Mechanical Arm Series

Joint Robot - Basic Operation and Program Manual

2018/12　Ver：V09.00

Leading Numerical Controller

LNC
Enable intelligent machines

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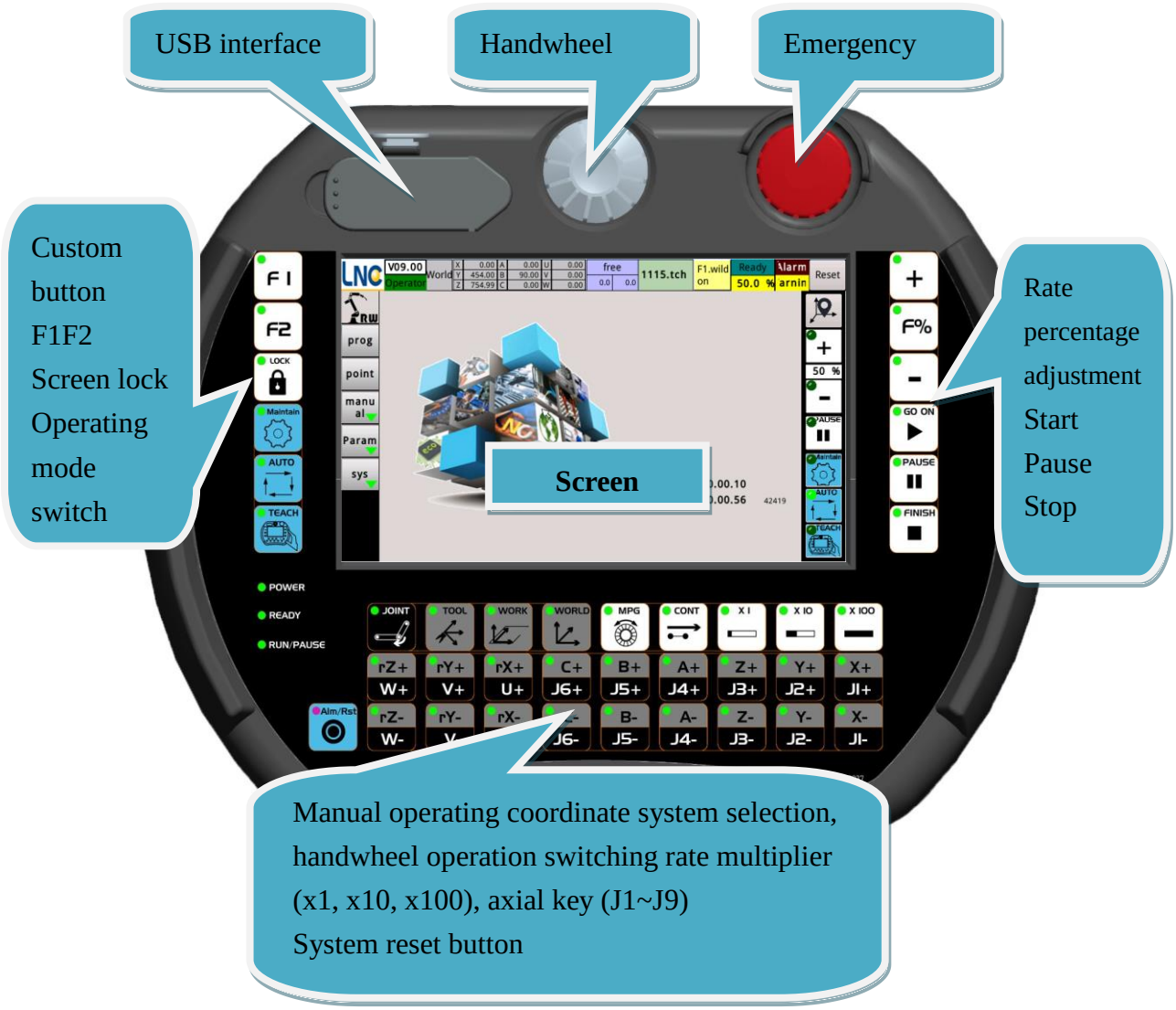
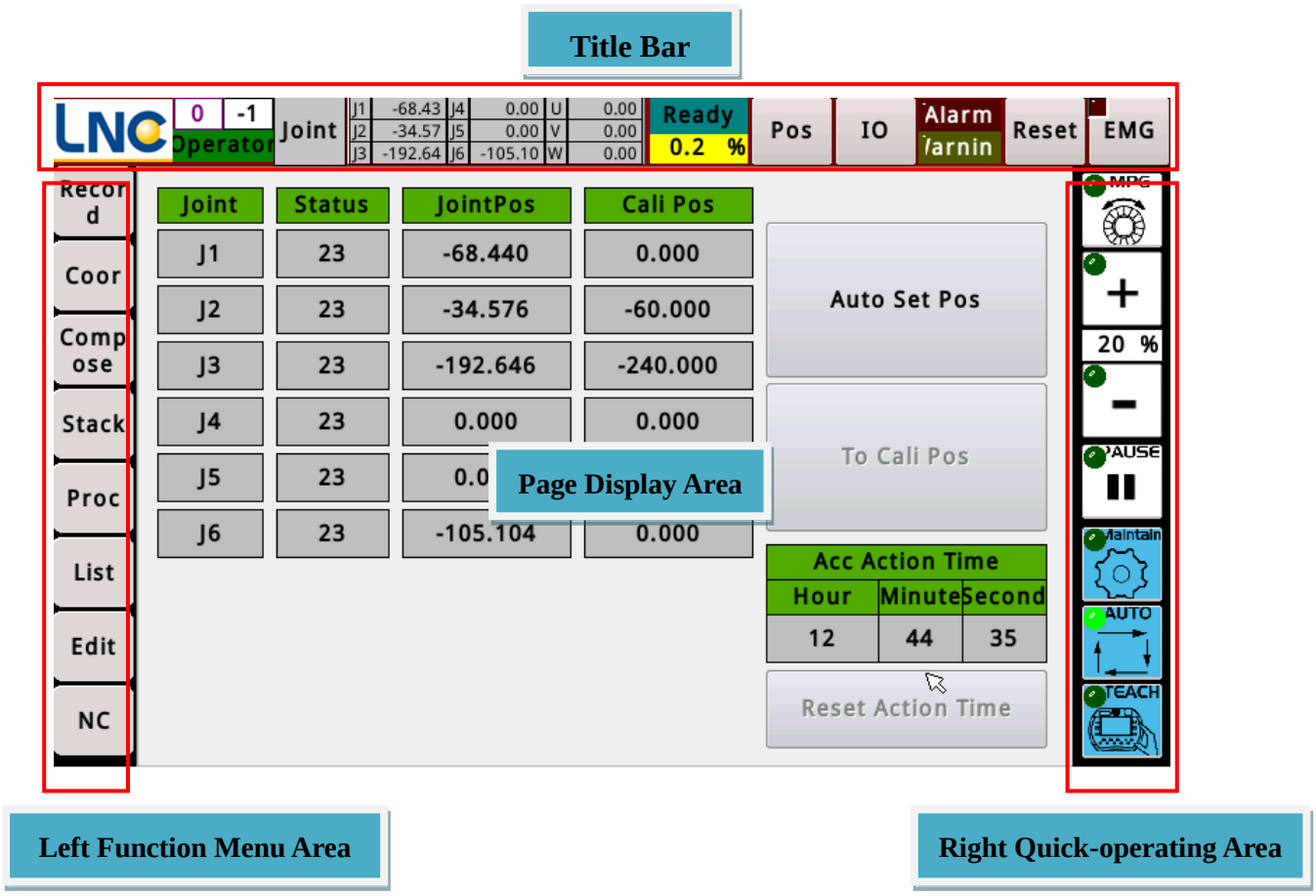
2. Instructions of handheld box and screen configuration

2.1. Shape of handheld box

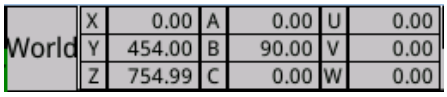
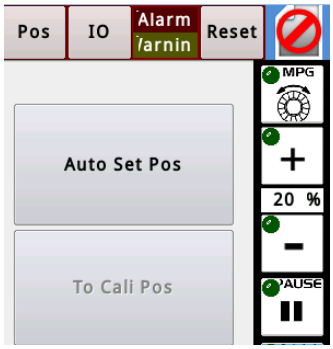
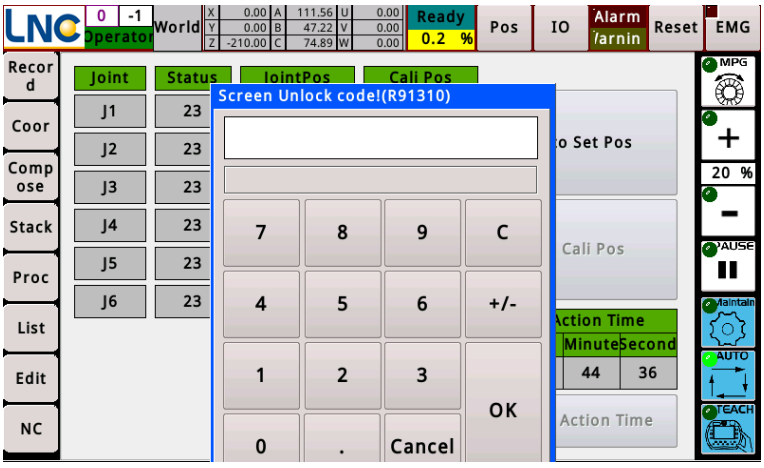
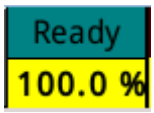
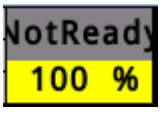


	User-defined button functions
	Screen lock function, refer to the description of following sections
	The light signal shows the current alarm and the button reset system (equivalent to the reset button on the screen)
Other buttons	Refer to the description of following sections

2.2. Instructions for screen configuration

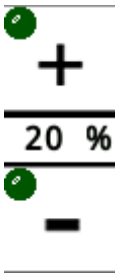


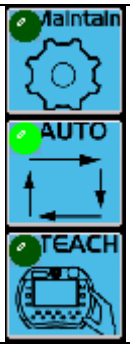
2.3. Title Bar

	Display the system version number, the current login level, click on this area to enter the permissions page.
	This area will display the coordinate values in this coordinate system according to the system mode (maintenance, automatic, teaching), and the selected coordinate system (world, work, tools, joints).
 	Screen lock function: Clicking three times in this area continuously allows the system to enter the screen lock state. It needs to enter the correct password to operate. If you click Cancel, it will display a small square of "Forbid" in the upper right corner. Click it and the password window will pop up again. 
 Click on the upper half to switch the start status of servo. 	Displays the rate percentage of the system operating speed in the current system state and automatic mode. Not ready：It will stay in this state until the coordinates of any of the motors are not confirmed. In this state, the automatic mode cannot be used, and the teaching mode operation can only be the joint coordinates. Ready：When the coordinates of each motor have been confirmed, it will become ready to complete. After the being ready, there is a way to enter the "automatic mode",

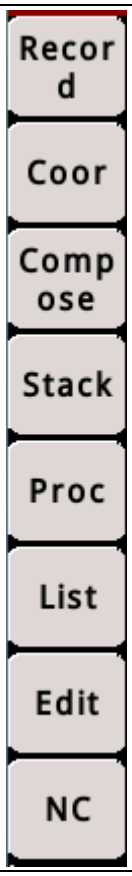
	because the kinematics calculation path of the robot is meaningful after the coordinates of the axes of the system are correct. Operating：The automatic program is running. Pause, section stop: The system is running but enters the pause state for any reason. Teaching: Performing teaching.
	Enter the link between the coordinate page and the IO page.
	Prompt whether the system currently has an alarm warning. Click on the alarm warning area to display the current content of alarm warning. Click "Reset" to clear the current alarm warning if the establishment condition for the alarm warning has disappeared.
	Press this button to switch the A870 to put the system into an emergency stop state. The system's emergency stop can be triggered by multiple sources: handheld box, upper software, electric cabinet, external signal...

2.4. Right quick-operating area

	Handwheel mode: switch whether to operate with the handwheel
	Automatic mode: adjust the percentage of speed during automatic operation Maintenance and teaching mode: adjust the speed percentage during manual operation
	Make the program running in automatic mode enter the pause state.

	These three buttons switch system modes: Maintenance mode: Perform operation control of a single motor. Usually used for the time of debugging. Auto: Used to launch a program or to operate a specific action on each page. Teaching: Move with the coordinate system direction such as "world", "work", "tool" and "joint" as a reference.

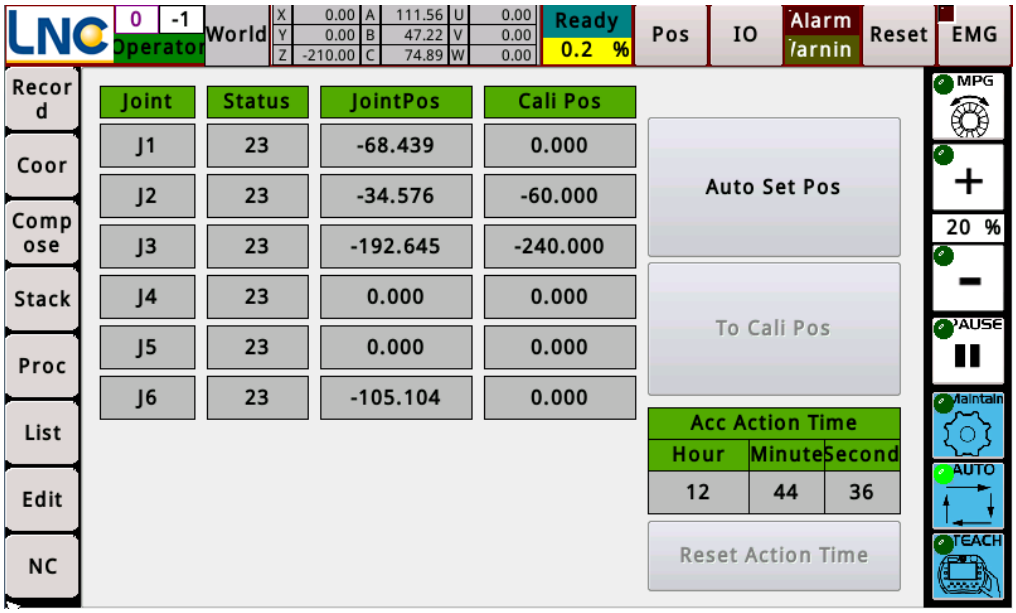
2.5. Left function menu

	The buttons displayed on the left are arranged as standard version of the function items, which can edit the page and add the linked function buttons according to the application requirements. Each button is linked to the corresponding function page, and the description of each page is described in the following sections.

3. Common pages

3.1. Startup

When the system starts, the “Startup” page will be displayed first, through which you can see the coordinate status of each axis. The number in the “Status” column represents the result of setting the coordinates, 23 represents the completion of setting coordinates, and the remaining numbers represent “Unsettings", "Settings" or "Settings failure".



Automatically set coordinates:

Press this button in the automatic mode to automatically execute the program of setting the coordinates.

Note 1: If the control mode is bus absolute, this function is unnecessary. Normally, the coordinate reset will be completed automatically after each emergency stop state is released.

Note 2: The operation of setting the coordinates will be different depending on the use of "absolute motor". If "absolute motor" is used, the set coordinates will directly read the motor's encoder and convert it to the coordinates in the controller, there will be no actual mechanism movement; If a "non-absolute motor" is used, there will be an actual mechanism movement to find the reference point (origin sensor or Z-phase signal).

Back to the calibration point:

In the "teaching" mode, the mechanism may gradually move toward the coordinates of the calibration point when pressed, and stop when it arrives or is released.

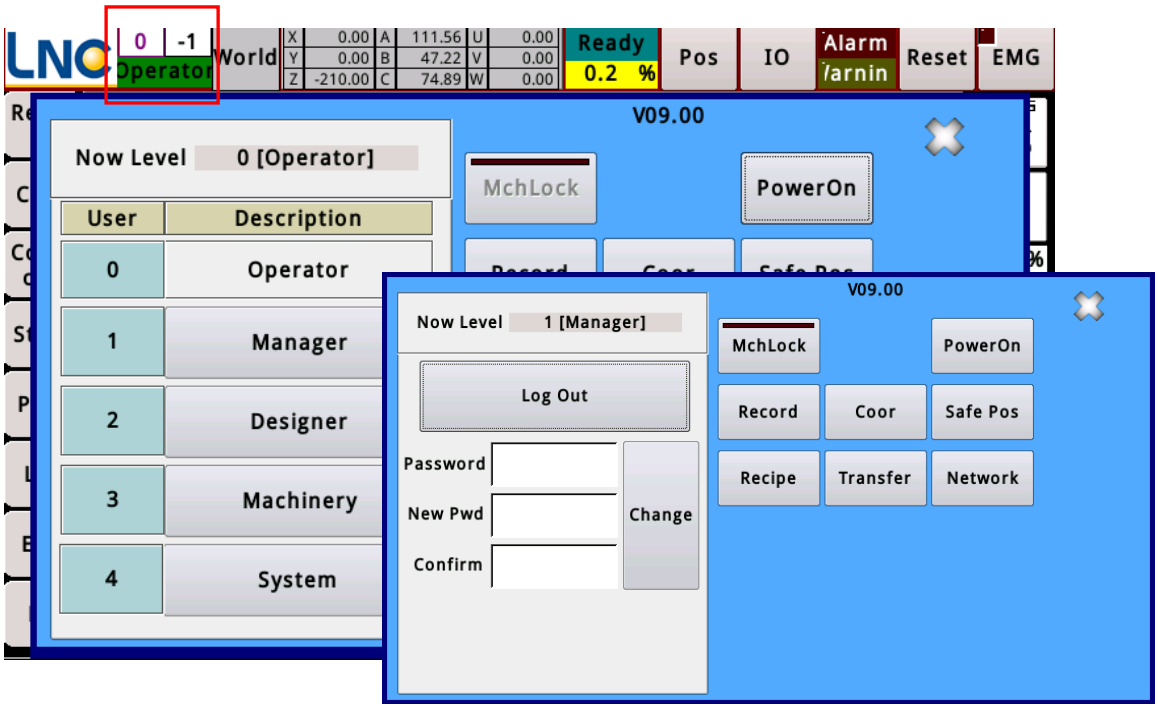
Accumulated motion time:

This time will accumulate as long as any motor has an motion.

Reset motion time:

When pressed, the accumulated motion time can be reset to zero.

3.2. Permissions



This system is divided into five types of permissions:

0. Operator: end-user operator, responsible for operating the machine. This is the permission preset when startup.
1. Manager: The management of the end-user, responsible for the editing and writing of the program. Please ask the factory personnel for the factory default password.
2. Developer: Used by the motion process developer to write the motion process. Please ask the machine factory for the default password.
3. Machinery factory: used by the machinery factory that manufactures robots, responsible for robot debugging, origin calibration, limit and authorization settings. Please ask the machine factory for the default password.
4. System level: used by the person responsible for system settings, responsible for the robot's mechanism and motor parameter settings. Please ask the machine factory for the default password.

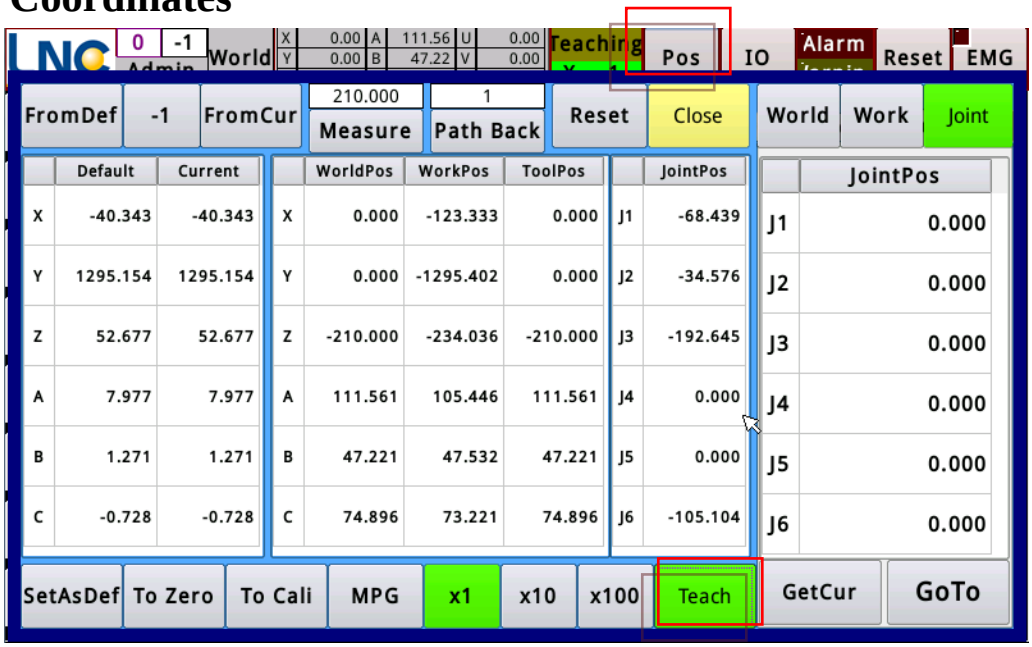
The default permission of the system after startup is the operator.

The method of login permission: Click on one of the manager, developer, and machine factory to pop up the password input screen. After inputting correctly, you can see the functions that can be performed.

Logout: Simply press the "Logout" button.

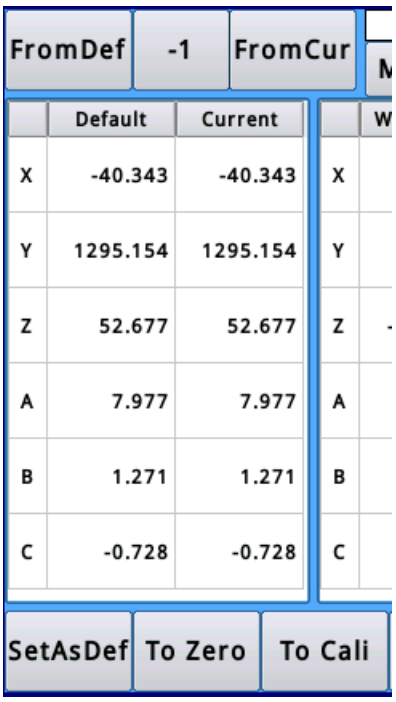
Change password: Enter the current password, new password, confirm password and press "Change".

3.3. Coordinates



This page contains coordinate system display and setting, coordinate display, coordinate motion function. When login with administrator or above and in the "teaching" mode, all functions of this page can just be used.

3.3.1. Coordinate system and settings



Preset bar: When startup, the system will set this set value to the current work coordinate system. You can enter a value on the content of the field.

Coordinate system bar: The value of the work coordinate system currently in use, which can be entered in the content of the field.

Select preset: re-apply the setting of the preset coordinate system to the work coordinate system.

Select current: Set the current world coordinates to the coordinate system value. You can also click on a field in the world coordinates to set the value of the field to the current coordinate system.

Set as preset: Set the current coordinate system value to the default coordinate system for the next startup.

Origin：Move straight to the origin of the coordinate system (move when pressed and stop when released.)

Calibration point：To the calibration point position marked on the startup page (move when pressed and stop when released).

3.3.2. Current coordinates display

Display current world coordinates, work coordinates, tool coordinates

Span: Zero the current tool coordinates to understand the distance of the motion.

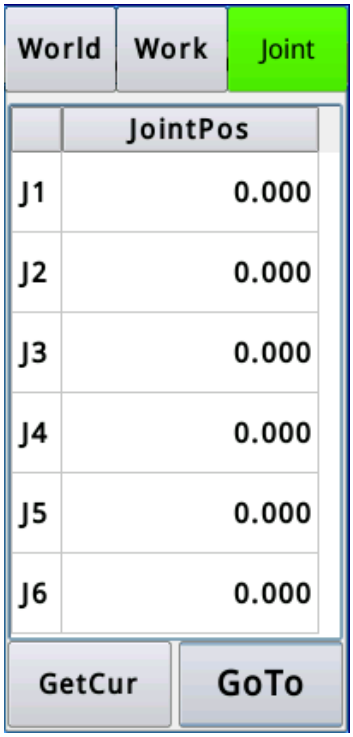
Note 1: From the tool coordinate information, the relative relationship between the current point and the point when the span is pressed can be known.

Note 2: When the "tool" of the coordinate selection is pressed, it is equivalent to pressing the Span key.

