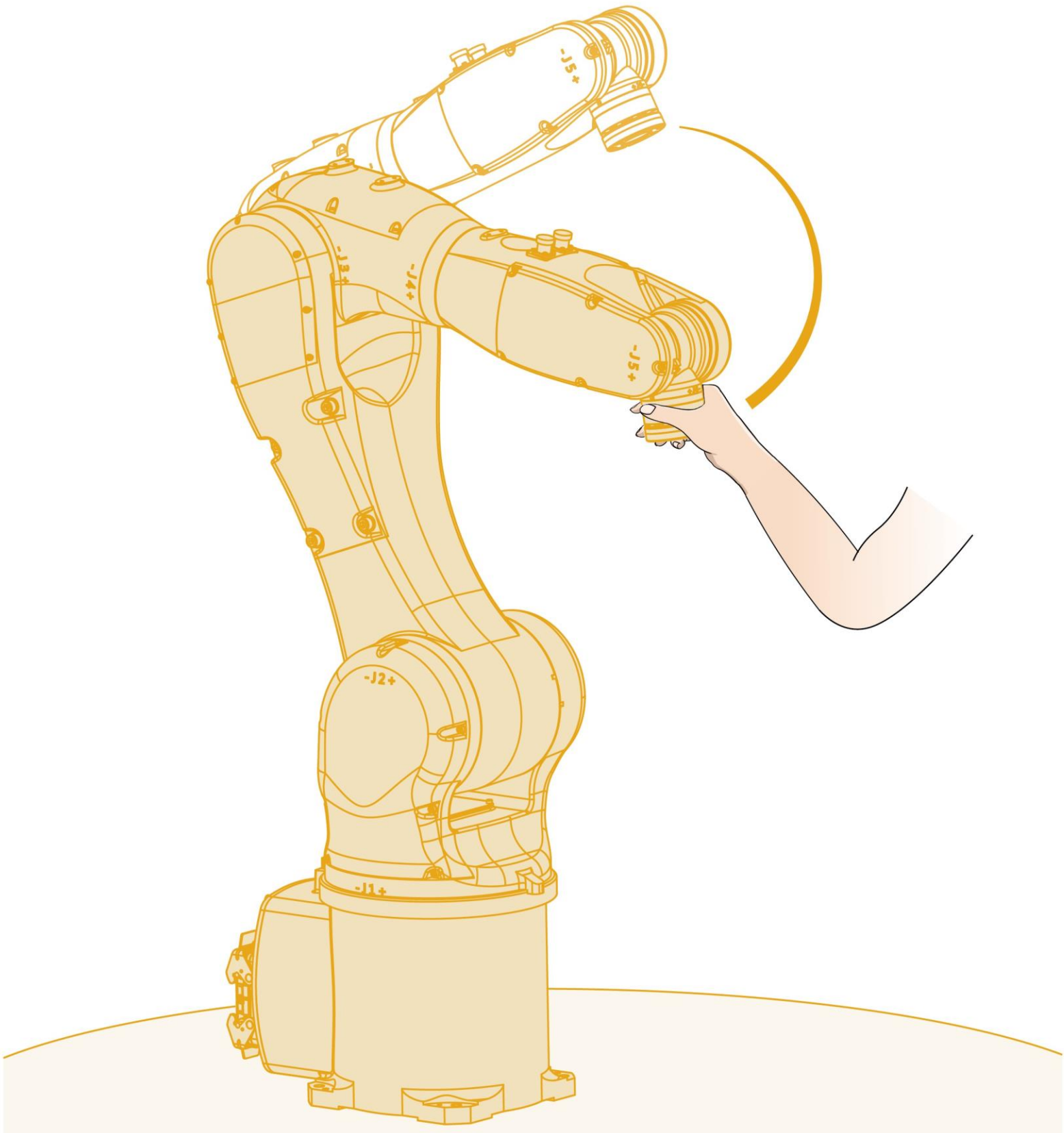
PEITIAN ROBOTICS

Drag teaching user manual

V1.2.0



Foreword

About this manual

This manual introduces the application of robot drag teaching and provides a detailed description of the software configuration and practical operation process when using drag teaching. Reading this document will help readers master the working principles and usage methods of drag teaching.

Prerequisites

Before operating the robot, please carefully read the relevant safety and operating instructions of the product. Users need to understand safety knowledge and basic operating knowledge before using the drag teaching function.

Please refer to:

- AIR-TP Teach pendant operation manual
- ARL programming manual
- AIR Series industrial robot system fault and handling manual

Target group

- Operator
- Product technical personnel
- Technical service personnel
- Robot instructor

Meaning of Common Signs

The signs and their meanings appearing in the manual are detailed in Table 1 below.

Table 1 Signs used in this article

Sign	Meaning
 Danger	Failure to follow the instructions may cause accidents, resulting in serious or fatal personal injury.
 Warning	Failure to follow the instructions may cause accidents, resulting in moderate or minor personal injury, and may also cause damage to materials only.
 Notice	You are prompted to keep in mind environmental conditions and important matters, or quick operation methods.

Sign	Meaning
 Tip	You are prompted to refer to other literature and instructions for additional information or more details about operation instructions.

Manual description

The content of this manual will be supplemented and modified. Please regularly pay attention to the "Download Center" on our company's website and update acquire with the latest version of the manual.

Our company website address: http://robot.peitian.com/

Revision history

The revision history accumulates instructions for each document update. Updated content for all document versions before the latest version.

Table 2 sign used in this article

Version	Release time	Modification instructions
V1.0.0	2020/06/30	First official release
V1.1.0	2020/08/30	Second official release Upgrade this version of the software to V2.6.3
V1.2.0	2023/03/30	Third official release Upgrade this version of the software to V2.6.5

Document number and version

The relevant information of the document is shown in Table 3.

Table 3 Document related information

Document Name	Drag teaching user manual
Document number	UM-S01500000027-001
Document version	V1.2.0
HMI version	2.6.5

Symbolic conventions

The relevant symbol conventions for the document are shown in Table 4.

Table 4 Symbol conventions

Format	Significance
<>	The angle bracket "<>" indicates the button name, such as "click on the <Yes> button".
[]	Square brackets "[]" indicate the window name, menu name, and data table, such as "Pop up the [New User] window".
/	Multi level menus are separated by '/'. For example, [File/New/Folder], a multi-level menu represents the [Folder] menu item under the [New] submenu of the [File] menu.

Contents

1 Introduction to drag teaching

1.1 Outline

Robot drag teaching also known as direct teaching, manual traction teaching, lead through teaching, manual teaching, etc., belongs to a type of robot teaching control method. Operators can use their hands to directly drag the manipulator and record the teaching points or teaching trajectories through the robot control program (as shown in Figure 1-1).

Figure 1-1 Drag teaching diagram

1.2 Application scenario

Some production application scenarios often require robots to move along complex curve trajectories, while traditional teaching methods are complex and time-consuming to operate. They also require knowledge of robot models, which requires high operator requirements and cannot meet the current high intensity and high-speed production efficiency. Dragging teaching involves manually dragging the robot end to move according to the desired trajectory, and then the robot records the moving points to restore the teaching process. The drag teaching operation is flexible and more intuitive, and the operator can quickly record the working point position of the robot. increase improves teaching efficiency and saves production time.

1.3 Explanation of proper terms

- Work Area — The range of motion of TCP points in the Cartesian coordinate system. The shape and position can be set by the user, as shown in the area within the rounded rectangle in Figure 1-2.
- Critical Area — This area is a sub area of the work area, and its shape and position can be set by the user, as shown in the area between rounded rectangles and ellipses in Figure 1-2. During the drag teaching process, when the TCP point enters the area, the user will feel resistance acting on the TCP point, which prevents the user from moving the TCP point outside the working area.
- General Area — This area is a sub area of the work area, and its shape and position can be set by the user, as shown in the area within the ellipse in Figure 1-2. The intersection of the critical area and the conventional area is an empty set, and the union is the working area.

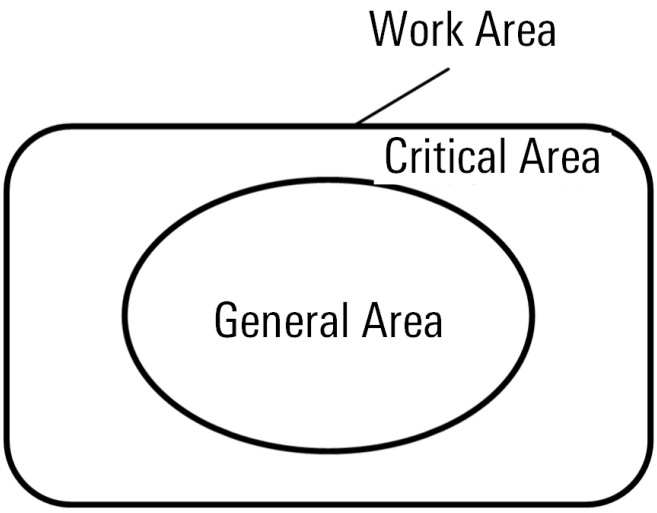


Figure 1-2 Working area and critical area

■ Soft limit	The range of joint motion in axis space. Its value can be set by the user.
■ Critical soft limit area	This area is a sub area of the soft limit, and the range can be set by the user. During the drag teaching process, when axis enters this area, the user will feel the resistance moment of axis , preventing axis from moving beyond the soft limit.
■ Axis space general area	This area is a sub area of the soft limit, and the range can be set by the user. The intersection of the conventional region of axis space and the critical soft limit is an empty set, and the union is a soft limit.
■ Tool direction vector	A free vector specified by the user, with a length of 1, in the direction usually pointed by the tool coordinate system Z axis when the robot is working. As shown in Figure 1-3.
■ Work posture area	The set of tool coordinate system postures where the angle between the tool coordinate system Z axis and the tool direction vector is less than a certain value. This value can be set by the user, ranging from 5° to 180°. As shown in Figure 1-3, the solid line cone.
■ Critical attitude region	The angle between the boundary of the sub area of the working posture area and the boundary of the working posture area can be set by the user. During the drag teaching process, when the tool coordinate system Z axis enters this area, the user will feel a resistance moment, preventing the tool from moving outside the working posture area.
■ Conventional attitude area	The sub region of the working attitude region is the union of the critical attitude region, and the intersection is the empty set. As shown in Figure 1-3, the dashed cone.

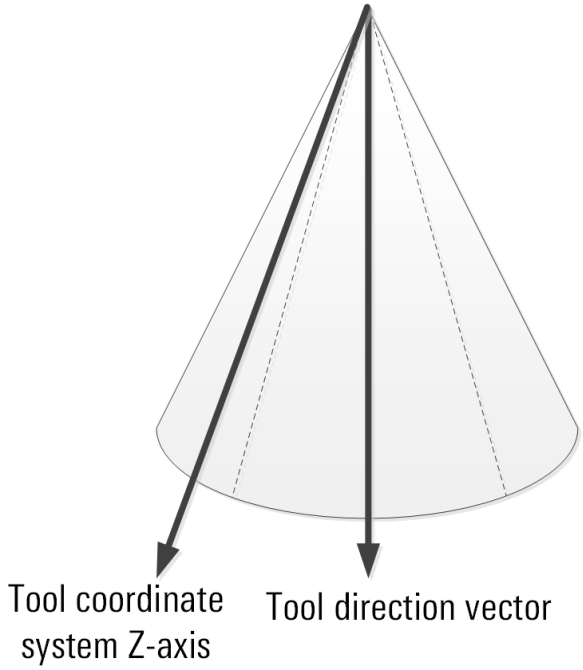


Figure 1-3 Working attitude region and critical attitude region

2 Authorization to use the drag teaching function

2.1 Privilege level

When using the AIR-TP teach pendant for the first time, the user interface for the first login will be prompted, and the user can choose:

- Teacher: Permission 4

  It can perform operations such as writing robot work programs, and have permission to modify some parameters. The initial login password is: PEACE.

- Operator: Permission 5

  It can easily view the operation status of the robot's position parameters without permission to modify programs or parameters. The initial login password is: LOVE.

Ordinary users can only log in to the teaching device with the privileges of the teacher and operator. The operator is not allowed to use the teaching function.

2.2 Authorize import

The drag teaching function requires authorization to start using. The specific authorization process is as follows:

Step1. Contact the aftersales engineer acquire for corresponding authorization.

Step2. Place the obtained authorization file into a USB drive, and then insert the USB drive into the USB interface of the teach pendant.

Step3. Select the [System/System and Update/Authorization Import] option in the menu area in the upper right corner of the main interface of the teach pendant, as shown in Figure 2-1.

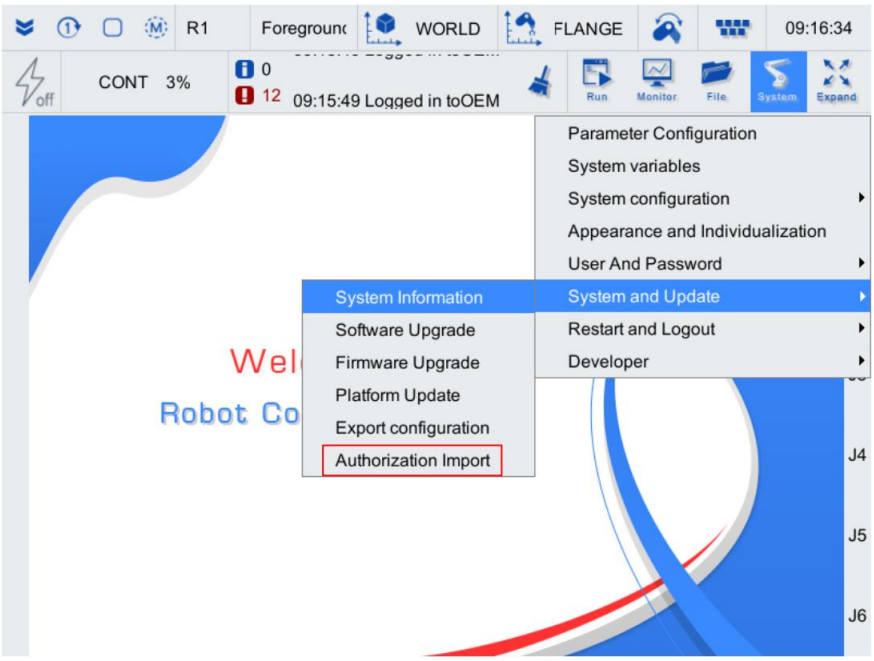


Figure 2-1 Teach pendant main interface

Step4. The [Choose an authorization file] dialog box shown in Figure 2-2 pops up. In the pop-up directory, locate the "USB" folder and double-click to enter.

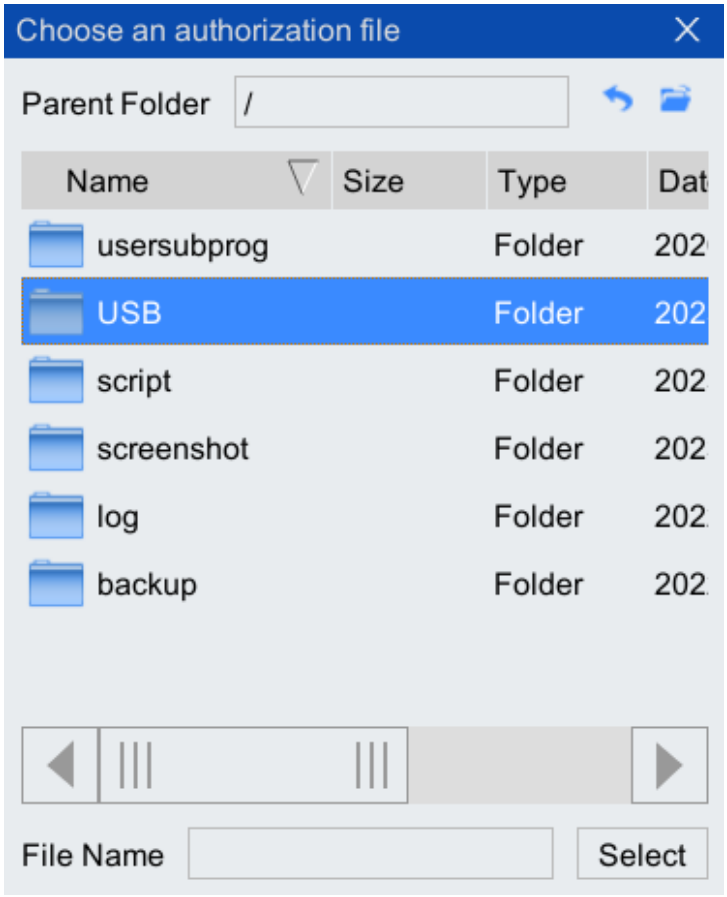


Figure 2-2 Select authorization file dialog box

Step5. Find the authorization file "hg. lic" in the "USB" folder, select it, and click<Select>.

Step6. If the authorization import dialog box shown in Figure 2-3 pops up and displays "Import succeeded", click <Yes> to complete the authorization.

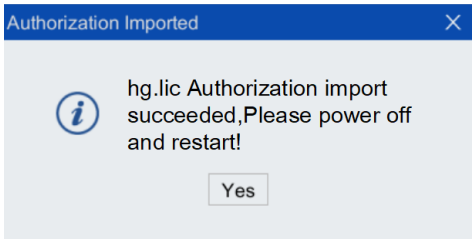


Figure 2-3 Authorization dialog box

Step7. Power off and restart the control cabinet, authorization takes effect.

Tip

The drag teaching function serves as an extension package and is controlled by the authorization management function. If the control cabinet is not authorized or has expired for the acquire drag teaching function extension package, please contact after-sales service.

3 Precautions for dragging teaching

Tip

The <2nd> and keys on the teach pendant can be customized according to their functions, and all the keys mentioned in this manual are the initial set keys.

- The drag teaching function can only be used when manipulator is horizontally installed. If reverse or side installation is required, please contact after-sales service.
- When clicking the <F2> button to enter the external axis control, it is not allowed to enter the drag teaching mode; after entering the drag teaching mode, it is also not allowed to enter the external axis control mode.
- Switching to drag teaching mode is not allowed in both automatic and manual high-speed control modes.
- Entering drag teaching mode, the driver is not enabled. Press the <Enable> button to start dragging, and release the <Enable> button manipulator to not drag. If the user does not release the enable button and press the <2nd+F1> button to exit the drag teach pendant mode, the driver will disconnect the enable button and switch to manual low speed mode.
- If the currently selected mechanical unit in the system is not AIR4-560A/AIR6-A/AIR6L/AIR7L-920B/AIR8-710A/AIR8-B, the drag teaching mode cannot be entered.
- When the robot is in the running or paused state of the program, it is not allowed to switch to the drag teaching mode.
- When entering and exiting the drag teaching mode, the already loaded program will be automatically reset.
- In the drag teaching mode, there is an alarm at the same time, and users cannot use the <Enable> button to power on.
- In drag teaching mode, the system cannot be powered on or off by clicking on the power on/off icon.
- In the drag teaching mode, if the user selects the operation mode as non-manual low speed using the key, they will first execute stop0 and then switch to the mode corresponding to the key selection.
- In drag teaching mode, when the user uses the disconnect teach pendant coupled function, they will execute stop0, and then they will execute the disconnect teach pendant coupled function.
- In drag teach mode, and if it is already powered on, the user is not allowed to perform a logout operation.
- In drag teaching mode, other alarms that trigger shutdown will execute stop0.
- Restart ARCS in drag teaching mode; After logging into the system, it will enter the mode corresponding to the key selection instead of dragging the teaching mode.
- In the drag teaching mode, it is prohibited to use the load, unload, run, reverse run, and simulation functions.

4 Teaching process and parameter settings

4.1 Enable inspection

Before using the drag teaching function, it is necessary to perform the enable check operation, as follows:

Step1. Log in to the teach pendant and you will see the main interface of the teach pendant as shown in Figure 4-1.

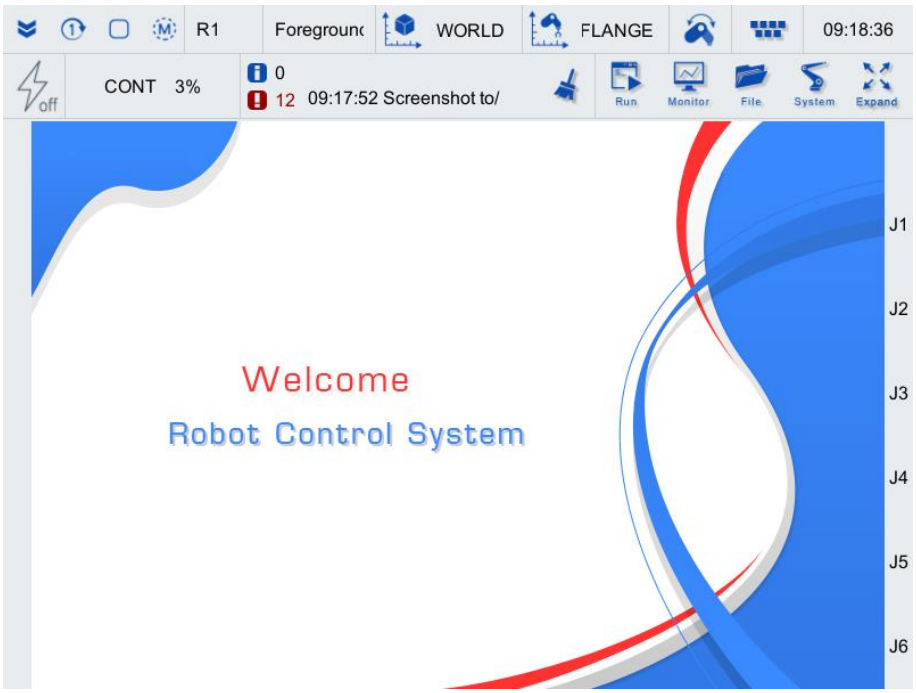


Figure 4-1 Teach pendant main interface

Step2. Click on [System/Parameter Configuration] in the upper right corner menu area, as shown in Figure 4-2.

