Technical reference

MODEL

Name: Pulse Type 8-axis Control System

Series: Industrial Robot Control System

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Version and Function List

Publishing Time	**Version Number**	**Newly Increased Function**	Marking
2016-8-28	V1.0	First edition	
2019-1-6	V2.0	1. Selection of machine models; 2. Palletization procedure, welding procedure and stamping procedure; 3. Swing arc function; 4. Flexible to set the zero position and return to zero-bit point for each axis. 5. Resume factory settings for each module; 6. Screen alignment function; 7. Functional configuration; 8. Interfering in the establishment of the regional safe areas; 9. Program reservation function; 10. Communication protocol settings; 11. Curve Properties Definition; 12. Custom alert function.	

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1. Terms, Definitions, Symbols and Abbreviations

In order to facilitate use of the control system for users, the system explains some terms, definitions, symbols, and abbreviations that are involved in the use procedure.

1.1 Point

The “point position” indicates the position and posture of the end of the robot in space.

1.2 Angle of Articulation

Reading of “angle of articulation” indicates reading of the position and posture of the current “point” in space, and the angle of articulation is expressed in “degrees”. When using a 6-axis robot, it is indicated by 6 articulation angle degrees, i. e. the “6-dimension” angle (“J7” and “J8” are the angles of articulation of “0 degree” by default); When additional axes J7 and J8 are used, they extend to "8-dimensional" and need to read the angle of additional axis.

1.3 Coordinate value

Reading the “coordinate value” of the “point” also represents the position and status of the current “point” in space, expressed in a “base coordinate system” and shown through “X”, “Y”, and “Z” space coordinate system, and the unit is “millimeter”.

1.4 Procedure

A series of statements and instructions of operation of the system according to steps of procedure establishment and for achieving the intended purpose includes the creation, management, and operation of the procedure.

1.5 Machine Parameters

The control system needs to set up “machine parameter” before operation, including the setting of machine parameters such as “connecting rod length”, “reduction ratio”, “joint positive/negative limit”, “maximum speed”, “PNOUT”, “PNIN”, and “encoding direction” etc..

1.6 Coordinate System

In the control system, there are two coordinate systems,"joint coordinate system" and "base coordinate system". Users can also create "user coordinate system" and "tool coordinate system" on their own.

1.7 I/O Interface

The control system is provided with 8-path relay outputs, 10-path collector open circuits, and in total 18-path I/O output ports. The initial state defaults to low level “0”; A 20-path “optical coupling” isolated input port is provided, the initial state defaults to low-level “0”.

1.8 Analog Output

The control system provides 4 analog channels of “0”, “1”, “2” and “3”. The analog value can be output, and the analog value range is 0V-12 V.

1.9 Additional Axis

The control system is provided with 8 pulse driver interfaces of “J1– J8”, six interfaces are used in normal usage, that is to say, “6-axis robot”, so that when the “J7” and the “J8” are connected to the driver interface external articulation shaft, it is also referred to as an“additional axis”. The “J7” shaft is configured as an “additional axis_0” in the control system, and the “J8” shaft is configured as an “additional axis_1”.

1.10 Zero Angle

Setting the system “zero angle” is a very important step in preparatory work before the system is running, because when reading the articulation angle of the “point”, it is positioned taking the set “zero angle” as the reference point.

1.11Task Type

The task types of the control system mainly include motion instruction, basic instruction, process instruction, function instruction, logic instruction and sub-path call 6 types.

1.12 Type of Motion

When applying curve motion task type, the system provides four kinds of motion types: joint motion, linear motion, circular arc motion and circular motion.

1.13 Process

The control system adopts a complicated and mode-fixed work-flow, and forms a “process package” (hereinafter referred to as “process”) through internal “collection”, so that the user can easily finish the originally complicated and cumbersome work. The current system process supports “spraying procedure”, “palletization procedure”, “welding procedure” and “stamping procedure”.

1.14 Function

The control system provides three functions of "tracking", "swing arc" and "synergy". In the task type of "functional instruction" of creating "program", it is flexible to choose whether to use any of the three functions or not.

1.15 Safe area

The “safe area” in the control system refers to a space area running at the end of a mechanical arm. By setting the “safe area”, the area range of the end of the manipulator is defined.

1.16 Interference area

The “interference area” in the system is divided into three types: “spatial interference”, “point interference” and “axial interference”, which also define the region range of the end operation of the manipulator.

1.17 System Update and Backup

The control system provides the update and backup functions of the system program, including the update and backup of the controller system and the update and backup of the demonstrator system, which can complete the update and backup of the system through the USB interface.

1.18 Limit

Limit is divided into “hard limit” and “soft limit”. The mechanical arm rotation angle has extremity, i. e. “hard limit”; for machine safety, the rotating angle size of the mechanical arm can be controlled by a procedure, i. e., the “soft” limit is set, but the value cannot exceed the “hard limit” scope.

1.19 Direction of Encoding

It is the motion direction of the various joints of the manipulator body. The control system sets the motion direction of each joint, and if it is not the same as the set motion direction, it is necessary to modify the “encoding direction” parameter so that its consistent (such as the value of the “encoding direction” is “1”, the value should be modified to “0”; It was “0” in the beginning, then change it to “1”.

1.20 Origin, Zero Point, and Start Point

The origin is the position where the first step runs of the whole curve motion trail in a full procedure containing a “curve” task type, and it is the “origin” position of the whole procedure (distinguished from the “origin” in the user coordinate system; the coordinate system “origin” represents the origin coordinate (0.0.0)) of the coordinate system plane.

The zero point is the “zero-bit angle” position.

Starting point--is referenced during the creation process, and a “curve” consists of two points, namely “starting point” and “terminal point”.

2. Overview

2.1 Introduction to the System

A pulse type 8-axis control system (hereinafter referred to as “control system” or “system”) is to provide a control system for an industrial robot, and a pulse-type driving servo and a speed reducer are arranged on an industrial robot to finish the corresponding work-flow instead of manual, and the pulse type 8-axis control system can be widely applied to the automobile industry, electronic appliances and machinery manufacturing and other industries.

Over the years, the company has invested heavily in the research and development of the control system, and has completed a series of technical problems and has obtained fruitful results. The function of the system has been diversified and can meet needs of different users.

(1) Motion function: The system provides 4 motion types of “ articulation” motion, “straight line” motion, “circular arc” and “circle” motion; “smoothness” can be added to the curve; manual teaching can be carried out through the “articulation motion” coordinate system, the “base coordinate system” and the “user coordinate system”; the “singular point” alarm function and the motion protection function are added, so that it is safer for a user when using.

(2) Programming function: The system adopts “modular” programming. In addition to creating, saving and modifying the basic program, it can also call the basic program through the “subroutine call” task type, which greatly improves the utilization and programming efficiency of the user program.

(3) Program running control: “pause”, “go on”, “stop”, “return to zero” and other operations are supported; “single step”, “single”, and “cycle” motion modes are supported; The parameters input interfaces, such as “velocity ratio” and “movement frequency”, can be used to debug the actual motion performance of the machine.

(4) “Point” operation function: The “point” and the “procedure” are mutually alone and can be used for multiple “reference” of the user program, in this way, the user programming efficiency is greatly improved.

(5) Articulation definition: The 6 articulations and 2 additional axle articulations of the 6-axis mechanical arm can be mapped to any driver interface of the controller, and the articulations are flexible and convenient for system maintenance.

(6) Additional shaft function: Provides 2 “additional axes” and can be arbitrarily set for both the “joint mode” and “velocity mode”.

(7) Calibration function: The screen is calibrated by means of a “calibration function”.

(8) Hot key function: The common I/O input port is configured into “pause”, “continue”, “zeroing”, “switch modes of work”, “run to the starting point”, “enable program”, “disable program” and also the special “emergency stop” function. The normal I/O output port is configured as special functions of “operation instruction”, “servo state”, and “alarm state”.

(9) Urgent stop configuration: When the system receives the external "emergency stop" command, it can configure the output state of the "I/O" output port.

(10)Commissioning function: The system "Relay Port", "I/O Output Port", "simulation Output" and "I/O Input Port" can be "manually" set and monitored for their current status.

(11) Restore the factory settings: Through this function, the factory settings can be restored to such functional modules as "point", "basic program", "process program", "modular program", "PLC program", "coordinate system" and "system settings".

(12) Tracking Functions:The system supports both “Ontology Tracking” and “sliding rail tracking” modes.

(13) Swing arc function:The system “swing arc function” provides two kinds of swing arcs of “Z word” and “circular arc”.

(14)Process support: There are four supporting processes:“spraying procedure”, “palletization procedure”,“welding procedure” and “stamping procedure”.

(15) PLC programming: The system comes with PLC programming function, can be programmed and run on PLC.

(16) Regional settings: By setting the “safe area” and “interference area”, we can determine the area range of the end of the manipulator and improve the safety level.

(17) Reservation function: The working efficiency can be greatly improved through the application of the

“reservation” program.

(18)System Update and Backup:The system provides a convenient update and backup function, and uses U disk to carry out the “update” and “backup” of the controller and demonstrator device.

(19)“On-line” system operation: The system provides the “on-line” help document, and the user can consult the system help file at any time through the demonstrator, so that the user can quickly understand the function and operation method of the system conveniently and immediately.

2.2 System Composition

2.2.1 Controller

As shown in Fig. 2.1, a well-assembled control box is shown, including a control module and a power supply module. The meaning of each part is as follows: The meaning of each part is as follows:

1.8-path pulse drive interface

2. Screen is “COM5”, system “RS485” communication interface and “RS232” communication interface

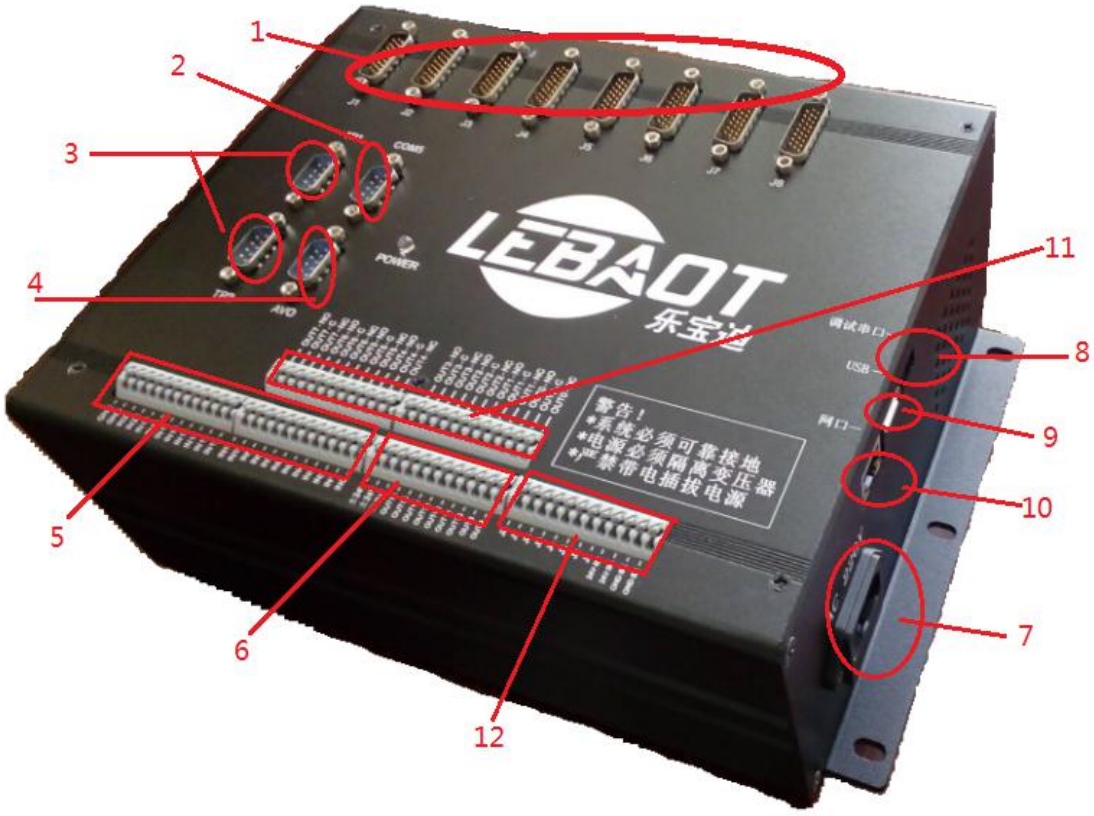


Figure 2.1 Control Box Structure of Control System

3. Silk-screen is “TP1” and “TP2” and indicates system “RS422” interface, and is connected with teaching module

4. Silk-screen is “AVO”, and indicates analog quantity output interface

5. 20-path “optical coupling” isolation input port, pull down during use

6. The 10-path collector open-circuit output ports should be pulled up when being used.

7. Input of alternating current 220 VAC

8. Debugging of a serial port

9. USB interface can update and backup system procedure

10. Internet access

11.8-path relay output ports

12.8-path braking outputs, thebraking line should be connected with “24V-BK” and “J1-J8” interfaces.

(1) J1-J8 pulse driving interface signal definition

Pin	Signals	Explanation	Pin	Signals	Explanation
1	JX_PULS-	JX-axis position command pulse negative	14	JX_PC+	JX-axis encoder pulse C phase positive
2	JX_SIGN-	JX-axis position command direction negative	15	JX_S-RDY-	JX-axis servo ready
3	JX_PA-	JX-axis encoder pulse A phase negative	16	JX_SEN	JX-axis encoder initial value
4	JX_PB-	JX-axis encoder pulse A phase negative	17	JX_ALM-RST	JX-axis alarm removal
5	JX_PC-	JX-axis encoder pulse A phase negative	18	GND	Ground 0V
6	JX_ALM-	JX-axis alarm signal input	19	GND	Ground 0V
7	JX_S-ON	JX-axis servo-enabling output	20	JX_BK+	JX axis brake+
8	+24V	Output+24 V	21	NC	Empty, no signal
9	GND	Ground 0V	22	NC	Empty, no signal
10	JX_PULS+	JX axis position command pulse positive	23	NC	Empty, no signal
11	JX_SIGN+	JX axis position command direction positive	24	NC	Empty, no signal
12	JX_PA+	JX-axis encoder pulse A phase positive	25	NC	Empty, no signal
13	JX_PB+	JX-axis encoder pulse B phase positive	26	+24V	Output+24 V

(2) Signal definition of RS485 and RS232 communication interface

Pin	Signals	Explanation	Pin	Signals	Explanation
1	+5V	Output+5 V	6	I2C2_SDA	Bi-directional data line
2	I2C2_SCL	Clock line	7	RS232_TX4	RS232 sending signal
3	RS485B	RS485 Signals B	8	RS232_RX4	RS232 receiving signal
4	RS485A	RS485 Signals A	9	GND	Ground 0V
5	GND	Ground 0V			

(3) Definition of analog quantity output interface

Pin	Signals	Explanation	Pin	Signals	Explanation
1	DA_OUT1	Analog Output 1	6	NC	Empty, no signal
2	DA_OUT2	Analog Output 2	7	NC	Empty, no signal
3	DA_OUT3	Analog Output 3	8	GND	Ground 0V
4	DA_OUT4	Analog Output 4	9	GND	Ground 0V
5	NC	Empty, no signal			

2.2.2 Demonstrator

As shown in Fig. 2.2, a well-assembled demonstration box is shown in the figure, and the demonstration module is in it. The meaning of each element on the demonstration box is as follows:

Figure 2.2 Demonstration Box Structure

1. Mode changeover switch, “manual” and “auto” operating modes are switchable

2. “Procedure stop” physical key to stop the procedure during “operation”

3. “Procedure starting” physical key to enable “procedure” to start “operation”

4. “UP” physical button, up one grid

5. The outgoing line hole of the demonstration box is connected with the “RS422” interface in the control box.

6--“DOWN” Physical button, down one grid

7. “Returning” physical key can return to the previous step

8. “Menu” physical key, which can set the curve “starting point” when the procedure is inserted into the “procedure management”Press the physical keys of the “menu”+“program start-up” to calibrate the screen

9. The physical keys of “J6-” and “J6+” respectively; after “enabling”, the J6 articulation motion can be controlled.

10. The physical keys of “J5-” and “J5+” respectively; after “enabling”, the J5 articulation motion can be controlled.

11. The physical keys of “J4-” and “J4+” respectively; after “enabling”, the J4 articulation motion can be controlled.

12. The physical keys of “J3-” and “J3+” respectively; after “enabling”, the J3 articulation motion can be controlled.

13. The physical keys of “J2-” and “J2+” respectively; the J2 articulation motion can be controlled after “enabling”, and the J8 articulation motion can be controlled due to the fact that the additional shaft is arranged.

14. The physical keys of “J1-” and “J1+” respectively; the J1 articulation motion can be controlled after “enabling”, and the J7 articulation motion can be controlled due to the fact that the additional shaft is arranged.

15. Touch screen, most of the data input in the system, the function switch and so on, are done through the “touch screen”

16. Emergency stop switch, people can press down the “emergency stop” under “emergency circumstances”, and all the operation of the system and servo can be stopped.

17.2 enabling switches to “enabling” the servo

2.3 Software interface

The software interface of the control system can be classified into two types: manual interface and automatic interface.

2.3.1 Automatic Interface

Switch to "automatic mode" through "mode switch" on the demonstration box, and the "automatic interface" will appear, as shown in figure 2.3. The program can be "run" on the "automatic interface", including the realization of "enable", "disable", "pause", "continue" and "run to zero point" of the program; The “enable”, “disable” and “monitor” of PLC program; The settings of parameters such as “velocity ratio”, “mode of motion” and “motion frequency” are done in “automatic interface”.

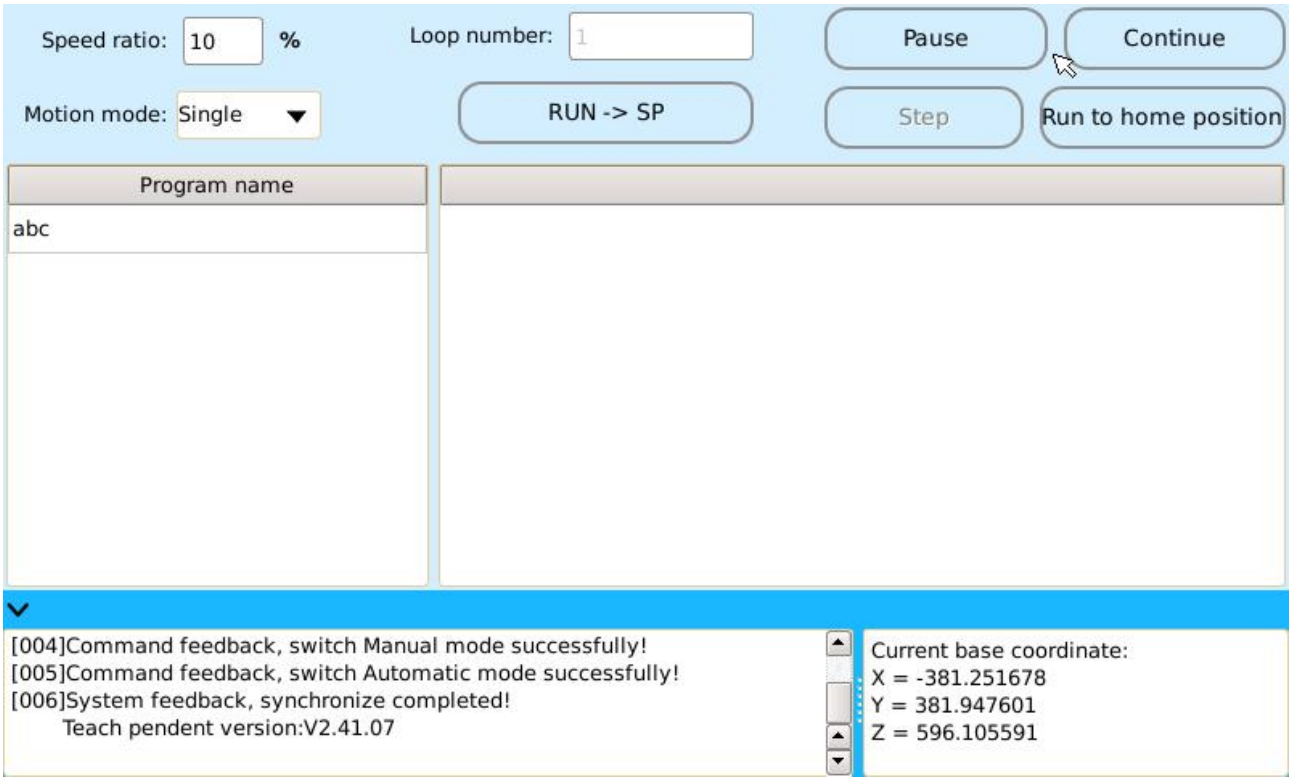


Fig. 2.3 Automatic Interface

2.3.2 Manual Interface

The control system manual interface consists of 6 parts, namely [motion], [PLC], [tool], [configuration], [user] and [help], as shown in Figure 2.4.

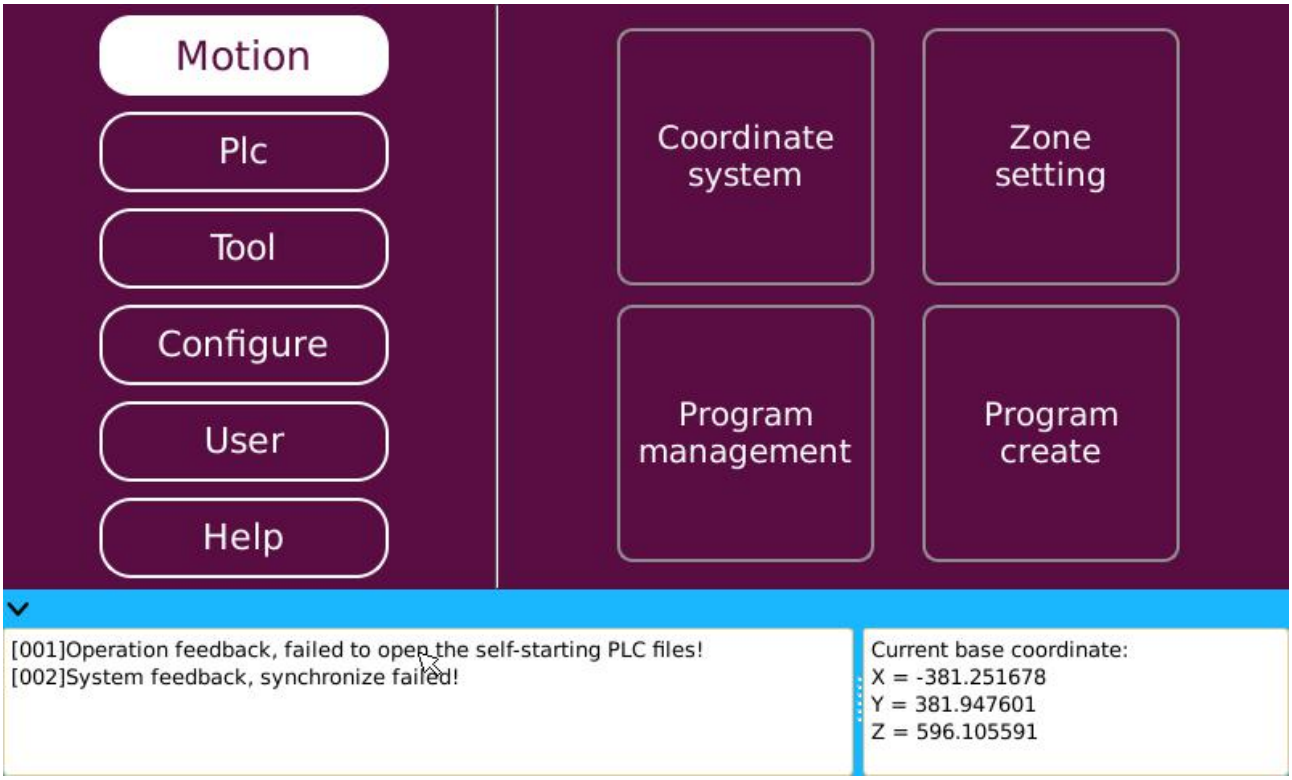


Fig. 2.4 Composition of Manual Interface Structure

➢ Motion

The “motion” part of the system consists mainly of “coordinate system”, “regional settings”, “program management”, and “create program”, as shown in Figure 2.4.

◆ Coordinate System

The “user coordinate system” and “tool coordinate system” can be created and managed at the “coordinate system” interface, as shown in Figure 2.5.

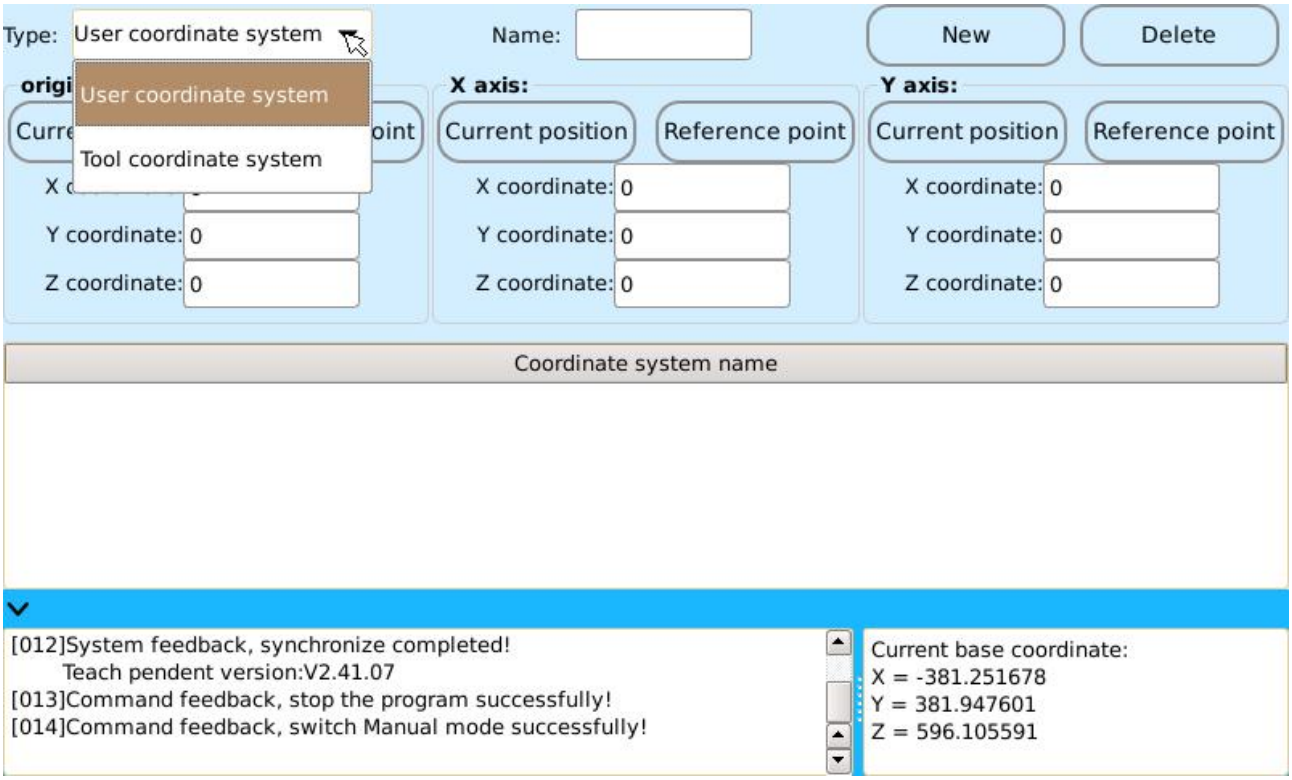


Figure 2.5 Coordinate system Interface

◆ Regional settings

"Safe area" and "interference area" can be set at the "Regional Settings" interface, as shown in Figure 2.6, defining the "safe interval" and "Interference interval" can greatly improve the security of the staff.

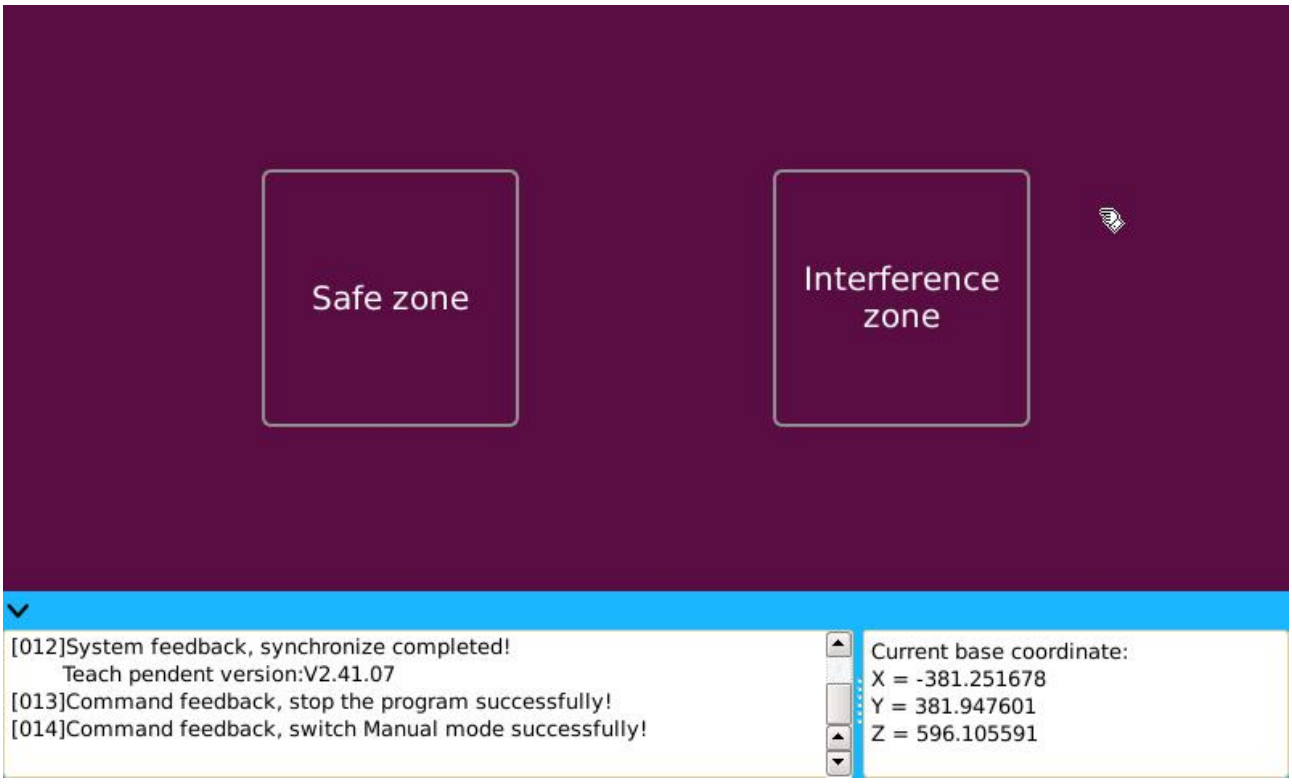


Figure 2.6 Regional Settings Content

◆ Program management

"Program management" is a storage module for the "program" and "point" that have been created, including 5 parts, namely "basic program", "point", "process pack", "functional pack", and "modular program", as shown in Figure 2.7. Here users can carry out operations such as "detailed" "query" and "edit" for "program" and "point".

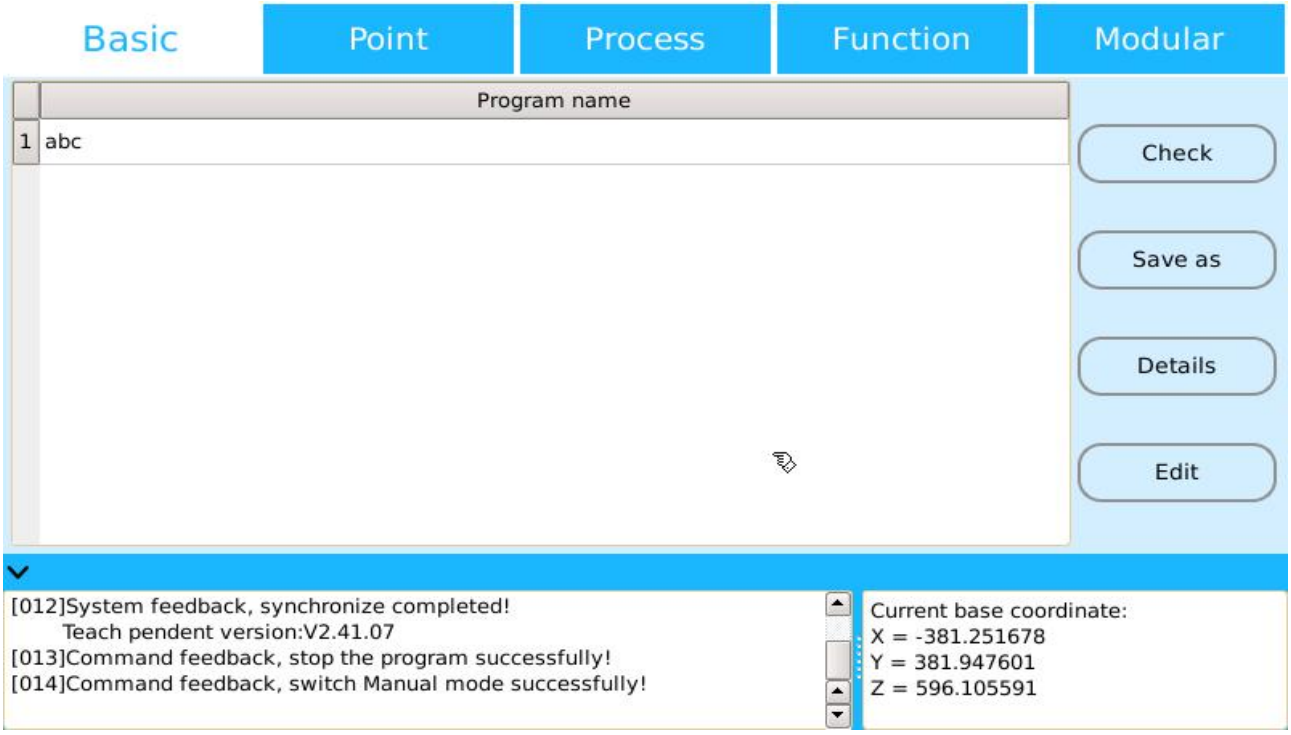


Figure 2.7 the composition of the program management structure

◆ Create program

"Create program" consists of 4 parts, namely "process pack", "functional pack", "basic program" and "modular program", as shown in Figure 2.8, they are the creation program module of the system, the "process program", "functional program", "basic program", and "modular program" of the system are created here.

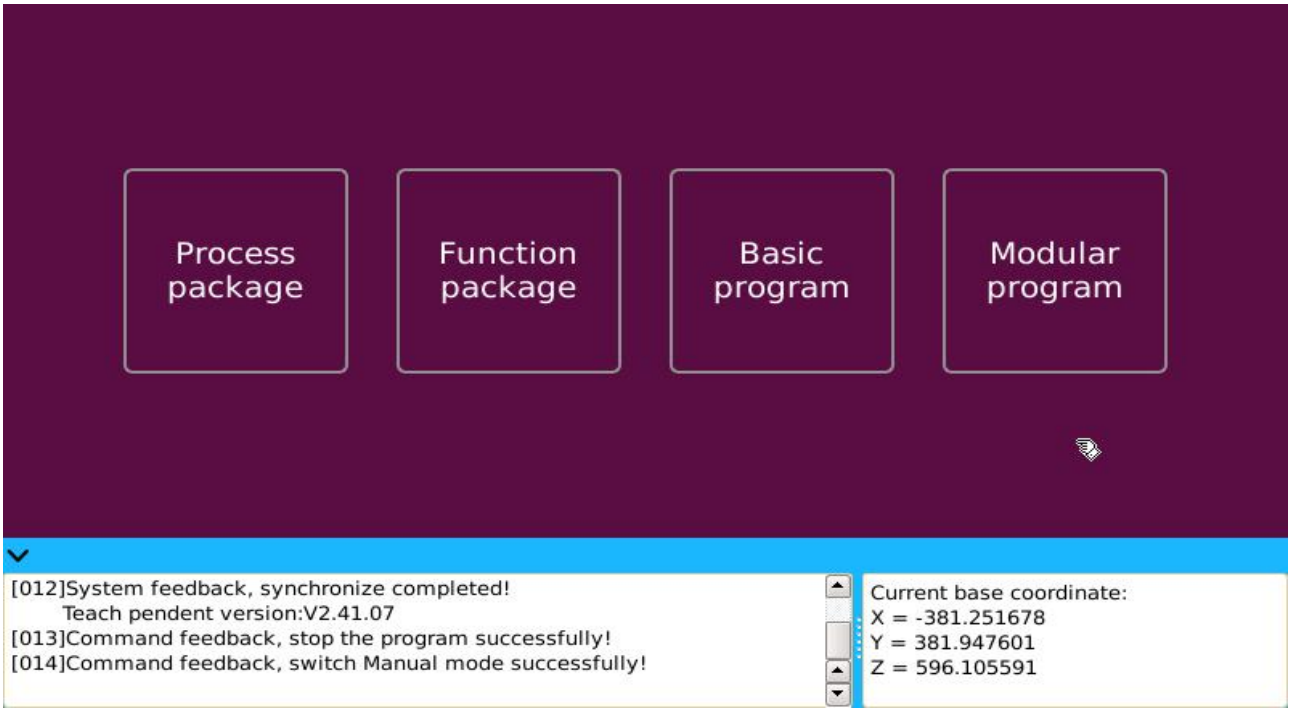


Figure 2.8 Composition of the creation of the program

➢ PLC

The system provides the “PLC” programming function, as shown in Figure 2.9, composed of “PLC Editing” and “PLC operation”. The PLC program can be created and edited in the “PLC Editing”; The “PLC operation” is performed on the PLC program that has completed the “edit”.

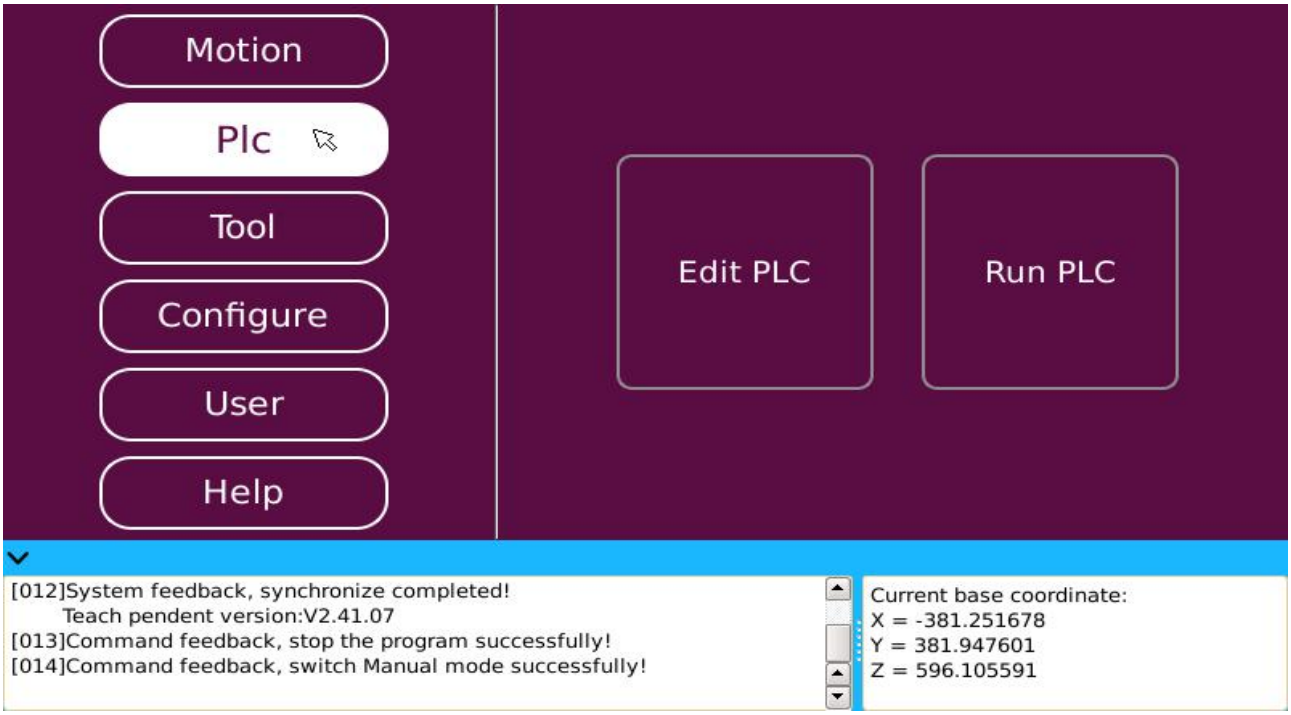


Figure 2.9 Composition of “PLC” structure

➢ Tools

For the convenience of users, the system provides a variety of tools, among which including 4 parts of "setting zero-bit angle", "authorization", "update and backup" and "language", as shown in figure 2.10.

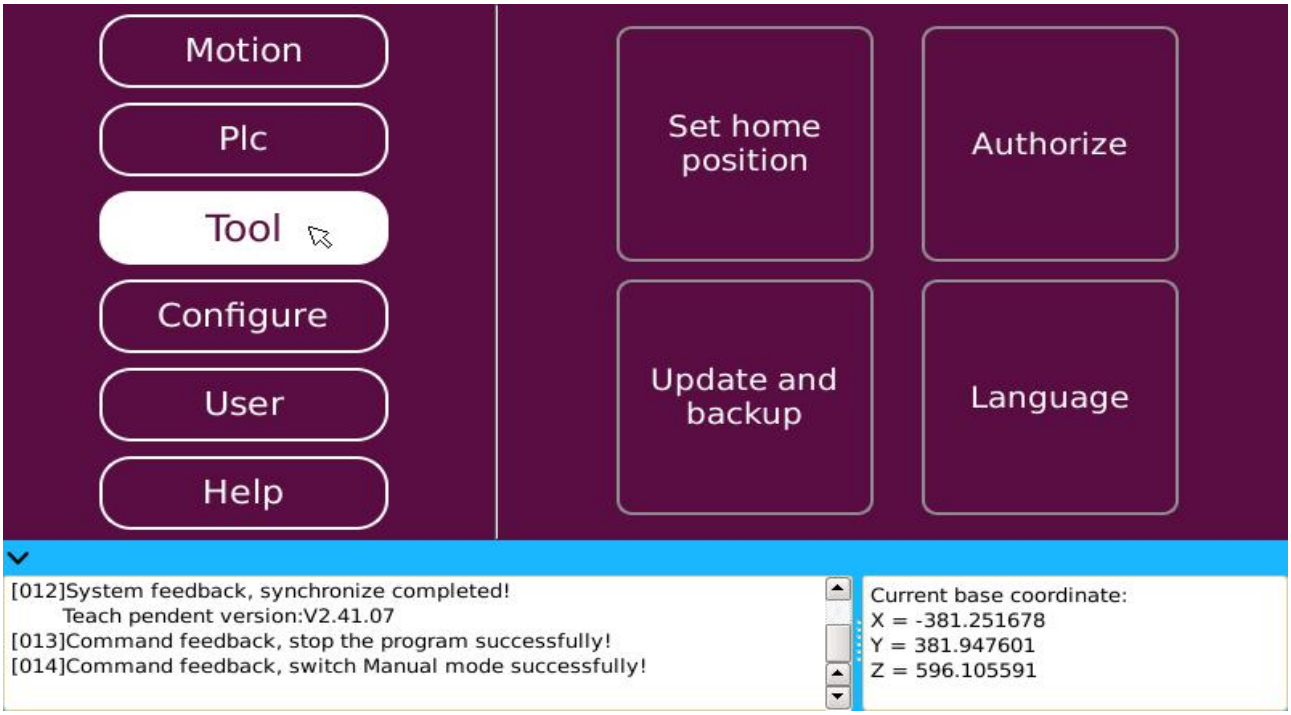


Figure 2.10 “tool” Structure Diagram

◆ Setting zero-bit angle

In the “set zero-bit angle” interface, the current position and status of the machine end can be set to “zero point”, as shown in Figure 2.11, the system provides two “zero-bit angle” settings, namely the “all settings” and “single setting”. The zero-bit angle “all settings” means that all eight “axes” are set up at one time. The “single setting” is a zero-bit angle that can be arbitrarily selected in eight “axes”, and the zero-bit angle of the other unselected “axes” remains unchanged.

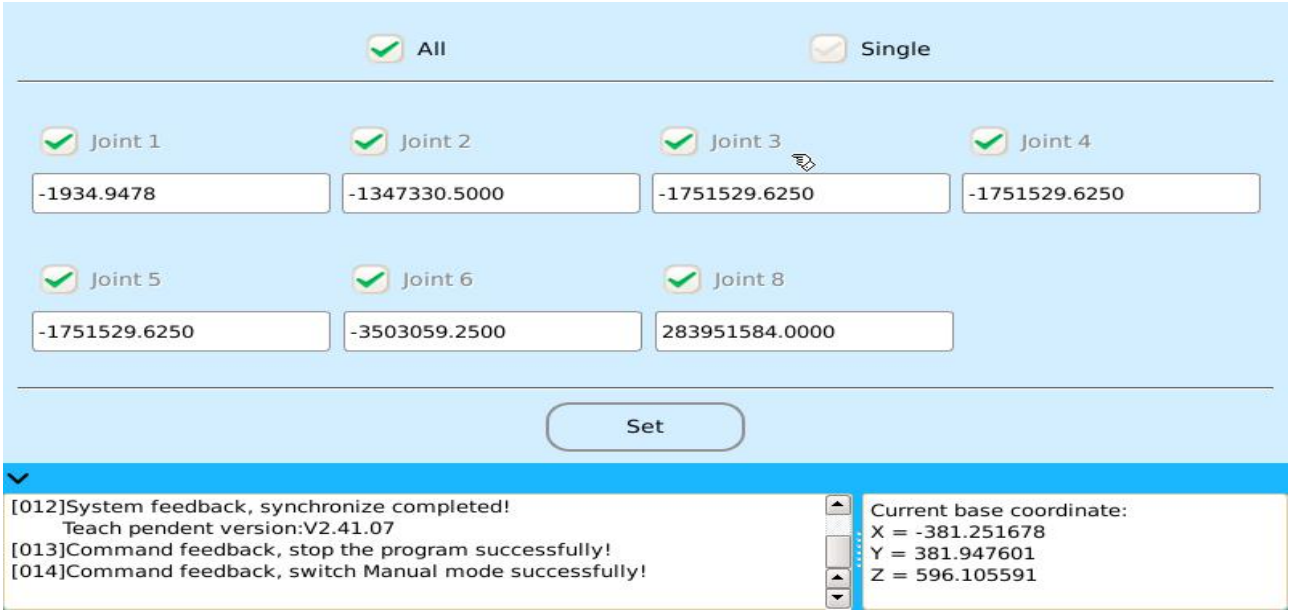


Figure 2.11 setting zero-bit angle

◆ Authority

The system must be licensed to use, “authorization” is set by the manufacturer, as shown in Figure 2.12. The “authorization” can be divided into two ways: “permanent authorization” and “interim authorization”, and the effective working time of the system can be set by means of “interim authorization”.

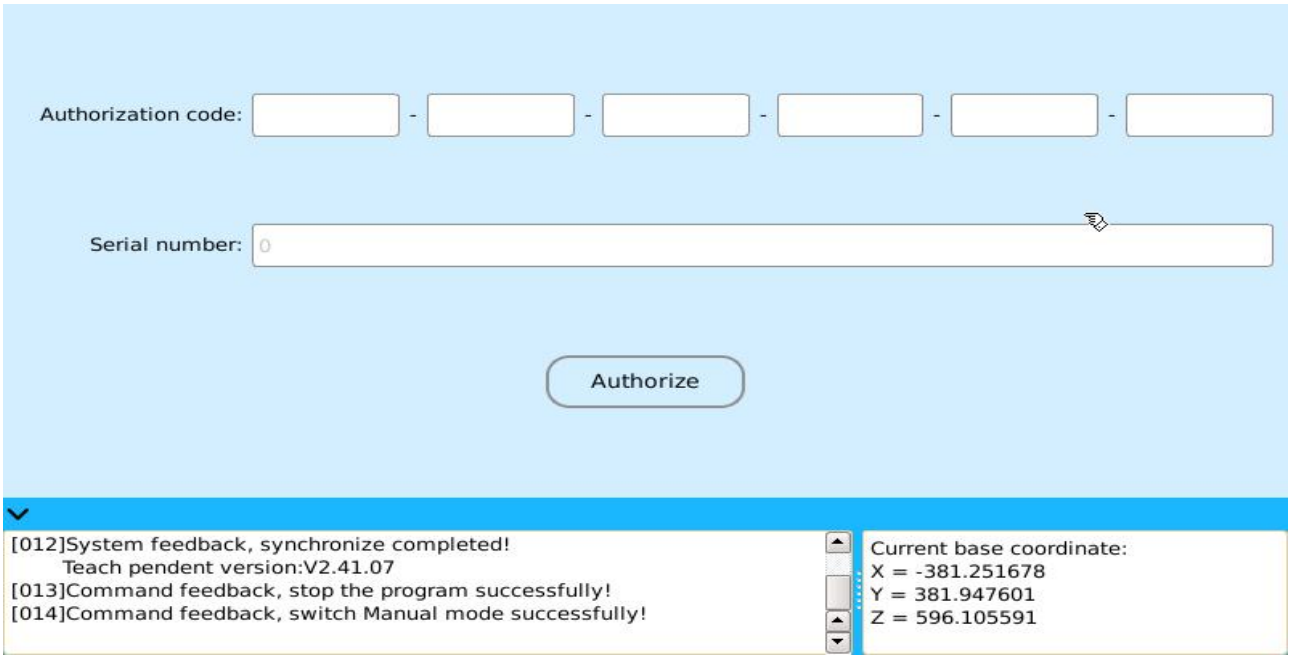


Figure 2.12 “Authorization” interface

◆ Update and backup

In the “update and backup” interface, the system program can be “updated” and “backuped”, including the update and backup of the “demonstrator” program and the update and backup of the “controller” program, as shown in Figure 2.13.

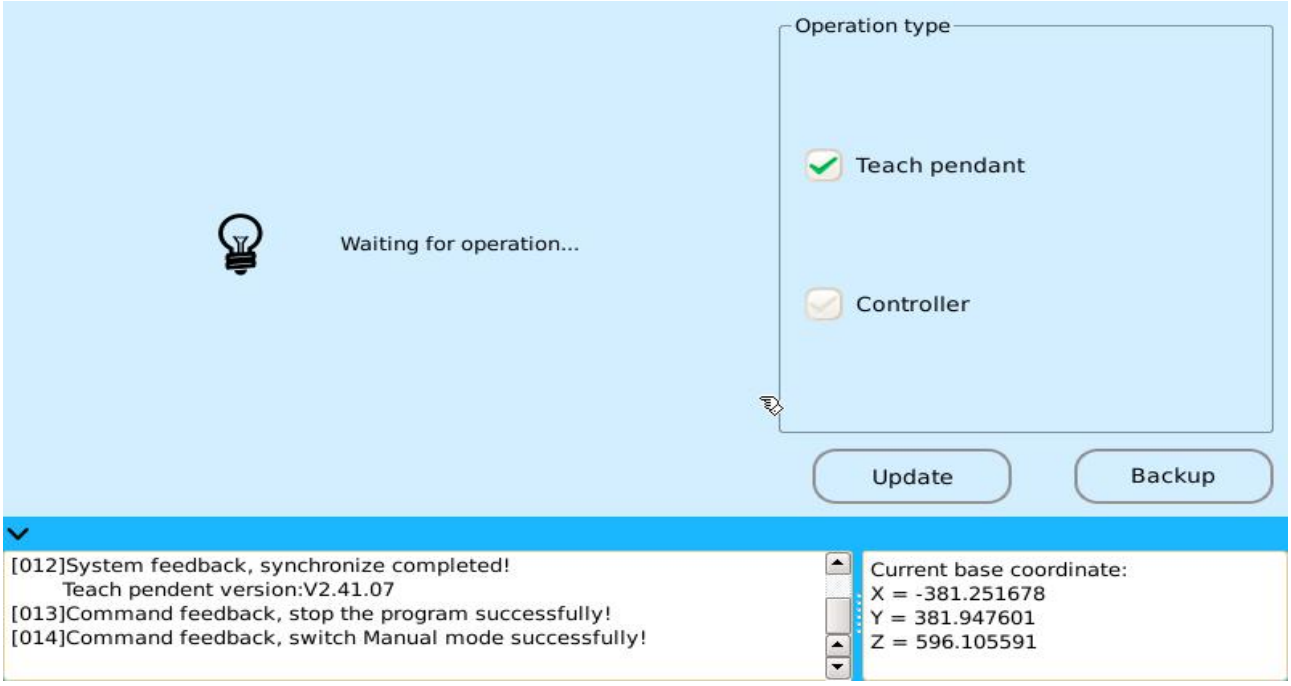


Figure 2.13 “update and backup” interface

◆ Language

The system provides two language switching functions,"simplified Chinese" and "English". Users can choose and switch any language of the current system in the "language" interface, as shown in figure 2.14

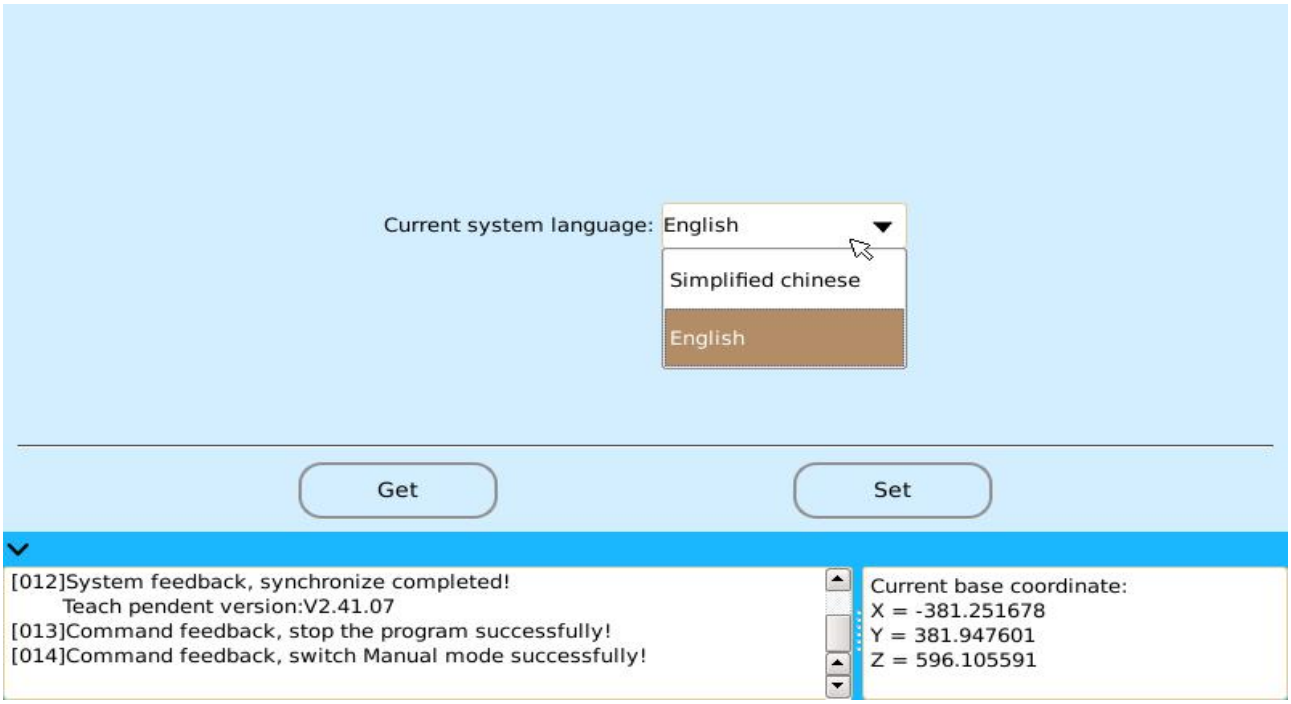


Figure 2.14 Language switching between Chinese and English

◆ Configuration

The "configuration" section of the system includes "port configuration", "custom alert" and "other configuration", as shown in figure 2.9.