Path rollback: system automatically

	records the path that has been traveled. This function can be used to reverse back according to the path that has traveled. In the automatic mode, it moves when this button is pressed and stops when released. **Reset**：equivalent to the reset function on the title bar **Close**：Close window of coordinate page

3.3.3. Operation for motions

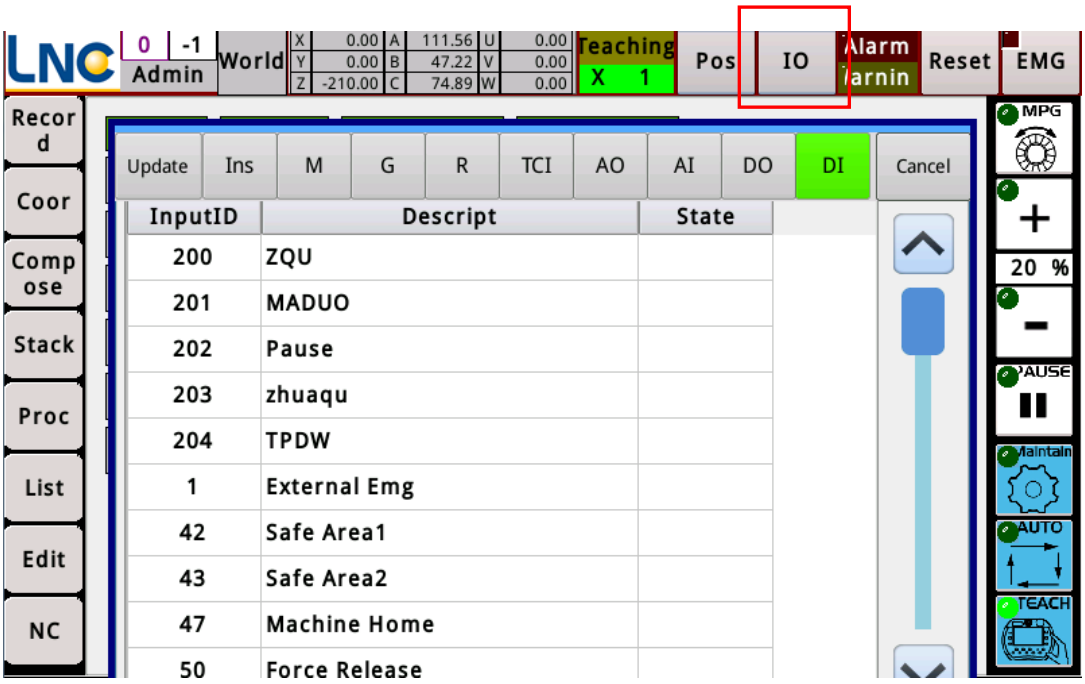


Coordinate selection:
You can select the coordinates of "World", "Work" and "Joint".

Coordinate input:
You can click the coordinate value field to input the value directly, or press “Select Current” to bring the current coordinate value first, and then modify it for specific items.

Move to coordinates:
Press "To" to move to the target coordinate value, and stop when it is released.

3.4. IO



This page displays system built-in resources along with user-defined resources.

DI : Digital input signal

DO : Digital output signal

AI : Analog input

AO : Analog output

TCI : Temperature sensing input

R : Register

G : G-code

M : M-code

Ins : Insert macro

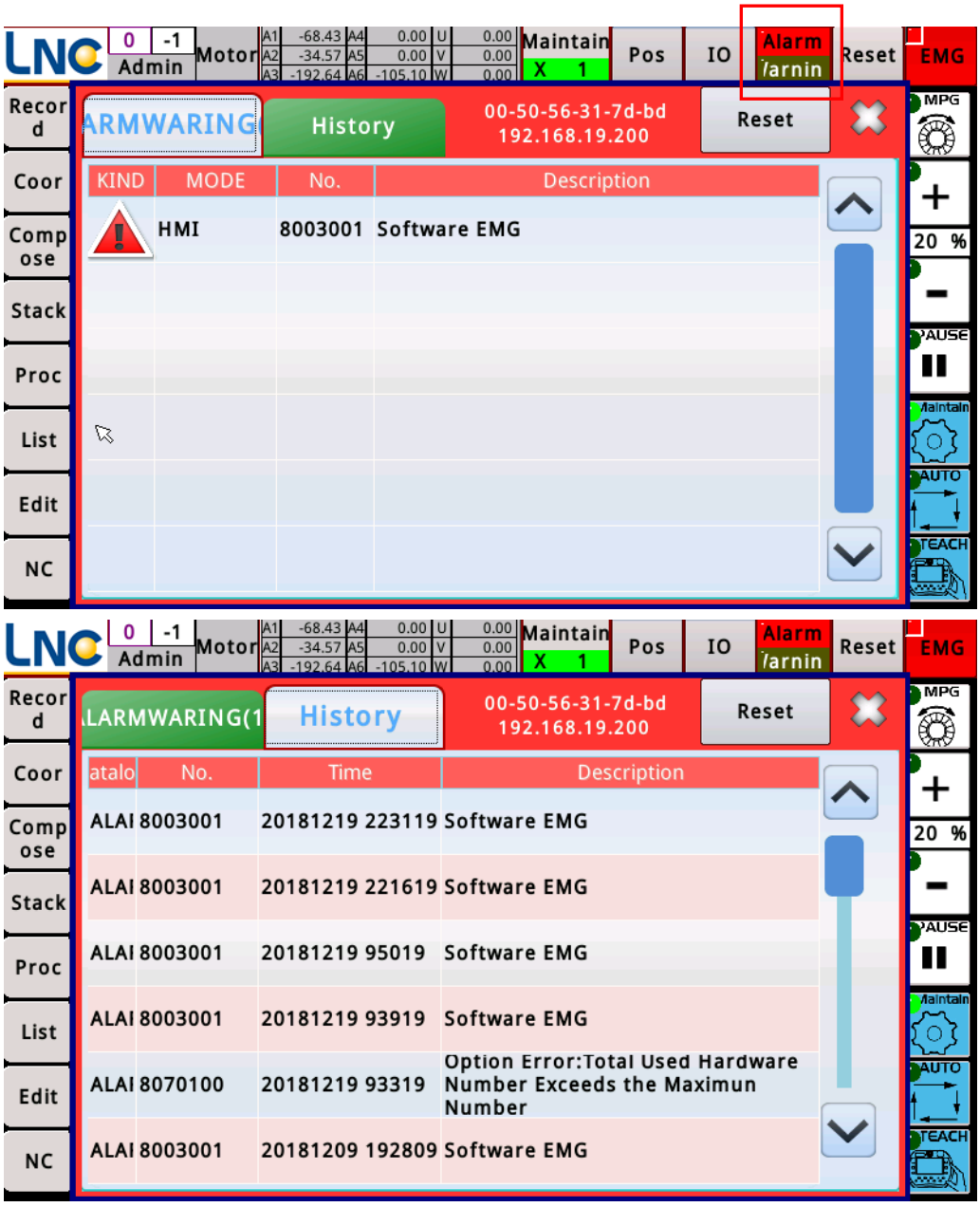
Update: Used in the development phase of the developer to re-read the contents of definition files of the resources.

Cancel: Close this window

Note 1: The sample files of the user-defined resource can be obtained from ReconTool/File/language/UserString_0000.str

3.5. Alarm warning page

This page shows current and historical alarms and warnings.



Note 1: The user-defined alarm warning exists in ReconTool/file/language/UserAlarm_0000.str, which can be downloaded and edited, and then uploaded to overwrite the original file. The alarm range is from R29000.00 to R29049.31, and the warning range is from R29050.00 to R29099.31.

4. Introduction to basic concepts

4.1. Introduction to space coordinates (position and attitude)

The coordinates of the manipulator generally refer to the position and attitude of the end point. Refer to the figure below, which is a six-joint manipulator with a schematic diagram of an additional tool. The following is a description of the coordinates of the LNC joint robot:

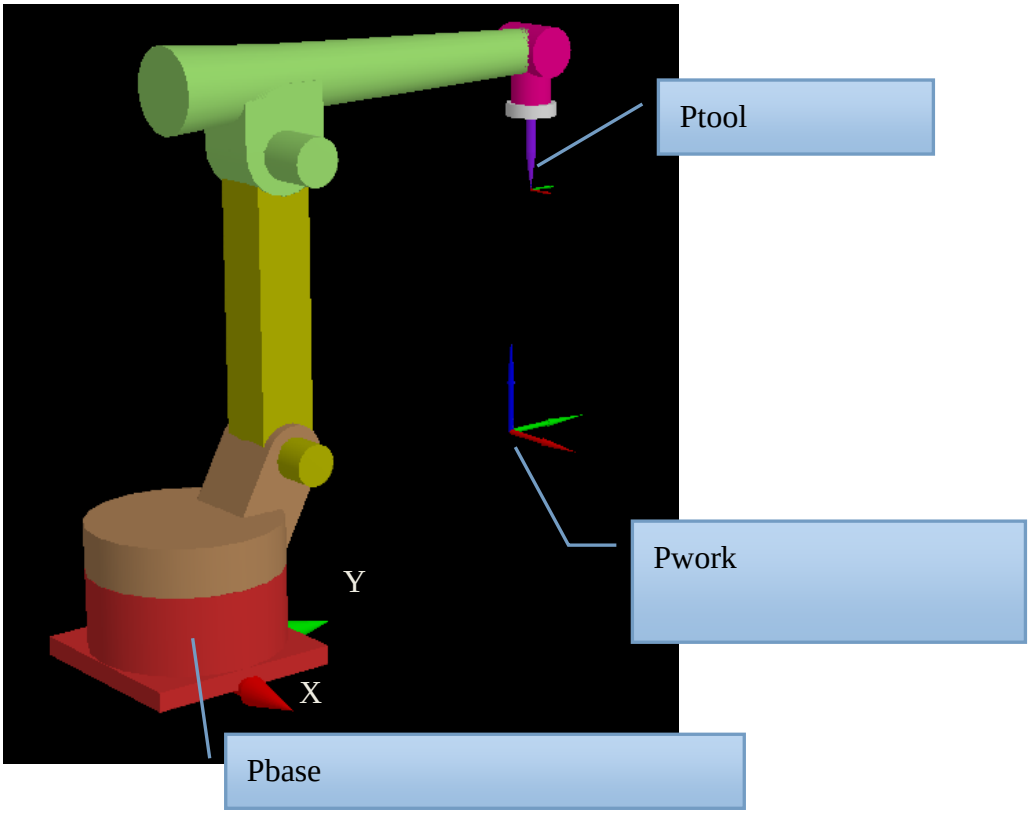
Pbase (the origin of world coordinates) is defined in the center of the base. If you think of the manipulator arm as a person, the direction of the XYZ axis is the same as the direction of our well-known axis. The right side is +X, the front is +Y, and the above is +Z.

In addition to the position in space, the **Ptool** also contains the axis representing its attitude.

Pwork is designed to facilitate offline programming and to allow multiple groups of robots to share the same set of machining programs. It also includes position and attitude axes in space.

World coordinates refer to the spatial position and attitude of Ptool relative to Pbase.

Work coordinates refer to the spatial position and attitude of Ptool relative to Pwork.



The Pbase, Ptool, Pwork, world coordinates, and work coordinates all include position and attitude. The position in space is as commonly understood and commonly used (X, Y, Z), but the space attitude is different and difficult to understand.

The space attitude is usually represented by (A, B, C). It has a specific rule, collectively called Euler's rotation theorem, which is used to indicate the possibility of various directions. A more detailed description can be found by searching the Internet for Euler's rotation theorem. The rules of Euler's rotation theorem are not necessarily the same in each robot system.

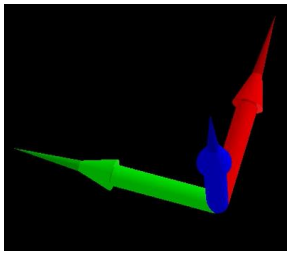
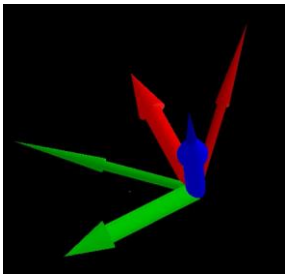
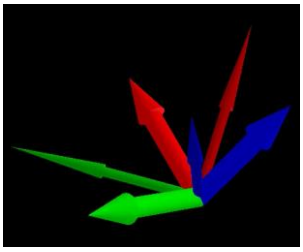
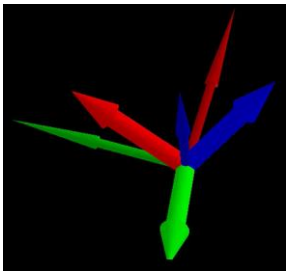
LNC's Euler's rotation theorem is defined as ZXZ, and the universal is the right-hand rule, ie

A is the angle of rotation around the +Z axis.

B is the angle at which the axis rotates (+X after A rotation).

C is the angle at which the axis rotates (+Z after AB rotation).

The figure below is an example:

			
Before rotation (0, 0, 0)	Rotate 45 degrees around Z (45, 0, 0)	Rotate 30 degrees around X (45, 30, 0)	Rotate 30 degrees around Z (45, 30, 30)

4.2. Various coordinates and their relevance

The system can adapt to a variety of robot types at the same time and uses the same coordinate concept for development, please be clear, which is helpful for subsequent operations, programming and development. Some special terms are as follows:

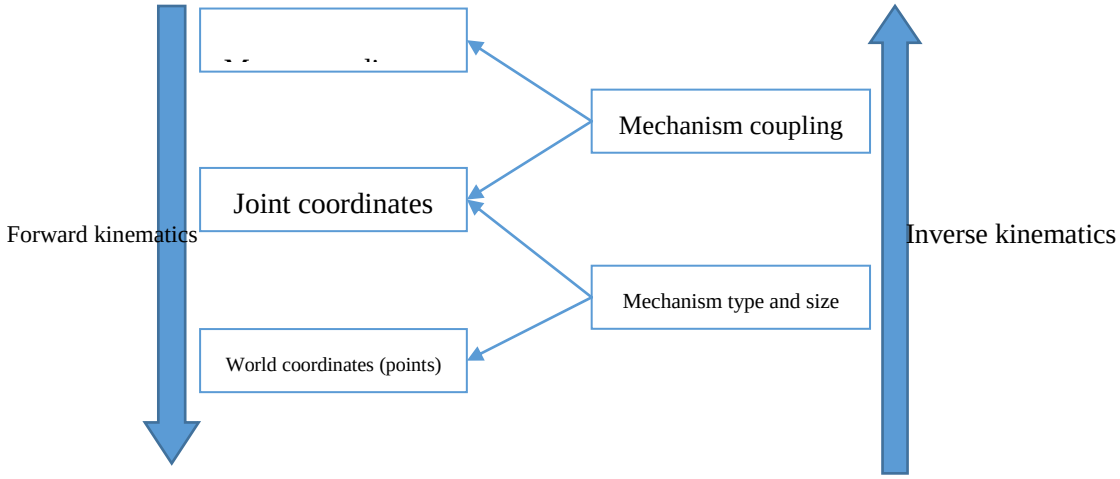
Motor coordinates: The actual coordinate value of the motor is independent of the coaction between the mechanisms.

Joint coordinates: The coordinate value of the motor coordinate after the mechanism coupling relationship is converted. (visual mechanism state in appearance)

World coordinates: The position and attitude of Ptool when the center of the manipulator base is the origin.

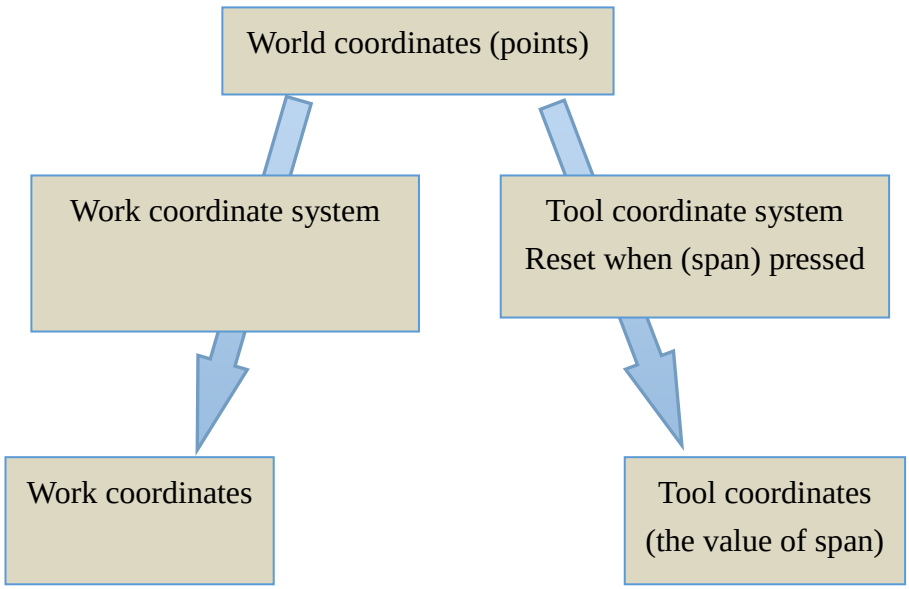
Forward kinematics: An algorithm that converts motor coordinates to world coordinates.

Inverse kinematics: An algorithm that converts world coordinates to motor coordinates.



Work coordinates:
Converted from world coordinates (points) through the work coordinate system

Tool coordinates:
Converted by world coordinates (points) through tool coordinates



4.3. Fast moving

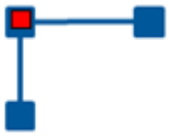
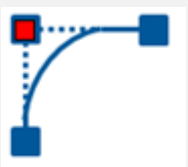
The motor of each axis is directly rotated to the target position according to the joint coordinates of the target point, regardless of the motion curve. There are two types of quick instruction applications:

1. There are no obstacles between the starting and ending points, as long as they can arrive quickly.
2. The attitude of the starting and ending points spans different quadrants, using when path motions cannot be achieved.

Note: This instruction can be used when the 3rd or 5th joint of joint coordinate of starting and ending points has a span of 0 degrees.
The change process of each joint is proportionally converted according to the difference between the current and target joint coordinates, so that the target point can be reached most quickly, but since the attitude change in the actual conversion process is related to the current coordinate, the change process cannot be ensured. Therefore, it's necessary to be careful when using it.

4.4. Path motions

The path motion is a reference point for the path calculation of the Ptool. In addition to the spatial position, the attitude change should also be considered. The guidelines for processing path motions in the system are as follows

Path type (command composition)	Position track	Attitude change
Linear  (Starting point – linear point)	Spatial linear	According to the distance traveled, the attitude is changed in equal proportions.
Arc transition  (Starting point – transition	Three points form a spatial plane The radius of the transition circle can be specified on the	Half of the arc is classified as the first half and the other half is classified as the second half. The first half changes to the attitude of the transition point by the distance ratio, and the second half also changes

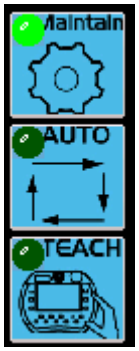
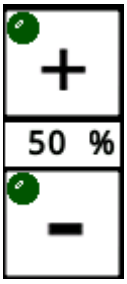
point – linear) (Starting point – transition point – transition point – linear)	arc transition point. Setting 0 means using the default value. If it is larger than the maximum possible radius, it means using the maximum radius.	to the end point according to the distance ratio.
Three-point arc  (Starting point – midpoint of the arc – linear) (Starting point – midpoint of the arc–arc end point)	Three points form a spatial plane If the end point uses the arc endpoint command, you can additionally specify the angle that the arc will around in total.	The midpoint of the arc can specify the way the attitude changes. 1. Three-point linearity: The starting point, the midpoint, and the end point are divided into two straight lines to change the attitude. 2. Two-point linearity: Ignore the midpoint's attitude and change the attitude by the arc length ratio. 3. Three-point arc: The starting point, the midpoint, and the end point are divided into two arcs, and the attitude is changed along with the arc plane. 4. Two-point arc: Ignore the midpoint's attitude and change the attitude around the arc plane by the length ratio of the arc. 5. Fixed starting point: fixedly use the starting point of the attitude, and the attitude of midpoint and the endpoint are ignored 6. Starting point AB: The B value of the starting point is fixedly used. The A value changes with the rounding angle, and A+C is the fixed value. 7. Starting point ABC: The BC value of starting point is fixedly used, A value changes with rounding

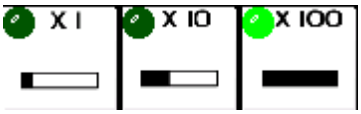
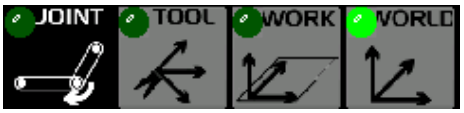
		angle
Center and arc  (Starting point – arc center – linear) (Starting point – arc center – arc end point)	Three points form a spatial plane If the end point uses the arc endpoint command, you can additionally specify the angle that the arc will around in total.	The center of the arc can specify the way the attitude changes. The attitude change refers to the items 2, 4, 5, 6, and 7 of the three-point arc.

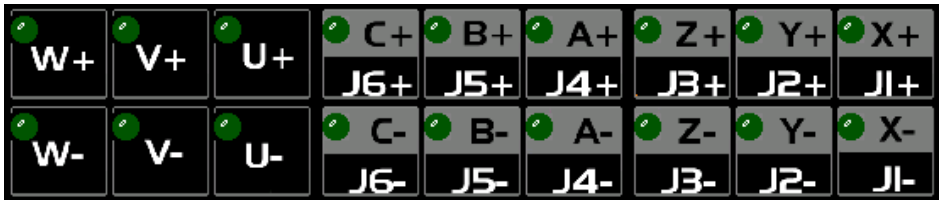
Note: The attitude change has its practicality in some processing applications. Please select the appropriate method according to actual needs.

5. Maintenance and teaching mode

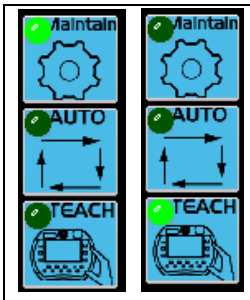
5.1. Button names

Mode selection	Handwheel mode	Speed percentage	Continuity
			

Speed multiplier	Coordinate system selection
	

Motion buttons

When the button light is on, it means that the button will work when pressed. If it is not lit, it will not work.

5.2. Mode description

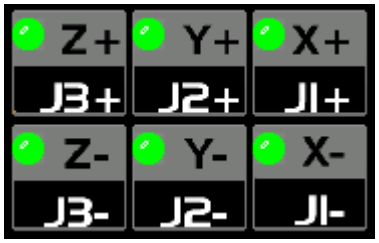
	Maintenance mode: Rotate the motor, it can still move when the preparation is not ready, and it can still run away from the limit when the axis exceeds the limit. Teaching mode: It operates according to the type of coordinates required, and cannot enter the teaching mode when it is not ready.

5.3. Differences between handwheel and non-handwheel modes

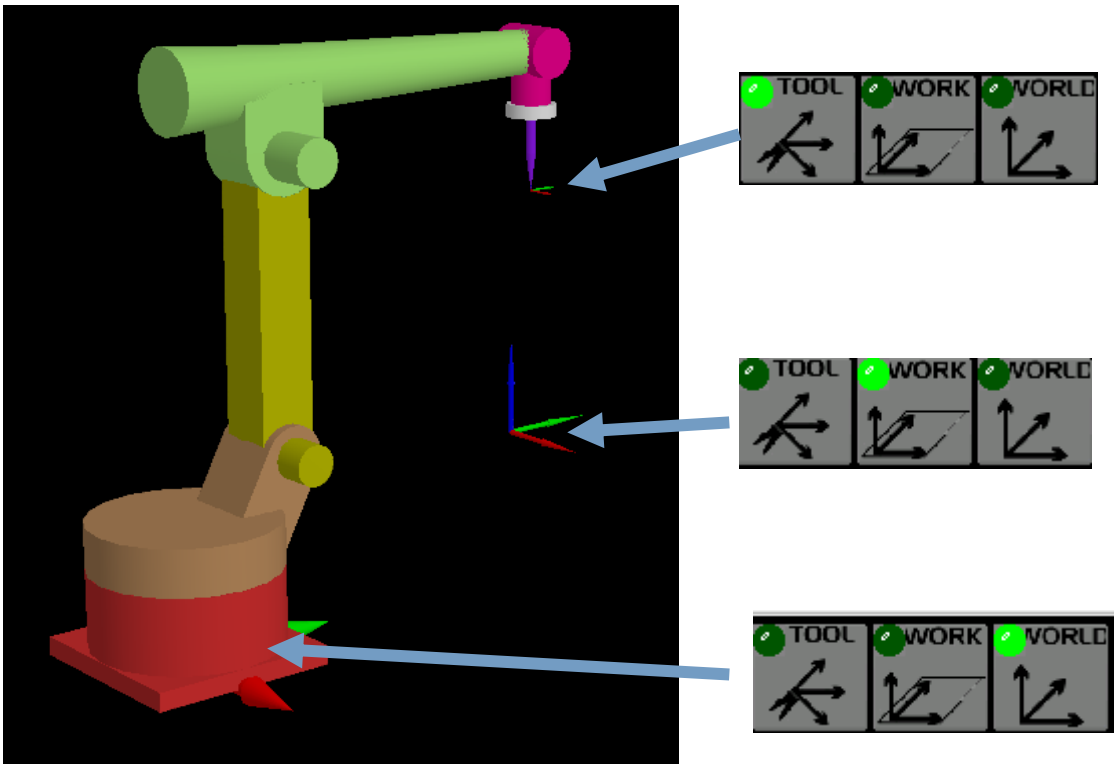
	 Non-handwheel mode	 Handwheel mode
When the motion button is pressed	The machine moves immediately	It represents the axial direction of the motion when the handwheel is rotated.
Direction control	Press different arrow keys	The handwheel rotates in the forward and reverse directions.
Speed control	Select Contiguous  Speed multiplier x speed percentage	Speed multiplier x handwheel rotation rate
Incremental control	Select non-contiguous  It moves some distance if pressed for one click, and the distance is determined by the speed multiplier.	Rotate grid by grid.
Position control (e.g. "To" on multiple pages)	"To" button moves when pressed and stops when released	Press "To" to enter the motion state, when the handwheel rotates forward, it advances, and when the handwheel reverses, it retreats.