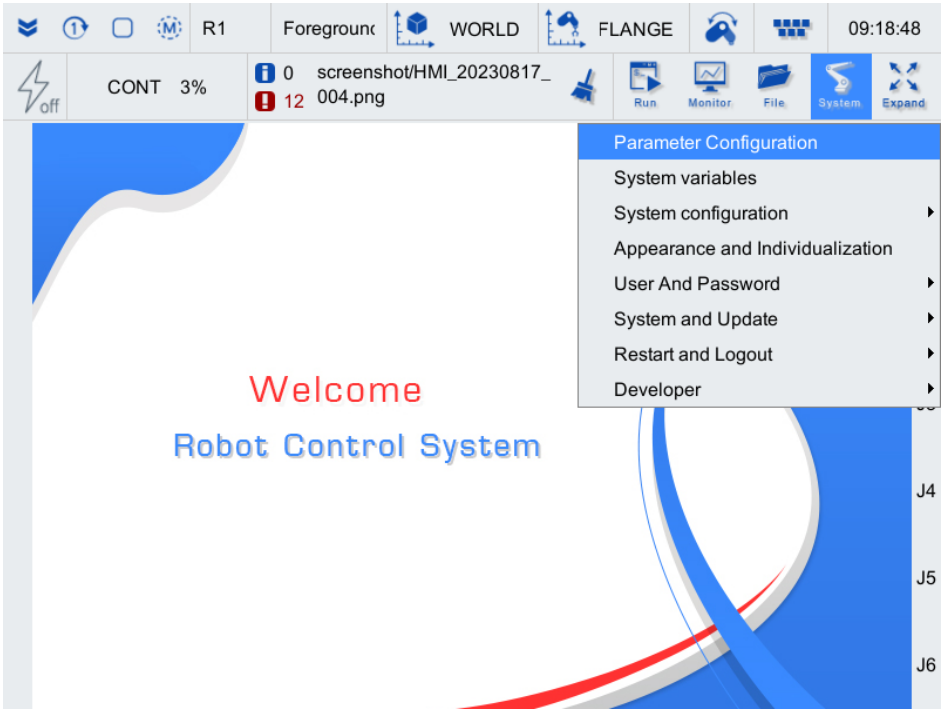


Figure 4-2 System Related Dropdown List

Step3. Enter the parameter configuration interface and select the [Channel 1] tab, as shown in Figure 4-3, select the row where [HG-ENABLE (whether drag teaching is supported)] is located, and click <edit>.

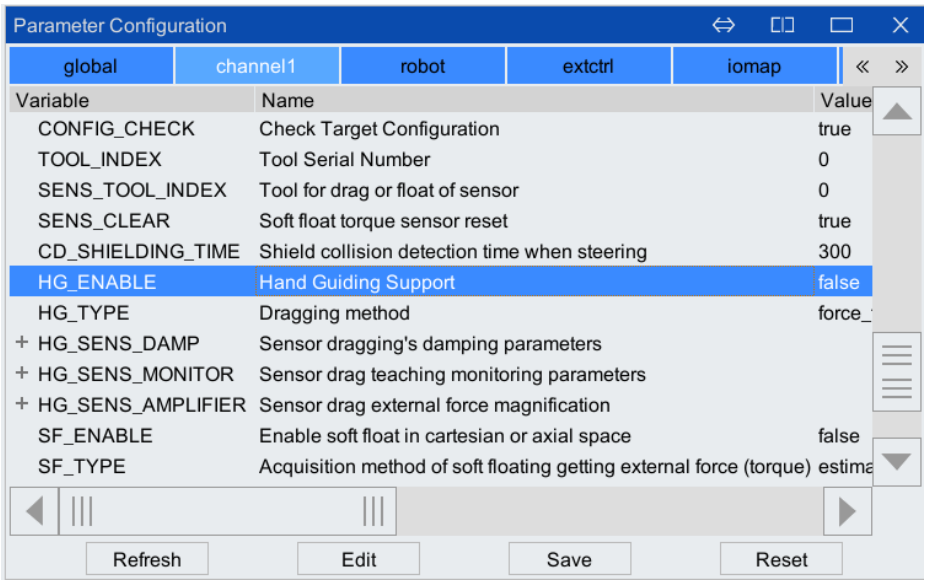


Figure 4-3 Drag Teaching Enable Parameter Setting Interface

Step4. In the pop-up [Parameter Editing] configuration interface (as shown in Figure 4-4), if the [Value] is "true", mode switching can continue; If the value is "false", please contact after-sales service. Parameter description can be found in Table 4-1.

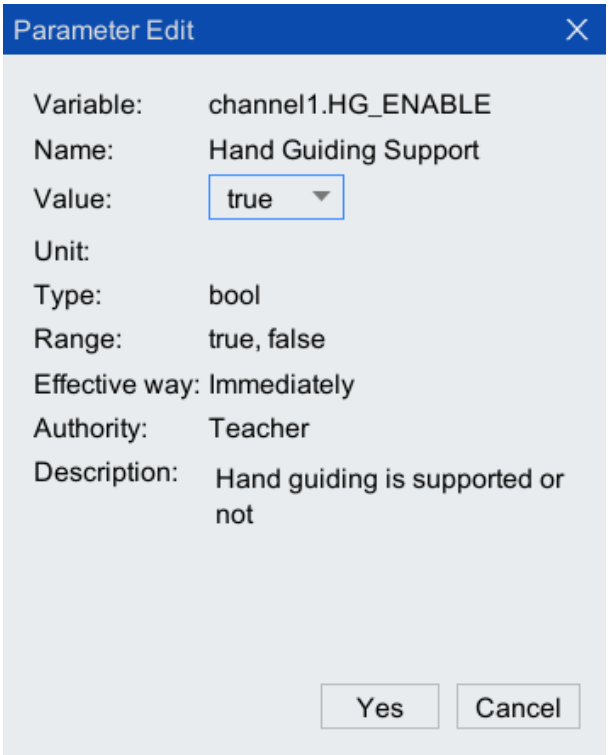


Figure 4-4 Drag the teaching display configuration page

Table 4-1 Parameter description

Parameter	Meaning
Value	Whether dragging teaching is supported. The values are as follows: ■ True: Support ■ False: not supported

Step5. After completing the parameter configuration, click <Save> and a dialog box as shown in Figure 4-5 will pop up. Select [Save All] in [Please Select Save Type] and click <Yes>.

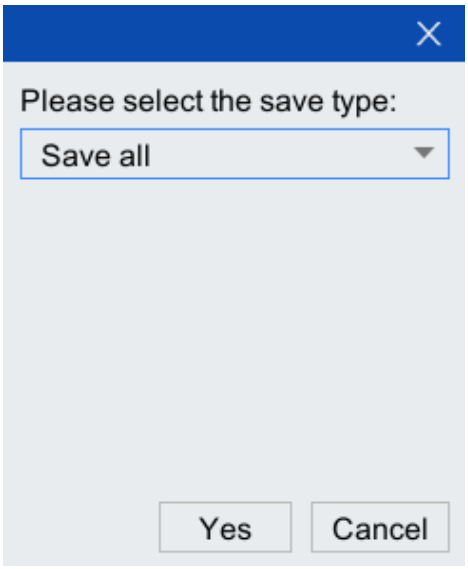


Figure 4-5 Save Type dialog box

Step6. Click <Yes> in the pop-up prompt dialog box. As shown in Figure 4-6.

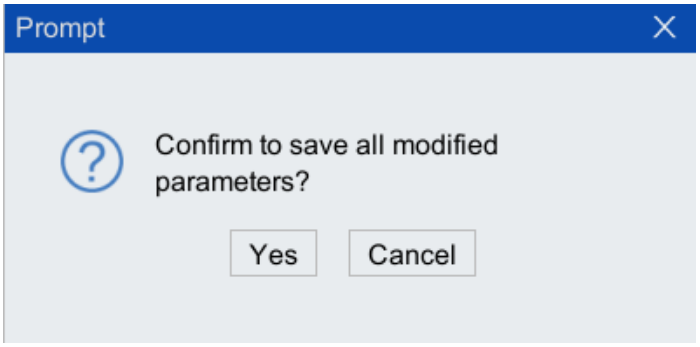


Figure 4-6 Confirm save modify prompt box

Step7. Click <Yes> in the pop-up parameter save success dialog box. As shown in Figure 4-7.

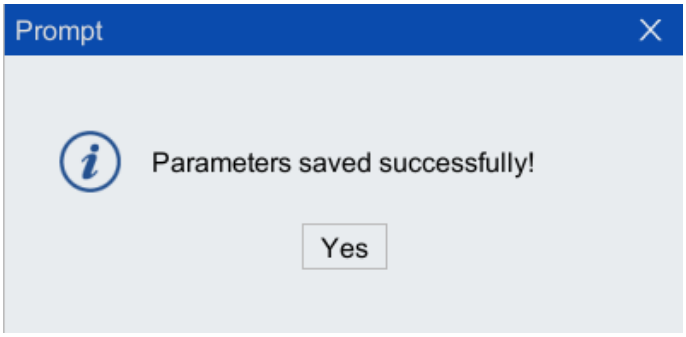


Figure 4-7 Save successful prompt box

4.2 Mode switching

Tip

The <2nd> and <Fn> keys on the teaching pendant can be customized according to their functions, and all the keys mentioned in this manual are the initial set keys.

When using the drag teaching function, it is necessary to ensure that the parameter value of [HG_ENABLE (whether drag teaching is supported)] is "true" before switching the mode of drag teaching. The specific operation steps are as follows:

Step1. The mode switch key shown in Figure 4-8 is set to manual low speed.

Step2. Switch to drag teaching mode by pressing <2nd+F1> in the left control key of the teach pendant (as shown in Figure 4-9).

Step3. After using the drag teach function, you can press <2nd+F1> again to return to normal mode.

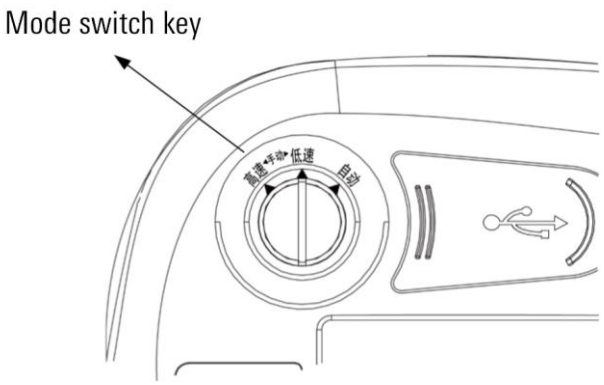


Figure 4-8 Mode switching key

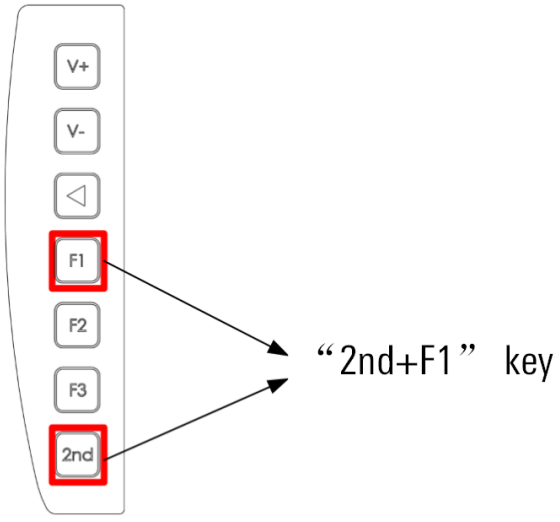


Figure 4-9 Teach pendant function buttons (left side of teach pendant)

4.3 Setting of tool inertia parameters

Manually input load parameters

The configuration steps are as follows:

Step1. Click on [Run/Load Identification] on the main interface of the teach pendant to enter the [Load Identification] interface as shown in Figure 4-10.

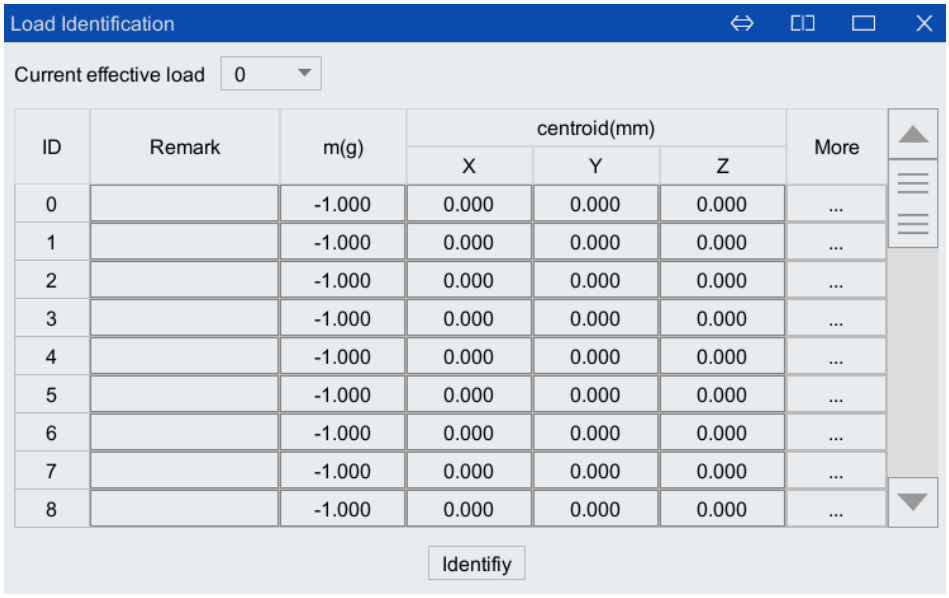


Figure 4-10 Load identification interface

Step2. Select the load number that needs to be entered in the table on the interface. Manually fill in the mass, center of mass, and inertia tensor of the tool.

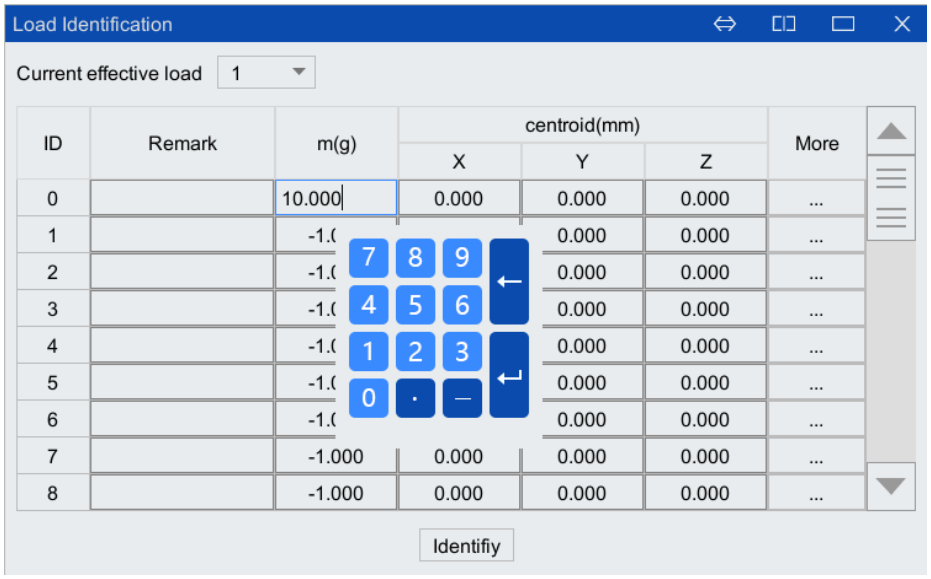


Figure 4-11 Manual input load parameter interface

Notice

When the program is running, the system will give an alarm if the load parameters are illegal. The alarm message is "[3115] The currently selected load inertia parameters are invalid and have automatically switched to the default load DF_TOOL_INERTIA. If using the actual load, please identify or switch the load on the "Load Parameter Settings" page. If an illegal operation is found in the soft move program or collision detection program, an alarm will sound and the operation cannot continue.

Automatic measurement of load parameters

The configuration steps are as follows:

Step1. Install the required load on the robot.

Step2. Click on［Run/ Load Identification］on the main interface of the teach pendant to enter the [Load Identification] interface as shown in Figure 4-12.

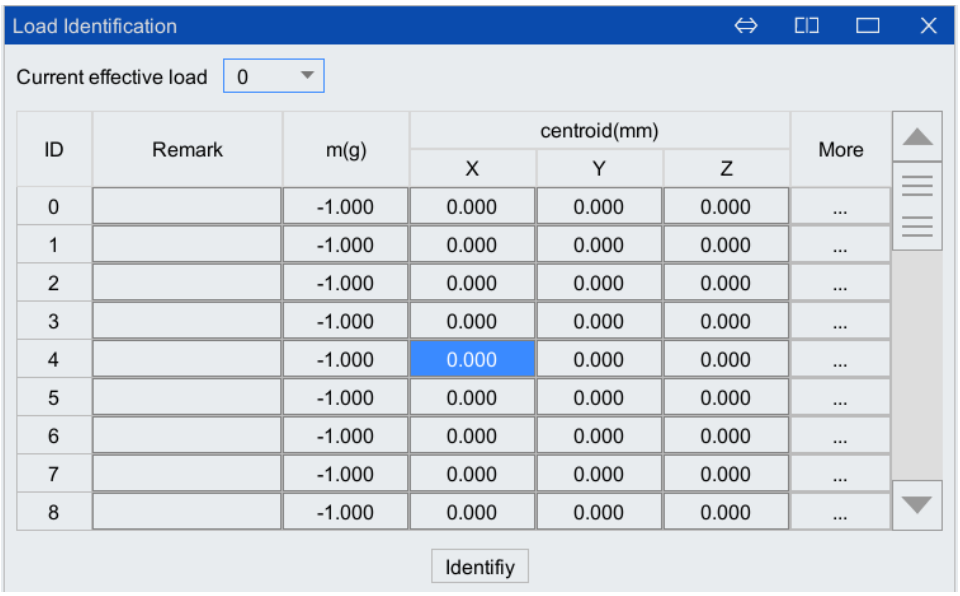


Figure 4-12 Load Identification interface

Step3. Click the <Identify> button, and the configuration interface shown in Figure 4-13 will pop up.

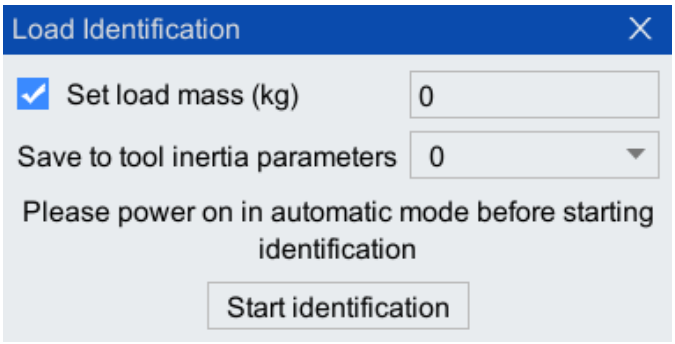


Figure 4-13 Load parameter identification configuration interface

Step4. If the user can accurately measure the load quality, they can check the checkbox in front of [Set load mass] and fill in the [Saved to tool inertia parameters] for load identification. If you do not need to configure it yourself, you can uncheck this option.

Step5. Select the tool number that needs to be saved in the [Saved to tool inertia parameters]. Click <Start identification> and a prompt window will pop up as shown in Figure 4-14.

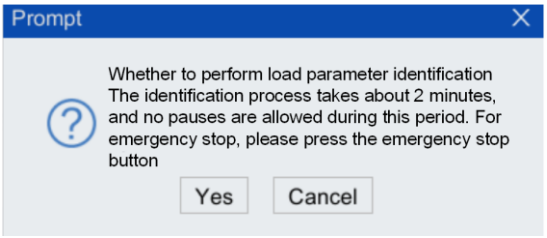


Figure 4-14 Prompt window

Step6. Click <Yes>, the robot will automatically adjust to the reference position and start load identification. The entire identification process takes about two minutes, during which no pauses are allowed. If an emergency stop is required, please press the emergency stop button on the teach pendant.

Step7. After successful identification, the interface shown in Figure 4-15 will pop up, and click <Yes>.

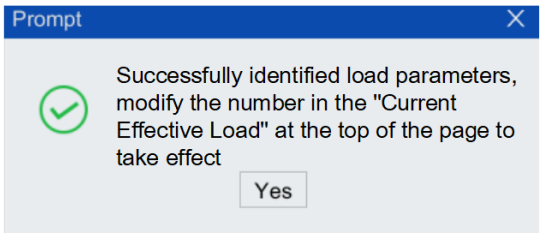


Figure 4-15 Prompt window

Step8. After identification is completed, click on the [System/Parameter Configuration/global] option on the main interface of the teach pendant, and you can view the saved identification parameters in the [Tool Inertia].

Select the current load

Select the desired payload number in the [Current effective load] (as shown in Figure 4-16) and close the interface. The selected current load parameter will be applied to the functional configuration that requires this parameter.

If there is a significant change in the load during program execution due to operations such as grabbing and placing, the current effective load can be switched through toolswitch instruction.

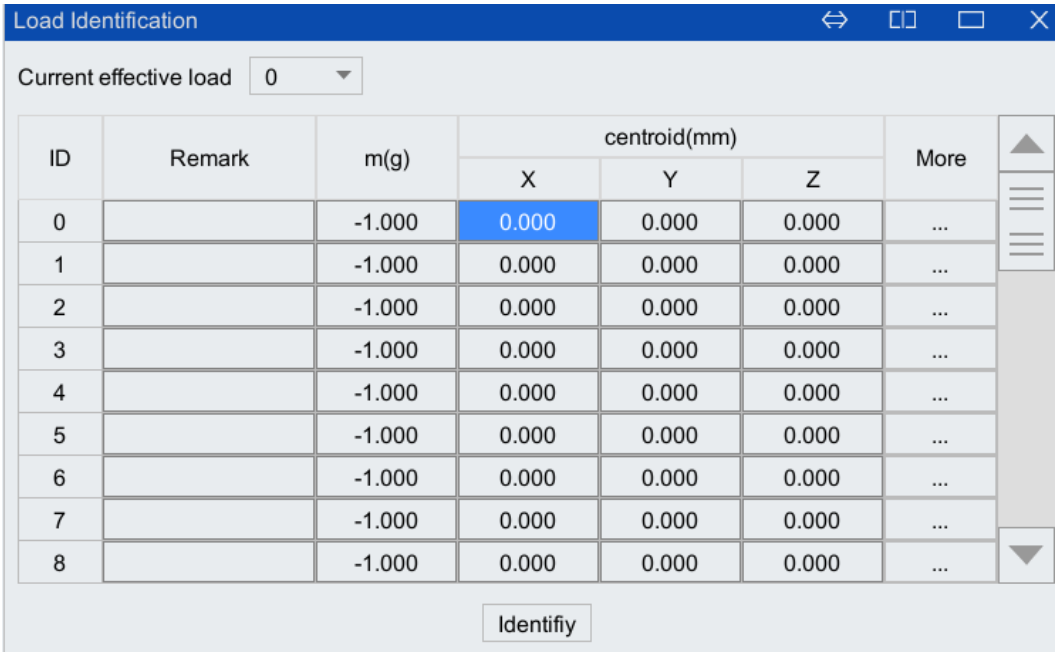


Figure 4-16 Configuration of current effective load parameters

4.4 Teaching practice

Enable button description

The left and right sides of the rear housing of the teach pendant can be equipped with enable buttons, which are installed on the right side by default at the factory, as shown in Figure 4-17.

