iNexBot

Robot Operation Manual

4-Axis SCARA

Catalogue

4-Axis SCARA Robot Operation Manual

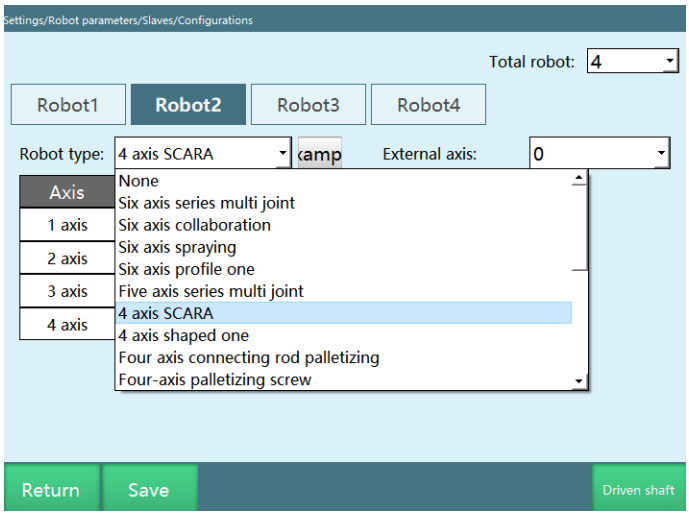
SCARA robot introduction

The SCARA robot has four joints, three of which are rotary joints with axes parallel to each other for positioning and orientation in the plane. The other joint is a movable joint, which is used to complete the movement of end pieces in perpendicular to the plane.
SCARA system has compliance in X-axis and Y-axis directions and good stiffness in Z-axis direction, this feature is especially suitable for assembly work.
SCARA robot is also widely used in plastic industry, automotive industry, electronic product industry, pharmaceutical industry and food industry and other areas. Its main functions are parts handing and assembly work.
Its first and second axes have rotation characteristics, while the third and fourth axes can be manufactured in a variety of different forms depending on the needs of the job, with one having rotation and the other having linear movement characteristics. Due to its specific shape, its working area is similar to a sector.

4-axis SCARA robot

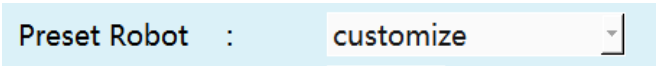
Slave configuration

If you need to select 4-axis SCARA robot, click [Settings-Robot parameters-Slave configuration-Robot] and select "4-axis SCARA" in the "Robot type" drop-down menu, then click "Save".



Parameters presetting

When you click "Save" after selecting "4-axis SCARA", you need to import the robot parameter profile, but in the "DH parameters" interface, we provide the function of presetting robot parameters. If this drop-down list contains the robot model you are using, you can set up all the robot parameters quickly and easily with this function. There is no need to import the controller configuration parameters separately.
Click [Preset robot] in the upper left corner of the "DH parameters" interface, you can select the robot model that has already been adapted, and the DH parameters and joint parameters of the robot will be filled in automatically after the selection.



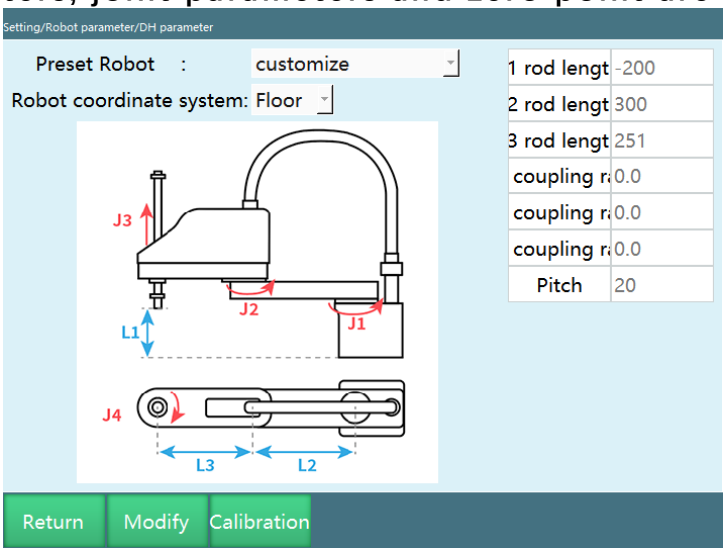
You need to calibrate the zero point manually after selecting the preset robot.

