深圳贯虹自动化有限公司
Shenzhen Guanhong Automation CO.,LTD

# Robot User Manual

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Website : www.szgh-auto.com

Address : Room 201, Building 5, South Digital Innovation Industrial Base, No. 80, Pusha Road, Liuyue Community, Henggang Street, Longgang District, Shenzhen, Guangdong, China

Post code : 518100

# Copyright description

# Warnings

★ Before operating the robot, press the emergency stop key on the teach pendant, and confirm that the main servo power supply is cut off, and the motor is in the state of power loss and holding brake.

**In case of emergency, if the robot cannot be braked in time, personal injury or equipment damage may be caused.**

★ When the servo power supply is switched on after the emergency stop is removed, the servo power supply shall be switched on after the accident causing the emergency stop is removed.

**The robot action caused by misoperation may cause personal injury accidents.**

★ When teaching within the action range of the robot, please observe the following:

**Keep looking at the robot from the front.**

**Follow the operating procedures.**

**The strain scheme when the robot suddenly moves to its own orientation is considered.**

**Be sure to set up a shelter in case.**

**The robot action caused by misoperation may cause personal injury accidents.**

★ When carrying out the following operations, please confirm that there is no one within the action range of the robot and the operator is in a safe position:

**When the robot control cabinet is powered on**

**When operating the robot with the teach pendant**

**During commissioning**

**During automatic reproduction**

**Inadvertently entering the action range of the robot or contacting with the robot may cause personal injury accidents.**

# Notes

★ To operate the robot, you must confirm:

**Whether operators have received relevant training on robot operation**
**Have enough understanding of the motion characteristics of the robot**
**Have enough knowledge of the dangers of robots**
**Work without drinking**
**Did not take drugs that affect the nervous system and slow response**

★ Before robot teaching, the following items shall be checked, and any abnormality shall be repaired in time or other necessary measures shall be taken.

**Whether the robot moves abnormally**

**Whether the external auxiliary equipment associated with the robot is normal**

★ After use, the teach pendant must be put back to its original place and ensure that it is firmly placed.

★ Prevent the accidental drop of the teach pendant from causing the misoperation of the robot, resulting in personal injury or equipment damage.

# Content

# 1 Welcome to the SZGH control system

This chapter introduces the characteristics and application scenarios of SZGH control system, explains the composition of system hardware and software, and the way of using the system to control robot motion.

## 1.1 System introduction

SZGH control system is independently developed by Hunan SZGH robot Co., Ltd. and has completely independent intellectual property rights. It can customize intelligent factory solutions according to customer needs.

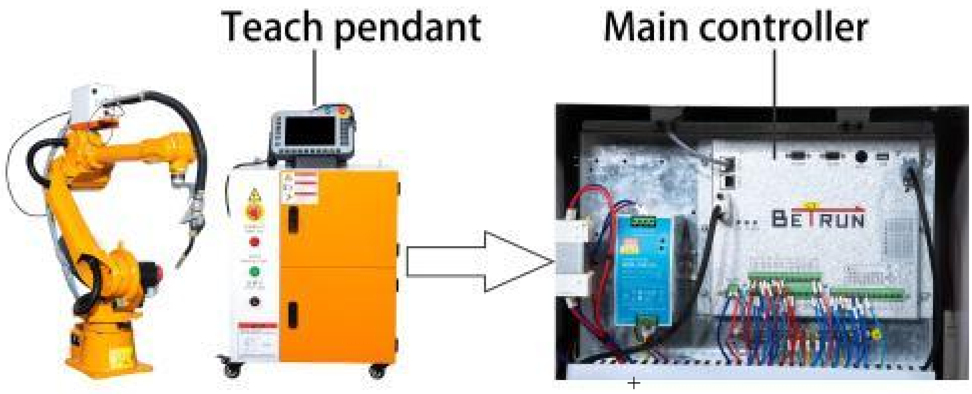



Figure 1. 1 Appearance of SZGH control system

The appearance of the system is shown in Figure 1. 1, which mainly includes two parts: main controller and teach pendant. The main controller is installed in the robot control cabinet, and the teach pendant is placed on the robot control cabinet. The basic technical parameters are shown in Tables 1.1 and 1.2.

The system currently supports:

. Robot: 4-axis / 6-axis robot

. Maximum number of supported axes: 11

. Driver: pulse, Ether cat bus, mixed

System features:

. Hardware: the embedded system design scheme is adopted, which has the advantages of small volume, low power consumption and fast response to system maintenance and upgrading.

. Motion performance: the control cycle is 2ms, the deviation between the actual motion trajectory and the ideal motion trajectory of the manipulator is small, and the motion process is stable and flexible.

. Operation: it adopts graphical man-machine operation interface and programming mode, which is simple to use and easier for customers to accept

Table 1. 1 technical parameters of SZGH controller

| Number | Item | Specification description |
|---|---|---|
| 1 | Control hardware | Multiprocessor system8-way pulse drive interface, MODBUS bus, dual network port, USB Expansion board<br>Flash memory for mass storage22 optocoupler isolation inputs, 10 collector open circuit outputs and 8 brake outputs |
| 2 | Control software | Object oriented design SZGH software products Preinstalled software |
| 3 | Input voltage | 220V~50Hz 、24V |

Table 1.2 technical parameters ofteach pendant

| Number | Item | Specification description |
|---|---|---|
| 1 | Material | Reinforced plastic shell |
| 2 | Quality | 1kg |
| 3 | Operation | 8-inch touch screen + Physical keys Scroll wheel + Touch pen |
| 4 | Operating habits | The left hand passes through the hand rope and gently presses the enable button. |
| 5 | Language | At present, in addition to Chinese, it also supports English, Russian, Korean and Vietnamese. |

## 1.2 Main controller

The main controller is composed of CPU, action control circuit, storage circuit, bus circuit, input / output (I / O) circuit, power supply circuit, etc., which is loaded with core function software package to complete the functions of robot motion control, auxiliary equipment control, input / output response, external communication and so on.

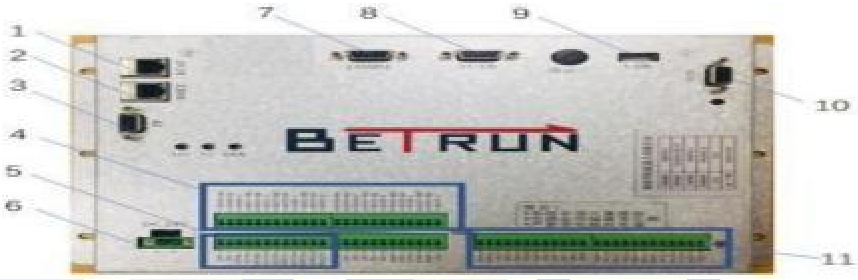



Figure 1.2 Appearance of the main controller

1——The printing is "ECAT", which is the Ether CAT bus interface used to connect the robot servo driver

2——The printing is "ENET", which is the network port used for Mod bus Communication in TCP / IP mode.

3——The screen printing is "TP", which relates to the teach pendant.

4——8-way relay output port

5——10 open collector output ports

6——24V DC input

7——The printing is "COMM", which is the RS485 and RS232 communication interfaces.

8——Reserved interface

9——USB 2.0 interface used to update and back up the system program

10——The printing is "AVO", which is the analog output interface. (Additional options are required.)

11——22 optocoupler isolation input ports, of which the last two are used as phase A and phase B ports of external encoder (used in pipeline tracking function)

## 1.3 Teach pendant

Teach pendant is a device to facilitate operators to complete the control of robot system online. The subsequent contents ofthis manual are based on the teach pendant.

SZGH teach pendant has the following specific features:

- It adopts 8-inch touch screen and is equipped with a touch pen. When wearing gloves, it can operate the interface through the touch pen;
- More abundant keys are provided for convenient operation;
- Equipped with a scroll wheel, which greatly improves the efficiency of manual teaching programming.

## 1.3.1 Scroll wheel functions

The scroll wheel functions are different in two working modes: focus mode and scroll mode.

The Default mode is focus mode. In focus mode, you can open a basic program with the scroll wheel.

. You can quickly switch the highlight of the control on the software interface by rolling the scroll wheel;

. Pressing the scroll wheel is equivalent to the Enter key;

. When a control with a list is highlighted, press the scroll wheel to enter the control list and quickly switch by rolling the scroll wheel. When you press the scroll wheel again, you will return to the control switch.

Press and hold the scroll wheel for 2 seconds to switch to the scroll mode. For all units with scroll bars, you can scroll through the content.

. In the main interface of teach pendant,you can use the scroll wheel to find the function icon;

. In the programming interface, you can use the scroll wheel to browse the program line.

Press and hold the scroll wheel for 2 seconds again to switch to the focus mode.

## 1.3.2 Key functions

Teach pendant is a hand-held programmer for robot online operation. It can realize various operation and display functions required by robot programming and control without mouse and keyboard.

The main key functions on the front and back of the teaching pendant are described as follows.


Figure 1.3 Front appearance of the teach pendant

The physical keys on the front of the teach pendant are divided into three types, and the function definitions are shown in Table 1.3.

Table 1.3 Functions of physical keys on the front of the teach pendant

| Type | Number | Function description |
|---|---|---|
| Program execution keys | 1 | Mode switch It is used to switch between manual mode and automatic mode. |
| | 2 | "Program stop" key in automatic mode It can stop the running program and the robot stop at the current position. Then press the "program run" key, and the program will return to the first instruction line and start running. |
| | 3 | "Program pause" key in automatic mode It can make the running program pause in the current position line and the robot stop at the current position. Then press the "program run" key, and the program will continue to run from the current instruction line. |
| | 4 | "Program run" key in automatic mode |

| | | |
|---|---|---|
| | 5 | "Step forward" key in automatic mode<br>Under "single motion" mode: select a curve below the current position as the target line, and then click "step forward", it will go and pause on the target line. Click the "Program stop" key to exit. Under "single step motion" mode: click "step forward" to execute one line of instructions downward. |
| | 6 | Under "single motion" mode: select a curve above the current position as the target line, and then click "step back", it will go reversely and pause on the target line. Click the "Program stop" key to exit.<br>Under "single step motion" mode: click "step back" to execute one line of instructions upward Non-curves are not executed during a step back. The motion mode cannot be switched under the s paused state.<br>Be careful:<br>(1) It has a high security level. After logging in the system each time, you need to manually turn on the function according to the configuration interface.<br>(2) It is unavailable in the following scenarios: no reverse collaborative process; ……<br>"Emergency stop" key<br>It can be used to stop all operations of the system and servo in case of "emergency". |
| Software editing keys | 7 | "HOME" key<br>It is mainly used to return to the home page from the sub page, including the exit of the modal dialog box. |
| | 8 | "Shift" combination key<br>You can customize the function through system - user defined key. |
| | 9 | F1: the default is "move focus forward" in the roller focus mode. F2: The default is "move focus backward" in the wheel focus mode. You can customize the function through system - user defined key. |
| | 10 | I / O key: basic port debugging. Press once to pop up and again to hide. |
| | 11 | "Menu" key You can pop up a box on the touch screen for corresponding query and setting operations. |
| | 12 | "Tab" key You can switch the operation history box/ configuration and monitoring box.<br>"Tab" combination key You can customize the function through system-user defined key. |
| Manual teaching Keys | 13 | "-V,+V" keys in manual mode<br>They are used to increase or decrease the teaching speed according to a certain step. The step is divided into four gears according to the current speed: 0.01, 0.1, 1 and 10. |
| | 14 | "J6 -" and "J6 +" keys in manual mode<br>After pressing "enable", J6 joint motion can be controlled in the joint coordinate system (C attitude adjustment in the base coordinate system). |
| | 15 | "J5 -" and "J5 +" keys in manual mode<br>After pressing "enable", J5 joint motion can be controlled in the joint coordinate system (B attitude adjustment in the base coordinate system). |
| | 16 | "J4 -" and "J4 +" keys in manual mode<br>After pressing "enable", J4 joint motion can be controlled in the joint coordinate system (A attitude adjustment in the base coordinate system). |
| | 17 | "J3 -" and "J3 +" keys in manual mode<br>After pressing "enable", J3 joint motion can be controlled in the joint coordinate system (z-axis direction movement in the base coordinate system). |
| | 18 | "J2 -" and "J2 +" keys in manual mode<br>After pressing "enable", J2 joint motion can be controlled in the joint coordinate system (y-axis direction movement in the base coordinate system) |
| | 19 | "J1 -" and "J1 +" keys in manual mode<br>After pressing "enable", J1 joint motion can be controlled in the joint coordinate system (x-axis direction movement in the base coordinate system). |
| | 20 | "EXT" key in manual mode |

| | | |
|---|---|---|
| | | Switch to additional axis teaching mode. |
| | 21 | Coordinate system switching key in manual mode<br>It is used to switch the currently used teaching coordinate system (Joint Coordinate System → Base Coordinate System→User Coordinate System →Joint Coordinate System).<br>Tool Coordinate System needs to be selected at the same time sometimes. |


Figure 1.4 Rear appearance of teach pendant

An enable button is used on the back of the teach pendant. During manual teaching, the left hand passes through the hand rope and gently presses the button.

This enable button has three states:

State 1: when fully released, the driving device of the robot is cut off;

State 2: when gently pressed, the driving device of the robot is connected;

State 3: when pressed hard, the driving device of the robot is cut off.

### 1.3.3 System login permission

Turn on the power switch of the robot control cabinet and the human-computer interaction interface of the teach pendant starts.

The login interface will appear on the teach pendant screen, which is divided into three login permissions: administrator, operator and viewer, as shown in Figure 1.5.Different types of operators have different permissions. The specific permissions are shown in Table 1.4.Three different types of users need to check the corresponding type and log in through user name and password. USER:admin Password:admin


Figure 1.5 Login interface

Table 1.4 User permissions

| Number | Type | User permissions |
|---|---|---|
| 1 | Administrator | . Robot control system programming teaching<br>. Debugging of peripheral equipment<br>. Manage the permissions of different operators in the system<br>. Maintenance of robot control system<br>. Robot system power on / off operation<br>. Start and stop of robot program<br>. Recovery of system alarm state<br>(part of the work needs to be carried out in the robot work area and must receive |

| | | |
|---|---|---|
| 2 | Operator | After logging in the "Administrator" mode, set the "user name" and "password" of the operator mode in [user] - [user management].<br>. Robot system power on / off operation<br>. Start and stop of robot program<br>. Recovery of system alarm state(only work outside the robot working area.) |
| 3 | Viewer | You do not need to set"user name"and"password"when logging in. You can "login" Directly You can only "Browse" the system and can't do anything else. |

## 1.3.4 Operation modes

There are two operation modes of using the teach pendant: manual mode and automatic mode.The switching between the two modes is realized by the "mode switch" button on the teach pendant

**Manual mode**

Carry out "manual teaching" for the robot, and carry out parameter setting, program design,configuration of various functions and process packages, system management, etc., which are realized interactively in the manual mode interface.

In manual mode, the teach pendant can be used to control the movement of the robot by using 6 groups of manual control physical keys on the right side of the front while pressing the "enable" button on the back, to realize the manual operation of single joint movement and linear movement of the robot at different movement speeds.

**Automatic mode**

It is mainly used for program execution.The robot performs single step, single or cyclic motion according to the program setting and the set motion speed.

## 1.4 Control modes of robot

Based on SZGH control system,the robot has several different control modes, as shown in Table1.5.

Table 1.5 Robot control modes

| Control mode | Method | Speed |
|---|---|---|
| Manual operation of teach pendant | In the manual mode of the teach pendant, 6groups of control physical keys are used to control the single axis or linear motion of the robot | . The maximum speed of joint movement is 600r/min<br>. The maximum speed of linear motion is 200 mm/s<br>. The maximum rotation speed in the tool coordinate system is 50 degrees/second<br>When manually controlling the physical key operation,the default is 10% slow operation on this basis |
| Manual fast operation | In the manual mode of the teach pendant, use the interface software keys to test the program | . Run at the speed set by the program |
| Run in automatic mode | In the automatic mode of the teach pendant,use the interfaces of two are keys to run the program | . Run at the speed set by the program<br>6 groups of physical keys cannot be controlled manually |
| External control | When there is no teach pendant,the external key/upper computer communication mode controls the program to run | . Run at the programmed / set speed |

## 1.5 Setting of safety zone and interference zone

### 1.5.1 Safety zone

In the process of industrial robot running,it is often necessary for the robot to return to the starting point of program curve or zero point from a certain position. This motion process does not consider the surrounding environment of the robot,but the control system calculates the motion trajectory by point motion control. In some cases,if the operator does not consider the position of the workpiece, the machine collision accident will occur due to miss operation.In order to ensure that the robot does not touch other objects and is in a safe state when starting the robot from the current position and posture to the program starting position and posture, it is necessary to set the safe starting area of the robot through the teaching pendant after the installation of the robot is completed. When the robot is not in the safe area of a job, the job program cannot be started and run,and the corresponding prompt box will pop up.

The program cannot be started until the robot is manually taught to the safe area. Similarly, when the robot exits the operation, it also needs to be zeroed in the safety zone, and the zeroing safety zone needs to be set in advance.

Click [tools] - [regional setting] - [safety zone] in the manual interface of the teach pendant, as shown in Figure 1.6, and the setting interfaces of "Starting-safety zone" and "Home-safety zone" appear. Multiple safety zones can be set, which can be completed by creating the starting point and ending point of the opposite corner of the safety zone (as shown in Figure 1.7).


Figure 1.6 Safety zone setting interface

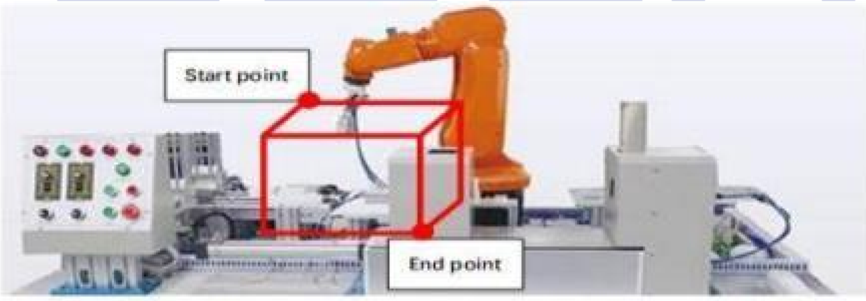



Figure 1.7 Start point and end point of safety zone

## 1.5.2 Interference zone

Setting the "interference area" has no effect on the running track of the system curve, but it can interact with the program through PLC programming or with other robots through the output port to work together. For example, in the stamping process, the robot must set the picking and discharging interference area in order to ensure the safety when working with the front and rear robots. The interference function of the system is divided into three types: point interference, space interference and axis interference. After setting the "interference section", whether it is manual teaching or program operation, the system will detect if it enters the "interference section".

Click [tools] - [area setting] - [interference area] in the manual interface of the teach pendant, as shown in Figure 1.8, and three types of interference area setting interfaces of "Space interference", "Point interference" and "Axis interference" appear.

Figure 1.8 Interference area setting interface

The interference function is represented by "I" type in PLC editing, and different numbers represent different interference intervals:

. Point interference - when setting "point" interference, when running to this point, enter the interference interval, which is represented by i0-i19 in PLC editing.

. Space interference - when setting "spatial" interference, the interference interval refers to a "spatial body" generated diagonally with "starting point" and "end point" (excluding the "face" generated by "starting point", "end point" and "base coordinate system", so the "interference interval" can be set larger as needed). It is represented by i20-i39 in PLC editing.

. Axis interference - it is divided into 8 groups, which are respectively used to set the interference interval of 8 axes (j1-j8). It is represented by i40-i47 in PLC editing.



# 2 Coordinate systems

This chapter introduces five coordinate systems commonly used by industrial robots, and how to use teach pendant to establish tool coordinate system and user coordinate system.

## 2.1 Five common coordinate systems of robot

Coordinate system is a position index system defined on the robot or space in order to determine the position and attitude of the robot, including: base coordinate system, joint coordinate system,tool coordinate system, flange coordinate system and user coordinate system. In the process of"manual teaching", the motion of the robot is carried out in several different coordinate systems.

### 2.1.1 Base coordinate system

The base coordinate system is composed of the origin and coordinate orientation of the robot base,which is the basis of other coordinate systems of the robot. The direction of the base coordinate system is specified: the x-axis is forward,the z-axis is upward, and they axis is determined according to the right-hand rule (as shown in Figure 2. 1).

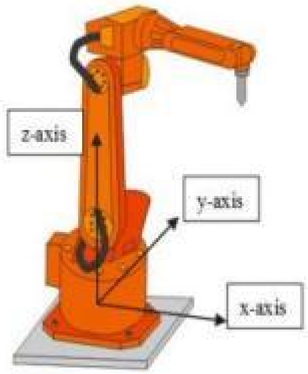



Figure 2. 1 Robot base coordinate system

### 2.1.2 Joint coordinate system

Joint coordinate system the joint coordinate system of robot is used to describe the motion of each independent joint of robot. For six axis robots, the joint type is rotating joint. In the joint coordinate system, each joint can be driven in turn, so that the end of the robot can reach the specified position. First, specify the "zero position" of the robot in the joint coordinate system, as shown in Figure 2.2. Then, the coding direction is set by the controller to specify the rotation direction of each joint. In the joint coordinate system, the rotation direction of each joint of the robot must be consistent with Figure 2.2, that is, standing directly behind the robot body and using the "right-hand screw rule".

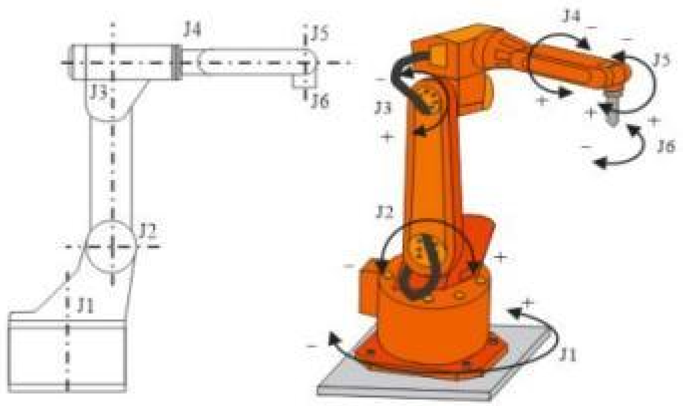



Figure 2.2 Robot joint coordinate system

## 2.1.3 Tool coordinate system and flange coordinate system

Tool coordinate system and flange coordinate system tool coordinate system is used to determine the position and attitude of the tool. It is composed of tool center position (TCP) and coordinate orientation. The tool coordinate system must be set in advance. The default coordinate axis direction is to rotate around the axis under the base coordinate system, or you can customize the coordinate axis direction. When there is no definition, the origin of the robot's default tool coordinate system is in the center of the robot's wrist flange. At this time, the coordinate system established with the center of the flange as the origin is called the flange coordinate system. When the robot is in the zero position, the flange coordinate system is parallel to the base coordinate system, as shown in Figure 2.3.

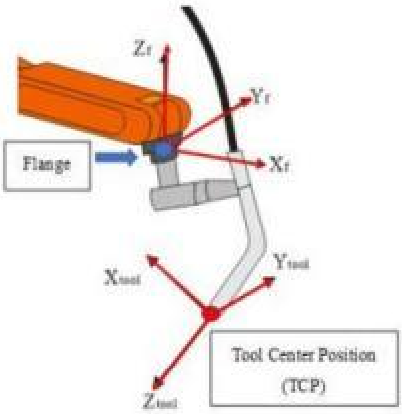



Figure 2.3 Robot tool coordinate system

## 2.1.4 User coordinate system

User coordinate system is a rectangular coordinate system defined by the user within the allowable range of robot action, which can be defined by the user according to their own needs and habits. As shown in Figure 2.4, the user coordinate system can be defined on the workbench.

With a user coordinate system, we can:

(1) Quantify the position of the point on the workbench.

(2) When teaching, the robot can move strictly according to the edge path of the workpiece in the user coordinate system.

(3) When the workpiece position or the workbench changes, transformation instructions of user coordinate system can be used without teaching the robot again.

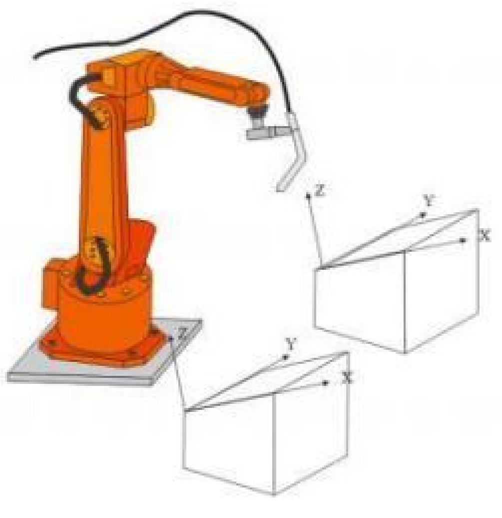


Figure 2.4 Robot user coordinate system

## 2.2 Establishment of tool coordinate system

The establishment of a tool coordinate system is also called tool coordinate system calibration.There are two main approaches：

. **Multi-point calibration method**

We usually use four-point method. Let the tool TCP arrive at the same point with four different attitudes, and obtain the data of these four points, then the system can calculate the position of TCP relative to the center of flange.

When we need change the Axis direction, we use six-point method. Based on the four-point method, the data of points are obtained in x-axis and z-axis respectively, and the y-axis is determined by the right-hand rule.

Click [tool coordinate system] in the "manual interface" of the teach pendant, and the new tool coordinate system interface as shown in Figure 2.5 will appear

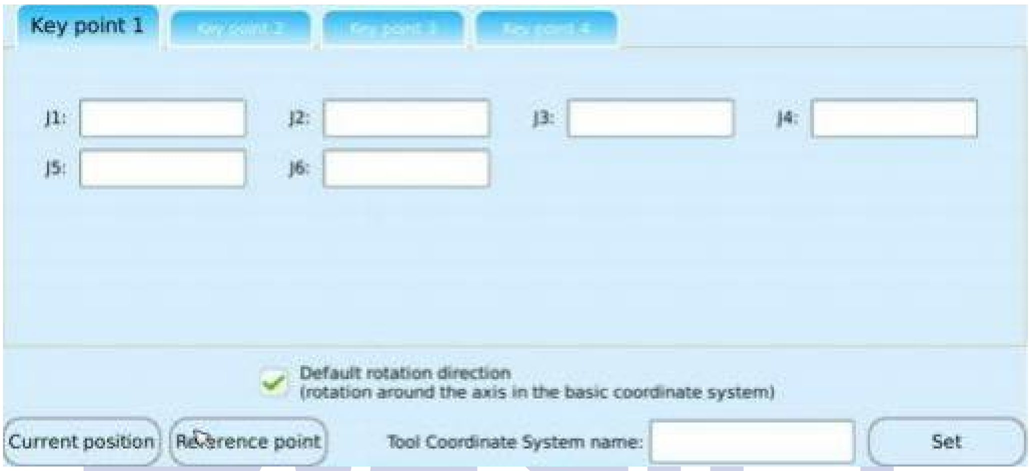



Figure 2.5 Tool coordinate system interface 1

When checked,the attitude of the default tool coordinate system is to rotate around the axis under the base coordinate system. The tool coordinate system can be established only by using four-point method to realize TCP measurement.

Principle of four-point method:

(1) Find a very accurate fixed point (the sharp cone end of the workpiece) within the working range of the robot as the reference point.

(2) Manually teach the robot, and use different tool postures to just touch the TCP of the robot tool with the reference point as far as possible, as shown in Figure 2.6.

(3) Through the 6-joint data of the robot flange position in four different postures of key point 1-key point 4, the system can automatically calculate the TCP data.

(4) The system records TCP data and constructs the conversion relationship between tool coordinate system, flange coordinate system and base coordinate system.

Note: If the TCP setting is accurate, when the tool is checked in the manual teaching, the TCP position will not change when the tool attitude is changed.

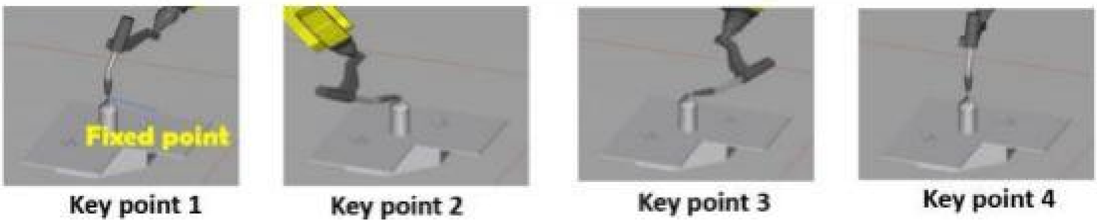



Figure2.6Thesharpconeendoftheworkpiece is used as the reference point to establish the tool coordinate system

When the tool coordinate system attitude to be established is not the default rotation direction, it is necessary to additionally determine the direction point x and the direction point z, as shown in Fig. 2.7 and Fig. 2.8. Determine key point 1- key point 4 points according to the previous method, and then direction point z point shall move vertically upward on the basis of key point 4, and direction point x point shall move forward on the basis of key point 4 to determine the direction points of Z axis and X axis

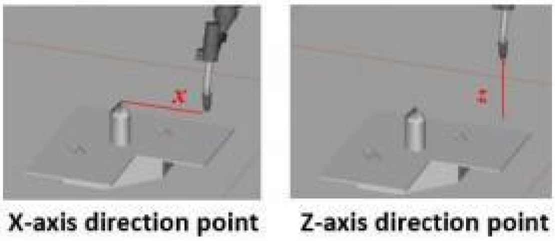



Figure 2.7 Additionally determine the direction point x and the direction point z

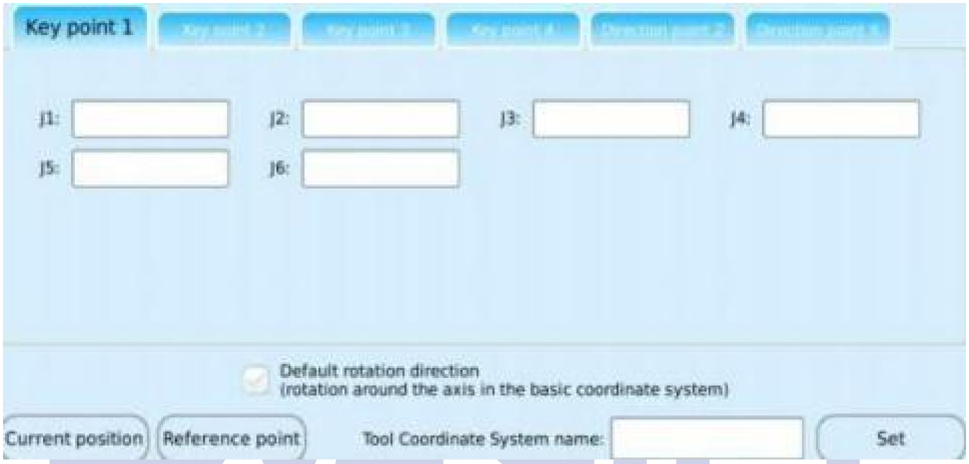
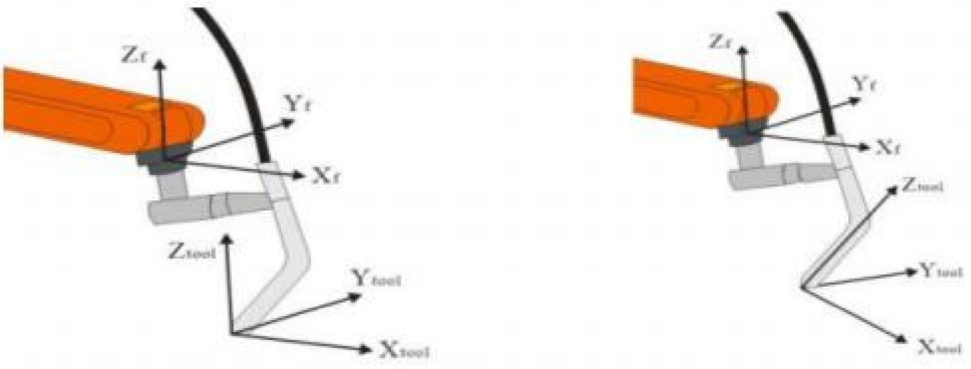



Figure 2.8 Tool coordinate system interface 2

**Comparison:**

Four-point calibration method: The tool coordinate system is parallel to the flange coordinate system.Six-point calibration method: Define the X and Z directions by yourself.



(a) Four-point calibration method (b) Six-point calibration method

Figure 2.9 Comparison of two calibration methods

. **External reference calibration method**

let the tool TCP reach a measured external reference point (mark point),as shown in Fig. 2. 10. If the tool needs to be changed frequently, this method can be used for rapid calibration.

All the program points associated with the original tool coordinate system will be associated with the revised new tool coordinate system,and the six joint data will be automatically corrected to keep the pose of TCP unchanged.

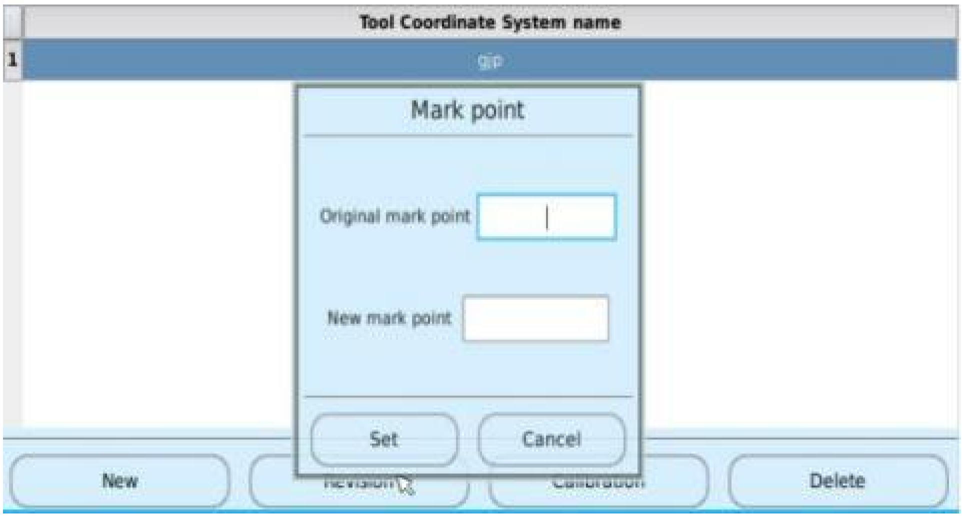



Figure 2. 10 Using mark point for rapid calibration

## 2.3 Establishment of user coordinate system

The establishment of user coordinate system generally uses the three-point method:

(1) We let the tool TCP reaches the origin of the coordinate system, a point on the x axis and a point on the y axis.

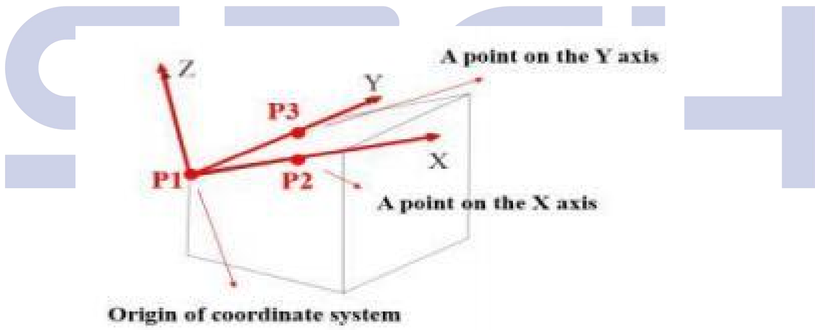



Figure 2. 11 Three-point method to establish user coordinate system

As shown in t Figure 2. 12, we obtain the data and create three points. Please pay attention here, the created "point" needs to check the tool coordinate system.

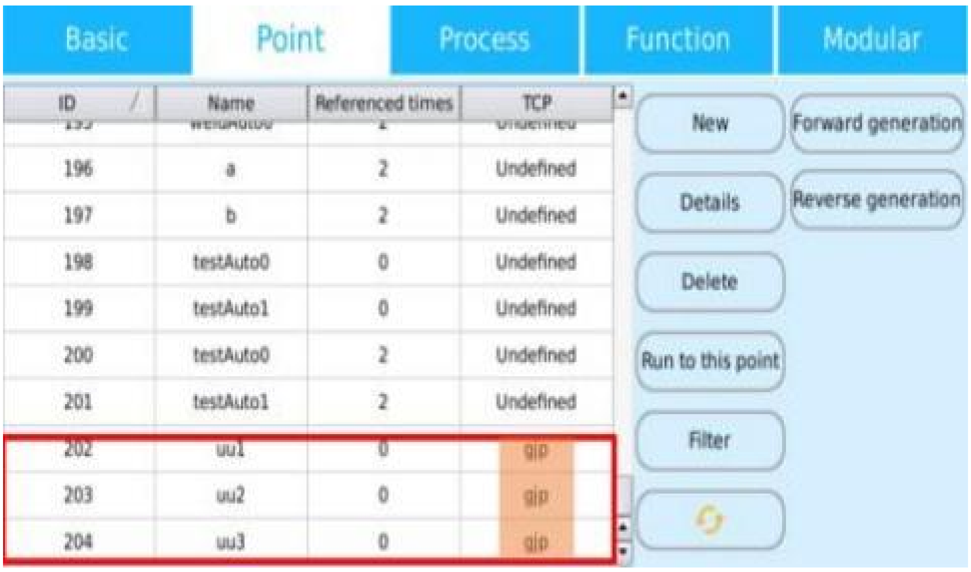



Figure 2 12 Create three points for user coordinate system

(2)Click [user coordinate system] in the "manual interface" of the teach pendant, and the user coordinate system interface as shown in Figure 2. 13 will appear. Then the user coordinate system can be established by referencing the three points in turn.

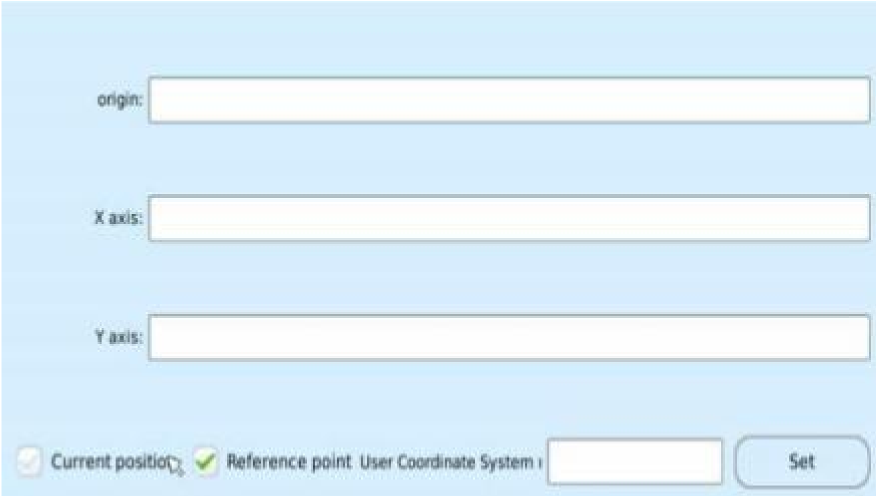



Figure 2.13 User coordinate system interface

# 3 Robot manual teaching

Using teach pendant to operate robot manually is the basis of industrial robot programming.

You can switch the teach pendant to "manual mode";Press the "enable" button on the back of the teach pendant, select the coordinate system and set the teaching speed; then operate the button on the right side of the teach pendant to control the movement of the robot, as shown in Figure 3.1.

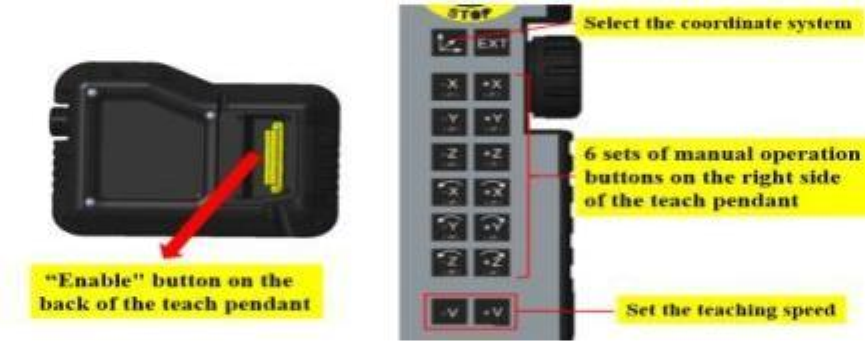



Figure 3. 1 Buttons for manual teaching

## 3.1 Enable button

Carry out "manual teaching" in the "manual mode" of the teach pendant. The way to start is to press the "enable" button on the back of the teaching pendant. Release the "enable" button, and the teach pendant cannot control the motion of the robot.

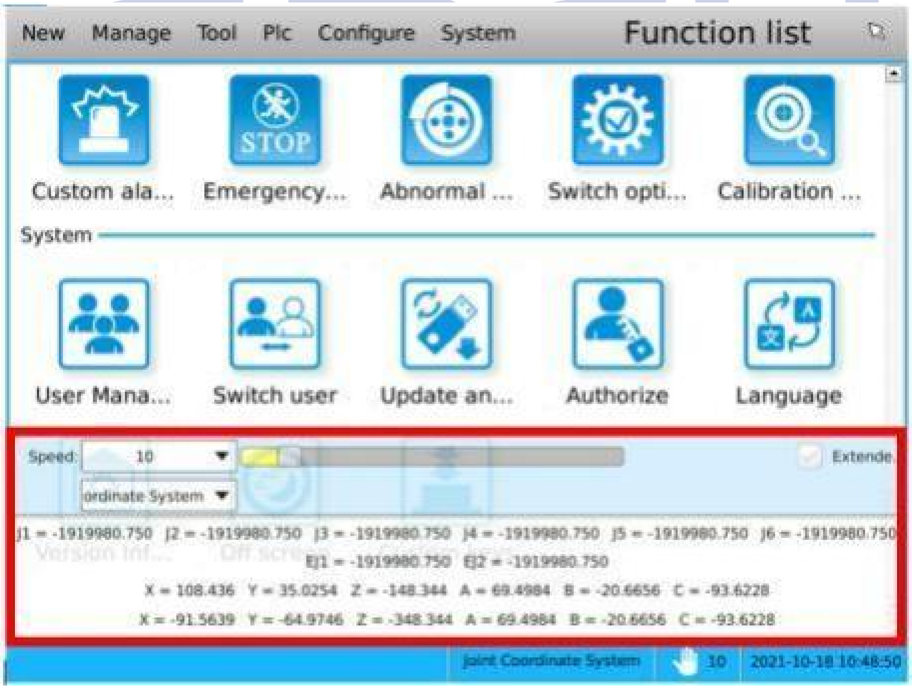



Figure 3.2 Manual teaching configuration and motion monitoring page

After pressing the "enable" button, the manual teaching configuration and motion monitoring page will be displayed at the same time, as shown in Figure 3.2. The upper part is the teaching configuration:including teaching speed, additional axis radio box, teaching coordinate configuration, precise position function button and so on. The lower part is the display of the current joint angles and the coordinate values under the corresponding coordinate system.

This page will pop up automatically when the "enable" button is pressed. It will be hidden after the focus is lost. In manual mode, when the "enable" button is pressed, slide from left to right or from right to left anywhere on the interface to call up the interface again.

## 3.2 Manual Teaching in Different Coordinate Systems

When selecting different coordinate systems and manually controlling the physical keys according to the six groups on the right side of the teach pendant, the motion mode of the robot is different.

### Operation type: joint coordinate system

The robot has six movable joints, which are defined as j1-j6. In the joint coordinate system, six groups of buttons enable each joint of the robot to rotate independently, as shown in Figure 3.3.

The joint coordinate system can be selected for large range motion without TCP attitude.

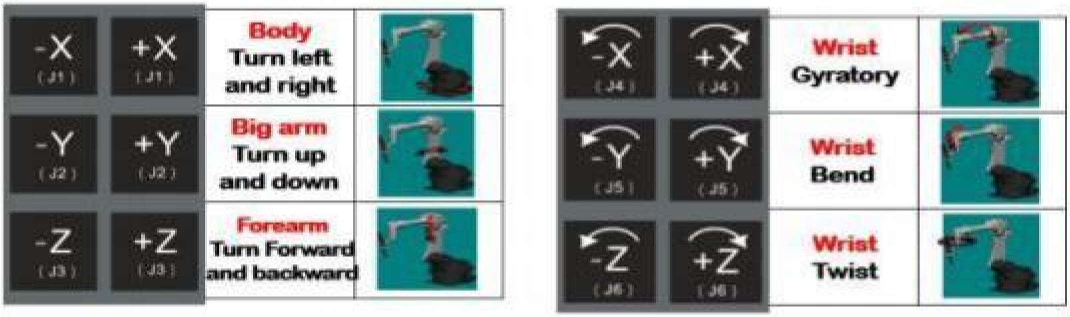



Figure 3.3 Keys function when the operation type is "joint coordinate system"

### Operation type: base coordinate system + TCP

The base coordinate system is a common coordinate system in teaching. In this operation type,the robot is multi-joint linkage.


Figure 3.4 Keys function when the operation type is " base coordinate system"

Among the six groups of keys: the first three groups of keys respectively control TCP to move horizontally along the X, Y and Z axes of the base coordinate system, and the last three groups of keys make the tool rotate around the X, Y and Z axes of the base coordinate system on the premise that TCP position remains unchanged.

Note: if the corresponding tool coordinate system is not selected before manual operation, the point at the same position during rotation is the center of the connecting flange.

### Operation type: user coordinate system + TCP

The robot is multi-joint linkage.

Among the six groups of keys: the first three groups of keys respectively control TCP to move horizontally along the X, Y and Z axes of the user coordinate system. The last three groups of keys make the tool rotate around the X, Y and Z axes of the user coordinate system on the premise that TCP position remains unchanged.

Note: if the corresponding tool coordinate system is not selected before manual operation, the point at the same position during rotation is the center of the connecting flange.

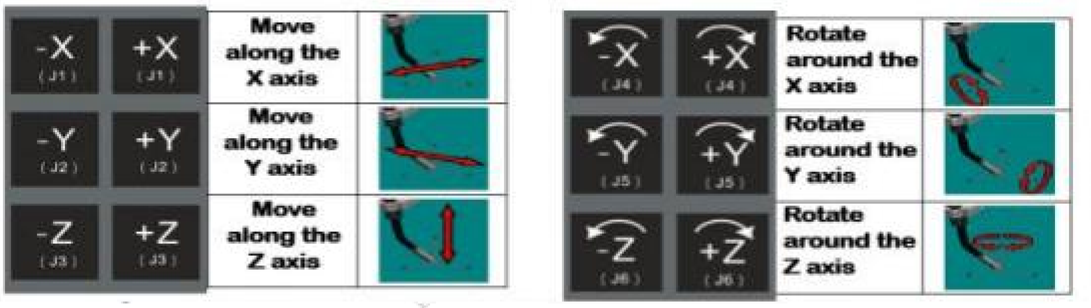



Figure 3.5 Keys function when the operation type is " user coordinate system"

**Operation type: tool coordinate system**

The robot is multi-joint linkage.

Among the six groups of keys: the first three groups of keys respectively control TCP to move horizontally along the X, Y and Z axes of the tool coordinate system. The last three groups of keys make the tool rotate around the X, Y and Z axes of the tool coordinate system on the premise that TCP position remains unchanged.

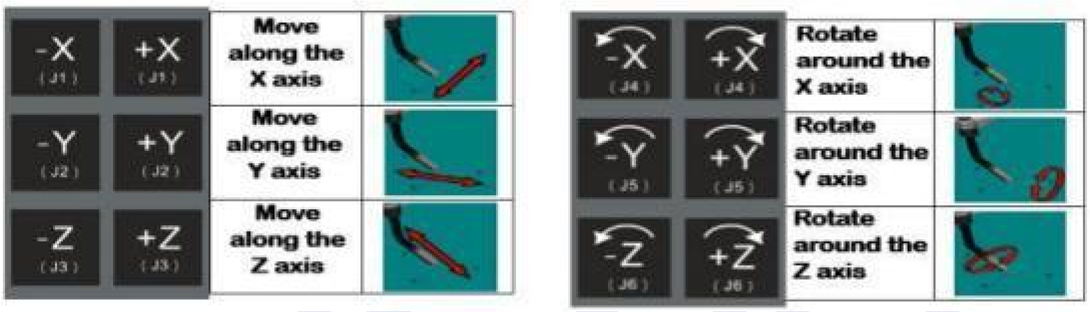



Figure 3.6 Keys function when the operation type is " tool coordinate system"

In the "tool coordinate system" operation mode, it is relatively easier to control the motion track of the tool TCP, and the posture of the tool can be adjusted when the TCP position is not moved. If the six point method is used to establish the tool coordinate system and the effective direction of the tool is set as the Z axis,as shown in Figure 3.7,in some cases,the tool coordinate system is the most suitable for the translation operation without changing the tool attitude relative to the workpiece.


Figure 3.7 Manual teaching in tool coordinate system

## 3.3 Manual teaching speed

During manual teaching, it is better for the robot to move slowly in the working area. At present,the system settings during manual teaching:

. The maximum speed of joint movement is 600 r/min;

. In the base coordinate system, tool coordinate system and user coordinate system, the maximum speed of linear movement in X,Y and Z directions is 200 mm/s, and the maximum speed of rotation around X, Y and Z axes is 50 degrees/s.

## 3.4 Operational feedback

For each operation on the teaching pendant, the history can be seen in the operation feedback display box.

For each operation on the teach pendant, the history can be seen in the operation feedback display box. The operation history display box of the teach pendant is a pop-up page, which is displayed at the bottom of the screen.

In manual mode: slide the interface from left to right or from right to left, you can call up the operation history pop-up box, and it will be hidden automatically when the focus is lost.

Manual mode + press the enable key:slide the interface from left to right or from right to left. By default, the motion configuration page will be called out first. At this time, switch with the "tab" key to switch to the operation history page and automatically hide when the focus is lost.

In automatic mode: slide the interface from left to right or from right to left. You can call up the operation history pop-up box and hide it automatically when the focus is lost.

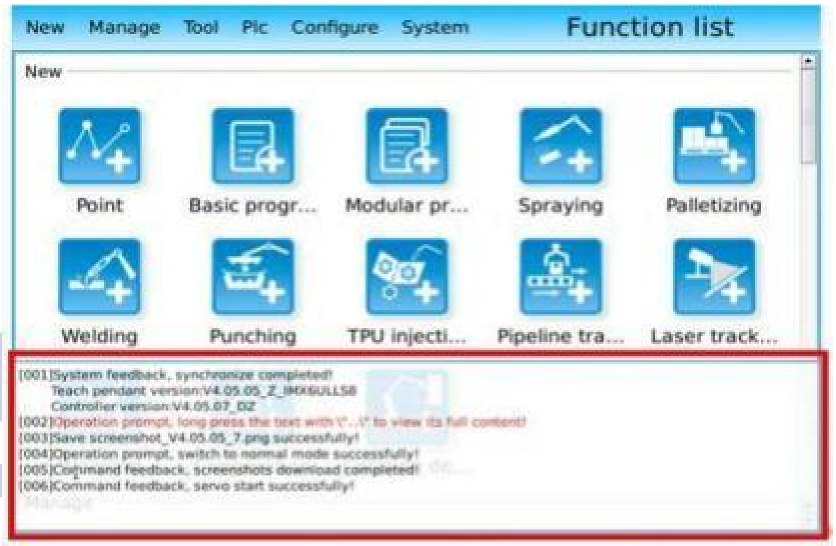



Figure 3.8 Operation feedback display box

# 4 Online teaching programming

This chapter explains how to quickly generate and execute a simple robot motion control program through teaching programming, to help operators master the basic programming method of teach pendant.

## 4.1 Contents of teaching programming

The information required for robot operation includes three parts: motion trajectory, operation conditions and operation sequence

### 4.1.1 Path of particle

Motion trajectory is the key point for the robot to complete an operation. When teaching, it is impossible to teach all the points on the operation trajectory once, but segments the trajectory, manually teach the starting point, and end point of each segment of the trajectory, then confirm the attributes of each segment of the trajectory in the programmed curve motion command, and then the path planning module of the control system performs interpolation operation.

### 4.1.2 Operating conditions

In teaching programming, in addition to telling the robot motion trajectory, it is also necessary to reasonably configure the process conditions of robot operation in advance. For example, in order to obtain good welding quality, robot welding operation needs to set welding conditions, including welder model, welding sequence, welding control signal, welding current and voltage control and other parameters.

There are two types of input methods for operating conditions on SZGH teach pendant:

(1) Create function package or process package

(2) Set by command in the program

### 4.1.3 Operation sequence

The movement and process implementation of robot need to be carried out according to a certain operation sequence. The setting of operation sequence mainly involves two aspects.

(1)Process sequence of operation object

(2)When writing the robot trajectory program by manual teaching, it is necessary to integrate the operation sequence of the process.Action sequence of robot and peripheral equipment

In the complete industrial robot system, in addition to the robot itself, it also includes some peripheral equipment. The discovery device provides functions such as collaboration, pipeline tracking and so on, which can be set up before programming and invoked in the program.

## 4.2 "Point" in teaching programming

"Point" is a description of the position and attitude of the robot. Specifically, it is the position and attitude of the center of the end flange in space when the tool TCP reaches the target position when the robot is taught manually. This information can be uniquely determined by the joint angle data of the robot.

### 4.2.1 "Point" management

Click [manage] - [point], as shown in Figure 4.1, to open the "point" management interface, it shows the relevant information of the points, including ID number, name, reference times and the name of the corresponding TCP (tool center point).

(1) ID: the ID number is the unique identification of the point, which is automatically generated when it is created. The points referenced in the curve motion instruction in the basic program are associated and uniquely confirmed by the ID number.

(2) Name: the point name can be automatically generated during teaching or input by operators, which is convenient for point reference and management in the program.

(3) Reference times: refers to the number of times the point is referenced in all basic programs in the controller.


Figure 4. 1 "Point" management interface

Note:when the reference times is greater than 1,modifying the data of this point may affect some motion curves in a basic program or the motion curves in many basic programs.

(4)TCP: the corresponding tool coordinate system needs to be checked. When it is undefined, this point can only determine the position and attitude of the robot flange center, but cannot determine the position and attitude of the TCP.

## 4.2.2 Creation of "point"

When the robot reaches the specified position, click [new] - [point], as shown in Figure 4.2, to open the "point" information interface. It can be named according to the purpose of the point. Enter the "point" name and click [current position], then the system will read the six joint data of the current robot and display the X, Y and Z coordinate values at the same time.

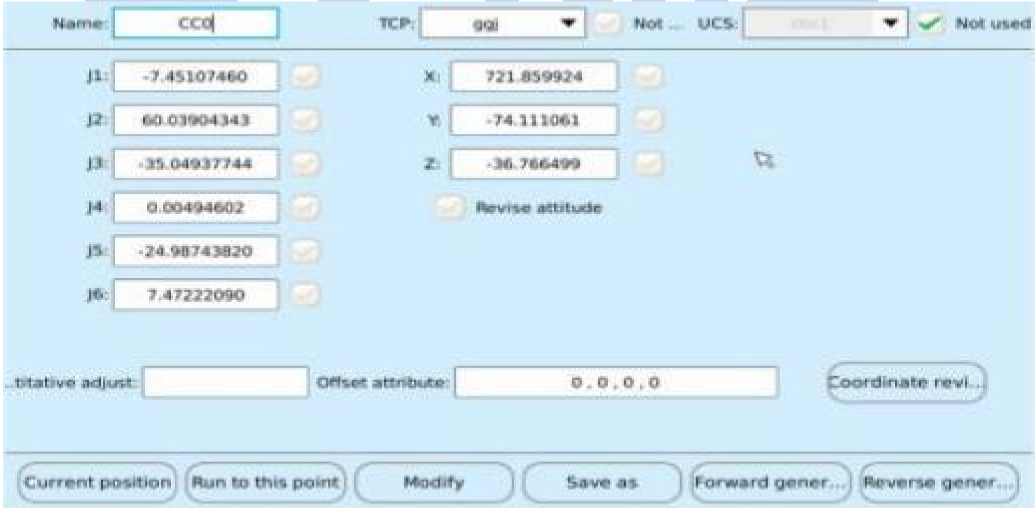



Figure 4.2 "Point" information interface

In the "Point" information interface, five basic functions are provided:

(1) Click [run to this point] to control the robot to directly reach the position and attitude of this point.

(2) Select "user coordinate system", we can view the position data of the point in the user coordinate system.

(3) Check "Revise attitude", then enter the revised value, and click [coordinate revision], then the 6 joint values will be revised. Click Modify or save as a new point.

(4) If checking the "check boxes", you can modify multiple coordinate value data at the same time by entering the value in the quantitative adjust text box.

(5) The "offset attribute" function is provided. You can enter the maximum absolute value of the point offset to limit the operator's modification of the point.

Note:

(1) The six joint coordinate value can only determine the position of the center of the robot flange.However, the operator pays attention to the posture of TCP when teaching, so the tool coordinate system must be selected when creating a new point, and the controller can carry out interpolation operation based on TCP to generate straight-line or arc continuous path trajectory

(2) When saving point data, only six joint data and associated tool coordinate system ID are stored, and user coordinate system ID is not saved. Therefore, when you need to copy the program written on one robot to other robots, you need to click the [forward generation] button to bind the user coordinate system.

(3) The displayed X, Y and Z coordinate values have the following meanings:

. When "do not use" tool coordinate system is checked, it is the X, Y and Z coordinate values of the flange center under the base coordinate system;

. When selecting the corresponding tool coordinate system, the X, Y and Z coordinate values of the tool TCP in the base coordinate system;

. When the tool coordinate system and user coordinate system are selected at the same time, it is the X, Y and Z coordinate values ofTCP in the user coordinate system.

## 4.2.3 Display of current "point"

When entering the manual or automatic mode main interface of the teaching pendant, you can see the real-time display of the current "point" information of the robot as shown in Figure 4.3 at the bottom of the interface.


Figure 4.3 Real time display of current "point" information

## 4.2.4 Home position

As shown in Figure 4.4, after the installation of the robot system, each joint of the robot body will move to each position as shown in the figure before leaving the factory, and then set the home point in the "machine parameter setting" interface. When the robot manually teaches and reads the joint angle of the "point", it is positioned with the set "home.

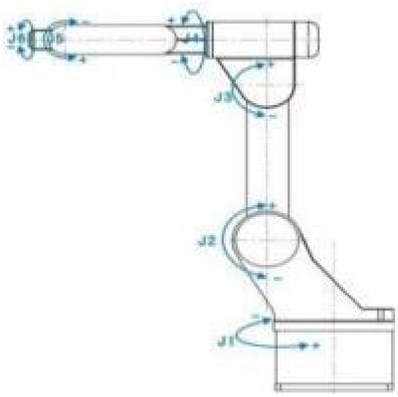



Figure 4.4 Robot home position attitude

When the teach pendant is in "automatic mode", click the "run to home position" button on the interface (as shown in Figure 4.5)to control the robot to run to the home position. At this time,read the angle value of each joint of the current "point", and the angle value is displayed as "0".

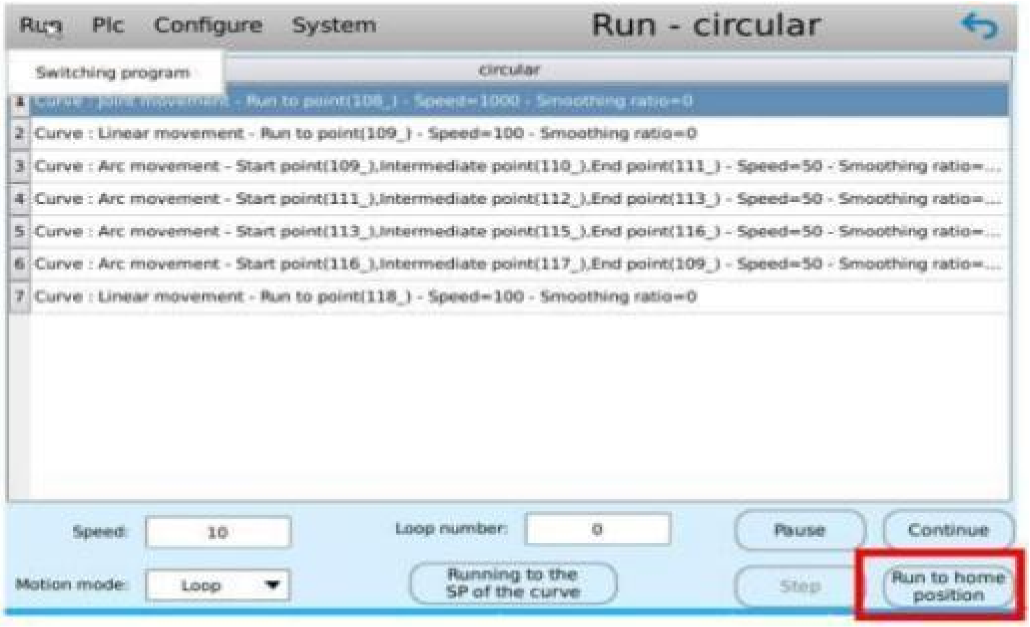



Figure 4.5 "run to home position" button in "automatic mode"

## 4.3 Online teaching a basic program

### 4.3.1 Task description

Write a "test1" motion curve control program for robot welding through manual teaching, let the robot move from T1 (operation start point) to T2 (operation adjacent point) at the speed of 1000mm/s, and then move in a straight line at the speed of 100mm/ from T2 to T3 (operation start point) to start welding at the speed of 10mm/s, After welding to T4 (operation end point), exit to T5 (operation avoidance point) in a straight line at the speed of 100mm/s. The trajectory of the robot is shown in Figure 4.6.