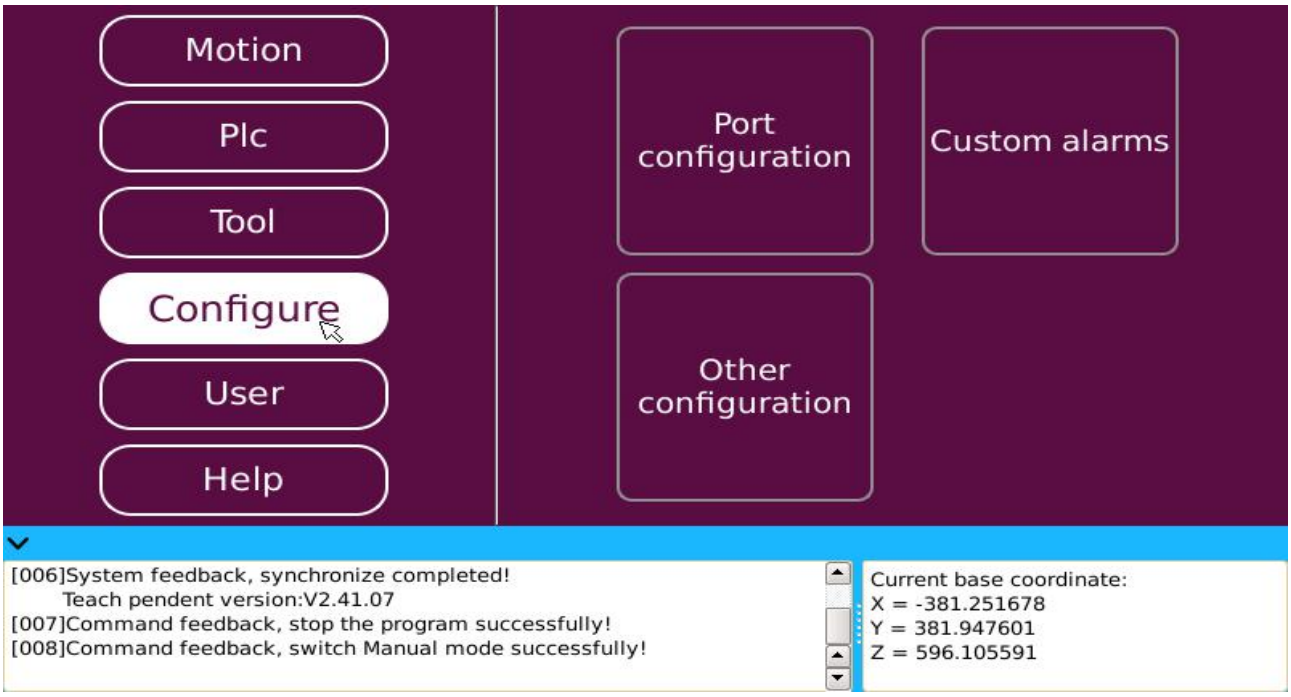


Figure 2.15 components of “configuration”

◆ Port configuration

According to the actual configuration of the mechanical application environment, we can configure the system I/O port accordingly through “port configuration”, including 4 parts of content of “functional port”, “indicating port”, “program reservation” and “communication protocol”, as shown in Figure 2.16.

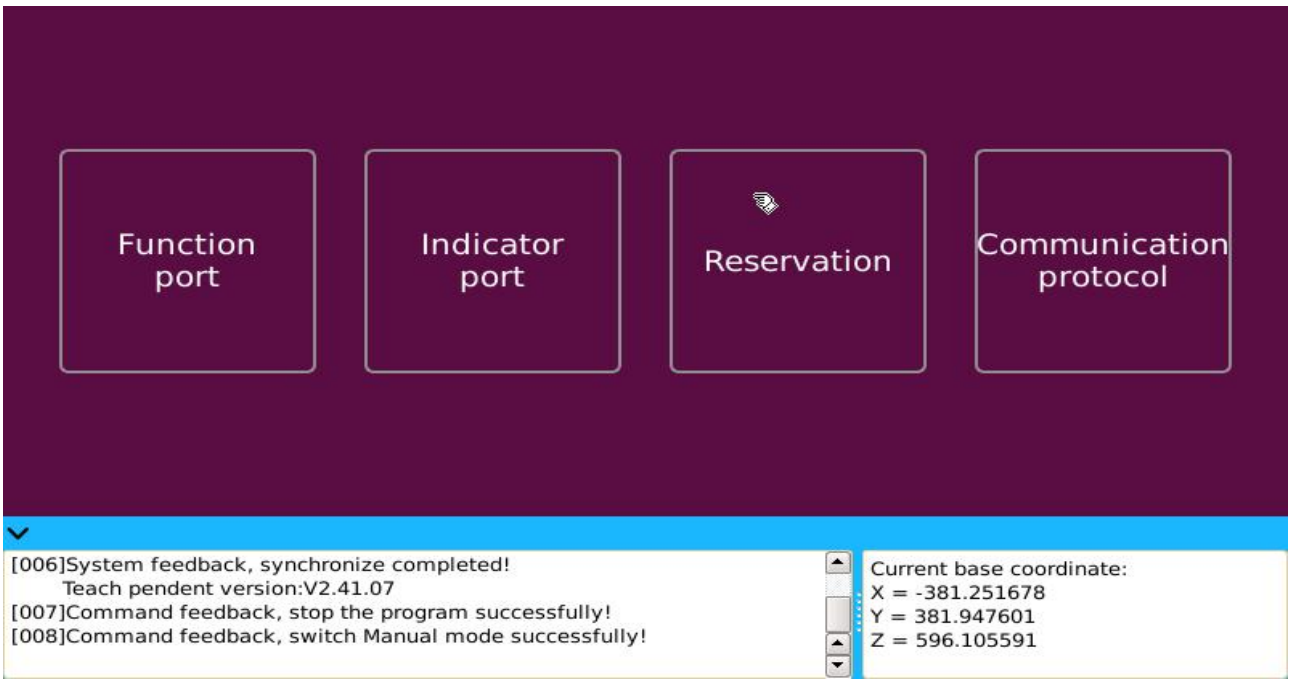


Figure 2.16 components of “port configuration”

◆ Custom alert

In the "custom alert" interface, you can create "alert title" and "alert content" by yourself, and you can "edit" the completed "alert", including "modify" and "delete" alert, as shown in figure 2.17Use with PLC when using custom alert.

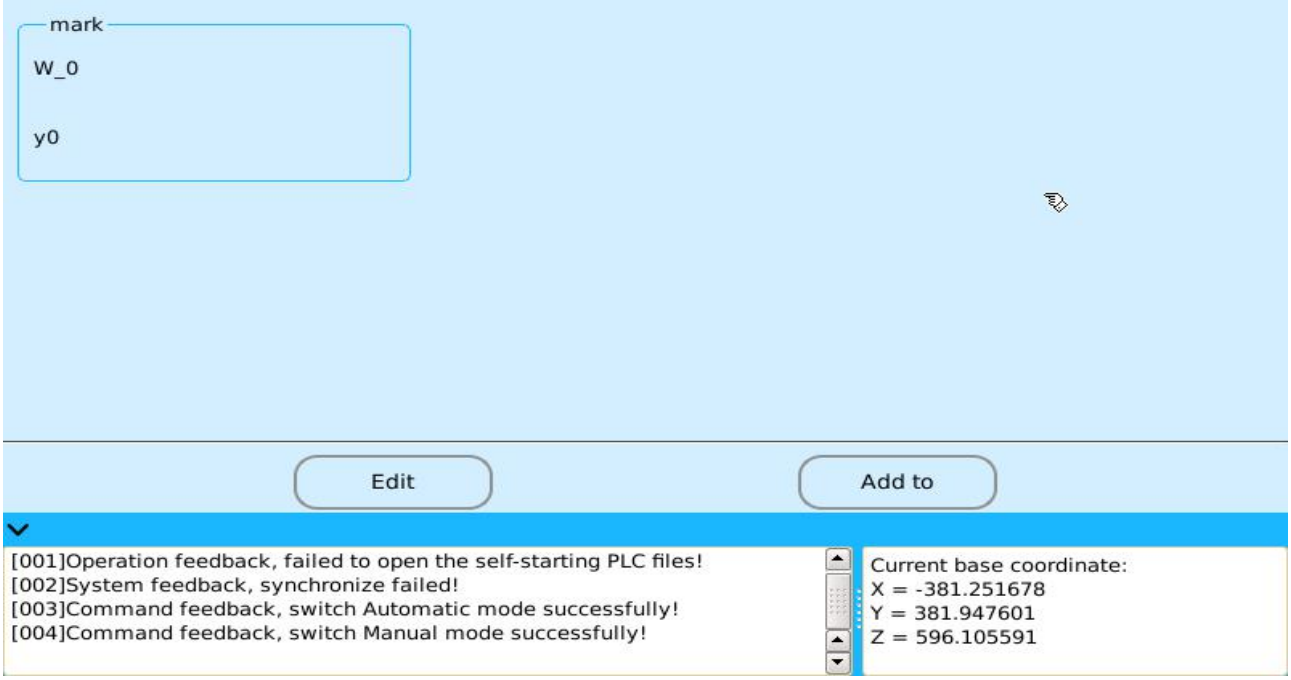


Figure 2.17 “Custom alarm” interface

◆ Other configurations

"Other configuration" is the configuration to meet some special functions. Users can consider whether to configure it according to their actual situation, including 4 parts of content of "emergency stop configuration", "switch volume configuration", "brake abnormal detection" and "network configuration", as shown in figure 2.18.

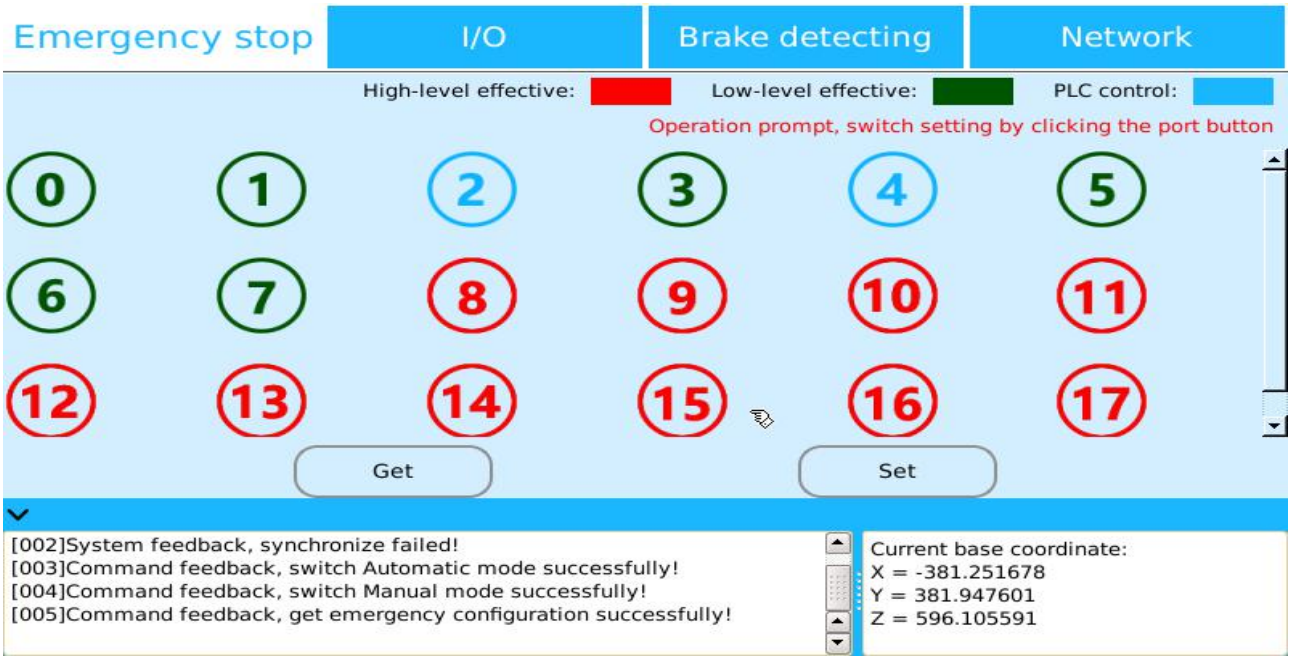


Figure 2.18 Structures of “Other configuration”

➢ User

The "user" section of the system contains "user management" and "switching users", as shown in figure 2.19. In "user management", "user name" and "password" of "administrator" and "operator" can be "edited", such as "modifying" account password or "adding" login account; "Switch users" can switch to the login interface and select the login mode again.

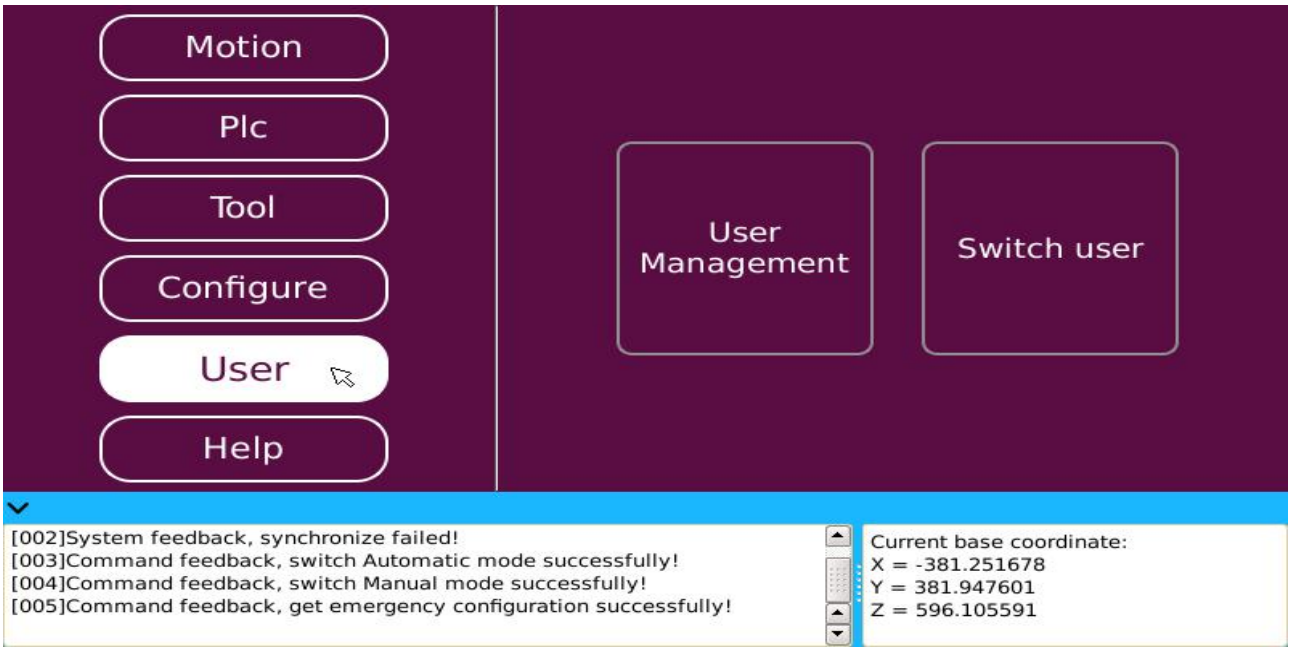


Figure 2.19 “user” Structure Diagram

➢ Help

The "help" section of the system contains "version information", as shown in figure 2.20. In "version information", "machine code", "controller system version number", "demonstrator system version number" and other information in the current system can be viewed, as shown in figure 2.21.

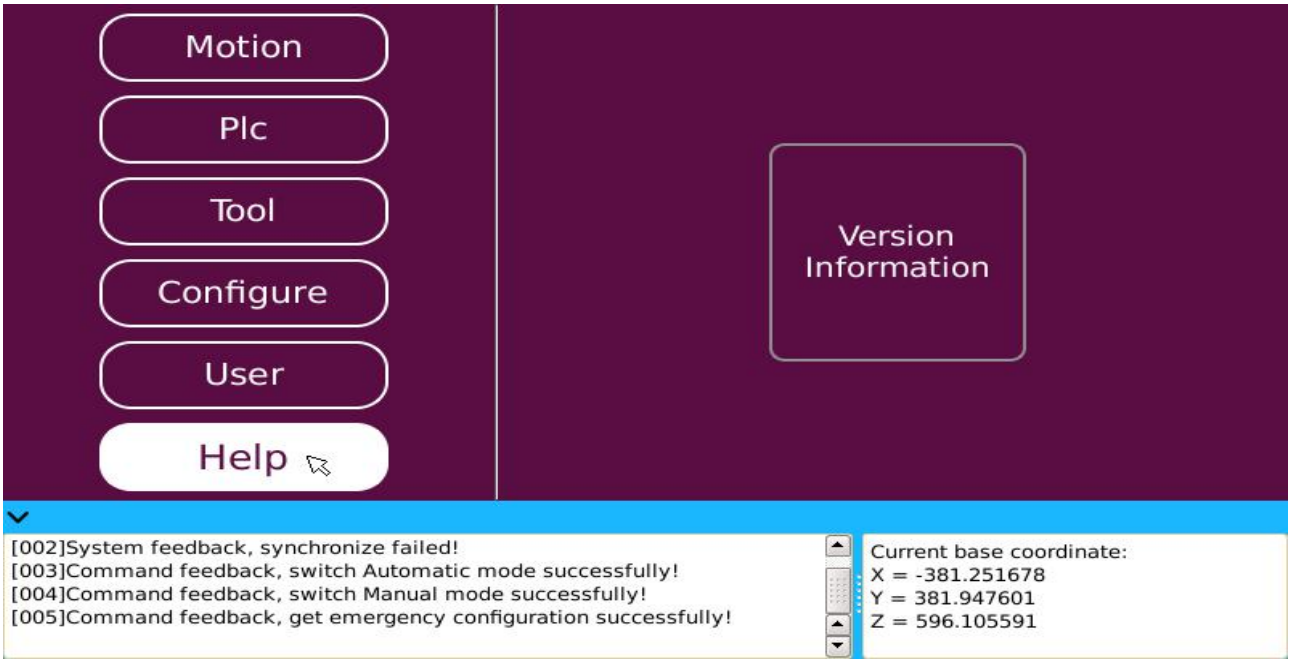


Figure 2.20 “Help” Structure Diagram

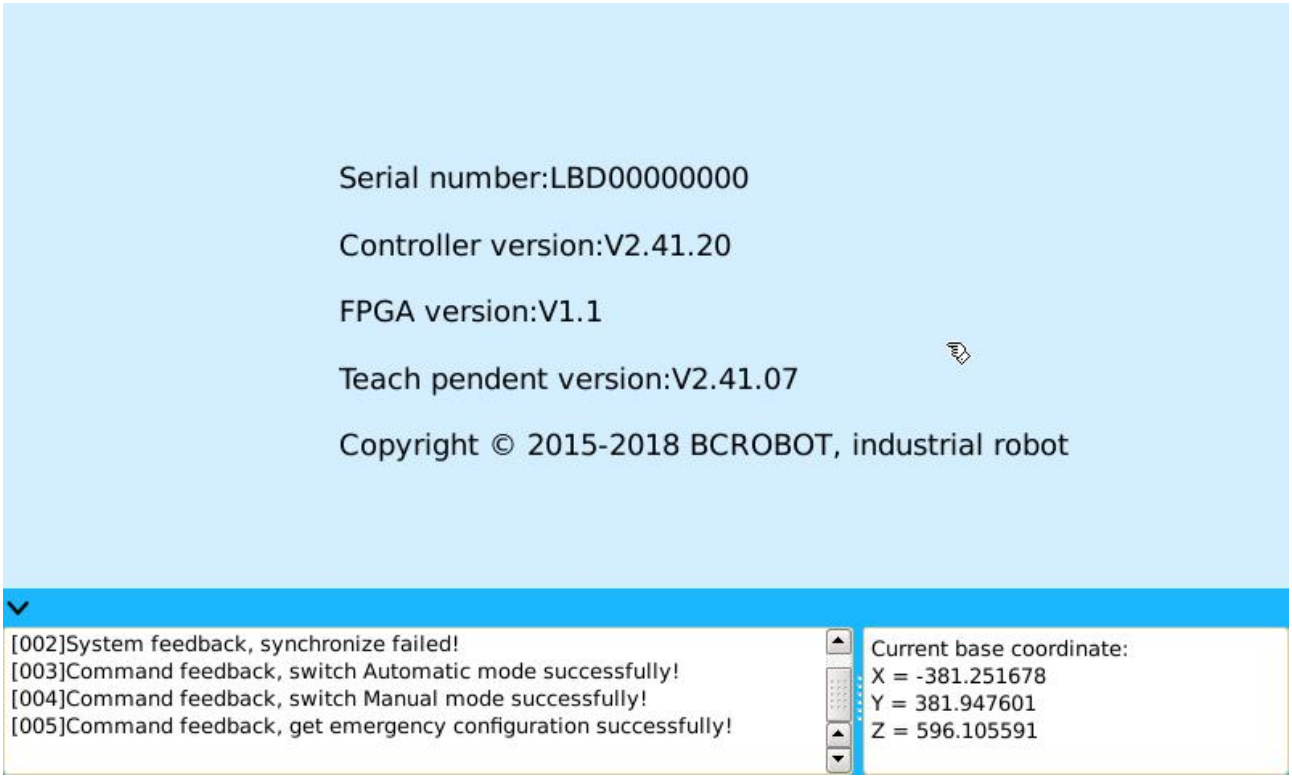


Figure 2.21 System version information

2.4 Login of the system

After the control system is powered on and started (with 220V single-phase ac), the login interface will appear on the screen of the demonstration box, which is divided into three login modes: "administrator", "operator" and "browser", as shown in figure 2.22 below.

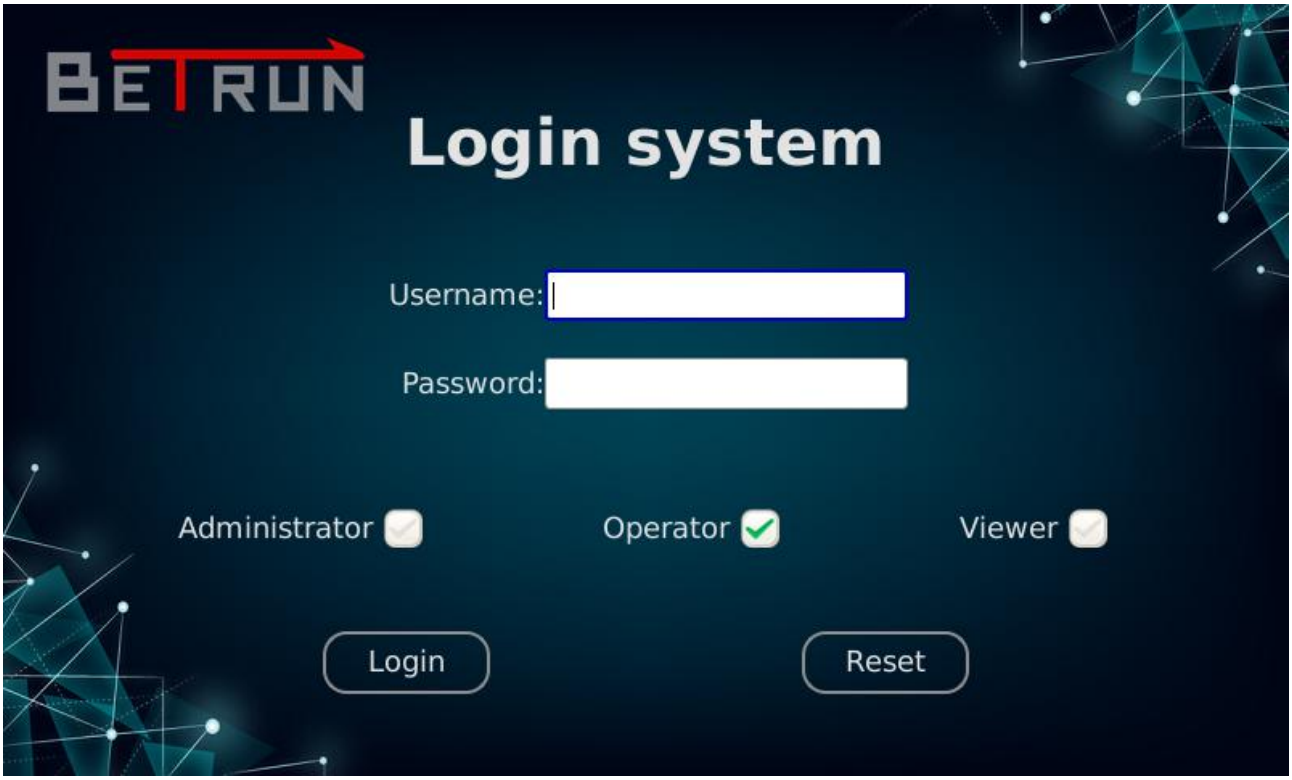


Figure 2.22 System Login Interface

Different user login mode different has different permissions. After login, high-to-low "permission" can be divided into "administrator" mode login,"operator" mode login and "browser" mode login.

"Administrator" mode--the initial "user name" and "password" of the system are both "admin". The "administrator" mode has the highest login authority, and can create and manage "point", "program", run "program" and all other operations.

"Operator" mode--there is no "operator" mode login at the beginning of the system. You need to log in "administrator" mode and then go through the following path: [User]--[User Management], the "user name" and "password" of the operator mode can be set before login in the "operator" mode. "Operator" mode has slightly lower login authority, and cannot change the machine parameters, system configuration and other operations. Only the "basic program" completed in the "administrator" login mode can be "run" and the "point" authorized in the "administrator" login mode can be modified.

"Browser" mode- "Username" and "Password" are not required for login. The “browser” mode login permissions are the lowest, and only the system can be browsed, and no other operation can be carried out.

2.4.1 User Management

Select “user” in the main “demonstrator” interface, and then select “user management” to enter “user management” interface, as shown in Figure 2.23. In "user management", one "administrator" account and 10"operator" accounts can be "managed" for a total of 11 accounts.

The Settings of "user management" for users mainly include 5 parts of content "user type", "user name",

"user password", "enable flag" and "automatic login".

User type--includes both "administrator" and "operator" login types.

User name--i.e. login “user name”.

User password--i.e. password corresponding to the login's “user name”.

Enable flag-- "operator" login account is marked when enabled. When enabled, check box "☑" will be checked.

Automatic login--after the "user type" selects the "automatic login" mode, the next system login will be changed to select the "user type" automatic login, without the step of "login"; And if you want to manually "login" to this user type, the login password is "empty".

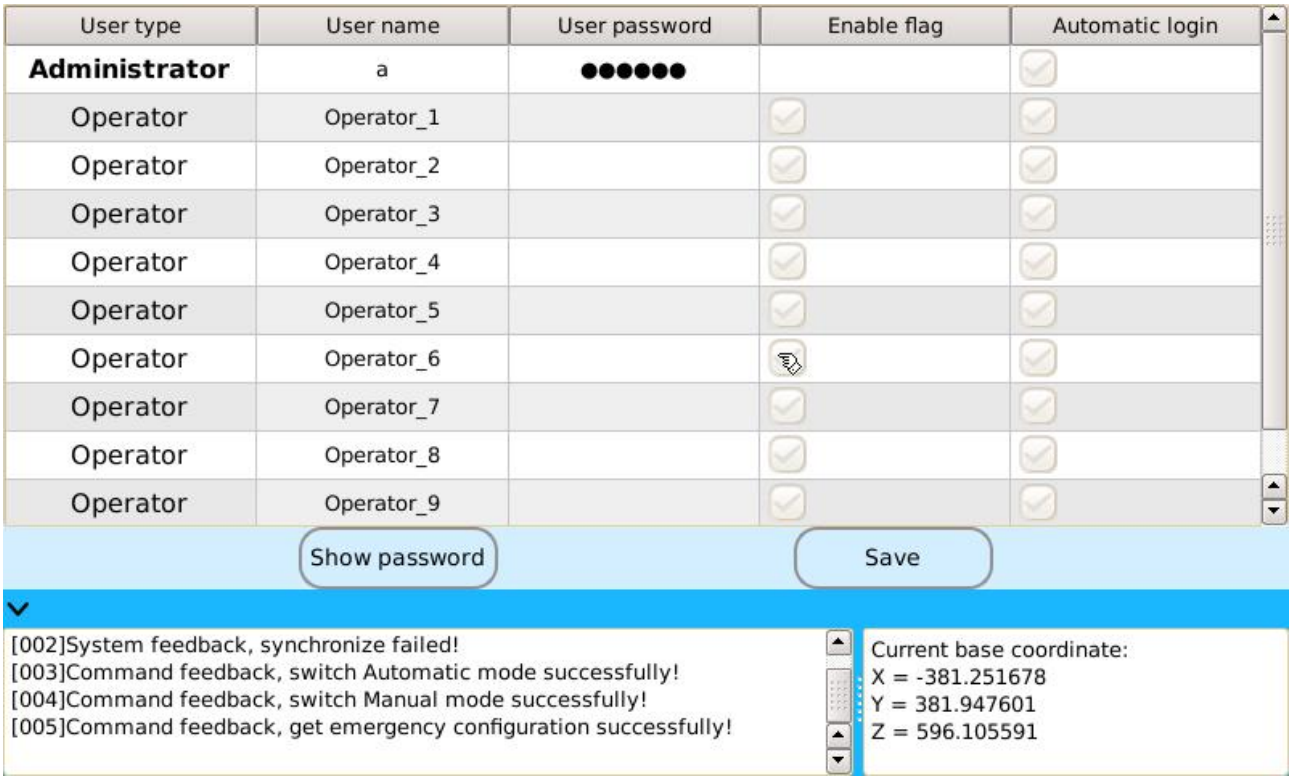


Figure 2.23 “User management” interface

The "management" of the logged-in user can be assisted by the "display password" button, and the "save" button needs to be clicked to take effect after the "user management" setting content is completed.

Remarks: Must be the "administrator" login mode to have the right to modify the "login name" and "password" of the user through the "user management" function.

2.4.2 Switch User

Select "user" in the main interface of "demonstrator", and then select "switch user", as shown in figure 2.24. The user can switch different "login modes" or "login accounts" through the "switch user" function.

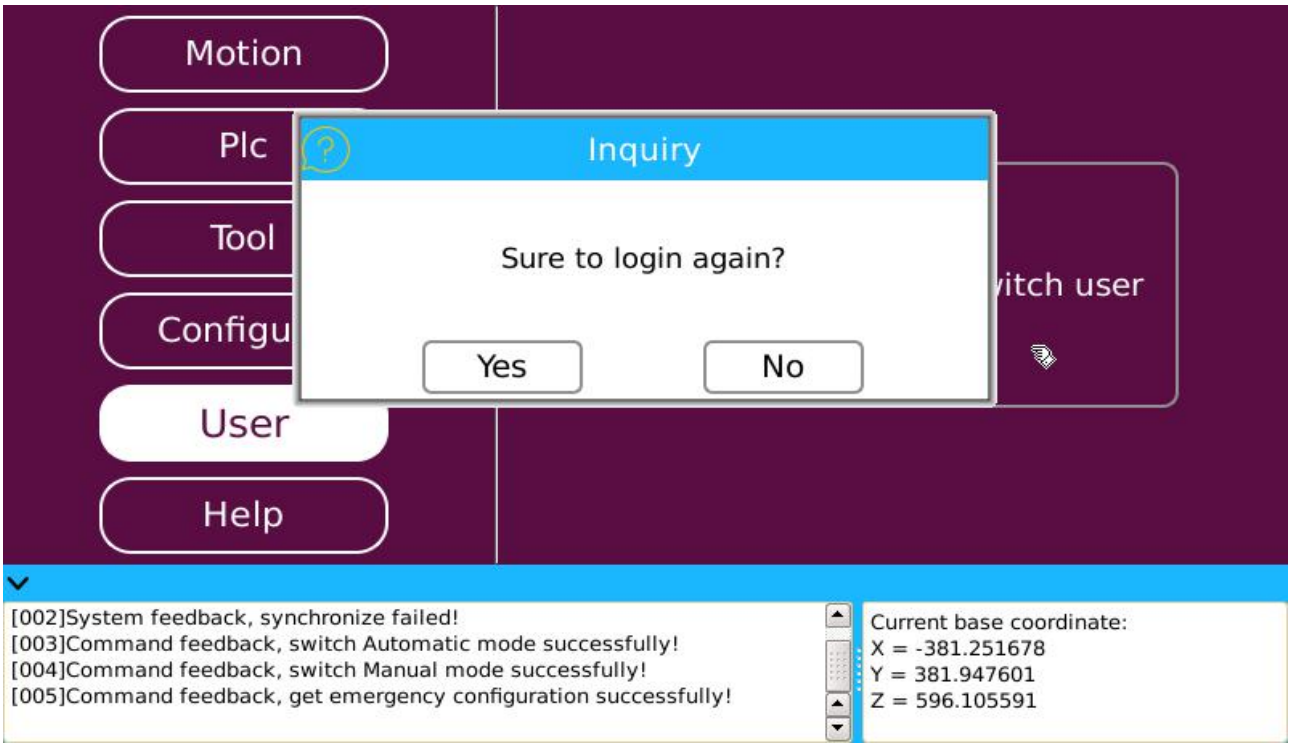


Figure 2.24 “switch user” Login Mode

2.4.3 Vendors Account Login

Some of the functions in the system must be set when the “special account” is logged in, i. e., the “manufacturer's account” log-in. Select "administrator" mode in the login interface and enter "manufacturer account" to log in the system, as shown in fig. 2.25. You can set 4 parts of content "machine model", "driver", "machine parameters" and "restore factory settings" for the system.

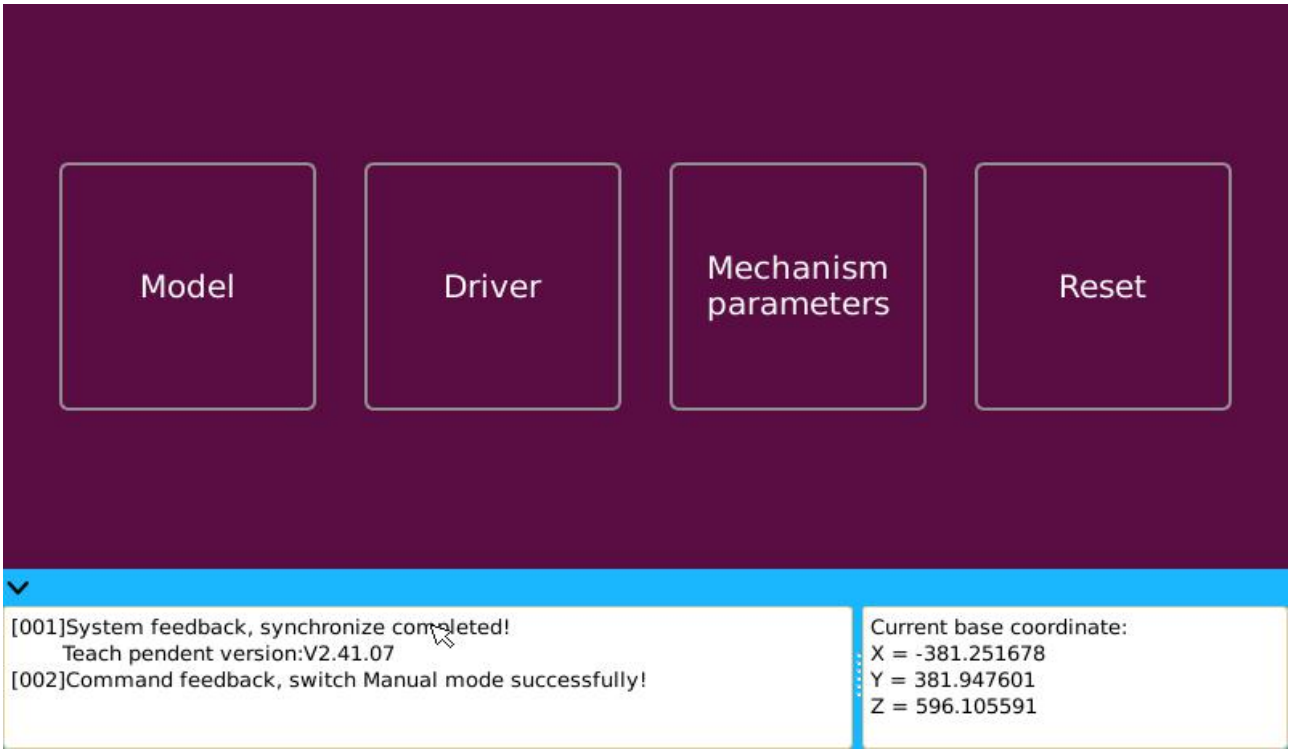


Figure 2.25 “manufacturer's account” login system interface

In the login system interface of "manufacturer account", press the "menu" button of the membrane switch on the "demonstrator", and a display box will pop up, as shown in figure 2.26. In the pop-up display box, the “Query current joint angle”, “velocity coefficient”, “run to zero point”, and “switch user” 4 operations can be carried out.

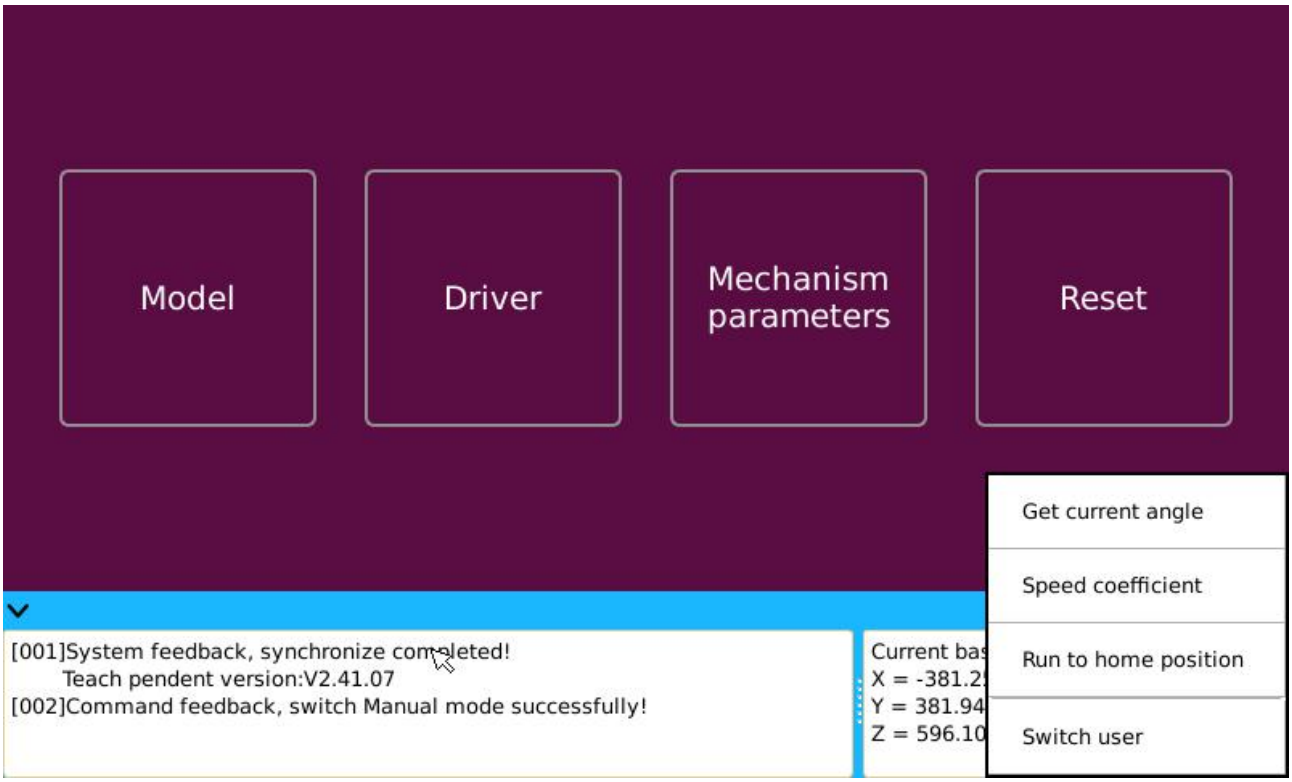


Figure 2.26"Manufacturer account" login press "menu" display box

Query the current joint angle--query the position and status at the end of the current mechanical arm, using the “angle” representation.

Velocity coefficient--contains the "acceleration coefficient" and "uniform velocity coefficient" of the system, and the "acceleration coefficient" can be divided into three types of motion: "joint motion", "linear motion" and "circular motion".

Run to zero point--i.e. set all the joints of the mechanical arm to zero point.

Switch users--switch to the "login interface" and select "account" again to log in.

The premise of using "manufacturer account" to log in the system is that the program version of "controller" and "demonstrator" must be above V2.40; “Account"and"password"of the"manufacturer account"can be obtained by consulting the" manufacturer ".

◆ Restore the factory settings

In the "manufacturer account" login system interface (as shown in fig. 2.25), select the "restore factory settings" icon to enter the "restore factory settings" interface, as shown in fig. 2.27. Users can restore the factory settings of "point", "basic program", "process program", "modular program", "PLC program", "coordinate system" and "system setting" and other functional modules in the system through "restore factory settings".

The data after the system's functional modules are restored to "factory settings" by using the "factory settings" function cannot be recovered, so care should be taken.

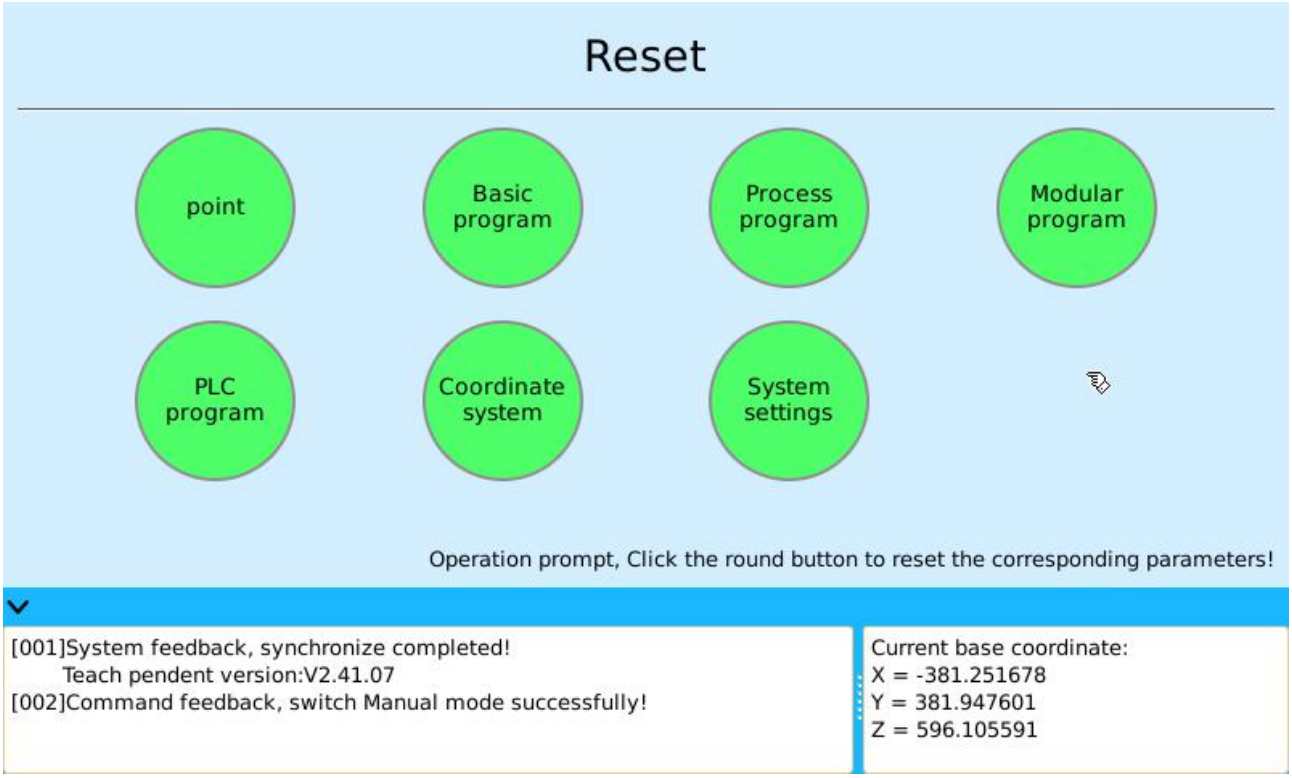


Figure 2.27 Structure diagram of “restore factory settings”

3. Preparation Work

After the user logs in to the system, the user must complete some preparatory work before running the control system, including:(1) Screen calibration (2)"Machine model" setting;(3) “Driver” configuration;(4) “Machine parameters” settings (5) There are 5 preparations for setting “zero-bit angle”.

3.1 Screen Calibration

When operating the system, since most functions are completed by "clicking" on the touch screen,"contact" must be accurate, and the "screen calibration" function of the system can meet this requirement. The specific operation steps for "screen calibration" of touch screen are as follows: Press and hold the "menu" physical button and the "program start-up" physical button at the same time, the calibration screen will appear, as shown in figure 3.1. A "cross" indicator will appear on the screen. Use the "stylus pen" to successively click the cursor center on the calibration screen, and successively track and click the "cursor" center for 5 times to complete the "calibration" of the screen. During the "screen calibration" process, press the "return" physical button to cancel the "screen calibration" operation.

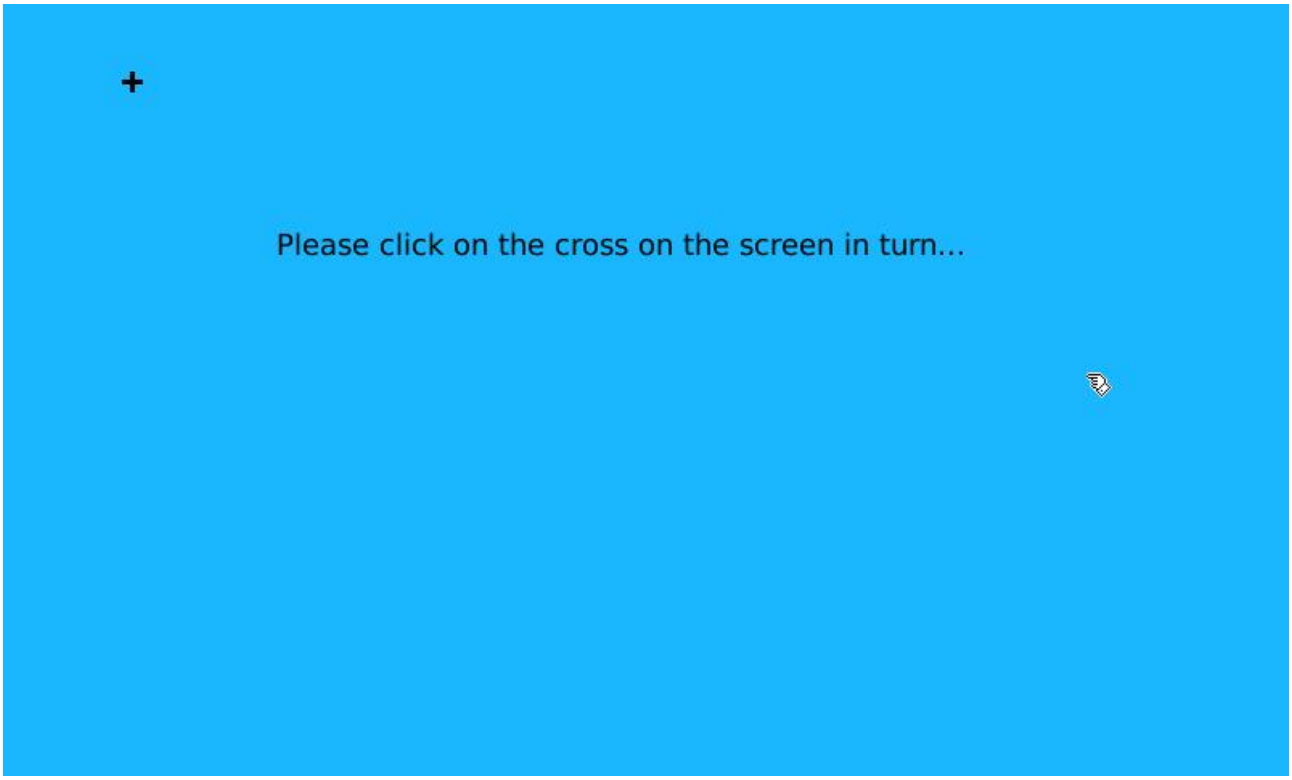


Figure 3.1 calibration screen

3.2 Machine model settings

Enter the system login interface of "manufacturer account" through "manufacturer account", as shown in figure 2.25. Select the "machine model" icon and enter the "machine model" setting interface, as shown in figure 3.2. The "machine model" setting includes "machine model selection" and "joint coupling".

"Machine model selection" includes three major parts: "type of mechanism", "number of axes" and "machine

model". Users can set it according to the actual model. After completion, click "save" button and the program of "demonstrator" program will start again, indicating that the "machine model selection" setting is successful.

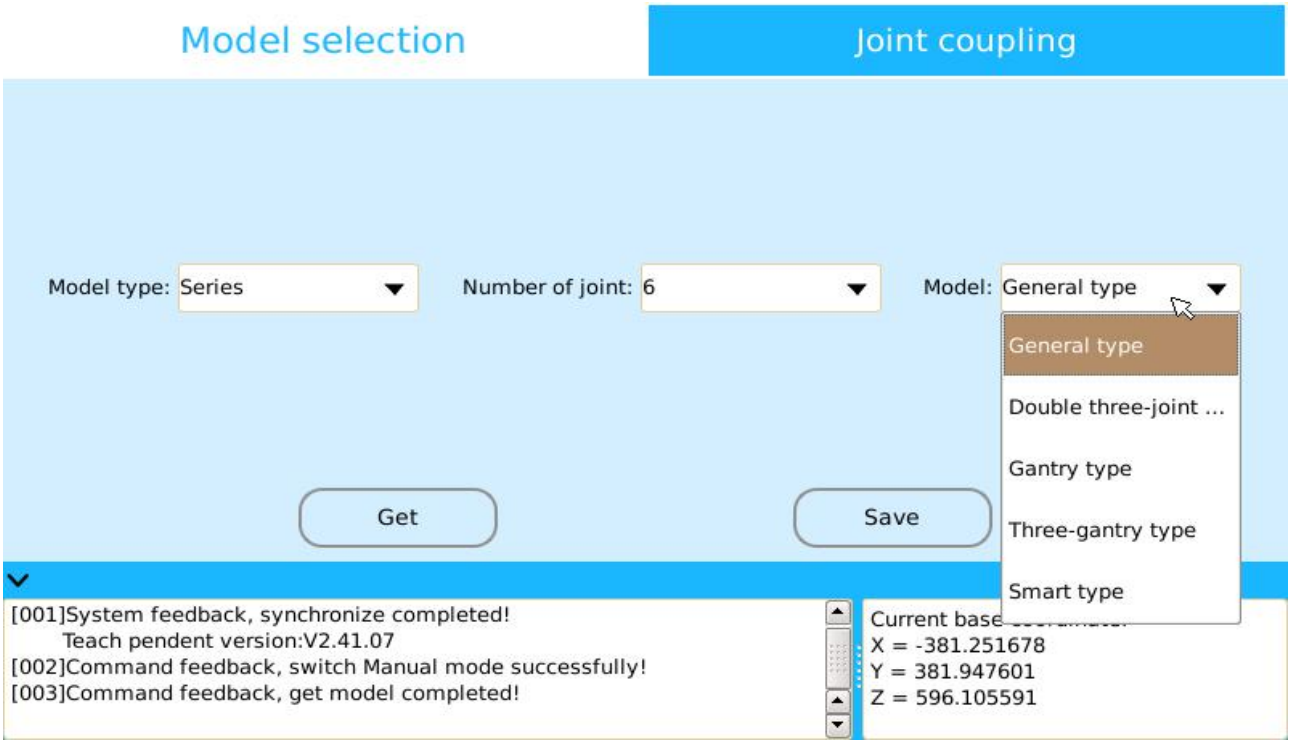


Figure 3.2 machine model setting interface

If there is interaction or mutual influence between the various “axes” of the machine, it is necessary to set the "joint coupling" of the machine, as shown in figure 3.3. “Joint coupling” consists of “axis number” and “coupling coefficient”. According to the specific connection between each axis of the machine, select the "axis number", enter the "coupling coefficient", and click "save" button to complete the setting of "joint coupling".

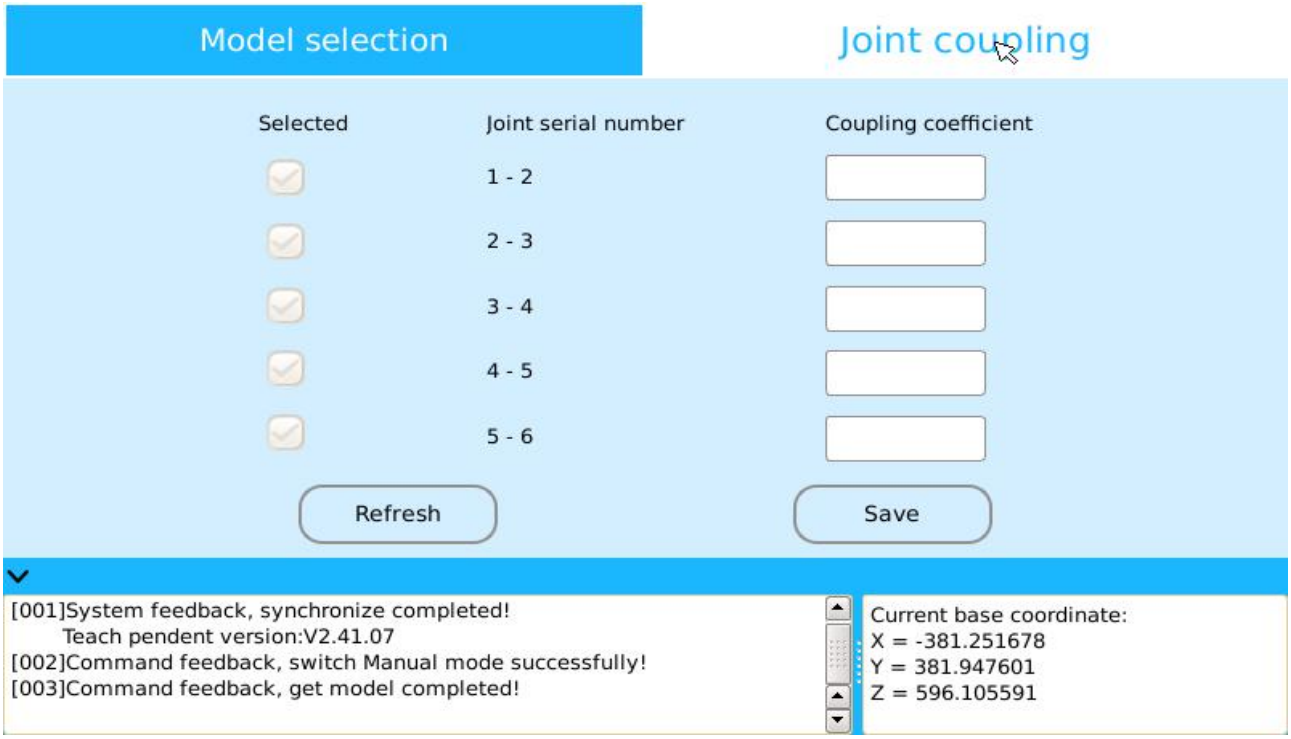


Figure 3.3 Joint Coupling Settings

3.3 Driver Configuration

Select the “driver” icon in the “manufacturer's account” login system interface shown in Figure 2.25, as shown in Figure 3.3_2, entering the “driver” configuration interface. The “driver” configuration comprises a “joint name”, a “driver port”, and a “driver type”.

