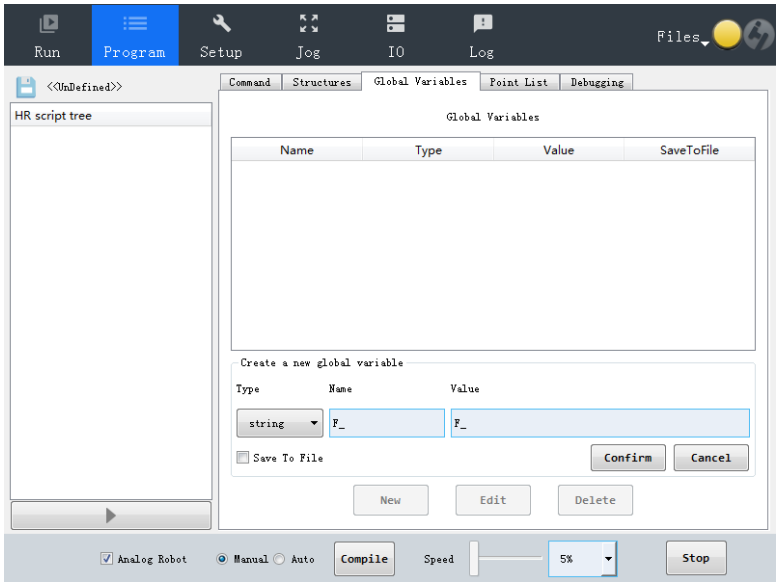
(1) When "disable user coordinate system" is not checked, the z-type trajectory in the current user coordinate system is realized by setting "z-type width", "start point" and "end point".



(2) When "Disable User Coordinate System" is checked, the third point "Determining Plane Point" will be added, and a user coordinate system will be obtained by "Starting Point", "Ending Point", "Determining Plane Point", and then on this coordinate system. Implement a Z-shaped trajectory.

➔ 3、ReadSerial、StringAdd、Call Command

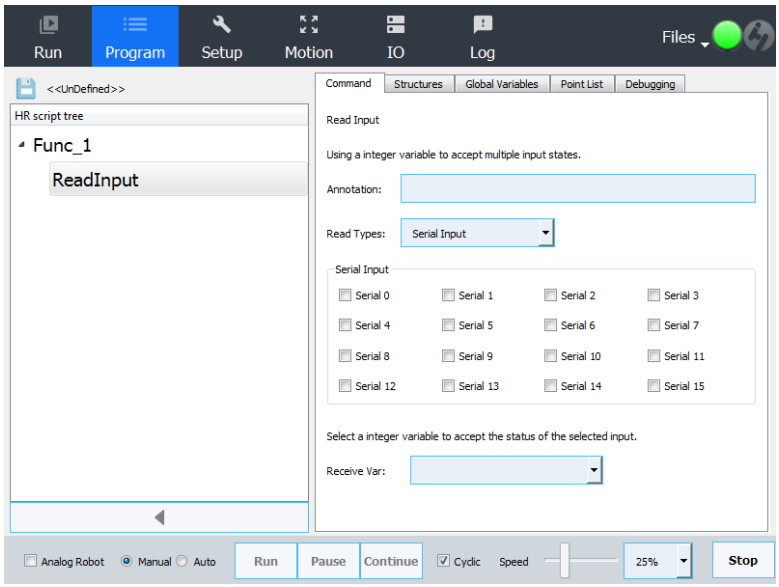
①Click to enter the "command edit" interface and switch to the variable interface. Create a string variable and set the variable name to "F_" (the name can only be F_). Then click "ok" and "save" buttons to complete the creation of the variable.



②Create a second string variable with freely defined names such as string1:

③Create a second integer variable with freely defined names such as int1:

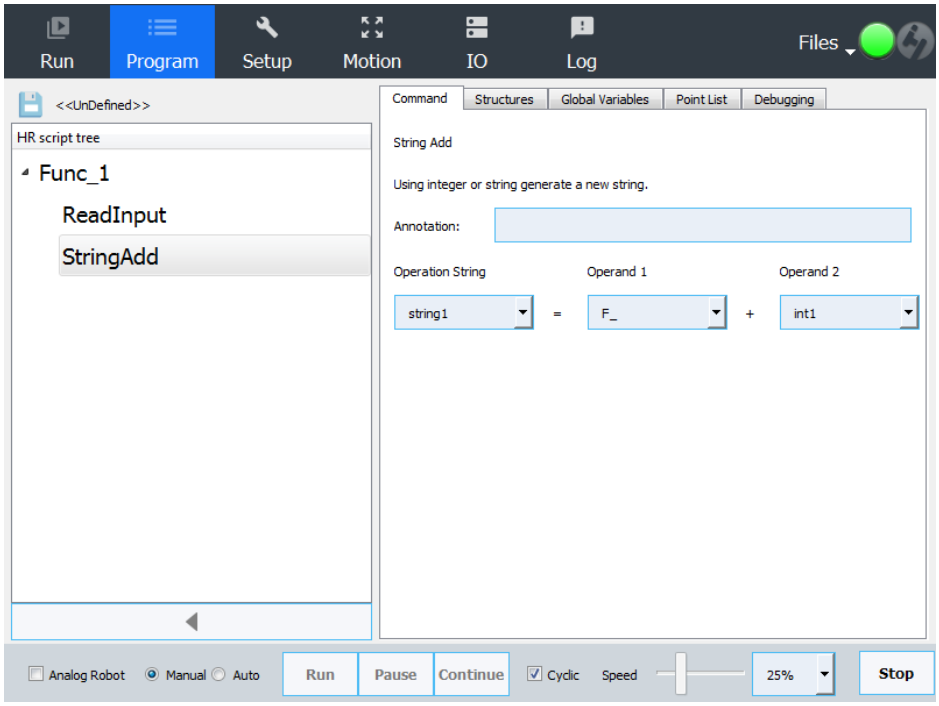
④ Add the ReadInput command to the program, check the option in front of the serial port IO to be monitored, and select the new integer variable in step 3 in the Write Variable option, then click the "Save" button.



The value of an int variable is determined by:

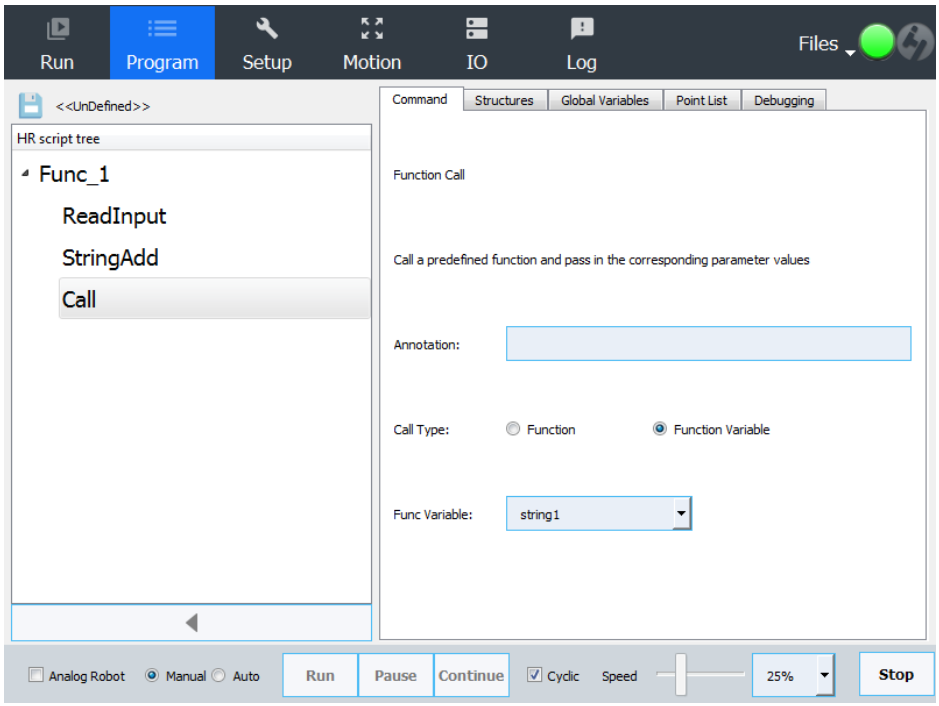
If the IO signal state of S0, S3, and S6 are selected, it is written into the int variable. When the signals of S0, S3 and S6 are all set high, that is, int=$2^0 + 2^1 + 3^2$=7. If the signal of S0 and S3 is set high and the signal of S6 is set low, int=$2^0 + 2^1$=3;

⑤Add the StringAdd instruction in the program, select the string variable named "F" of the parameter 1 drop-down list in the instruction details, select the new int1 variable in the drop-down list of parameter 2, select the string1 variable of the step called new in the drop-down list of the result, and then click the "save" button.

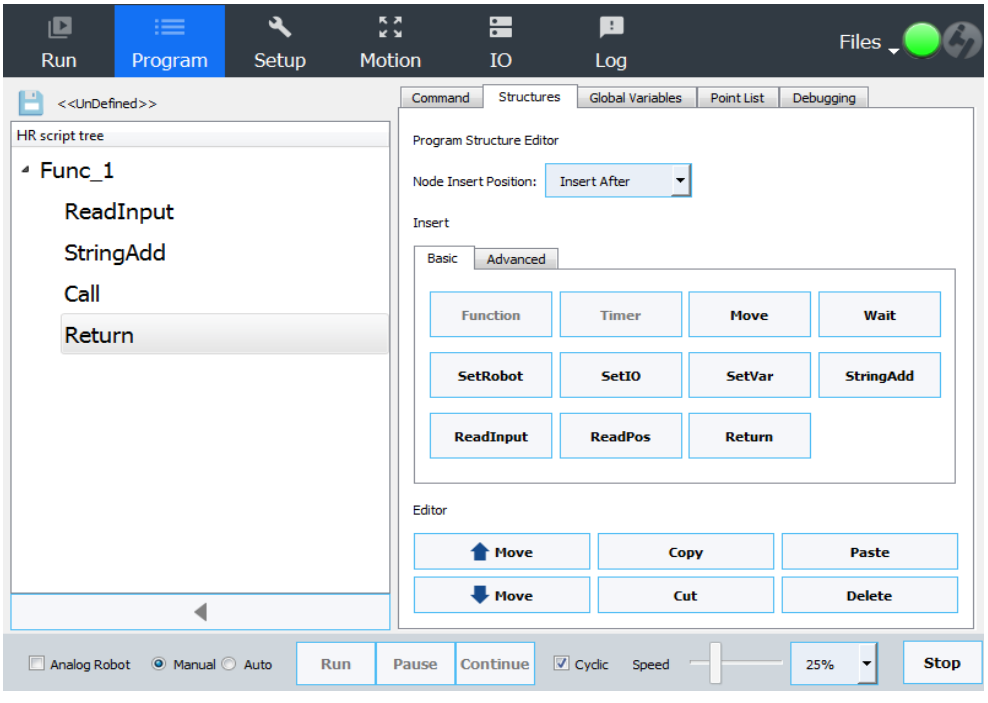


As shown in the figure above, because the variable name of parameter 1 is “F_”, when the value of the parameter 2int variable is equal to 7, the call of the Call instruction is the F_7 function; if the value of the parameter 2int variable is equal to 8, the call of the Call instruction is For the F_8 function;

⑥Add a Call command to the program, select the "Global Variables" option in the "Instruction Details" interface, select the result variable set in step 4 in the drop-down list that follows, and then click the "Save" button;



⑦Finally, the Return instruction is added at the end of the program; here, how to call the program through the change of the IO signal is completed.



➔ 4、TCP/IP Communication Commands：Communicate, send, receive, ModbusWrite, ModbusRead

The Teach Pendant Communication Module supports the two most popular communication methods: the network port (TCP protocol) and the serial port (MODBUS TCP protocol). The communication module of the teach pendant software is used in script editing as follows.