When teaching practical operations, the enable button provides 2 key positions, and the specific operation method is as follows:

- Gently press the Ⅰ key to turn on the power.
- The power is cut off when the button is completely released.

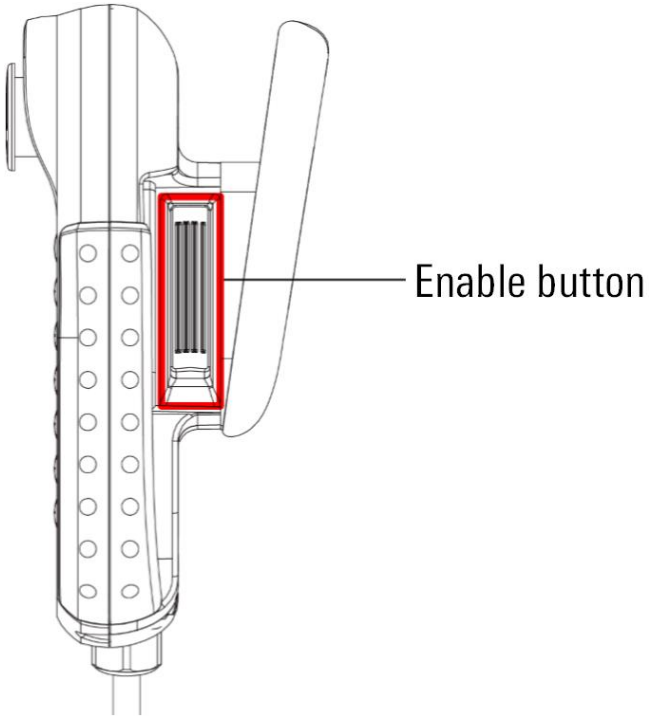


Figure 4-17 Teach pendant enable button

Dragging teaching practice

The operation steps for dragging the teaching are as follows:

Step1. In the drag teaching mode, manually drag the robot to move while pressing the <Enable> button I of the teach pendant.

Step2. After reaching the target point, release the <Enable> button

Step3. Click on [Run/Program Editor] on the main interface of the teach pendant.

Step4. In the pop-up [Program Editor] interface, click [More Editors/Open] to open the created arl program file.

Step5. Manually input or insert motion instruction, such as ptp, movej, lin, etc.

5 Safety function of drag teaching

5.1 Robot stop mode

According to GB5226.1-2008 "Mechanical and Electrical Safety - Part 1: General Technical Conditions" 9.2.2 Definition of Stop Function, and combined with the specific design of the robot, three stop modes are defined as follows:

- STOP0

  1. Case 1: CCB alarm stop0 indicate that DCB execution immediately stops without maintaining the trajectory. Afterwards, CCB delay control is enabled to cut off the power supply through thyristor, which is an uncontrollable stop.
  2. Case2: If an uncontrollable fault occurs in the DCB, triggering a free stop or holding brake stop, it belongs to an uncontrollable stop.
  3. Case3: If an external power outage suddenly occurs and DCB is unable to execute an immediate stop, triggering a bandbrake stop, it is considered an uncontrollable stop.

- STOP1

  Quickly stop the robot, maintain the current planned path, and when the robot stops, control the drive serve_ off, and cutting off the power supply through thyristor, belongs to controllable stop.

- STOP2

  Make the robot stop quickly and maintain the current planned path. When the robot stops, do not save_ off, without cutting off the power supply, is a controllable stop.

For details on the triggering conditions of the robot's stop mode, please refer to the "AIR Series Industrial Robot System Fault and Handling Manual".

5.2 Axis space safety function

5.2.1 Axis position related safety functions

Soft limit parameter setting

In the drag teaching mode, the positions of each axis during the robot operation should be within the soft limit (refer to Figure 5-1 below).

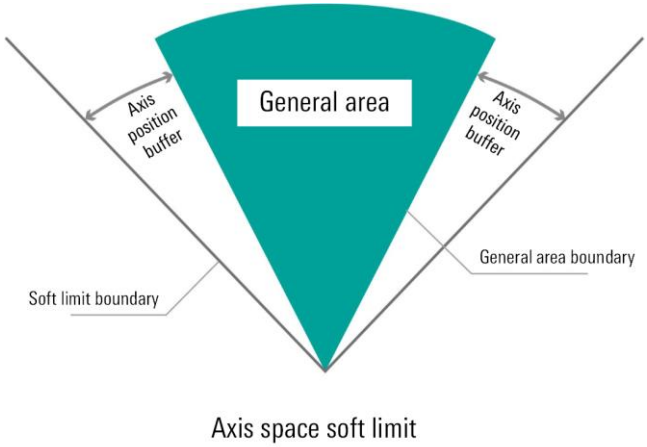


Figure 5-1 Diagram of 1-axis spatial soft limit

Tip	When a certain axis position exceeds the soft limit, an alarm will be issued and stop0 will be executed; The system will automatically switch from drag mode to manual low speed mode, and the user must use JOG mode to move the axis back within the soft limit.

The specific steps for setting the soft limit parameter values are as follows:

Step1. Log in to the teach pendant and you will see the main interface of the teach pendant as shown in Figure 5-2.

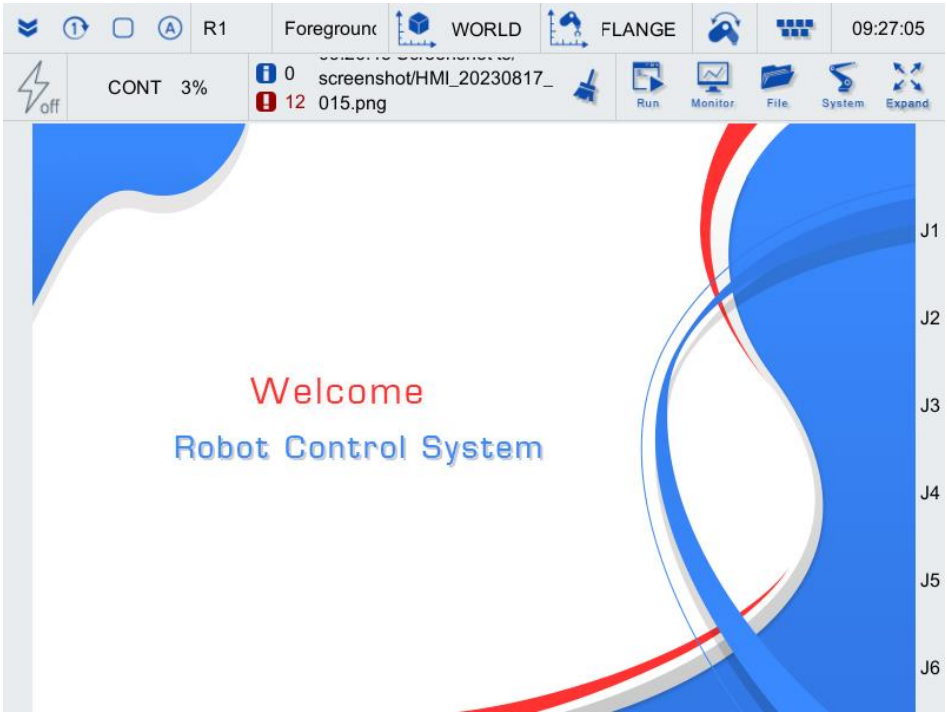


Figure 5-2 Teach pendant main interface

Step2. Click on [System/Parameter Configuration] in the upper right corner menu area, as shown in Figure 5-3.

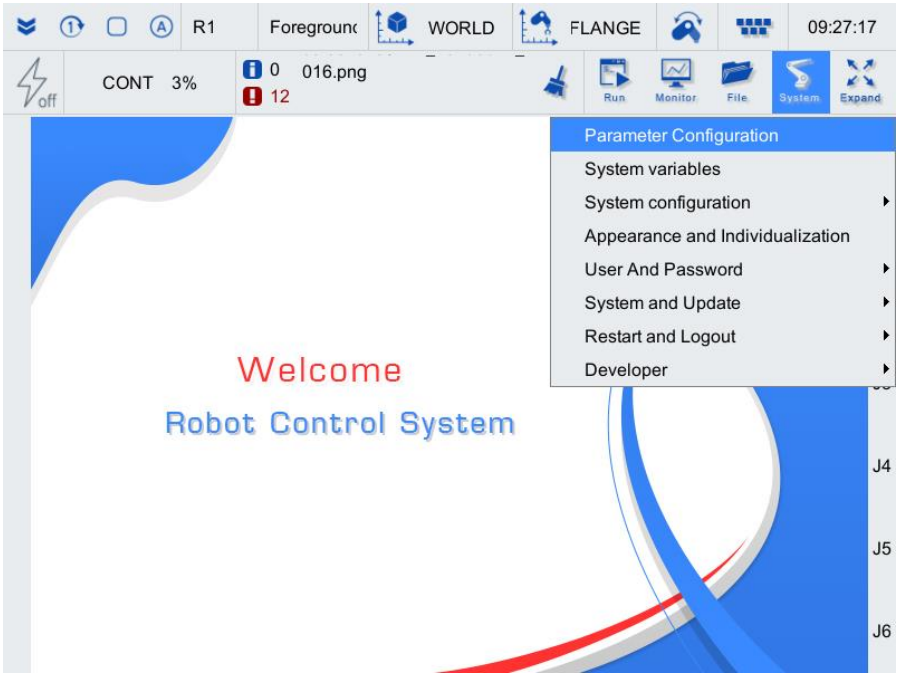


Figure 5-3 System related dropdown list

Step3. Enter the parameter configuration interface and select the [robot] tab. The value of the soft limit is limited by two parameters: [HG_JNT_POS_MAX] and [HG_JNTPOS_MIN].

Step4. Click to select the sub item of the [HG_JNT_POS_MAX] parameter that needs to be configured, and click <Edit>.

Step5. In the pop-up [Parameter Editing] interface (as shown in Figure 5-4), configure the parameters for [Value]. Parameter description is shown in Table 5-1.

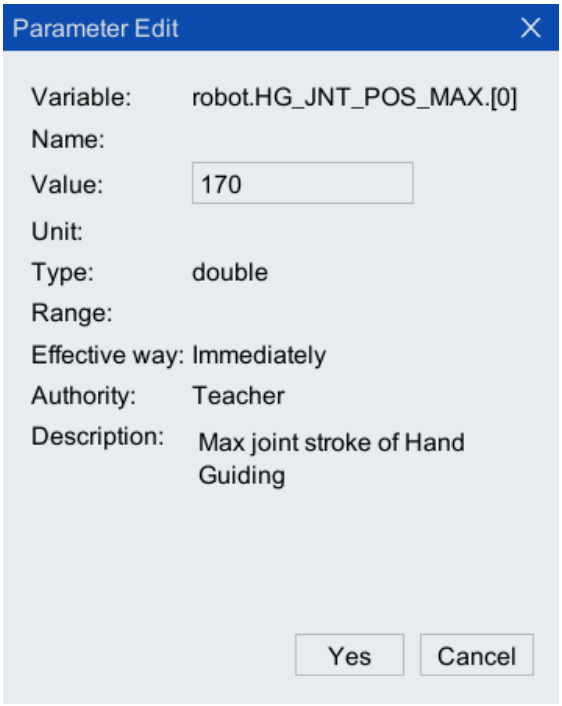


Figure 5-4 Soft limit parameter configuration

Table 5-1 Parameter description

Parameter	Meaning
Value	Drag to teach the maximum range of each axis.

Step6. After completing the parameter configuration, click <Yes>.

Step7. Click to select the sub item of the [HG_JNTPOS_MIN] parameter that needs to be configured, and click <Edit>.

Step8. In the pop-up [Parameter Editi] interface (as shown in Figure 5-5), configure the parameters for [Value]. Parameter description is shown in Table 5-2.

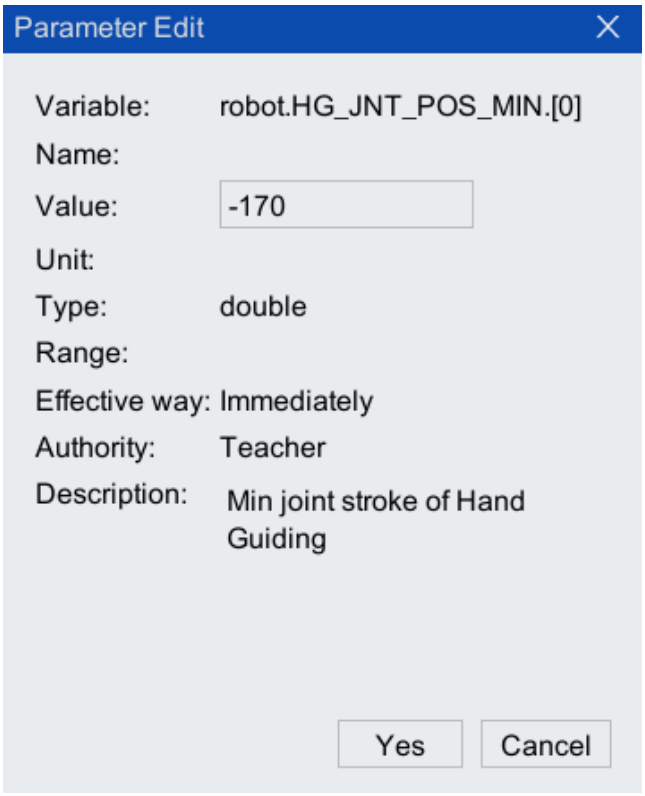


Figure 5-5 Soft limit parameter setting interface

Table 5-2 Parameter description

Parameter	Meaning
Value	Drag to teach the minimum range of each axis.

Step9. After completing the parameter configuration, click <Yes>.

Axis maximum additional resistance moment parameter setting

In drag teaching mode, when a certain axis position enters the critical soft limit area, the robot should provide a torque that hinders the axis from moving beyond the soft limit. The magnitude of this torque is proportional to the proximity of the current axis position to the soft limit boundary:

- When the current position of axis is on the boundary of the regular region of axis space, the torque is 0.
- When the current axis position is on the soft limit boundary, this torque is maximum.

The maximum torque is called the maximum additional resistance torque of axis, and the specific steps for setting its parameter values are as follows:

Step1. Log in to the teach pendant and you will see the main interface of the teach pendant as shown in Figure 5-6.

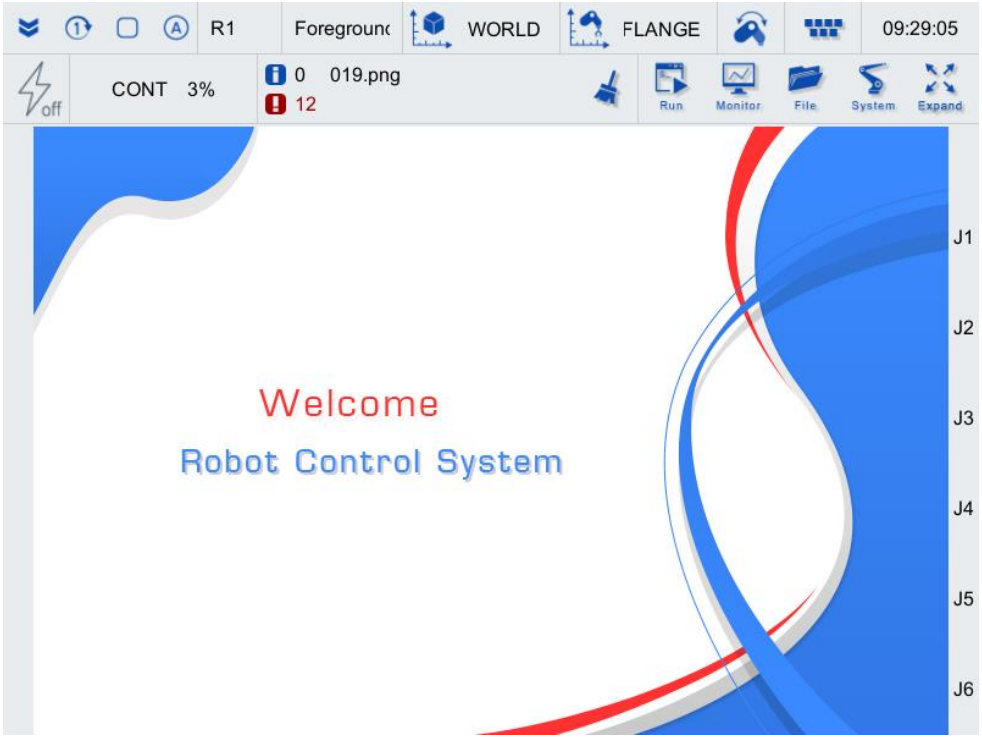


Figure 5-6 Teach pendant main interface

Step2. Click on [System/Parameter Configuration] in the upper right corner menu area, as shown in Figure 5-7.

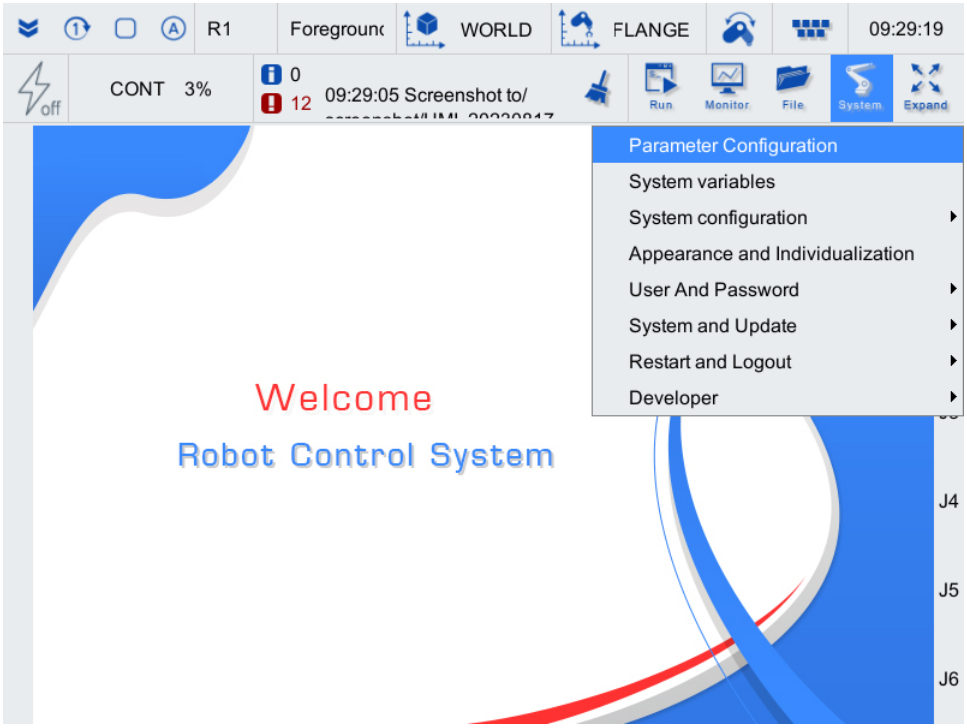


Figure 5-7 System related dropdown list

Step3. Enter the parameter configuration interface, select the [robot] tab, as shown in Figure 5-8, click and select the sub item of the [HG_JNT_RESIST] parameter that needs to be configured (6 sets of data correspond to 1-6 axes respectively), and click <Edit>.

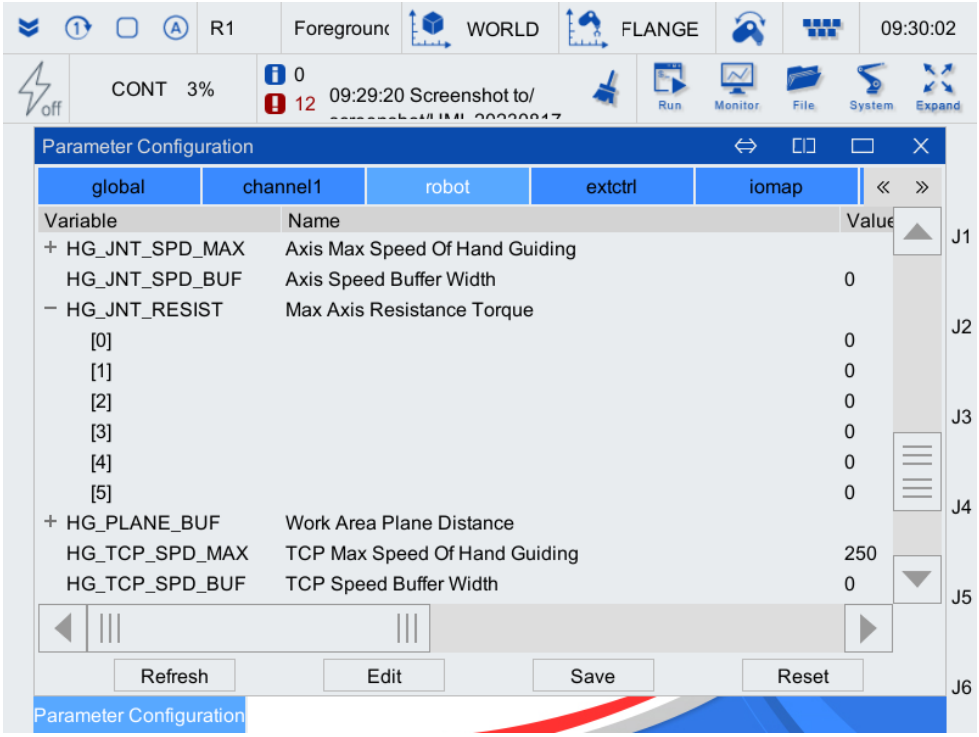


Figure 5-8 Axis maximum additional resistance moment parameter setting interface

Step4. In the pop-up [Parameter Edit] interface (as shown in Figure 5-9), configure the [Value]. Parameter description is shown in Table 5-3.

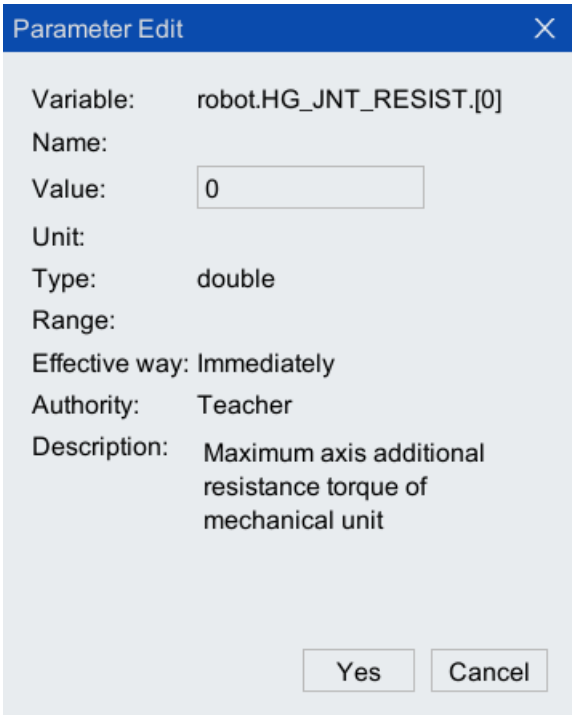


Figure 5-9 Parameter editing interface

Table 5-3 Parameter description

Parameter	Meaning
Value	The maximum additional torque of mechanical unit axis is in Nm.