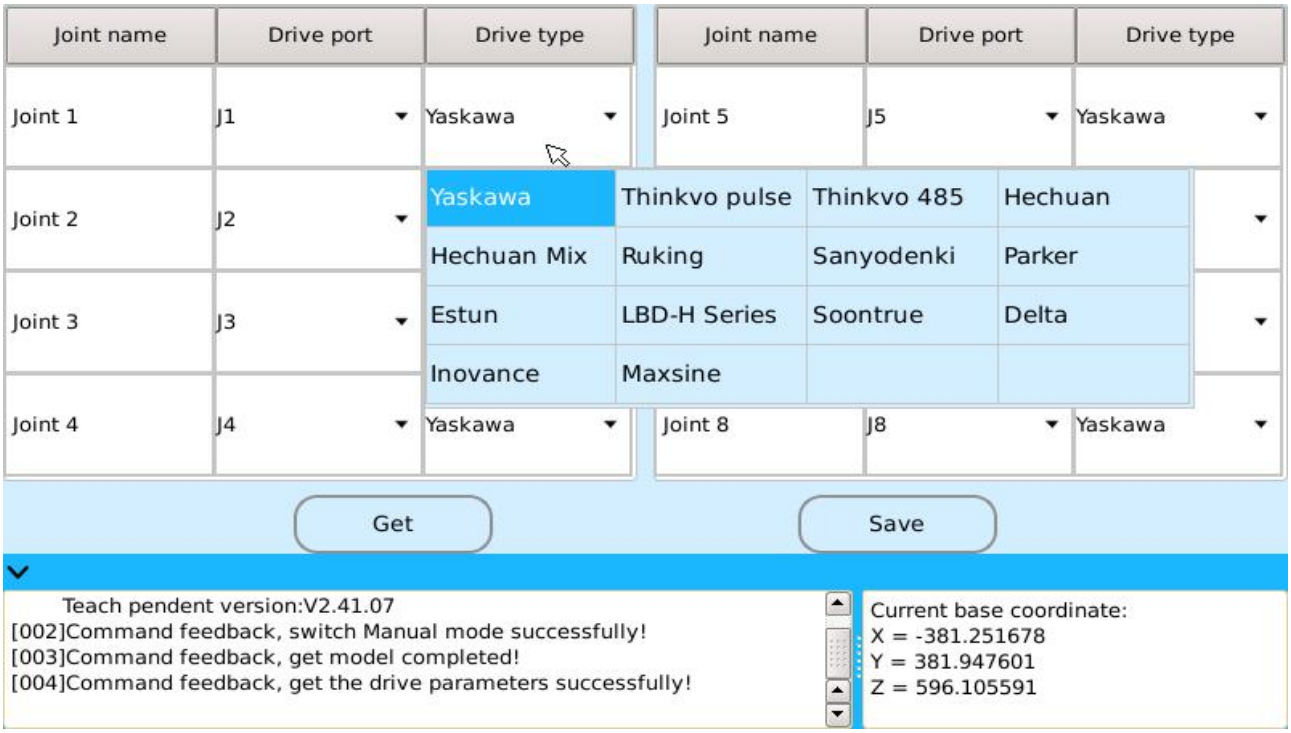


Figure 3.3_2 Driver Configuration Interface

Joint name--8-pathpulse drive interface on the controller, from left to right are "joint 1" to "joint 8".

Drive port--drive servo and motor end port.

Driver type--The drive type currently matched with this system, including various brands such as “Yaskawa”, “Hechuan”, “Delta”, and “Parker”.

According to the actual driving servo type of the external connection and the actual serial number of the system pulse drive interface, the “drive port” and “driver type” are configured, and the drive configuration is completed by clicking [Save] button.

Through the setting of the “drive port”, the 6 joints and 2 additional axis joints of the 6-axis mechanical arm can be flexibly set to map to any driver interface of the controller for the convenience of users.

3.4 Machine Parameter Setting

Select the "machine parameters" icon in the login system interface of "manufacturer account" shown in figure 2.25. As shown in figure 3.4, enter the "machine parameters" setting interface. Machine parameters setting, including "connecting rod length", "deceleration ratio", "joint positive/negative limit", "maximum speed", "PNOUT", "PNIN" and "encoding direction" setting.

Connecting rod length--length of each joint body of the mechanical arm, the unit is millimeter (mm).

Reduction ratio-determined by the specifications of the reducer installed at each joint, and the value of the reduction ratio of the reducer can be input.

Joint positive/negative limit--the rotation angle of the robot body has a limit, that is, the "hard limit". For the safety of the machine, the rotation angle of the mechanical arm is specified in the program, that is, the "soft" limit

is set, and the value shall not exceed the category of "hard limit".

Maximum speed--the maximum speed shall not exceed the rated speed (RPM) of the motor, generally 3000 RPM

PNOUT--set to 6000

PNIN--is related to driver and system “mode of communication”: When communicating with “pulse”, set to 2500; When communicating with “485”, PNIN expresses the motor encoder “digit” (e. g.: When the driver and the system “485” communicate, the PNIN value is set to “23” when the encoder number of the servomotor is a “23” bit.

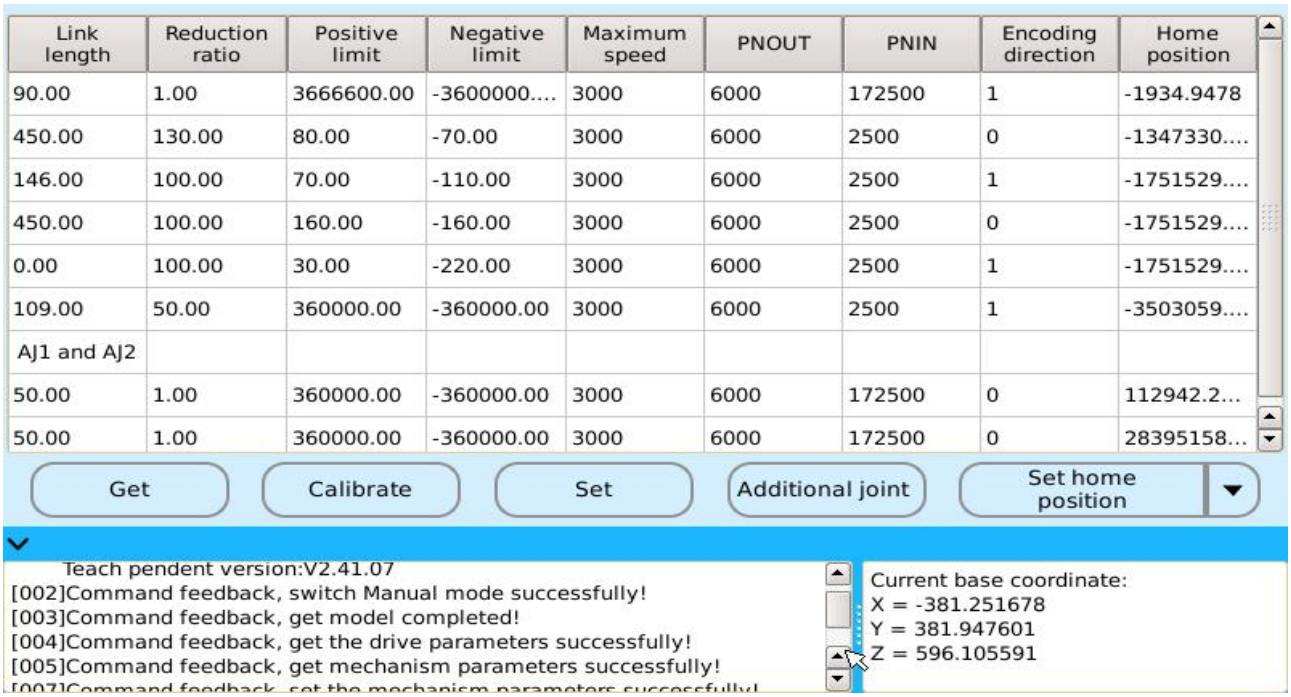
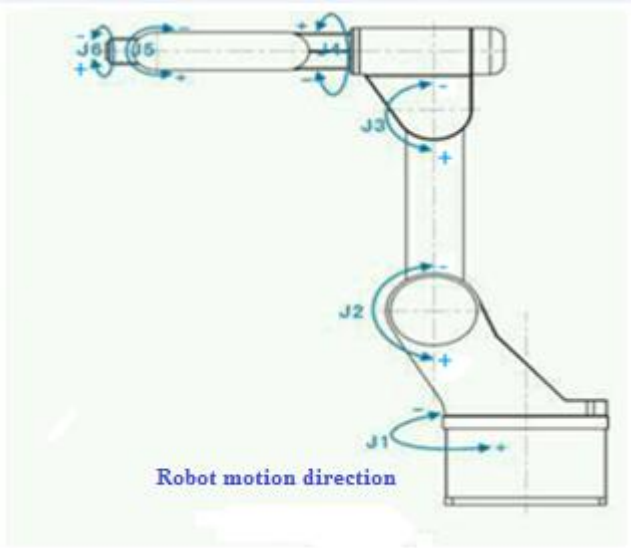


Figure 3.4 Structure diagram of the machine parameters

(7) Encoding direction--to determine the “direction of motion” of each joint of the mechanical arm and the setting values are “0” and “1”. Use the “right-handed spiral rule” to determine. The motion direction of each joint of the machine body is set as the motion direction in the motion direction of the robot in the figure below, J+and J-corresponding to the “+” and “-” membrane buttons of the “membrane switch” matrix switch position of the teach pendant. When the "motion direction" of each joint of the mechanical arm is different from the "motion direction" of each joint of the machine shown below, the "value" of "encoding direction" is modified to make it consistent (if it is originally "1", then modify it to "0"; If it is originally "0", then modify it to "1".



The direction of motion of each articulation identified when a person stands at the rear of the robot body

After all the “machine parameters” are entered, click the button [set]--[query] to complete the settings of the “machine parameter”.

Set “machine parameter” can also be set in “integral column”: Click the "name" of "machine parameters" to set, and enter the "value" to complete the parameter setting of the whole column under the "name"(if the name of "connecting rod length" is selected first, enter the value, then the parameter setting of the whole column of "connecting rod length" can be completed).

3.4.1 Additional Shaft Arrangement

The control system provides 8 pulse driver interfaces of "J1--J8", which can simultaneously control the motion of 8 axes at the same time. When the "J7" and "J8" pulse driver interfaces are connected to the joint axis, it is called "additional axis". The "J7" axis is configured as "Additional Axis 1" and the "J8" axis is configured as "Additional Axis 2". The "Additional Axis Setting" button can be set by selecting the [Additional Axis Configuration] button in the "Machine Parameters" setting screen of Figure 3.4.

(1) “Additional shaft” use mode: As shown in Fig. 3.5, the "additional axis usage mode" is divided into three modes: "not used", "joint mode", and "speed mode".

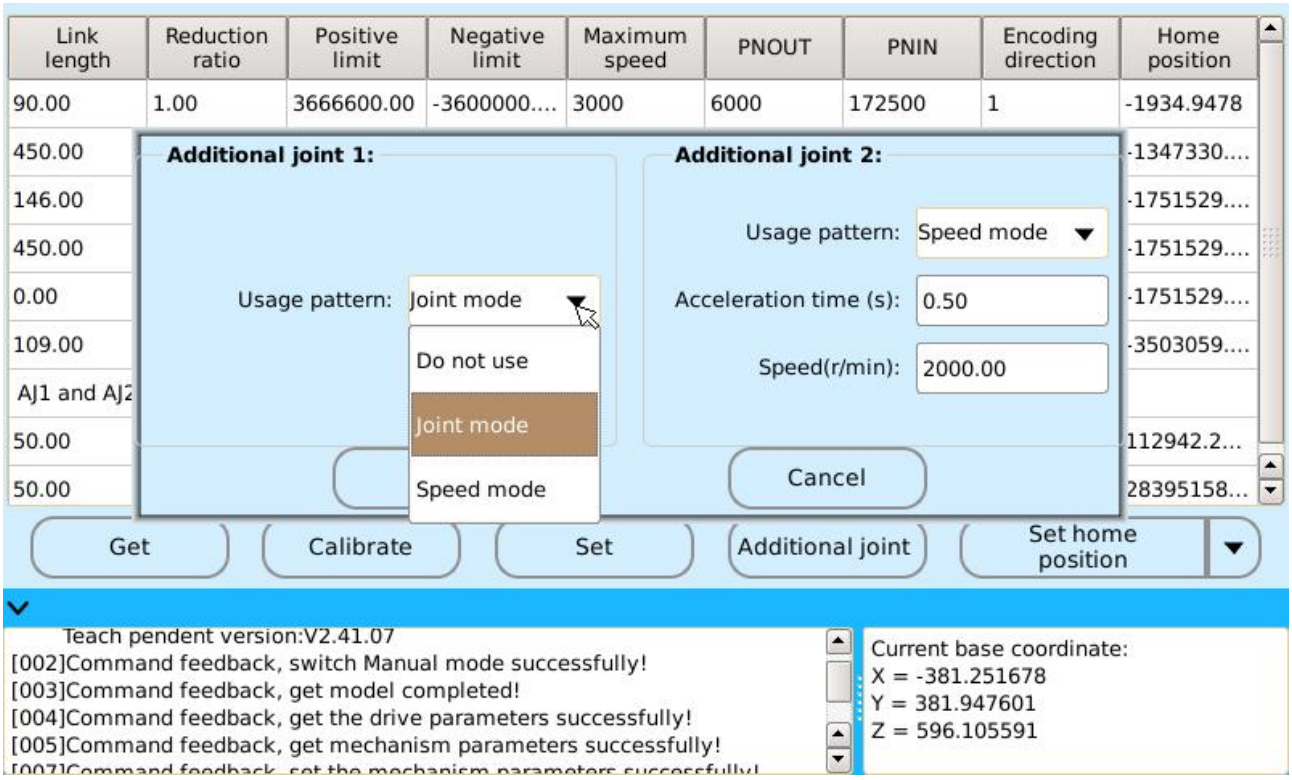


Figure 3.5 “additional axis” Usage Pattern

Not used-that is, the "additional axis" mode is not used. In this case, the "additional axis" corresponding to the pulse drive interface with the "DB26 short-circuit terminal" to clear the system alert.

Joint mode--when setting the "additional axis" to "joint mode", the "additional axis" is used in the same way as the "J1-J6” 6 common "joint axes".

Speed mode--when "additional axis" is set to "speed mode", "acceleration time" and "speed" need to be set, as shown in figure 3.6.

Acceleration time--controls the starting speed of "motor", the unit is second (s).

Speed--set the speed of "motor" in "RPM" and cannot exceed the "maximum speed" of "machine

parameters".

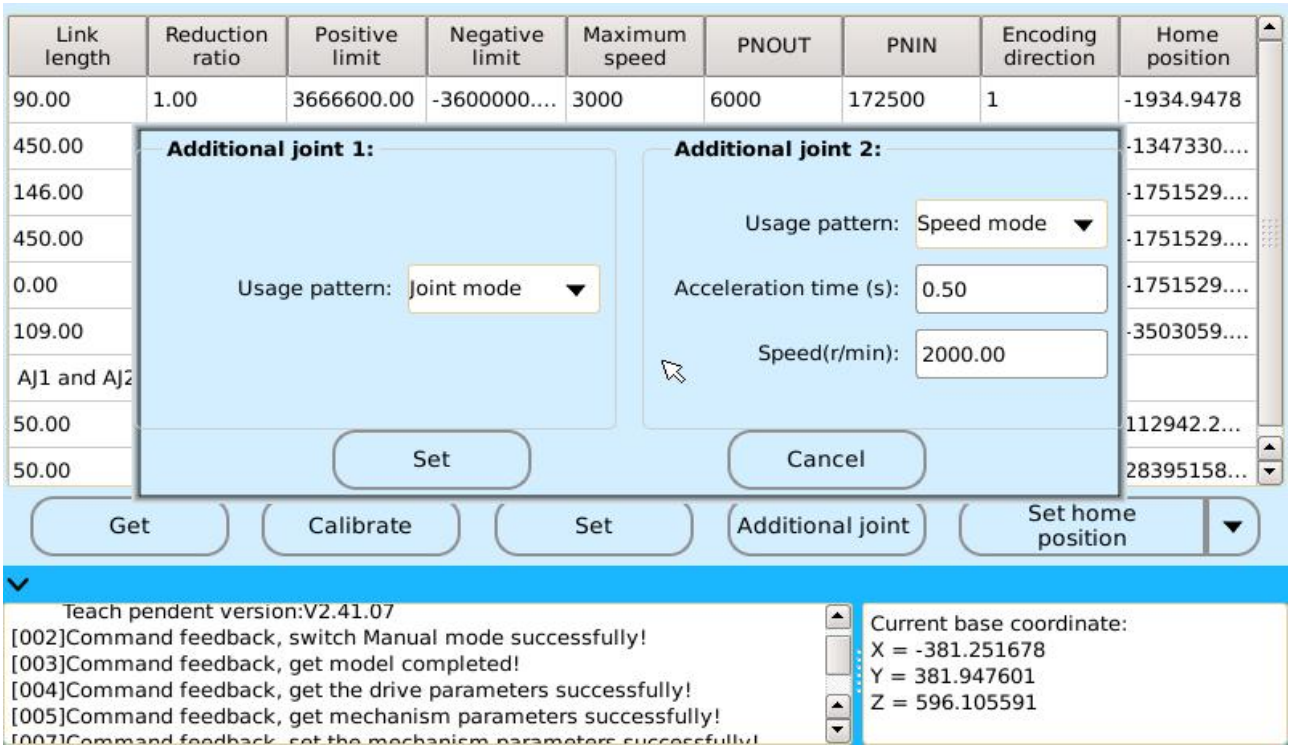


Fig. 3.6 Additional Shaft “Speed” Mode Setting

After setting "additional axis", "enable" on the system will pop up the "demonstrator" box, as shown in figure 3.7. Click the check box in front of "extension axis" in the figure and select "extension axis". Then "J1" and "J2" on the membrane matrix switch on the "demonstrator" can be used to manually teach "additional axis" movement: The membrane matrix “J1” can control the motion of the “J7” axis, and the membrane matrix “J2” can control the motion of the “8” axis.

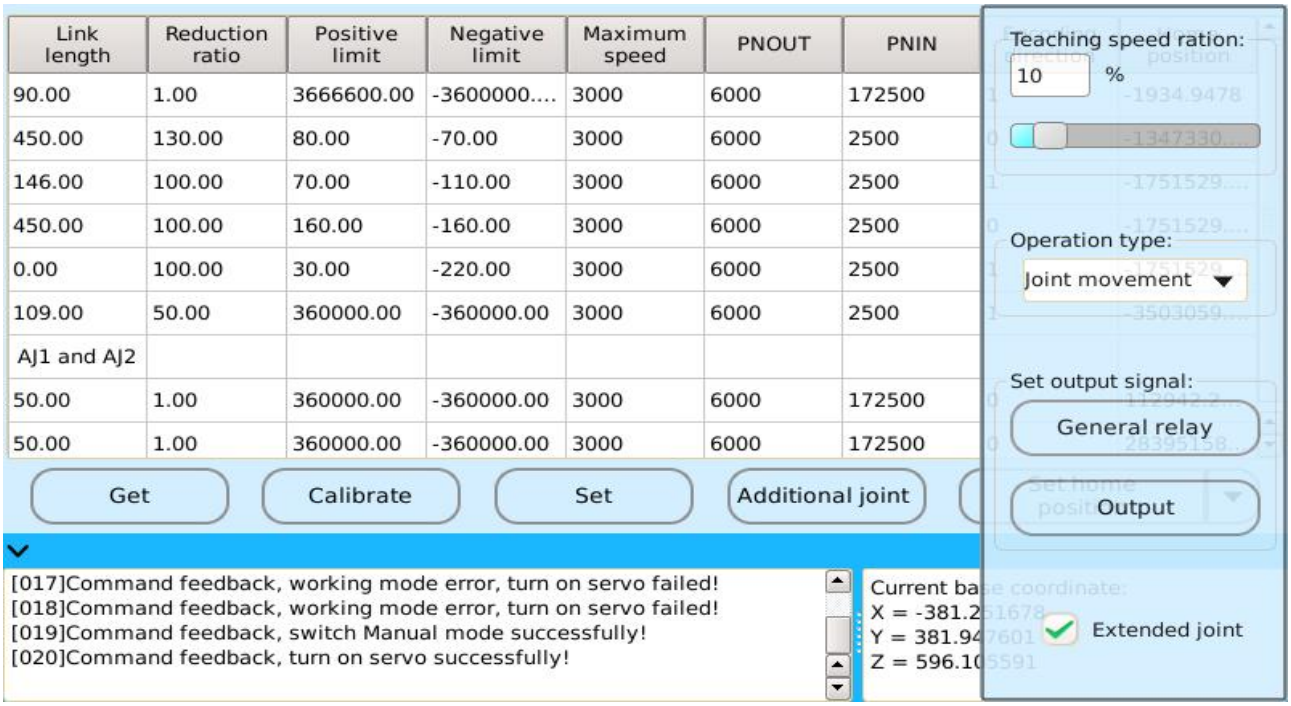
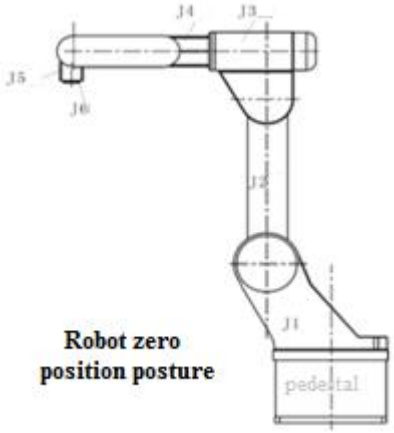


Figure 3.7 Manual demonstration of “additional axis”

3.5 Setting zero-bit angle

After the system's “machine model setting”, “driver configuration”, and “machine parameter setting” are completed, the system's “zero-bit angle” can be set. Setting the “zero-bit angle” of the system is a very important step because when the system obtains all the "positions" and "statuses" of the mechanical end, that is, the joint angular coordinates of the "point", it is positioned with the set current "zero-bit angle" state as the reference point.



As shown in the left figure, move each joint of the mechanical arm body to each position in the left figure. In the "machine parameters" setting interface (as shown in figure 3.4), click the button "set zero-bit angle" -- "query" to complete the setting of "zero-bit angle" of the system.

The system provides two ways to set up “zero-bit angle”.

The first kind: In the “manufacturer account” login mode, complete the setup of the system “zero-bit angle” by "set zero-bit" button of "machine parameter" setting interface (shown in Figure 3.4). When setting the “zero-bit angle”, users can choose to set the “zero-bit angle” for the “single axis” of the system, as shown in Figure 3.8.

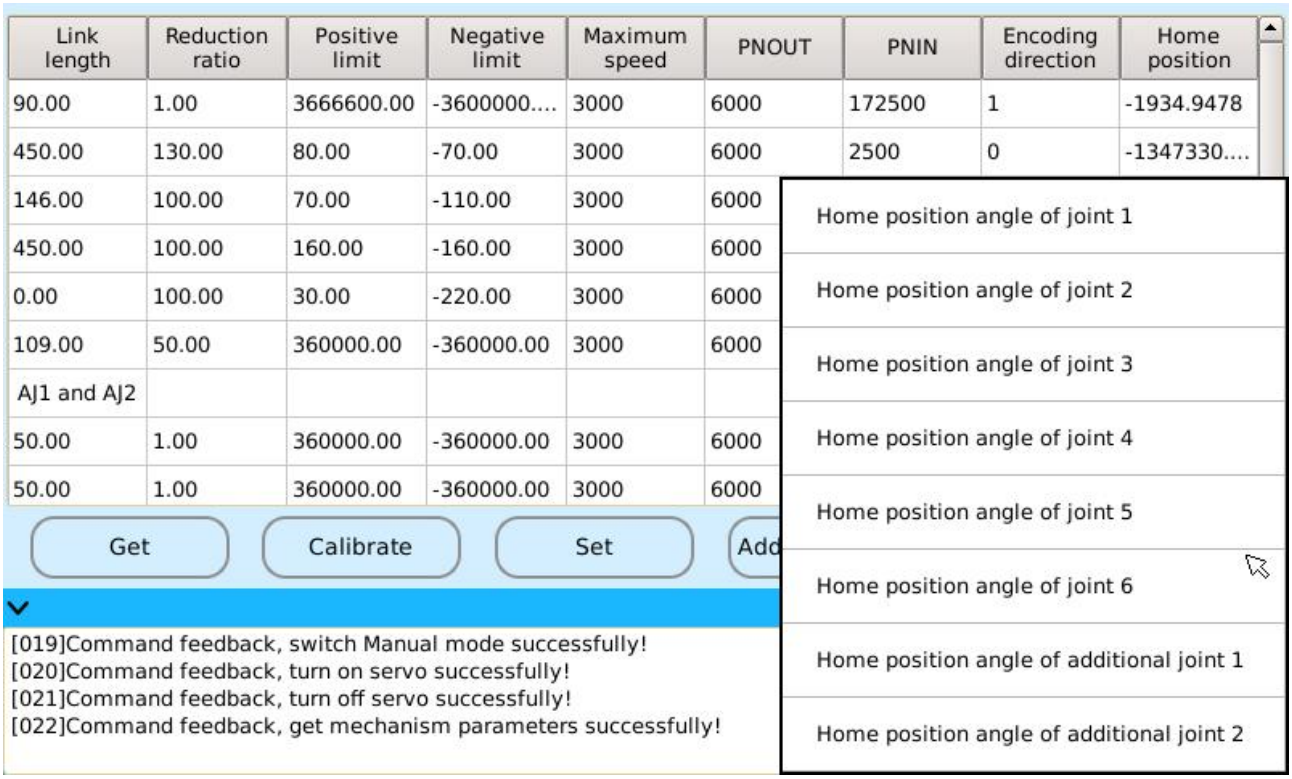


Figure 3.8 “manufacturer's account” login setting zero-bit angle

The second kind: When logging into the system in the common "administrator" mode, select the path in the main interface of "demonstrator": [tool]--[set zero-bit angle], enters the “set zero-bit angle” interface, completes the system’s “zero-bit angle” setting. As shown in Figure 3.9, the "second" method for setting the “zero-bit angle”

of the system can also select the “all settings” or “single setting” to set the “zero-bit angle” settings of the system.

Figure 3.9 “Administrator” login mode setting zero-bit angle

After the completion of setting zero-bit angle, the coordinate angle reading value of each joint is 0.

4. Procedure Control

The program control mainly includes three aspects: “program creation”, “program management” and “program run”.

4.1 Creation of basic procedure

In the “demonstrator” login main interface (shown in Figure 2.4), select [create program] icon, enter [create program] interface, including the creation of the “process pack” program, the creation of the “functional pack”, the creation of the “basic program”, and the creation of the “modular program”, as shown in Figure 4.1. The application of the “process pack” program and the “functional pack” program will be described in detail in the following sections.

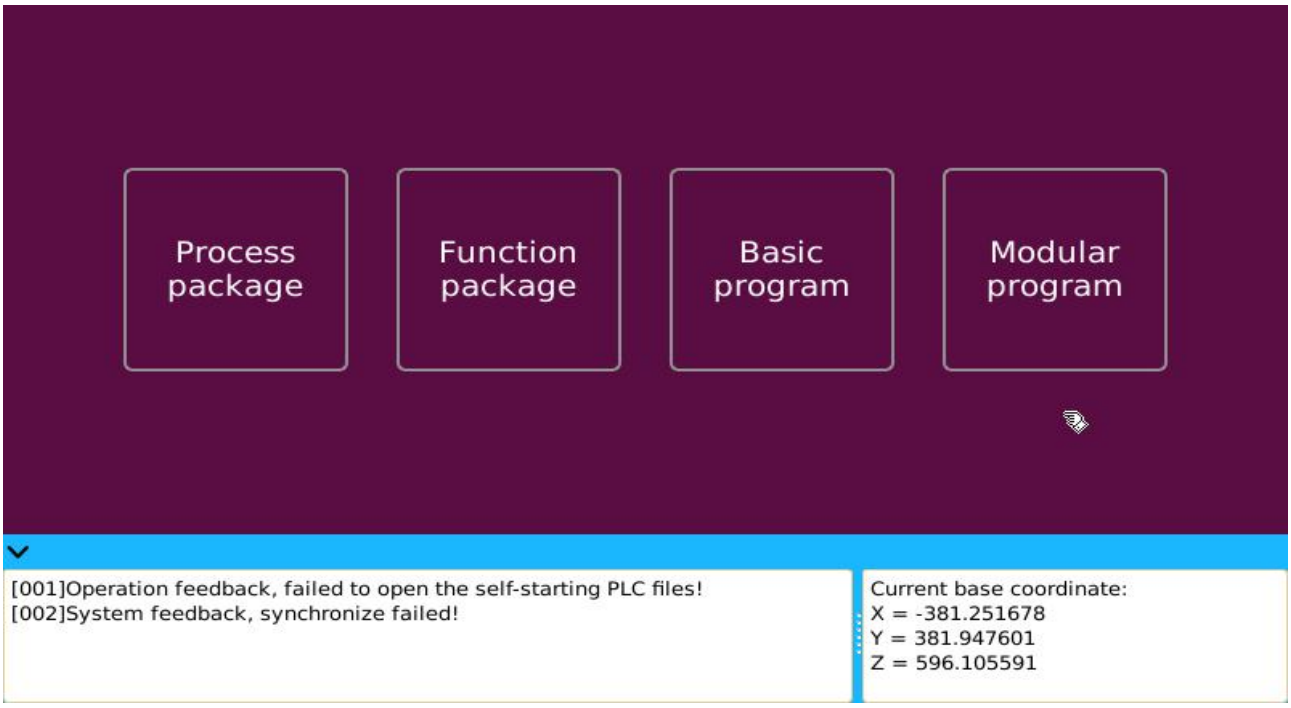


Figure 4.1 Compositions of “create program”

The specific content created by the system “program” mainly includes the creation of “program name”, “point”, “task type”, “type of motion”, “velocity of motion” and “smoothness ratio” settings, as shown in Figure 4.2.

The program name--program name can be “English”, “digit”, or “Chinese”.

Task type--divided into “motion instruction”, “basic instruction”, “process instruction”, “functional instruction” and “logical order”, plus “subroutine call” task type in “modular program”.

Motion type--divided into four types: “joint motion”, “linear motion”, “circular arc motion” and “circular motion”. Among them, the two types of motion of “circular arc motion” and “circular motion” must first determine the “point” on the “curve” before they appear.

Speed--parameter that determines the speed of the “curve” is related to the selected “type of motion”. In “joint motion”, the maximum speed is “3000”, the unit is “RPM”;the maximum speed of motion in “linear motion”, “circular arc motion” and “circular motion” is “2000”, and the unit is “millimeters per second”.

Smoothness ratio-- "Smoothness ratio" can only be found in the "linear motion", "circular arc motion" and "circular motion". Setting the "smoothness ratio" parameter can make the machine "run" faster. The “smoothness ratio” parameter setting range is “0-100”. The “0” indicates that the “smoothness ratio” is not set. The “100” is the

maximum “smoothness ratio” parameter.

The “starting point” or “terminal point”--belong to the creation scope of “point”, representing the position and status of the end of the mechanical arm in space, expressed in “angle value”.

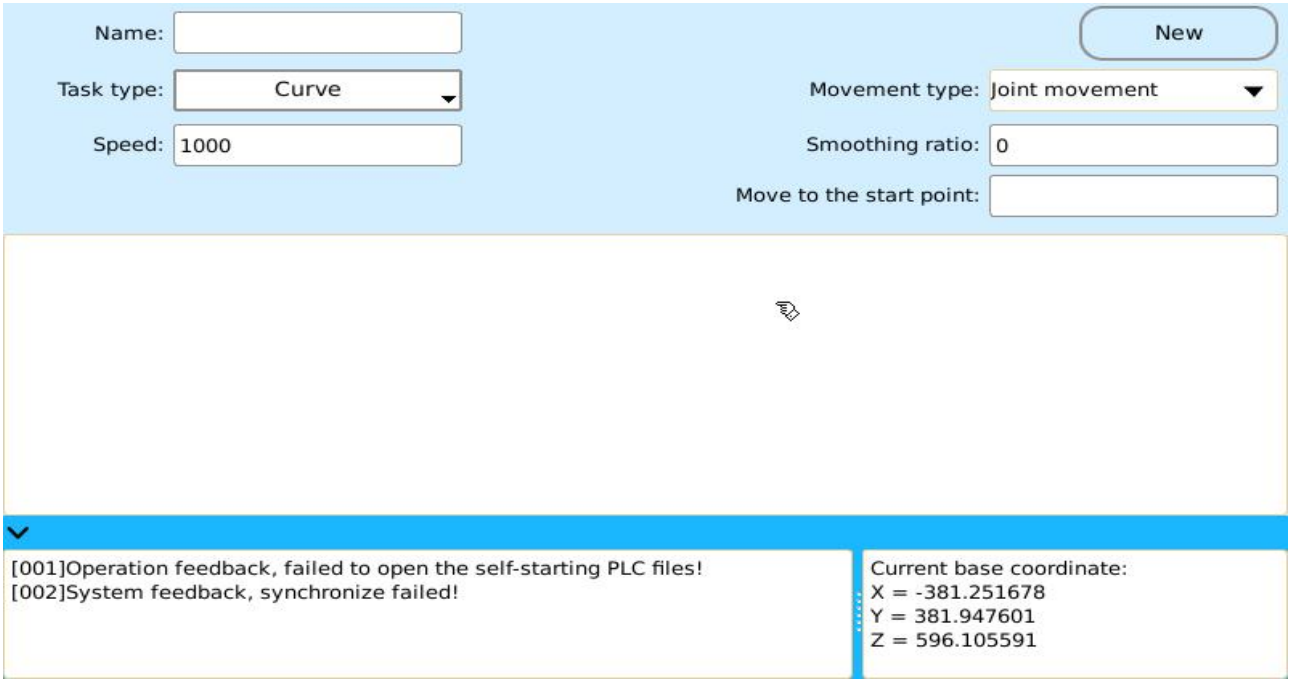


Figure 4.2 “Program creation” Interface

4.1.1 Creation of points

The “point” in the system actually represents the position and status of the end of the mechanical arm in space, which is displayed by "joint angle" and "coordinate value". The system provides two paths that can be created for “point”.

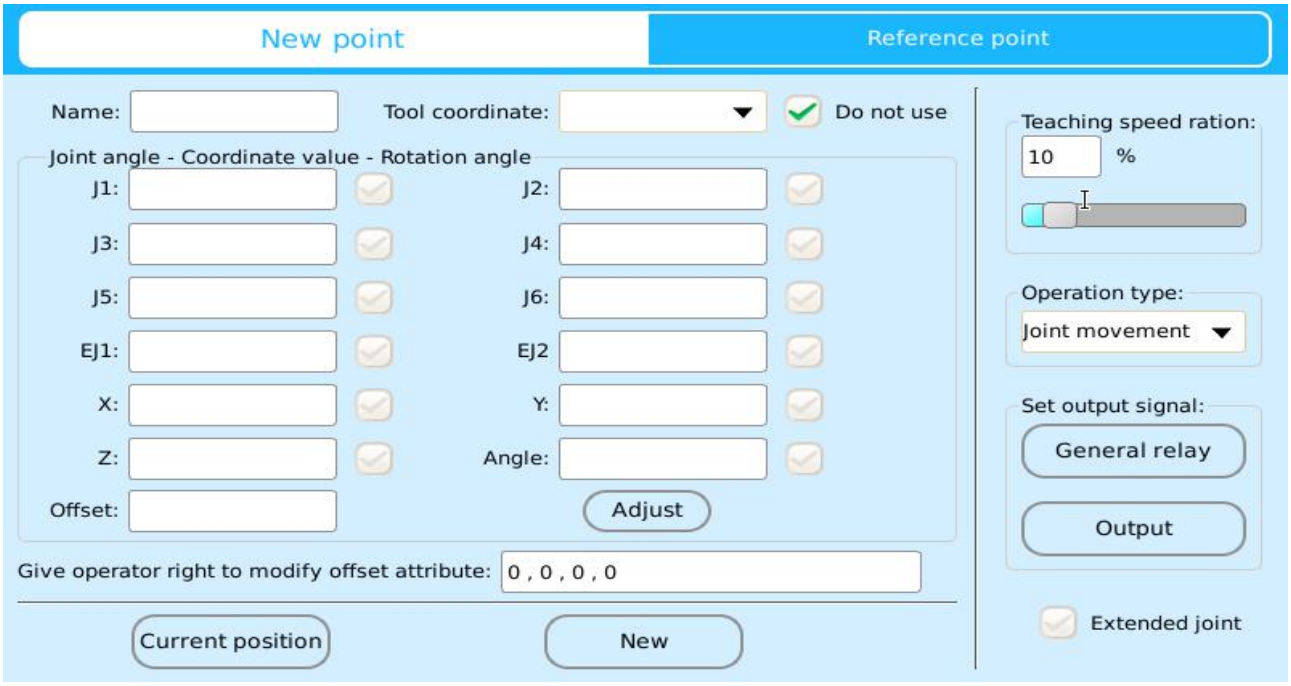


Figure 4.3 Creating interface for “point”

The first kind: As shown in Figure 4.2, click the “starting point” or “terminal point” at the “program creation” interface and a “create frame” for “point” will pop up, which is the “point” creation interface, as shown in Figure 4.3. Create the “name” for a “point”, choose whether to use a “tool coordinate system”, manually demonstrate the end of the mechanical arm to the specified location, click “read current point” button to get the “joint angle coordinate value” of the current “point”, and then click the “create” button to complete the creation of the “point”.

The second kind: After selecting the "program management" icon in the main login interface of "demonstrator"(as shown in figure 2.4), select management of "point" to enter the "point management" interface, and then click "create" button to enter the creation interface of “point”.

The specific mode of operation of the system “manual demonstration”: In the state of "manual" of the system, press the "enable" switch at the bottom of the "demonstrator" arbitrarily, that is, the "enable" button on the "demonstrator", set the "demonstrator speed" and "operation type", and then operate each joint movement of the mechanical arm through the "demonstrator" membrane matrix button.

If the "use" tool coordinate system is selected during the creation of the "point", the "point" in the entire "program" must select "use" and the same "tool coordinate system".

If the position of the “point” has been created, user can also select the “reference point” icon in the creation interface (shown in Figure 4.3) of “point” and directly “reference” it.

4.1.2 Classification of Task Types

The “task type” of the system program can be divided into six categories: “motion instruction”, “basic instruction”, “process instruction”, “functional instruction”, “logical instruction” and “subroutine call”, as shown in Figure 4.4.

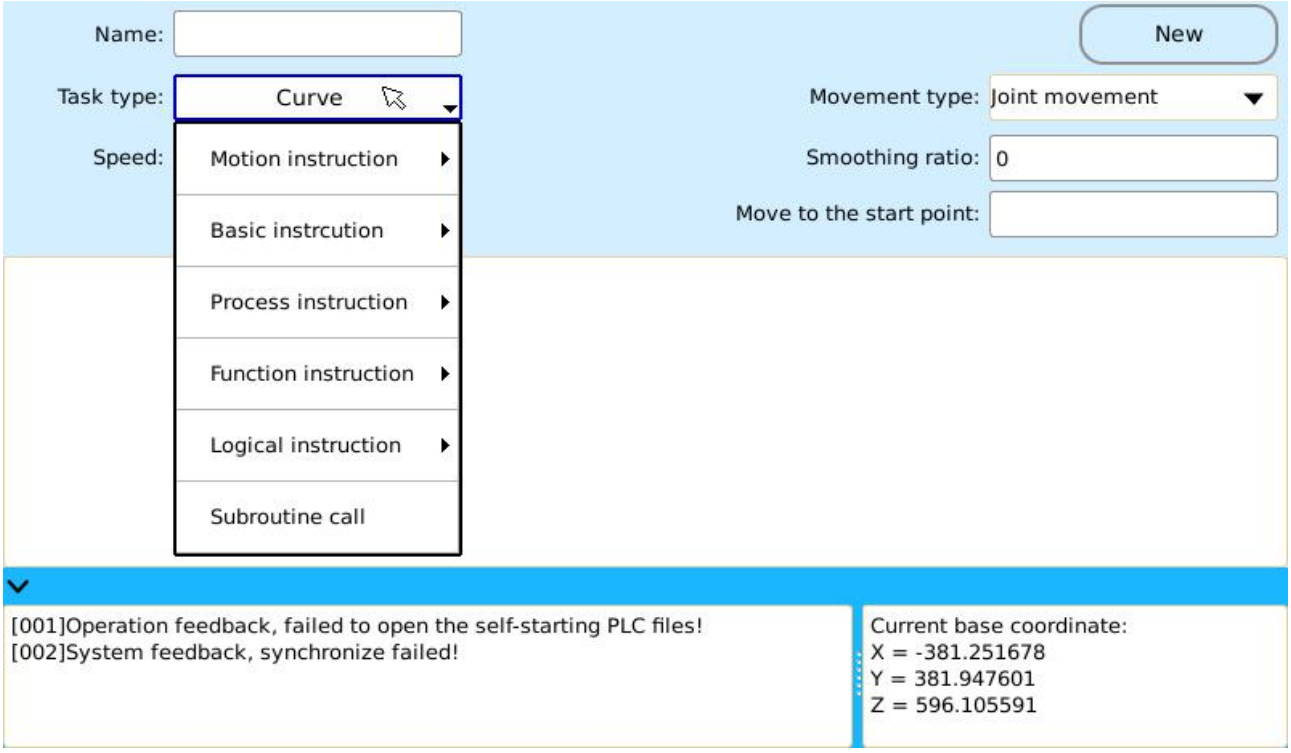


Figure 4.4 Classification of “task type”

◆ Motion instruction

The “motion instruction” task type of the system contains three types: “curvilinear motion”, “additional axis motion”, and “forbidden axis”.

(1) The task type of the “curve”: As shown in Figure 4.2, the “type of motion”, “velocity of motion”, “smoothness ratio”, “starting point”, or “terminal point” are required to be set when selecting the “curve” task type.

Apply the “curve” task type format: After selecting the “curve” task type, determine “type of motion”, enter

“velocity of motion”, set “smoothness ratio”, “create” or “reference” for “starting point” or “terminal point”, and finally click [Add] button to complete the establishment of a “curve”.

(2) The task type of the “additional axis motion”: That is, the speed of the “additional axis” motion. When "additional axis movement" task type in "motion command" task type is selected,"additional axis number", "enable/disable" additional axis motion,"positive/negative" rotation direction and "speed" need to be set.

Apply the “additional axis motion” task type format: After selecting the “additional axis motion” task type, determine the “additional axis serial number”, when selecting the “enable” additional axis motion, and then determine whether the “direction of motion” is “positive direction” or “negative direction” and the motion “speed of rotation”, and finally click [add] button to complete the creation of the “additional axis motion” task type, as shown in Figure 4.5.

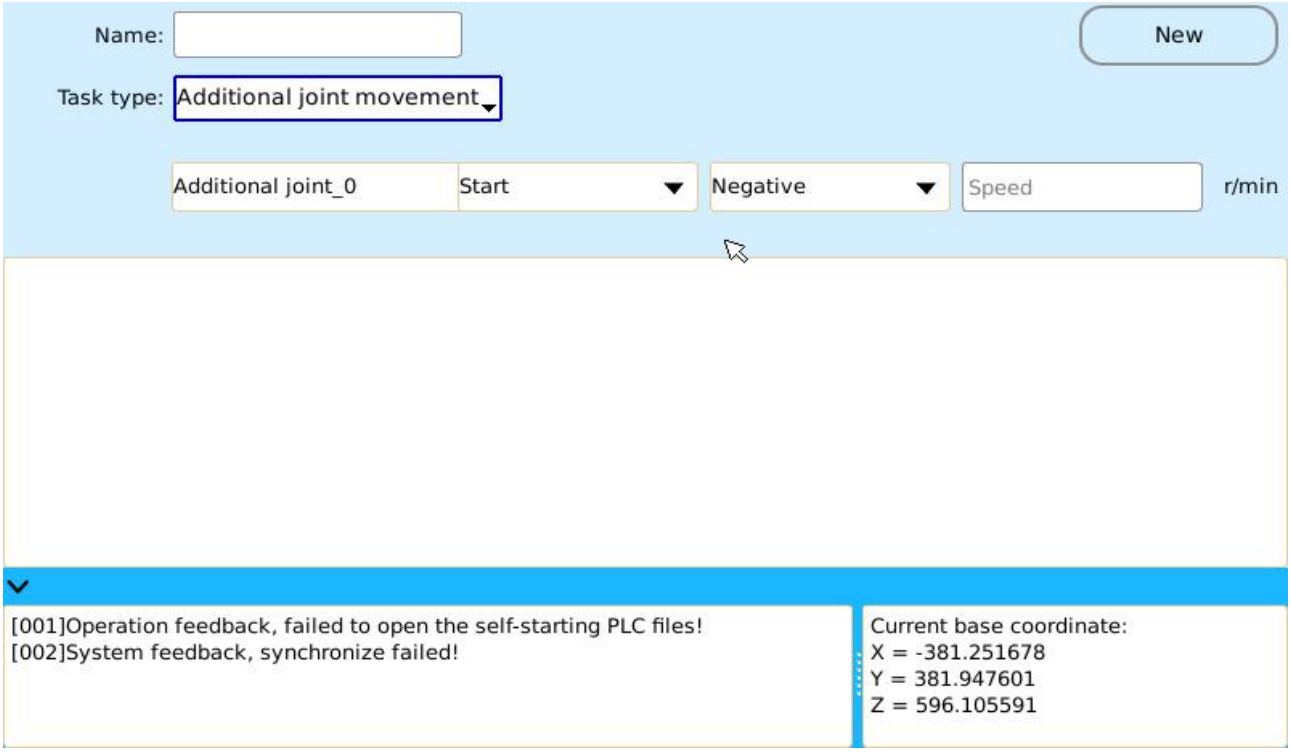


Figure 4.5 “Additional axis motion” task type

Selecting the “additional axis motion” task type must be based on the “additional axis” set to the “velocity” usage mode. In the “additional axis serial number”, the “Additional axis_0” represents the J7 axis and the “additional axis_1” represents the J8 axis. When "stop" additional axis motion is selected, there is no need to set "positive/negative" rotation direction and "speed" parameters of "additional axis motion".

(3) Task type of “forbidden axis”: The movement of "additional axis" can be "forbidden". Select "forbidden axis" task type in "motion instruction" to set "additional axis": "Enable additional axis" or "forbid additional axis", where "additional axis_0" represents the J7 axis and "additional axis_1" represents the J8 axis.

◆ Basic instructions

As shown in Figure 4.6, the “basic instruction” task type of the system contains 12 types: “output”, “pulse output”, “simulation quantity”, “delay”, “PLC operation”, “offset”, “pose offset”, “additional axial offset”, “enabling contour offset, ”, “stop contour offset”, “enabling absolute speed” and “deactivate absolute speed”

(1) The task type of the “output”: Set the output "high/low level" of the IO output port of the system. When selecting the output task type, users need to set “output port number” and “output level value”.

Apply the “output” task type format: After selecting the “output” task type, set up the “output port number” and “output level value” separately, and click [Add] button to complete the operation.

The system provides an 18-path I/O port “output”, including 8-path “relay output” and 10-path “collector

circuit", and the initial IO port "output" state of the system defaults to low-level "0". The maximum number of "output port number" and "output level value" set at the same time is "6", connected by the "-".

(2) The task type of the "pulse output": The IO output port state can be "persisted" and "automatically" turned off when the "hold time" runs out. When selecting pulse output task type, users need to set output port number, polarity, and pulse width.

Output port number--the system provides a total of 18-path IO "output" port numbered "0--17". When setting multi-channel "output port number", use the connector "-" in the middle.

Polarity--is divided into two kinds: "positive polarity" and "negative polarity", which are related to the external device connected with IO output port.

Pulse Width--Duration, the unit is milliseconds (ms).

Apply the "pulse output" task type format: After selecting the "pulse output" task type, set up "output port number" and "polarity" according to external wiring, then enter the "pulse width" parameter, click [add] button to complete the operation.

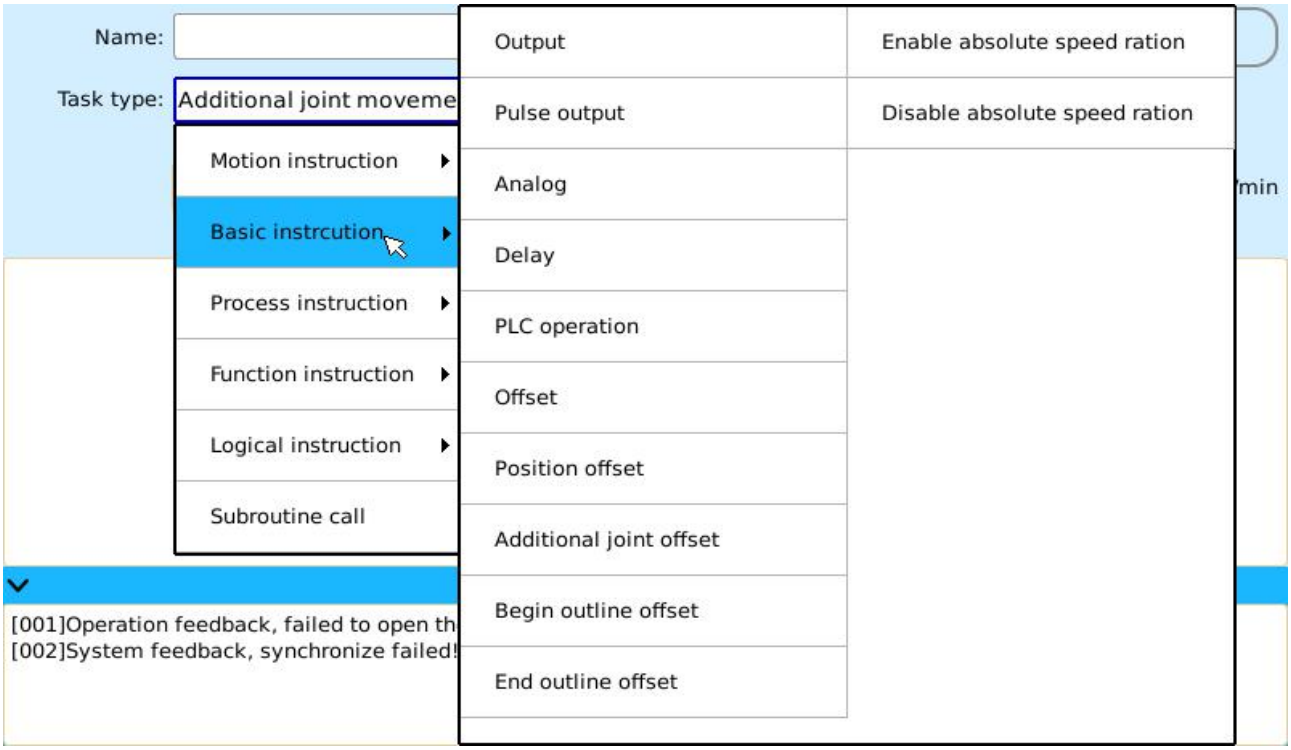


Figure 4.6 "basic instruction" Task Type Content

(3) Task type of "simulation quantity": Set the "simulation output" value of each "channel port" of the system. When you select the "simulation quantity" task type, you need to set the "channel number", "data source", and "simulation value".

Channel Number--System provides a total of 4 passageways: "0", "1", "2" and "3".

Data Sources--There are two sources: "constants" and "variables".

Simulation value--value range is [0, 12V].

Apply the "simulation quantity" task type format: After selecting the "simulation quantity" task type, the "channel number", "data source" and "simulation value" are set according to the external connection. Click [Add] button to complete the operation.

(4) The task type of "delay": Namely delay time. When you select the "delay" task type, you need to set the "delay time".

Delay time--Delay time, the unit is milliseconds (ms).

Apply the "delay" task type format: After selecting "delay" task type, complete setting "delay time", and click the [add] button to complete the operation.

(5) Task type of "PLC operation": Namely the output state of the "auxiliary register" is set. When "PLC operation" task type is selected,"M (auxiliary register) serial number" and "register status" need to be set.

M sequence number--i. e. the serial number of “auxiliary register”, scope is [0,500].

Register status--divided into "invalid" and "valid", represented by "0" and "1" respectively.

Apply the “PLC operation” task type format: After selecting the task type of "PLC operation", complete setting "M serial number" and "register status", and click [add] button to complete the operation.

The initial state of “auxiliary register” in the system is the “Invalid” state by default;through the “PLC operation” task type, the system associates the “system programming” with the “PLC” program.

(6) The working type of the “offset”: Use "OFFSET" to indicate that the "terminal point" of the "line" curve after "OFFSET" can be OFFSET. The "direction" and "range" of OFFSET can be set by themselves. When you select the “offset” task type, you need to set the “coordinate system type” and the “data source”.

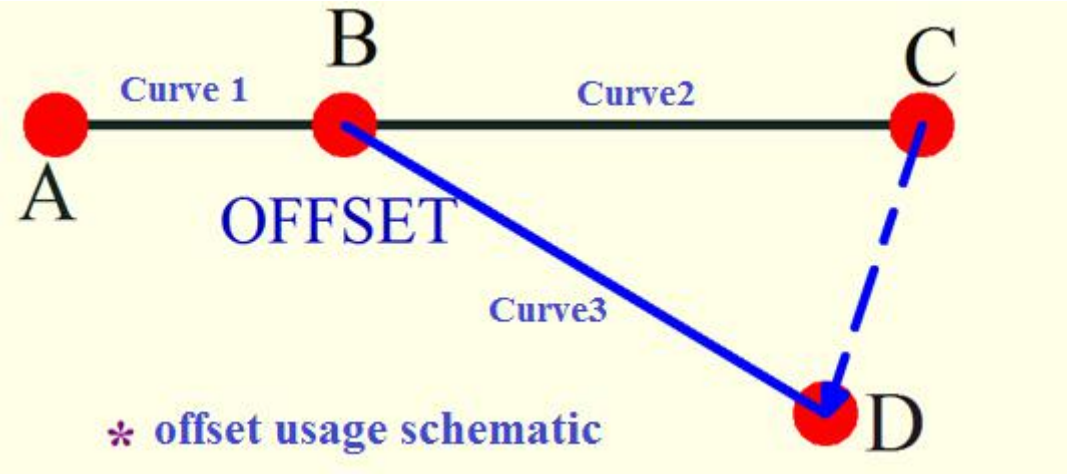
The coordinate system type--is divided into two kinds: “base coordinate system” and “user coordinate system”.

Data sources--contains “global variables” and “demonstration parameter”. When the source of demonstration parameter is selected, the values of "X-axis migration", "Y-axis migration" and "Z-axis migration" can be input directly. The "positive and negative" values indicate the migration direction.

Apply the “offset” task type format: After selecting the “offset” task type, complete the setting of “coordinate system type” and “data source”, and click [Add] button to complete the operation.

When the “offset” is used, the offset curve is only a “terminal point” of the curve after the “OFFSET”, and the “terminal point” of the subsequent two or more curves is not “offset”. When the "global variable" source is selected in the "offset" task type, the global variables "GV200", "GV201" and "GV202" in the system respectively represent the "X", "Y" and "Z" offset in the "coordinate system". The global variable “GV205” represents the offset of the “angle of rotation”: The “value” of the global variable means the migration “amplitude”, the unit is millimeters (mm), and the “positive and negative” values represent the migration direction.

Use the following "offset usage schematic" for a simple example: In the figure, it is a simple program with 2 curves. When using the "offset" task type "OFFSET", the program's running path will change.



Curve 1:A-B;Curve2: B—C;In the absence of the “OFFSET” task type, the complete trajectory of the curve is “A-B-C”; After using the "OFFSET" task type after curve 1(i. e., at the point "B"), the terminal point "C" of the original curve 2 will be OFFSET to the position of "D", so the curve trajectory of the program after using the "OFFSET" task type becomes "A--B--D".

(7) The task type of the “pose offset”: Use "POSE_OFFSET" to represent the offset from the "current position", that is, after the curve runs to this position, a "new curve" will be generated--a curve with "current position" as the "starting point" and "position after offset" as the "terminal point", and execute the "new curve" first and then run the "next" curve. The “coordinate system type”, “data source”, “type of curve” and “desired speed” are required to be set when the “pose offset” task type is selected.