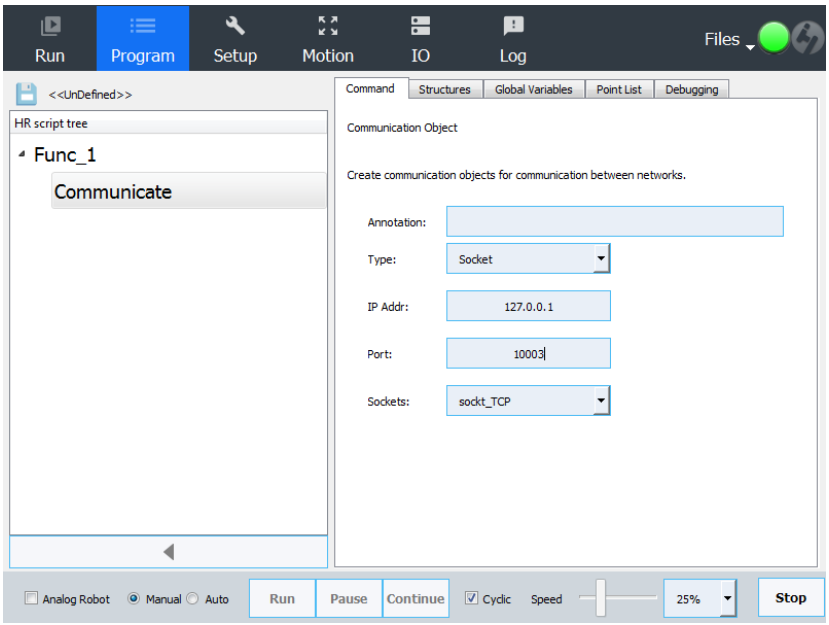
★TCP protocol

①**New variable (Variant)**

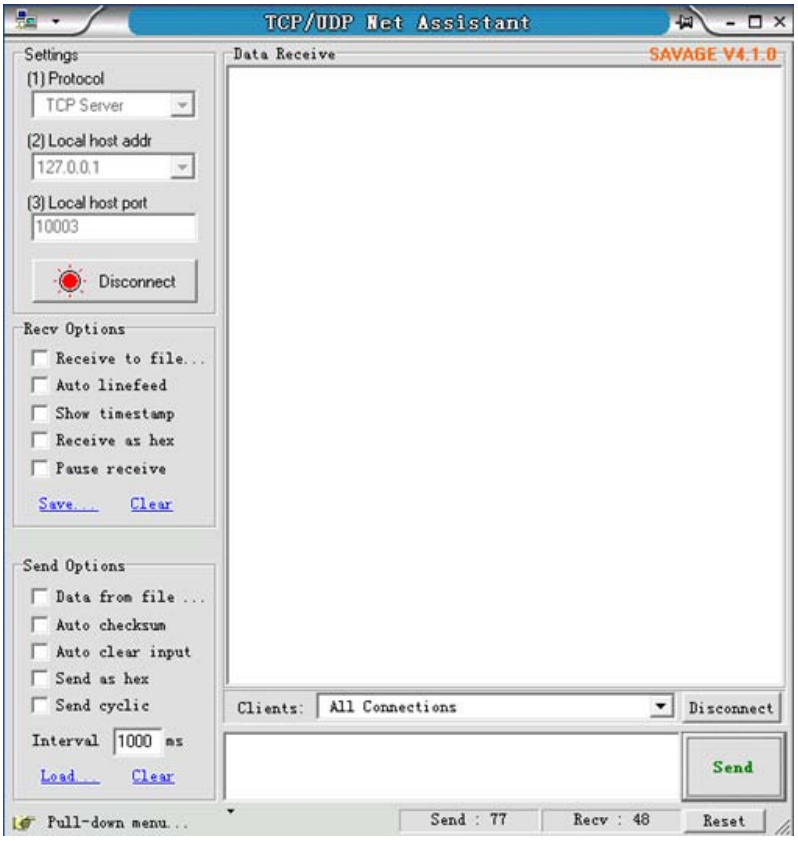
Added socket type variable socket_TCP (for new connection slot) and string type variable string_TCP_recieve (for receiving message string).

②**Establish a configuration connection (Communicate)**

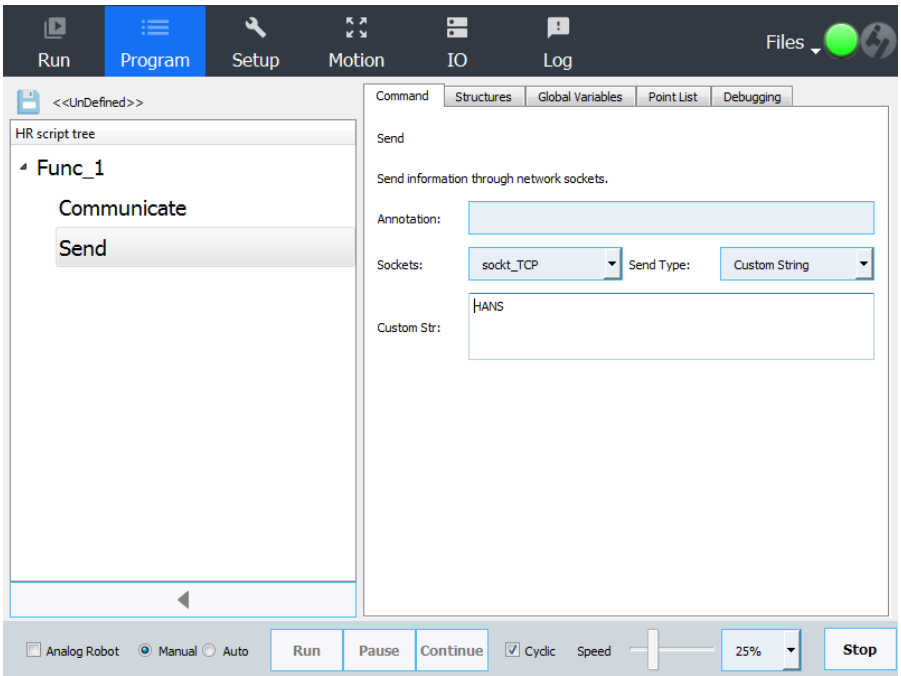
As a client, the TCP communication uses the Socket connection method, configures the IP (using the loopback address 127.0.0.1 or the remote host address) and Port, the socket uses the socket type variable (socket_TCP) created before, and uses the communication assistant as the server. Establish a connection with it.



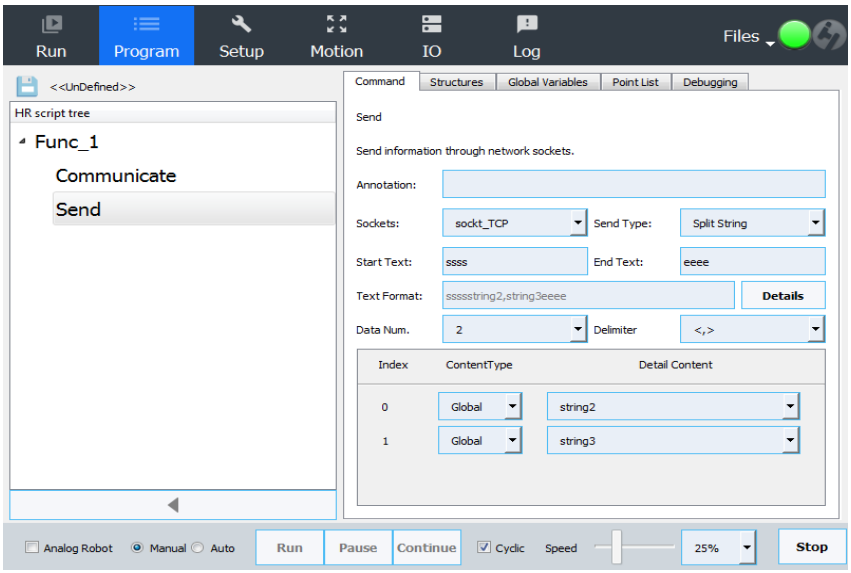
Note: If you use 127.0.0.1 as the loopback address, the port number must be 10003.



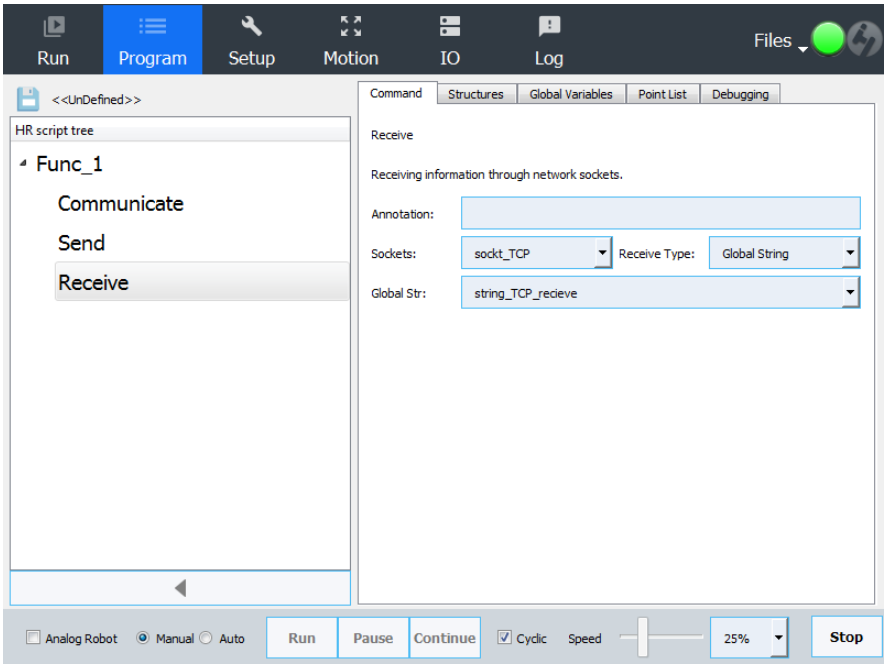
③**Send**: as shown in the figure below, you can select the form of custom string sending, string variable sending, and multiple string variables sending. Select "custom Str" to send, and the content is "HANS".



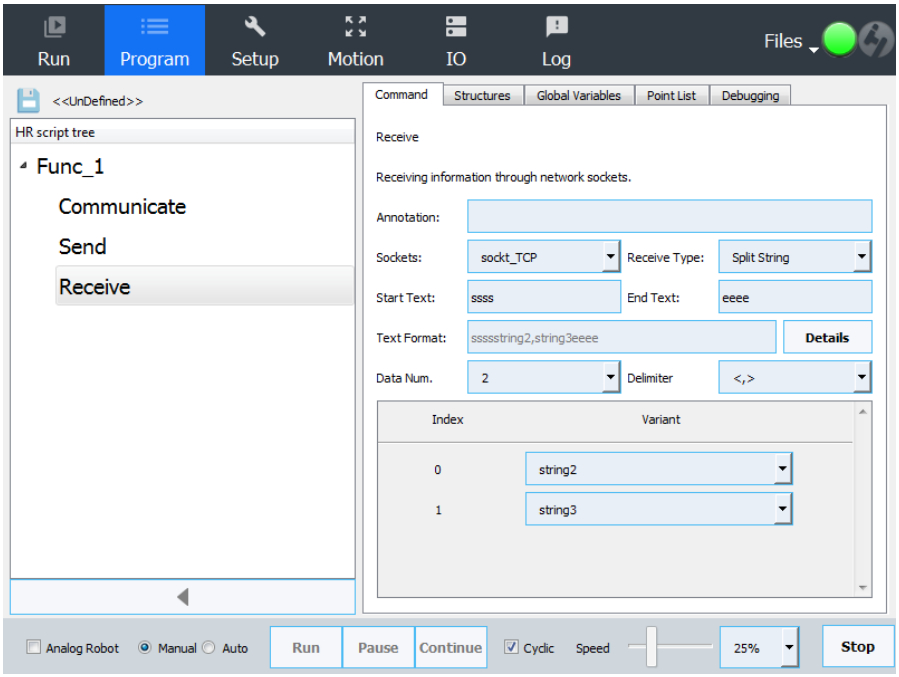
When "Split String" is selected for transmission, as shown in the figure below, "Start Text" and "End Text" are the opening and ending characters of the sent string, and whether the "Start Text" and "End Text" are required according to the actual application of the client. "Settings, "delimiter" is the separator character between the string and the string, "number of data" is the number of strings sent, as shown in the following figure, the number is 2; the data format sent is Custom (Custom strings) and Global (string variables).



④Accept the message in string format, here select the string variable (string_TCP_recieve) created before, as shown below:



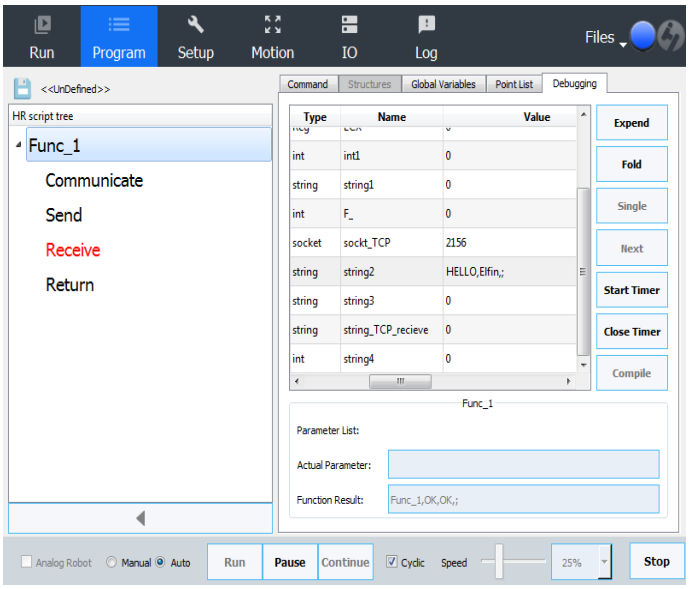
When you select "split string" to receive, as shown in the figure below, you can set the "start text" and "end text" form of the received data. The "delimiter" is the separator between the received strings, and the number of data. For the number of received strings, the received variable types can be Int, Double, and String.

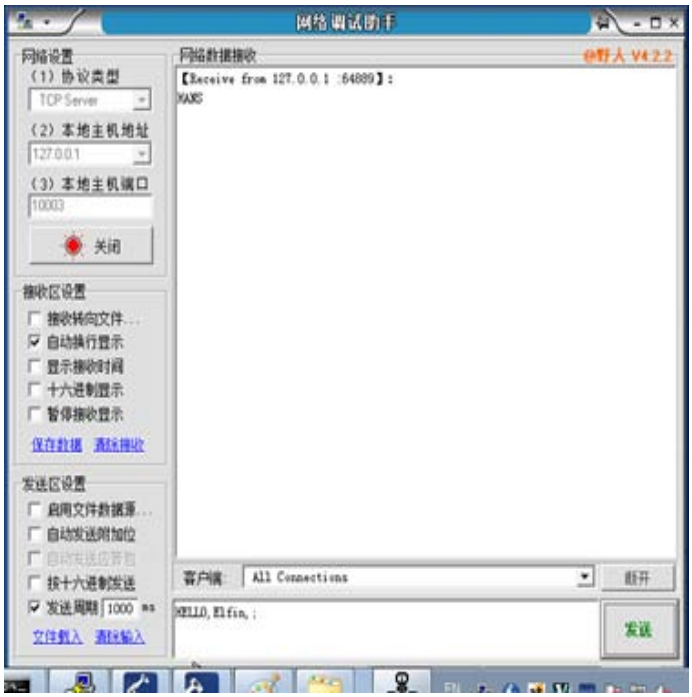


⑤**Return**: End the function, returning a custom string indicating that the function has been executed.