DH parameters setting

1.Fill in the parameters of the robot, such as rod length, coupling ratio and pitch; these parameters will affect the linear motion and accuracy of the robot.
2.If the robot accuracy is poor, you can return to this interface for 4-point calibration after the configuration is completed, and calibrate the rod length parameters. The following figure shows

the values of each parameter in the robot "DH parameters" interface after importing the controller configuration.

Note: Please do not power on and operate the robot until the DH parameters, joint parameters and zero point are set.



4-axis SCARA

Parameter description

Preset robot

By importing the robot joint parameters and DH parameters into the controller in advance, you can eliminate the need to fill in the parameters repeatedly

Rod length

The rod length parameter should be filled in as shown in the model diagram on the "DH parameters" interface, if no value is given, we can only measure the length of each axis of the robot by using a ruler, and inaccurate filling will affect the robot motion accuracy

Coupling ratio

How to tell if the robot is coupled?
We can run the robot, when jogging the axis 1, the axis 2 also moves, indicating that there is coupling.
How to calculate the coupling ratio?

For example, when axis A rotates by a degrees, it causes axis B to rotate by b degrees, so the coupling ratio of the two axes is

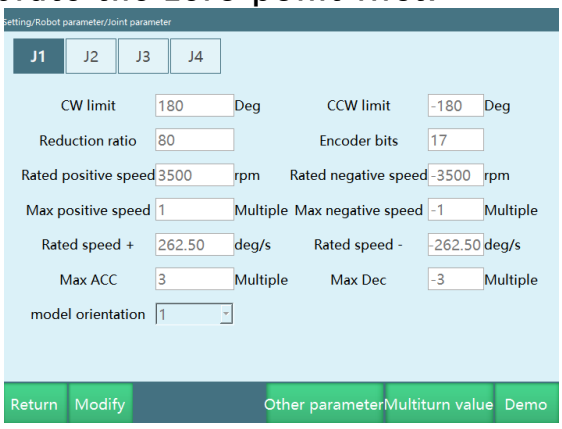
$$c = b \div a$$

Pitch

Pitch of the link responsible for up and down movement in 4-axis SCARA (axis 3 of 4-axis SCARA and axis 1 of 4-axis SCARA special-shaped robot)

Joint parameters

Note: Please do not power on and jog the robot before DH parameters and joint parameters are set to prevent the robot from getting out of control and causing danger to the operator. If you need the robot to return to the zero position, click [Robot parameters - Zero position] to see if it is at the zero position, if not, please calibrate the zero point first.



Meaning of each parameter

CW limit

The maximum range of the robot joints in the positive direction. After importing the controller configuration, the values of each parameter in the joint parameter interface will be entered automatically and the values of the limits can be modified

CCW limit

The maximum position of the robot in the reverse direction during single-axis rotation (This value must be negative)

Reduction ratio

The ratio of instantaneous input speed to output speed in the reduction mechanism

Encoder bits

The number of bits of the encoder. Usually 17 or 23 bits

Rated positive RPM

The rated rotation speed of the motor in the positive direction

Rated reverse RPM

The rated rotation speed of the motor in the reverse direction (This value must be negative)

Maximum positive RPM

The maximum rotation speed of the motor in the positive direction; its value is a multiple of the rated positive RPM. If the rated positive RPM is 3000 rpm and the maximum positive RPM needs to be 6000 rpm, then fill in 2 times here.

Maximum reverse RPM

The maximum rotation speed of the motor in the reverse direction; its value is a multiple of the rated reverse RPM. If the rated reverse RPM is -4000 rpm and the maximum reverse RPM needs to be -6000 rpm, then fill in -1.5 times here. (This value must be negative)

Rated positive speed

The rated positive speed of the robot joint; it is automatically calculated from the rated positive RPM, encoder bits and the reduction ratio (the axis 3 of the 4-axis SCARA and axis 1 of the 4-axis SCARA special-shaped robot also need to add the pitch), no need to fill in.

Rated reverse speed

The rated reverse speed of the robot joint; it is automatically calculated from the rated reverse RPM, encoder bits and the reduction ratio, no need to fill in. (This value must be negative)

Maximum acceleration

The maximum acceleration of the robot joint movement; its value is a multiple of the rated positive (reverse) speed. If the rated positive speed is 300 degrees/s, the maximum acceleration needs to be 1500 degrees/s², then fill in 5 times here.