The coordinate system type--divided into three kinds: “base coordinate system”, “user coordinate system” and “joint coordinate system”.

Data sources--contains “global variables” and “demonstration parameter”. When the source of demonstration parameter is selected, the values of "X-axis migration", "Y-axis migration" and "Z-axis migration" can be input

directly. The "positive and negative" values indicate the migration direction.

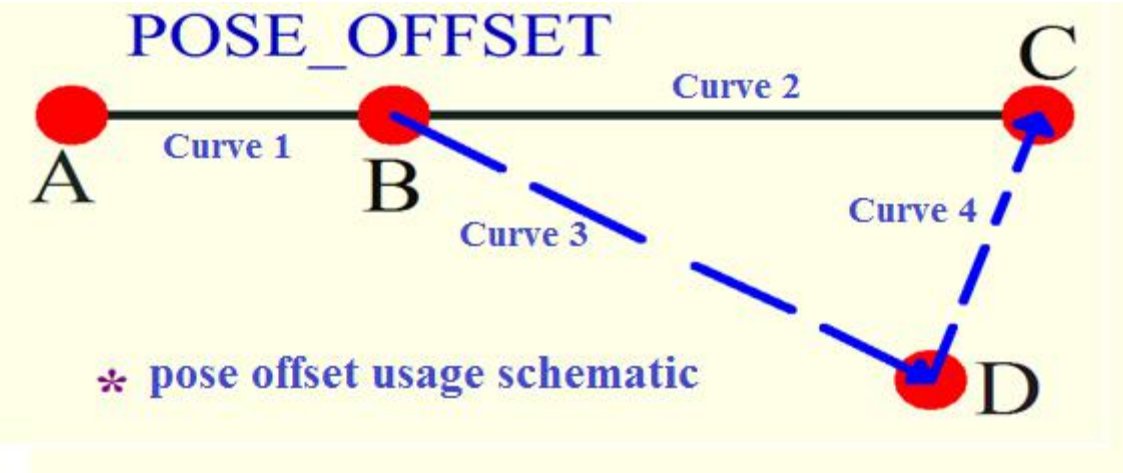
Curve types--divided into two kinds: “joint motion” and “linear motion”.

Desired speed--set the “current position” to the “position after offset” to generate the running speed of the “new curve”.

Apply the “pose offset” task type format: After selecting the “pose offset” task type, complete the setting of the “coordinate system type”, “data source”, “type of curve” and “desired speed”, and click [Add] button to complete the operation.

When the "global variable" source is selected in the "pose offset" task type, the global variables "GV209", "GV210" and "GV211" in the system respectively represent the "X", "Y" and "Z" offset in the "coordinate system". The global variable “GV214” indicates the pose offset of the “angle of rotation”: The “value” of the global variable means the migration “amplitude”, the unit is millimeters (mm), and the “positive and negative” values represent the migration direction.

Use the following "pose offset usage schematic" for a simple example: This is a simple program with 2 curves. When using the "POSE_OFFSET" task type "POSE_OFFSET", the running track of the program will change.



Curve 1:A-B;Curve2: B—C;When the “POSE_OFFSET” task type is not used, the running track of the program is “A—B—C”; When the “POSE_OFFSET” task type is used at the curve 1(i. e. the B-point position), the “point”'s running track offsets from the current point “B” to the “D” point position, then runs to the “C” point position, that is, after the “POSE_OFFSET” task type is used, The program's running track is turned into a “A-B-D-C”.

(8) Task type of “additional axial offset”: Use “EXTRA_OFFSET” to indicate that the “additional axis” is provided with “offset”. “Serial number”, “direction”, “speed” and “angle of rotation” are required to be set when the “additional axial offset” task type is selected.

Serial number--the serial number of “additional axial offset”, containing both “additional axis_0” and “additional axis_1”.

Direction--offset direction of the “additional axis”, divided into “positive” and “negative direction”.

Speed--set the speed of the “additional axis” offset, the maximum speed cannot be greater than the speed set in the “machine parameter”.

Rotation Angle--the offset number of the additional axis, expressed as “angle” and the unit is degrees.

Apply the “additional axial offset” task type format: After selecting the “additional axial offset” task type, complete the setting of the “serial number”, “direction”, “speed” and “angle of rotation”, and click [Add] button to complete the operation.

The prerequisites of the system using “additional axial offset” task type: The use pattern of “additional axis” must be set to “speed mode”.

(9) Type of “enabling contour offset” and “stop contour offset”: Two types of task types are used together,"OUTLINE_OFFSET" is used to indicate that the "contour" formed by the constituent curve between "enable contour offset" and "disable contour offset" in the program can be offset. When you select the “Enable contour offset” task type, you need to set the “user coordinate system”.

Apply “Enable contour offset” and “disable contour offset” task type format: After selecting the “Enabling

contour offset" task type, set the "user coordinate system" complete and click [Add] the button. Then set the "direction" and "amplitude" of "contour offset" and the "contour" formed by "curve". Finally, select "disable contour offset" and click [add] button to complete the operation.

The "direction" and "amplitude" of the system's "contour offset" are set by selecting the corresponding "global variable" and "assignment" of the corresponding "global variable". The global variables "GV215" and "GV216" respectively represent the offset in the direction of "X" and "Y" in the "coordinate system". The global variable "GV217" represents the contour offset of "rotation angle": The "value" of the global variable means the migration "amplitude", the unit is millimeters (mm), and the "positive and negative" values represent the migration direction.

The "user coordinate system" of the task type of system "contour offset" needs to be "created" according to the actual situation, and then "enable" can be used directly.

(10)"enable absolute speed" and "disable absolute speed" task types: Two types of task types are used together, using "ABS_SPEED" to indicate that the "curve" speed between "enable absolute speed" and "disable absolute speed" in the program is "absolute speed", independent of the "speed ratio" parameters at run time.

Apply "enable absolute speed" and "disable absolute speed" task type formats: After selecting the "enable absolute speed" task type, click [Add] button;then set the "curve" of "absolute speed" to be performed. Finally, select "disable absolute speed" and click the "add" button to complete the operation.

◆ Process instruction

As shown in Figure 4.7, the task type "process instruction" contains 4 types of "enable palletization procedure", "disable palletization procedure", "enable welding", and "disable welding". Among them, the "enable palletization procedure" and "disable palletization procedure" task types and "enable welding" and "disable welding" task types are used together with each other.

The "enable palletization procedure" and "disable palletization procedure" task types in the system are represented by "PALLET"; "enable welding" and "disable welding" task types are represented by "WELD".

When applying 4 types in the "process instruction" task type, firstcreate the "process program", and then select the corresponding "process procedure" at the time of the "enable".

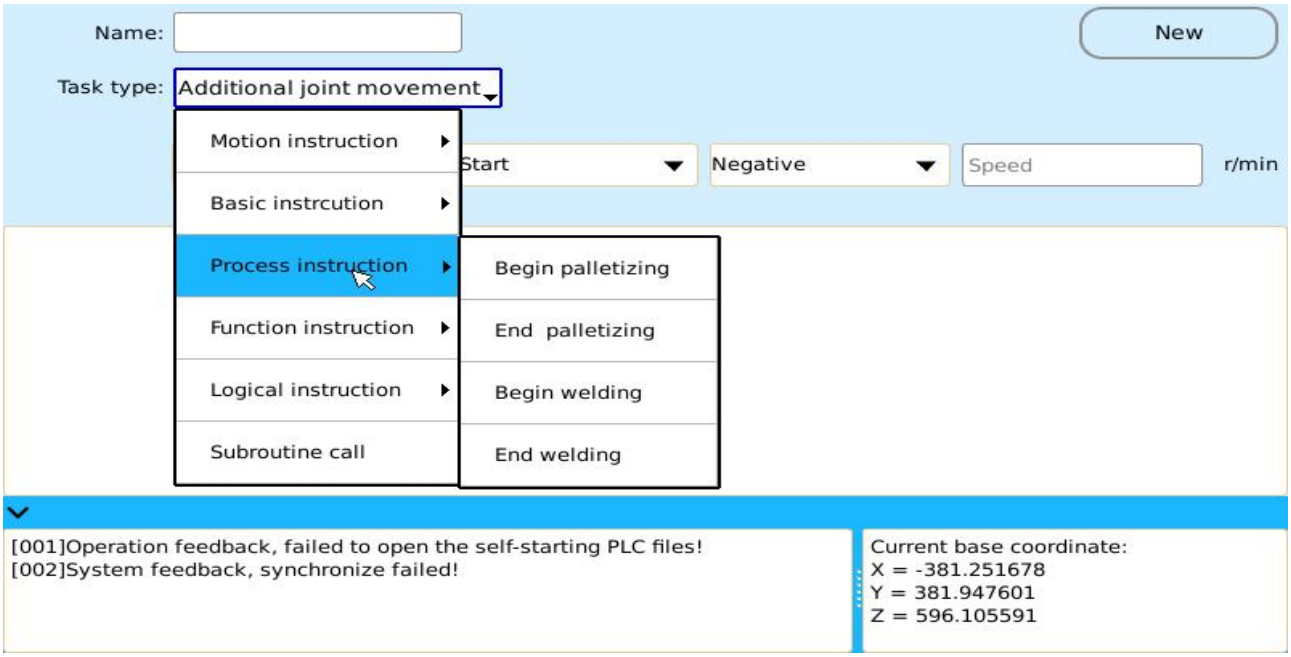


Figure 4.7 "process instruction" Task Type

◆ Functional instruction

As shown in Figure 4.8, the task type "functional instruction" contains 6 types of "enable tracking", "disable

tracking", "enable swing arc", "disable swing arc", "enable collaboration", and "disable collaboration". The "enable tracking" and "disable tracking" task type, "enable swing arc" and "disable swing arc" task type and "enable collaboration" and "disable collaboration" task type are also used together with each other.

The "enable tracking" and "disable tracking" task types in the system are represented by "(TRACK)". The "enable swing arc" and "disable swing arc" task types are represented by "WAVE"; "enable collaboration" and "disable collaboration" task types are represented by "COOPERATE".

When applying the 6 types in the "functional instruction" task type, first create the "functional program", and then select the corresponding "functional program" at the time of the "enable".

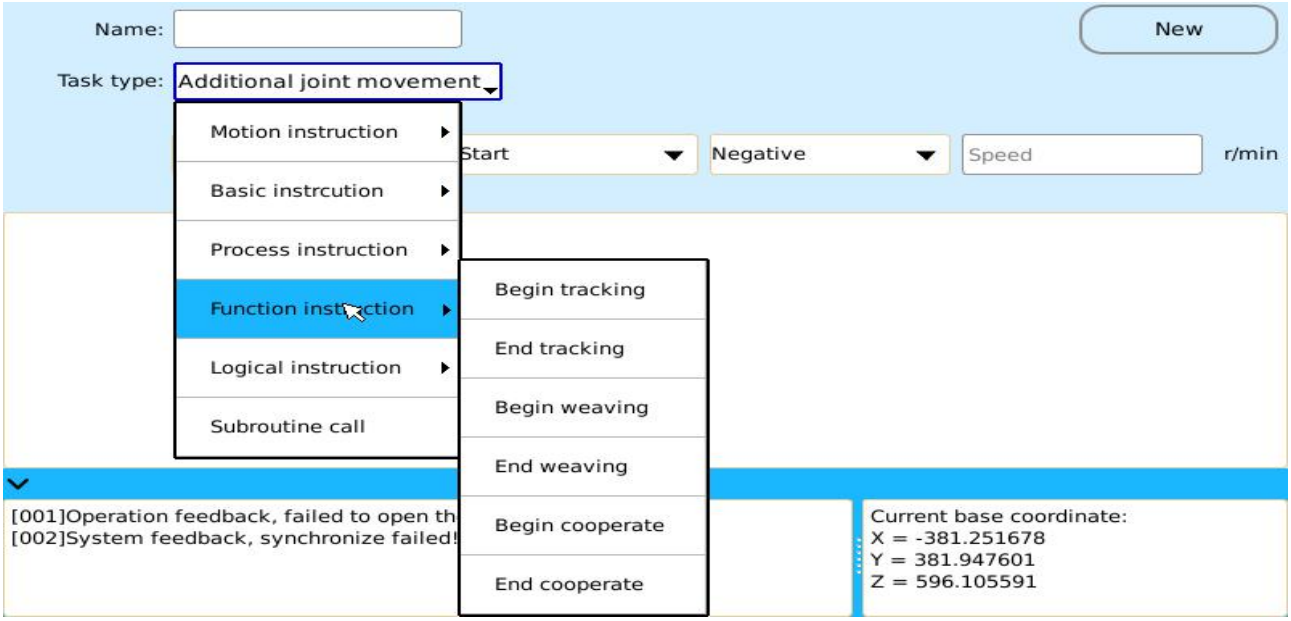


Figure 4.8 "functional instruction" Task Type

◆ Logical instruction

As shown in Figure 4.9, the task type "logical instruction" contains the "GLOBAL_VAR", "MODBUS_VAR", "WAIT", "IF", "ELSE_IF", "ELSE", "END_IF", "WHILE", "CONTINUE", "BREAK", and "END_WHILE", These logical instruction sets can greatly facilitate users to build basic programs.

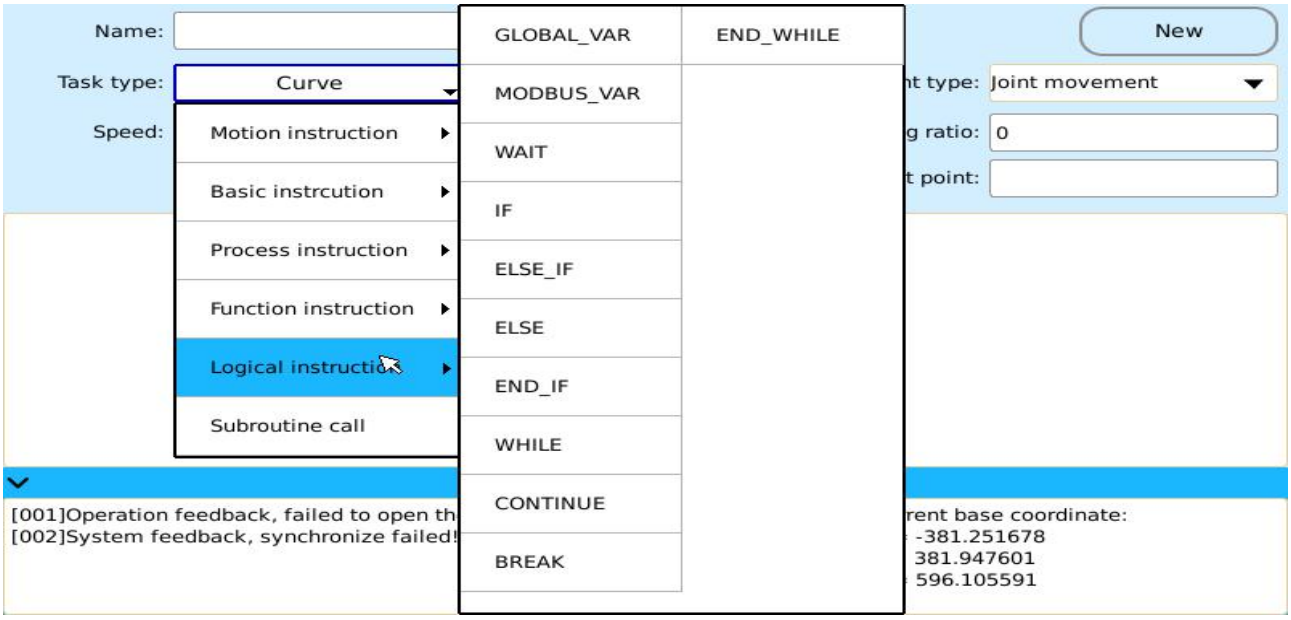


Figure 4.9 "logical instruction" Task Type

(1)GLOBAL_VAR:The “global variable” task type can define “global variable” and assign and “operate” to the “global variable”.

(2)MODBUS_VAR:The “MODBUS register” task type can define “global variable” and assign and “operate” to the “global variable”. The “MODBUS communication protocol” is associated with the “system programming” through the “MODBUS_VAR” task type.

(3) “WAIT” task type:The task type of the “waiting event” needs to be used with the I/O input port. The “type of waiting”, “waiting sequence number”, “waiting status” and “event relationship” are required to be set when selecting the “WAIT” task type.

Waiting type--divided into four types: “input port”, “PLC”, “register variable” and “global variable”.

Waiting Sequence Number--Determined by the selected “type of waiting”: When selecting the “input port” waiting type, it is the “input port number”;the “relay number” and the “register variable” during “PLC” waiting type and the “variable number” during “global variable” waiting type.

Waiting status--also determined by the “waiting type”.

Event Relation--There are two event relationships between “with” and “OR”.

Apply the “WAIT” task type format: After selecting the “WAIT” task type, set up the “waiting sequence number”, “waiting status” and “event relationship” according to the selected “waiting type”, and click [Add] button to complete the operation.

After selecting the "WAIT" task type, enter the corresponding value in the three prompt boxes of "input port number", "input level value" and "event relationship", and click the "add task" button to complete the operation.

The system provides a 20-path "coupling isolation" input port numbered "0-19" and the initial state of the system is also low level "0" by default. When setting multiple “input port numbers” and “input level values” at the same time, connect them with the symbol “-”.

The "with" and "or" events in the system "wait event" task type: The "with" event relation means that the program can continue to run only if all the "wait events" are satisfied. The "or" event relationship allows the program to proceed by satisfying only a portion of the "wait event".

(4)IF:Condition judgment instructions for use with ELSE, ELSE_IF, END_IF.

Instruction Format:a. IF...END_IF;

b. IF...ELSE...END_IF;

c. IF...ELSE_IF...ELSE...END_IF;

a. judging whether the content in the IF condition is satisfied; if the condition is true (condition), executing the following procedure; If the condition is false (the condition is not satisfied), the procedure does not perform the content contained in the “IF...END_IF”.

b. judging whether the content in the IF condition is satisfied; if the condition is true (condition), executing the content contained in the “IF...ELSE”; If the condition is false (the condition is not satisfied), the procedure executes the content contained in the “ELSE...END_IF”.

c. If multiple conditions are needed for judgment, “IF... ELSE_IF...ELSE...END_IF” format instructions (where ELSE_IF can be used multiple times in one “IF... END_IF”, ELSE can also be used).

Each IF must correspond to an END_IF, which is used in conjunction with "IF...END_IF".

For example:

GLOBAL_VAR_OP:GV_0=0//Set global variable 0, and assign GV_0 to 0

IF (GV_0==0) IF Condition

OUTPUT:Y1=1//I/O output port 1 outputs high potential “1”

ELSE_ IF (GV_0==1)IF Condition

OUTPUT:Y1=0//I/O output port 1 output low potential “0”

ELSE

OUTPUT:Y1=0 //I/O output port 1 outputs high potential “1”

OUTPUT:Y2=1//I/O output port 2 outputs high potential “1”

END_IF//IF procedure ended

Procedure description: if condition GV_0==0, Y1=1; if condition GV_0==0, Y1=0; Y0=0, Y2=1 if both conditions are not satisfied.

(5)WHILE:Cyclic instructions for use with END_WHILE.

Instruction Format: **WHILE...END_WHILE**

When the condition behind WHILE is satisfied, that is, the condition is true (condition), the procedure in the "WHILE...END_WHILE" is executed until the condition after WHILE is false (the condition is not satisfied), and then the WHILE loop is retired.

Each WHILE must correspond to an END_WHILE, which is used in conjunction with "WHILE...END_WHILE".

For example:

```
GLOBAL_VAR_OP:GV_0=0//Set global variable 0, and assign GV_0 to 0
WHILE(GV_0 < 3)                    // WHILE Condition
GLOBAL_VAR_OP:GV_0 = GV_0 + 1 //global variable plus 1
OUTPUT:Y2 = 1                      //I/O output port 2 outputs high potential "1"
END_WHILE//WHILE Cycle End
OUTPUT:Y2 = 0                      //I/O output port 2 output low potential "0"
```

Procedure description: If GV_0 <3, GV_0=GV_0+1, Y2=1; Otherwise, Y2=0, that is, if the condition is not satisfied after 3 output Y2=1, the WHILE cycle is finished, and the output Y2=0.

(6)BREAK:Exit loop instruction.

The BREAK instruction is used in the middle of the "WHILE...END_WHILE" instruction to terminate the "WHILE...END_WHILE" loop statement. In general, BREAK instructions are used matching with IF...END_IF, and when the condition is satisfied, it jumps out of the loop body.

For example:

```
GLOBAL_VAR_OP:GV_0 = 0    //Set global variable 0, and assign GV_0 to 0
WHILE(GV_0 < 10)                   // WHILE Condition
IF (GV_0==5)                       // IF Condition
BREAK//Interrupt Procedure
END_IF//IF procedure ended
GLOBAL_VAR_OP:GV_0 = GV_0 + 1    //global variable plus 1
OUTPUT:Y2 = 1                      //I/O output port 2 outputs high potential "1"
END_WHILE//WHILE Cycle End
OUTPUT:Y2 = 0                      //I/O output port 2 output low potential "0"
```

Procedure description: When the IF (GV_0==5) is satisfied, WHILE terminates the loop, that is, after output Y2=1 for 5 consecutive times, IF (GV_0==5) meets the condition, exit WHILE loop and output Y2=0.

(7)CONTINUE:Exit this loop instruction.

CONTINUE instruction is used in WHILE...END_WHILE instruction. The next cycle is enforced after skipping the remaining statements in the WHILE...END_WHILE circulation body. Normally, the CONTINUE instruction is used in combination with the IF...END_IF, i. e. when the condition is satisfied, it jumps out of this cycle to accelerate the cycle.

For example:

```
GLOBAL_VAR_OP:GV_0 = 0             //Set global variable 0, and assign GV_0 to 0
WHILE(GV_0 < 10)                   //WHILE Condition
GLOBAL_VAR_OP:GV_0 = GV_0 + 1 //global variable plus 1
IF (GV_0==5)                       // IF Condition
OUTPUT:Y3 = 1                      //I/O output port 3 outputs high potential "1"
CONTINUE//Abort this cycle
END_IF//IF procedure ended
OUTPUT:Y2 = 1                      //I/O output port 2 outputs high potential "1"
END_WHILE//WHILE Cycle End
```

OUTPUT:Y2 = 0 //I/O output port 2 output low potential “0”

Procedure description: When IF (GV_0=5) is satisfied, the statement behind this circulation CONTINUE will not be executed (jump out of this cycle, WHILE circulation continues), i. e., after five consecutive outputs of Y2=1, the 6th outputs Y3=1, the seventh, eighth, ninth, tenth consecutive outputs Y2=1; the condition is not satisfied; the WHILE cycle is finished; Output Y2=0.

◆ Subroutine call

A subroutine call task type occurs when the system creates a "modular program" that "calls" the base program that has been created.

Apply the “subroutine call” task type format: After selecting the task type of "subroutine call", set the "subroutine name", and click the [add] button to complete the operation.

4.1.3 Use of Sports Type

Select the "curve" task type, and the system provides "joint motion", "linear motion", "arc motion" and "circle motion", as shown in figure 4.10.

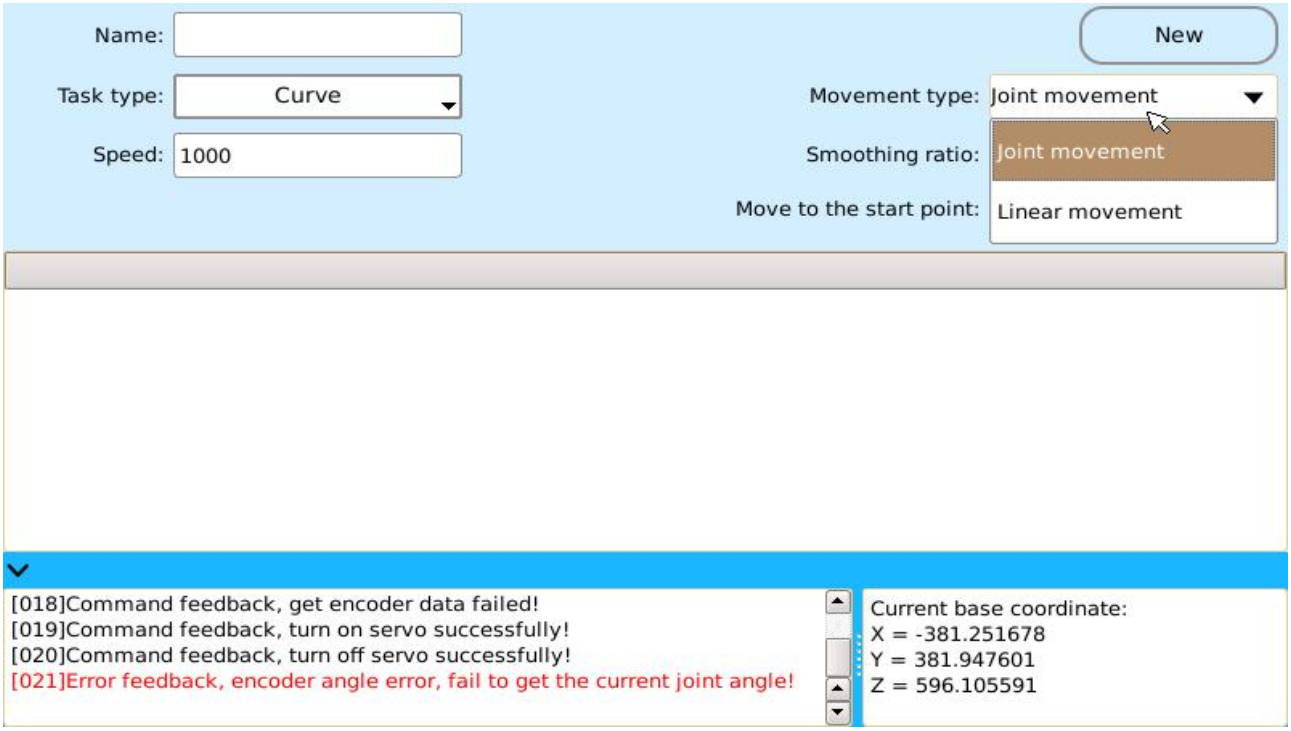


Fig. 4.10 “Type of motion” Category

Articulation motion: Control the "joints" of the mechanical arm to make the robot end move to the specified position.

Linear motion: The robot end is controlled to move in a "straight line" to the specified position.

Circular arc motion: Control the robot end to move to the specified position in the way of "arc", through the "starting point", "middle point" and "terminal point" three "points" to determine a section of the arc.

Circular motion: Control the robot end to move to the specified position in a circle, and determine a circle through "starting point", "central point" and "circular point". The “point of circle surface” indicates the direction of “drawing circle”.

When selecting the motion type of "joint motion", the motion process does not involve the "trajectory", but

just moves the end of the mechanical arm to the specified position at the "fastest" speed. In the motion type of "circular motion", "circular point" determines the "direction" of the trajectory of "circular motion".

When the program is created, it is necessary to determine a "point" on the "curve" before the “arc motion” and “circular motion” are present.

4.1.4 Program Creation

In the system “demonstration mode”, a “program name” is set up in the “program creation” interface (shown in Figure 4.2), then the “task type”, “motion type”, “motion speed”, “smoothness ratio”, “starting point”, or “terminal point” are set up respectively, and the program is saved to the “program management” by clicking [save] button to complete the "create" of the program.

In the "creation” process of “basic program” and “modular program”, the operation is generally consistent and the" program "after" save "is saved in" program management ", but when “modular program” is created and saved, the modular program is stored in the modular program file that is stored in the program management. The “basic program” then converts the “modular program” to the “basic program” file in the “program management”.

4.2 Creation of basic procedure

Once the program is created, it is stored in the system's “program management”, which can be managed by “program management”, such as modifying and deleting the completed programs, and so on. In the “demonstrator” login main interface (shown in Figure 2.4), select [program management] icon, enter [program management] interface, include 5 parts of “basic program”, “point”, “process pack”, “functional pack”, and “modular program” as shown in Figure 4.11.

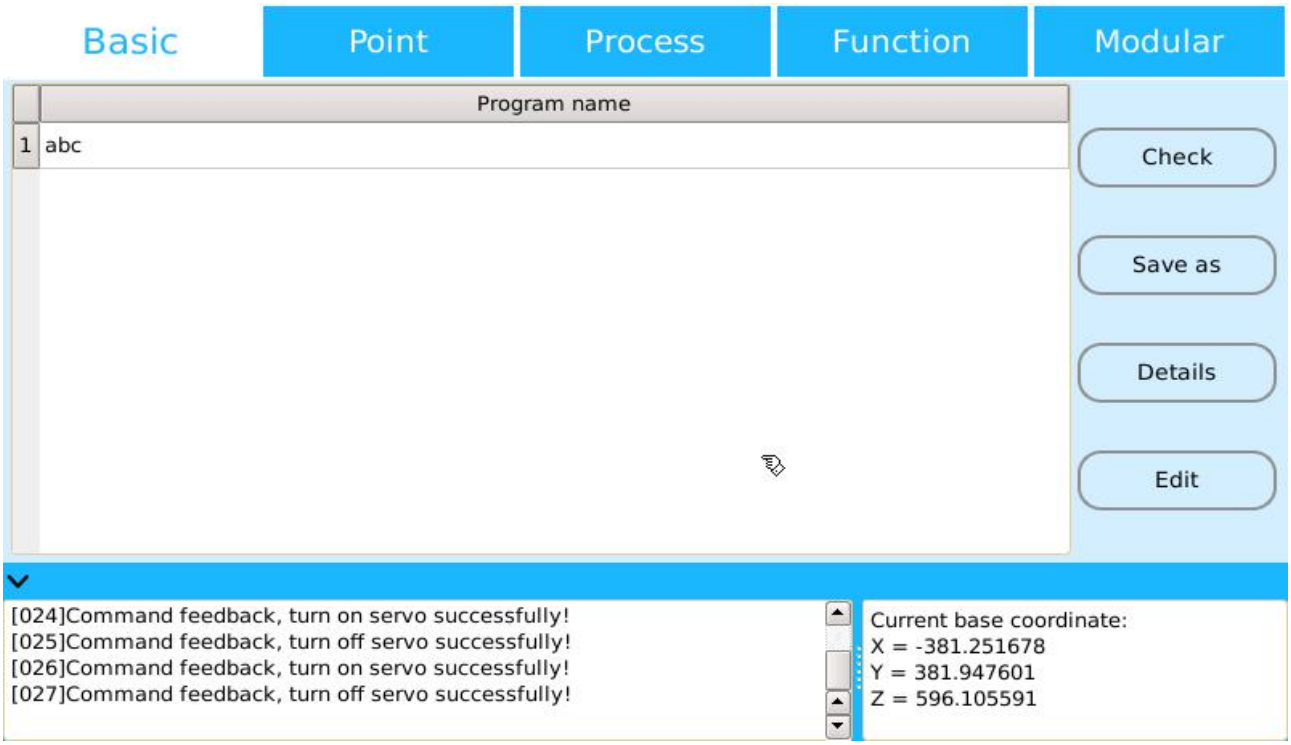


Figure 4.11 “program management” interface

4.2.1 Management of basic procedures

As shown in Figure 4.11 above, in the “program management” interface, the management of “basic program” contains four operations: “check”, “file save as”, “details”, and “edit” of the program.

Check--when used in conjunction with the management of a “point”, any changes to a “point” must be “checked” against all “programs” that have used the “point”.

File save as--through the “file save as” operation, you only need to modify the “program name” in the “selected program” so you can back up the “program”.

Details--see the details of the “program”.

Editing--select the “edit” button, perform “delete” operation on the “program”.

◆ Detailed operation

The “details” operation in the program management is an important part of the “program management”. Click the “details” button to enter the “program creation” interface of the “program”, and the “program” can be “modified” in the “program creation” interface: Includes the “modification” and “add-on” content of the “original program” content. The “add-on” of “original program” is consistent with the method of “create program”. And the “object” of the “modification” content is divided into two main categories: The “curved” task type and the “non-curved” task type.

For the “non-curved” task type, the “modification” is relatively simple, directly complete modifying the content, click [modify] button to complete the operation. The “modification” for the “curve” task type includes changes to the “motion type”, “motion speed”, “smoothness ratio”, “starting point”, or “terminal point” of “curve”, and then click [modify] to complete the change after completion.

You can also perform “property”, “delete”, “modify”, and “insert” in “create program” interface.

(1)Property: Use “UNTIL” to indicate that it is applied to “curve” task type and the first line “curve” can not use the “property” function. When using the “property” function for the selected curve, a “property type UNTIL” setting interface will appear, and “trigger type”, “input port number”, “input level value” and “event relationship” are required to be set.

Trigger types--are divided into two types: “input port” and “PLC”.

Enter the port number--that is, IO input port, user can choose the “multipath” input port and connect with a “-”.

Input level values--are divided into low-level “0” and high-level “1”.

Event Relations--There are “with” and “OR” two event relations.

After the “trigger type”, “input port number”, “input level value”, and “event relationship” are set, click [add] button, the “COND_UNTIL:XXX” task will be generated on the line below the selected curve, and the “property” definition of “curve” will be completed.

After using the function of "property", the curve is embodied as follows. The trajectory of the “property” before defining the “curve” is “A-B-C”, that is, starting point A running to B, then running to C;when curve "A-B" is used as "property" function, point E is any point on curve "AB". If the condition of curve "property" is satisfied at point "E", the trajectory will run directly from point "E" to point C, that is,"A-E-C", and the "type of motion" of the trajectory will remain unchanged.

(2) Delete: Select the program to delete, click the “delete” button, and you can delete the selected current “program line”.

(3) Modification: Modifications of the “program” are divided into two types: “curved” task type modification and “non-curved” task type modification, in which “non-curved” task types such as “delay”, “waiting event”, “output” and “simulation quantity”, etc.

After completion of the program “modification”, make sure to click [save] button to complete the program's modification. The “non-curved” task type in the system “modification” operation is modified into a “curve” task type or the “curve” task type is modified into a “non-curved” task type that can't be directly “modified”, but can be realized through the “insert” operation.

(4)Insertion: Divided into the insertion of “curve” and insertion of “non-curved”, and the inserted “position”

is the “previous one” procedure line of the “select line”.

a. Insert the “non-curve”: Select the location of the program to insert, set “task type”, complete the related settings for the “non-curved” task type, and click [insert] button, select [confirm] to complete the non-curved “insert”.

b. Insert “curve”: Select the location of the program to insert, click [insert] button, select the “curve” task type, complete the settings of “motion type”, “motion speed”, “smoothness ratio” and “starting point” and “terminal point” of the curve, and so on. Click [insert] button to complete “insertion” of the curve.

In the process of "management" of the program, the current step can be "canceled" by the [return] membrane button. After editing the program, click the "save" button to complete the "save" of the editing operation of the program, otherwise the editing operation of the program is invalid and remains as is.

In "program creation interface", press the "pop-up box" after the physical "menu" button of the membrane matrix switch on the "demonstration box" and select "set curve starting point" to set "mode" setting of "curve starting point": Manual mode and automatic mode. When the "starting point" of the curve is set to "automatic" mode, the "terminal point" of the previous curve in the program will automatically become the "starting point" of the current curve. When the “starting point” of the curve is set to “manual” mode, the “starting point” of the curve can be modified. The system defaults to the curve "starting point" mode to "automatic" mode.

4.2.2 Management of points

The system uses the positioning function of the “point”. The “point” and “program” are independent and the same “point” can be “referenced” at the same time by multiple different “programs”. As shown in Figure 4.11, in the “program management” interface, select the management of the “point” and enter the “point” management interface, as shown in Figure 4.12. The management of “point” includes 6 operations of the “create”, “details”, “edit”, “run to the specified point”, “filter” and “refresh” of “point”.

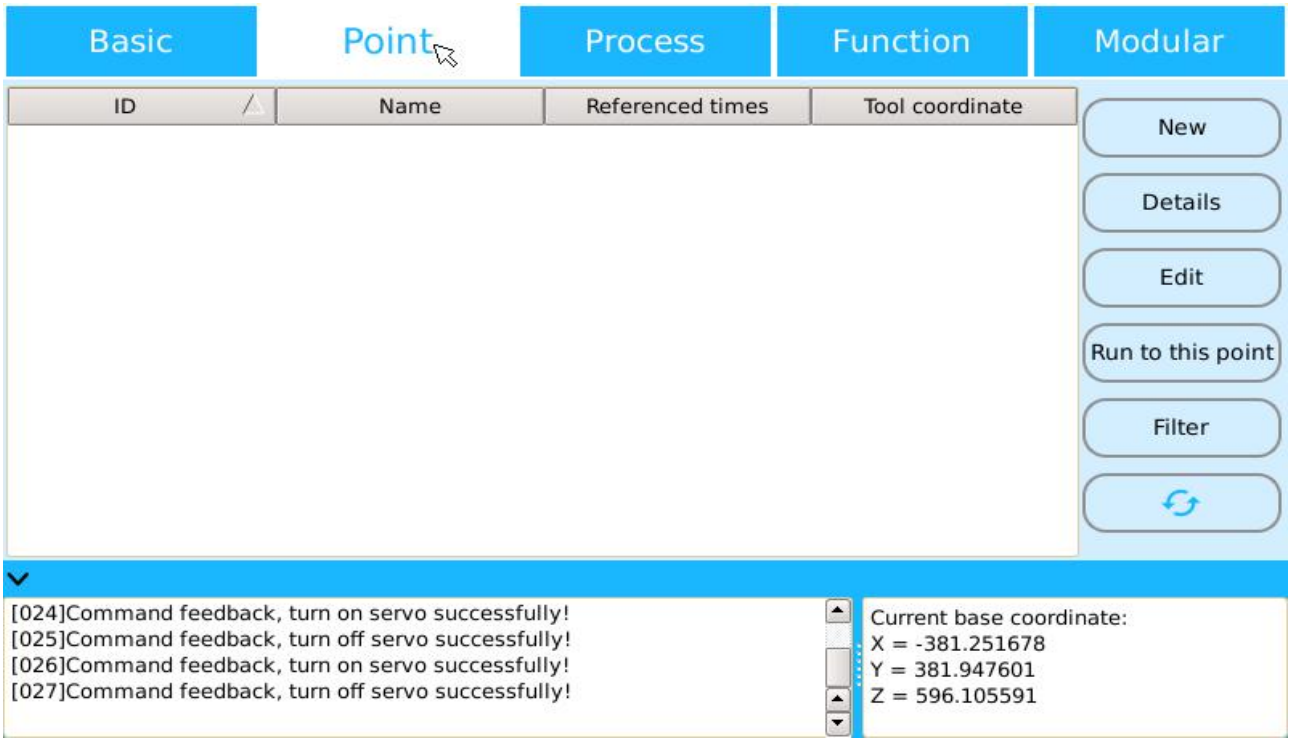


Figure 4.12 “point” management interface

Create--i. e. “create” new “point”. Click [create] button, a “point creation interface” will pop up and a “point” in the interface can be created.

Details--query the details of the “point”. Click [details] button to query the details of the “point” in the pop-up “point creation interface”, including the “name” of the “point”, the “joint angle” and “coordinate value” of

each joint, and the “position and status” of the “point” can be modified.

Edit--Select the “edit” button to “delete” the “point”.

Run to the specified point--that is, to make the end of the mechanical arm move to the selected "point" position Specific operation steps: First select the "point" to run, then open the servo enable, click the "run to the specified point" button. After clicking the "run to the specified point" button, set the speed parameter in the "set the speed to the specified point" prompt box, and click the "confirm" button, the robot body will move to the "point" with the type of "joint movement".

Filtering--in case the number of "points" is too large to be managed, the needed "points" can be selected through the "filter" operation. Click the [filter] button, and in the pop-up prompt box, you can select and set "hide the points automatically generated in the process program" and "show only the points related to the specified program". When selecting the “show only the points associated with the specified program”, the “program type” shown comprises a “basic program”, a “spraying process”, a “palletization program”, and a “modular program”.

Refresh--Click the “refresh” icon to refresh all the “points” and re-synchronize with the system.

When the "point" in the program is modified through the management of "point", it must be switched to the "basic program" management interface to "verify" all "basic programs" that have "referenced" the modified "point".

4.2.3 Process Pack Management

In the “program management” interface, select the management of the “process pack” program and enter the “process pack” program management interface, as shown in Figure 4.13. All the “process packs” created by the system are stored in the “process pack” management file, divided into four processes: “spraying”, “palletization”, “welding” and “stamping”.

Management of Spraying Procedure Program

As shown in Figure 4.13, the management of the “spraying procedure” consists of four operations: “generate”, “file save as”, “details” and “edit” of the “spraying process”.

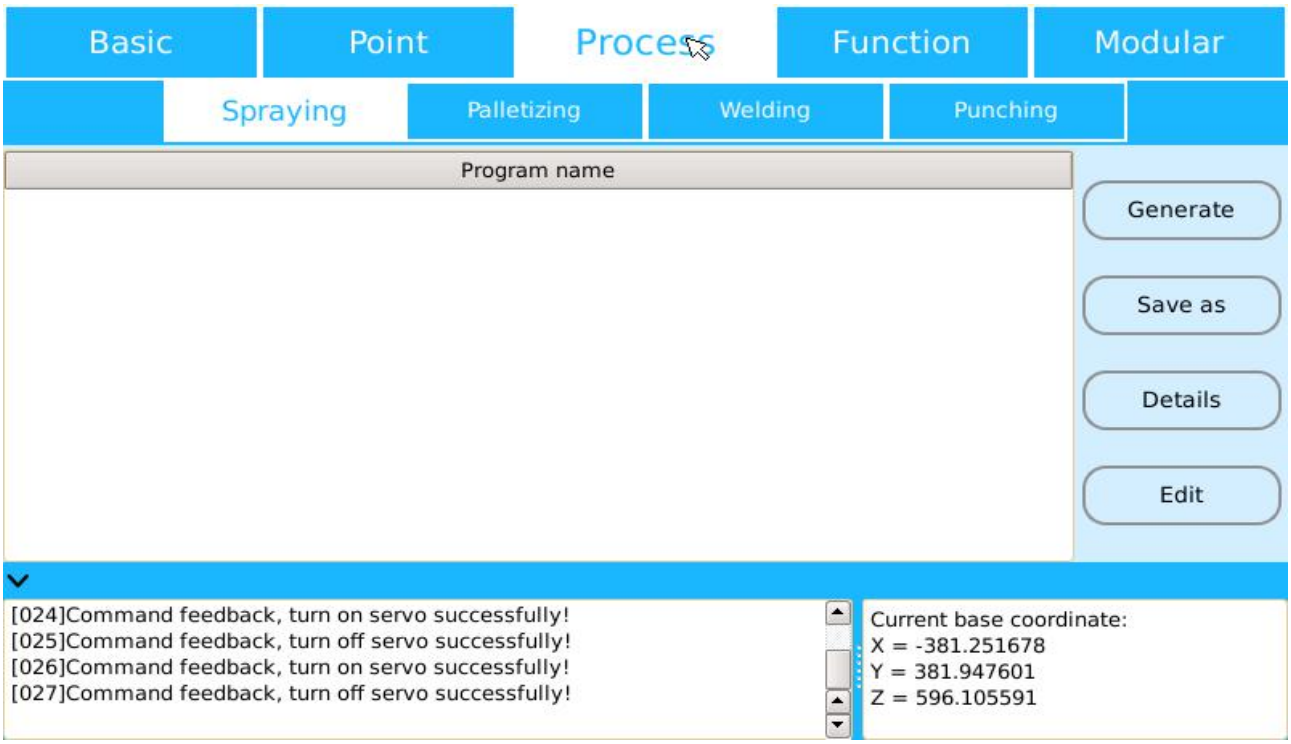


Figure 4.13 Management Interface of the “process pack”

Create--Click [Create] button to convert the selected spraying procedure program into a basic program.

File Save As--through the “File Save As” operation, you can back up the selected “spraying procedure” program.

Details--can be accessed through a “details” operation to the “create” interface of the “Spraying Procedure” for “enquiry” and “modification”.

Edit--Select the “edit” button to delete the Spraying Procedure Program

◆ Management of palletization procedure

As shown in Figure 4.14, the management of the “palletization procedure” consists of five operations: “stacking position”, “template”, “file save as”, “details”, and “edit” of the “stacking process”.

Palletization position--click [Palletization Position] button to query the details of all “palletization positions” in the “Palletization Procedure” Program and can modify it.

Template--creates a “template program” for the “Palletization Procedure” Program through “template” operation.

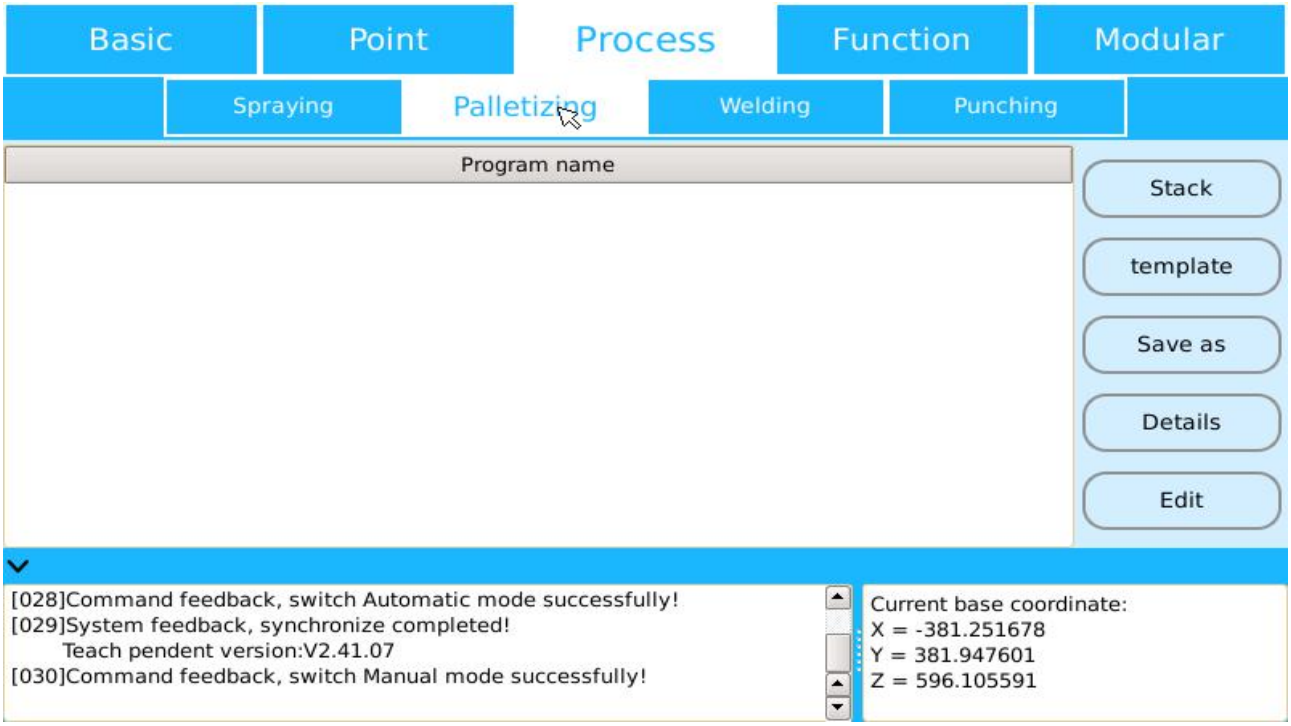


Figure 4.14 Management Interface of the “palletization procedure”

File Save As--through the “File Save As” operation, you can back up one of the selected “Palletization Procedure”Program.

Details--can be accessed through “details” operation to the “create” interface of the “Palletization Procedure” Program for “enquiry” and “modification”.

Edit--Select the “edit” button to delete the Palletization Procedure Program

◆ Management of Welding Procedure Program

As shown in Figure 4.15, the management of the “welding procedure” consists of three operations for “file save as”, “details”, and “edit” of the “welding procedure”.

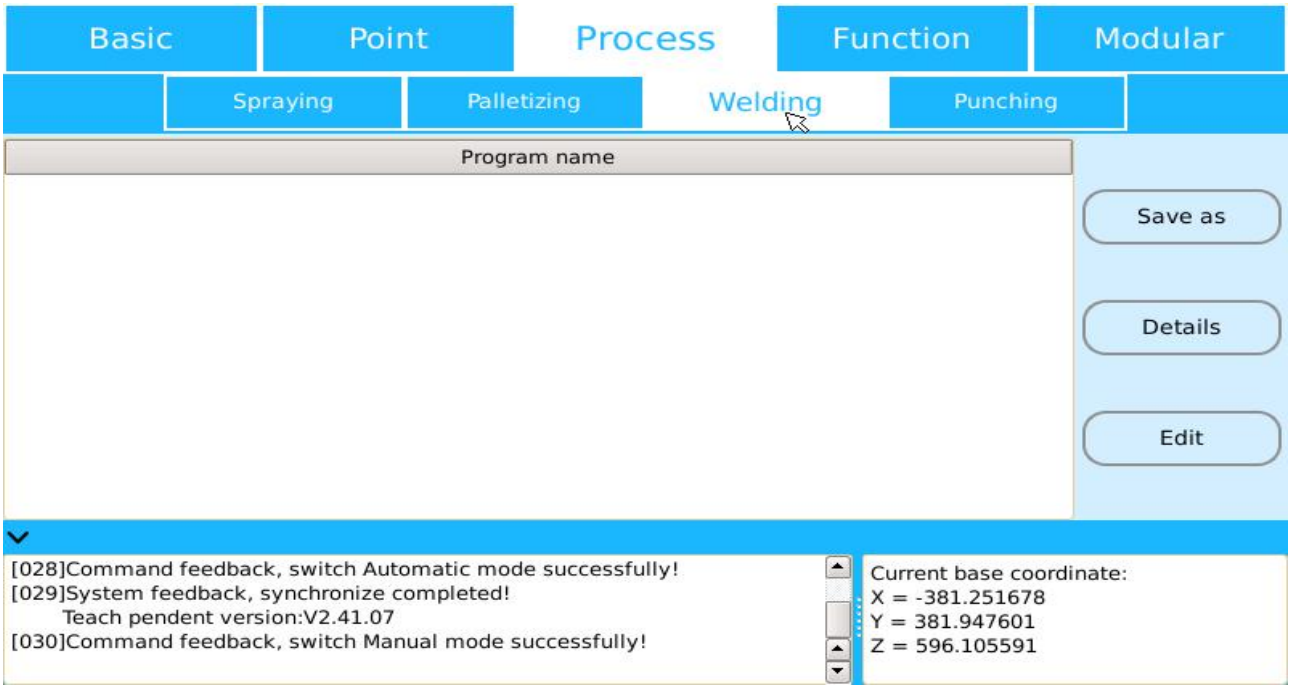


Figure 4.15 Management Interface of the “welding procedure”

File Save As--through the “File Save As” operation, you can back up the selected “welding procedure”program.

Details--can be accessed through “details” operation to the “create” interface of the “welding procedure program” for “enquiry” and “modification”.

Edit--select the “edit” button to delete the welding procedure program.

◆ Management of the stamping procedure

As shown in Figure 4.16, the management of the “stamping procedure” consists of four operations: “generate”, “file save as”, “details” and “edit” of the “stamping procedure”.

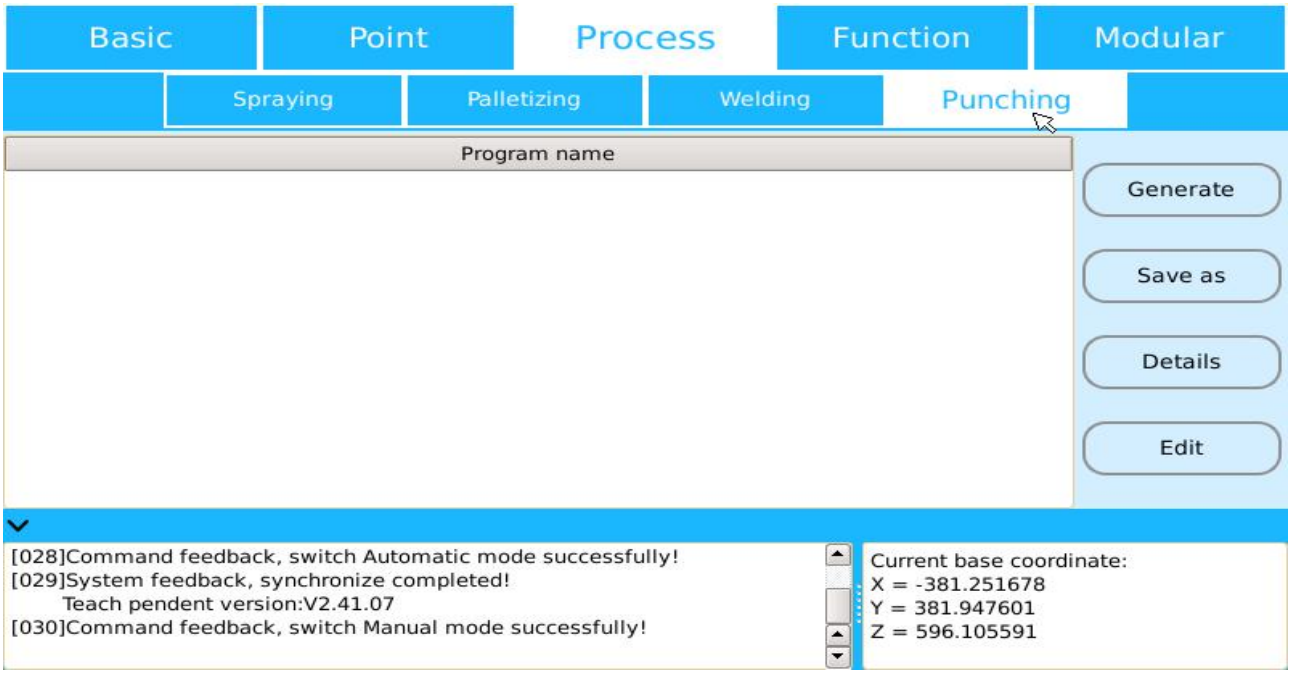


Figure 4.16 Management Interface of the “stamping procedure”

Create--Click [Create] button to convert selected “stamping procedure”program to “basic program”.

File Save As--through the “File Save As” operation, you can back up the selected “stamping procedure”program.

Details--can be accessed through “details” operation to the “create” interface of the “stamping procedure” program for “enquiry” and “modification”.

Edit--Select the “edit” button to delete the stamping procedure program.

Enter the "create" interface of the "process program" through the "details" operation and "modify" the process program. When "save" the program again, save it as "process program" and then select "save" to convert it into "basic program".

4.2.4 Functional Pack Management

In the “program management” interface, select the management of the “functional pack” program and enter the “functional pack” program management interface, as shown in Figure 4.17. All the “functional pack” programs created by the system are stored in the “functional pack” management file, divided into three functional programs of “tracking”, “swing arc”, and “synergy”. The management of the “functional pack” consists of three operations: “file save as”, “details”, and “edit” of the “functional pack” program.

File save as—through“file save as” operation, you can back up the selected “functional program”.

Details--can be accessed through “details” operation to the “functional program's” “create” interface for “query” and “modification”.

Edit--Select “edit” button to delete the functional pack program.