⑥When configured, run the function (F_TCP_communicate) :

⑦After the teach pendant sends (HANS) to the communication assistant, it waits to receive the message of the communication assistant; the teach pendant receives the message "HELLO, Elfin,;" , and the corresponding variable string_TCP_recieve is Change, the effect is as shown below:





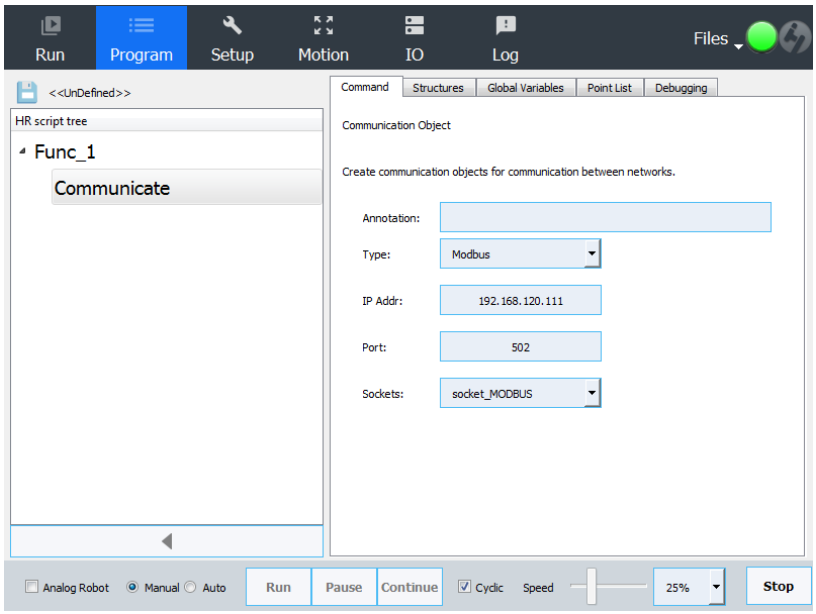
★MODBUS TCP Protocol

① NEW Variable(Variant):

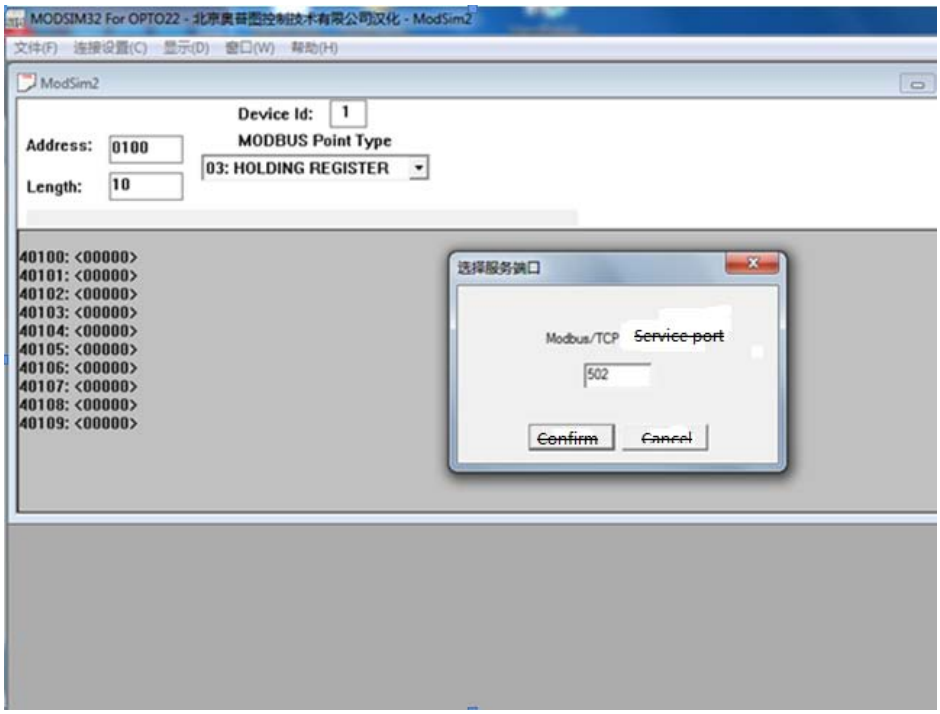
Added socket type variable, named socket_MODBUS (for new connection slot) and ten integer variables (for reading serial port data).

② Setting up configuration connections（Communicate）:

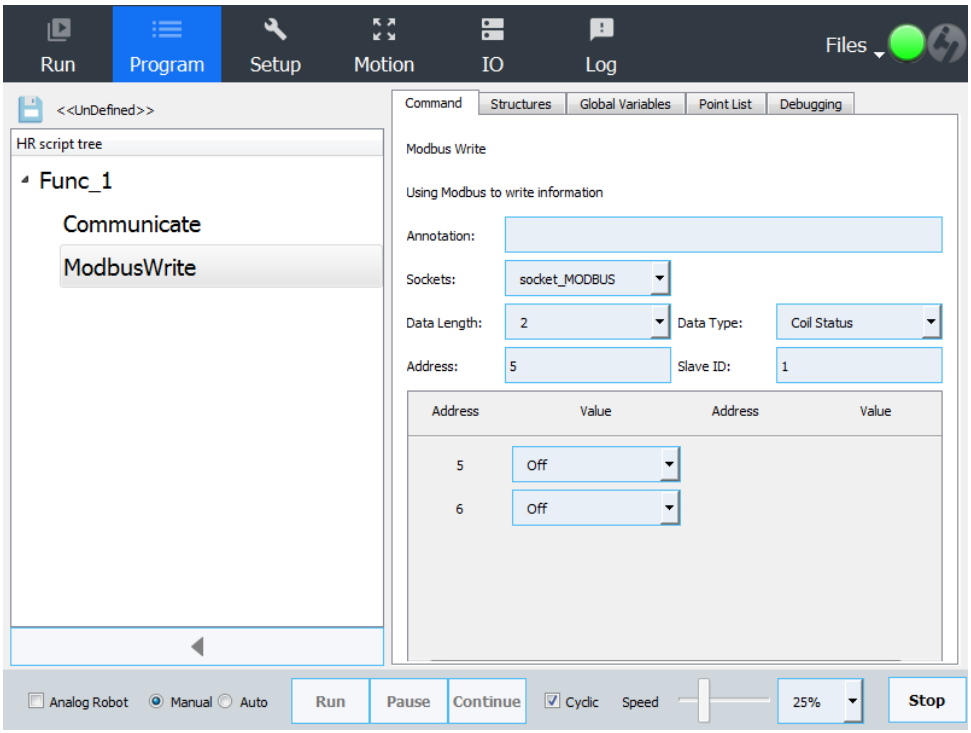
MODBUS communication selects MODBUS, configures IP (using loopback address 227.0.0.1 or host address) and Port (sets consistently), and Socket uses the socket type variable (socket_MODBUS) created before.



③Take the virtual serial port software again for example. Configure the virtual serial port as shown below.

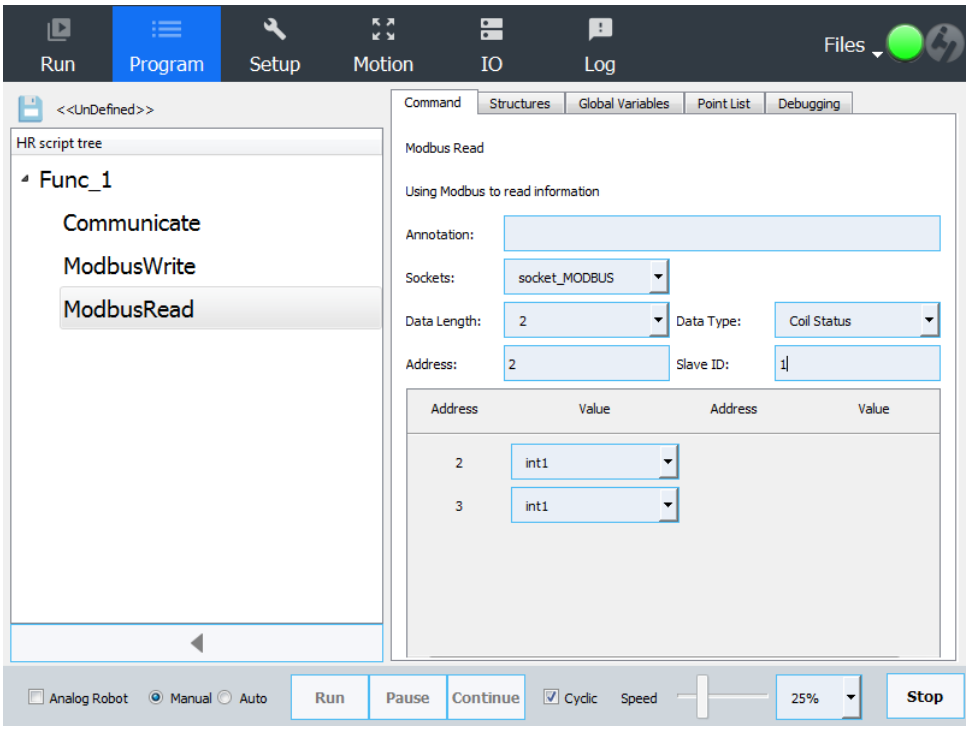


④Write data to the serial port（ModbusWrite）



⑤Read serial port data（ModbusRead）:

Accept the message in the integer format (int) and select the previously created integer variable (int_3, int_4,..., int_12).



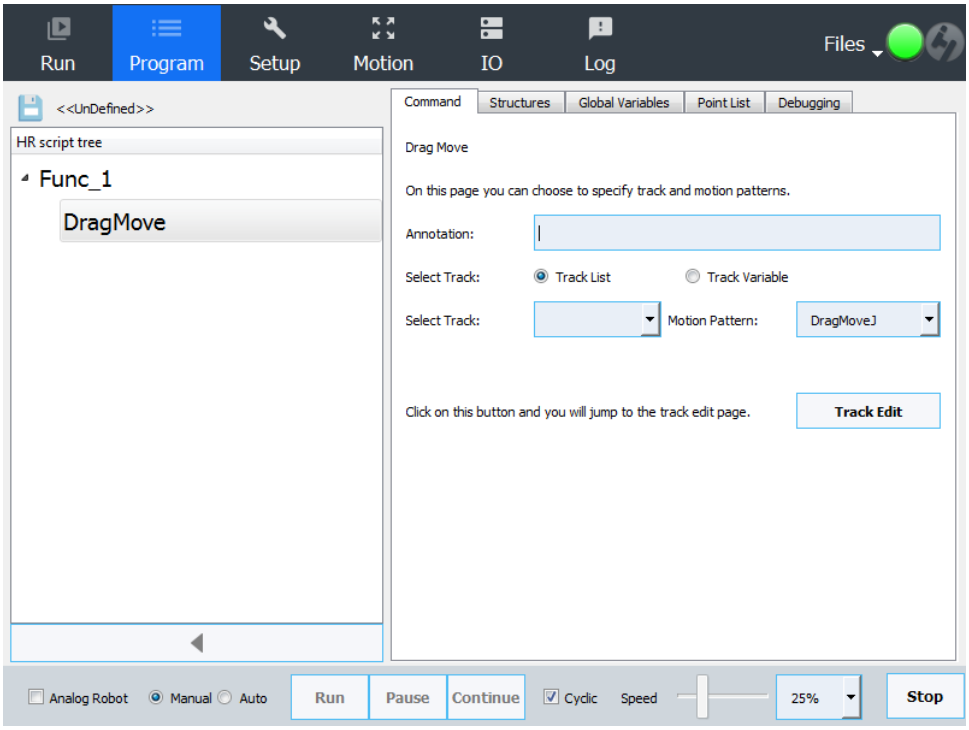
Return: End the function, returning a custom string indicating that the function has been executed.

⑥When configured, run the function (F_MODBUS_communication.

⑦The teach pendant writes (ModbusWrite) data to the serial port. After the serial port data is changed, the corresponding shaping variables (int_3, int_4, int_12) are changed after the teach pendant reads the changed value.

➔ 5、DragMove Command

After the FreeDrive teaching is turned on, the user drags the robot to record the motion trajectory at a certain sampling frequency. When the robot runs the command, the robot can reproduce the trajectory of the user manually dragging;

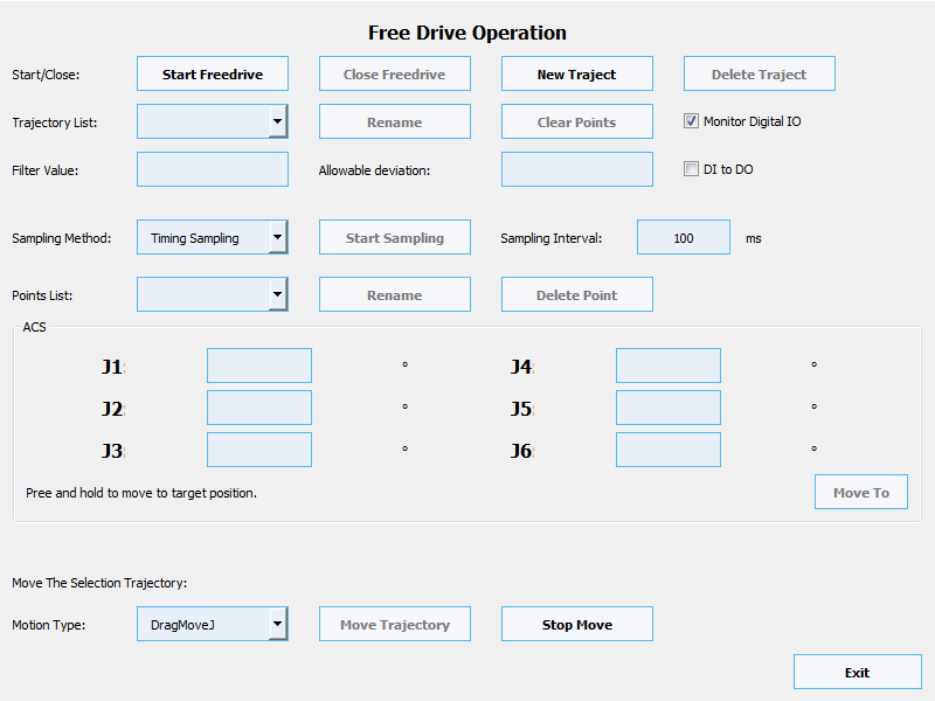


As shown in the figure above, "selection trajectory" has two modes: track list, track variable.