Step5. After completing the parameter configuration, click <Yes>.

Axis position buffer width parameter setting

The axis position buffer zone (refer to Figure 6-1) is located between the conventional area boundary of axis space and the soft limit boundary. Its width parameter is called the axis position buffer zone width parameter, which determines the range of positions where the additional resistance moment takes effect. The specific steps for setting the parameter values are as follows:

Step1. Log in to the teach pendant and you will see the main interface of the teach pendant as shown in Figure 5-10.

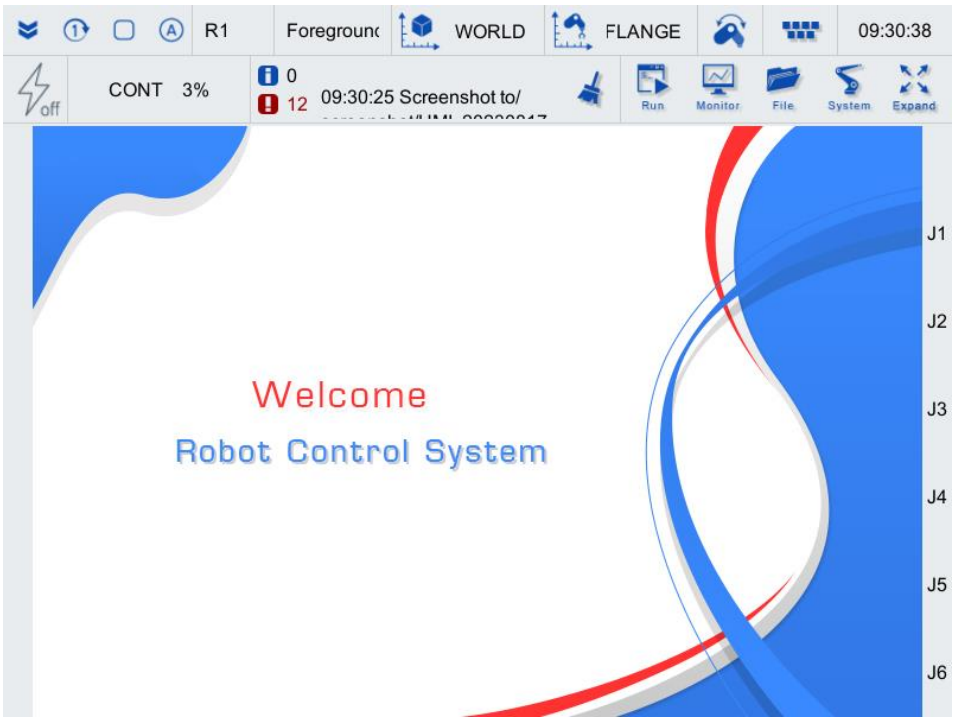


Figure 5-10 Teach pendant main interface

Step2. Click on [System/Parameter Configuration] in the upper right corner menu area, as shown in in Figure 5-11.

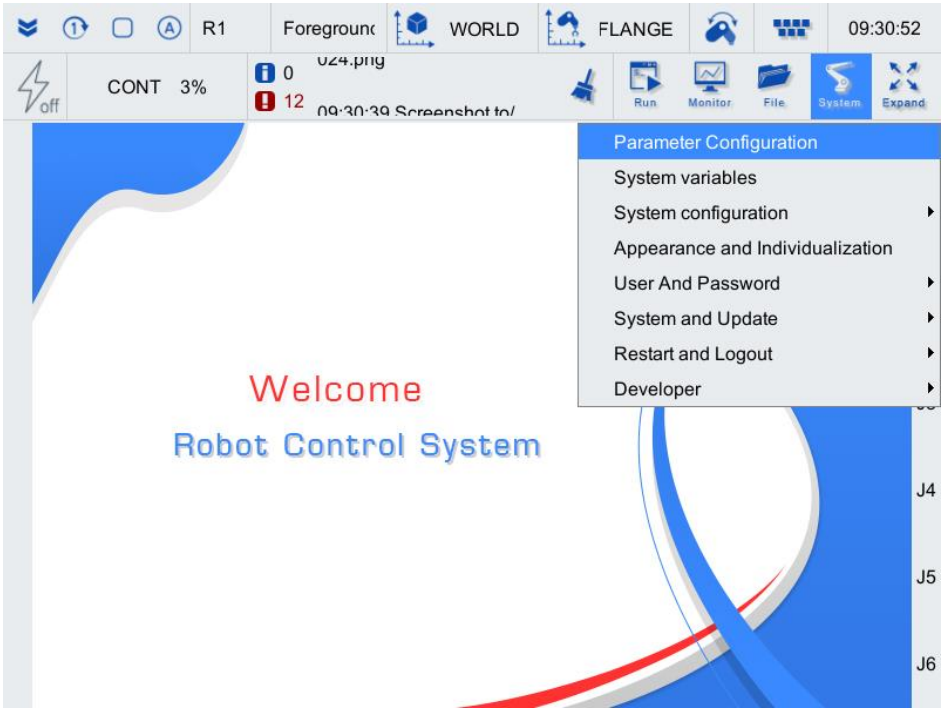


Figure 5-11 System related dropdown list

Step3. Enter the parameter configuration interface and select the [robot] tab, as shown in Figure 5-12, click to select [HG_JNT_POS_BUF] and click <Edit>.

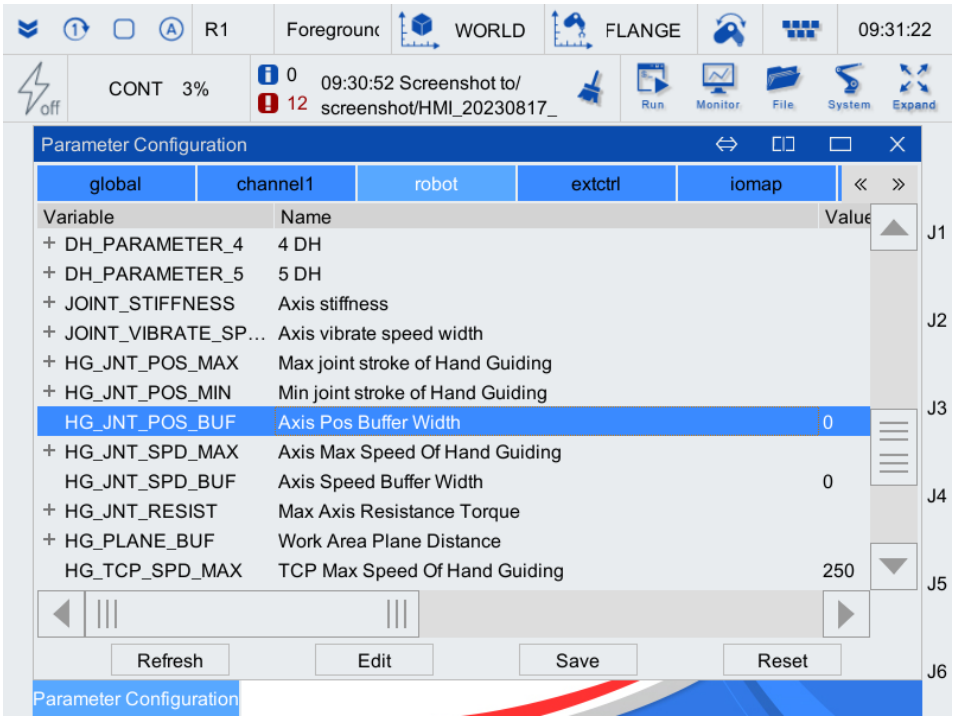


Figure 5-12 Axis position buffer width parameter setting interface

Step4. In the pop-up [Parameter Edit] interface (as shown in Figure 5-13), configure the [Value]. Parameter description is shown in Table 5-4.

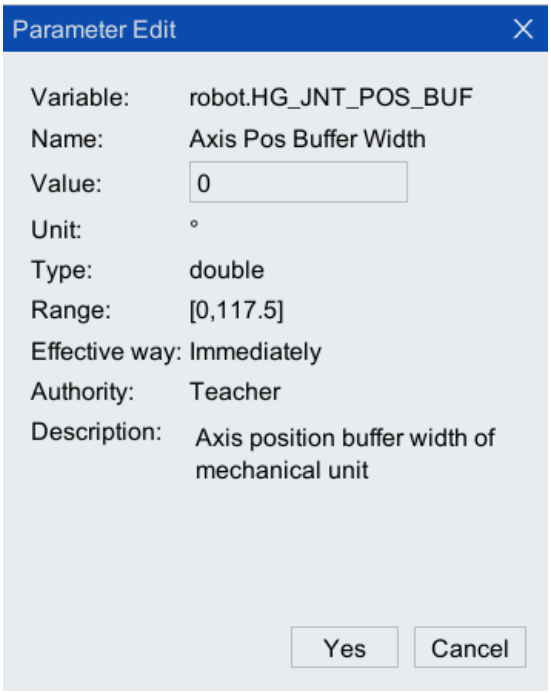


Figure 5-13 Axis position buffer width configuration interface

Table 5-4 Parameter description

Parameter	Value range	Meaning
Value	0-117.5	Mechanical unit axis position buffer width.

Step5. After completing the parameter configuration, click <Yes>.

5.2.2 Axis speed related safety functions

Maximum allowable angular velocity parameter setting for dragging

In the drag teaching mode, the user can set the maximum allowable angular velocity for dragging, and the specific setting steps are as follows:

Step1. Log in to the teach pendant and you will see the main interface of the teach pendant as shown in Figure 5-14.

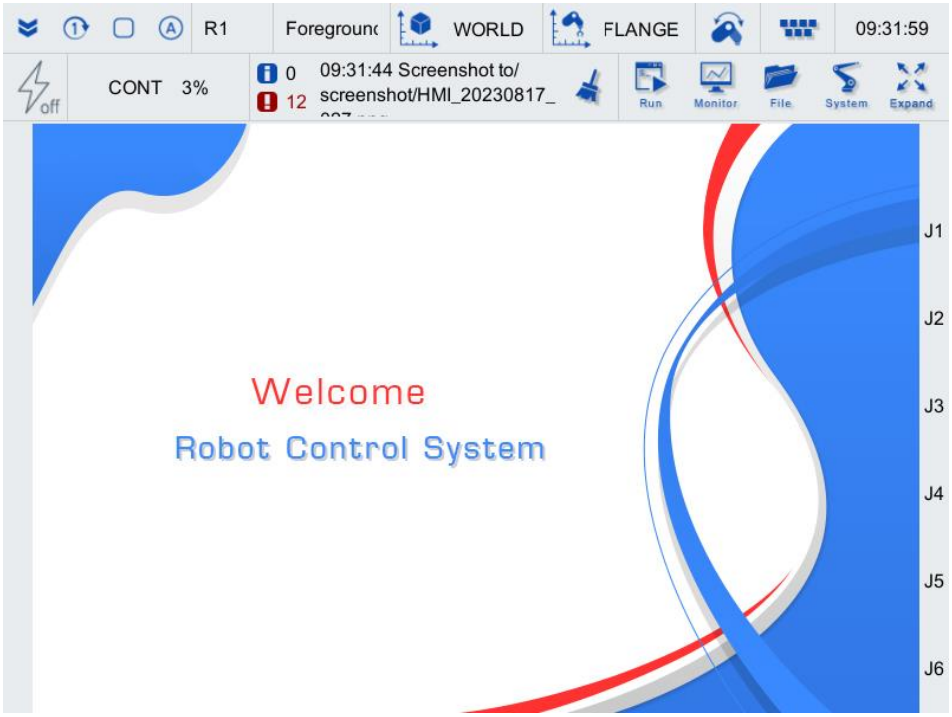


Figure 5-14 Teach pendant main interface

Step2. Click on [System/Parameter Configuration] in the upper right corner menu area, as shown in Figure 5-15.

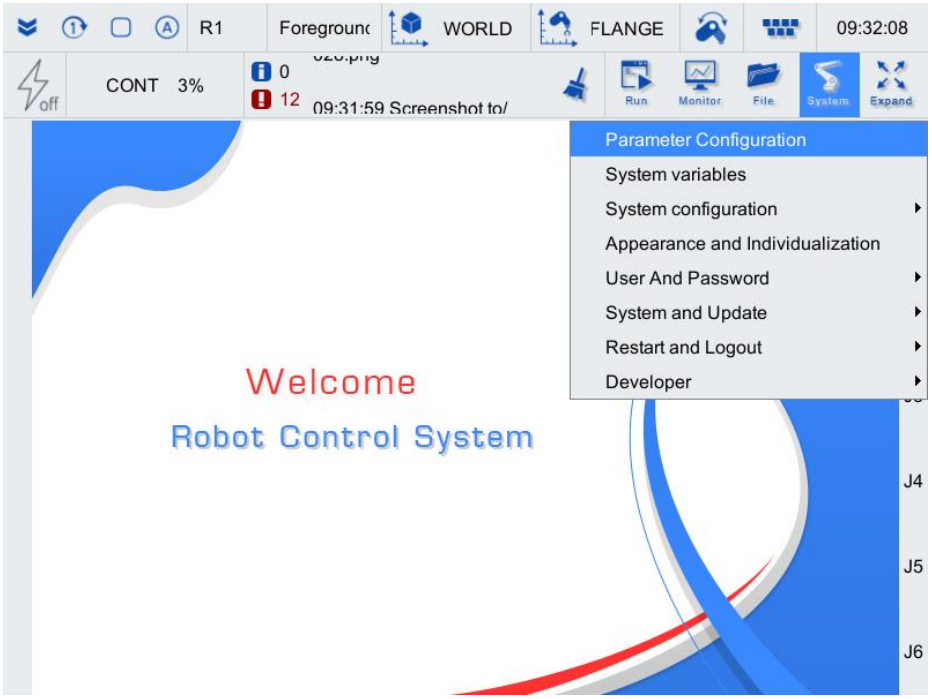


Figure 5-15 System related dropdown list

Step3. Enter the parameter configuration interface, select the [robot] tab, as shown in Figure 5-16, click and select the [HG_JNT_SPD_MAX] sub item to be configured (6 sub item data correspond to 1-6 axes respectively), and click <Edit>.

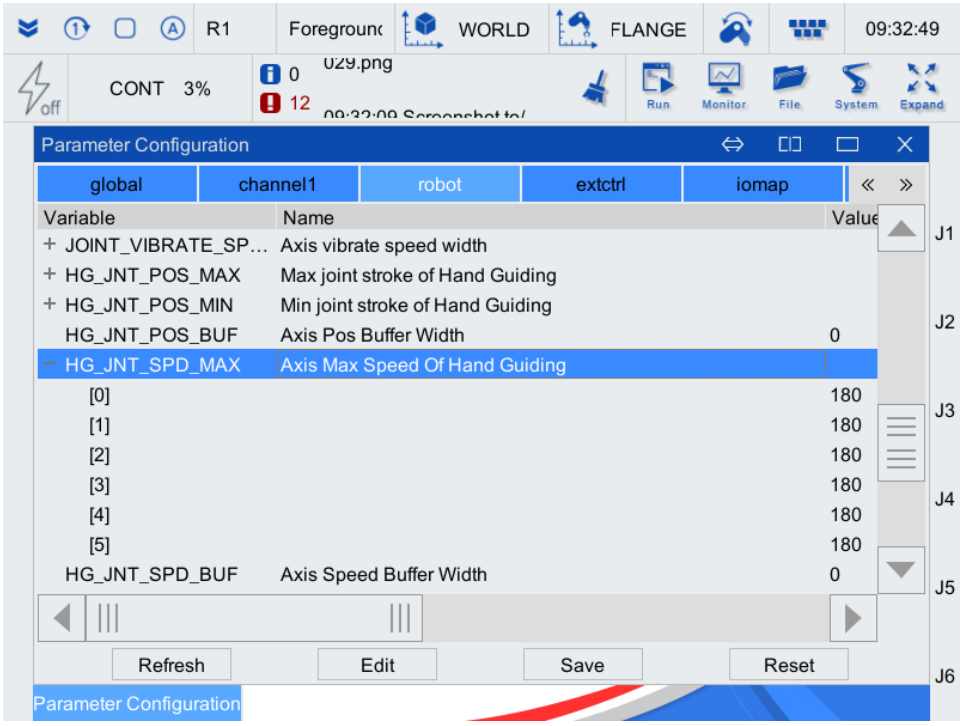


Figure 5-16 Maximum allowable angular velocity parameter setting interface for dragging

Step4. In the pop-up [Parameter Edit] interface (as shown in Figure 5-17), configure the [Value]. Parameter description is shown in Table 5-5.

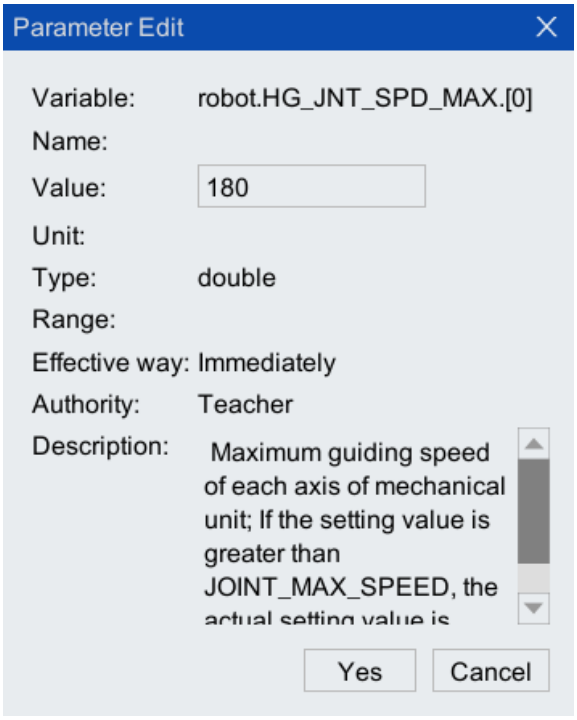


Figure 5-17 Maximum allowable angular velocity parameter setting interface for dragging

Table 5-5 Parameter description

Parameter	Value range	Meaning
Value	0-180	The maximum drag speed of each axis mechanical unit, if the set value is greater than JOINT_ MAX_ SPEED, the actual setting value is JOINT_ MAX_ SPEED.

Tip

In drag teaching mode, when the angular velocity of a certain axis exceeds the maximum allowable angular velocity for drag, an alarm will be issued and stop0 will be executed; The user must clear the alarm before pressing the enable button again to drag.

Step5. After completing the parameter configuration, click <Yes>.

Axis speed buffer width parameter setting

In drag teaching mode, when the angular velocity of a joint exceeds the maximum allowable angular velocity for dragging, the driver will provide a torque to reduce the magnitude of the joint angular velocity, hindering the operator from further increasing the magnitude of the joint angular velocity. The magnitude of this torque is linearly related to the joint angular velocity:

- When the joint angular velocity is equal to the critical joint angular velocity, the torque is 0.
- When the joint angular velocity is equal to the maximum joint angular velocity, the torque is taken as the maximum value (i.e. axis maximum additional resistance torque).

The distance between the critical angular velocity of the joint and the maximum angular velocity of the joint is the axis speed buffer zone, and its width parameter is called the axis speed buffer zone width parameter, which determines the speed range in which the additional resistance moment takes effect. The specific steps for setting the parameter values are as follows:

Step1. Log in to the teach pendant and you will see the main interface of the teach pendant as shown in Figure 5-18.

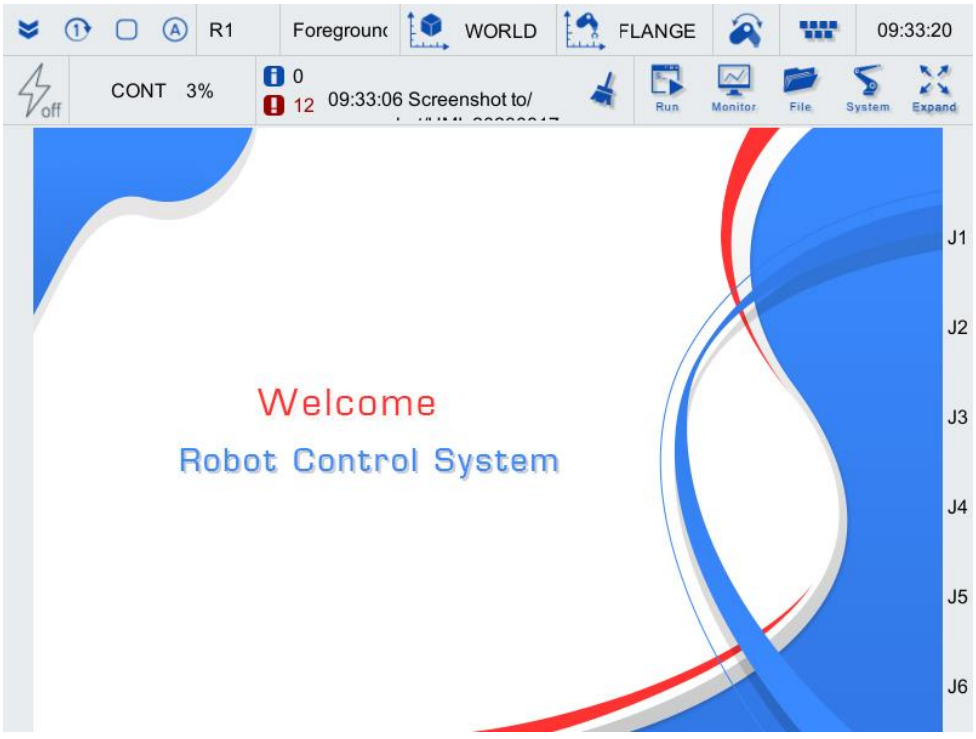


Figure 5-18 Teach pendant main interface

Step2. Click on [System/Parameter Configuration] in the upper right corner menu area, as shown in Figure 5-19.