Note: The usual usage in non-handwheel mode is to use the  method when it is far enough away from the target point so that the target point can be approached quickly; When the target position is approaching, use the  mode so that it can be accurately adjusted to the target point.

5.4. Coordinate system selection during motions

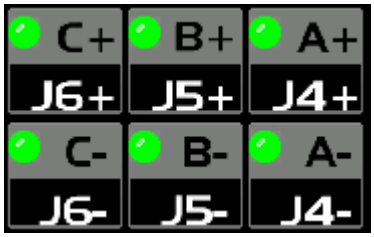


Depending on the selected coordinate system, the direction of XYZ motions is determined by the selected coordinate system.



Joint coordinate system：Defines the decision based on the direction in which the joint rotates.

5.5. Direction rotation in teaching mode



There are three ways to rotate the direction in teaching. You can choose the options that are easier to understand according to the type of mechanism and personal habits. The options are as follows.

Teach Rotate Mode	Change ABC Value

Directly operate on the current coordinate ABC value of the selected coordinate system, which is more suitable for the end axis of the orthogonal robot.

Teach Rotate Mode	Tilt By Selected Coor

Rotate the XYZ axis of the selected coordinate system to maintain the same angle with the coordinate axis and rotate in different directions.

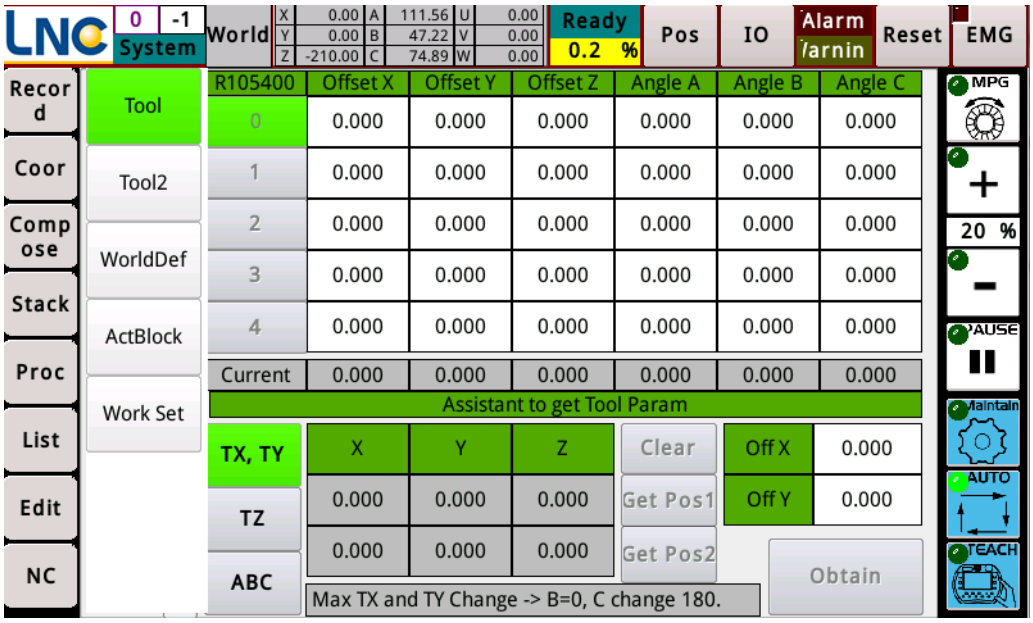
Teach Rotate Mode	Tilt Always By Tool Coor

Regardless of the currently selected coordinate system, it is forced to change to the direction of the tool. It can be imagined that people sit in the Ptool, the eyes are facing Y+ direction, the joystick is in the hand, A+, A- is equivalent to the left and right of the joystick, which will cause the tool to tilt in the X direction; B+, B- is equivalent to the front and rear of the joystick, which will cause the tool to tilt in the Y direction; C+, C- means rotate in place.

6. Tools

The coordinates of the robot represent the spatial position and attitude of Ptool at end, but the tool is installed after the robot is out of the machine, so there must be parameters to specify the position and direction of Ptool, which is called the tool parameters.

The system provides four sets of tool parameter settings, each set of parameters contains six items, where offset X, offset Y, offset Z describes the relative position between the Ptool and the flange face, angle A, angle B, and angle C describe the direction of the point.



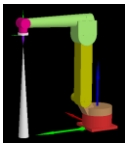
Tool calibration steps

1. Click the tool number 0~3 to be corrected , for example 3 。

2. **Click the item** TX, TY **to be corrected and press** 清除

3. The robot moves to the attitude of the right figure, while a point is installed externally, and press 取點1 after aligned.

4. The external point does not move, the world coordinates rotate C about 90 or 180 degrees, then XYZ moves, so that the Ptool is aligned again with the external points, press 取點2 。

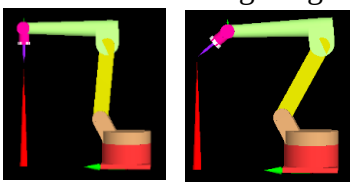


5. Press 推算 , 誤差X 0.000 and 誤差Y 0.000 to show the value.

6. Click the value on 誤差X 0.000 and 誤差Y 0.000 to add the error to tool parameters.

7. Click the item TZ to be corrected and press 清除

8. After the robot aligns the points with the two attitudes as shown on the right figure, press respectively 取點1 and 取點2.



9. Press 推算 and 誤差Z 0.000 to see the value.

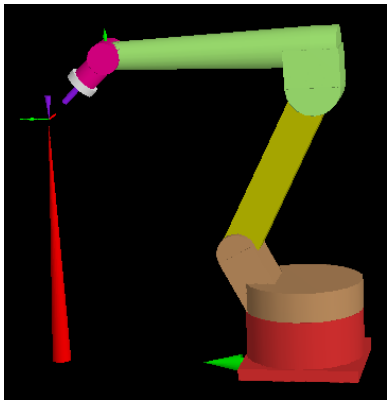
10. Click the value on 誤差Z 0.000 to add the error to tool parameters.

11. If the direction of the Ptool is not parallel to the axis of the sixth axis, you need to set the tool angle. First set the tool angle A, angle B, and angle C to 0.

12. Click the item to be corrected ABC

13. Turn the direction of the Ptool so that the tool direction is consistent with the direction of the world coordinates.

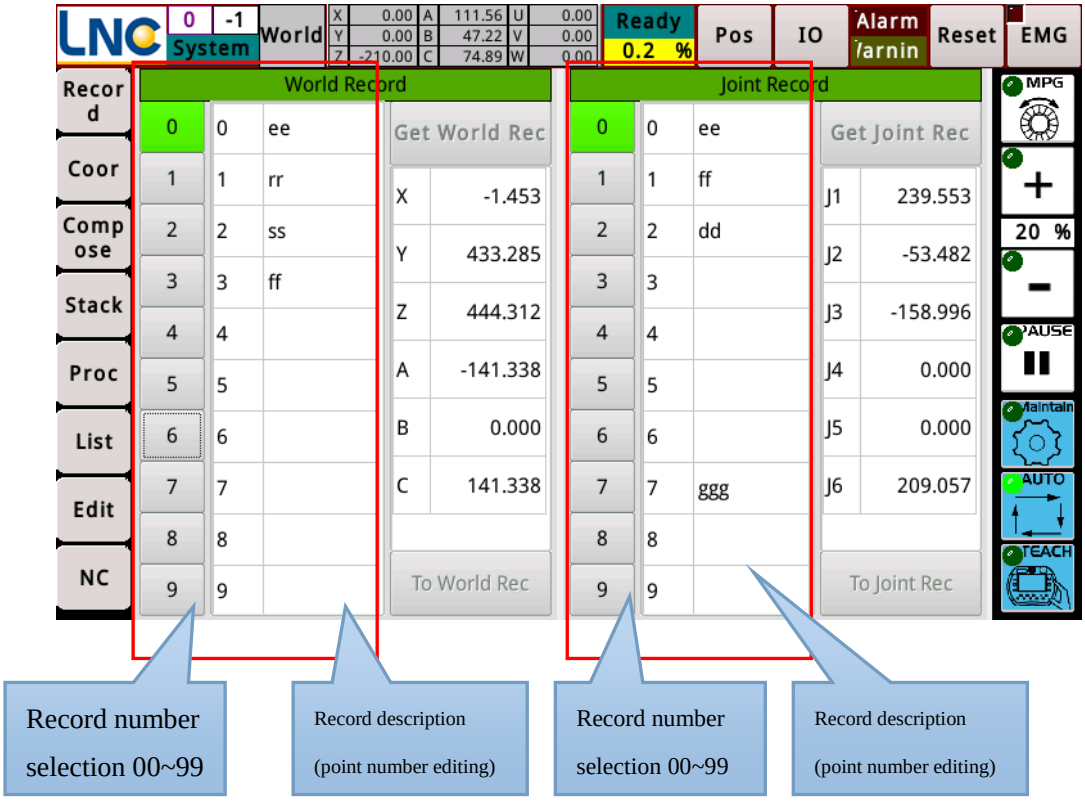
14. Press 推算 and the system will automatically bring in the value of angle A, angle B and angle C.



7. Point record

There are two types of point records: world records and joint records.

You can use the "joint record" or "world record" command to program the position that needs to be different due to installation. It is only necessary to re-calibrate the point record when the actual site is installed, and it is not necessary to modify the programming content on site.



Get World Rec : Update to the currently selected world record with current world coordinates

To World Rec : The linear path is calculated according to the current position and the target position.

Get Joint Rec : Update to the currently selected joint record with the current joint coordinates.

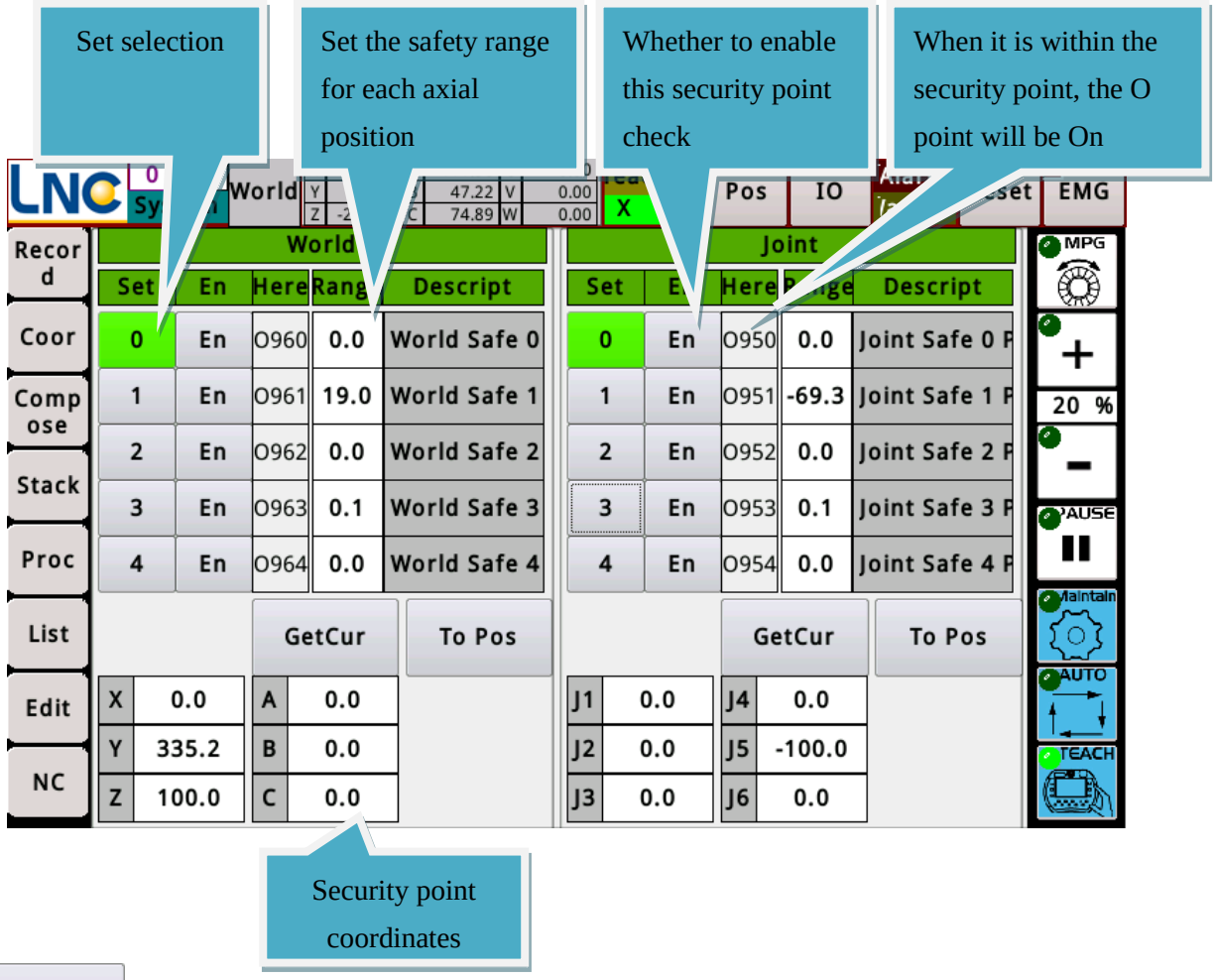
To Joint Rec : Move to the selected joint record position in a fast moving manner.

Note 1: The point record can be used as a coordinate system in addition to the point of operation.

8. Security point

During the running of the program, the initial position of the restarting program may be different from the ideal starting position due to sudden power failure or reset. If the manipulator stops at a point where interference may occur, start program rashly may cause a collision.

The setting of system planning five sets(0~4) joint coordinate check interval, five sets(0~4) world coordinates check interval and the position interval can be set through the following page.



GetCur: Get the current coordinate value and set it as the coordinate of the security point.

To Pos: Move to the security point position (Moves when pressed and stop when released)

Note 1： SafePos0 to Start Yes can be set on the option page. If the robot's point is wrong when starting, it will directly send an alarm to avoid the danger of collision.

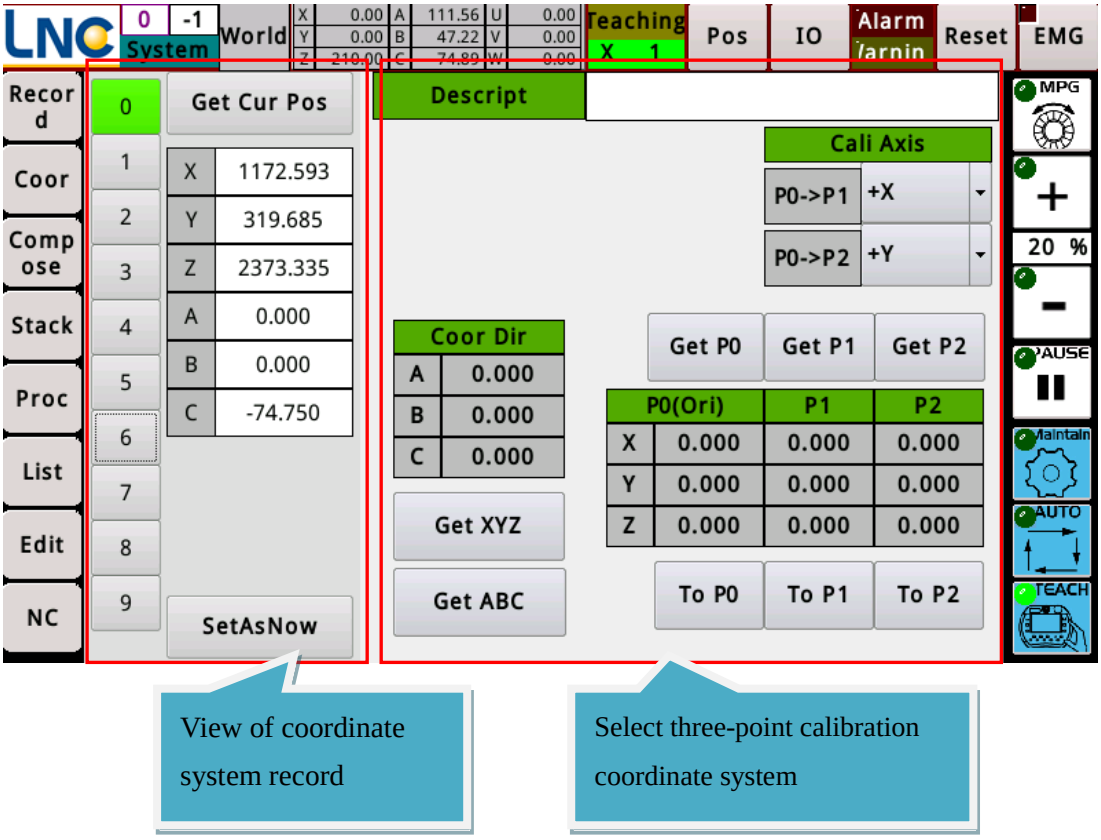
Note 2：When the program starts, you can check the position of the robot by checking whether 0950~0954, 0960~0964 are on, and give the appropriate path back to the safe starting position.

9. Coordinate system

The coordinate system is mainly used to adapt to the position relationship between the robot and the workpiece, including the offset and rotation and tilt of the work area. The system provides 10 sets of coordinate system records to meet the needs of multiple sets of processing areas.

The following figure can be divided into two areas, the left side is used to view the current coordinate system record, and the right side is a three-point coordinate system method to help calculate the positional offset, direction rotation and tilting of the coordinate system.

After the coordinate system is determined using three points, it can be stored in the coordinate system record for use in the program.



Get Cur Pos: bring the current world coordinates of the robot into the coordinate system

record.

SetAsNow: Set the selected coordinate system record value to the current work coordinate system.

Get XYZ: bring the XYZ of the right P0 into the coordinate system record.

Get ABC: bring the "coordinate system attitude" ABC calculated from the coordinate system on the right into the coordinate system record.

Principle and operation of three-point coordinate system

In mathematics, we can determine a coordinate system through three-point positions, where:

P0：origin of the coordinate system

P1：the point on the main axis

P2：point on the secondary axis (on the plane)

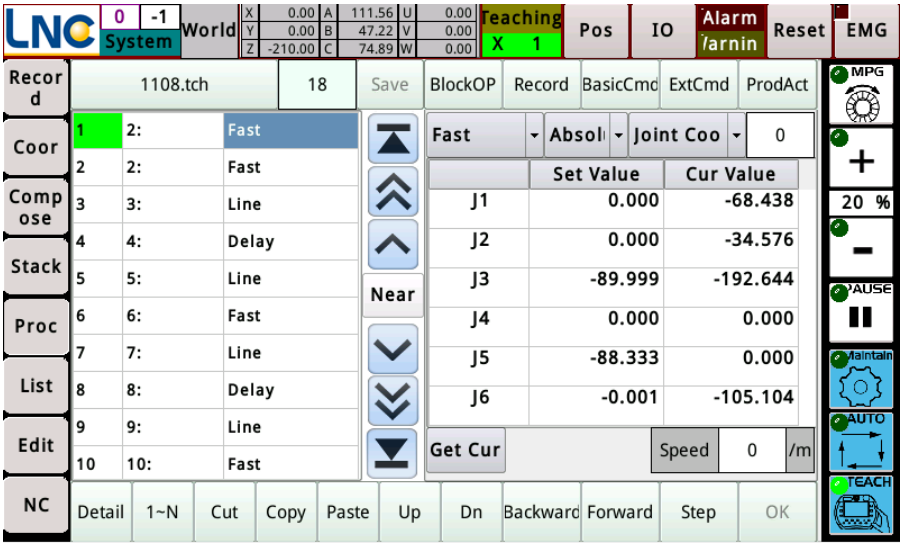
According to the difference of the actual workpiece or the direction of the action path, the main axis may be a point on +X, -X, +Y, -Y, +Z, -Z, and the secondary axis is also the same, so 24 kinds of three-point definition can be provided.

After selecting the relative position of the object in the working area and the manipulator arm, the three-point coordinate system can be set. The operation mode is as follows:

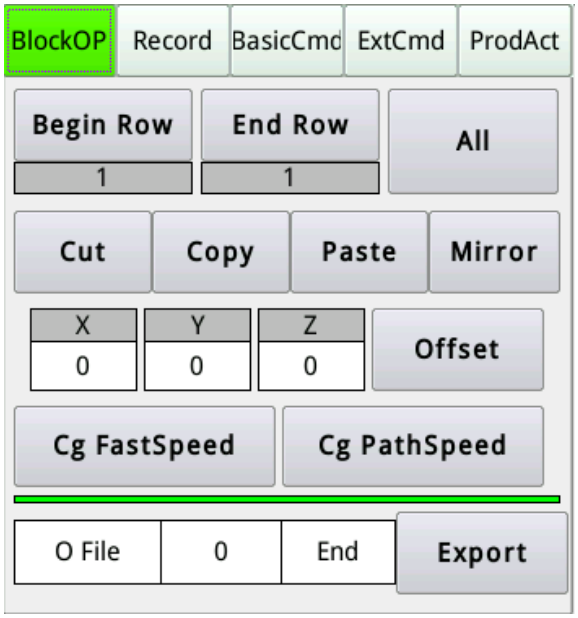
1. First select the origin P0 and P1, P2 to be used as the basis for the calculation of the coordinate system.
2. First adjust the robot to an appropriate attitude and align to P0, P1, P2.
3. According to the axial direction where P1 and P2 are located, click the upper axial selection to switch the axis.
4. Press XYZABC below to align the Ptool to P0, then press "P0" to bring "Current World Coordinates" into P0 coordinates.
5. If you only intend to use the position of the offset coordinate system and do not intend to change the rotation of the coordinate system, just correct P0.
6. Press XYZABC below to align the tool Ptool to P1, then press "P1" to bring "Current World Coordinates" into P1 coordinates.
7. Press XYZABC below to align the tool Ptool to P2, then press "P2" to bring "Current World Coordinates" into P2 coordinates.
8. The system automatically calculates the attitude of the coordinate system.

10. Introduction to operation interface of program page

10.1. Teaching mode



10.1.1. Block operation



Start column, end column: After selecting a column in the list, press the two buttons to set the processing range.

All columns: select all columns

Cut: Cut all the contents in the setting range and put them in the internal clipping area.

Copy: Copy all the contents of the setting range and put them in the internal clipping area.

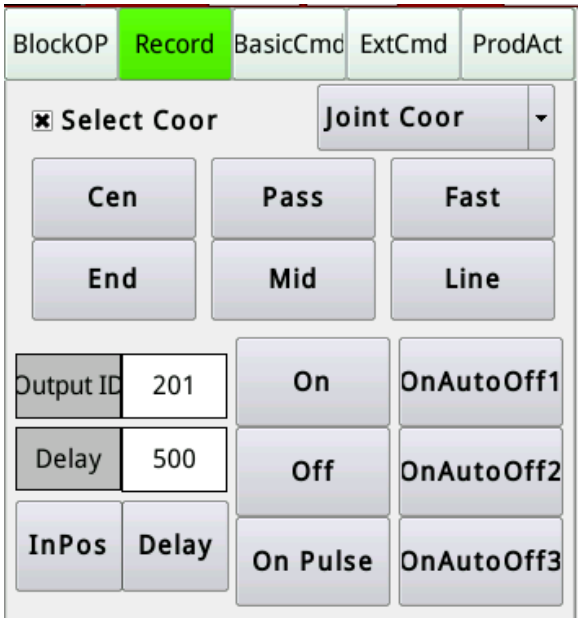
Paste : Paste the contents of the internal clipping area onto the position of the selected column in the list.

Offset XYZ: Offsets all the items of "world coordinates" and "work coordinates" in the set range from the set value.

Modify speed: Change all the commands including the speed field in the setting range to the input speed value.

Export: Export the current file to G file, O file or insert file.

10.1.2. Recording



The recording function is mainly for the convenience of quickly teaching a motion path, so only a few path commands and output control commands are placed on the screen.

On the list of programs, after selecting the position where the recording command is to be inserted, click the button on this screen.

After moving the robot to the preset position, press the action to be performed to move to this position. This process is called "recording". Because each robot position has a variety of coordinate system representations, the recording is directly using the coordinate system used in the current teaching, or specifying which coordinate system to record.

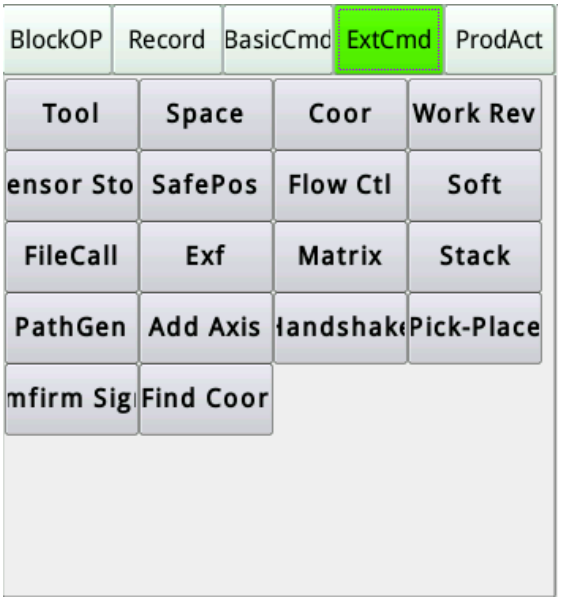
Keys	Record command	Command parameters
Select coordinate system	Select coordinate system	The coordinate system selected is used as the recorded coordinate system.
Fast path	Fast path	If the "Select Coordinate System" function is not on, the coordinate system of the teaching motions is used as the recording coordinate system to generate a command line that moves to the current position. If the "Select Coordinate System" function is on, the coordinate system selected at rear is the recorded coordinate system.
Linear path	Linear path	
Arc midpoint	Arc midpoint	
Arc transition	Arc transition	
Arc center	Arc center	
Arc end	Arc end	
In place	In place	Range of in-place
Delay	Delay	Delay time
ON	Set O	Different setting states
OFF		
ON pulse		
ON background OFF1		
ON background OFF2		
ON background OFF3		

10.1.3. Basic instructions

The basic instructions include the flow control class, waiting class, state setting class, and the motion instruction.
After clicking one of them, the item details of the item will appear for editing. After editing, press "OK" to add the instruction to the program list.