1) Track list: the taught track run can be selected from the track list;

2) Track variable: Create a new string variable string, set the string variable name to the name of the track to be run; when the instruction calls the variable, run the track.

Click the “Track Edit” button to enter the track teaching interface, as shown below:



(1) New Traject: Click this button to create a new track for storing the points of FreeDrive. You can query the newly created track in the Track List.

(2) Two collection methods:

①Timing sampling: select timed collection, input the sampling interval time (in ms) in the edit bar of sampling interval, click the button of FreeDrive, and click start collection timer, that is, the controller will collect the point position of the track dragged and dragged by the user at the interval set by the user.

②Manual sampling: select manual collection and click the button to start the FreeDrive. After the robot is dragged to the target point, click the button "collection current point" to record the point. In this way, multiple target points can be collected continuously.

(3) Collection point bit table: the point bit obtained by dragging is displayed in this table;

(4) Motion Type: Select DragMoveJ to execute the points in the Dragmove instruction.

(5) Delete Point: after selecting the dots in the collection point bit table, click "delete dots" to delete corresponding points.

(6) Clear points: click the "clear points" button to delete all points in the collection point table.

(7) Position ACS and PCS display bar: used to display the ACS and PCS data values of the selected position.

(8) Move to: after selecting the spot in the collection point table, click the motion to button to move to the point in ACS or PCS mode.

(9) Monitoring digital IO: Check this option to open the FreeDrive teaching not only to record the point of the drag track, but also to record the change of the IO signal during the drag and drop process.

(10) DI reflet to DO: Check these options to reflect the effect of the DI signal to the associated DO signal.

DragMove operating steps:

①Add the DragMove command in the program tree, and click the "track edit" button to enter the command details interface for editing;

②Click "new track" button to create an empty track;

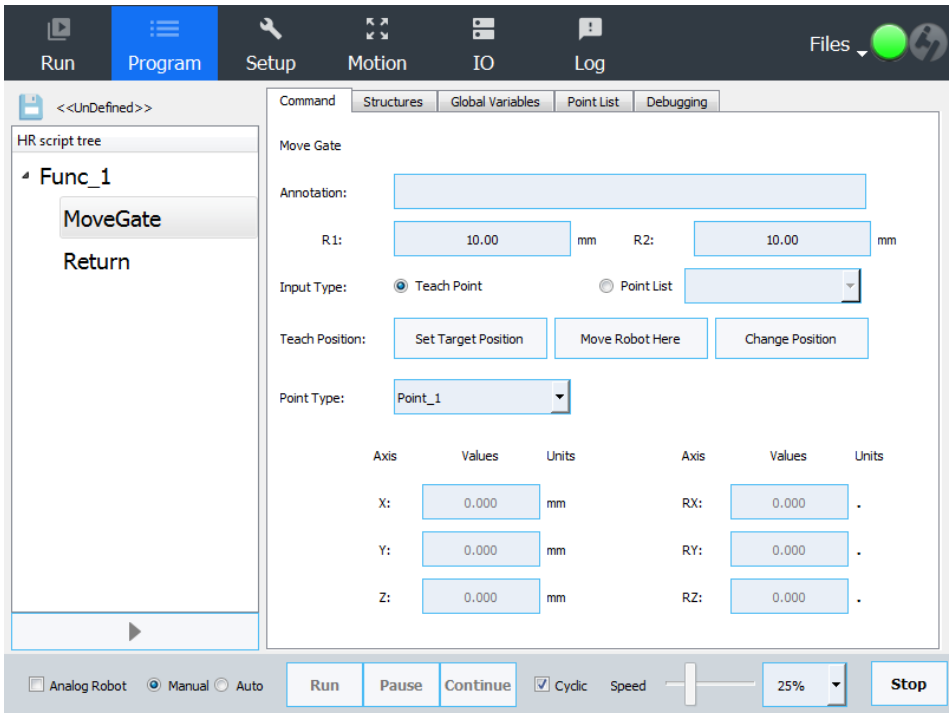
③Select the point-point collection method in the instruction details, such as "timed collection", and set the sampling interval (such as 500ms);

④Click the buttons of "Start FreeDrive" and "Start Sampling" in the interface and manually drag the end of the robot to run the user-defined track.

⑤At the end of the track dragging, Close sampling and “Stop move” buttons to complete the teaching of the track;

⑥Click the "Move Trajectory" button, and the robot will reproduce the track dragged by the user.

➔ 6、MoveGate Command



MoveGate type track interface button meaning

Command comments: add comments to the command line that can be ignored.

Radius R1, R2: see the following trajectory diagram. The user can set the transition radius of the first point and the second point. The radius range is 10~1000mm.

Input type: If you select "Point List", the point will be selected in the "Point List" column.

Note: The 3 points required for teaching must be unified input type, for example, the unified input type is “Teaching Point”.

Teaching position: The “Set Target Position” button is used for the user to teach the point, the “Robot Move Here” button is used to move the robot to the position or point that has been taught, and the “Change Position” button is used to modify the previous teaching point.

Position type: select the first point, the second point, and the third point of the gate track. The meaning is shown in the following trajectory diagram.

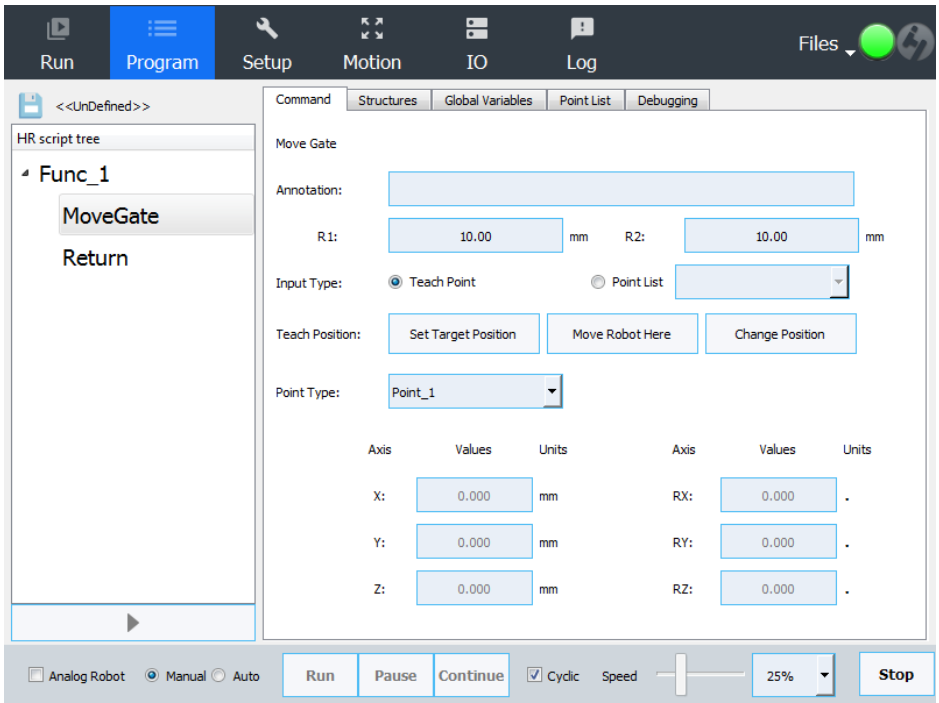
The red track is the gate track calculated.

➔ 7、SetRobotiq Command

The Robotiq gripper is supported at the end of the robot and can be applied to the program interface via the profile configuration gripper port.

The steps are as follows:

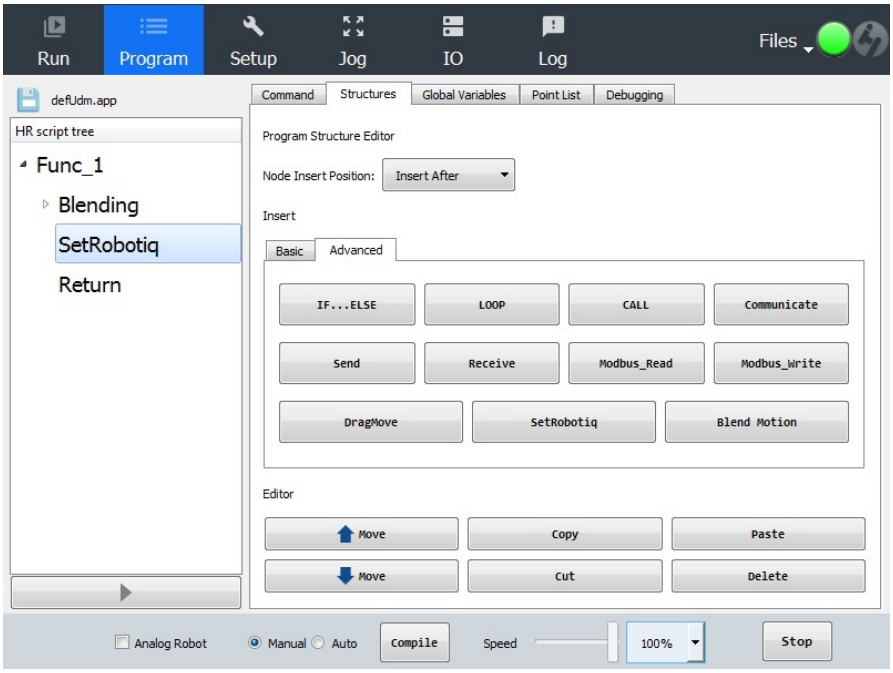
1) Switch to the “gripper” interface, hook the “Enable” option box, the choice of the com port depends on the com of the actual gripper connection, as shown below:



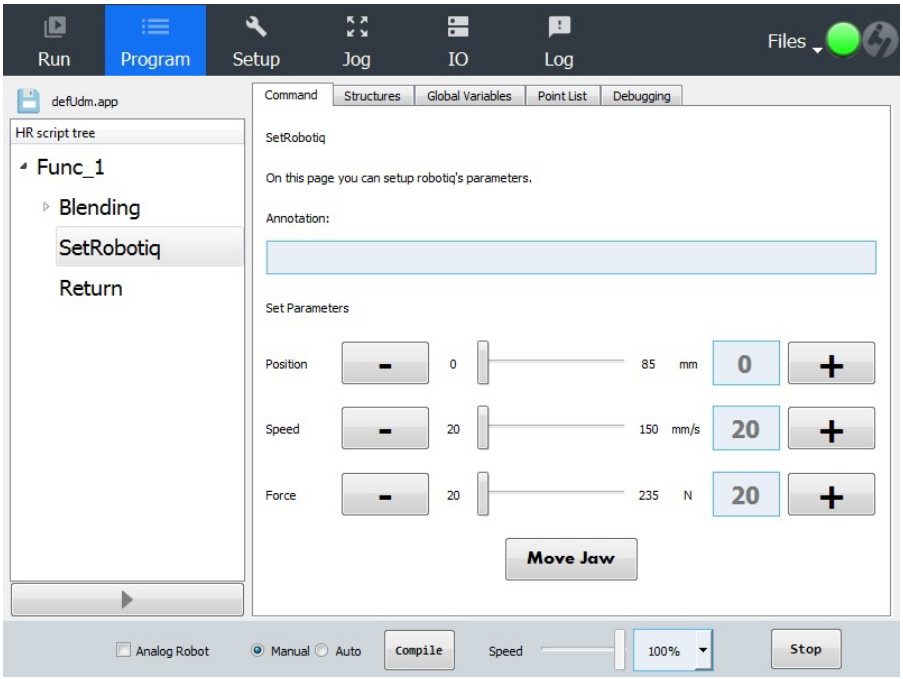
2) Application of Command

(1) Add SetRobotiq command to the program tree:

It is generally necessary to add two SetRobotiq commands, corresponding to the clamping of the jaws and the release of the jaws.



(2) Edit SetRobotiq Command:



In the command interface, the meanings of the buttons are as follows:

①**Command comment**: adds a comment to this command.