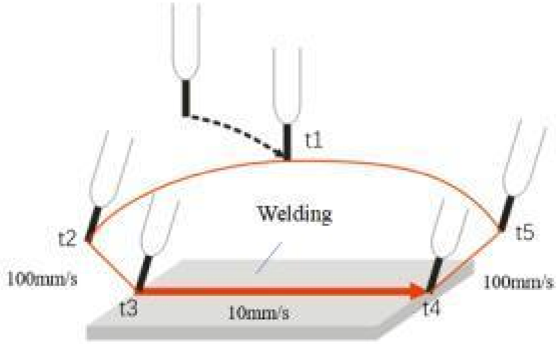



Figure 4.6 Robot motion trajectory for welding

Before creating the basic program, there are four things to do:

- Set startup safety zone and home safety zone
- Create the tool coordinate system and user coordinate system
- Create the welding process package
- Carry out trajectory path planning

After completing the above steps, you can start teaching and write a basic program.

### 4.3.2 Create a basic program

The programs in SZGH software system are divided into four types: basic program, process package, function package and modular program. Among them, the other three types will eventually be converted into basic programs for interpretation and execution by the main controller.This section describes how to create a new basic program.

### Log in to the software with administrator privileges

Turn on the power supply of the robot control cabinet, wait for the human-computer interaction interface of the teaching pendant to start, and then log in to the system as an administrator. The other two types of operators (operators and viewers) do not have programming permission when logging in.

### Enter the basic program programming interface

Switch the mode change-over switch of the teach pendant to the "manual" sign. On the manual main interface:click [new] [basic program] to enter the basic program programming interface, as shown in Figure 4.7. Here you can create a "basic program"

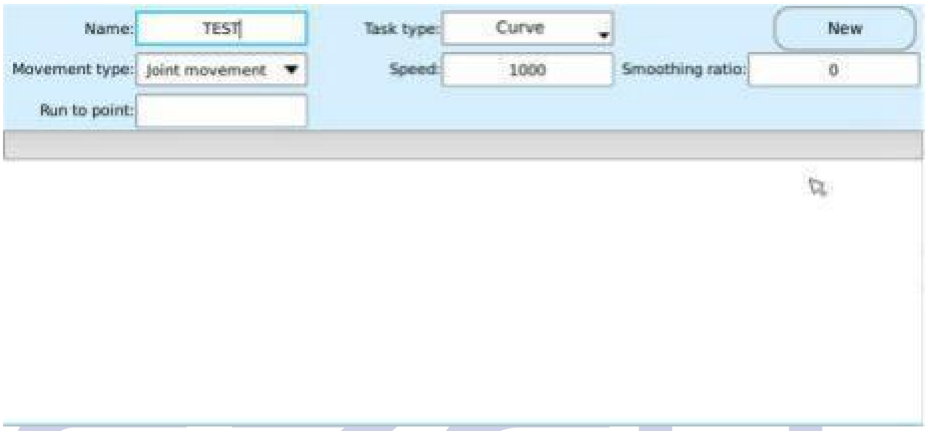



Figure 4.7 Basic program programming interface

### Program naming and creation

After entering the "basic program" creation interface, the first step is to establish the program name. As shown in Figure 4.7, click the blank box after "program name" on the touch screen by hand, and a soft keyboard will appear. Enter the English letter "XXX", click [Enter] on the soft keyboard, and the blank box after "program name" will appear "XXX".

After naming the new program, click the [new] button in the upper right corner of the interface, and the program name "program: XXX" will appear on the blank programming area in the middle, as shown in Figure 4.8. At this time, the [new] button will change to the [Cancel] button, indicating that the new program is created; Click the [Cancel] button to cancel the whole current program operation.

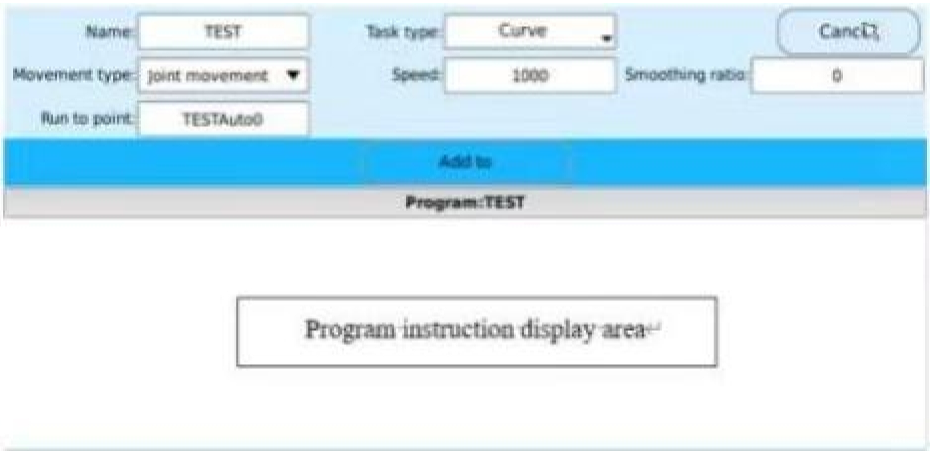



Figure 4.8 Creating the basic program named "TEST"

### 4.3.3 Manual teaching for the program design

After the basic program is created, you need to teach it manually and add corresponding instructions one by one in the programming area (as shown in Figure 4. 11).

| Operation 4.2 Manually plan to complete the design of a simple motion program | |
|---|---|
| Condition | Teaching pendant in manual mode |
| Step | 1 The default task type is "curve" or select "motion command" - "curve motion" in the pull-down menu<br>2 Manual teaching programming for curve segments one by one<br>3 Commissioning procedure<br>4 Click the [Save] button to complete the creation of the program |

#### 4.3.3.1 Select task type

After the basic program is created, it is necessary to conduct manual teaching and add corresponding instructions one by one in the program instruction display area.

In the "task type" drop-down menu, we can see various instructions provided by the software, as shown in Figure 4.9. Among them, the command to control the precise motion of the robot is the default "curve" of "task type", or select "movement statement" - "curve motion" in the drop-down menu (both are the same command).

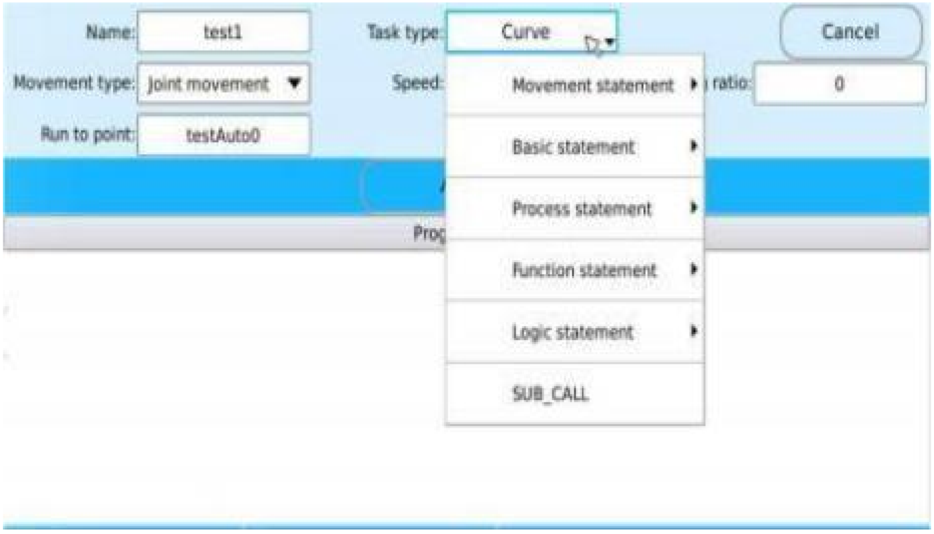



Figure 4.9 Various instructions included in the task type

#### 4.3.3.2 Curve instruction description

A curve instruction runs in the robot system, which is expressed as a moving track that accurately controls the robot from "start point" to "end point". In this instruction, the following contents need to be specified:

. Movement type: Specifies the motion control method of the moving track.

. Run to point:teach the pose of the end point that the curve segment robot TCP will move.

. Speed:Specifies the movement speed of the robot.

. Smoothing ratio:the smoothness of robot motion

The format of curve instruction is as follows:

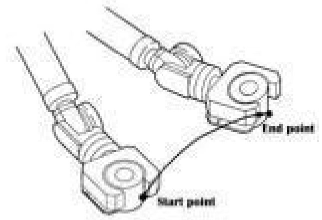
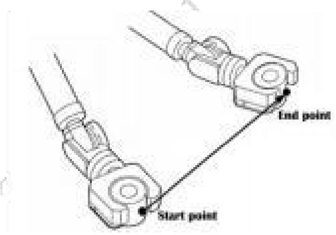
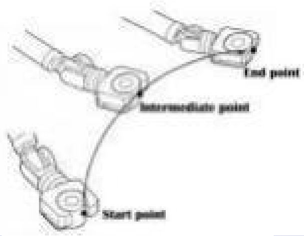
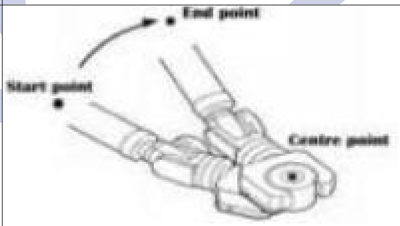
Curve - Movement type: Run to point (ID_point name); Speed=XXXX ; Smoothing ratio =XXX

**Movement type**

The movement type specifies how the motion of the movement track is controlled. The movement types and functions currently provided are shown in Table 4. 1.

Table 4. 1 Description of curve instruction movement type

| Type | Figure | Description |
|---|---|---|
| Joint movement |  | The basic movement method of moving the robot TCP to the specified position. All axes of the robot accelerate at the same time. After moving at the teaching speed, it decelerates at the same time and stops. |
| Linear movement |  | A moving method for controlling the robot TCP moving trajectory in a linear motion mode from the start point to the end point. |
| Arc movement |  | A moving method to control the TCP moving track of robot in the form of arc from the start point through the intermediate point to the end point. |
| Circular movement |  | A movement method for controlling the TCP movement trajectory of the robot in a circular motion from the start point to the end point. The Centre point needs to be taught. |

## Run to point

The running track of the program is connected by the "start point" and "end point" of each curve in the program. The "end point" of each curve is the "start point" of the next curve. Therefore, when using the curve instruction, you only need to set the "end point" of the curve through manual teaching, that is, the "motion to point".

After the program is named and created successfully, the system will automatically set a "point" name for the "run to point" for the first curve instruction. As shown in Figure 4.9, the name "testauto0" is set for the new "TEST" program. You can click the "run to point" text box to change the name of the point, or select an existing "point" for reference.

## Speed

In the process of robot movement, the speed of movement needs to be set. The speed unit in the "joint movement" type is r/min, and the maximum should not exceed the setting parameters in "machine parameters"; The speed units of "linear movement", "arc movement" and "circular movement" types are mm/s, and the maximum speed should not exceed 2000 mm/s.

## Smoothing ratio

By setting the "smoothing ratio", the robot can run more smoothly. The range of "smoothing ratio"parameter is "0- 100", "0" means no "smoothing", and "100" means the maximum "smoothing".

### 4.3.3.3 Teaching programming

The trajectory of the robot is composed of several curve instructions. According to the task, there are two methods to teach manually and add curve instructions: one is to teach t1-t5 points manually and add curve instructions synchronously in the basic program programming interface; The other is to manually teach new t1-t5 points in the "point" management interface, and then add curve instructions by referencing points in the basic program programming interface.

After adding curve instruction by manual teaching method for many times, the program instructions display area is shown in Figure 4.10. Click one of the instructions, you can modify, replace and delete the instruction.

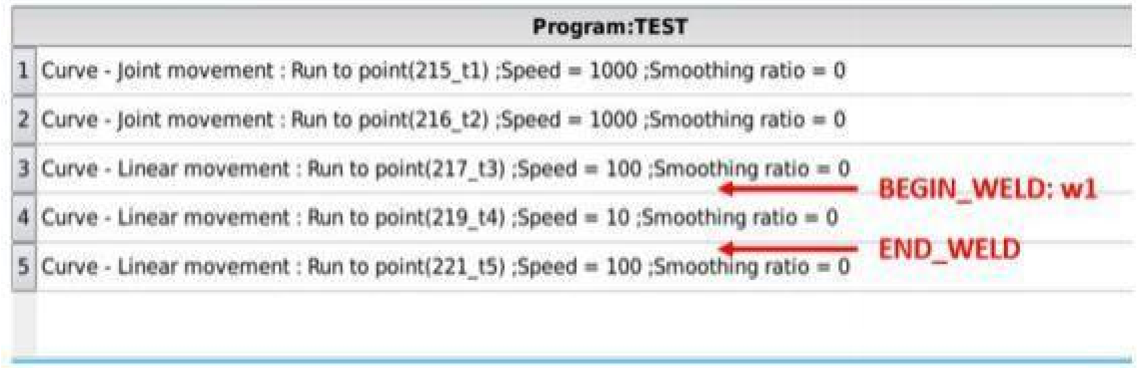



Figure 4.10 TEST program

In the "TEST" program, if the program is run for a single time, the robot will eventually stop at T5. If the motion program is cycled, after the last curve trajectory is completed, the robot takes T5 as the start point and continues to run the first curve to the "run to point" T1 to form a closed loop of motion trajectory.

### 4.3.3.4 Save program

After the program design is completed, click the [save] button to save the program.

When the program is saved in "program management", the creation of "basic program" is completed.

## 4.3.4 Program running

After the program is created, switch the mode change-over switch of the teach pendant to the"automatic" sign, and the system will switch to enter the "automatic interface". In automatic mode,the program can be run without pressing the "Enable" button.

# 5 SZGH programming

This chapter describes the type of instructions constituting the application program in SZGH control system, the steps of writing, debugging, modifying, and executing the application program, the composition of modular program, and how the system starts up and automatically runs the program.

## 5.1 Program instruction

Program instruction is the basic unit of robot program and the execution method to control the specified actions of robot and peripheral equipment. In the SZGH control system, writing the program only needs to select the corresponding instructions, input parameters, and click the "add" button. There is no need to manually input the command line code, which is very convenient and easy to use.

The instructions provided in SZGH control system are divided into the following types, as shown in Figure 5.1.(See Appendix 1 for specific instructions.)

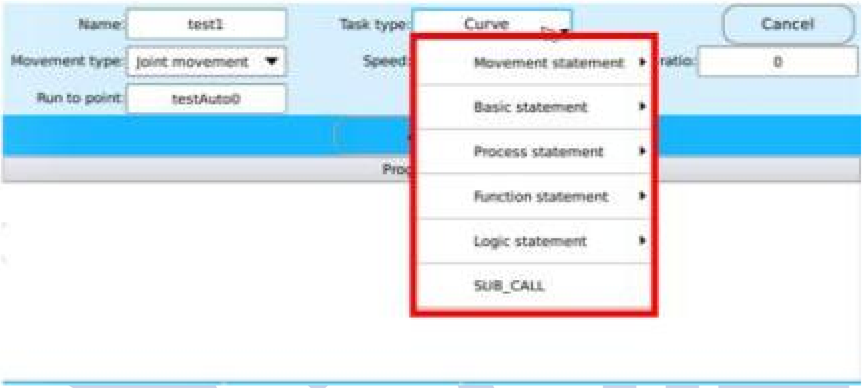



Figure 5.1 Instructions provided in SZGH control system

## 5.2 Global variable definition

In order to cooperate with program instruction function,logic judgment and external communication interaction, the system defines global variables with specific meaning in the storage space.(See Appendix 2 for details.)

## 5.3 Programming and testing

The robot programming and operation described in this section are realized through the teaching pendant.

| Operation 5.1 Programming | |
|---|---|
| Condition | Teaching pendant in manual mode |
| Step | 1 Click [Motion] - [Create Program] - [Basic Program], enter the program name, and click [New Create] completes the creation of the program.<br>2 Add robot motion commands and other commands through manual teaching.<br>3 Complete the program design through program editing.<br>4 Program debugging to test whether the robot's motion track is correct.<br>5 Program modification.<br>6 Program saving. |

### 5.3.1 New program

Switch the mode change-over switch of the teach pendant to the "manual" sign, and enter the new basic program interface in the main interface of manual mode.(See Section 4.3, Chapter 4, part I of the manual for specific operation.)

### 5.3.2 Manual teaching programming

In the task type, select the corresponding instruction through the drop-down menu (as shown in Figure 5.2), and the interface of the instruction parameter setting area will switch to the parameter setting interface corresponding to the instruction. Set the parameters of the instruction and click the"add" button to complete the programming.Among them, see Chapter 3 for the procedure manual teaching steps of the robot motion part.

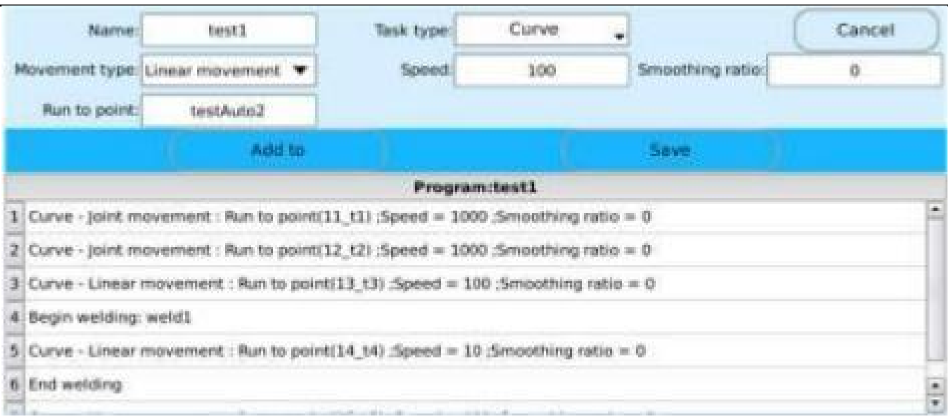



Figure 5.2 Basic program editing interface

## 5.3.3 Program notes

The program instruction display is divided into left and right parts, as shown in Figure 5.3. The program content is displayed on the left. Click the blank area on the right of the instruction to pop up the soft keyboard, and you can enter the program notes in Chinese or English.


Figure 5.3 Program content and annotation display

## 5.3.4 Program editing

After the program is created, modify the program as needed. You can change, insert, delete, copy, cut and other operations of instructions through the toolbar and clicking the program name.

### Deletion, modification and insertion of instructions

Select an instruction in the program instruction display area on the touch screen, the instruction will turn gray, and the task type and parameter setting area above the interface will be changed to be consistent with the instruction. The toolbar in the programming area will be switched to figure 5.4.

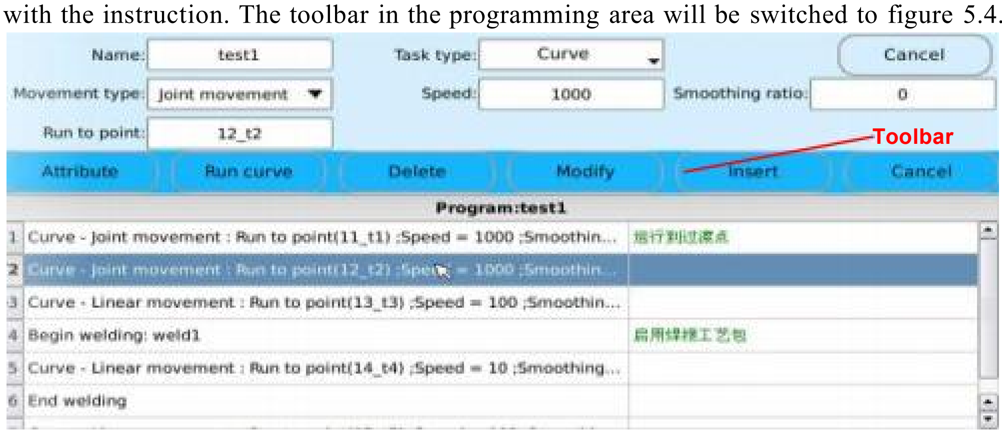



Figure 5.4 Toolbar in the programming area

## Clip and copy of program segments

Click the program name bar, and it will switch to the full screen interface of the program. Click the command on the touch screen, the command will change color, the "selected task" appears on the right, and the [Delete], [Copy] and [Cut] buttons appear on the lower bar at the same time, as shown in Figure 5.5. Multiple instructions can be selected at one time for copying and cutting.

Figure 5.5 Copy and cut program instructions

After clicking [copy] or [cut], the lower bar will switch to another toolbar, as shown in Figure 5.6. At this time, select the position to be inserted, and the corresponding instruction will turn gray. You can realize the "selected task" instruction in front of the "front" or "rear" of the gray instruction [forward paste] or [reverse paste].

Figure 5.6 Forward or reverse pasting instructions at the specified position

### 5.3.5 Trajectory debugging

In the manual mode, there are two methods to debug whether the robot motion trajectory instructions in the program is correct: line by line debugging in the program command display area and entering the special motion trajectory debugging interface through the menu.

## Line by line debugging of program instruction display area

Elect a curve command in the program command display area on the touch screen, the curve command will become gray, and the task type and parameter setting area above the interface will be changed to be consistent with the command. The toolbar will be switched to Figure 5.7.


Figure 5.7 [Run curve] button will appear when selecting curve command

The [operation curve] button on the toolbar is a one-step debugging button only available for curve instructions. Under the condition of ensuring safety, press the "enable" button on the back of the teach pendant and click the [Run curve], and the robot will execute the curve instruction and run to the "run to point" set by the curve.Select the next curve instruction, continue to press any "enable" button on the back of the teach pendant, and click [run curve] for manual teaching to check whether the motion trajectory of the robot meets the design requirements.

## Motion track debugging interface

The program includes not only a series of robot trajectory instructions executed in sequence, but also many basic instructions, process instructions, function instructions and logic instructions. In the program instruction display area, look for the motion instruction line by line for debugging, which is inefficient and easy to miss. Therefore, the system provides a special motion trajectory debugging interface.

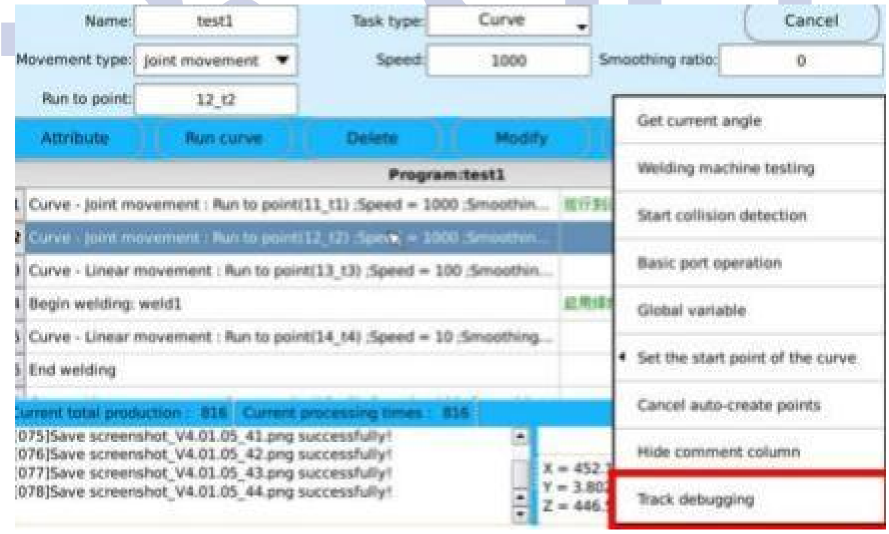



Figure 5.8 Menu [track debugging]

Click the [menu] key on the teach pendant, and click the [track debugging] key in the pop-up menu (as shown in Figure 5.8), and the motion track debugging interface will appear.

As shown in Figure 5.9, on the motion track debugging interface, other instructions in the program are shielded, and all curve instructions are presented visually in turn, so as to enable the user to verify the consistency between the running track of the program and the teaching track.


Figure 5.9 Motion trajectory debugging interface

In this interface, you can check "single step" or "continuous" operation by "sequence" or "reverse order". You can select the corresponding instruction to stop the program when it runs to the instruction. Note that click the [run] button here to debug the motion track. It is a manual teaching process, and you need to press the "enable" button on the back of the teaching pendant at the same time.

Note:

(1) "Track debugging" is to extract curve tasks in the program and run them one by one to preview the running track of the program. Therefore, only curve instructions are executed and non-curve instructions are skipped. When the program contains logical statements "if", "while" and "Jmp", special attention should be paid: if there is an "if", "while" or "Jmp" that is not completely paired between the two points to be run, the result of judgment and jump is uncertain because the non-curve does not run. At this time, the track between these two points cannot complete automatic operation, which needs to be judged by the user, manually reset the starting point to skip such statements.

(2) During track operation, the interface will be set to read-only to prevent users from modifying configuration parameters during operation.

## 5.3.6 Modification of track points

There are two ways to modify the position and attitude of the track point in the program during the motion track debugging or due to subsequent changes in the environment: at the instruction of the program editing interface and at the point management interface.

### Modify at the instruction of program editing interface

Enter the basic program editing interface, select the motion instruction line to be modified, and the instruction will turn gray. Click this instruction again, and the program editing toolbar will switch to Figure 5.10. The border of the text box after "run to point" will be highlighted.


Figure 5.10 "point" modification in curve instruction

At this time,press the "enable" button to manually teach to a new position and attitude,and click:

. [global modification] - a prompt box appears, "are you sure to modify the joint angle of curve point * * to the joint angle of the current posture?", Click "yes" and the point data will be modified and saved. If other motion instructions in the program use the point data,it will also be modified synchronously.

. [Create and replace] - a prompt box appears,"do you want to create and replace curve points* * with the current joint angle?", Click "yes", a new "point" will be created and saved, and the "motion to point" of the instruction will be replaced with the new point. At this time, the original * * point data will not be modified.

## Modify in the point management interface

In the system, some key track points will be referenced by multiple programs for many times. At this time, if you need to modify the point data, you can implement it in the point management interface.

Click [manage] - [point] to enter the "point" management interface, as shown in Figure5.11.Select the point to be modified, click the [details] button, the "edit box" of the selected "point" will appear, press the "enable" switch, manually teach to the new position and attitude, click "read the current point", and click "save" to complete the modification of "point".

Note: if the modified "point" is referenced, be sure to switch to the "program" management interface and [check] the program that "references" the modified "point" (as shown in Figure 5.12), otherwise the motion track in the program will make mistakes and cause accidents.

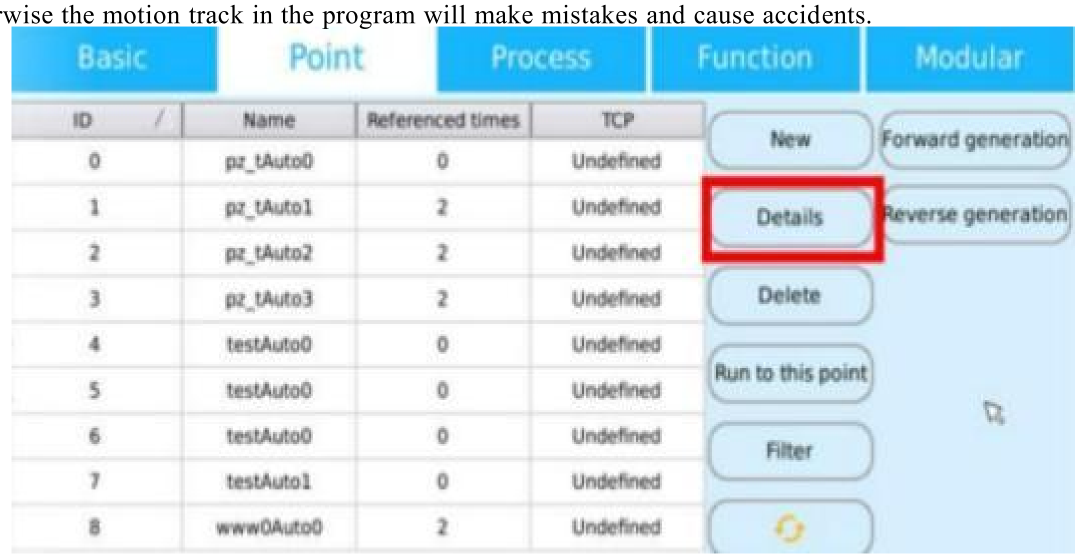



Figure 5.11 Click the [details] button to modify the data of the point

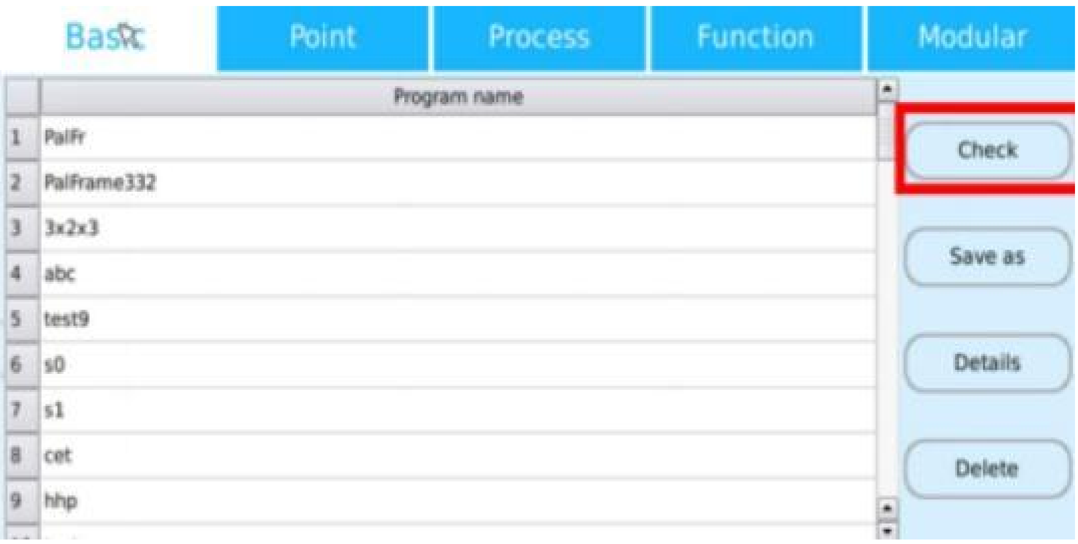



Figure 5.12 Program check

### 5.3.7 Program saving

After program editing and debugging, you must click the [Temporary save] or [Formal save] button to complete the establishment of "basic program", as shown in Figure 5.13.

[Temporary save]: Continue to stay in the program editing interface.

[Formal save]: Automatically jump to the basic program management interface.

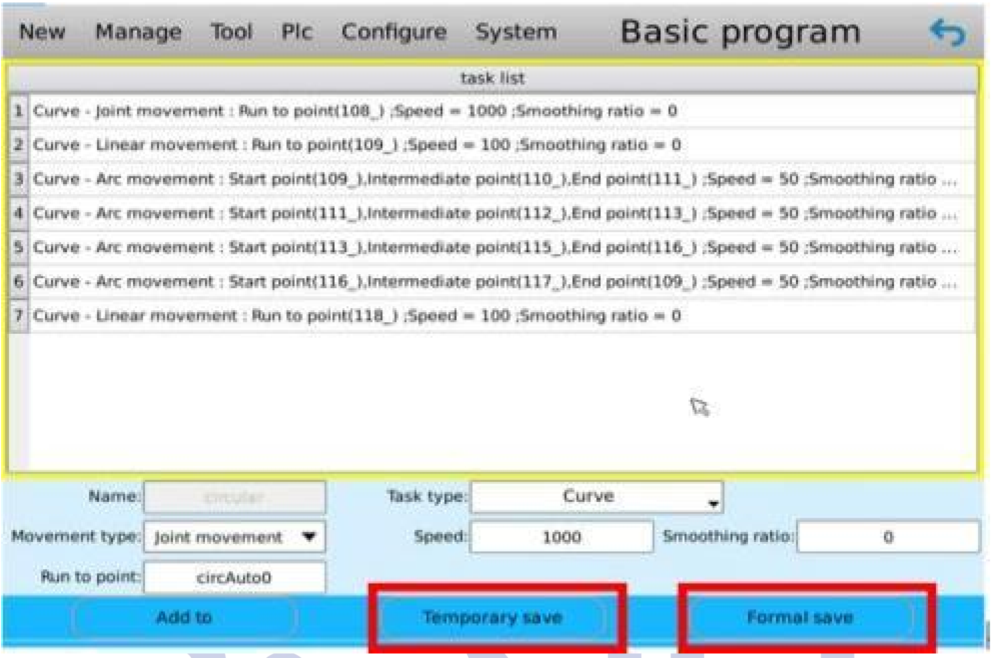



Figure 5. 13 Program saving

## 5.4 Programming interface menu function

Click the [menu]key in the lower right corner of the teaching pendant, and a menu will appear in the lower right corner of the interface, as shown in Figure 5. 14.

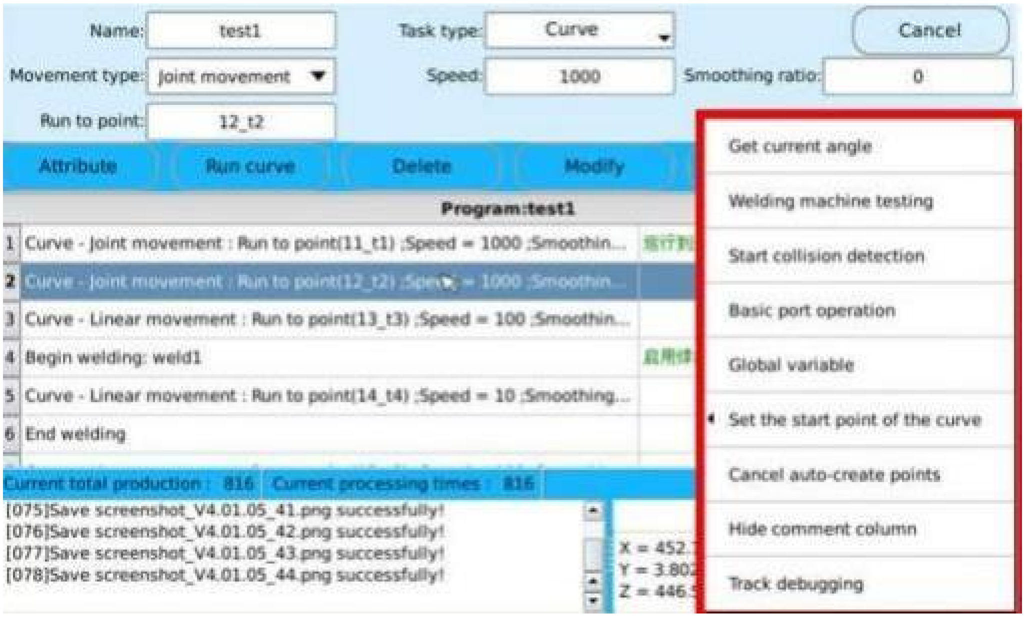



Figure 5.14 Menu of programming interface

The function description of the menu is shown in Table 5. 1

Table 5. 1 Menu function description

| Number | Item | Function description |
|---|---|---|
| 1 | Basic port operation | Monitor the status of input port and relay port, and check the output effect by setting output port and analog quantity. |
| 2 | Get current angle | The operation record display area displays the joint angle data of the current point. |
| 3 | Global variable | Open the global variable interface to view the global variable data. |
| 4 | Welding machine resting | Adjust the welding machine according to the welding process. |
| 5 | Set the start point of the curve | Set the starting point of the program running curve. |
| 6 | Auto-create point | Auto name the "run to point" in curve instruction. |
| 7 | Hide comment column | Hide / show the comment column in the program instruction display area. |
| 8 | Track debugging | Enter the program track debugging interface. |
| 9 | Start collision detection | Select the created collision detection function package and alarm output port to make the robot in collision detection state and stop moving immediately in case of collision. |

## 5.5 Modular program

Modular programming refers to dividing a large program according to its functions, writing subroutines to complete the determined functions, and then calling it in the main program. To this end, SZGH system provides two modular programming methods:

(1) Using SUB_CALL instruction in basic program

(2) (2) Enter [modular program] to create "modular program"

### 5.5.1 Use SUB_ CALL instruction

As shown in Figure 5.15, you can use sub_ The CALL instruction calls another basic program in a basic program. Click "save" and the subroutine will be saved into the program as an instruction.

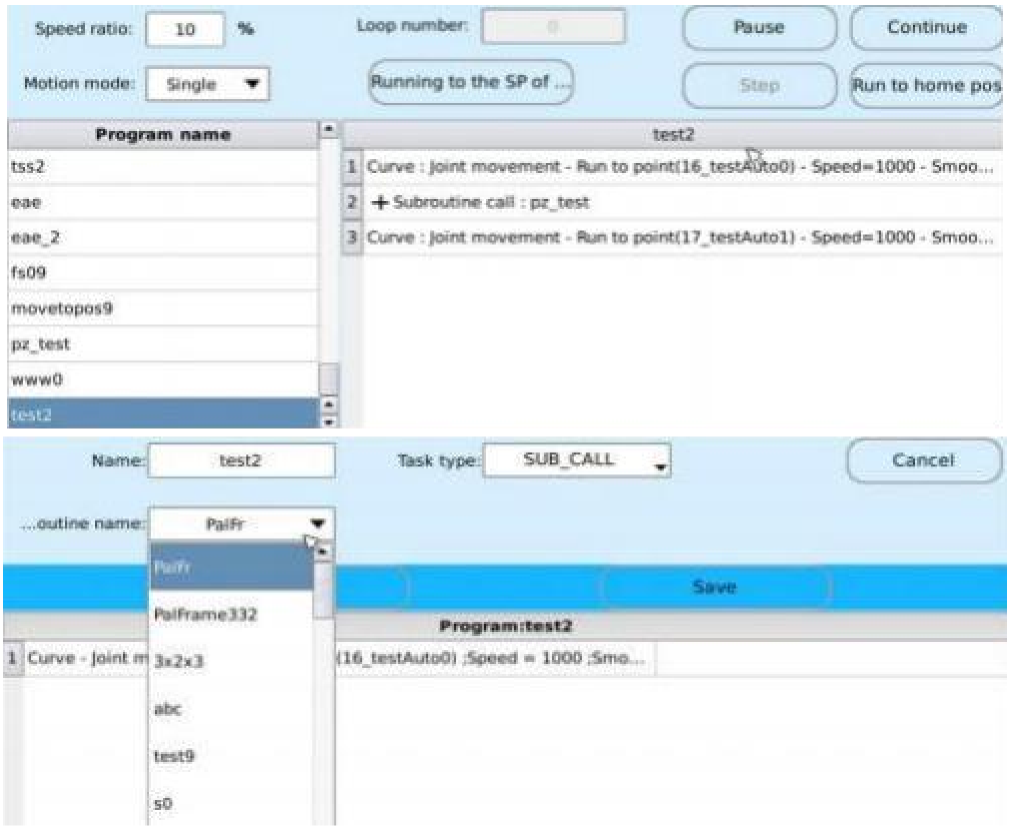



Figure 5. 15 Using SUB_CALL in basic program

Switch the teaching pendant to the "automatic mode" interface, and a plus sign will appear in front of the Subroutine instruction. As shown in Figure 5.16, click the plus sign and the instruction line of the called subroutine will appear.

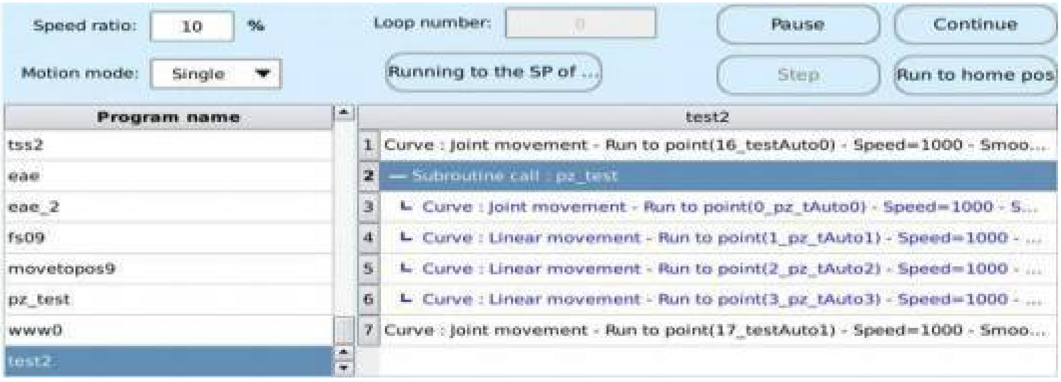



Figure 5. 16Presentation of subprogram in automatic mode

In this way, the program design is simpler and more intuitive, and the readability and maintainability of the program are improved. The disadvantage is that when running the main program, the preprocessing of the subroutine is running to SUB_CALL instruction. If there are many curve instructions in the subroutine and they need to be smoothed, the subroutine preprocessing during operation will affect the operation efficiency.

## 5.5.2 Create a "modular program"

Enter the modular program programming interface. The programming process of the modular program is the same as that of the basic program, but there are multiple "p call" task types in the "modular program". In "modular program", you can call "subroutine" through "p call" task type to generate "modular program". The "subroutines" called by the "p call" task type are all completed "basic programs"

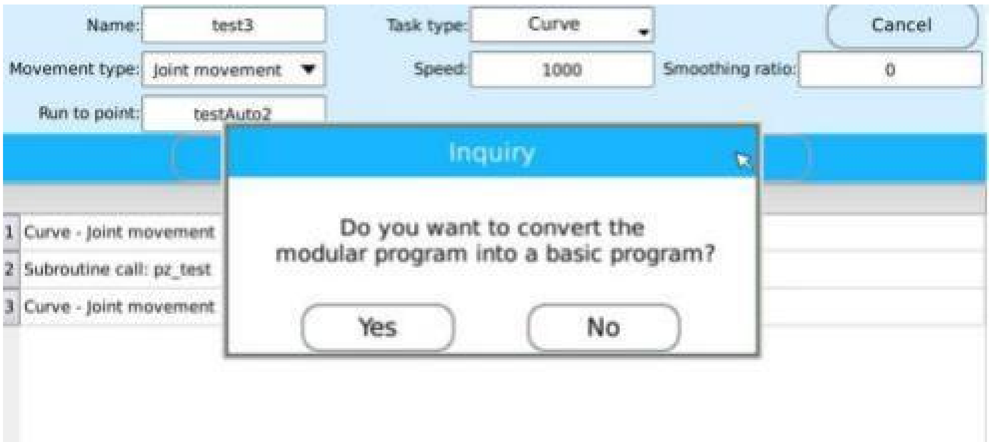



Figure 5.17 "PCALL" task type and usage

After the modular program is created, click [Save] to save it into a "modular program" in [management] - [modular program], and then you will be prompted: "Do you want to convert the modular program into a basic program?", as shown in Figure 5.17. After selecting [Yes], the system will convert the "modular program" into a "basic program" and save it in the "basic program".

In this way, when the teach pendant is switched to "automatic mode", only the generated basic program will appear in the list, and the program instruction will not be preprocessed in the process when the program is running, so as to ensure the operation efficiency. The disadvantage is that when the program is long, its readability is poor, which is not convenient for program testing.

## 5.6 Program execution in automatic mode

After the program is created, switch the teach pendant to "automatic mode" to run the program.

### 5.6.1 Program automatic positioning

For the last newly created program or the last modified and saved program, switch to "automatic mode", and the system will automatically locate the name of the program and automatically query its details, and locate the task line of the last operation of the program in the program (operations include creating, modifying, inserting, and deleting the task line).

### 5.6.2 Parameter setting

As shown in Figure 5.18 below, various parameters need to be set on the configuration page before "operation", including movement speed, movement times and movement mode.The description of parameters is shown in Table 5.2.

For safety, it's best to slow down the " speed" before running the program, select the "single" motion mode to test the running track, and then set the "speed" and "motion mode" according to theoperation requirements after there is no problem

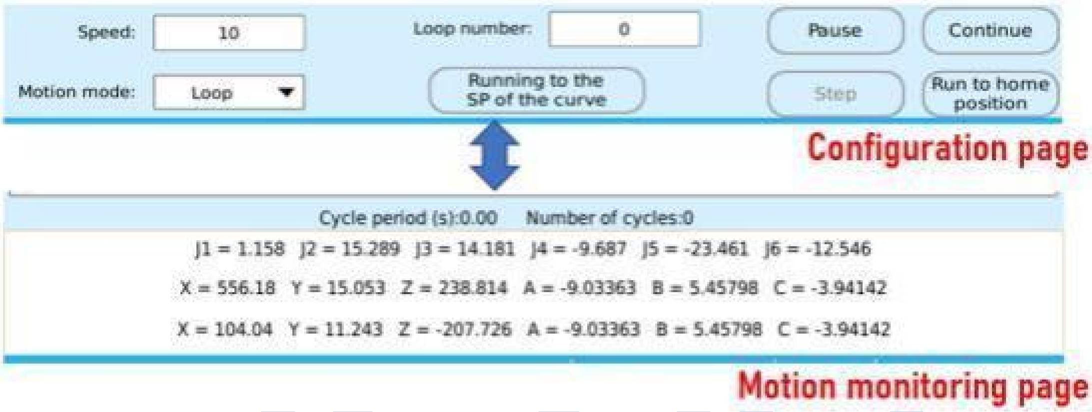



Figure 5. 18 pages in automatic mode interface

Table 5.2 Description of program operation parameters

| Number | Parameters | Description |
|---|---|---|
| 1 | Speed | Set the overall speed of "program",with a range of 1- 100 (percentage). |
| 2 | Loop number | Used in "Loop" motion mode to determine the number of cycles. |
| 3 | Motion mode | Three motion modes are available:<br>a. "Single" motion: let the program perform a complete operation, that is,the motion track runs from the "start point" along the track set by the "program" to the "end point".<br>b. "Step" motion:let the program start from the "start point" and execute "step by step" along the track set by the "program". Specific format: select the "program name" to be executed, press the physical key [program start] on the teach pendant,wait until the first step of the robot body is completed, then click the [step] key to proceed to the next step, and then click the [single] key repeatedly to complete the single step operation.<br>c. "Loop" motion: let the program "cycle" run, which should be used in conjunction with the setting of "motion times". When the parameter in "motion times" is set to "0", the circular motion will become the "infinite cycle" motion mode. |

In automatic mode: the program is displayed as the configuration page by default before startup.

After the program starts running, the interface will automatically switch to the motion monitoring page.Click the program task list to switch the motion monitoring page back to the configuration page. When the interface is idle for 5 seconds, it will automatically switch back to the motion monitoring page.

### 5.6.3 Use of keys

In the "automatic mode" mode of the teach pendant, see Table 1.3 in Chapter 1 for the description of key functions.

## 5.7 Run the program by using external keys

After programming and testing with the teach pendant, by setting the port configuration, you can run a job program using the external keys instead of entering the teach pendant interface.

Step 1: install physical keys on the control box and connect the input port of the main controller.

Step 2: in [user management], select the check box of [automatic login] and complete the "automatic login" function setting according to the prompt, as shown in Figure 5.19.


Figure 5. 19 Select the check box of [automatic login]

Step 3: Select [configuration] - [environment configuration], as shown in Figure 5.20. Check "Load running parameters automatically". The parameters set in "automatic mode" (such as "speed ratio", "motion mode" and "loop number") will be saved, and the parameters will be loaded automatically after the system is restarted.


Figure 5.20 Check "Load running parameters automatically.

Step 4: select [port configuration], the system provides 8 special functions. Enter the port according to the physical keys installed in the control box, and configure the special function, as shown in Figure 5.21

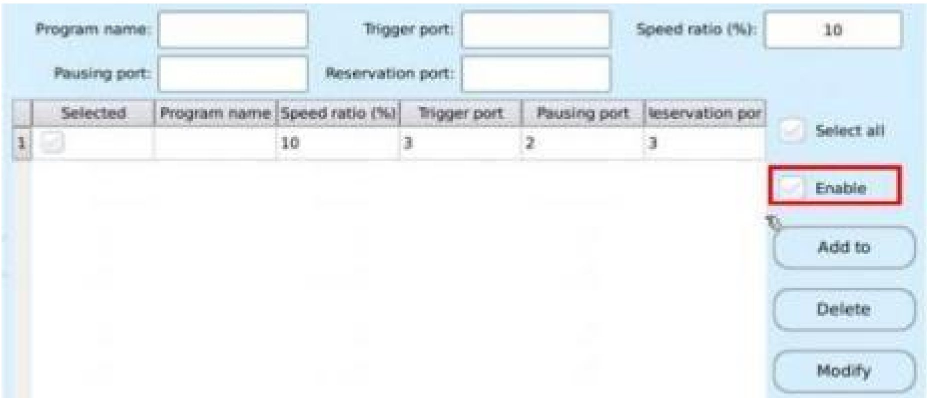



Figure 5.21 Port configuration

Note:. The same special function can be configured many times with different I/O input ports. If the I/O input port is configured as a special function, it can no longer be used as a common I/O input port.

. There are some differences between "emergency stop" function and other "special functions":when configuring "emergency stop" function, it is "valid" when I/O input port level is low;When configuring other "special functions", it is "valid" when I/O input port level is high.

Step 5: set the operation parameters in the “automatic mode” interface of the teaching pendant, execute the selected program,and the parameters during program operation will be “saved”. Restart the system, you can control the program by using the external keys.

## 5.8 Execution of the reservation programs

When a robot needs to cooperate with many operators to complete multiple operations, the operators can click the [reservation] button to make a reservation after preparing the workpiece. The robot will complete the corresponding program work in turn according to the reservation order of different operators.

### 5.8.1 Reservation Settings

In the manual interface of the teach pendant, click [reservation] to enter the "program reservation" setting interface, as shown in Figure 5.22. The description of each parameter is shown in the Table 5.3.

After setting the parameters, click the [add to] button to complete the reservation setting of one program, repeat the operation, select “enable” to take effect. The number of “enable” reservation procedures cannot exceed 10

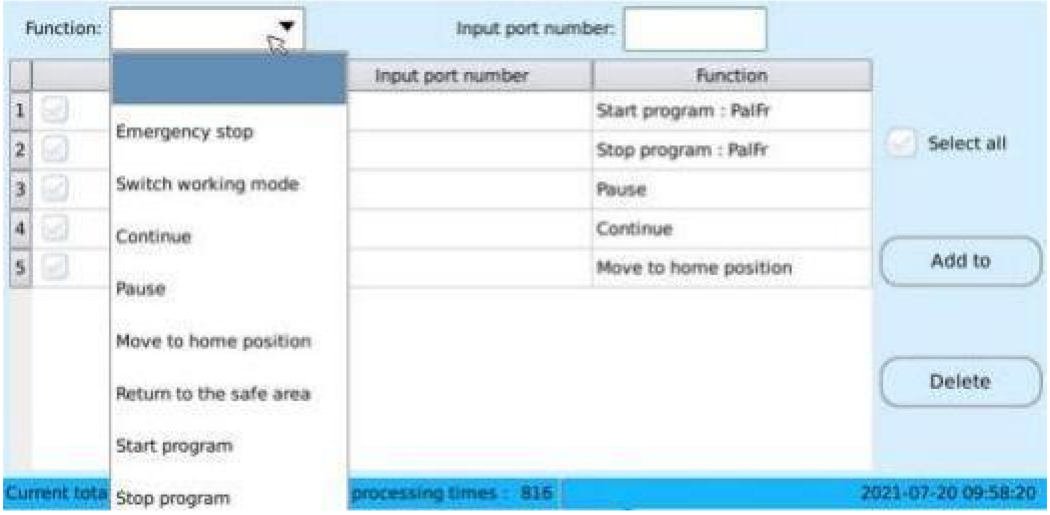



Figure 5.22 Program reservation execution settings

Table 5.3 Parameter description of program reservation setting interface

| Number | Parameter | Description |
|---|---|---|
| 1 | Program name | Select a basic program for program reservation. |
| 2 | Trigger port | Set the "IO input" port number that triggers the "reservation program",and the"IO input" port number cannot coincide with the"function configuration" port number. |
| 3 | Speed ratio | Set the running speed ratio of "reservation program", the unit is "%",and the value is an integer of " 1- 100". |
| 4 | Pausing port (indication) | Set the"IO output"indication port number when the "reservation program" pauses or stops. When the "reservation program" runs, the output is "low level". Otherwise, the output is "high level". |
| 5 | Pausing port (indication) | Set the"IO output" indication port number when the"reservation program" pauses or stops. When the "reservation program" runs, the output is "low level". Otherwise, the output is "high level". |

### 5.8.2 Execution of The Reservation Programs

When the system uses the "reservation program", it must be "triggered" in the "automatic mode"state to run. The "sequence" of the running program runs according to the time sequence of successful triggering. When the "reservation program" runs successfully and the program is "triggered" again, it will not be counted.

When multiple programs are reserved successful, and the "program stop" or "emergency stop" button is pressed through the teach pendant, all "reservation programs" will be stopped and the "count" will be cleared, including "reservation programs" of "being executed" and "not executed".When executing the reservation program, if it is in the "pause" state, press the "trigger" button corresponding to the program again, and the reservation program will "continue" from the current command line; If you need to start from the first task, you need to select [configuration] - [other configuration] - [environment configuration], as shown in Figure 5.23, and check "Appointment to start the program from the first task".

Note: the [stop] external key can only stop the program of the current operator and will not affect the program execution of other operators.


## 5.9 Program management

After the program is established, sometimes the set "point" position changes, or the program needs to be modified according to the robot operation requirements. At this time, it should be realized through "program management".

Click [management] - [basic program], as shown in Figure 5.24, and the program name will be displayed in the list.

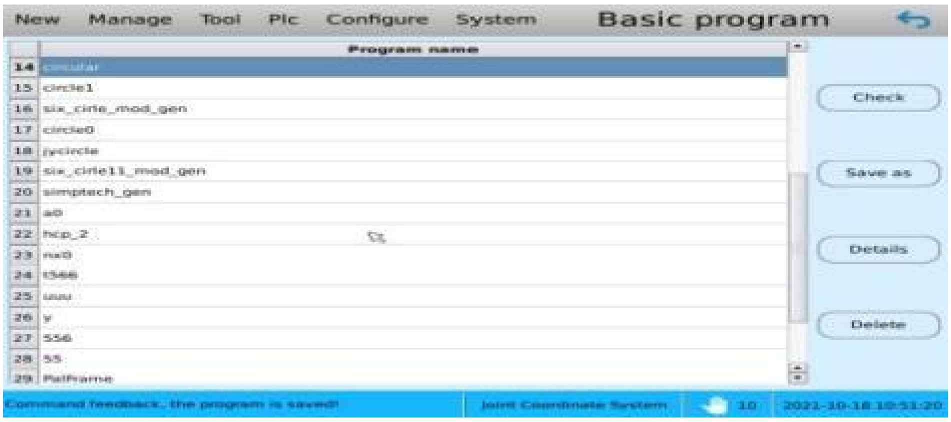



Figure 5.24 Basic program management interface

The management of "basic program" is divided into "check", "save as", "details" and "delete" of the program. The functions of each key are shown in Table 5.4.

Table 5.6 Function description of "basic program" management keys

| Number | Key | Description |
|---|---|---|
| 1 | Check | When it is used in conjunction with the management of "points", when a "reference point" in the program changes, it must "check" the program (all other programs that have referenced this"change point" need to "check"), otherwise the motion trajectory in the program will make mistakes and cause accidents. |
| 2 | Save as | Select the "program name", click the "save as" button to enter the basic program creation interface of the selected "program", modify and save the "program name", and then save the "program" as a program with a new name under the condition that the original program remains unchanged |
| 3 | Details | You can return to the basic program creation interface to "delete","modify" and "insert" the selected program. |
| 4 | Delete | Delete the completed program. |

# 6 PLC programming

In order to facilitate the programming habits of operators, the system provides PLC programming mode, so that users can use the standard PLC programming language to write specific control applications.

## 6.1 PLC programming environment

The system provides two PLC programming environments: ladder diagram and instruction table.Click[PLC edit] to enter the PLC ladder diagram programming interface shown in Figure 6.1.

Click[instruction list] on the interface to switch to PLC instruction list programming interface, as shown in Figure 6.2.

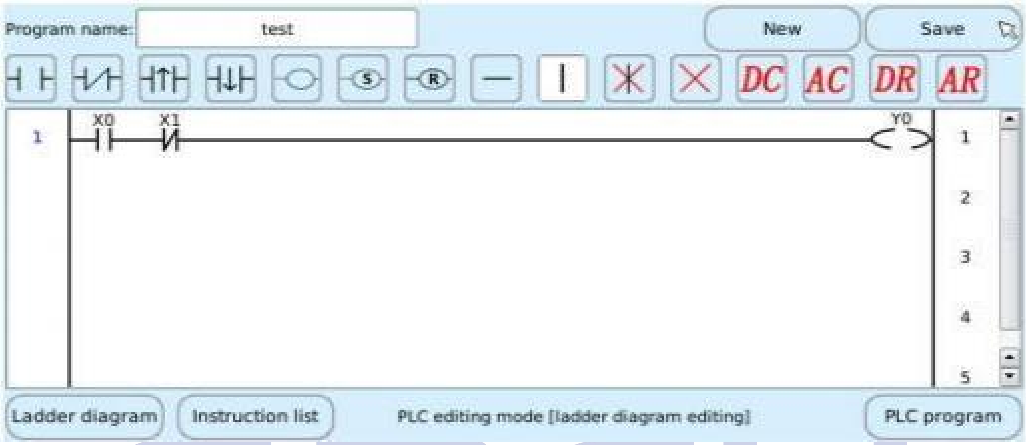



Figure 6.1 PLC programming ladder diagram

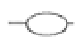

Figure 6.2 PLC instruction list programming interface

The capacity of PLC program is 800 component symbols, and the basic instructions can realize the logic control of internal relay,timer,counter,input relay X and output relay y. The ladder column range is 0 ~ 100, and the command line range is 0 ~ 1000.

### 6.1.1 Ladder component symbols

The basic symbols of components provided by PLC ladder diagram programming interface are shown in Table 6.1.

Table 6.1 Component symbol description

| Number | Symbol name | Symbolic graphics | Description |
|---|---|---|---|
| 1 | Normally open contact |  | Normally open contact of each element (relay) |
| 2 | Normally closed contact |  | Normally closed contact of each element (relay) |
| 3 | Direct output coil |  | Coil of each element (relay) |
| 4 | Set output coil |  | Coil of each element (relay)(set hold) |

| | | | |
|---|---|---|---|
| 5 | Reset output coil | —— | Coil of each element (relay)(reset hold) |
| 6 | Horizontal connection | —(R)— | Used to connect the contacts and coils of each relay horizontally |
| 7 | Vertical connection | \| | Used to vertically connect the contacts and coils of each relay (usually for branch) |

## 6.1.2 Basic logic instruction in instruction table

There are 15 basic logic instructions in the PLC instruction table, which are used to realize the basic logic control, as shown in Table 6.2.