The following sections are described in detail.

10.1.4. Extended instruction



Extended instructions contain some common features, either to make the program list easier to read, or to include a composite motion flow in a single instruction.
After clicking one of them, the item details of the item will appear for editing. After editing, press "OK" to add the instruction to the program list.

The following sections are described in detail.

10.1.5. Editing columns

Detail: It can be used to switch the display mode of the program. There are three types: detailed, simple, and G code.

1~N：Re-arrange the order in the description based on the column number of the program. The main purpose of this motion is to let the operator understand the order of the operations, so that when the insertion position is mishandled, it is convenient to know how to adjust the order of the program lines.

Cut：Cut the contents of the selected column and paste it into the internal clipping area.

Copy：Copy the contents of the selected column and paste it into the internal clipping area.

Paste：Paste the contents of the internal clipping area onto the position of the selected column in the list.

Up：Moves the currently selected column up.

Down：Moves the currently selected column down.

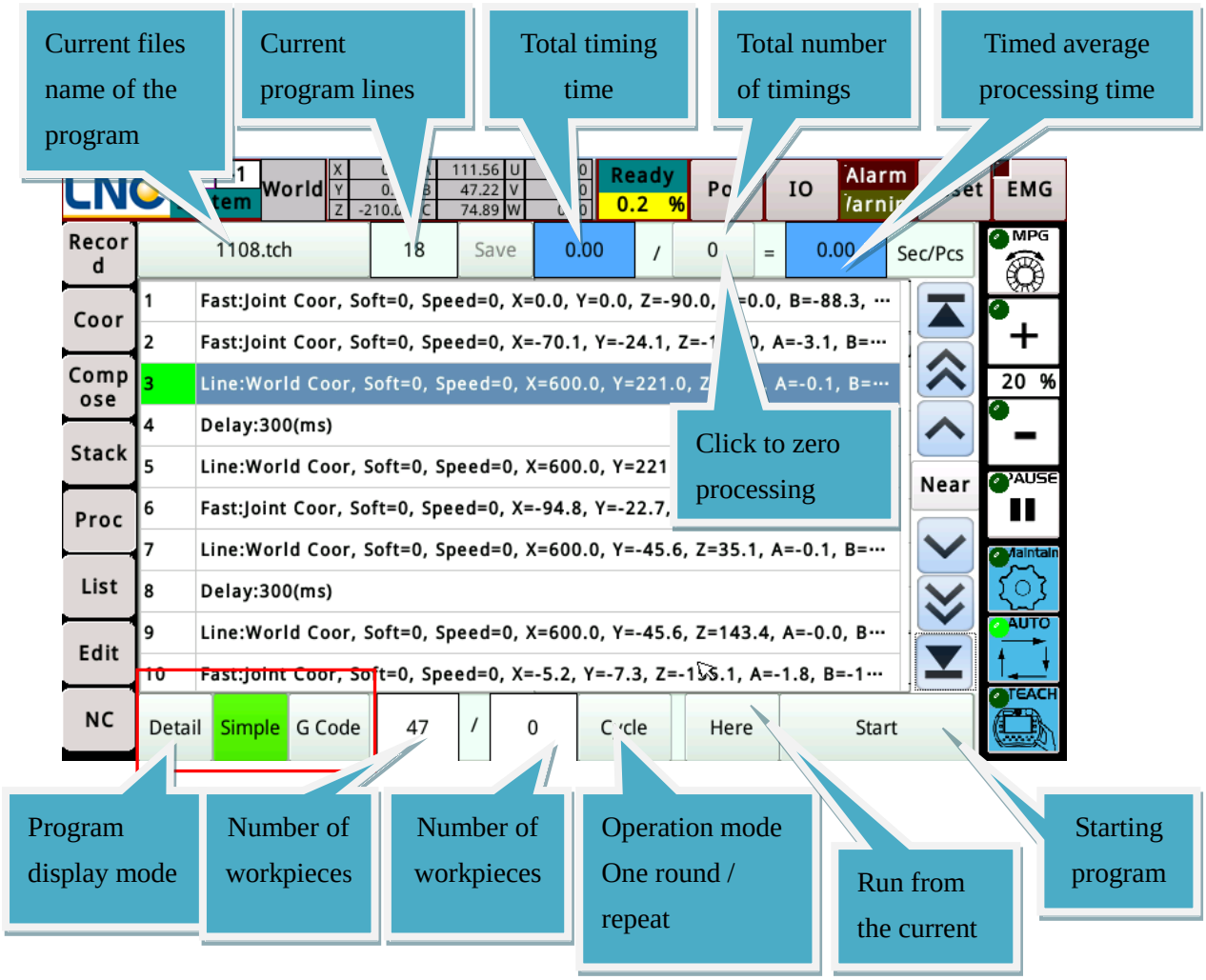
Back：If the current position is matched with the selected command line, pressing this button to let the robot return along the path until the previous command point.

Forward：If the current position is matched with the selected command line, pressing this button to allow the robot to forward along the path until the next command point.

Single-step：Move the robot to the position where the command line is currently selected.

Description: The single step, forward and back functions are especially suitable for confirming the accuracy of the track and speeding up the debugging program.

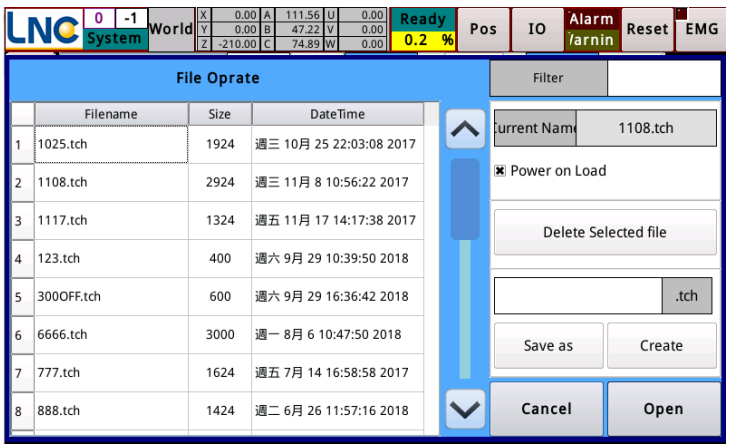
10.2. Automatic mode



10.3. Process of editing and running the program

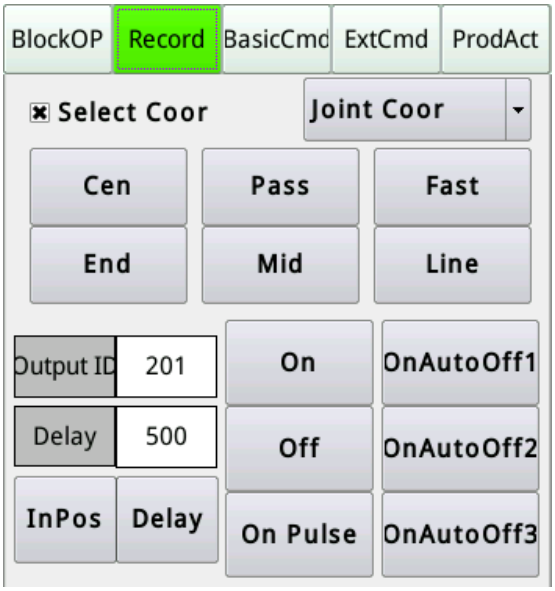
10.3.1. Creating or opening a file

Clicking on the block of file name to pop up operation page of program files, through which to create, save, and open the program files.



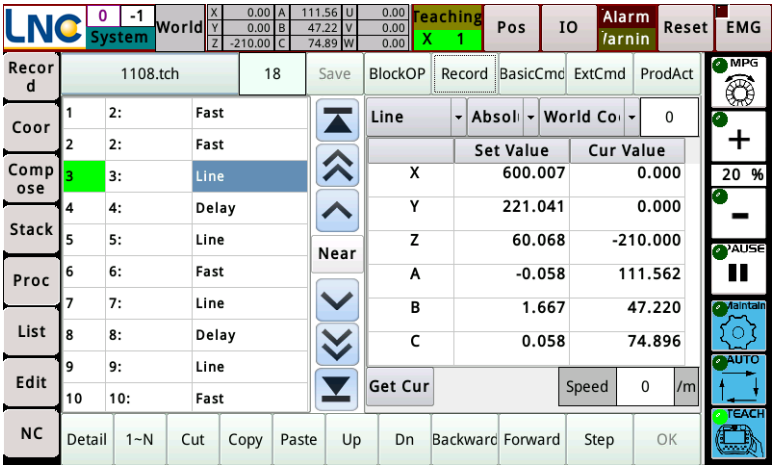
10.3.2. "Record" continuous track and IO motion

1. Switch to teaching mode and click Record
2. Move the robot to the target position with a button or handwheel
3. Set "Select coordinate system"
4. Click on the line or other action command
5. Repeat steps 2~4 to complete the action flow.



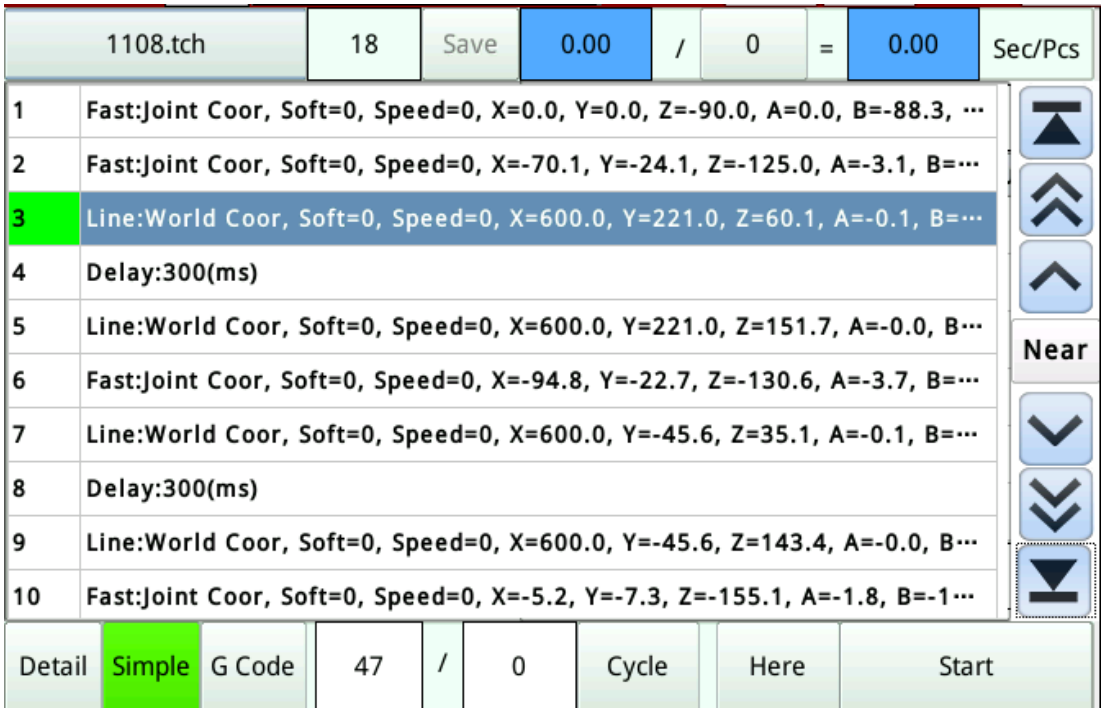
10.3.3. "Step", "Forward", "Back" function confirmation and correction track

1. The robot can be reached on the trajectory by pressing the Step to execute the selected command line.
2. Pressing forward and back allows the robot to move along the trajectory to the next command point.
3. If the trajectory is deviated, you can adjust the position, then press Get Cur and archive, then continue to use the Forward and Back to test to correct the trajectory.



10.3.4. Handwheel run test

1. Cut to automatic mode and select the handwheel.
2. Press Start to rotate the handwheel to let the program run at the speed of the handwheel.
3. If you think that the program does not work as expected, you can reset the program and then switch to manual mode to adjust the program.
4. After the adjustment is completed, execute the single step to the command line that the test just interrupted.



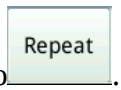
5. Switch to automatic mode again.
6. Click 

to change it to 

.
7. Press Start to continue the unfinished run test.

10.3.5. Operation observation of "Repeat"

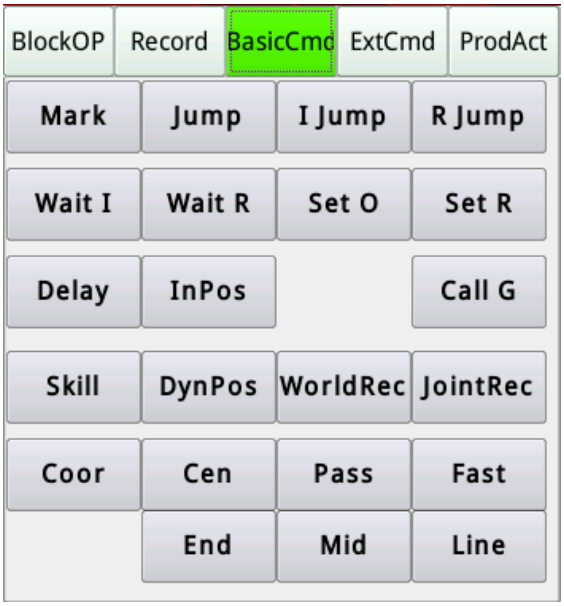
1. Click 

to change it to 

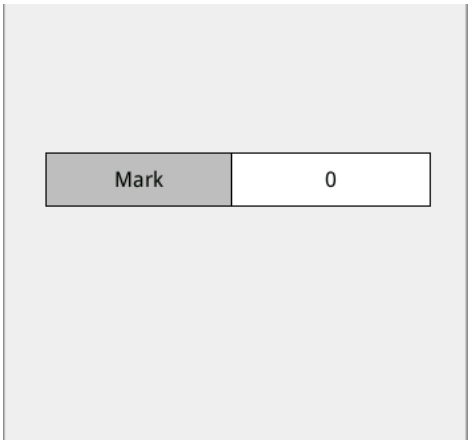
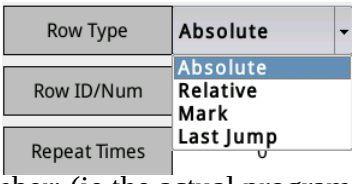
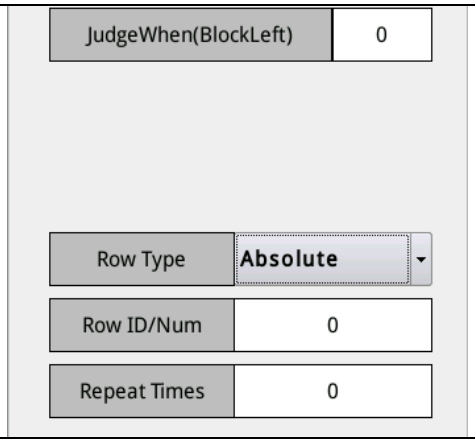
.
2. Close the handwheel.
3. Start the program, observe the effect of repeated running, and continuously adjust and optimize to the best.

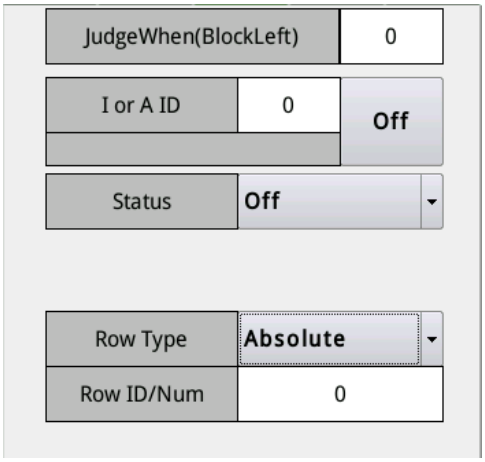
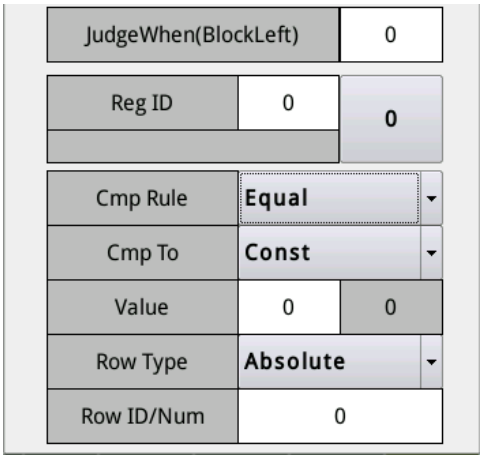
11. Introduction to program page instructions

11.1. Basic instructions

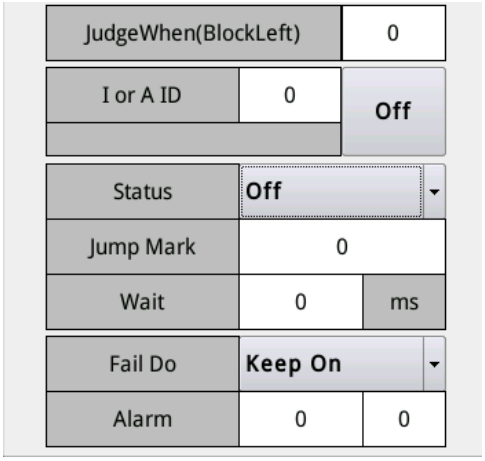
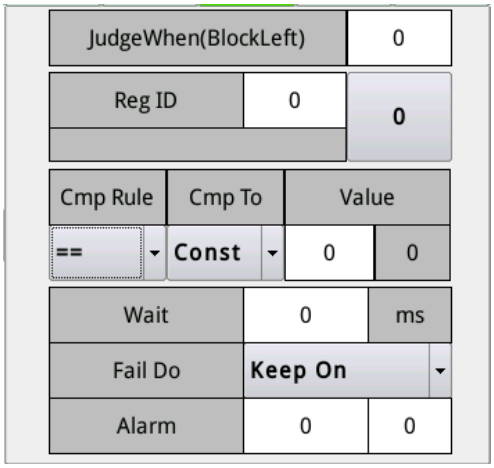
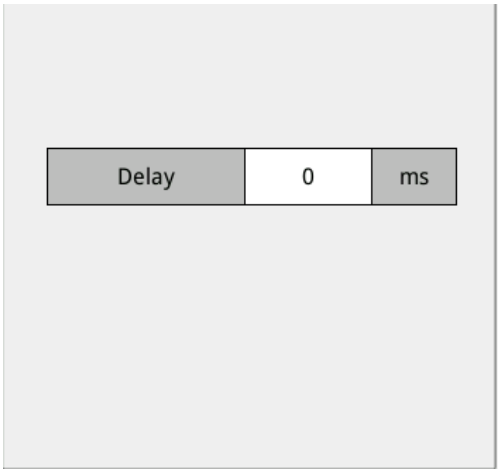


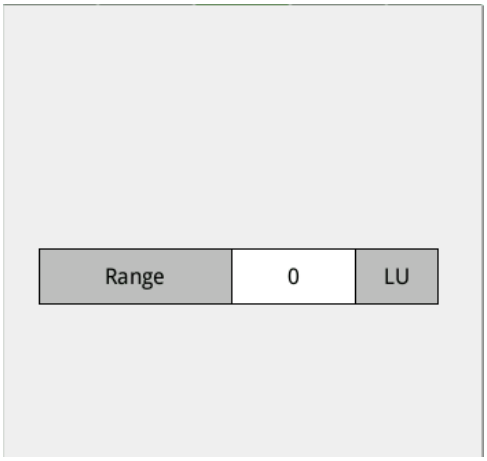
11.1.1. Process Control

Mark Set the label of the command line for the reference of skipping setting.	
Jump Skip directly to a line. Line number type: Absolute line number: (ie the actual program line number). Relative line number: (relative to the current line of line number, for example, currently line 8, -4 means skipping to the 8 - 4 = line	 

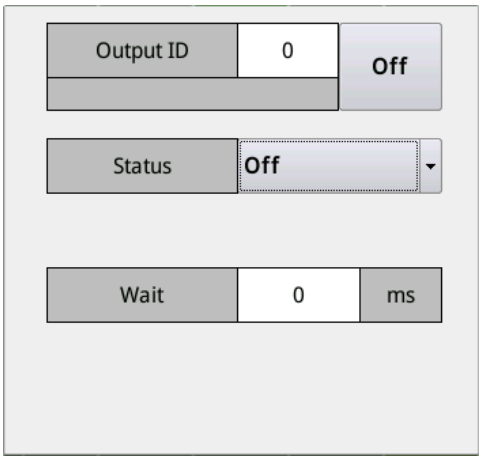
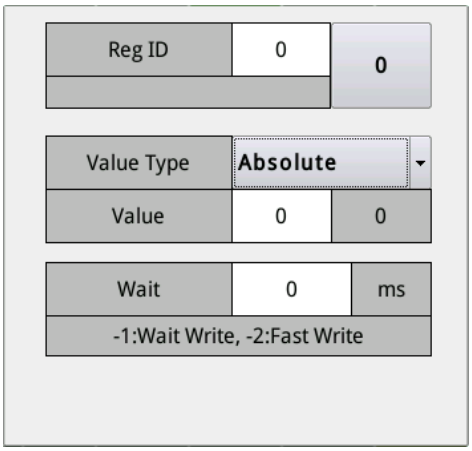
4). Label: (ie the label column set previously) Last skip: Return to the next line of the last calling skip command. Line number / lines: refer to skip mode Times: Repeat the times of this skip action	
I Jump Skip to the specified line when the conditions of I or A meets the requirements. No: number of point I Value: When the state of point I is in accordance with this setting, the skip action is performed. Skip mode: refer to skip command	
R Jump When the condition of R matches, skip to the specified line. No.: R value number Comparison method: Value: Constant (fixed value), R value (refer to the content of another R value). Right box (constant value / R value number) Skip mode: refer to skip command	

11.1.2. Waiting type

Wait I Continue operating after waiting for I to match the status Number: number of point I Value: When the status of point I is in accordance with this setting, the next action is performed. Waiting: The longest waiting time. Failure processing: processing after waiting time	
Wait R Continue operating after waiting for R value to match the status No.: R value number Comparison method: Value: Constant (fixed value), R value (refer to the content of another R value). Right box (constant value / R value number) Skip mode: refer to skip command Waiting: The longest waiting time. Failure processing: processing after waiting time	
Delay Moves after waiting time Delay：The time need to wait	

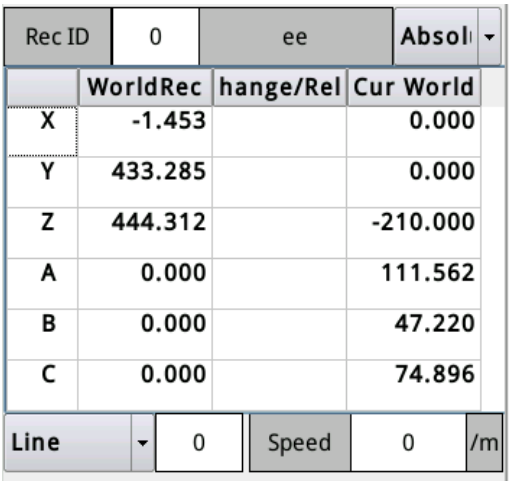
InPos Move after waiting for arriving the position Arriving: 1/1000 degree, or 1um Note: The range of arriving will only be checked after the commands have been sent. So, setting a very large value may not have the desired effect.	

