Robot Series

# Joint Robot-Basic Operation & Program Manual

2020/02 Ver.：V09.03

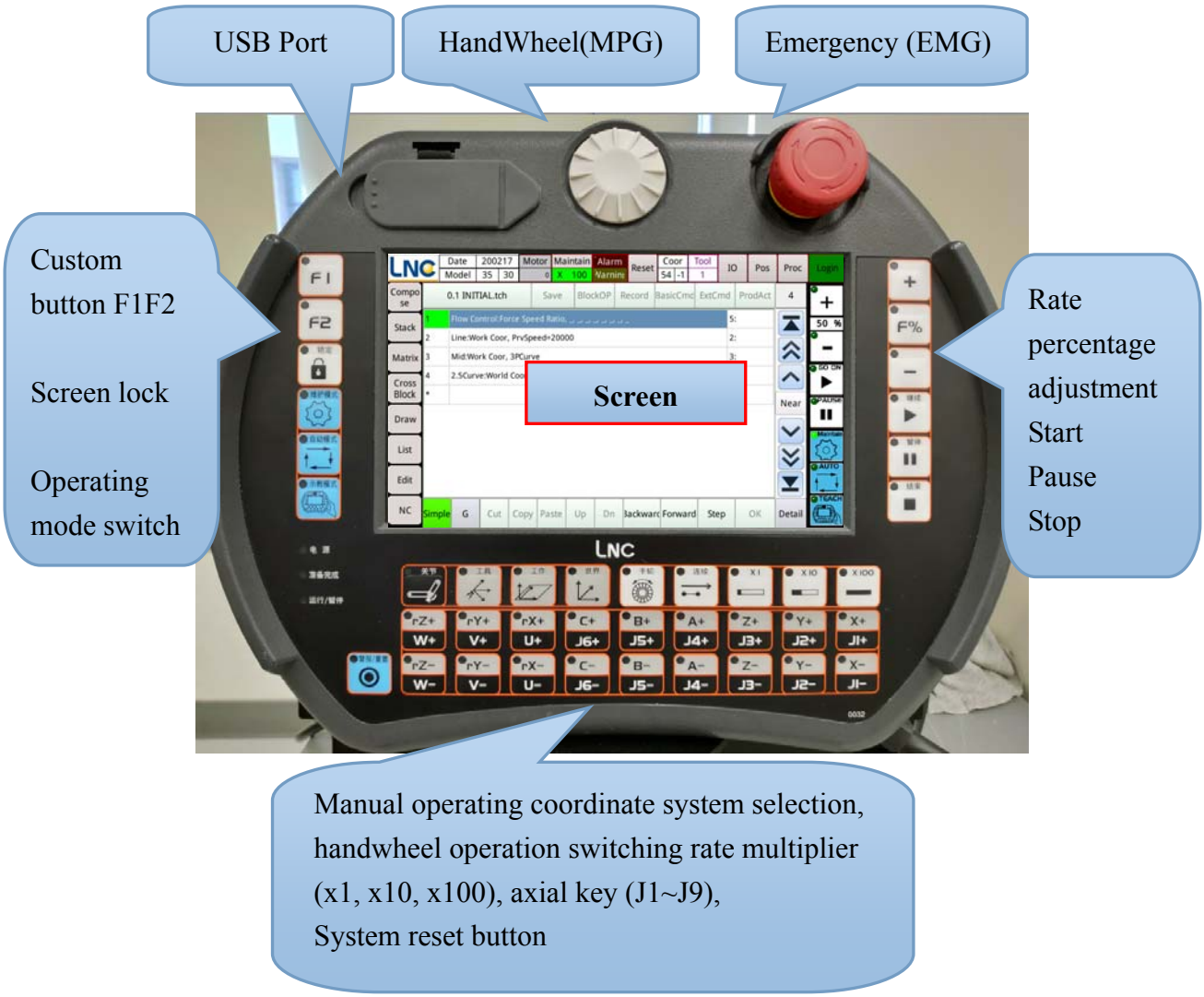
*Leading Numerical Controller*

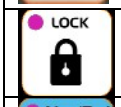
LNC
Enable intelligent machines

# 1. Content

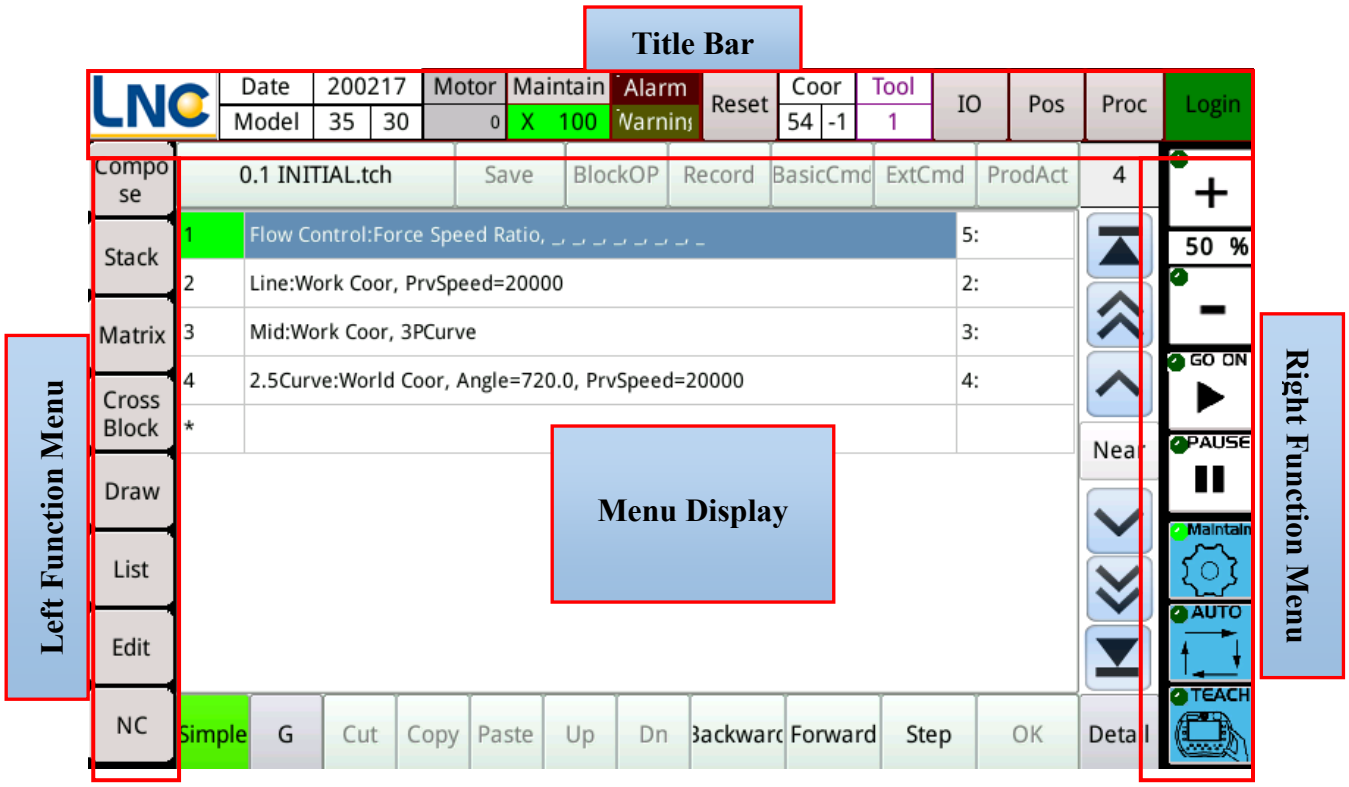
# 2. Instructions of Teach Pendent & Screen Display Description

## 2.1. Outlook of Teach Pendent

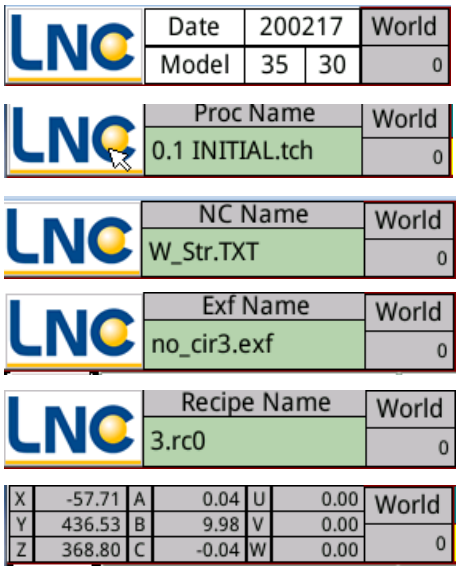
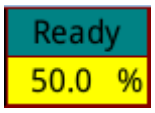
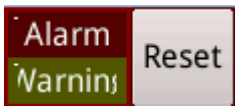


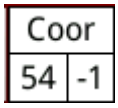

| | |
|---|---|
|  | User-defined button functions |
|  | Screen lock function, refer to the description of following sections |
|  | The light signal shows the current alarm and the button reset system (equivalent to the reset button on the screen) |
| Other Keys | Refer to the description of following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

## 2.2. Instructions of Screen Display



## 2.3. Title Bar

| | |
|---|---|
|  | Display the system version number & date, robot model types, each type of file names, coordinates etc.<br>：Click this area to switch between different display items, which are suitable for different applications.<br>World 0 ：The type of coordinates on the left is displayed at the top, and the current space velocity of the tool tip is displayed at the bottom. Clicking this area can switch the display of coordinate values or the aforementioned different information |
|  | Displays the rate percentage of the system operating speed in the current system state and automatic mode.<br>**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.<br>**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.<br>**Operating**：The automatic program is running.<br>Pause, section stop: The system is running but enters the pause state for any reason.<br>**Teaching:** Performing teaching. |
|  | Prompt hint 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. |

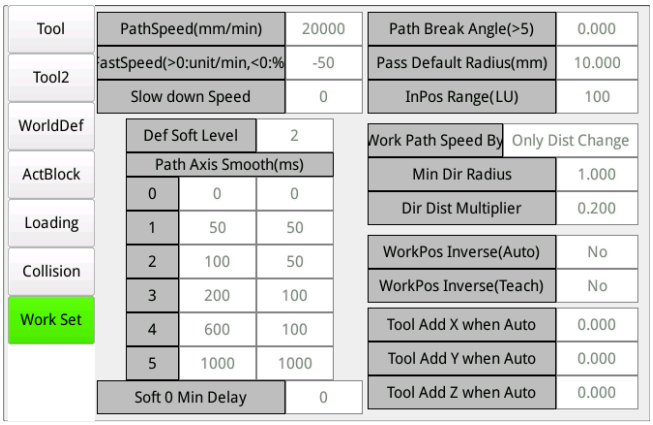



The lower left number represents the type of coordinate system
54: fixed coordinate system
55: Single rotation axis coordinate system
56: Collaboration Coordinate System
The lower right number represents the coordinate system set times, and -1 represents the non-set time.
This shows the type and number of the current coordinate system. Click to enter the coordinate system page.
This also Indicates the type and number of the coordinate system currently used. Click to enter the coordinate system page.



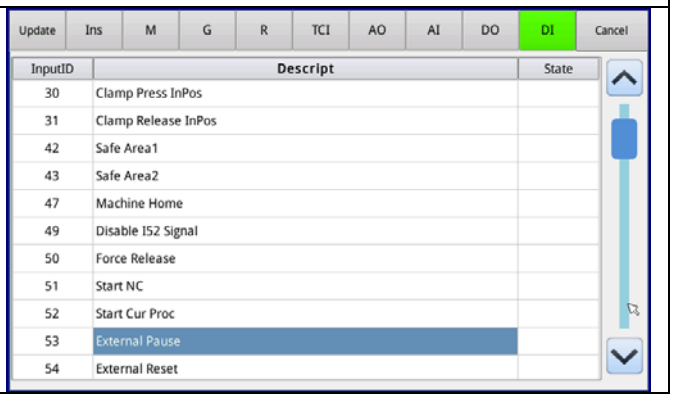
The numbers below represent the current tool number.

This shows the tool number currently in use. Click to enter the tool page.

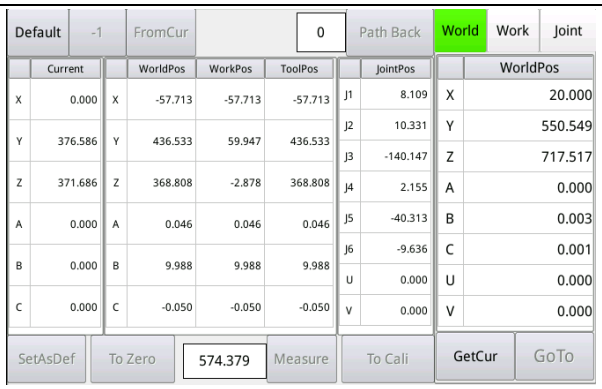




Enter to the IO menu link.

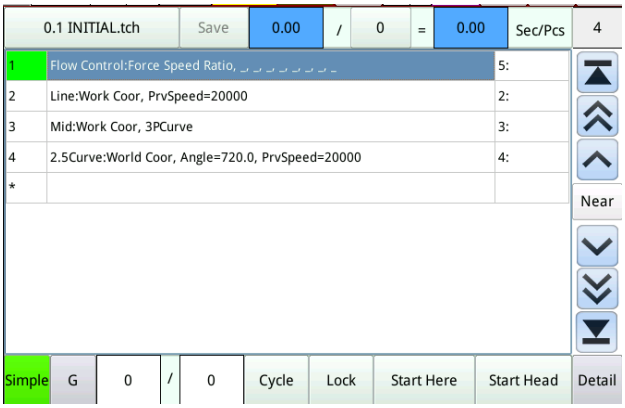



Enter to the coordinate menu link.



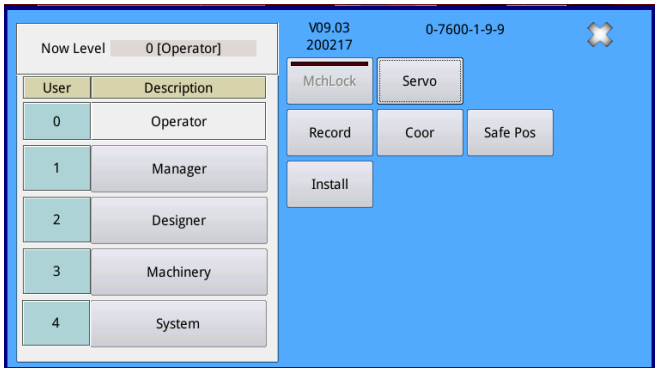


Enter to the procedure menu link.



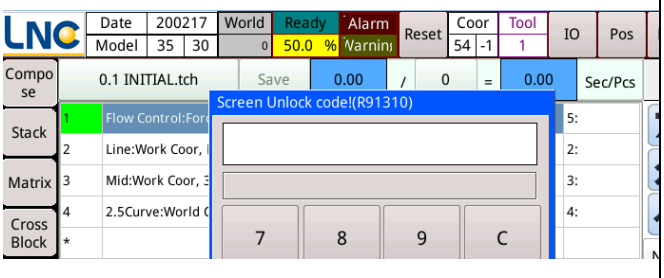


Enter to the authority level login menu link.



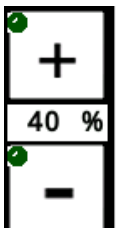
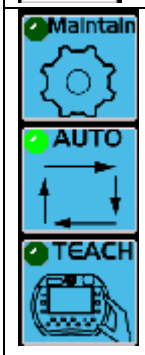


Screen lock function: When the system enters the screen lock state.
Click this icon to pop out the password window.

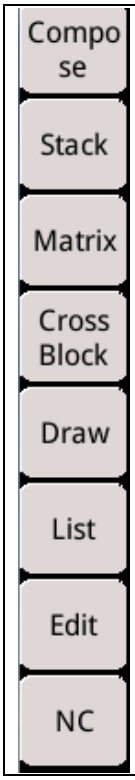



**Enter the correct password to unlock. The default password is 0.**

## 2.4. Right Quick Operation Area

| | |
|---|---|
|  | Automatic mode: adjust the percentage of speed during automatic operation<br>Maintenance and teaching mode: adjust the speed percentage during manual operation |
|  | In automatic mode, to enable the program (with options to set) to continue the program and put the running program into a pause state. |
|  | These three keys can switch system modes:<br>**Maintenance Mode**: control the operation of a single motor. It is usually used in the machine tuning stage.<br>**AUTO Mode**: Use to enable programs or perform specific actions on each page.<br>**Teach Mode:** You can move using coordinate system directions such as "World", "Work", "Tool", and "Joint" as a reference for movement. |

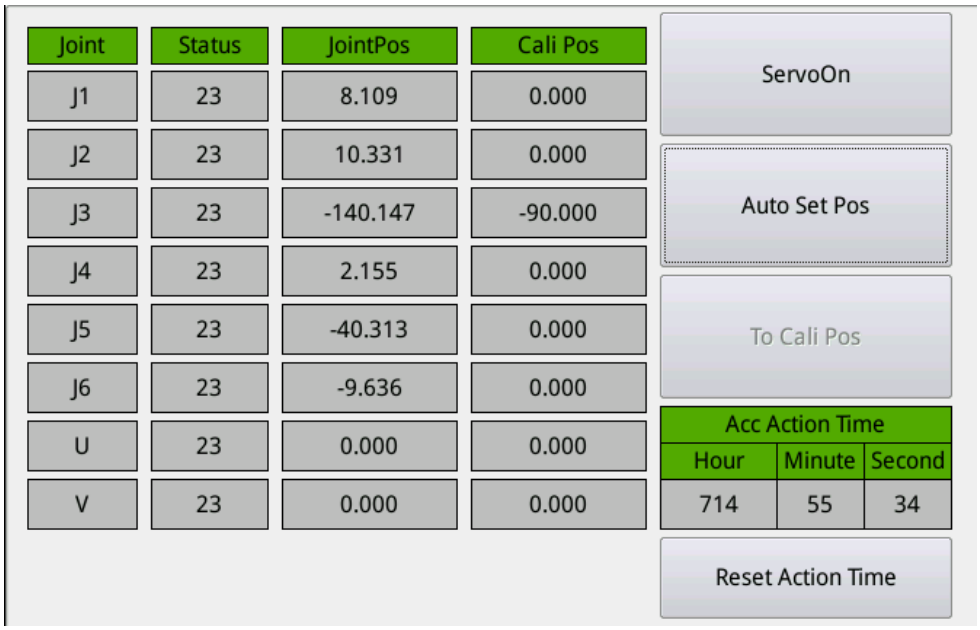
## 2.5. Left Function Menu

| | |
|---|---|
|  | 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.<br><br>Each button is linked to the corresponding function page, and the description of each page is described in the following chapters or in the extended instruction manual |

# 3. Common Menus

## 3.1. Startup(Servo)

You can see the coordinate status of each axis on this page, where 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 absolute type with digital interface, 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 (zero position sensor or Z-phase signal).

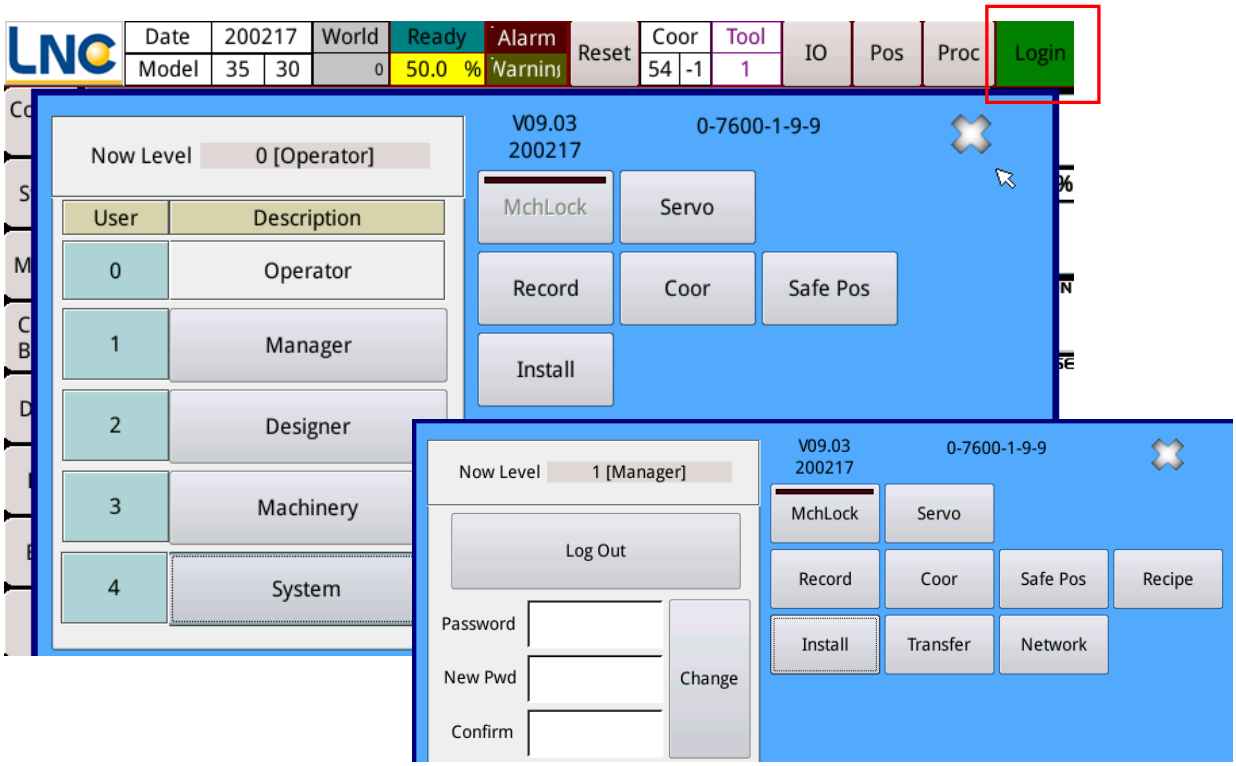
**Back to the calibration point:**

In the "Teach" 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:**
time will be accumulated as long as any motor has taken action.

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

## 3.2. Authority Level




This system is divided into five types of permissions:
Operator: end-user operator, responsible for operating the machine. This is the permission preset when startup.
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.
Developer: Used by the motion process developer to write the motion process. Please ask the machine factory for the default password.
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.
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.

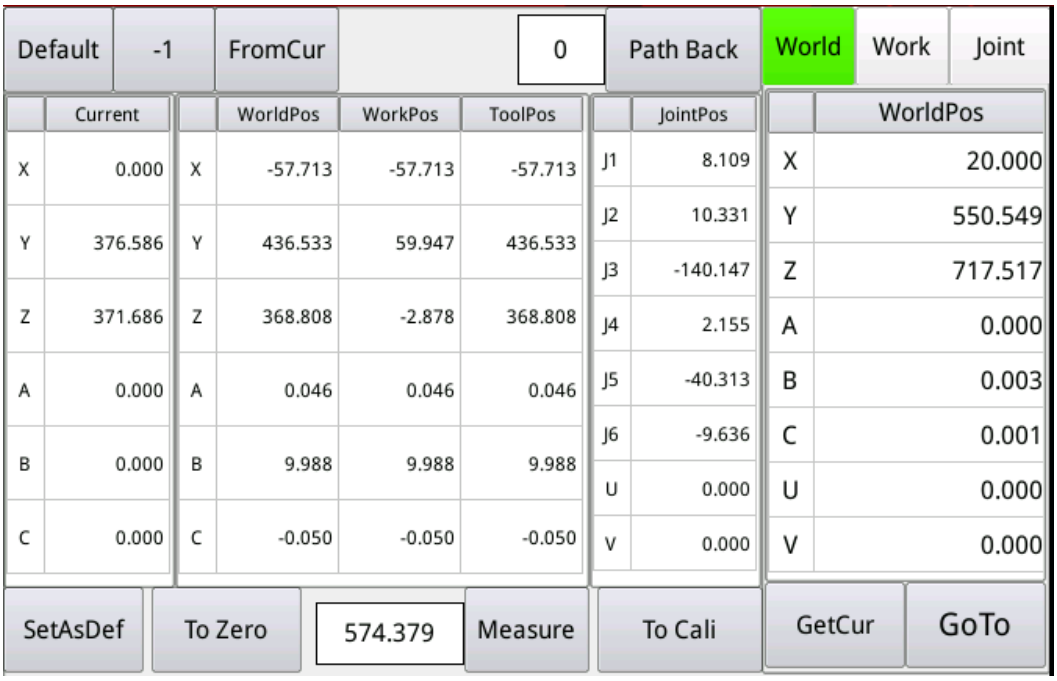
The default permission of the system after startup is the operator.