Table 6.2 Basic logic instruction in instruction table

| Number | Instruction name | Description |
|---|---|---|
| 1 | LD, LDI instructions | LD: normally open contact and bus connection command.<br>LDI: normally closed contact and bus connection command LD and LDI instructions can be used for X, Y, S, A, M, C and(including TGT, TGH, AGT and AGH). They can also be used for the start point of branch circuit in combination with AND and ORB instructions.<br>Out: relay coil output command.<br>The out command can be used for Y,M,C and T (including TGT,TGH, AGT and AGH), but cannot be used for input relay X,status relay S and alarm relay A. |
| 2 | AND, ANI instructions | AND: normally open contact series connection command.ANI:normally closed contact series connection command. AND and ANI instructions can be used for X, Y, M, C and T (including TGT, TGH, AGT and AGH). |
| 3 | OR, ORI instructions | OR: normally open contact parallel connection command.<br>ORI: normally closed contact parallel connection command.OR and ORI instructions can be used for X, Y, M, C and T (including TGT, TGH, AGT and AGH). |
| 4 | ORB instruction | ORB: parallel connection command of series circuit block. The circuit formed by connecting more than two contacts in series is called "series circuit block". When the series circuit blocks are connected in parallel, ORB command is used. |
| 5 | ANB instruction | ANB: serial connection command of parallel circuit block.<br>The ANB command connects the parallel circuit block in series with the previous circuit. Before using the ANB command, the internal connection of the parallel circuit block should be completed. |
| 6 | MPS, MRD, MPP Stack memory and multiple output instructions | MPS, MRD and MPP instructions are stack in, stack read and stack out instructions respectively, which are used in multiple output circuits. |
| 7 | SET, RST instructions | SET: set instruction, the instruction to hold the operation.<br>RET: reset command, the command to keep the operation reset. SET instruction can be used for Y and M, RST instruction can be used for Y, M, C and T (including TGT, TGH, AGT and AGH). |
| 8 | NOP, END instructions | NOP: empty operation instruction.<br>END: end instruction, indicating the end of the program. |

## 6.1.3 Run PLC program

Click [PLC] - [Run PLC] to enter the PLC program execution interface shown in Figure 6.3. In this interface, you can run, stop and monitor the PLC program, and view the program details.

In the interface shown in Figure 6.3,the automatic operation of PLC program can also be realized through setting. Click the [PLC program] button in the lower right corner, then select the program to be run automatically, click the [menu] key in the lower right corner, and select "Setup program self-starting" in the pop-up menu item, as shown in Figure 6.4. Then power off and restart, and the PLC program will run automatically.

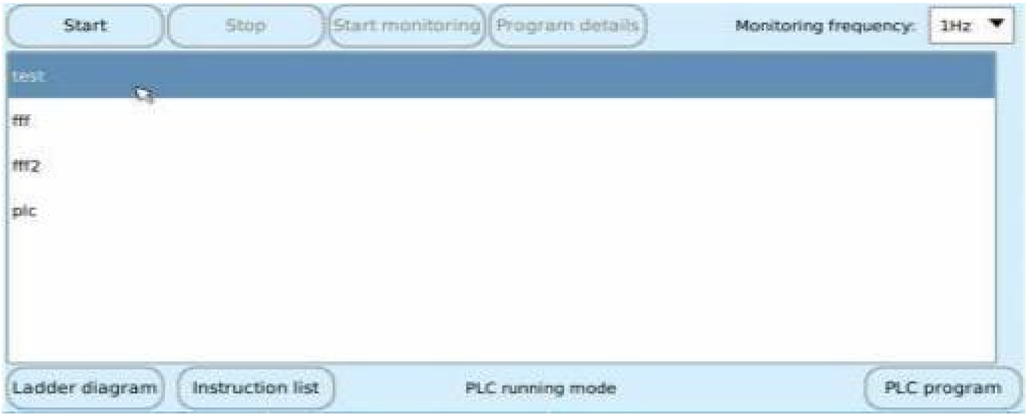



Figure 6.3 PLC program execution interface

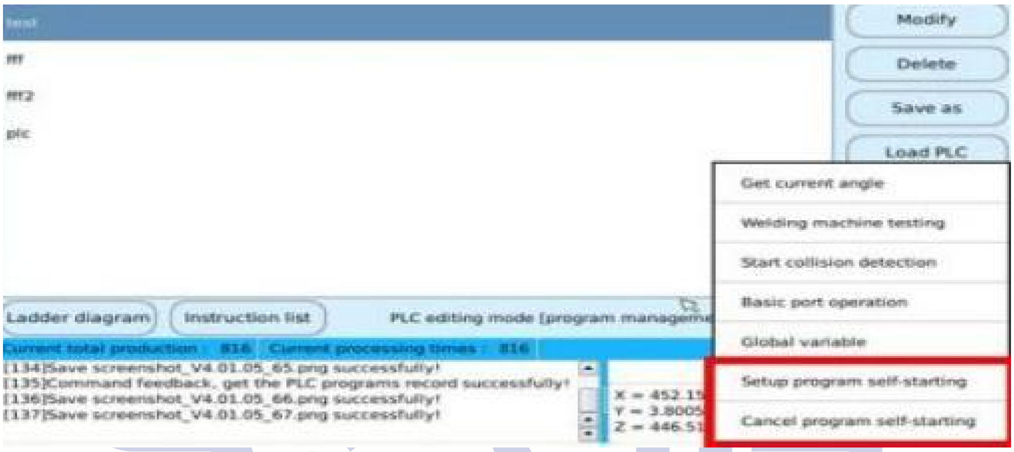



Figure 6.4 Setting the automatic operation of PLC program

## 6.1.4 Load PLC program

The "PLC Editor" software can be used on the PC to complete PLC programming, and finally generate the PLC program required by the control system.

Copy the PLC program file to the folder named PLC under the root directory of USB flash disk (create a new folder named PLC under the root directory). The teach pendant enters the [PLC-edit] interface, click [PLC program] - [load], and select the PLC program to be loaded in the pop-up list (the loaded PLC program name cannot be the same as the program name already in the control system).

## 6.1.5 PLC program encryption

The system provides PLC program encryption function. As shown in Figure 6.5, the password can be set in this interface. If you need to check the PLC program details later, you need to enter the password, as shown in Figure 6.6.

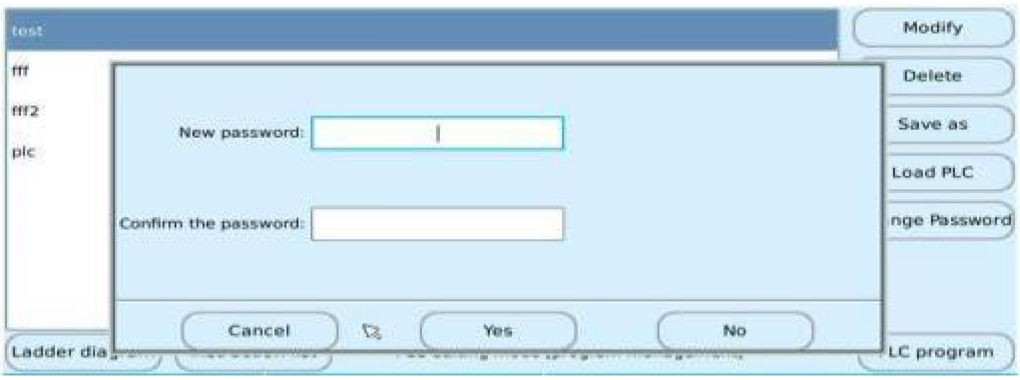



Figure 6.5 Setting password for PLC program

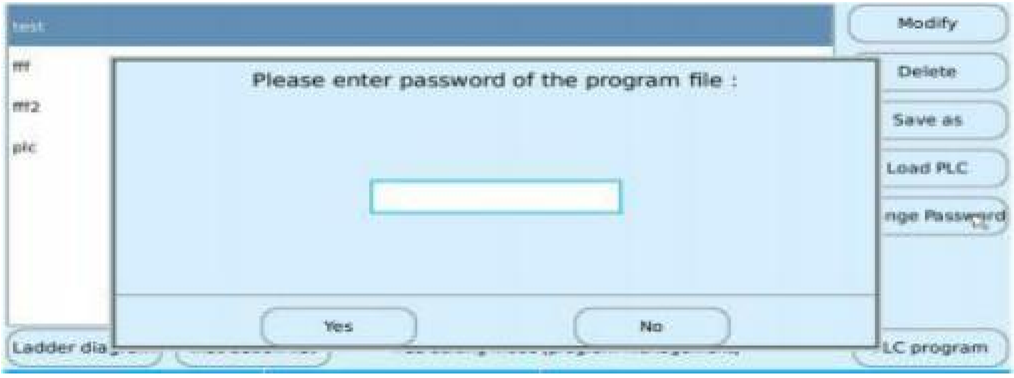



Figure 6.6 Enter password to view PLC program details

## 6.2 PLC component library

Components are address symbols used to identify signals processed in PLC. The component number is the serial number assigned to the component. Components in the PLC system are represented by X, Y, M, etc.

See Appendix 3 of the manual for the definition of PLC elements.

# 7 I/O communication of SZGH system

SZGH system provides rich I / O communication interfaces, including standard I / O circuit, serial port, network port, USB interface, etc., which can easily realize the communication with peripheral devices.

## 7.1 Interface signal definition

The definitions of comm and AVO interfaces ofthe main controller are shown in Table 7. 1 and table 7.2. By default, there is no analog output module in the controller and additional configuration is required.

Table 7. 1 Definition ofRS485 and RS232

| Pin | Signal | Definition | Pin | Signal | Definition |
|---|---|---|---|---|---|
| 1 | CAN1H | CAN1_H | 6 | | |
| 2 | CAN1L | CAN1_L | 7 | / | 232_TX |
| 3 | U4B | 485_B | 8 | U5TX | 232_RX |
| 4 | U4A | 485_A | 9 | U5RX | 232_GND/ |
| 5 | / | | | GND | |

Table 7.2 Definition of analog output interface

| Pin | Signal | Definition | Pin | Signal | Definition |
|---|---|---|---|---|---|
| 1 | AOUT1 | Analog output 1 | 6 | / | Empty, no signal |
| 2 | AOUT2 | Analog output 2 | 7 | / | Empty, no signal |
| 3 | AOUT3 | Analog output 3 (not open) | 8 | | |
| 4 | AOUT4 | Analog output 4 (not open) | 9 | | |
| 5 | GND | Analog output ground | | | |

## 7.2 Standard I/O circuit

The standard I/O port circuit of the system is divided into three types:

**(1) 20 optocoupler isolation inputs**

The circuit diagram of optocoupler isolation input is shown in Figure 7. 1.

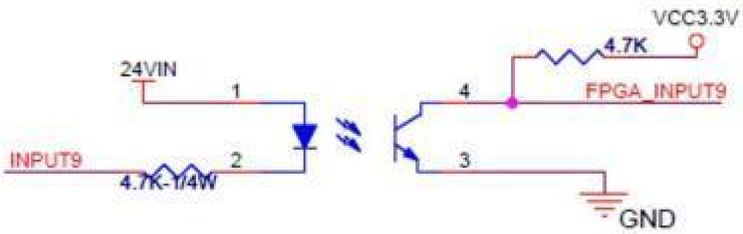



Figure 7. 1 Optocoupler isolation input circuit

**(2) 10 open collector outputs**

The open collector output circuit is shown in Figure 7.2. The default system output is low level and the triode is off; The system output is at high level, and the triode is on. When the collector is open and the output port is connected externally, pay attention to current limiting, and do not exceed the maximum collector current of the triode.

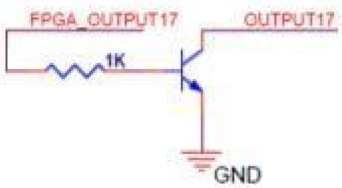



Figure 7.2 Open collector output circuit

**(3) 8 relay outputs**

The relay output circuit is shown in Figure 7.3, and the ports are normally closed NC, common terminal COM and normally open NO. By default, the system outputs low level, the two contacts of common terminal COM and normally closed NC are closed, and they are disconnected from normally open NO. When the system output is high level, the common terminal COM is disconnected from the normally closed NC and switched to the normally open NO contact.

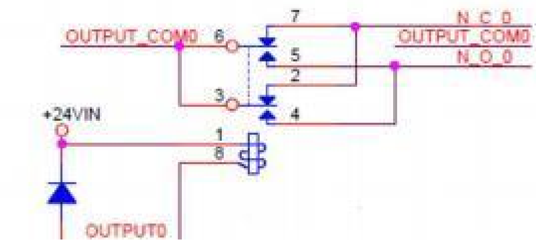



Figure 7.3 Relay output circuit

## 7.3 Basic port operation

The system provides input and output related program instructions for programming. In addition,click the [menu]key in the lower right corner of the teach pendant, and a menu will appear in the lower right corner of the interface


Figure 7.4 Basic port operation interface

Click [Basic port operation] to enter the basic port operation interface, as shown in Figure 7.4 including "monitoring relay port", "setting output port", "setting analog quantity" and "monitoring input port".

### 7.3.1 Monitor relay port

As shown in Figure 7.5, after selecting "Relay", click the [add to] key to pop up a prompt box of "add single or multiple relays", enter the "relay port" number to be monitored, and click the [set] key to complete the "add" of "relays". When multiple relays are "added" at the same time, the serial numbers are connected by "underline".

After completing the "add" of "relays",you can carry out "status monitoring","status setting" and "delete" operations on these "relays".

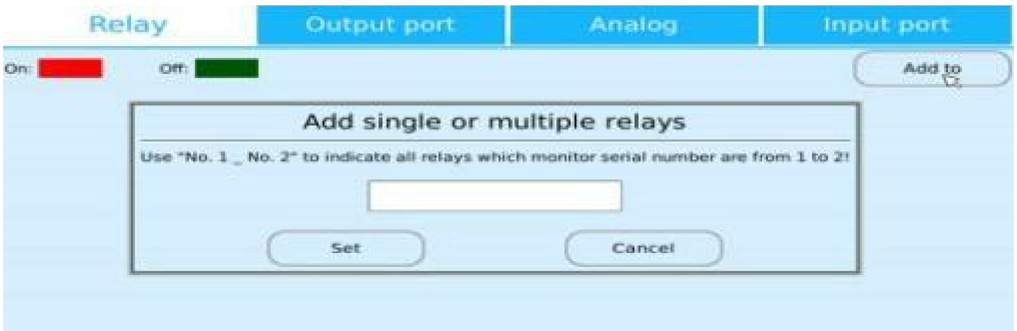



Figure 7.5 Monitor relay port

## 7.3.2 Set output port

As shown in Figure 7.6, after selecting "Output port", you can perform "status monitoring" and "set status" operations on the "output port". The "set status" operation means that the "output port" can be manually "send high level" and "send low level".


Figure 7.6 Set output port

## 7.3.3 Set analog quantity

As shown in Figure 7.7, after selecting "Analog", the "analog value" output can be set for the "analog quantity output channel" of the system. Among them, the number of analog channels depends on the actual situation of the system, and 02/4 channels are possible.


Figure 7.7 Set analog quantity

After inserting AVO module,the main controller provides 2 channels of "analog" output channels, which are "0" and "1" respectively, and the output range of "analog value" is [0, 10V]. The specific setting steps are as follows: first select the "analog" output channel, set the "analog value", and click the [send] button to complete the "analog output" setting.

## 7.3.4 Monitor input port

As shown in Figure 7.8, after selecting "input port", the system "input port" can be "status monitored". status" operations on the "input port", "output port" and "analog channel" in the "IO expansion module"


Figure 7.8.

# 8 Software configuration and use

SZGH system provides port configuration, automatic positioning of programs and tasks, custom alarm and other functions, which is convenient for operators to quickly complete program programming and debugging.

## 8.1 Port configuration

In the manual interface, click [tool]-[port], including function port, indication port and program reservation. The procedure reservation method is detailed in Section 5.8 of Chapter 5 of the manual.

### 8.1.1 Function port

Function port can map the input port to a function related to the control system, such as start program, stop program, etc., as shown in Figure 8. 1.

At present, the special function keys that can be set directly include: emergency stop, switching working mode, continue, pause, return to zero, return to safety zone, start program, and stop program. The operator does not need programming, just set the function corresponding to the corresponding input key, and then directly control the program operation through the external key.

I/O input port number "0- 19" can configure these functions arbitrarily. Different I/O input ports can be configured for the same special function,but only one special function can be configured for the same I/O input port, and the configuration will take effect only after the "add" button is clicked; If the I/O input port is configured with special functions,it can no longer be used as an ordinary I/O input port. Only after the special function of "I/O input port" configuration is "deleted", the "I/O input port" can be used as a normal I/O input port again. See Chapter 5, section 5.7 of the manual for more instructions.

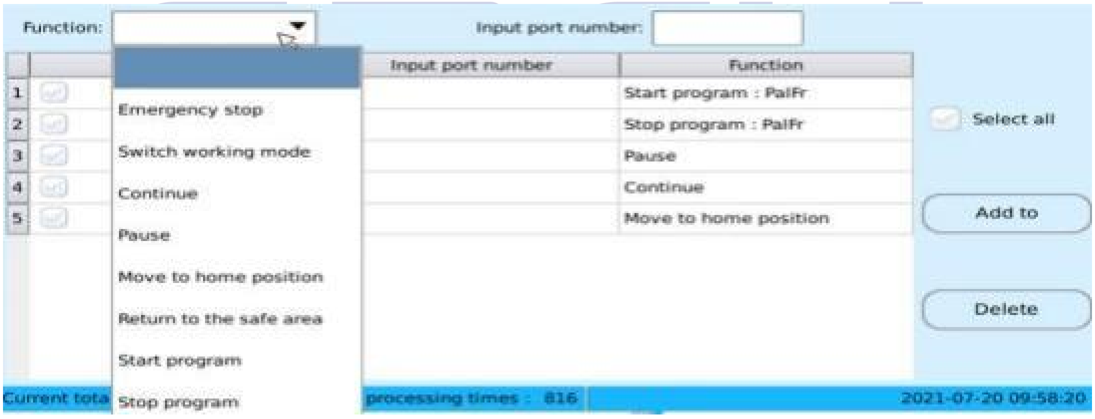



Figure 8. 1 Function port setting

### 8.1.2 Indication port

The indicating port can map the output port to a certain state of the system, such as running state, servo state, alarm state, etc., so that the user can judge the state of the current program through output, as shown in Figure 8.2

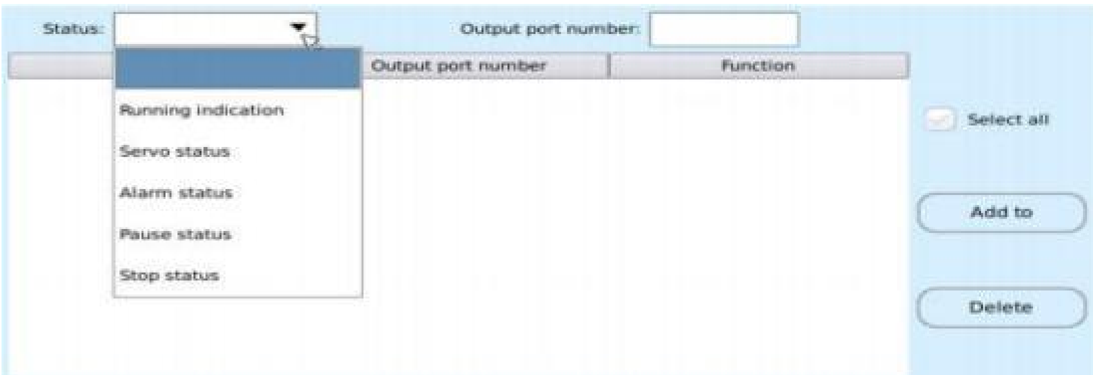



Figure 8.2 Indication port setting

## 8.2 Custom alarm prompt

The operator can define the alarm prompt information and map it to the output element w of PLC in turn, as shown in Figure 8.3.


Figure 8.3 Custom alarm setting

## 8.3 Other configurations

Click [configure] in the manual interface to configure emergency stop, operation environment, abnormal braking and network.

### 8.3.1 Emergency stop trigger output configuration

When pressing the [emergency stop] button of the teach pendant or the external [emergency stop] button, in order to stop the work of other cooperative systems outside the robot at the same time, it is necessary to configure the corresponding output for the "emergency stop" trigger. As shown in Figure 8.4, the emergency stop output configuration can be customized to output high level or low level.


Figure 8.4 Emergency stop output configuration

The system provides three setting modes for the output port,which are distinguished by different colors: "high level effective" red, "low level effective" green and "PLC control" yellow. Different states can be switched by clicking the port button.

Operation steps of "emergency stop configuration" of the system: first select the serial number of "IO output port" according to the actual situation and click the port button to switch the state, and finally click the [set] button to complete "emergency stop configuration". The initial state of the system for "emergency stop configuration" is "active at low level" by default, that is, when the controller receives the "emergency stop" command, the IO output port outputs "low level".

### 8.3.2 Calibration cycle configuration

When performing programmed work, robots often deviate from their predetermined path over time. Therefore, in order to ensure the accuracy and reliability of the robot on the production line, recalibration is necessary. As shown in Figure 8.5, you can configure how many times the robot runs the program and then calibrate it once.


Figure 8.5 Robot calibration cycle configuration

## 8.3.3 Off screen time configuration

The teach pendant can enter the sleep state during the working process of the robot. As shown in Figure 8.6, you can set how long it takes to turn off screen display. Click the teach pendant screen to wake up.


Figure 8.6 Off screen time configuration

## 8.3.4 Abnormal braking detection

The robot body needs six degrees of freedom, and the power provided comes from six three- phase AC servo motors. When the robot is not working, the brake circuit of the motor is not powered on, and the motor is fixed by friction of the brake pad. After passing through the reducer, the whole mechanical mechanism is deadlocked. When working, the motor is powered on, the brake circuit is powered on, the brake pads are released, and the motor is fixed by the magnetic field. Therefore, it is necessary to detect abnormal braking conditions, as shown in Figure 8.7. The braking detection attribute of each pulse driver port can be set.


Figure 8.7 Brake abnormality detection attribute setting

## 8.3.5 Network configuration

As shown in Figure 8.8, before using the network, it is necessary to configure and detect the network IP address, port number, etc.

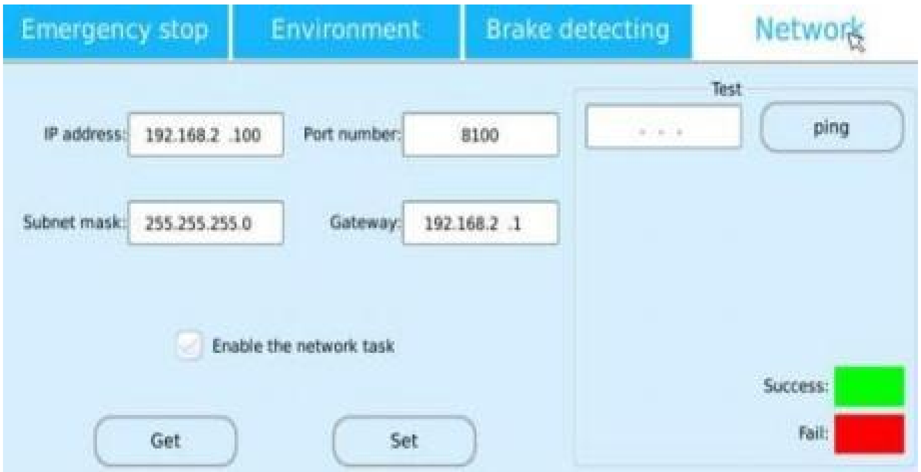



Figure 8.8 Network configuration

## 8.4 Language configuration

Click [system] - [language] in the manual interface to switch the language of the teaching pendant system. At present, in addition to Chinese, English, Russian, Korean and Vietnamese are also supported.


Figure 8.9 Language configuration

# 9 System backup and update

## 9.1 System backup

SZGH system software provides direct configuration and USB flash disk configuration backup functions. The backup programs and file types are shown in Table 9. 1.

Table 9. 1 Backup programs and file types

| Number | Storage location | Program type |
|---|---|---|
| 1 | Controller | Exe system program "robcon", FPGA program and user program |
| 2 | Teach pendant | Exe system program "robteach", resource document, manual |

### 9.1.1 Backup configuration

Enter the system [update and backup], as shown in Figure 9. 1. There are two backup configuration methods: direct configuration and USB flash disk configuration.

Select "direct configuration" to check the backup of "user program", "PLC program" and"exe system program".


Figure 9. 1 update and backup interface

Select "USB flash disk configuration" and prepare a FAT32 format USB2 0 and create a new folder and configuration file in it. This method can backup more file types. The steps are as follows:

1) Create a new folder under the root directory of the USB flash disk. The name must be "robcon"

2) Create a new text document in the "robcon" folder and rename it "config.ini".

3) Open "config.ini" with notepad and edit the text content as shown in Figure 9.2. The text contents related to backup are described in table 9.2.

If you want to back up, set the corresponding parameters. If you don't want to back up, set the parameters to “0”

Table 9.2 Description of configuration file content

| Text content | Description | Text content | Description |
|---|---|---|---|
| [control_backup] | Controller backup | [teach_backup] | Teach pendant backup |
| app | 1：Exe system program backup pic | pic | 2：Screenshot backup |
| fpga | 1:FPGA program backup | doc | 1：Document backup |
| record | 1：User program backup<br>2：PLC program backup<br>3：The user program and PLC program are backed up at the same time<br>64：User program reuse | app | 1：Exe system program backup |

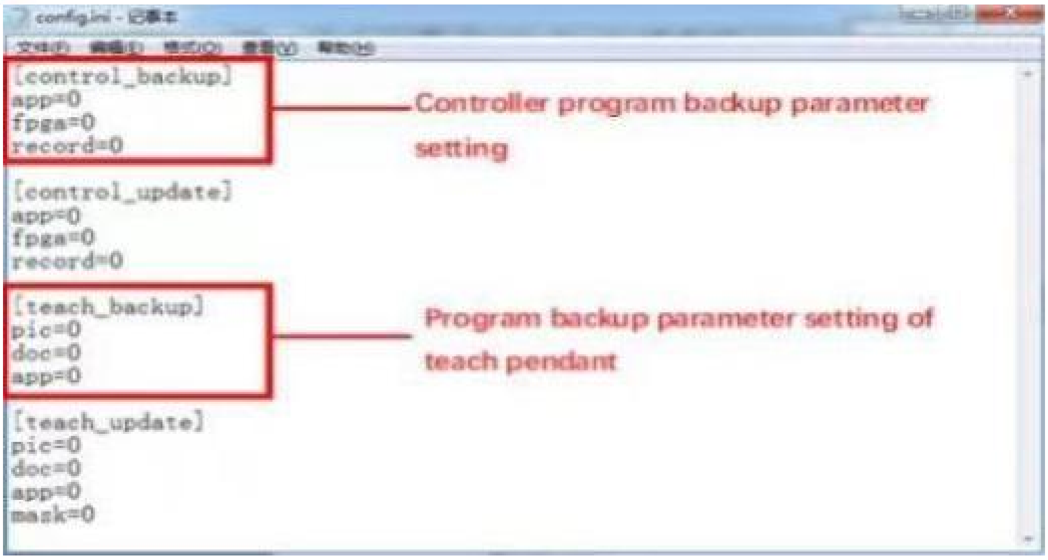



Figure 9.2 Related contents of "config.ini" configuration file backup

## 9.1.2 System program backup

Before backup, you need to select "direct configuration", check "exe" (controller and teach pendant system files can only be backed up separately), or select "USB flash disk configuration", and then set parameters in the "config.ini" configuration file in the "robcon" folder of USB flash disk (controller and teaching pendant system files can be backed up at the same time).

As shown in Figure 9.3, when the USB flash disk is configured to back up the EXE system program of the main controller, modify the parameter app = 1 in [control_backup] in the "config.ini" configuration file to save the configuration file. When backing up the teaching pendant exe system program, modify the parameter app = 1 in [teach_backup] in the "config. ini" configuration file and save the configuration file.


Figure 9.3 Configuration file setting parameter backup system program

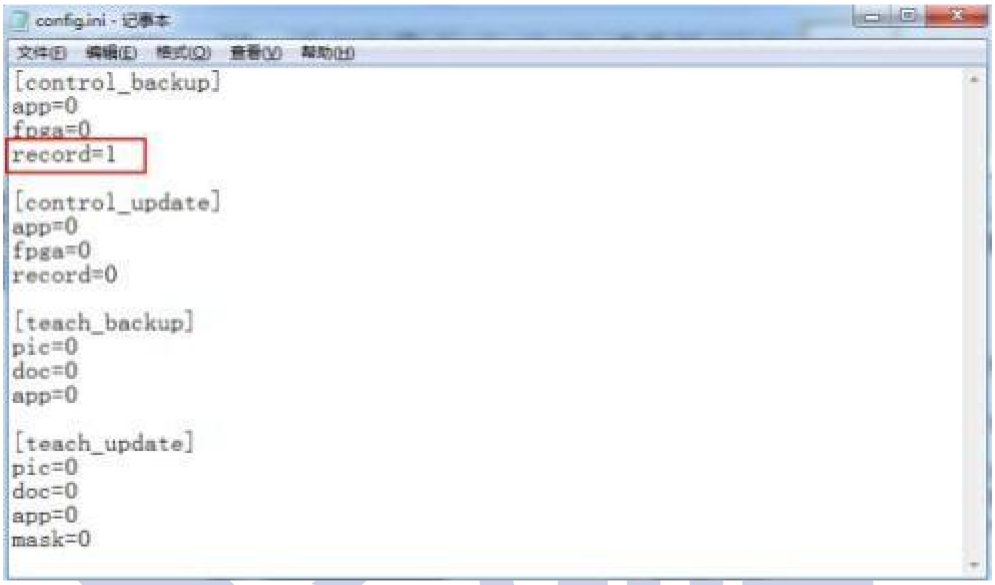
After setting the backup configuration, insert the USB flash disk into the controller, click [system] - [update and backup] in the manual interface of the teach pendant, select "backup" and click . After the backup is successful, the "robcon" folder of USB flash disk will contain three files, as shown in Figure 9.4.


Figure 9.4 Files of USB flash disk backup controller and teach pendant program

### 9.1.3 User program backup

Before backup, you need to select "controller" - "direct configuration", check "user program", or select "USB flash disk configuration", then set the "[control_backup]" parameter record = 1 in the USB flash disk configuration file "config.ini", and save the configuration file, as shown in Figure 9.5. After setting the configuration file, insert the USB flash disk into the controller, and click [system] - [update and backup] in the manual interface of the teach pendant to backup.

After the user program is backed up successfully, the folder "robcon" will contain "program" folder, "teachRecord.dat" file and "Point.dat" file, in which the "program" folder contains the program files established in the system and is stored in "*.raw" format


config.ini - 记事本
文件(F) 编辑(E) 格式(O) 查看(V) 帮助(H)

```
[control_backup]
app=0
fpga=0
record=1

[control_update]
app=0
fpga=0
record=0

[teach_backup]
pic=0
doc=0
app=0

[teach_update]
pic=0
doc=0
app=0
mask=0
```

Figure 9.5 Configuration file backup controller user program

### 9.1.4 PLC program backup

Before backup, you need to select "controller" -"direct configuration", check "PLC", or select "USB flash disk configuration", and then save the configuration file in the parameter "record = 2" of "[control_backup]" in the USB flash disk configuration file "config.ini". After setting the configuration file, insert the USB flash disk into the controller and click [system] - [update and backup] in the manual interface of the teach pendant to backup.


config.ini - 记事本
文件(F) 编辑(E) 格式(O) 查看(V) 帮助(H)

```
[control_backup]
app=0
fpga=0
record=2

[control_update]
app=0
fpga=0
record=0

[teach_backup]
pic=0
doc=0
app=0

[teach_update]
pic=0
doc=0
app=0
mask=0
```

Figure 9.6 Configuration file backup PLC program

After the PLC program is backed up successfully, the "robcon" folder will contain two files: the configuration file "config.ini" and the "PLC" folder. Among them, the PLC program in the system is backed up and saved in the "PLC" folder and stored in the format of "*.PLC", as shown in Figure 9.7.

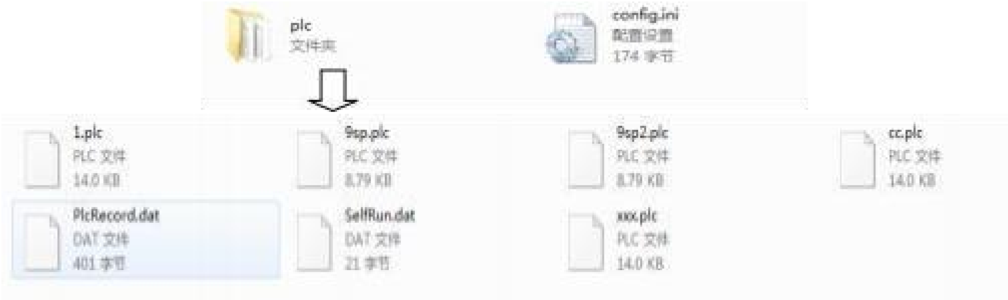



Figure 9.7 PLC program backup files

## 9.2 System update

SZGH system software provides the functions of direct configuration update and USB flash disk configuration update. The up datable programs and file types are shown in table 9.3.

Table 9.3 Update programs and file types

| Number | Storage location | Program type |
|---|---|---|
| 1 | Controller | Exe system program "robcon", FPGA program and user program |
| 2 | Teach pendant | Exe system program "robteach", resource document, manual, mask file |

### 9.2.1 View system version

Select [system] - [version] information to view the system version information. As shown in Figure 9.8 below, you can view the specific information of "machine code", "controller system version number", "teach pendant system version number", "authorization status" and "copyright" of the control system.


Figure 9.8 View system program version information

### 9.2.2 Update configuration

Before system update, prepare a FAT32 format USB2 0, copy the "robcon" folder with updated files into the root directory. Then you need to "configure directly" in [update and backup], or configure in "config.ini" on USB flash disk.

1) In the root directory of the USB flash disk, the name of the update folder must be "robcon". The "robcon" folder contains the update application files robcon and rob teach, "config.ini" configuration file and "check.dat" verification file.

2) Open "config. Ini" with Notepad, as shown in Figure 9.9, and the text content description related to update is shown in Table 9.4.

For updates, the corresponding parameters will be set in the configuration file. If not updated, the parameters will be set to "0".

Table 9.4 Description of configuration file content

| Text content | Description | Text content | Description |
|---|---|---|---|
| [control_update] | Controller program update | [teach_ update] | Teach pendant program update |
| app | 1： Exe system program update | Pic | 1： Resource document update |
| fpga | 1： FPGA program update | Doc | 1： Manual update |
| record | 1： Local user program update | app | 1： Exe system program update |
| | 2： Local PLC program update<br>3 ： The user program and PLC program are updated at the same time machine user programs<br>64 ： Reuse and update of other | mask | 1： Mask file update |

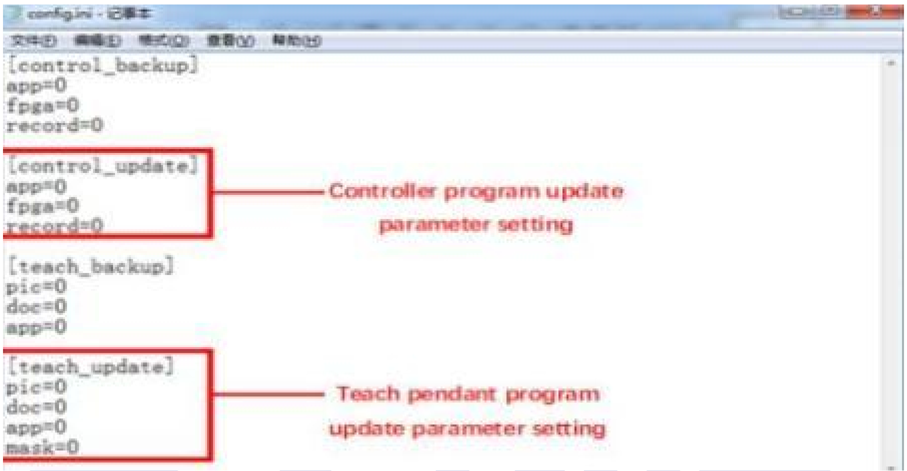



Figure 9.9 Update related contents of "config.ini" configuration file

## 9.2.3 System program upgrade

The system upgrade includes the upgrade and update of "controller program" and "teach pendant program ":

1) If you use USB flash disk configuration, you need to set the parameters in the configuration file "config.ini", mainly in the two "types of" [control_update] "and" [teach_update] ": app = 1, as shown in Figure 9.10.

2) Log in as administrator and click [System] – [update and backup].

3) First update the teach pendant. After the update is completed, the system will remind"whether to restart?". Please click "NO" and then update the controller. After the update is completed, click restart to confirm.

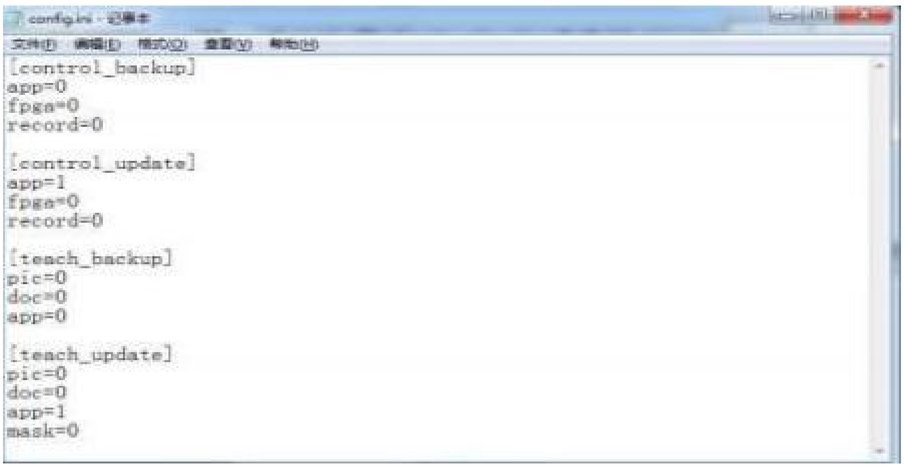



Figure 9. 10 Configuration file setting parameter update exe program

# Appendix 1 Instruction description

## (1) Movement instructions

Please refer to the motion instructions provided in Table 1 when programming the robot. When the tool attitude needs to be changed greatly, it is suggested to divide the motion trajectory into several curves for teaching.

Table 1 motion instructions

| Instruction name | Description | | |
|---|---|---|---|
| Curve movement | Function | Robot motion control. | |
| | Items | Movement type | Joint motion / linear motion / arc motion / circular motion |
| | | Run to point | The end point of the curve movement Arc movement: it is also necessary to set the intermediate point (the center of the arc is on the vertical line connecting the start point and the end point, and the intermediate point is any point on the arc)<br>Circular motion: it is also necessary to set the centre point and circular surface point (a sphere can be determined by the start point and centre point, and a circle can be determined by adding any point on the circular surface.) |
| | | Speed | Range(0, 2000], unit: mm/s |
| | | Smoothing ratio | The range is "0- 100","0" means there is no "smooth",and "smooth" is the largest when it is "100". |
| | Note | For arc movement, during debugging, if the current position is in the middle of the arc curve when pausing, you can't run directly from the current curve instruction when running again, but you need to return to the previous curve instruction to start running. | |
| Additional joint movement | Function | Additional axis motion control. | |
| | Item | Axis | EJ1/EJ2/…… |
| | | Control | Start/Stop |
| | | Direction | Positive/Negative |
| | | Speed | Unit: r/min |
| Forbidden additional joint | Function | Disable and enable additional axes. | |
| | Items | ENABLE EJ1/DISABLE EJ1；ENABLE EJ2/DISABLE EJ2 | |
| Additional joint Zeroing parameter | Function | Return the additional axis to zero. | |
| | Items | Number | EJ1/EJ2/…… |

## (2) Basic instructions

Basic instructions include: I / O instruction, register instruction, global variable instruction, speed control instruction, wait event instruction, other control instructions, etc. Please refer to Table 2.

Table 2 Basic instructions

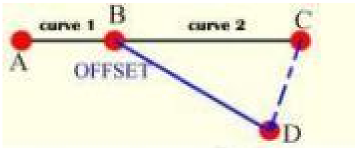
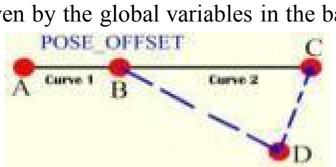
| Instruction name | Description | | |
|---|---|---|---|
| Output | Function | Change the state of the output port by assignment. | |
| | Items | Output port number | Y0-Y17 |
| | | Output level value | 0 indicates low level and 1 indicates high level. |
| Pulse output | Function | Make the output port output in pulse form by assignment. | |
| | Items | Output port number | Y0 -Y17 |
| | | Polarity | Positive/Negative |
| | | Pulse width | Unit: ms |
| Analog quantity | Function | Sets the analog value of the channel. | |
| | Items | Channel number | 0-3, 4 channels in total. |
| | | Data source | Variable (take value from global variable) /constant (input analog value directly) |
| | | Analog value | [0, 12), (required when "constant" is selected as the data source) |

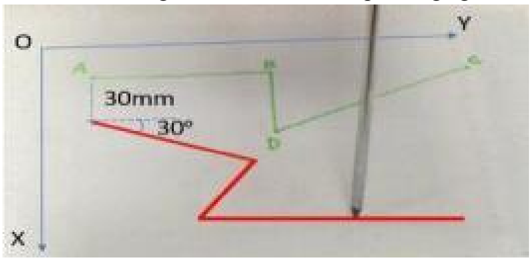
| | | | |
|---|---|---|---|
| Start input monitoring<br>Stop input monitoring<br>(Used in pairs) | Function | Monitor the level value of the input port, and assign the output port if there is any change. | |
| | Items | Input port number | X0-X19 |
| | | Port value | 0 indicates low level and 1 indicates high level. |
| | | Event relationship | And/ |
| | | Output port number | Y0-Y17 |
| Global variable assignment and operation | Function | Global variable assignment operation. | |
| | Items | Number | General global variable 0-99 |
| | | Operation symbol | =, +=, -=, /= |
| | | Assignment | Constant/Variable |
| Global variable self increment | Function | The value of the global variable increases by 1. | |
| | Items | Number | General global variable 0-99 |
| Global variable self-subtraction | Function | The value of the global variable is reduced by 1. | |
| | Items | Number | General global variable 0-99 |
| Global variable reset | Function | The value of an interval global variable is reset to 0. | |
| | Items | Starting number | General global variable 0-99 |
| | | End number | General global variable 0-99 |
| Register variable | Function | Assignment of register variables. | |
| | Items | Number | Register 0-499 |
| | | Operation symbol | =, +=, -=, /= |
| | | Assignment | Constant/Variable |
| Digital welding machine operation | Function | Digital welding machine operation. | |
| | Items | Brand | Jinrui |
| | | Function | Wire feeding / wire withdrawing / gas inspection |
| | | Enable or not | Enable / Non enable |
| Wait for accurate position | Function | Wait for the robot to reach the specified target point within the distance deviation in the setting time. | |
| | Items | Target point ID | "Point" ID number |
| | | Distance deviation | Unit: mm |
| | | Time | Unit: ms |
| Pipeline | Function | While the robot moves,preheat the welding gun through the pipeline time. | |
| | Items | Pipeline duration | Unit: ms |
| PLC operation | Function | Operate the PLC relay. | |
| | Items | M number | 0-499 |
| | | State | Valid/Invalid |
| Wait (event) | Function | Wait for the event. | |
| | Items | Event type | Input port / PLC / register variable / global variable / signal edge /signal edge hold |
| | | logical relationship | And / Or |
| | | Related parameters | Enter relevant information according to the event type. |
| Delay | Function | Delay. | |
| | Items | Parameter type | Variable / Constant |
| | | Time | Unit: ms, (required when "constant" is selected) |
| | | Variable number | 0-99 |

### (3) Offset instructions

Aiming at the problem of low precision of teaching points in the process of manual teaching programming and the deviation of workpiece placement position in the actual operation process, the system provides a variety of offset instructions (Table 3) to realize the offset of robot motion trajectory during the operation of the program.

Table 3 Offset command

| Instruction name | Description | | |
|---|---|---|---|
| Offset | Function | | In a coordinate system, set the offset to offset the "run to point" of the next curve instruction. |
| | Items | Coordinate system | Base coordinate system / User coordinate system / Tool coordinate system |
| | | Data source | Global variables / teaching parameters (input)(Set the offset of X, Y and Z axes and the offset of A, B and C attitude angles) |
| | Example | | Procedure:<br>Curve- Linear movement: Run to point(1-B); Speed=1000; Smoothing ratio=0<br>OFFSET ： Base coordinate system<br>Curve- Linear movement: Run to point(2-C); Speed=1000; Smoothing ratio=0 Explain:<br>Curve 1: A-B; Curve 2: B-C; When the OFFSET instruction is not used,the complete trajectory is A-B-C; When the OFFSET instruction is used after curve 1, the movement of original curve 2 to point "C" will shift to point "D". Therefore, after using the OFFSET instruction, the running track of the program will change to A-B-D. The offset "amplitude" and "offset direction" of point d relative to point C are given by the global variables in the base coordinate system.<br><br><br>Global variable: "value" represents the offset amplitude, and "+" and "-"before "value" represent the offset direction. |
| | Function | | In a coordinate system, by setting the offset, add a new curve from the current position, and the "run to point" is the offset point after the offset of the current position, and then run from the offset point to the "run to point" of the next curve instruction |
| | Items | Coordinate system | Base coordinate system / User coordinate system / Tool Coordinate system / Joint coordinate system |
| | | Data source | Global variables / teaching parameters (input)(Set the offset of X, Y and Z axes and the offset of A, B and C attitude angles) |
| | | Curve type | Joint movement /Linear movement |
| | | Speed | Range(0, 2000], unit: mm/s |
| | | | Procedure:ratio=0 Curve- Linear movement: Run to point(1-B); Speed=1000; Smoothing |
| Pose Offset | Example | | **POSE_OFFSE; Base coordinate system;** Linear movement;Speed=1000<br>Curve-Linear movement: Run to point(2-C); Speed=1000; Smoothing ratio=0<br>Explain:<br>Curve 1: A-B; Curve 2: B-C; When the POSE_OFFSET instruction is not used, the program running track is A-B-C; When the POSE_OFFSET instruction is used after curve 1 (i.e., the position of point B), the motion track of the point will first offset from the current point "B" to the position of point "D" and then run to the position of point "C". Therefore, after using the POSE_OFFSET instruction, the operation track of the program will become A-B-D-C. The offset "amplitude" and "offset direction" of point D relative to point B are given by the global variables in the base coordinate system.<br><br><br>Global variable: "value" represents the offset amplitude, and "+" and "-"before "value" represent the offset direction |
| | Function | | Offset the outline formed by the curve between begin outline offset instruction and end outline offset instruction by setting the offset. |

<table>
<tr><td rowspan="2">Begin outline offset End outline offset</td><td>Item</td><td colspan="2">User coordinate system Procedure:<br>BEGIN_OUTLINE_OFFSET：h0<br>Curve- Linear movement: Run to point(1-A); Speed= 100; Smoothing ratio=0<br>Curve- Linear movement: Run to point(1-B); Speed= 100; Smoothing ratio=0<br>Curve- Linear movement: Run to point(1-C); Speed= 100; Smoothing ratio=0<br>Curve- Linear movement: Run to point(1-D); Speed= 100; Smoothing ratio=0<br>END_OUTLINE_OFFSET</td></tr>
<tr><td>Example</td><td colspan="2">The "direction" and "amplitude" of the contour offset are set Explain:Before using this pair of instructions,you need to establish a corresponding "user coordinate system" for the "outline" and select it."assignment" to the corresponding "global variable".<br></td></tr>
<tr><td rowspan="4">Begin range-offset End range-offset</td><td>Function</td><td colspan="2">By setting the offset, all the run to points of the curve between " Begin range-offset" and " End range-offset" can be operated with the "offset" instruction in a certain coordinate system.</td></tr>
<tr><td rowspan="3">Items</td><td>Coordinate</td><td>Base coordinate system / User coordinate system</td></tr>
<tr><td>System</td><td></td></tr>
<tr><td>Data source</td><td>Global variables / teaching parameters (input)</td></tr>
</table>

## (4) Process instructions

In order to facilitate users to better use the SZGH control system, the system fixes some operation processes, and manual teaching programming is particularly cumbersome. Through "collection" to form a "process package", users can easily complete the original complex and cumbersome work. To invoke the process package in the basic program, we need to use the process instruction, and use the method in detail in the part III of the instruction.



## (5) Function instructions

For some complex operation processes, the SZGH control system is packaged in advance, and the packaging is successful. Users only need to set parameters and can call them in the basic program. See Part II of the manual for the call of function instructions.

## (6) Logic instructions

Many logic judgment, loop and jump operations are often involved in the application. The logic instructions provided by SZGH control system are shown in Table 4

Table 4 Logic instructions

| Instruction name | Description |
|---|---|
| IF | Conditional judgment |
| ELSE_IF | Conditional branch judgment |
| END_IF | End of condition judgment |
| WHILE | Loop |
| CONTINUE | Exit this cycle and judge the conditions of the next cycle |
| BREAK | Exit loop |
| END_WHILE | End loop |
| JMP | Jump |
| LABEL | Label |
| COND_UNTIL_BEGIN | Interval interrupt start |
| CON_UNTIL_END | Interval interrupt end |

# Appendix 2 Definition of Global Variables

| Address | Data meaning |
|---|---|
| GV0-GV99 | General |
| GV100-GV109 | Number of stacks already placed in 10 pallets in palletizing process |
| GV110-GV199 | Exclusive reservation |
| GV200 | X offset (for “offset”, “section offset”, “outline offset” instructions) |
| GV201 | Y offset (for “offset”, “section offset”, “outline offset” instructions) |
| GV202 | Z offset (for “offset”, “section offset” instructions) |
| GV203 | Attitude angle A offset (for “offset”, “section offset” instructions) |
| GV204 | Attitude angle B offset (for “offset”, “section offset” instructions) |
| GV205 | Attitude angle C offset (for “offset”)/Rotation (for “outline offset”) |
| GV206-GV208 | XYZ data in Base Coordinate System |
| GV209-GV211 | ABC data in Base Coordinate System |
| GV212-GV217 | 6 joints offset / X-Y-Z-A-B-C offsets in base coordinate system (for “position offset” instruction) |
| GV218 | Current number of layers in palletizing process |
| GV219 | Serial number of the position to be stacked in the current layer in palletizing process |
| GV220-GV225 | Special register for program control |
| GV226-GV229 | Exclusive reservation |
| GV230 | X offset (for “offset”, “section offset”, “- Intermediate point) |
| GV231 | Y offset (for “offset”, “section offset”, “- Intermediate point) |
| GV232 | Z offset (for “offset”, “section offset”, “- Intermediate point) |
| GV233-GV235 | Rotation angle (for “offset”, “section offset”, “- Intermediate point) |
| GV236-GV240 | Rotation angle of the additional joints 0-4 (Additional joint offset instruction) |
| GV241 | User coordinate system ID |
| GV242-GV244 | XYZ coordinate value in user coordinate system |
| GV245 | The tool coordinate system ID used to display the robot end coordinates and attitude, and the pose offset function.<br>The default value is 255, indicating no tools. |
| GV246-GV256 | Current joint angle of each joint |
| GV257_L | Completion flag of arc swing process parameter setting |
| GV257_H | Completion flag of welding machine process parameter setting |
| GV258-GV263 | Arc swing process parameters (mode < 0-z, 1-arc, > - frequency – amplitude - left stay time - right stay time - arc swing radius) |
| GV264-GV265 | Welding process parameters (welding current / wire feeding speed - welding voltage) |
| GV266-GV279 | Exclusive reservation |
| GV280_L | Mode (0-manual, 1-automatic) |
| GV280_H | Running status (0-stop, 1-running, 2-pause) |
| GV281 | Alarm category (represented by bits, 0-no such alarm, 1-have such alarm) (B0 emergency stop alarm, B1 servo alarm, B2 brake abnormal alarm, B3 algorithm alarm, B4 encoder angle acquisition alarm) |
| GV282 | Running times |
| GV283 | External encoder task enable flag (read / write) |
| GV284 | Zero crossing trigger port of external encoder (read / write) |
| GV285 | External mechanism reduction ratio (read only) |
| GV286 | Number of external encoder lines (read / write) |
| GV287 | Current value of external encoder (read only) |

| | |
|---|---|
| GV288 | System date: Year (2B) + Month (1B) + Day (1B) |
| GV289 | System time: Hour (2B) + Minute (1B) + Second (1B) |
| GV290 | System millisecond counter |
| GV291 | Incremental motion command return status |
| GV292-GV299 | Exclusive reservation<br>(0 - initial value, 0xff - command execution completed, others: error status) |
| GV300-GV499 | General, Data loss after power failure |
| GV500-GV699 | General, No data loss after power failure |
| GV700-GV705 | Special,palletizing frame curve skip flag （0-don't skip, 1-skip） |
| GV706 | Special, palletizing transition point (entry) modification mark（0 - do not modify, 1 -modify） |
| GV707 | Special, modified palletizing transition point (entry) ID |
| GV708 | Special, palletizing prepare to release point modification mark（0 - do not modify, 1 -modify |
| GV709 | Special, modified palletizing prepare to release point ID |
| GV710 | Special,palletizing release point modification mark （0 - do not modify,1 - modify） |
| GV711 | Special, modified palletizing release point ID |
| GV712 | Special,palletizing leaving point modification mark （0 - do not modify,1 - modify） |
| GV713 | Dedicated, modified palletizing leaving point ID |
| GV714 | Special, palletizing transition point (away) modification mark （0 - do not modify, 1 -modify |
| GV715 | Special, modified palletizing transition point (away) ID |
| GV716 | Special, Hongtu packaging process, current quantity |
| GV717 | Special, Hongtu packaging process, total production |
| GV718-GV799 | Exclusive reservation |

**Note: gv700-gv799 is special global variables with no data loss after power failure**

# Appendix 3 Definition of PLC components

| Number | Component type | Component number | Component range |
|---|---|---|---|
| 1 | Input relay (X) | 20+40(expansion board) | X0-X19; X20-X59 (expansion board) |
| 2 | Output relay (Y) | (expansion board) | Y0-Y17; Y18-Y53 (expansion board) |
| 3 | Status relay (S) | 100 | S0-S99 |
| 4 | Alarm relay (A) | 50 | A0-A49 |
| 5 | Universal relay (M) | 500 | M0-M499 |
| 6 | Counter (C) | 50 | C0-C49 |
| 7 | Hotkey relay (F) | 30 | F0-F16; F17-F29 (reserved) |
| 8 | Interference relay (I) | 48 | I0-I47 |
| 9 | User defined alarm relay (W) | 60 | W0-W59 |
| 10 | Universal 10ms timer (TGT) | 10 | TGT0-TGT9 |
| 11 | Universal 100ms timer (TGH) | 10 | TGH0-TGH9 |
| 12 | Universal 1s timer (TGS) | 10 | TGS0-TGS9 |
| 13 | Cumulative 10ms timer (TAT) | 10 | TAT0-TAT9 |
| 14 | Cumulative 100ms timer (TAH) | 10 | TAT0-TAT9 |
| 15 | Cumulative 1s timer (TAS) | 10 | TAS0-TAS9 |

The specific description of PLC elements is as follows:

## 1. Input relay

| Number | Meaning | Note |
|---|---|---|
| X0-X19 | System onboard input INPUT0-INPUT19 | |
| X20-X59 | Expansion board input INPUT0-INPUT39 | |

## 2.Output relay

| Number | Meaning | Note |
|---|---|---|
| Y0-Y7 | System onboard output OUTPUT0-OUTPUT7 | Relay output |
| Y8-Y17 | System onboard output OUTPUT8-OUTPUT17 | OC output |
| Y18-Y33 | Expansion board output OUTPUT0-OUTPUT15 | Relay output |
| Y34-Y53 | Expansion board output OUTPUT16-OUTPUT35 | OC output |

## 3.Status relay

Program status and interaction for interaction with PLC.

| Number | Meaning | Note |
|---|---|---|
| S0 | Run | |
| S1 | Stop | |
| S2 | Pause | |
| S3 | Manual mode | |
| S4 | Automatic mode | |
| S5 | Single step motion | |
| S6 | Single motion | |
| S7 | Loop motion | |

| | | |
|---|---|---|
| S8 | Servo on | |
| S9 | Servo off | |
| S10 | Additional axis 0 position control | |
| S11 | Additional axis 0 speed control | |
| S12 | Additional axis 0 tracking control | |
| S13 | Additional axis 1 position control | |
| S14 | Additional axis 1 speed control | |
| S15 | Additional axis 1 tracking control | |
| S16-S69 | Y0-53 output status during pause | |
| S70 | There are continuing events | |
| S71 | Program running completed | |
| S72-S99 | Reserve | |

## 4. Alarm relay

The state when the controller gives an alarm.

| Number | Meaning | Note |
|---|---|---|
| A0 | There's an alarm. | |
| A1 | Emergency stop alarm | |
| A2 | Servo alarm | |
| A3 | Joint overrun alarm | |
| A4 | Algorithm operation error alarm | |
| A5 | Encoder angle update error alarm | |
| A6 | Failed to get external encoder angle | |
| A7 | Tracking failed | |
| A8 | Failed to read stacking process file | |
| A9-A49 | Reserve | |

## 5. Universal relay

Input / output interaction area.

| Number | Meaning | Note |
|---|---|---|
| M0-499 | User defined | |

## 6. Counter

| Number | Meaning | Note |
|---|---|---|
| C0~C49 | User defined | |

## 7. Hotkey relay

Start the function corresponding to the hotkey.

| Number | Meaning | Note |
|---|---|---|
| F0 | Emergency stop | |
| F1 | Continue to run | |
| F2 | Pause the program | |
| F3 | Stop the program | |
| F4 | Switch to manual mode | |

| | | |
|---|---|---|
| F5 | Switch to automatic mode | |
| F6 | Run to zero – all the joints | |
| F7 | Run to zero – joint 1 | |
| F8 | Run to zero – joint 2 | |
| F9 | Run to zero – joint 3 | |
| F10 | Run to zero – joint 4 | |
| F11 | Run to zero – joint 5 | |
| F12 | Run to zero – joint 16 | |
| F13 | Run to zero – joint 7 | |
| F14 | Run to zero – joint 8 | |
| F15 | Run to zero – joint 9 | |
| F16 | Run to zero – joint 10 | |
| F17 | Run to zero – joint 11 | |
| F18 | Run to safety zone | |
| F19 | Run the program | The parameter is the program ID |
| F20-F29 | Reserve | |

## 8. Interference relay

| Number | Meaning | Note |
|---|---|---|
| I0-I19 | Point interference output | Interference point 0 - interference point 19 |
| I20-I39 | Spatial interference output | Space interference 0 - Space interference 19 |
| I40-I47 | Axis interference output | Axis interference 0 - axis interference 7 |

## 9. User defined alarm

| Number | Meaning | Note |
|---|---|---|
| W0~W59 | User defined alarm input | The corresponding alarm prompt box pops up on the teach pendent interface |

## 10.Timer

| Number | Meaning | Note |
|---|---|---|
| TGT0-TGT9 | Universal 10ms timer | |
| TGH0-TGH9 | Universal 100ms timer | |
| TGS0-TGS9 | Universal 1s timer | |
| TAT0-TAT9 | Cumulative 10ms timer | |
| TAH0-TAH9 | Cumulative 100ms timer | |
| TAS0-TAS9 | Cumulative 1s timer | |

# 10 Searching

In the robot welding operation, some products have high welding accuracy requirements and tooling assembly requirements. The welding robot alone cannot solve the actual needs of the factory. At this time, it is necessary to locate and track the welding seam. The welding seam positioning and tracking function can solve the deviation caused by welding thermal deformation, workpiece blanking deviation, and clamping. Positioning is not necessarily used in every weld. When the error is not large, only one long weld needs to be used. Just find the starting point.

Weld tracking is divided into arc tracking and laser tracking. Arc tracking is generally used for thick plates, mostly weaving welding, such as excavator arm, driving welding, etc. The approximate location of the weld is calculated by the wire touching the edge of the base metal. Laser tracking is to feed back the welding seam information to the robot through the laser sensor, and the robot will automatically modify the trajectory according to the obtained data during the welding process to complete the welding.

Arc tracking is to find the position first and then welding. Laser tracking is to find the position while welding. In terms of efficiency, the laser is much faster, and the accuracy of the arc tracking is not as high as that of the laser tracking, so the products that are too precise are not suitable for arc tracking. However, the cost of arc tracking is several times lower than that of laser tracking, so the welding seam tracking method should be selected according to the actual situation of the product.

## 10.1 Laser Position searching

In robot welding, some products require high welding accuracy, so it is necessary to find the weld position. SZGH robot system can be combined with laser weld tracking sensor to realize direct position searching of weld points during operation.

Step1: Create the laser tracking package

Set the sensor network port communication and its related parameters.

For laser positioning, the system needs to connect an external laser vision sensor on the welding torch side through LAN communication. Click [Motion]-[Create Program]-[Function]-[Laser Tracking], you can set up the "Laser Tracking" function package, which is used to realize the welding seam laser positioning in the program.