Maximum deceleration

The maximum deceleration of the robot joint movement; its value is a multiple of the rated positive (reverse) speed. If the rated positive speed is 300 degrees/s, the maximum acceleration needs to be 1200 degrees/s², then fill in -4 times here. It is recommended that the maximum acceleration and maximum deceleration values be the same. (This value must be negative)

Model direction

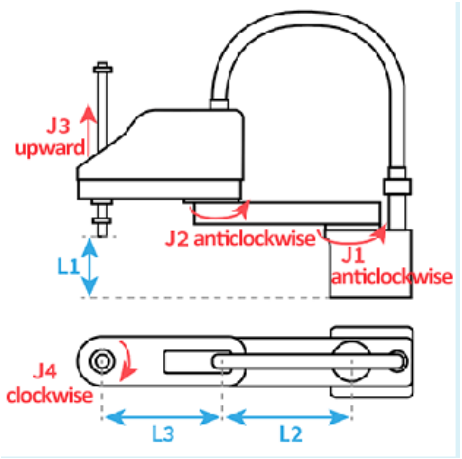
The model direction should be set by referring to the joint positive direction diagram below, and the direction of the jogging "+" key of each axis should be the same as the joint positive direction diagram (choosing 1 for the same and -1 for the opposite).

Gear backlash

The angle to compensate for the filled value whenever the joint moves in the opposite direction; not filled by default.

Robot type	Axis	Positive direction (top view or left view)
4-axis SCARA	J1	anticlockwise
	J2	anticlockwise
	J3	upward
	J4	clockwise

Joint positive direction diagram

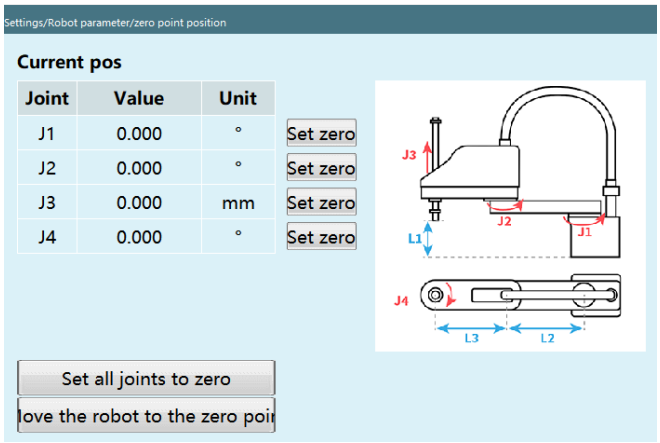


Note: Please do not power on and operate the robot until the positive direction of the joint has been set.

Zero calibration

If the robot zero position is a non-standard zero position, users can align the robot according to the robot's alignment hole, and then set the current robot position coordinates to the zero position on the robot zero position interface. The diagram of the SCARA zero position is as follows.

Make sure the robot is in this position and click "Set all joints to zero"

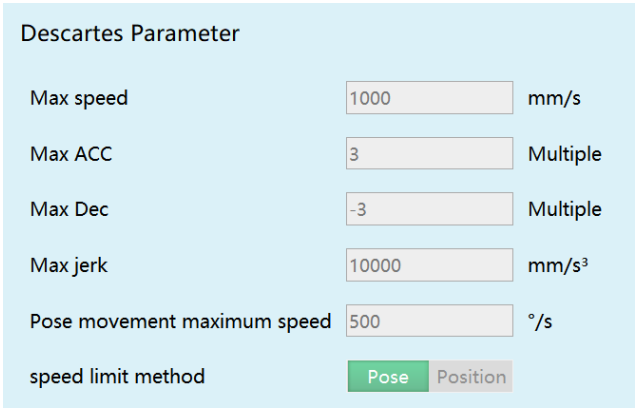


Note: Please do not power on and jog the robot before DH parameters and joint parameters are set to prevent the robot from getting out of control and causing danger to the operator. If you need the robot to return to the zero position, click [Robot parameters - Zero position] to see if it is at the zero position, if not, please calibrate the zero point first.