Set the parameters (take the 5KG load of Robotiq clamping jaw as an example) as follows:

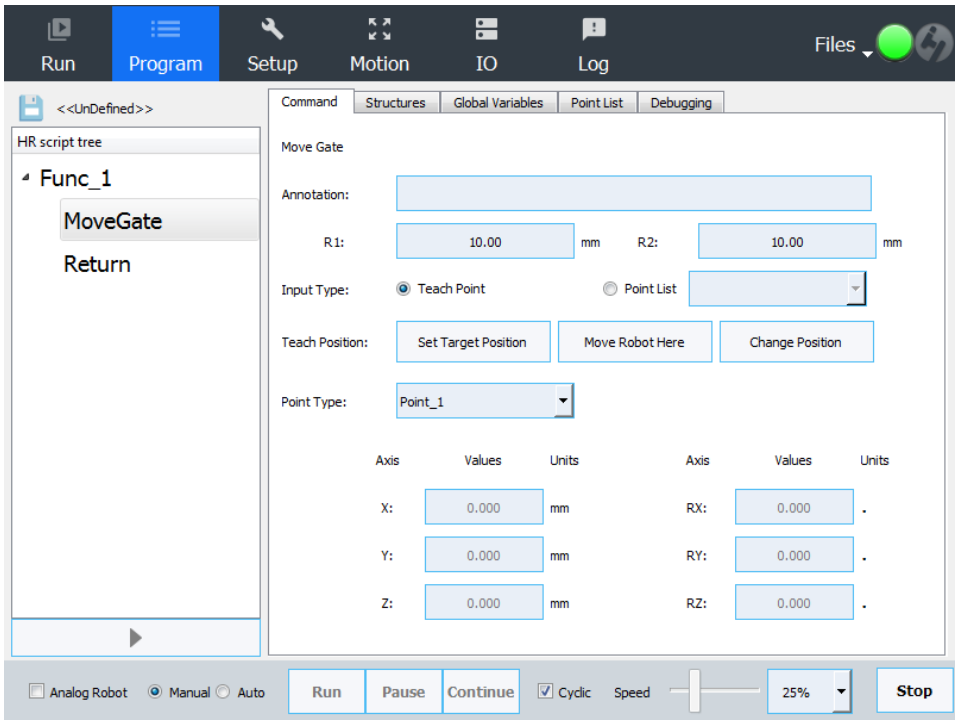
②**Position**: range 0~85mm. When the jaw is closed, its position value is 0 mm, and when the jaw is fully opened, the position value is 85 mm.

③**Speed**: range 20~150mm/s, set the motion speed of the clamping claw state change (open to closed, closed to open).

④**Force**: range 20~235N, set the size of holding force when clamping jaw is closed.

⑤**Motion jaw**: this button is used to open the motion jaw, and check the movement of the jaw under the above setting parameters.

Global Variable



This region edits global variables with up to 128 variables. The "new" button is used to create a new global variable, the "edit" button is used to modify the selected variable, and the "delete" button is used to delete the selected variable. New robot programs can update variable values at run time through variable assignments such as SetVar instructions.

Variables have the following types:

(1) Int variable：The range is:−32768 -32767.

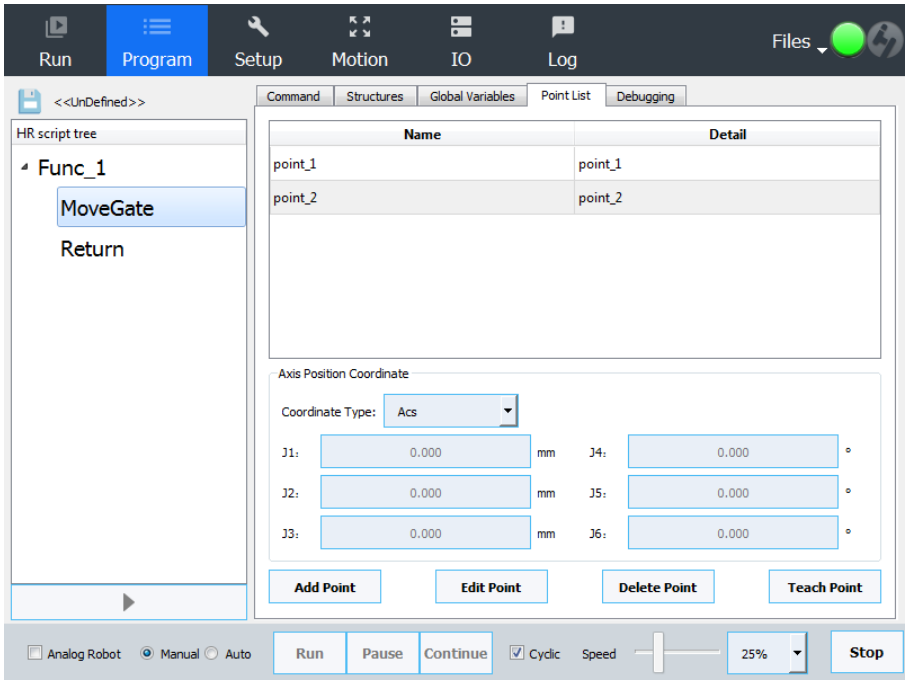
(2) Double floating point values: floating point Numbers (decimal).

(3) String: a sequence of characters.

(4) Socket: communication connection

“SaveToFiles” Function: when this option is selected as "YES", the value of the variable is saved in the configuration file in real time.

Point list



This area is a list of editing points, and the meanings of buttons in the interface are as follows:

Name: point name.

Detail: description of the related points.

Axis position coordinates: display the joint coordinates (J1~J6) or spatial position (X, Y, Z, RX, RY, RZ) of the selected point.

Coordinate type: ACS means to display joint coordinates or joint angle to move to the taught point; PCS means to display spatial position coordinates or move to the taught position in the spatial position direction.

Add a point: adds a point to the list of points.

Edit point: edit the point selected in the point list and modify its Name and Detail.

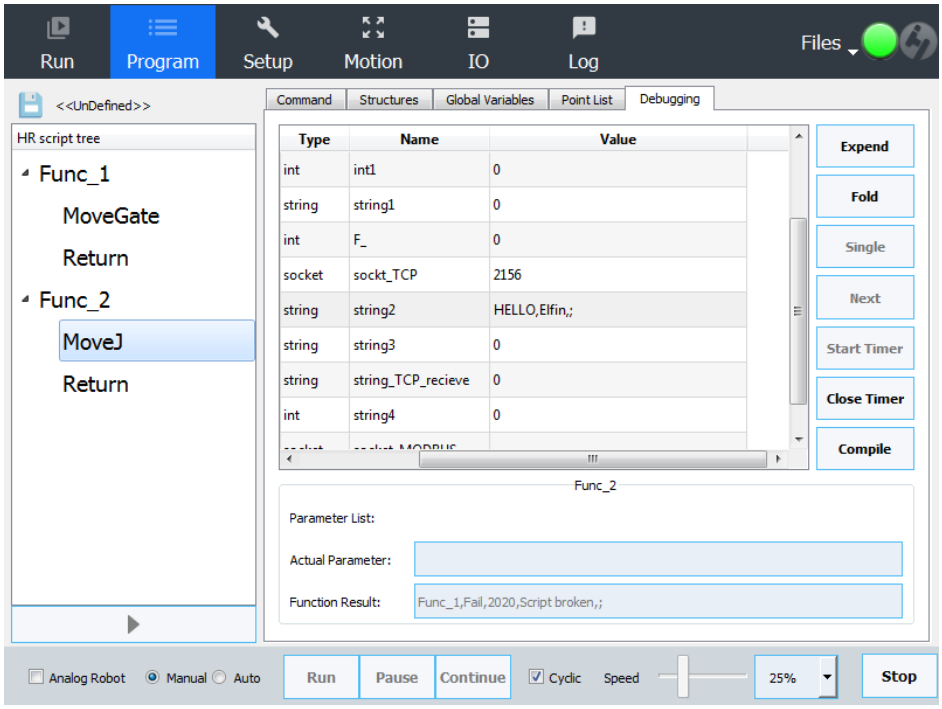
Delete point: Delete the selected point in the point list. Teaching point.

Teaching point: The selected point in the teaching point list.

(1) Teaching method 1: Manual teaching. The user can select the articulation button of the page, the space motion button, or enter the target point position in the data field to teach the point.

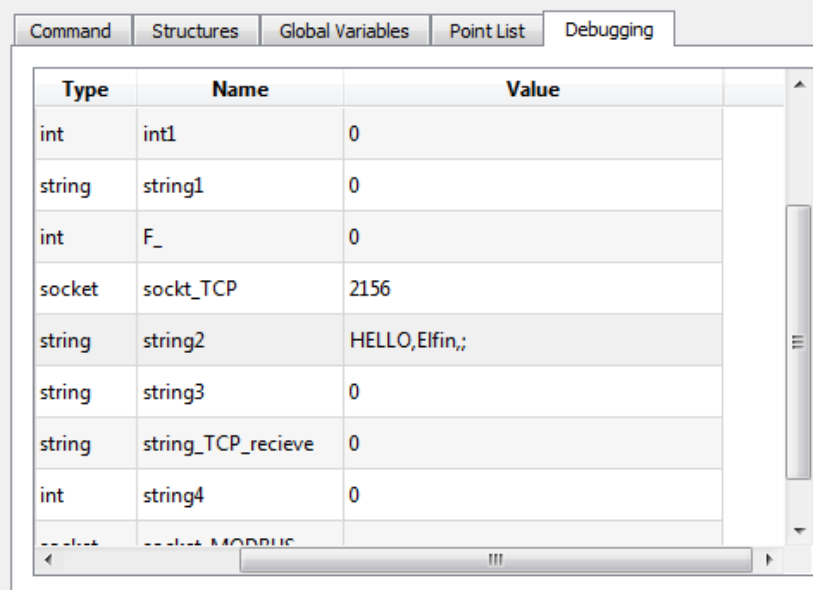
(2) Teaching method 2: FreeDrive. Click the “FreeDrive” button to enter the FreeDrive operation interface. The user can manually drag the robot to make the robot reach the target position and then record the point.

Debugging



The meanings of each region and button in the debugging interface are as follows:

(1) Debug list: as shown in the figure below, this list shows the values of global and local variables during function operation. Global variables contain registers and variables defined in the global variable list.



(2) Expand: expands the program tree so that each command line in the program is displayed for easy viewing of the program.

(3) Fold: collapses the program tree so that only the function name is displayed in the program, and the command line is hidden.

(4) Single-step: for running programs step by step, generally used for debugging.

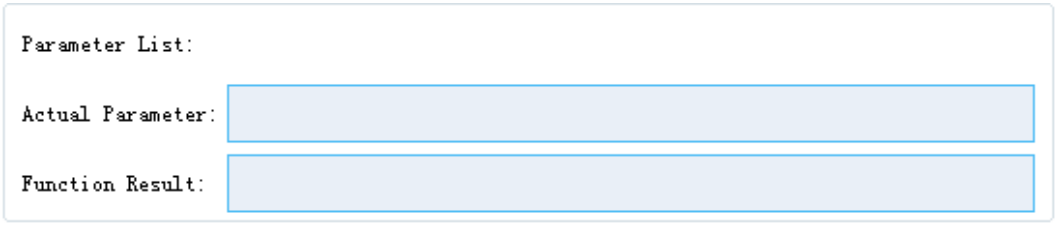
(5) Next step: when run in a single step, jump to the next command line in the program.

(6) Start Timer: Turn on the timer independent thread. At this time, the instruction in the timer and the instruction in the function run simultaneously. (Note: According to the time sequence of creating timers, the current timer can open up to 5 [1~5], and the 5th timer cannot be paused).

(7) Turn off timer: turn off timer threads.

(8) Compile: Compile the current program script. If the compilation is successful, the program can be run. If the compilation fails, the cause of the failure will be displayed.

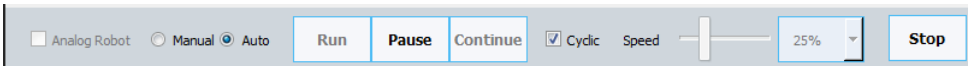
(9) Function transfer parameters: as shown below



As shown in the figure above, the function Func_1 selected in the current program tree has parameters Var_1, Var_2. When the user wants to run this function, input the actual parameters. For the parameter type and format, refer to the parameter list. The above parameters are int variables.

Note: This parameter is only valid for the function Func_1 and belongs to a local variable; the function returns the result only after the function is executed.

(10) Run robot:



Analog robot: When this button is checked, the robot control mode will be converted to the analog state, and the actual robot body will no longer move. When the user operates the software interface, the data values of the software interface will be simulated.

Manual: select this button, and the robot will be in the non-script state. Users can program, FreeDrive, IO control, etc.

Automatic: if this button is selected, the robot will be in the state of script. The user can only run the program, and other operations cannot be conducted.

Run: when a function is selected in "automatic" mode, click the "run" button to start running the function.

Pause: when the program is running, click the "pause" button to pause the current movement. For timer, the pause button is effective for the 1st to 4th timer and fails for the 5th timer. (Note: The wait command cannot be paused in the timer, and the 1~5 timers sorting are relative to the time sequence in which the timer is created)

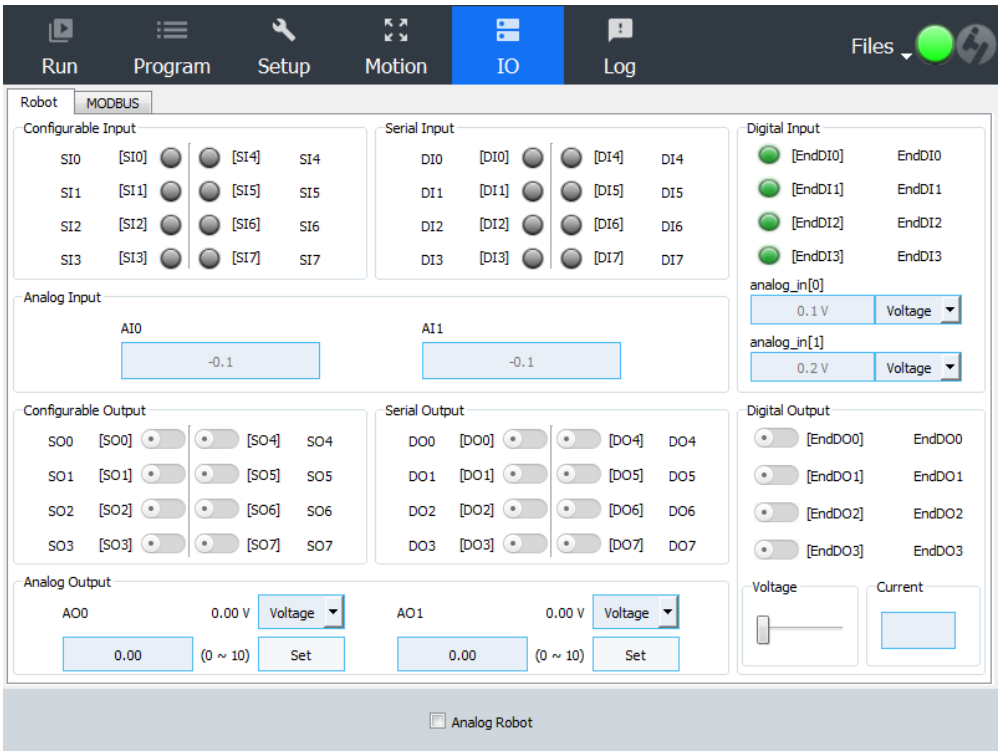
Continue: after the program is paused, click the "continue" button and the program will be executed from the pause command line.