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

Logout: Simply press the "Logout" button.

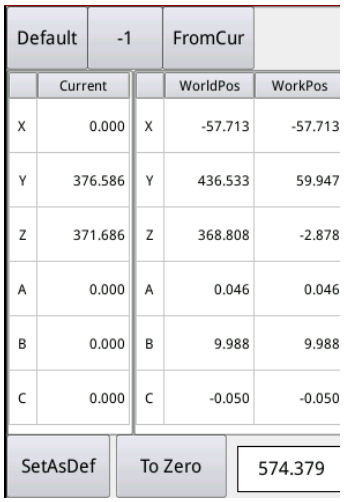
Change password: Enter the current password, new password, confirm password and press "Change".

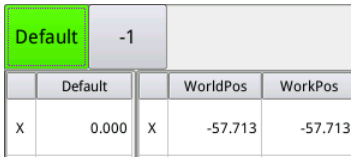
## 3.3. Coordinates




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 & Setting




**Default**：Switch display of current coordinate system, or coordinate system default setting.

**Coordinate system bar:**

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

**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.

**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.

**Take from the Coordinate System**：

Take the content in the coordinate system record to set the current coordinate coefficient value. 


**Set as Default:** Set the current coordinate system value to the default coordinate system for the next startup

**SetAsNow**：Re-set the default coordinate system and apply it to the current coordinate value.

**Origin**：Move straight to the origin of the coordinate system

(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 movement.

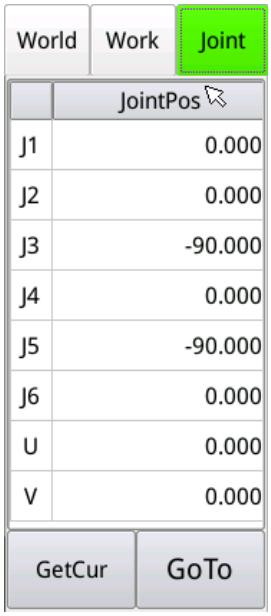
Note 1: From the tool coordinate information, the relative relationship between the current point and the point when the span is pressed can be known.

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

**Path Back**: 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.

**To Zero**：Go to the calibration point marked on the start page (press to enable, release to stop)

## 3.3.3. Operation for Movements




**Coordinate selection:**

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

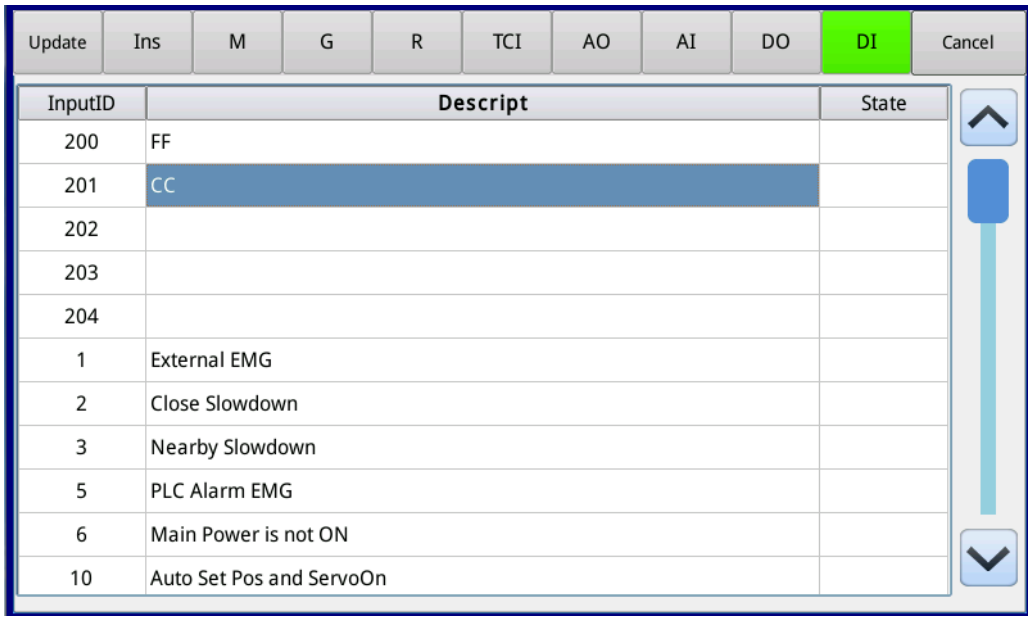
**Coordinate input:**

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 project.

**Move to coordinates:**

Press "GoTo" to move to the target coordinate value, and stop when it is released.

## 3.4.IO



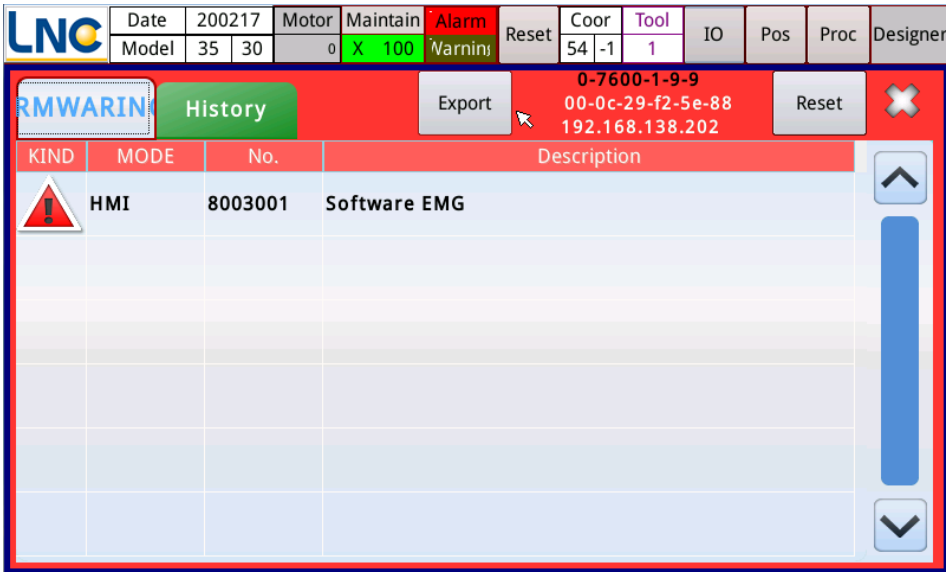

This page displays system built-in resources along with user-defined resources.
DI : Digital Input Signal, I points which correspond to the setting hardware will displayed.
DO : Digital Output Signal, O points which correspond to the setting hardware will displayed.
AI : Analog Input
AO : Analog Output
TCI : Temperature Sensing Input
R : Register
G : G Code,Manufacturer macros with Macro folders are displayed.
M : M Code
Ins : Insert Macro

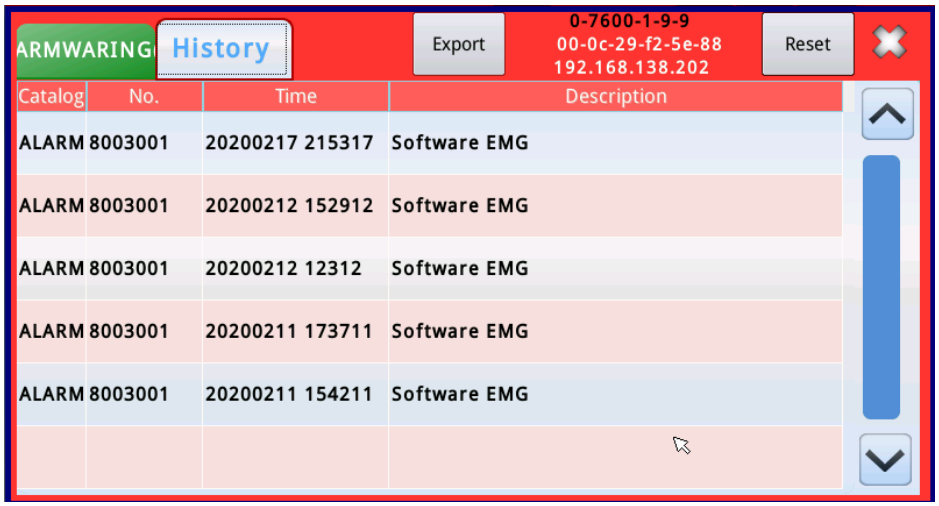
Update: Used in the development phase of the developer to re-read the contents of definition files of the resources.
Cancel: Close this window

Note 1: User-defined resources can be obtained from ReconTool / Files / language / UserString_0002.str for editing Chinese annotations, uploading them and pressing Update to display Chinese.
Note 2: Designers have the above authority, you can click the description field to edit.

## 3.5. Alarm/Warning Menu

This page shows current and historical alarms and warnings.



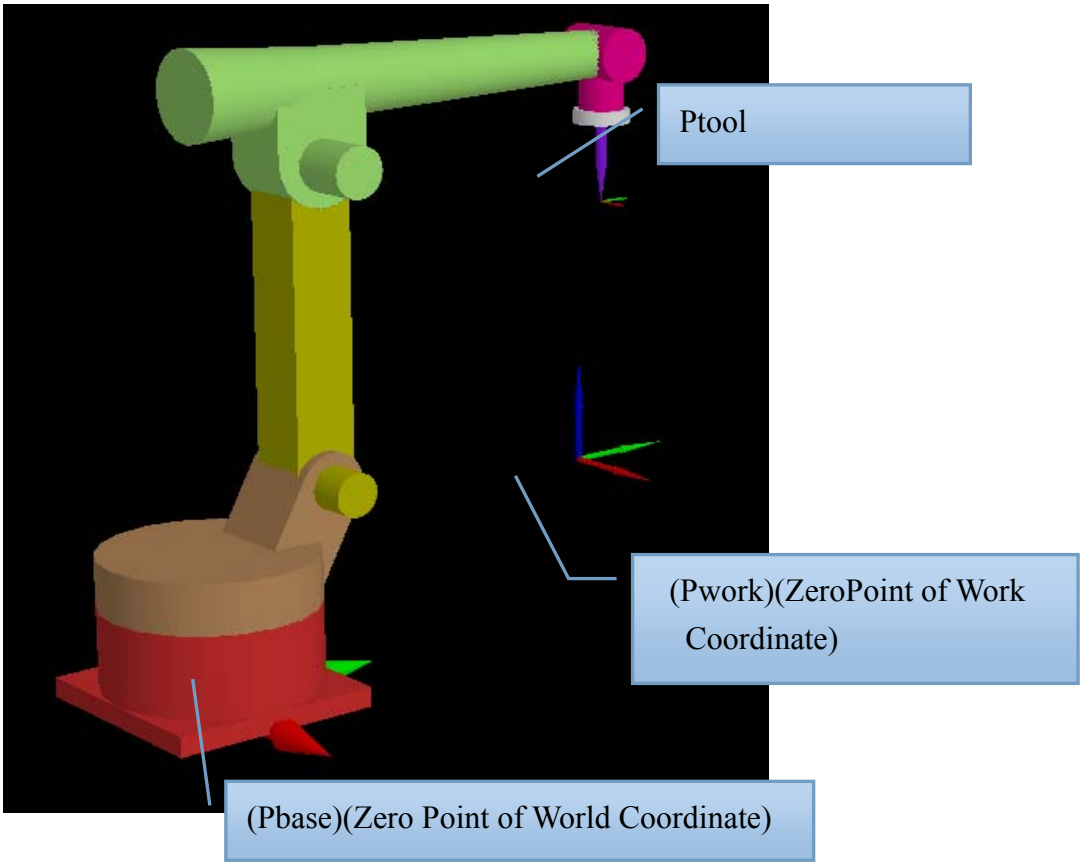




Note 1: The user-defined alarm warning exists in ReconTool/file/language/UserAlarm_0000.str, which can be downloaded and edited, and then uploaded to overwrite the original file. The alarm range is from R29000.00 to R29049.31, and the warning range is from R29050.00 to R29099.31.

# 4. Introduction of Basic Concepts

## 4.1.Introduction of Space Coordinate (Euler's Rotation Theorem)

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.

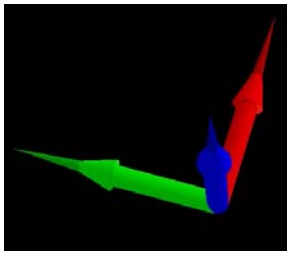
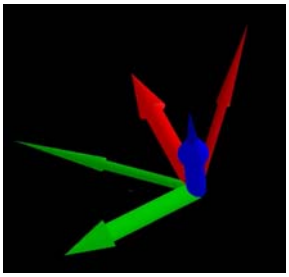
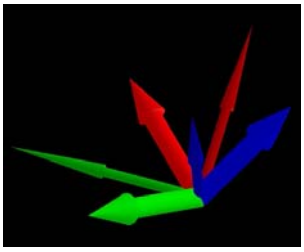
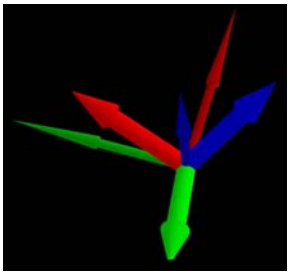
LNC's Euler's rotation theorem is defined as ZXZ, and the universal is the right-hand rule, ie

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<br>(0, 0, 0) | Rotate 45 degrees around Z<br>(45, 0, 0) | Rotate 30 degrees around X<br>(45, 30, 0) | Rotate 30 degrees around Z<br>(45, 30, 30) |

## 4.2. Various Coordinates & Its 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:

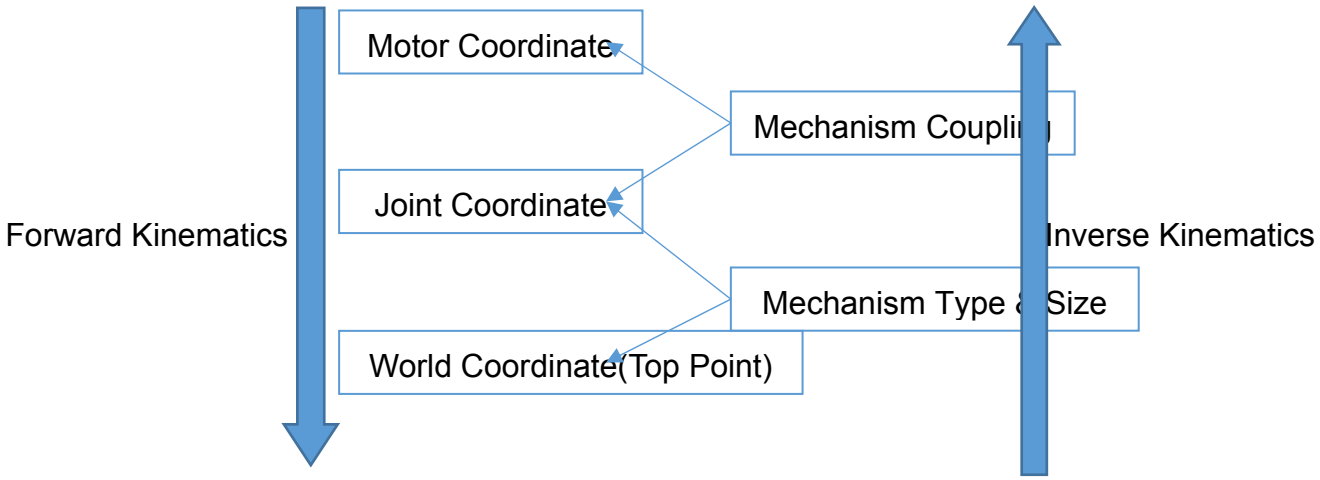
**Motor coordinates:** The actual coordinate value of the motor is independent of the coaction between the mechanisms.

**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.

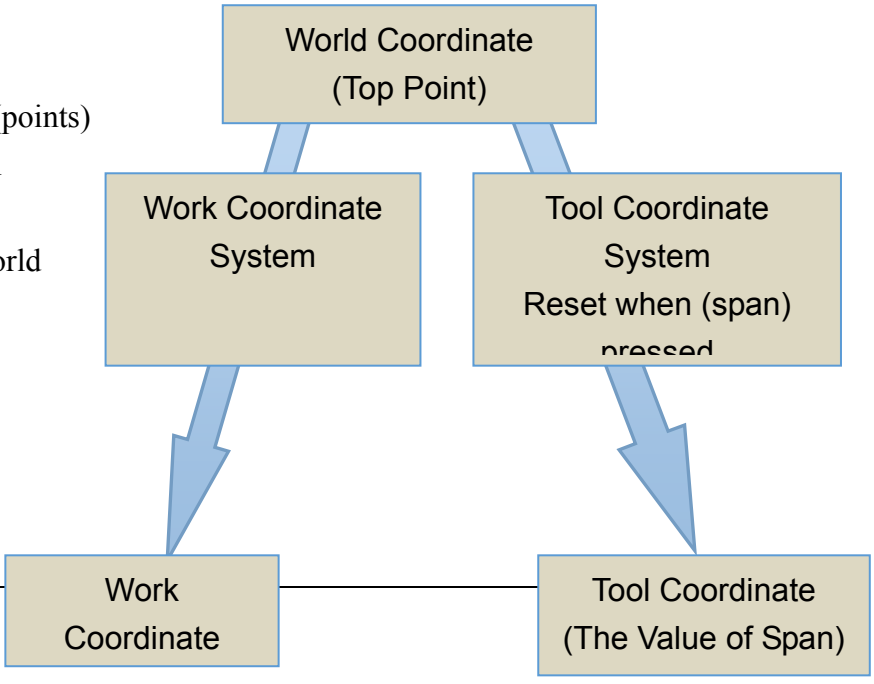
**Forward kinematics:** An algorithm that converts motor coordinates to world coordinates.

**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. Absolute Accuracy of the Robot

In the joint robot algorithm, the world coordinates represent the position of the end effector relative to the card-type coordinate coefficient of the robot base, XYZ is the distance in each direction, and ABC represents the rotation direction and attitude of the end effector. When the end effector is a sharp point, it is easiest to understand the meaning of its position.
The absolute accuracy of the robot refers to the difference between the world coordinate value of the tip point and the real physical quantity in real space. Because the physical quantity of real space is difficult to measure, it cannot be verified directly, but it can be presented through indirect phenomena. The easiest way to judge In order to change the direction and attitude of the robot's sharp points in manual mode instead, the larger the position of the sharp points at this time, the worse the absolute accuracy is.
When the absolute accuracy is not good, it will show in three aspects:
1. When the direction is changed, the position of the sharp point is shifted
2. The distance between the two points of the robot is different from the value entered in the program.
3. The path is deformed when running, the straight line is not straight and the arc is deformed
The absolute accuracy will affect the applications of trajectory processing and absolute position, such as welding, cutting, polishing, gluing, matrix, stacking, etc., it is very important !

The absolute accuracy of the robot is related to the following conditions:
1. The processing surface of the joint is completely consistent with the design of the mechanism, and the parallelism and perpendicularity of the mechanism assembly are perfect.
2. The reduction ratio of each axis is correct.
3. The robot component mechanism is the correct dimension.
4. The zero position of each joint is consistent with the algorithm definition and completely accurate.
5. The additional tools are set correctly and the mechanism parameters are correct.

Items 1 to 4 are completed when the robot leaves the machine maker factory, but you must add the required tools (end effectors) during your application. You must also calibrate it to show the best results. Please use the “Installation Application / Tools” chapter to calibrate the installed tools.

## 4.4. Rapid Movement

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 orbit. There are two types of rapid commands applications:

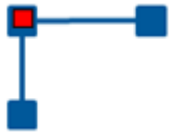
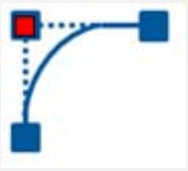
1. There are no obstacles between the starting and ending points, as long as they can arrive quickly.
2. The attitude of the starting and ending points spans different quadrants, using when path movement cannot be achieved.

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 rapidly, 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

## 4.5. 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 Orbit | Attitude Change |
|---|---|---|
| Linear<br>  <br>(Start Point – Linear Point) | Spatial Linear | According to the distance traveled, the attitude is changed in equal proportions. |
| Arc Transition<br>  <br>(Start Point–Transition Point–Linear)<br>(Start Point–Transition Point–Linear) | Three points form a spatial plane<br><br>The radius of the transition circle can be specified on the 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. | Half of the arc is classified as the first half and the other half is classified as the second half.<br>The first half changes to the attitude of the transition point by the distance ratio, and the second half also changes to the end point according to the distance ratio. |
| Mid-Point<br>  <br>(Start Point–Mid Point of the | Three points form a spatial plane<br><br>If the end point uses the arc endpoint command, you can | The midpoint of the arc can specify the way the attitude changes.<br>Three-point linearity: The starting point, the midpoint, and the end point are divided into two straight lines to change the attitude. |

| | | |
|---|---|---|
| Arc–Linear)<br>(Start Point–Mid Point of the Arc–Arc End Point)<br><br>There are three types of end points：<br>1. 3D Arc →Space Arc<br>2. 2.5D Arc →Helix<br>3. 2D Arc →XY Plane Arc | additionally specify the angle that the arc will around in total. | Two-point linearity: Ignore the midpoint's attitude and change the attitude by the arc length ratio.<br>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.<br>Two-point arc: Ignore the midpoint's attitude and change the attitude around the arc plane by the length ratio of the arc.<br>Fixed starting point: fixedly use the starting point of the attitude, and the attitude of midpoint and the endpoint are ignored<br>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.<br>Starting point ABC: The BC value of starting point is fixedly used, A value changes with rounding angle |
| Center Point<br>  <br>(Start Point–Arc Center–Linear)<br>(Start Point–Arc Center–Arc End Point) | Three points form a spatial plane<br><br>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.<br><br>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.