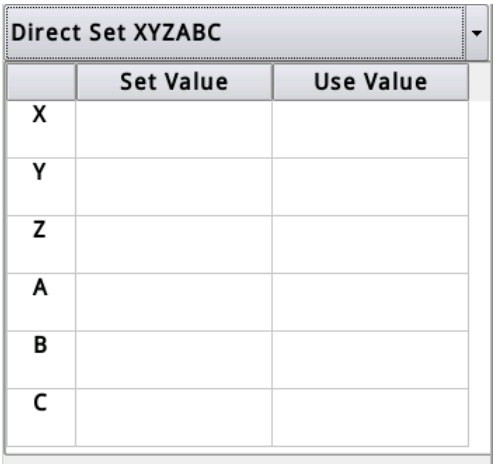
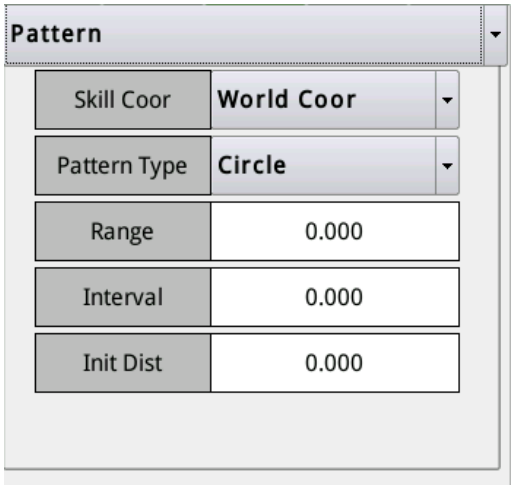
11.1.3. Status setting

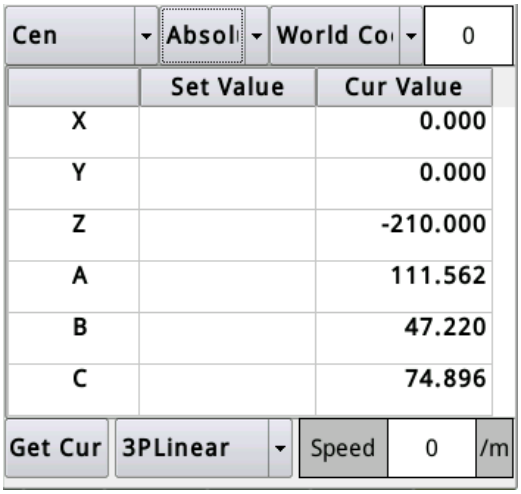
Set O Set the status of point O Number: the number of the point O Value: Off, On, commutation (change to another state based on the current state of the point O) Wait: Set how long to wait before executing the next line.	
Set R Set the content of R value Number: the number of R value Type of value: Absolute: directly set the content of the R value to the content in the "Value" field. Relative: Accumulate the content of the Value field based on the content of current R value. No.: Set the R value of the specified R number in the Value field to this R value. Add 1 to the circulation: Add 1 to the current R value and set it to 0 when the value is greater than the set value in the Value field. Value: Reference mode description	

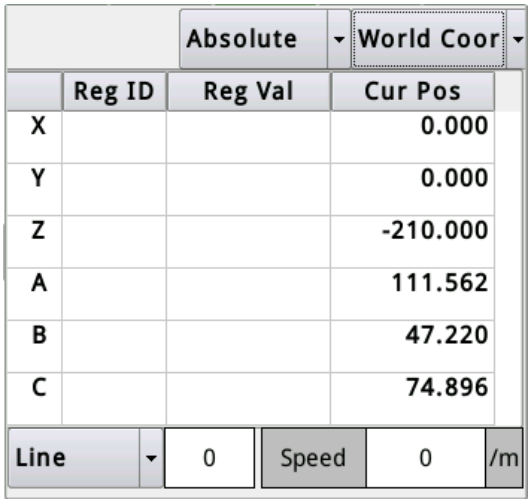
Waiting：Set how long to wait before executing the next line. When this value is filled in -1, the system will wait until the previous command is executed, and then continue to interpret, which can be used to avoid synchronization during the motions, but it may make the motions less continuous. When set to -2, it means to write immediately, not to write until the motions arriving to this line.	

11.1.4. Motion command

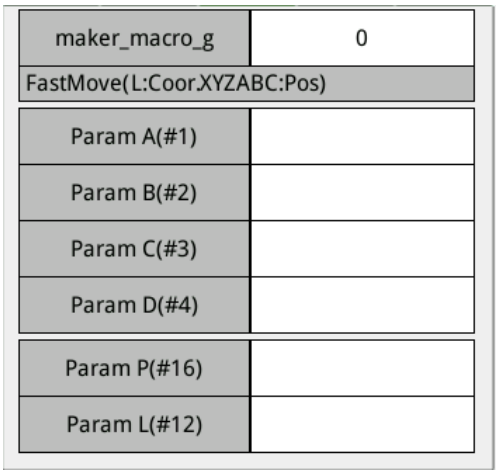
WorldRec Record number: based on the record number. World record: Display the value of the world record directly based on the record number. Current world coordinates: Display current world coordinates. Point type: fast, linear... Flexibility: input blank or 0~5 (corresponding to the setting of debugging page) Speed: If the speed is 0, it means the default linear speed is used. -1~-100 represents the percentage of the set speed in the debugging page.	
JointRec Record number: based on the record number. Absolute/Relative: The input value in the "Alternate/Offset" column is absolute or relative and can be used to change an element in the coordinates. Joint record: Display the value of the Joint record directly based on the record number. Current joint coordinates: Displays the current joint coordinates. Point type: fast, linear... Flexibility: input blank or 0~5 (corresponding to	

the setting of debugging page) Speed: If the speed is 0, it means the default moving speed is used. -1~-100 represents the percentage of the set speed in the debugging page.	
Coor There are many ways to set work coordinate system, as detailed in the sections.	
Skill Set whether to use special movement when the path moves. Stop process: If there is a process started, this command will generate a linear path from the process offset position to the original position. Start process: If the process is not started, this command will generate a linear path that moves the current position to the process offset position. If the process is already enabled, this command will generate a linear path that moves the current process offset position to the new process offset position. Process coordinate system: The coordinate system on which the process path is based. Sample type: There are three types of winding, moving back and forth, moving left and right, and can be expanded according to actual needs in the future. Moving range: The swing range, that is, the maximum distance from the original path.	

Paragraph distance: The position of the swing is repeated after every certain paragraph distance on the path. Initial movement amount: The amount of movement at the beginning of the process when the movement distance is 0. Dynamic process: Same as Start, except that the parameters of the process are determined by the content of the R value. Note: When using this function, the actual calculated process offset value must be smaller than the "Max Range of Process" column in the "Options Page/Run", otherwise the alarm will pop up.	
 Absolute/relative: The content representing the set value is either absolute to the selected coordinate system or relative to the current coordinate of the target coordinate system. Coordinate system: the coordinate system used to represent the contents of the set value Flexibility: input blank or 0~5 (corresponding to the setting of debugging page) Set value: XYZC Speed: If the speed is 0, it means the default moving speed. -1~-100 represents the percentage of the set speed in the debugging page. Set to the current: Fill the current coordinates of the coordinate system into the set value according to the selected coordinate system.	

DynPos Absolute/relative: The content representing the set value is either absolute to the selected coordinate system or relative to the current coordinate of the target coordinate system. Coordinate system: the coordinate system used to represent the contents of the set value Number of XYZC set value: Source buffer for obtaining XYZC coordinate information. If this field is blank, it means that the previous coordinates are used. ,lPoint type: fast, linear... Flexibility: input blank or 0~5 (corresponding to the setting of debugging page) Speed: If the speed is 0, it means the default moving speed is used. -1~-100 represents the percentage of the set speed in the debugging page.	

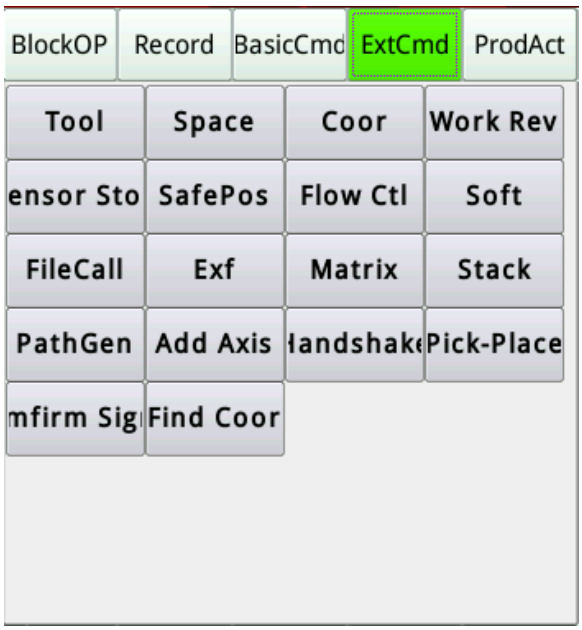
11.1.5. Function module calling

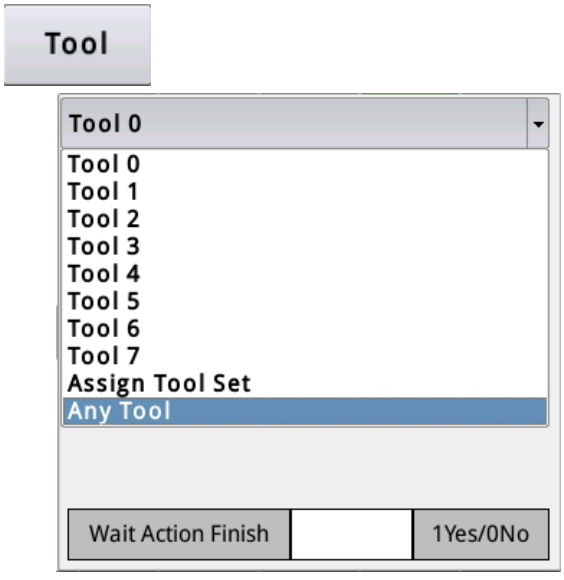
Call G Call G code built-in by the system or manually written by the developer to provide greater flexibility Parameter A(#1) : The first parameter to be transmitted to the G-code. Parameter B(#2) : The second parameter to be transmitted to the G-code. Parameter C(#3) : The third parameter to be transmitted to the G-code. Parameter D(#4) : The forth parameter to be transmitted to the G-code. Parameter P(#16) : The fifth parameter to be	

transmitted to the G-code. Parameter L(#12) : The sixth parameter to be transmitted to the G-code.	

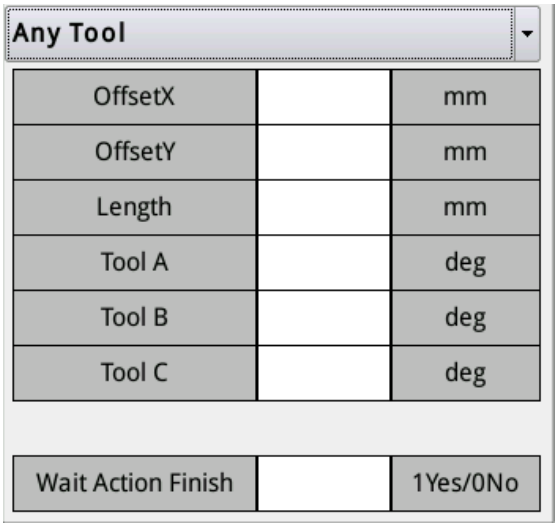
11.2. Extended instructions

The extended command currently contains 18 practical process packages. The contents of many task packages need to be combined with additional page settings. Because there are many scopes, this document contains detailed instructions for the instructions and pages. Please ask the machine for instructions.





Used to dynamically switch the tool groups set in the tool page, or dynamically set the desired tool parameters.



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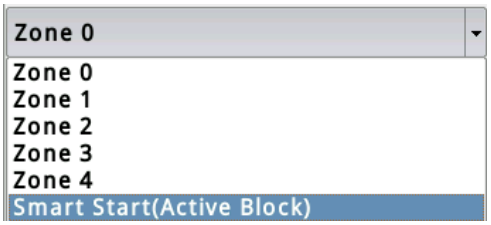

Used to dynamically switch the preset range of points in the limit page to avoid operation or programming errors and exceed the allowed active space.
</td>
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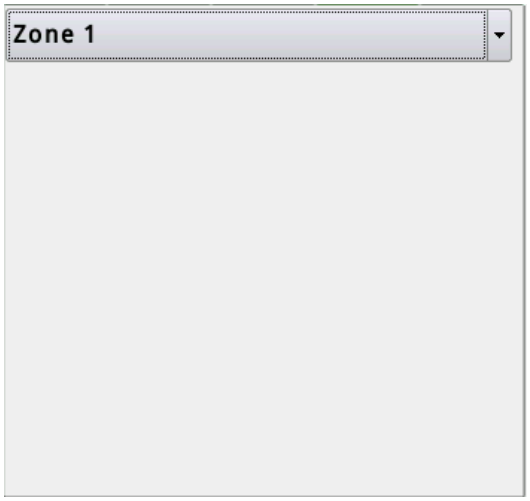

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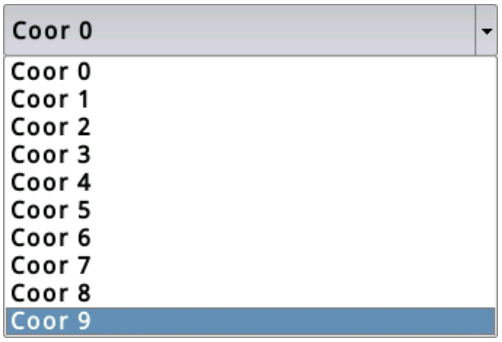

It is used to dynamically switch the coordinate system record set in the coordinate system page. The use can easily see the current coordinate system in the program list.
</td>
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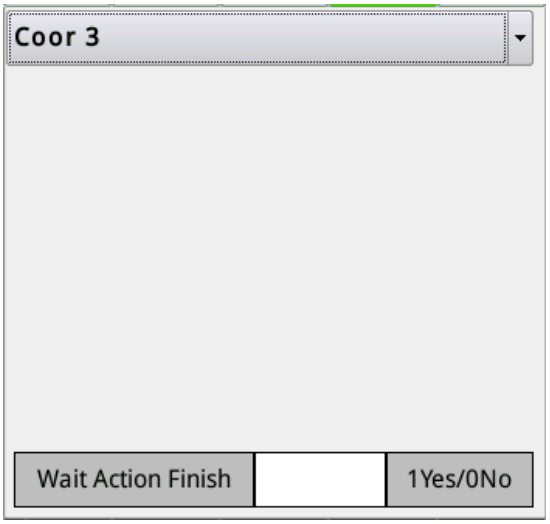

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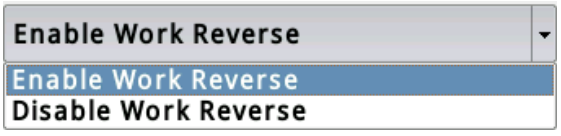
Work Rev


It is used in applications where the robot clamps the workpiece for path editing, such as polishing.
When the working coordinates are reversed, the three-point arc of the workpiece surface can be realized, which can greatly reduce the number of teaching points.
</td>
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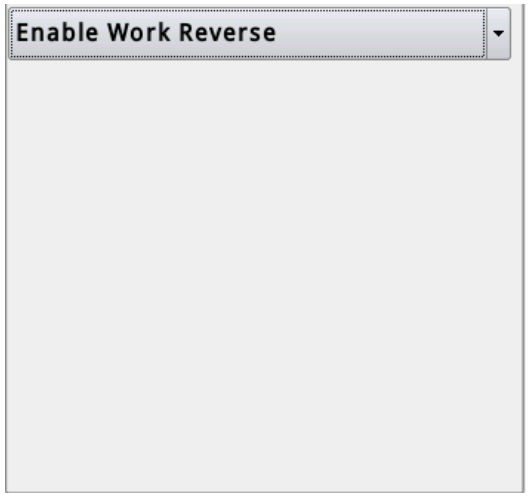

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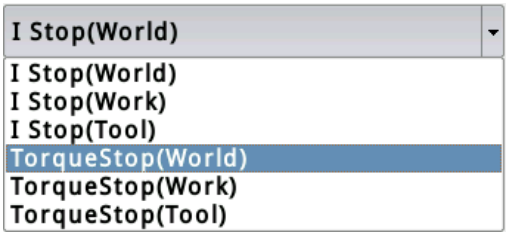
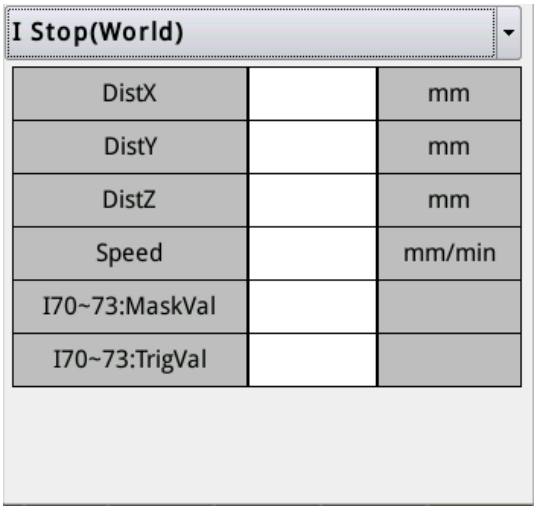
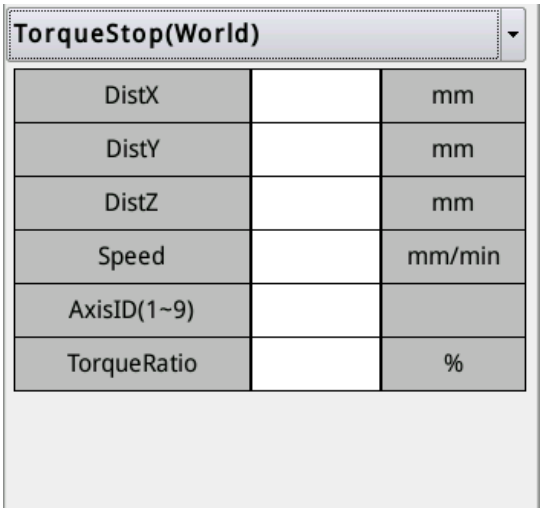
ensor Sto



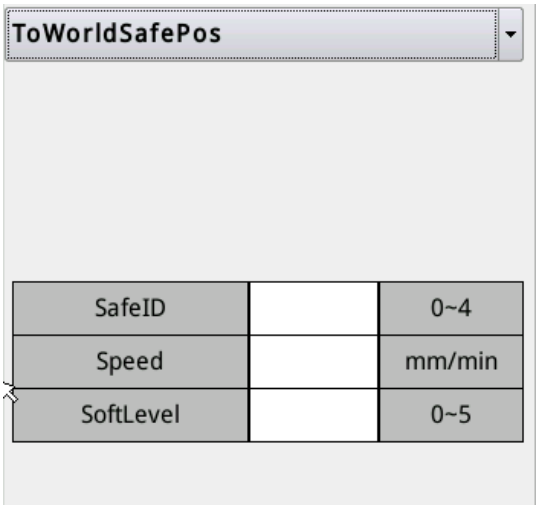
It is used to stop the action when the sensing signal changes during the motion, for example the raw materials stacked by the punching machine, as the quantity decreases, the suction position changes. It can be judged whether the reclaiming position is reached by the sensor mounted on the tool during the process of lowering the reclaiming.





SafePos

With the settings in the security point page, check whether the current position is within the range of the security point, and provide the function of moving the position of the security point.



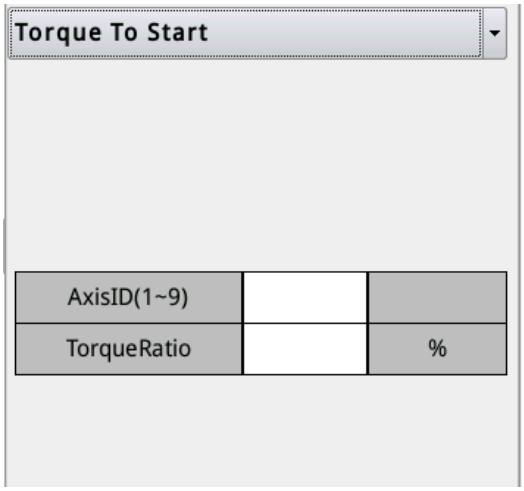
Flow Ctl

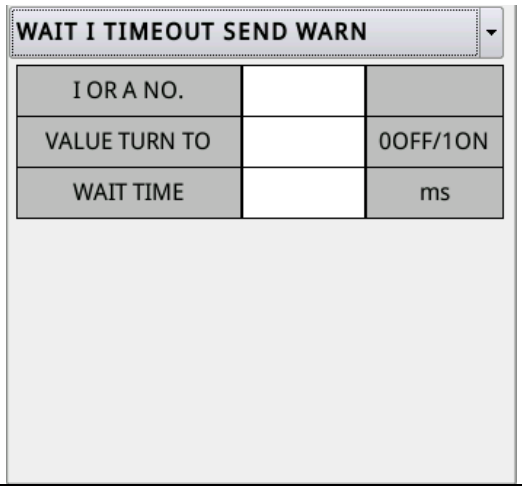
Provide three methods to control the program flow

Program pause: put the program into a pause state

Wait for the torque to reach the start: the action is in a waiting state until the torque of a certain axis arrives, and then continue to run the subsequent action.

Issue warning when Wait I timeout:it is equivalent to Wait I command, but if the waiting time is exceeded, a warning signal will be issued.





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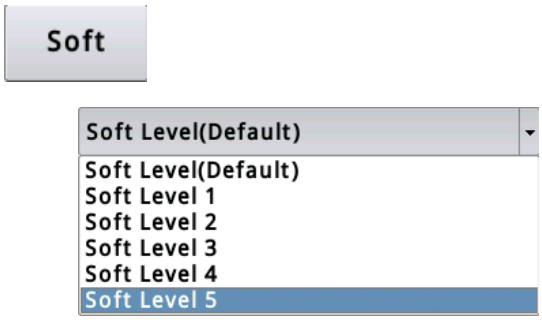

Dynamically switch the flexibility settings in the debugging page
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<tr>
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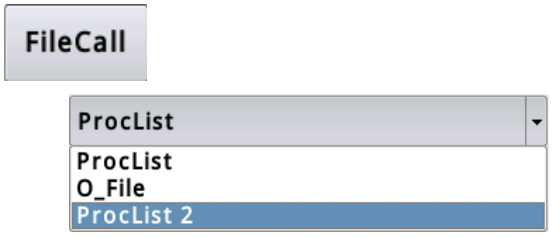
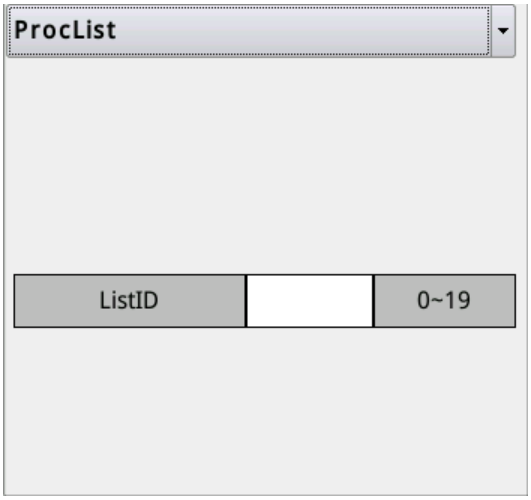
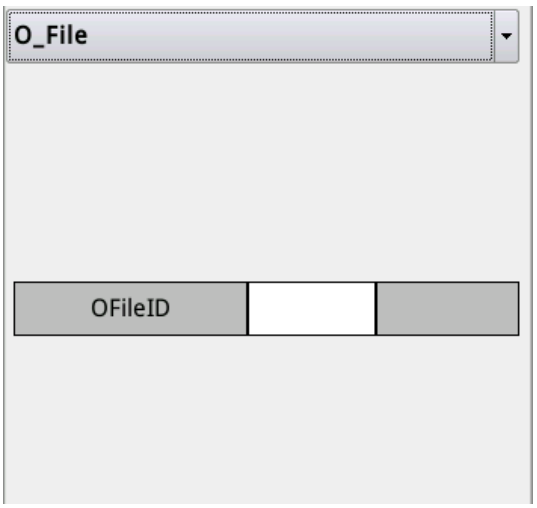


You can call the program login the program list page, or the O files exported from the block operation.
</td>
<td>




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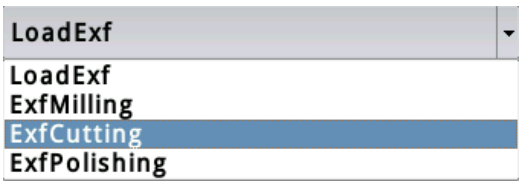
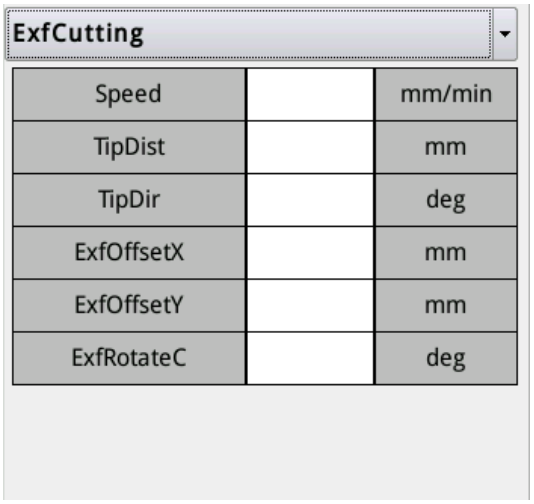
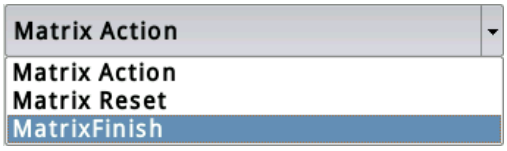
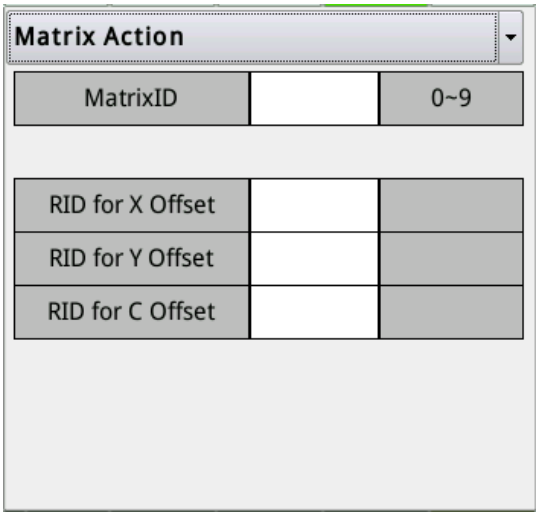


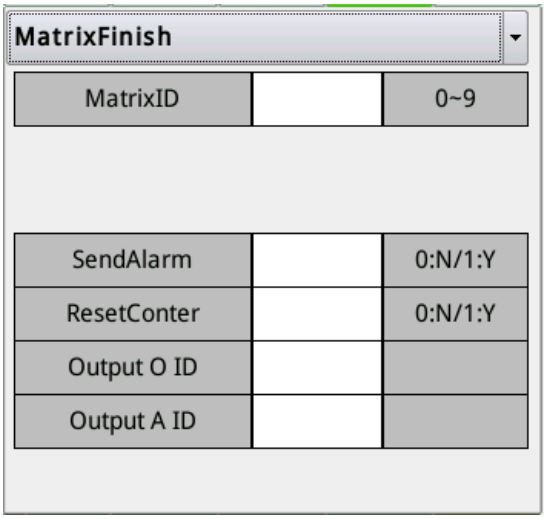
The image files login the map files list page can be loaded, and the path directly from the image file to the corresponding processing action is operated by the system.