Cautions

If the robot is not zero position calibrated, you can not return it to the zero point and jog it.
For systems that use multiple robots, each robot must perform origin position calibration.
When there is a coupling relationship between joint axes, such as the common coupling relationship between the fifth axis and the sixth axis of a robot, the fifth axis must be at the zero position, then the zero data recorded for the sixth axis will be valid, otherwise, the zero data recorded for the sixth axis will be invalid. So the zero data of the sixth axis must be recorded with the fifth axis at the zero position. If there is no coupling relationship, each axis can calibrate the zero position individually, and the respective zero position will not affect the zero position of other joints.
When all the used axes (body axes and auxiliary extension axes) have been zero-calibrated, the "All" indicator on the "Zero calibration" interface turns green, indicating that the robot has completed zero calibration, and the robot is ready to move in Cartesian space.

Cartesian parameters setting
Cartesian parameters can use default values directly.



Meaning of each parameter

Maximum speed

The maximum linear speed of the robot during operation.

Maximum acceleration

The maximum acceleration of the robot during operation; its value is a multiple of the maximum speed. If the maximum speed is 1000mm/s and the maximum acceleration needs to be 3000mm/s², then fill in 3 times here.

Maximum deceleration

The maximum deceleration of the robot during operation; its value is a multiple of the maximum speed. If the maximum speed is 1000 mm/s and the maximum deceleration needs to be -3000 mm/s², then fill in -3 times here. It is recommended that the maximum acceleration and maximum deceleration values be the same and the same as the maximum acceleration and maximum deceleration in the joint parameters. (This value must be negative)

Maximum jerk

This parameter is a reserved parameter and is currently invalid.

Pose movement maximum speed

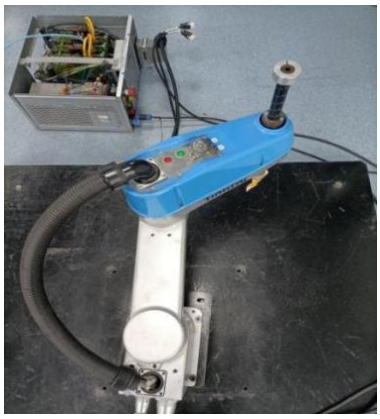
The maximum speed of the robot during operation, if the instruction speed exceeds this value, it will be decelerated.

Speed limit method

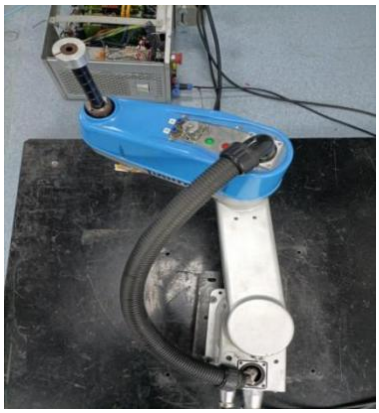
Pose: The linear interpolation motion of the robot is limited by the maximum speed and the pose movement maximum speed.
Position: The linear interpolation motion of the robot is limited only by the maximum speed.

4-axis SCARA robot left and right hand

Left and right hand (4-axis SCARA robots only)



left hand attitude



right hand attitude

For example:

1.Jog the robot to adjust it to position of the left hand attitude

2.Insert the movl instruction, modify the current position to the P001 point, and select "Left hand" and save

3.Jog the robot to adjust it to the position of the right hand attitude

4.Step movl instruction

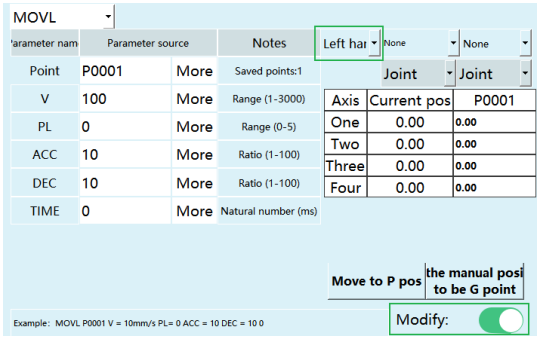
The running result will report an error: The left and right hand system of robot 1 is incorrectly used