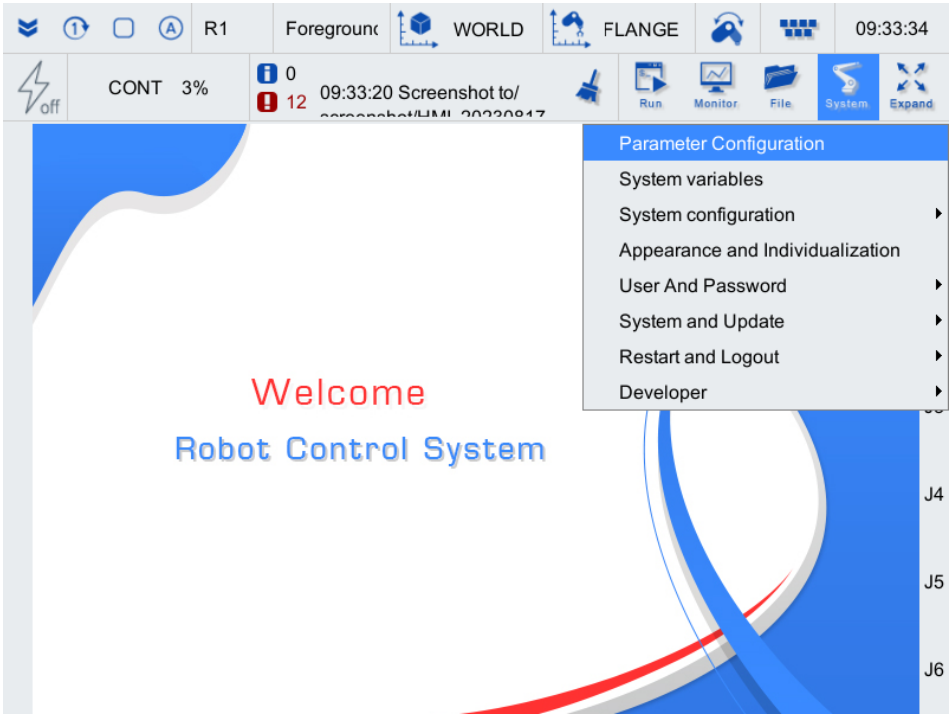


Figure 5-19 System related dropdown list

Step3. Enter the parameter configuration interface, select the [robot] tab, as shown in Figure 5-20, click and select the row where [HG_JNT_SPD_BUF] is located, and click <Edit>.

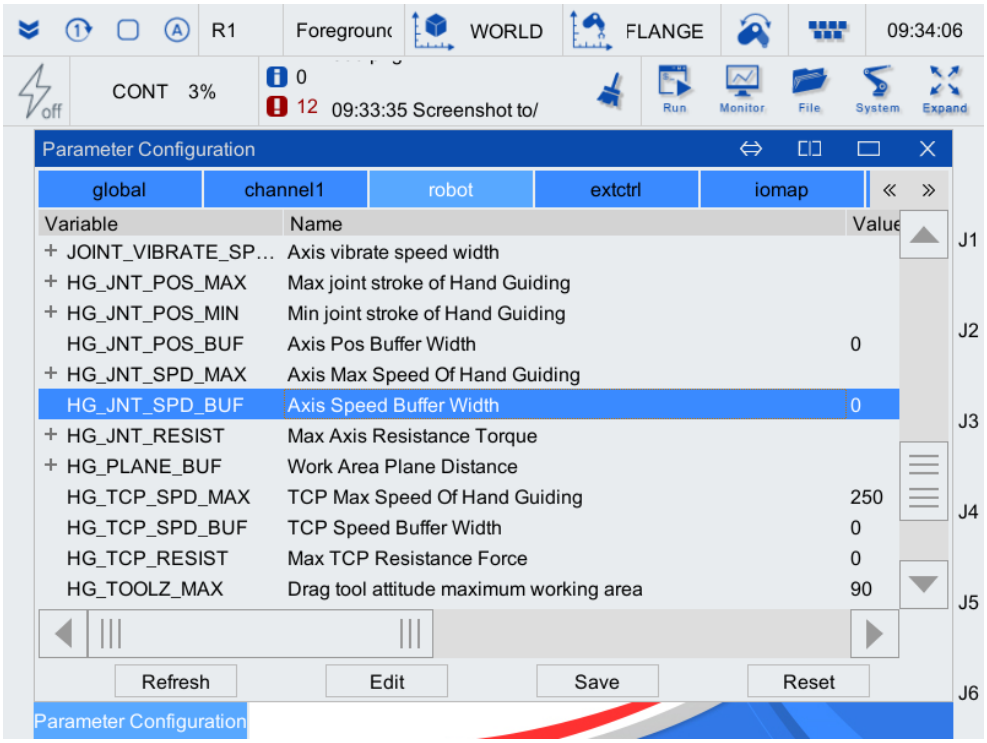


Figure 5-20 Axis speed buffer width parameter setting interface

Step4. In the pop-up [Parameter Edit] interface (as shown in Figure 5-21), configure the [Value]. The width of the axis speed buffer should usually be set to a value greater than 20 °/s. If the set additional resistance moment is not felt, the width of the axis speed buffer should be further increased. Parameter description is shown in Table 5-6.

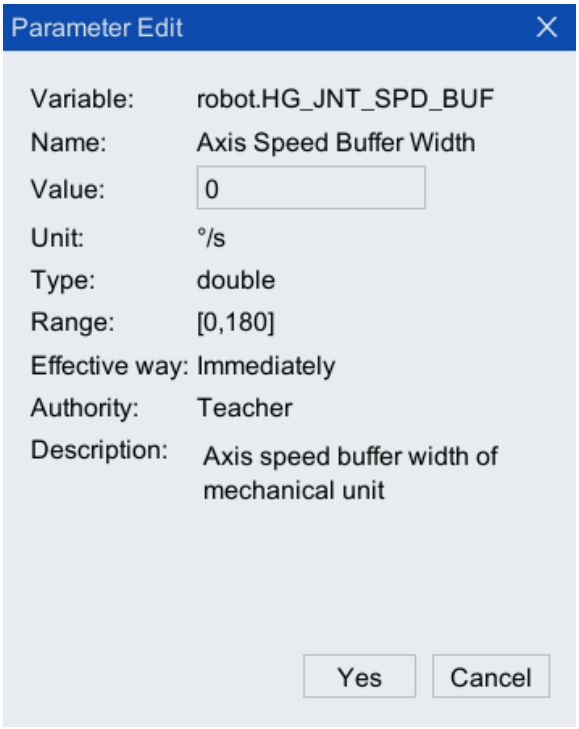


Figure 5-21 Axis speed buffer width configuration interface

Table 5-6 Parameter description

Parameter	Value range	Meaning
Value	0-180	Mechanical unit axis speed buffer width.

Step5. After completing the parameter configuration, click <Yes>.

5.3 Cartesian space security function

5.3.1 TCP location related security functions

Safety area plane calibration

The specific steps for safety zone calibration are as follows:

Step1. Log in to the teach pendant and you will see the main interface of the teach pendant as shown in Figure 5-22.

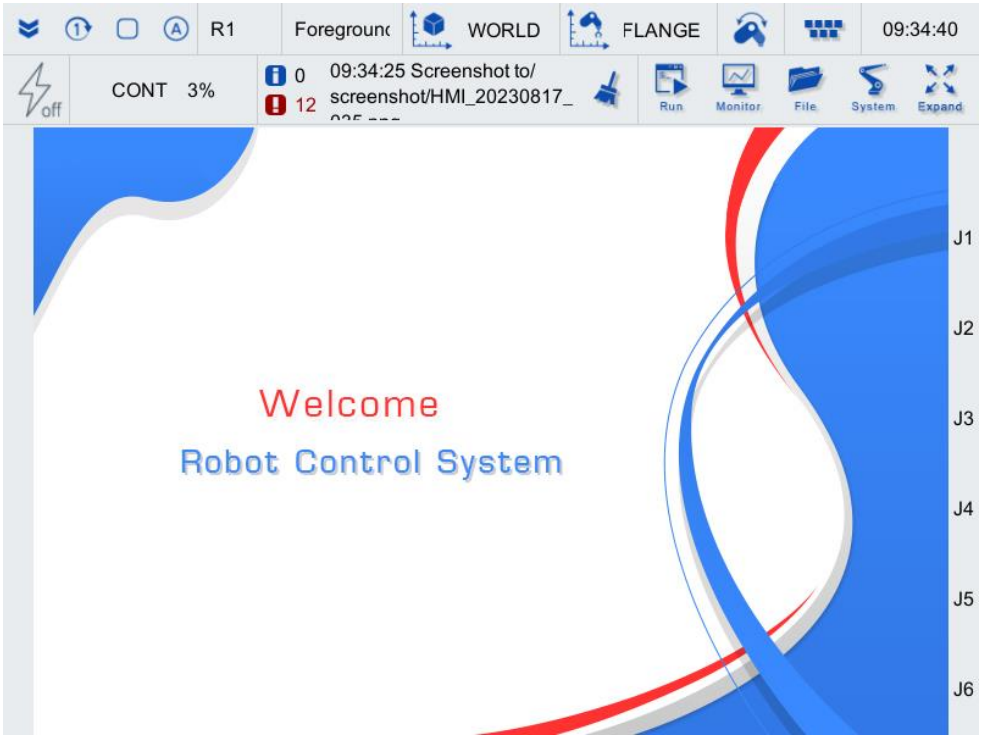


Figure 5-22 Teach pendant main interface

Step2. Click on the [Monitoring/Drag teaching settings] in the upper right corner menu area, as shown in Figure 5-23.

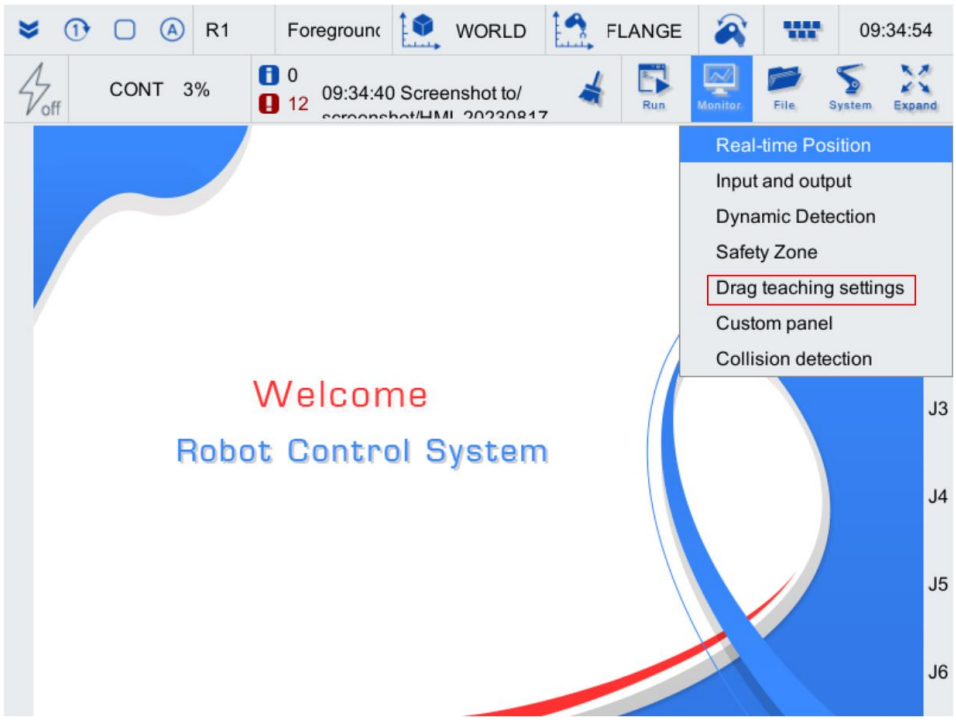


Figure 5-23 System related dropdown list

Step3. In the pop-up [Drag teaching settings] interface, configure [Type] as "Safety Zone Plane", click and select the row of the safety zone plane that needs to be calibrated, click and select [Enable], and then click <Calibrate>. As shown in Figure 5-24. Parameter description is shown in Table 5-7.

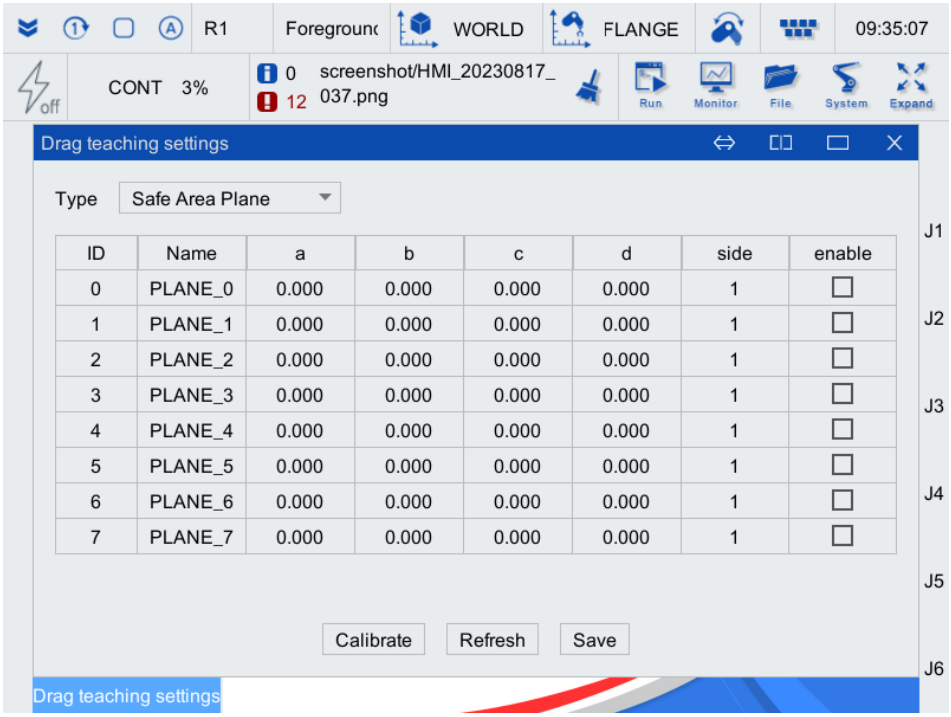


Figure 5-24 Safety zone plane parameter setting interface

Table 5-7 Safety zone plane parameters

Serial number	Parameter Name		Remarks
1	Plane solving parameters	A	Safety zone plane equation: ax+by+cz+d=0
		B	
		C	
		D	
2	Safety side	side	The "true" represents the positive direction of the plane as the working area; The "false" represents negative direction
3	Whether enabled	enable	The "true" represents the enabling safety plane; The "false" represents no

Step4. In the pop-up [Safety zone plane calibration] calibration interface (as shown in Figure 5-25), follow the prompts to calibrate the four points. By manually teaching, identify three points to determine a plane, and then teach a fourth point on one side of the plane to determine which side of the plane allows TCP point movement, thereby determining a reasonable motion space (i.e. work area). In this case, the corresponding plane parameters are also determined accordingly.

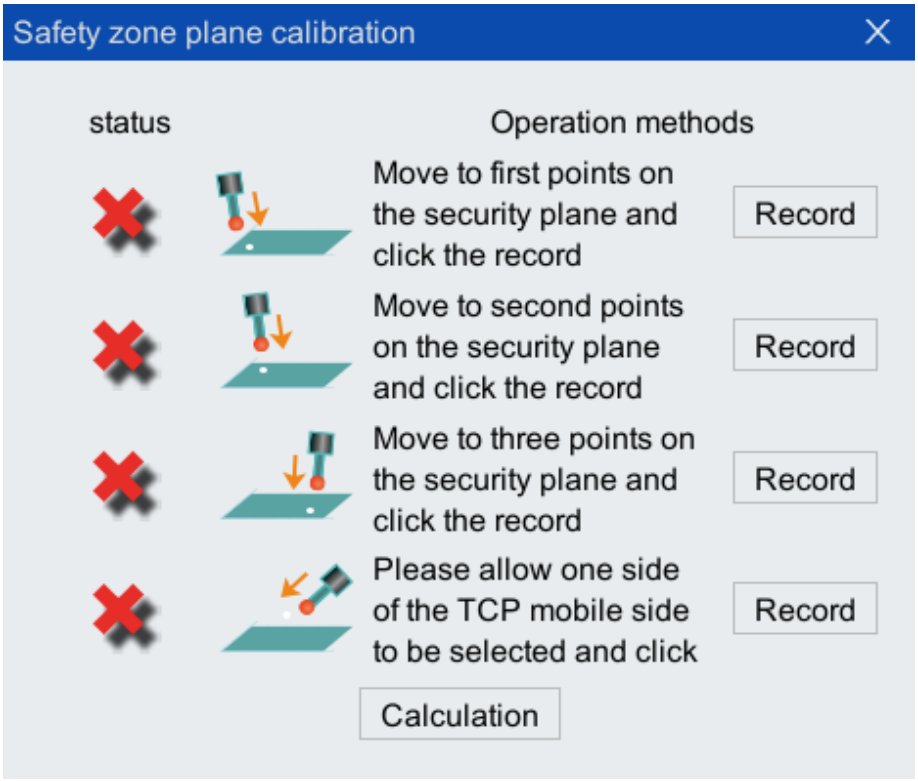


Figure 5-25 Four point calibration interface

Step5. When all 4 × become √, click <Calculate> to complete the calibration. As shown in Figure 5-26.

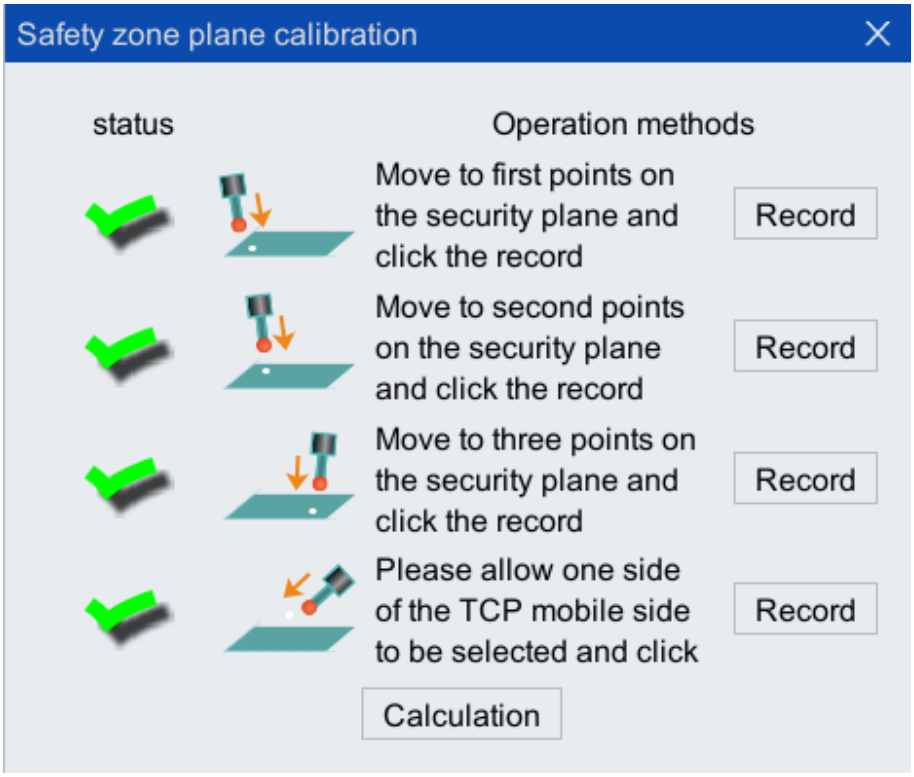


Figure 5-26 Four point calibration successful interface

Step6. Click <Safe> in the [Safety zone plane calibration] interface to save the configuration.

TCP maximum additional resistance parameter setting

In drag teaching mode, when the TCP point position enters the critical area, the robot should provide a force that hinders the TCP point from moving outside the working area. The magnitude of this force is proportional to the proximity of the TCP point to the boundary of the working area:

- When the TCP point is on the boundary of a regular area, the resistance is 0.
- When the TCP point is on the boundary of the work area, this resistance is the highest.

The maximum resistance is the maximum additional resistance of TCP (parameter values can be set by the user), and the specific steps for setting the parameter values are as follows:

Step1. Log in to the teach pendant and you will see the main interface of the teach pendant as shown in Figure 5-27.

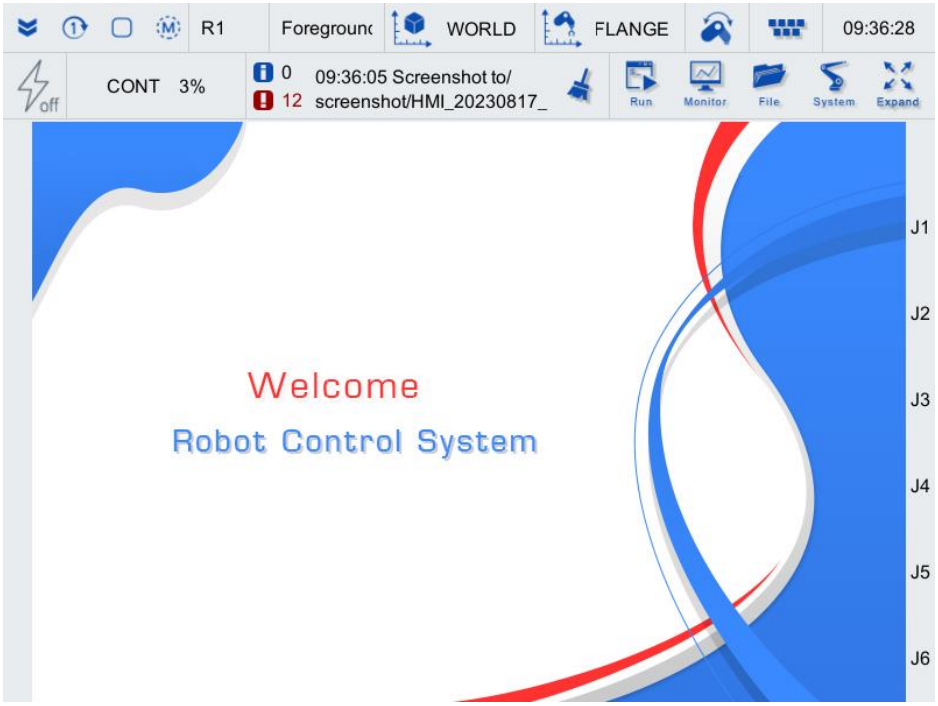


Figure 5-27 Teach pendant main interface

Step2. Click on [System/Parameter Configuration] in the upper right corner menu area, as shown in Figure 5-28.