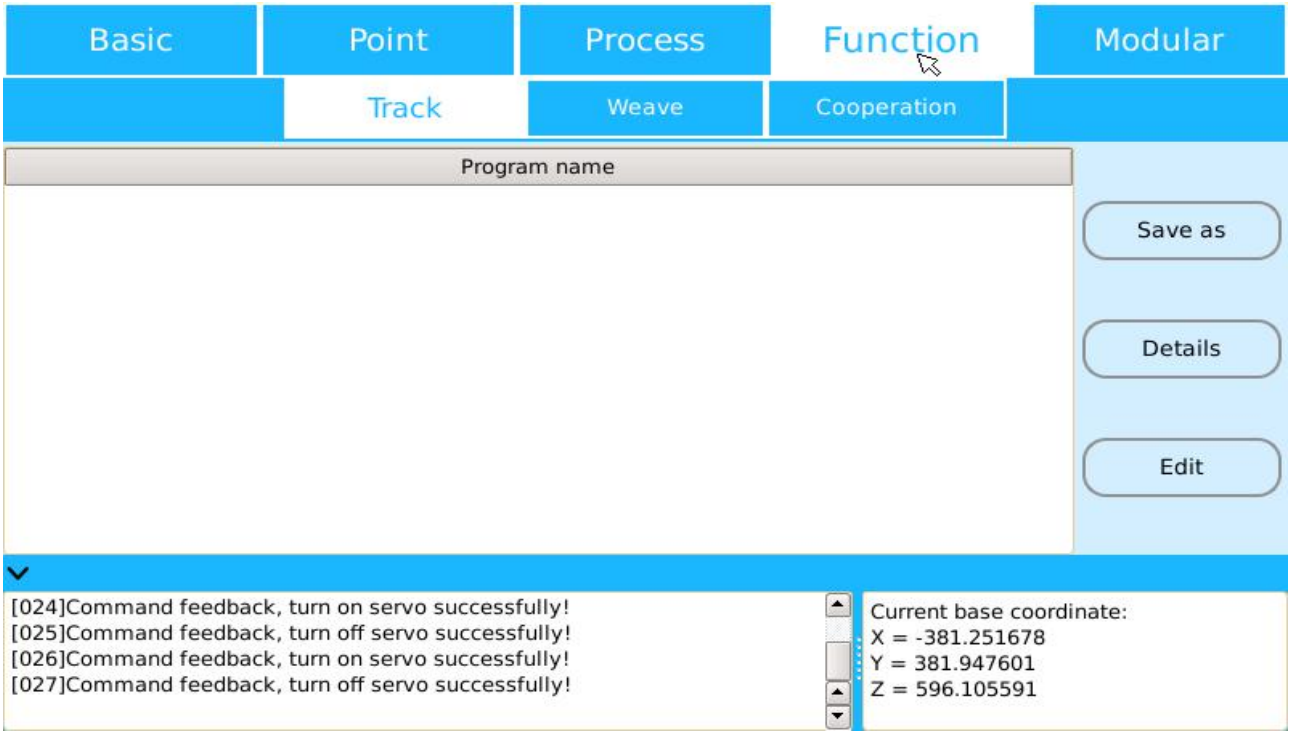


Figure 4.17 Management Interface of the “functional pack”

4.2.5 Modular Program Management

In the “program management” interface, select the management of the “modularize” program and enter the “modularize” program management interface, as shown in Figure 4.18. The management of a “modular program” contains the “creation”, “file save as”, “details” and “edit” of a “modular program”.

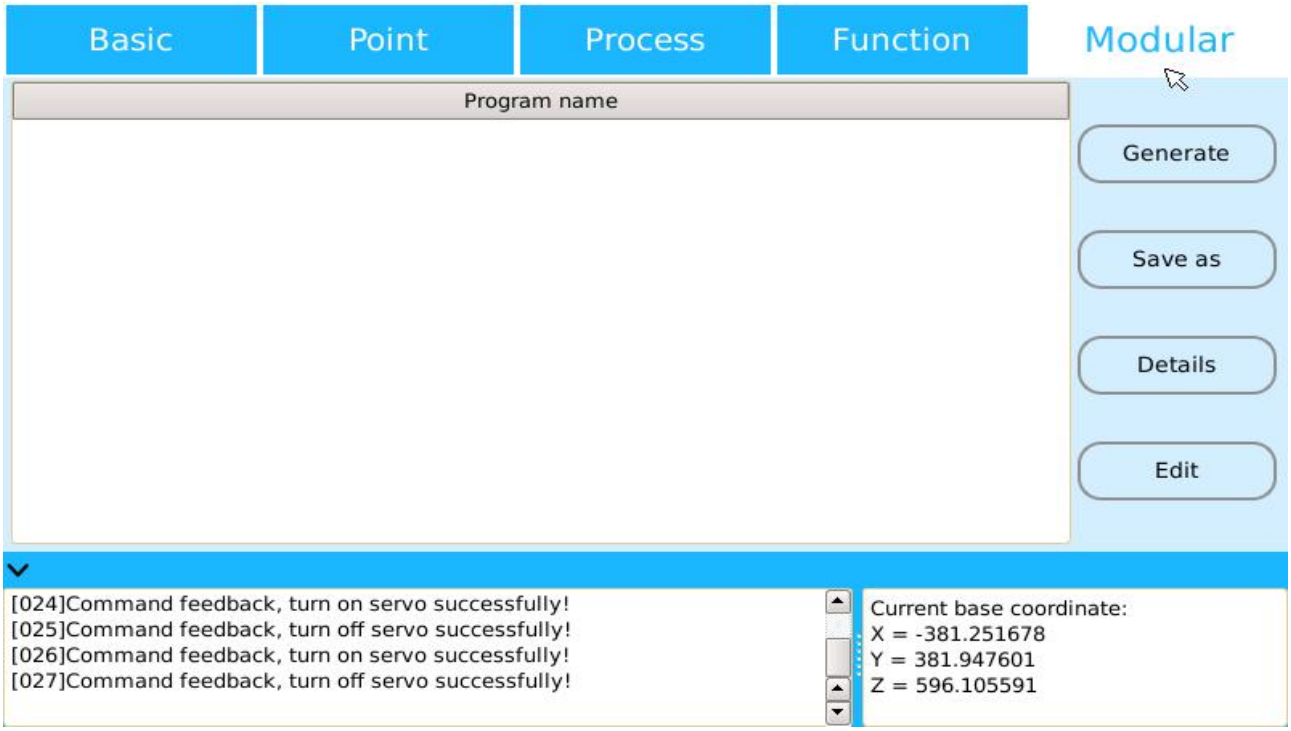


Figure 4.18 “modular program” Management Interface

Create--Click [Create] button to convert selected “modular program” into “basic program”.

File save as--through the “file save as” operation, you can back up the selected “modular program”.

Details--can be accessed through “details” operation to the “create” interface of the “modular program” for “query” and “modification”.

Edit--Select the “edit” button to “delete” the “modular program”.

After entering the "create" interface of the "modular program" through the "details" operation and "modify" the modular program, when the user “re-save” the program, the re-“save” procedure is saved as “modular program”, then select “save” to convert to “basic program”.

4.3 Operation of the procedure

After the program is created, switch to the "automatic mode" interface through the "mode switch" on the demonstration box to conduct the program operation, as shown in figure 4.19 below. The “run” of the program needs to be accomplished by setting the “operating parameter” and operating the membrane “physical key”.

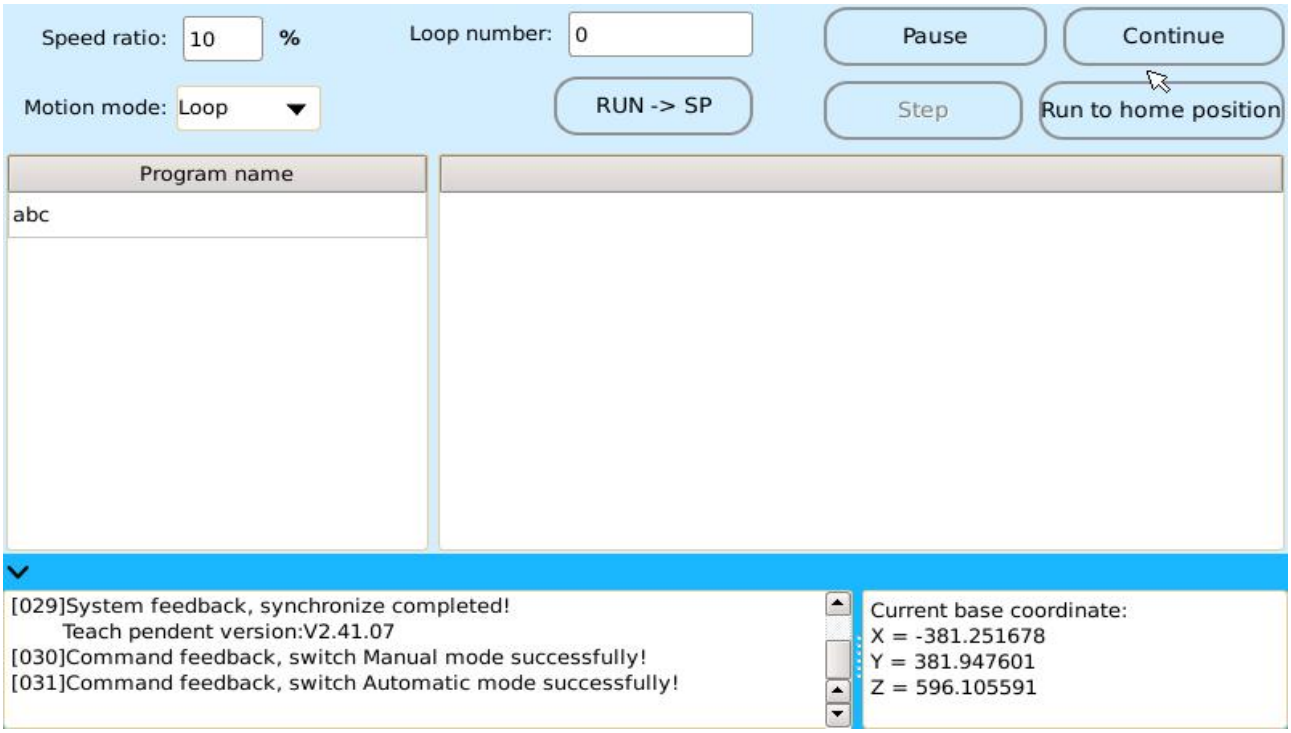


Fig. 4.19 Automatic Mode Interface

4.3.1 Parameter setting

As shown in figure 4.19, when the program "runs", the parameters are set as "speed ratio", "motion mode" and "motion frequency".

Speed ratio--controls the overall speed of the “program run”, setting range is 1-100(percentage).

Motion patterns--divided into three modes of motion: “single-step motion”, “single motion” and “circular motion”.

(1) Single-step motion: After selecting a “program name”, select the “single-step motion” mode to enable the program to proceed from the “starting point” to the path “step by step” set by the “program”. Specific format: Select the "program name" of the program to be run, press the "program start-up" physical button on the demonstration box, wait for the robot body to complete the first step, then click the "step execution" button to proceed to the next step, wait for the "next step" to complete, and repeat the "step execution" button to complete the "single-step movement" operation.

(2) Single motion: The control program performs a full operation, i. e. the trajectory runs from the “starting point” along the “program” setting to the “terminal point”.

(3) Cyclic motion: The "cycle" operation of the control program needs to be used in conjunction with the "motion frequency" setting. When the parameter in the "motion frequency" is set to "0", the circular motion becomes the "infinite cycle" motion mode. After setting the "circular motion" mode, when the program is started to run, the "cycle number" and "cycle period" prompts will appear in the lower right corner of the interface, respectively representing the "completed cycle number" and "cycle once" of the program.

Motion frequency--Controls the parameters of the number of “circular motion” during the run-time of the program. In the “circular motion” mode, set the parameters in the “motion frequency” as “0”, so that the “program” can circulate indefinitely.

When enabling the program to "run", first set the "speed ratio" parameter a bit small, select the "single step motion" mode to test the moving trajectory, if there is no problem, then set the "speed ratio" and "motion mode" to the required parameters.

4.3.2 Use of the physical buttons and the buttons on the touch screen

There are still some “buttons” on the “procedure running” interface, and the buttons have a great impact on the procedure running. The buttons mainly include physical keys: “program stop”, “program start-up” and “menu”; Buttons on the touch screen: "Pause", "continue", "run to zero point" and "switch mode" rotary button.

(1) “Procedure Stop” physical key: While the program is running, you can use the “program stop” physical button to “disable” the program.

(2) “Procedure launch” physical key: Select the physical key of the “program start-up” to control the “enable operation”. After setting the parameters of the program "run", the program can be "enabled" by pressing the physical button of "program start", and the "program" will start from the "starting point" and run along the designed "trajectory".

(3) The physical key of the “menu”: In the “automatic mode” interface, press the physical key of the “menu”, as shown in Figure 4.20, in the pop-up “menu” interface, 9 operations can be carried out, which includes the “monitoring port”, “Query current joint angle”, “enable the PLC program”, “process enablement”, “source of program”, “disable the PLC program”, “monitor PLC program”, “set global variable” and “start running from the specified row”.

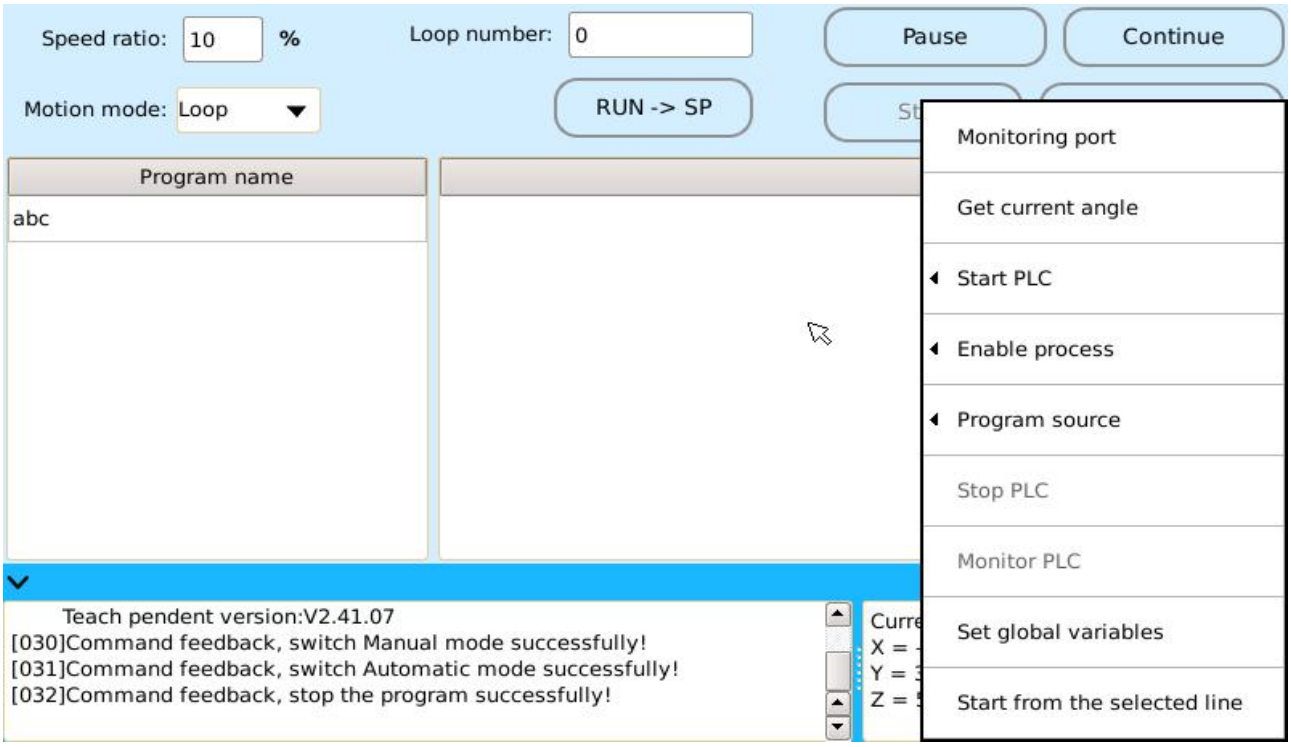


Figure 4.20 “automatic mode” key interface under “menu”

Monitor port--when selecting "monitor port", you can enter the "monitor" interface to monitor IO input and output ports.

Query the current joint angle--can only be executed in the "manual" state of the system.

Enable the PLC program--enable the completed “PLC” program in the system.

Process enablement operation can be carried out for “palletization procedure”, “tracking function”, “welding procedure” and “swing arc function”, and when the “non-enabling” is selected, procedures related to process in the running program will not be executed.

The source of the program -- divided into “demonstrators”, “third party program”, and “off-line program”.

Disable the PLC program--When the “PLC program” is “running”, it can be disabled by “disabling the PLC program”.

Monitor PLC program--monitor the operation of the “PLC” program.

Set the global variable--can assign to the “global variable”.

Start running from a specified line-select a “program row” from the context of the selected "program name", through "run from the specified row" operation, a curve that sets the "current location" as "starting point", selects

the curved “terminal point” as the “terminal point”, and runs along the trajectory of the selected “program”.

(4) “Pause” and “continue” keys: These are two buttons on the touch screen, which can be used together. When "program" is running, click the "pause" button to disable the running "program". When in the state of "pause", click the "continue" button to enable the paused "program" to continue to run according to the trajectory of program editing from the position of "pause".

(5) “Run to zero point” button: In the “stop” process state of the “up enabled”, click [Run to Zero Point] button to allow the mechanical arm body to return to the desired “zero-bit angle” position.

(6)"Switch mode" rotary button: Can switch the "manual/automatic mode" state of the system. The program will “stop” when the “switch mode switch” is switched to a “manual mode” during the operation of the “program”.

When the program is in a state of “pause”, press [Continue] touch-screen button and press the physical button “program start-up” are two completely different trajectories: when [Continue] is selected, the motion track moves along the [Pause] position and continues to run according to the procedure edited by the procedure; After selecting the physical button of the “program start-up”, the trajectory will first return to the position of the “starting point” when the program was designed, and then continue running along the path of the program editing.

5. Use of Coordinate System

There are four coordinate systems in the system: The “joint motion” coordinate system, “base coordinate system”, “user coordinate system” and “tool coordinate system”, the system “manual demonstrating” can select the necessary “coordinate system” operation according to the actual situation.

Articulation motion coordinate system: When selecting the “joint motion” operation type, the “joint motion” coordinate system is selected when the “manual demonstrating” is represented. When in motion, each joint of the robot body is independent of each other. First, press the "enable switch" on the back of the "demonstrating box" to turn on the "servo enable", and then operate the machine movement through the 12"+" and "-" physical buttons on the right side of the "demonstrating box".

Base coordinate system: The motion trajectory is divided into six axes of "X", "Y", "Z" and "A", "B" and "C". The three axes of "A", "B" and "C" are the auxiliary axes of "X", "Y" and "Z" respectively, which can be used to adjust the posture of the end of the machine. The motion direction is determined by the "right-handed spiral rule". When select the “base coordinate system” operation types, respectively with physical buttons "J1+", "J1-" stands for "X" axis,"J2+", "the J2-" represents "Y" axis,"J3+", "the J3-" represents "Z" axis,"J4+", "the J4-" represents "A", "J5+", "the J5-" represents "B" axis,"J6+", "J6-" represents "C" axis.

The two coordinate systems of "user coordinate system" and "tool coordinate system" need to be "created" by the "user" according to the actual situation.

In the “demonstrator” login main interface (shown in Figure 2.4), select the [coordinate] icon and enter the “coordinate system” interface, as shown in Figure 5.1, user can create and manage the “user coordinate system” and “tool coordinate system” in the “coordinate system” interface.

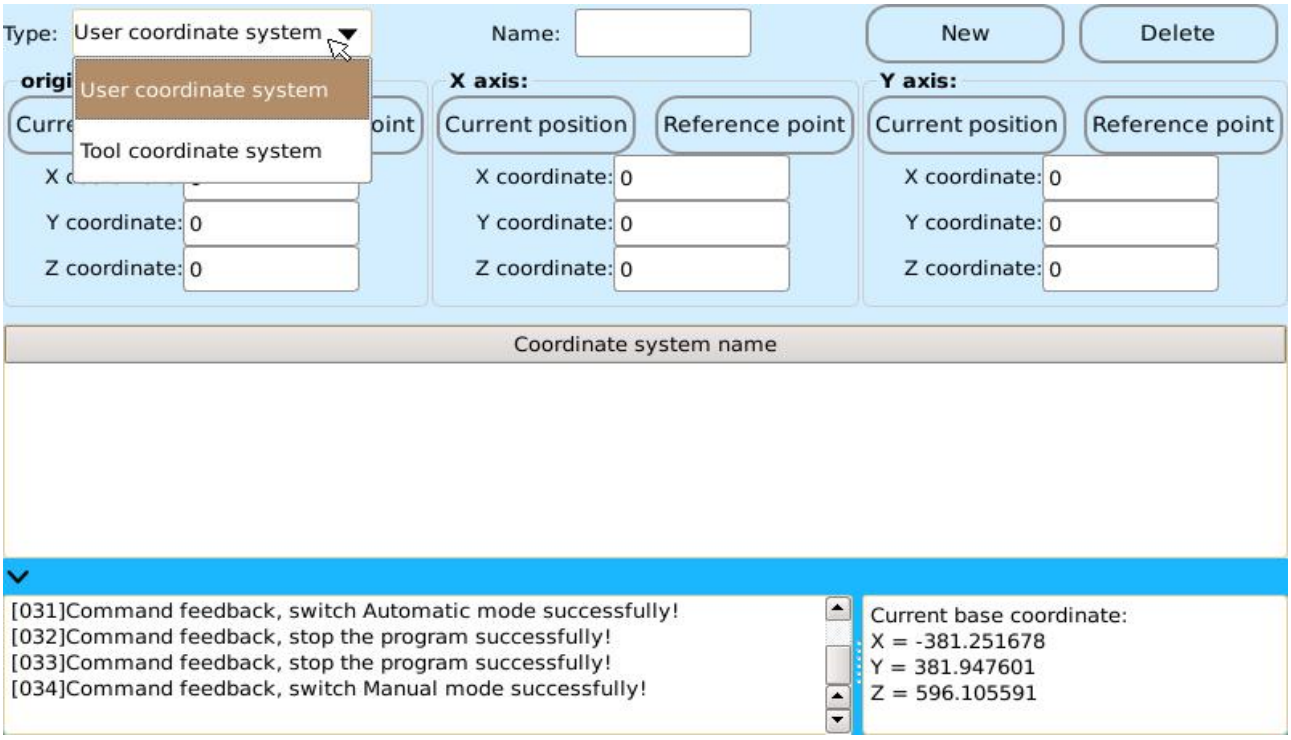


Figure 5.1 “coordinate system” interface

5.1 User Coordinate Systems

As shown in Figure 5.1, in the “coordinate system” interface, user can “create” and “manage” user coordinate systems.

5.1.1 Establishment and Use of User Coordinate Systems

The "user coordinate system" in the system can be determined by three points that are not in the same line, as shown in fig. 5.1. In the "coordinate system" interface, select the coordinate system type of "user coordinate system", respectively determine the 3"points" of" original point "," X-axis "and" Y-axis ", and click the "create" button to complete the establishment of" user coordinate system ".

Original point--Namely the "0" position on the space of creating the "user coordinate system".

X-axis--the straight line between the "original point" and the "X-axis" determines the direction of the "X-axis".

Y-axis--the straight line between the "original point" and the "Y-axis" determines the direction of the "Y-axis".

After setting the "original point", "X axis", "Y axis" "points" of the "coordinate system", the line from the "original point" to the "X axis" determines the direction of the X axis, and the line from the "original point" to the "Y axis" determines the direction of the Y axis, forming an "X-0-Y flat". The Z axis is determined by the vector perpendicular to the "X-0-Y flat" through the "original point"(right-handed spiral rule).

Specific steps of setting the "original point": When "manual demonstrator" is performed to the corresponding position of "original point", click the "get current point" button, and the system will read the position of the current robot end as the "original point" position of the user coordinate, represented by "coordinate value". If the "point" at the "original point" position has been established, you can also click the [reference point] button and "refer the" point "to complete the"original point"setting.

The way to set "X axis" and "Y axis" 2"points" is the same as the way to set "original point".

Upon completion of the creation of the "user coordinate system", all "user coordinate systems" will "save" and "display" in the middle position of the "coordinate system" interface.

5.1.2 Use of User Coordinate System

As shown in figure 5.1, the "user coordinate system" can be "modified" and "deleted" in the "coordinate system" interface after the completion of the creation.

Operation of the "modification": Select the "user coordinate system" in the middle of the "coordinate system name", the user coordinate system will display the "coordinate values" of the "original point", "X axis" and "Y-axis" points. The "coordinate value" can be obtained by changing the position of 3"points", and then click the "modify" button and select the "confirm" button to complete the "modify" of the user coordinate system.

"Delete" operation: Select the "coordinate system name" corresponding to the "user coordinate system", click the "delete" button, and select the "confirm" button to "delete" it.

When "manual demonstration" is displayed,"user coordinate system" can be selected from the "operation type" box that pops up after "enablement". At the same time, some "task types" selected in the "create program" can also be "applied" to "user coordinate system".

5.2 Tool coordinate system

As shown in Figure 5.1, in the “coordinate system” interface, select the “tool coordinate system” coordinate type, enter the “tool coordinate system” interface, as shown in Figure 5.2, the “create” and the “manage” tool coordinate system in the interface.

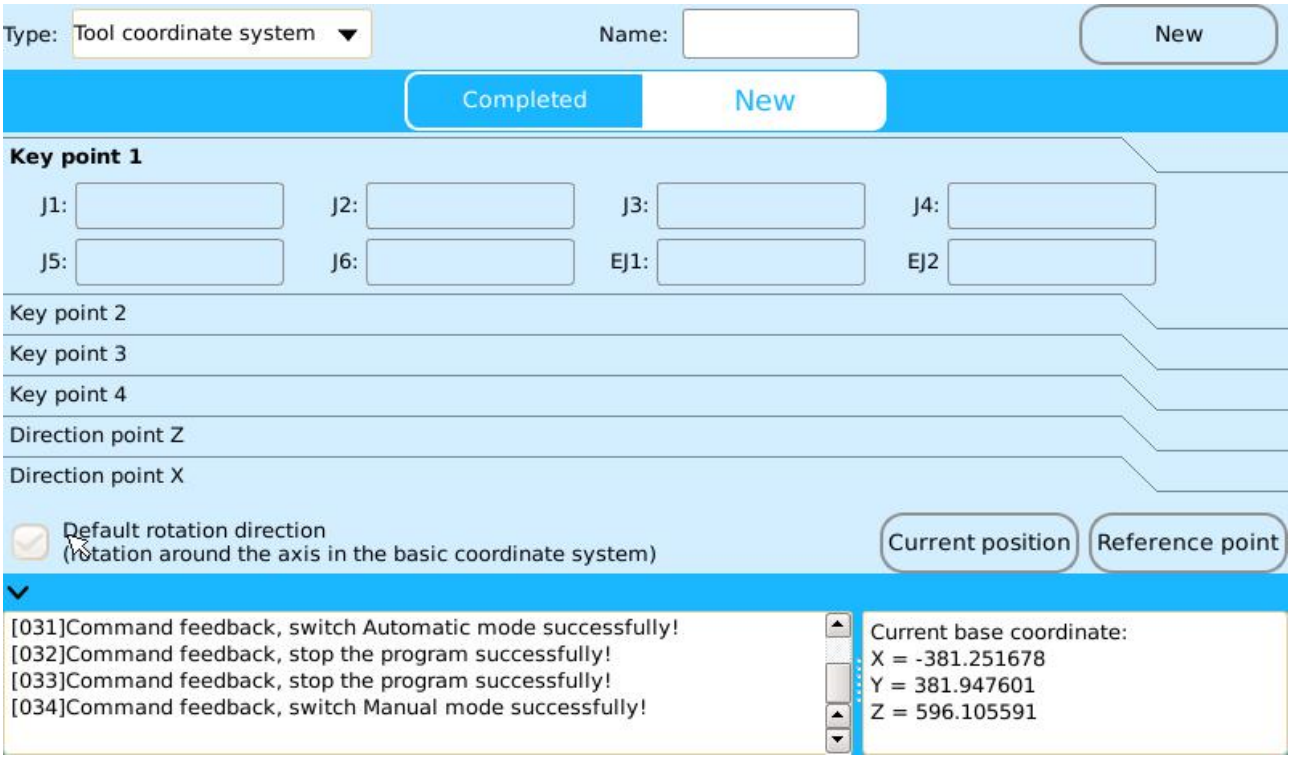
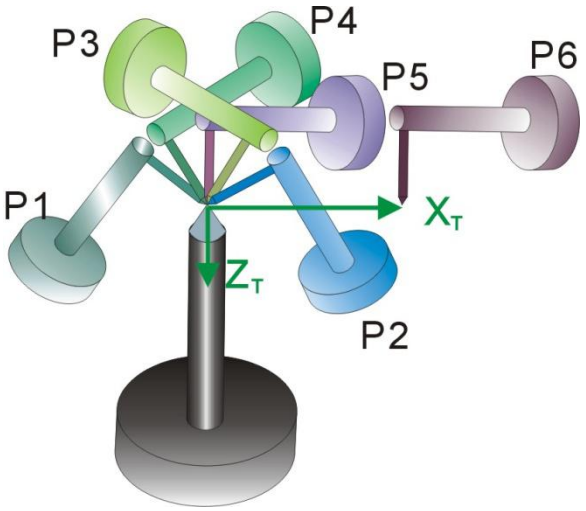


Figure 5.2 “tool coordinate system” interface

5.2.1 Creation of tool coordinate system

As shown in Figure 5.2, select the “create” button in the “tool coordinate system” interface and enter the “tool coordinate system” creating interface. When creating a “tool coordinate system”, you need to complete the settings for the “coordinate system name” and “6 Key Points”, and then click the [create] button and “save” tool coordinate system.

As shown in the right figure, the 6"key points" of the "tool coordinate system" are represented by "P1", "P2", "P3", "P4", "P5" and "P6" respectively, and their settings requires: The posture change of "P1--P4" key points should be as large as possible. The "Z" direction of the "tool coordinate system" is determined by the key point "P5", that is, the direction of the straight line "p4-p5" is the "Z" direction of the "tool coordinate system". The key point "P6" determines the "X" direction of the "tool coordinate system", that is, the direction of the line "p4-p6" is the "X" direction of the "tool coordinate system".



When creating the 6"key points" of the "tool coordinate system", the "manual demonstration" can be used to move to the specified position respectively, and click "get the current point" in the interface to get the "joint coordinate value". Besides, it is also possible to create 6"key points" of "P1--P6" first, and then "reference". The settings can be obtained from the “obtain the current point”, and can also create a save and then "reference" it.

In the "tool coordinate system" creation interface, when the "default rotation direction" is set through "check", the "tool coordinate system" only needs to set 4"key points", and the "rotation direction" of "tool coordinate system" is "rotation around the axis in the base coordinate system" by default.

5.2.2 Application of tool coordinate system

After the "tool coordinate system" is created, all the "tool coordinate systems" will be "saved" in the "completed" interface of the "tool coordinate system", and the "delete" operation can be carried out on the "tool coordinate system" in the interface.

When "manual demonstration" is displayed,"tool coordinate system" can be selected from the "operation type" box that pops up after "enable". At the same time, when "point" is created, the system defaults to "point" which is the "definition" under the "tool coordinate system", but can be set: When selecting the “non-use” tool coordinate system in the “point” creation interface, the saved “point” is defined as “undefined”.

After “tool coordinate system” is “applied”, the "control end" of the system is to take the end of the mechanical arm after the "fixture" installation as the "reference", which is different from the "mechanical arm end" in the "base coordinate system" application as the "reference".

6 PLC

In the “demonstrator” login main interface (shown in Figure 2.4), select the [PLC] icon to enter the “PLC” interface, as shown in Figure 6.1, including the “PLC editing” and “PLC operation”.

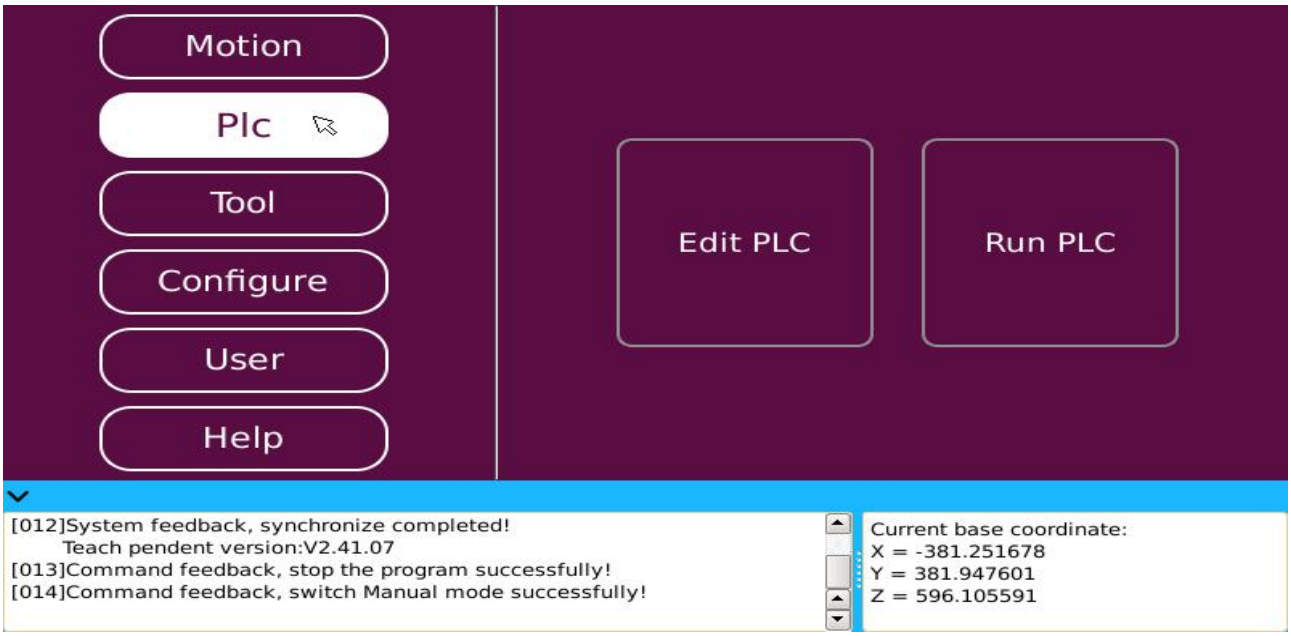


Figure 6.1 “PLC” interface

6.1 PLC Editing

As shown in Figure 6.1 above, select the [PLC edit] icon in the “PLC” interface and enter the “PLC” editing interface, as shown in Figure 6.2, where “create” and “edit” can be performed on the “PLC program”.

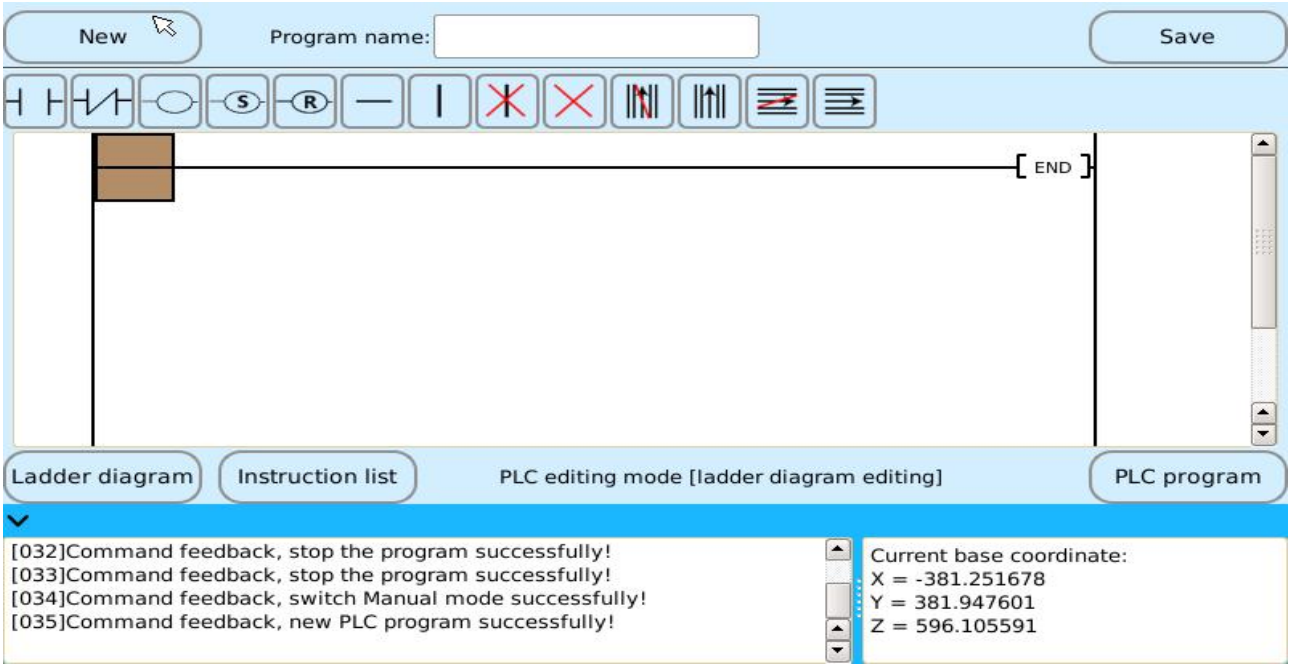


Figure 6.2 “PLC” Editing Interface

(1) System PLC Component Library: Including “component type”, “component quantity” and “component range”, as shown in the following table.

Component type	Component quantity	Component range
External Input Relay (X)	20	X0～X19
Output relay (Y)	18	Y0～Y17
Status Relay (S)	100	S0～S99
Alert relay (A)	50	A0～A49
Counter (C)	50	C0～C49
Universal 10ms Timer (TGT)	10	TGT0～TGT9
Universal 100ms Timer (TGH)	10	TGH0～TGH9
Accumulative 10ms Timer (TAT)	10	TAT0～TAT9
Accumulative 100ms Timer (TAH)	10	TAT0～TAT9
Universal Relay (M)	100	M0～M499
Hot-key relay (F)	30	F0-29

(2) When the program runs normally: State Relay-Specialized input: S0-99

Serial No.	State meaning	Serial No.	State meaning
S0	Running	S18	Y2 output state when pause
S1	Stop	S19	Y3 output state when pause
S2	Pause	S20	Y4 output state when pause
S3	Manual mode	S21	Y5 output state when pause
S4	Automatic mode	S22	Y6 output state when pause
S5	Single-step motion	S23	Y7 output state when pause
S6	Single motion	S24	Y8 output state when pause
S7	Cyclic motion	S25	Y9 output state when pause
S8	Servo on	S26	Y10 output state when pause
S9	Servo off	S27	Y11 output state when pause
S10	Additional Axis 0 Position Control	S28	Y12 output state when pause
S11	Additional Axis 0 Speed Control	S29	Y13 output state when pause
S12	Additional Axis 0 Tracking Control	S30	Y14 output state when pause
S13	Additional Axis 0 Position Control	S31	Y15 output state when pause
S14	Additional Axis 1 Speed Control	S32	Y16 output state when pause
S15	Additional Axis 1 Tracking Control	S33	Y17 output state when pause
S16	Y0 output state when pause	S34	There are continuing events
S17	Y1 output state when pause		

(3) The state of the controller when alert occurs: alert Relay-Specialized Input: A0-49

Serial No.	State meaning	Serial No.	State meaning
A0	There is alert	A5	Encoder Angle Update Error alert
A1	Emergency-stop alert	A6	Failed to get external encoder angle
A2	Servo alert	A7	Follow-up failure
A3	Joint overload alert	A8	Failed to read palletization procedure file
A4	Algorithm operation error alert		

(4) Input/output interactive area: Universal Relay-Input/Output: M0-499

(5) Enable the functions corresponding to hot keys: Hot-key Relay-Output: F0-29

Serial No.	Function	Serial No.	Function
F0	emergency stop	F9	Runs to zero-3 joint
F1	Continuation program	F10	Runs to zero-4 joint
F2	Pause program	F11	Runs to zero-5 joint
F3	Stop program	F12	Runs to zero-6 joint
F4	Switch to manual mode	F13	Runs to zero-7 joint
F5	Switch to automatic mode	F14	Runs to zero-8 joint
F6	Run to zero point-total joint	F15	Run to “program” starting point
F7	Runs to zero-1 joint	F16	Run the program (the parameter is the serial number of the running program)
F8	Runs to zero-2 joint		

Create a “PLC program” format: In the “PLC” editing interface, first set up the “program name”, then edit the PLC program in the “ladder diagram”, and finally click [Save] button to complete the “PLC program”.

After the PLC program is completed, all PLC programs will be “saved” in the PLC program file, click [PLC program] button, enter the PLC program file, wherein user can “modify”, “delete”, “file save for”, “load” operation, and can set the self-enabling mode for PLC program.

Modify--modify the PLC program.

Delete--delete selected PLC program.

File save for--can back up the selected “PLC program”.

Load--can “load” the PLC program in USB to the system.

Set “self-enabling” mode of “PLC program”: In the "PLC program" file, select a "PLC program", press the "menu" membrane button on the "demonstrator", a "menu" option will "pop up", select the "set program self-enable" option to complete the setting.

After the "self-enable" of "PLC program" is successfully set, when the system is powered up and enabled, the "PLC program" will start up and run "automatically". In the system, you can also cancel the "self-enable" mode by pressing the "menu" membrane button in the "PLC program" file on the "PLC program" that has set the "self-enable" mode.

6.2 PLC Running

As shown in figure 6.1 above, select the "PLC operation" icon in the "PLC" interface and enter the "PLC" operation interface, as shown in figure 6.3. In the interface, 4 operations can be performed for "PLC program", including "run program", "stop operation", "start monitoring" and "program details".

Run program--enable “run” to create the completed “PLC program”.

Stop running--stop the “PLC program” being “run”.

Begin monitoring--can monitor the “PLC program” being “run”.

Program Details--query the specific information of the “PLC program”.

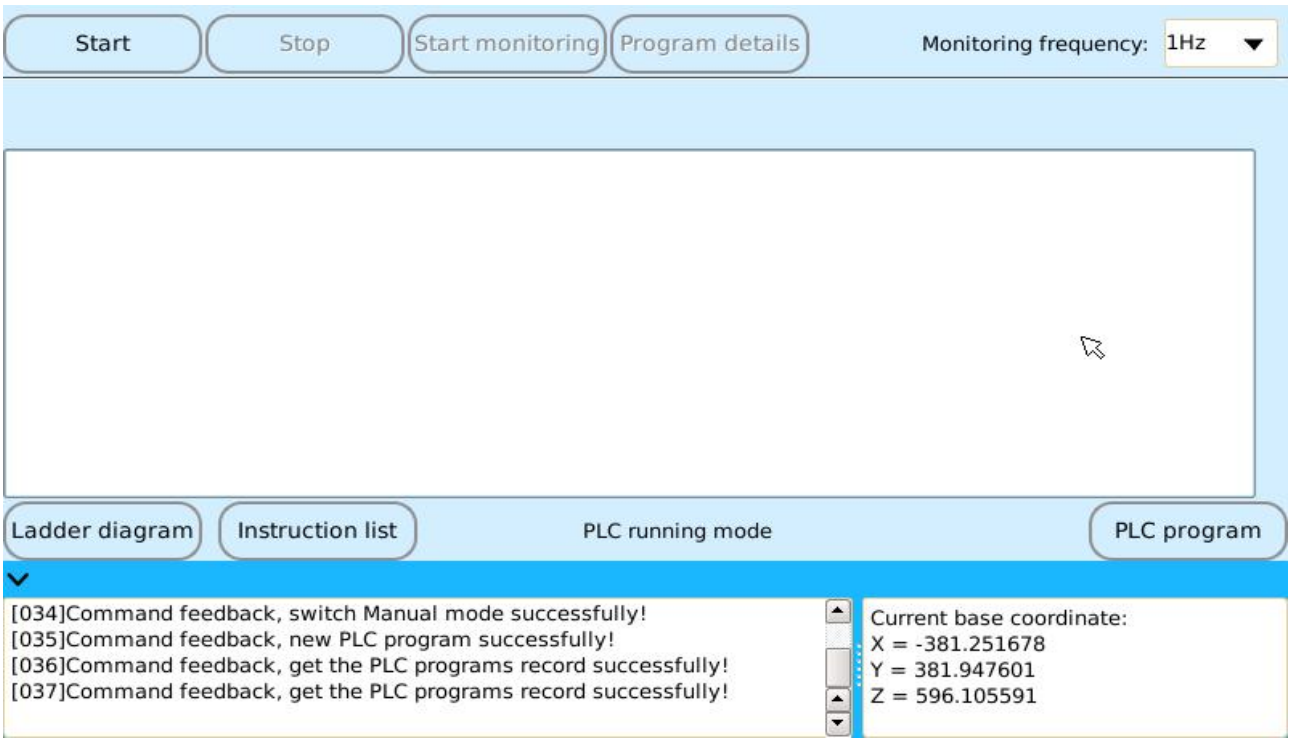


Figure 6.3 “PLC” running interface

7 Editing and Application of Functional Program

In the “demonstrator” login main interface (shown in Figure 2.4), select [motion]--[create program]--[functional pack] icons and enter the system “functional pack” interface, as shown in Figure 7.1. The “functional program” of the system is divided into three types: the “tracking” function, the “swing arc” function and the “synergy” function.

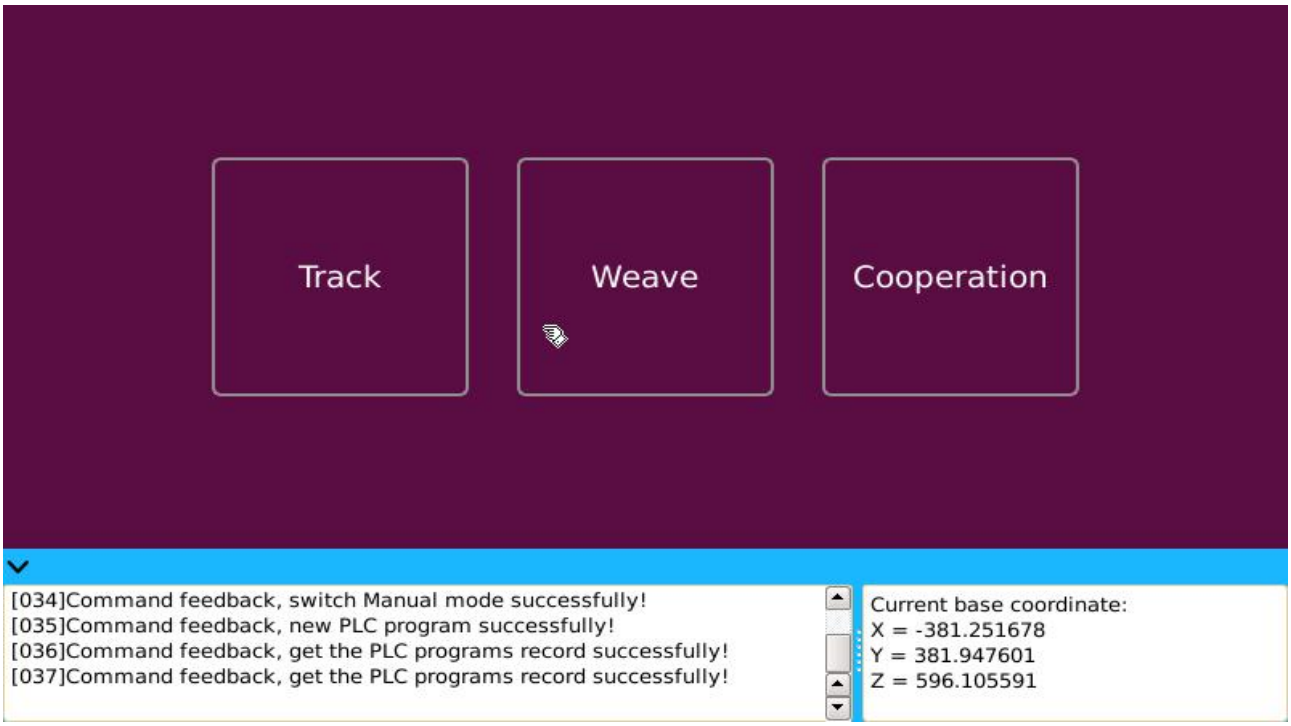


Figure 7.1 “functional program” Classification

7.1 Tracking Functions

7.1.1 Creation of Tracking Function Program

As shown in Figure 7.1, click the [track] icon in the “functional pack” interface to enter the “tracking function” creation interface, as shown in Figure 7.2. The “tracking function” of the system provides two following modes of tracking: “Ontology Tracking” and “sliding rail tracking”: The “Ontology tracking” is used for realizing pipeline motion tracking by using a mechanical arm body, and is suitable for small-range tracking application occasions; “Sliding track tracking” refers to a pipeline motion trackingrealized by using the combination of an additional shaft joint and an external sliding rail, and is suitable for wide-range trackingapplication occasions.

◆ Ontology tracking

According to the different “encoder types”, the “Ontology Tracking” can be divided into two types: “non-use encoder” and “pulse type”.

(1) The “non-use encoder” ontology tracking: After selecting the “non-use encoder ontology tracking function, it is necessary to complete the parameters setting such as "tracking functional pack name", "encoder type", "tracking mode", "acceleration and deceleration time", "line speed", "tracking starting point", "tracking terminal point", "failure alert output port", "linkage output port", "triggering input port", "tracking start time" and "tracking end time".

Tracking function package name--create the “tracking function” program name.

Encoder type--selects the “non-use encoder” type.

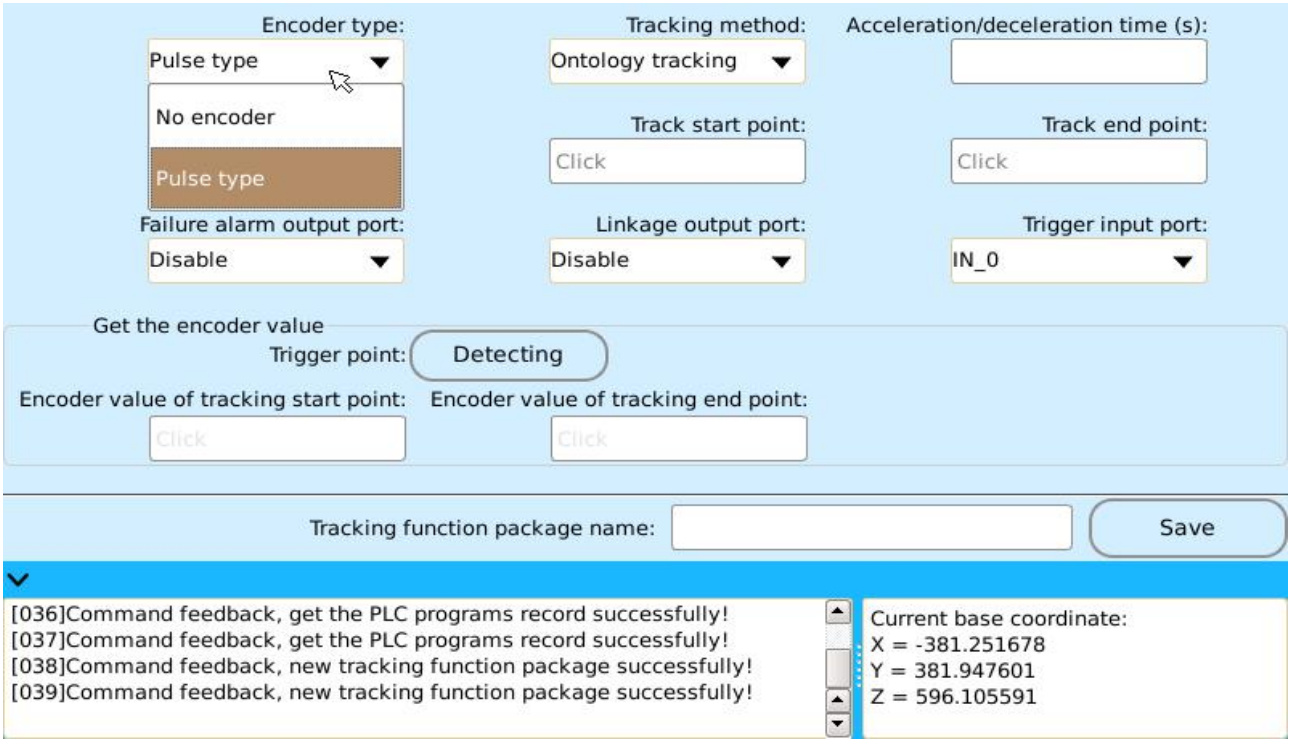


Figure 7.2 “Tracking function” program creation interface

Tracking mode--Select the “Ontology tracking” type.

Acceleration and deceleration time--set the “accelerated speed”, the unit is “second” (s).

Line Speed--refers to the motion speed of the machine “ontology” tracking, the unit is the “millimeters per second” (mm/s).

“Tracking starting point” and “tracking terminal point”--Set the direction of the “Ontology Tracking”, move straight from "starting point" to "terminal point".

Failure alarm output port--connected to the remote monitoring through the system I/O output port. When the tracking fails, it will be displayed at the remote monitoring end. It is not necessary to set this function when it is not needed.

The linkage output port--connects with the “assembly line” through the system I/O output port, the operation of “pause”, “continue” and “start” of the system can control the operation of the assembly line. It is not necessary to set this function when it is not needed.

Trigger input port--uses the I/O input port as a condition to trigger the “tracking function program”, and a high-level “1” is required when successfully triggered.

Tracking start time--is after the I/O input port is triggered, enable “tracking” time, the unit is “second” (s).

Tracking end time--refers to the "tracking" end time after the I/O input port is triggered, and the unit is seconds (s). If the tracking function program is “triggered”, the “tracking” has not yet been successful after the “tracking end time”, indicating that the “tracking” has failed.

(2) The “pulse type” encoder ontology tracking: After selecting “pulse type” encoder ontology tracking” function, it is necessary to complete the settings of parameters such as "tracking functional pack name", "encoder type", "tracking mode", "acceleration and deceleration time", "encoder line speed", "tracking starting point", "tracking terminal point", "failure alert output port", "linkage output port", "triggering input port", "tracking start point encoder value" and "tracking terminal point encoder value".

Tracking function package name--create the “tracking function” program name.

Encoder type--selects the “pulse type” encoder.

Tracking mode--Select the “Ontology Tracking” tracking type.

Acceleration and deceleration time--set the “accelerated speed”, the unit is “second” (s).

Encoder line number--Enter an “encoder line number” according to the “encoder” specification.

“Tracking starting point” and “tracking terminal point”--Set the direction of the “Ontology Tracking”, move straight from "starting point" to "terminal point".

Failure alarm output port--connected to the remote monitoring through the system I/O output port. When the tracking fails, it will be displayed at the remote monitoring end. It is not necessary to set this function when it is not needed.

The linkage output port--connects with the “assembly line” through the system I/O output port, the operation of “pause”, “continue” and “start” of the system can control the operation of the assembly line. It is not necessary to set this function when it is not needed.

Trigger input port--uses the I/O input port as a condition to trigger the “tracking function program”, and a high-level “1” is required when successfully triggered.

Tracking starting point encoder value--“encoder value” obtained from the “tracking starting point” position after successful detection of “trigger point”.

Tracking terminal point encoder value--“encoder value” obtained from the “tracking terminal point” position after successful detection of “trigger point”.

When choosing the pulse encoder type, the system provides an “IN_19” and “IN_20” two-path special interface with the “encoder”.

◆ Sliding track tracking

As with “Ontology Tracking”, according to the "encoder type", "sliding rail tracking" mode is also divided into "non-use encoder" and "pulse type" encoder type.

(1) The “non-use encoder” sliding rail tracking: After selecting the “non-use encoder sliding rail tracking” function, the parameters that need to be set are basically in agreement with the tracking function of the “non-use encoder ontology tracking”, except with an “additional axis number” parameter.

Before setting the “additional axis number” parameter, user must set the “additional axis” to the “joint pattern” usage mode. In the “sliding rail tracking” process, the slide rail returns to the starting position after each tracking is completed.

(2) Trajectory tracking of the “pulse type” coder: After selecting the trace function of the “pulse type coder sliding rail tracking”, the parameters that need to be set are basically in agreement with the trace function of the “Pulse Encoder Ontology Tracking”, and it is necessary to set the “additional axis number” parameter and the “additional axis” must be set to the “joint pattern” mode.

After setting all "parameters", click the "save" button to complete the creation of "tracking function" program and "save" it to the "tracking" file of "functional pack" in "program management".

7.1.2 Application of Tracking Function Program

Successful tracking function programs will be "saved" to the "tracking" file of "functional pack" in "program management". In the "tracking" file, user can carry out "file save as", "details" and "edit" the "trace function program".

File save as--through the “file save as” operation, you can back up the selected “tracking functional program”.

Details--can be accessed through “details” to the “create” interface of the “tracking functional program” for “query” and “modify”.

Edit--Select the “edit” button to delete the “tracking function” program.