Note:A tool coordinate system for the welding gun should be created in advance and be selected in this interface.See Figure10. 1.

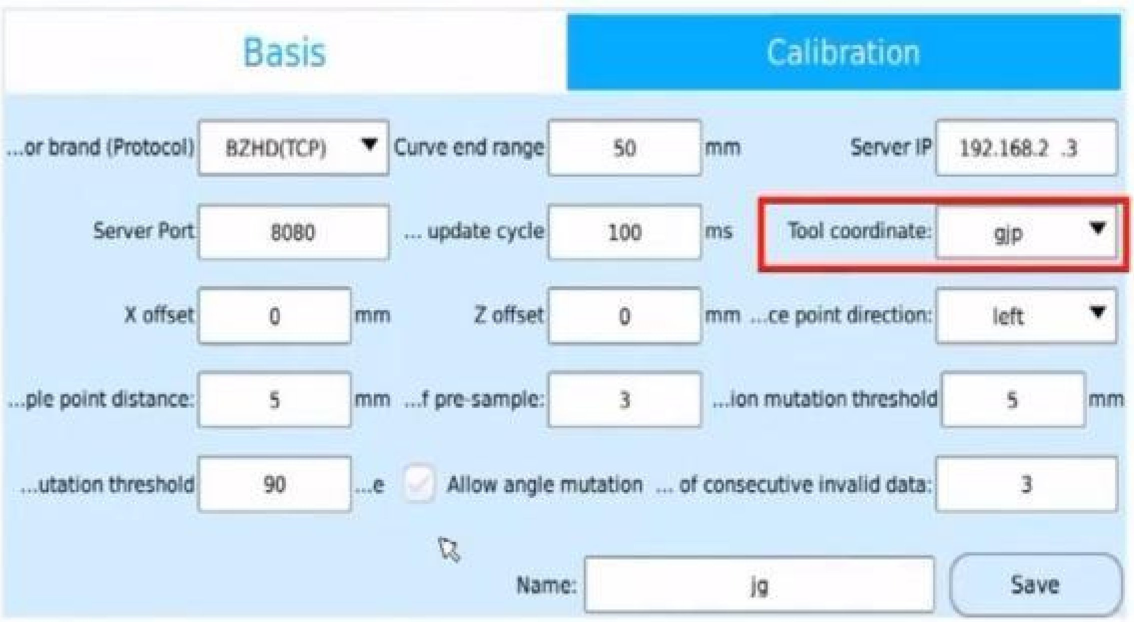



Figure10. 1 Setting of Basic parameter for Laser Tracking Package

Table10. 1 Explanation of basic parameter of laser tracking package

| Seq. | Parameter | Explanation |
|---|---|---|
| 1 | Curve end range | Set the positional relationship between the actual curve running end point during laser tracking welding and the curve end point during teaching, that is, enter the end range of the curve end point set during teaching, that is, stop tracking and curve running. Unit: mm. |
| 2 | Server IP,Server Port | Communication settings between the laser seam tracking sensor system and the control system LAN port. |
| 3 | Tool coordinate | Select the tool coordinate system created by the torch. |
| 4 | X offset, Z offset | Sets the offset between the laser seek point and the actual weld point. Unit: mm. |
| 5 | Auxiliary point direction | |
| 6 | Sample point distance, Length of pre-sample | The distance between sampling points and the number of pre-sampling during the tracking process. |
| 7 | Feature position mutation threshold | Length threshold for no weld feature during weld tracking. Beyond the threshold, the laser tracking data is considered to be in error. |
| 8 | Weld angle mutation threshold | Set according to the welding seam that needs to be tracked. If the threshold is exceeded, the laser tracking data is considered to be wrong. |
| 9 | Maximum sample times of consecutive invalid data | Used to monitor whether the laser seam tracking sensor system is working properly. |

(1) Sensor calibration is required

(2) Select a reference point P1 on the weld line.Perform sensor calibration. As shown in Figure 10.2, the calibration needs to randomly select a reference point P1 on the weld, move the robot tool TCP to the reference point, obtain the data of the six joints of the robot at this point, and then click [Start Calibration]. For this reference point, change the detection height (Z axis) and detection offset (X axis), detect from 6 different positions (P2-P7), see Figure10.3. and read the robot six joint data and sensor values of P2-P7 respectively , the calibration process can be completed, as shown in Figure 10.4.

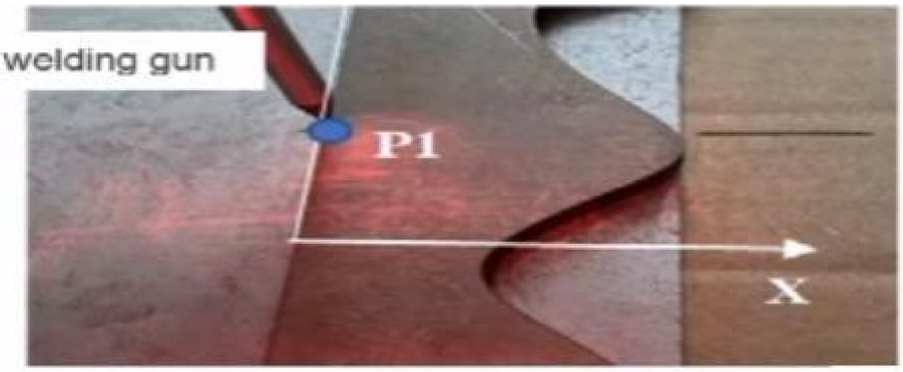



Figure10.2 Point of P1 with welding gun

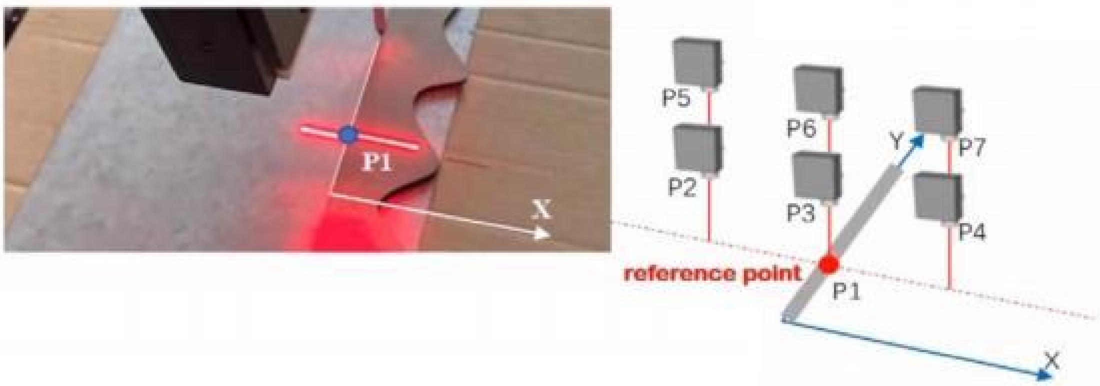



Figure10.3 Calibrate process

A. Step 3: Click the [Save] button to save the laser tracking function package for direct and indirect laser positioning.

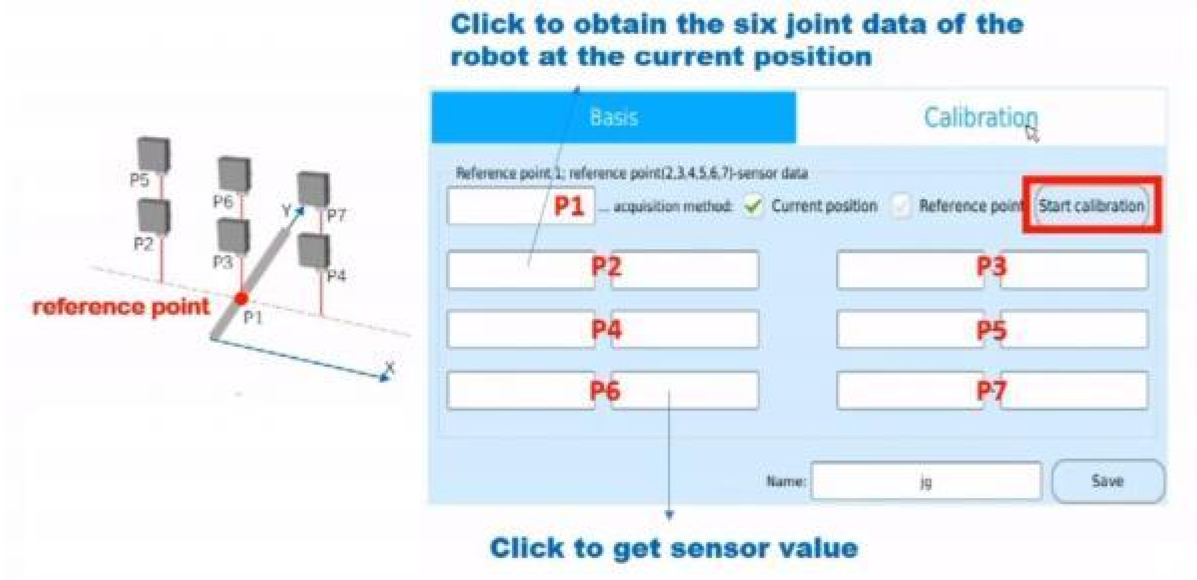



Figure10.4 Screen for P1~P7 calibrate points

## 10.2 Direct Laser Position searching

Switch the mode switch of the teach pendant to the "Manual" mark, click [Motion] - [Create Program] - [Basic Program] on the touch screen in the manual main interface, and select "Task Type" - "Function Command" - - "Direct searching position".

The "direct searching position function" of the system includes five functions: "obtaining the search point", "calculating the intersection point", "point position replacement", "position search point operation" and "point position stretching", as shown in Figure 10.5. After the "tool coordinate system" and "laser tracking function package" are created, the "direct positioning" function task can be used.

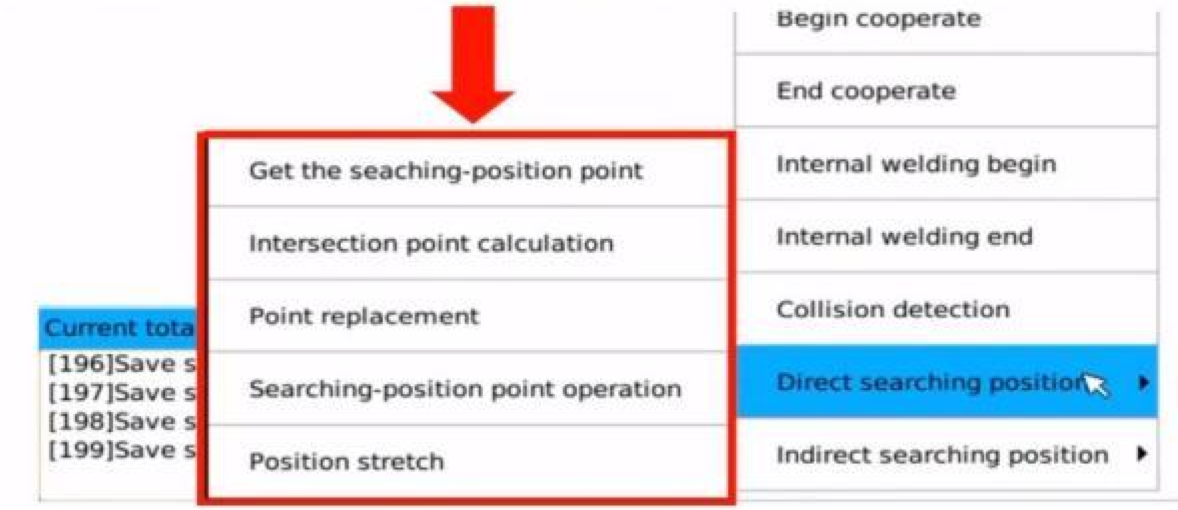



Figure10.5 Command of Direct Laser Searching

### 10.2.1 Get the searching-position point

Select the task type "Get the searching-position Point", as shown in Figure 1.6, which includes 4 parts: "Location Point ID", "Function Package", "Weld Seam Type" and "Parameter ID",also Weld Seam Serial Number.

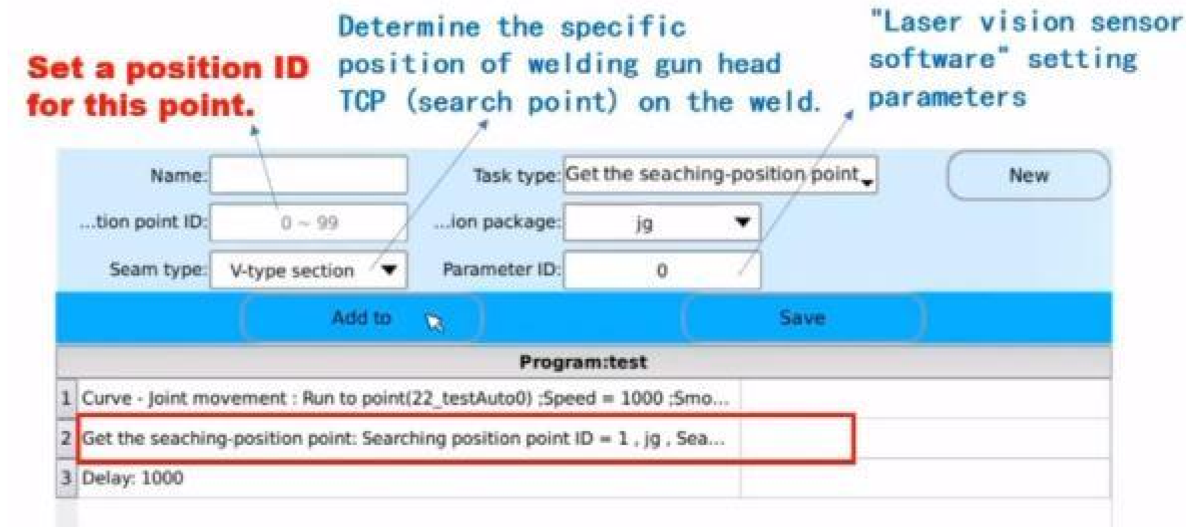



Figure10.6 Command of “Get the searching-position point”

Details about parameters for “get searching point”,see table10.2.

| Seq. | Parameter | Explanation |
|---|---|---|
| 1 | Location Point ID | Configure the "ID" number of the locating point, the range is "0 - 99", this ID is "unique" in a single program. (Note: This ID is not the same as the point ID definition in point management.) |
| 2 | Function Package | Select the created "Laser Tracking" feature package. |
| 3 | Seam Type | Set the type of Weld, including V-Cut, Left Lap, Right Lap, Fillet Weld, Butt, Left Edge, Right Edge, Circumscribed Corner, Left Girdle and Right Girdle. |
| 4 | Parameter ID | Setting the "weld seam serial number" is related to the setting parameters of the "laser vision sensor display and control software". |

Example on Figure10.7, if there is no "curve" command after the "get searching position point" command, you need to add a "delay" non-curve task type to "buffer" for the underlying operation of the system.

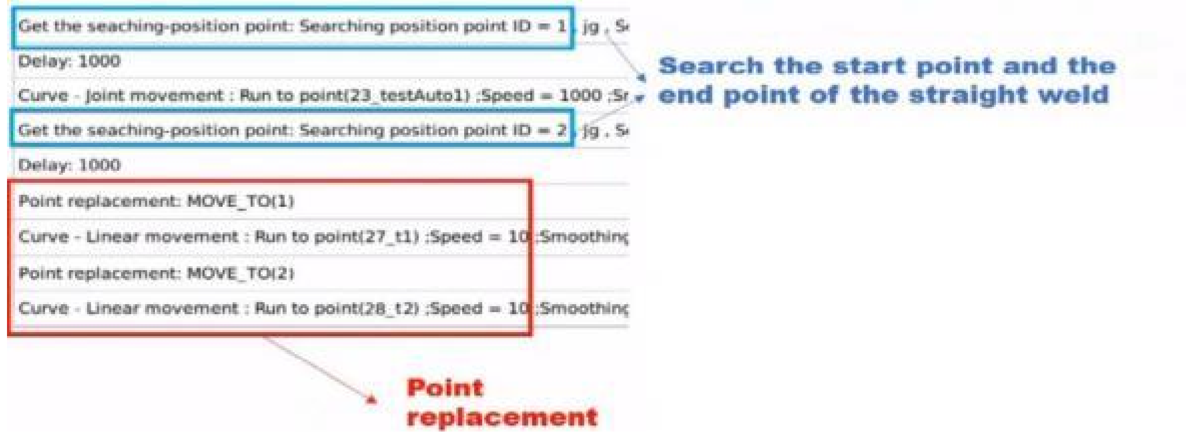



Figure10.7 Program example of “Get the searching-position point”

## 10.2.2 Intersection point calculation

The system can obtain the data of two "reference points" by using the method of "obtaining locating points" on the two curves respectively, and then calculate the coordinates of the intersection points of the two curves based on the 4 "locating points", that is, the "intersection point". coordinate.

As shown in Figure 10.8, the straight line L1 and the straight line L2 intersect at point P, where A1 and B1 are the "reference points" obtained by "obtaining the search point" on the straight line L1, and A2 and B2 are the "obtaining The "reference point" obtained by "Finding Point".

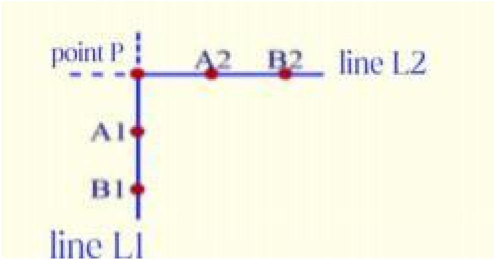



Figure10.8

Select the "Calculate Intersection" task type, as shown in Figure 10.9, you need to set the parameters of "Distance Threshold", "Intersection ID", "Start-End Point" of "Intersection Curve 1" and "Intersection Curve 2". The detailed description of the parameters is shown in Table 10.3.

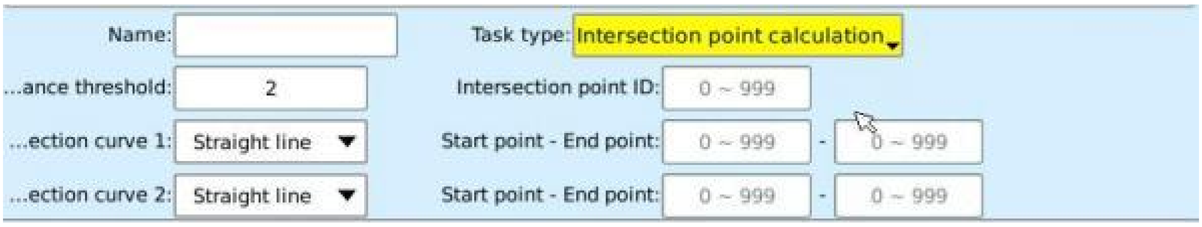



Figure10.9

Table10.3

| Seq. | Parameter | Explanation |
|---|---|---|
| 1 | distance threshold | The threshold of the intersection distance between the two curves, the unit is "mm". |
| 2 | Intersection ID | Set the "ID" number of "Intersection", which is represented by "0 - 99". (Note: This ID is not the same as the point ID definition in point management.) |
| 3 | Intersecting curves | Set the type of "Intersection Curve", including "Line" and "Arc". |
| 4 | starting point - end point | Set the "reference point" of the curve, that is, the "ID" number obtained by "obtaining the search point" in the program. |

There is an example of a program using the "Calculate Intersection" command,shown on Figure 10.10 and Figure 10.11.

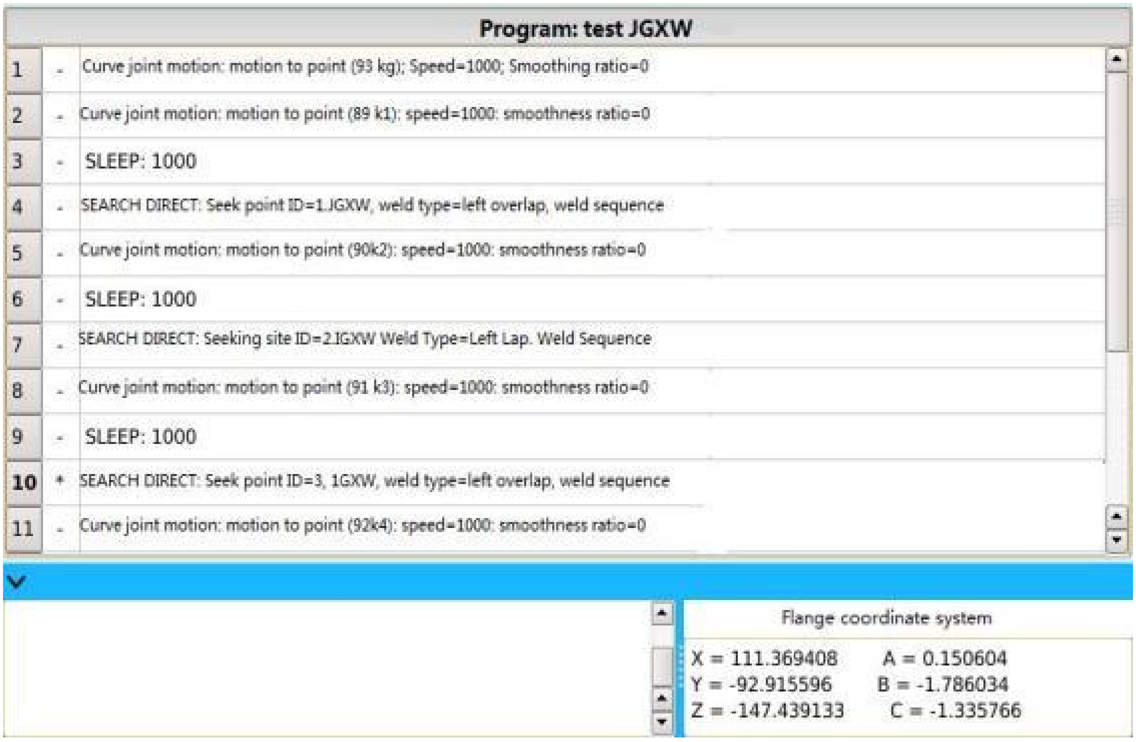



Figure10.10

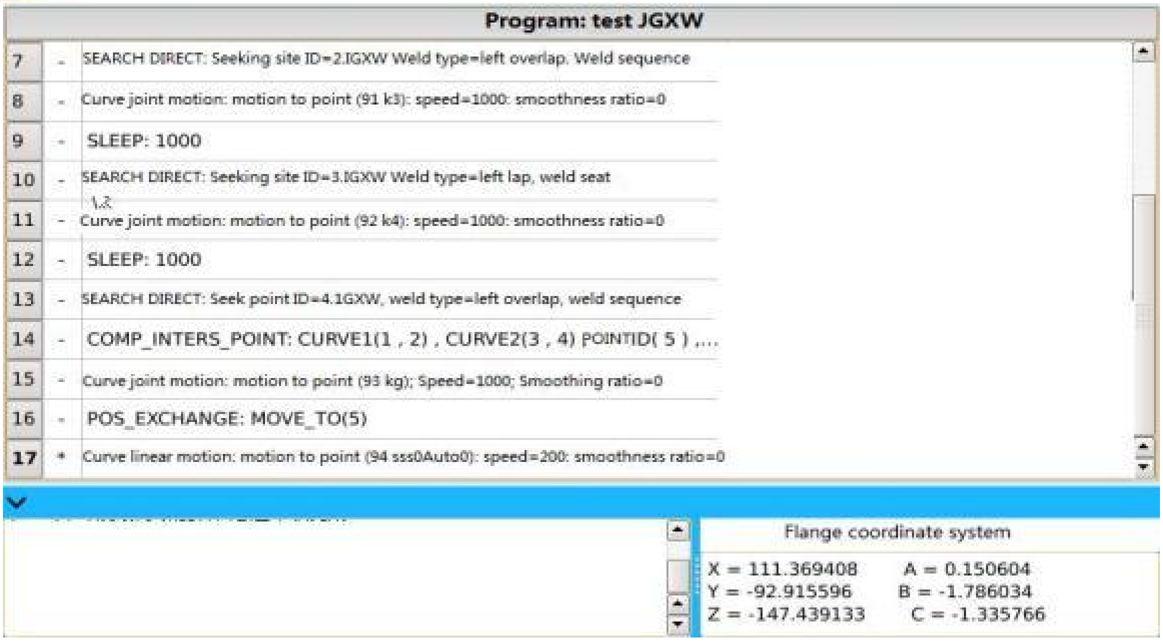



Figure10. 11

## 10.2.3 Point replacement

In the robot welding operation program, the movement to point in the motion curve command is obtained by manual teaching, and there is a deviation from the actual workpiece position. At this time, the actual position point data of the workpiece can be obtained through the "Get Positioning Point" and "Calculate Intersection" commands. , which replaces the motion-to-point in the curve.

As shown in Figure 10. 12, after selecting the "Point Replacement" task type, you need to set two parameters, "Curve Type" and "End Point". There are two types of curves: "Line" and "Arc". The end point is the "ID" number of the "replacement point", and the "movement to point" of the curve following the instruction is replaced. When selecting the "Arc" curve type, you need to set the ID numbers of the "Middle Point" and "End Point" two "Replacement Points".

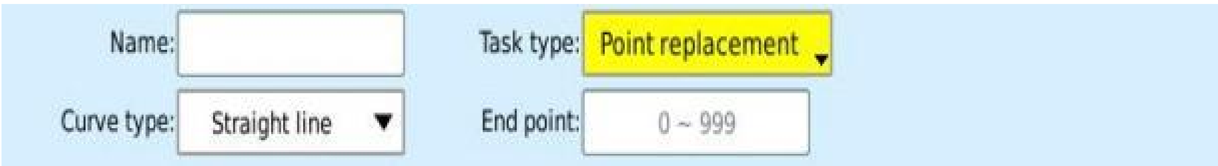



Figure10. 12

## 10.2.4 Search point operation

As shown in Figure 10.13, after selecting the "Location Point Operation" task type, the system can query the coordinate value of the "Location Point" and assign it to the "Global Variable", or by performing "Assignment", " After the "Operation" operation, set the value of the global variable to the coordinate value of the "Location Point".

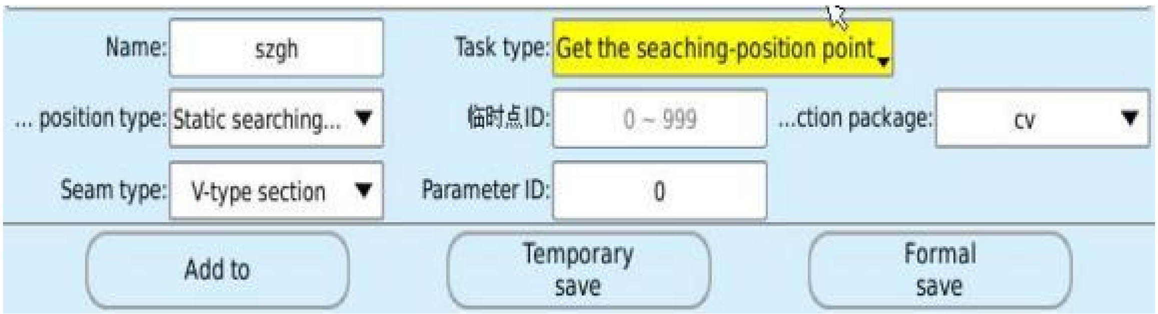



Figure10.13

## 10.2.5 point stretch

As shown in Figure 10. 14, for applications where the start and end points of the weld are not suitable for direct laser positioning, programming can be quickly implemented through "point stretch".

As shown in Figure 10.15, for a straight line weld, it is necessary to set the offset of the starting point and the ending point, as well as the ID of the starting point and the ending point. The program is shown in Figure 10.16. The direction from the start point to the end point is the positive direction. When setting the offset, you need to pay attention to the offset direction. For arc welds, you need to set three locating points and offsets for the start point, middle point and end point.

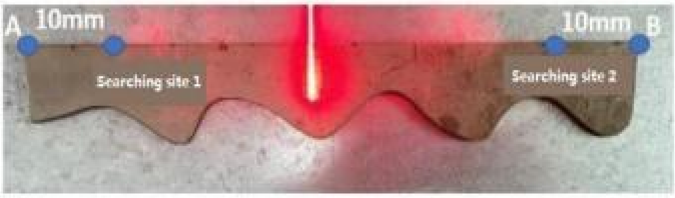



Figure10. 14

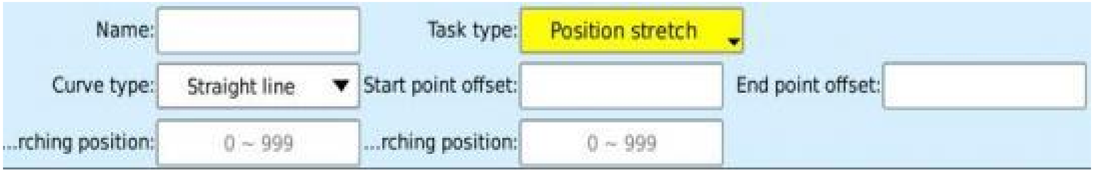
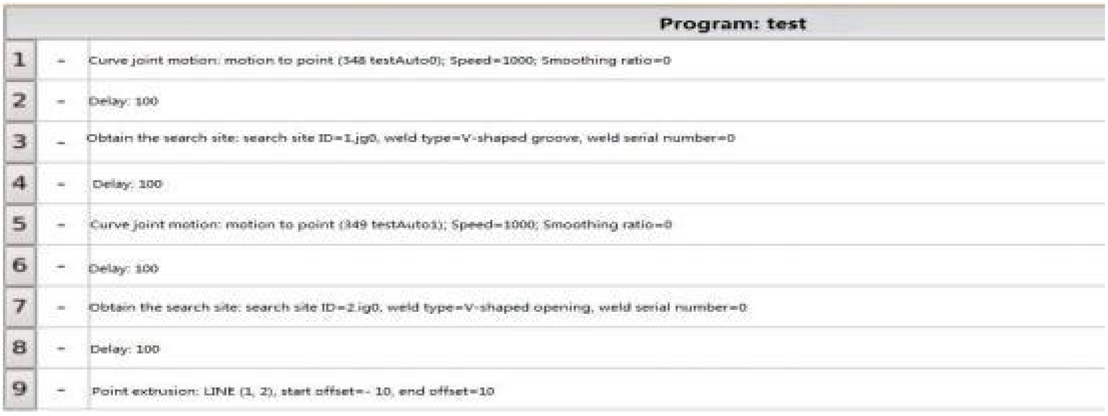



Figure10.15



Program: test

| | | |
|---|---|---|
| 1 | - | Curve joint motion: motion to point (348 testAuto0); Speed=1000; Smoothing ratio=0 |
| 2 | - | Delay: 100 |
| 3 | - | Obtain the search site: search site ID=1.jg0, weld type=V-shaped groove, weld serial number=0 |
| 4 | - | Delay: 100 |
| 5 | - | Curve joint motion: motion to point (349 testAuto1); Speed=1000; Smoothing ratio=0 |
| 6 | - | Delay: 100 |
| 7 | - | Obtain the search site: search site ID=2.jg0, weld type=V-shaped opening, weld serial number=0 |
| 8 | - | Delay: 100 |
| 9 | - | Point extrusion: LINE (1, 2), start offset=- 10, end offset=10 |

Figure10.16

## 10.3 Indirect electrical positioning

As shown in Figure 10.17, the indirect search command includes: start search, next search, stop search, start search offset, stop search offset. These 5 instructions constitute the process of indirect positioning.

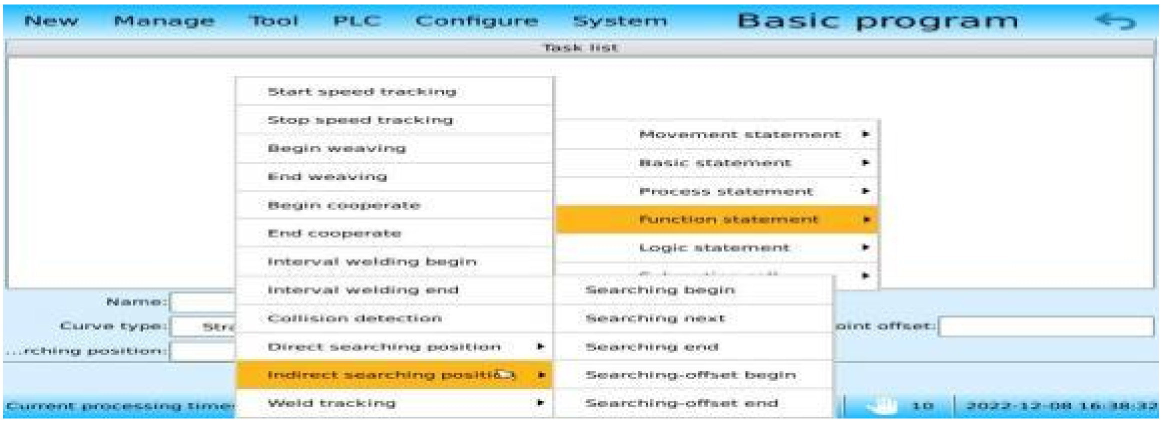



Figure10.17

The principle of indirect electric positioning: the welding wire is energized and the workpiece is grounded. During the movement of the robot along the positioning track, once the welding wire and the workpiece come into contact with the workpiece, a contact signal will be generated, and the robot will stop moving. Correct the path by using the deviation between the current position and the position set by the program, so as to obtain the real trajectory value and complete the welding positioning.

## 10.3.1 Parameter Setting for indirect electrical searching position

Click [Indirect Search] - [Start Search], select the search method as "Electric Search", as shown in Figure 10.18, which is the parameter setting interface. The specific parameter description is shown in Table 10.4.

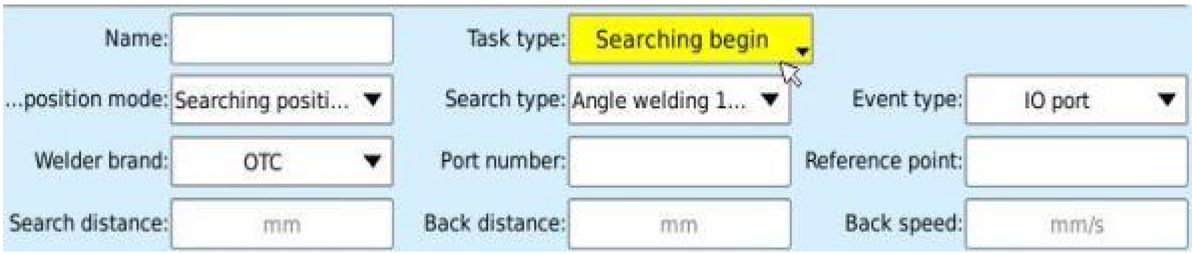



Figure10.18

Table10.4

| Seq. | Parameter | Explanation |
|---|---|---|
| 1 | Searching Catalog | Including: Fillet Weld Positioning 1D, Fillet Weld Positioning 2D, Fillet Weld Positioning 3D, V-Port Positioning, Arc Inner Diameter Positioning, Arc Outer Diameter Positioning, Fillet Weld Seam Positioning 2D + Rotation, Fillet Welding Seam positioning 3D + rotation, etc.<br>1D: Positioning on a certain plane of XYZ.<br>2D: Positioning of any two of the three XYZ planes.<br>3D: Positioning in three planes XYZ.<br>2D+Rotation: It refers to the rotation positioning of any two sides plus one of the three XYZ planes.<br>3D+Rotation: It refers to the rotation positioning of adding a certain surface among the three XYZ surfaces. |
| 2 | Type of Searching | Positioning trigger is divided into: communication port and I/O port<br>Communication port: CAN communication, such as corresponding to CLOOSE welding machine LAN communication RS485, RS232 |
| 3 | Brand of welding machine | The system provides: OTC, LBBBD-ME, LBBBD-MA, Jin Rui, Diman, general simulation welding machine. |
| 4 | Port Number | The port number for the seek trigger. |
| 5 | Reference point of searching position | Enter the ID according to the c, f, i reference points of the seek type. |
| 6 | Distance of Searching position | Starting from point a, the distance to seek along the direction from a to b. Unit: mm. |
| 7 | return distance | The return distance at c', f', i' after the contact signal is generated between the welding wire and the workpiece. Unit: mm. |
| 8 | return speed | The return motion speed after the contact signal of the welding wire and the workpiece is generated. Unit: mm/s. |

## 10.3.2 Electric positioning process

As shown in Figure 10.19, the start and end points of the weld curve command obtained by manual teaching in the program are point A and point B, respectively. In the process of robot operation, to accurately determine the actual positions of points A and B of the welding seam, positioning is required.

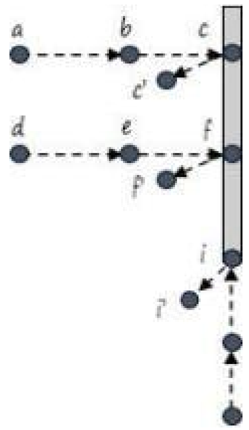



Figure10.19

The positioning curve is: a→b, d→e, g→h, that is, the moving direction of the robot positioning is determined by these six points. The positioning reference points are c, f and i, respectively. Once the contact signal is generated by the contact between the welding wire and the workpiece, it will return to c', f', and i' (the three return points in the figure are actually on the positioning curve). The different types of seek procedures are shown in Table 10.5.

Table 10.5

| Seq. | Searching Catalog | Track of searching position & process |
|---|---|---|
| 1 | 1D | Positioning track: a→b→c→c'→P→A→B<br>Process description: reach point a and start the search → set the search direction of point b → search to point c and return to point c' → calculate the deviation value (finish the search) → run to the buffer point P → start the search offset → start A To B welding → stop seek offset |
| 2 | 2D | Positioning track: a→b→c→c' →P1→g→h→i→i' →P2→A→B<br>Process description: reach point a and start the search → set the search direction of point b → search to point c and return to point c' → run to the buffer point P1 → start the next search at point g → set the search direction of point h → search Go to point i and return to point i'→calculate the deviation value (finishing of positioning)→run to buffer point P2→start the positioning offset→start welding from A to B→finish the positioning deviation |
| 3 | 2D+Rotary | Positioning track: d→e→f→f→P1→a→b→c→c→P2→g→h→i→i'→P3→A→B<br>Process description: (omitted)<br>Note: The rotation angle is determined by the first search point and the second search point, and its direction is the movement direction of the third search, that is, it is necessary to search for f first and then search for c, f→c and g→h directions Consistent. |

## 10.3.3 Example of Program

Example program for 1D Searching Position, shown as figure 10.20 .

| Procedure: 1D | | | |
|---|---|---|---|
| 1 | - | Curve joint motion: motion to point (31 a): speed=1000 | |
| 2 | - | BEGIN SEARCH: X 5, fillet weld locating 1D, locating reference point (33), locating distance=150 | |
| 3 | - | Curve linear motion: motion to point (32 b): speed=8: smoothness ratio=0 | |
| 4 | - | END_SEARCH | |
| 5 | - | Curve joint motion: motion to point (38 GDD): speed=1000 | |
| 6 | - | BEGIN_SEARCH_OFFSET | |
| 7 | - | Curvilinear linear motion: motion to point (34 A); Speed=1000; Smoothness ratio=0 port | |
| 8 | - | Curve linear motion: motion to point (35 B): speed=20: smoothness ratio=0 | |
| 9 | - | END_SEARCH_OFFSET | |

Figure 10.20

Example program for 2D Searching Position, shown as figure 10.21 .

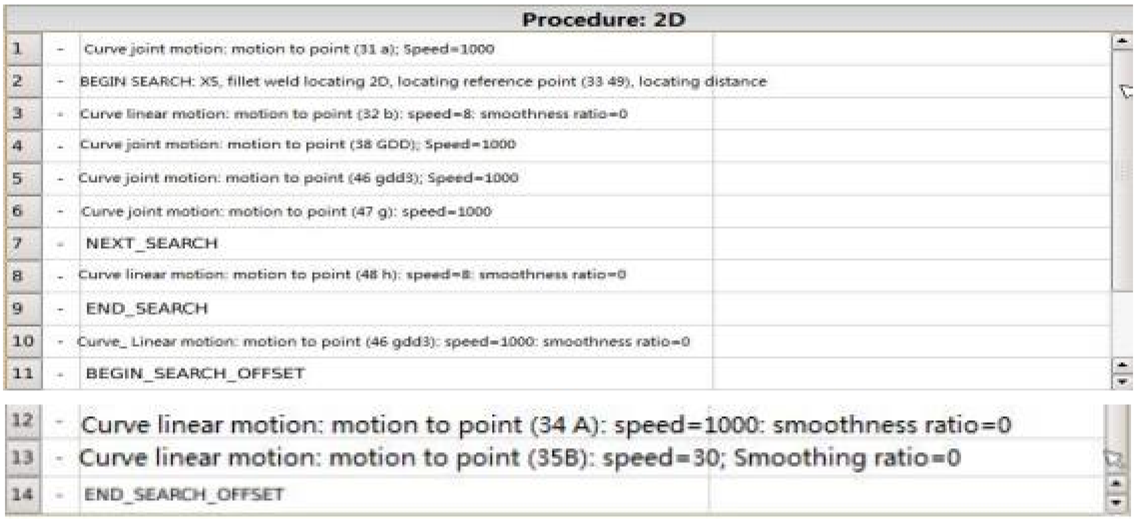



Figure10.21

Example program for 2D Searching Position+rotary, shown as figure 10.22 .

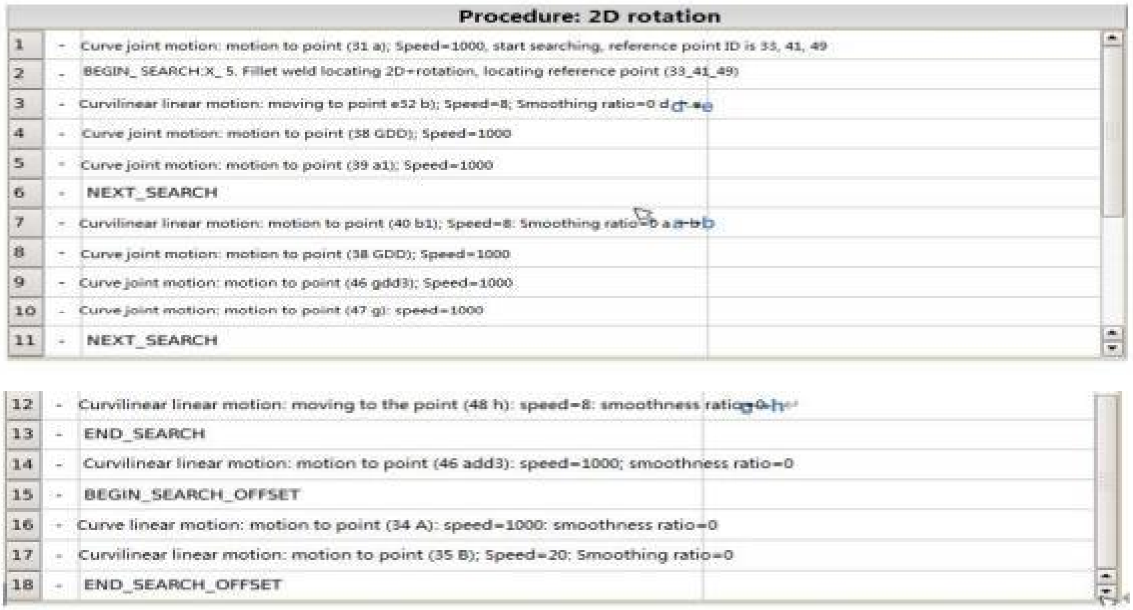



Figure10.22

## 10.4 Indirect laser positioning

The principle of laser positioning: in the process of positioning along the welding seam track, the external laser sensor is scanned, and the deviation value between the actual position information obtained by scanning and the position set by the program is used to correct the path through the offset command, so as to obtain the real position. Track value, complete welding tracking.

### 10.4.1 Parameter setting

Click [Indirect Search] - [Start Search], select the search method as "laser search", as shown in Figure 10.23, which is the parameter setting interface. The specific parameter descriptions are shown in Table 10.6.

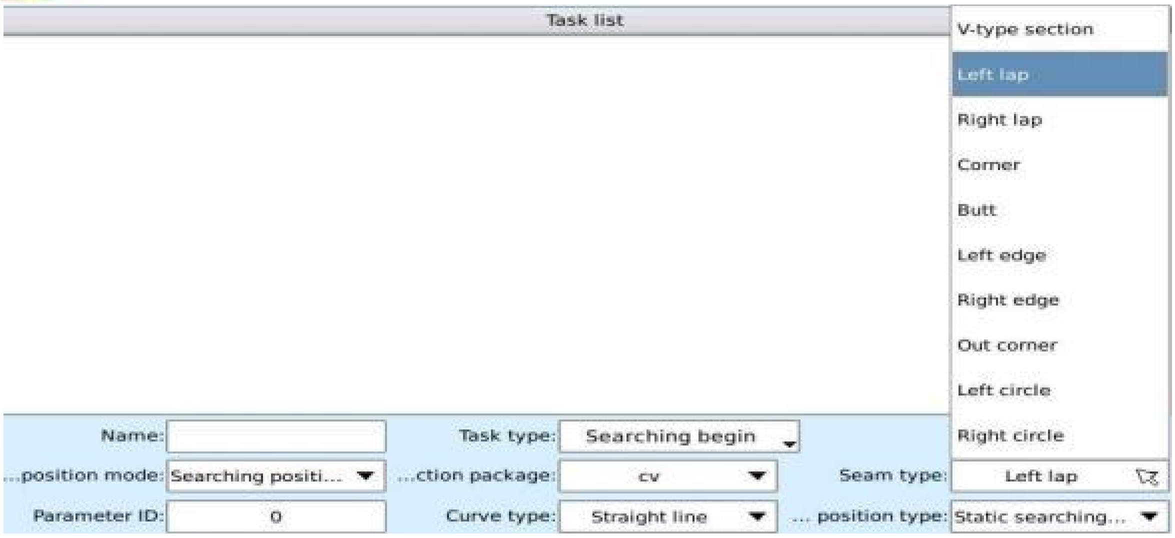



Figure10.22

Table10.6

| Seq. | Parameter | Explanation |
|---|---|---|
| 1 | Function package | Select the Laser Tracking Feature Pack. |
| 2 | Weld Type | Contains V-Cut, Left Lap, Right Lap, Fillet Weld, Butt, Left Edge, Right Edge, Circumscribed Corner, Left Girth and "Right Girdle" and other types. |
| 3 | Weld serial number | Setting the "weld seam serial number" is related to the setting parameters of the "laser vision sensor display and control software". |
| 4 | Curve category | "Line", "Arc", "Circle" can be selected. 2 points for straight line positioning, 3 points for arc and circle positioning. |
| 5 | Positioning mode | You can choose "Static Positioning" or "Dynamic Positioning". |

## 10.4.2 Laser Positioning Process

During the laser positioning process, there is no need for the welding wire to contact the workpiece, that is, the starting point A and the end point B of the welding seam are given. After starting the positioning, the laser tracking function will scan the workpiece and calculate the deviation value. The specific search process is shown in Table 10.7.

Table10.7

| Seq. | Command | Explanation |
|---|---|---|
| 1 | Articulation: A | Curve command |
| 2 | start seek | Set the parameters to searching position of the starting point A of the previous curve successfully |
| 3 | Linear motion: B | Curve command |
| 4 | next seek | will successfully locate the end point B of the straight line |
| 5 | stop seek Joint | Stop search function command |
| 6 | Movement: C | Movement to transition point: C |
| 7 | Start seek offset | Start search offset function command |
| 8 | Joint movement: D | Determine the attitude angle of the welding torch and the starting point of the welding direction |
| 9 | start welding | Start welding process command |
| 10 | Linear motion: E | Determine the attitude angle of the welding torch and the end point of the welding direction |
| 11 | stop welding | Stop welding process command |
| 12 | stop seek offset | Stop seek offset function command |

Notice:

(1) Run the curve to point A, and then use the "Start Positioning" function to successfully search for point A. Run the curve to point B, and then use "next search", point B will be successfully searched.

(2) When using the "Start Search Offset" function command, it is related to the search point, not all the included curves are "offset curves" (for example, two points for search are one straight line)Specific format: curve→function command→start search (search mode: laser search, search mode: static search)

### 10.4.3 Program Cases

Figure 10.24 is an example of laser linear positioning program using indirect positioning command.

| Procedure: linear search | | |
|---|---|---|
| 1 | - | Curve joint motion: motion to point (92 heel healer Auto0): speed=1000: smoothness ratio=0 |
| 2 | - | BEGIN SEARCH: laser positioning, left oblique angle, left overlap, 0, straight line, static positioning |
| 3 | - | Curve_ Linear motion: moving to the point (93 heel healer Auto1): speed=300; smoothness ratio=0 |
| 4 | - | NEXT_SEARCH |
| 5 | - | END_SEARCH |
| 6 | - | Curve joint motion: motion to point (94 heel healer Auto2): speed=1000: smoothness ratio=0 |
| 7 | * | BEGIN_SEARCH_OFFSET |
| 8 | - | Curve joint motion: motion to point (94 heel ensemble Ayto2): speed=800: smoothness ratio=0 |
| 9 | - | BEGIN_WELD: Flat welding |
| 10 | - | SLEEP: 100 |
| 11 | - | Curve_ Linear motion: moving to the point (95 heel healer Auto3): speed=13: smoothness ratio=0 |
| 12 | - | END_WELD |
| 13 | - | END_SEARCH_OFFSET |
| 14 | - | Curve joint motion: motion to point (96 x1 zd): speed=1000: smoothness ratio=0 |

Figure10.24

Figure 10.25 is an example of laser arc positioning program using indirect positioning instruction.

| Procedure: arc locating | | |
|---|---|---|
| 1 | - | Curve joint motion: motion to the point (starting point of 200 arc); Speed=1000: Smoothing ratio=0 |
| 2 | - | BEGIN SEARCH: laser positioning, left oblique angle, left overlap, 0, straight line, static positioning |
| 3 | - | Curve joint motion: motion to the point (middle point of 201 arc); Speed=300: Smoothing ratio=0 |
| 4 | - | NEXT_SEARCH |
| 5 | - | Curve joint motion: motion to point (202 arc end point): speed=300: smoothness ratio=0 |
| 6 | - | NEXT_SEARCH |
| 7 | - | END_SEARCH |
| 8 | - | Curve joint motion: motion to point (203 arc transition point) speed=1000: smoothness ratio=0 |
| 9 | - | BEGIN_SEARCH_OFFSET |
| 10 | * | Curve joint motion: motion to the point (starting point of 204 arc direction); Speed=800; Smoothing ratio=0 |
| 11 | - | BEGIN_WELD: Flat welding |
| 12 | - | Curve arc motion: starting point (starting point in 204 arc direction), middle point (middle point in 205 arc direction) |
| 13 | - | END_WELD |
| 14 | - | END_SEARCH_OFFSET |

Figure10.25

# 11 Interval Welding Function

Intermittent is a function designed to achieve a regular welding trajectory in welding operations. Through simple parameter setting, you can use this function in the basic program editing interface by means of instructions. For some typical regular track operation requirements in the welding process, SZGH robot system provides “interval welding” function in the program instruction to facilitate users to quickly realize programming.

## 11.1 Code of Interval Welding Function

In the basic program programming interface, select "Task Type" - "Function Command", as shown in Figure 11.1. Among them, the "start intermittent" and "stop intermittent" function command pairs are included. In the program, the invocation of the "Start Intermittent" function instruction needs to be placed after the "Start Welding" instruction and before the welding track segment. The "Stop Intermittent" function command needs to be placed after the welding track segment and before the "Stop Welding" command, as shown in Figure 11.2.

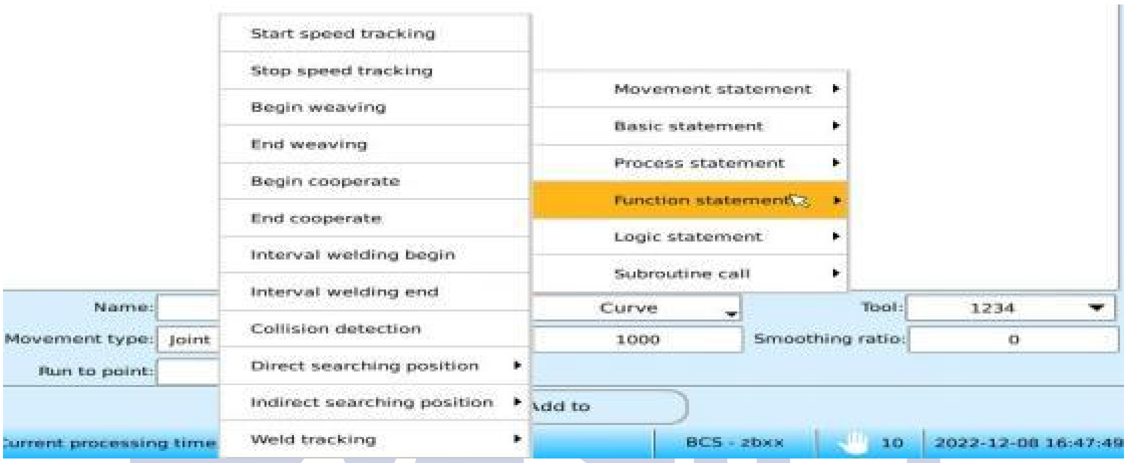



Figure 11.1

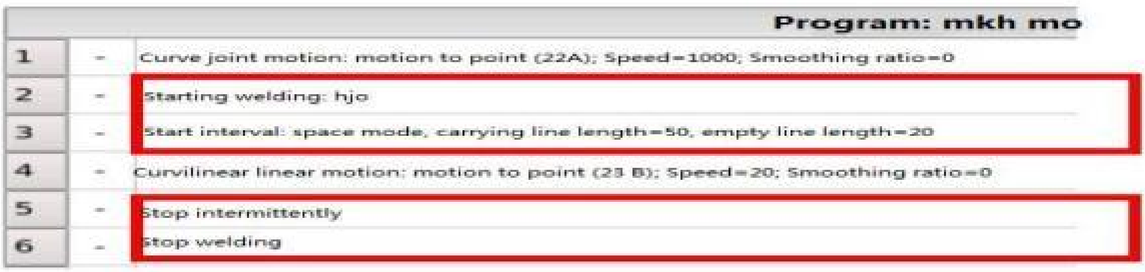



Figure11.2

## 11.2 Mode of Interval Welding Function

As shown as Figure 11.3,in the "Start Intermittent" function command interface, 4 modes are currently provided, namely "Space Mode","Time Mode", "Reciprocating Mode" and "Pause Mode".

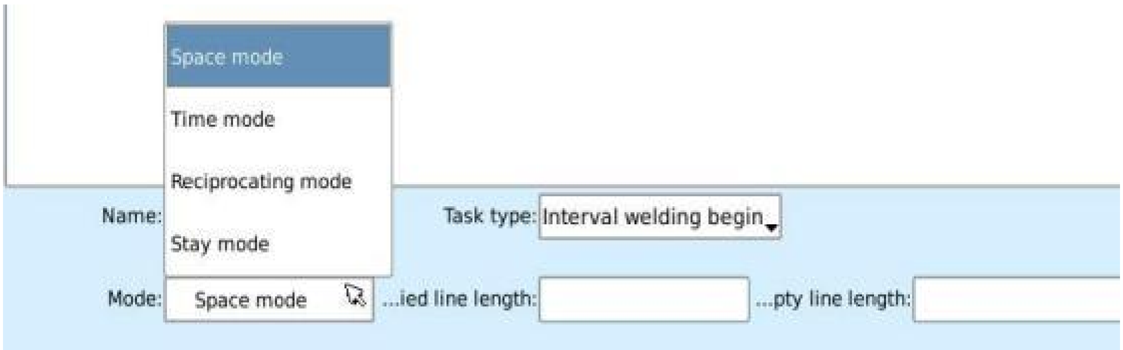



Figure11.3

### 11.2.1 Space Mode

The robot intermittently welds in this mode. As shown in Figure 11.4, you need to set the length of the loaded line (unit: mm) and the length of the blank line (unit: mm). Among them: the length of the loaded line is the length of the welding operation, and the length of the empty line is the length of the non-welding operation.

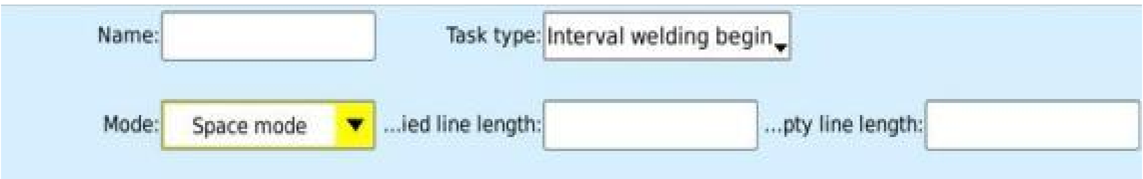



Figure11.4

An example of a welding program and trajectory using the space mode intermittent function is shown in Figure 11.5. The welding track will start from point A, first weld, then blank, then weld, then blank, and complete the entire operation to point B according to this rule.

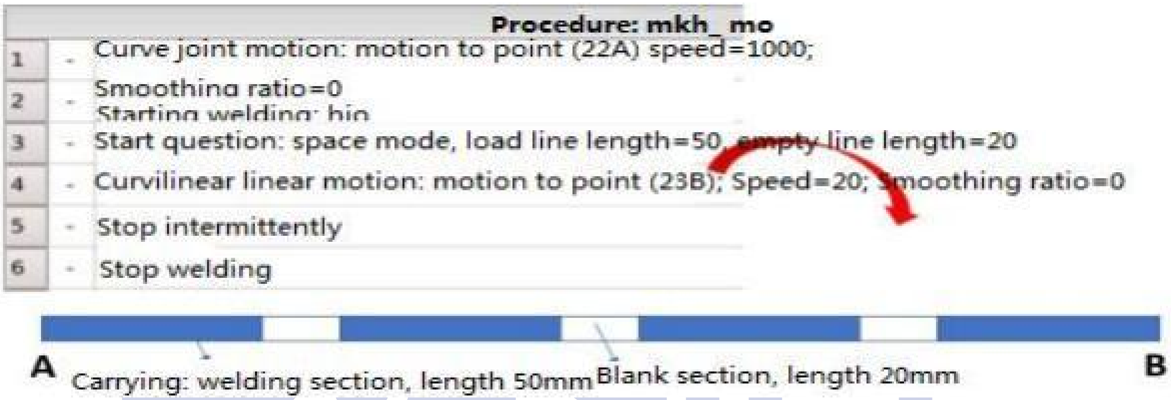



Figure11.5

### 11.2.2 Time Mode

The robot intermittently welds in this mode. As shown in Figure 11.6, you need to set the blank line length (unit: mm) and dwell time (unit: ms). Among them: the length of the blank line is the running length without welding, and the dwell time is the length of the welding at a certain point.

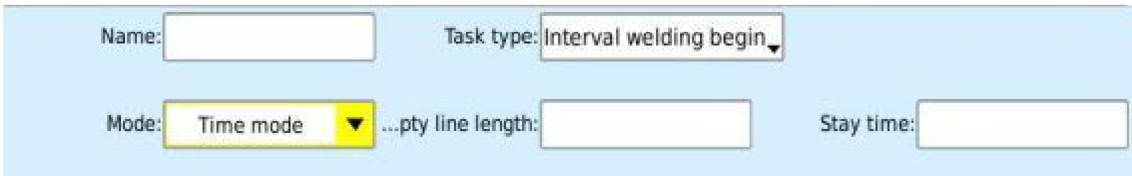



Figure11.6

Figure 11.7 shows an example of a welding program and trajectory using the Time Mode Intermittent function. The welding track will start from point A, first stop welding at point A, then go blank, then stop welding and then blank, and complete the entire operation to point B according to this rule.

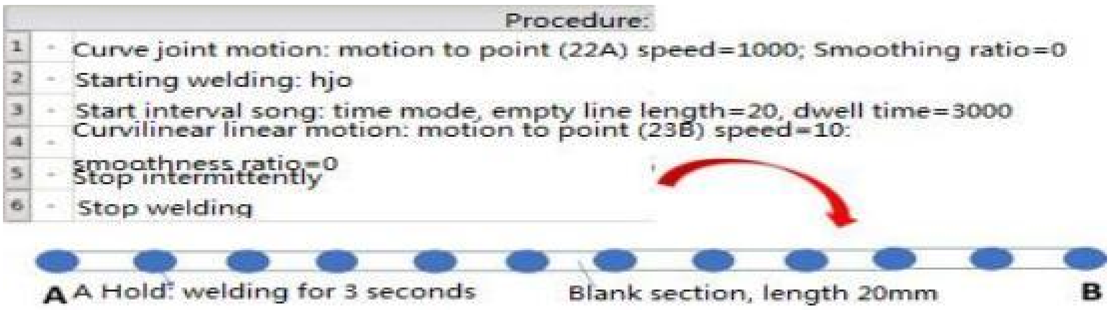



Figure11.7

### 11.2.3 Reciprocating Mode

The robot continues welding in this mode. As shown in Figure 11.8, it is necessary to set the carrying length (unit: mm) and the retracting length (unit: mm). Among them: the carrying length is the single-layer welding running length, and the retracting length is the retracting welding running length.