Loop: tick this button and the program will loop through the selected function.

Speed: adjust the speed of the robot.

Stop: stop the program, which contains stop functions and timers, and exit script mode, switching to manual mode.

7.7 IO



Robot IO

In this interface, you can monitor and set the real-time I/O signals sent and received by the robot's electrical control box. The screen displays the current status of the I/O, including the I/O status during program execution. The program will stop running if there are any changes during the program run. All output signals will remain in their state when the program stops running. The screen is updated at 10 Hz, so a particularly fast signal may not be displayed correctly.

Configurable IO: Configurable input SI0~SI7, if the serial port input is high level, the corresponding input serial port indicator will be bright; configurable output SO0~SO7, check the corresponding output serial port, then the output level can be set high, corresponding to the output serial port indicator Brighten.

Serial port IO: Serial port input DI0~DI7, if the serial port input is high level, the corresponding input serial port indicator lights up; Serial port output DO0~DO7, check the corresponding output serial port, the serial port output level is set high, and the corresponding output serial port indicator lights up.

Digital IO: The digital input EndDI0~EndDI3 corresponds to the IO input signal at the end of the robot. When the input is high, the corresponding digital indicator lights up; the digital output EndDO0~EndDO3 corresponds to the IO output signal at the end of the

robot, and the output is high level. The digital indicator lights up.

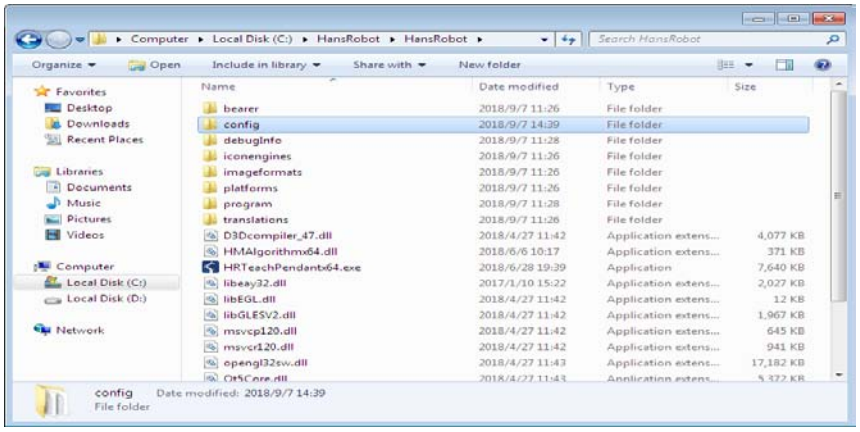
Analog input/output: analog I/O can be set as current [4-20ma] output or voltage [0-10v] output.

7.8 Run

At present, many customers want to add one or two pages to the interface of the teach pendant to let the teach pendant realize the function of the upper computer. Based on this, Elfin software provides a plug-in page---"Run". For some simple applications, the client interface of a specific customer can be mounted in the framework of the teach pendant through a plug-in. After the setup is complete, you can load the plug-in interface written by the customer into the “Run” interface after restarting the software.

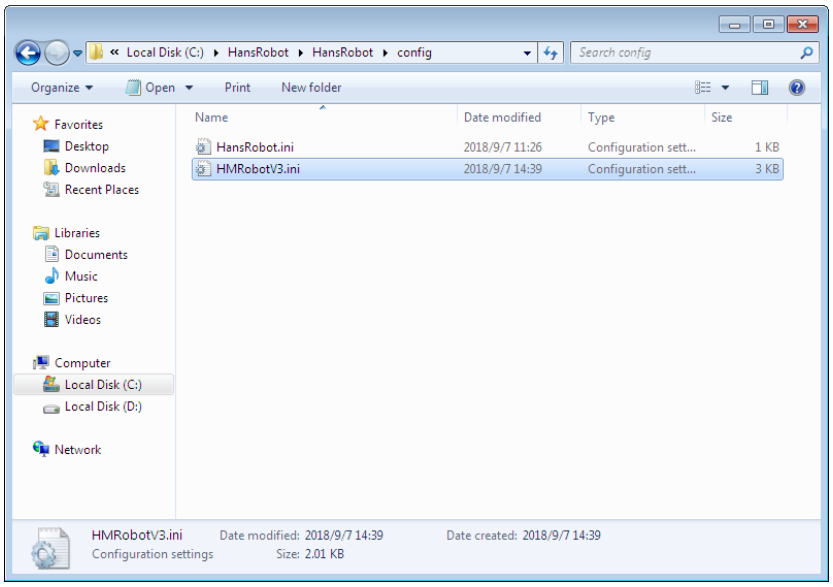
Usage steps:

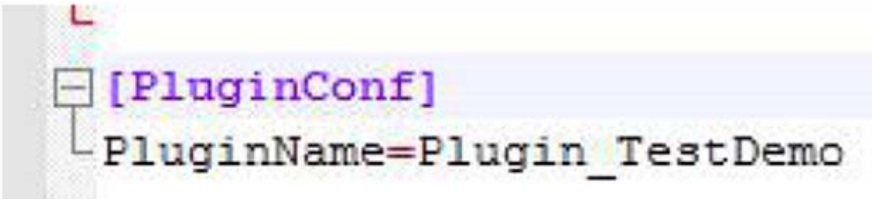
1) After the process plug-in is written, put the corresponding version dll generated by the plug-in into the EXE execution directory of the teach pendant V3.5;



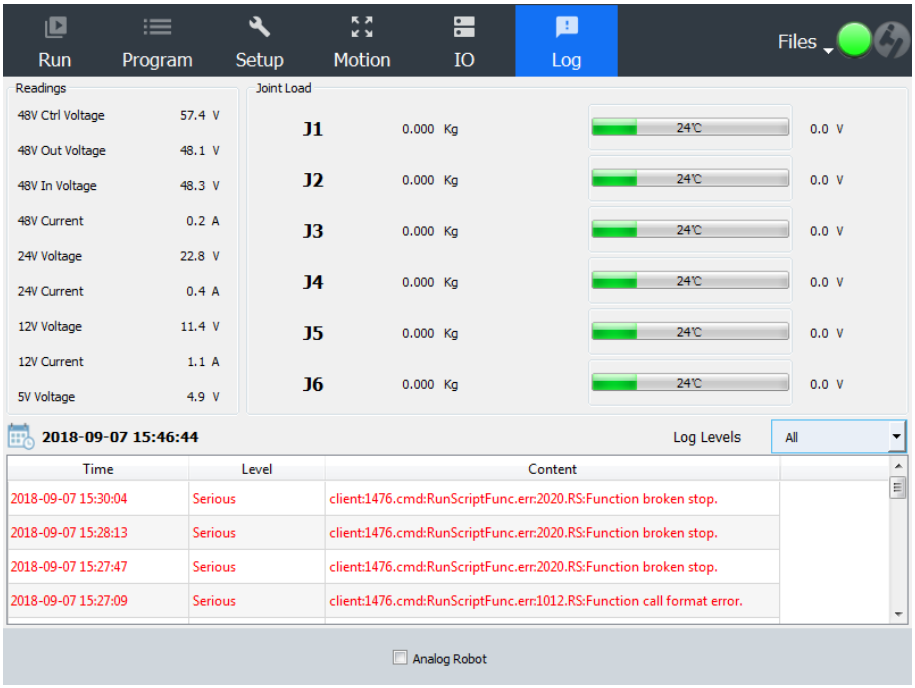
2) In the execution directory of the teach pendant V3.0, modify the "[PluginConf]" option in HMRobotV3.ini and change its "PluginName" to the name of the plugin;

Note: The plugin name does not need to have the suffix "x64", "d", etc., just the plugin name, as shown below:


Local Disk (C:) ▸ HansRobot ▸ HansRobot ▸ config
Search config
Organize
Open
Print
New folder
Favorites
Desktop
Downloads
Recent Places
Libraries
Documents
Music
Pictures
Videos
Computer
Local Disk (C:)
Local Disk (D:)
Network
Name
Date modified
Type
Size
HansRobot.ini 2018/9/7 11:26 Configuration sett... 1 KB
HMRobotV3.ini 2018/9/7 14:39 Configuration sett... 3 KB
HMRobotV3.ini Date modified: 2018/9/7 14:39 Date created: 2018/9/7 14:39
Configuration settings Size: 2.01 KB


[PluginConf]
PluginName=Plugin_TestDemo

7.9 Log


Run
Program
Setup
Motion
IO
Log
Files
Readings
48V Ctrl Voltage 57.4 V
48V Out Voltage 48.1 V
48V In Voltage 48.3 V
48V Current 0.2 A
24V Voltage 22.8 V
24V Current 0.4 A
12V Voltage 11.4 V
12V Current 1.1 A
5V Voltage 4.9 V
Joint Load
J1 0.000 Kg 24℃ 0.0 V
J2 0.000 Kg 24℃ 0.0 V
J3 0.000 Kg 24℃ 0.0 V
J4 0.000 Kg 24℃ 0.0 V
J5 0.000 Kg 24℃ 0.0 V
J6 0.000 Kg 24℃ 0.0 V
2018-09-07 15:46:44
Log Levels
All
Time
Level
Content
2018-09-07 15:30:04 Serious client:1476.cmd:RunScriptFunc.err:2020.RS:Function broken stop.
2018-09-07 15:28:13 Serious client:1476.cmd:RunScriptFunc.err:2020.RS:Function broken stop.
2018-09-07 15:27:47 Serious client:1476.cmd:RunScriptFunc.err:2020.RS:Function broken stop.
2018-09-07 15:27:09 Serious client:1476.cmd:RunScriptFunc.err:1012.RS:Function call format error.
Analog Robot

Robot condition

The top half of the screen shows the robot arm and control box status. The left side displays information about the robot's electrical control box, and the right side shows information about each joint of the robot. Robot joint information includes the temperature of the motor and electronics, the joint load, and the voltage at the joint.

Robot log

The log message is displayed in the lower part of the screen. The first column will log the arrival time of the message. The second column shows the severity classification of the message. The next column shows the specific message content. The message contains:

(1) Command sender: client

(2) Sent command: cmd

(3) Error code: for example, Error: 1035 or err: 1041. For specific Error code information, please refer to the communication protocol file.

(4) Error explanation: for example, RS: DCS Status Error.

Log level: this button filters messages through the log severity level.

7.10 DCS interface

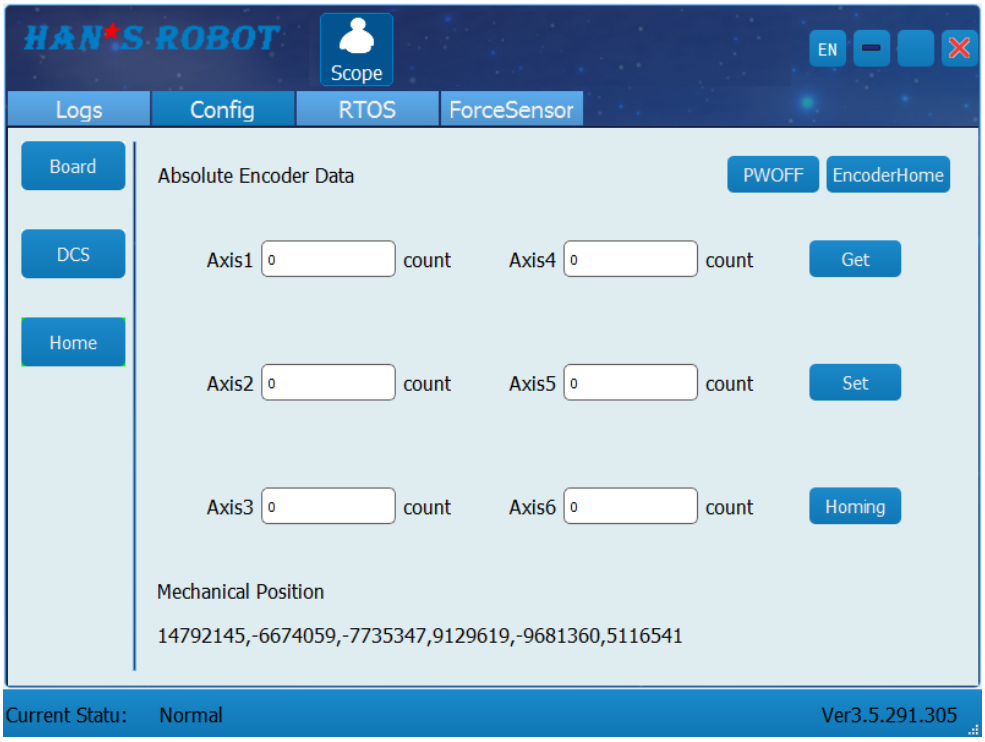
Double-click the DCS icon at the bottom right of the screen to open the DCS interface.