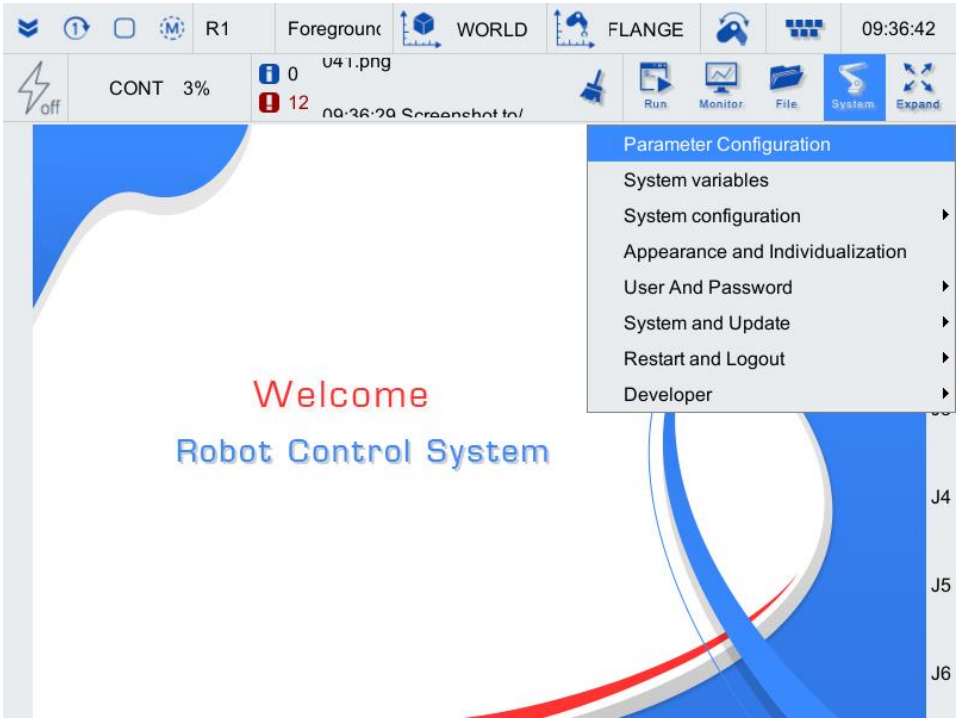


Figure 5-28 System related dropdown list

Step3. Enter the parameter configuration interface and select the [robot] tab, as shown in Figure 5-29, click and select the row where [HG_TCP_RESIST] is located, and click <Edit>.

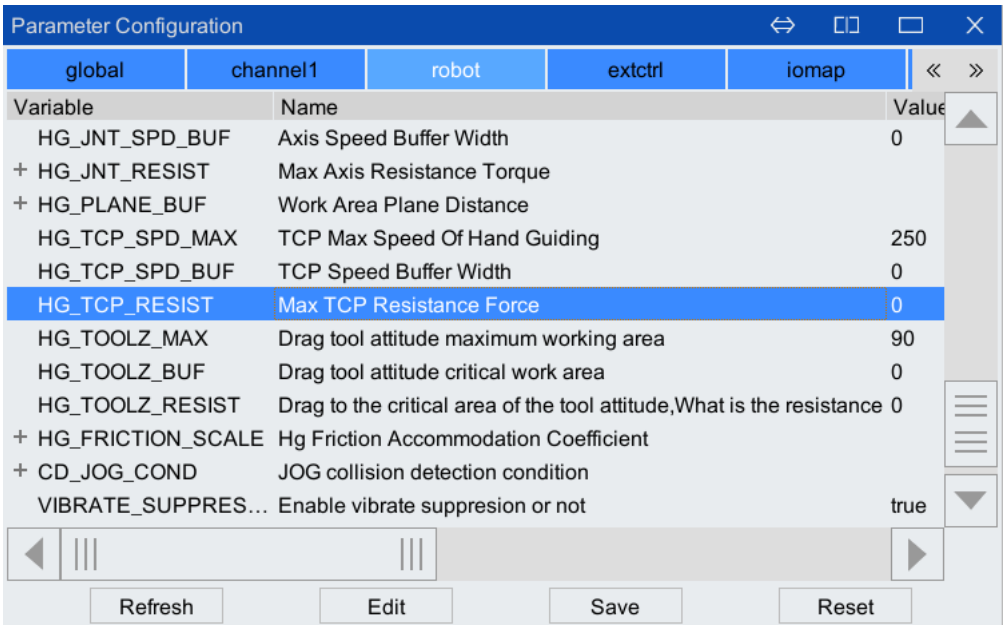


Figure 5-29 Parameter configuration interface

Step4. In the pop-up [Parameter Edit] configuration interface (as shown in Figure 5-30), configure the [Value]. Parameter description is shown in Table 5-8.

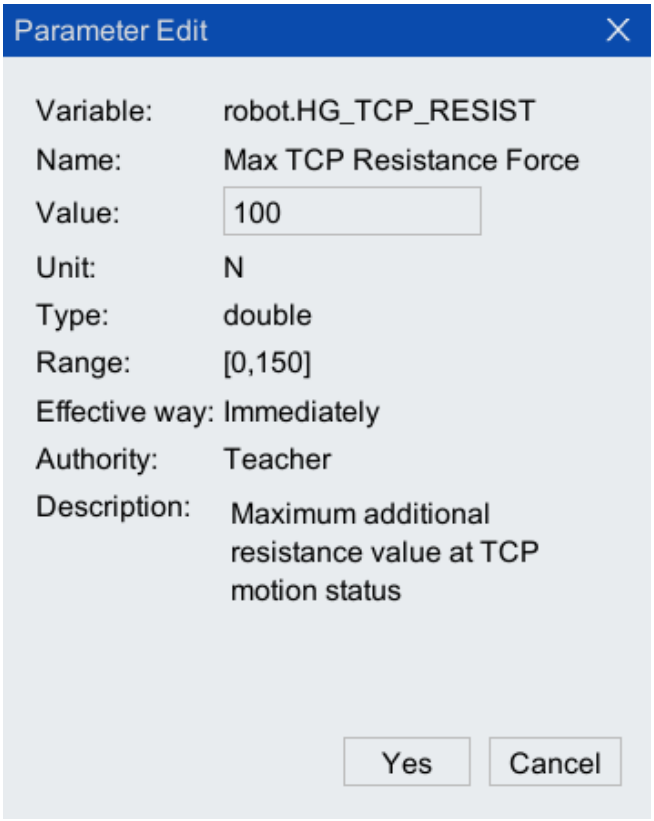


Figure 5-30 TCP Maximum additional resistance value configuration interface

Table 5-8 Parameter description

Parameter	Value range	Meaning
Value	0-150	Maximum additional resistance value for TCP motion state limit

Step5. After completing the parameter configuration, click <Yes>.

Tool direction vector calibration

The specific steps for setting the tool direction vector parameters are as follows:

Step1. Log in to the teach pendant and you will see the main interface of the teach pendant as shown in Figure 5-31.

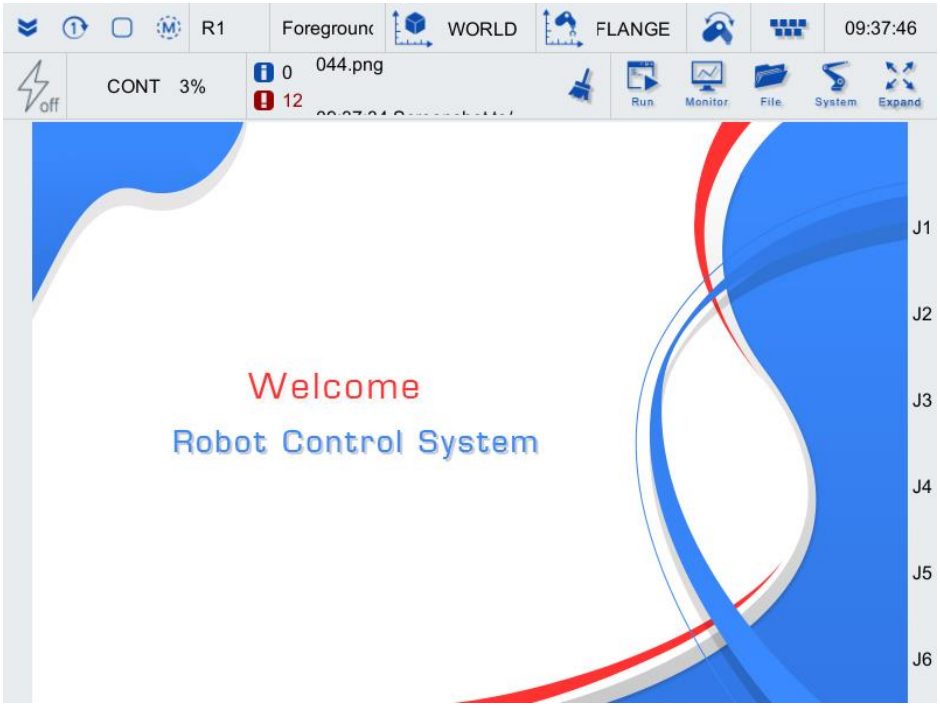


Figure 5-31 Teach pendant main interface

Step2. Click on the [Monitoring/Drag teaching settings] in the upper right corner menu area, as shown in Figure 5-32.

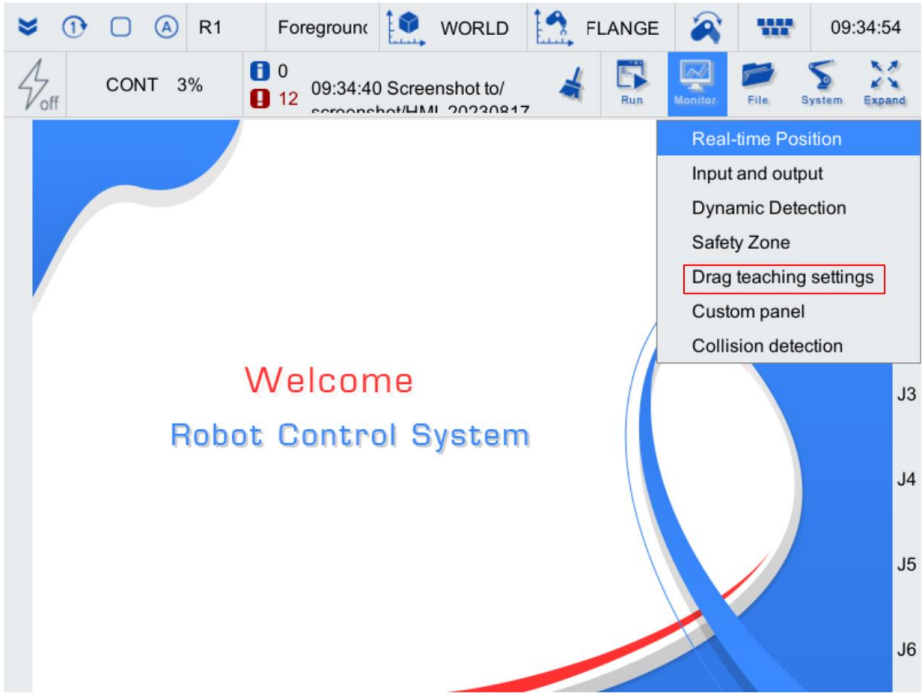


Figure 5-32 System related dropdown list

Step3. In the pop-up [Drag teaching settings] interface (as shown in Figure 5-33), configure [Type] to "Tool Vector Direction", click to select the row of the tool to be calibrated, and click <Calibrate>.

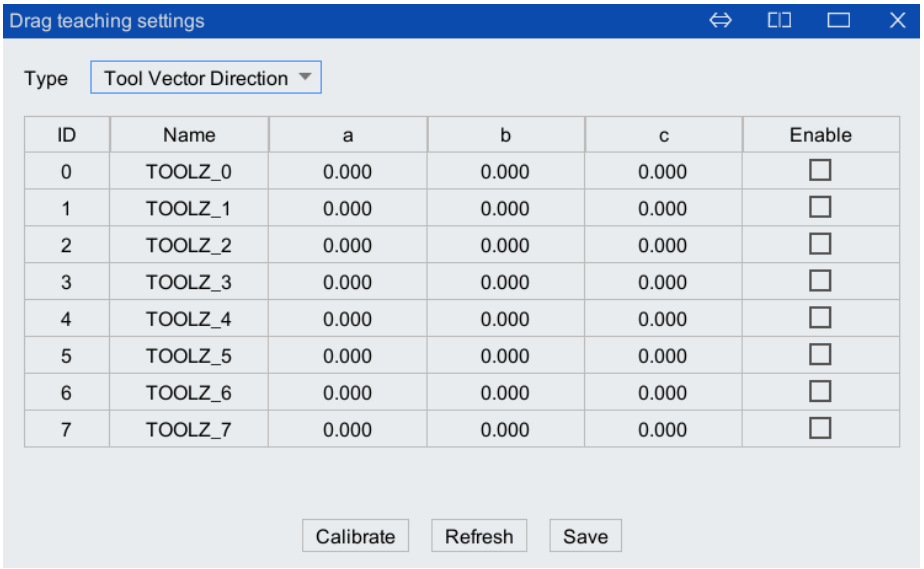


Figure 5-33 Safety zone plane parameter setting interface

Step4. In the pop-up [Tool vector direction calibration] interface (as shown in Figure 5-34), follow the prompted operation method for calibration and click <Setting>.

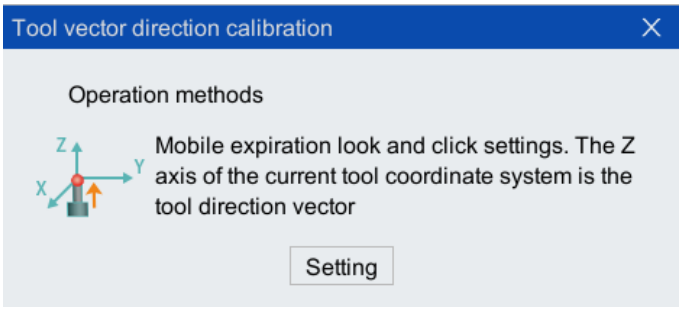


Figure 5-34 Tool direction vector setting interface

Step5. After the calibration is completed, click "  " to complete the calibration.

Drag to teach safe working area buffer parameter settings

The TCP position buffer is located between the regular area boundary and the working area boundary, and its width parameter is called the TCP position buffer width parameter, which determines the range of positions where additional resistance takes effect.

Step1. Log in to the teach pendant and you will see the main interface of the teach pendant as shown in Figure 5-35.

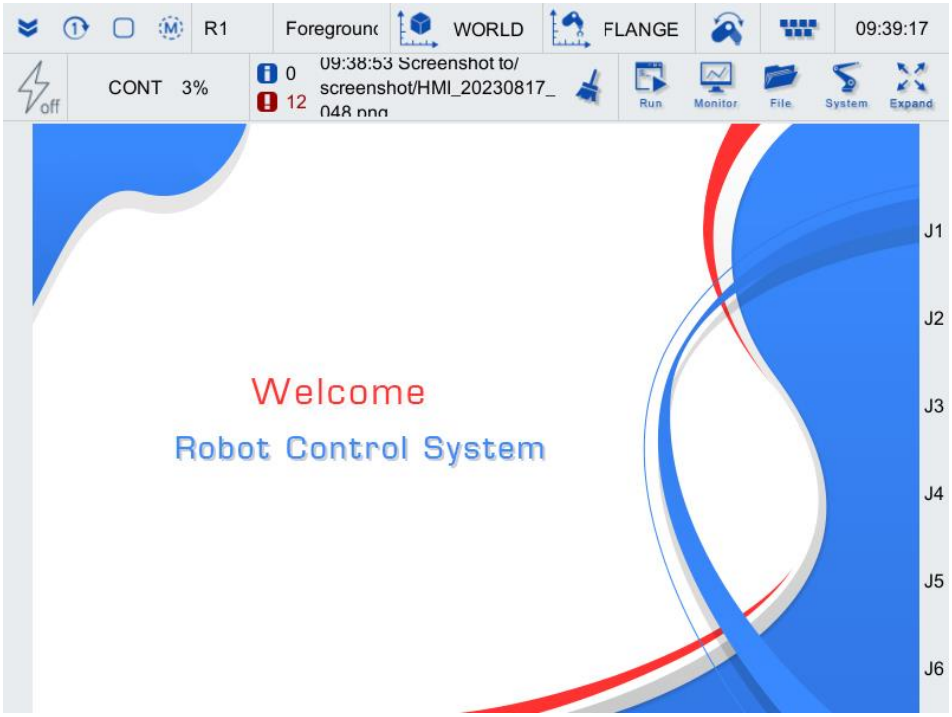


Figure 5-35 Teaching pendant main interface

Step2. Click on [System/Parameter Configuration] in the upper right corner menu area, as shown in Figure 5-36.

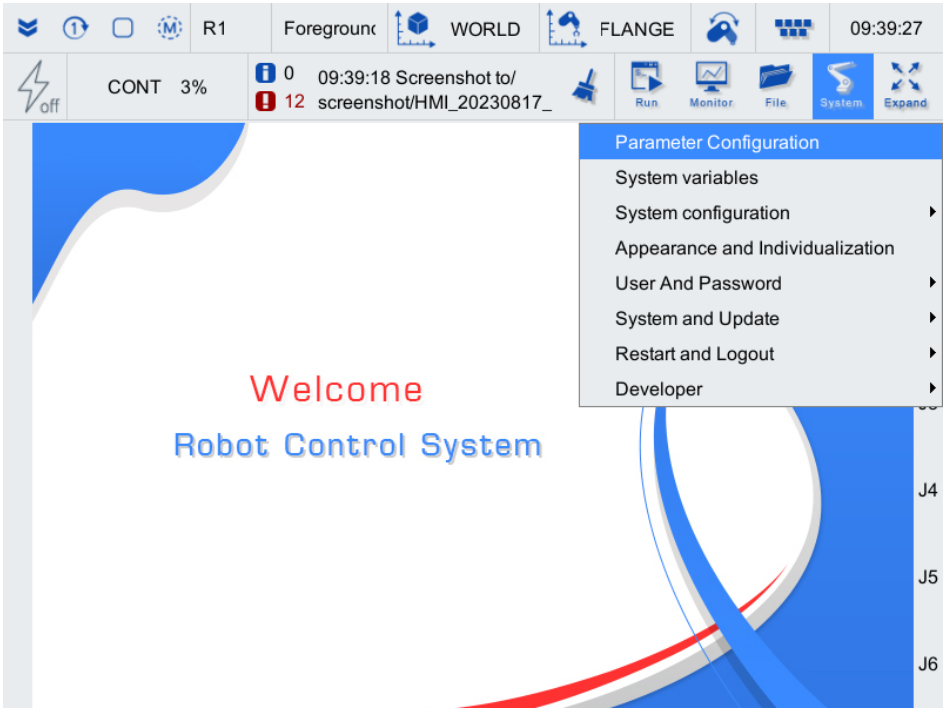


Figure 5-36 System related dropdown list

Step3. Enter the parameter configuration interface, select the [robot] tab, click the [+] in front of the [HG_PLANE_BUF] parameter, and click to select the sub items that need to be configured, as shown in Figure 5-37.

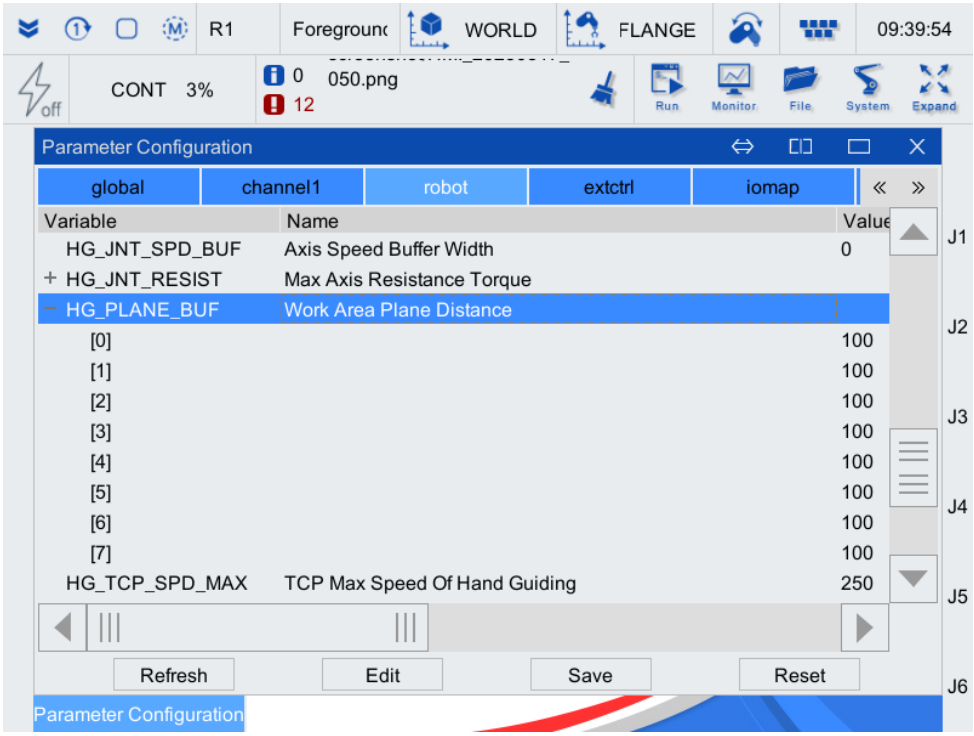


Figure 5-37 Drag teach safe work buffer area option interface

Step4. Click <Edit> and configure the [Value] in the pop-up [Parameter Edit] interface (as shown in Figure 5-38). Parameter description is shown in Table 5-9.

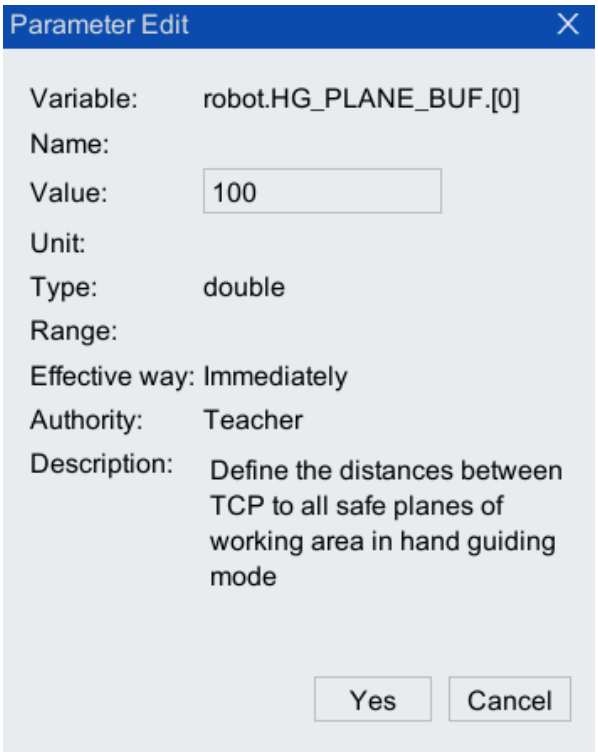


Figure 5-38 Drag teaching safety work buffer area width parameter configuration

Table 5-9 Parameter description

Parameter	Meaning
Value	Drag to teach the width of the safety work buffer area

Step5. After the configuration is completed, click<Yes>.