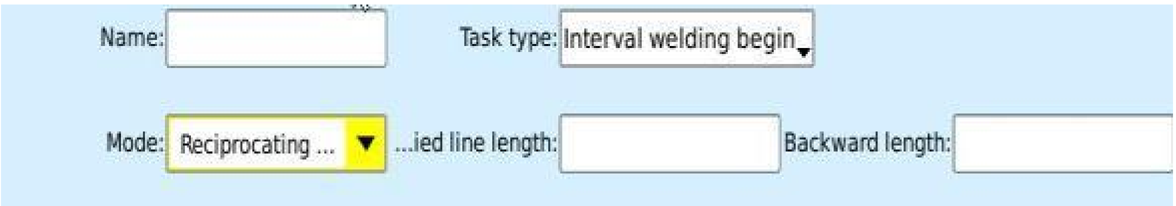



Figure11.8

Figure 11.9 shows an example of a welding program and trajectory using the reciprocating mode intermittent function. The welding track will start from point A, firstly weld "carrying length + retracting length", then welding "retracting length" back, then continue welding "carrying length + retracting length", then welding back "retracting length". Length", and complete the whole operation to point B according to this rule.

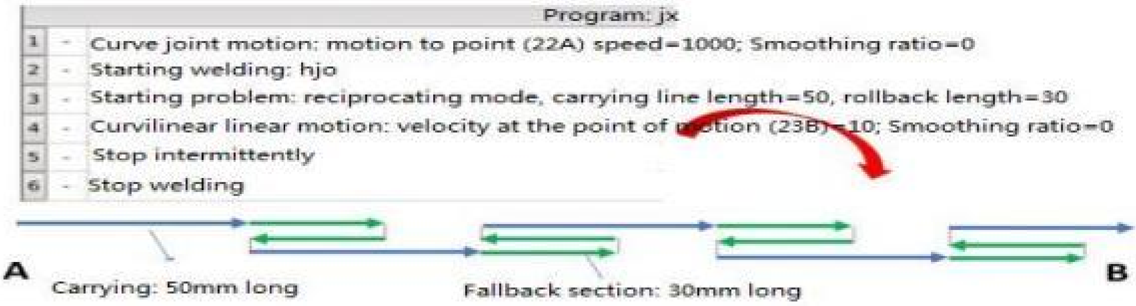



Figure11.9

### 11.2.4 Pause Mode

The robot continues welding in this mode. As shown in Figure 11.10, you need to set the line length (unit: mm) and dwell time (unit: ms). Among them: the length of the load line is the length of the welding operation, and the dwell time is the length of the welding at a certain point.

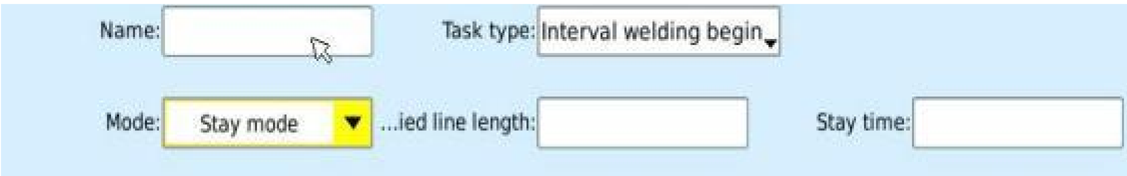



Figure11.10

Figure 11.11 shows an example of a welding program and trajectory using the Dwell Mode Intermittent function. The welding track will start from point A, first stop welding at point A, then weld the carrying length, then stop welding, and then weld the carrying length, and complete the entire operation to point B according to this rule.

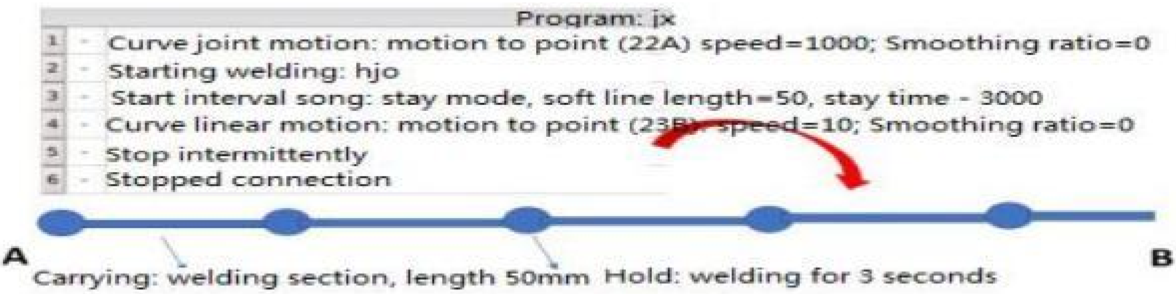



Figure11. 11

# 12 Swing Arc Welding

Swing arc is a movement method in which the electrode is slightly perpendicular to the welding direction and moves interactively while welding during the welding process. In order to facilitate calling this function in the program, the system encapsulates the parameter setting part related to the swing arc into a "swing arc" function package.

## 12.1 Setup Function package of Swing Arc

Press [Swing Arc] key on manual mode of robot pendant to new function package of swing arc.The system provides two arc swing modes, "Z-shape" and "Arc".

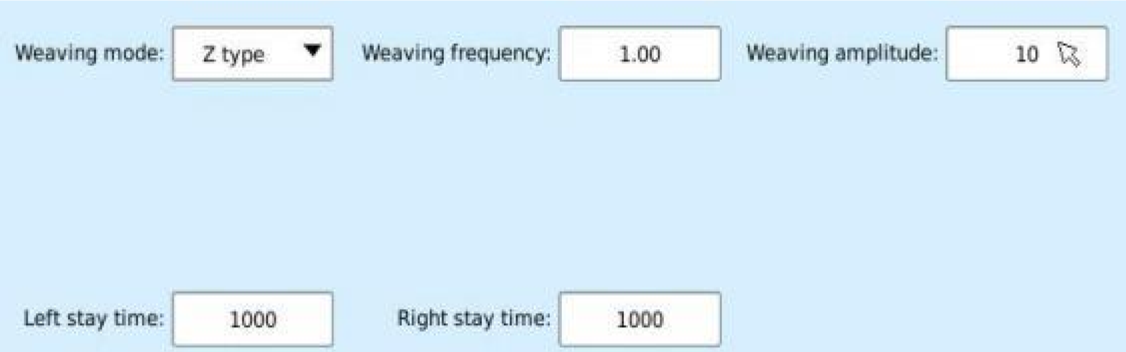



Figure 12.1

Select the swing mode "Z", the parameters to be set include: swing frequency (Hz), swing amplitude (mm), left dwell time (ms) and right dwell time (ms).

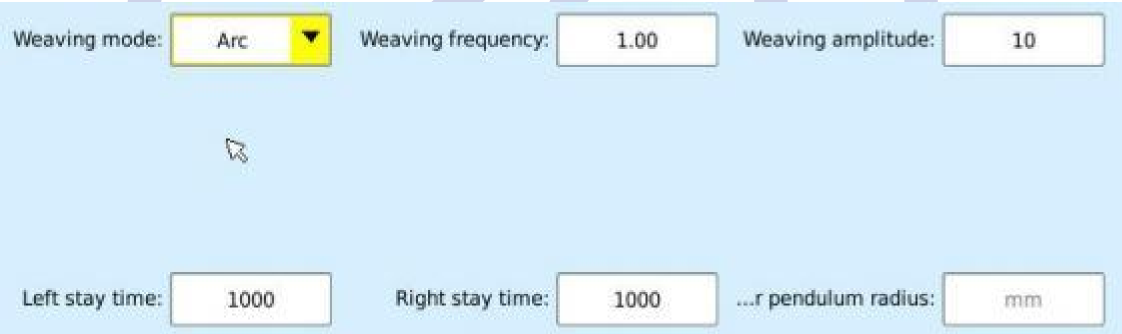



Figure 12.2

Select the swing mode "Arc", the parameters to be set include: swing frequency (Hz), swing amplitude (mm), left dwell time (ms), right dwell time (ms) and circle radius.

## 12.2 Use of swing arc function package

When writing a program, the arc swing function and the welding process need to be used synchronously. The sequence of use is: "start welding", then "start swing arc", command linear motion in the welding direction, "stop swing arc", and finally "stop welding". The program example is shown in Figure 12.3.

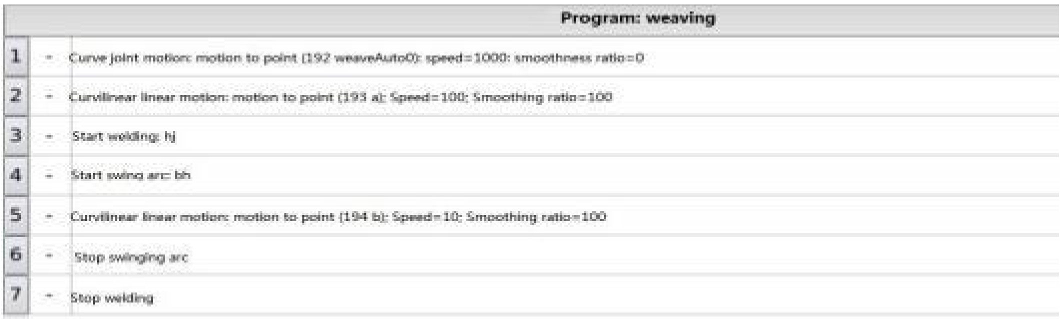



Figure 12.3

## 12.3 Testing of Swing arc parameter

According to the parameter settings in Figure 12.1, create a new Z-shaped swing arc function package, and then write the program as shown in Figure 12.4, and the schematic diagram of the running track is shown in Figure 12.5. Among them, the unit distance is equal to the welding linear motion speed divided by the oscillation frequency.

| | | Program: test11 |
|---|---|---|
| 1 | - | Curve joint motion: motion to point (43 ta); Speed=100; Smoothing ratio=0 |
| 2 | - | Start swing arc: test1 |
| 3 | - | Curvilinear linear motion: motion to point (44 tb); Speed=10; Smoothing ratio=0 |
| 4 | - | Stop swinging arc |
| 5 | - | Curve joint motion: motion to point (46 tc); Speed=100; Smoothing ratio=0 |

Figure 12.4

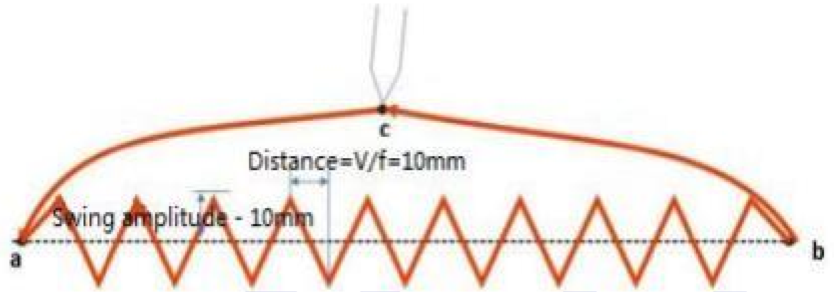



Figure 12.5

According to the parameter settings in Figure 12.2, create a new arc pendulum function package, and then write the program as shown in Figure 12.6, and the schematic diagram of the running track is shown in Figure 12.7.

| | | Program: test11 |
|---|---|---|
| 1 | - | Curve joint motion: motion to point (43 ta); Speed=100; Smoothing ratio=0 |
| 2 | - | Start swing arc: test2 |
| 3 | - | Curvilinear linear motion: motion to point (44 tb); Speed=10; Smoothing ratio=0 |
| 4 | - | Stop swinging arc |
| 5 | - | Curve joint motion: motion to point (46 tc); Speed=100; Smoothing ratio=0 |

Figure 12.6

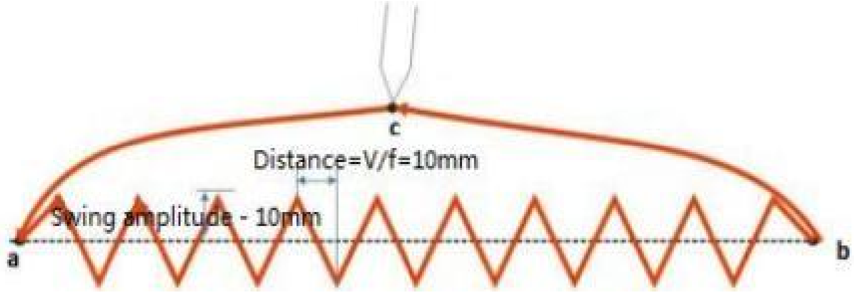



Figure 12.7

## 12.4 Swing arc in situ

For welding operations that require additional shafts, such as linear welds that are too long, large arc welds, etc., the Bortron system provides the function of "swing arc in place", that is, the additional shaft drives the movement of the weld seam, and the welding torch performs swing arc welding in situ.

(1) Create a swing arc function package according to the swing arc amplitude and frequency

The creation of the original swing arc function package is exactly the same as that of the general swing arc function package. To realize the in-situ swing arc, as shown in Figure 12.8, when inserting the "Start swing arc" function command, you need to select "Origin swing arc" in the programming interface.

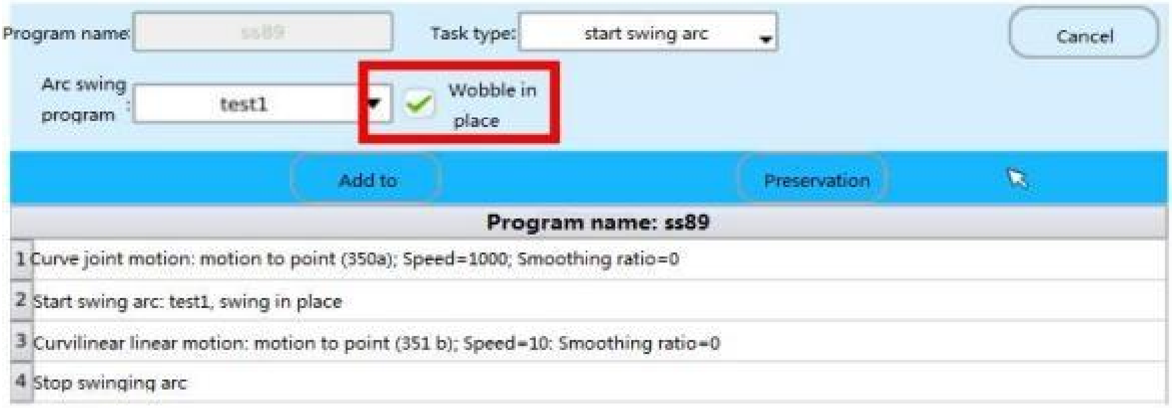



Figure 12.8

(2) Teaching

The first step is shown in Figure 12.9. First, teach the center point of the in-situ swing arc, and at the same time manually teach the additional axis to the starting point. As shown in Figure 12.10, the point J1-J6 joint data and tool coordinate system determine the center point of the welding torch's in-situ swing arc, and this point contains the joint data of the additional axis motion starting point. This point is referenced as the starting point of linear motion between pairs of swing arc function instructions.

The second step is to teach the movement end point of the additional axis and the swing direction point. Figure 12.11 shows the direction of the in-situ swing arc, as well as point information and reference methods. This point is referenced as the end point of the linear motion between the pair of swing arc function instructions.

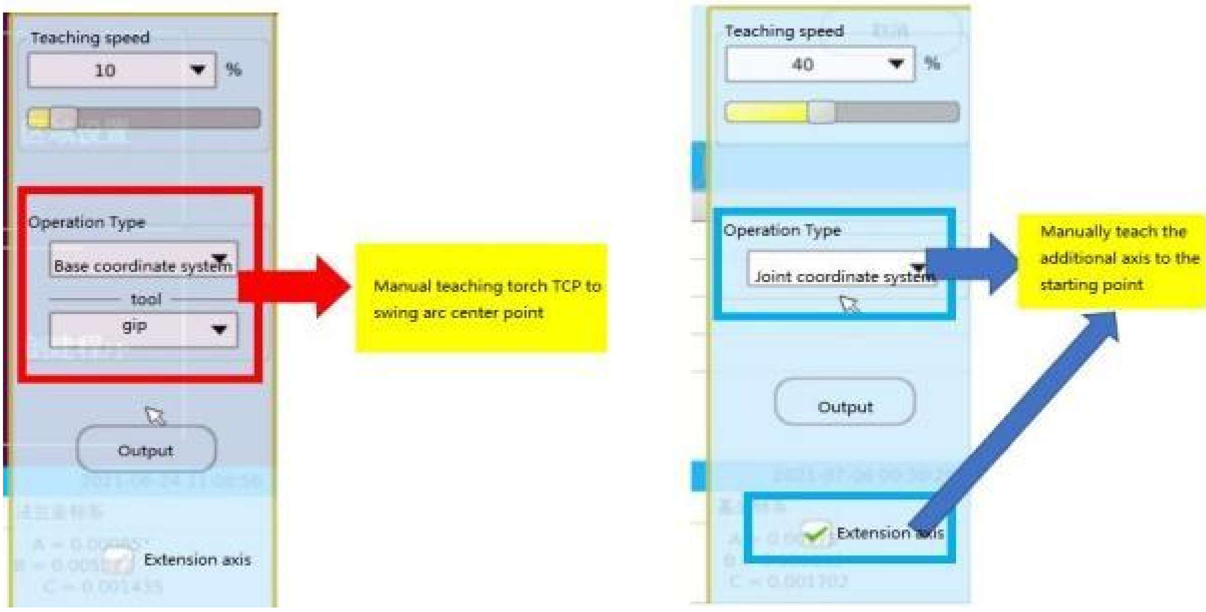



Figure 12.9

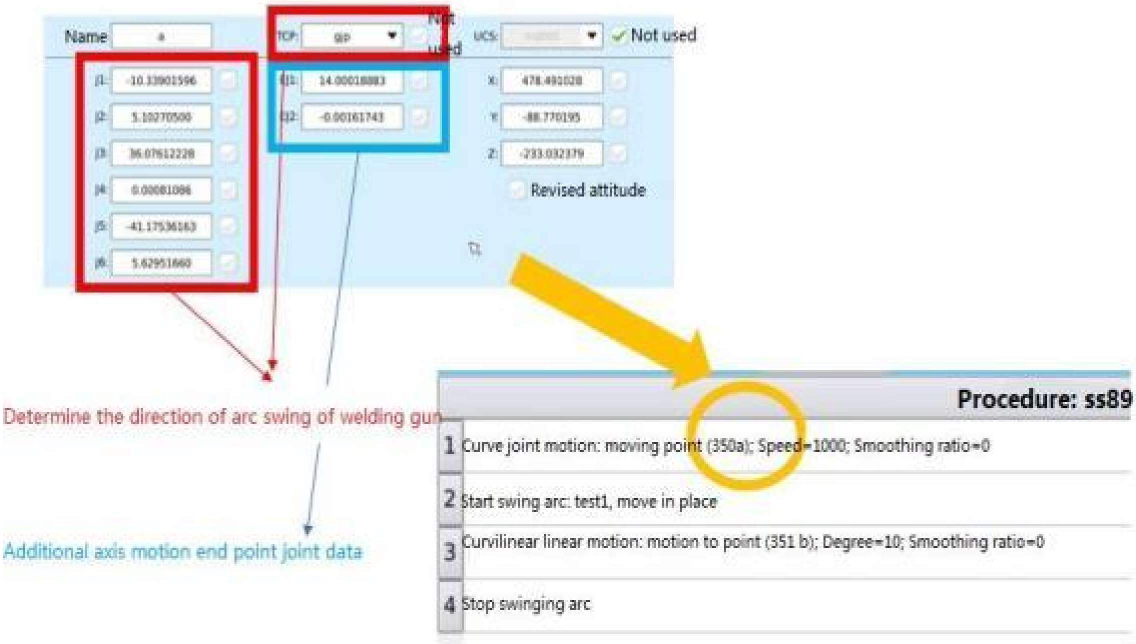



Figure 12.10

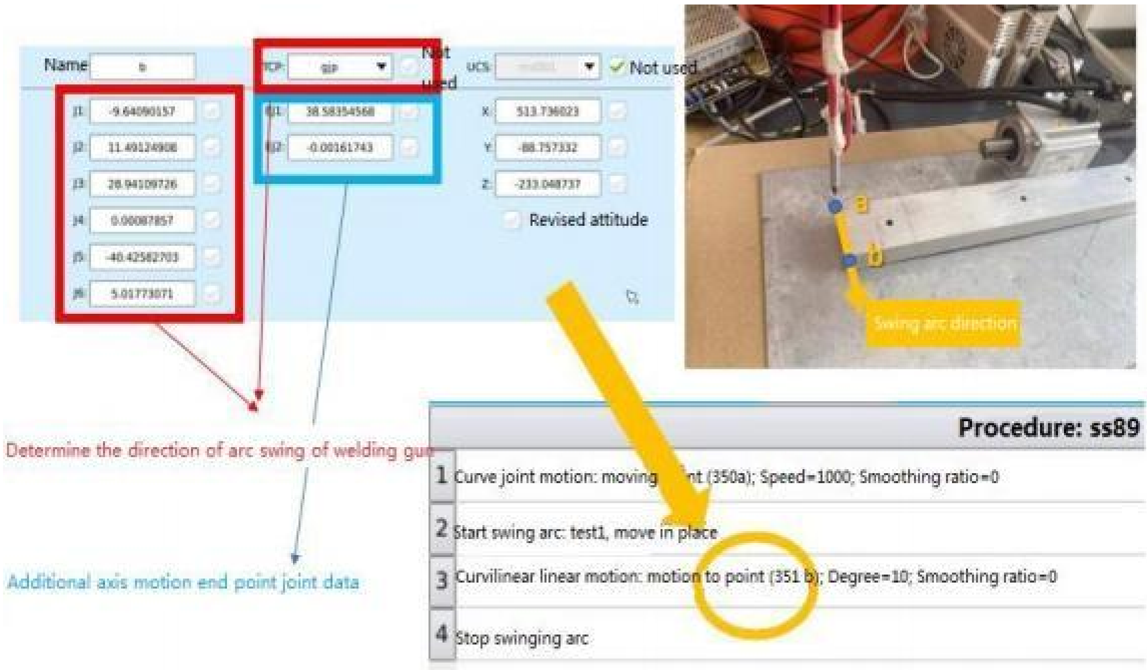



Figure 12.11

Running the program, the welding torch of the robot will take point a as the center and perform in-situ swing arc motion in the direction of ab. At the same time, the additional axis starts from the starting point and runs to the end point according to the linear motion speed.

# 13 Collaboration

This system is the simplest if the workpiece does not need to be displaced throughout the welding process, and the fixture can be used to position the workpiece on the work surface. However, in actual production, more workpieces need to be displaced during welding, so that the weld is welded in a better position (attitude). In this case, the positioner and the robot can move separately, that is, the robot is re-welded after the positioner is positioned; it can also be moved simultaneously, that is, the positioner is displaced while the robot is welded, which is often referred to as displacement. Machines and robots move together. At this time, the movement of the positioner and the movement ofthe robot are combined, so that the movement of the welding torch relative to the workpiece can meet the requirements of the welding seam trajectory as well as the welding speed "cooperative" function package.

## 13.1 Create Collaboration Function Package

Click [Motion] - [Create Program] - [Function] - [Collaboration], as shown in Figure 13.1. The "Collaboration" function package can be created by setting, which can be called in the program to realize the cooperation between the additional axis (turntable 1 (pitch), turntable 2 (roll) and slide rail) and the robot.

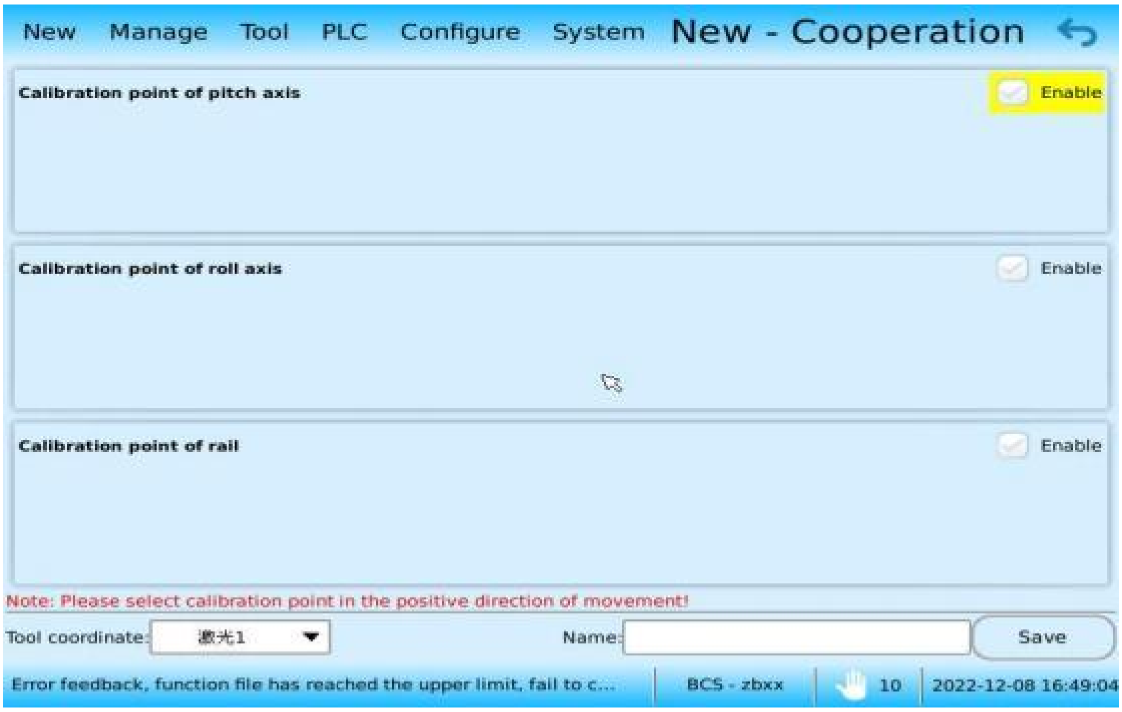



Figure 13. 1 Collaboration Function Package Settings

### 13.1.1 Usage and zero detection

Before applying the cooperative function of the additional axis and the robot body, it is necessary to check whether the motion direction of each axis (including the additional axis) of the robot is normal, whether the straight line motion of the robot is straight, and to detect the "zero" of the robot. See Section 13.2.2, Chapter 4, Part I of the Manual for the specific method of "zero" detection.

Note: The way to use additional axes for collaboration needs to be set to Joint Mode.

### 13.1.2 Establishment of tool coordinate system

In order to make the robot perform correct linear interpolation, arc interpolation and other interpolation actions, it is necessary to correctly input the size information of the welding gun tool and define the position of the control point. Therefore, it is necessary to establish the tool coordinate system. See Section 12.2, Chapter 3, Part I of the Manual for the establishment method of tool coordinate system.

### 13.1.3 Determine collaborative calibration point

In order to achieve collaboration, three calibration points need to be established under the tool coordinate system. Take the slide rail coordination as an example to explain the method of establishing the calibration point:

(1)Align the end point of the tool with the calibration rod, and create a new point (ID167 point in Figure 13.3) on a straight line (along the Z-axis direction of the tool coordinate system), as shown in Figure 13.2.

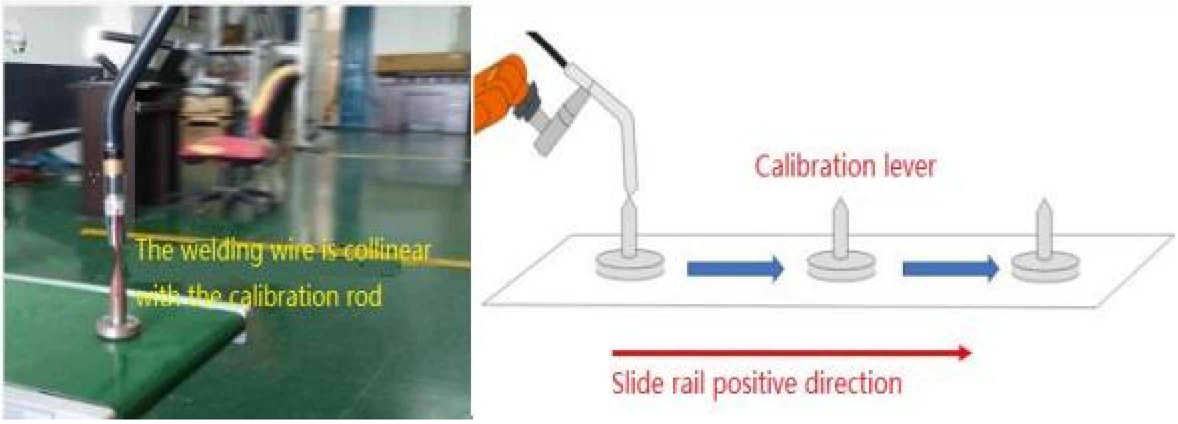



Figure 13.2 New Calibration Point

(2) Move the slide rail more than 10 ° in the positive direction (the more the better), and then align the end point of the robot tool with the calibration bar to create a second point (point ID168 in Figure 13.3).

(3)Continue to move the slide rail more than 10 ° in the positive direction (the more the better), and then align the end point of the robot with the calibration bar to create a third point (point ID 169 in Figure 13.3).

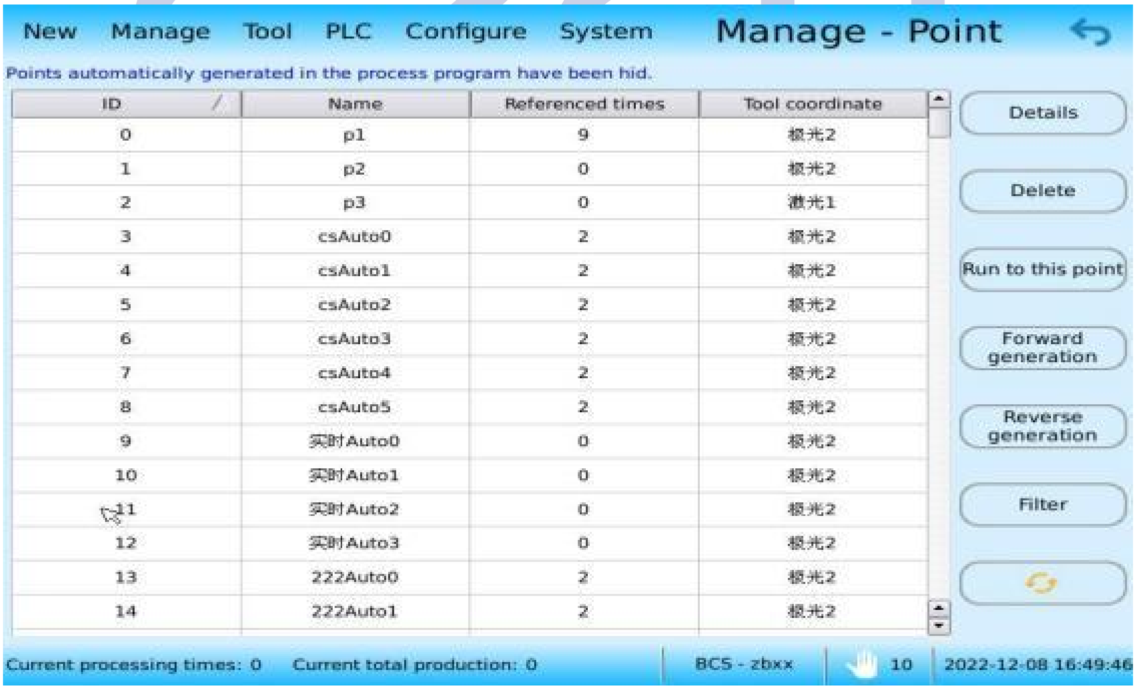



Figure 13.3 Creating Calibration Points

Be careful:

(1) For the new calibration point, check the corresponding tool coordinate system.

(2) When there are multiple additional axes, the turntable needs to be at the zero position when determining the relevant calibration point of the slide rail, and remain stationary throughout the process. When determining the relevant calibration point of turntable 1 (pitch), the slide rail needs to be at the zero position and remain stationary throughout the process.

## 13.1.4 Create Collaboration Function Package

After the three calibration points are determined, click [Motion] - [Create Program] - [Function] - [Collaboration] to create a collaboration function package:

(1) Create a collaboration function name, such as "Slide Collaboration".

(2) Enables the external axis that requires collaboration.

(3) Determine that the axis number is 0 or 1.

(4) Determine the name of the tool coordinate system used, here "tool1"

(5) Reference the created points (ID167, ID168, ID169) to P1, P2, and P3. Long press the P point to reference the created point.

(6) Saving the collaboration function will automatically calibrate the reduction ratio of the additional axis and import it into the system. As shown in Figure 13.4, the calibrated deceleration ratio is 26.59.

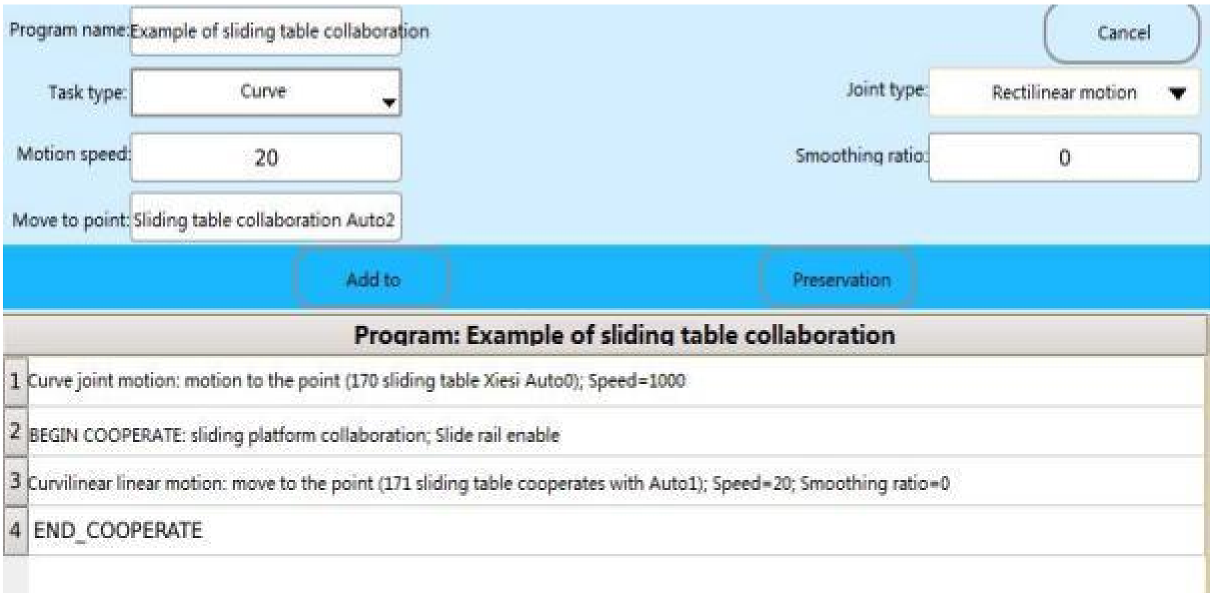



Figure 13.4 Create Collaboration Function Package

Note: It is possible to "enable" multiple additional axes to cooperate at the same time, but each additional axis must be determined under the premise that other axes are at zero position when determining the coordination calibration point.

## 13.2 Use of collaboration function package

By adding function instructions, the collaborative function package can be called in the program.

As shown in Figure 13.5, when adding the "Start Collaboration" command, you need to select the collaboration program (name of the collaboration function package), and set turntable 1/turntable 2 and slide rail as disabled or enabled according to the "Enable" configuration of the function package.


Figure 13.5 Add Collaboration Function Command

The "Start Collaboration" and "Stop Collaboration" commands need to appear in pairs, as shown in Figure 13.6. When the curve motion command between the two commands is manually taught, move the robot joint and additional axis to the specified position respectively, and then determine the "Move to Point".

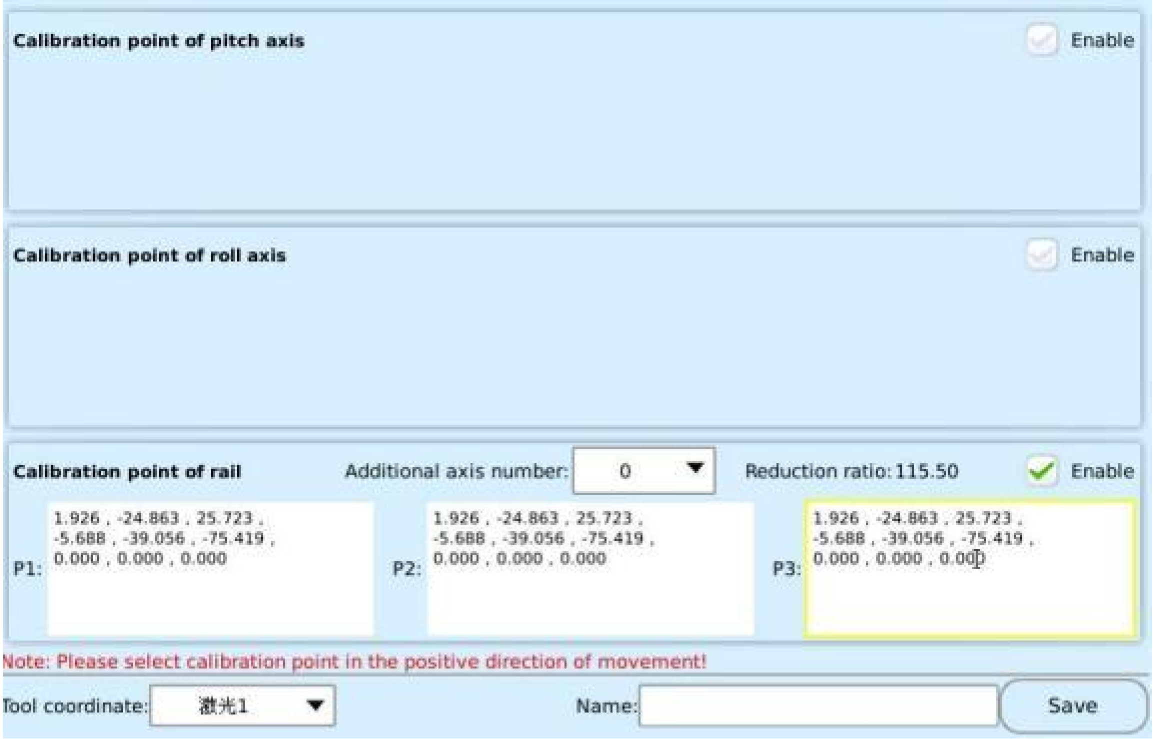



Figure 13.6 Collaborative Function Program Case

Be careful

(1) The teaching point of the motion curve between the "Start Collaboration" and "Stop Collaboration" commands must be equipped with a tool coordinate system.

(2) If the slide rail collaboration is not used, do not move the slide rail at the teaching point of the motion curve between the "Start Collaboration" and "Stop Collaboration" commands. The same is true for other collaboration axes.

(3) The "Start Collaboration" and "Stop Collaboration" commands should appear in pairs.

(4) For each function startup, you can select to enable the collaboration of a certain additional axis or all additional axes, and select according to the actual needs.

(5) The internal curve of the collaboration function must be "linear motion" or "circular motion".

(6) During debugging, if the current position is in the middle of the arc curve when it is paused, it cannot run directly from the current curve command when it runs again, but needs to return to the previous curve to start running.

# 14 Pipeline tracking

In some cases, the working object of the robot is the workpiece running on the assembly line at a uniform speed. For this application, manual teaching is relatively complex and low in accuracy when the pipeline is running. To this end, the system provides a "pipeline tracking" function package, which enables the workpiece to be in a static state to write a job program during manual teaching. Then, by calling the "pipeline tracking" function, the robot can automatically calculate the trajectory and complete the pipeline operation.

There are two pipeline tracking methods: ontology tracking and sliding track tracking. "Body tracking" is to use the robot arm body to achieve pipeline motion tracking, which is suitable for small range

Tracking application occasions; "Slide track tracking" is to use an additional external slide track to achieve pipeline motion tracking, which is suitable for large-scale tracking applications.

## 14.1 Hardware conditions

To achieve pipeline tracking, the following hardware conditions are required at least:

- Pipeline: install the encoder or know its running speed. When installing the encoder, the last two channels of 22 optocoupler isolated input ports are used to connect the A and B phase ports of the external encoder, as shown in Figure 14. 1.
- Sliding table: required for sliding track tracking, not for small-scale ontology tracking.
- Sensor or limit switch: used to track triggering.

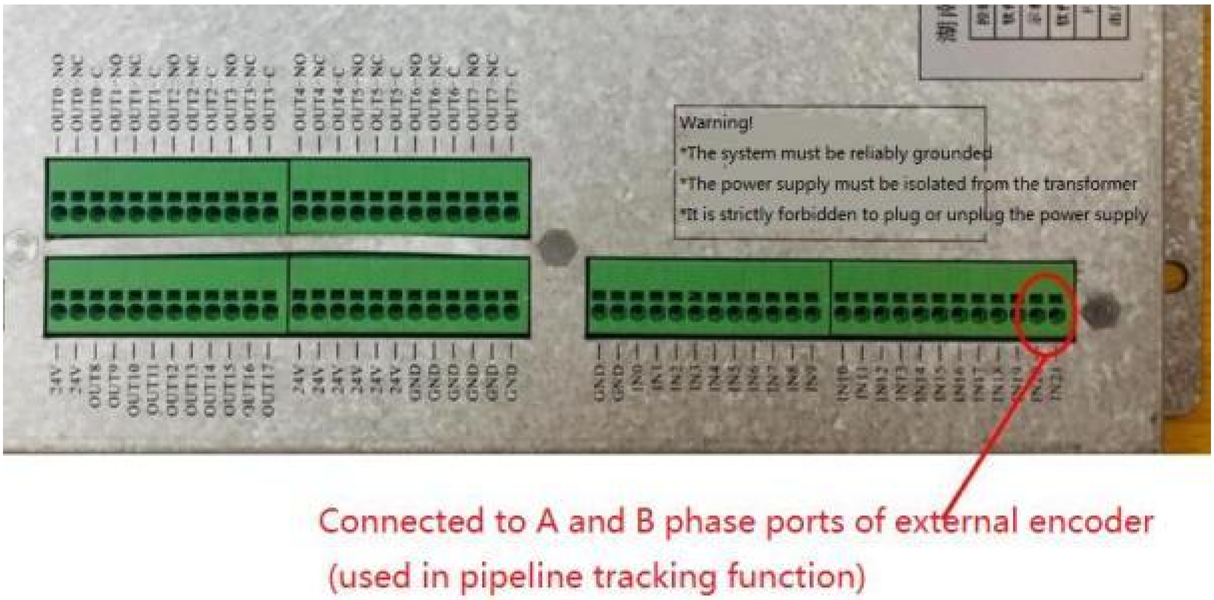



Fig. 14. 1 System Connected to External Encoder A and B Ports

## 14.2 Create ontology tracking function package

Click [Motion] - [Create Program] - [Function] - [Pipeline Tracking] to create a "Pipeline Tracking" function package by setting.

According to the different types of encoders, the "body tracking" mode can be divided into two types: "without encoder" and "pulse type".

### 14.2.1 Tracking without encoder body

Select the "Tracking without encoder body" function, and the parameters to be set are shown in Figure 14.2.

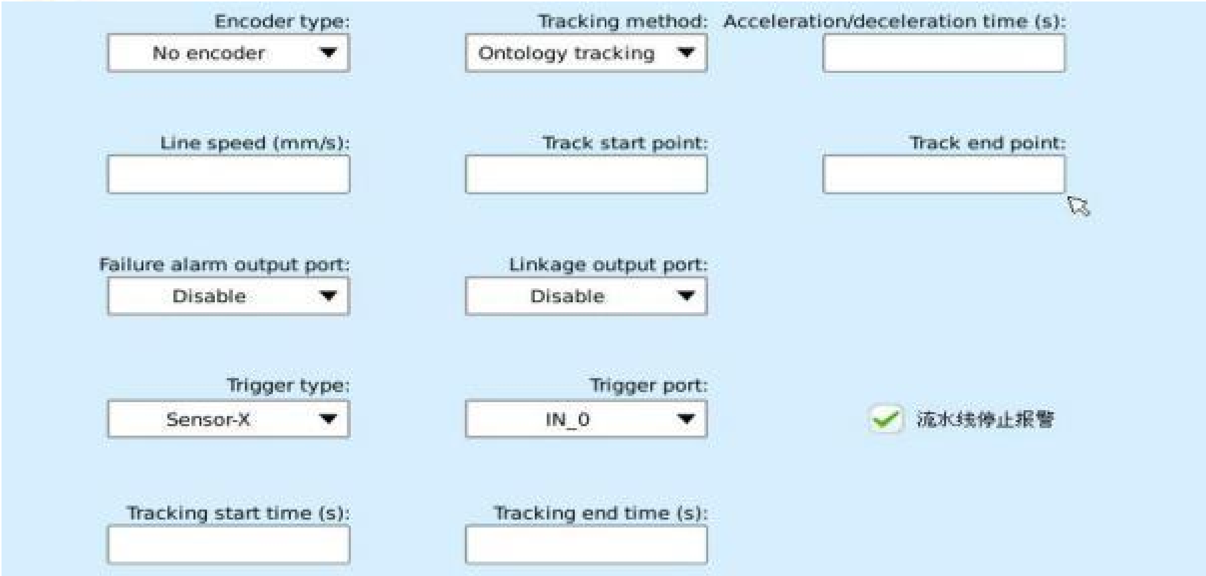
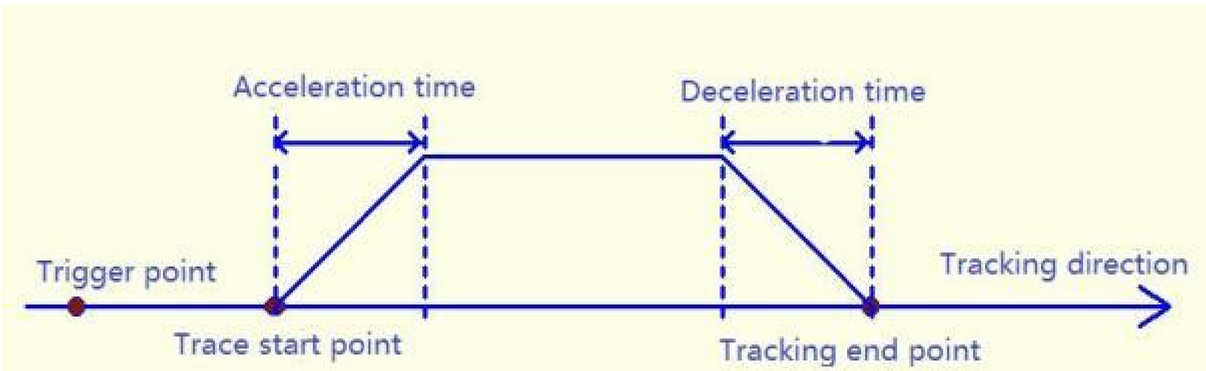



Figure 14.2 Tracking parameter settings without encoder body

The description is shown in Table 14. 1, and the parameter illustration is shown in Figure 14.3.

Table 14. 1 Parameter Description of Tracking Function without Encoder Body

| Parameter | Explanation |
|---|---|
| Acceleration and deceleration time | Determine the "acceleration and deceleration". The smaller the time, the greater the "acceleration and deceleration". The unit is ms. |
| Linear velocity | Body tracking speed, unit: mm/s. |
| Trace start point<br>Tracking end point | Determine the direction of the body tracking, and move in a straight line from the "start point" to the "end point". |
| Failed alarm output port | It is connected to remote monitoring through a system I/O output port. When the tracking function program is "triggered", it has not been "tracked" after the "tracking end time", indicating that this "tracking" failed and will be displayed on the remote monitoring terminal. It is unnecessary to set when this function is not used. |
| Linkage output port | It means that the pipeline can be associated with a system I/O output port, and the system's "Pause", "Continue", "Start" and other operations can also control the operation of the pipeline. If this function is not used, it can not be set. |
| Trigger input port | Determine an I/O input X or relay M port, and provide a high level "1" when triggered by a sensor or limit switch. |
| Tracking start time | After the workpiece triggers the sensor, start the "tracking" time, in seconds (s). |
| Tracking end time | After the workpiece triggers the sensor, end the "tracking" time in "seconds" (s). If there is no "tracking" after this setting time, it means that the "tracking" failed this time |



The method to create a function package is as follows:

(1) Create a new tracking feature package name.

(2) Open the assembly line and start timing when waiting for the workpiece to trigger the sensor or limit switch. When the starting point of tracking is reached, record the time, set it as "starting time of tracking", manually teach the robot tool TCP to this position, and click the input box of "starting point of tracking" to create a new "starting point of tracking".

(3) When the workpiece reaches the tracking end point along the assembly line, set the time as "tracking end time". At this time, manually teach the robot tool TCP to this position, and click the input box of "tracking end point" to create a new "tracking end point".

(4) After setting the parameters, click Save to generate the tracking function package

## 14.2.2 Pulse encoder body tracking

After selecting the tracking function of "pulse encoder body tracking", its parameter settings are shown in Figure 14.4 and the description is shown in Table 14.2.

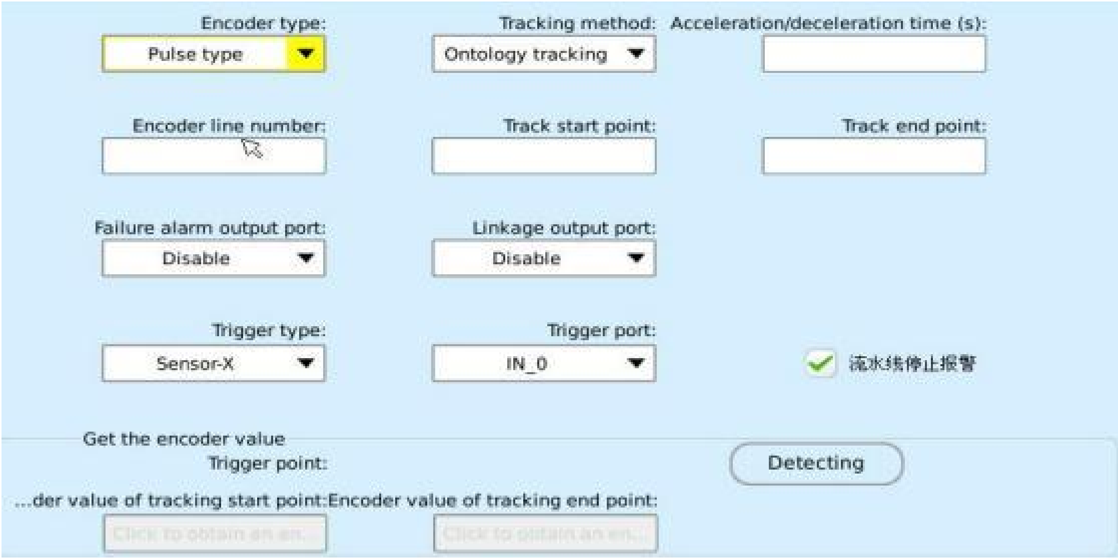



Figure 14.4 Tracking parameter setting of pulse encoder body

Table 14.2 Description of tracking function parameters of pulse encoder body

| Parameter | Explanation |
|---|---|
| Acceleration and deceleration time | Determine the "acceleration and deceleration". The smaller the time, the greater the "acceleration and deceleration". The unit is ms. |
| Encoder wire speed | The tracking speed of the body is determined by the specification of the pulse encoder. |
| Trace start point<br>Tracking end point | Determine the direction of the body tracking, and move in a straight line from the "start point" to the "end point". |
| Failed alarm output port | It is connected to the remote monitoring through a system I/O output port. When the tracking fails, it will be displayed on the remote monitoring terminal. If this function is not used, it can not be set. |
| Linkage output port | It means that the pipeline can be associated with a system I/O output port, and the system's "Pause", "Continue", "Start" and other operations can also control the operation of the pipeline. If this function is not used, it can not be set. |
| Trigger input port | To determine an I/O input X or relay M port, a high level "1" needs to be provided when triggered by a sensor or a limit switch. |
| Tracking start encoder value | Position detection, starting from the trigger of I/O input port, is the encoding value when the encoder runs to the "starting point of tracking". |
| Tracking end encoder value | Position detection, starting from the trigger of I/O input port, is the encoding value when the encoder runs to the "tracking end point".<br>If the encoder runs these "encoded values" and has not started "tracking", it means that this "tracking" failed. |

The method to create a function package is as follows

(1) Create a new tracking feature package name.

(2) Open the assembly line, click [Start to detect trigger point], when the workpiece trigger sensor reaches the tracking start point, click the input box under "Tracking start point encoder value" to obtain the tracking start point encoder value, and manually teach the robot tool TCP to this position, click the input box of "Tracking start point" to create a new "Tracking start point".

(3) When the workpiece reaches the tracking end point along the assembly line, click the input box under "Tracking end point encoder value" to obtain the end point encoder value. At the same time, manually teach the robot tool TCP to this position, and click the input box of "Tracking end point" to create a new "Tracking end point".

(4) After setting the parameters, click Save to generate the tracking function package.

## 14.3 Creating the track tracking function package

As with "body tracking", "slide track tracking" can also be divided into two encoder types, "without encoder" and "pulse type", depending on the type of encoder.

### 14.3.1 Tracking without encoder slide

Select the tracking function of "track without encoder", which is basically the same as the tracking function of "track without encoder body", except that there is an additional parameter of "additional shaft number". Before setting the "Additional Axis Number" parameter, the additional axis of the connected slide rail must be set to the "Joint Mode" in the "Machine Parameters".

### 14.3.2 Pulse encoder slide track tracking

Select the tracking function of "Pulse encoder slide track tracking", which is basically the same as the tracking function of "Pulse encoder body tracking", and also set the connected additional axis to "joint mode" in the "machine parameters".

## 14.4 Use of pipeline tracking function package

By adding function instructions, the pipeline tracing function package can be called in the program. The Start Trace and Stop Trace commands need to be paired. The motion track between the instruction pairs is obtained by operating the workpieces on the pipeline with the manual teaching robot when the pipeline is stationary.

The program case is shown in Figure 14.5.

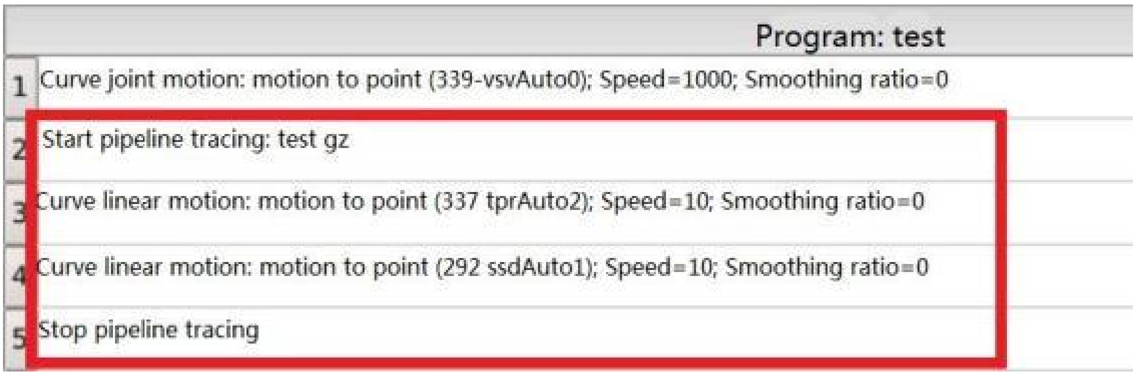



Figure 14.5 Calling Program Case of Pipeline Tracking Function Package

# 15 Collision detection

In order to enhance the safety of the operation process of the industrial robot, the SZGH system provides the robot collision detection function, which enables the robot to stop moving immediately in case of accidental collision with surrounding objects during the operation process to avoid major damage.

The realization of collision detection function includes three steps: (1) sampling program operation parameters; (2) Create collision detection function package; (3) Use of collision detection function.

## 15.1 Sampling of program operation parameters

As shown in Figure 15.1, in the automatic mode of the teaching pendant, set the speed ratio to 100% and the operation mode to circular motion, so that the robot can run the program according to the operation speed in a circular manner, and the entire operation process can be reproduced.

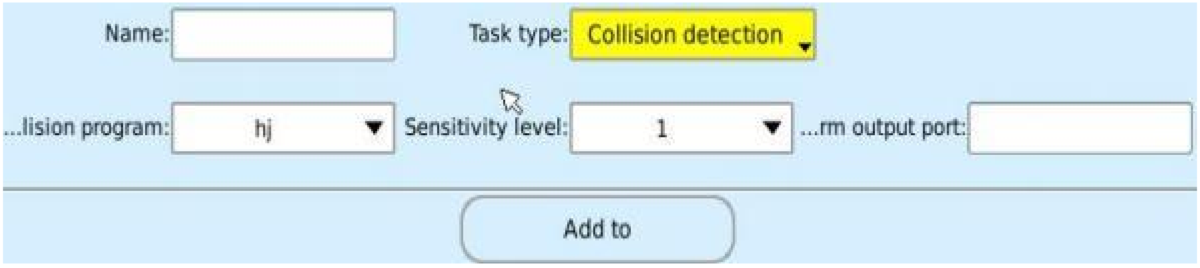



Figure 15.1 Teaching pendant automatic mode interface setting

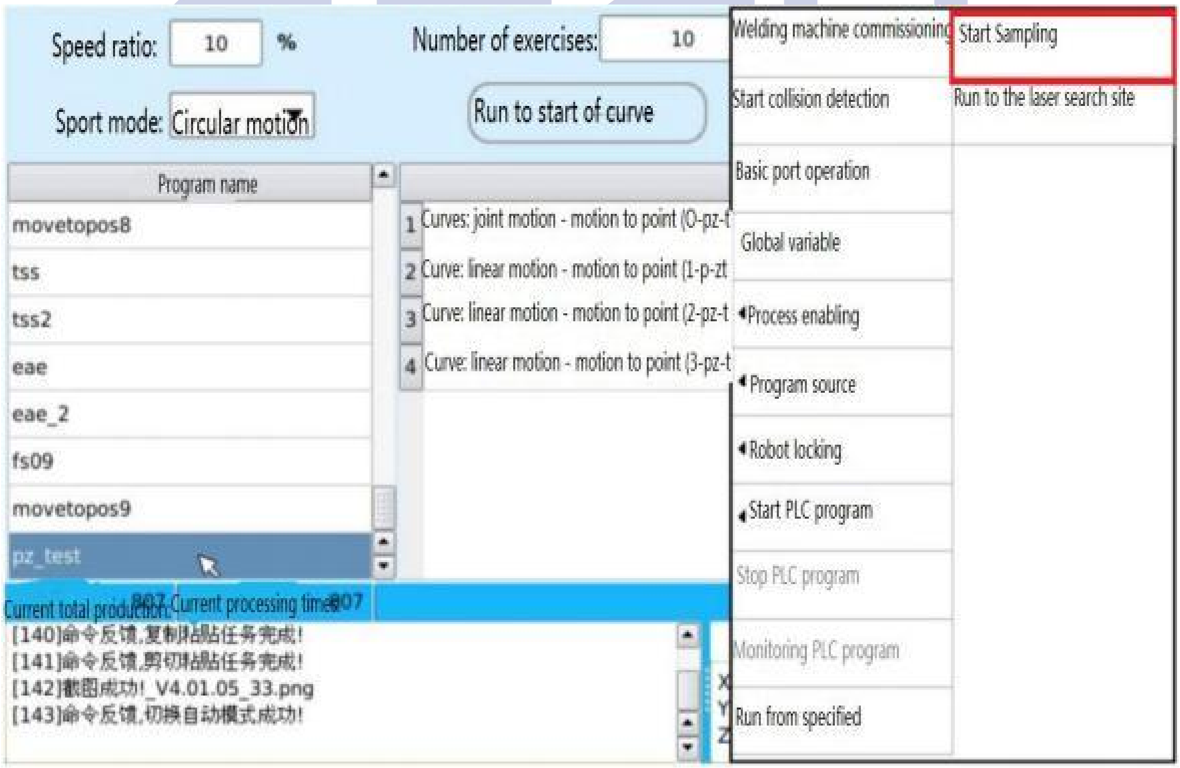



Fig. 15.2 Start Sampling Button in Menu Bar

After the robot starts the operation, as shown in Fig. 15.2, click the [Menu] button and select "Start Sampling". The sampling process requires.