Robot origin position

The following figure shows the **Home** interface of the DCS interface.

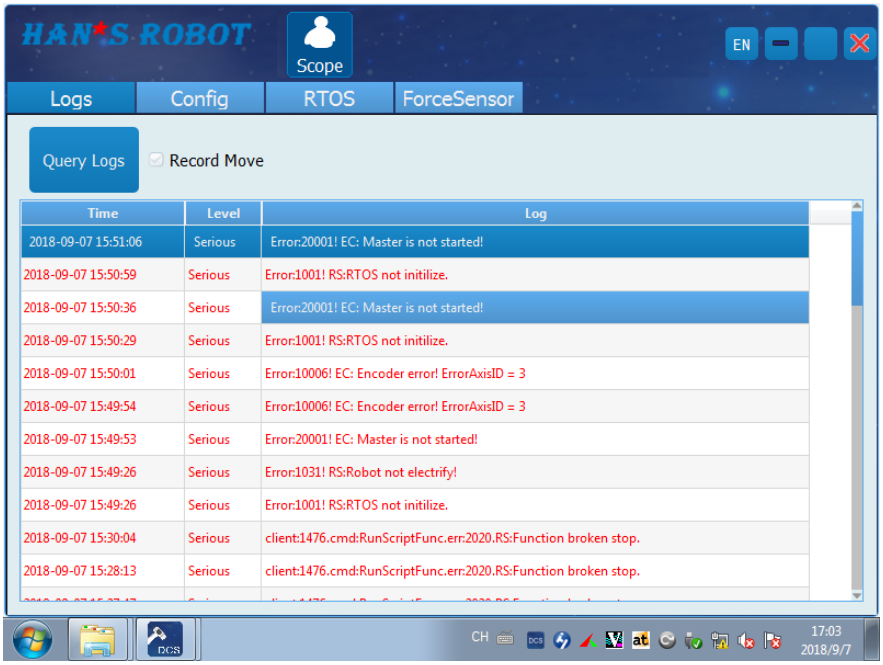
The general user does not need to operate the interface, the only situation where the interface needs to be used: home point is lost.

If there is a home loss, please contact our technical engineer and we will assist you with the problem.



Real-time log

In this interface, the user can view the error status of the robot in real time; you can check the “Moving Move” option to get the status of the robot movement in real time.



Chapter 8 ROS Control

For standard products (Elfin body, electric control box, handheld teach pendant), the robot is controlled based on Windows system. However, Elfin also provides the ROS platform control interface. If you want to use the ROS platform to control the robot, please do the following:

Software preparation:

1. Download the Ubuntu system image from this page: http://releases.ubuntu.com/14.04/, Select 64bit or 32bit under desktop image and recommend 64bit.

2. https://jingyan.baidu.com/article/76a7e409bea83efc3b6e1507.html

Follow this tutorial for dual system installation.

3. http://wiki.ros.org/indigo/Installation/Ubuntu

Install ROS according to this tutorial and recommend Desktop-Full install

Hardware Connection

1. Power the robot with an electric cabinet:

1) Hardware preparation

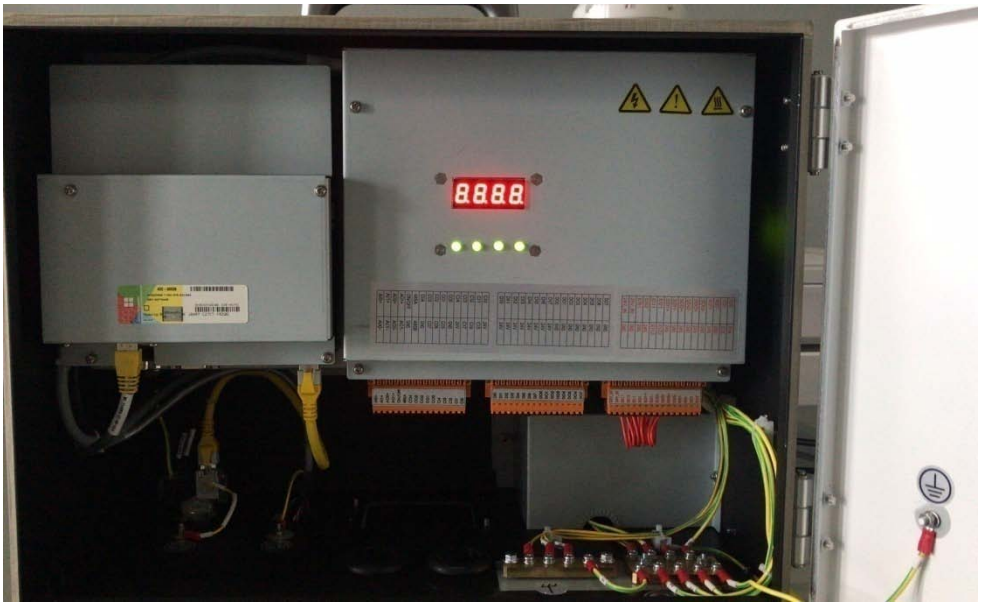
A network cable, a computer

2) Operation procedure

①Open the door of the electric cabinet (each electric cabinet has corresponding key

when shipping);

②Connect the network line: unplug the yellow port of the red box below, and connect the external network line to the network line with a network port extension module;



③Connect the other end of the external network cable to the network port of the computer;

④Press the power button on the handheld indicator to power the robot.

2. Use external power to power the robot

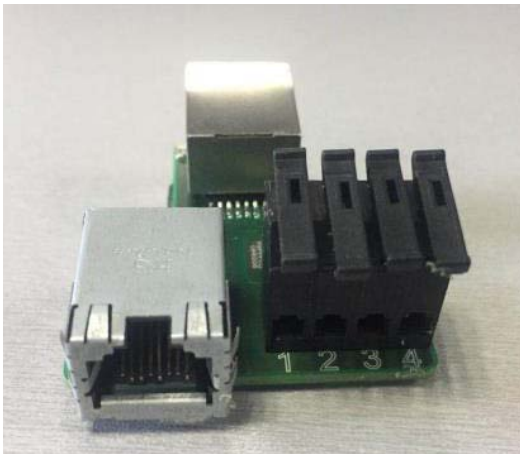
When you only buy our Elfin ontology or do not want to use the electric cabinet to power

the robot, you can use the external power supply to power the robot.

1) Hardware preparation

External power supply, network cable, computer, body/cabinet adapter

Note: ①"Body/electric cabinet swivel" is a product developed by our company, which needs to be purchased from our company for use.



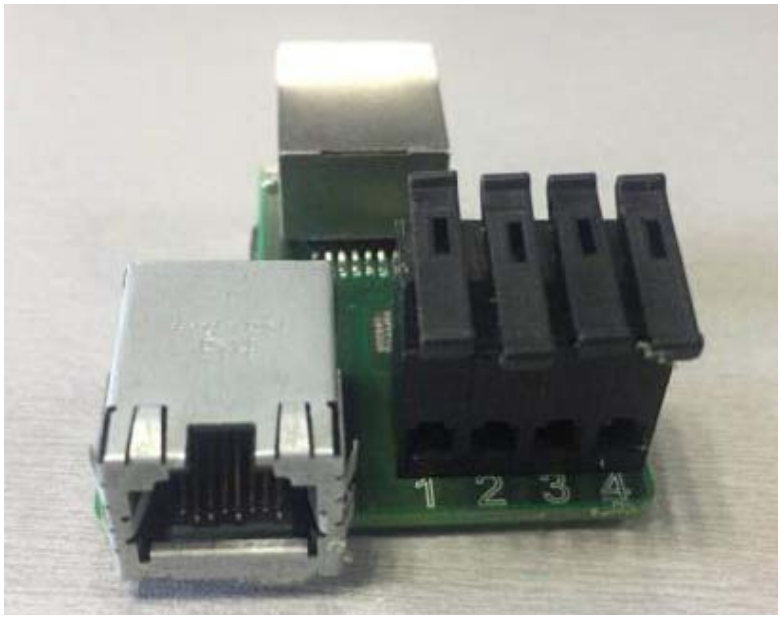
②The normal voltage of the Elfin body is 42V~54V, and the peak current cannot be lower than 19A.

The external power supply illustrated here is as follows:

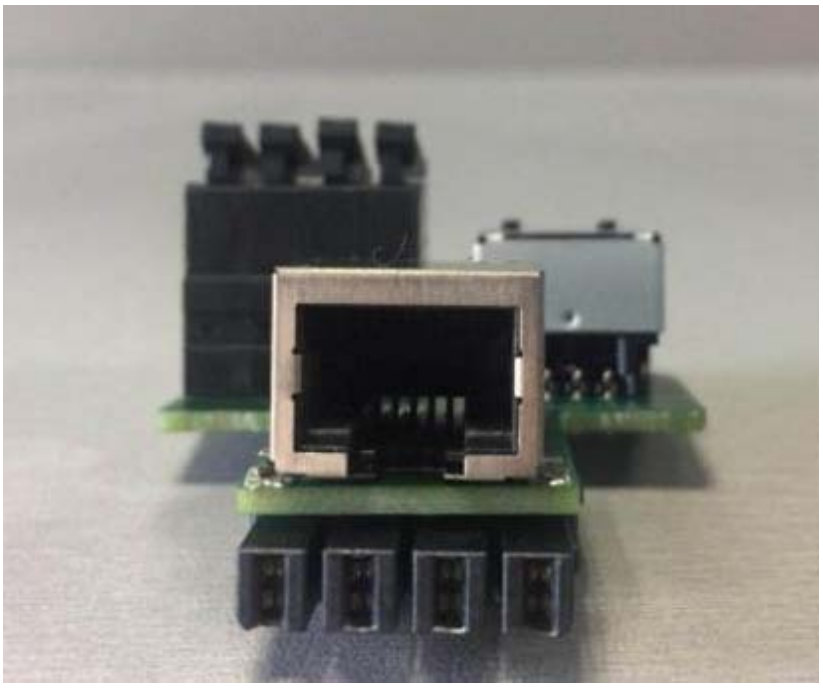
2) Operation procedure

(1) Hardware connection

1) Power supply wiring



The front end of the rotary joint is shown in the figure above. The left side of this end USES the network cable to connect the network port of the computer and plug it in. There are four ports on the right side, and the corresponding number code is written on the interface, among which 123 does not deal with port 4 which should be connected with 1.+48V 2. -48v 3.



The rear end of the rotary joint is shown in the figure above. The end can be connected with the Elfin body and buckled.

(2) Power on the external power supply, that is, power on the robot.

3. ROS operation：

•Tutorials on the ROS official website: http://wiki.ros.org/ROS/Tutorials

•Chinese tutorials can also be found from baidu, such as the following tutorial is good

https://www.ncnynl.com/category/ros-junior-tutorial/1/

•Instructional website for ROS control Elfin

github.com/hans-robot/elfin_robot

Chapter 9 shutdown procedure

1. Save the program: If there is a program being edited before shutting down, please save the program first;

2. PWOFF: Move the robot to a relatively safe position, then switch to the DCS interface, click the “PWOFF” button in the upper right corner to disable the robot;

3. OFF: switch to the "initialization" interface in the indicator, and click "OFF" button to power off the robot;

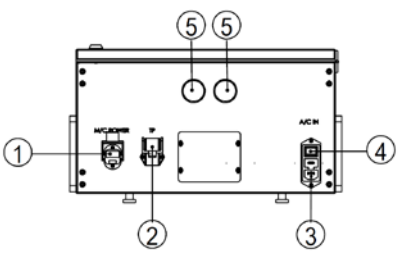
4. Close the software:

1) Turn off the teach pendant: Click on "File" and select the "Exit" option in its drop-down menu to close the controller;

2) Close DCS: Right click the "DCS" icon in the lower right corner and select "Exit".

5. Close Windows system:

6. Turn off the electric cabinet power supply: after the system is completely shut off, disconnect the electric cabinet power supply (click the button of electric cabinet power supply below);



Chapter 10 Quality Warranty

10.1 Product Quality Warranty

In the principle of no prejudice to any claim agreement that may be reached between users (customers) and distributors or retailers, the manufacturer shall give customers a product quality warranty according to the following terms:

If any defect occurs due to defective manufacturing or materials within 12 months after new equipment and its components are put into operation (not more than 15 months if transportation time is included), Han's Robot shall provide necessary spare components while users (customers) shall provide labor for replacement with spare components. Related components shall be maintained or replaced with another component embodying the up-to-date technological level. This product quality warranty is invalid provided that equipment defects are caused by improper handling or failure to observe related information described in the user manual. This product quality warranty does not apply to or extend to any maintenance performed by authorized distributors or customers such as installation and software downloading. Users (Customers) must provide a purchase receipt and purchase date as valid evidence of enjoying the product quality warranty. According to this product quality warranty, any claim must be made within two months when the product quality warranty is not obviously fulfilled. Any equipment or components replaced or returned to Han's Robot shall be owned by Han's Robot. Any other claim arising from or in connection with equipment is not within the scope of this product quality warranty. Any terms of this product quality warranty do not try to limit or exclude customers' legal rights as well as the manufacturer's liability for any casualties due to its negligence. The duration of this product quality warranty shall not be extended due to any services provided according to the terms of this product quality warranty. Han's Robot reserves the right to collect replacement or maintenance costs to customers without violating the principles of this product quality warranty. The preceding regulations do not imply any change of burden of proof, harming the interests of customers.

If equipment shows any defect, Han's Robot shall not bear any resulting damage or loss, e.g. production loss or damage to other production equipment.