## 4.6. Inverse of Work Coordinate

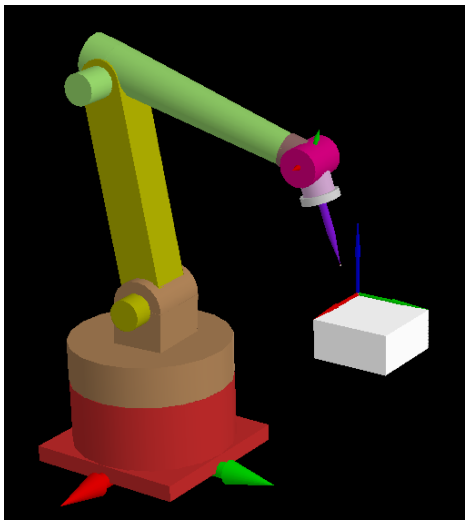
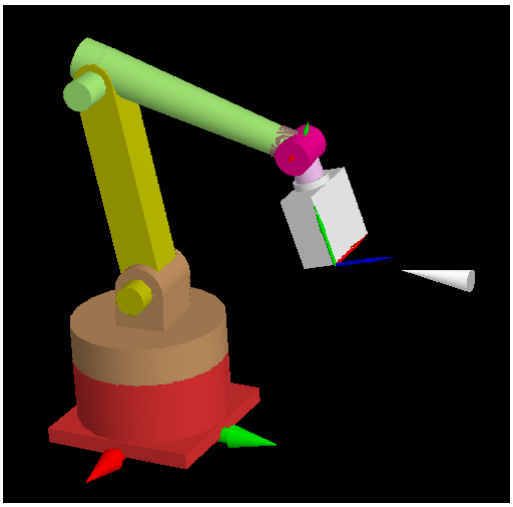
The path interpolation of a general robot is designed by using a robot clamping tool to process externally fixed workpieces. When the robot clamping workpiece is changed to contact an external tool for processing, the original path interpolation method is used in addition to the straight path without changing the attitude Will not apply.

In order to solve this common application method, the system provides the option of "work coordinate inversion". The method is to first invert the input coordinates to the coordinates of the external tool relative to the workpiece before path interpolation, and then perform interpolation. For each interpolation point, the coordinates of the workpiece relative to the external tool are reversed.

This function provides trajectory interpolation that conforms to the relationship between the actual tool and the workpiece. When the robot grips the workpiece, the arc trajectory on the workpiece surface can effectively reduce the number of points. For the method of generating a trajectory using teaching, it can greatly reduce the programming time.

This feature has the following characteristics:

1. Coordinate inversion function is only for working coordinates, it has no effect on world coordinates and joint coordinates.
2. When coordinate reversal is selected, the working coordinate displayed on the system is the coordinate after reversal.
3. The straight and circular functions of the working coordinates are valid.
4. Available in both manual and automatic modes. ◦

| Robot Clamping Device + External Workpiece | Robot Clamping Device + External Workpiece |
|---|---|
|  |  |

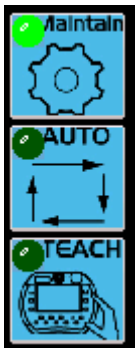
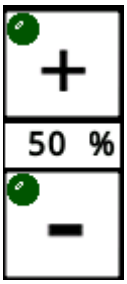
When using work coordinate reversal, the following steps should be taken to complete the calibration

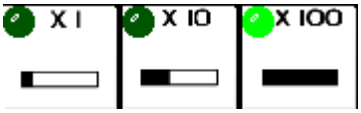
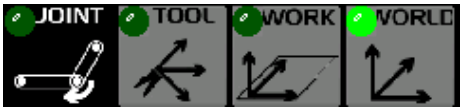
work.

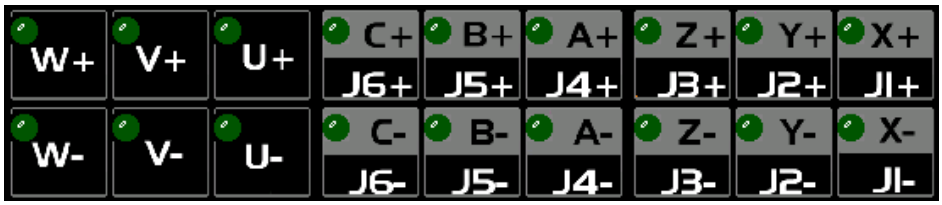
1. Install a sharp point tool on the tip of the robot and complete the tool calibration.
2. Align the external tool with the sharp point on the robot to obtain the coordinates of the external tool and set it as the working coordinate system.
3. Replace the robot tip tool with the workpiece.
4. Use the equipment application / reverse calibration to calibrate the reference position on the workpiece and set it as the tool parameter.

# 5. Maintenance & Teaching Mode

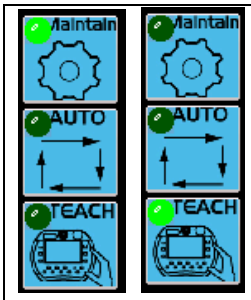
## 5.1. Keys Description

| Mode Selection | MPG Mode | Speed Percentage | Continuity |
|---|---|---|---|
|  |  |  |  |

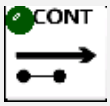
| Speed Multiplier | Coordinate System Selection |
|---|---|
|  |  |

| Motion Keys |
|---|
|  <br>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

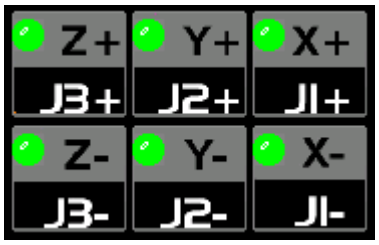
| | |
|---|---|
|  | Maintenance Mode:<br>Rotate the motor, it can still move when the machine status is not ready, and it can still run away from the limit when the axis exceeds the limit.<br>Teaching mode:<br>It operates according to the type of coordinates required, and cannot enter the teaching mode when the machine status is not ready. |

## 5.3. Difference Between Handwheel & Non-Handwheel Modes

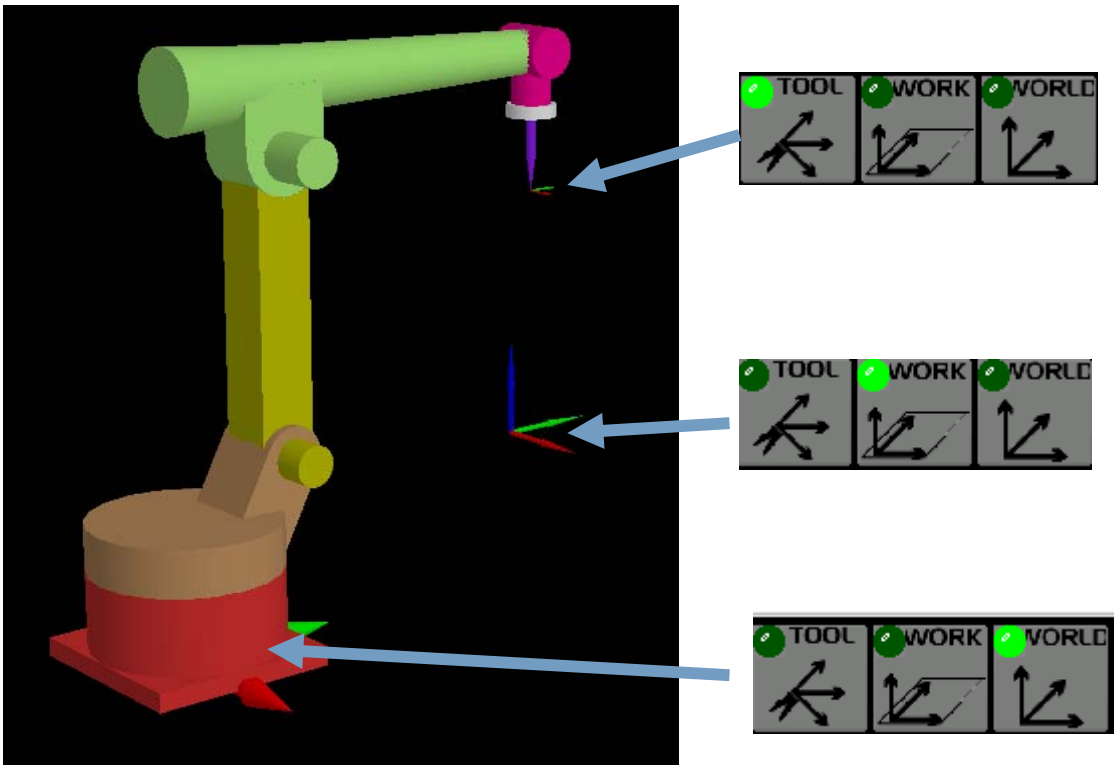
| |  Non-MPG Mode |  MPG Mode |
|---|---|---|
| When the motion key is pressed | The machine moves immediately | It represents the axial direction of the motion when the MPG is rotated. |
| Direction control | Press different arrow keys | The handwheel rotates in CW and CCW directions. |
| Speed Mode | Select Conitnous  Speed multiplier x speed percentage | Speed multiplier x MPG rotation rate |
| Incremental Control | Select Non-Continues  It moves some distance if pressed for one press 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 status, when the handwheel rotates CW, it moves forward and when the handwheel rotates CCW, it moves backward. |

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



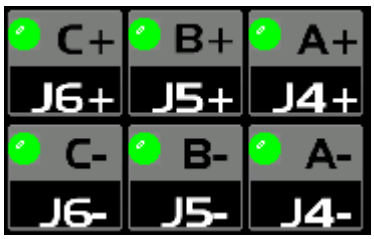

Depending on the selected coordinate system, the direction of XYZ motions is determined by the selected coordinate system.

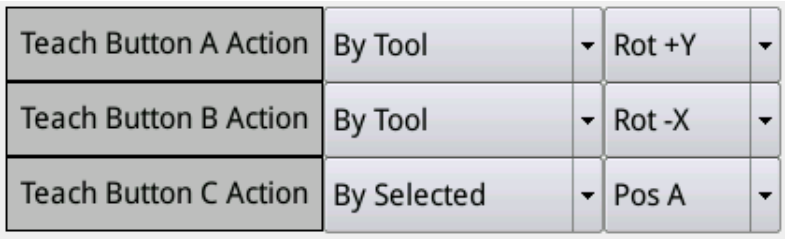




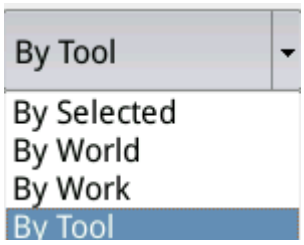
**Joint Coordinate System**：Defines the decision based on the direction in which the joint rotates.

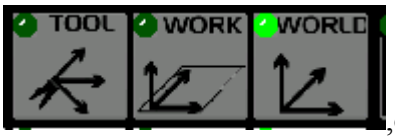
## 5.5. Direction Rotation Under Teaching Mode



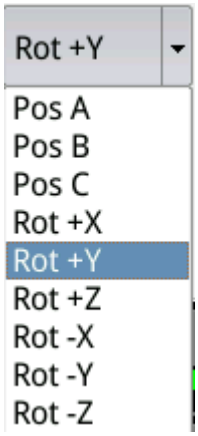




Each of the three ABC keys can be set to its operation mode, which is set by the login authority above the machine maker ID.




：according to 

,or force to set as world, work, tool cooredinate system.

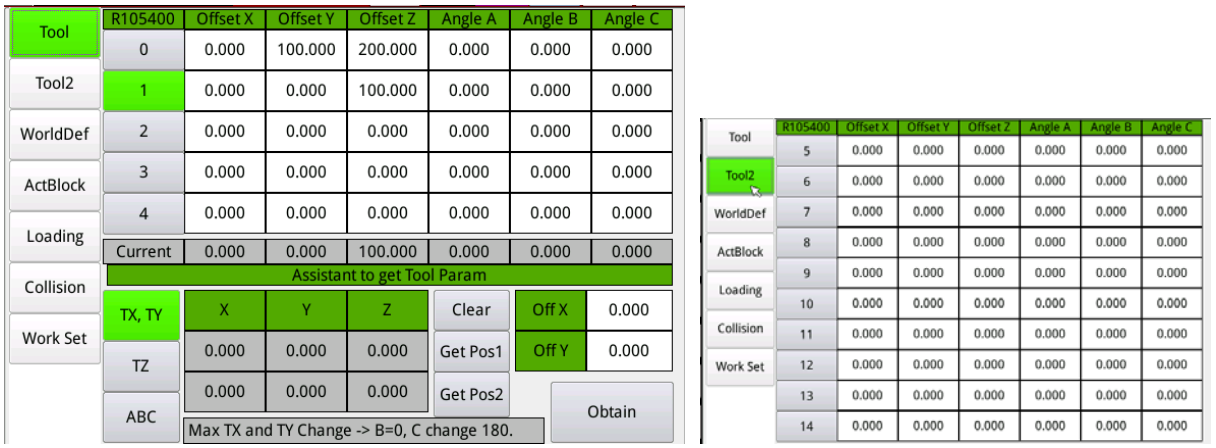



：Change the ABC value in the coordinates, or rotate around the coordinate axis.

There are three ways to rotate the direction during teaching. You can choose the options that are easier to understand according to the type of organization and personal habits. The options are described below.

# 6. Installation Applications

## 6.1. 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 maker factory, 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 describe the relative position between the Ptool and the flange, angle A, angle B, and angle C describe the direction of the Ptool point.

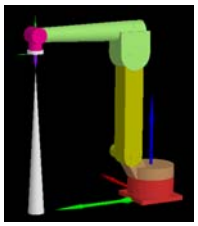
Steps for Tool Calibration:

1. 1. Click the tool number to be calibrated 0 ~ 14, for example: 

2. **Click the item to be calibrated** 

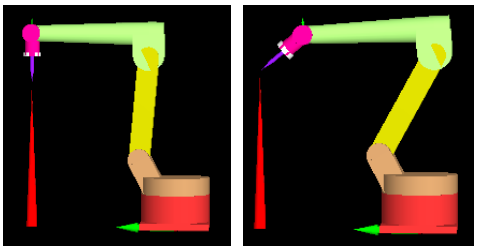
**, and press** 

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

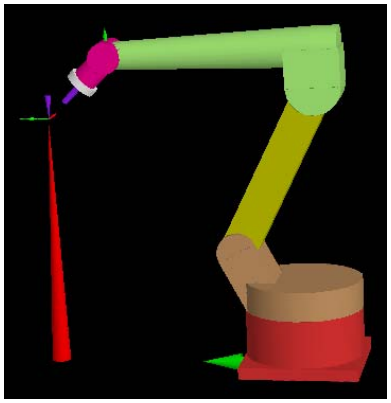
after aligned. 
4. The external point does not move, the world coordinates rotate C about 90 or 180 degrees, then XYZ moves, so that the Ptool is aligned again with the external points, and then press 

.

5. Press Obtain, and then Off X 0.000 / Off Y 0.000 will display the value.
6. Click the value on the right columns of Off X /Off Y Off X 0.000 / Off Y 0.000 to add the offset value to tool parameters.
7. **Click the item to be calibrated TZ, and press Clear.**
8. After the robot aligns the points with the two attitudes as shown on the right figure, press respectively Get Pos1 and Get Pos2.

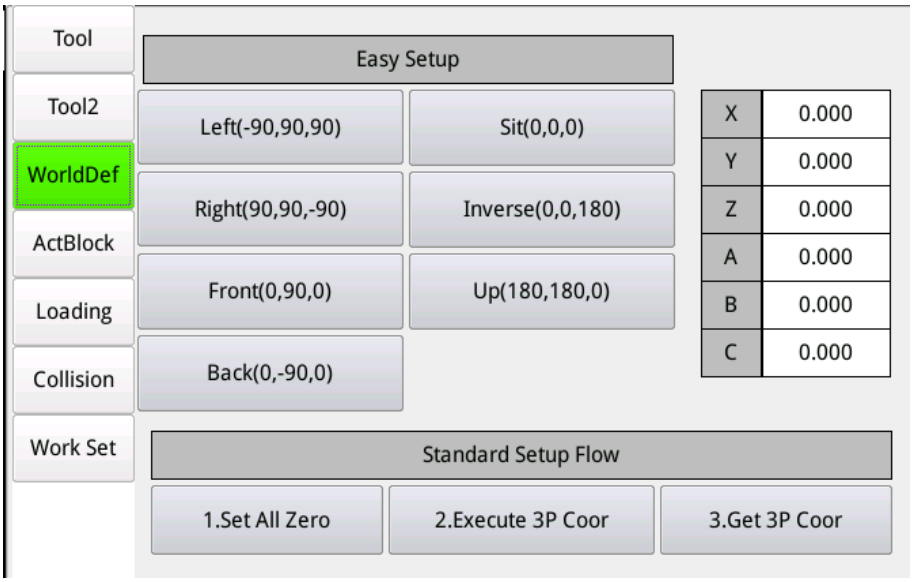


9. Press Obtain, and the right column Off Z 0.000 will display the value.
10. Click the right column of Off Z Off Z 0.000 to add the offset value to tool parameters.
11. **If the direction of the Ptool is not parallel to the 6th axis, you need to set the tool angle. Firstly set the tool angle A, angle B, and angle C to 0.**
12. **Click the item to be calibrated ABC.**
13. Turn the direction of the Ptool so that the tool direction is consistent with the direction of the world coordinates.
14. Press Obtain, and the system will automatically bring in the value of angle A, angle B and angle C.



## 6.2. World Definition

By default setting, the center point of the base of the robot is used as the zero position of the world coordinates. However, according to the actual application requirements, such as the side-hanging and upside-down of the robot, you self-adjust the zero point and direction of the world coordinates.




**Easy Setup**：

Click on an installation method to change the relationship between the world coordinate direction and the base, usually to match the direction of the operator.

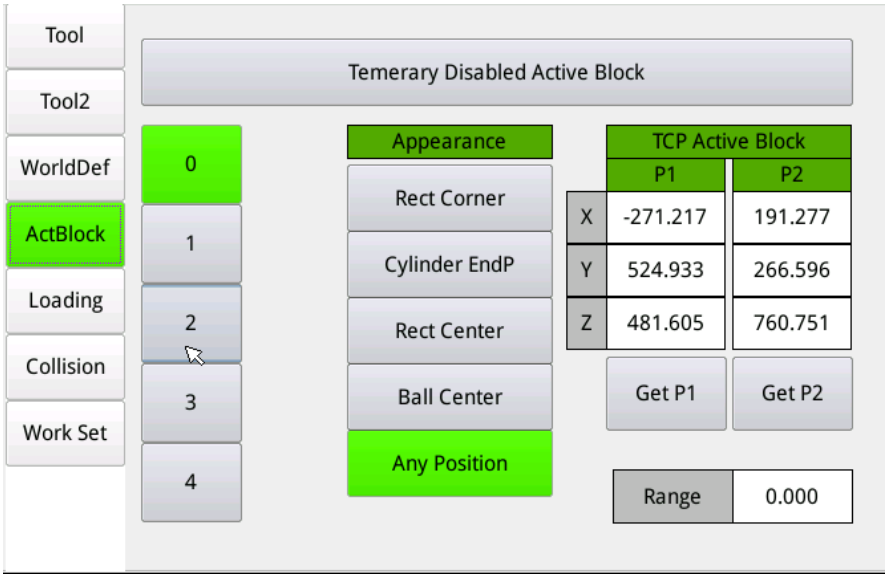
**Standard Setting Procedure**：

The standard way of defining the world coordinate zero position is divided into three steps.

1. Set the world defined value to be zero.
2. Using the coordinate system menu, take three points from the world zero position and its axis, the system shall automatically caculate the value of threes points coordinates.
3. Get the three point cordinate system and set it as the zero point of the world coordinates.

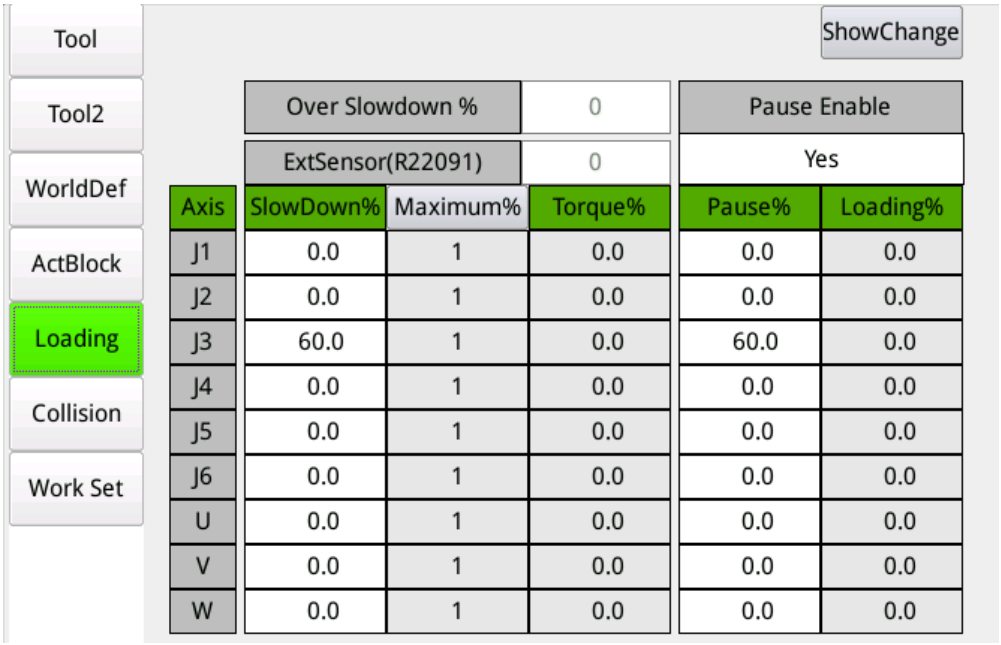
## 6.3. Act Block

The sharp point range is used to limit the tool's sharp point to only move within a certain range of space. Its purpose is equivalent to the limit setting in the space..




The system provides up to five groups (0 ~ 4) of sharp point range settings, which can be switched in manual mode or dynamically switched during automatic program operation.
Each group of settings can choose its own appearance setting method, rectangular corner point, cylindrical axis, rectangular center, spherical center or no limit.

## 6.4. Axis Loading




**Display the Change：** make the current value, loading percentage% and other columns to be updated instantly.

**Maximum %：** Click this button to re-detect the maximum value, which is convenient for setting reference of the deceleration value%.

### Overload Automatic Deceleration：

Designed for deburring purposes. When encountering large burrs, the robot should be slowed down to avoid the cutter breaking.

**Overload Automatic Deceleration %：** Setting 0 means this function is not used, 1 ~ 100, it means the maximum deceleration%, 80 means it can decelerate to 20%.

**Deceleration Value of Each Axis%：** When the torque output value of any axis is greater than the set value, it will continue to decelerate. When the torque output value of each axis is less than 80% of the set value, it will start to recover to the set speed percentage.

**Note: When this function is used, it is necessary to dynamically set the effective action interval through "Expanded Command / Torque Application / Automatic Overload Deceleration". The settings on this menu will disappear after restarting the controller.**

### Overloading Percentage Pause：

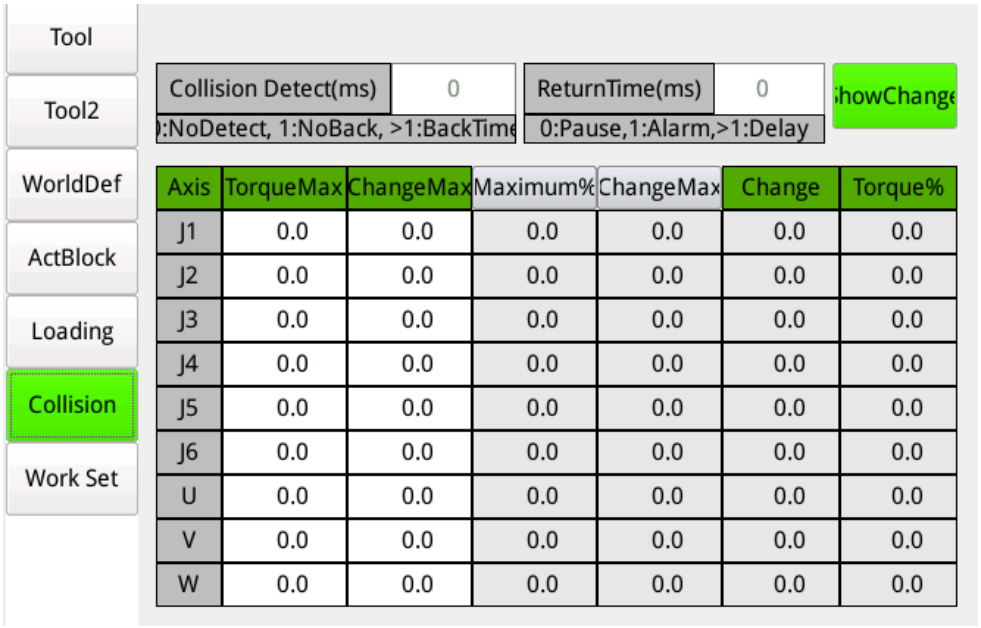
It is used to protect the motor from overheating damage caused by long-term operation.