To run the operation program for 5-7 times, click the [Menu] key and select "Stop Sampling". Operation record display area.

The parameters collected now indicate successful collection.

Note: To ensure the accuracy of the sampling parameters, the load of the robot when running the program needs to be exactly the same as the actual operation.

## 15.2 Create collision detection function package

Switch to the manual mode of the teaching pendant, click [Function Package] - [Collision Detection] to enter the collision detection function package creation page. As shown in Figure 15.3, the parameters collected in automatic mode have been automatically filled in the relevant area. Just enter the name and click Save.

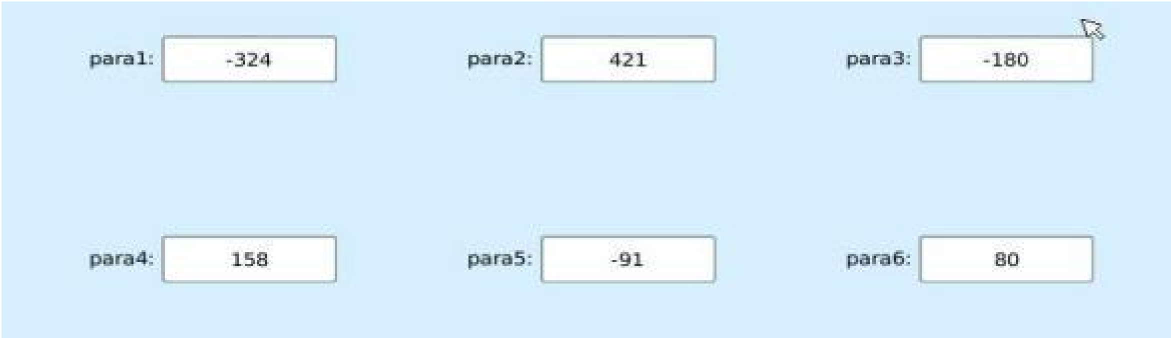



Figure 15.3 "Collision detection" function package creation interface

## 15.3 Use of collision detection function package

There are two modes to use the collision detection function package.

### 15.3.1 Use collision detection command

Open the program in the basic program programming interface, and add the "collision detection" command in the function command in the program head. As shown in Figure 15.4, the command needs to select the collision detection function package, set the sensitivity level and alarm output port. The sensitivity level is 1-5, and the lower the level, the higher the anti-collision sensitivity.

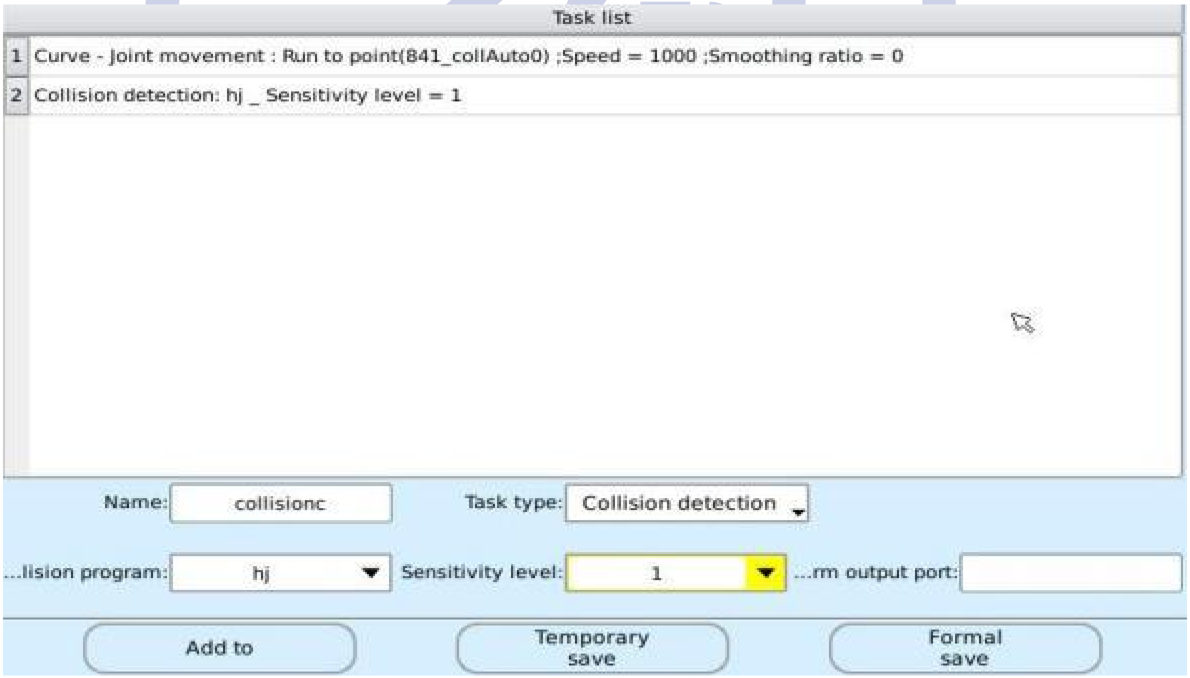



Figure 15.4 "Collision detection" command

### 15.3.2 Start collision detection in automatic mode

As shown in Figure 15.5, in the automatic mode of the teaching pendant, click [Menu] and select "Start collision detection". Select the collision detection function package created in the pop-up window (Fig. 15.6), and set the sensitivity level and alarm output port,. No matter whether the program is running or not, collision detection will start immediately and remain effective until you click "Stop Collision Detection" in [Menu].

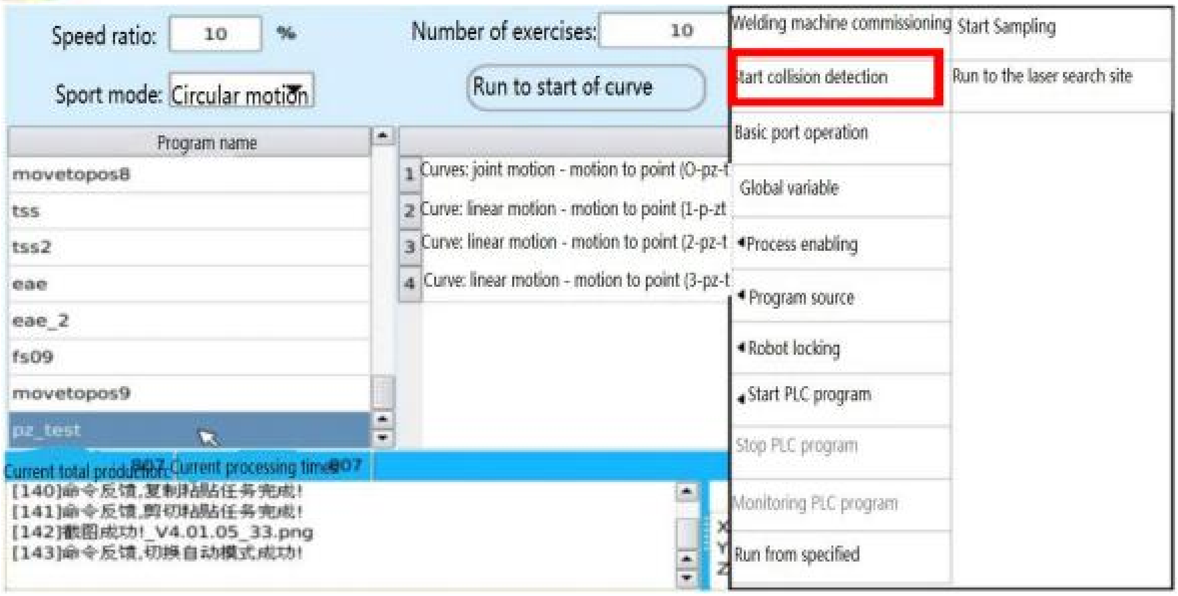



Figure 15.5 Start collision detection in menu bar

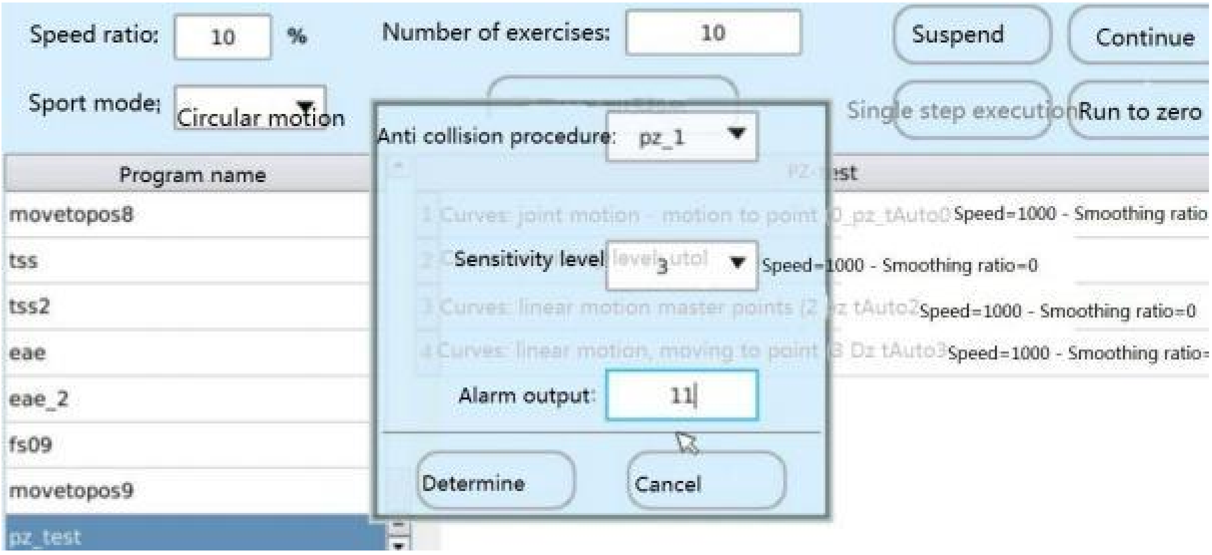



Figure 15.6 Start Collision Detection Configuration Window

# 16 Coordinate system switching

The coordinate system is a position index system defined in the robot or space to determine the position and posture of the robot. Common coordinate systems include joint coordinate system, base coordinate system, tool coordinate system and user coordinate system. In order to facilitate the flexible application of the coordinate system by the operators in the teaching programming process, the "coordinate system switching" function provided by the Shenzhen Guanhong control system includes:

- . Coordinate System Dynamic Transformation command.
- . Reuse of programs among multiple robots.
- . Quick correction of tool coordinate system.
- . Dynamically create user coordinate systems.

## 16.1 "Dynamic transformation of coordinate system" command

Objective: To expand the teaching program of a robot based on a tool on a worktable into a flow line program with replaceable worktables and tools.

As shown in Figure 16.1, a pair of basic commands for "coordinate system transformation" are provided in the robot control system, which should appear in pairs when used. This pair of instructions can realize three coordinate system transformations, and the functional description is shown in Table 16. 1.

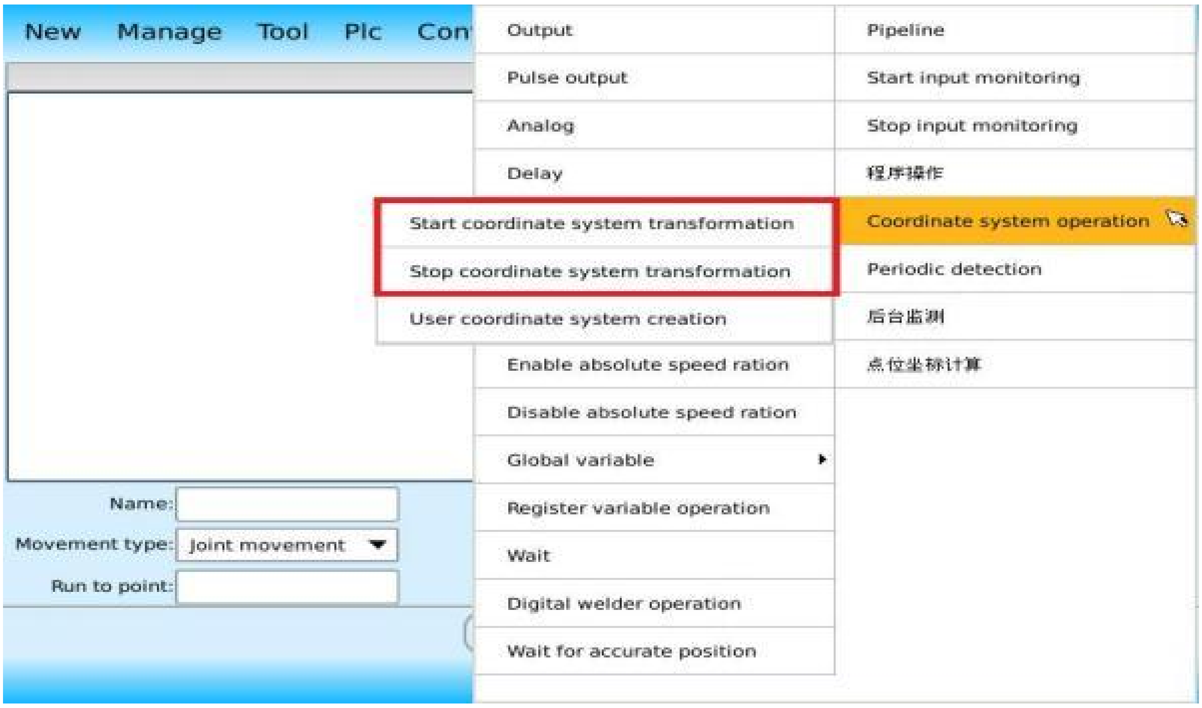



Figure 16. 1 "Coordinate System Transformation" Command Pair

Case: As shown in Figure 16.2, establish user coordinate system test on two worktables_ U1 and test_ u2。During teaching, it is only necessary to teach P1-P3 points on worktable 1, and then use the coordinate system transformation command in the program according to Figure 16.3 to test the user coordinate system_ U1 is transformed into test_ U2, call the motion track program segment in the command alignment, then the robot will continue to complete the same motion at the corresponding position of worktable 2 after worktable 1 moves. When there are many objects on the worktable, it is recommended to add a transition point before the coordinate system transformation command to prevent the unpredictable collision of the motion track during the worktable switching

Table 16.1 Function Description of "Coordinate System Transformation" Command

| Serial No | Coordinate system type | Function description |
|---|---|---|
| 1 | User | When there are multiple workbenches that need pipelining, multiple user coordinate systems can be established. It is only necessary to carry out teaching programming on one of the workbenches, and then use the user coordinate system transformation command for many times, and call the teaching program segment in it to realize the pipeline action of multiple workbenches. |
| 2 | Tools | For multiple process operation tasks with the same movement track, such as welding+grinding, tool coordinate systems can be established for welding guns and grinding tools respectively. Just use the welding gun to complete the teaching programming, and then use the tool coordinate system transformation command in the program to transform the welding gun tool coordinate system into the grinding tool coordinate system, in which the teaching program segment is called to complete the grinding operation according to the same motion track. |
| 3 | Users+Tools | For a teaching program, the user coordinate system and tool coordinate system can be transformed atthe same time to realize the combination of the above two functions. For example, teach the welding track program on worktable 1, and then call the program through coordinate system transformation to complete welding and grinding on worktable 1, welding and grinding on worktable 2 |

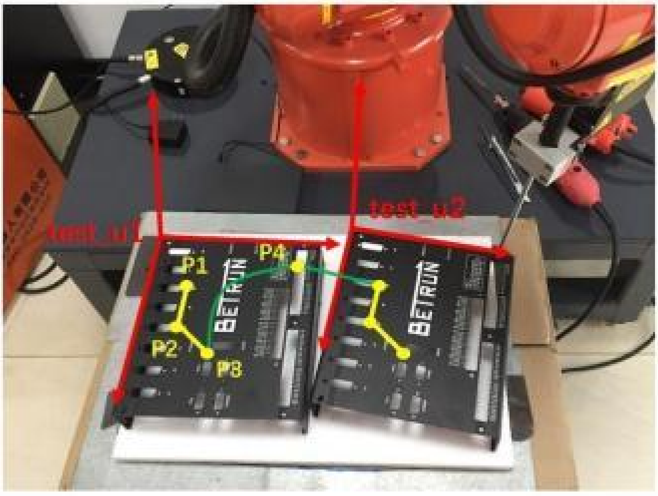



Figure 16.2 Example of "User Coordinate System Transformation" command

| Program: test11 | | | |
|---|---|---|---|
| 1 | - | Curve linear motion: motion to point (112-point1); Speed=100; Smoothing ratio=0 | |
| 2 | - | Curve linear motion: motion to point (113-point2); Speed=100; Smoothing ratio=0 | |
| 3 | - | Curve linear motion: motion to point (114-point3); Speed=100; Smoothing ratio=0 | |
| 4 | - | Curve joint motion: motion to point (115-point4); Speed=1000; Smoothing ratio=0 | Move to transition point |
| 5 | - | Enable coordinate system transformation: original user coordinate system=testul, new user coordinate system=tecu2 | Toggle User Coordinate System |
| 6 | - | Curve linear motion: motion to point (112-point1); Speed=100; Smoothing ratio=0 | |
| 7 | - | Curve linear motion: motion to point (113-point2); Speed=100; Smoothing ratio=0 | |
| 8 | - | Curve linear motion: motion to point (114-point3): speed=100: smoothness ratio=0 | |
| 9 | - | Stop coordinate system transformation | Stop User Coordinate System Switching |

Figure 16.3 Example of "User Coordinate System Transformation" Instruction

## Matters needing attention:

(1) When establishing the user coordinate system, the reference point needs to be associated with the corresponding tool coordinate system. The teaching points P1-P3 in the program also need To associate the corresponding tool coordinate system. As shown in Figure 16.4, it is necessary to remove the "√" in front of "Do not use" and select the tool coordinate system currently used.

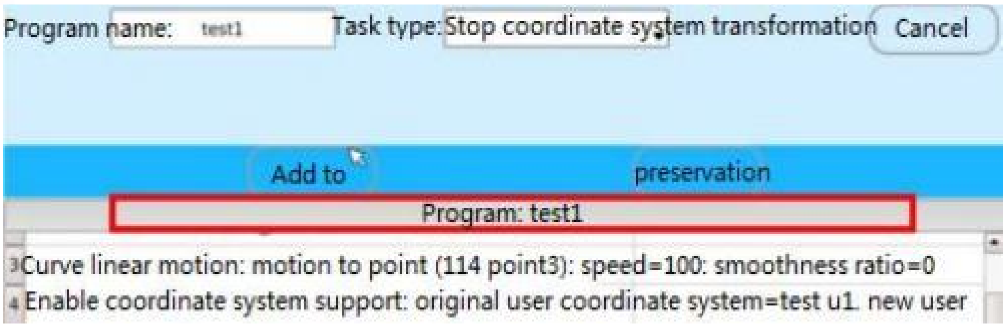



Figure 16.4 When creating a new point, you can select whether to associate the tool coordinate system

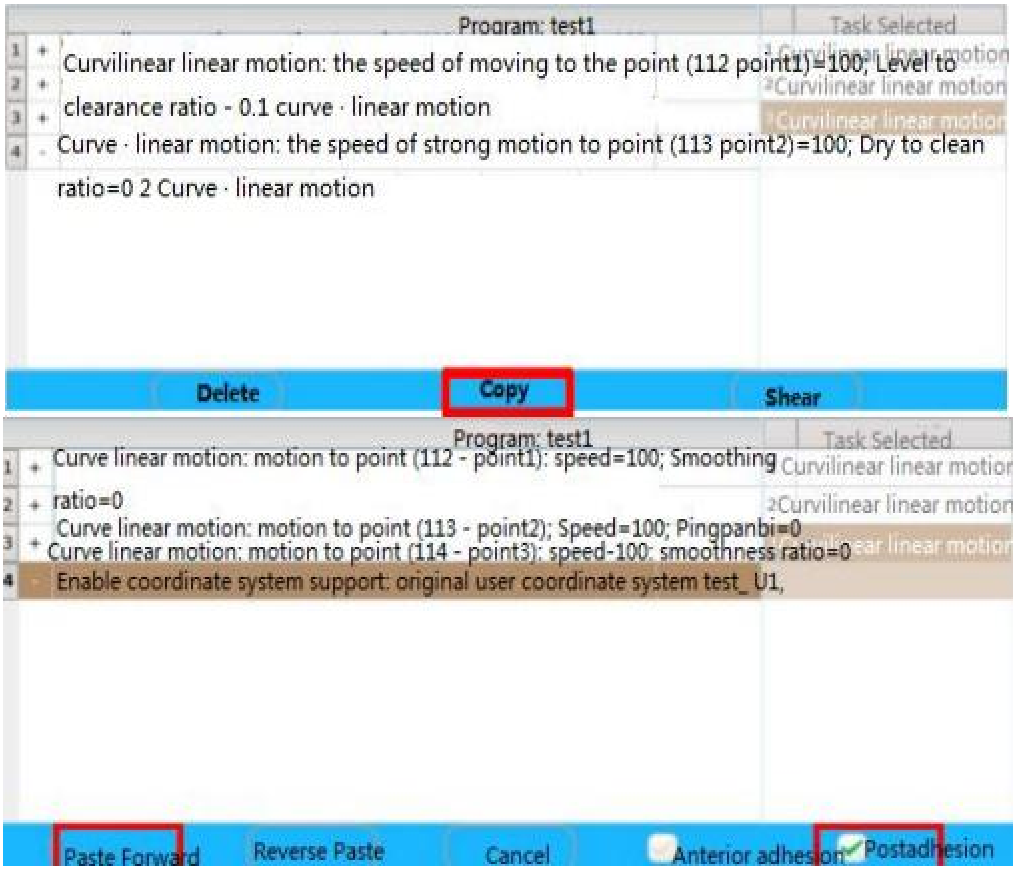



Fig. 16.5 Copying and pasting program segments

(2) To copy and paste a program section, click the program name bar to switch to the program full screen interface, as shown in Figure 16.5. Select the program to be copied ("Selected Tasks" will appear on the right), click [Copy], and then the Paste button and options will appear. Select the command line of "Enable coordinate system transformation", check "Paste after", and click the [Paste Forward] button to finish copying and pasting the program segment.

(3) When the operation on the worktable is complex and the program segment is long, the modular program can be used for programming. As shown in figure.

(4) As shown in 16.6, teaching the new program test123 on a worktable, and then calling the subprogram between the "coordinate system transformation" command pairs of the modular program can quickly complete the multi worktable pipeline programming.

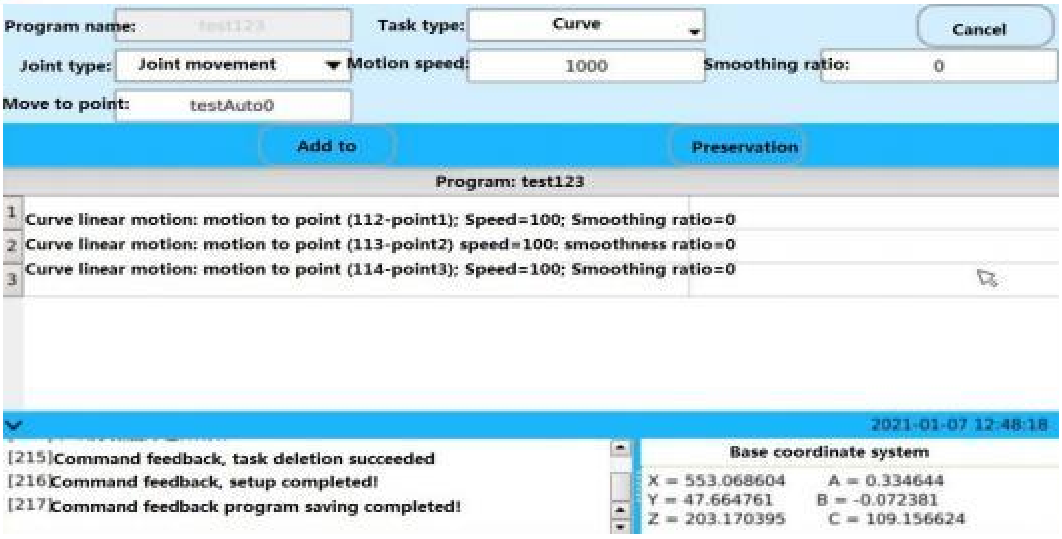



Fig. 16.6 (1) Teaching program on a single worktable

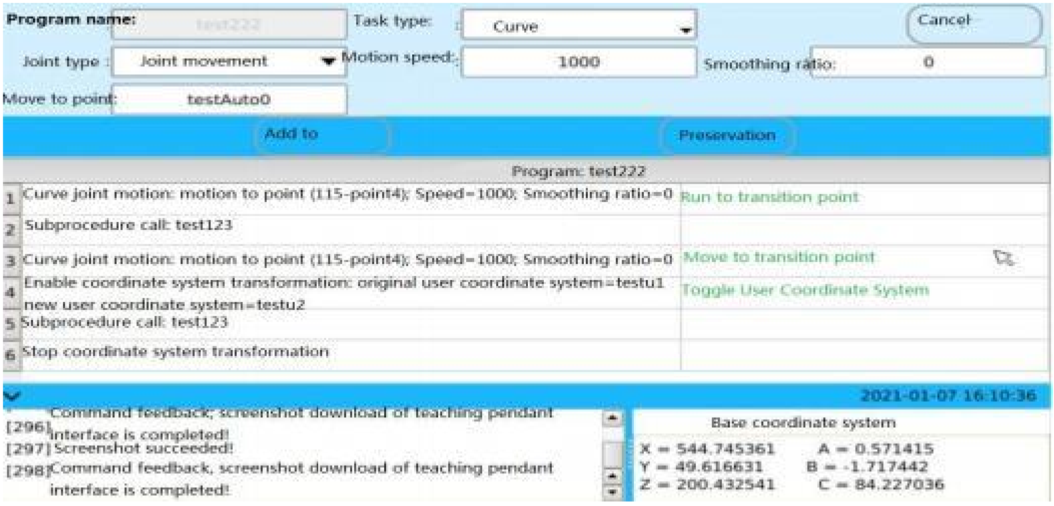



Fig. 16.6 (2) Calling subprogram to complete multi worktable pipeline programming

## 16.2 Reuse of programs among multiple robots

Purpose: To convert a program teaching point on a robot into a package with parameters through "forward generation", and then copy it to multiple robots for "reverse generation" of program teaching points, so as to realize the shared use of programs.

Step 1: Complete the association of program points with user coordinate system and robot parameters on the current robot teaching pendant

As shown in Figure 16.7, in the "Point Management" interface of the robot teaching pendant, click the [Filter] button and select the name of the basic program to be copied to other robots, then only the points in the program can be displayed.

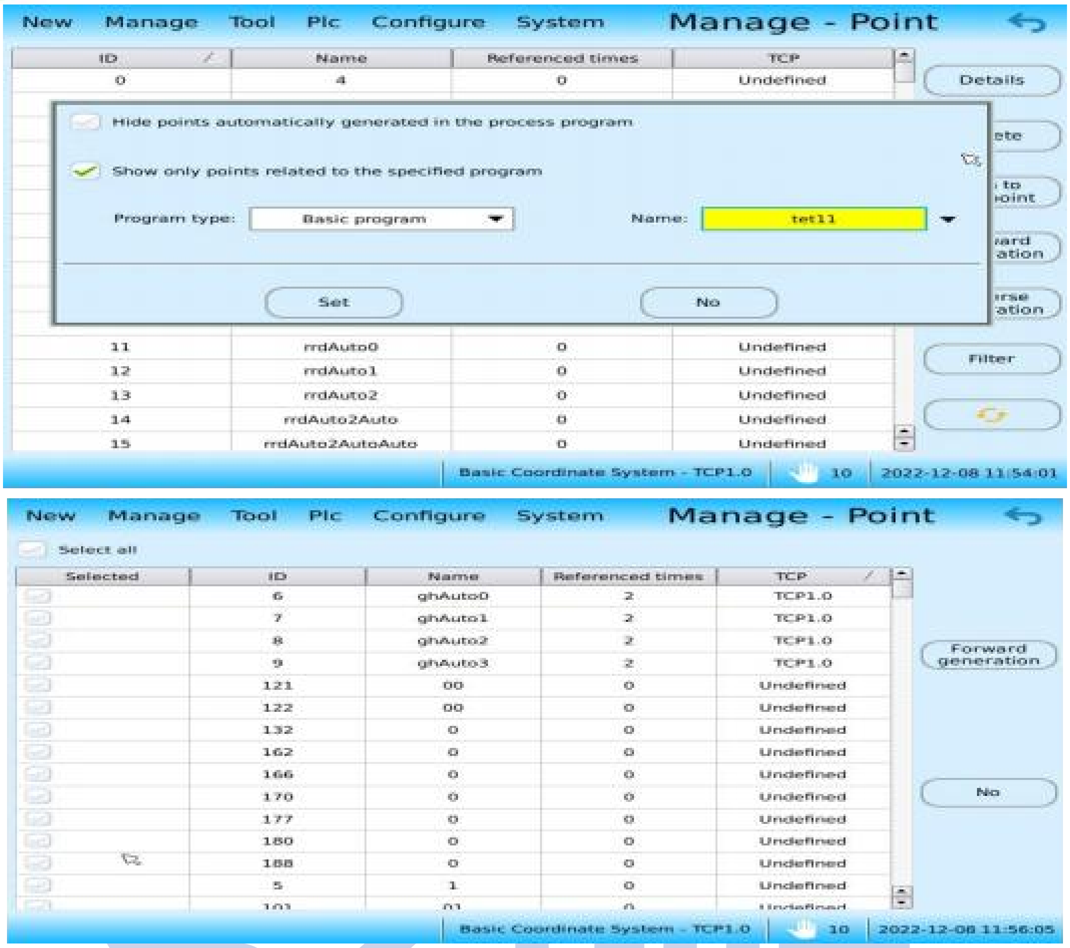



Figure 16.7 Show Points in a Program

Click the [Forward Generation] button, as shown in Figure 16.8, select all points, then click the [Forward Generation] button again, select the user coordinate system name used for the current robot teaching point, and click [Confirm], then all program points will include not only the six joint data and tool coordinate system data during teaching, but also their relative position and pose data under the user coordinate system. Note: When establishing the user coordinate system, the reference point needs to be associated with the corresponding tool coordinate system. The teaching points in the program also need to be associated:Corresponds to the tool coordinate system.

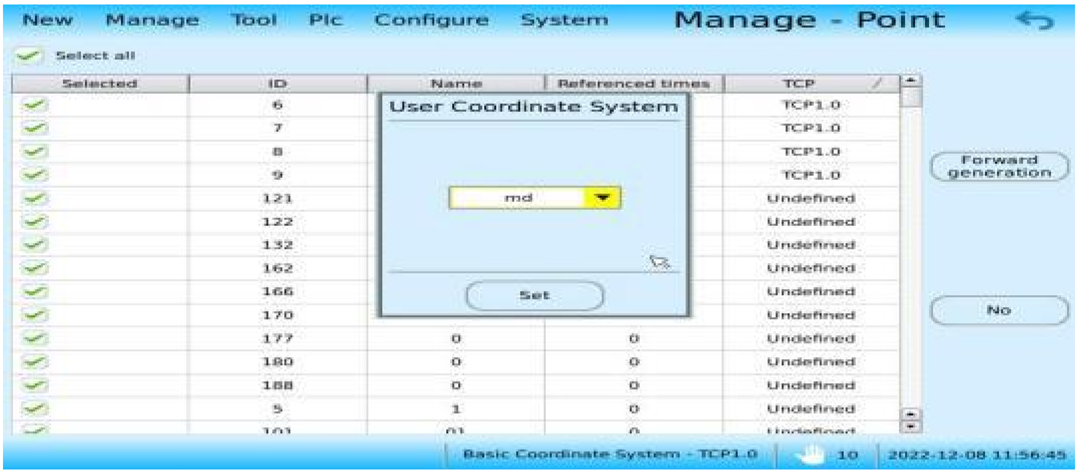



Figure 16.8 Data Association between Points and User Coordinate System

Step 2: Backup the user program with a USB flash disk and update it to another robot controller

Prepare a USB flash disk ofFat32 format USB2.0, and create corresponding folders and configuration files in it. The steps are as follows:

(1) In the root directory of the USB drive, create a new folder with the name "robcon".

(2) Create a new text document in the "robcon" folder and rename it "config. ini".

(3) Open "config. ini" with Notepad, and edit the text as shown in Figure 16.9. Here, the user program is not simply copied and backed up, but needs to take the robot parameters and set record=64.

```
*config.ini - Notepad
File(F) Edit(E) Format(O) View(V) Help(H)
[control_backup]
app=0
fpga=0
record=64

[control_update]
app=0
fpga=0
record=64

[teach_backup]
pic=0
doc=0
app=0

[teach_update]
pic=0
doc=0
app=0
```

Figure 16.9 Configuration of "config. ini"

Insert the USB flash disk into the controller, enter [Tools] - [Update and Backup], and select the controller for backup.Then insert the USB flash disk into the target robot controller (the software version needs to be the same), enter [Tools] - [Update and Backup], select the controller and update it. The interface is shown in Figure 16.10.


Figure 16. 10 Backup and update of user program

Step 3: Establish the tool coordinate system and user coordinate system in the target robot teaching pendant

The machine parameters of the target robot and the original robot are different, and the data of the tool coordinate system and the user coordinate system may be different. Therefore, the tool coordinate system and the user coordinate system need to be re established before the target robot uses the application.

Note: Since all program points are associated with the tool coordinate system ID, after establishing a new tool coordinate system.

To delete the copied original tool coordinate system and ensure that the new tool coordinate system uses the same ID number as the original tool coordinate system, the copied program points will be associated with the new tool coordinate system.

The reference point needs to be associated with the tool coordinate system when establishing the user coordinate system.

Step 4: Complete the reverse generation of program points on the target robot teaching pendant

In the "Point Management" interface of the target robot teaching device, click the [Filter] button and select the name of the copied basic program, then only the points in the program can be displayed.

Click the [Reverse Generation] button, select all points, then click the [Reverse Generation] button again, select the name of the user coordinate system created by the target robot, and click [Confirm], then all program points will be converted into six joint data matching the user coordinate system and robot parameters of the target robot.

After completing the above steps, the target robot can complete the same tasks as the original robot without manual teaching and programming.

## 16.3 Quick correction of tool coordinate system

Purpose: If the tool is replaced due to wear or damage, the external reference method can be used to correct the tool coordinate system (calibration can be completed only by aligning the tool with a measured external reference point).

For the teaching pendant version 1.0, in the tool coordinate system interface of the robot teaching pendant, the steps for quickly correcting the tool coordinate system are as follows:

(1) As shown in Figure 16.11, select the tool coordinate system and click the [Correction] button to pop up the landmark input box.

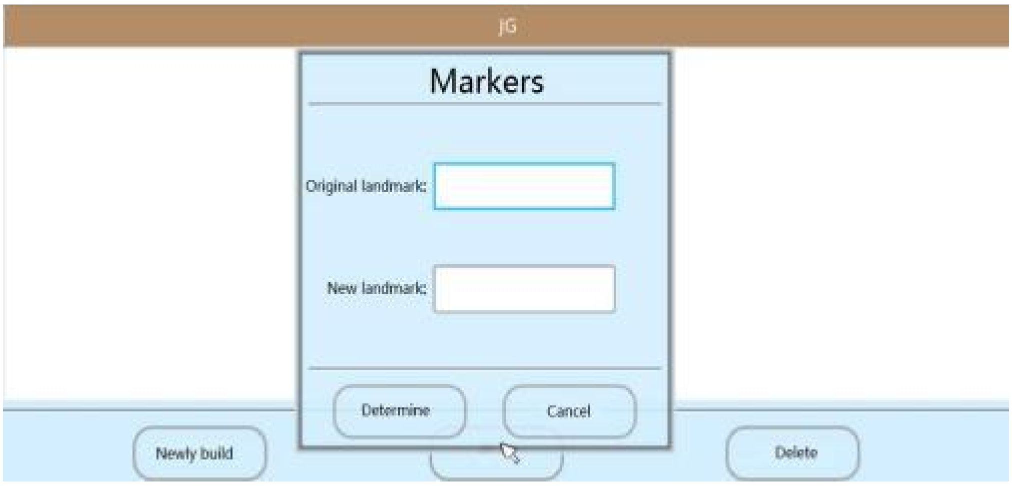



Fig. 16.11 Correction of tool coordinate system through "landmark"

(2)Select Original Flag Point. Here, the "original marker point" is the "point" read when the original tool reaches a specific position on the worktable in a specific posture after the tool coordinate system is established. Note that the tool coordinate system needs to be associated when creating this point.

(3)Replace the tool, then create a new one and select "New Flag Point". Here, the "new marker point" is the "point" read when the tool is replaced and the new tool is used to reach the same position on the worktable with the same attitude. Note that you also need to associate the tool coordinate system when creating this point.

Click [OK], and the original tool coordinate system data will be quickly corrected to the new tool coordinate system data. At the same time, all program points associated with the original tool coordinate system will be associated with the revised new tool coordinate system, and its six joint data will be automatically revised, so that the TCP pose remains unchanged.

For the teaching pendant version 2.0, in order to prevent "original landmarks" from being stored in the point management list and being wrongly modified or deleted, the quick correction method has been improved. The steps are:

(1) As shown in Figure 16.12, when creating a new tool coordinate system, the tool can reach a specific position on the worktable with a specific posture, and the "original marker point" can be configured at the Mark point of the new interface.

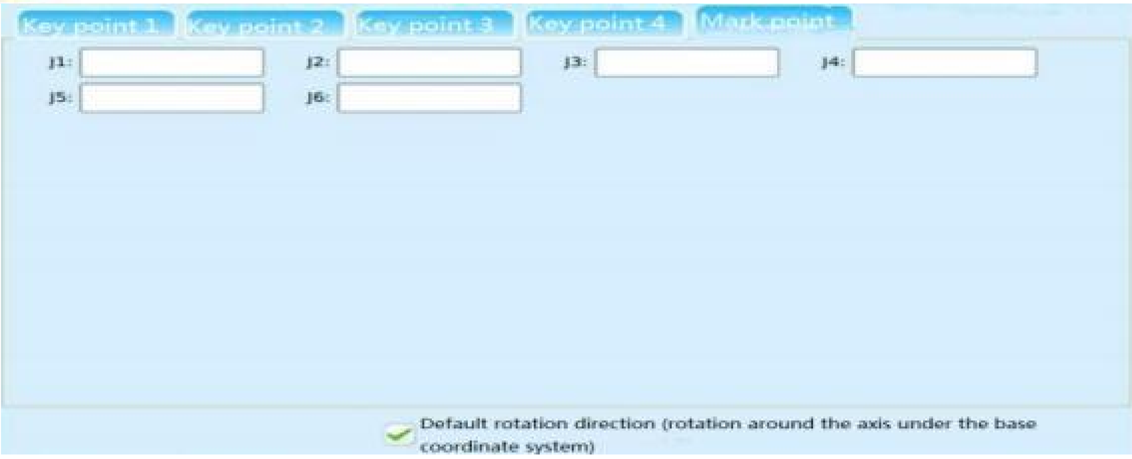



Figure 16. 12 New Tool Coordinate System Interface

Note: If there is no Mark point configured when creating a tool coordinate system, you can also select the tool coordinate system in the tool coordinate system management interface, as shown in Figure 16.13, and click [Update Mark Point] to configure it before replacing the tool. The point is saved directly in the corresponding tool coordinate system data.

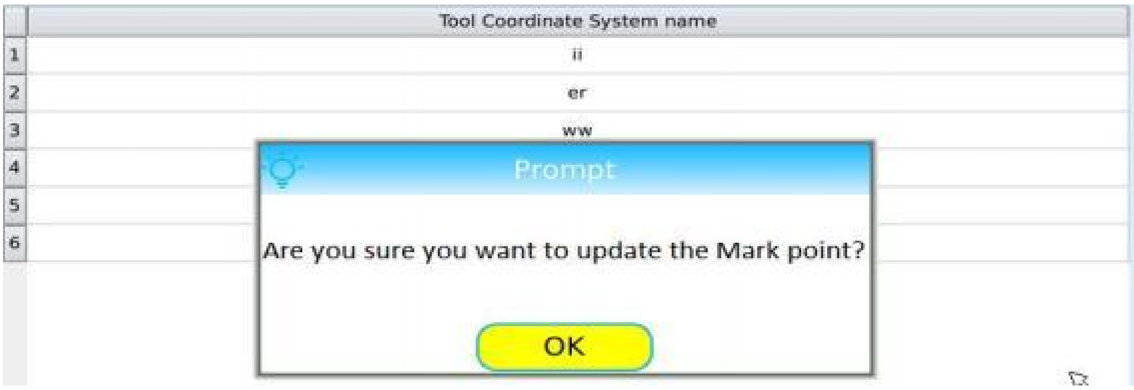



Figure 16. 13 Update Mark point in tool coordinate system management interface

(2)In the tool coordinate system management field, select the tool coordinate system and click the [Modify] button to pop up the "New Marker Point" input box, as shown in Figure 16. 14. After replacing the tool, click the blank box behind the "new mark point", manually teach the new tool to reach the same position on the worktable with the same posture, and create a new "new mark point". Note that the tool coordinate system needs to be associated when creating this point.

(3)Click [OK], and the original tool coordinate system will be quickly modified to the new tool coordinate system. At the same time, the point will be updated to a new Mark point, and its data will be saved to the new tool coordinate system.

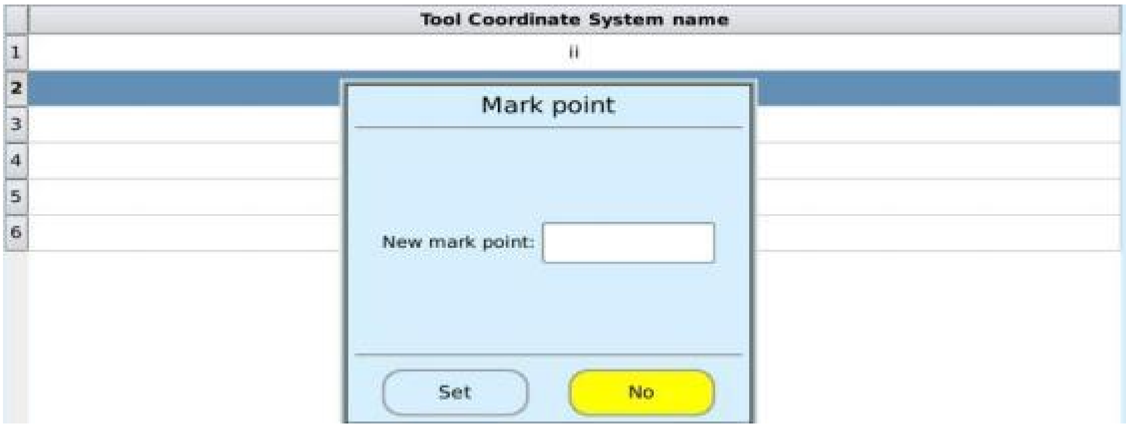



Figure 16. 14 Tool coordinate system correction interface

## 16.4 Dynamic creation of user coordinate system

Purpose: To solve the problem that the workpiece placement changes the user coordinate system, obtain the positioning point through laser positioning, and then dynamically create the user coordinate system in the program.

As shown in Figure 16.15, select "User Coordinate System Creation" in the basic command, and its command interface is shown in Figure 16.16

When the connecting line is vertical, three search points need to be determined.


Figure 16.15 "User coordinate system creation" command in the basic command.

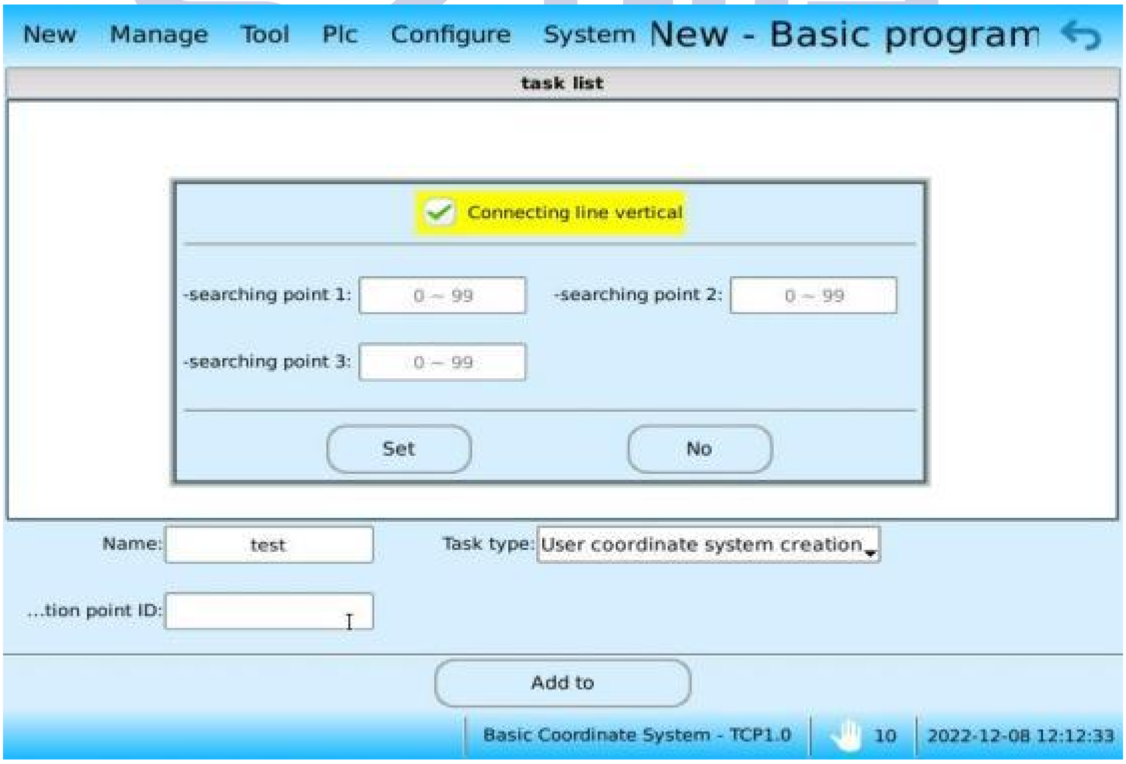



Figure 16.16 "User Coordinate System Creation" Command Parameter Interface

When the new workpiece is placed, as shown in Figure 16.17, the search points 1, 2, and 3 are obtained on the two mutually perpendicular edges ofthe workpiece by laser search, and the search point ID is set in the "User Coordinate System Creation" command interface, then the command will create a new user coordinate system.

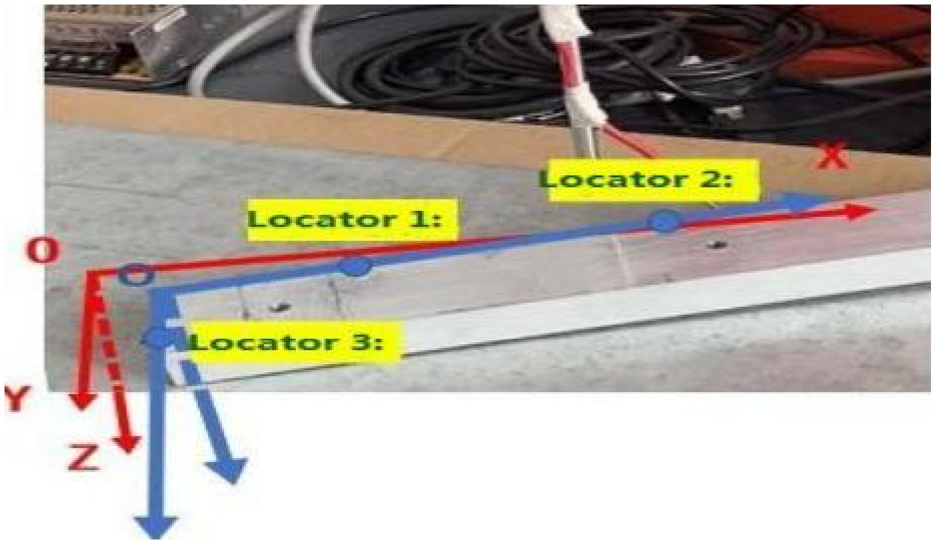



Figure 16.17 3 Schematic diagram of location of search sites

Note that if the "Connecting line is vertical" is not checked, it means that the two edges ofthe workpiece are not vertical. The parameter interface of the "User Coordinate System Creation" command is shown in Figure 16.18, and four search points need to be determined. At this time, as shown in Figure 16.19, it is necessary to find two points on the edge of the workpiece along the Y axis in order to determine the coordinate system.


Figure 16. 18 Parameter Setting Interface without Checking "Vertical Connecting Line"

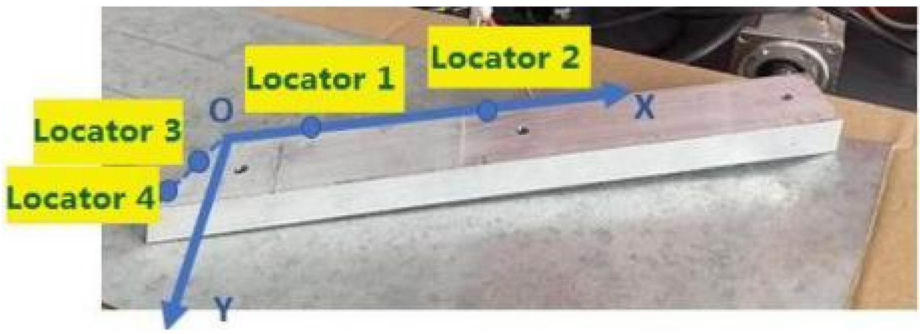



Figure 16. 19 Schematic diagram of four search sites

The following is an example to illustrate the use of this command: for the program test that is taught in the user coordinate system u0, after each placement of the workpiece, in order to ensure that the position of the motion track remains unchanged, it is necessary to first find the position by laser in the program, obtain the location in turn, then dynamically create the user coordinate system, and finally transform the user coordinate system of the teaching program. The final procedure is shown in Figure 16.20.

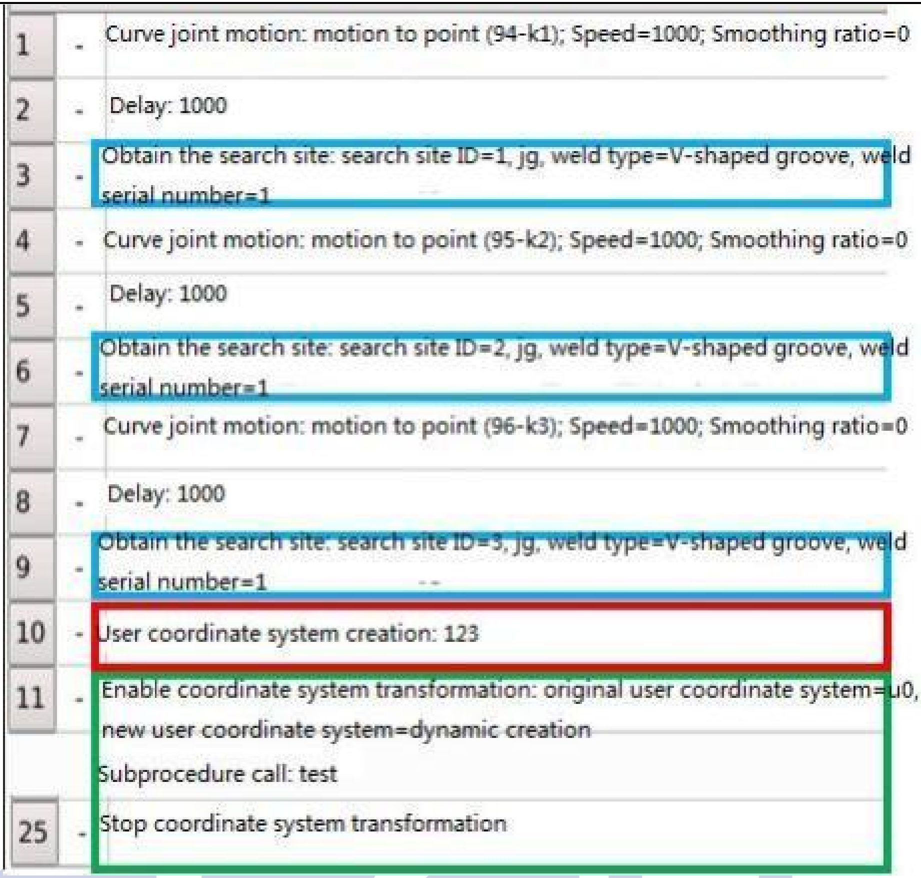



Figure 16.20 Case Procedure

# 17 Palletizing

Palletizing is to stack the stacks on the pallet according to a certain arrangement law.

As shown in Figure 17.1, it is a typical application of palletizing robot. The robot takes the stack from the assembly line, then moves to the specified position and angle of the pallet, and releases the stack to place the stack.

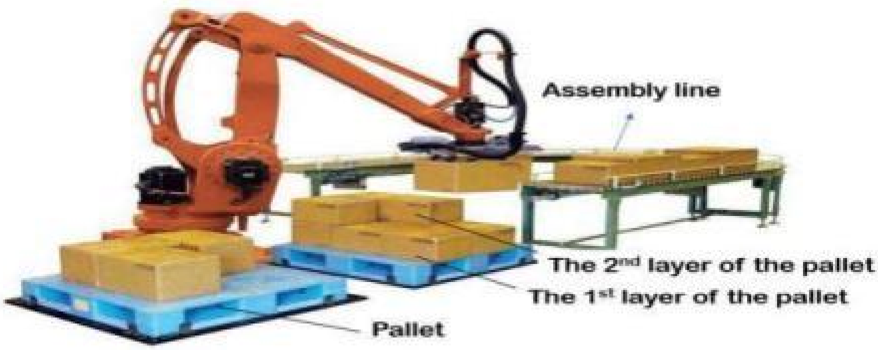



Figure 17. 1 Robot palletizing

For palletizing process, manual teaching robot trajectory usually includes two parts:

. Assembly line: transition point (near), prepare to take point, taking point and leaving point after taking

. Pallet stacking: transition point (enter), prepare to release point, release point, leaving point after releasing, transition point (away)

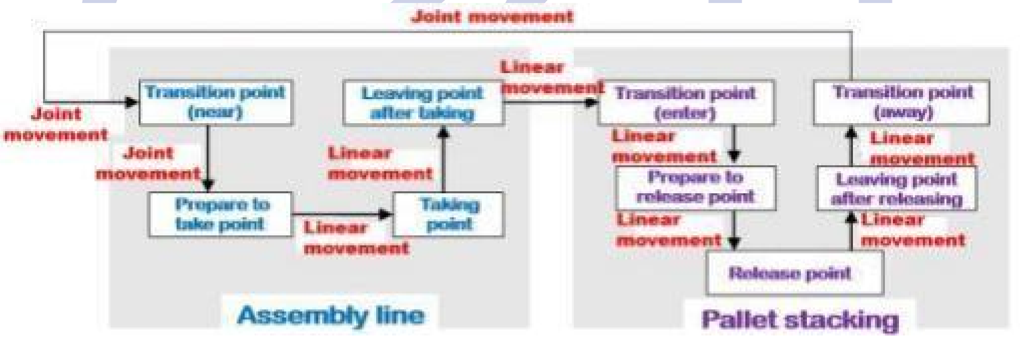



Figure 17.2 Flow chart of robot palletizing trajectory

As shown in Figure 17.2, the characteristics of robot trajectory are:

(1) The taking and releasing process of each stack is the same, except for the track points.

(2) For a certain assembly line, the moving track points of each stack are the same.

(3) For a pallet, after the placement point of the first stack is determined, the placement point of each stack can be calculated in turn when the layer arrangement on the pallet and the spacing between stacks are known.

Therefore, SZGH system encapsulates the palletizing process of a single pallet into a process package by simply setting the pallet user coordinate system, the placement position of the pallet, the pallet frame points, layout methods and floor height.

Then, for four different palletizing templates:

- Single assembly line single pallet
- Single assembly line double pallet
- Double assembly line single pallet
- Double assembly line double pallet

SZGH system creates the palletizing template by setting the assembly line frame points corresponding to the palletizing process package, and quickly generates the palletizing program to realize the automatic palletizing operation of the robot.

The terms involved in palletizing are shown in Table 17.1.

Table 17.1 Description of palletizing operation

| Number | Term | Description |
|---|---|---|
| 1 | Stack | Items to be placed, such as workpieces, cartons, and products. |
| 2 | Pallet | Items (areas) used to place stacks. |
| 3 | Number of palletizing process packages | 100 (pallet0-99). That is, it can support up to 100 pallets. |
| 4 | Layout method | Up to 99 different layout methods can be realized, usually one layout per layer. |
| 5 | First stack | The first stack of a layer on a pallet. |
| 6 | Transition point(enter) | The teaching point on the track for the robot moving to the pallet movement after taking the stack from the assembly line. |
| 7 | Transition point(away) | The teaching point on the track for the robot moving to the assembly line after releasing the stack on the pallet. |
| 8 | **Release point** | **The pose of the robot when the stack is placed at the origin of the user coordinate system. In the future, the pose of each stack is offset and calculated based on it.** |
| 9 | Prepare to release point | Generally, it is located directly above the release point, and it can also have a certain offset angle. |
| 10 | Leaving point after releasing | Generally, it is located directly above the release point, and it can also have a certain offset angle. |
| 11 | Transition point (near) | The teaching point on the track for the robot moving to the assembly line before taking the stack. |
| 12 | Taking point | The teaching point for taking stack on the assembly line. |
| 13 | Prepare to take point | Generally, it is located directly above the taking point, and it can also have a certain offset angle. |
| 14 | Leaving point after taking | Generally, it is located directly above the taking point, and it can also have a certain offset angle. |

## 17.1 Preparation

### 17.1.1 Create user coordinate system

In the process of palletizing, in order to stack accurately, the user coordinate system needs to be established based on the pallet frame.

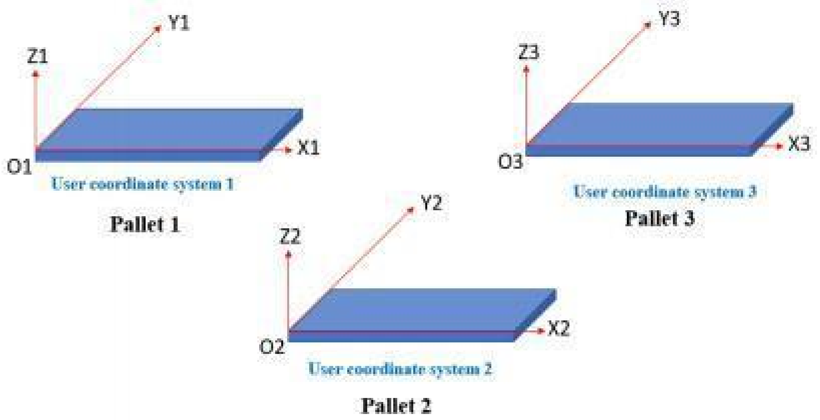



Figure 17.3 Create the user coordinate system for each pallet

Click [user coordinate system] in the "manual interface" of the teach pendant. Let the tool TCP reaches the origin of the coordinate system, a point on the x axis and a point on the y axis. The user coordinate system can be established by referencing the three points in turn. Please pay attention here, the created "point" needs to check the tool coordinate system. See Chapter 2, Section 2.3 of the manual for the detail.

Note:

- . The origin O of the user coordinate system is the "release point" of the pallet, the pose of each stack is offset and calculated based on it.
- . The establishment of user coordinate system refers to the right-hand spiral rule. When establishing pallet coordinates, the positive direction of Z is usually far away from the pallet. Therefore, it is necessary to consider which side is in the X and Y directions when establishing the user coordinate system.

### 17.1.2 Workpiece fixture control

In the process of palletizing, the clamping action of workpiece fixture can be controlled directly through output, or M relay controlled by PLC programming.

PLC ladder diagram programming is shown in Figure 17.4. Yxx represents the output port of the control fixture solenoid valve or cylinder.

```
---| |-------------------------------O
  M100                              Yxx
```

Figure 17.4 PLC ladder diagram of fixture control

## 17.2 Create palletizing process package

Click [new] - [palletizing] to create a palletizing process package. There are four steps to set, including selecting the user coordinate system, setting the reference points, determining layout methods and setting layer information.