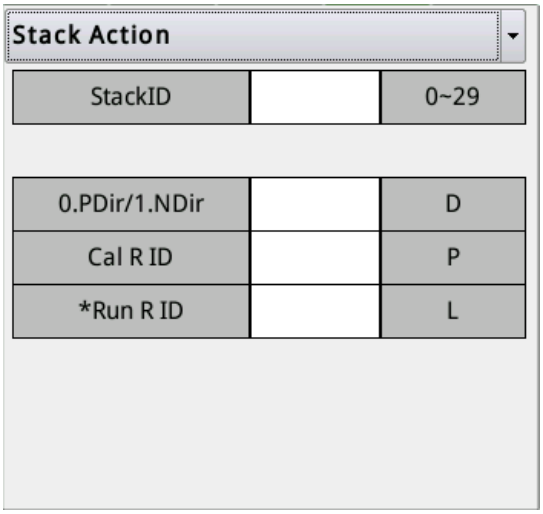


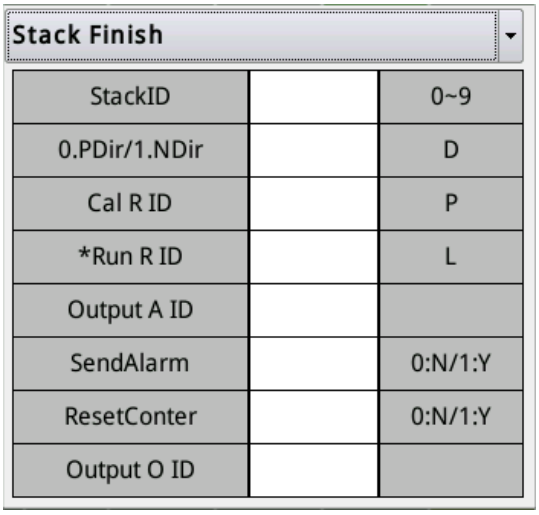
Match the settings of the matrix page to perform related actions.





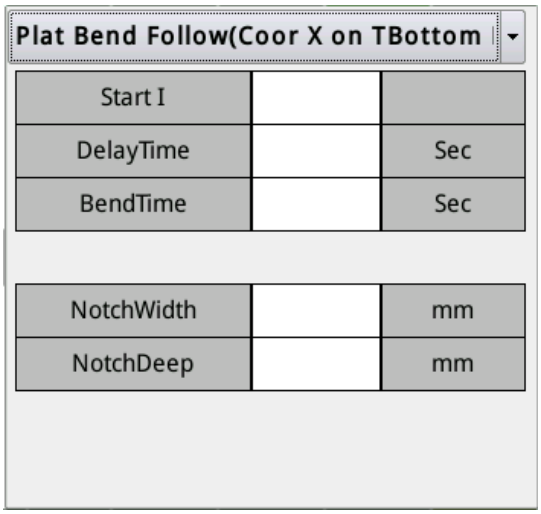
Use the settings of the stack page to perform related actions.



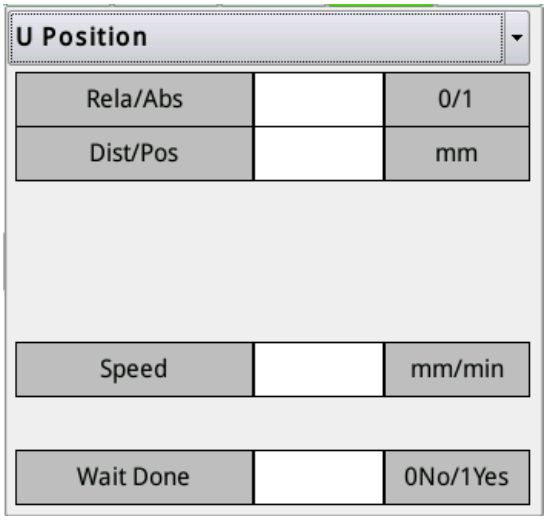


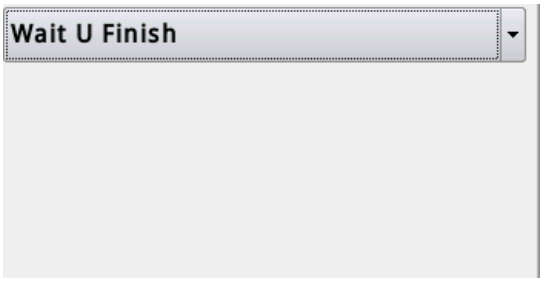
Used to generate the path of special application.

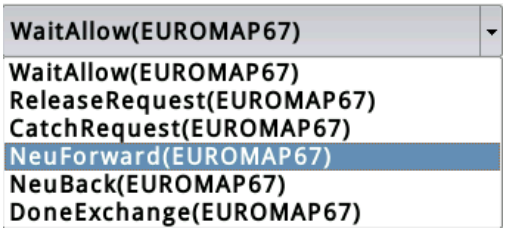
Follow bending of bending machine: When the folding machine bends the sheet metal, the robot must follow the path of the sheet metal bending for movement.



Used for a command for positioning the additional axis separately when the additional axis is not in motion with the body.

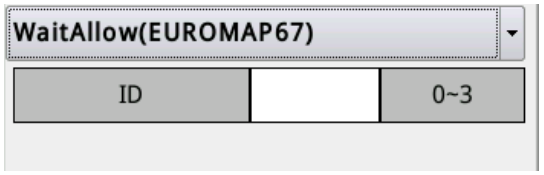






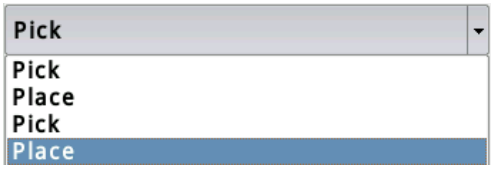
Follow the EUROMAP67 specification for the signal communicating with the machine.

The system has four sets of peset machine



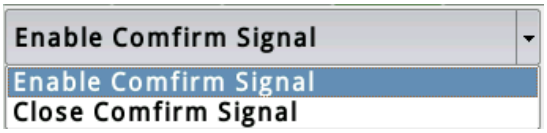
handshaking signals.

Pick-Place

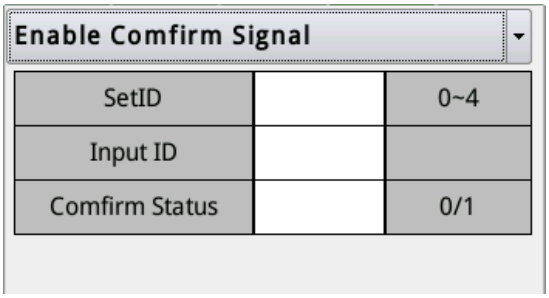


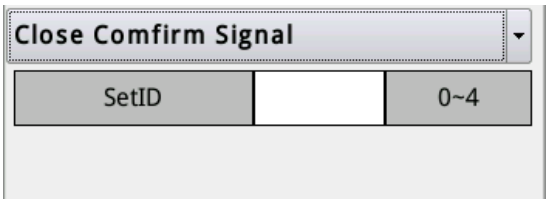
The four instructions operate in the same way and provide different names to facilitate the purpose of distinguishing their instructions in the program list.

mfirm Sig

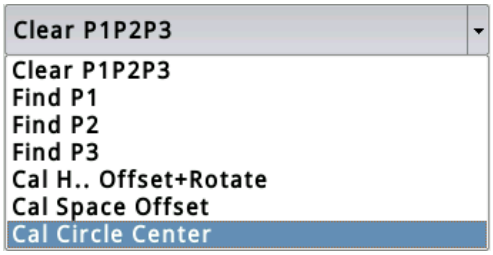


Provides detection of four sets of signals. When the command between the start and the stop is running, if the signal of the I point is detected to be inconsistent with the state that it should be, an alarm will be issued.
It can be used in the process of taking workpieces to detect the use of falling workpieces.

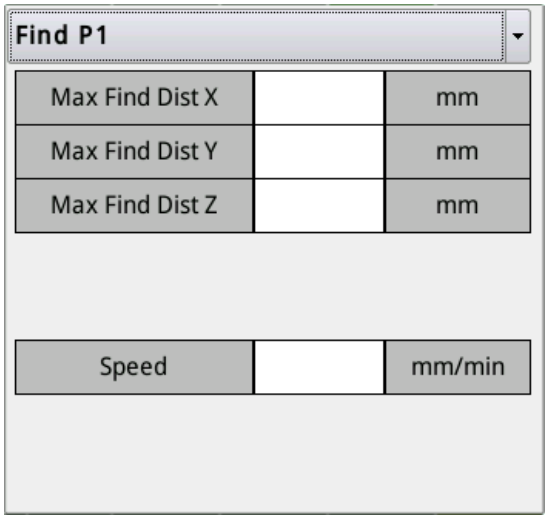


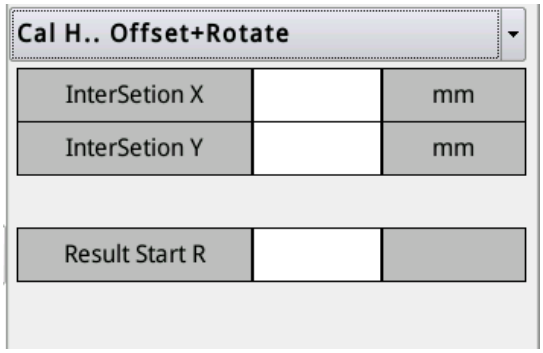


Find Coor



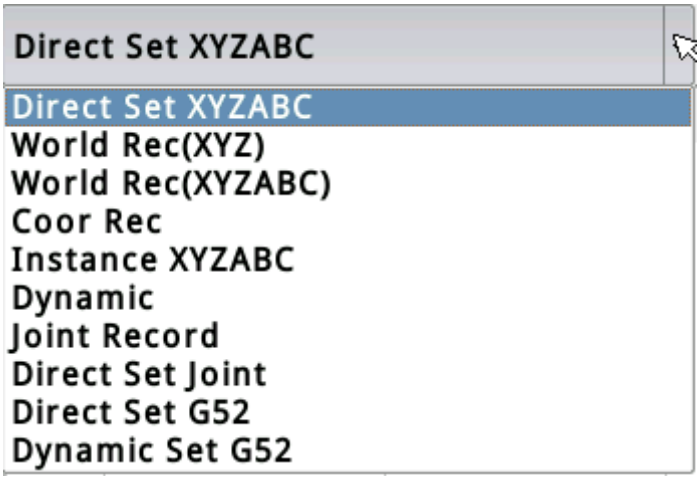
When used in welding, the workpiece cannot be accurately placed. It is necessary to touch the surface of the workpiece through the welding wire to know the true position of the workpiece and set the actual work coordinate



system.	 Cal H.. Offset+Rotate InterSetion X mm InterSetion Y mm Result Start R

12. Use coordinate system to simplify programming and maintenance

In addition to being used to calibrate the work area, the coordinate system can also be used as a reference point for peripheral actions. By using the coordinate system, the influence factor of the programming content can be reduced to only a few key points to achieve the purpose of program sharing and convenient maintenance.
The following is a description of the applicable timing for various setting of the coordinate system options:



12.1. Setting XYZABC directly

Fill in the value of the coordinate system directly.
It is suitable for use when inputting values arbitrarily in the development environment or when the coordinate system is fixed.

12.2. World Record XYZ

Set position (X, Y, Z) in the set world record number to "Work coordinate system", but set (A, B, C) to 0.
Applicable to the XYZ type of the base and the coordinate system does not tilt and rotate. In the teaching mode, the position pointed by Ptool can be recorded as the origin of the coordinate system.

12.3. World record XYZABC

Set the position (X, Y, Z) and (A, B, C) in the set world record number to "Work coordinate

system".
It is suitable for the purpose of loading and unloading. And it only needs to calibrate the point at which the material of loading and uploading, then can be applied to the complete action position of material of loading and uploading. The method is to first set the world record point as the coordinate system, and then move to the position under the coordinate system, for example:

```
G54 O2 P15                      // Set P15 as the coordinate system
G1 X0 Y0 Z10 A0 B0 C0 F3000     // Straight line to the position of Z10 of coordinate system
G1 Z0 F1000                     // Move slowly to the position of coordinate system Z0
G22 O201 S1 P100                // O201 is set to On and waits for 100ms.
G1 Z10 F3000                    // Move up to Z10 position
```

12.4. Coordinate system record

Set the coordinate system record to "Work coordinate system".
It is suitable for applications with fixed processing tabletops, which can be used to calculate the coordinate system by taking three points, such as coating adhesive, cutting and other uses.

12.5. Current position and attitude

Set the world coordinate position (X, Y, Z) and (A, B, C) when the program is executed to this line to the "work coordinate system".
It is suitable to perform multiple moves according to the position after moving to a certain position while teaching the recording program, and if the point is modified later, all the subsequent moves can be automatically adjusted based on the modified point.
This use is especially suitable for packaging into G code. As long as it is moves to the processing reference point and then call G-code, a series of actions of the position can be completed. The requirement for multiple reaming classes on one workpiece can effectively simplify programming.

12.6. Dynamic position and attitude

The content is read from the set R value as the value of the "work coordinate system".
It is suitable to match the visual system. The coordinate system converted by the visual result is first filled in the R value, and the coordinate system value is dynamically captured by the program.

12.7. Joint record

The point position corresponding to the joint record is used as the "work coordinate system". The system first converts the joint record to world coordinates and then brings it into the value of the "coordinate system".
It is suitable for the condition that the tool parameters need to be dynamically switched but the actual position of the object cannot be changed. For example, the multi-fork jaw of the palletizer needs to be inserted into the groove of the roller conveyor to clamp the feed bag, but it cannot affect the position of the clamping because of setting different tool parameters.

12.8. Setting the joint coordinates directly

Same as the previous option, except that the coordinate values are direct inputs and are typically used for development environment testing.

12.9. Re-offset direct setting

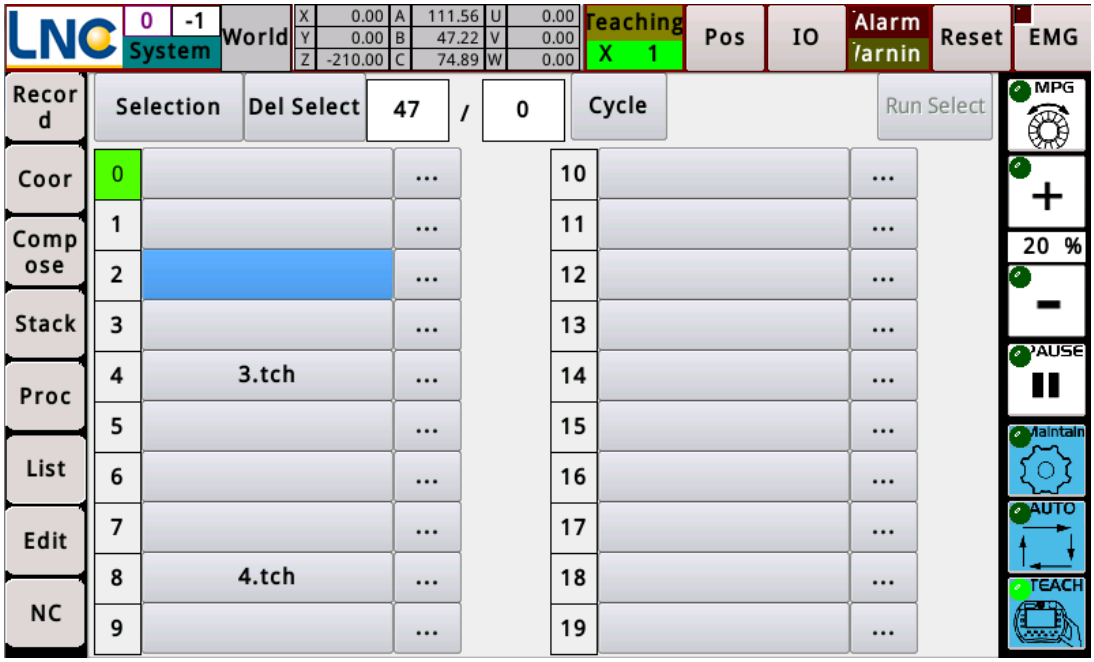
Based on the current work coordinate system, the work coordinate value at a certain point is converted to world coordinates to replace the original "work coordinate system". It's usually used for development environment testing, or to simplify the repetitive coordinate conversion work on the working path.

12.10. Re-offset dynamic setting

Based on the current work coordinate system, the work coordinate value recorded in the R value is converted to world coordinates to replace original "work coordinate system".
It is suitable for resetting the coordinate system with the offset obtained after recognition when the vision system is mounted on the end of the robot.

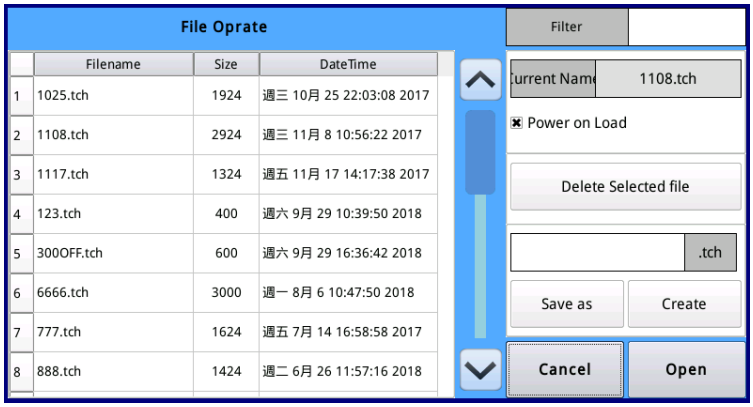
13. List

The list page is used to put program files into the list for easy recalling.



13.1. Put the program into the list

1. Switch to teaching mode.
2. Click ... .
3. Select the file intended to put and press Open



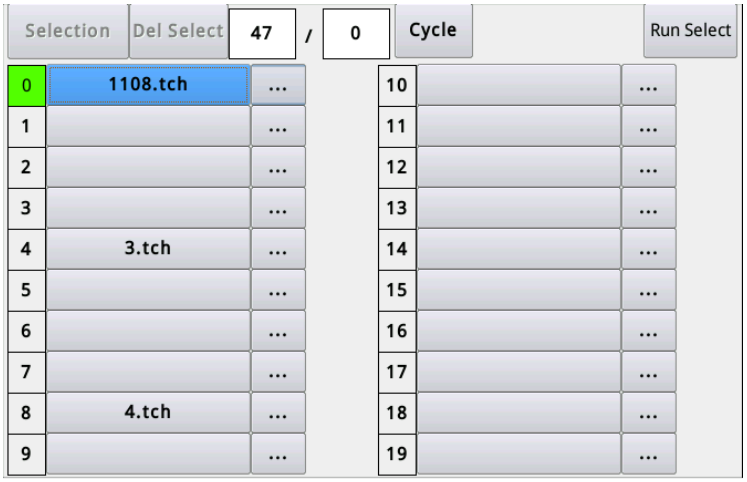
13.2. Select to execute

1. Switch to automatic mode
2. Click the program to be executed to make it a blue background 

3. Press 

to execute the program.

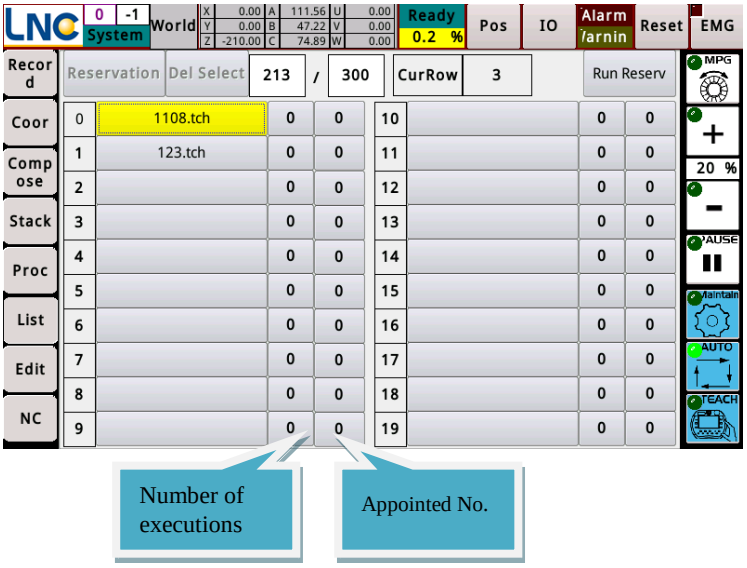
Note: You can also use the binary value composed of I80~I84 to represent the selected program, and then use I55 to start the program.



13.3. Appoint to execute

1. Switch to automatic mode
2. Press 

to execute the appointed programs in order.
3. The appointed number represents the order number of execution, 0 means not scheduled, -1 means being executed, and >0 means the current order.
4. Press and hold the button of appointed number for a sufficient amount of time to perform the appointment, cancel the appointment, and if it is in progress, you can pause, and you can continue while paused.
5. Number of executions:



Represents the number of times the program has been executed， which can be cleared after pressed and released.	

Note 1：I730~I749 correspond to the buttons of 20 appointed numbers, respectively, and they operate in the same way.

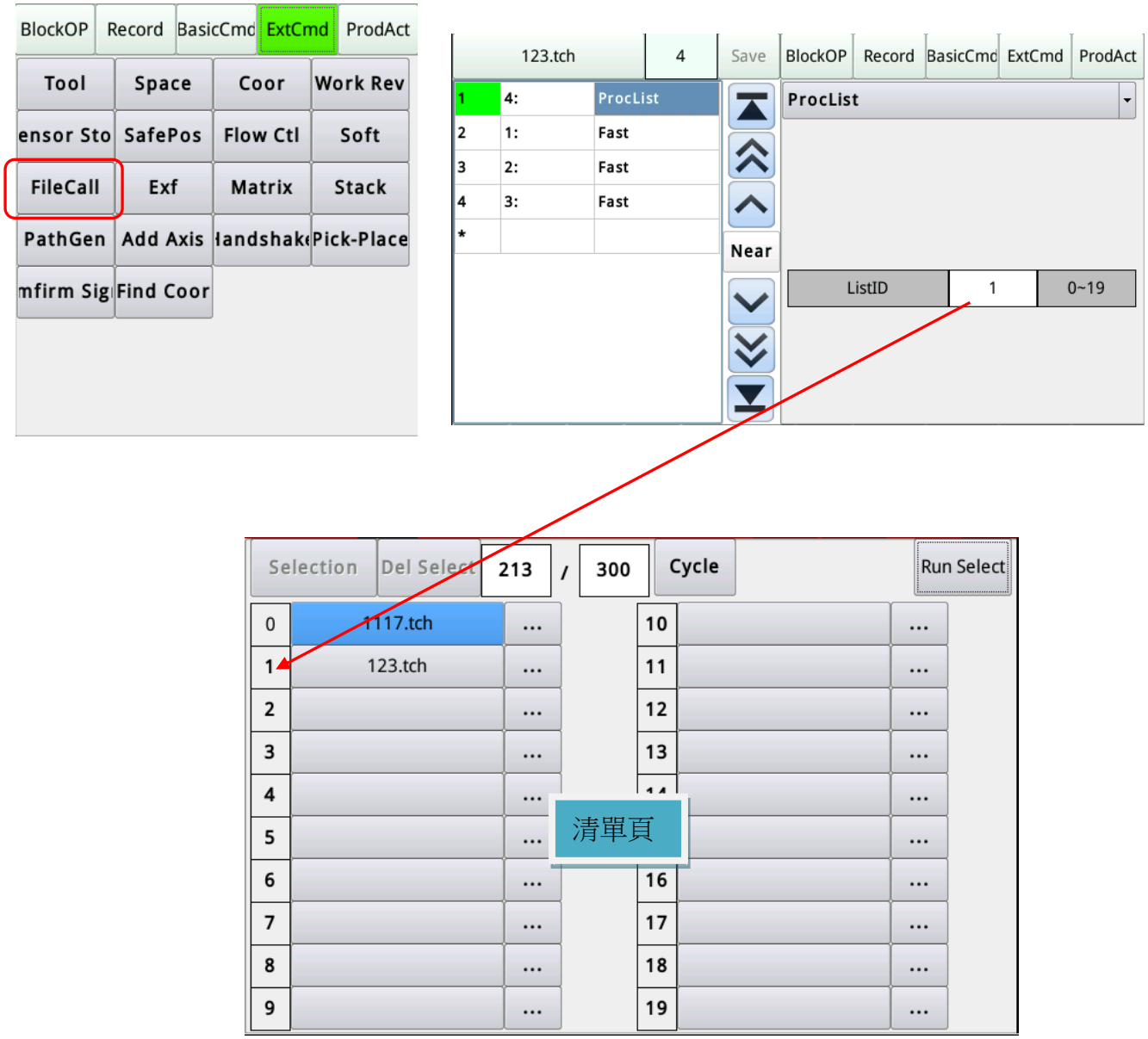
Note 2：O730~O749 corresponds to the status of appointment of the 20 sets of list program. It is always on when it is being appointed, flash when it is appointed, and off when it is not appointed.