Select the “enable tracking” and “disable tracking” task types of the “functional instruction” at the time of

“creating program” will be “applied” to the “tracking program”.

7.2 Swing arc function

7.2.1 Creation of Swing Arc Functional Program

As shown in Figure 7.1, click [swing arcs] icon in the “functional pack” interface to enter the “swing arc function” creation interface, as shown in Figure 7.3. The “swing arc function” of the system is divided into two kinds of swing modes of “Z shape” and “circular arc”.

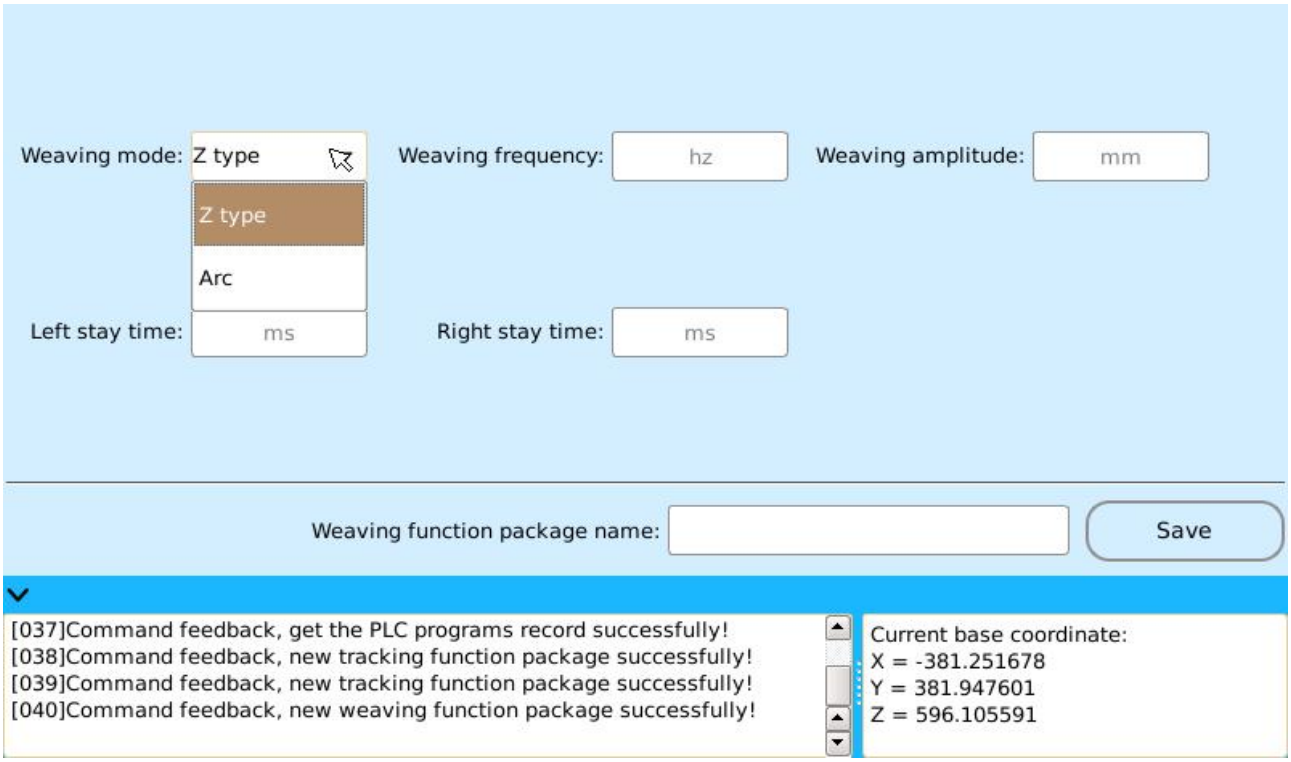


Figure 7.3 “swing arc function” program creation interface

◆ Z-shaped swing arc

The trajectory of "swing arc" is just like "Z" shape, so it is called "Z" swing arc. As shown in Figure 7.3, when selecting the “Z shaped” swing mode, it is necessary to set "name of swing arc functional pack", "swing mode", "swing frequency", "swing amplitude", "left dwell time" and "right dwell time"..

Swing arc function package name--creates the “swinging arc function” program name.

The swing mode--sets the “Z shaped” swing mode.

The oscillatory frequency--swing speed is slow, the unit is the “Hertz” (Hz).

Swinging amplitude--the distance from one side to the other, the unit isthe "millimeters"(mm).

Left side stopping time period--the duration of the swing to the left vertex, the unit is the milliseconds (ms).

Right side stopping time period--the duration of the swing to the right vertex in milliseconds (ms)

After all the parameters are set, click [Save] button to complete the creation of the Z-shaped swing arc program and save the swing-arc file of the functional pack in the program management.

◆ Circular arc pendulum

The trace of the “circular arc pendulum” is “circular arc”-like, so call the “circular arc” pendulum. As shown in Figure 7.4, when selecting "circular arc" swing mode, it is necessary to set "name of arc swing functional pack", "swing mode", "swing frequency", "swing amplitude", "left dwell time", "right dwell time" and "radius of circular

pendulum".

Swing arc function package name--creates the “swinging arc function” program name.

Swing mode--sets the “circular arc” swing mode.

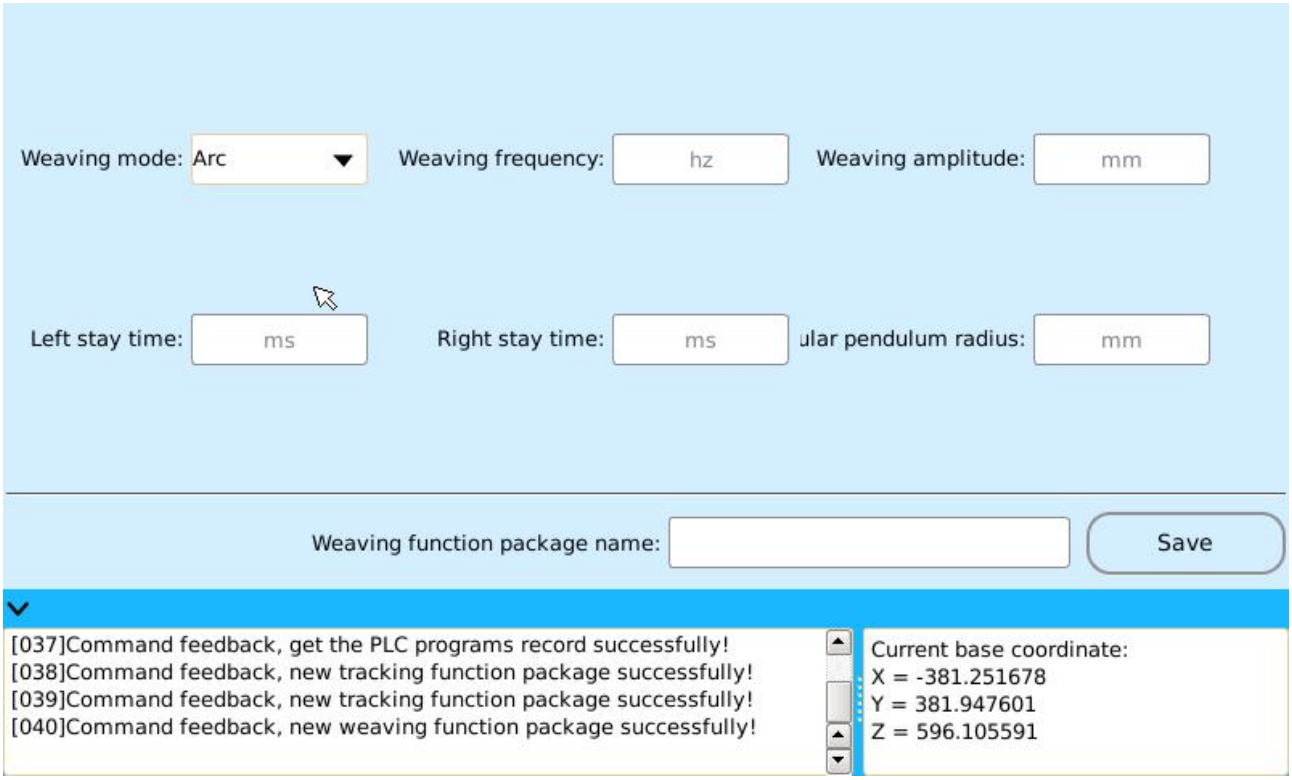


Figure 7.4 An interface for the “circular arc pendulum” functional program

The oscillatory frequency--swing speed is slow, the unit is the “Hertz” (Hz).

Swinging amplitude--the distance from one side to the other, the unit is "millimeters"(mm).

Left side stopping time--the duration of the swing to the left vertex, the unit is milliseconds (ms).

Right side stopping time period--the duration of the swing to the right vertex in milliseconds (ms)

Swing radius-sets the length of the swing radius in mm.

After all the parameters are set, click [Save] button to complete the creation of” circular arc pendulum” program and save it to the “swing-arc” file of the functional pack in program management.

7.2.1 Application of Swing Arc Functional Program

The creation of a successful swing-arc function program is stored in the swing-arc file of the functional pack in program management. In the "tracking" file, you can "save as", "details" and "edit" the "arc pendulum" program.

File save as--through “file save as” operation, you can back up the selected “arc pendulum” program.

Details--can be accessed through “details” operation to the “create” interface of “arc pendulum program” for “query” and “modify”.

Edit--Select the edit button to delete the arc function program.

The “enabling swing arc” and the “disable swing arc” task types of the “functional instruction” will be “applied” to the “swing arc program” at the time of “create program”.

8 Editing and Application of System Process

In the “demonstrator” login main interface (shown in Figure 2.4), select [motion]--[create program]--[Process Pack] icons and enter the system “process pack” interface, as shown in Figure 8.1. The “process program” of the system is divided into 4 kinds: “spraying” process, “palletization process”, “welding” process and “Stamping” process.

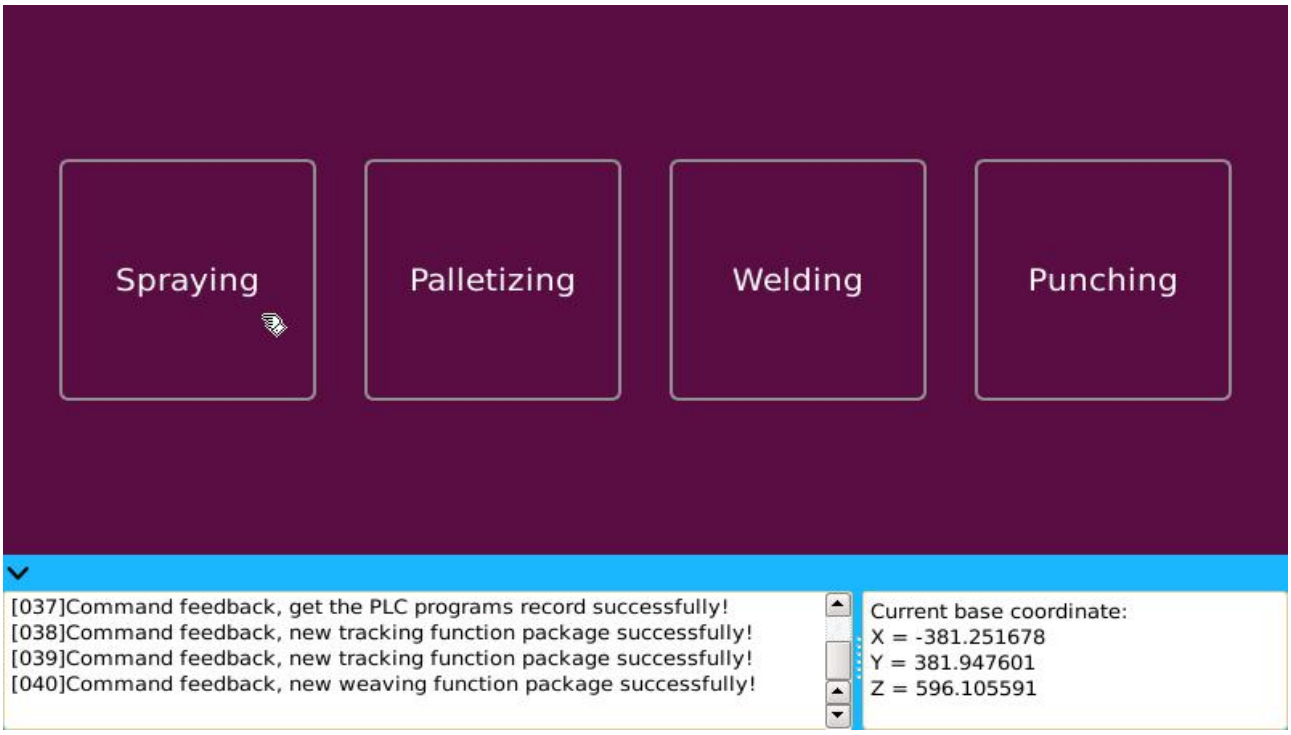


Figure 8.1 “process pack” Interface

8.1 Spray painting process

Spraying procedure refers to the few key points on the surface of the workpiece selected by the system, through the internal "integration", "calculation" and automatically generate a process that contains the spraying trajectory of the entire workpiece surface, saving users a lot of repeated and tedious work, greatly improve the work efficiency.

8.1.1 Creation of Spraying Procedure Program

As shown in Figure 8.1, in the “process pack” interface, select the [spray] icon to enter the creation interface of the “spraying procedure”, as shown in Figure 8.2. The system “spraying procedure” is divided into 6 spraying modes: “linear”, “flat”, “flatinch-motion”, “camber”, “arc surface” and “arc surface inch-motion”. “Motion parameter” and “control parameter” are required to be set when creating a “spraying procedure” program.

◆ Motion parameters

As shown in Figure 8.2, the 6 kinds of spray modes of “linear”, “flat”, “flatinch-motion”, “camber”, “arc surface” and “arc surface inch-motion” when choosing different spraying modes, the motion parameter setting is also different.

(1) The motion parameters of the “linear spraying mode”: As shown in Figure 8.2, when in “linear” spraying

mode, the motion parameters that need to be set include 7 kinds: process program name, spraying pattern, round trip number, P1 and P2, round trip speed and end-to-point speed.

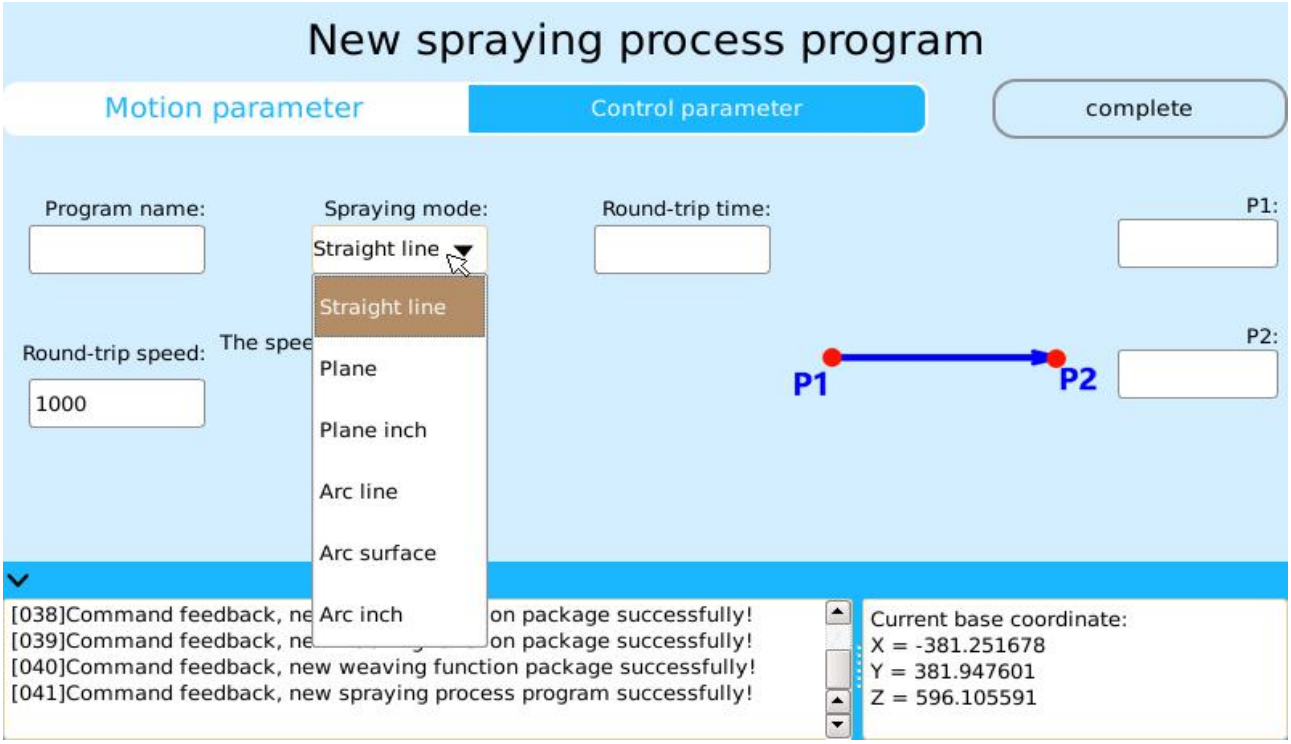


Figure 8.2 Spraying Procedure Creation Interface

The process program name--creates the name of the “spraying process” program.

Spray mode--select “straight line” spraying mode.

Round trip number--number of repeated movements, the value range is "1-10".

P1 and P2--determine the “starting point” and “terminal point” of “linear spraying mode”, and the two points exercise the “straight line” motion type.

Round trip speed--set “round trip speed”, which belongs to the type of “linear” motion, the value range is “1-2000”and the unit is the “millimeters per second” (mm/s).

Velocity from the terminal point to the starting point--Set the speed from the terminal point to the starting point, which belongs to the type of "linear" motion. The value range is "1-2000" and the unit is "millimeter/second"(mm/s).

(2) The motion parameters of the “flat spraying mode” are: As shown in Fig. 8.3, when in “flat” spraying mode, the motion parameters that need to be set include 12 kinds: "Process program name", "spraying mode", "round trip times", "P1", "P2" and "P3", "round trip speed", "terminal to starting speed", "reentry speed", "interval times", "reentry smoothness-1" and "reentry smoothness-2"

The process program name--creates the name of the “spraying process” program.

Spray mode--select “flat” spraying mode.

Round trip number--number of repeated movements, the value range is "1-10".

P1, P2 and P3--points “P1” and “P2” are the “starting point” and “terminal point” of the “first line” curve in "flat" spraying, and the motion type of the “straight line” is between two points. Point “P3” is the “reference terminal point” of the entire “flat” spraying process.

Round trip speed--set “round trip speed”, which belongs to the type of “linear” motion, the value range is “1-2000”and the unit is the “millimeters per second” (mm/s).

Velocity from the terminal point to the starting point--Set the speed from the terminal point to the starting point, which belongs to the type of "linear" motion. The value range is "1-2000" and the unit is "millimeter/second"(mm/s).

The speed of reentry--i.e. the speed of the connecting curve between “first line” and “second line” belongs to the type of “straight line” motion type, the range of values is “1-2000”, unit “millimeters per second” (mm/s).

Number of intervals--refers to the number of spraying intervals. The "vertical distance" of "first line curve" and "last line curve" is divided into even "numbered intervals", ranging from "1-80", i. e. the maximum number of intervals is 80.

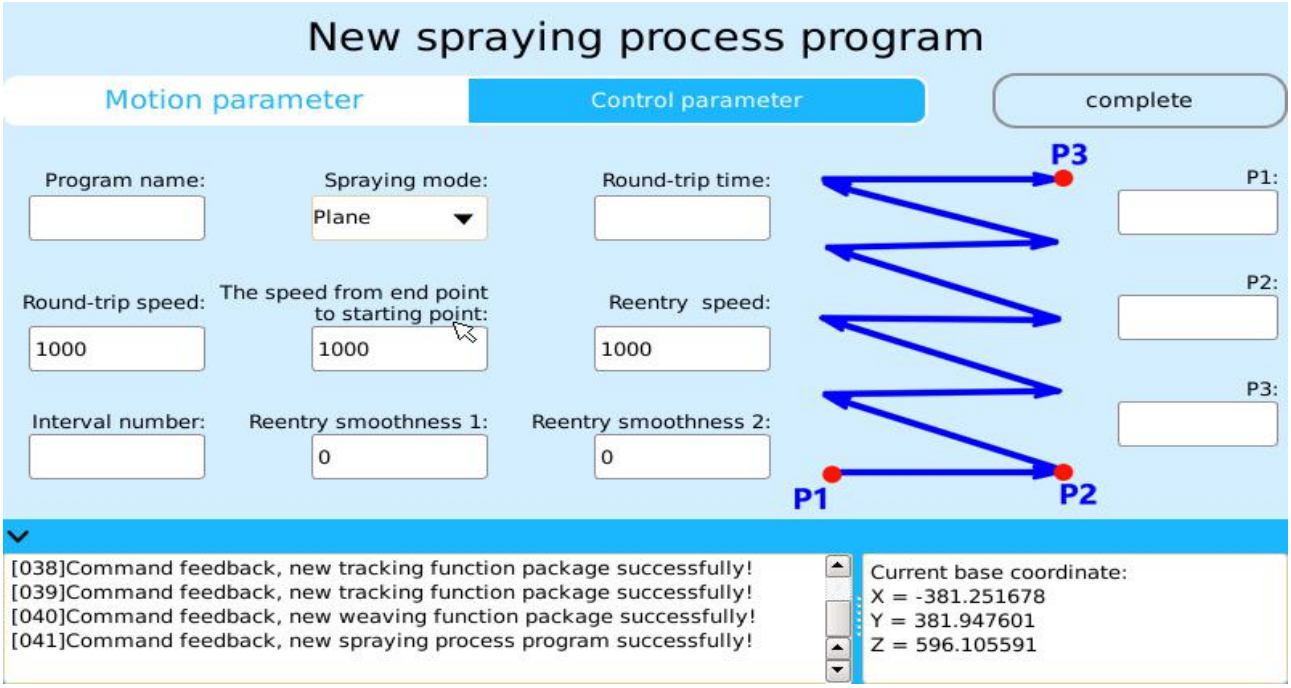


Figure 8.3 “flat spraying procedure” Motion Parameters

Reentry smoothness-1& reentry smoothness-2--is the smoothness of the “reentry” curve, the value range is “0-100”.

(3) The motion parameters of the “flat inch-motion spraying mode” are: As shown in Fig. 8.4, when in “flat inch-motion spraying mode”, the motion parameters that need to be set include 12 kinds: "Process program name", "spraying mode", "round trip times", "P1", "P2" and "P3", "round trip speed", "terminal to starting speed", "flat-inch section speed", "interval times", "flat-inch section smoothness-1" and "flat-inch section smoothness-2"

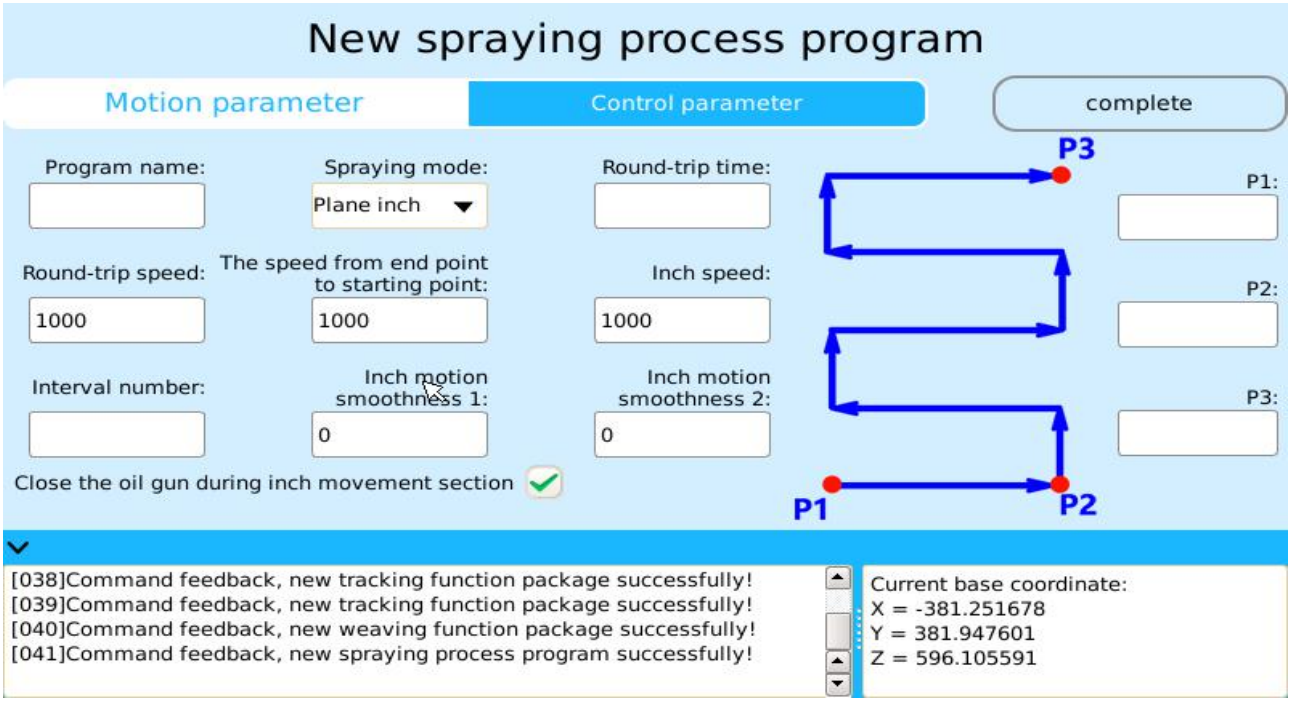


Figure 8.4 “Plane flat-inch Spraying Procedure” Motion Parameters

The process program name--creates the name of the “spraying process” program.

Spraying mode--select “flat inch-motion” spraying mode.

Round trip number--number of repeated movements, the value range is "1-10".

P1, P2 and P3--point “P1” and “P2” are the “starting point” and “terminal point” of the “first line” curve in the “flat inch-motion” spraying, and the motion type of the “straight line” is between two points. Point “P3” is the “reference terminal point” of the entire “flat” spraying process.

Round trip speed--set “round trip speed”, which belongs to the type of “linear” motion, the value range is “1-2000”and the unit is the “millimeters per second” (mm/s).

Velocity from the terminal point to the starting point--Set the speed from the terminal point to the starting point, which belongs to the type of "linear" motion. The value range is "1-2000" and the unit is "millimeter/second"(mm/s).

The speed of inching section--set the speed of the “inching section”, which belongs to the type of “linear” motion, the range of values is “1-2000” and the unit is “millimeters per second” (mm/s).

Number of intervals--refers to the number of spraying intervals. The "vertical distance" of "first line curve" and "last line curve" is divided into even "numbered intervals", ranging from "1-80", i. e. the maximum number of intervals is 80.

Smoothness of inching section-1 and section-2--Set the smoothness of the “inching section” curve with a value range of “0-100”.

When the “flat inch-motion” spraying mode is set, the motion parameters of the “flat-inch section oil gun closed” can be set: When the “flat-inch section oil gun closed” motion parameter is “selected”, the “oil gun” is closed when running at the “flat-inch section” and automatically opens the “oil gun” after the “flat-inch section”.

(4) The motion parameters of the “swing arc spraying mode”: As shown in figure 8.5, when in arc spraying mode, the motion parameters that need to be set include 8kinds: Process program name "," spraying mode "," round trip times "," P1"," P2"and" P3"," round trip speed ", and" terminal to starting speed ". "

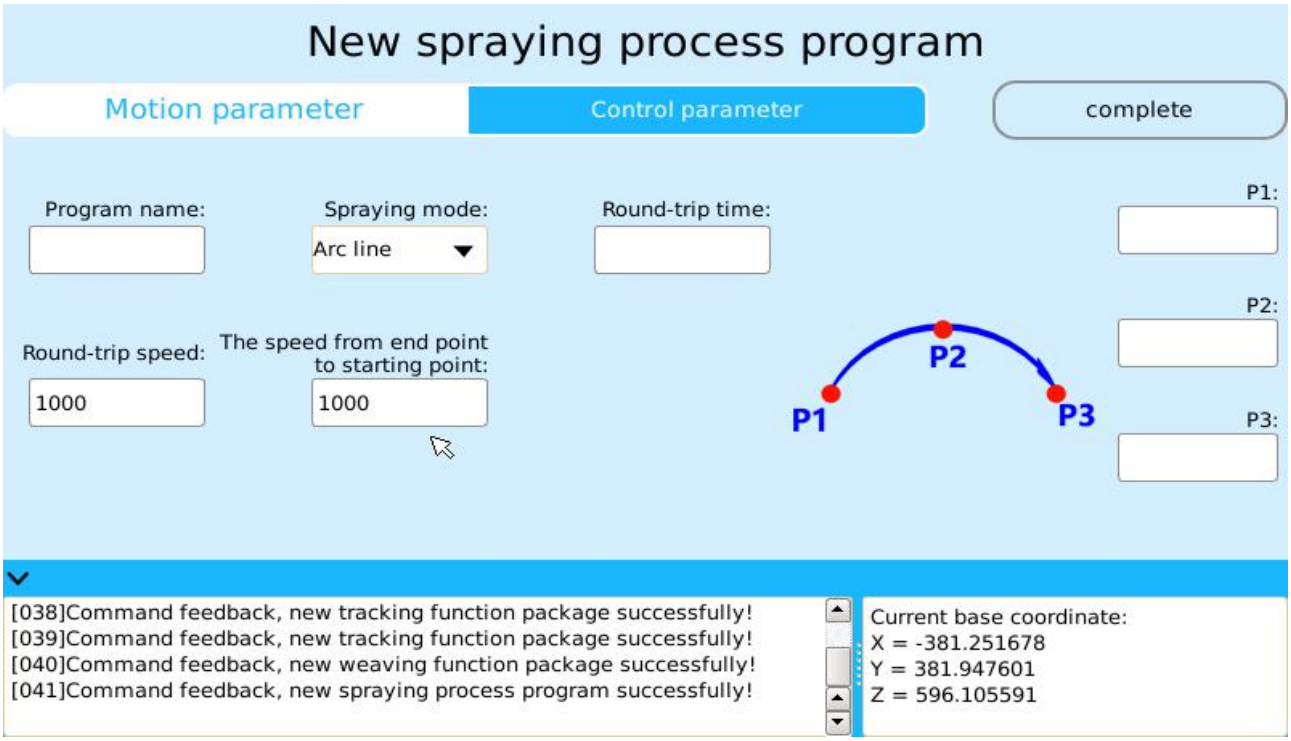


Figure 8.5 “swing arc spraying procedure” Motion Parameters

The process program name--creates the name of the “spraying process” program.

Spraying mode--select “swing arc” spraying mode.

Round trip number--number of repeated movements, the value range is "1-10".

P1, P2 and P3--point “P1”, “P2” and “P3” are respectively the “starting point”, “intermediate point” and “terminal point” that determine the “circular arc” curve.

Round trip speed--set “round trip speed”, which belongs to the type of “linear” motion, the value range is “1-2000”and the unit is the “millimeters per second” (mm/s).

Velocity from the terminal point to the starting point--Set the speed from the terminal point to the starting point, which belongs to the type of "linear" motion. The value range is "1-2000" and the unit is "millimeter/second"(mm/s).

(5) The motion parameters of the “arc surface spraying mode”: As shown in Fig. 8.6, when in “arc surface” spraying mode, the motion parameters that need to be set include 13 kinds: Process program name", "spraying mode", "round trip times", "P1", "P2","P3" and “P4”, "round trip speed", "terminal to starting speed", "reentry speed","interval times", "reentry smoothness-1"and" reentry smoothness-2".

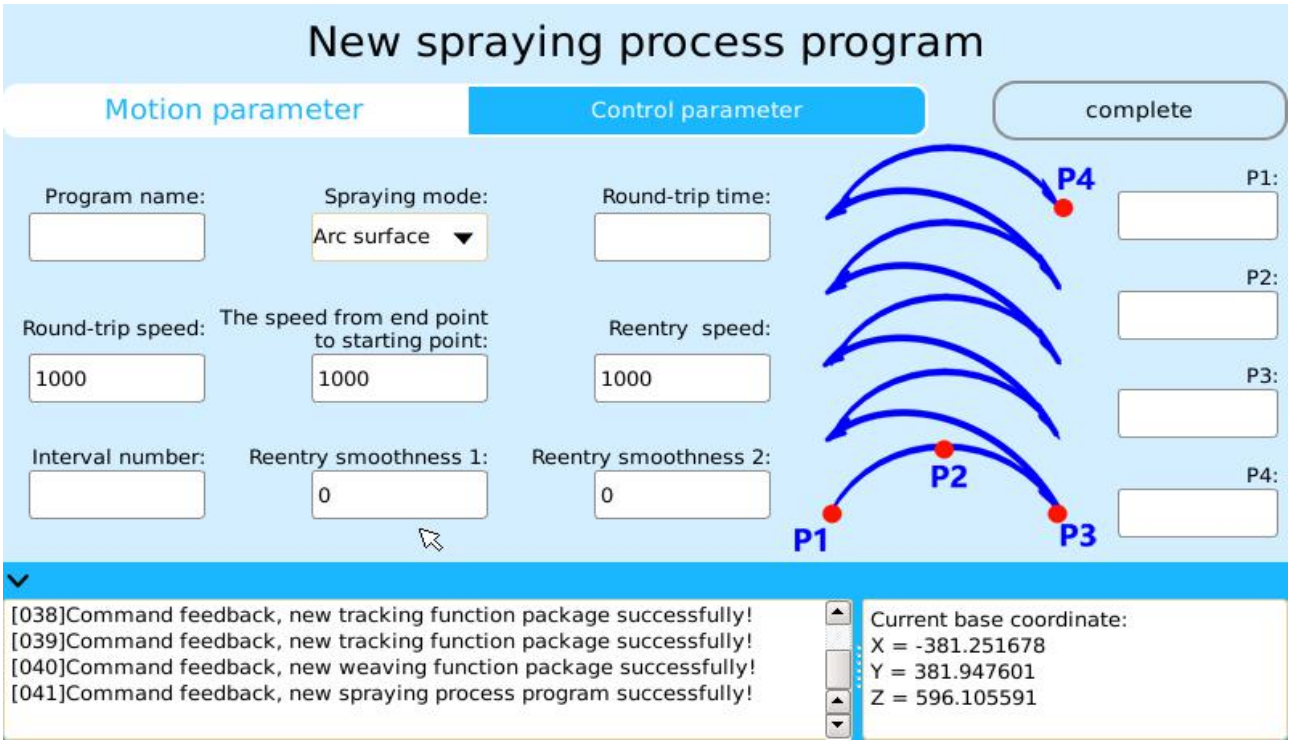


Figure 8.6 “arc surface spraying procedure” Motion Parameters

The process program name--creates the name of the “spraying process” program.

Spray mode--select “arc surface” spraying mode.

Round trip number--number of repeated movements, the value range is "1-10".

P1, P2, P3 and P4--point “P1”, “P2” and “P3” are “starting point”, “intermediate point” and “terminal point” of the “first line” arc curve of in “arc surface” spraying. Point “P4” is the “reference terminal point” of the entire “flat” spraying process.

The round trip speed--“round trip speed setting” belongs to the “circular arc” movement type, the value range is “1-2000”, the unit is “millimeters per second” (mm/s).

Velocity from the terminal point to the starting point--Set the speed from the terminal point to the starting point, which belongs to the type of "linear" motion. The value range is "1-2000" and the unit is "millimeter/second"(mm/s).

Reentry speed--i.e. the speed of the connecting curve between “first line” and “second line” belongs to the “circular arc” motion type, the range of values is “1-2000”, unit “millimeter per second” (mm/s).

Number of intervals--refers to the number of spraying intervals. The "vertical distance" of "first line curve" and "last line curve" is divided into even "numbered intervals", ranging from "1-80", i. e. the maximum number of intervals is 80.

Reentry smoothness-1&turning smoothness-2--is the smoothness of the “turn back” curve, the value range is “0-100”.

(6) The motion parameters of the “arc surface inch-motion spraying mode” are: As shown in Fig. 8.7, when in “arc surface inch-motion” spraying mode, the motion parameters that need to be set include 13 kinds: Process program name", "spraying mode", "round trip times","P1", "P2","P3"and “P4”,"round trip speed","terminal to starting speed", flat-inch section speed", "interval times", "flat-inch section smoothness-1" and "flat-inch section smoothness-2".

The process program name--creates the name of the “spraying process” program.

Spray mode--select “arc surface inch-motion” spraying mode.

Round trip number--number of repeated movements, the value range is "1-10".

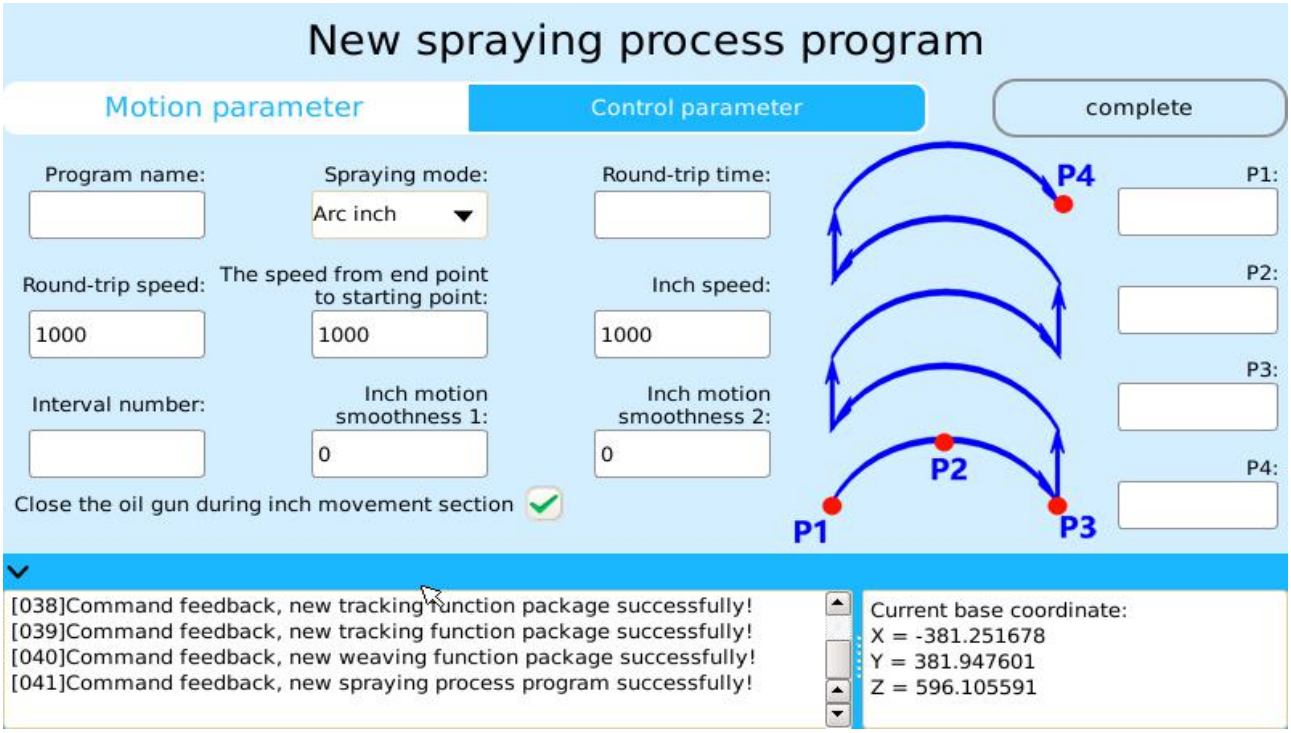


Figure 8.7 “arc surface inch-motion spraying procedure” motion parameters

P1, P2, P3 and P4--point “P1”, “P2” and “P3” are “starting point”, “intermediate point” and “terminal point” of the “first line” arc curve of “arc surface inch-motion” spraying. Point “P4” is the “reference terminal point” of the entire “arc surface inch-motion” spraying process.

The round trip speed--“round trip speed setting” belongs to the “circular arc” movement type, the value range is “1-2000”, the unit is “millimeters per second” (mm/s).

Velocity from the terminal point to the starting point--Set the speed from the terminal point to the starting point, which belongs to the type of "linear" motion. The value range is "1-2000" and the unit is "millimeter/second"(mm/s).

The speed of inching section--set the speed of the “inching section”, which belongs to the type of “linear” motion, the range of values is “1-2000” and the unit is “millimeters per second” (mm/s).

Number of intervals--refers to the number of spraying intervals. The "vertical distance" of "first line curve" and "last line curve" is divided into even "numbered intervals", ranging from "1-80", i. e. the maximum number of intervals is 80.

Smoothness of inch-motion section-1 and section-2--Set the smoothness of the “inching section” curve with a value range of “0-100”.

In accordance with the flat-inch spraying mode, the arc surface inch-motion spraying mode can control the oil gun by setting the motion parameters of "inch-motion section oil gun closed”.

◆ Control parameters

The “control parameters” including “straight line”, “flat”, “flatinch-motion”, “camber”, “arc surface” and “arc surface inch-motion” 6 spray patterns are all the same in system “spraying procedure”, as shown in Figure 8.8. The control parameters for setting “spraying procedure” include 6kinds: “coordinate system type”, “open-pump delay time”, “pump shut-off delay time”, “pump output port number”, “quantity of spray guns”, and

“spray gun output port”.

Coordinate system type--divided into three kinds: “base coordinate system”, “user coordinate system” and “tool coordinate system”.

The open-pump delay time--i.e. the pump opening delay time, the unit is the “millisecond” (ms).

Pump shut-off delay time--i. e. pump shut-off delay time, the unit is the “millisecond” (ms).

Pump output port number--system uses the I/O port output “high/low level” to set the “switch on and off” of “oil pump”.

Spray gun number&spray gun output port--“quantity of spray gun” and “spray gun output port” are combined for use together. The “quantity of spray gun” determines the setting of the “spray gun output port”, and the “spray gun output port” sequence number is connected with a “-” when the “spray gun” is multiplied. The amount range of spray gun is “1-4”, that is, up to 4 spray guns can be controlled at the same time.

Figure 8.8 “spraying procedure” Control Parameters

After setting completion of the “motion parameter” and “control parameter” of the spraying procedure, click [Finish] button, the “spraying process” program will first be “saved” as “spray process”, then the “conversion generation” is selected as a “basic program”.

8.1.2 Management of Spraying Procedure Program

Successful "spraying process" programs will be "saved" to "spraying" file of "process pack" in "program management". In the "spraying" file,"generate", "save as", "details" and "edit" can be carried out for "swing arc function program".

Create--Click [Create] button to convert the selected spraying procedure program into a basic program.

File Save As--through the “File Save As” operation, you can back up the selected “spraying procedure” program.

Details--can be accessed through a “details” operation to the “create” interface of the “Spraying Procedure” for “enquiry” and “modification”.

Edit--Select the “edit” button to delete the Spraying Procedure Program

8.2 Palletization Procedure

The palletization procedure means that that all stacking can be stacked neatly by setting the basic parameters of "stacking number" and "layer number" and simply confirming the position of "stacking" through "key points".

8.2.1 Creation of Palletization Procedure Program

Creating a “palletization procedure” is divided into three steps:(1) creating a “user coordinate system”;(2) creating a “palletization procedure” program;(3) Create “template” and generate “basic program”.

➢ Basic Situation Instructions

(1) The basic facts: Some terms in the palletization procedure and the basic parameters to be set are briefly explained.

Stack:i. e. Workpieces, objects, products, etc that need to be stacked.

Pallet: Refers to a region used to stack “pile”, which in the system it is used as “palletization procedure”, there are a total of 100 pallets (Pallet0-99), that is, it can support up to 100 pallets.

Stack position: I. e. the stacked position of “stack” in “pallet”, represented by “coordinate data” in “user coordinate system”, which contains “XYZ” and “angle of rotation”.

Setting point: The position of the “first stack” is represented, and the coordinates of each stack are offset and calculated as the datum.

Transition point: In the current palletizing process, robots are used to grab objects from an external mechanism (such as a conveyor belt) and move back to the middle point of the pallet.

Auxiliary point-Ready point: Prepare to “grab” workpiece points, mainly the offset of the current "stack point" height direction. When oblique advance is needed, the offset of XY direction can be set, which is the direction of user coordinate and higher than the arranged workpiece.

Auxiliary point-Departure point: The departure point after "grabbing" the workpiece is mainly the offset of the height direction of the current "stack site".

Number of layout methods: That is, the number of “way of placing”, the range is “1-99”, that is, 99 different ways of layouts can be realized at most, usually 1"way of layout" in each layer.

(2) Variable description: The relationship between “pallet” and “variable” in palletization procedure is one-to-one correspondence. The first “pallet” variable number is “GP_100”, the second “pallet” variable number is “GP_101”, the third “pallet” variable number is “GP_102” and so on, the “GP_199” is a variable number of the hundredth “pallet”.

➢ Process steps for creating palletization procedure

◆ Preparation Work

Preparation Work:Editing PLC to control the workpiece holder, convenient program editing.

In PLC edit, the control of the state of M-assisted relay is realized, and the control of fixture can be realized by editing PLC.

To achieve the control of the fixture, you usually need to edit the PLC according to the following figure.

```
---| |-------------------------------O
  Mx                                Yx
```

Explanation:(1)Yx represents the outlet of the control fixture solenoid valve.

(2) The number of editing shall be determined according to the control object.

◆ Create user coordinate system

The palletization procedure needs to set up the “user coordinate system” required by itself.

In the main interface of the “demonstrator”, select [motion]_[Coordinate System] icons, enter the “coordinate system” create interface, select the “user coordinate system” type, determine the “original point”, “X axis”, “Y axis” 3“point” coordinates according to the “pallet” flat of the palletization procedure, and complete the creation of the “user coordinate system”.

Explanation:The “user coordinate system” is established according to the “right-handed spiral rule”. The positive direction of Z is in the "thumb" direction of rotation from X to Y. When creating pallet coordinates, Z's positive direction is usually far away from the pallet, so it is necessary to consider which side is in the X and Y direction when establishing pallet coordinates.

◆ Create palletization procedure program

(1) As shown in Figure 8.1, in the “process pack” interface, select the palletization icon to enter the creation interface of the “palletization procedure”, as shown in Figure 8.9.

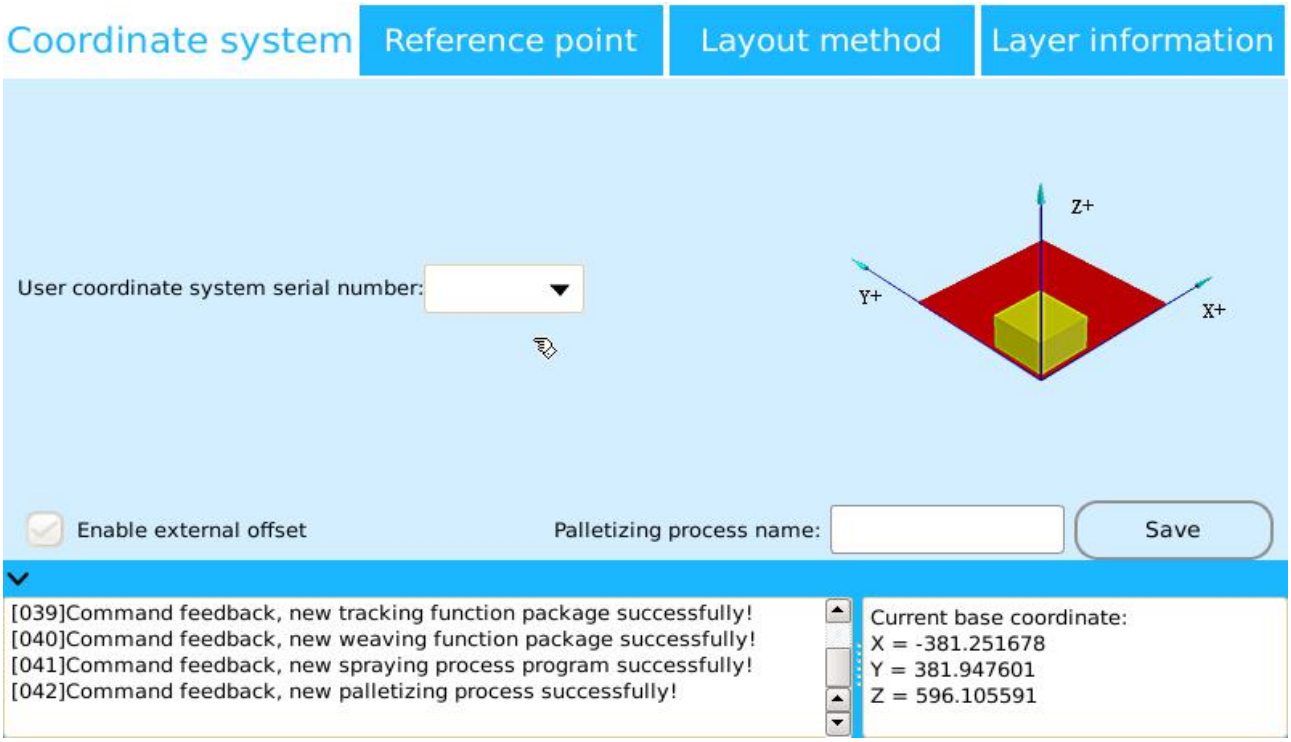


Figure 8.9 palletization procedure Creation Interface

(2) After entering the creation interface of the “palletization procedure”, the first choice is to select one created “user coordinate system” and enter a “palletizing process name” to create the stack. The “enable external offset” parameter can be set according to the actual situation.

(3) The establishment of “reference point” in the palletization procedure, as shown in Figure 8.10, includes key points such as “transition point”, “ready release point”, “release point” and “post-release point”.

Transition point: Divided into “enter transition point” and “exit transition point”. “enter transition point” refers to the “point” that must pass before entering the “stack”; “Exit transition point” refers to the points that must pass before leaving the “stack” after releasing. Choosing whether “enable” the transition point has a great influence on the trajectory of the entire “palletization procedure”.

Ready release point: Generally speaking, it is in a position directly above or below the "release point", and it can also have a certain offset angle.

Setting point:Refers to the "point" position to be reached by the material.

Post-release point: Same with “ready release point”.

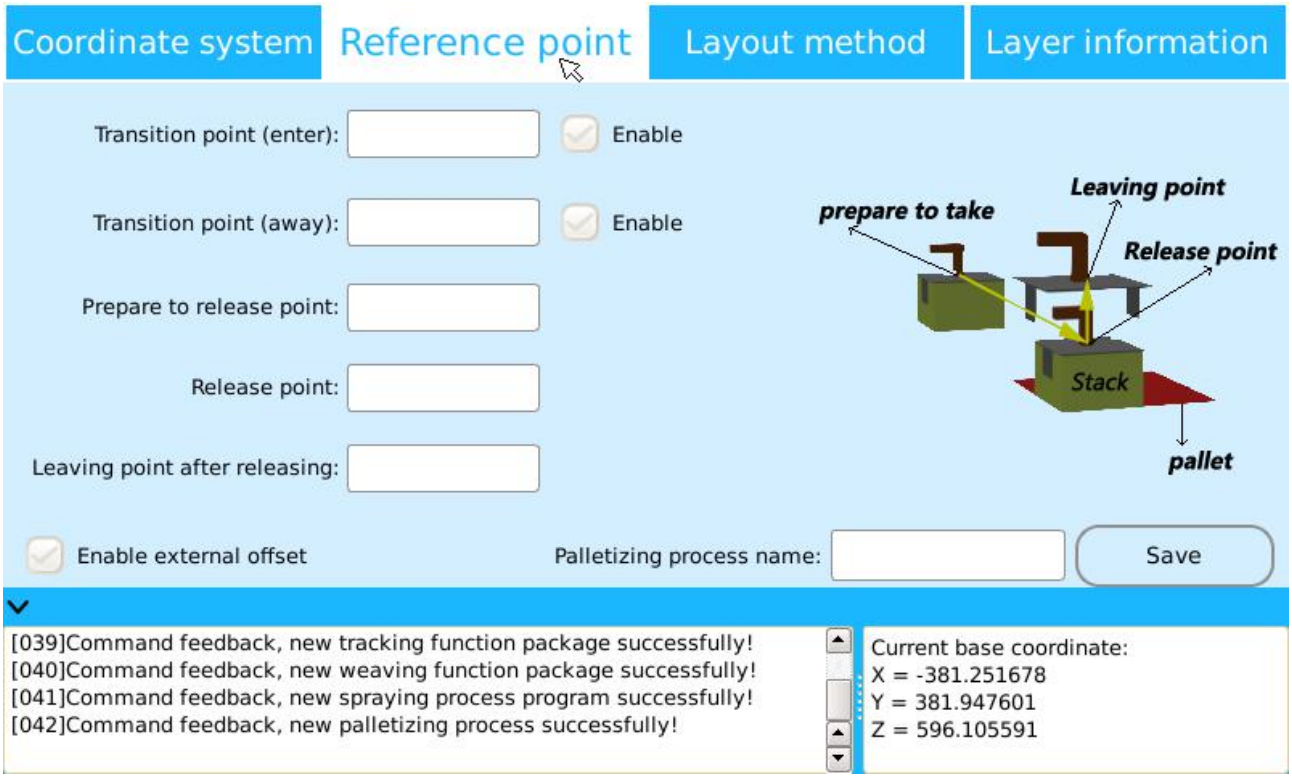


Figure 8.10 Palletization procedure "reference point" setting interface

(4) The establishment of "layout mode" in the palletization procedure, as shown in Figure 8.11, first enters the "quantity of sample layout", determines the "stack number", clicks [array type] button, and sets the "first stack" coordinates, "array pattern" and the "offset" of "line" and "column" in the "array type" interface.

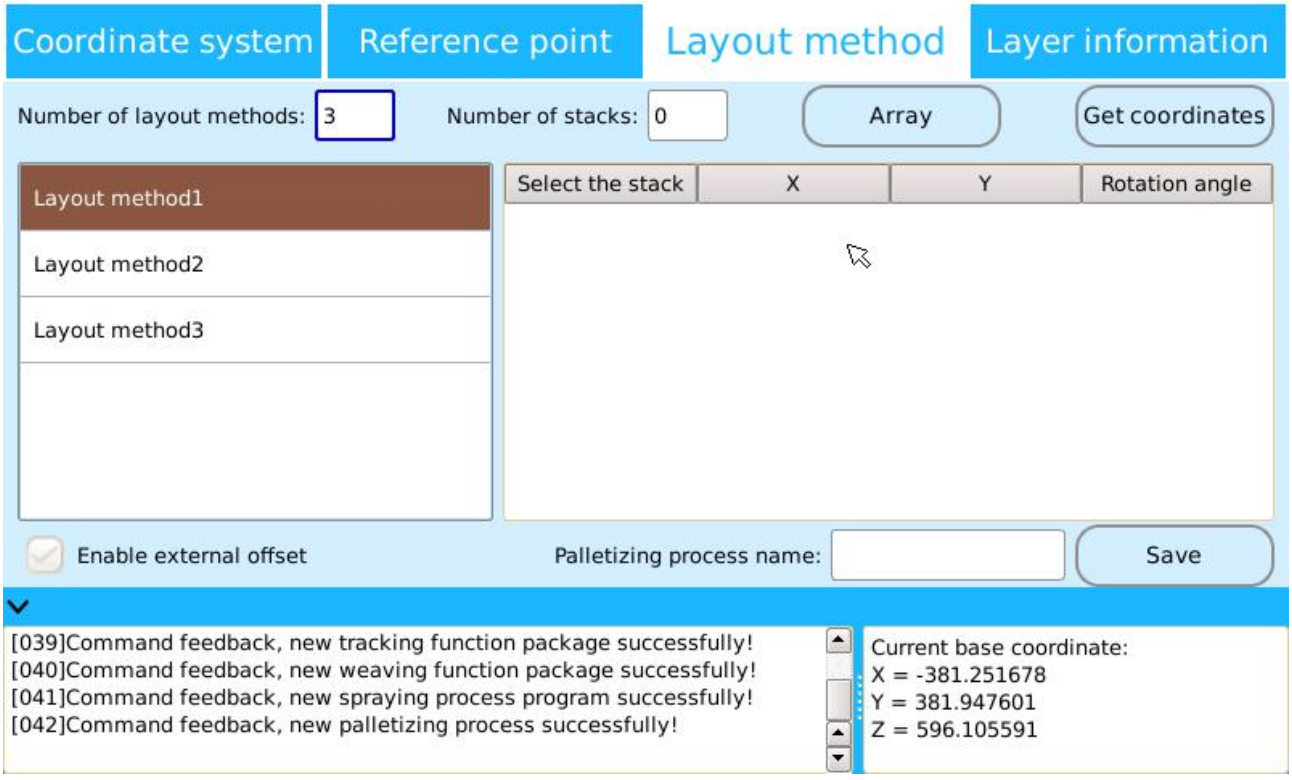


Figure 8.11 palletization procedure "layout mode" setting interface

Stack number: The number of samples included in the current "layout pattern", each "stacking number" will generate a corresponding "stacking position", represented by "coordinate value" and "rotation angle".