**Enable “Overloading Percentage Pause” Function：**

**Overloading Rate %：** Read the cumulative loading rate of the motor.

**Overloading Rate Pause %：** Set the robot to pause when the loading rate is greater than the set value.

## 6.5. Collision Detection



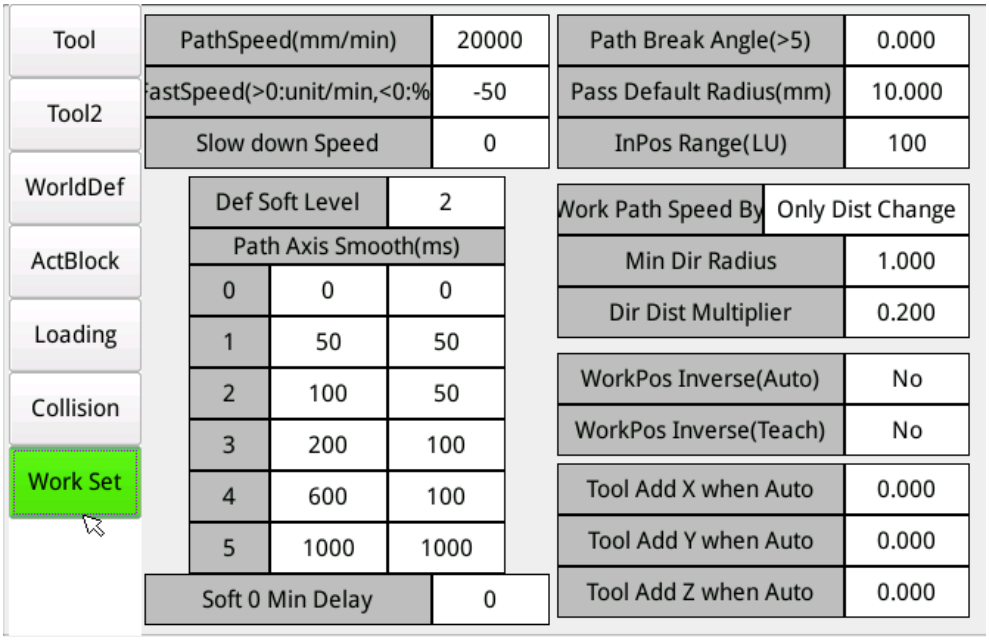

It is used to sense the instantaneous change of torque output and the maximum value of torque during the action, to determine whether a collision occurs, and take corresponding measures.

**Display Change**：make the current value, overloading % and other columns update instantly.
**Maximum Value %**：Click this button to re-detect the maximum value, which is convenient as a reference for setting the deceleration value%.
**Collision Detection(ms)**：0: no detection, 1: detection without backward, >1: means the time to backward when detected.
**Restart Time(ms)**：Represents the way to deal with when a collision is detected. 0: The action is paused. 1: The alarm is issued. When> 1, it means that the action will be restarted automatically after some time.
**Max. Torque**：When the torque is greater than this set value, it is determined that a collision has occurred.
**Max. Change**：When the torque change is greater than this set value, it is judged that a collision occurs.

**Note: When this function is used, it is necessary to dynamically set the effective motion interval through "Extended Command / Torque Application / Collision Detection". The settings on this menu will disappear after restarting the controller.**

## 6.6. Work Setting

Contains settings for controlling motion speed, acceleration / deceleration, trajectory, and position.




**Path Default Speed**：The default speed in the program except for fast commands, the unit is mm/min.
**Rapid Speed**：The default speed of fast commands in the program, the unit is deg/min. When a negative value is entered, it represents the highest speed percentage of each axis.
**Decelerating Stopping Speed**：If there is a “slow distance” setting in the fast command in the program, there will be a distance before the end and this speed should be used instead. The purpose of this function is to allow the robot to stop steadily and reduce jerking.
**Default Soft Level**：Set the default soft level number 0~5.
**The smoothing time of the path axis of each level:** the greater the time, the softer the robot moves, and the larger the trajectory error with the set movement.
**Soft 0 Minimum Delay**：When the selected soft level is 0, the system will automatically add a set time delay at the end of the action when the system is running, so that the action can be correctly in place.
**Path Breaking Angle**：When the set trajectory direction angle is greater than this set value, the system will automatically add a waiting time to the corner so that the robot can actually reach the corner. This function is effective only when the setting value is greater than 5.
**Default Diameter of Arc Transition (mm)**：When the arc transition command is used in the program and its radius is not specified, it will be substituted with this set value.
**Correct In-Position Range**：When the correct in-position command is used in the program but no in-position range is specified, this set value is used instead.
**Work Path Speed Basis**：Contains two different options: "Use only the distance change" and "Distance direction change". This parameter has effect only on "Work coordinates". The world

coordinates and tool coordinates are forced to use the distance change.

**Use Only the Amount of Distance Change**：It is applied to the situation that the attitude will change during processing. In order to keep the speed of the sharp point constant, it can be used for glue application, cutting and other purposes.

**Amount of Change in Distance Direction**：When the position of the tip point changes very little, but the attitude changes greatly, in order to avoid the situation of the robot's instantaneous acceleration, the movement amount of the attitude change must be considered.

**Min. Attitude Change Radius**：When calculating the considerable distance of attitude change, the tool length is used as a reference, but the set tool length may be 0. This parameter is used to replace the situation when the tool length is less than this set value.

**Attitude Change Distance Multiplier**：The attitude change distance is the angle of the attitude change times the radius, which is equivalent to calculating the arc length. This parameter is multiplied by the arc length. The larger the ratio of this value to the moving distance of the tip point, the system will divide more path speed.

**Work Coordinate Reversal(Automatic)**：The interpolation method of work coordinate reversal is preset to be activated during automatic operation.

**Work Coordinate Inverse(Teaching)**：In teaching mode, work coordinate inversion is started. When this option is enabled, and teaching is performed at the working coordinates, the action method is described as follows.

When the XYZ key is pressed: relative movement is performed based on the coordinate system direction of the tool tip.

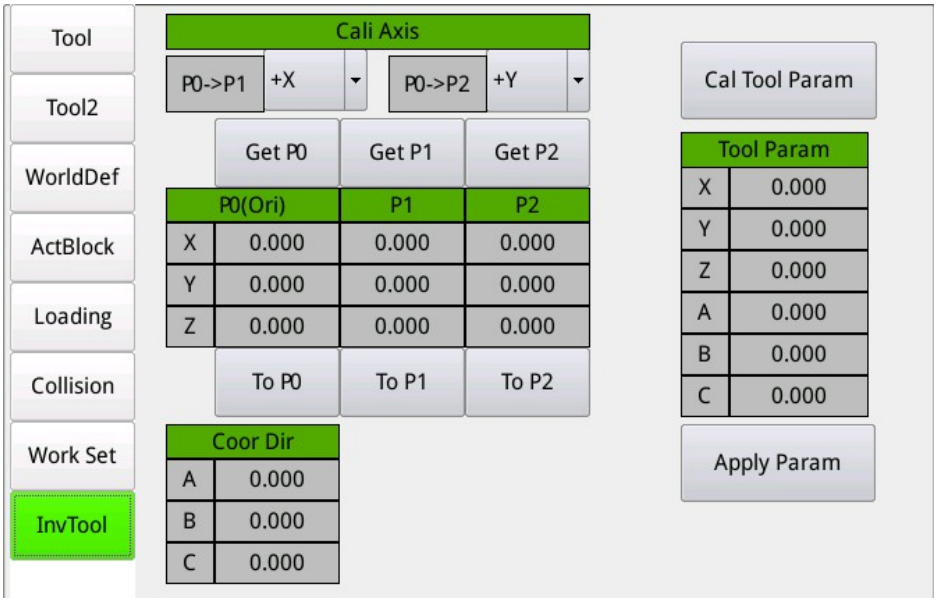
When the ABC key is pressed: The robot's tip point is rotated around the coordinate system based on the direction of the coordinate system.

**Tool parameter compensation X, Y, Z during automatic operation**：During automatic operation, the current tool parameter setting value is automatically added to the setting value here. There are two application scenarios.

1. A floating spindle or tool holder is installed at the end of the robot, and it will not contact the workpiece when teaching the point, but the tool should be contacted during actual operation, and then compensated by the floating equipment, and adjusted by itself.
2. At the beginning of teaching point, the size of the tool is large, such as a polishing wheel, but as the number of processing times increases, the size of the tool gradually decreases, so the processing position needs to be adjusted by changing the tool parameters.

## 6.7. Inverse Setting

This tab appears when the work coordinate inversion is set to Yes.
This page is used to calibrate the reference position and orientation of the workpiece held by the robot (tool parameters)




The calibration method is similar to that of the coordinate series, except that the original workpiece is external and is clamped at the end of the robot.

1. Mark the three points on the workpiece, and then use the points of the coordinate system to align the three points to get the values of the coordinate system.
2. Press "Cal Tool Param" to calculate the necessary tool parameters based on the calculated three-point coordinate coefficient value and the robot's current posture, which can satisfy the point pair of the external tool (coordinate system) to P0. The XYZ value of the coordinate is 0. When moving to the work coordinate XYZ, it moves along the XYZ direction on the workpiece.
3. Click "Apply Param" to bring the calculated tool parameters into the current tool parameters

# 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 rapid moving manner.

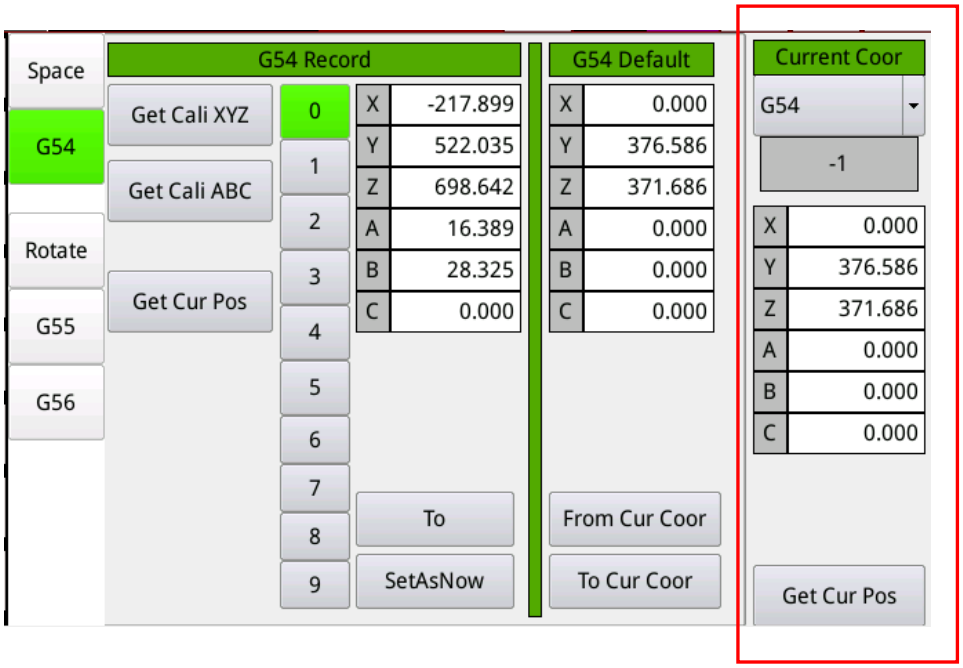
Note 1: The point record can be used as a coordinate system in addition to the point of operation.

# 8. Coordinate System

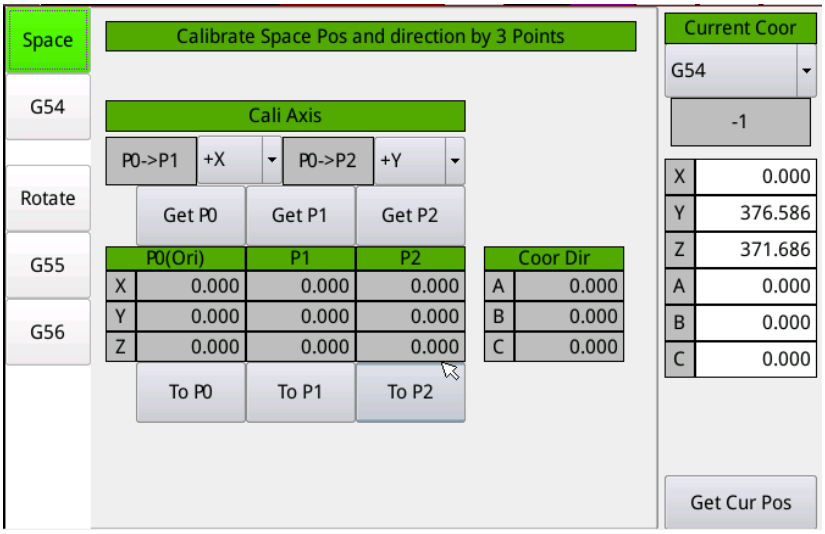
The coordinate system is mainly used to adapt to the position relationship between the robot and the workpiece, including the offset and rotation and tilt of the work area. The coordinate system needs to be calibrated on site before use. According to the type of coordinate system, the calibration method is different.

| Type | Calibration Method |
|---|---|
| G54：Fixed Coordinate System | Three-point calibration in space, origin, point on direction axis, point on plane |
| G55: Rotary Coordinate System | At the same point on the rotating table, point calibration at three different angles |
| G56：Collaboration Coordinate System (Multiple Rotary Axes) | Rotation calibration + system conversion estimation process |

The below right side marking in red of this menu shows the type and group of the current coordinate system.



## 8.1. Space Setting

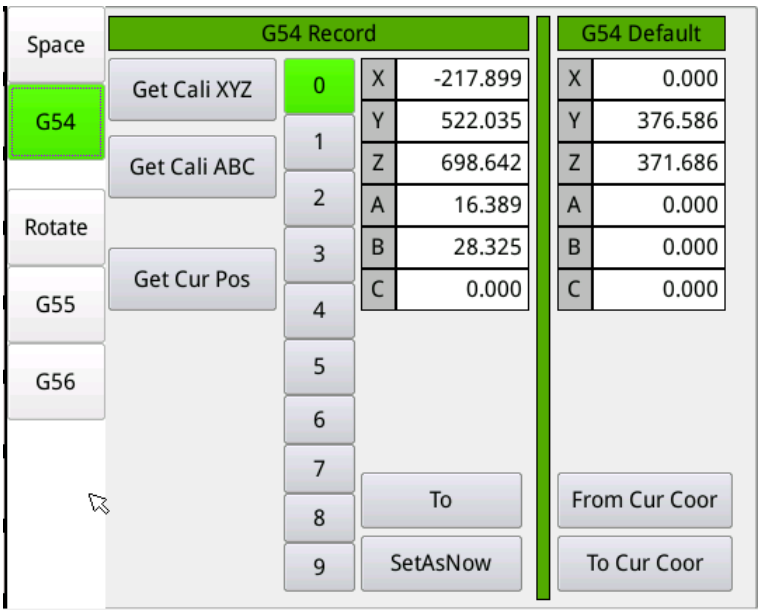



Mathematically, we can determine a coordinate system through three point positions, where:
P0: zero position of the coordinate system
P1: point on the main axis
P2: point in minor axial direction (in plane)
According to the difference of the actual workpiece or the direction of the movement path, the main axis may be a point on + X, -X, + Y, -Y, + Z, -Z, and the minor axis is also. Therefore, we could provide 24 kinds of three point positions..

After selecting the relative position of the object in the work area and the robot arm, you can set the three-point coordinate system. The operation method is described as follows:

1. First select the zero position P0 and P1, P2 to be used as the basis for calculating the coordinate system.
2. First adjust the robot to a proper posture, which can be aligned to P0, P1, and P2.
3. According to the axis where P1 and P2 are located, click the upper axis selection to switch the axis.
4. Press XYZABC below to align the tool tip with P0, then press "Get P0" to bring the "current world coordinates" into the 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 tip with P1, and then press "Get P1" to bring "Current World Coordinates" into P1 coordinates.
7. Press XYZABC below to align the tip of the tool with P2, and then click "Get P2" to bring the "current world coordinates" into the P2 coordinates.
8. The system will automatically calculate the attitude of the coordinate system.

## 8.2.G54




This system provides 10 sets of coordinate system records and a set of coordinate systems that are preset to be brought in at startup to meet the needs of multiple machining areas.

G54 Record

Get Cali XYZ : Bring the XYZ of P0 into the coordinate system record in the space calibration page.

Get Cali ABC : Bring the "Coordinate System Attitude" ABC from the Space Calibration tab into the coordinate system record

Get Cur Pos : Bring the current world coordinates of the robot into the coordinate system record.

To : Move straight to the position of the selected coordinate system.

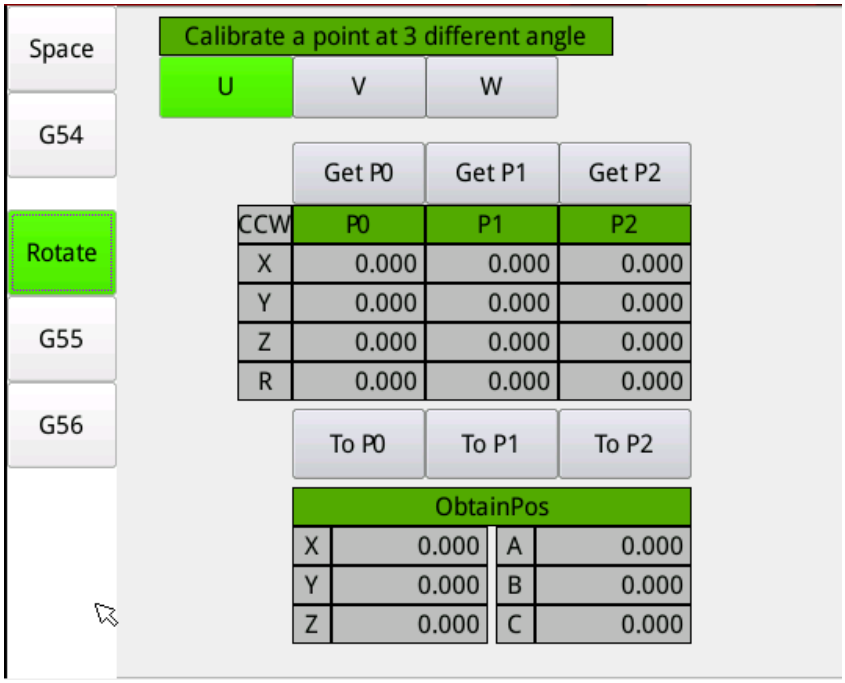
SetAsNow : Set the selected coordinate system record value to the current working coordinate system.

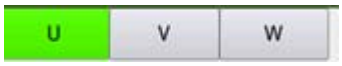
G54 Default

From Cur Coor : Replace the G54 default coordinate system with the current coordinate system.

To Cur Coor : Set the G54 preset coordinate system to the current coordinate system value again.

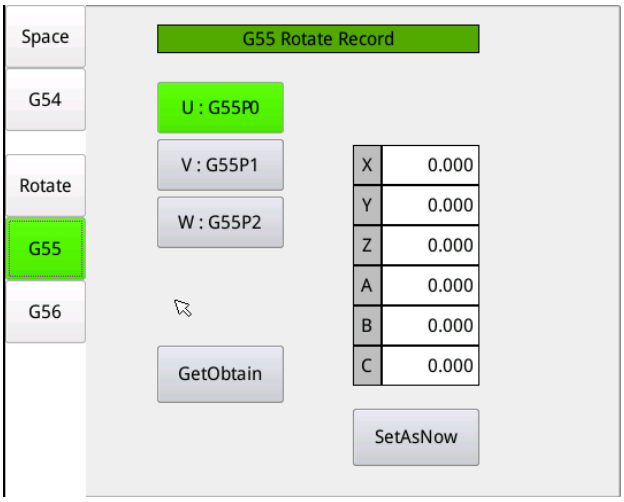
## 8.3. Rotating Setting

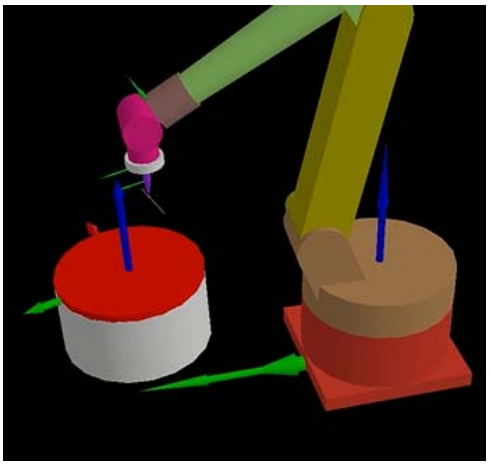



1. Click on one of the axis UVW of the rotary table. 

2. Turn the rotary table to the 0 degree position
3. Mark a point in the direction of 0 degrees
4. Turn to the position of about -90 degrees, move the sharp point of the robot to align with the marked point, and press to get P0.
5. Turn to the position of about 0 degrees, move the sharp point of the robot to align with the marked point, and press to get P1.
6. Turn to the position of about 90 degrees, move the sharp point of the robot to align with the marked point, and press to get P2.
7. The system calculates the value of the rotating coordinate system and displays it in the calibration coordinates.

## 8.4.G55



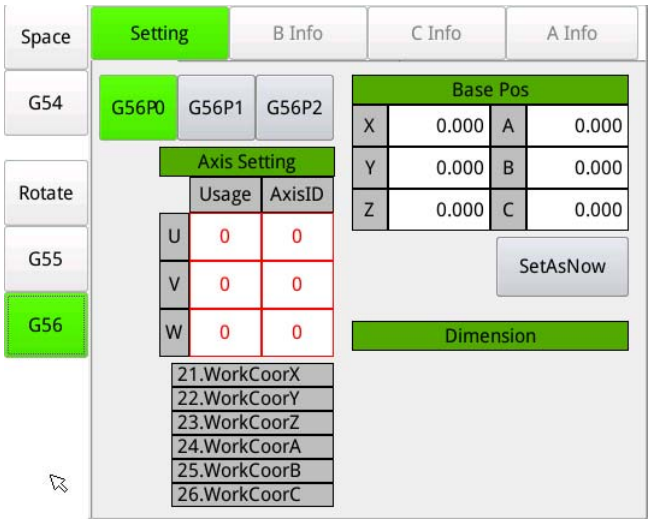
The system provides up to three rotating coordinate systems corresponding to up to three additional axes.