5.3.2 TCP speed related security features

Setting the TCP maximum speed parameter allowed by dragging

In drag teach mode, the user can set the maximum TCP speed allowed for drag, and the specific setting steps are as follows:

Step1. Log in to the teach pendant and you will see the main interface of the teach pendant as shown in Figure 5-39.

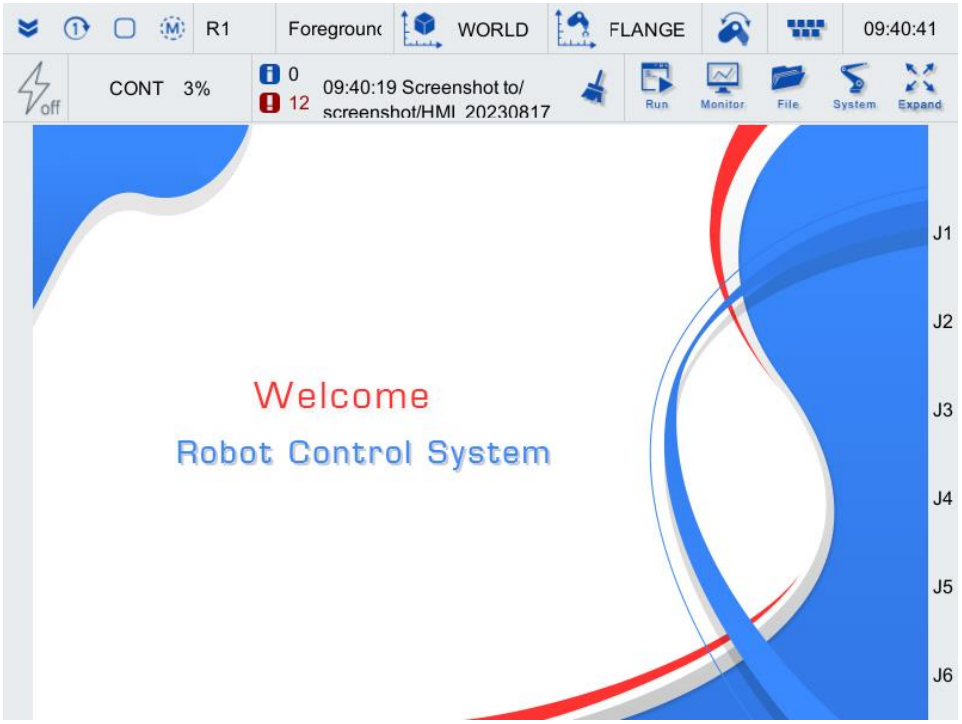


Figure 5-39 Teach pendant main interface

Step2. Click on [System/Parameter Configuration] in the upper right corner menu area, as shown in Figure 5-40.

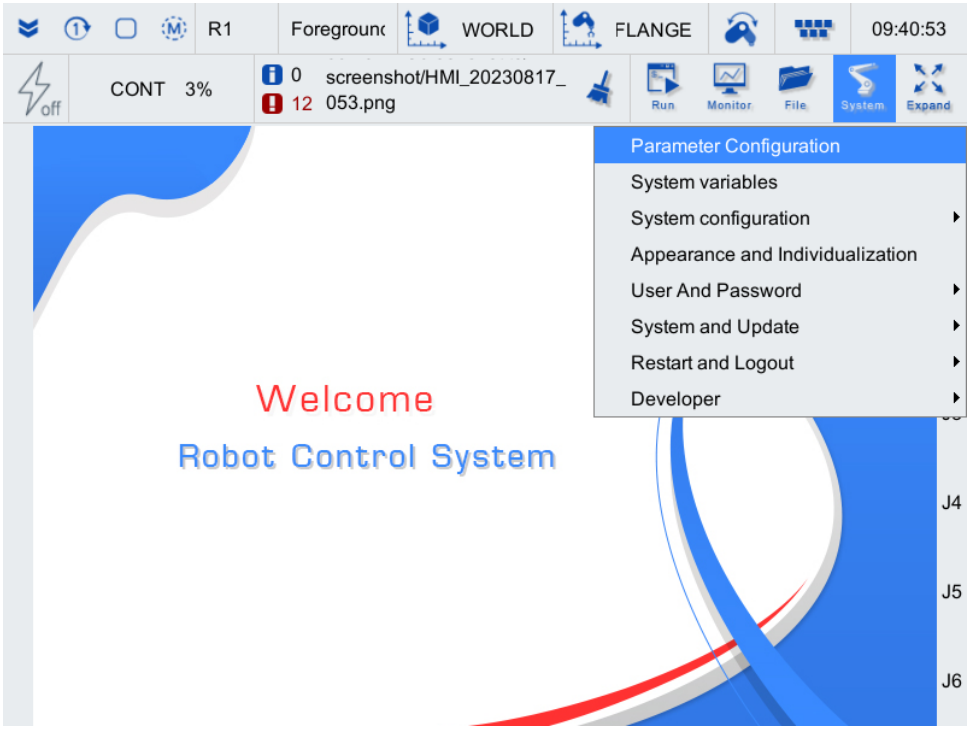


Figure 5-40 System related dropdown list

Step3. Enter the parameter configuration interface, select the [robot] tab, as shown in Figure 5-41, click to select the [HG_TCP_SPD_MAX] parameter in the row, and click<Edit>.

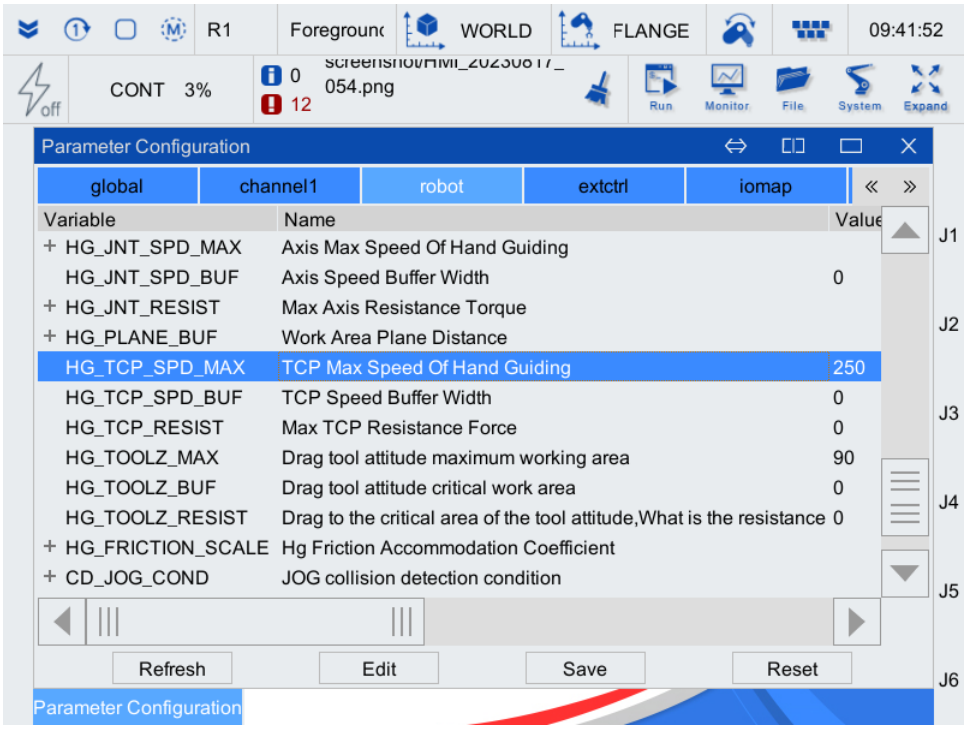


Figure 5-41 Parameter configuration interface

Step4. In the pop-up [Parameter Edit] interface (as shown in Figure 5-42), configure the [Value]. Parameter description is shown in Table 5-10.

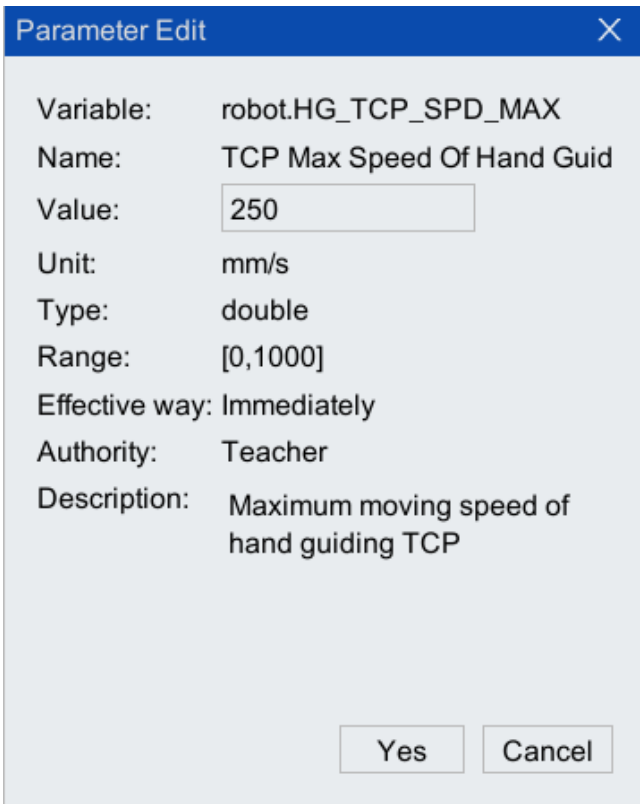


Figure 5-42 Drag allowed TCP maximum speed parameter setting interface

Table 5-10 Parameter description

Parameter	Value range	Meaning
Value	0-1000	Drag to teach the maximum movement speed of TCP, in mm/s.

Step5. After the configuration is completed, click<Yes>.

Tip

When the TCP point speed exceeds the maximum TCP point speed allowed by dragging, an alarm will be issued and stop0 will be executed; The user must clear the alarm before pressing the enable button again to drag.

TCP speed buffer width parameter setting

In drag teach mode, when the TCP point speed is greater than the critical speed, the driver should provide a force to reduce the TCP point speed, preventing the operator from further increasing the TCP point speed. The magnitude of this force is linearly related to the TCP point velocity:

- When the TCP point speed is equal to the critical speed, the resistance is 0.
- When the TCP point speed is equal to the maximum allowed TCP point speed for dragging, the resistance is the maximum (i.e. the maximum additional resistance for TCP, and the parameter setting method is detailed in Chapter 5.3.1).

The distance between the critical speed of the TCP point and the maximum speed of the TCP point is the TCP speed buffer, and its width parameter is called the TCP speed buffer width parameter, which determines the speed range in which additional resistance takes effect. The specific steps for setting the parameter values are as follows:

Step1. Log in to the teach pendant and you will see the main interface of the teach pendant as shown in Figure 5-43.

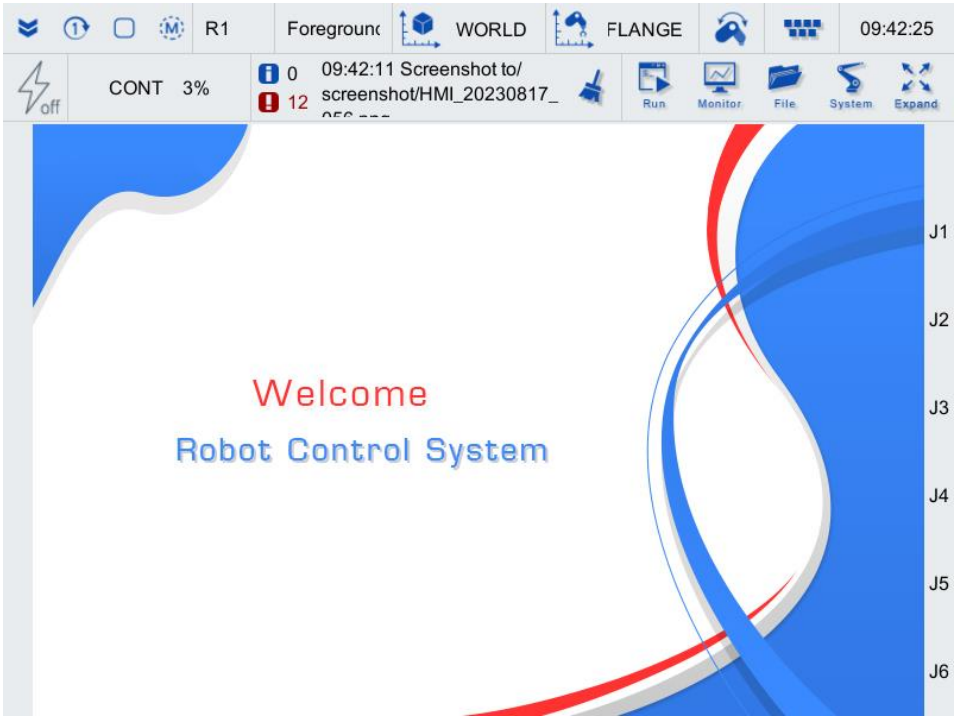


Figure 5-43 Teach pendant main interface

Step2. Click on [System/Parameter Configuration] in the upper right corner menu area, as shown in Figure 5-44.

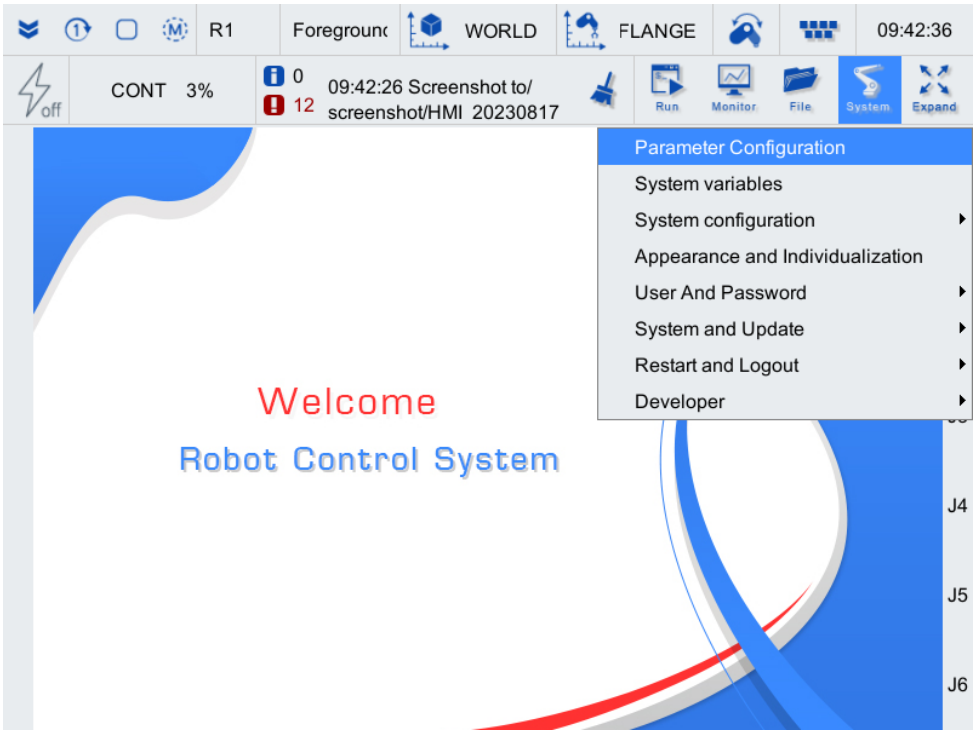


Figure 5-44 System related dropdown list

Step3. Enter the parameter configuration interface, select the [robot] tab, as shown in Figure 5-45, click and select the row where the [HG_TCP_SPD_BUFF] parameter is located, and click <Edit>.

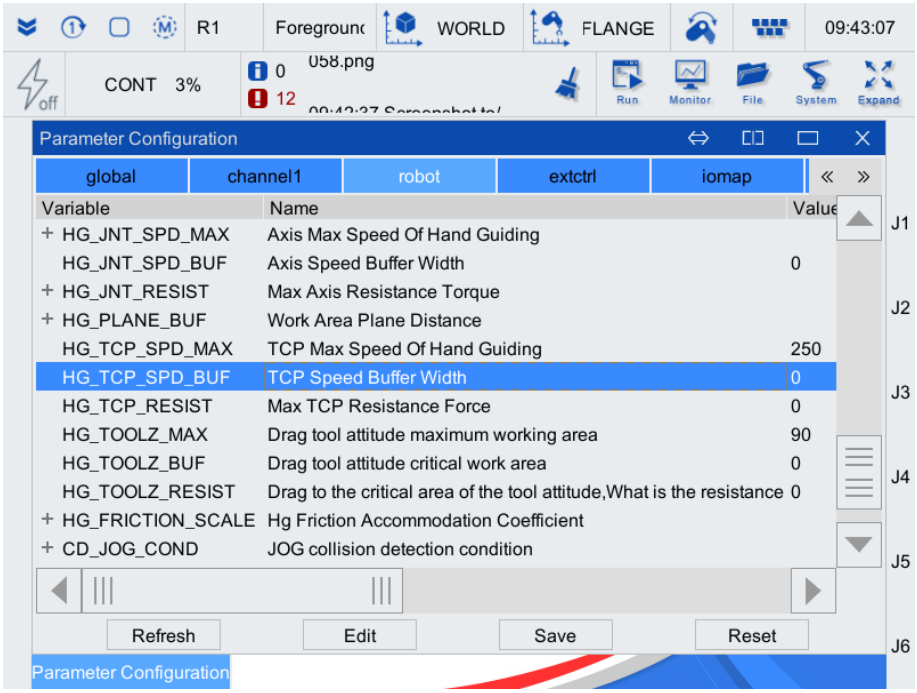


Figure 5-45 Parameter configuration interface

Step4. In the pop-up [Parameter edit] interface (as shown in Figure 5-46), configure the [Value]. Parameter description is shown in Table 5-11.

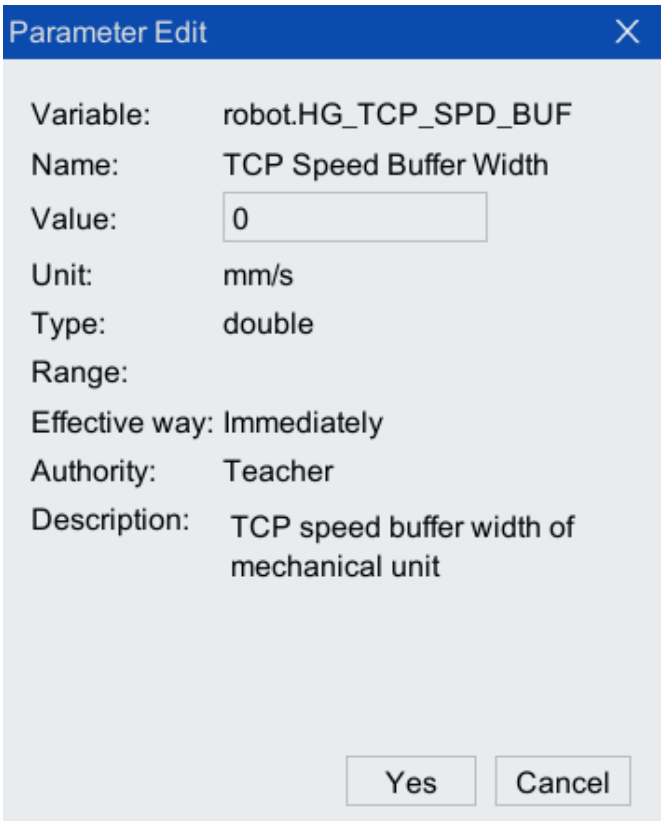


Figure 5-46 TCP speed buffer width parameter setting interface

Table 5-11 Parameter description

Parameter	Meaning
Value	Mechanical unit TCP speed buffer width. For example, if the maximum movement speed of the drag teaching TCP is set to 150mm/s and the width of the TCP speed buffer is set to 50mm/s, the resistance will be increased according to the set TCP maximum additional resistance value within the speed width of 100mm/s~150mm/s to prevent the speed from exceeding the maximum value.

Step5. After completing the parameter configuration, click <Yes>.

5.3.3 Save configuration

After completing the configuration of security parameters, it is necessary to save the configured parameters. The operation steps are as follows:

Step1. After completing the parameter configuration, click <Save> at the bottom of the interface, and a dialog box as shown in Figure 5-47 will pop up. Select 'Save All' in [Please Select Save Type] and click <Yes>.

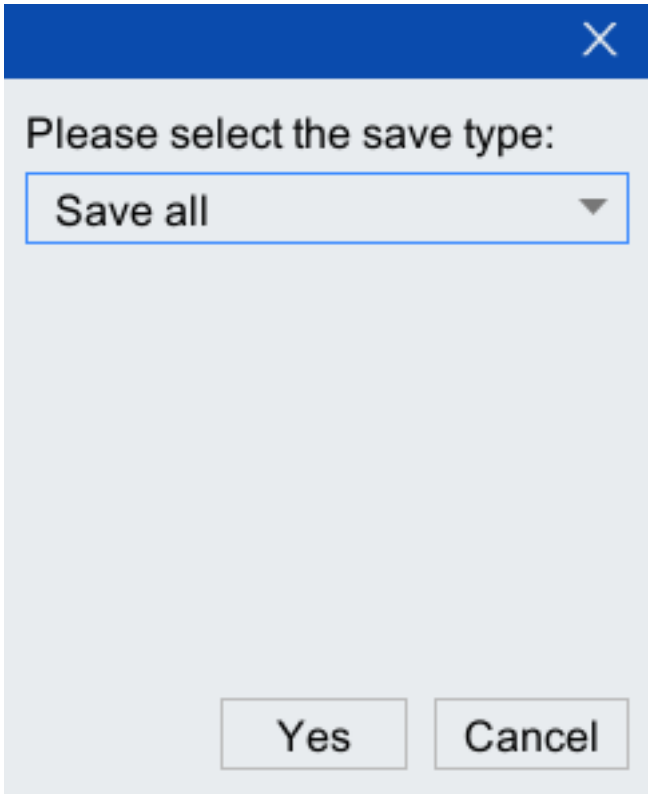


Figure 5-47 Save type dialog box

Step2. Click <Yes> in the pop-up prompt dialog box. As shown in Figure 5-48.