14. Composition of Program Modularization

The program page has multiple ways to call module files.

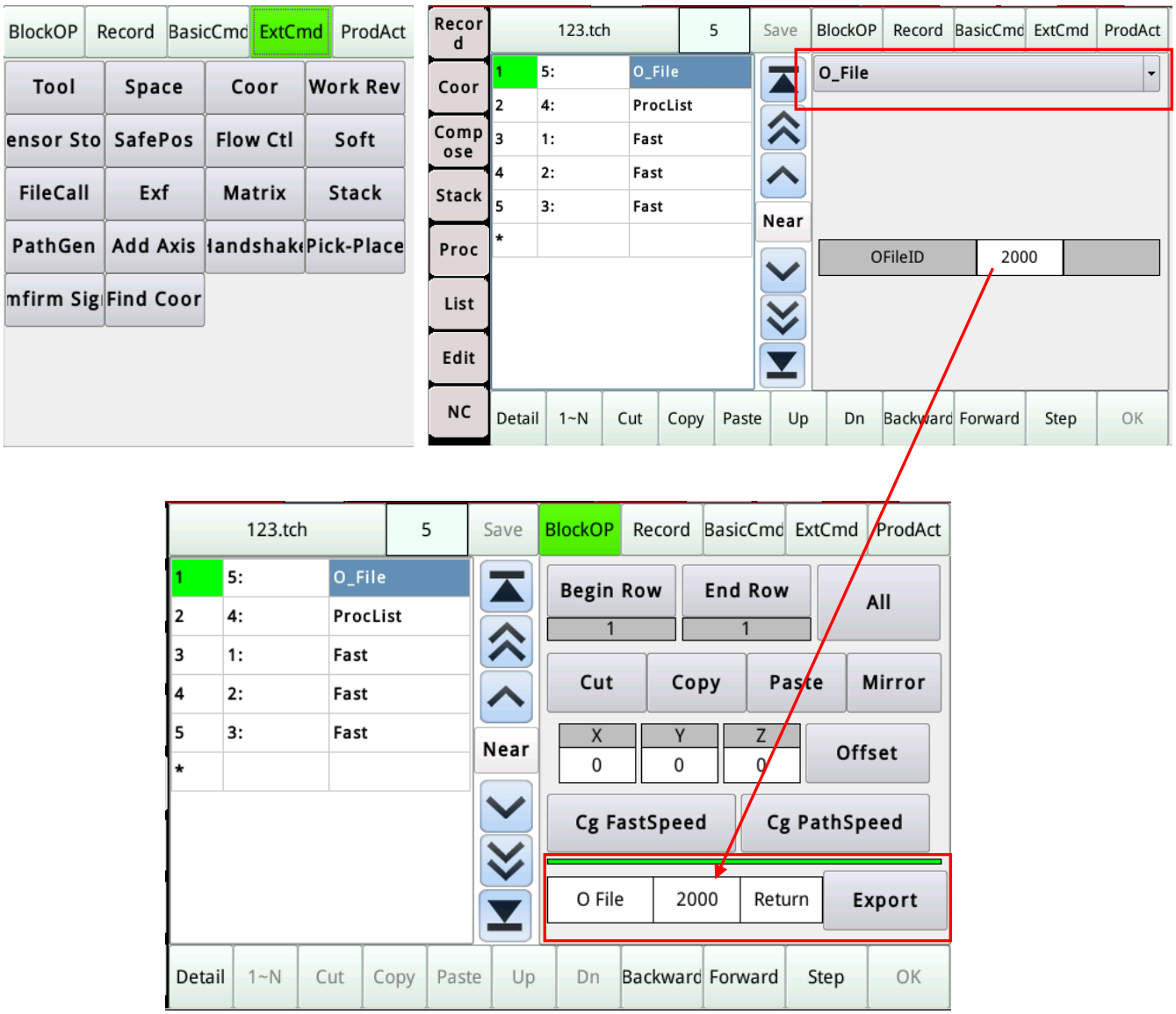
14.1. Calling program files

Call the program files that previously placed in the list page.



14.2. Calling O files

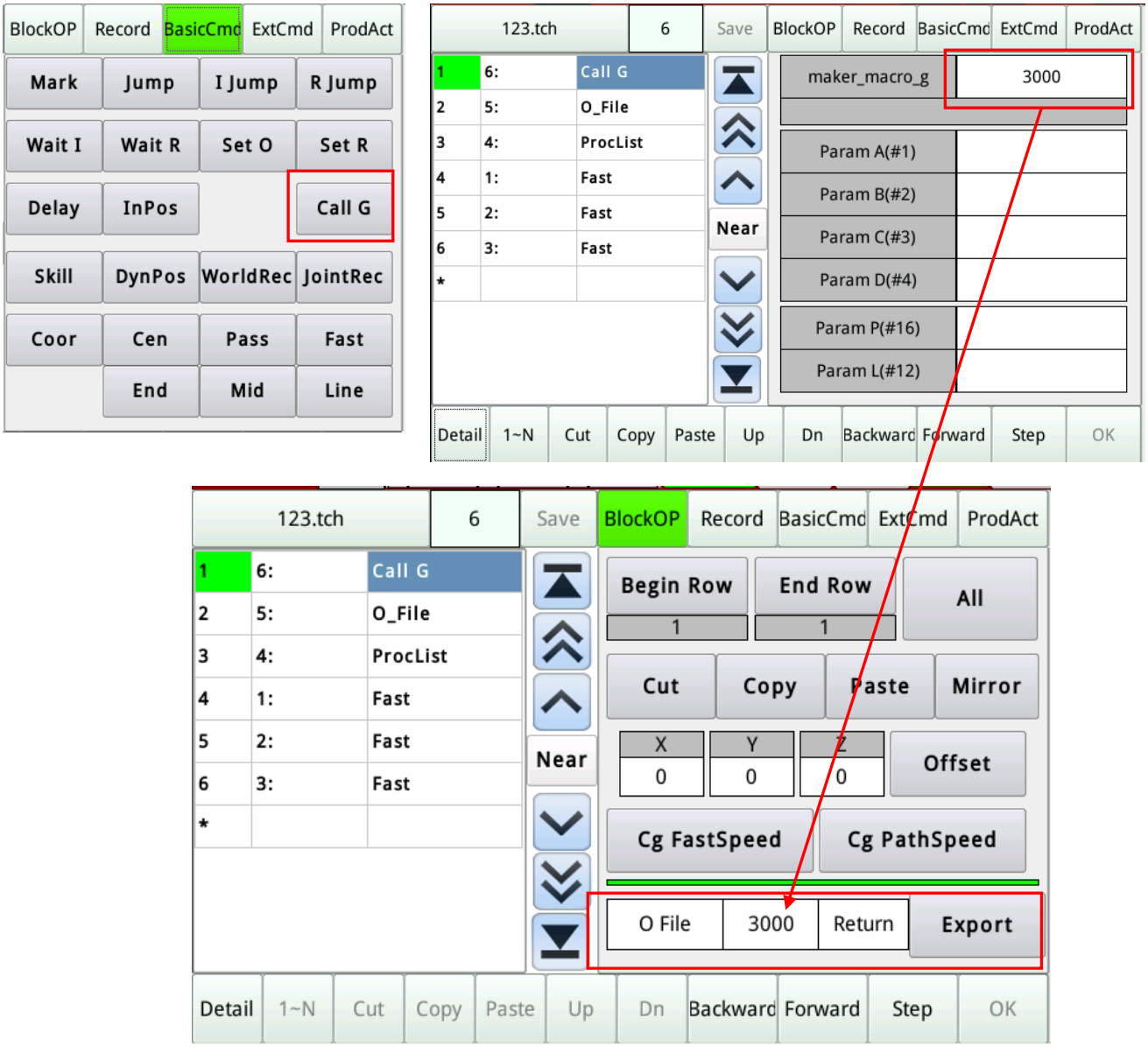
Calling the O files exported by another program.



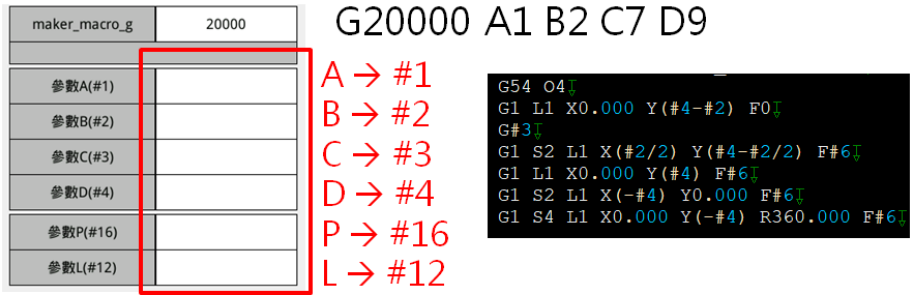
Note: The exported files are the most basic format, which can save the program files from being converted at runtime and the efficiency will be higher. The figure below is the content exported by the above program, which is the G code format of text.

1	N1
2	G1 L0 X64.309 Y969.058 Z274.585 A8.627 B9.868 C159.805 F20 K0
3	N2
4	G1 L0 X64.309 Y969.058 Z274.585 A8.627 B9.868 C159.805 F20 K0
5	N3
6	G1 S2 L0 X67.666 Y980.552 Z272.598 A46.830 B9.869 C165.798 F20 K0 D0
7	N4
8	G1 S4 L0 X63.734 Y988.323 Z269.585 A76.905 B9.867 C165.792 F20 K0
9	N5
10	G1 L0 X65.819 Y1017.302 Z269.592 A76.903 B9.866 C165.795 F20 K0

14.3. Calling G files

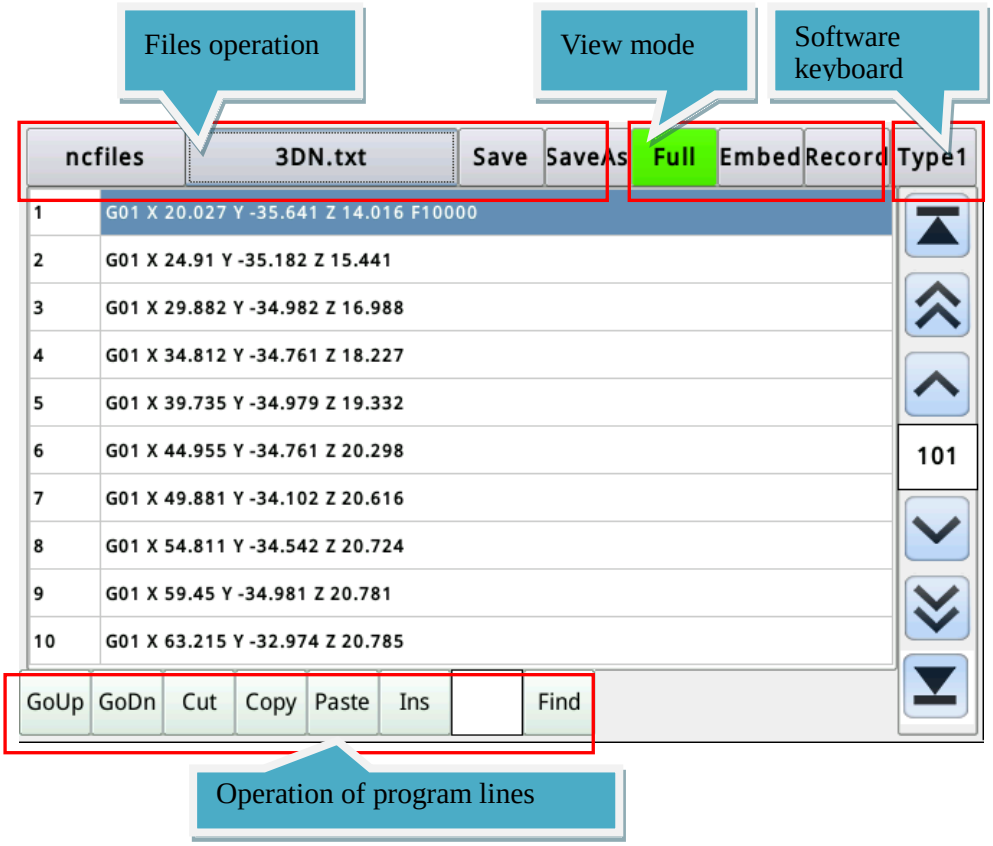


Note: The incoming parameters when the exported G code cannot be connected to the calling of upper layer can be achieved to receive parameters by writing the G code and run according to the parameters.



15. NC Editing

This page is suitable for short modifications to the program. If you need lots of writing, it is recommended to write at PC and then pass it to the controller.



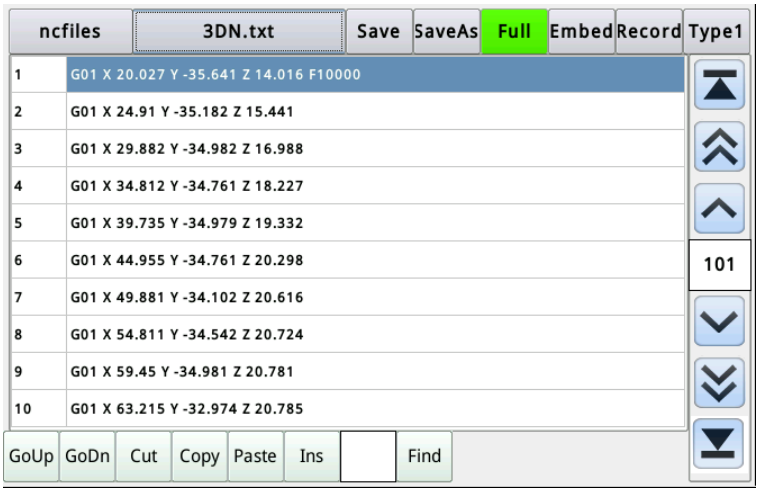
15.1. Types of files

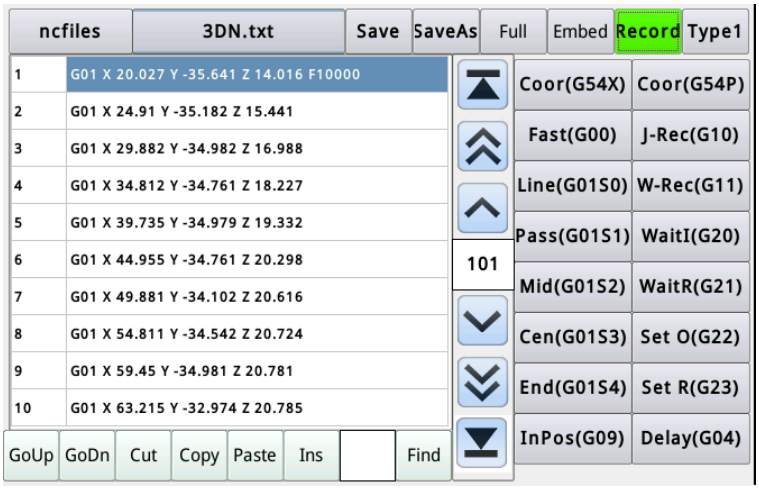
	ncfiles	G Macro	Ins Macro
Save location	NCFiles Folder	Macro Folder	Macro Folder
Rules of file names	Arbitrarily	maker_macro_g1000	maker_func_ins_macro1000
NC executing page	Name of Start files		Start No.
External executing mode	R17022~R17029=File name R23030=1 C0=1		R17004=1000 C22=1

The O file also belongs to ncfiles, and its file name format is O plus four digits, for example O1234, which can be called with G65 P1234.

The G code format can be written as described in the last two sections.

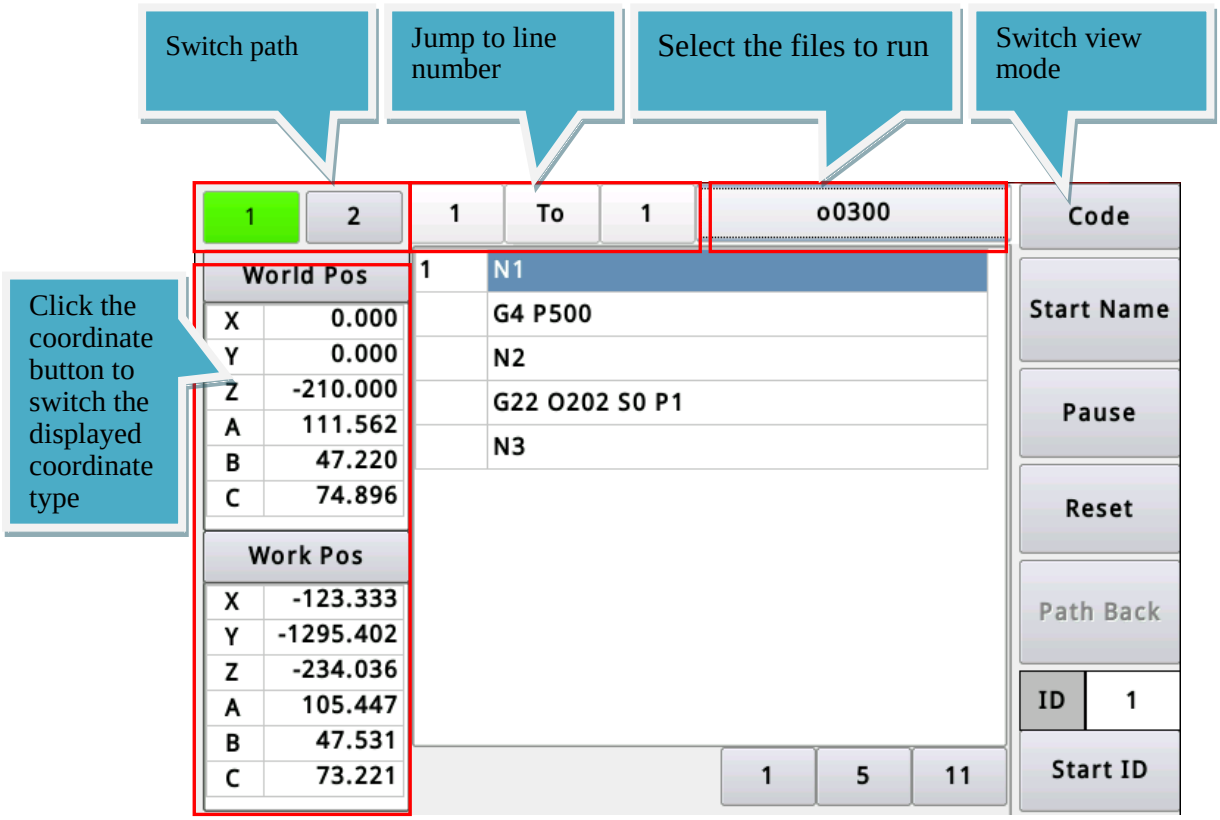
15.2. Viewing and editing methods

Full screen It is convenient to see more lines of code. When you click to edit, a soft keyboard pops up.	
Embedded Reduce page jumps, click on the line of code when editing, and then type directly in the keyboard below	

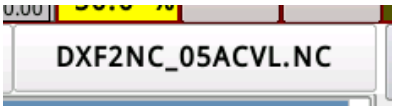
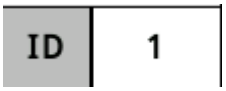
Record Similar to the recording of the program page, put some commonly used instructions on the right side, move to the point, click the command button of Record, it can automatically bring in the code.	

16. NC execution

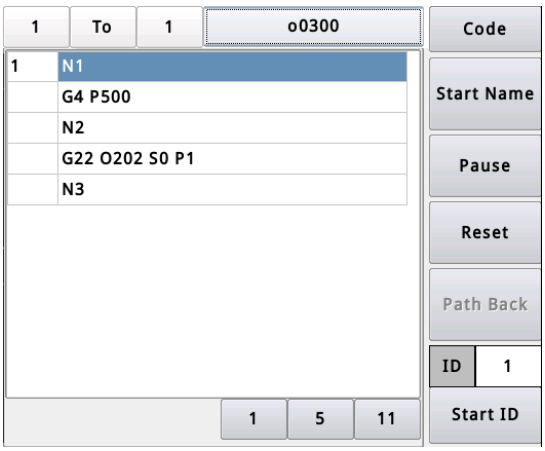
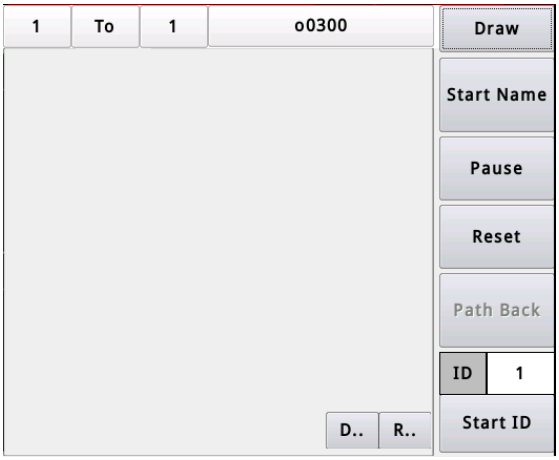
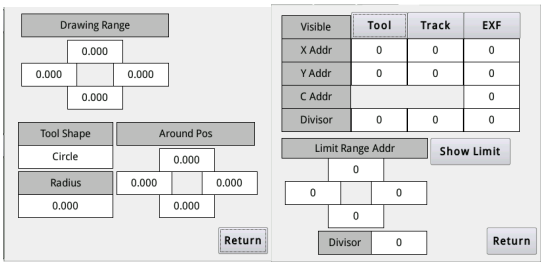
This page can be used to run the machining path files (GM code) generated by CAM, or the files exported by the program page, or the files edited manually by the user. These files must conform to the G code format requirements of this robot system. For detailed G code and program syntax, please refer to the last two sections.

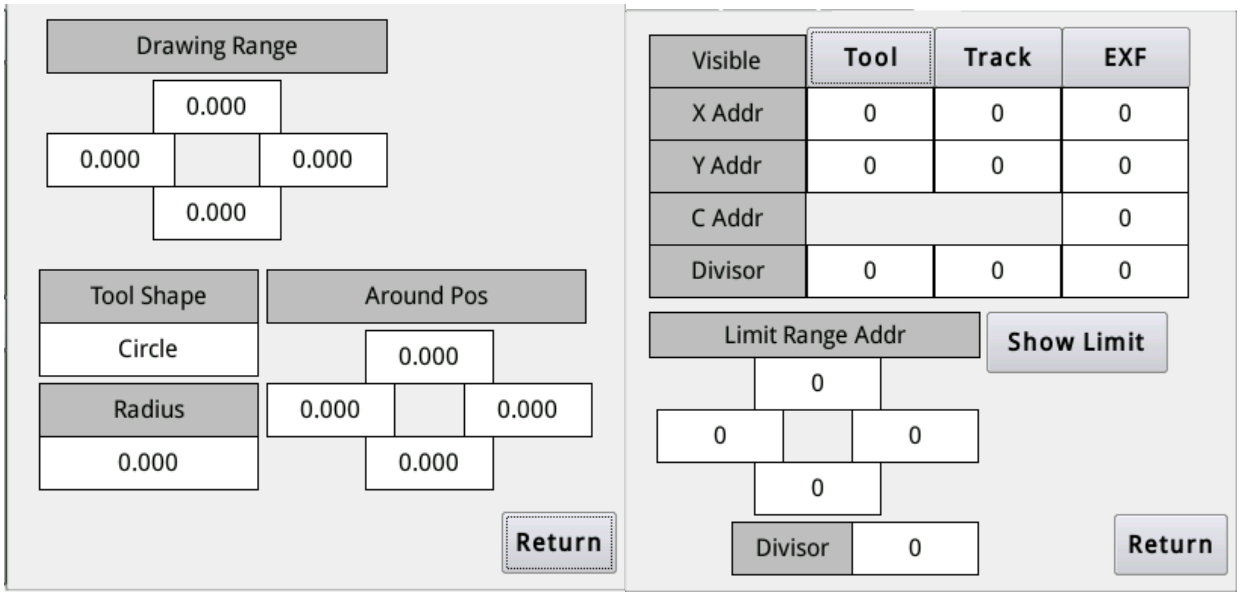


16.1. Runnable files

	Start file name (NC file)	Start number (insert file)
File folder	ncfiles	Macro
Format of file name	Arbitrarily	maker_func_ins_macro1000
File selection	Click the File Name button and select the file. 	Enter the number of the inserted file 
Start button		

16.2. Viewing mode

	Program code	Drawing
Display		
Option of Change	 Switch the number of lines you can see. Note: Because it needs to take CPU time for the system to update the displayed lines, only five lines are displayed by default.	 Set the relevant parameters of the display 


Drawing Range
0.000
0.000
0.000
0.000
Tool Shape
Circle
Radius
0.000
Around Pos
0.000
0.000
0.000
0.000
Return
Visible
Tool
Track
EXF
X Addr
0
0
0
Y Addr
0
0
0
C Addr
0
Divisor
0
0
0
Limit Range Addr
Show Limit
0
0
0
0
Divisor
0
Return

17. Description of use of system G code

17.1. Fast moving (G0, G1T2), direct moveing (G1T4)

Code description

L: 0 world, 1 work, 2 tools, 3 joints. (default: work)

M: 0 absolute, 1 relative. (Default: Absolute)

X: coordinate X or J1.