(5) The establishment of “layer information” in the palletization procedure, as shown in Figure 8.12, requires the setting of a “number of layers”, “layout mode”, “height of layer” and “transition point offset height”.

Number of layers: Set the number of “layers” in the “palletization procedure”.

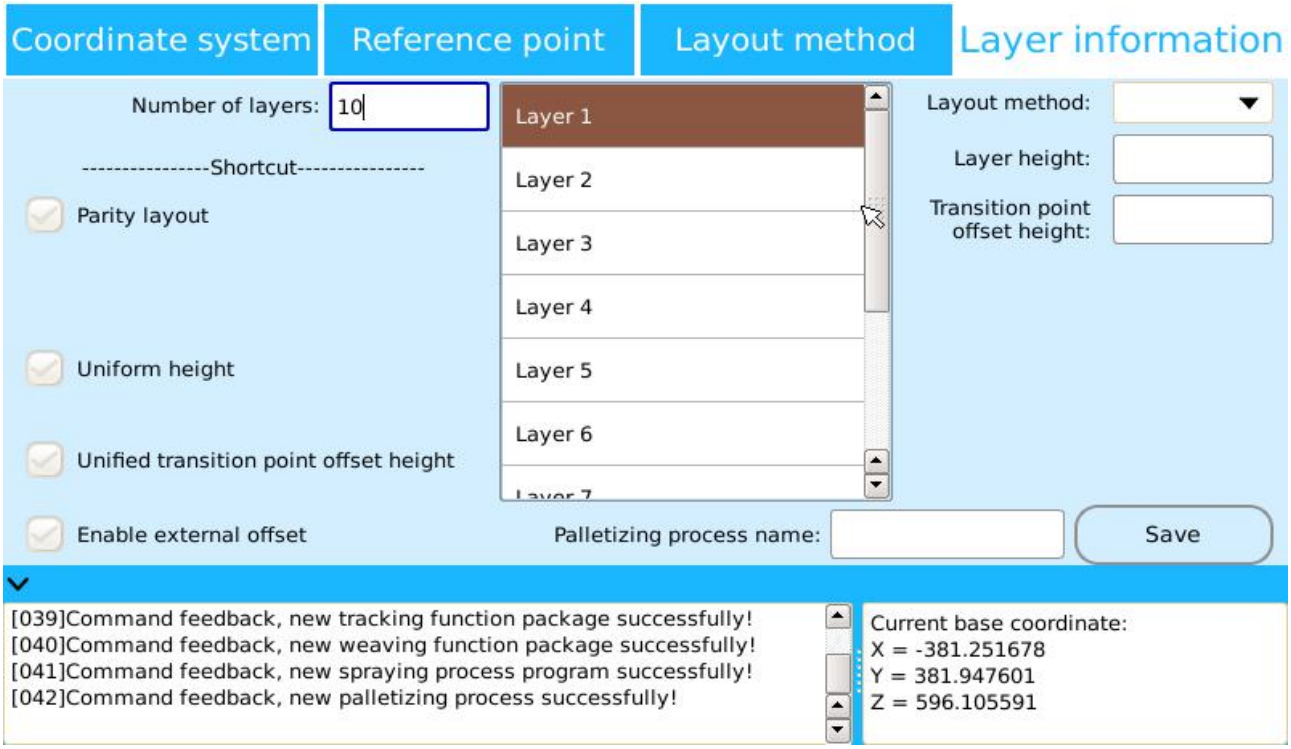


Fig. 8.12 palletization procedure “layer information” setting interface

Layout pattern: Different “layout patterns” can be selected for each “layer”.

Layer height: Set each “layer” height, the unit is “millimeter” (mm).

Transition Point Offset Height: For multi-“layer” stacks, the “transition point” offset height of each “layer” is set, and the unit is “millimeter” (mm).

(6)After setting all the parameters, click the Save button to complete the creation of the “palletization procedure”.

◆ Create Template and Generate Base Program

On the save of the “palletization procedure” interface, tap the “menu” membrane button on the “demonstrator”, select “create template”, and enter the “create template” interface, as shown in Figure 8.13.

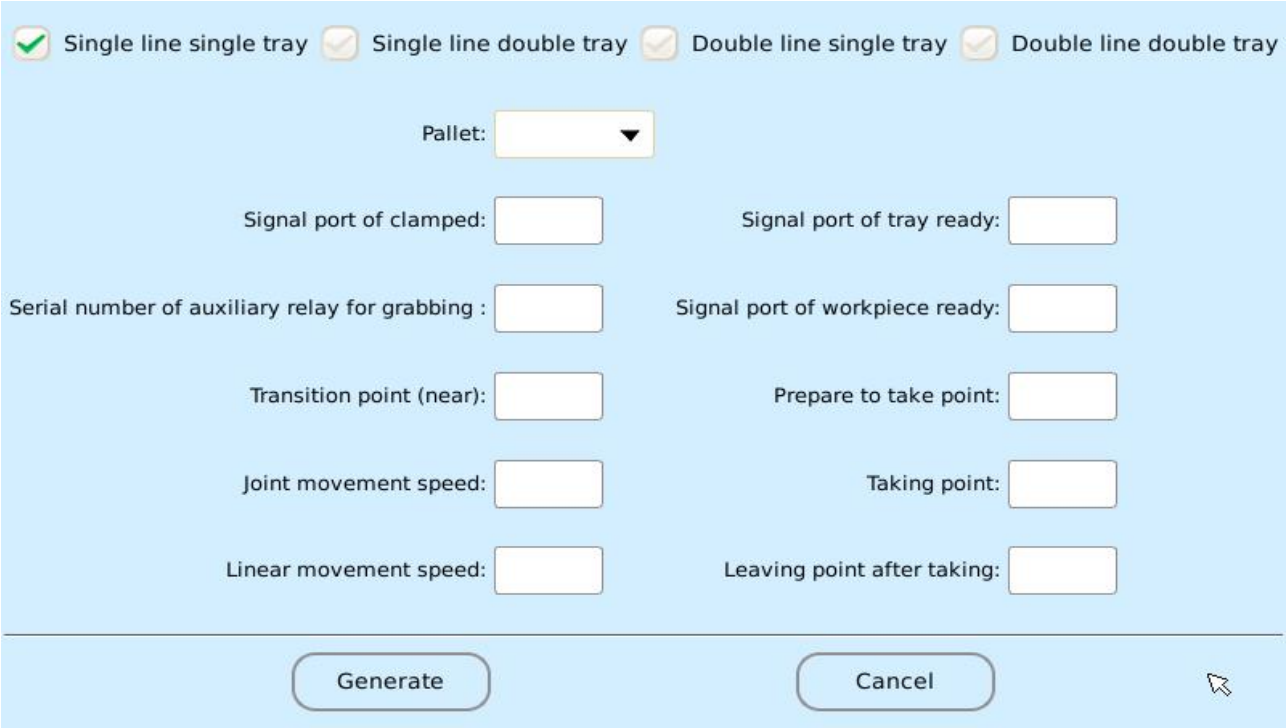


Fig. 8.13 palletization procedure “create template” interface

In the palletization procedure template creation interface, parameters need to be set include: the “palletization procedure type”, “pallet”,"clamping completion signal port", "pallet preparation completion signal port", "grasping auxiliary relay serial number", "workpiece preparation completion signal port", "picking transition point", "preparation release point", "joint motion speed", “linear motion speed”, “pick-up point” and “pick-up departure point”, etc..

Types of palletization procedure: Divided into "single wire single disk", "single wire double disk", "double wire single disk" and "double wire double disk" four types.

Pallet: Select the “pallet” name, that is, the name of the “palletization procedure” created.

Clamping completion signal port: After the cylinder clamp is clamped, the sensor output signal is connected to the IO output port number of the system.

Pallet preparation completion signal port: The pallet is ready, allow access to the pallet's output signal connected to the system's IO output port number.

Grasping auxiliary relay serial number: Control the auxiliary relay M that clamps the signal, write control output through PLC.

Workpiece preparation completion signal port: The output signal is connected to the IO output port number of the system after the completion of workpiece preparation.

“Picking transition point "," preparation release point ", “pick-up point” and “pick-up departure point” are similar to the “reference point” used to create “palletization procedure”.

Joint motion speed: Setting the speed of all the “joint motion” movement types in the “palletization procedure”, maximum speed is “3000”, the unit is “RPM”.

Linear motion speed: Setting the speed of all the “linear motion” movement types in the “palletization procedure” maximum speed is “2000”, the unit is “millimeters per second”.

After setting all the parameters, click the "generate" button to complete the creation of the "template" program and convert&generate a "PalFrame" basic program.

8.2.2 Application of Palletization Procedure Program

The creation of a successful palletization procedure will be stored in the stack file of the process pack in the program management. In the stack file, the stack processing program can carry out stack position, template, file save as, details and edit 5 operations.

Palletization position--click [Palletization Position] button to query the details of all “palletization positions” in the “Palletization Procedure” Program and can modify it.

Template--creates a “template program” for the “Palletization Procedure” Program through “template” operation.

File Save As--through the “File Save As” operation, you can back up one of the selected “Palletization Procedure”Program.

Details--can be accessed through “details” operation to the “create” interface of the “Palletization Procedure” Program for “enquiry” and “modification”.

Edit--Select the “edit” button to delete the Palletization Procedure Program

In running the “palletization procedure” program, the “palletization procedure” program must be converted to a “basic program” to run. In the "automatic" mode interface of the system, when running the program containing "palletization procedure", the "global variable" value corresponding to "pallet" can be changed to control the trajectory of "palletization procedure" program. Also, by pressing the “menu”membrane button of the “demonstrator”, select "process enable" function to carry out "palletization procedure" program for "stacking process non-enable" operation,that is, not running in stacking "tray" program.

The “enable palletization procedure” of the “process instruction” and the “disable palletization procedure” task types will be “applied” to the “palletization procedure” at the time of “create program”.

8.3 Welding Procedure

Welding process refers to the process of welding various boards through robot-controlled automatic digital welding machine.

8.3.1 Welding structure module

When using “welding procedure” of the system, it is necessary to add some equipment together, mainly including “digital welder”, “signal isolator” and “DB9 female head”.

(1) Digital welder: One of the important modules in welding procedure, such as the “Megmeet” CM350 digital welder.

(2) Signal isolator: It can isolate the output current and voltage of the robot and control the operation of the welding machine. Such as the “two-path input/output” 0-10V DC signal isolator.

(3) DB9 mother head: Used for system “simulation output” transfer. The system “simulation output” interface (corresponding to the “AVO” interface on the controller) contains 4 simulation output channels, the output range is (0, 12]. The system simulation output interface is defined in the following table.

Pin	Signals	Explanation	Pin	Signals	Explanation
1	DA_OUT1	Analog Output 1	6	NC	Empty, no signal
2	DA_OUT2	Analog Output 2	7	NC	Empty, no signal
3	DA_OUT3	Analog Output 3	8	GND	Ground 0V
4	DA_OUT4	Analog Output 4	9	GND	Ground 0V
5	NC	Empty, no signal			

Needle No. 1 is corresponding to simulation quantity channel 0, used in this process to control the welding machine current control. If there is a corresponding error, channel 0 can be adjusted with channel 1.

Needle No. 2 is corresponding to simulation quantity channel 1, used in this process to control the welding machine voltage control. If there is a corresponding error, channel 2 can be adjusted with channel 0.

Needle No. 3 is corresponding to simulation quantity channel 2, used in this process to control the welder for later use

Needle No. 4is corresponding to simulation quantity channel 3, used in this process to control the welder for later use

8.3.2. Creation of Welding Procedure Program

(1) As shown in Figure 8.1, select [welding] icon in the “process pack” interface, enter the creation interface of the “welding procedure”, as shown in Figure 8.14, and complete the setting of the parameter “welding procedure name”, “welding machine brand”, “number of consecutive arcs”, “enable rollback function”, and “rollback distance”.

Name of welding procedure: Create the “welding procedure” program name.

Welding machine brands: The system provides four welding machine brands including “OTC”, “Meganice”, “Megmeet” and “Jin Rui”.

Quantity of consecutive arcs: Set the number of “consecutive arcs”.

When selecting the “enable rollback function” parameter, the “rollback distance” parameter needs to be set, the unit is “millimeter” (mm).

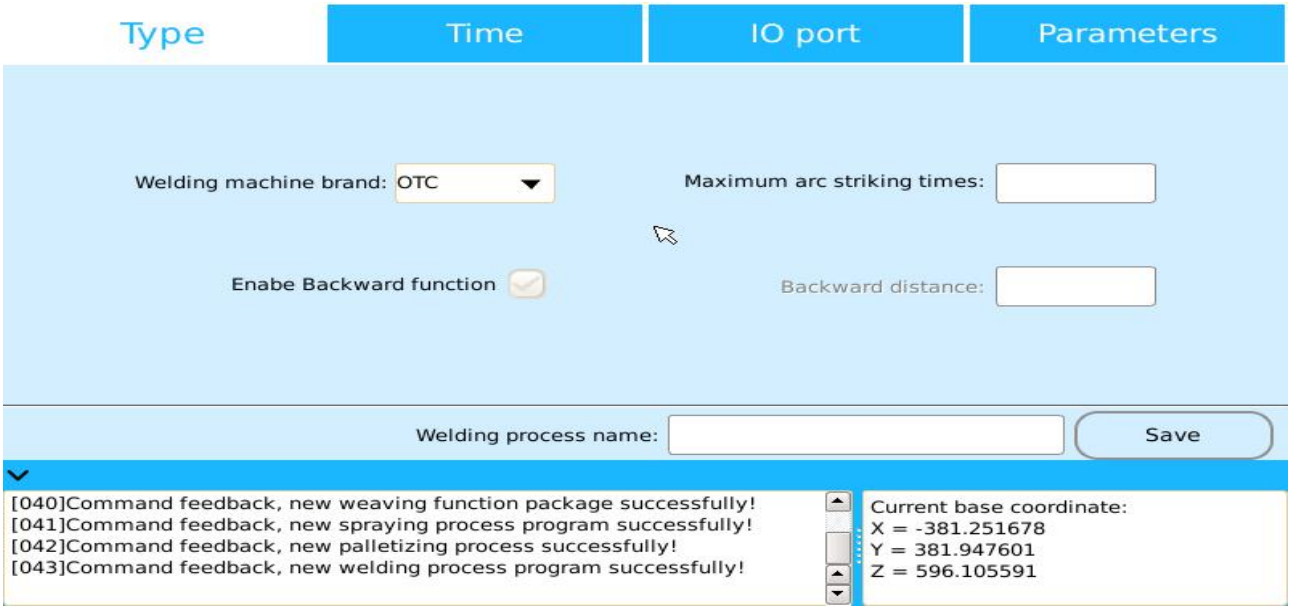


Figure 8.14 welding procedure Creation Interface

(2) Set a “welding time”: The parameters such as “advance gas supply time”, “empty-load time”, “arc starting time”, “arc retraction time”, “delayed gas supply time” and “anti-viscose time” are required to be set.

Advance gas supply time: Refers to advance gas supply time before welding arc starting time, unit is “millisecond” (ms).

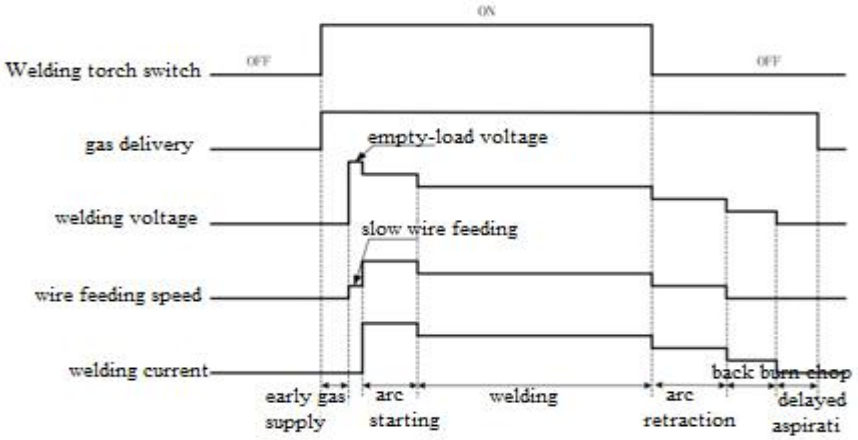
Empty-load time: Refers to the period of time from the end of "advance gas supply" to the beginning of "arcing". The unit is "ms", usually tens of milliseconds.

Arc starting Time: Refers to the time between the sending of arcing signal and the receiving of arc starting "success", the unit is "ms", which is determined according to the actual situation. The initial definition is 500. If arc starting is too fast and not successful, the time can be appropriately increased. If welding has accumulation, the time can be appropriately reduced.

Arc retraction time: Refers to the time between the completion of welding signal sent and the actual stop of welding, which is preliminarily defined as 500. If the arc retraction is too fast and unsuccessful, the time can be appropriately increased; if there is welding accumulation, the time can be appropriately reduced.

Anti-viscose time: The time between the end of the welding signal until the arc retraction voltage is stopped, the unit is a “millisecond” (ms).

Delayed gas supply time: When all welding work is finished, the delay is closed and delivered.



Sequence diagram

(3) Set an “IO port”: The parameters “arc starting control signal output port”, “gas delivery control signal

output port", and "arc starting detection signal input port" need to be set, as shown in Figure 8.15.

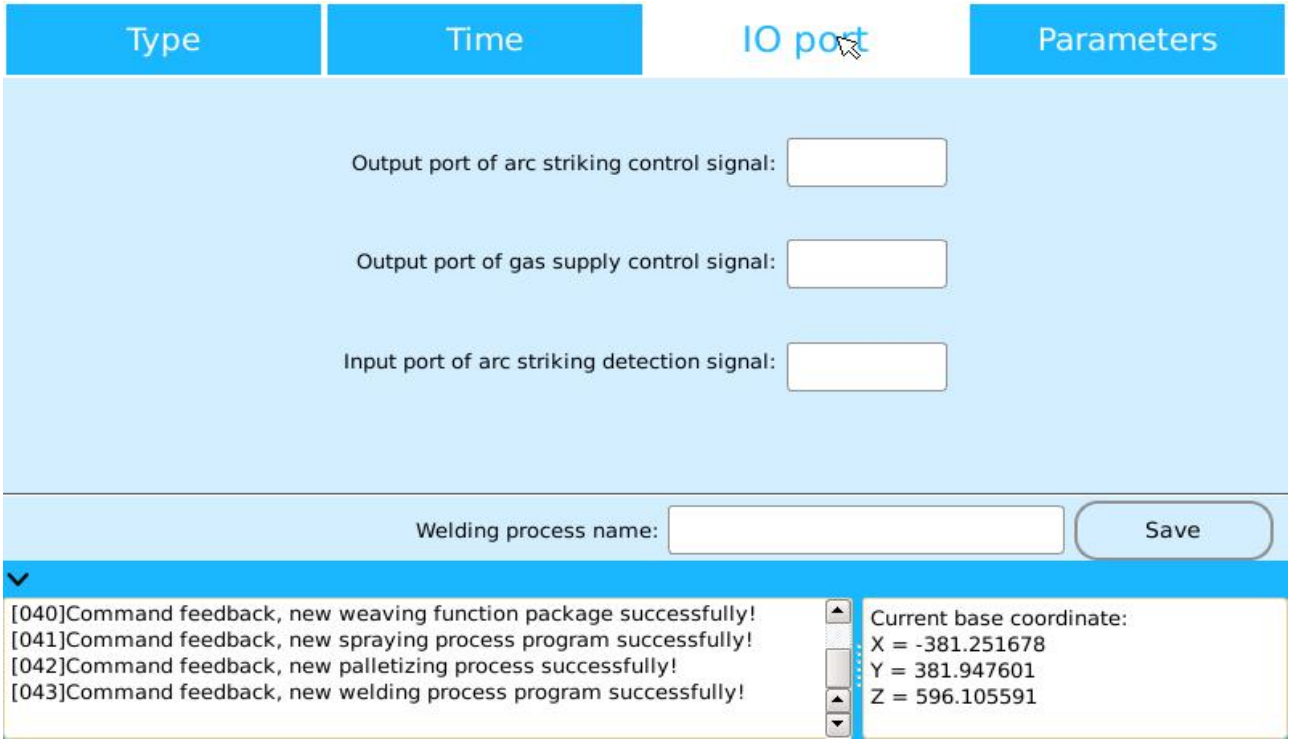


Figure 8.15 "welding procedure" IO port settings interface

According to the welding machine instructions to find "arc starting signal control port", "gas supply signal control port" and "arc starting detection signal feedback port", respectively to distribute corresponding to their I/O distribution table.

(4) Set "welding parameters": The "welding parameters" set by the system are related to the "welding machine type" selected. Taking the "Megmeet" welding machine as an example,"current calibration" and "voltage calibration" are required first, and then parameters are set according to the welding machine specifications and actual conditions: "Empty-load current", "empty-load voltage", "arc starting current", "arc starting voltage", "welding current", "welding voltage", "arc retraction current", "arc retraction voltage", "anti-viscose current" and "anti-viscose voltage", as shown in Figure 8.16.

Calibration of current: First, the "current simulation output port" input "0" (if the display is not current but voltage, can be adjusted with channel 1), click [Calibrate] button to enter the "current check" interface. The current value corresponding to the input voltage of "1" and the current value corresponding to the voltage of "6", click the "confirm" button, and the color of "display light" will be changed to "green" after "current calibration" is completed.

Voltage Calibration: First, the "voltage simulation output port" input "1" (if the display is not voltage but current, can be adjusted with channel 0), click [Calibrate] button to enter the "voltage check" interface. The voltage value corresponding to the input voltage of "1" and the voltage value corresponding to the voltage of "6", click the "confirm" button, and the color of "display light" will be changed to "green" after "voltage calibration" is completed.

According to the requirements of the process, complete setting of empty-load current, empty-load voltage, arc starting current, arc starting voltage, welding current, welding voltage, arc retraction current, arc retraction voltage, anti-viscose wire current and anti-viscose wire voltage and other parameters, click [Save] button to complete the creation of welding procedure program.

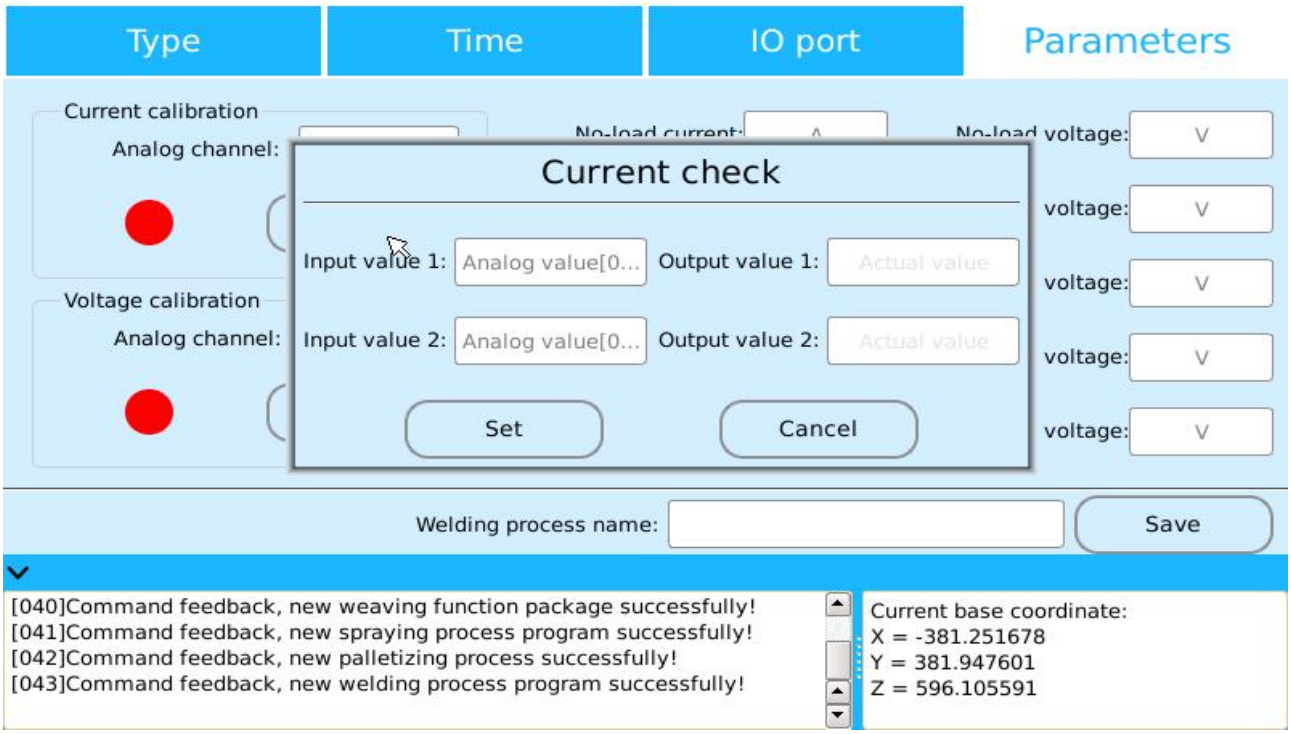


Figure 8.16 Settings interface for “welding procedure”

8.3.3 Application of Welding Procedure Program

The creation of a successful welding procedure will be stored in the stack file of the process pack in the program management. In the welding file, the welding procedure can carry out file save as, details and edit 3 operations.

File Save As--through the “File Save As” operation, you can back up the selected “welding procedure”program.

Details--can be accessed through “details” operation to the “create” interface of the “welding procedure program” for “enquiry” and “modification”.

Edit--select the “edit” button to delete the welding procedure program.

When “create program”, the “enable welding” and “disable welding” task types of “process instruction” will be “applied” to the “welding procedure”program and the “curve” speed between “enable” and “disable” welding procedure is “absolute speed”.

In the system “automatic” mode interface, when the operation contains a “welding procedure” program, which can be operated by pressing the “menu” membrane button of the “demonstrator”, selecting the “process enablement” function to carry on the “Non-Enable welding procedure” operation of the “welding procedure” program, that is, the “welding procedure” program in the non-running program.

In the state of "manual" mode of the system, the "manual wire feeding" operation of "Jin Rui" welding machine brand can be carried out by pressing the "menu" of "demonstrator" and selecting the function of "wire feeding of welding machine".

When using "welding procedure", there is also "swing arc" function inside. For the setting of "swing arc function", please refer to "swing arc function" in chapter 7.

8.4 Stamping Procedure

Stamping procedure refers to the process of stamping various sheet materials by using moulds and stamping equipments through robots.

8.4.1 Creation of Stamping Procedure Program

As shown in Figure 8.1, select the [stamp] icon in the “process pack” interface and enter the creation interface of the “stamping procedure”, as shown in Figure 8.17.

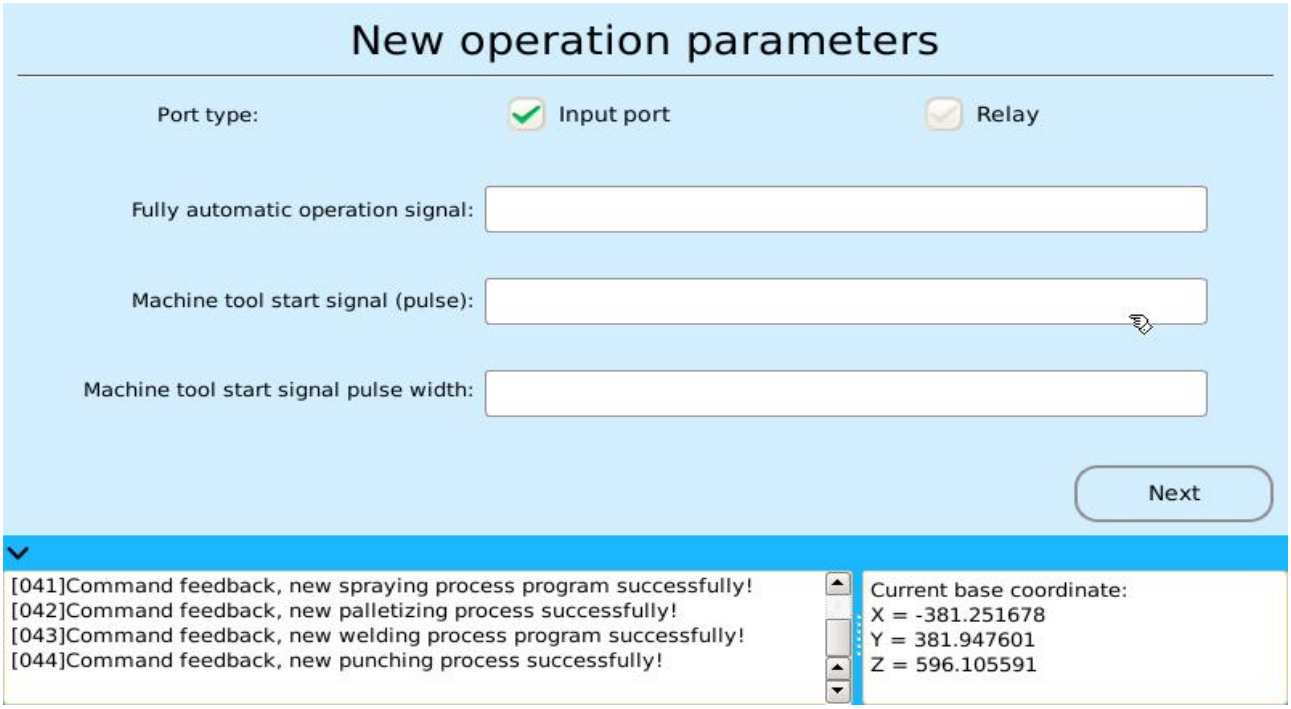
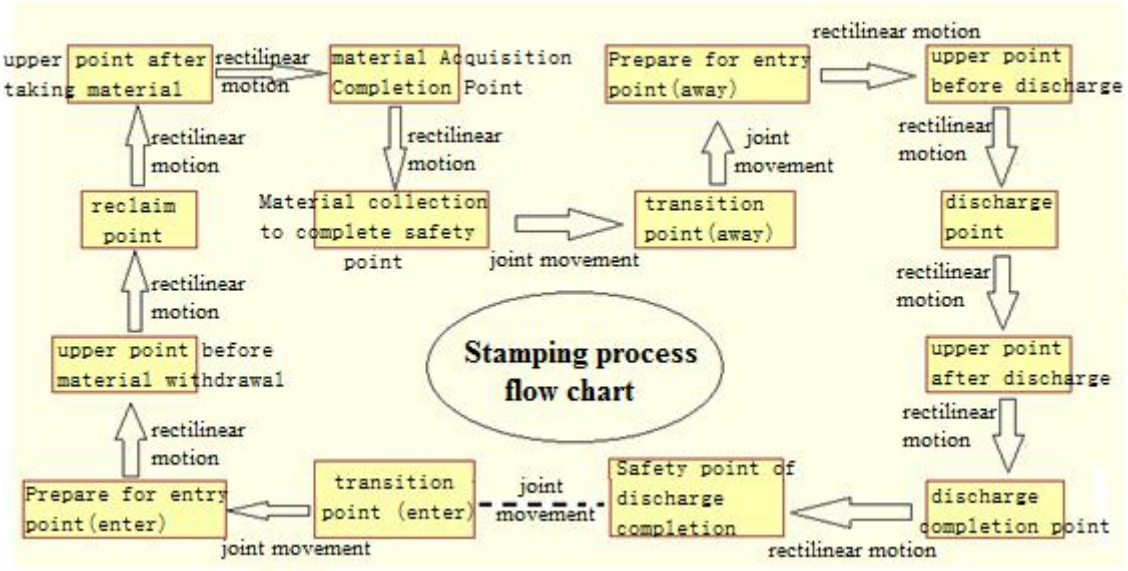


Figure 8.17 stamping procedure Creation Interface

The system “stamping procedure” program is divided into two parts: the “pick-up materials” and “release materials”, and the specific “Stamping Process” are as follows.



As shown in the stamping procedure flow chart, creation interface in the “stamping process”, through the [next step] button and [last step] button to create a stamping procedure interface, which sets the key points such as transition point, feed point and material release point, and waiting parameters, such as waiting signal, control signal, motion speed, etc. Click [Finish] button, as shown in Figure 8.18, complete the creation of the “stamping procedure” and convert it to the corresponding stamping procedure “basic program”, represented as “xx_pun_gen”.

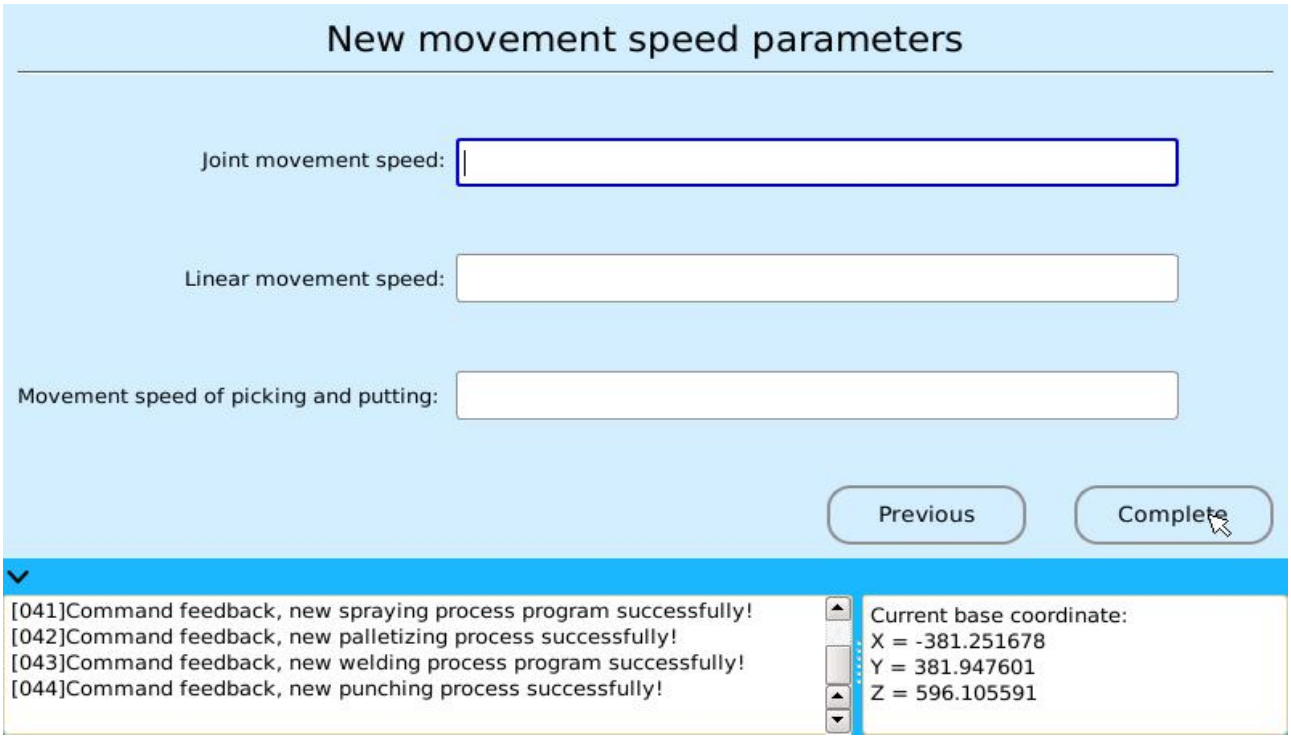


Figure 8.18 “Stamping procedure” save Interface

The “transition point” in stamping procedure can be one or more, such as “P1”, “P2”, “P3”, etc., the curve tracks are “P1-P2-P3”, and the motion types between “transition points” are all “joint motion”.

In stamping procedure, when “picking-up materials”, “control signal trigger timing” can choose between two different position “points”, i. e. “point above materials” or “materials pick-up point”.

Waiting signals in the stamping procedure include 2kinds: waiting for input signals and waiting for relay signals, which can be flexibly set as “and”, “or” event relationships, depending on the actual situation.

In the “material pick-up” process, there is a “judging from material pick-up results” function, that can be “repeated feed” when the material pick-up “failed”, user can pick up materials repeatedly, and if the “pick-up” is completely “failure”, an output “material pick-up failure alert signal” can be sent to interrupt program.

8.4.2 Application of Stamping Procedure Program

The creation of a successful stamping procedure program will be stored in the stamping file of the process pack in the program management. In the stamping file, the stamping procedure program can carry out “create”, “file save as”, “details” and “edit” 4 operations.

Create--Click [Create] button to convert selected “stamping procedure”program to “basic program”.

File Save As--through the “File Save As” operation, you can back up the selected “stamping procedure”program.

Details--can be accessed through “details” operation to the “create” interface of the “stamping procedure” program for “enquiry” and “modification”.

Edit--Select the “edit” button to delete the stamping procedure program.

When the “stamping procedure” program is created, first save it as “procedure program”, then select “save” to convert to the corresponding “basic program”.

9 Auxiliary Function

For a variety of different application scenarios, the system provides a series of auxiliary functions, so that users can better use and improve programming efficiency.

9.1 port configuration function

Some special functions can be configured with “IO port” in the system. In the “demonstrator” login main interface (shown in Figure 2.4), select the path: [configuration]--[terminal configuration] to enter the system “port configuration” interface. The “port configuration function” of the system is divided into two types: the “functional port” configuration and the “indicating port” configuration.

◆ Functional port configuration

In the “port configuration” interface, click the [function port] icon and enter the “functional port” configuration interface, as shown in Figure 9.1, which provides 8 special functions of “emergency stop”, “switch mode of work”, “continue”, “pause”, “zeroing”, “run to the starting point”, “enable program” and “disable program”. These functions can be configured arbitrarily through the “I/O input port”.

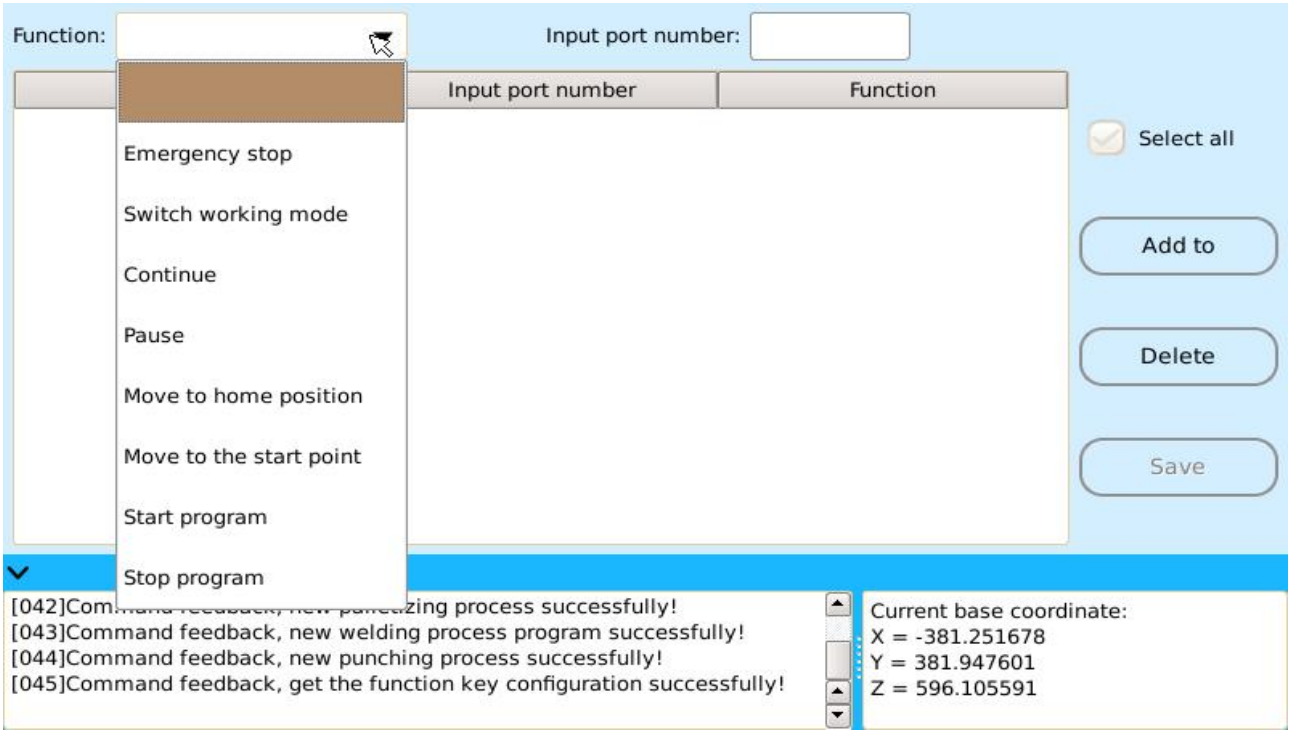


Figure 9.1 “functional port” configuration interface

The same kind of special function allows different I/O input port configurations, but the same I/O input port can only configure a special function; If I/O input port configuration is special function, it can not be used as a common I/O input port, only after the "I/O input port" configuration special function is "deleted", "I/O input port" can become a normal I/O input port; When configuring the function port, whether it's a “add” or a “delete”, you end up configuring the “functional port” by clicking [Save] button.

The use of IO input port configuration “emergency stop” is somewhat different from other “special functions”: When the "emergency stop" function is configured, the "logic" relationship is "normally closed", that is,"valid" when the IO input port is low potential "0"; IO input port is valid at high potential "1" when other "special functions" are configured.

◆ Indication port configuration

In the “port configuration” interface, click [Indication port] icon to enter the “indicating port” configuration interface, as shown in Figure 9.2. The system provides 3 special functions of “operation indication”, “servo state” and “alert condition”, which can be configured arbitrarily through the “I/O output port”.

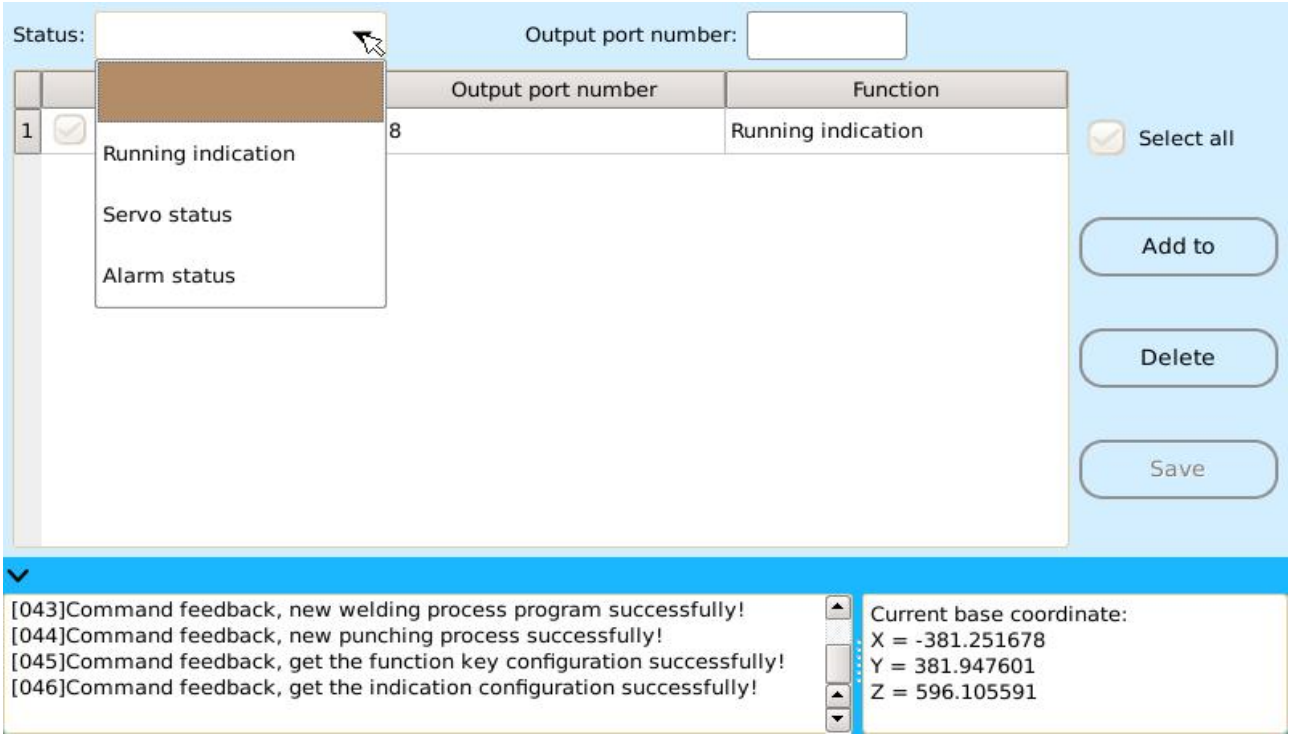


Figure 9.2 “indicating port” configuration interface

The configuration format of "indicating port" is basically the same as that of "function port". After the IO output port is configured with special functions, the "save" button must be clicked to indicate the successful configuration.

9.2 Basic Port Operation

After the system is successfully logged in, press the "menu" membrane button of the "demonstrator" and select the "basic port operation" function to enter the "basic port operation" interface, as shown in figure 9.3.

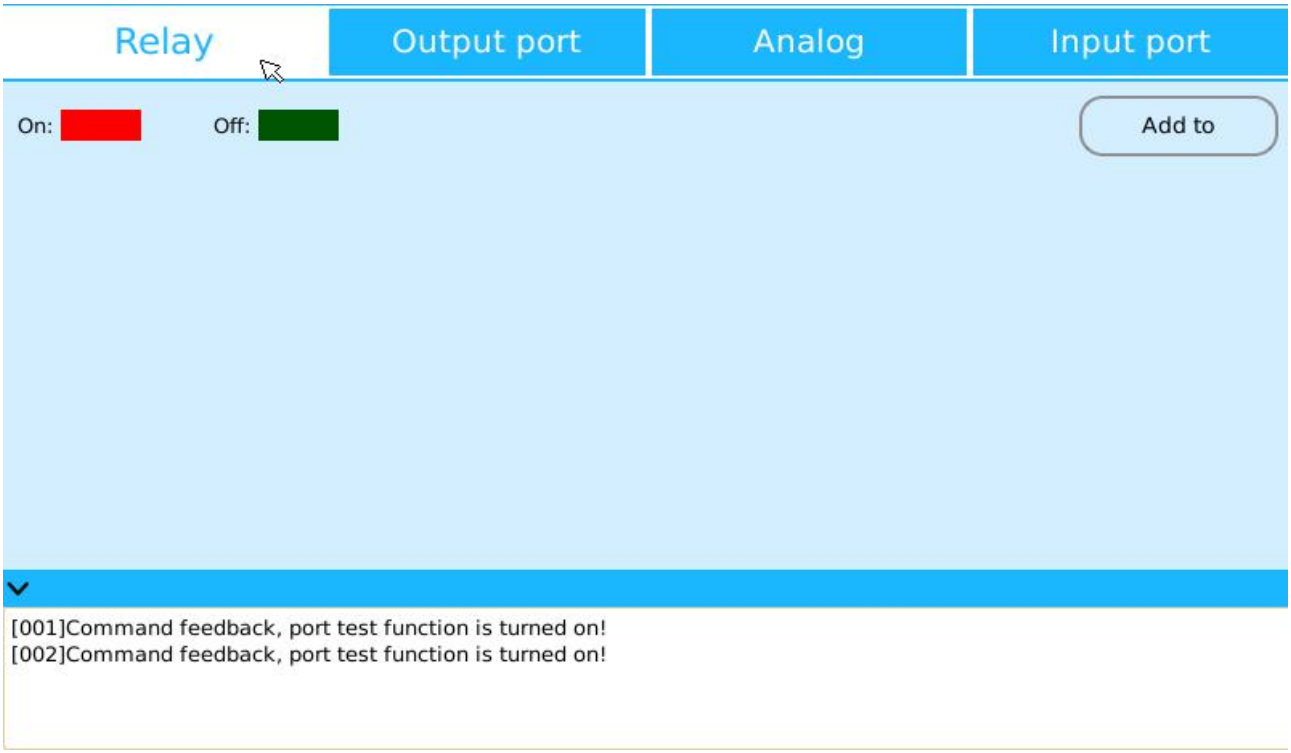


Figure 9.3 “basic port operation” interface

Once again press the “menu” membrane button, set the “enable to monitor” state, user can execute “monitor relay port”, “set output port”, “set the simulation quantity” and “monitor input port” 4 operations in the “base port operation” interface.

◆ Monitor relay port

As shown in Figure 9.3, set the “enable to monitor” status, click [Add] button, “add a single or more relay” prompt box will pop up, enter the “relay port” that needs to be monitored, click [confirm] button to complete the “add” on the “relay”. When multiple relays are added at the same time, the serial number is interlinked with underscore.

After completing the “add” of “relay”, “state monitoring”, “status settings” and “delete” operation of these “relay” can be carried out.

◆ Setting output port

As shown in Figure 9.3, when setting enable monitoring state, after selecting “set output port”, user can carry out “state monitoring” and “status setting”, as shown in Figure 9.4. The “status setting” operation indicates that "send high level" and "send low level" can be manually performed on the "output port".

In the interface, after "check" on "details" function,"remarks" information can be added to each "output port".

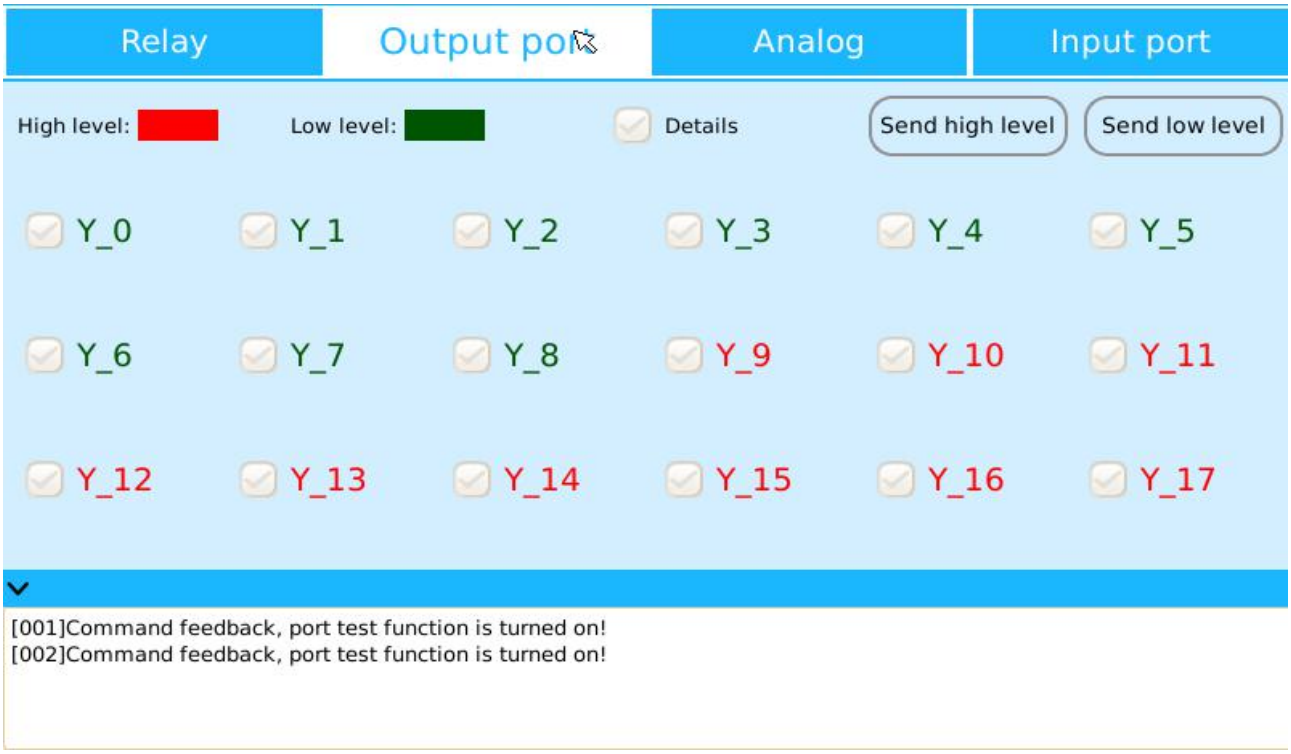


Figure 9.4 “set output port” interface

◆ Setting of analog quantity

As shown in figure 9.3, under the state of "enable monitoring" and after selecting "set simulation quantity", "simulation value" output can be set to the 4-channel "simulation quantity output channel" of the system, as shown in figure 9.5.

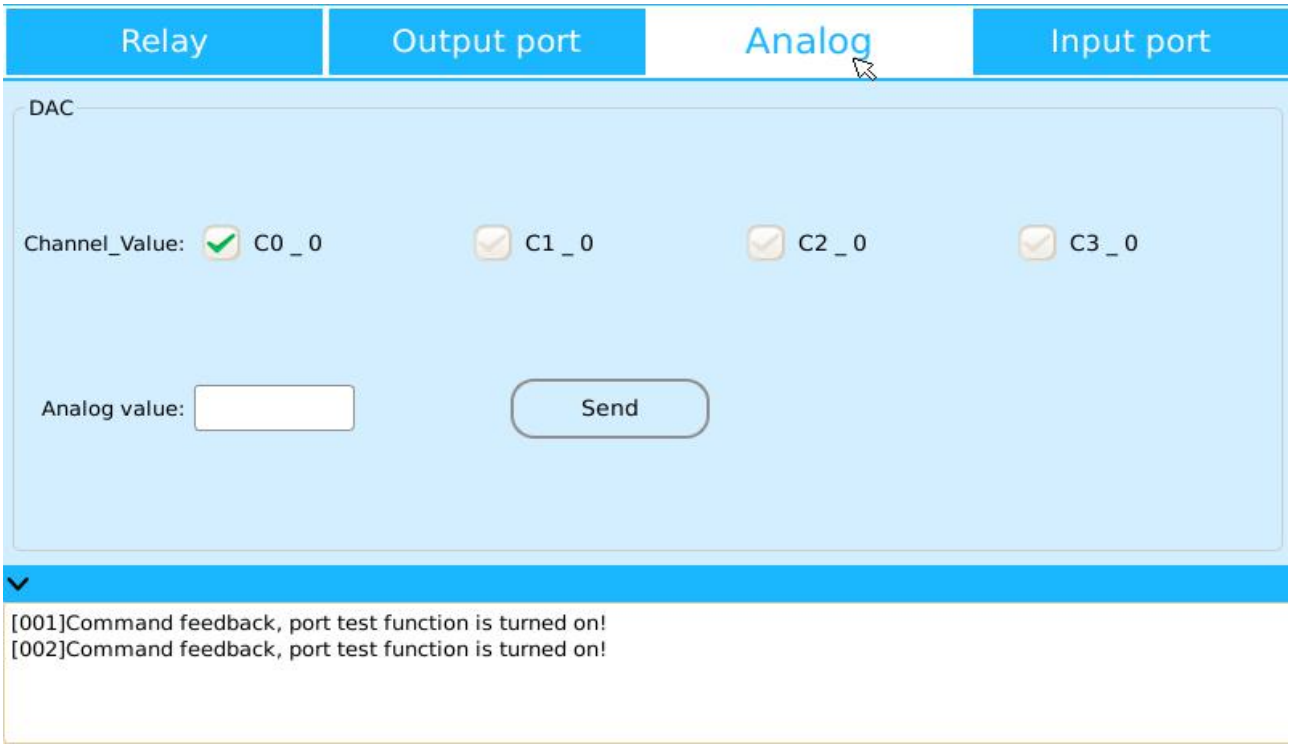


Figure 9.5 “set simulation quantity” interface

The system provides four channels of “simulation quantity” output for “0”, “1”, “2” and “3.4. The output

scope of the “simulation value” is [0, 12V]. The specific setting steps are: First select the “simulation quantity” output channel, set the “simulation value”, click [Send] button to complete the “simulation output” setting.