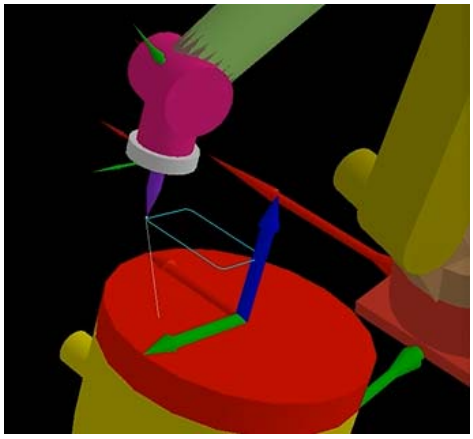

：Select the current display rotary coordinate system.


：Bring the calibration results in the rotation calibration tab to the recorded values of the rotation coordinate system.


：Set the current coordinate system and type.

## 8.5.G56

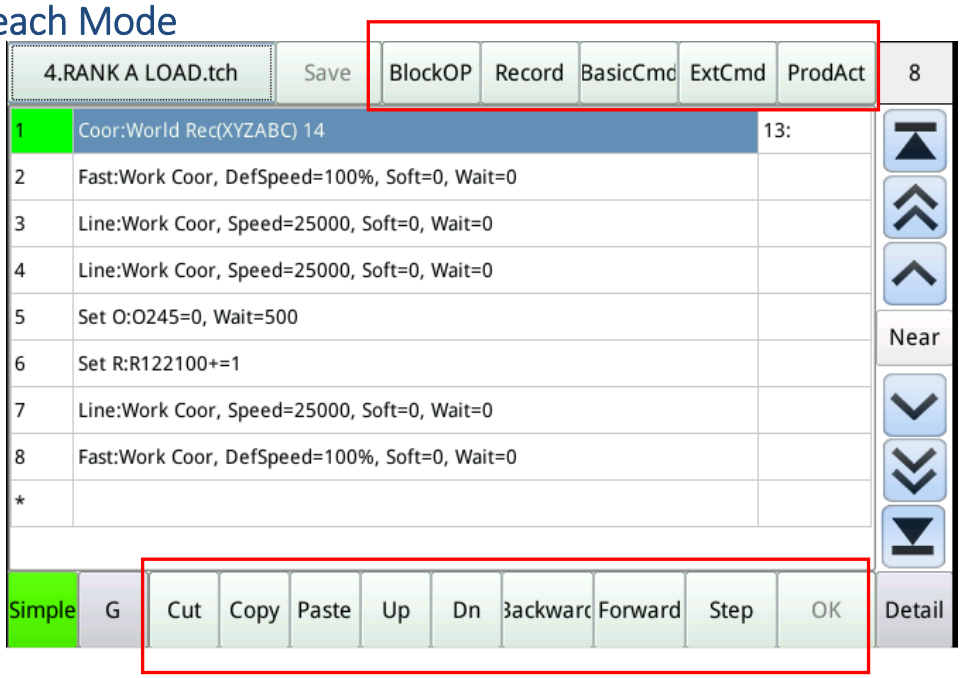


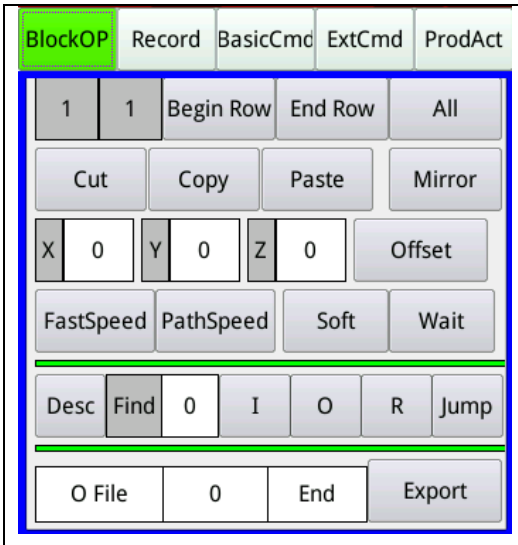
This calibration process is more complicated; please refer to another document "R8800 External Coordinate Axis Calibration Method.pdf".

# 9. Introduction to Operate Interface of Program Menu

## 9.1. Teach Mode




### 9.1.1. 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.

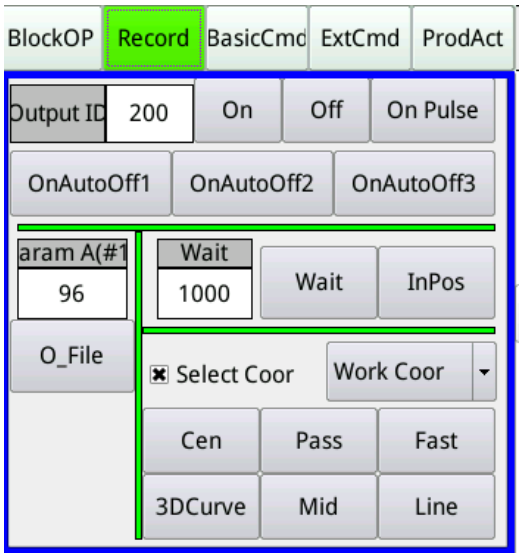
Offset XYZ: Offsets all the items of "world coordinates" and "work coordinates" in the set range from the set value.

**Fast Speed**：Modify the speed column of the fast command in the range.

**Path Speed**：Modify the speed column of the path

| | |
|---|---|
| | command in the range.<br>**Soft**：Modify the soft column of motion command in the range.<br>**Wait**：Modify the wait column of motion command in the range.<br>**Desc**：Remove the line number of the remark columninthe program. When adding a new column, the column number is automatically added to facilitate identification of the new column.<br>**Find,I,O,R,Jump**：Find lines where I, O, R, jumps occur<br>**Export**：Export the current file to G file, O file or insert file. |

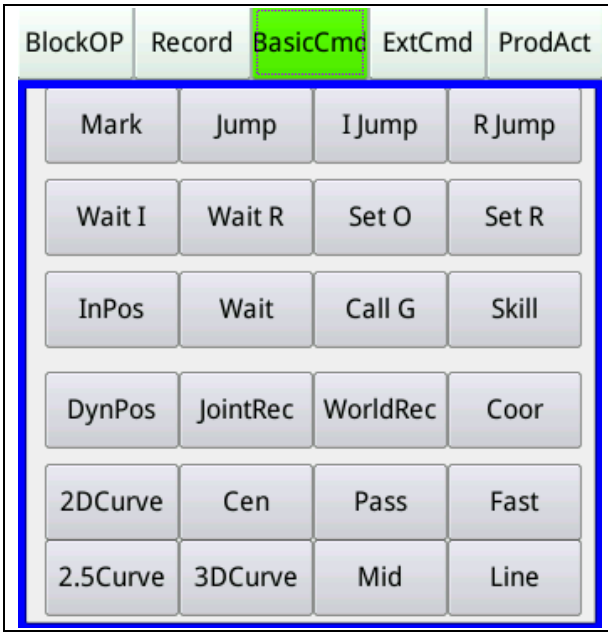
## 9.1.2. Record

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

| Key | Record Command | Command Parameters |
|---|---|---|
| ON | Set O | Different setting status |
| OFF | | |
| ON Pulse | | |
| ONAutoOFF1 | | |

| | | |
|---|---|---|
| ONAutoOFF2<br>ONAutoOFF3 | | |
| InPos | InPos | Range of In Position |
| Delay | Delay | Delay Time |
| Select Coordinate System | Select Coordinate System | Use the selected coordinate system as the recorded coordinate system |
| Fast | Fast | If the "Select Coordinate System" function is not enabled, the coordinate system taught by teaching is used as the recording coordinate system, and a command line to move to the current position is generated.<br>If the "Select Coordinate System" function is enabled, the coordinate system selected later is the recorded coordinate system. |
| Line | Line | |
| Mid | Mid Point | |
| Pass | Pass | |
| Cen | Center | |
| 3D Curve | 3D Curve | |
| 2.5D Curve | 2.5D Curve | |
| 2D Curve | 2D Curve | |
| Lower left corner area, up to three self-defined | Extended or customized commands | You can modify the setting file of the extension command and application process to make this area display the customized recording key. The parameter field above it will be automatically brought into the first parameter of the command when you press record. |

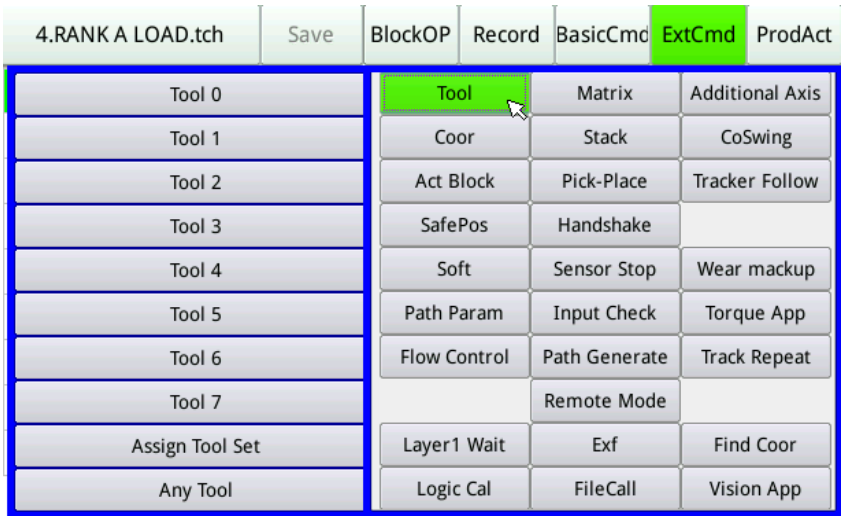
### 9.1.3. Basic Command




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

The following sections are described in detail.

## 9.1.4. Extension Command




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

The following sections are described in detail.

## 9.1.5. Edit Column


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.

Dn：Moves the currently selected column down.

Backward：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.

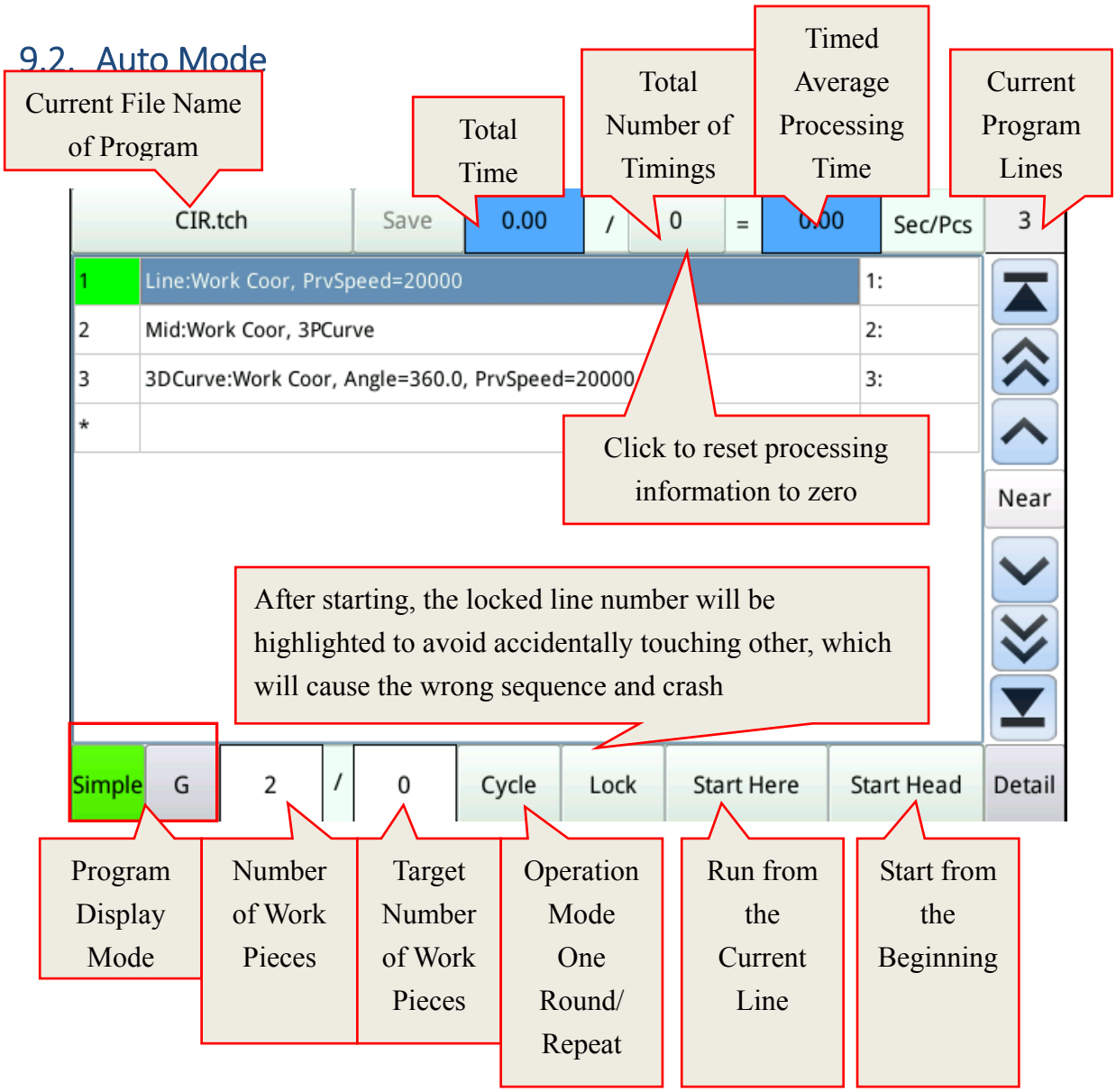
Forward：If the current position is matched with the selected command line, pressing this button to allow the robot to forward along the path until the next command point.

Step：Move the robot to the position where the command line is currently selected.

OK：After modifying or adding a program column, press this button to confirm the modification.

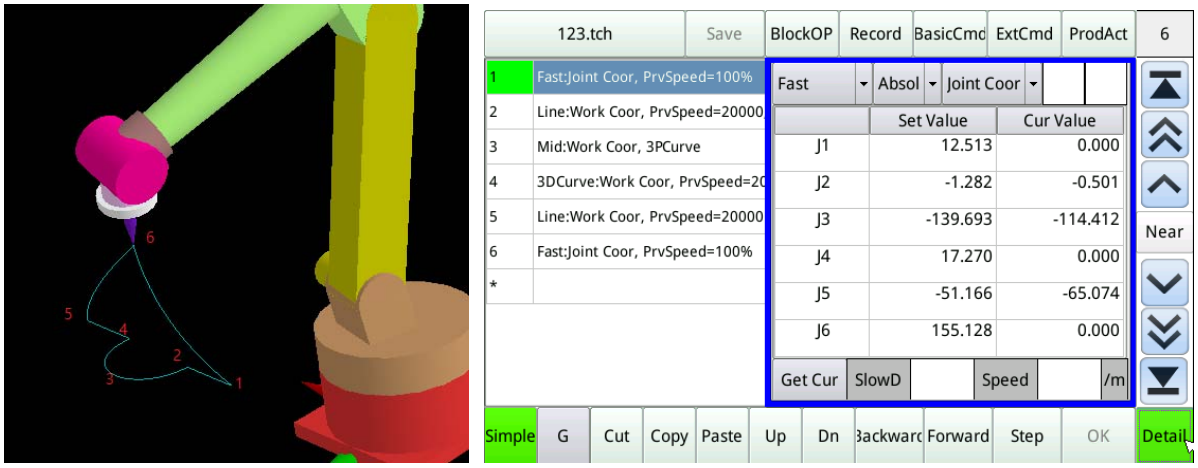
**Description: The single step, forward and back functions are especially suitable for confirming the accuracy of the track and speeding up the debugging program.**

## 9.2. Auto Mode


Current File Name of Program
Total Time
Total Number of Timings
Timed Average Processing Time
Current Program Lines
CIR.tch
Save
0.00
/
0
=
0.00
Sec/Pcs
3
1
Line:Work Coor, PrvSpeed=20000
1:
2
Mid:Work Coor, 3PCurve
2:
3
3DCurve:Work Coor, Angle=360.0, PrvSpeed=20000
3:
*
Click to reset processing information to zero
Near
After starting, the locked line number will be highlighted to avoid accidentally touching other, which will cause the wrong sequence and crash
Simple
G
2
/
0
Cycle
Lock
Start Here
Start Head
Detail
Program Display Mode
Number of Work Pieces
Target Number of Work Pieces
Operation Mode One Round/ Repeat
Run from the Current Line
Start from the Beginning

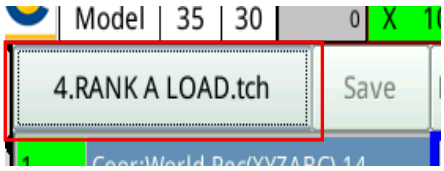
## 9.3. Process of Editing & Sequence Running Program

Take the trajectory to be completed as the example below, and the edited program on the right.




### 9.3.1. Create or Open the File

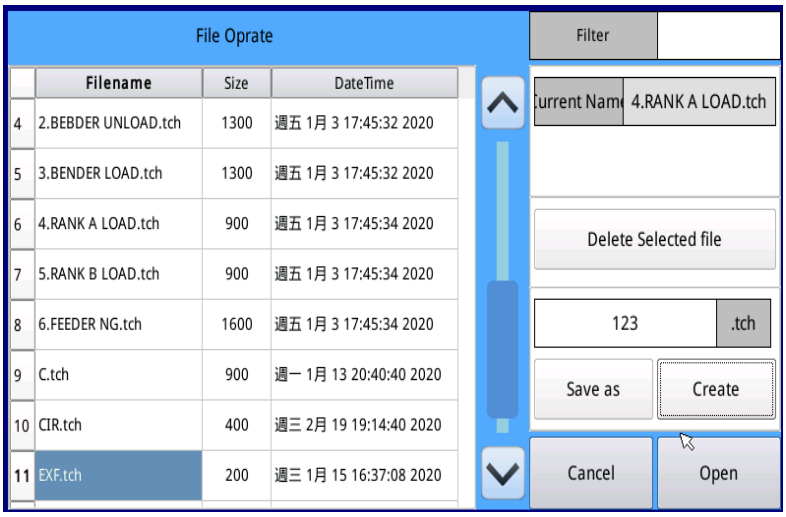
Clicking on the block of file name to pop up operation page of program files, through which to create, save, and open the program files.




Please input the file name 123,

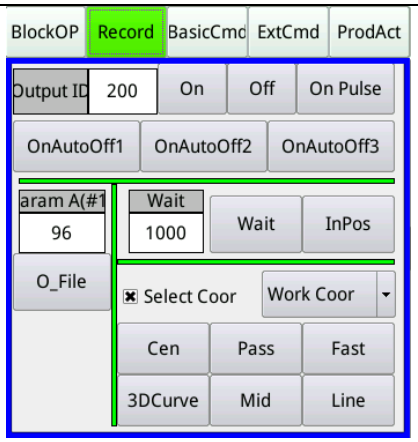
And then press 

.



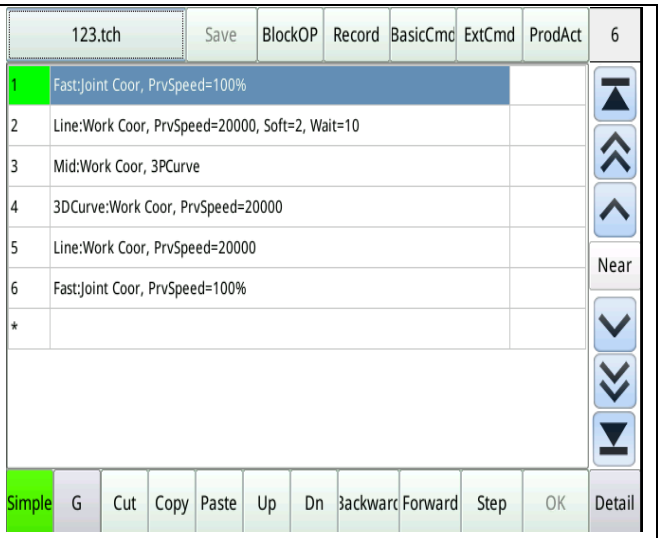
### 9.3.2. 「Record」Continuous Track & IO Sequence

1. Switch to teaching mode and click Record
2. Move the robot to the target position with a button or handwheel
3. Move to point 1, and press “Fast”.
4. Move to point 2, and press “Line”.
5. Move to point 3, and press “Mid”.
6. Move to point 4, and press “3D Curve”.
7. Move to point 5, and press “Line”.
8. Move to point 6, and press “Fast”.
9. Press “Save”.

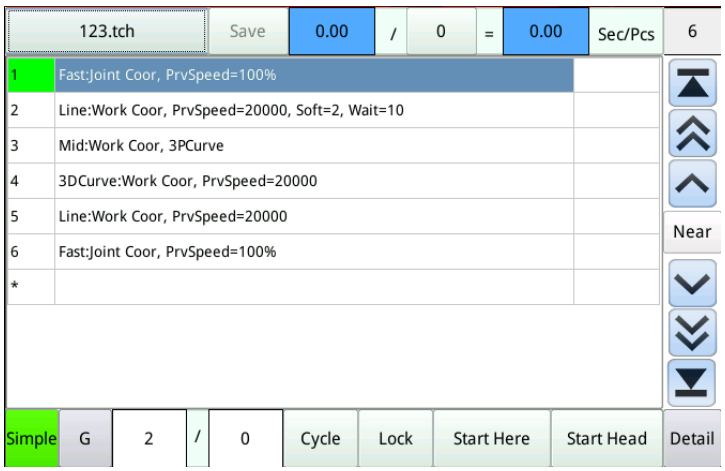



### 9.3.3. 「Step」「Forward」「Backward」Function Confirmation & Correction the Sequence

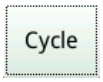
1. Click the first line.
2. Press “Step” to let the robot move to point 1.
3. Press “Forward” to let robot move along the trajectory to the next command point.
4. Press “Backward” to let robot move along the trajectory to the former command point.
5. If collision may occur during forward and backward, release the forward and backward keys, press reset and then manually adjust to the target point.
6. To correct the point content, move the position to be modified and press Get Cur and then save the file, then continue to use the Forward and Back to test and correct the trajectory.



### 9.3.4. MPG Dry Run Test

| | |
|---|---|
| 1. Switch to the auto mode, and select handwheel.<br>2. Press “Start Head” to enable to rotate the handwheel to let the program run at the speed of the handwheel.<br>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.<br>4. After the adjustment is completed, execute the single step to the command line that the test just interrupted.<br>5. Then switch to the auto mode again.<br>6. Click “Start Here” to continue the unfinished dry run test. |  |

### 9.3.5. 「Repeat」Running Check

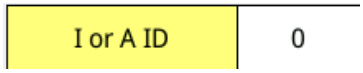
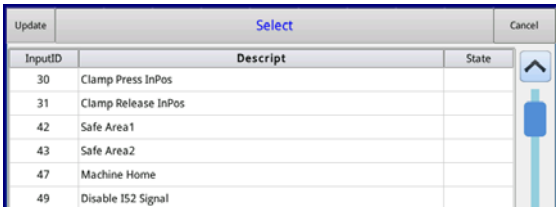
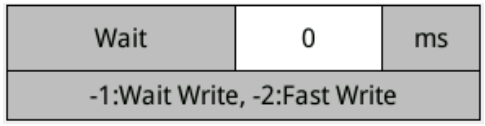
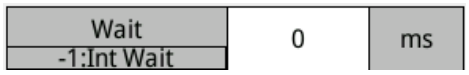
1. Click  to make it become  .
2. Turn off the handwheel(MPG).
3. 3. Start the program, observe the effect of repeated running, and continuously adjust and optimize to the best.