Y: coordinate Y or J2.

Z: coordinate Z or J3.

A: coordinate A or J4.

B: coordinate B or J5.

C: coordinate C or J6.

U: coordinate U

V: coordinate V

F:Speed

K: flexibility 0~5

Note: When using T4, the set speed represents the space speed of the points. It is suitable to use CAD/CAM to convert the point path into small lines and directly specify the space speed between the two small lines.

Examples

G00 X100 Y100 Z10 A0 B0 C39 F4000 G1 T2 X100 Y100 Z10 A0 B0 C39 F4000	Move to the position of the work coordinates (100, 100, 10, 0, 0, 39) at 4000 deg/min
G00 L0 X100 Y100 Z10 A0 B0 C39 F4000 G1 T2 L0 X100 Y100 Z10 A0 B0 C39 F4000	Move to the position of the world coordinates (100, 100, 10, 0, 0, 39) at 4000 deg/min
G00 M1 X100 Y100 Z0 F4000 G1 T2 M1 X100 Y100 Z0 F4000	Move to a position relative to the current work coordinate (100, 100, 0) at a speed of 4000 deg/min
G00 L0 M1 X100 Y100 Z0 F4000 G1 T2 L0 M1 X100 Y100 Z0 F4000	Move to a position relative to the current world coordinate (100, 100, 0) at a speed of 4000 deg/min
G00 L2 M1 Z-20 F4000 G1 T2 L2 M1 Z-20 F4000	At a speed of 4000 deg/min, move to the position relative to the current tool

	coordinate Z-axis-20
G00 L3 X100 Y100 Z10 A0 B0 C39 F4000 G1 T2 L3 X100 Y100 Z10 A0 B0 C39 F4000	Move to the position of the joint coordinates (100, 100, 10, 0, 0, 39) at 4000 deg/min
G00 L4 X100 Y100 Z10 A0 B0 C39 F4000 G1 T2 L4 X100 Y100 Z10 A0 B0 C39 F4000	Move to the position of the motor coordinates (100, 100, 10, 0, 0, 39) at 4000 deg/min

17.2. Path movement (G1, G1T5)

Code description

	Linear (S0)	Arc transition (S1)	Arc midpoint (S2)	Arc center (S3)	Arc end point (S4)
D			Attitude change mode: 0: Three-point linear 1: Two-point linear 2: Three-point arc 3: Two-point arc 4: Fixed starting point 5: Starting point AB 6: Starting point ABC		Rotational direction 0: Set by point (preset) 2: Forced along the arc 3: Forced reverse arc
R					Bypassed angle
O	Output point number				
P	Start point distance				
Q	End point distance				
L	0 world, 1 work, 2 tools, 3 joints. (default: work)				
M	Absolute, 1 relative. (Default: Absolute)				
X	Coordinate X or J1				
Y	Coordinate Y or J2				
Z	Coordinate Z or J3				
A	Coordinate A or J4				
B	Coordinate B or J5				
C	Coordinate C or J6				
U	Coordinate U				
V	Coordinate V				

W	Coordinate W
F	Speed
K	Flexibility 0~5

Note: T5 is the default value of G1 command T code, so it's unnecessary to write. In addition, L1 work coordinate system and M0 absolute are also the default value. When the parameters are the same as them, it's unnecessary to write.

17.2.1. Linear (S0)

Use G1 T5 S0 to set, as S0 is the default value, it's unnecessary to write.

G1 X100 Y100 Z10 A0 B0 C39 F4000	Move straight to the position of the work coordinates (100, 100, 10, 0, 0, 39) at a speed of 4000 mm/min
G1 L0 X100 Y100 Z10 A0 B0 C39 F4000	Move straight to the position of the world coordinates (100, 100, 10, 0, 0, 39) at a speed of 4000 mm/min
G1 M1 X100 Y100 Z0 F4000	Move straight at a speed of 4000 mm / min to the position relative to the current work coordinates (100, 100, 0)
G1 L0 M1 X100 Y100 Z0 F4000 O201 P30 Q20	Move straight at a speed of 4000 mm / min to the position relative to the current world coordinates (100, 100, 0) Set O201 on at 30mm from the starting point Set O201 off when it is 20mm from the target point.
G1 L2 M1 Z-20 F4000	Move straight at a speed of 4000 mm/min to a position relative to the current tool coordinate Z-axis-20

17.2.2. Arc Transition (S1)

Use G1 T5 S1 to set the arc transition point.
The R code is the radius of the arc transition.

G1 S1 X100 Y100 Z10 A0 B0 C39 R50	The arc transfer to the position of the work coordinates (100, 100, 10, 0, 0, 39) at a speed of 4000 mm/min

17.2.3. Arc midpoint (S2)

Use G1 T5 S2 to set the points on the arc and G1 T5 S4 to set the end point of the arc.

G1 S2 X100 Y90 Z80	Starting from the current position, the work coordinates (100, 90, 80) are a point on the arc, and the work coordinates (100, 100, 10) is the end point of the arc.

17.2.4. Arc Center (S3)

Use G1 T5 S3 to set the center of the arc and G1 T5 S4 to set the end point of the arc, and use D2, D3 to specify the clockwise arc or the counterclockwise arc.

G1 S3 X100 Y90 Z80 G1 S4 D2 X100 Y100 Z10 A0 B0 C39 F4000	Use work coordinate (100, 90, 80) as the center of the arc, the work coordinate (100, 100, 10) as the end point of the arc to draw a clockwise arc, and the attitude at the end of the arc is (0, 0, 39).

17.2.5. Arc End Point (S4)

Use G1 T5 S2 to set the point on the arc, and G1 T5 S4 to set the end point of the arc.

G1 S2 X100 Y90 Z80 G1 S4 X100 Y100 Z10 A0 B0 C39 F4000	Starting from the current position, the work coordinates (100, 90, 80) are a point on the arc, and the work coordinates (100, 100, 10) are the end point of the arc.

17.3. Clockwise arc and counterclockwise arc (G2, G3)

Code description

L: 0 world, 1 work, 2 tools, 3 joints. (default: work)

M: 0 absolute, 1 relative. (Default: Absolute)

I: center relative position X

J: center relative position Y

K: center relative position Z

X: coordinate X or J1.

Y: coordinate Y or J2.

Z: coordinate Z or J3.

A: coordinate A or J4.

B: coordinate B or J5.

C: coordinate C or J6.

R: Bypassed angle
U: coordinate U
V: coordinate V
F:speed
K:Flexibility 0~5

Examples

G2 I100 J90 K80 X100 Y100 Z10 A0 B0 C39 F4000	Use relative work coordinates (100, 90, 80) are the center, the work coordinates (100, 100, 10) are the end point of the arc to draw a clockwise arc, and the attitude at the end of the arc is (0, 0, 39).

17.4. Wait (G4)

Code description

X: waiting seconds
P: Waiting milliseconds

Examples

G4 X1 P200	Waiting for 1200 milliseconds

17.5. Switch tool parameters (G5)

Code description

L: The tool parameter group is 0~3. If not specified, the direct setting value of XYZABC is used.
X: Tool parameter X
Y: Tool parameter Y
Z: Tool parameter Z
A: Tool parameter A
B: Tool parameter B
C: Tool parameter C

Examples

G5 L1	Switch to tool parameters of group 1

17.6. Switch coordinate inversion mode (G6)

Code description

A: 0 does not use the work coordinate inversion mode, 1 uses the work coordinate inversion mode

Examples

G6 A1	Use work coordinate inversion mode

17.7. Set the path process (G7)

Code description

E	0 Stop	1 Regular style	2 Linear follow
L		Process coordinate system 0 World coordinates， 1 Work coordinate， 2 Tool coordinate， 3 Path X+ Tool Z， 4 Path X+ Work Z， 5 Path X+ World Z	
Q		Style category 0 Round 1 Front and rear 2 Left and right	
X		Moving range	X speed R number
Y		Paragraph distance	Y speed R number
Z		Initial movement	Z speed R number

Examples

G7 E0	Disable path process
G7 E1 L0 Q0 X10 Y8 Z0	Use regular pattern process, world coordinate system, circling mode, circling radius of 10mm, make a circle every 8mm's walk with no initial movement

G7 E2 L1 X100 Y0 Z0	Use the linear following process and work coordinate system, read the speed value in the X direction from R100

17.8. Wait for arrival of interrupt counting (G8)

Code description

A: Interrupt counting value

Examples

G8 A1234567	Wait for the interrupted counting value to reach 1234567 and then continue to run

17.9. Wait correct arrival (G9)

Code description

A: Range value of correct arrival

Examples

G9 A20	Continue to run when waiting for the servo of each axis behinds the total value for less than 20.

17.10. Joint Record Movement (G10)

Code description

P: Record number 0~99

M: If XYZABC has a value, its value should be 0 replace or 1 offset to the original recorded value.

XYZABC : Substitute or offset value

F:speed

T: action mode, 2 fast, 5 path. The default value is 2.

S: For T5, point type 0 line, 1 arc transition, 2 arc midpoint, 3 arc center, 4 arc end point

Examples

G10 P2 F1000	Move quickly to the "joint record" position of number 2 at 10,000 deg / min.
G10 P2 T5 F1000	Move linear to the "joint record" position of

	number 2 at 10,000 deg / min.

17.11. World record movement (G11)

Code description

P: Record number 0~99

M: If XYZABC has a value, its value should be 0 replace or 1 offset to the original recorded value.

XYZABC : Substitute or offset value

F:speed

T: action mode, 2 fast, 5 path. The default value is 2.

S: For T5, point type 0 line, 1 arc transition, 2 arc midpoint, 3 arc center, 4 arc end point

Examples

G11 P67 F2000	Move linear at a speed of 20,000 mm/min to the "World record" position of number 67.
G11 P67 T2 F2000	Move quickly at a speed of 20,000 mm/min to the "World record" position of number 67.

17.12. Set whether the command of the axis output (G13)

Code description

A: Axis number 1~9

B: 0 output, 1 no output

Examples

G13 A7 B1	Set stop command output to the 7th axis (U axis)

Note: Special attention will be required to use this instruction, do not use it unless you are clear about the purpose. When use is resumed, you need to call G95 to re-update the coordinates.

17.13. Get the world coordinates (G17, G1T17) of the final position

Examples

G17	Get the world coordinates of the final position and the return value is @71~@79
G1T17	Get the world coordinates of the final position and the return

	value is #71~#79

17.14. Get the work coordinate(G18, G1T18) of the final position

Examples

G18	Get the work coordinates of the final position and the return value is @71~@79
G1T18	Get the work coordinates of the final position and the return value is #81~#89

17.15. Get the joint coordinates (G19, G1T19) of the final position

Examples

G19	Get the joint coordinates of the final position and the return value is @81~@89
G1T19	Get the joint coordinates of the final position and the return -value is #91~#99

17.16. Wait for Point I(G20)

Code description

I : Number of point I

S : Comparison value (waiting value)

T : Waiting time

F : Failure processing mode 0 continue to wait 1 skip this line 2 alarm

A: Alarm number

B : Alarm bit

Examples

G20 I100 S1	Wait for I100 to become 1.
G20 I110 S0 T1000 F1	Wait for I110 to become 0. If the waiting time exceeds 1000ms, skip this line.
G20 I120 S1 T2000 F2 A29010 B3	Wait for I120 to become 1, and if the waiting time exceeds 2000ms, an alarm of alarm R29010.3 is issued.

17.17. Wait for R value (G21)

Code description

R : R value number

C : Comparison mode 0 equal, 1 unequal

M : Mode, 0 constant, 1R value

V : Comparison value (waiting value)

T : Waiting time

F : Failure processing mode 0 continue to wait 1 skip this line 2 alarm

A : Alarm number

B : Alarm bit

Examples

G21 R100 V1	Wait for R100 to become 1.
G21 R110 V0 T1000 F1	Wait for R110 to become 0. If the waiting time exceeds 1000ms, skip this line.
G21 R110 M1 V99 T1000 F1	Wait for R110 to become equal to R99. If the waiting time exceeds 1000ms, skip this line.
G21 R110 M1 V99 C1 T1000 F1	Wait for R110 to become unequal to R99. If the waiting time exceeds 1000ms, skip this line.
G21 R120 V1 T2000 F2 A29010 B3	Wait for R120 to become 1, and if the waiting time exceeds 2000ms, an alarm of alarm R29010.3 is issued.

17.18. Set O(G22)

Code description

O: output point number

S: output point status

P: Waiting time, ms

Examples

G22 O201 S0 P200	After setting O201 to Off, pause for 200ms.
G22 O203 S1	Set O203 to On
G22 O205 S2	Switch the status of O205
G22 O205 S3 P100	Set O205 to on 100ms, then Off (the program will wait for off before continuing).
G22 O205 S4 P100	Set O205 to on 100ms, then On (the program will wait for

	on before continuing).
G22 O205 S5 P100	Set O205 to on, the program continues to run (using the first set of auto off, after 100ms, the background program will automatically turn it off).
G22 O205 S6 P100	Set O205 to on, the program continues to run (using the second set of auto off, after 100ms, the background program will automatically turn it off).
G22 O205 S7P100	Set O205 to on, the program continues to run (using the third set of auto off, after 100ms, the background program will automatically turn it off).
G22 O205 S8 P100	Set O205 to on, the program continues to run (using the fourth set of auto off, after 100ms, the background program will automatically turn it off).

17.19. Set R(G23)

Code description

R: the number of R

T: Numerical type (0 absolute, 1 relative, 2 number, 3 cycles plus 1)

S: Output point status

P: Waiting time , ms

Examples

G23 R2010 T0 V3 P200	Set R2010 to 3, then pause for 200ms.
G23 R2011 T1 V2	R2011 = R2011+2
G23 R2012 T2 V2060	R2012 = R2060
G23 R2013 T3 V10	R2013 = R2013+1, if R2013>10, then set R2013=0

17.20. Sensing point I stop (Rbit comparison) (G31)

Code description

R: the number of R

S: The value of the R number to be used for the shielding value of the And operation. For example, when only the bit 0 of the R value is monitored, S1 is used. When only the bit 1 of the R value is used, S2 is used. When bit 0 and bit 1 are simultaneously monitored, S3 is used.

T: The value after the And operation must be the same as the value of this code to trigger the action to stop.

L: 0 world, 1 work, 2 tool, 3 joint. (default: work)
M: 0 absolute, 1 relative. (Default: Absolute)
X: Coordinate X or J1.

Y: Coordinate Y or J2。

Z: Coordinate Z or J3。

A: Coordinate A or J4。

B: Coordinate B or J5。

C: Coordinate C or J6。

U: Coordinate U
V: Coordinate V
F:Speed

Examples

G31 M1 Z-100 F3000 R4000 S1 T1	Decrease by 100mm at a speed of 3000. If R4000.0=1 during the decrease, the unfinished action of this command is ignored.
G31 Z-100 F3000 R4000 S3 T3	At the speed of 3000, the Z axis moves to the position of the work coordinate-100mm. During the descent, if R4000.0=1 and R4000.1=1, the unfinished action of this instruction is ignored and is no longer executed.

Note: In the system built-in PLC program, I70~I73 will be corresponding to R23730, and the I point to trigger stop can be set to this number to facilitate the use of this function.

17.21. Sensing torque stop (R value comparison) (G32)

Code description

R: the number of R
S: Compare conditions. 0 greater than, 1 greater than or equal to, 2 equal to, 3 less than, 4 less than or equal to, 5 not equal to 6, 6 absolute value greater than, and 7 absolute value less than.
T: The value being compared.
L: 0 world, 1 work, 2 tool, 3 joint. (default: work)
M: 0 absolute, 1 relative. (Default: Absolute)

X: Coordinate X or J1.

Y: Coordinate Y or J2。

Z: Coordinate Z or J3。

A: Coordinate A or J4。

B: Coordinate B or J5。

C: Coordinate C or J6。

U: Coordinate U
V: Coordinate V
F:Speed

Examples

G32 M1 Z-100 F3000 R4000 S1 T1	Decrease by 100mm at a speed of 3000. If R4000 is greater than or equal to 1, during the descent, the unfinished action of this command is ignored and is no longer executed.
G32 Z-100 F3000 R4000 S3 T3	At a speed of 3000, the Z axis is moved to the position of the work coordinate-100 mm. During the descent process, if the R4000 is less than 3, the unfinished action of this instruction is ignored and is no longer executed.

Note: This function can be used to determine to stop the action after the torque of an axis after reaching the value. The torque value can be read by R250096~.

17.22. Coordinate system re-offset (G52)

Code description

X: Coordinate X or J1.

Y: Coordinate Y or J2。

Z: Coordinate Z or J3。

A: Coordinate A or J4。

B: Coordinate B or J5。

C: Coordinate C or J6。

Examples

G52 X20Y10 C5	Re-offset the current coordinate system to the position of the work coordinate X20 Y10 and rotate it 5 degrees

Note: When matching with the visual system, it is necessary to perform re-offset on the coordinate system according to the feedback value of the visual system. This command can achieve requirement of this function.

17.23. Set the work coordinate system (G54)

17.23.1. The offset of position and attitude specified directly by O0 (preset)

G54 X0 Y100 Z300 A0 B0 C0	Set (0,100,300) to the origin of the work coordinate system No rotation and tilting
G54 X20 Y100 Z300 A0 B0 C30	Set (20,100,300) to the origin of the work coordinate system Rotate 30 degrees horizontally
G54 X20 Y100 Z300 A0 B10 C30	Set (20,100,300) to the origin of the work coordinate system The attitude of coordinate system is (0, 10, 30)

17.23.2. O1 uses position XYZ in the world record

G54 O1 P8	The XYZ of world record No. 8 (P8) is used as the work coordinate system. No rotation and tilting.

17.23.3. O2 uses position and attitude XYZABC in world records

G54 O2 P6	XYZABC of world record No. 6 (P6) is used as the work coordinate system.

17.23.4. O3 uses coordinate system records

G54 O3 P8	Use the coordinate system record No. 8.

17.23.5. O4 uses the current position and attitude

G54 O4	Use the coordinate XYZABC of the program at the time as work coordinate system.

17.23.6. O5 uses dynamic position

G54 O5 X100 Y101 Z102 A103 B104 C105	The value of R100~R105 is read to set the work coordinate system.

17.23.7. O6 uses joint records

G54 O6 P3	The work coordinate system is set using the value of the world coordinates corresponding to the third set of joint records.

17.23.8. O7 directly set joint coordinates

G54 O7 X0 Y0 Z-90 A0 B-90 C30	Set the world coordinates of J1~J6= (0,0,-90,0,-90,30) as work coordinate system

17.23.9. O8 directly set re-offset

G54 O8 X0 Y10 C20 G52 X0 Y10 C20	Set the world position of the work coordinate XYZABC (0,10,0,0,0,20) to work coordinate system

17.23.10. O9 re-offset dynamic setting

G54 O9 X100 Y101 C102	The world position corresponding to the work coordinate of the values of R100, R101, and R102 is the work coordinate system.

17.24. Rotating the coordinate system (G55)

Code description

P: the group of rotating coordinate system.

Examples

G55 P0	Use 0 set of rotating coordinate system

17.25. Coordinated coordinate system (G56)

Code description

P: the group of rotating coordinate system.

Examples

G56 P0	Use 0 set of coordinated coordinate system

17.26. Bulk separating axis coordinate system (G57)

Code description

P: Set of bulk separating axis coordinate system.

Examples

G57 P0	Use 0 set of bulk separating axis coordinate system.

17.27. Start dynamic compensation (G61)

Examples

G61	Close dynamic compensation

17.28. Turn off dynamic compensation (G60)

Examples

G60	Start dynamic compensation

17.29. Interpolation table conversion (G69)

Code description

T: Interpolation table set 0~9.

X: The first comparison value.

A: The second comparison value.

Examples

G69 X100 A203	Call the interpolation table to convert with the input values of 100 and 203, and the converted return value will be placed at @25, @2

17.30. Set the flexibility level (G89)

Code description

A: The flexibility level set is 0~5.

Examples

G89 A0	Use the default flexibility level
G89 A2	Use the Group 2 of set flexibility level.

17.31. Set the synthetic acceleration/deceleration time (G90)

Code description

A: Synthetic linear acceleration and deceleration time. (blank means using default values)

B: Synthetic bell acceleration and deceleration time. (blank means using default values)

Examples

G90 A300 B100	Set the synthetic linear acceleration/deceleration time to 300 and the bell time to 100.

17.32. Set the shaft speed smoothing time (G91)

Code description

A: The shaft speed smoothing linear time. (blank means using default values)

B: The shaft speed smoothing bell time. (blank means using default values)

Examples

G91 A100 B50	Set the shaft speed smoothing linear time to 100 and the bell time to 50.

17.33. Set the shaft speed tolerance (G92)

Code description

A: Axis number 1~9.

B: Allowable difference. (blank means using default values)

Examples

G92 A3 B100	Set the tolerance of the 3rd axis to 100.

17.34. Serve lag eliminates and updates coordinates (G95)

Examples

G95	Eliminate servo lag and update coordinates

17.35. Update coordinates (G96)

Examples

G96	Update coordinates

18. Macro syntax

18.1. Variables

18.1.1. Regional variables:

Each file has 200 local variables, floating point numbers:
#0 : represents a null value, which can be read to determine whether other variables are null and cannot be written.
#1~#26 : If the file is not the top layer directly called by system, the 26 variables correspond to the 26 letters of A~Z. When called, the various codes in the calling command of the previous layer are brought into the corresponding variables of this file, and can also be used in subsequent program lines.
#27~#199 : The intended use can be defined by the user.

18.1.2. Global Variables:

When the program is running, there are 1000 global variables available with floating point number:
@0 : represents a null value, which can be used to read whether other variables are null and cannot be written.
@1~@999 : The intended use can be defined by the user.

Global variables can be accessed across files, so they can be used as a conduit for interworking between different files.

18.2. Core resource IOCSAR access

The following table is a list of all resources and access functions in the joint manipulator system.

Rsources	Quantity	R read, W write (interpretation execute immediately)	R read, W write (Interpretation waits for the core to complete before executing)	Handed over to the core for simultaneous execution	Description
I (Input)	1000	R_MLC_I_F	R_MLC_I		Software number,

O (Output)	1000	R_MLC_O_F W_MLC_O_F	R_MLC_O W_MLC_O		set the hardware point of the actual output through the IO comparison table
C (Control)	4096	R_MLC_C_F W_MLC_C_F	R_MLC_C W_MLC_C		
S (Status)	4096	R_MLC_S_F	R_MLC_S		
A (Aid)	4096	R_MLC_A_F W_MLC_A_F	R_MLC_A W_MLC_A		
R (Register)	6,000,000	R_REG_F W_REG_F	R_REG W_REG	W_REG_AT	

#32 = R_MLC_I(206)	Read the contents of I206 into the local variable 32
W_MLC_O(123, 1)	Set O123 to On
W_MLC_C(9, 1)	Set C9 to On → Start handwheel mode
#33 = R_MLC_S(9)	Read the contents of S9 into the local variable 33 → Check if it is currently in handwheel mode
#34 = R_MLC_A(2000)	Read the contents of A2000 to local variable 34
W_MLC_A(2000, 1)	Set A2000 to On
#35 = R_REG(1200)	Read the contents of R1200 into local variable 35
W_REG(1200, 3434)	After waiting for the motion instruction, set the content of R1200 to 3434.
W_REG_F(1200, 3434)	The content of the R1200 will be set to 3434 immediately.
W_REG_AT(1200, 3434)	Assign this instruction that sets the content of R1200 to 3434 to a motion core, and this instruction is executed synchronously when the motion core is executed. (Avoid causing motion pauses)

18.3. Mathematical fnctions

The following table is the mathematical functions supported in the joint manipulator system.

Mathematical function	Description
SIN(DEG)	SIN function
COS(DEG)	COS function

TAN(DEG)	TAN function
ASIN(VALUE)	ASIN function
ACOS(VALUE)	ACOS function
ATAN(VALUE1，VALUE2)	ATAN function
SQRT(VALUE)	Obtain root mean square value
ABS(VALUE)	Obtain absolute value
ROUND(VALUE)	Obtain rounded value
FIX(VALUE)	Drop unconditionally
MOD(VALUE, VALUE2)	Obtain the remaining value

18.4. Program flow control

The following table is the supported program flow control syntax in the joint manipulator system.

Process control command	IF ~GOTO
Select narrative	IF …ELSE
Select narrative	SELECT
Cycle	FOR … END_FOR, EXIT_FOR
Cycle	DO …UNTIL, EXIT_DO
Calling function	CALL_SUB, EXIT_SUB