### 17.2.1 Coordinate system selection

The first step is to select the user coordinate system, as shown in Figure 17.5. The user coordinate system is established based on a pallet in palletizing operation.

Note: if there are multiple pallets in the palletizing operation, you need to create multiple user coordinate systems,and then configure the corresponding palletizing process package for each pallet.

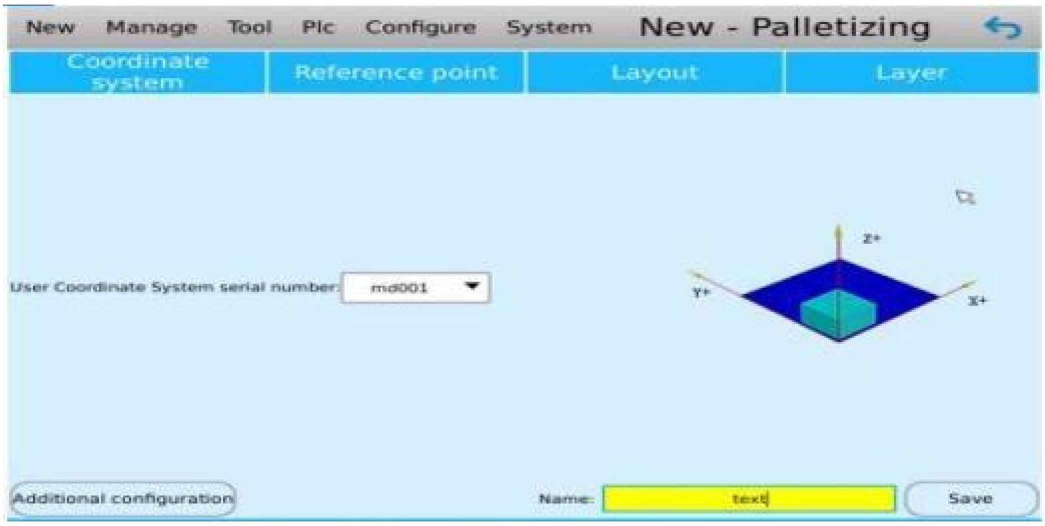



Figure 17.5 Select user coordinate system

## 17.2.2 Reference point setting

The second step is to set the motion track point when the robot places the stack at the origin O of the pallet user coordinate system through manual teaching, as shown in Figure 17.6. The "transition point" can be used according to the actual situation. If it is not "enabled", the stack grabbed from the assembly line will move directly to the "prepare to release point".

Note: the manual teaching is to place the stack at the origin O of the pallet user coordinate system.


Figure 17.6 Reference point setting

## 17.2.3 Layout method setting

The third step is to set the layout method to be adopted for stacking on the pallet, as shown in Figure 17.7.

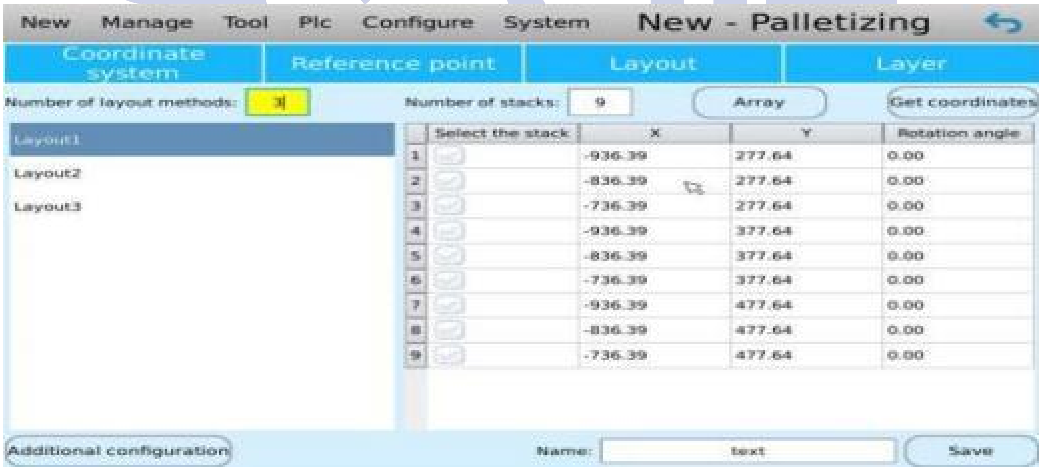



Figure 17.7 Set layout method

First, enter the number of layout methods that will be used for stacking on the pallet. If there is only one type of layout, enter "1", and enter n for n types. After input, "layout 1", "layout 2" ...,"layout n" will be automatically generated in the box.

Then, select a layout method and enter the number of stacks, that is, the number of stacks contained in the layer with the current layout method, and then you can teach manually to obtain the position coordinates of each stack.

If it is array layout, click the [array] button to enter the array setting interface, as shown in Figure 17.8. Select the running direction, determine the offset data of the first stack relative to the "release point", enter the row spacing, column spacing, etc., and finally click [Set].

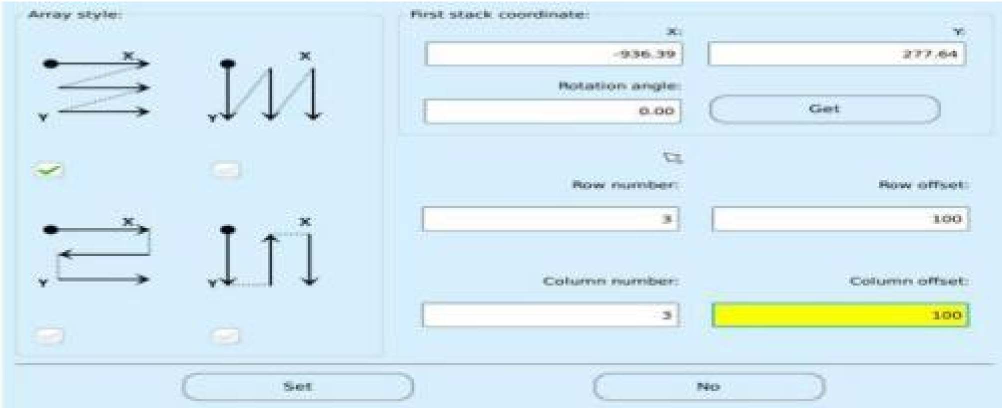



Figure 17.8 Array layout setting

### 17.2.4 Layer information setting

The fourth step is to set layer information, as shown in Figure 17.9.

First, enter the number of layers on the pallet. If only one layer of stacks is placed on the pallet, enter "1" and N for layer n. After input, "layer 1", "layer 2” …, "layer n" will be automatically generated in the box.

Then, starting from the first layer at the bottom of the pallet, select "layout method" layer by layer, and set the layer height and transition point offset height.

Finally, click the [save] button to complete the creation of "palletizing process". If there are multiple pallets, you need to create multiple palletizing packages.

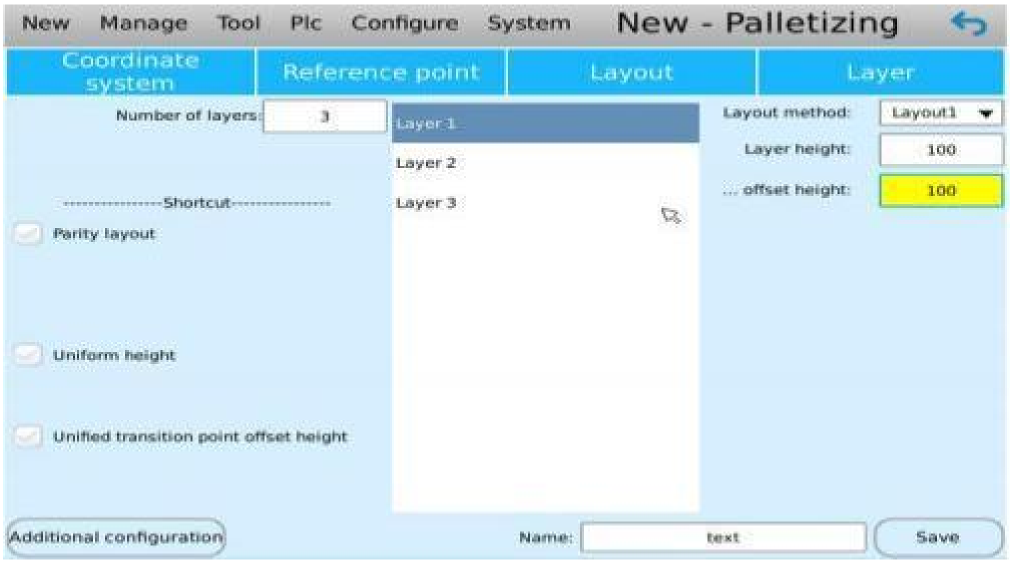
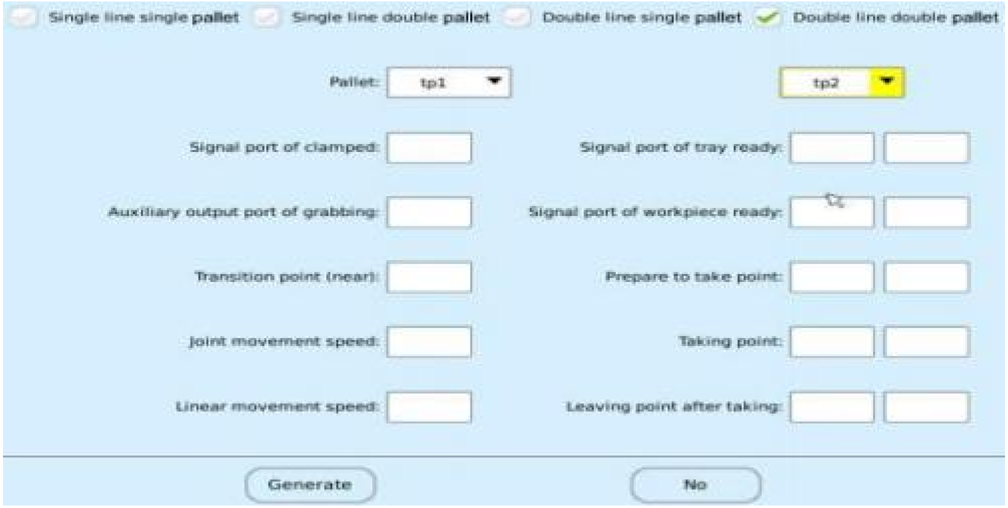



Figure 17.9 Set layer information

## 17.3 Generate palletizing program based on "template"

On the screen shown in Figure 17.9, click the [menu] button of the teach pendant and select [template], and the interface shown in Figure 17.10 appears.




There are four types of palletizing operation provided by the system: single line single pallet, single line double pallet, double line single pallet and double line double pallet. The basic palletizing program can be automatically generated by template setting.

Take "double line and double pallet" as an example to explain the template setting steps.

As shown in Figure 17.10, the template is generated for the "double line and double pallet" palletizing program. First select the "palletizing process" packages of the created two pallets, and then set the tool signal ports, transition point, robot motion speed and the corresponding two assembly line taking points.

The relevant instructions are shown in Table 17.2.

Table 17.2 Description of template parameters

| Number | Term | Description |
|---|---|---|
| 1 | Pallet | Select the palletizing package created for this pallet. |
| 2 | Signal port of clamped | A sensor is installed on the tool to detect the clamping of the tool. Set the corresponding input port of the sensor. |
| 3 | Auxiliary output port of grabbing | Output port to control the tool clamping |
| 4 | transition point (near) | The teaching point on the track for the robot moving to the assembly line before taking the stack. Multiple assembly lines take this point as the transition point. |
| 5 | Joint movement speed | Running speed of corresponding motion curve in figure 17.2. |
| 6 | Linear movement speed | Running speed of corresponding motion curve in figure 17.2. |
| 7 | Signal port oftray ready | The input port used to know whether the pallets is ready. The order needs to correspond to the palletizing process package. |
| 8 | Signal port of workpiece ready | The input port used to know whether the workpiece is ready. The order needs to correspond to the assembly line. |
| 9 | Prepare to take point | Generally, it is located directly above the taking point, and it can also have a certain offset angle. The order needs to correspond to the assembly line. |
| 10 | Taking point | The teaching point for taking stack on the assembly line. The order needs to correspond to the assembly line. |
| 11 | Leaving point after taking | Generally, it is located directly above the taking point, and it can also have a certain offset angle. The order needs to correspond to the assembly line. |

Click [generate] to automatically generate the basic program file "PalFrame". Click [manage] - [basic program], select the "PalFrame" program, click [save as] to modify the program name and save it.

Note: the name of the palletizing basic program generated through the template each time is "PalFrame". If it is not saved as a program with other names, each newly generated basic program will automatically overwrite the basic program generated by the previous template.

## 17.4 Modification of palletizing program

When creating the "palletizing process" program, enable the "transition point (enter)" and "transition point (away)", and then the basic program generated through the template is shown in Figure 17.11, which will list the instruction segment of the robot's running track curve between the start palletizing process instruction and the end palletizing process instruction.

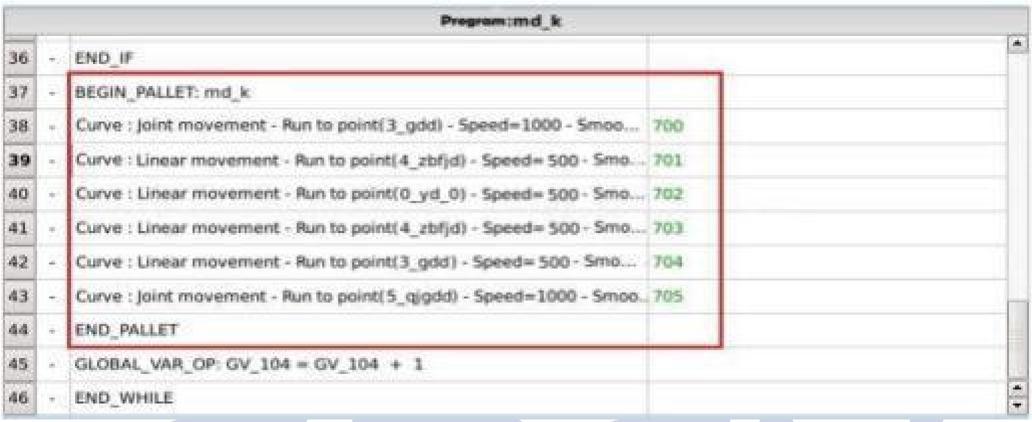



Figure 17.11 Palletizing basic program

### 17.4.1 Global variable definition

On the basis of the palletizing basic program generated through the template, in order to quickly realize the dynamic modification of the motion track according to the operation requirements, the system uses a group of global variables as the flag of whether the six curves in the palletizing process are skipped, and provides global variables "gv218" and "gv219", which respectively represent "current palletizing layers" and " current serial number to be palletized", which can be used as the logic judgment of the program.

Table 17.3 Description of global variables of palletizing program (1)

| Number | Global variable | Description |
|---|---|---|
| 1 | GV700-GV705 | Palletizing motion curve skip flag（0-don't skip, 1-skip） |
| 7 | GV218 | Current number of layers in palletizing process |
| 8 | GV219 | Serial number of the position to be stacked in the current layer in palletizing process |
| 9 | GV100-GV109 | Number of stacks already placed in 10 pallets in palletizing process |

The corresponding global variable number is given on the right side of the instruction line in Figure 17.11. See table 17.3 for details. According to the flag definition, for example, in the global variable "gv700-gv705", if "gv700 = gv702 = gv703 = gv704 = gv705 = 0, gv701 = 1" is set, the curve running track will change: when the curve runs to the "transition point (enter)" position, it will no longer run to the "ready to release point" position, but directly run from the "transition point (enter)" position to the "release point" position.

### 17.4.2 Modify reference points

The palletizing basic program can also modify the reference points according to the five groups of global variables provided by the system. The description of global variables is shown in table 17.4.

Table 17.4 Description of global variables of palletizing program (2)

| Number | Global variable | Description |
|---|---|---|

| | | |
|---|---|---|
| 1 | GV706 | Special, palletizing "transition point (enter)" modification mark （0 - do not modify, 1 - modify） |
| | GV707 | Special, modified palletizing "transition point (enter)" ID |
| 2 | GV708 | Special, palletizing "prepare to release point" modification mark （0 - do not modify, 1 - modify） |
| | GV709 | Special, modified palletizing "prepare to release point" ID |
| 3 | GV710 | Special, palletizing "release point" modification mark （0 - do not modify, 1 - modify） |
| | GV711 | Special, modified palletizing "release point" ID |
| 4 | GV712 | Special, palletizing "leaving point after releasing" modification mark（0 - do not modify, 1 - modify） |
| | GV713 | Dedicated, modified palletizing "leaving point after releasing" ID |
| 5 | GV714 | Special, palletizing "transition point (away)" modification mark （0 - do not modify, 1 - modify） |
| | GV715 | Special, modified palletizing "transition point (away)" ID |

Application example: in the palletizing program shown in Figure 17.11, reference points are: "transition point (enter)" and "transition point (away)" (the ID number is 3); "prepare to release point" and "leaving point after releasing" (the ID number is 4); "release point" (the ID number is 0). When the global variables gv706 = gv708 = gv710 = gv712 = gv714 = 1, gv707 = gv715 = 26, gv709 = gv713 = 27, gv711 = 28 are set, as shown in Figure 17.12, it means to modify the five " reference points": "transition point (enter)" and "transition point (away)" (the ID number is 26);"prepare to take point" and "leaving point after releasing" (the ID number is 27); "release point" (the ID number is 28).

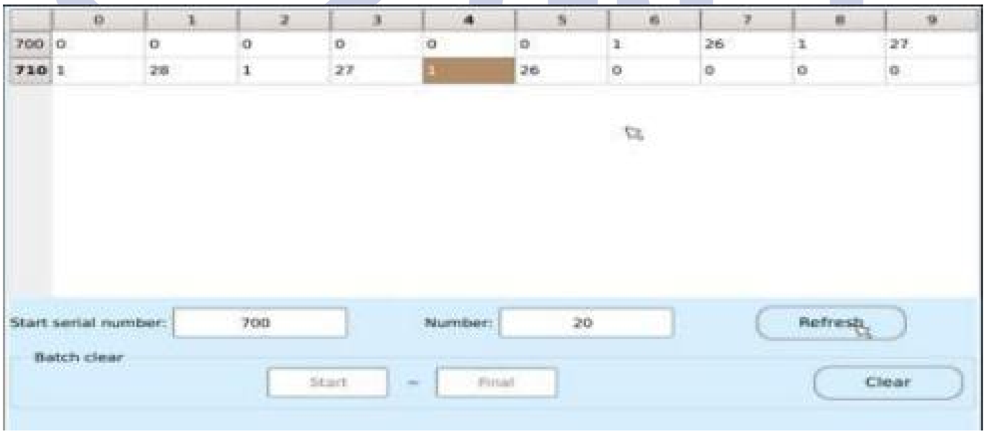



Figure 17. 12 Set global variable modification reference points

## 17.5 Offset setting

The system provides corresponding offset settings for the pallet offset in the process of palletizing and the need to offset the transition point according to the stacking position.

### 17.5.1 Pallet offset setting

As shown in Figure 17.13, click [additional configuration] in the process package interface, and the system provides the "enable external offset" function of the user coordinate system. Check "enable external offset". The system uses three global variables gv200, gv201 and gv202 to correspond to the X-axis offset, Y-axis offset and rotation of the pallet user coordinate system respectively. The offset of the pallet user coordinate system can be realized by assigning values to these three global variables in the program.

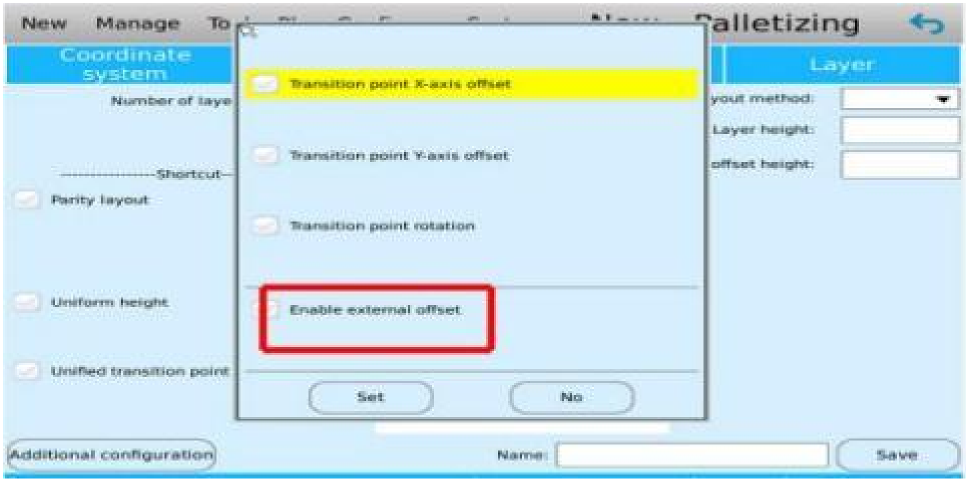



Figure 17. 13 Pallet user coordinate system enable external offset setting

### 17.5.2 Transition point offset settings

In the palletizing process package, by default, the transition point is a fixed point when the robot puts stacks on the pallet in turn. In some special applications, such as placing knifes, the "transition point" needs to be offset with the position of the "prepare to release point". At this time, check the corresponding transition point X-axis offset, transition point Y-axis offset and transition point rotation in the interface of figure 17.13

.

# 18 Welding

Welding, also known as fusion welding and fusion welding, is a manufacturing process and technology ofjoining metals or other thermoplastic materials by heating, high temperature or high pressure.

Using industrial robot to realize welding needs to complete two parts of teaching and programming design, one is the teaching programming of robot motion trajectory, and the other is the setting of robot welding operation. In the second part, the setting of robot welding operation is to obtain good welding quality, and set the welding conditions, including welder model, welding sequence, welding control signal, wire feeding speed, welding current and voltage control and other parameters.

In SZGH system, the work of the second part is encapsulated into a "welding" process package, which can be quickly generated by setting it in the corresponding interface and called in the basic program.

## 18.1 System composition

The welding robot system is generally composed of industrial robots, welding machine partitions, etc.

The connection between the control system and the welding machine includes: Io input, IO output, and analog output. The details are shown in Figure 18.1.


Figure 18. 1 Connection between the control system and the welding machine

## 18.2 Create welding process package

Click [new] - [process] - [welding] to create a welding process package. There are five steps to set, including welding machine configuration, time, IO port, basic parameters, and calibration.

### 18.2.1 Welding machine configuration

Step 1: select the welding machine. The system provides several welding machines brands. You can choose one and set the welding mode, as shown in Figure 18.2.

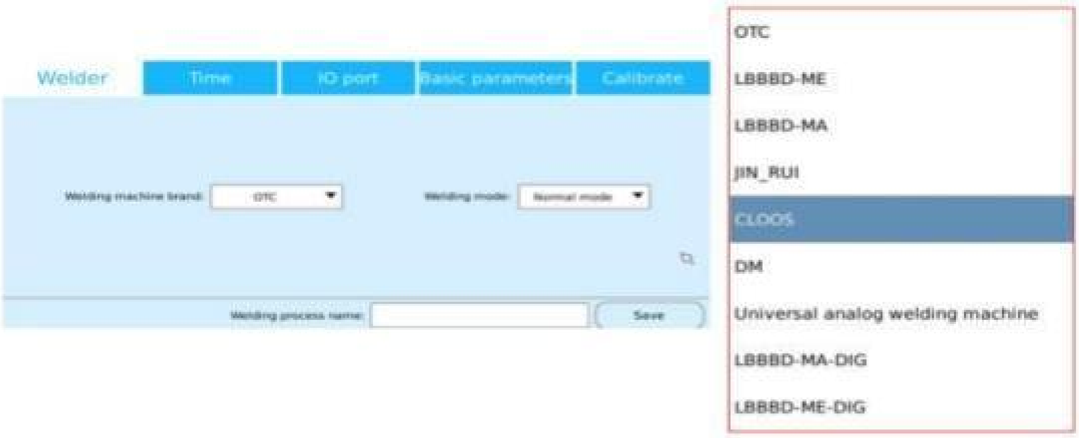


Figure 18.2 Select the welding machine

## 18.2.2 Time setting

Step 2: set the time parameters of voltage control in each operation step in the welding process, as shown in Figure 18.3. The time parameter description and recommended values are shown in Table 18.1. Figure 18.4 shows the sequence diagram of welding voltage control.

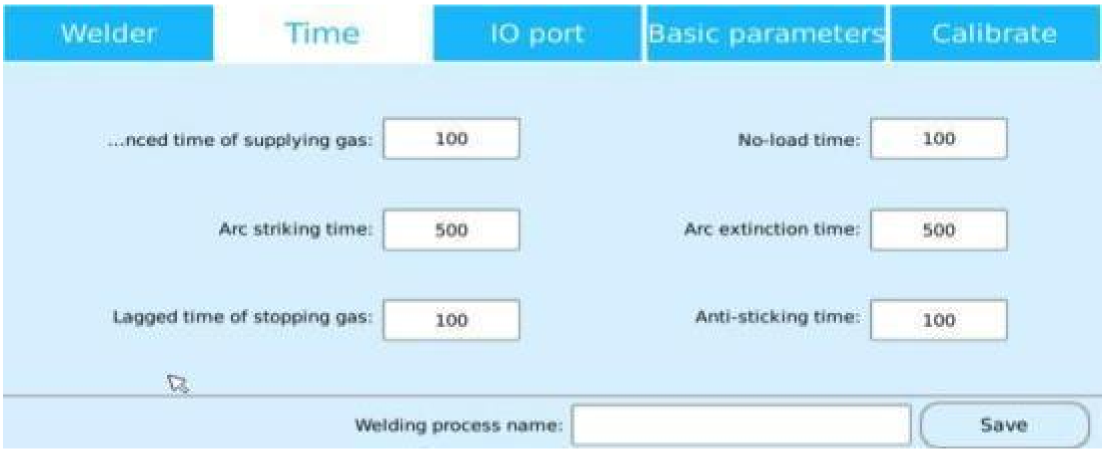



Figure 18.3 Set welding time parameters

Table 18.1 Description of welding process time parameters

| Number | Time parameter | Description | Recommended value (ms) |
|---|---|---|---|
| 1 | Advanced time of supplying gas | Advanced time of supplying gas before welding arcing. | 100 |
| 2 | No-load time | The time between the end of air supply in advance and the beginning of arcing. | 100 |
| 3 | Arc striking time | The time between sending the arcing signal and receiving the successful arcing. | Preliminary definition: 500 If the arc striking is too fast and unsuccessful, the time can be appropriately increased. If there is accumulation in the welding, the time can be appropriately reduced. |
| 4 | Arc extinction time | The time between the end of welding and the actual stop of welding. | Preliminary definition: 500 If the arc suppression is too fast and unsuccessful,the time can be appropriately increased. If there is accumulation in the welding, the time can be appropriately reduced. |
| 5 | Anti-sticking time | The time between the welding end signal and the stop of arc stopping voltage. | 100 |
| 6 | Lagged time of stopping gas | Delay time of closing air supply when all welding work is completed. | 100 |

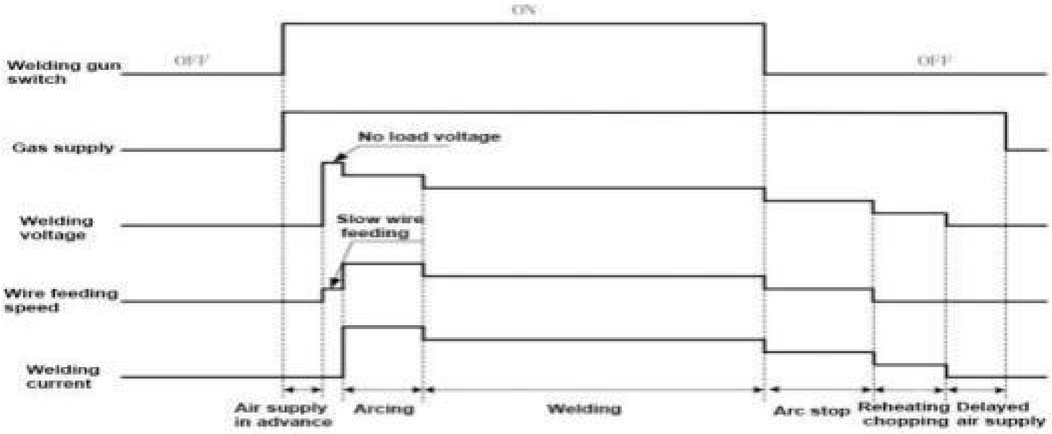



Figure 18.4 Sequence diagram of welding voltage control

## 18.2.3 IO port configuration

Step 3: find the output port of are striking control signal, output port of gas supply control signal and input port of arc striking detection signal according to the welding machine manual, and allocate them respectively according to their respective I/O allocation table, as shown in Figure 18.5.


Figure 18.5 Welding IO port setting

## 18.2.4 Basic parameter setting

Fourth step: set the control voltage (unit: V) and current (unit: A) required for each operation step in the welding process according to the process requirements and the welding conditions (plate thickness, welding position, welding speed, material and other parameters). The reference values are shown in Figure 18.6.

- . Welding voltage: provide welding wire melting energy. The higher the voltage, the faster the welding wire melting speed;
- . Welding current: adjust the wire feeding speed to balance with the melting speed.

Figure 18.6 Set welding voltage and current parameter

- If selecting "Enable Backward function", you need set the Backward distance. When the welding process is stopped and started again, it will be back for a certain distance before continuing welding.

## 18.2.5 Calibration

For the analog welding machine, in order to realize the current and voltage analog quantity control, as shown in Figure 18.7, the value of the analog quantity output port needs to be corresponding to the actual required current and voltage value, that is, calibration.


Figure 18.7 Current and voltage calibration

First, input the current output port "0" (if the display is not current but voltage, it can be adjusted with channel 1), click "calibration" to enter the "current verification" screen. Input the corresponding current value when the current is "1" and the corresponding current value when the current is "6". Click "OK" to finish.

Then input the voltage output port "1" (if the display is not current but voltage, it can be adjusted with channel 0), click "calibration" to enter the "voltage verification" screen. Input the corresponding voltage value when the voltage is "1" and the corresponding voltage value when the voltage is "6". Click "OK" to finish.

Note: for some analog welding machines, such as DM welding machine, the calibration of current and voltage is not completely linear and needs to be divided into multiple sections.

## 18.3 Welding program design

When writing the program, write different welding points, lines, or arcs in turn. In the process of manual teaching, the angle adjustment of the welding gun shall rotate each axis in the way of joint movement to adjust the angle. After the angle is appropriate, it shall be moved to the required position in the way of base coordinates. For each welding, "start welding" and "stop welding" shall appear in pairs, and different welding processes can be used in different curve segments.

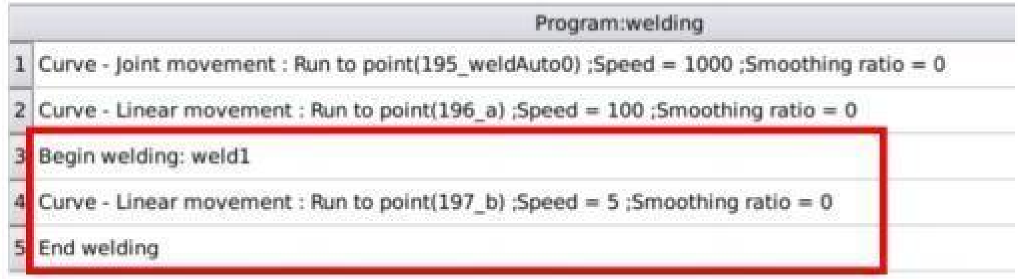



Figure 18.8 Welding process program

Note:

(1) "Begin welding" and "End welding" should appear in pairs.

(2) The motion type of welding section program must be linear, circular, circular motion or delay of spot welding, and cannot be joint motion.

(3) For different welding materials, corresponding gas shall be selected; Welding wires of different specifications shall be selected according to the process requirements; According to the selected welding wire, check whether the wire feeding wheel and electric nozzle match.

(4) Factors affecting the welding effect: gas type and flow, material of welding wire and conductive nozzle, welding angle, welding speed, welding control current and voltage.

# 19 Spraying

Using industrial robot to realize spraying needs to complete two parts of teaching and programming design, one is the teaching programming of robot motion trajectory, and the other is the setting of robot spraying control parameters. In this system, the spraying process package can be quickly created and the basic program can be directly generated only by setting in the corresponding two interfaces.

## 19.1 Create spraying process package

Click [new] - [spraying] to create a spraying process package. There are two steps: motion parameter setting and control parameter setting.

### 19.1.1 Motion parameter setting

The system provides six "spraying modes": "straight line", "plane", "plane inch", "arc line", "arc surface" and "arc surface inching". According to the "spraying mode", the motion parameters will be different.

**"Straight line" spraying mode**

As shown in Figure 19.1, it is the motion parameter setting interface of "straight line" spraying mode, and the parameter description is shown in Table 19.1.


Figure 19.1 "Straight line" spraying mode motion parameter setting interface

Table 19.1 Description of motion parameters of "straight line" spraying mode

| Number | Parameter | Description |
|---|---|---|
| 1 | Round-trip time | The number of repeated enter "0".spraying times. If there is no repeated spraying, |
| 2 | P1、P2 | The starting point and ending point of linear spraying in the figure. (You need to "check" the corresponding tool coordinate system when creating points) |
| 3 | Round-trip speed | The spraying speed from the starting point to the end point belongs to the "linear" movement type, and the value range is "1-2000" (mm/s). |
| 4 | End point to starting point | The running speed from the end point (P2) to the starting point (P1) of the spraying straight line belongs to the "straight line" motion type, and the value range is "1-2000" (mm/s). |

**"Plane" spraying mode**

As shown in Figure 19.2, it is the motion parameter setting interface of "plane" spraying mode, and the parameter description is shown in Table 19.2

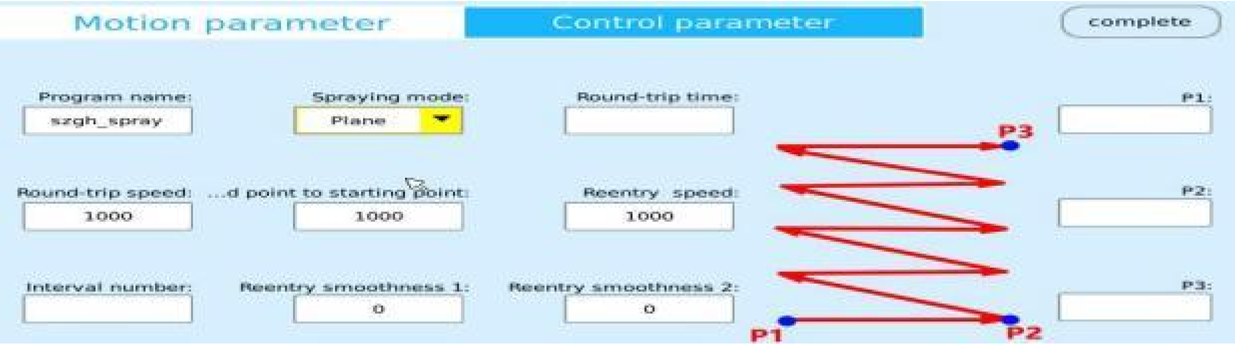



Figure 19.2 "Plane" spraying mode motion parameter setting interface

Table 19.2 Description of motion parameters of "plane" spraying mode

| Number | Parameter | Description |
|---|---|---|
| 1 | Round-trip time | The number of repeated spraying times. The value range is "1- 10". If there is no repeated spraying, enter "0". |
| 2 | Interval number | The turn back times between "first straight line" and "last straight line", with the value range of "1-80". |
| 3 | P1 、P2 、P3 | Three points for "plane" spraying which are shown in the figure. (The created point needs to "check" the corresponding tool coordinate system) |
| 4 | Round-trip speed | The spraying speed of P1 moving towards P2, with the value range of "1-2000" (mm/s). |
| 5 | Reentry speed | The spraying speed of turning back from P2, with the value range of "1-2000" (mm/s). |
| 6 | End point to starting point | The running speed from the end point P3 to the starting point P1, with the value range of "1-2000" (mm/s). |
| 7 | Reentry smoothness - 1, - 2 | Smoothness of "reentry" curve, with the value range of "0- 100". |

## "Plane inch" spraying mode

As shown in Figure 19.3, it is the motion parameter setting interface of "plane inch" spraying mode, and the parameter description is shown in Table 19.3.

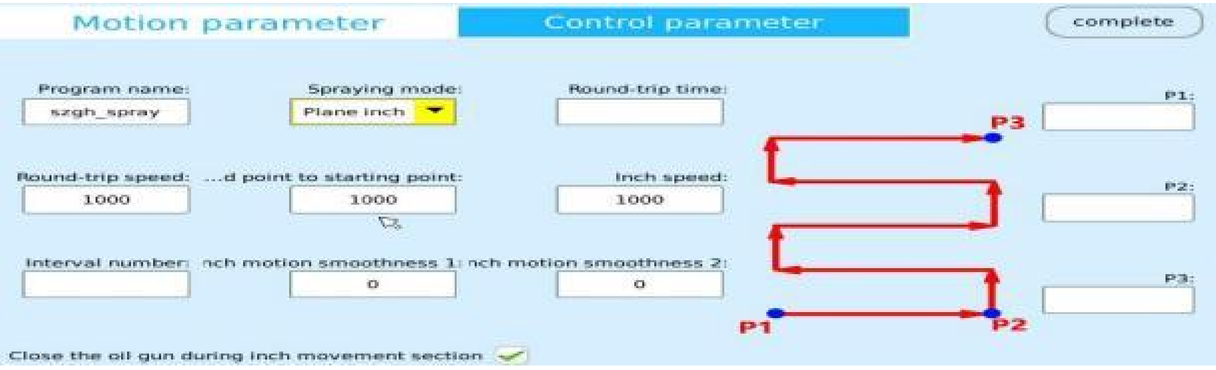



Figure 19.3 "Plane inch" spraying mode motion parameter setting interface

Table 19.3 Description of motion parameters of "plane inch" spraying mode

| Number | Parameter | Description |
|---|---|---|
| 1 | Round-trip time | The number of repeated spraying times. The value range is "1- 10". If there is no repeated spraying, enter "0". |
| 2 | Interval number | The turn back times between "first straight line" and "last straight line", with the value range of "1-80". |
| 3 | P1 、P2 、P3 | Three points for "plane inch" spraying which are shown in the figure. (The created point needs to "check" the corresponding tool coordinate system) |
| 4 | Round-trip speed | The back and forth spraying speed in P1-P2 direction, with the value range of "1 -2000" (mm/s). |
| 5 | Inch speed | The operating speed of inch movement section perpendicular to P1-P2, with the value range of "1-2000" (mm/s). |
| 6 | End point to starting point | The running speed from the end point P3 to the starting point P1, with the value range of "1-2000" (mm/s). |
| 7 | Inch motion smoothness - 1,-2 | Smoothness of inch motion curve,value range "0- 100". |
| 8 | Close the oil gun during inch movement section | If "checked", the oil gun will be closed when the inching section is running and will be automatically opened after passing through the inching section. |

## "Arc line" spraying mode

As shown in Figure 19.4, it is the motion parameter setting interface of "arc line" spraying mode, and the parameter description is shown in Table 19.4.

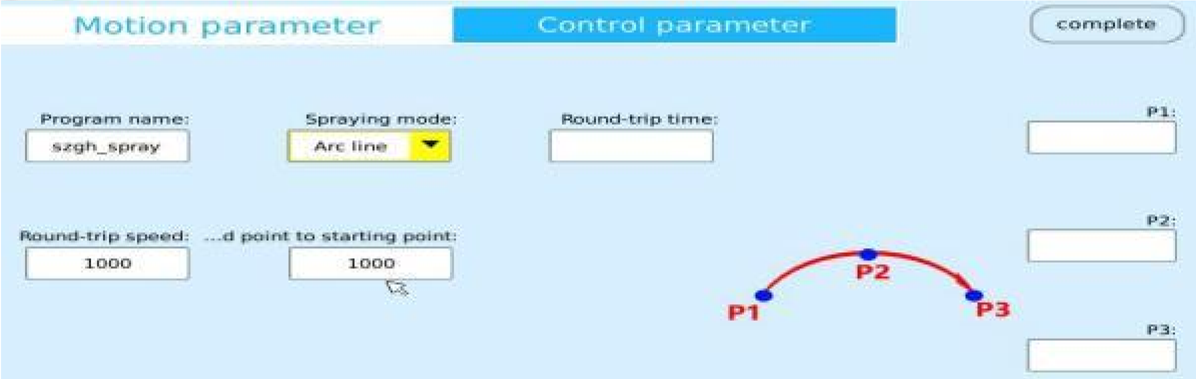



Figure 19.4 "Arc line" spraying mode motion parameter setting interface

Table 19.4 Description of motion parameters of "arc line" spraying mode

| Number | Parameter | Description |
|---|---|---|
| 1 | Round-trip time | The number of repeated spraying times. The value range is "1- 10". If there is no repeated spraying, enter "0". |
| 2 | P1 、P2 、P3 | Three points for "arc line" spraying which are shown in the figure. (The created point needs to "check" the corresponding tool coordinate system) |
| 3 | Round-trip speed | The spraying speed from the starting point to the end point, with the value range of "1-2000" (mm / s). |
| 4 | End point to starting point | The running speed from the end point P3 to the starting point P1, with the value range of "1-2000" (mm/s). |

## "Arc surface" spraying mode

As shown in Figure 19.5, it is the motion parameter setting interface of "arc surface" spraying mode, and the parameter description is shown in Table 19.5.

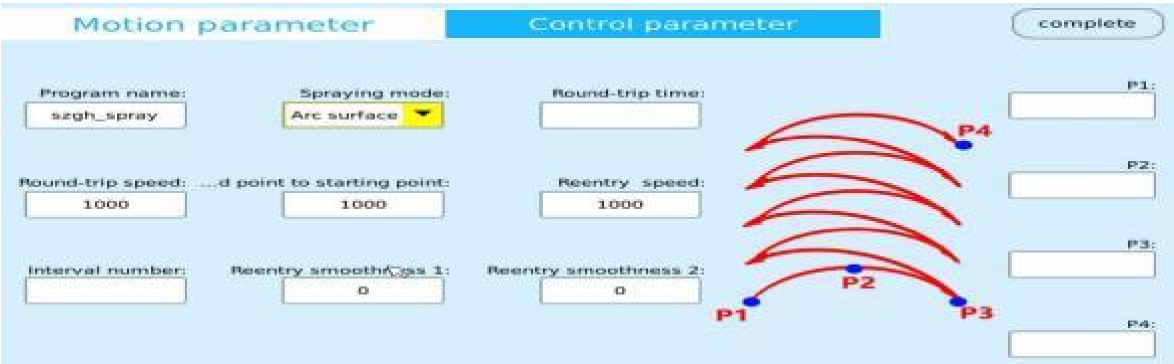



Figure 19.5 "Arc surface" spraying mode motion parameter setting interface

Table 19.5 Description of motion parameters of "arc surface" spraying mode

| Number | Parameter | Description |
|---|---|---|
| 1 | Round-trip time | The number of repeated spraying times. The value range is "1- 10". If there is no repeated spraying, enter "0". |
| 2 | Interval number | The turn back times between "first arc" and "last arc", with the value range of "1-80". |
| 3 | P1 、P2 、P3 、P4 | Four points for "arc surface" spraying which are shown in the figure. (The created point needs to "check" the corresponding tool coordinate system) |
| 4 | Round-trip speed | The spraying speed of P1 moving towards P3, with the value range of "1-2000" (mm/s). |
| 5 | Reentry speed | The spraying speed of turning back from P3, with the value range of "1-2000" (mm/s). |
| 6 | End point to starting point | The running speed from the end point P4 to the starting point P1, with the value range of "1-2000" (mm/s). |
| 7 | Reentry smoothness - 1, - 2 | Smoothness of "reentry" curve, with the value range of "0- 100". |

### "Arc inch" spraying mode

As shown in Figure 19.6, it is the motion parameter setting interface of "arc inch" spraying mode, and the parameter description is shown in Table 19.6.

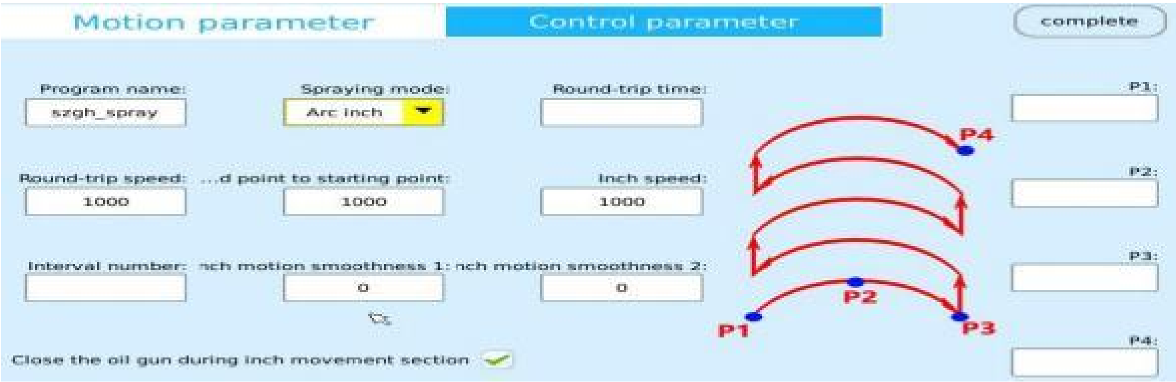



Figure 19.6 "Arc inch" spraying mode motion parameter setting interfaced

Table 19.6 Description of motion parameters of "arc inch" spraying mode

| Number | Parameter | Description |
|---|---|---|
| 1 | Round-trip time | The number of repeated spraying times. The value range is "1- 10". If there is no repeated spraying, enter "0". |
| 2 | Interval number | The turn back times between "first arc" and "last arc", with the value range of "1-80". |
| 3 | P1 、P2 、P3 、P4 | Four points for "arc inch" spraying which are shown in the figure. (The created point needs to "check" the corresponding tool coordinate system) |
| 4 | Round-trip speed | The back and forth spraying speed in P1-P3 direction, with the value range of " 1-2000" (mm/s). |
| 5 | Inch speed | The operating speed of inch movement section in P3 to P4 direction, with the value range of "1-2000" (mm/s). |
| 6 | End point to starting point | The running speed from the end point P4 to the starting point P1, with the value range of "1-2000" (mm/s). |
| 7 | Inch motion smoothness -1, -2 | Smoothness of inch motion curve, value range "0- 100". |
| 8 | Close the oil gun during inch movement section | If "checked", the oil gun will be closed when the inching section is running and will be automatically opened after passing through the inching section. |

## 19.1.2 Control parameter setting

The "control parameters" of the six spraying modes in the "spraying process" of the system are the same, as shown in Figure 19.7.


Figure 19.7 Control parameter setting interface of spraying process package

Table 19.7 Description of control parameters of spraying process package

| Number | Parameter | Description |
|---|---|---|
| 1 | Coordinate system type | If a user coordinate system is created for the spray plane, select the corresponding user coordinate system, which is "base coordinate system" by default. |
| 2 | Delayed time of opening pump | The unit is "milliseconds" (ms). |
| 3 | Delayed time of closing pump | The unit is "milliseconds" (ms). |
| 4 | Output port number of oil pump | Use the I/O port to output "high/low level" to set the "on/off" of "oil pump". |
| 5 | Number of spray guns | The range is " 1-4", that is, up to "4" oil guns can be controlled at the same time. |
| 6 | Output port of spray guns | Set with "number of spray guns". When there are multiple "spray guns", the serial numbers of "spray gun output port" are connected with "-". |

## 19.2 Generate spraying basic program

After setting the "motion parameters" and "control parameters", enter the name of the process package and click the [finish] button. A [generate] button will appear. Click the [generate] button - [OK] generate - automatically generate and save the "spraying" basic program.

# 20 stamping

In the stamping process, multiple robots often cooperate to complete the task, and the sequence control of the input and output processes between the machine tool and multiple robots is cumbersome.

In order to save programming time and minimize the chance of accidents caused by programming errors in manual teaching, SZGH system provides a stamping process package, which only needs to create the corresponding point coordinates in the program to match the actual production position. Programming can be completed.

## 20.1 Stamping line workflow

The stamping production line, according to the control process of the robot, needs to be divided into three types: the first machine, the middle machine (several) and the last machine. The schematic diagram is shown in Figure 20. 1.

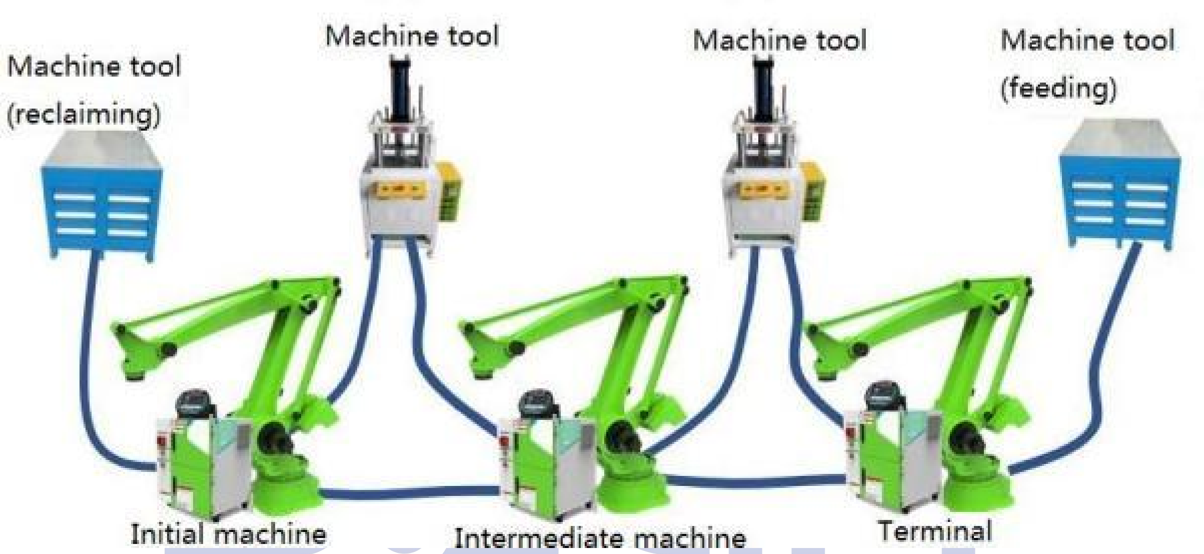



Figure 20. 1 Schematic diagram of stamping line

### 20.1.1 Robot trajectory

On the stamping assembly line, all robots have two steps of picking and unloading, so for each robot, 8 motion trajectory points need to be taught manually when creating a stamping process package.

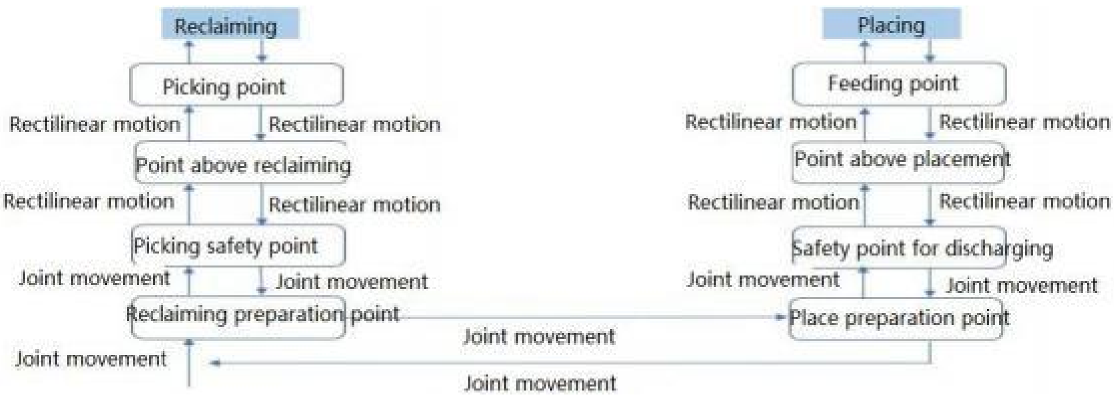



Figure 20.2 Robot motion trajectory process

The robot motion trajectory process is shown in Figure 20.2. in:

For reclaiming: reclaiming preparation point, reclaiming safety point, reclaiming upper point and reclaiming point,

For discharging: preparation point for discharging, safety point for discharging, top point for discharging and discharging point.

## 20.1.2 Different types of robot control process

For the first machine, the middle machine (several) and the last machine on the assembly line, although the motion trajectories are similar, the signal control process is different during the operation.

### (1) The first machine

The first machine cooperates with the reclaiming table at the front end, the machine tool or turning machine at the back end, and a robot at the back according to a certain process.

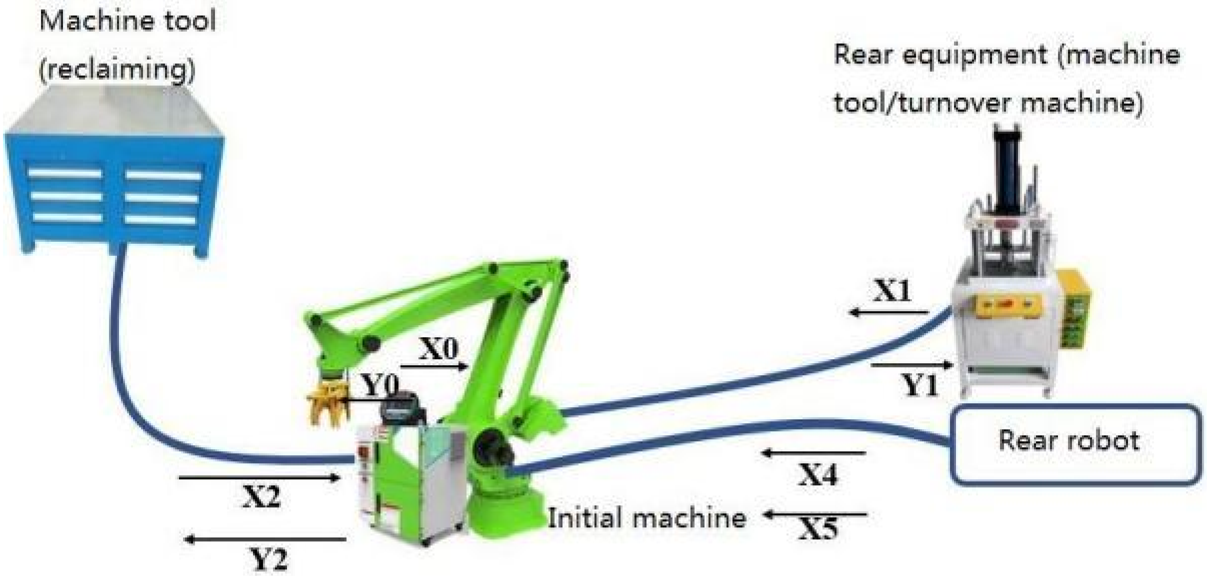



Figure 20.3 Input and output signal connections ofthe first unit

As shown in Figure 20.3, its input and output control includes two parts:Need to interact with the reclaiming machine tool and fixture during the reclaiming process;During the unloading process, it is necessary to interact with the back-end machine tool, fixture and a robot behind.

Table 20. 1 Definition of input and output signals of the first machine

| Connect the device | Signal | Illustrate |
|---|---|---|
| Fixture | Enter X0 | Check the current state of the fixture 0: Release 1: Clamp |
| | Output Y0 | Control clamp action 0: Release 1: Clamp |
| Rear equipment (Machine / Turning Machine) | Enter X1 | Discharge detection |
| | Output Y1 | After the device starts |
| Front equipment (receiving table) | EnterX2 | Retrievable material detection |
| | Output Y2 | Finished taking out the material |
| Post robot | Enter X4 | Rear robot take material interference area detection 0: Rear robot is not in the interference area 1: Rear robot is in the interference area (This area is also the feeding area for the rear equipment of the robot) |
| | Enter X5 | After the robot takes the material and completes the inspection |

The control signal cooperates with the motion process of the robot, as shown in Figure 20.4, to realize the reclaiming and discharging operations of the first machine under the condition of ensuring safety.

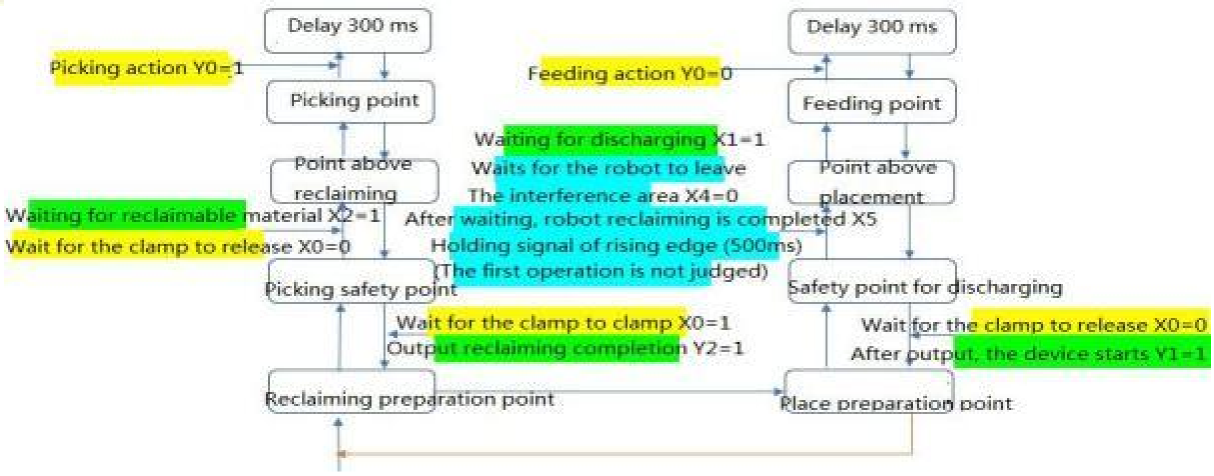



Figure 20.4 The control signal is matched with the motion process of the first machine

## (2) Intermediate machine

For the intermediate machine, as shown in Figure 20.5, the control process of discharging remains unchanged, and the control process of reclaiming has two differences. First, the middle machine needs to be connected to the front robot. The second is that the front equipment is a machine tool or a turning machine, input and output Signals are different.

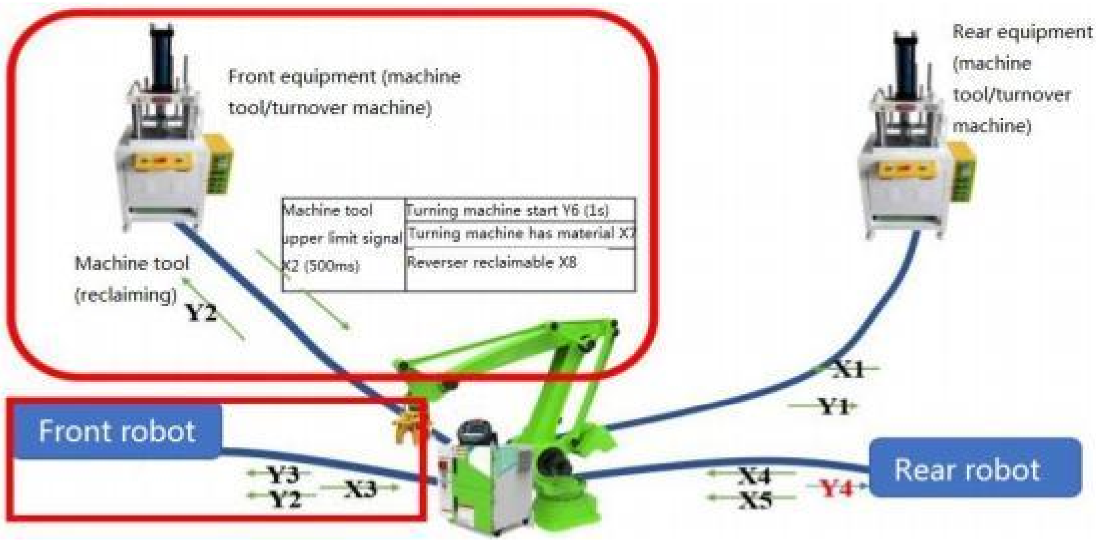



Figure 20.5 Intermediate machine input and output signal connections

The signal input and output process of the reclaiming part is shown in Figure 20.6.