◆ Monitoring of input port

As shown in Figure 9.3, when setting enable monitoring state, after selecting “monitor input port”, user can carry out “state monitoring” of system “IO input port”, as shown in Figure 9.6.

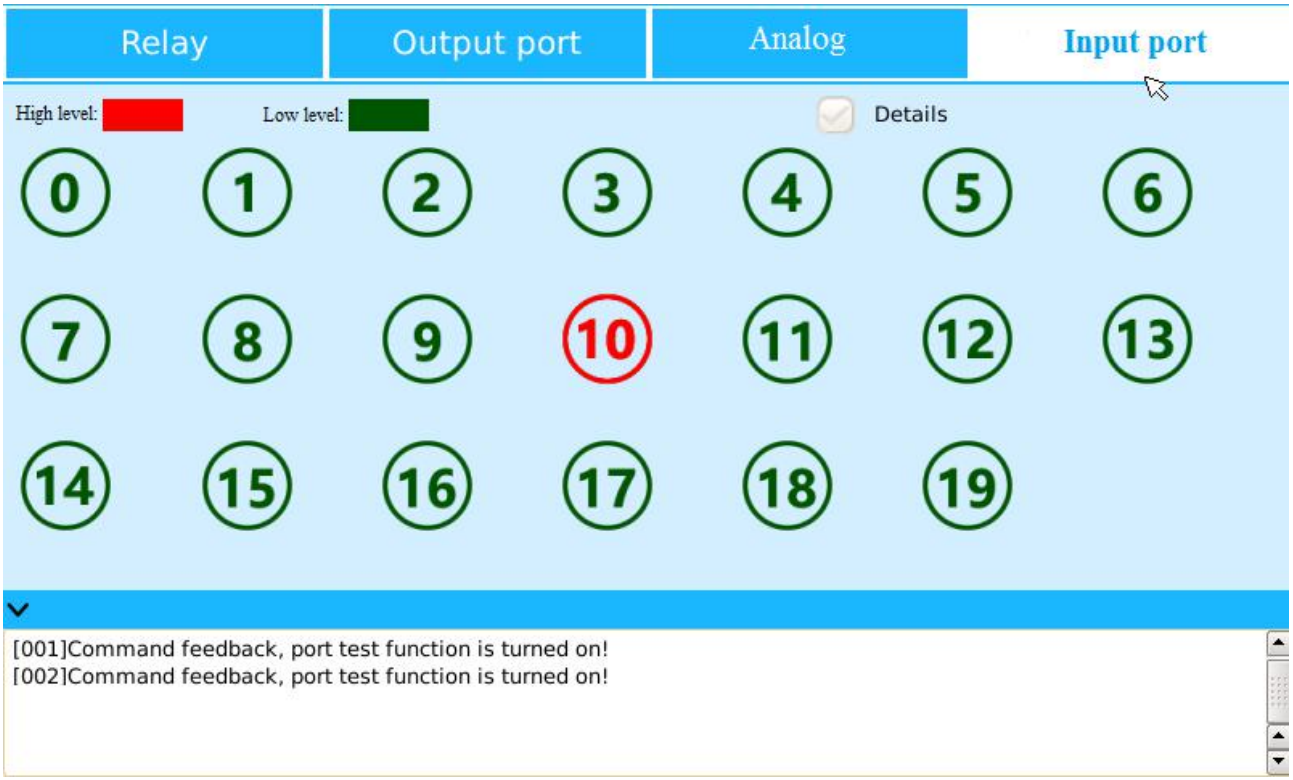


Figure 9.6 “monitor input port” interface

In the interface, after "check" on "details" function,"remarks" information can be added to each "input port".

When IO expand module outside the system, use can select the display extension port by pressing the “menu” membrane button, and then the IO input port, IO output port and simulation output channel in IO extension module can be monitored and set up state operation. “

9.3 Other configuration

In the “demonstrator” login main interface, select the path: [Configuration]--[Other configuration], click [other configuration] icon to enter the “Other configuration” interface, as shown in Figure 9.7, including “emergency stop configuration”, “switch-on and switch-off volume configuration”, “brake anomaly detection”, and “network configuration” 4 special features that users can configure on their own.

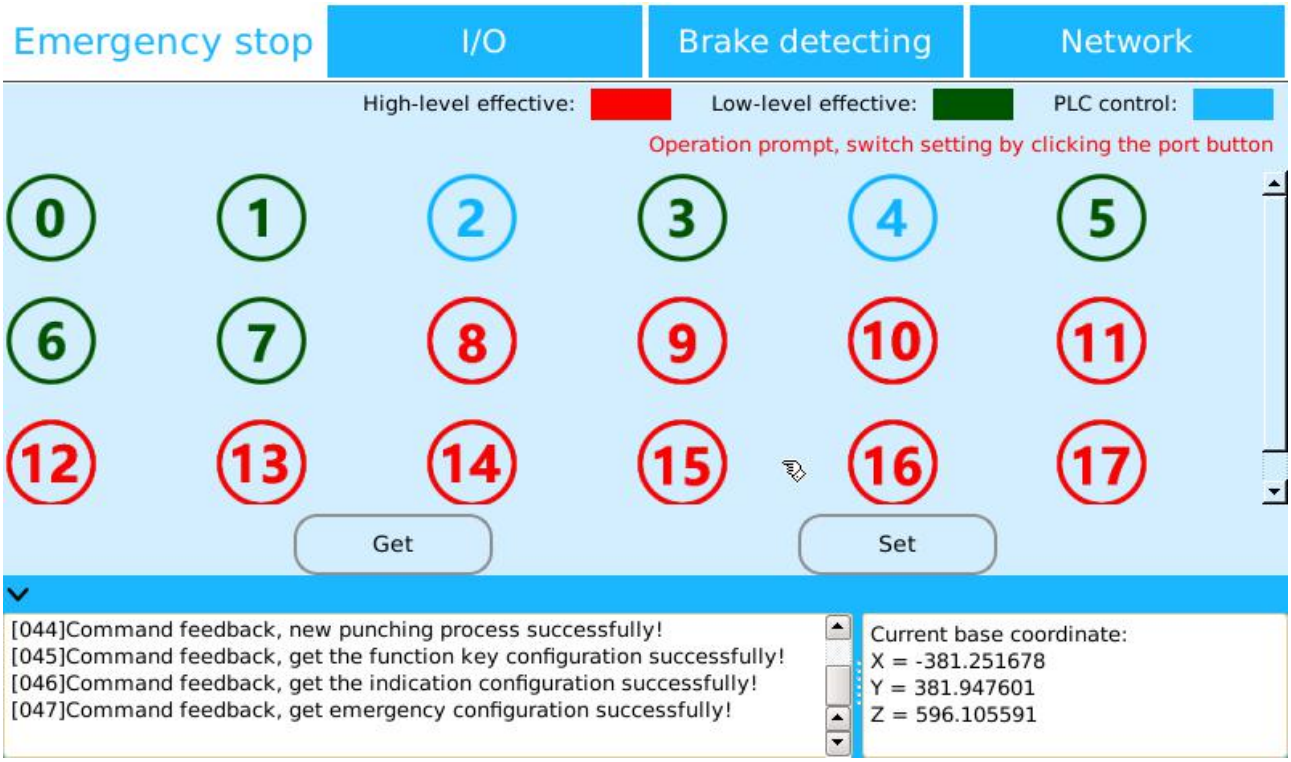


Figure 9.7 “Other configuration” interface

◆ Urgent stop configuration

The system “emergency stop configuration”, when the system receives an external “emergency stop” command, configures the output state for the “I/O” output port, as shown in Figure 7.7. The system provides three ways of setting and distinguishes them from different colors: "High level effective" red,"low level effective" black and "PLC control" blue, through the "click the port button" to switch different states.

System “emergency stop configuration” Operation Steps: First, select the serial number of "IO output port" according to the actual situation and "click the port button" to switch the state. Finally, click the "set" button to complete the "emergency stop configuration".

The initial state of the system for "emergency stop configuration" is "low level effective" by default, that is, when the controller receives the "emergency stop" command, the IO output port outputs "low level".

◆ Switch-on and switch-off volume configuration

As shown in Figure 9.8, in the switch-on and switch-off volume configuration interface, select "check box" before "auto load base program runtime parameters"., that is, switch-on and switch-off volume configuration is successful, indicating that in the following system operation, the parameters set in the automatic mode,(such as speed ratio, motion mode, and motion frequency) will load automatically. The specific form is that when "manual mode" is switched to "automatic mode", the parameters set will be "saved" and remain the parameters set last time.

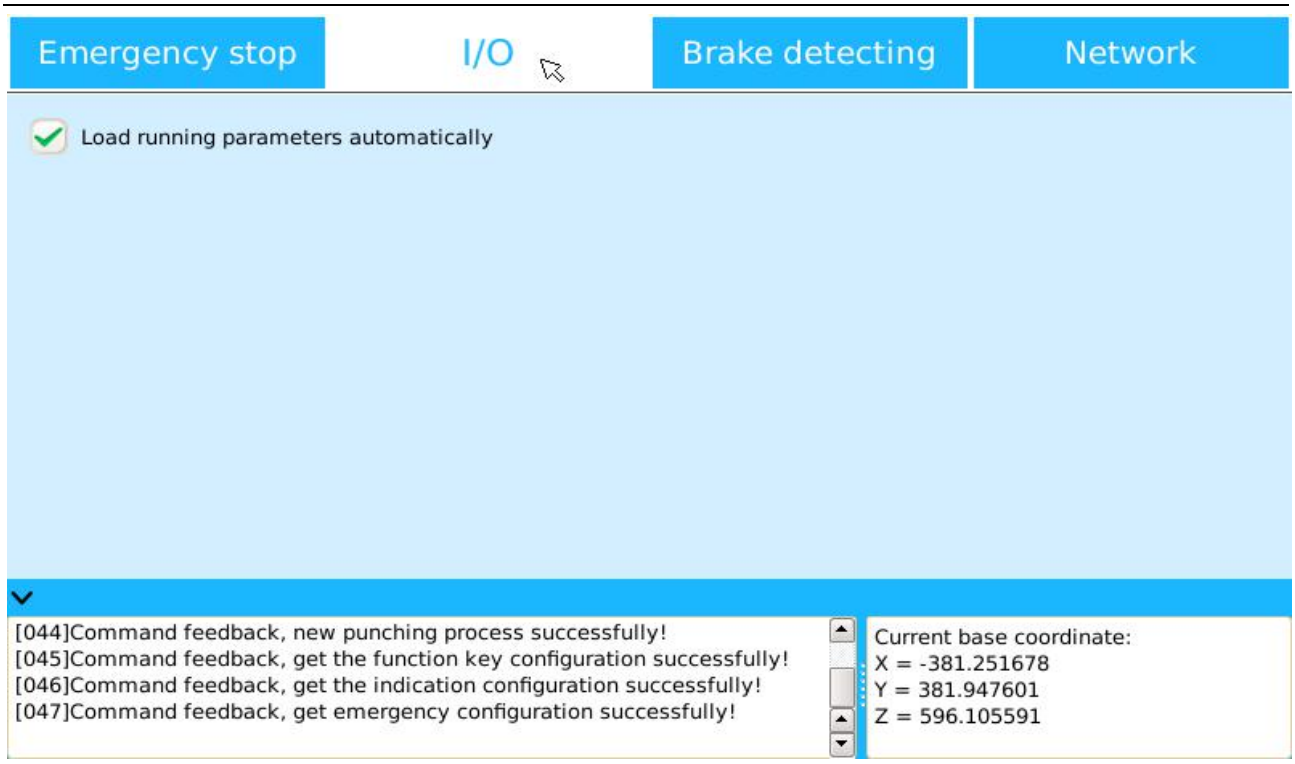


Figure 9.8 “switch-on and switch-off volume configuration” interface

◆ Brake anomaly detection

The system can set the state of "brake detection" for each joint, as shown in FIG. 9.9. Check the "check box" after the serial number of each joint, and click the "set" button to complete the configuration of "brake anomaly detection".

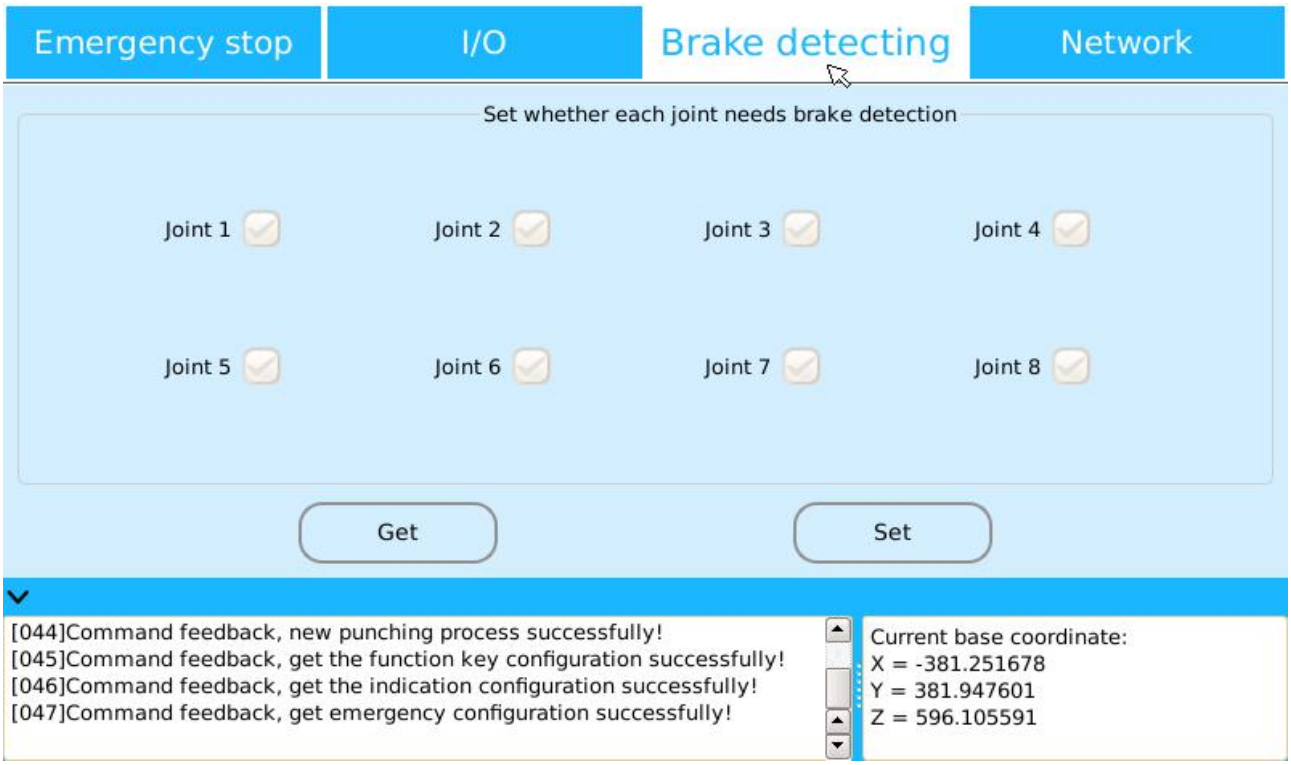


Figure 9.9 configuration of “brake anomaly detection”

◆ Network configuration

As shown in Figure 9.10, through the network configuration of the system's IP address, port number, sub-net cover and gateway configuration, the MODBUS protocol or PROFIBUS protocol allows the system to communicate with external settings.

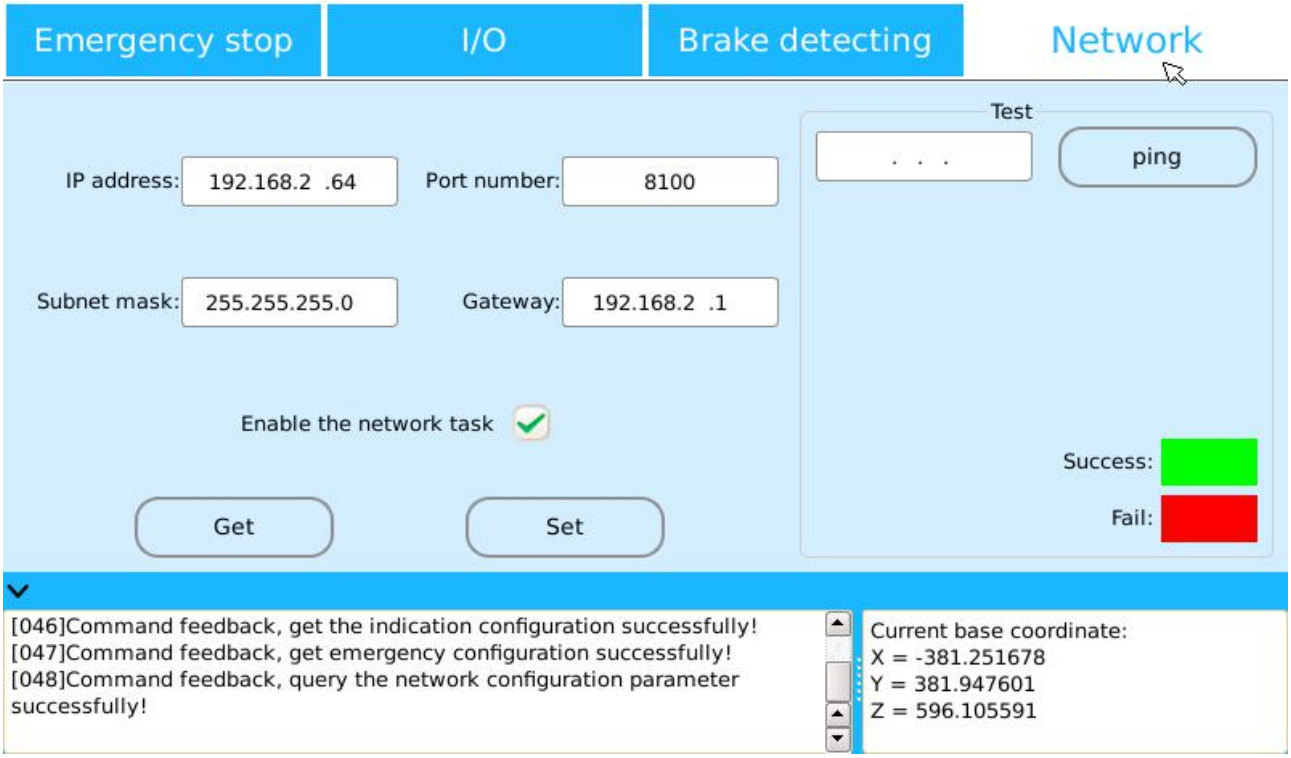


Figure 9.10 “network configuration” interface

After setting all “parameters”, click [settings] button, check“network task enabling”, complete the system’s “network configuration”. It can also be connected via the wire to test whether communication is successful.

9.4 Regional Settings Function

In the “demonstrator” login main interface, select the path: [motion]--[region settings], click [region configuration] icon to enter the “Regional Settings” interface, as shown in Figure 9.11, including two regional settings for “safe area” and “interference area”.

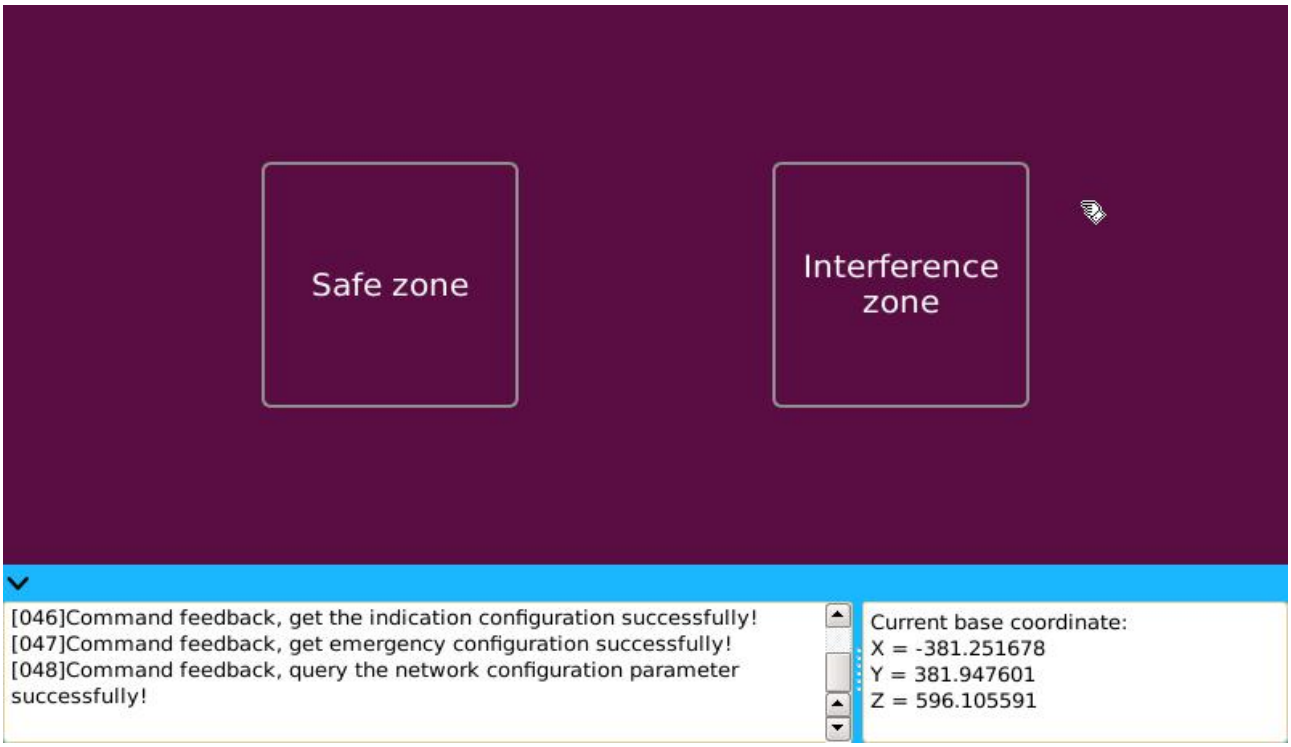


Figure 9.11 “Regional Settings” interface

9.4.1 Safe Area Settings

On the “Regional Settings” interface, click the [safe area] icon and enter the “safe area” settings interface, as shown in Figure 9.12. The “safe area” of the system is a cube space composed of “diagonal line” formed by “starting point” and “terminal point”, divided into two kinds: “boot safe area” and “zeroing safe area”. The system can only carry out a series of operations in the “safe area”, such as “program start-up”, “zeroing” operation.

◆ Enable safe area settings

As shown in Figure 9.12, set the “boot safe area”: After setting the “vector ordinal number”, “starting point”, “terminal point” and “enable”, click [Save] button to complete the settings of the “boot safe area”.

Vector Sequential Number: There are 10 vector ordinals in the safe area of the system, that is, the maximum number of boot safe areas can be set is 10, the relationship between different regions is or, that is, the location is only in any part of those enabling safe areas, all of which belong to the enabling safe areas.

Starting point:"Safety area" three-dimensional space "diagonal" starting point".

Terminal point: The "terminal point" of the three-dimensional space "diagonal" in "safety area" and the "diagonal line" formed with the "starting point" constitute the "safety area" three-dimensional space.

Enable: Select the “enable” option to indicate that the “safe area” is valid.

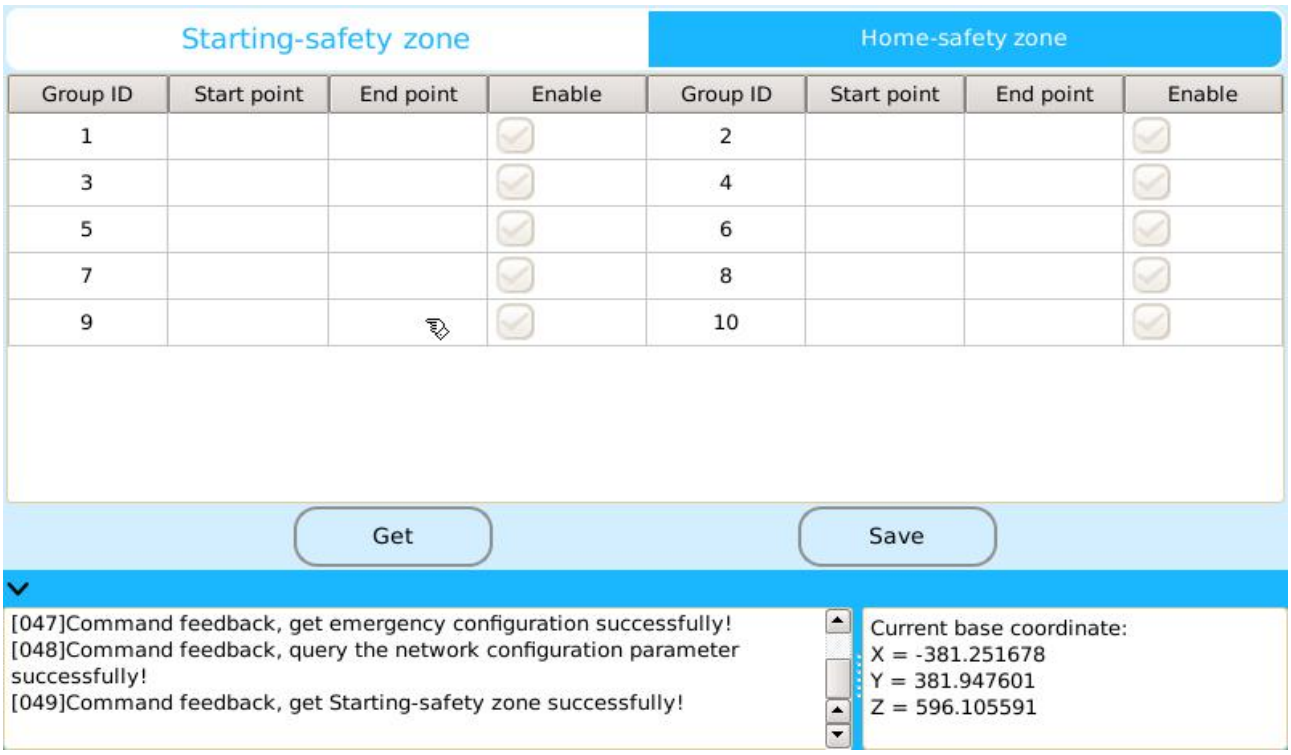


Figure 9.12 set “safe area” interface

The system “boot safe area” represents a “safe interval” for “enabling” program, that is, only if the current position at the end of the machine is in this “enable safe area” to “enable” the program, otherwise it will prompt "Alert:" Error Feedback, the current location is not in the safe area!”.

◆ Zeroing safe area settings

Setting “zeroing safe area” is the same as that of the “boot safe area”, also by respectively setting up the “vector ordinal number”, “starting point”, “terminal point” and “enable”, “save” to complete the setting of the “zeroing safe area”.

The system “zeroing safe area” represents a “safe interval” for the “zeroing” operation, that is, only when the current position at the end of the machine is in this “zeroing safe area” to complete the “zeroing” operation, otherwise it will prompt "Alert:" Error Feedback, the current location is not in the safe area!”.

If the “boot safe area” and “zeroing safe area” are not set, a “program start-up” or “zeroing operation” can be carried out by default for all regions (mechanical ranges) as “safe area”.

9.4.2 Interference Area Settings

In the “Regional Settings” interface, click the interference area icon to enter the “interference area” settings screen, as shown in Figure 9.13. Setting “interference area” has no effect on the running track of the system curve, but it can be programmed by PLC to interact with the program. The “interference area” of the system can be divided into 3 kinds: “spatial interference”, “point interference” and “axial interference”.

The “interference area” set by the system in PLC editing uses the “I” type to indicate that the different numbers represent different interference intervals: The system designed the 20 “point” interfering groups (currently 4 open groups) and the serial number in the “I” type is represented by “0-19”. The 20 “space” interfering groups (currently 10 open groups) and the serial number in the “I” type is represented by “20-39”; 8 groups of the “axis” interferes and the serial number in the “I” type is represented by “40-47”.

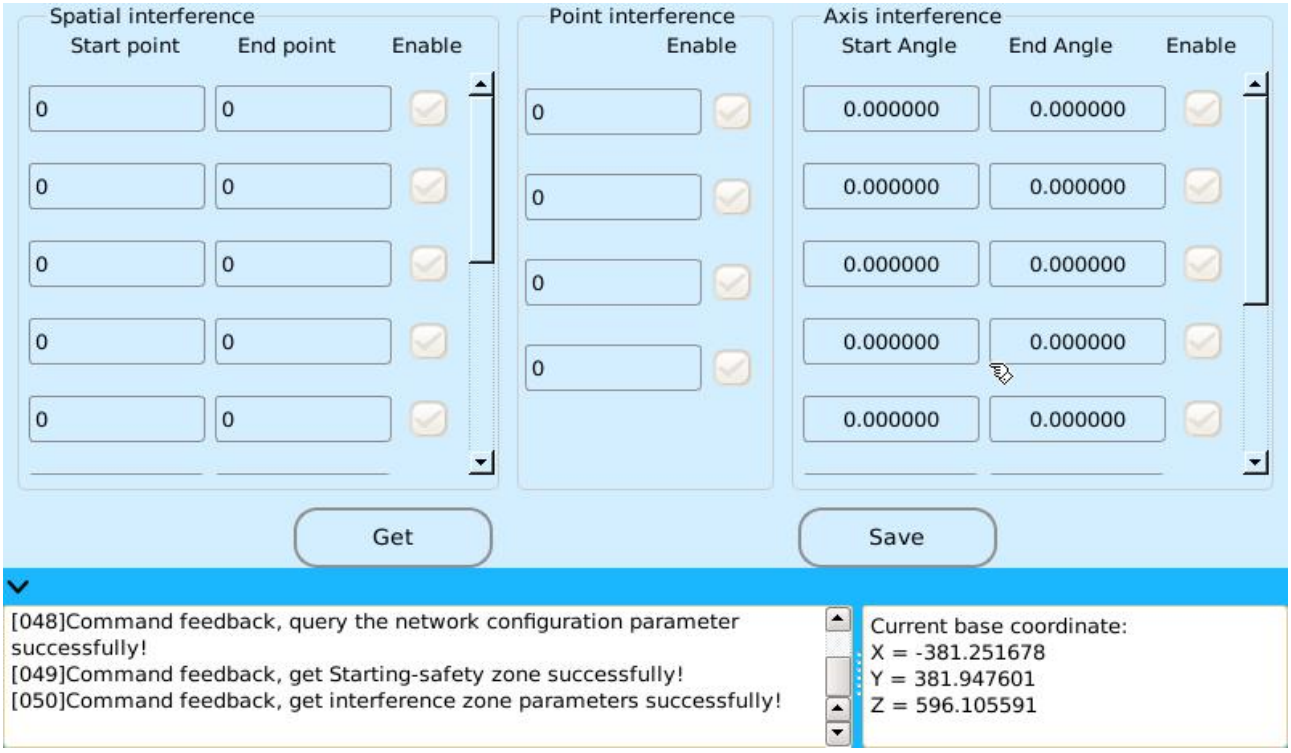


Figure 9.13 set the “interference area” interface

◆ Spatial interference setting

The space interference interval of the system refers to a space body generated by the diagonal line at the beginning point and terminal point,(which does not contain the starting point and the terminal point, the surface generated by the base coordinate system), and in PLC editing, it is represented with I20-I39.

As shown in Figure 9.13, set the “spatial interference”: After setting the “starting point”, “terminal point” and “enable”, click [Save] button to complete the settings of the “spatial interference”.

Starting point: "Spatial interference" three-dimensional space "diagonal" starting point".

Terminal point: The "terminal point" of the three-dimensional space "diagonal" in "spatial interference" and the "diagonal line" formed with the "starting point" constitute the "safety area" three-dimensional space.

Enable: Select the “enable” option to indicate that the “spatial interference” is valid.

◆ Point interference setting

The “point interference” of the system means that the machine enters the interference interval when running to the “point”, indicated by I0-I19 in the PLC editing.

Set the “point interference”: After setting the interfering “point”, select the “enable”, click [Save] button to complete the “point interference” setting.

Axis interference setting

The “axial interference” of the system means to set the interfering area of the “axis”, define the operating range of the “axis”, indicated by I40-I47 in the PLC editing.

Set the “axial interference”: After the “starting angle”, “terminal angle”, and “enable” of each “axis” interference section are set, click [Save] button to complete the “axial interference” setting.

Starting Point angle: Set the “starting point” angle of the “axial interference” interval.

Terminal point angle: Set the “terminal point” angle of the “axial interference” interval to form the “axial interference” interval with the “starting point angle”.

Enable: Select the “enable” option to indicate that the “interference area” is valid.

After setting up the “Interference interval”, whether manual demonstrating or program running, the system will detect it as long as it enters the “Interference interval”.

9.5 Program reservation function

When the system is running a "program", it can be connected to the next one or more "programs" for "reservation". When the running program is over, according to the order of "reservation" program, the "program reservation" function of the system will be started immediately. This is the “program reservation” function of the system

After logging into the system and entering the main interface of "demonstrator" successfully, you can go through the following path: [configuration]--[terminal configuration]--[program reservation], click [program reservation] icon to enter the “program reservation” creation interface, as shown in Figure 9.14, in the interface user can “set” and “edit” reservation program.

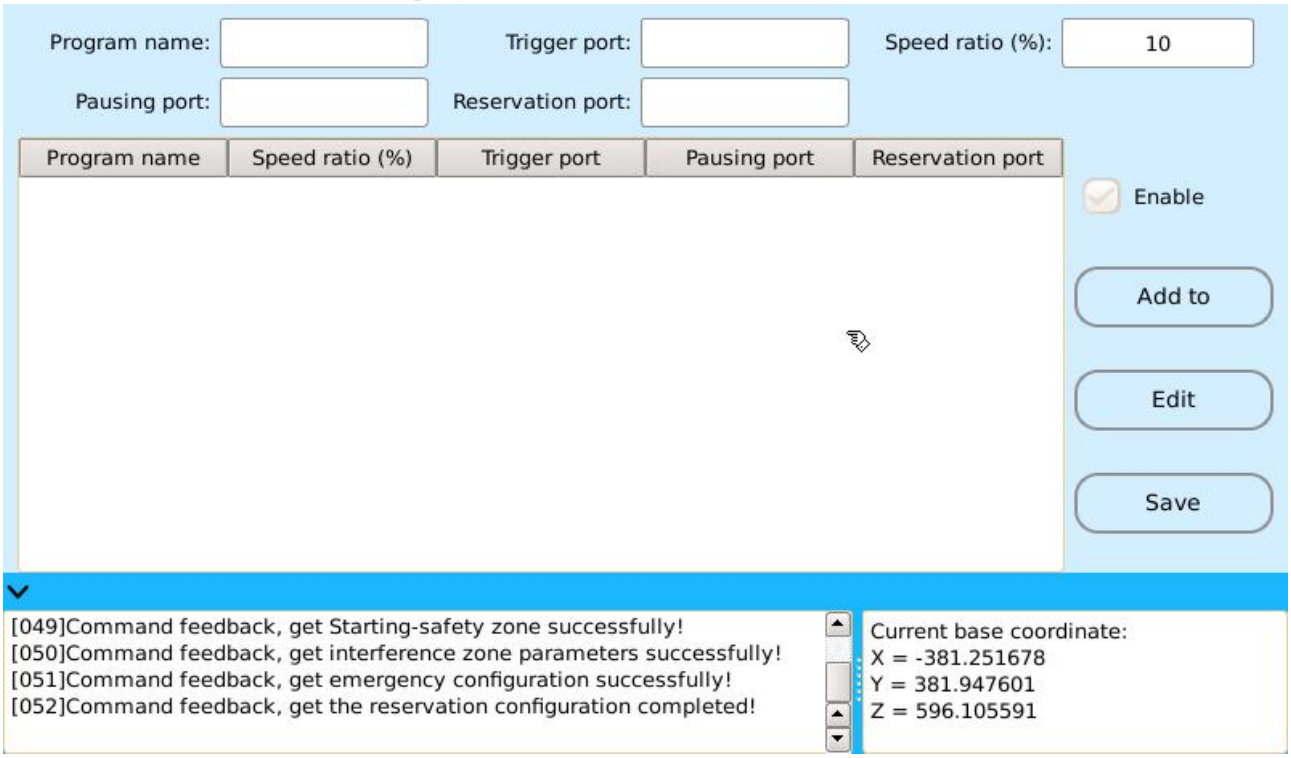


Figure 9.14 set the “reservation program” interface

9.5.1 Set Reservation Program

As shown in Figure 9.14, parameters such as the “reservation program name”, “trigger input port”, “global speed ratio”, “stop indication port”, “reserve Indicator Port”, and “enable” are required to be set in the “program reservation” creation interface.

Reservation program name: Select the “basic program” name for the “reservation program”.

Trigger input port: Set the “IO input” port number that triggers the “reservation program” and the “IO input” port number cannot coincide with the port number of the “functional configuration”.

Global speed rate: Set the speed ratio of the “reservation program”, the unit is “%”, the value is an integer "1-100".

Stop indicating port: Set the “IO output” port number that stops the “reservation program”. When the "reservation program" is halfway "paused", the "stop indicating port" outputs a "high level";If the reservation program continues to run, stop indicating port outputs a low level.

Reservation Indicator Port: Set the “IO output” port number after the “reservation program” is successful. An "LED light" attached to the "appointment indicator port" indicates that the "LED light" will start to "flash" when

the "reservation program" has not been successfully "executed". And when "reservation program" starts "running", "LED light" changes from "flashing" to "bright" state.

Enable: Select “enable” to execute the “reservation program”.

Set the “reservation program”: Set the “reservation program name”, “trigger input port”, “global speed ratio”, “stop indication port” and “reservation Indicator Port” separately, click [Add] Button to complete a “reservation program” setting, repeat operation, after “adding” multiple “reservation programs”, select “enable”, click [Save] button to complete the settings for all “reservation programs”.

9.5.2 Application of Reservation Program

When complete the settings for the “reservation program”, user can edit the “reservation program” by clicking the [edit] button on the interface, including the “modify” and the “delete” operation on the “reservation program”.

Delete: After selecting the “reservation program”, click [Delete] button to “delete” the program.

Modification: First select “reservation program”, after modifying one or more of the following parameters such as “reservation program name”, “trigger input port”, “global speed ratio”, “stop indication port”, and “reservation Indicator Port”, and click [modify] button to “modify” the program.

After deleting or modifying a reservation program, the user needs to re-save the edited reservation programs.

The "reservation program" function of the system is to set the completed "basic program", and the number of "reservation program" is less than or equal to 10. When the system USES the "reservation program", it must be "triggered" in the "automatic mode" state to run, and "manual mode" cannot "trigger" the "reservation program" to "make a reservation".

When the "reservation program" successfully runs and "triggers" the program again, the trigger is not counted;after other reservation programs are successfully triggered, the order in which the programs are run is sorted by the time they were successfully triggered.

When successfully reserving multiple programs, clicking the "program stop" membrane button or pressing the "emergency stop" button will stop all the "reservation programs" and clear the "count", including "executing" and "not yet executed""reservation programs".

When the reservation procedure is executed, if it is in the state of "pause" and "trigger" the "input port number" of the reservation procedure again, the reservation procedure can "continue" to run. At this time, the "reservation" of the "input port number" corresponding to the reservation procedure triggered is equivalent to the "continue" of the reservation procedure. Triggering other “reservation programs” does not affect reservation.

9.6. Communication protocol settings

After logging into the system and entering the main interface of "demonstrator" successfully, you can go through the following path: [configuration]--[terminal configuration]--[communication protocol], as shown in Figure 9.15, the “communication protocol” of the system consists of both “ModBus” and “ProfiBus”.

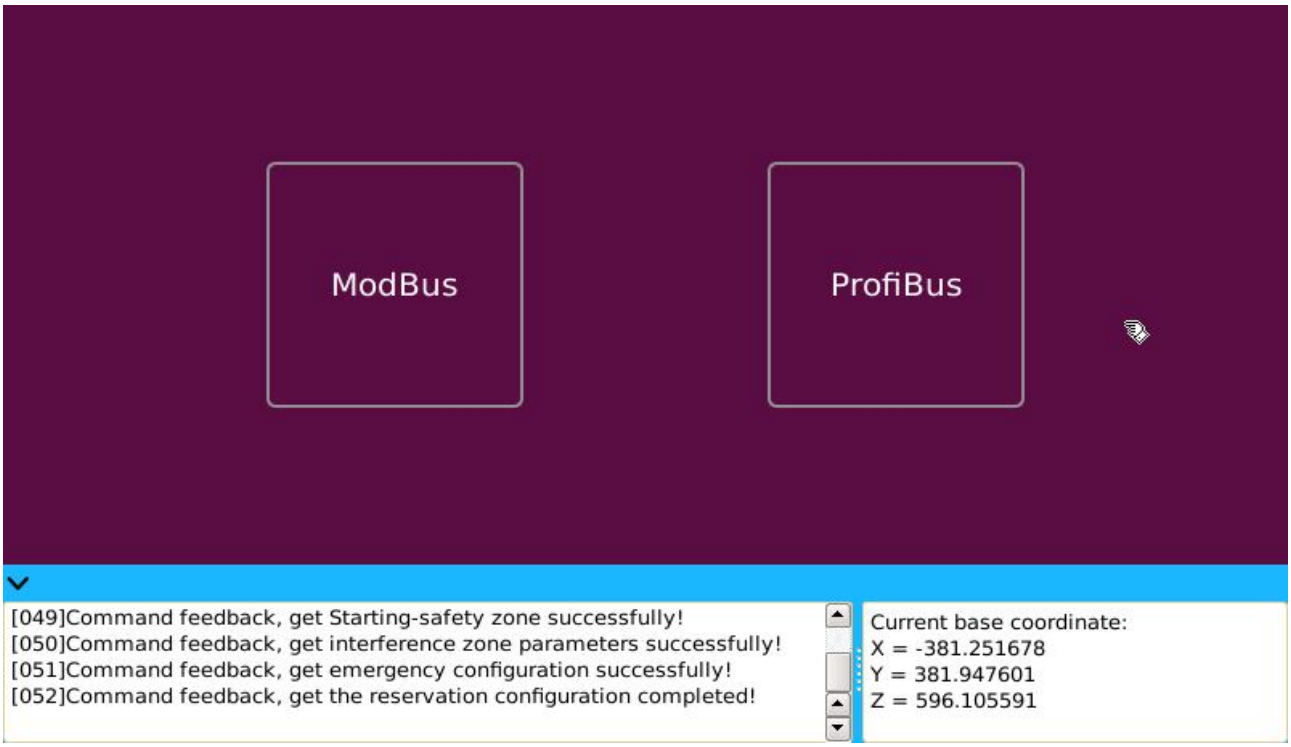


Figure 9.15 System Communication Protocol

◆ ModBus Protocol

As shown in Figure 9.15, click the “ModBus” icon and enter the “ModBus” protocol interface, as shown in Figure 9.16. When “Enable ModBus Protocol” is “checked”, “mode of work”, “interface type”, “local address”, “transmission mode”, “Baud Rate Type” and “check type” are required to be set.

Working modesThere are two kinds: “slave node” and “master node”.

Interface type: There are 4 kinds: “RS232”, “RS485”, “RS422” and “LAN”.

Native address: Set the system address.

Transmission mode: It is divided into two transmission modes: “RTU” and “ASCII”.

Baud Rate Type: There are 6 kinds: “4800”, “9600”, “19200”, “38400”, “57600” and “115200”.

Check type: There are three kinds: “odd”, “even” and “no”.

After setting the parameters to complete the “Enable ModBus Protocol”, click the Save button to complete the settings of the “ModBus Protocol”.

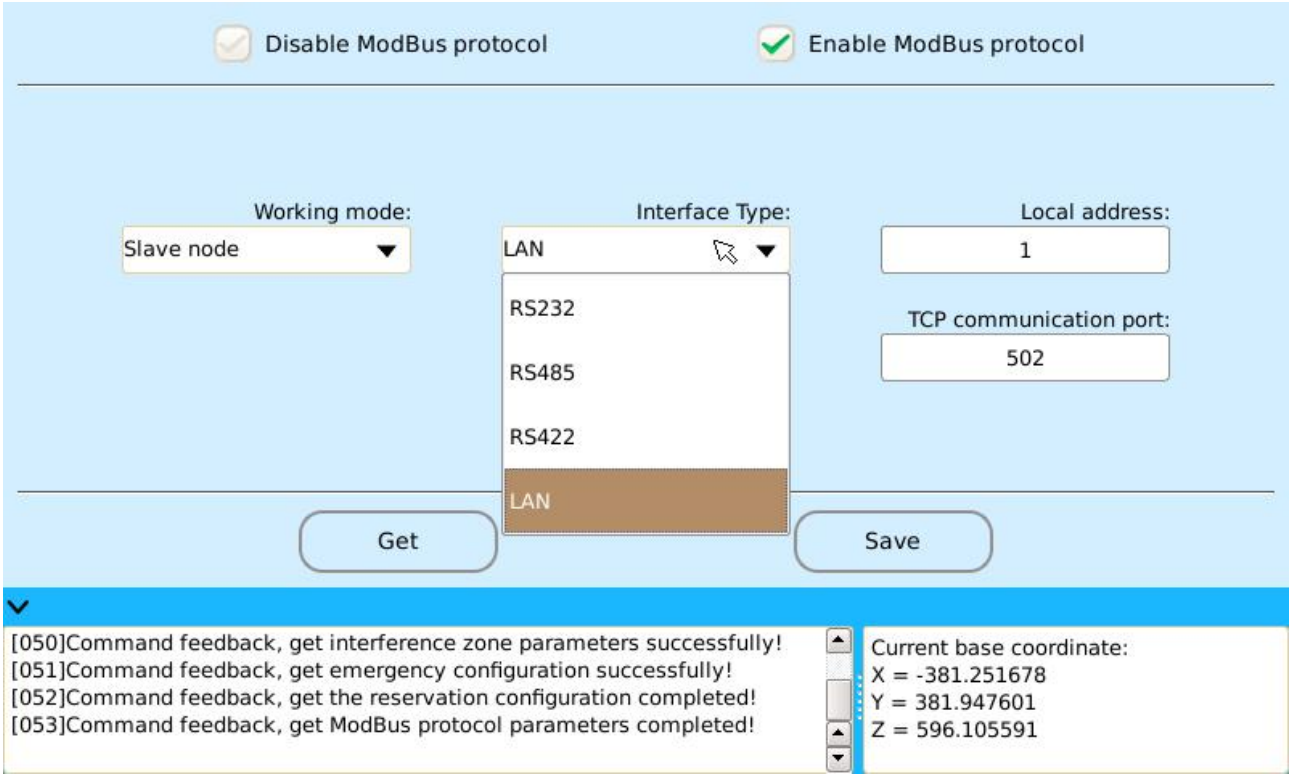


Figure 9.16 “ModBus” Communication Protocol

◆ ProfiBus Protocol

As shown in Figure 9.15, click the “ProfiBus” icon and enter the “ProfiBus” protocol interface, as shown in Figure 9.17. When the “enable ProfiBusProtocal” is “checked”, the“serial port type”, “local address”, “Baud Rate Type” and “slave station label” are required to be set.

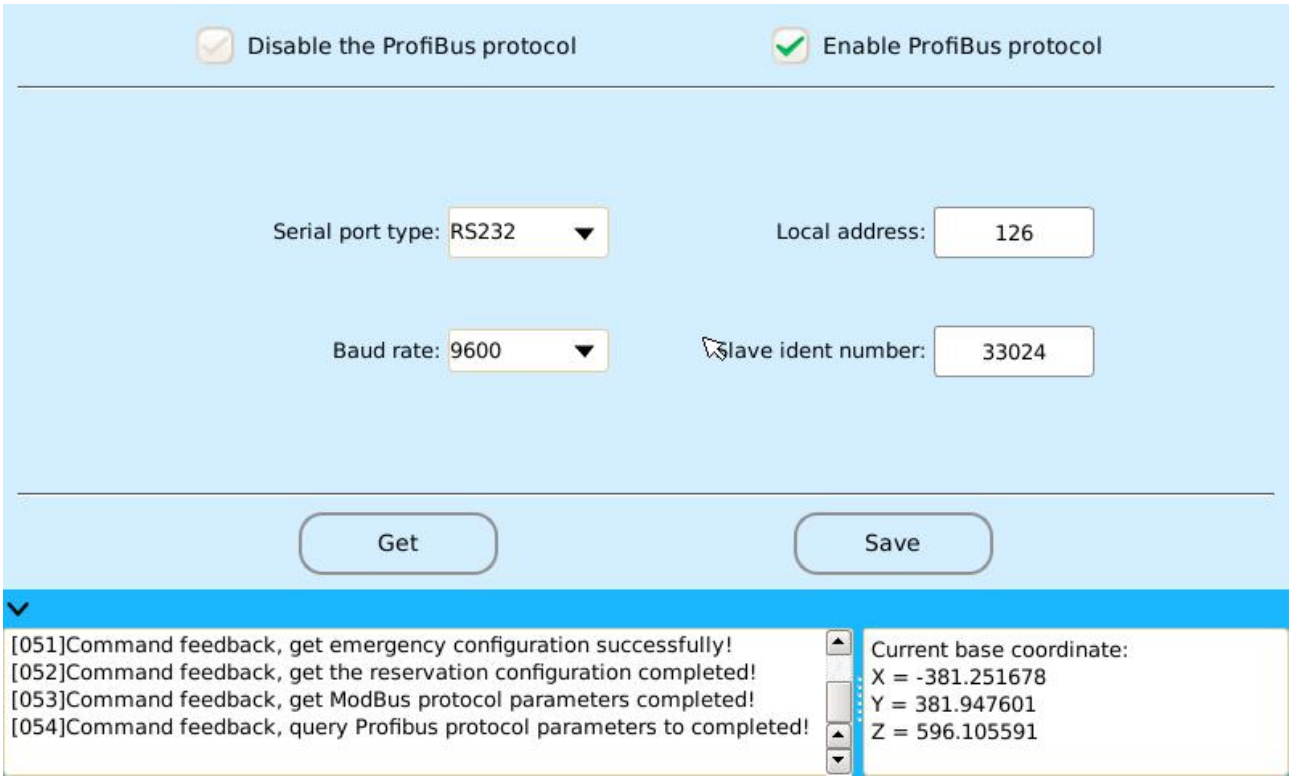


Figure 9.17 “ProfiBus” Communication Protocol

Serial types: There are two kinds: “RS232” and “RS485”.

Native address: Set the system address.

Baud Rate Type: There are 2 kinds: “9600”, and “19200”.

Slave station label: Set the slave station label.

After setting the parameters to complete the “Enable ProfiBus Protocol”, click the Save button to complete the settings of the “ProfiBus Protocol”.

9.7. Custom alert function

After logging into the system and entering the main interface of "demonstrator" successfully, you can go through the following path: [Configuration]--[Custom Alert], click [Custom Alert] icon to enter the “custom alert” interface, as shown in Figure 9.18.

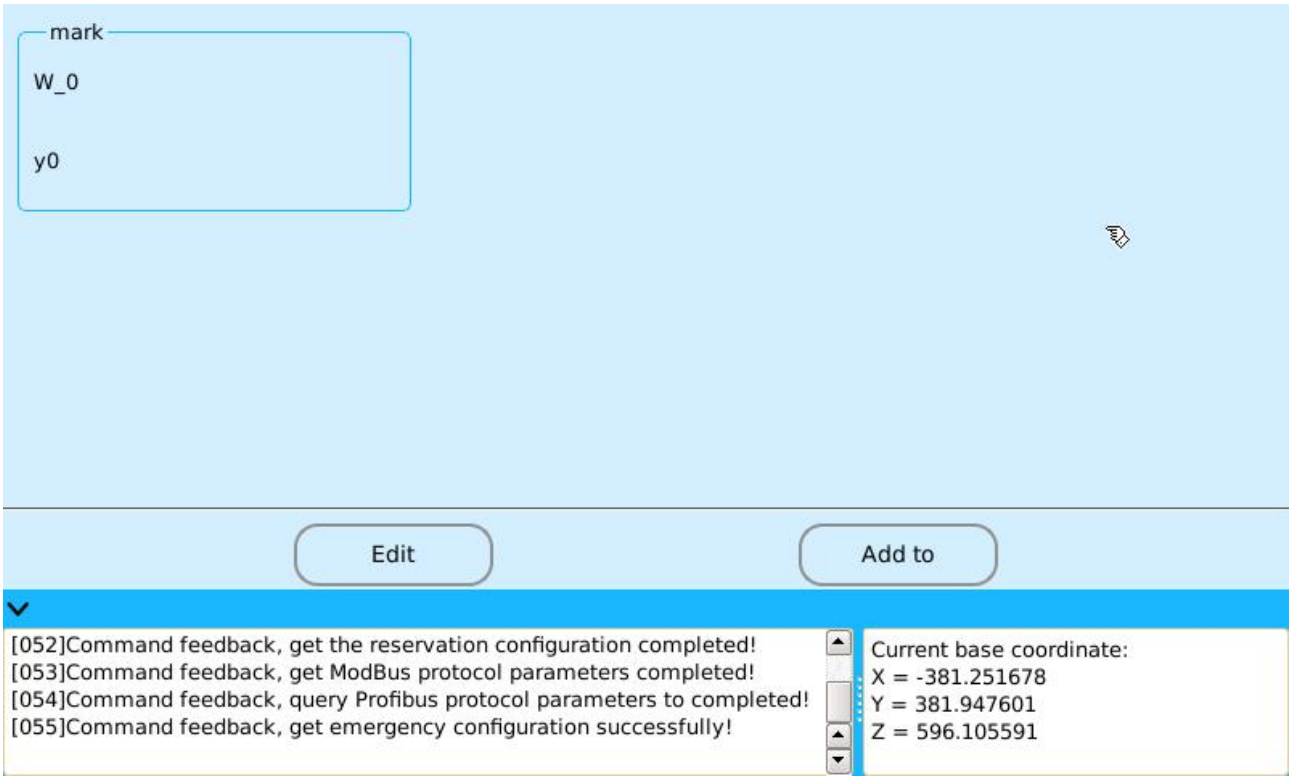


Figure 9.18 “Custom alarm” interface

Create “custom alert”: Click [Add] button to set the “alert heading” and “alert content” in the pop-up message box, and click “confirm” to complete the creation of the “custom alert”.

Manage “custom alert”: Click the edit button to “edit” the completed “alert”, including “modify” and “delete” alerts.

Use "custom alert" in conjunction with the PLC, the "custom alarm" created in the PLC "output type" is represented by "W".

9.8 Set Curve Properties

In the system,"property" can be set for "curve", which is represented by UNTIL, property is applied on the "curve" task type, and "curve" in the first line cannot use "property" function.

Set the curve “property”: In the “program creation” interface, select a “curve”, use the “property” function, set the “trigger type”, “input port number”, “input level value” and “event relationship” in the presence of “property type UNTIL” setting interface.

Trigger types-- divided into two types: “input port” and “PLC”.

Enter port number--that is, IO input port, user can choose the “multipath” input port and connect with a “-”.

Input level values--are divided into low-level “0” and high-level “1”.

Event Relations--There are “with” and “OR” two event relations.

After the “trigger type”, “input port number”, “input level value”, and “event relationship” are set, click [add] button, the “COND_UNTIL:XXX” task will be generated on the line below the selected curve, and the “property” definition of “curve” will be completed.

After using the function of "property", the curve is embodied as follows The trajectory of the “property” before defining the “curve” is “A-B-C”, that is, starting point A running to B, then running to C;when curve "A-B" is used as "property" function, point E is any point on curve "AB". If the condition of curve "property" is satisfied at point "E", the trajectory will run directly from point "E" to point C, that is,"A-E-C", and the "type of motion" of the trajectory will remain unchanged.