# 10. Introduction of Basic Commands for Program Menu

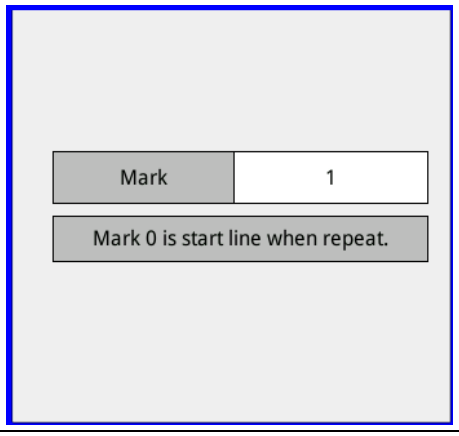
## Basic Commands

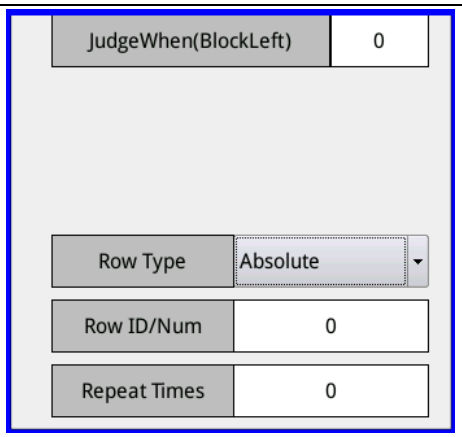
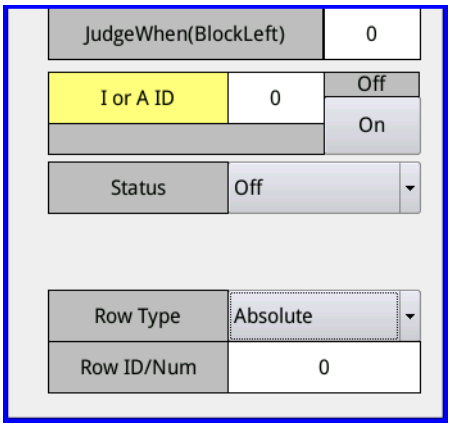
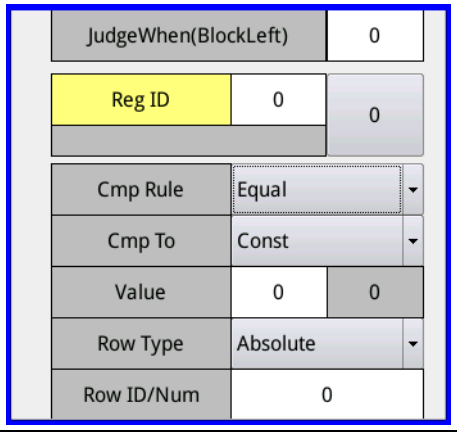

In the introduction of subsequent commands, there are several common principles that are explained here.

| | |
|---|---|
| **Judge When (Block Left)**<br>In order to ensure that the sequence process is smooth, the system presets the commands by Interpreter and sets them into the core motion module. When it is necessary to judge and wait for commands to determine the subsequent action path, the system must know when to judge, and avoid too early Judgment which shall get the wrong information.<br>This parameter refers to the number of remaining blocks in the core module before executing this command. Depending on different type of command, the time taken by each block is not necessarily set. You can set it with 50ms per block as a reference. |  |

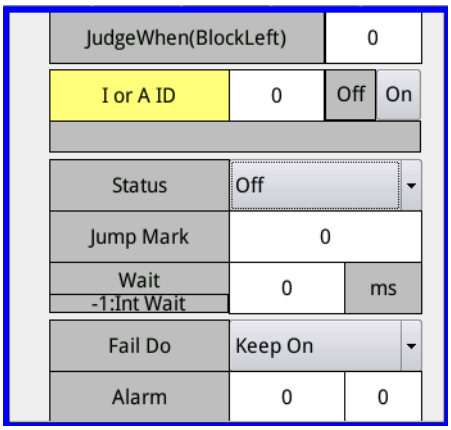
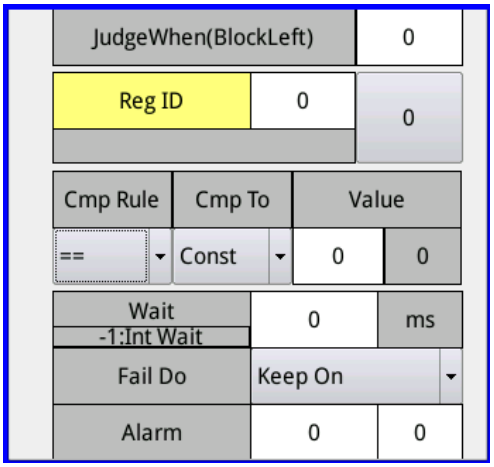
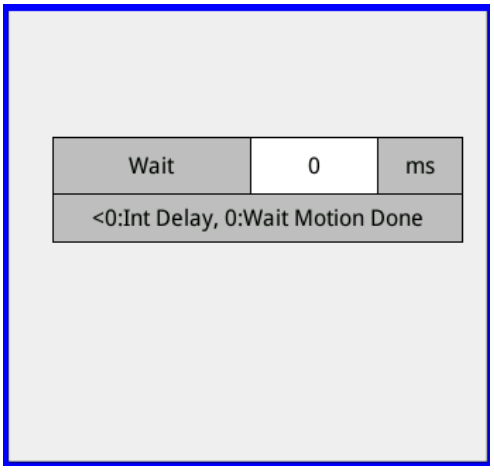
| | |
|---|---|
| **Yellow Block：**<br>Click the yellow block, it will pop out the use list for selection, in order to reduce the difficulty of human memory. |  <br>  |
| Wait(Unit: ms)：<br>During the waiting time, there are often -1, -2 values.<br>"Int" stands for Interpreter.<br>Under normal circumstances, Interpreter will deliver commands to the core module for processing.<br>"Wait" means that Interpreter will wait for the command delivered to the core module to be executed before Interpreter itself executes the command.<br>"Fast" means that Interpreter itself will execute this command directly, regardless of the current running status of the core module. |  <br>  |

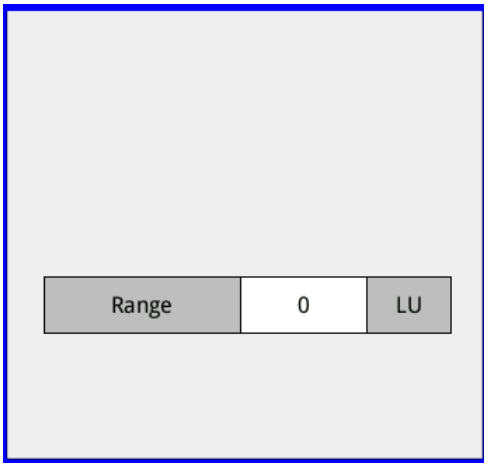
## 10.1. Progress Control

| | |
|---|---|
|  Set the label of the command line for the reference of jump setting.<br><br>**The number 0 has a special purpose.** In the "repeated" operation, after the second round, the system will only run from the line labeled 0, that is, the line before label 0 will only be executed during the first run. |  |

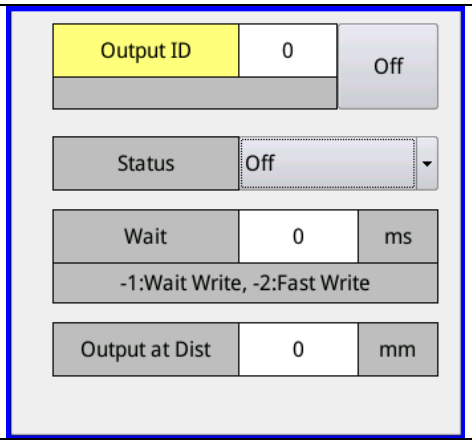
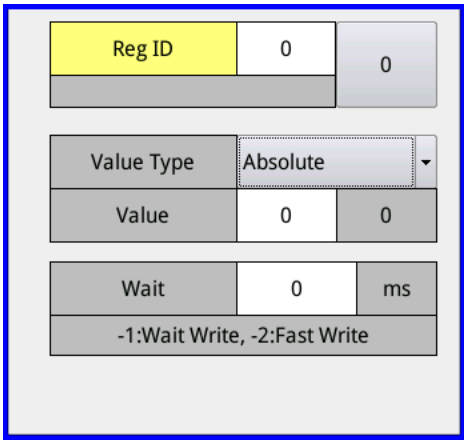
| | |
|---|---|
| Jump<br>Directly jump into the certain line.<br>  <br>**Line Number Type**：<br>Absolute：((I.e. the actual program number).<br>Relative：(Relative to the current line number, for example, currently the 8th line, -4 means to jump to the 8-4 = 4 line).<br>Mark：(That is, the label column set earlier)<br>Last Jump：Return to the next line of the previous call jump command.<br>**Row ID/Num**：Refer to Jump method<br>**Repeat Times**：Number of repeats of this jump. |  |
| I Jump<br>When the conditions of I or A are met, jump to the specified line.<br>I or A ID：Numbering of points I and A<br>Value：When the status of point I is in accordance with this setting, the jump action is performed.<br>Row Type：Refer to Jump command |  |
| R Jump<br>When the conditions of R are met, jump to the specified line.<br>Reg ID：R Value Number<br>Cmp Rule：Comparison Rule<br>Value: constant (fixed value), R value (refer to the content of another R value number). Right box (constant value / R value number)<br>Row Type: Refer to Jump command |  |

## 10.2. Waiting Type

| | |
|---|---|
| Wait I<br>Continue operating after waiting for I to match the status<br>**I or A ID**：Number of I Point<br>**Status**：When the status of point I is in accordance with this setting, the next action is performed.<br>**Jump Mark**：If you enter a value other than 0, the program will jump to the labeled line of the command after the conditions are met.<br>**Wait**：Longest waiting time |  |
| Wait R<br>Continue operating after waiting for R to match the status<br>**Reg ID**：R value number<br>**Cmp Rule( Comparison Method)**：<br>Value: Constant (fixed value), R value (refer to the content of another R value). Right box (constant value / R value number)<br>**Wait**：The longest waiting time.<br>**Fail Do**：processing after waiting time |  |
| Wait<br>Moves after waiting time<br>Wait：the time needs to be waited |  |

| | |
|---|---|
| InPos Move after waiting for arriving the position<br><br>**Arriving Range:** 1/1000 degree, or 1um<br><br>Note: The InPos 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. |  |

## 10.3. Status Setting

| | |
|---|---|
| Set O Set the status of point O<br>**Output ID**：The number of point O.<br>**Status**：Off，On，Reverse(change to another status based on the current state of the point O )<br>**Wait**：Set how long to wait before executing the next line |  |
| Set R Set the content of R value<br>**Reg ID**：R value number<br>**Value Type**：<br>**Absolute:** directly set the content of the R value to the content in the "Value" column.<br>**Relative:** Accumulate the content of the Value column based on the content of current R value.<br>ID: Set the R value of the specified R number in the Value field to this R value.<br>**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 column.<br>**Value**：Refer to mode description<br>**Wait**：Set how long to wait before executing the next line. |  |

## 10.4. Motion Command

**General Column Description**

**Absolute/Relative**：Indicates whether the content of the set value is absolute or relative to the current coordinates

**Coordinate System**：The coordinate system used to represent the contents of the set value

**Yellow Key**：Such as JointRec, After the representative clicks, it will jump to the associated page for easy viewing of the original setting data.

**Soft**：Represents the smoothing time to be used in this line of commands, which can correspond to the setting (0 ~ 5) on the "Tools" page. When the soft setting of this line is different from the previous command, the system will reset the axes before running this command If the soft column is blank, it means that the previous setting is retained. The system cannot change twice in less than the currently set smoothing time. Please pay attention when using.

**Delay**：Delay time after this action is completed

**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 tuning page。

WorldRec

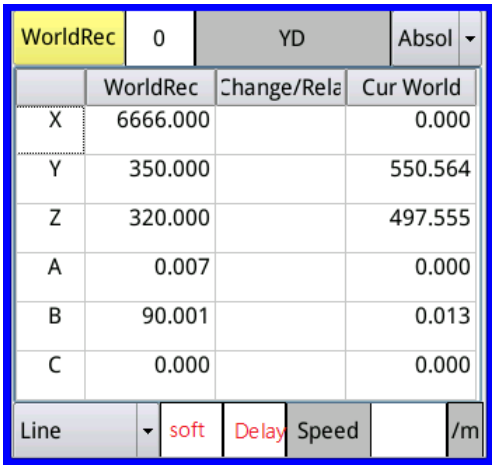
**Record No.**：based on the record number.

**World Record**：Display the value of the world record directly based on the record number.

**Absolute/Relative**：Represents「Change/Relative」The input value in the column is absolute or relative, which can be used to change an element in the coordinates.

**Current World**：Display current world coordinate.

**Point Type**：Fast、Line…



JointRec

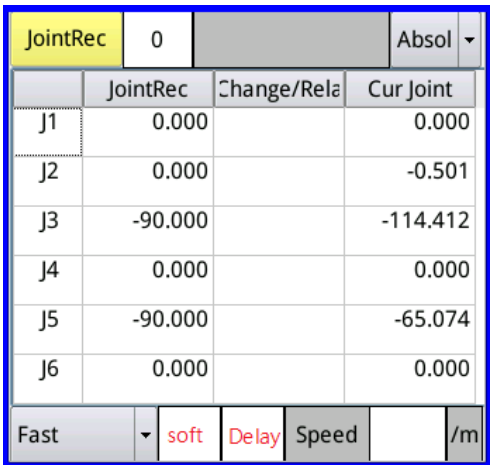
**Record No.**：based on the record number.

**Joint Record**：Display the value of the joint record directly based on the record number.

**Absolute/Relative**：Represents「Change/Relative」The input value in the column is absolute or relative, which can be used to change an element in the coordinates.

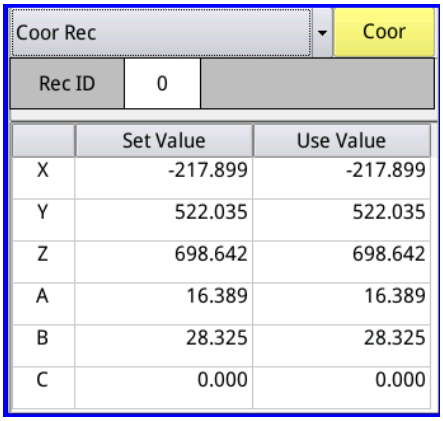
**Current Joint**：Display current joint coordinate.

**Point Type**：Fast、Line…




Coor

There are many ways to set work coordinate system, as detailed in the chapters.




Skill

Set whether to use special movement when the path moves.

**Disable Path Applications**：end work application setting.

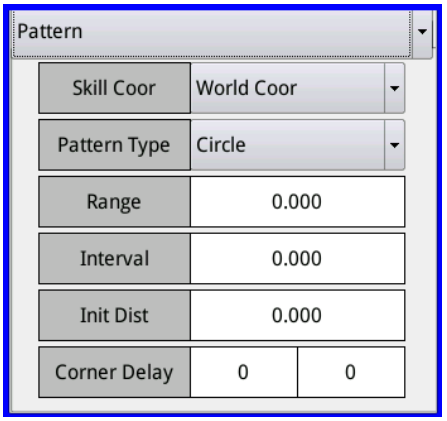
If there is a process started, this command will generate a linear path from the process offset position to the original position.

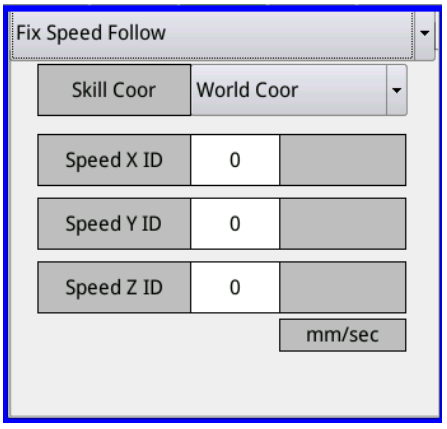
**Regular Patterns**：

**Skill Coor.**：The coordinate system on which the application path is based.

**Pattern 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.

**Range**：The swing range, that is, the maximum distance from the original path.



**Interval**：The position of the swing is repeated after every certain paragraph distance on the path.

**Initial Dist.**：The amount of movement at the beginning of the application when the movement distance is 0.

**Corner Delay**：Delay time when the action reaches to the corner. The two columns represent the two corners. ◦

**Fix Speed Follow**：Chasing workpieces on constant velocity axes

**Speed X ID**：Fill in the R number of the storage speed

Speed Y ID、Speed Z ID：same as the above.

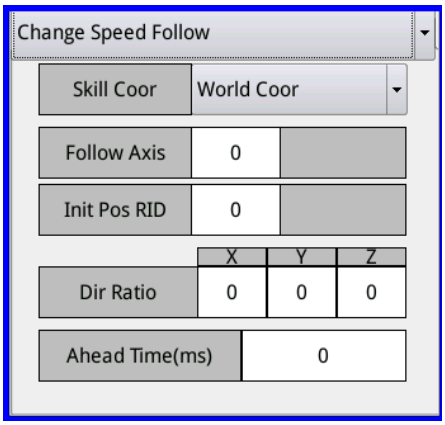
**Change Speed Follow**：Change workpieces on the changed axis.

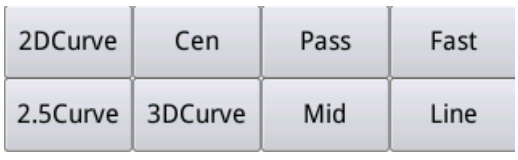
**Follow Axis**：Axis number of changed axis

**Initial Position of R ID**：In which R number is the position of the change axis stored at the start of machining.

**Direction Ratio**：Proportion of component in each direction

**Ahead Time(ms)**：Set the action time for the core module to avoid setting it too large and losing the ability to respond to speed changes. Generally, it is set to about 1000.

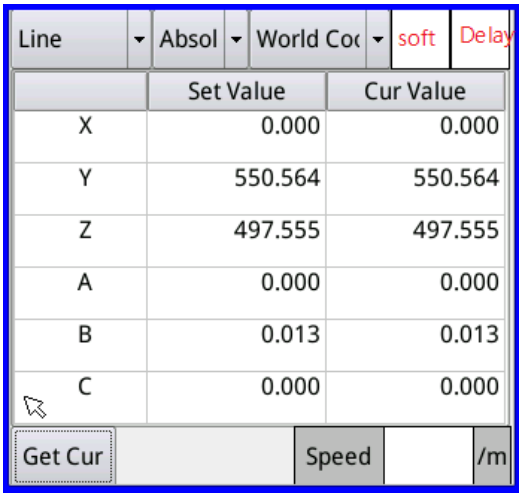


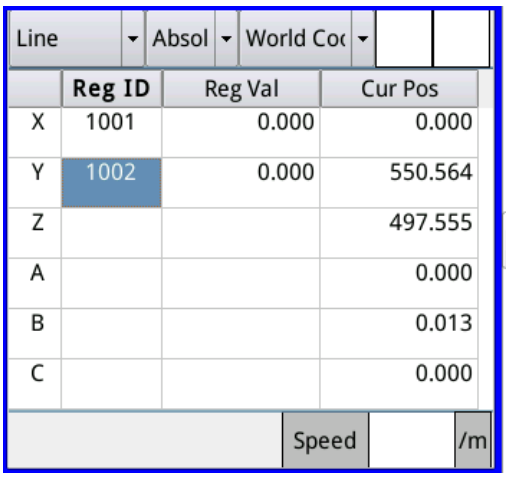





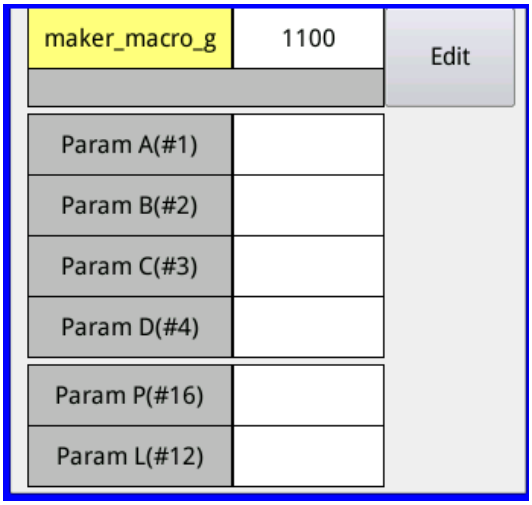
：According to the selected coordinate system, the current coordinate system coordinates are filled into the set value.


：When the distance of the number of axes before the target point is reached, switch to the deceleration speed.



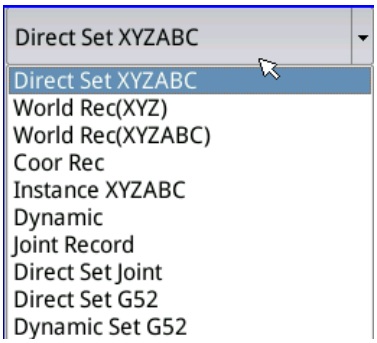
<table>
<tr>
<td>Pass Radius ：Corner Radius<br>Mid Cen 3PLinear ：There are three ways to change the attitude of the arc, such as three-point linear, two-point linear, three-point linear, two-point arc, fixed starting point, starting point AB, and starting point ABC.<br>3DCurve 2.5Curve 2DCurve Angle ：<br>When there is input, the bypass angle specified by the coordinates will be replaced by the input value.</td>
<td></td>
</tr>
<tr>
<td>DynPos ：Run to the position represented by the R value content<br>Point Type：Fast、Line…<br>XYZABC R ID：R number for storing XYZABC coordinates. If this column is blank, it means that the previous coordinates are used.</td>
<td> 
</td>
</tr>
</table>

## 10.5. Function Module Calling

| | |
|---|---|
| Call G<br>Call G code built-in by the system or manually written by the developer to provide greater flexibility.<br>**Param A(#1)** : The first parameter to be transmitted to the G-code.<br>**Param B(#2)** : The second parameter to be transmitted to the G-code.<br>**Param C(#3)** : The third parameter to be transmitted to the G-code.<br>**Param D(#4)** : The forth parameter to be transmitted to the G-code.<br>**Param P(#16)** : The fifth parameter to be transmitted to the G-code.<br>**Param L(#12)** : The sixth parameter to be transmitted to the G-code.<br><br>**Edit**：If the number is between 1000 and 9999, it will jump to the NC editing page, and this g-code file will be opened for easy editing. |  |

# 11. Use Coordinate System to Simplify Programming & 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：




## 11.1. Direct Set XYZABC

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.