Note: movj instruction does not distinguish between left and right hand

In summary,the right hand attitude cannot follow the position of the left hand

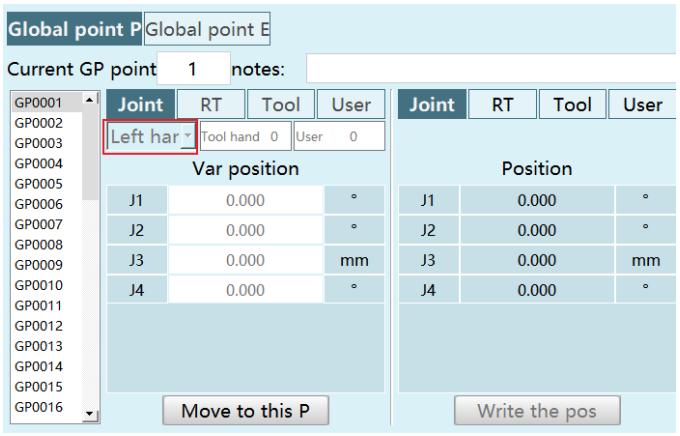
The left and right hand is generally used to compress the robot's movement space, and can also be used for obstacle avoidance. Generally, we only choose the cartesian coordinate system to set the left and right hand, and the decision procedure is based on the direction of axis 2. You can select the left and right hand in the instruction setting interface, and when the setting is completed,

click the [Manual modify] button and then click the "OK" button, as shown in the figure

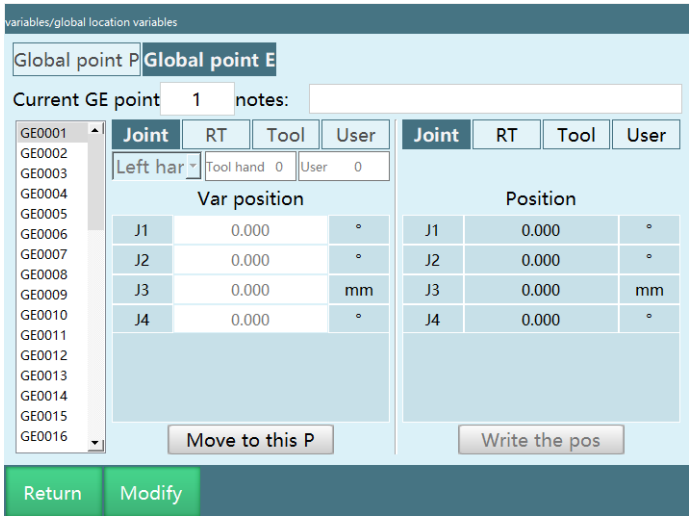


Global variables settings for left and right hand

Click [Variables] - [Global variables], then click the drop-down menu, you can set the left and right hand of the robot global point GP, the picture below shows the global variable interface to set the left hand.

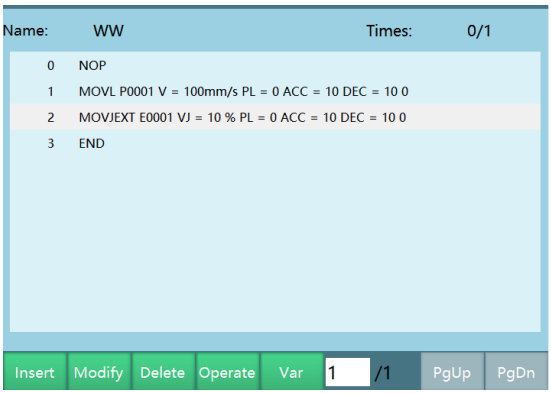


Set the left and right hand of GE points of 4-axis SCARA robots with external axes in the same way

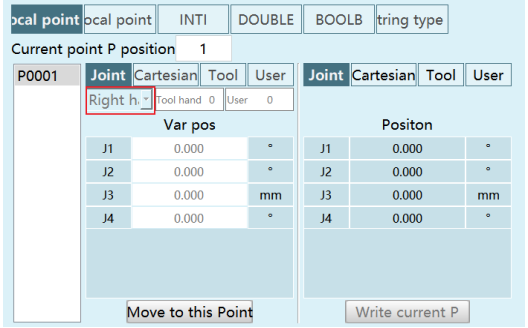


Local variables settings for left and right hand

Click [Program], select a program to open, and select [Variables] - [Local variables] at the bottom, as shown in the following figure



Click "Modify", click on the top drop-down arrow and select left or right hand, as shown in the figure