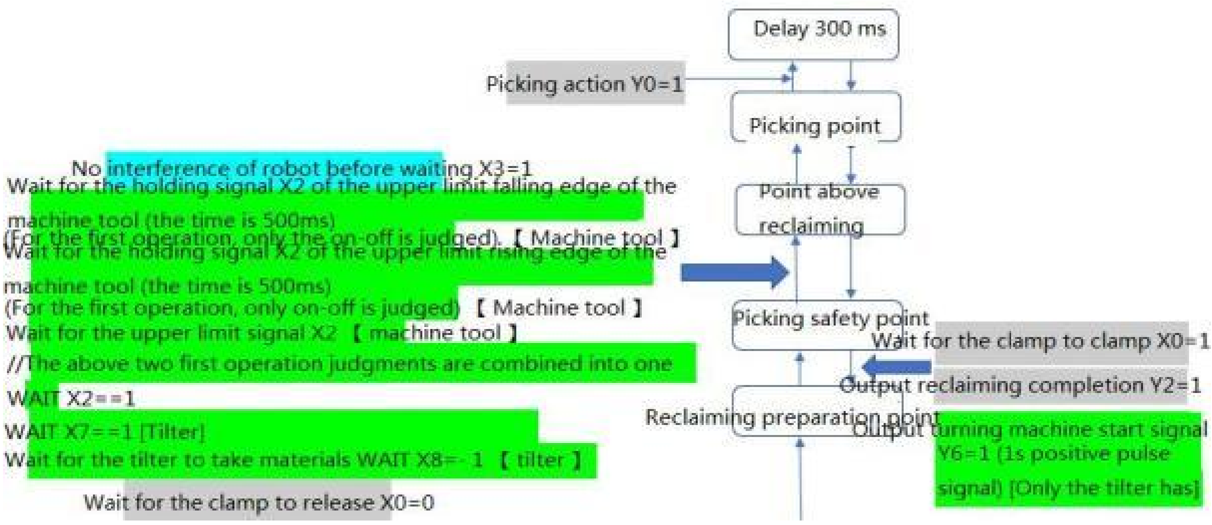



Figure 20.6 The control signal is matched with the motion process of the intermediate machine

### (3) End machine

Compared with the middle machine, the end machine reduces the connection of the rear robot and the start signal of the rear equipment, and its input and output connections are shown in Figure 20.7.

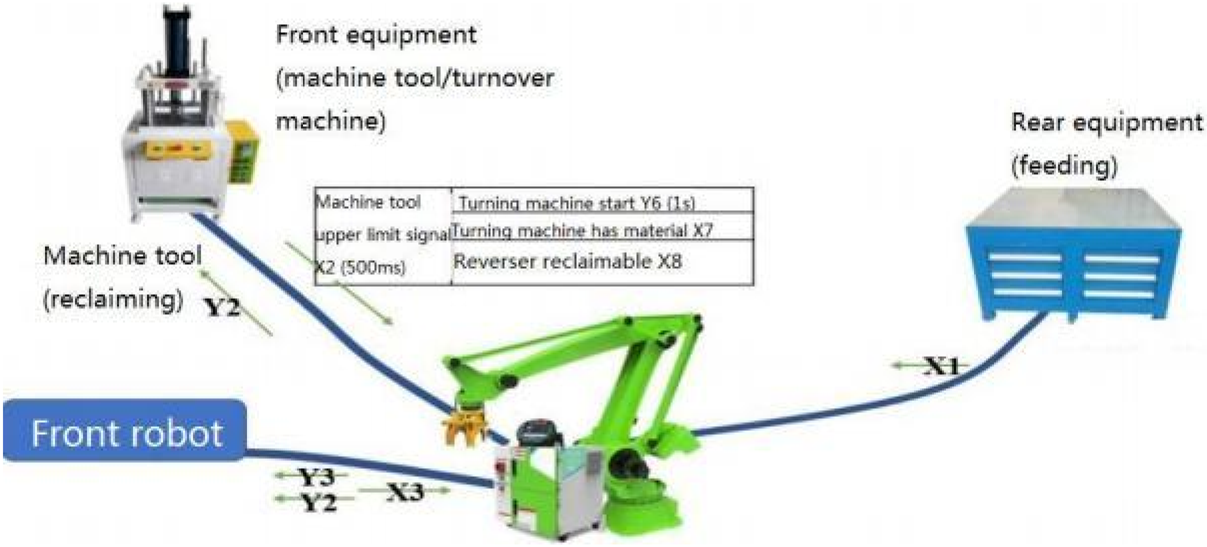



Figure 20.7 Terminal input and output signal connections

## 20.2 Preparations - Setting the Interference Area

Before creating a stamping process package, the first step is to ensure safety, each robot must set an interference area, which will also be required as an input signal when creating a stamping process package.

As shown in Figure 20.8, set the robot in the reclaiming area of the reclaiming machine as the interference area, and set the output to Y3. The previous robot needs to detect this signal before discharging. Set the robot in the feeding area of the feeding machine as the interference area, and set the output to Y4. The latter robot needs to detect this signal before taking the material.

Figure 20.8 Setting the Interference Area of Reclaiming and Discharging

## 20.3 Create a stamping process package

| | Start point | End point | Alarm output port | Enable |
|---|---|---|---|---|
| 1 | 334 | 335 | 17 | |
| 2 | 0 | 0 | 0 | |
| 3 | 0 | 0 | 0 | |
| 4 | 0 | 0 | 0 | |
| 5 | 0 | 0 | 0 | |
| 6 | 0 | 0 | 0 | |
| 7 | 0 | 0 | 0 | |
| 8 | 0 | 0 | 0 | |
| 9 | 0 | 0 | 0 | |
| 10 | 0 | 0 | 0 | |

Click [New] - [Stamping] on the manual interface of the SZGH teach pendant to create their own stamping process packages for the first machine, the middle machine and the last machine. The following takes "intermediate machine" as an example to illustrate the process of creating a stamping process package.

(1) Configure workstation and device signals

As shown in Figure 20.9, select "Intermediate Machine", and the default input and output of the device and related devices have been filled in on the interface. If there is no modification, the hardware connection of input and output can be carried out according to the interface instructions.

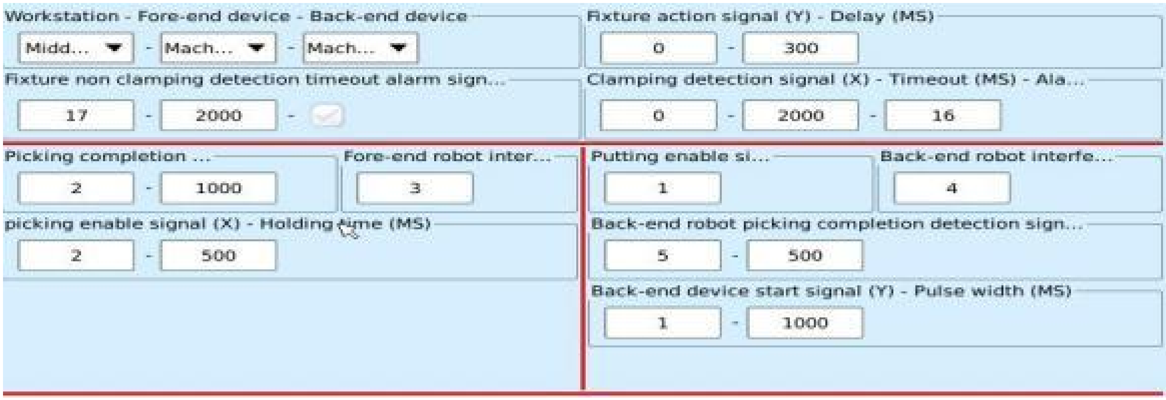



Figure 20.9 Configure the first workstation and input and output signals

(3) Manually teach 8 motion track points

As shown in Figure 20.10, switch to the "Point and Movement" interface. Click the text box below the point to enter the new interface of the point. You can directly create a new point or switch to the reference point by manual teaching for reference. Motion type and speed have given common values, which can be modified in this interface.

| | Picking parameters | | | Picking parameters | | |
|---|---|---|---|---|---|---|
| | Point position | Movement type | Speed | Point position | Movement type | Speed |
| Preparation | | Joint | 3000 | | Joint | 3000 |
| Safety | | Joint | 3000 | | Joint | 3000 |
| Above | | Straight line | 2000 | | Straight line | 2000 |
| picking or putting point | | Straight line | 500 | | Straight line | 500 |

Figure 20. 10 Configure the first machine motion track point

Create a new stamping process package name, click [Save], click [Yes], and the system will automatically generate the basic program file. For the first machine, the middle machine and the last machine, the basic program names will be prefixed with "first", "middle" and "last" respectively.

# Common Alarm of SZGH Robot Driver

| Betrun Series Driver | | |
|---|---|---|
| **Error code** | **Reason** | **Treatment** |
| E.017: Encoder battery voltage is too low Abnormal | Encoder battery voltage is abnormal | Replace the encoder battery and reset the multi-turn value |
| E.037 : Motor overload | The load operation exceeds the inverse time curve of the driver. The reasons are as follows:<br>1. The motor Uvw line or encoder line is bad or the connection is loose;<br>2. The motor is blocked or driven by external force, such as mechanical jamming, collision, gravity or other external force dragging, or the mechanical brake (holding brake) is not opened before running;<br>3. When wiring multiple drivers, the Uvw line and encoder line of the same motor are mistakenly connected to different drivers;<br>4. The load is too large, and the driver or motor is too small;<br>5. There may be a phase loss or the phase sequence is wrong;<br>6. The driver or motor is damaged | 1. Confirm whether there is a problem with the motor Uvw line and encoder wiring;<br>2. Confirm that the motor is not blocked or driven by external force, and confirm that the mechanical brake (holding brake) has been opened;<br>3. Confirm that there is no cross wiring between multiple drivers and motors, that is, there is no motor Uvw line and encoder line connected to different drivers; 4. Extend the acceleration and deceleration time and reselect the appropriate driver or motor;<br>5. Check whether the uvw output of the motor is connected incorrectly and whether it is short-circuited to the ground;<br>6. Replace the driver or motor, |
| E.021 : Motor runaway failure | Due to wiring errors, the control loop diverges, causing the motor to stall. | 1. Check UVW and encoder wiring<br>2. Check the driver and motor, replace if necessary, and contact the manufacturer for inspection |
| E.033: Position deviation is too large | 1. The uvw wiring of the servo motor;<br>2. The servo drive gain is low;<br>3. The frequency of the position command pulse is high<br>4. The acceleration of the position command is too large;<br>5. The position deviation exceeds the position deviation fault value (F01.16). The value set is too small. | 1. Confirm the wiring of the motor main circuit cable and rewire it;<br>2. Confirm whether the servo drive gain is too low and increase the gain;<br>3. Try to reduce the command frequency and then run to reduce the position command frequency, command acceleration or adjust the electronic gear ratio;<br>4. Reduce the command acceleration and then run to |

| | | |
|---|---|---|
| | 6.Servo drive/motor fault | add smoothing functions such as position command acceleration and deceleration time parameters;<br>5. Confirm whether the position deviation fault value (F01.16) is appropriate and set the (F01.16) value correctly;<br>6. Check the running graph in the background. If there is no feedback after input, please replace the servo drive |
| E.007:<br>Encoder initialization failed | Encoder signal abnormality detected during power-on | Check the encoder wiring or replace the encoder cable |
| E.009/010:<br>Overcurrent fault | 1. The command input is synchronized with the servo connection or the command input is too fast;<br>2. The external brake resistor is too small or short -circuited;<br>3. The motor cable has poor contact;<br>4. The motor cable is grounded;<br>5. The motor Uvw cable is short-circuited;<br>6. The motor is burned out;<br>7. The software detects that the power transistor is overcurrent | 1 Check whether the encoder line and power line between the motor driver are connected correctly;<br>1. Measure whether the resistance of the brake resistor meets the specifications, and reselect a reasonable brake resistor according to the instructions;<br>2. Check whether the cable connector is loose and ensure that the connector is tight;<br>3. Check the insulation resistance between the motor vw line and the motor grounding line. Replace the motor if the insulation is poor.<br>4. Check whether the motor cable connection UvW is short-circuited and connect the motor cable correctly;<br>5. Check whether the resistance values between the motor cables are the same. If not, replace the motor.<br>7. Reduce the load. Increase the capacity of the driver and motor, and extend the acceleration and deceleration time |

| M800 series Driver | | |
|---|---|---|
| **Error code** | **Reason** | **Treatment** |
| Er.033 | EtherCAT Communication Error | The master station is not connected, the master station is disconnected, the EtherCAT network cable connection is unreliable, the EtherCAT network cable is disturbed, etc. |
| Er.036/037 | Encoder multi-turn value lost | The absolute encoder is not connected to the battery, or the multi-turn information is lost when the battery is plugged in and out. When the alarm occurs, DS402 statusword bit3=1controlword is set to 0x80 and cannot be cleared. Controlword bit 12 must be set to 1 to clear it. After clearing successfully, statusword bit3=0 |
| Er.034/035 | Encoder battery fault | The battery is low and the encoder battery is not connected; Note: If the battery is not replaced, the fault will be reported again after running for 1 minute after being reset. |
| Er.020 | axies encoder error | Encoder communication is abnormal, encoder wiring is unreliable, encoder interference |
| Er.005/006 | Axis overload | The motor code is wrong, the motor brake is not open, the motor load is blocked, the motor is missing phase, the motor is too small, the load is too heavy, etc. |
| Er.007/008 | Axis motor initialization | The motor encoder is not connected, the encoder cable is abnormal (wiring error), the encoder protocol is abnormal (the motor encoder protocol corresponding to the motor code does not match the actual connected encoder), the current sampling is abnormal, etc. |
| Er.024 | External bus error | External module alarm input |
| Er.002/003 | Axies overcurrent | Motor code error, encoder cable does not correspond to the motor, UVW short circuit, short circuit to ground, power module drive undervoltage, |

| HCFA series Driver | | |
|---|---|---|
| **Error code** | **Reason** | **Treatment** |
| Err.047<br>Motor overload | The load operation exceeds the inverse time curve of the driver. The reasons are as follows:<br>1. The motor UVW line or encoder line is bad or the connection is loose;<br>2. The motor is blocked or driven by external force, such as mechanical jamming, collision, gravity or other external force dragging, or the mechanical brake (holding brake) is not opened before running.<br>3. When wiring multiple drivers, the UVW line and encoder line of the same motor are mistakenly connected to different drivers;<br>4. The load is too large, and the driver or motor is too small.<br>5. There may be a phase loss or the phase sequence is wrong;<br>6. The driver or motor is damaged | 1. Confirm whether there are any problems with the motor UVW line and encoder wiring; 2. Confirm that the motor is not blocked or driven by external force, and confirm that the mechanical brake (holding brake) is open; 3. Confirm that there is no cross wiring between multiple drivers and motors, that is, the UVW line and encoder line of a motor are not connected to different drivers; 4. Extend the acceleration and deceleration time, and reselect a suitable driver or motor; 5. Check whether the UVW output of the motor is connected incorrectly or short-circuited to the ground; 6. Replace the driver or motor |
| Err.007: Incremental encoder UVW data abnormal | Encoder signal abnormality detected during power-on | Check the encoder wiring or replace the encoder cable |
| Err.012: Incremental photoelectric encoder Z wire is broken or the number of turns of the absolute encoder is abnormal | Incremental encoder:<br>1. Abnormal Z signal reception, poor Z signal line connection or encoder failure causes Z signal loss; Absolute encoder:<br>2. Insufficient battery power for the absolute encoder;<br>3. Parameter P06.47 = 1 (set to absolute system) without encoder initialization;<br>4. During the power-off period of the drive, the encoder motor terminal wiring is plugged in or out | 1. Manually rotate the motor shaft. If the fault still occurs, check the encoder wiring, rewire or replace the cable, or replace the encoder and power on again. 2. Make sure the battery is normal. If the battery voltage is insufficient, replace the battery. 3. Initialize the number of turns with P20.06 = 7 and power on again. 4. Initialize the number of turns with P20.06 = 7 and power on again. |
| | 1. UVW connection of servo motor;<br>2. Low gain of servo drive;<br>3. High frequency of position command pulse;<br>4. Too large acceleration of position command;<br>5. Position deviation | 1. Confirm the wiring of the motor main circuit cable and rewire it;<br>2. Confirm whether the servo drive gain is too low and increase the gain;<br>3. Try to reduce the command frequency and |

| | | |
|---|---|---|
| Err.043: Position deviation is too large | exceeds the value set for position deviation fault value (P00.19) and is too small;<br>6. Servo drive/motor fault;<br>7. Abnormal release of brake, motor stall or driven by external force, such as mechanical jam, collision, gravity or other external force drag. | then run it. Reduce the position command frequency, command acceleration or adjust the electronic gear ratio;<br>4. Reduce the command acceleration and then run it. Add smoothing functions such as position command acceleration and deceleration time parameters;<br>5. Confirm whether the position deviation fault value (P00.19) is appropriate and set the (P00.19) value correctly;<br>6. Check the running graph in the background. If there is input but no feedback, please replace the servo drive.<br>7. Check the wiring and brake power supply, confirm whether the brake is normal, and confirm that the motor is not blocked or driven by external force. |
| Err.015: Encoder battery voltage is too low | The encoder battery voltage is lower than the threshold set by P06.48, and the tens digit of P06.47 is set to 1 | Change encoder buttery |
| Err.009/010 : overcurrent alarm | 1. The command input is synchronized with the servo connection or the command input is too fast<br>2. The external brake resistor is too small or short -circuited<br>3. The motor cable is grounded<br>4. The motor UVW cable is short-circuited<br>5. The motor is burned out:<br>6. The motor cable has poor contact<br>7. The software detects that the power transistor is over-charged | 1. Check the command input sequence, and input the command after connecting "rdy" to the same service<br>2. Measure whether the resistance of the brake resistor meets the specifications, and reselect a reasonable brake resistor according to the requirements of the manual;<br>3. Check whether the cable connector is loose, and ensure that the connector is tight;<br>4. Check the insulation resistance between the motor UVW line and the motor grounding line. Replace the motor if the insulation is poor;<br>5. Check whether the motor cable connection UVW is short-circuited and connect the motor cable correctly;<br>6. Check whether the resistance values between the motor cables are the same. If they are |

| | | |
|---|---|---|
| | | different, replace the motor;<br>7. Reduce the load.<br>Increase the drive and motor capacity, and extend the acceleration and deceleration time |

# Welding Robot Precautions

## ONE: New function------Run from the specified current line

1 Program starts. During the welding process, if you press the pause button in the upper right corner, the welding stops. Press the continue button and the program continues to weld from this point until the program ends.

2 During the welding process, if you press the stop button, click "Run from the specified current line" in the "Menu" in the lower right corner, and the program continues to execute from this position until the program ends.

## TWO: Appointment function------Configuration-Port configuration-Appointment function

1 Trigger input port: External control button, press the button, the program is successfully scheduled, press the second button to cancel the appointment. If the stop button is pressed during the program execution, the program needs to be re-scheduled before it can be executed.

2 Appointment indicator: System output port, the indicator light flashes after the program is successfully scheduled.

## THREE: Arc swing function

1 When swinging the arc, the arc radius>2mm, when the arc and Z-shaped, the amplitude<5mm

2 When the welding speed is slow (speed=8), the left and right dwell time is about 300-500.

3 When the welding speed is fast (speed = 15), the dwell time is about 100 milliseconds.

## FOUR:Debugging of the Magenice welding machine

1 Unified: A (wire feeding speed, panel display 0-24), V (28-30 equivalent to 7.5V)

2 Separately: A (wire feeding speed, panel display 0-24), V (actual welding voltage)

3 Welding parameters: arc starting A/V, no-load A/V, welding A/V are the same. Welding A/V > Arc Ending A/V

4 Increase arc ending voltage: There is a ball at the end of the welding wire/the welding wire sticks to the workpiece

5 Arc ending current: determines the remaining amount of welding wire

6 Arc starting time - 500 (adjusted according to actual conditions), arc ending time - 100 (adjusted according to actual conditions)

7 Arc starting detection failed, the welding wire exploded as soon as it came out of the wire. Reasons:

a The arc starting voltage is too high (wire jumping), reduce the arc starting voltage b The welding wire quality is too poor

## 5 Arc starting time:

Set the arc starting current and voltage holding time. If the setting is too large, there will be surfacing at the beginning of the weld

Arc ending time: Set the arc ending current and voltage holding time. If the setting is too large, there will be surfacing at the end of the weld
For example: the plate thickness is 1mm, process configuration:
Actual welding current (80-100A), actual welding voltage (16-18V), welding speed (10-15)

## 6: The welding machine is configured by the customer

1: Control steps: two steps
2: Two analog channels: 0-10V.
3: Control signal configuration (wire feeding, gas feeding, gun firing, arc detection, etc.).

## 7: Welding gas and material selection

Carbon steel 1 $CO_2$ shielded welding: $CO_2$ content is above 99.9%
2 MAG: argon 80%, $CO_2$ 20% (pulse ratio)
3 DC welding is better
Stainless steel: (MIG = melting electrode inert shielded welding) argon 98%, $CO_2$ 2% (304 and 306 are ordinary welding wires, 308 and above have better effects)
Pulse welding is better
Aluminum welding: (MIG) 99.99% argon (the wire feed tube is hard, change to a soft wire feed tube)
Argon arc welding: (TIG = non-melting electrode inert shielded welding, commonly known as argon arc welding) Argon

**8:** Vertical welding must be welded from top to bottom;
vertical welding is slower than flat welding; the arc current of vertical welding is slightly larger than that of flat welding to ensure that the welding wire remains at the same length after arc closure.

**9:** If the weld is smaller than the wire diameter, the welding gun can be welded vertically at an angle, or at other angles. If the welding wire diameter is concerned, it is best to push welding in the form of swing welding, or weld at an angle.

**10:** The gas pressure should be maintained within the range of 8-10/min, and the gas protection range should be 2-4CM

**11:** Pulse welding is instantaneous voltage of more than 25V, instantaneous current of more than 300A, and it is only needed for welding thick plates. DC welding is usually used. Welding

**12:** When testing the welding machine, if the manual wire feeding only runs for a period of time, it proves that the arc starting and wire feeding signals of the welding machine are connected in reverse.

**13:** When doing welding swing arc, you must make a tool coordinate system (six-point calibration method). After it is done, the swing arc will swing according to the plane of the welding nozzle.

**14:** When making a circle, a circle can be divided into two arcs for welding. The smoothness of welding depends on whether the tool coordinate system is well done.

**15:** Meganice welding pulse welding uses a 90:10 mixed gas.

**16:** When welding two different plates, aiming the welding gun at the thick plate for welding is conducive to welding and prevents welding through.

**17:** At the beginning of arcing, the end of the welding wire breaks the arc with a snap and the arcing fails. At this time, the arcing voltage should be increased.

**18:** Vertical welding is slightly slower than horizontal welding.

**19:** When welding, it is found that the welding is not strong and stable, which proves that the welding voltage is adjusted too low.

**20:** The welding voltage determines the welding width, and the welding current determines the welding wire feeding speed.

**21:** The larger the welding current, the larger the required shielding gas flow rate should be.

**22:** The welding methods are divided into short-circuit welding, single-pulse welding, and double-pulse welding. Carbon steel welding is mostly short-circuit welding and single-pulse welding. Single-pulse welding is mainly used to weld stainless steel and aluminum, and double-pulse welding is mainly used to weld aluminum. Generally, the aluminum weld of single-pulse welding is bulging, and the impact force of double-pulse welding is large, which can weld a smoother weld and the fish scale pattern is clearer.

**24:** The weld needs to swing the arc if it is larger than 1MM, and the welding plate cannot swing the arc if it is smaller than 1MM.

**25:** Welding machines are all constant voltage sources. When the load (arc) changes, the current should change accordingly.

**26:** Push welding has high penetration and large spatter, while pull welding has low penetration and small spatter. You can choose it by yourself when welding different products (especially thin plates).

**27:** Deposition rate

**28:** Welding inspection includes: flaw detection and gas detection.

**29:** The higher the concentration of argon gas, the more heat it will generate and the faster it will melt.

**30:** When the welding current is greater than 200A, it is best to use a water-cooled gun or use it intermittently.

**31:** If you want to see different welding success rates at different times, you must first check whether the three-phase electricity is balanced, and sometimes the multimeter cannot measure it. Or there is a problem with the welding nozzle.

# Comparison of various types of welding

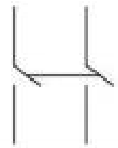
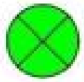
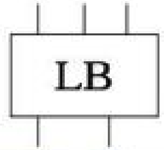
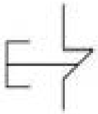
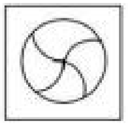
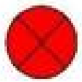
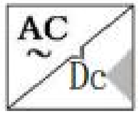
1. MIG and MAG, the welding wire is fed from the welding gun through an automatic wire feeder, which is suitable for automatic welding and can also be manually welded.
2. The main difference between MIG and MAG is the shielding gas. The equipment is similar, but the former is generally protected by argon gas, which is suitable for welding

non-ferrous metals; the latter uses carbon dioxide active gas in argon gas, which is suitable for welding high-strength steel and high-alloy steel.

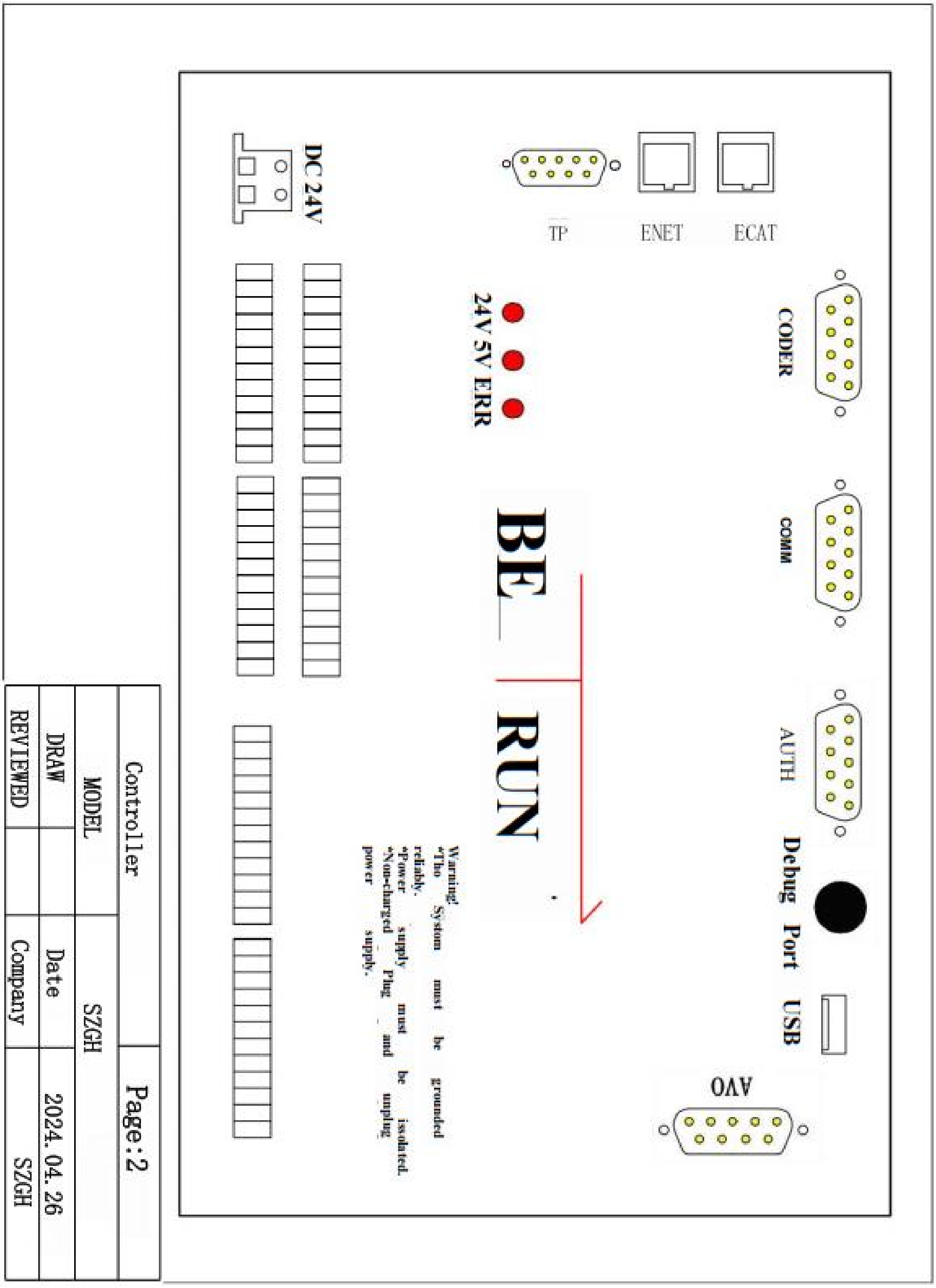
3. TIG and MIG are both inert gas shielded welding, commonly known as argon arc welding. The inert gas can be argon or helium, but argon is cheap, so it is commonly used, so inert gas arc welding is generally called argon arc welding.

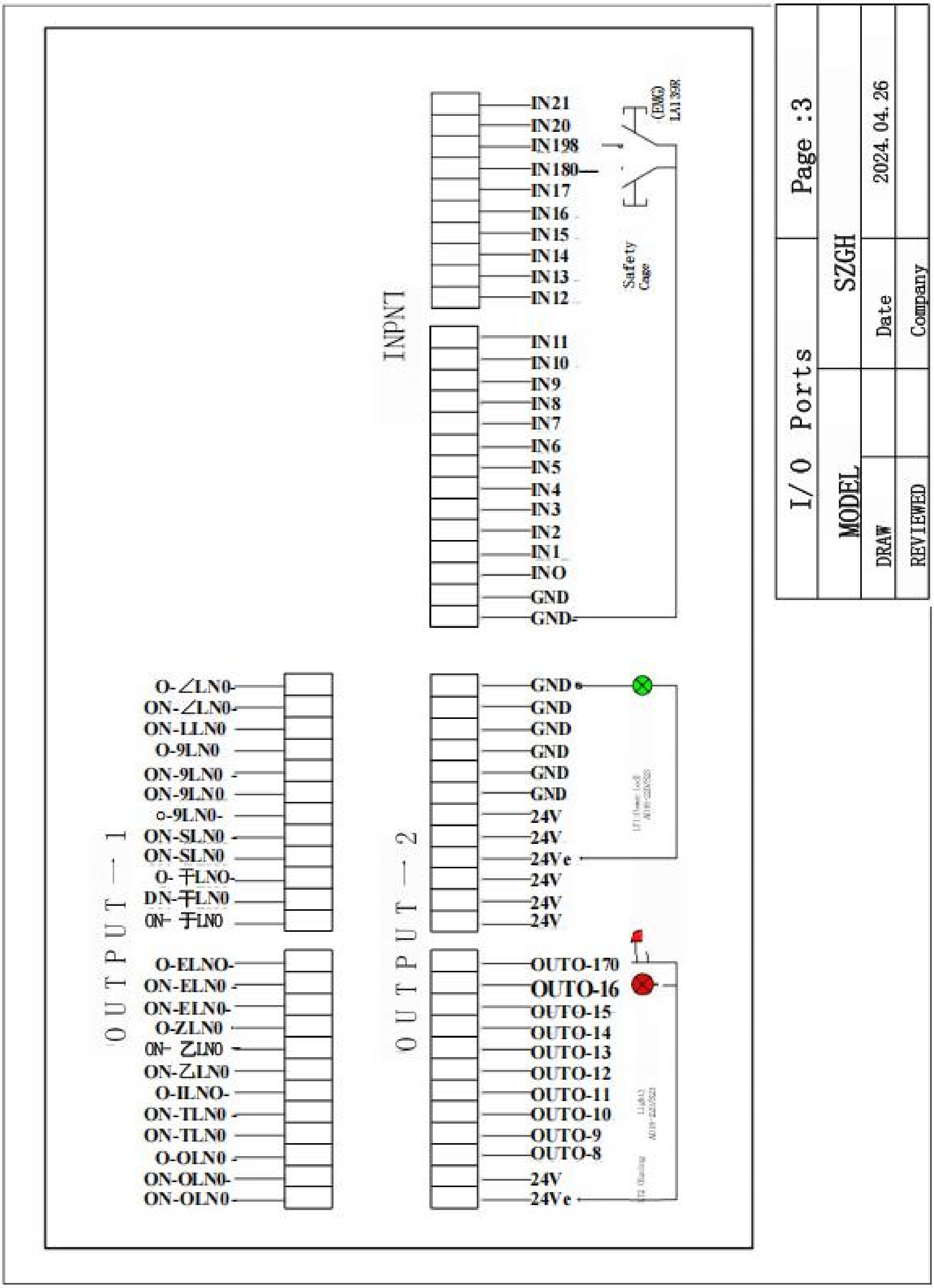
Comparison between MIG and TIG MIG (metal inert gas shielded welding) uses a melting electrode and an external gas as an arc medium to protect the metal droplets, welding pool and high-temperature metal in the welding area. The arc method is called metal inert gas shielded arc welding, and the arc welding method using a solid inert gas (Ar or He) is called metal inert gas shielded welding, referred to as MIG welding. MIG welding is the same as other TIG welding, except that a metal wire is used instead of the tungsten electrode in the welding torch. Therefore, the welding wire is melted by the arc and fed into the welding area. The electric drive roller feeds the welding wire from the spool into the welding torch as required for welding. The heat source is also a DC arc, but the polarity is exactly opposite to that used in TIG welding. The shielding gas used is also different. 1% oxygen should be added to the argon gas to improve the stability of the arc. Like TIG welding, it can weld almost all metals, especially suitable for welding aluminum and aluminum alloys, uranium and copper alloys, and stainless steel. There is almost no oxidation and burning during the welding process, only a small amount of evaporation loss, and the metallurgical process is relatively simple.

# Robot Electrical Schematic

| Symb. | Code | Name | Symb. | Code | Name |
|---|---|---|---|---|---|
|  | QS1 | 2P Air SW. |  | LT2 | Runing Light |
| | FU | FUSE |  | LB | Filter Element |
|  | SA | Knob Switch |  | BU | Alarm Lamp |
|  | SM | Serv0 Motor |  | FAN | FAN |
|  | LT1 | Power Led |  | PS1 | Power Supply |

| Electrical Parts | | | Page:1 |
|---|---|---|---|
| MODEL | | SZGH | |
| DRAW | | Date | 2024.04.26 |
| REVIEWED | | Company | SZGH |


TP
ENET
ECAT
DC 24V
CODER
COMM
AUTH
Debug Port
USB
24V 5V ERR
BE
RUN
Warning!
*The System must be grounded reliably.
*Power supply must be isolated.
*Non-charged Plug and unplug power supply.
Controller
Page:2
MODEL
SZGH
DRAW
Date
2024.04.26
REVIEWED
Company
SZGH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IN21
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IN198
IN180
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IN16
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IN13
IN12
IN11
IN10
IN9
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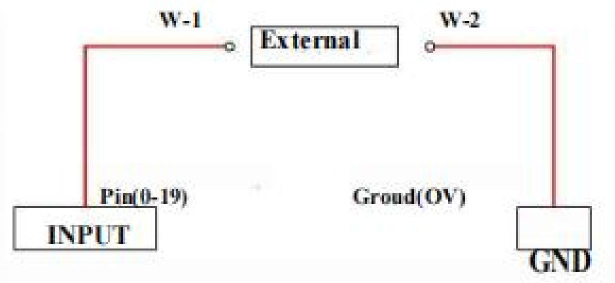
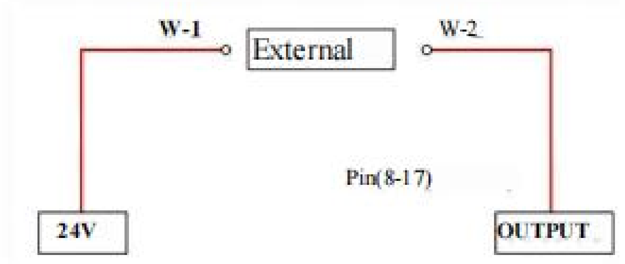
IN7
IN6
IN5
IN4
IN3
IN2
IN1
INO
GND
GND
(EMG)
LA139R
Safety
Gage
OUTPUT—1
OUTPUT—2
GND
GND
GND
GND
GND
GND
24V
24V
24Ve
24V
24V
24V
OUTO-170
OUTO-16
OUTO-15
OUTO-14
OUTO-13
OUTO-12
OUTO-11
OUTO-10
OUTO-9
OUTO-8
24V
24Ve
I/O Ports
Page :3
MODEL
SZGH
DRAW
Date
2024. 04. 26
REVIEWED
Company

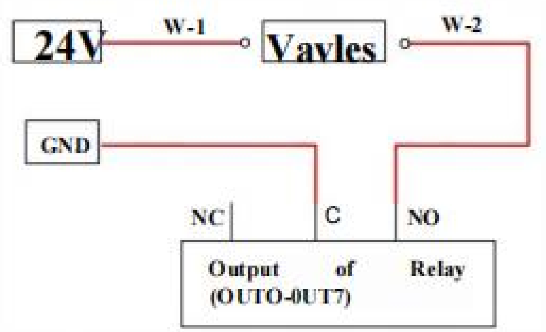
# System I/O Type




**1:20-Optocoupler isolation**
**24V-Standard**




**2:10-Open collector outputs**




**3:8-Outputs with relays**

| I/O Wiring | | | Page:4 |
|---|---|---|---|
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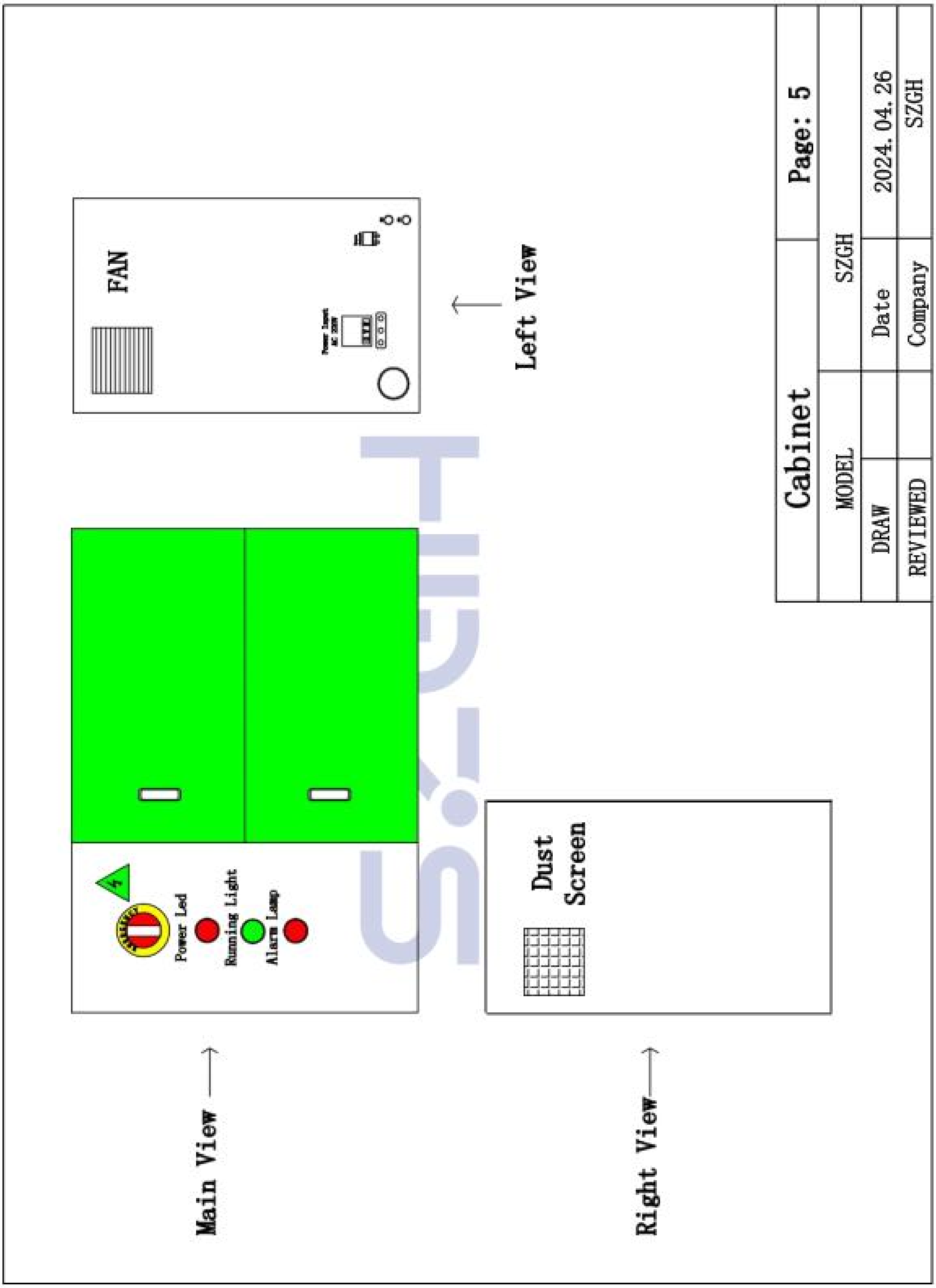
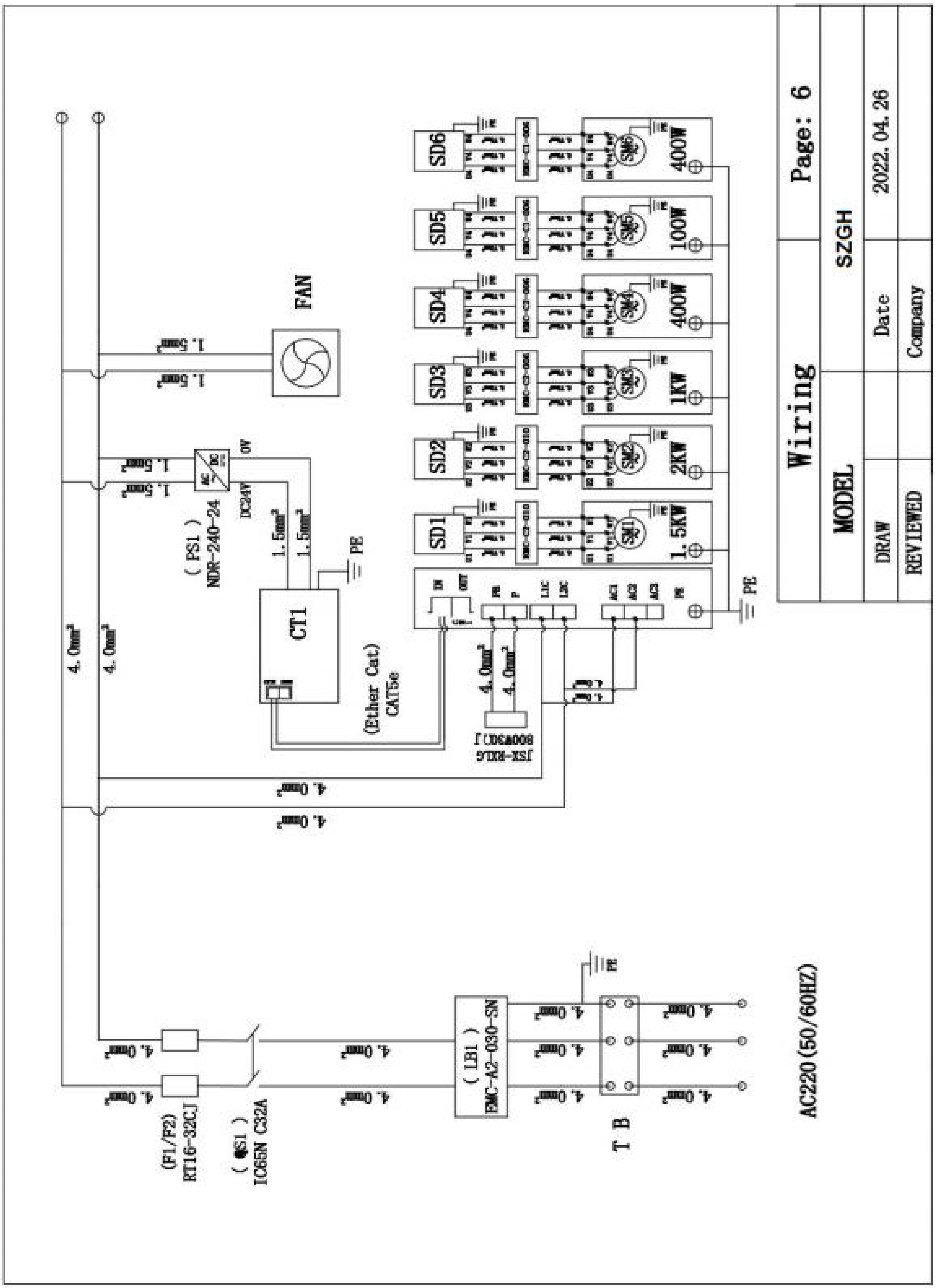
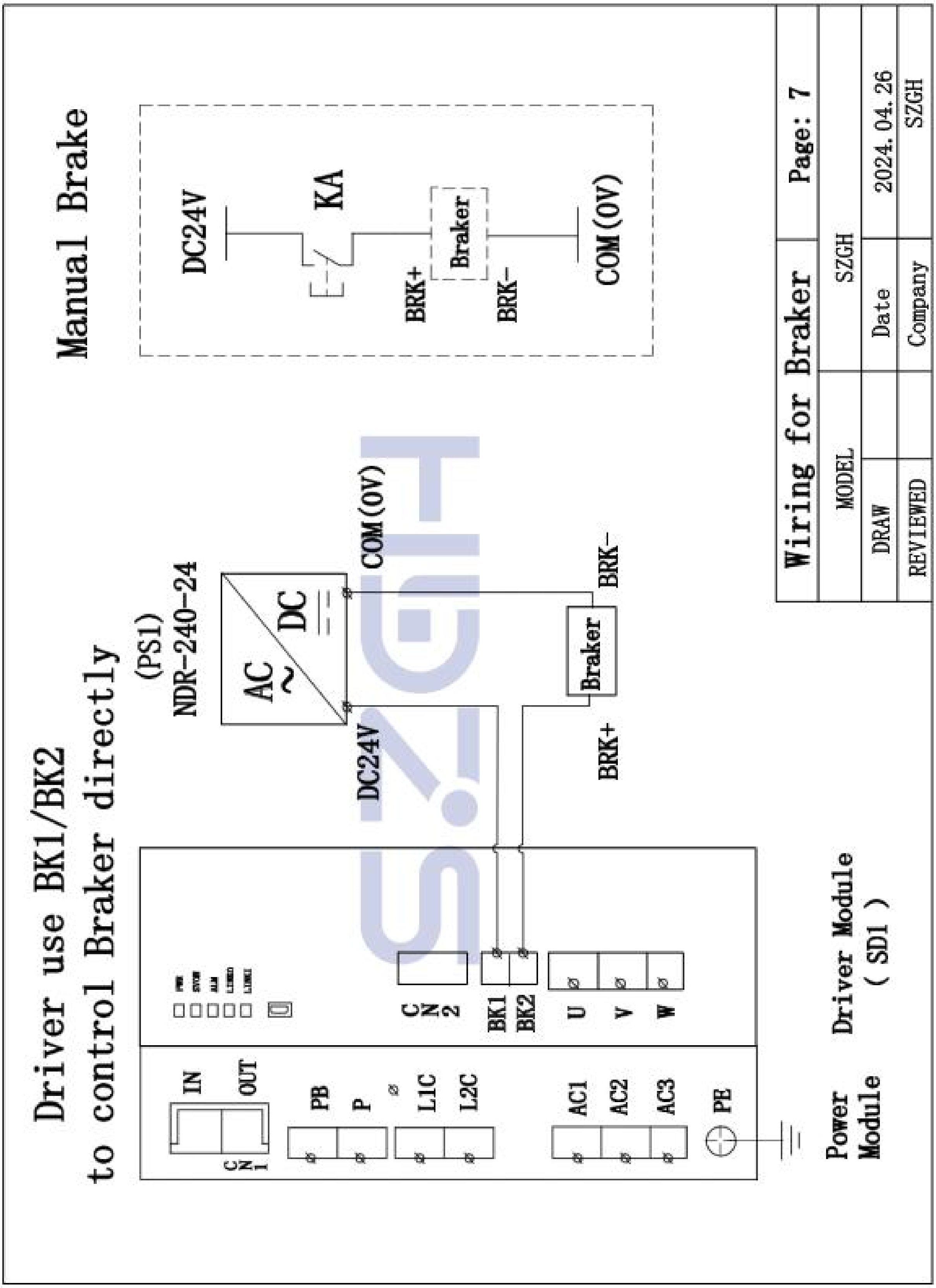
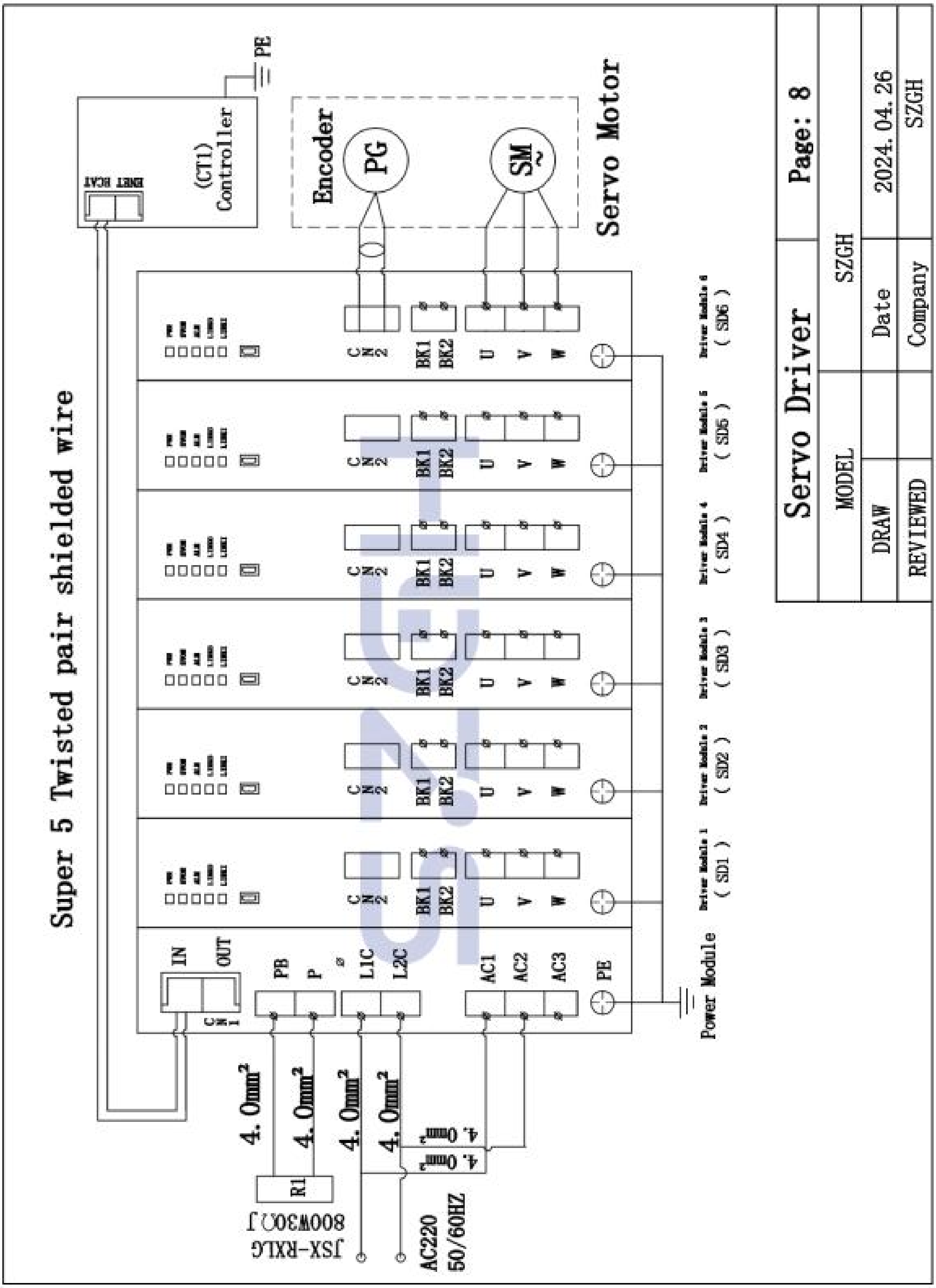
| DRAW | | Date | 2024. 04. 26 |
| REVIEWED | | Company | SZGH |


FAN
Left View
Main View
Power Led
Running Light
Alarm Lamp
Dust Screen
Right View
Cabinet
Page: 5
MODEL
SZGH
DRAW
Date
2024.04.26
REVIEWED
Company
SZGH


Wiring
Page: 6
MODEL
SZGH
DRAW
Date
2022. 04. 26
REVIEWED
Company
FAN
SD1
SD2
SD3
SD4
SD5
SD6
1. 5KW
2KW
1KW
400W
100W
400W
CT1
(Ether Cat)
CAT5e
( PS1 )
NDR-240-24
DC24V
0V
PE
JSX-RXLG
800W30Ω J
( LB1 )
EMC-A2-030-SN
T B
(F1/F2)
RT16-32CJ
( QS1 )
IC65N C32A
AC220 (50/60HZ)
4. 0mm²
1. 5mm²


Driver use BK1/BK2
to control Braker directly
(PS1)
NDR-240-24
AC
~
DC
DC24V
COM(0V)
BRK+
BRK-
Braker
Manual Brake
DC24V
KA
BRK+
Braker
BRK-
COM(0V)
CN1
IN
OUT
PB
P
L1C
L2C
AC1
AC2
AC3
PE
CN2
BK1
BK2
U
V
W
Power Module
Driver Module
( SD1 )
Wiring for Braker
Page: 7
MODEL
SZGH
DRAW
Date
2024.04.26
REVIEWED
Company
SZGH


Super 5 Twisted pair shielded wire
(CT1) Controller
ENET ECAT
PE
Encoder
PG
SM
Servo Motor
CN2
BK1
BK2
U
V
W
Driver Module 1 ( SD1 )
Driver Module 2 ( SD2 )
Driver Module 3 ( SD3 )
Driver Module 4 ( SD4 )
Driver Module 5 ( SD5 )
Driver Module 6 ( SD6 )
Power Module
IN
OUT
CN1
PB
P
L1C
L2C
AC1
AC2
AC3
PE
4.0mm²
R1
JSX-RXLG
800W30Ω J
AC220
50/60HZ
Servo Driver
Page: 8
MODEL
SZGH
DRAW
Date
2024.04.26
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Company
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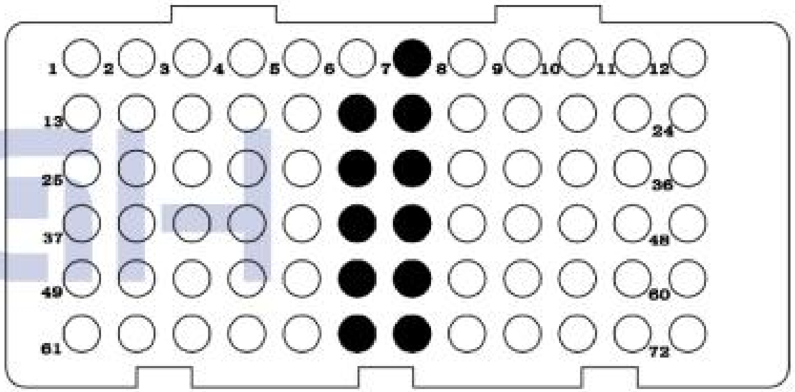
## Wiring Table (Female)

| Name | Signal | Pin | Name | Signal | Pin |
|---|---|---|---|---|---|
| J1-Motor | U1 | 1 | J1-Encoder | 5V1 | 12 |
| | V1 | 2 | | 0V1 | 11 |
| | W1 | 3 | | P+1 | 10 |
| | PE1 | 4 | | P-1 | 9 |
| J2-Motor | U2 | 13 | | PE1 | 8 |
| | V2 | 14 | J2-Encoder | 5V2 | 24 |
| | W2 | 15 | | 0V2 | 23 |
| | PE2 | 16 | | P+2 | 22 |
| J3-Motor | U3 | 25 | | P-2 | 21 |
| | V3 | 26 | | PE2 | 20 |
| | W3 | 27 | J3-Encoder | 5V3 | 36 |
| | PE3 | 28 | | 0V3 | 35 |
| J4-Motor | U4 | 37 | | P+3 | 34 |
| | V4 | 38 | | P-3 | 33 |
| | W4 | 39 | | PE3 | 32 |
| | PE4 | 40 | J4-Encoder | 5V4 | 48 |
| J5-Motor | U5 | 49 | | 0V4 | 47 |
| | V5 | 50 | | P+4 | 46 |
| | W5 | 51 | | P-4 | 45 |
| | PE5 | 52 | | PE4 | 44 |
| J6-Motor | U6 | 61 | J5-Encoder | 5V5 | 60 |
| | V6 | 62 | | 0V5 | 59 |
| | W6 | 63 | | P+5 | 58 |
| | PE6 | 64 | | P-5 | 57 |
| Braker | BK1 | 5 | | PE5 | 56 |
| | BK2 | 17 | J6-Encoder | 5V6 | 72 |
| | BK3 | 29 | | 0V6 | 71 |
| | BK4 | 41 | | P+6 | 70 |
| | BK5 | 53 | | P-6 | 69 |
| | BK6 | 65 | | PE6 | 68 |
| | 24V | 6 | | | |

## Define for Single Peer Line (Female)




| Wiring Peer Line | | Page: 9 | |
|---|---|---|---|
| MODEL | | SZGH | |
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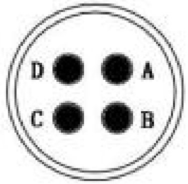
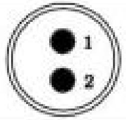
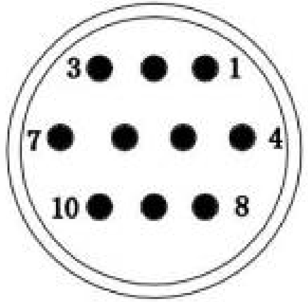
# ≧1KW Motor Aviation Plug Define

| Name | Pin | Define | Explanation | Picture |
|---|---|---|---|---|
| Motor Input | A | U | U Phase |  |
| | B | V | V Phase | |
| | C | W | W Phase | |
| | D | PE | Ground | |
| Braker | 1 | BRK+ | Braker-24V |  |
| | 2 | BRK- | Braker-GND | |
| Encoder (Absolute) | 1 | +5V | Encoder Power |  |
| | 2 | GND | Signal Ground | |
| | 4 | BAT+ | Battery + | |
| | 5 | +P | Communication Date+ | |
| | 6 | -P | Communication Date- | |
| | 9 | BAT- | Battery GND | |

| Wiring(Motor/Braker) | | Page: 10 | |
|---|---|---|---|
| MODEL | | SZGH | |
| DRAW | | Date | 2022. 04. 26 |
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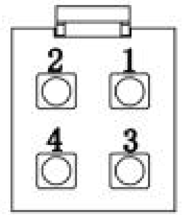
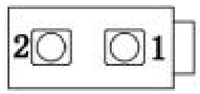
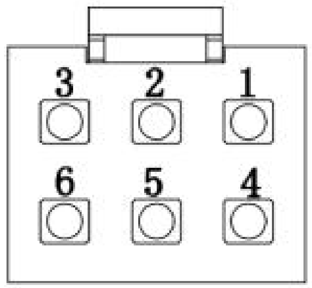
# ≦750W Motor Aviation Plug Define

| Name | Pin | Define | Explanation | Picture |
|---|---|---|---|---|
| Motor Input | 1 | U | U Phase |  |
| | 2 | V | V Phase | |
| | 3 | W | W Phase | |
| | 4 | PE | Ground | |
| Braker | 1 | BRK+ | Braker-24V |  |
| | 2 | BRK- | Braker-GND | |
| Encoder (Absolute) | 1 | BAT+ | Battery + |  |
| | 2 | +P | Communication Date+ | |
| | 3 | -P | Communication Date- | |
| | 4 | +5V | Encoder Power | |
| | 5 | GND | Signal Ground | |
| | 6 | FG | Shield Cover | |

| Wiring(Motor/Braker) | | Page: 11 | |
|---|---|---|---|
| MODEL | | SZGH | |
| DRAW | | Date | 2024.04.26 |
| REVIEWED | | Company | SZGH |