## 11.2. 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.

## 11.3. 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
```

## 11.4. Record of Coordinate System

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.

## 11.5. Current Position

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..

## 11.6. Dynamic Position

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.

## 11.7. 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.

## 11.8. Direct Setting Joint Coordinates

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

## 11.9. Direct Setting of Re-Offset

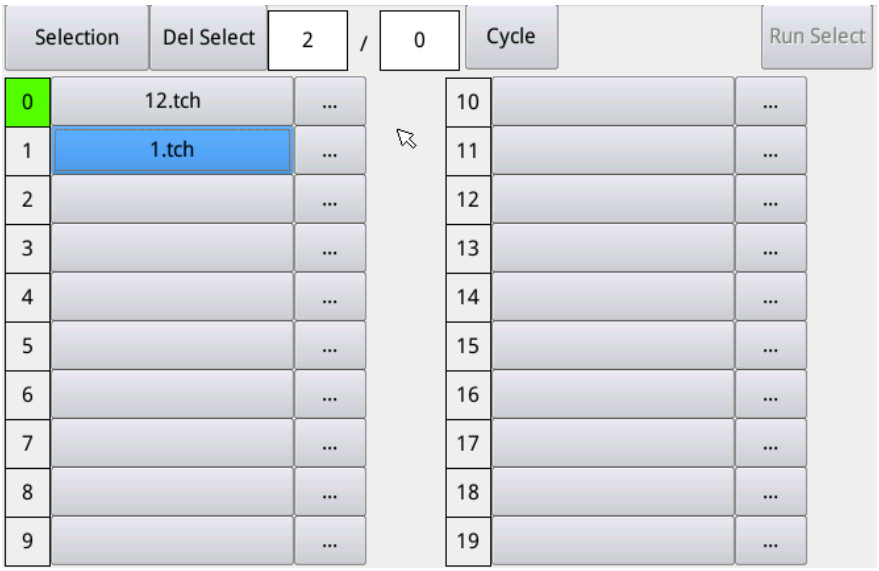
Based on the current work coordinate system, the work coordinate value at a certain point is converted to world coordinates to replace the original "work coordinate system". It's usually used for development environment testing, or to simplify the repetitive coordinate conversion work on the working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

## 11.10. Dynamic Setting of Re-Offset

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.

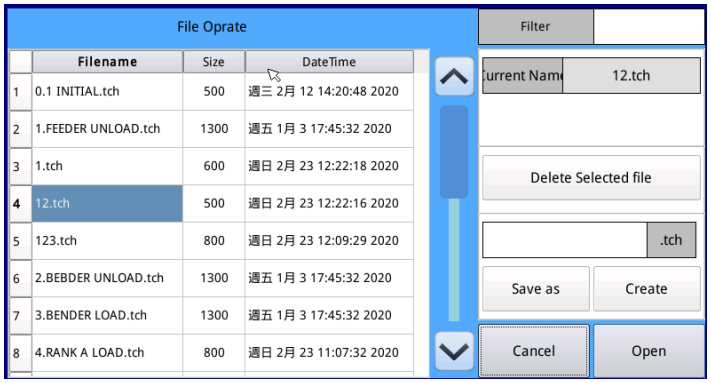
# 12. List

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




## 12.1. Put the Program into the List

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



## 12.2. Select to Execute

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

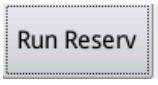

3. Press 

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 enable the sequence.


## 12.3. Appoint to Execute

Appointment refers to arranging multiple programs in order and let the system execute one by one in accordance with the planned order. During the execution process, you can add the completed program to make the robot continue to work. Commonly used for dual-table welding, during the robot welding of workpieces in one area, the next batch of workpieces to be processed by man.

1. Switch to the auto 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.<br>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.

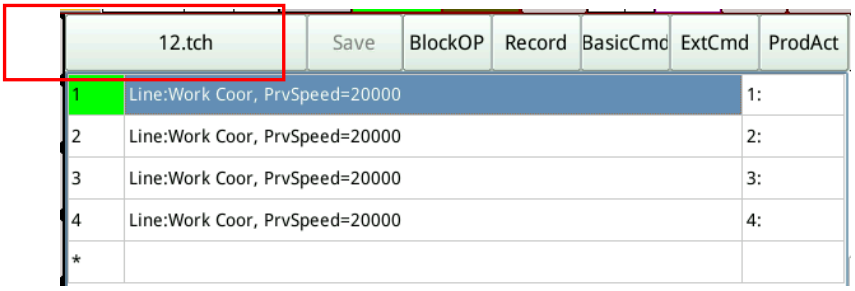
Note 2：O730~O749 corresponds to the status of appointment of the 20 sets of list program. It is always on when it is being appointed, flash when it is appointed, and off when it is not appointed.

# 13. Composition of Program Modularization

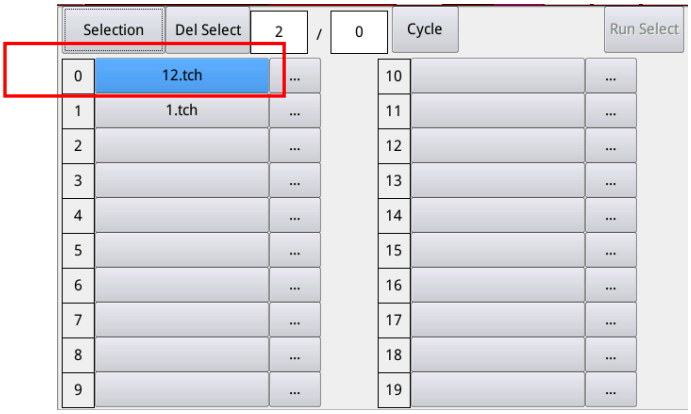
The program menu has multiple ways to call module files.

## 13.1. Calling Program Files

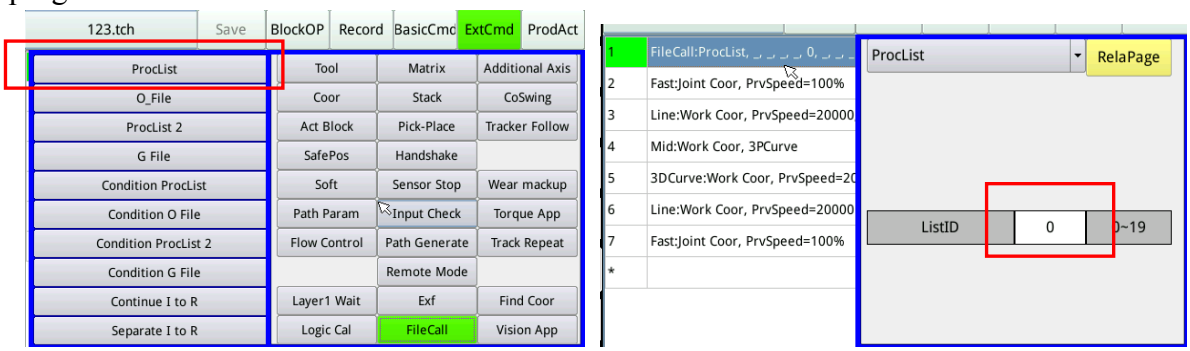
Use the program page to edit a program with a specific function 12.tch.




Open the list page and add 12.tch to the list

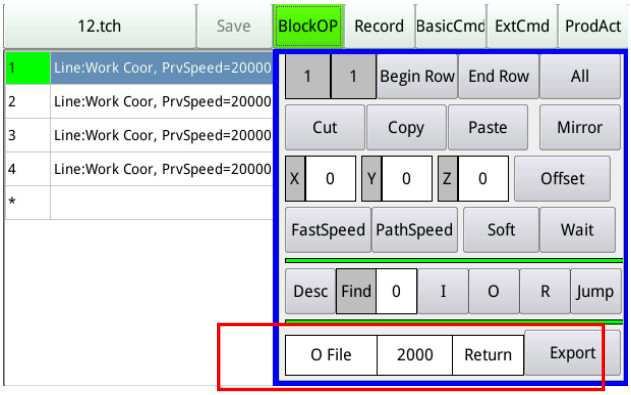



In the main program, add the extended command/ file call / program list and set the corresponding program number.

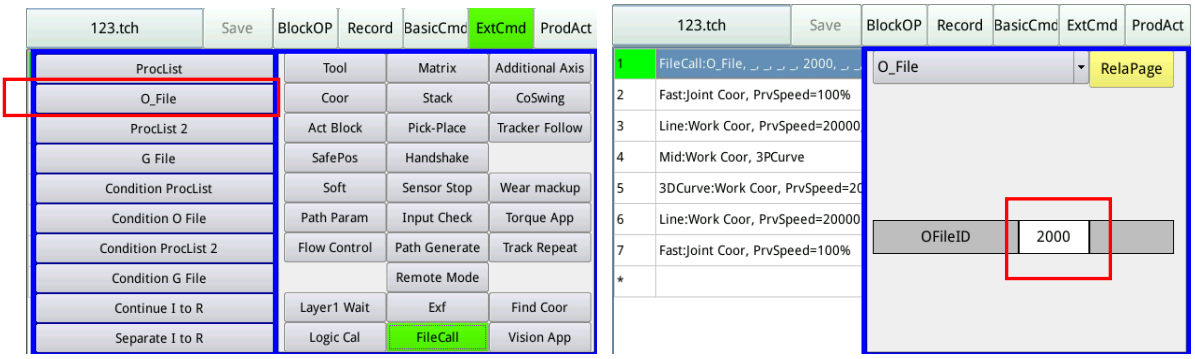


## 13.2. Calling O File

Edit the program, and then use the block operation / export function to export the O2000 file.




In the main program, add the extension command / file call / call O file.




Note 1: 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 L1 X163.233 Y227.078 Z228.335 A-48.881 B20.003 C-0.012 |
| 3 | N2 |
| 4 | G1 L1 X-36.757 Y227.075 Z228.337 A-48.875 B20.002 C-0.018 |
| 5 | N3 |
| 6 | G1 L1 X-36.769 Y377.073 Z228.347 A-48.875 B20.005 C-0.017 |
| 7 | N4 |
| 8 | G1 L1 X171.553 Y377.076 Z228.328 A-48.883 B20.002 C-0.010 |
| 9 | M99 |
| * | |

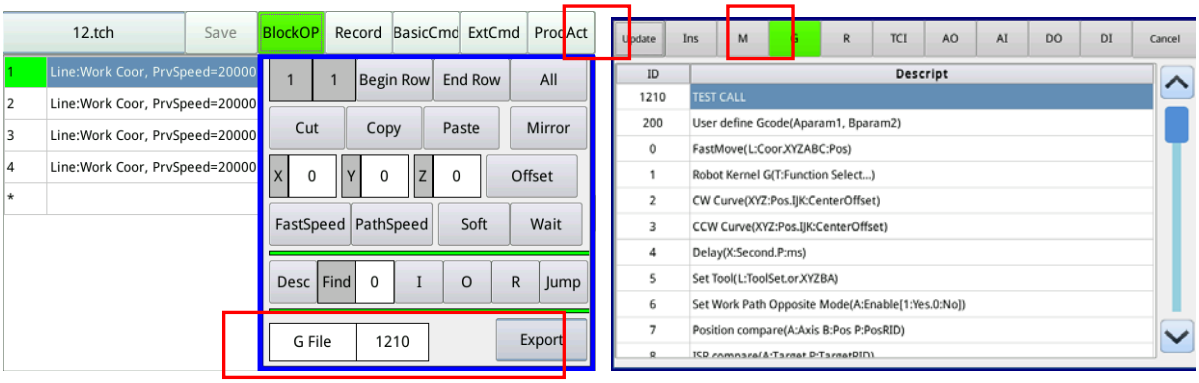
Note 2：If the macro instructions of this system are familiar, you can also directly edit the page with NC, or write directly with a PC's text editor to generate an O file and use it directly, to save the process of exporting again.

Note 3：You can use G view in the program page to understand the G code corresponding to the program commands.

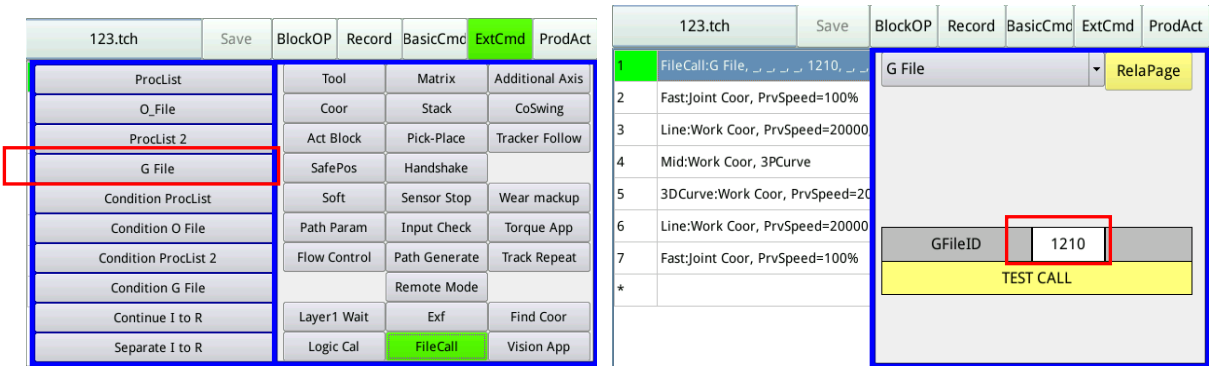
Note 4: A brief explanation of macro syntax is provided in the last chapter of this document.

## 13.3. Calling G File

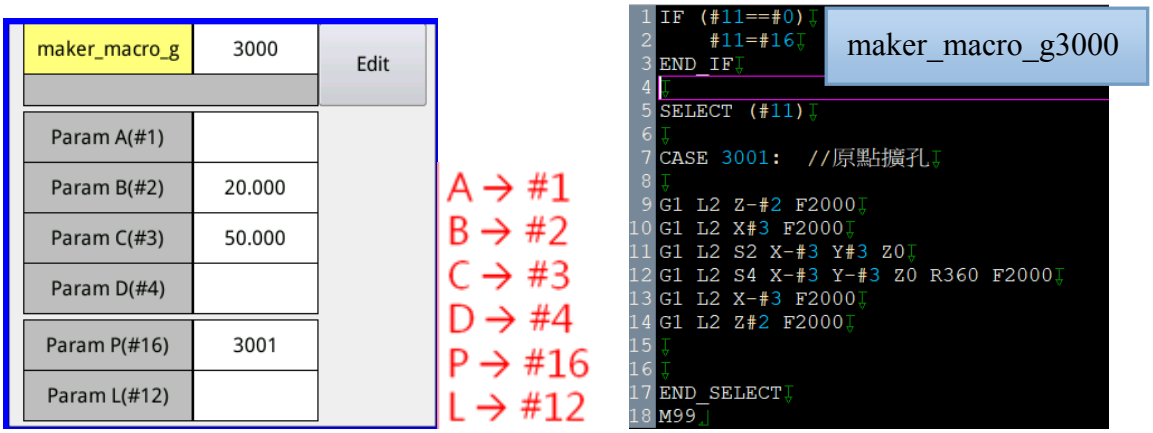
Edit the program, and then use the block operation / export function to export the G1210 file (1000 ~ 9999). After exporting, you can go to the IO page and press Update. The numbered table will appear in the G list. You can click to edit its description.




In the main program, add the extension command / file call / call G file.

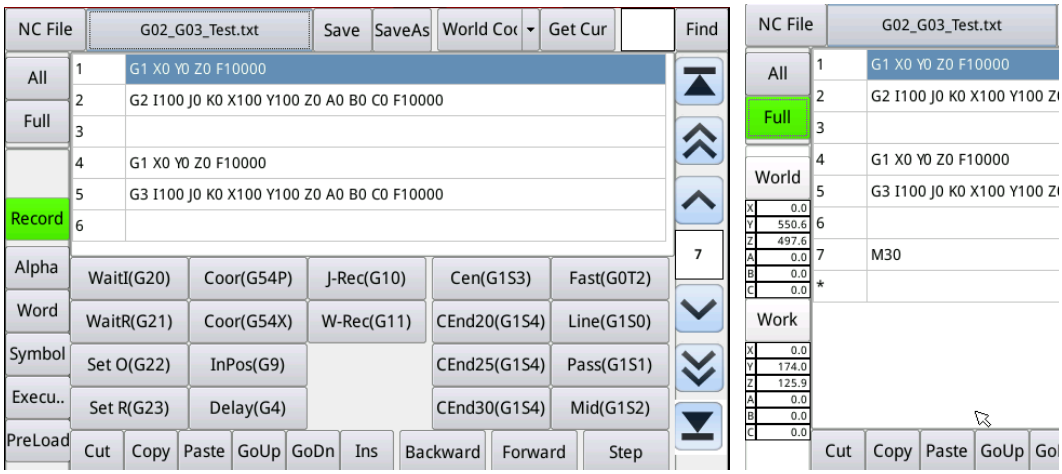



Note: There is also a command called G file in the basic command, which can pass parameters to G file. The G code exported by the above method cannot receive the parameters passed in when calling from the upper layer. You can achieve the effect of receiving the parameters by writing the G code by yourself and running according to the content of the parameters.



# 14. NC Editing

This page can be used to edit various files of editable macro syntax, including program files, G code files, insert files, PLC files. Due to limited editing functions, if a large amount of writing is required, it is recommended to write it on the PC and then transfer it to the controller.



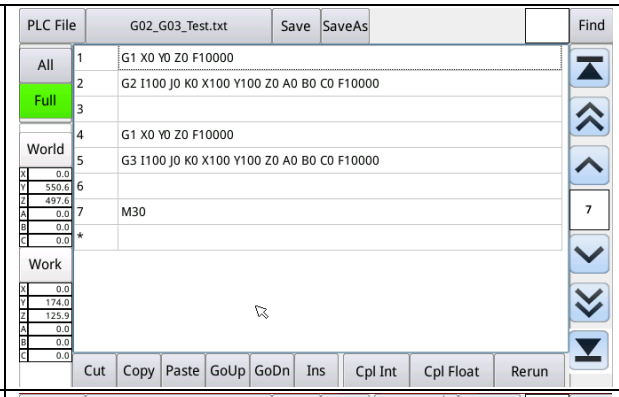

## 14.1. File Types

| | Save Location | File Name Rules | NC Executing Page | External Executing Mode |
|---|---|---|---|---|
| NC File | NC Files Folder | Arbitrarily<br>O file is also classified here. Its file name format is O plus four digits, such as O1234, which can be called by G65 P1234. | Enable File Name | R17022~R17029=FileName<br>R23030=1<br>C0=1 |
| G File | Macro Folder | maker_macro_g1000 | | |
| Ins File | Macro Folder | maker_func_ins_macro1000 | Enable the number | R17004=1000<br>C22=1 |
| PLC File | PLC Folder | Arbitrarily<br>When first created, if there is no plc.prj file in the folder, the system will automatically generate it to ensure that the program will be executed. | When the system is booting, the settings in plc.prj are checked and executed during system cycle time. | |

## 14.2. View & Edit Methods

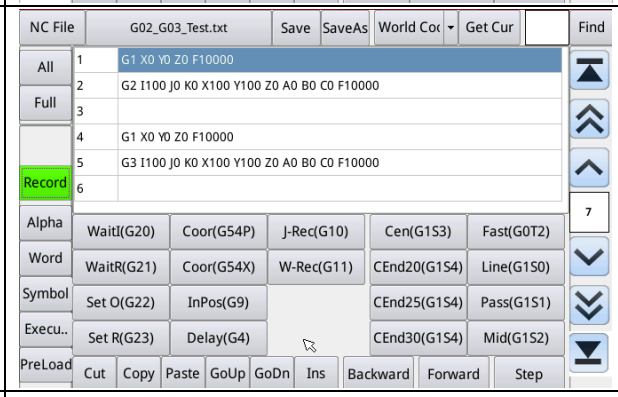
**Full**

It is convenient to see more lines of code. When you click to edit, a soft keyboard pops up.



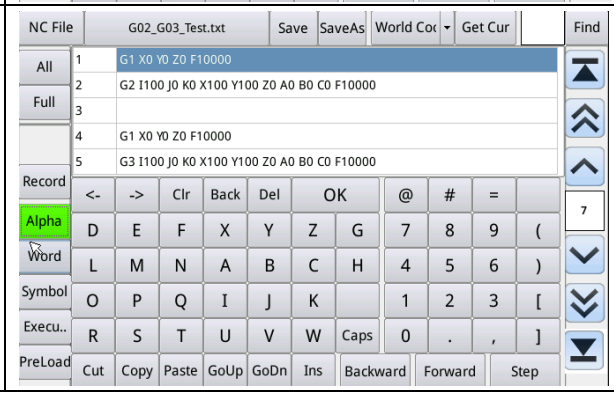

**Record**

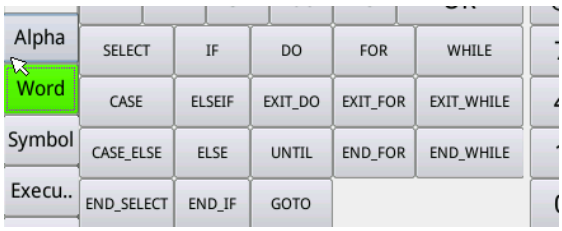
Similar to the recording of the program page, put some commonly used instructions commands on the right side, move to the point, click the command button of Record, it can automatically bring in the code.

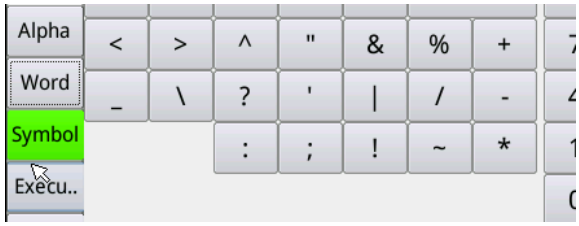


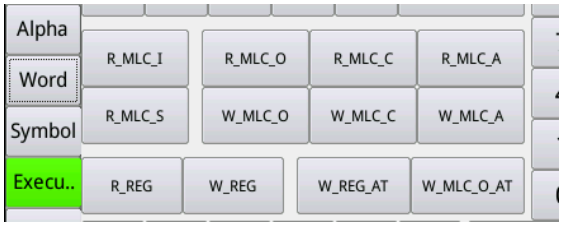

**Alpha、Word、Symbol、Execu..、PreLoad**

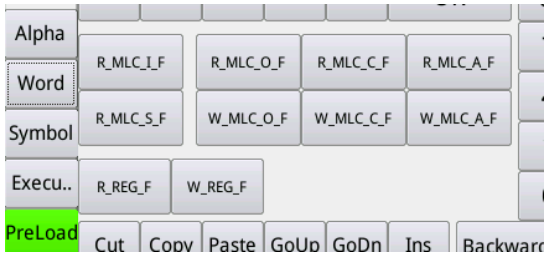
To reduce the number of page jumps, click the line of code while editing, and then type directly into the keyboard below. The keyboard content is commonly used letters and phrases to write G codes and macros.



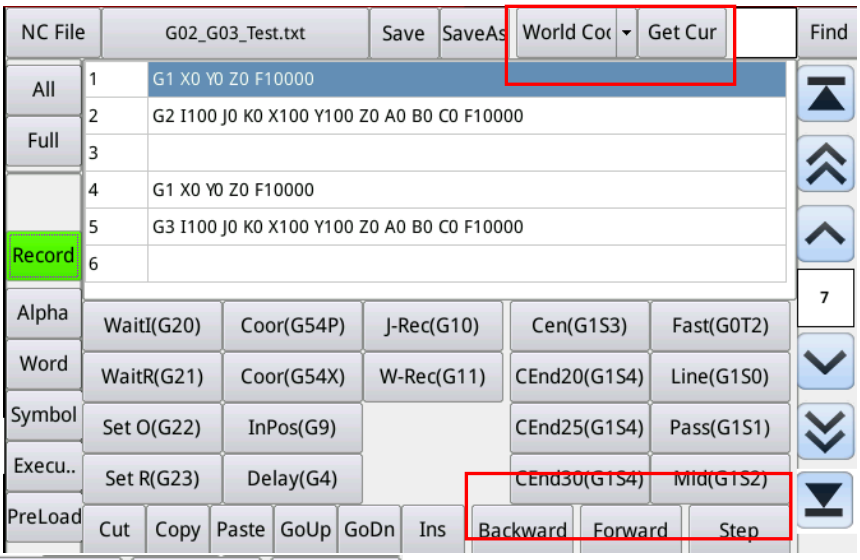



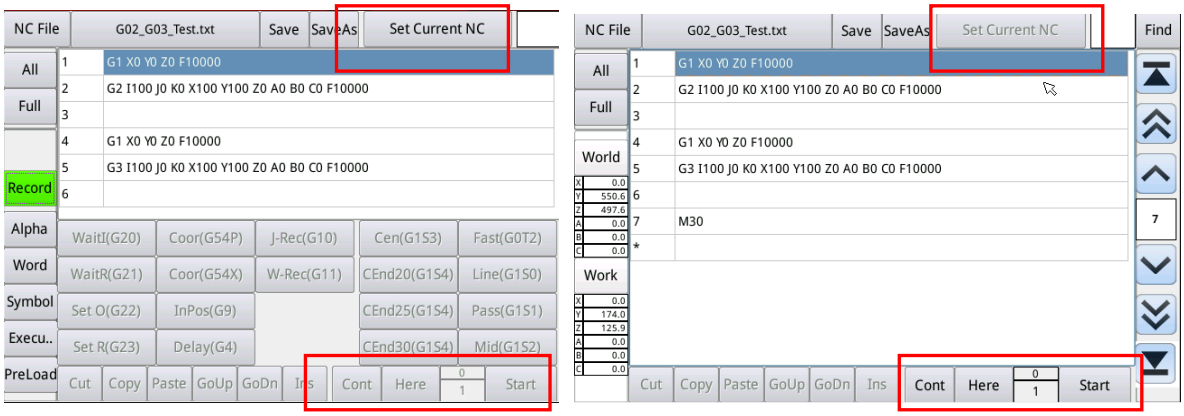



## 14.3. Teaching Mode

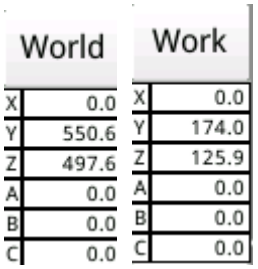



Get Cur Backward Forward Step : Functions similar to the same buttons on the program page

## 14.4. Auto Mode

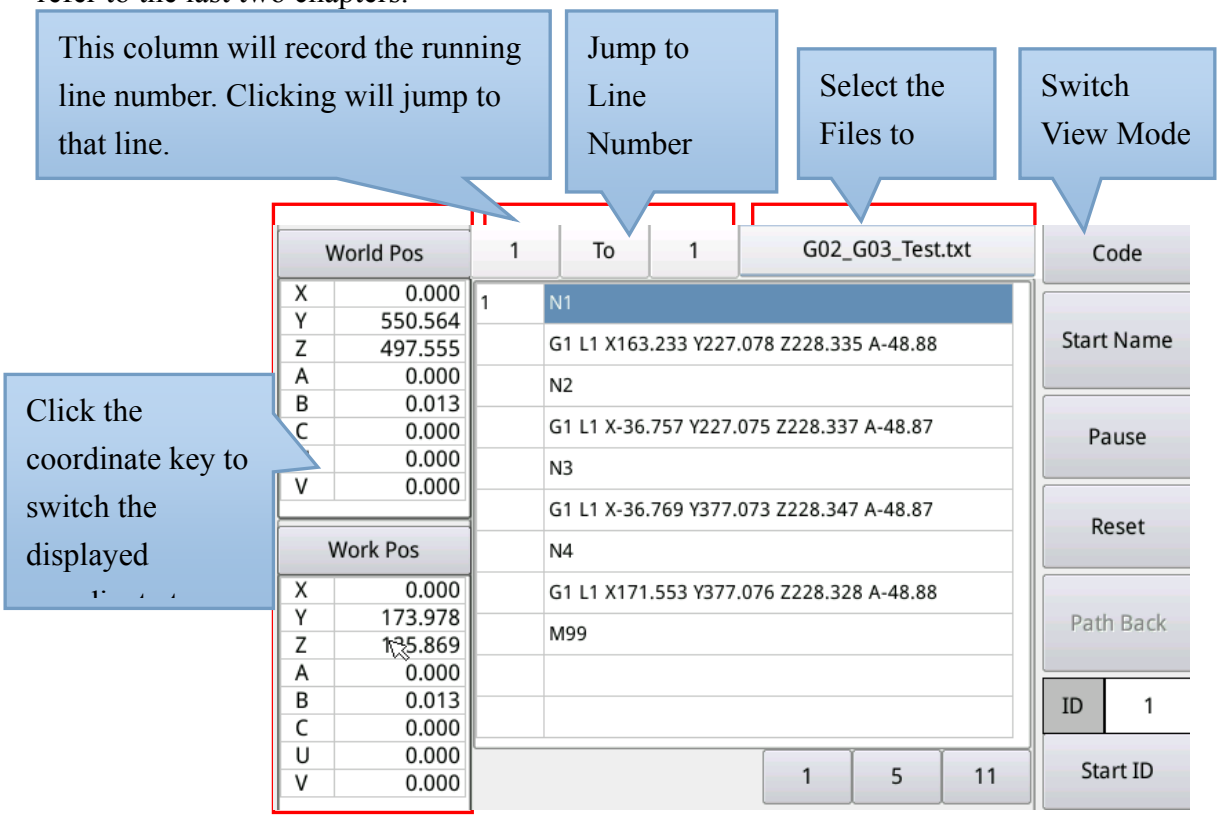



Set Current NC : After setting as the current NC file, Cont Here 0 1 Start Before it becomes usable, the usage is similar to the function of the program page.

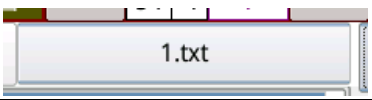
| | |
|---|---|
|   | In the lower left area, you can click the buttons to switch between the world, coordinate system, work, and joints.<br>When the two are the same content, one will be the command coordinates and the other will be the feedback coordinates. |

# 15. NC Execution

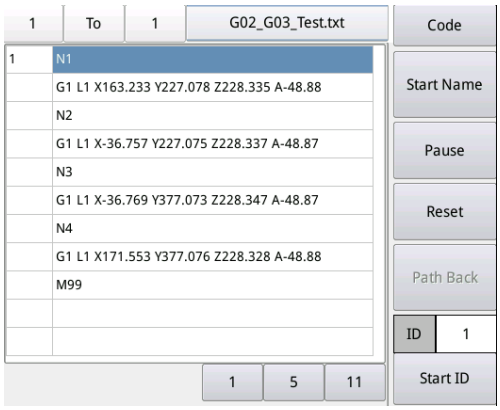
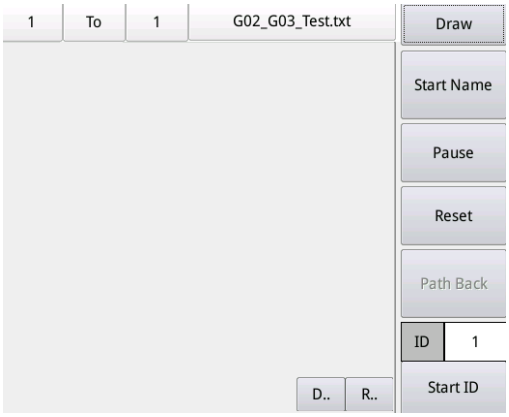
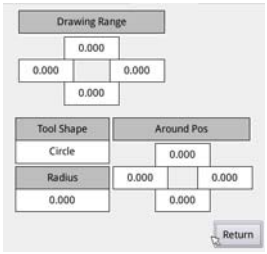
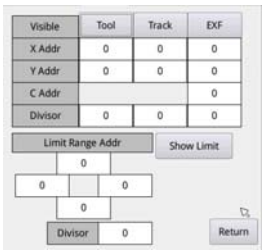
This page can be used to run the machining path files (GM code) generated by CAM, or the files exported by the program page, or the files edited manually by the user. These files must conform to the G code format requirements of this robot system. For detailed G code and program syntax, please refer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




## 15.1. Executable Files

| | Start File Name(NC File) | Start Number (Insert File) |
|---|---|---|
| File Folder | ncfiles | Macro |
| File Name Format | Arbitrarily | maker_func_ins_macro1000 |
| File Selection Method | Click the file name key and select the file.<br>  | Enter the number of the inserted file<br>  |
| Start Key |  |  |

## 15.2. View Display

| | Program Code | Drawing |
|---|---|---|
| Display |  |  |
| Option of Modifications |  <br>Switch the number of lines you can see.<br><br>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<br>  <br>  |

# 16. Description of System G Code

## 16.1. Rapid Positioning (G0)

**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

E: Soft 0~5

D: Delay

**Example**

| | |
|---|---|
| G00 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 | Move to the position of the world coordinates (100, 100, 10, 0, 0, 39) at 4000 deg/min |
| G00 L0 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 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 |

## 16.2. 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:<br>0: Three-point linear<br>1: Two-point linear<br>2: Three-point arc<br>3: Two-point arc<br>4: Fixed starting point<br>5: Starting point AB<br>6: Starting point ABC | | Rotational Direction<br>0: Set by point (Default)<br>2: Forced along the arc(CW)<br>3: Forced reverse arc (CCW) |
| 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 | | | | |
| E | Soft 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 with them(T5/L1/M0), it's unnecessary to write.

### 16.2.1. 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 at (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 at (100, 100, 0)<br>Set O201 ON at 30mm from the starting point<br>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 -20 at Z axis |

### 16.2.2. 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 |

### 16.2.3. 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 coordinate (100, 90, 80) is a point on the arc, and the work coordinates (100, 100, 10) is the end point of the arc. |

### 16.2.4. Arc Center Point (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<br>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). |

### 16.2.5. 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<br>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. |

## 16.3. CW Arc/ CCW 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: Soft 0~5

**Example**

| | |
|---|---|
| G2 I100 J90 K80 X100 Y100 Z10 A0 B0 C39 F4000 | Use relative work coordinates (100, 90, 80) as 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). |

## 16.4. Wait (G4)

**Code Description**

X: Waiting Seconds

P: Waiting Milliseconds

When the sum of the X and P code values is less than 0, it means that Interpreter will execute waiting.

**Example**

| | |
|---|---|
| G4 X1 P200 | Wait for 1200 milliseconds to be executed by the core software |
| G4 P-500 | Interpreter waits for 500 milliseconds after the completion of the core software actions. |

## 16.5. 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

**Example**

| | |
|---|---|
| G5 L1 | Switch to tool parameters of group 1 |

## 16.6. Switch Coordinates to Inversion Mode (G6)

**Code Description**

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

**Example**

| | |
|---|---|
| G6 A1 | Use work coordinate inversion mode |

## 16.7. Wait for Coordinates to Arrive (G7)

**Code Description**

A:Axis Number

B: Coordinate

P:Coordinate R Number

**Example**

| | |
|---|---|
| G7 A7 B50.333 | Wait for the 7th axis to reach 50.333 |
| G7 A7 P1200 | Wait for the 7th axis coordinate to the value stored in R1200 |

## 16.8. Wait for the Arrival of Cycle Time Counting (G8)

**Code Description**

A: System Cycle Time Counting Value

**Example**

| | |
|---|---|
| G8 A1234567 | Wait for the system cycle time counting to reach 1234567 before continuing |

## 16.9. Wait Correct Position Arrival (G9)

**Code Description**

A:Range Value of Wait Correct Position Arrival

**Example**

| | |
|---|---|
| G9 A20 | Continue to run when waiting for the total value of the servo lag of each axis is less than 20 |

## 16.10. Joint Record Movement (G10)

**Code Description**

P: Record Number 0~99

M: If XYZABC has a value, its value should be 0 substitute 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

**Example**

| | |
|---|---|