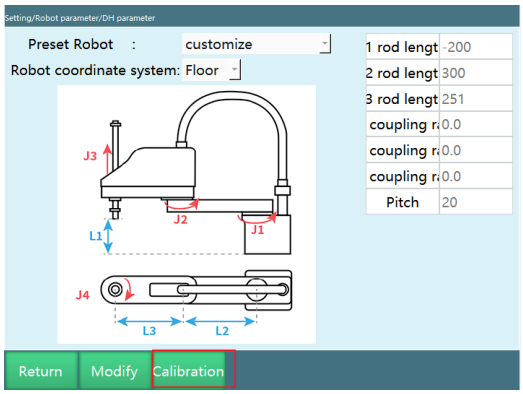


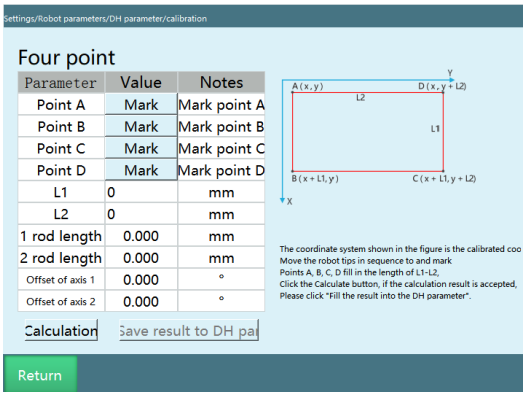
In the instruction parameter setting interface, you can select parameters to set the local position variable P point or E point

4-point calibration

4-point calibration can be used to correct rod length and zero point

Click the "Calibrate" button on the "DH parameters" interface to enter the 4-point calibration interface





Point A, point B, point C and point D form a rectangle; the values of L1 and L2 represent the width and length of the rectangle

The above figure shows the calibration of four points A,B,C,D.

For example: L1=50

L2=100

A (X,Y), B (X+50,Y), C (X + 50, Y+100), D (X, Y+100)

Click "Calculate" after calibrating the 4 points

Confirm the calculation result is correct and click "Fill the result into DH parameters"

2-point calibration

2-point calibration supports 4-axis SCARA.

Click the [2-point calibration] button at the bottom of the "Tool hand calibration" interface to enter the "2-point calibration" interface, as shown in the figure.

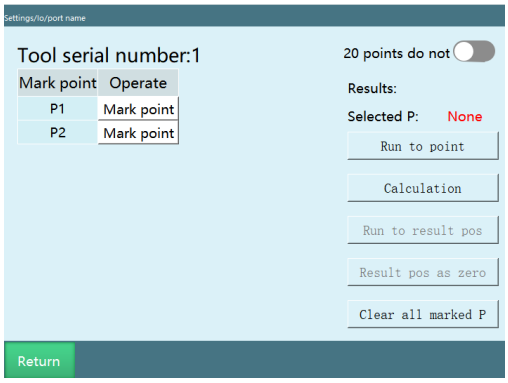


Figure. 2-point calibration

The specific calibration steps are as follows:

1.Find a reference point (pen tip) and make sure this reference point is fixed.

2.Calibrate a point under the left hand form (calibrated point and reference point tip to tip)

3.Calibrate a point under the right hand form (calibrated point and reference point tip to tip)

4.After calibrating 2 points, click [Calculate].

5.If you are not satisfied with the calibration of a point during the calibration process, you can click the [Cancel calibration] button corresponding to that line to cancel the calibration and then calibrate the point again.

6.You can click [Run to this point] after each point is calibrated, and the robot will run to that point.

7.Move the robot to another position, and then click [Run to calculation result position], then the robot will move to the original calibration position, which is equivalent to the zero position of the robot.

8.Mark the result position as zero point: After the 2-point calibration is finished, click [Calculate] and then click [Save results], a pop-up window will appear, displaying "Confirm whether to set the result to zero point"
9.[Clear all mark points]: The calibration points will be saved in the controller, and the calibration results will be cleared only after you click "Cancel calibration", "Clear all calibration points" and switch the tool hand into the calibration interface.

Cautions
Please try to take the pose of each point in any direction. If the pose taken is rotated in a certain direction, sometimes the accuracy is not accurate. Please keep the reference point fixed during the calibration process, otherwise the calibration error will increase.

Click the [Return] button at the bottom to return to the "Tool hand calibration" interface.