10.2 Disclaimer

Han's Robot reserves the right to upgrade products without prior notice because it devotes itself to continual improvement on product reliability and performance. Han's Robot does its best to ensure the accuracy and reliability of the contents of this manual, but disclaim any liability for any error or missing information.

Chapter 11 Appendix

11.1 Technical Specifications

Name	Parameter
Weight	23kg
Payload	5 kg
Reach	800 mm
Joint range	+/-360°
Joint speed	90°/s
Tool	1 m/s
Repeatability	+/- 0.05 mm
Installation area	Φ 200mm
Degree of freedom	6 rotating joints
Control box dimensions	445.2*236.5*536mm
I/O ports	Digital input 4
	Digital output 4
	Analog input 2
I/O power supply	Electric cabinet: 24V 2A Terminal IO: 24V 1.5A
Communication	TCP/IP
Programming	On-screen manipulation director; remote access
IP class	IP54
Power	About 180 W
Collaboration	10 advanced security configuration functions
Main material	Aluminum alloy
Operating ambient temperature	0-50°
External power input	100-240 VAC, 50-60 Hz
Cables	Control box connecting cable: 5 m
	Demonstrator connecting cable: 5 m

11.2 Limiting Security-Related Functions

Limiting Safety Function	Description
Joint position	Min. and max. joint angular positions
Joint speed	Max. joint angular speed
TCP position	Plane where the TCP position of the robot is limited in Cartesian space
TCP speed	Max. speed of robot TCP
TCP force	Max. thrust of robot TCP

11.3 Electrical Safety Specifications

Safety Input	Description
Robot emergency stop	Execute Class 1 stop* and use system emergency stop to notify the body
Emergency stop button	Execute Class 1 stop* and use system emergency stop to notify the body
System emergency stop	Execute Class 1 stop*
Protective stop	Execute Class 2 stop*
Emergency stop reset	Restore the robot from protective stop state

*** Term explanation:**

- Class 0 stop: The robot stops operation immediately after the robot power supply is cut off. This is an uncontrolled stop. The robot may deviate from a route set in the program because every joint is braked at the fastest speed.
- This protective stop can be used only when a safety evaluation limit is exceeded or when an error occurs in the safety evaluation part of the control system.
- Class 1 stop: The robot stops when you stop it for power supply to it. The power supply is cut off after the robot stops. This is a controlled stop. The robot will follow a route compiled in the program. The power supply is cut off after 1s or once the robot keeps its feet.
- Class 2 stop: Controlled stop during power-on of the robot. The robot stops all actions within 1s. The control of the safety evaluation control system enables the robot to stay in the stop position.

11.4 Robot Status Box

Robot Status	1	0
Moving	Moving	
Homing	Homing	
ErrStop	Error in the movement process	
StandBy	Be ready and wait for an instruction	Moving
Stopping	Stop state	
Disable	Disabled	Enabled
Power	Enabled	Disabled
Error	Error state	After resetting and clearing
HandType	Left hand type	Right hand type
Ready	The startup of the controller is finished	
SafeSpace	Exceed safe space	Not exceed safe space
MovSpace	Standby	

11.5 Elfin Function Return Error Code Table

Error Code	State Description	English Display	Solution
0	Normal	RS:Operatorsuccessed.	
1001	The robot is not initialized	RS:RTOS not init.	Click the "RTOS" icon to start the RTOS.
1002	The master is not started	RS:Master status is closed.	Click **Start master** to start the master.
1003	The slave is disconnected	RS:Slave dropped.	Click **Start master** to restart the master.
1004	The robot is safely locked	RS:Robot on safe locked.	Set the serial port Input17 to low.
1005	Physical emergency stop	RS:Robot on Emergency stop.	Release the emergency stop button and click the **Power on** button of the software to power on again.
1006	The robot is disabled	RS:Robot not ServoOn	Click the **Servo On** button to enable the robot.
1007	Slave error	RS:Slave on error	(1) Shut down the master; (2) Start the master.
1008	The robot exceeds safe space	RS:Robot out safe space.	(1) In enabled state, let the axis move back to safe space in the reverse direction of the axis that exceeds safe space due to long jog movement. Click **Reset** to perform resetting and clearing; (2) In disabled state, Click **Reset** to perform clearing. Click **Servo On**. Let the axis move back to safe space in the reverse direction of the axis that exceeds safe space due to long jog movement.
1009	The robot is moving	RS:Robot on Moving.	Prompting error code: Movement instructions are received in the movement process.
1010	Commands are invalid	RS:Command Invalid.	Prompting error code: The user sends invalid commands. Please check details of commands.
1011	Parameter error	RS:Parameter error.	Check and correct parameters set in the program
1012	Function call format error	RS:Function call format error.	Check and correct the format of called functions.
1013	Commands wait to be executed	RS:Command waiting execute.	Prompting error code: The DCS is in standby state and cannot read any movement state.
1014	I/O does not exist	RS:IO not exist.	Prompting error code: No digital I/O module set in a

Error Code	State Description	English Display	Solution
			corresponding program is available in the hardware. Check and modify it to an I/O number corresponding to the hardware.
1015	The robot does not exist	RS:Robot not exist.	Prompting error code: No corresponding robot is available. Check that the software is opened normally.
1016	No DCS server is connected	RS:Not connected to server.	Check whether the DCS interface is started. Click the **Login** button of the software to reconnect the DCS.
1017	Communication timeout	RS:Communication timeout.	Check the network. Re-click the **Login** button to reconnect the network.
1018	Connection fails	RS:Connected failed.	Check whether the DCS interface is started. Click the **Login** button of the software to reconnect the DCS.
1019	Serial port connection fails	RS:Communication Serial Failed.	Check whether the settings of the serial port module and the selection of the Com port are correct.
1020	Home position is not set	RS:Home position not set.	Set correct home data.
1021	The last command is not finished	RS:Last command not finished.	Wait until the execution of the command is finished before sending an instruction.
1022	The serial port DI is empty	RS:Serial DI is NULL.	No corresponding serial port I/O is available in the external hardware.
1023	The serial port DO is empty	RS:Serial DO is NULL.	No corresponding serial port I/O is available in the external hardware.
1024	Waiting timeout	RS:Wait Timeout.	Prompting error code: The execution of a command times out. Re-execute this command.
1025	Error state	RS:Robot On Fault.	(1) Prompting error code: The robot is in error state and cannot execute any command; (2) Click **Reset** to perform clearing; (3) Click the **Servo On** button to re-enable the robot.
1026	The robot is stopping	RS:Robot is Stopping.	Prompting error code: The robot is stopping.
1027	The robot is being disabled	RS:Robot is Disabling.	Prompting error code: The robot is being disabled.

Error Code	State Description	English Display	Solution
1028	The robot is being enabled	RS:Robot is Enabling.	Prompting error code: The robot is being enabled.
1029	The function is not enabled	RS:Option is not Enabled.	Prompting error code: It indicates that this function is not enabled.
1030	Master startup times out	RS:Robot start master time out!	Prompting error code: Master startup times out. (1) Click **Shut down master**; (2) Click **Start master**.
1031	The robot is not powered on	RS:Robot not electrify!	Click **Power on** to power on the robot.
1032	The serial port is not started	RS:Serial not Enabled!	Open the serial port settings in the DCS interface.
1033	The simulation state command is invalid	RS:Beening simulation!Command Invalid!	Prompting error code: This command is invalid in simulate state.
1034	The RTOS library does not exist	RS:RTOS Library not exist!	(1) Prompting error: The RTOS is not started; (2) Double-click the "RTOS" icon to start the RTOS.
1035	The DCS processing command thread crashes	RS:DCS Handle Command thread crash!	Restart the DCS software.
1036	Option is disabled	RS:Option forbidden!	Error prompt: It indicates that this operation is disabled at this moment.
1037	Emergency stop state is not cleared	RS:Emergency Stop Not clear!	Release the **E-stop** button and power on using the controller.
1038	Safe stop I/O is not cleared	RS:Safe Stop Not clear!	Move the object away and click **Reset** to perform clearing.
1039	The script is running	RS:Script running!	Prompting error code: Commands are invalid when a script is running.
1040	xml parameter error	RS:Xml Param Error!	Prompting error: xml file format error
1041	The system board is not connected	RS:System Board Not Connect!	Open the system board on the DCS interface. Set a correct serial port module and COM port. After they are set to defaults, open it.
1042	The controller is not started	RS:Controller Not Start!	Start the controller.
1043	Controller state error	RS:Controller Statu Error!	Prompting error code: Any issued command cannot be executed in this state.
1044	The robot is in effortless demonstration mode	RS:Robot in TeachMode!	Prompting error code: The robot is in effortless demonstration mode and commands are invalid. To

Error Code	State Description	English Display	Solution
			execute commands normally, disable the effortless demonstration function.
1045	The robot has been powered on	RS:Robot Already Electrify!	Prompting message: It indicates that the system has been powered on and it is unnecessary to power on again.
1046	Connecting the ModBus fails	EC: Connect to Modbus Failed!	Check whether the ModBus communication settings are correct. Check whether communication hardware is normal.
1047	The master has been started	EC: Master is Started!	Prompting message: It indicates that the master has been started.
1048	Load parameters exceed limits	EC:Parameter over specified payload!	Check whether load set values exceed system limits. For example, The load limit of E5 is 5 kg.
1049	DCS state error	EC: DCS Status Error!	Restart the DCS.
1050	The target position is invalid	EC: Target position invalid!	Check whether the target position exceeds safe space.
2000	Library loading fails.	RS:Load library failed.	Check whether the library file format is correct. Reload the library.
2001	The script is empty	RS:Script is empty.	Prompting error: The contents of the script is empty.
2002	Compilation error	RS:Compile error.	Prompting error: Check whether program instructions are incorrect.
2003	Script reloading error	RS:Reload script error.	Check whether the loaded text format is correct.
2004	The function does not exist	RS:Function not exist.	(1) The function instruction does not exist; (2) Check whether the sent command is incorrect.
2005	Function return type error	RS:Function return type is error.	(1) Function return value type error; (2) Check that the function return value is consistent with the definition.
2006	MissSignal1	RS:MissSignal.	This function is not enabled.
2007	MissSignal2	RS:MissSignal.	
2008	Parameter type error	RS:Function param type is error	Check that the function definition parameter is consistent with the incoming parameter type and quantity.

Error Code	State Description	English Display	Solution
2009	No header file is contained	RS:Can't not find head file.	The tcc is provided with a header file. Version V2.5 does not use this error code.
2010	No return value is available	RS:Function do not have return value.	Add a function return value.
2011	Parameter count error	RS:Function param count is error	Check whether the entered number of parameters is consistent with the set number of parameters.
2012	UDM stack error	RS:UDM Stack Err..	Test error code used by developers
2013	The script is locked and may be being compiled.	RS:Script been lock,maybe compiling.	Wait until the compilation is finished.
2014	Not in RunScript state	RS:Not In RunScript Statu.	Prompting error code: The DCS is not in RunScript state. This cannot be solved by running the script. Change the program mode to AUTO on the debugging interface of the demonstrator script programming.
2015	The serial port is not connected	RS:Serial Close.	Switch to the system setting subinterface of the DCS interface and open the serial port connection.
2016	The controller is not started	RS:Controller not started.	Start the controller normally.
2017	The socket is not connected	RS:Socket Not Connected.	Check whether the socket communication settings are correct.
2018	The function name cannot have any space	REC_FuncNamehaveSpace	Delete the space from the function name.
2020	The function is interrupted	RS:Function broken stop.	Prompting error code: It indicates that the Stop button is clicked in the running process of the program.
2021	Socket error	RS:Socket Error.	Check the socket in the program is selected correctly.

11.6 Elfin Controller Error Processing

Description	Error Display	Solution
Normal	Normal	
Short circuit error	Error: Short circuit error!	Click Reset to perform resetting and clearing. Click the **Servo On** button to enable the robot.
Overvoltage error	Error: Over voltage limit error!	
Undervoltage error	Error: Under voltage limit error!	
Overspeed error	Error: Over velocity limit error!	
Execution error	Error: Execute error!	
RMS overcurrent error	Error: Over current error!	
Encoder error	Error: Encoder error!	
Position following error	Error: Following position error!	
Speed following error	Error: Following velocity error!	
Negative limit error	Error: Negative limit error!	
Positive limit error	Error: Positive limit error!	
Servo overtemperature error	Error: Server over heating error!	
Peak current error	Error: Max current error!	
Hardware braking error	Error: Emergency stop error!	
UDM error	Error: UDM error!	
Servo parameter error	Error: Server parameter error!	
Enablement timeout	Error: Robot enable time out!	Check whether the robot body drive UDM operates normally. Click the **Servo On** button to re-enable the robot.
SDK collision detection	Error: Robot Collide with body!	(1) Manually open the brake using the demonstrator; (2) Manually drag the robot so that it leaves the self-collision posture; (3) Close the brake and perform clearing and enablement.
Joint limit	Error: Over joint limit error!	(1) In enabled state, let the axis move back to safe space in the reverse direction of the axis that exceeds safe space due to long jog movement. Click **Reset** to perform resetting and clearing;

Description	Error Display	Solution
		(2) In disabled state, Click **Reset** to perform clearing. Click **Servo On**. Let the axis move back to safe space in the reverse direction of the axis that exceeds safe space due to long jog movement.
Singularity	Error: Singularity error!	Click **Reset** to perform clearing. Click **Servo On** to enable the robot.
Abnormal stop	Error: General stopping criterion	Click **Reset** to perform clearing.
SDK calculation error	Error: calculate failed	Click **Reset** to perform clearing.
UDM state error	Error: UDM Statu Error!	Shut down the master; Start the master.
Slave error	Error: Init slave Error!	Click **Reset** to perform clearing.
HomeStep2 error	Error: Home Step2Error!	Click **Reset** to perform clearing.