| 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. |

## 16.11. World Record Movement (G11)

**Code Description**

P: Record number 0~99

M: If XYZABC has a value, its value should be 0 substitute 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

**Example**

| | |
|---|---|
| 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. |

## 16.12. Set the Command Output of the Axis(G13)

**Code Description**

A: Axis Number 1~9

B: 0 Output，1 No Output

**Example**

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

Note: Special attention will be required to use this command; do not use it unless you are clear about the purpose. When use is resumed, you need to call G995 to re-update the coordinates.

## 16.13. Get the Final Position of World Coordinates (G17, G1T17)

**Example**

| | |
|---|---|
| G17 | Get the world coordinates of the final position and provide the feedback value at @71~@79 |
| G1T17 | Get the world coordinates of the final position and the return value i provide the feedback value at s #71~#79 |

## 16.14. Get the Final Position of Work Coordinates (G18, G1T18)

**Example**

| | |
|---|---|
| G18 | Get the work coordinates of the final position and provide the feedback value at @71~@79 |
| G1T18 | Get the work coordinates of the final position and provide the feedback value at is #81~#89 |

## 16.15. Get the Final Position of Joint Coordinates (G19, G1T19)

**Example**

| | |
|---|---|
| G19 | Get the joint coordinates of the final position and provide the feedback value at @81~@89 |
| G1T19 | Get the joint coordinates of the final position and provide the feedback value at #91~#99 |

## 16.16. Wait for I Point (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

**Example**

| | |
|---|---|
| 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. |

## 16.17. 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

**Example**

| | |
|---|---|
| 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. |

## 16.18. Set O(G22)

**Code Description**

O: output point number

S: output point status

P: Waiting time, ms

**Example**

| | |
|---|---|
| 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). |

## 16.19. 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

**Example**

| | |
|---|---|
| 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 |

## 16.20. I Jump (G24)

**Code Description**

I: I or A Number

S: Status

P: Line Number (Jump to)

**Example**

| | |
|---|---|
| G24 I200 S1 P30 | If the value of I200 or A200 is 1, jump to the line of N30 |

## 16.21. R Jump (G25)

**Code Description**

R: R Number

M:Comparison Value Type，0: Value，1: R Value

V: Value or R Number

J: Judging Timing, Number of Blocks

C: Comparison Method，0: Equal to，1: Not Equal，2: Larger Than，3: Larger Than or Equal to，4: Less Than，5: Less Than or Equal to

P: Line Number (Jump to)

**Example**

| | |
|---|---|
| G25 R200 V3 P100 | If R200 == 3, jump to the line of P100 |
| G25 R200 M0 V3 J1 C0 P100 | With 1 block left, if R200 == 3, jump to the line of P100 |
| G25 R200 M1 V201 J1 C2 P100 | When 1 block is left, if R200> R201, jump to the line of P100 |

## 16.22. Sensing Point I Stopping (R Bit Comparison)(G31)

**Code Description**

R: R Number

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

**Example**

| | |
|---|---|
| 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.**

## 16.23. Target Point Action. Stop When R Value Condition is Met. (G32)

**Code Description**

R: R NUMBER
S: Comparison Condition. 0: Larger Than，1:Larger Than or Equal to，2: Equal to，3: Less Than，4: Less Than or Equal to，5: Not Equal，6: Absolute Value Larger Than，7:Absolute Value Less Than
T: The Value Being Compared
L:0 World、1 Work、2 Tools、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

**Example**

| | |
|---|---|
| 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 reaching to the value. The torque value can be read by R250096~.**

## 16.24. Rotate Downward. Stop When R Value Condition is Met. (G33)

**Code Description**

D:Displacement Per Rotation
Z:Z Phase Distance
F:Speed。
R: R NUMBER
S: Comparison Condition. 0: Larger Than，1:Larger Than or Equal to，2: Equal to，3: Less Than，4: Less Than or Equal to，5: Not Equal，6: Absolute Value Larger Than，7:Absolute Value Less Than。
T: The Value Being Compared

**Example**

| | |
|---|---|
| G33 D20 Z-50 F3000 R4000 S6 T3456 | At a speed of 3000, it is lowered by 50mm, and each time it is lowered by 20mm per rotation. When the absolute value of R4000 is greater than 3456, it stops. |

## 16.25. Warning When I Overtime (G34)

**Code Description**

A: I or A Number

B: Status

C: Waiting Time

**Example**

| | |
|---|---|
| G34 I200 B1 C1000 | Wait for the I200 status to be 1 and then perform subsequent sequences. If the status is not established within 1000ms, a warning will be issued by the system. |

## 16.26. Inverse Coordinates (G50)

**Code Description**

XYZABC: Set coordinates before inverse

The inverted coordinates will be stored in global variables @ 141 ~ @ 146

**Example**

| | |
|---|---|
| G50 X100Y200 Z100 A30 B20 C0 | Get the reverse coordinate and put the result in @ 141 ~ @ 146 |

## 16.27. Action to Inverse Coordinates (G51)

**Code Description**

XYZABC: Set coordinates before inverse

Reverse the coordinates in XYZABC first, then move to that position

**Example**

| | |
|---|---|
| G51 X100Y200 Z100 A30 B20 C0 | Reverse the coordinates in XYZABC first, then move to that position |

## 16.28. Coordinate System Re-Offset (G52)

**Code Description**

XYZABC: Set coordinates before inverse

**Example**

| | |
|---|---|
| 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.

## 16.29. Set Work Coordinate System (G54)

### 16.29.1. O0 (Default Setting) Directly Specify Offset Position

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

### 16.29.2. O1 Use World Record Position XYZ

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

### 16.29.3. O2 Use World Record Position XYZABC

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

### 16.29.4. O3 Use Coordinate System Record

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

### 16.29.5. O4 Use Current Position

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

### 16.29.6. O5 Use Dynamic Position

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

### 16.29.7. O6 Use Joint Record

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

### 16.29.8. O7 Direct Setting 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 |

### 16.29.9. O8 Direct Setting Re-Offset

| | |
|---|---|
| G54 O8 X0 Y10 C20<br>G52 X0 Y10 C20 | Set the world coordinates of J1~J6= (0,0,-90,0,-90,30) as work coordinate system |

### 16.29.10. O9 Dynamic Re-Offset 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. |

## 16.30. Rotating Coordinate System (G55)

**Code Description**

P: Group of Rotation Coordinate System。

**Example**

| | |
|---|---|
| G55 P0 | Use group 0 rotation coordinate system |

## 16.31. Collabration Coordinate System (G56)

**Code Description**

P: Group of Rotation Coordinate System。

**Example**

| | |
|---|---|
| G56 P0 | Use group 0 collaboration coordinate system |

## 16.32. Main Body Separating Axis Coordinate System (G57)

**Code Description**

P: Group of Main Body Separating Axis Coordinate System

**Example**

| | |
|---|---|
| G57 P0 | Use group 0 Main Body Separating Axis Coordinate System |

## 16.33. Turn Off Dynamic Compensation (G60)

**Example**

| | |
|---|---|
| G61 | Turn Off Dynamic Compensation |

## 16.34. Enable Dynamic Compensation (G61)

**Example**

| | |
|---|---|
| G60 | Enable dynamic compensation |

## 16.35. Calling O File (G65)

P: O File Number

L: Calling Times

**Example**

| | |
|---|---|
| G65 P1234 L2 | Call O1234 and execute twice. |

## 16.36. Interpolation Table List Conversion (G69)

**Code Description**

T: Interpolation Table Group Number 0~9

X:First Comparison Value

A:Second Comparison Value

**Example**

| | |
|---|---|
| G69 X100 A203 | Call the interpolation table for conversion. The input values are 100 and 203. The converted values will be put at @ 25 and @ 2. |

## 16.37. Interpreter Sleep (G104)

**Code Description**

P: ms

**Example**

| | |
|---|---|
| G104 P100 | Interpreter sleep for 100ms so as to decrease the CPU loading. |

## 16.38. Set Directory Program (G107)

Please refer to the basic instructions of the program / path applications. After setting, compare the corresponding parameters with G display mode. ◦

## 16.39. Interpreter Wait for I (G120)

**Code Description**

A: I or A Number

B: Comparison Value

**Example**

| | |
|---|---|
| G120 A200 B1 | Wait until I200 or A200 is 1 before continuing to interpret. |

## 16.40. Interpreter Wait for R(G121)

**Code Description**

A: R NUMBER

B: Comparison Value

**Example**

| | |
|---|---|
| G121 A200 B1 | Wait until R200 is 1, then continue to interpret. |

## 16.41. Interpreter Wait for R Value Larger Than or Equal to (G122)

**Code Description**

A: R NUMBER

B: Comparison Value

**Example**

| | |
|---|---|
| G122 A200 B1 | Wait until R200 is greater than or equal to 1, then continue to interpret. |

## 16.42. Interpreter Wait for R Value Smaller Than or Equal to (G123)

**Code Description**

A: R NUMBER

B: Comparison Value

**Example**

| | |
|---|---|
| G123 A200 B1 | Wait until R200 is less than or equal to 1, then continue to interpret |

## 16.43. Interpreter Wait for R Value within the Range (G124)

**Code Description**

A: R NUMBER

B: Small Value

C: Large Value

**Example**

| | |
|---|---|
| G124 A200 B1 C10 | Wait until R200 is between 1 and 10 then continue to interpret. |

## 16.44. Interpreter Wait for R the Same (G125)

**Code Description**

A: R NUMBER1

B: R NUMBER2

**Example**

| | |
|---|---|
| G125 A200 B201 | Wait until the value of R200 is equal to the value of R201, and then continue to interpret. |

## 16.45. Interpreter Wait for R Bit (G126)

**Code Description**

A: R NUMBER

B: Bit Number

C:Comparison Value

**Example**

| | |
|---|---|
| G126 A200 B2 C1 | Wait until the value of R200.2 is equal to 1, then continue to interpret. |

## 16.46. Interpreter Wait for R Bit the Same (G127)

**Code Description**

A: R NUMBER1

B: R NUMBER2

C: Bit Number

**Example**

| | |
|---|---|
| G127 A200 B201 C1 | Wait until the value of R200.1 is equal to the value of R201.1, then continue to interpret。 |

## 16.47. Set Composite Acc/Dec Time (G990)

**Code Description**

A:Synthetic Linear Acceleration Time

B:Synthetic Linear Deceleration Time

C:Synthetic Bell-Shaped Time1

D: Synthetic Bell-Shaped Time 2

E: Synthetic Corner Speed Reference

**Example**

| | |
|---|---|
| G990 A300 B100 C100 D0 E10000 | Set the composite linear acceleration time to 300, deceleration time to 100, bell time 1 to 100, bell time 2 to 0, and the corner reference Speed 10000 |

## 16.48. Set Axis Smoothing Time (G991)

**Code Description**

A: Axis Smooth Linear Time

B: Axis Smooth Bell-Shaped Time

**Example**

| | |
|---|---|
| G991 A100 B50 | Set the axis smooth linear time to 100 and the bell time to 50 |

## 16.49. Set Axis Acc/Dec & Its Tolerance (G992)

**Code Description**

A: Axis Number 1~9

B: Acceleration Time

C: Deceleration Time

D: Tolerance

**Example**

| | |
|---|---|
| G992 A3 B100 C50 D2000 | Set the acceleration time of the 3rd axis to 100, deceleration time to 50, and the allowable difference is 2000. |

## 16.50. Set Axis Feedforw3ard Compensation (G993)

**Code Description**

A: Axis Number 1~9

B: Gain%

C: Compensation Time

**Example**

| | |
|---|---|
| G993 A3 B10 C50 | Set the Speed gain of the 3rd axis to 10% and the compensation time to 50ms. |

## 16.51. Servo Lag Elemination & Update Coordinates (G995)

**Example**

| | |
|---|---|
| G995 | Eliminate servo lag and update the coordinate. |

## 16.52. Update Coordinates (G996)

**Example**

| | |
|---|---|
| G996 | Update coordinate |

## 16.53. Set Soft Level (G997)

**Code Description**

A: Soft Level Group 0~5

**Example**

| | |
|---|---|
| G997 A0 | Use default soft level |
| G997 A2 | Use second group soft setting level. |

# 17. Macro Syntax

## 17.1. Variables

### 17.1.1. Local 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.

### 17.1.2. 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.

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

## 17.3. Mathematical Functions

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 |

## 17.4. 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 |