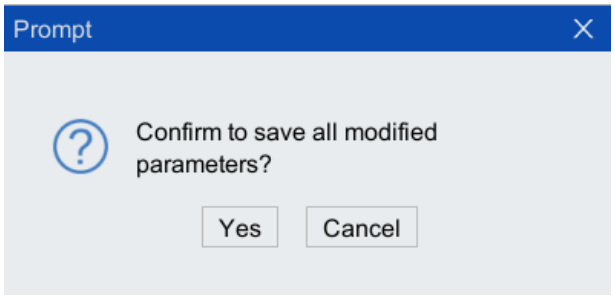


Figure 5-48 Confirmation save modification prompt box

Step3. Click <Yes> in the pop-up parameter save success dialog box. As shown in Figure 5-49.

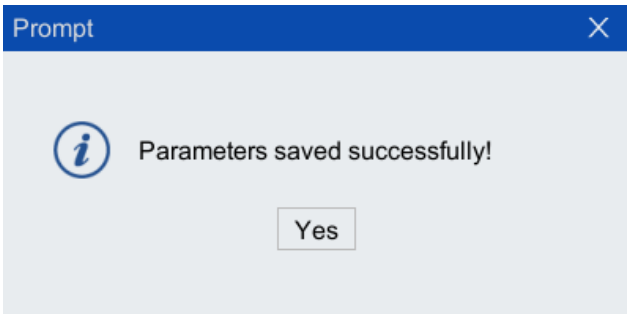


Figure 5-49 Save successfully prompt box

Step4. Power off and restart the device configuration to take effect.

6 Drag teaching playback function

6.1 External control configuration

The configuration steps are as follows:

Step1. Click on [System/Parameter Configuration] on the main interface of the teach pendant, and click on [Extctrl] in the pop-up interface. As shown in Figure 6-1.

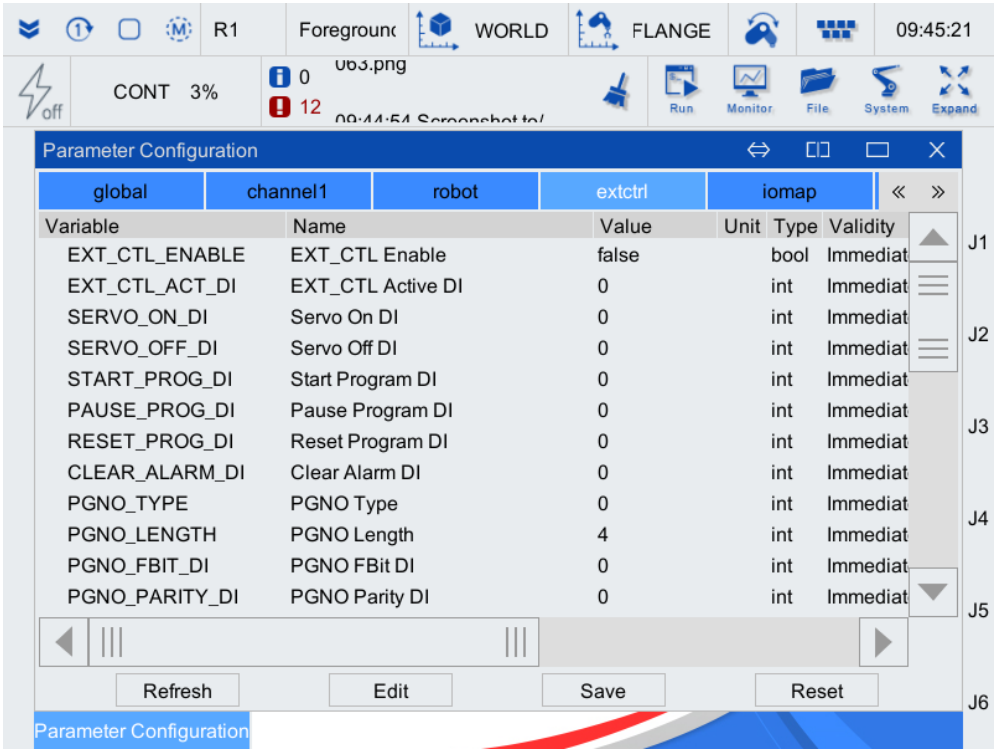


Figure 6-1 External control interface

Step2. Click to select the row where [EXT_CYL_ENABLE (External Automatic Control Enable)] is located, and click <Edit> at the bottom of the interface. The configuration interface shown in Figure 6-2 will pop up. The parameter in the configuration [Value] is "true", which means to enable the external automatic control function and click <Yes>.

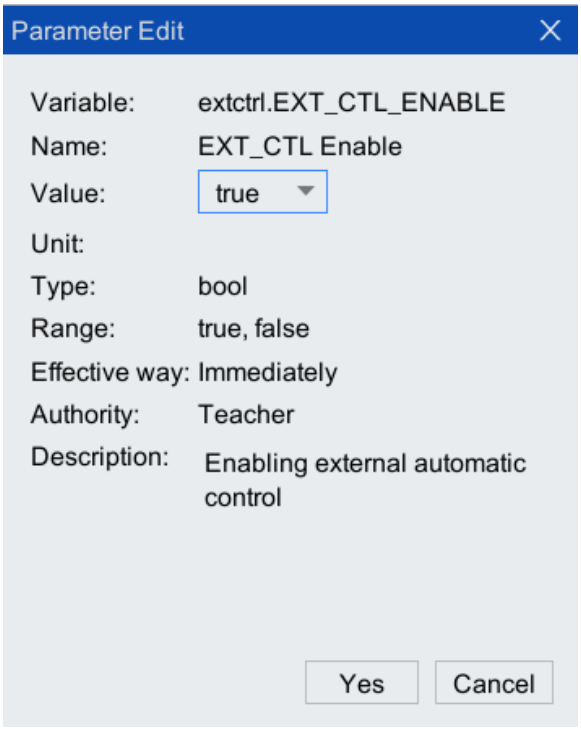


Figure 6-2 External automatic control enable configuration interface

Step3. Click and select [HG_SERVO_DI (drag the teaching up enable button DI)], click <Edit>, and the interface shown in Figure 6-3 will pop up. Configure the [Value] to the specified DI port number (for example, configure it to 1), and click <Yes>.

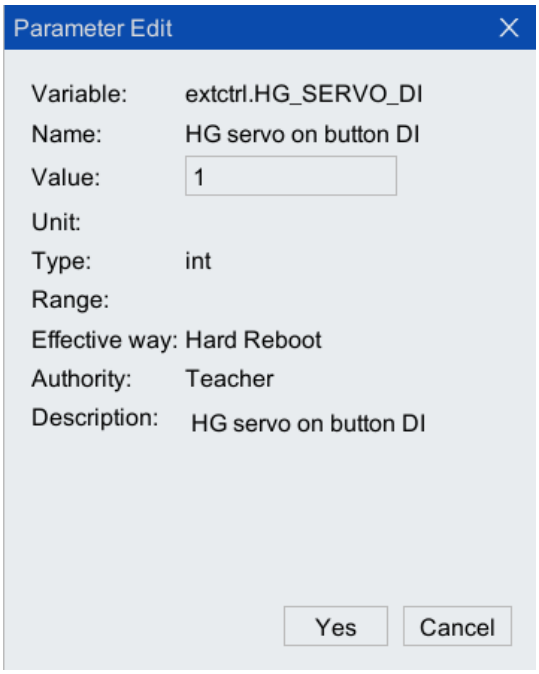


Figure 6-3 Drag teaching enable button di configuration interface

Step4. Click and select [HG_RECORD_DI (drag the teaching record trajectory button DI)], click <Edit>, and the interface shown in Figure 6-4 will pop up. Configure the [Value] to the specified DI port number (for example, configure it to 2), and click <Yes>.

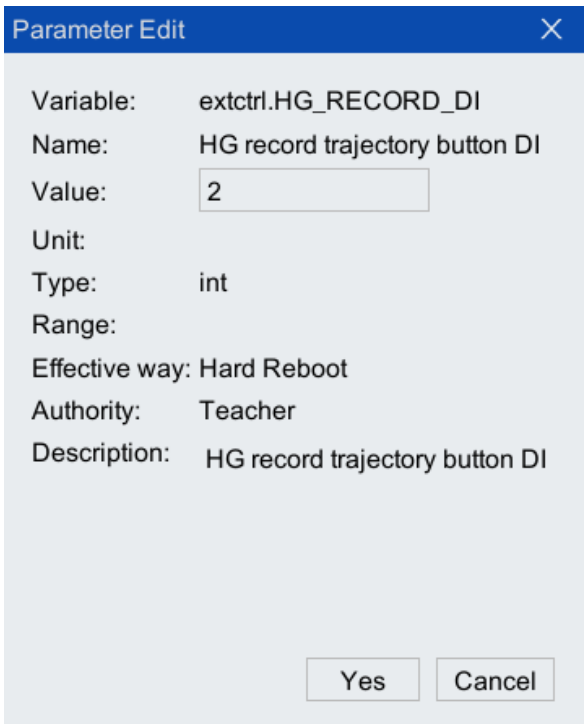


Figure 6-4 Drag teaching record track button DI configuration interface

Step5. Click and select [HG_TRIGGER_DI (drag to trigger DO button DI)], click <Edit>, and the interface shown in Figure 6-5 will pop up. Configure the [Value] to the specified DI port number (for example, configure it to 3), and click <Yes>.

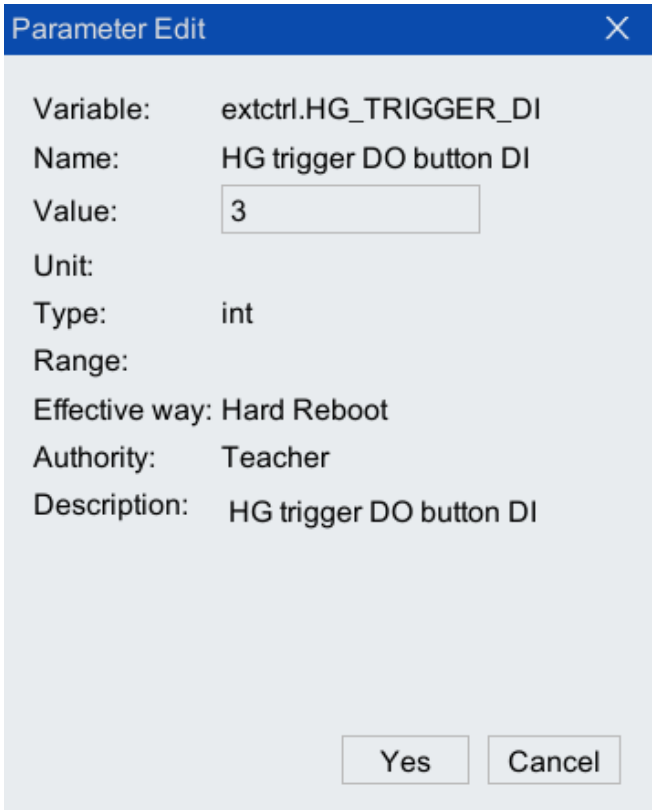


Figure 6-5 Drag teaching trigger DO button DI configuration interface

Step6. After completing the parameter configuration, click <Save> at the bottom of the interface, and a dialog box as shown in Figure 6-6 will pop up. Select 'Save All' in [Please Select Save Type] and click <Yes>.

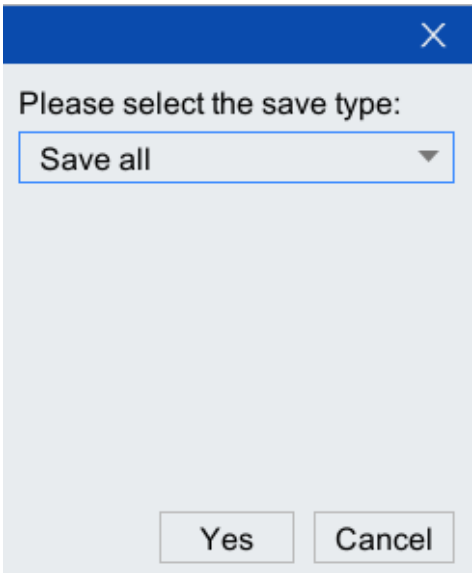


Figure 6-6 Save type dialog box

Step7. Click <Yes> in the pop-up prompt dialog box. As shown in Figure 6-7.

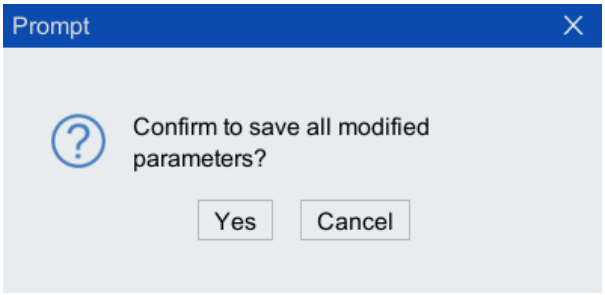


Figure 6-7 Confirm save modify prompt box

Step8. Click <Yes> in the pop-up parameter save success dialog box. As shown in Figure 6-8.

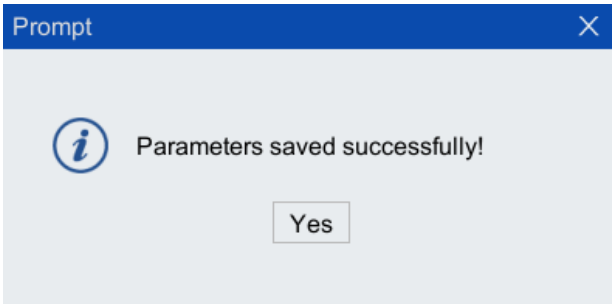


Figure 6-8 Save successful prompt box

Step9. Power off and restart the device configuration to take effect.

6.2 Simulate trigger button configuration

The configuration steps are as follows:

Step1. Click on [System/System configuration/Analog trigger] on the main interface of the teach pendant, as shown in Figure 6-9.

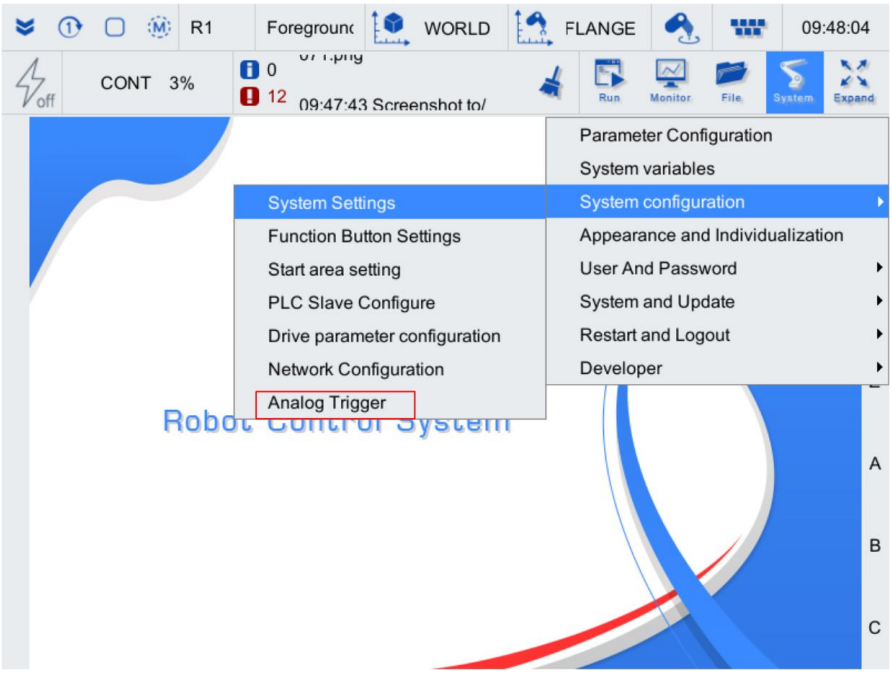


Figure 6-9 Teach pendant main interface

Step2. In the pop-up [Analog Trigger] interface (as shown in Figure 6-10), select the button to be configured (such as button 1), select the type of DI for each channel as "User DI", and configure the [Port] to correspond one by one with the key port numbers configured in steps 3 to 5 of section 6.1.

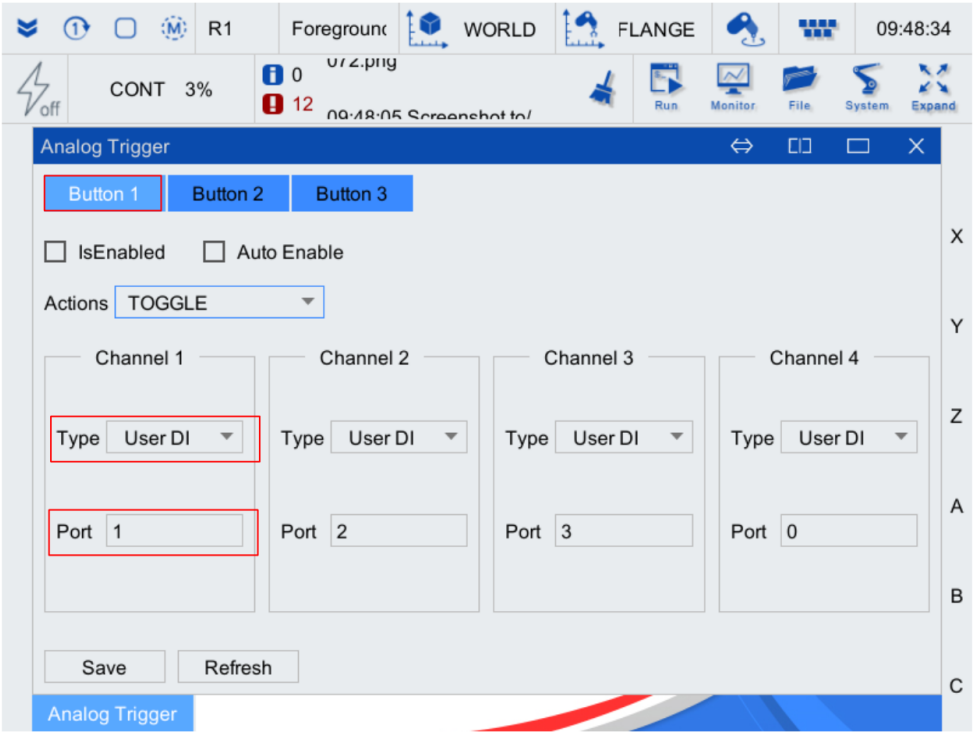


Figure 6-10 Simulation trigger configuration interface

Step3. Click on [System/System configuration/Function Button Settings] on the main interface of the teach pendant, as shown Figure 6-11.

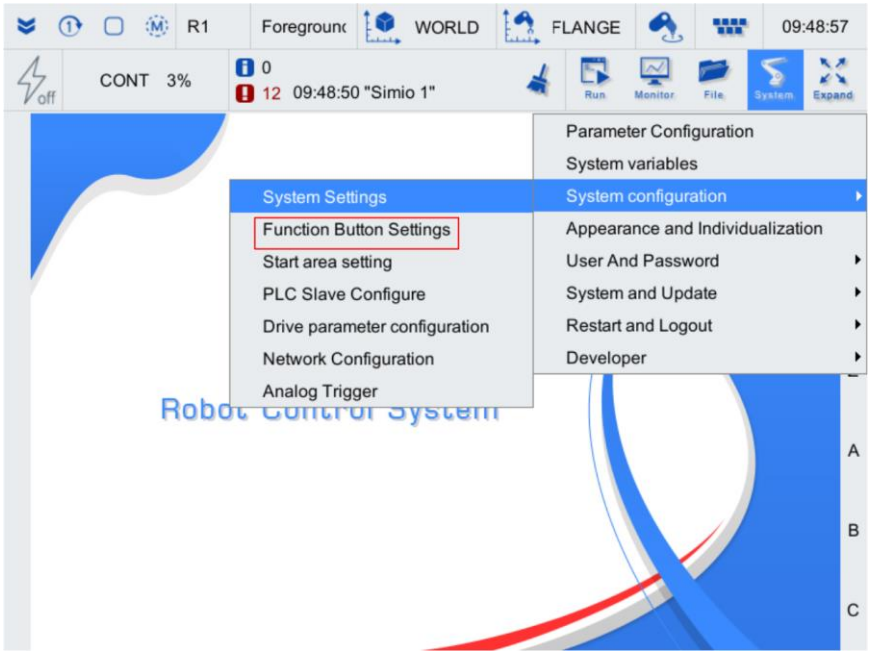


Figure 6-11 Teach pendant main interface

Step4. In the pop-up [Function Button Settings] interface (as shown in Figure 6-12), set the simulation trigger button (for example, set the simulation trigger button 1 to F3).

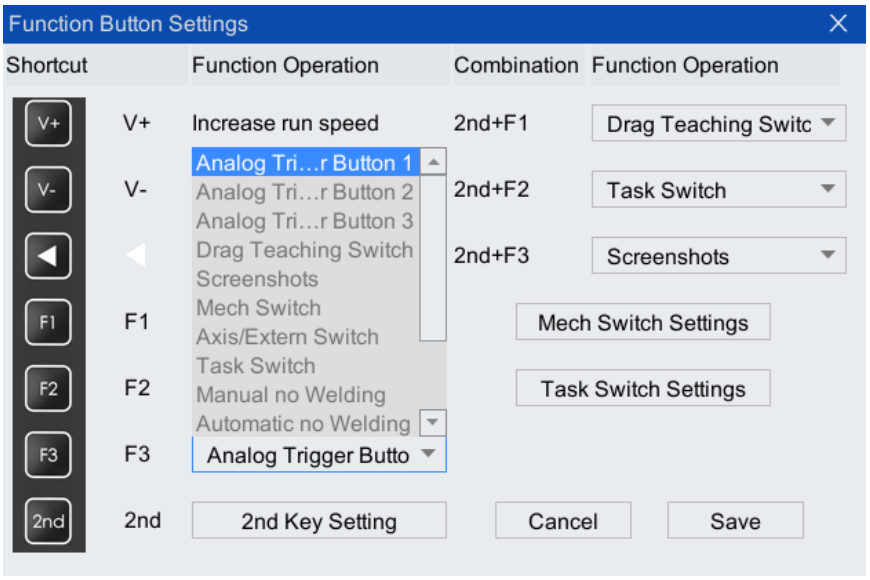


Figure 6-12 Function key setting interface

Step5. Press the <2nd+F1> button to switch to drag teaching mode, press the simulation trigger button (such as), make the corresponding DI light up, and the robot can automatically power on.

Step6. Drag the robot to move, and the motion trajectory will be automatically recorded. When you need to stop recording the trajectory, you can release the power.

Step7. Press the <2nd+F1> button to switch to normal mode, rotate the mode switch key to automatic mode, and power on the robot.

Step8. Click [Run/Teaching safety area plane] on the main interface of the teach pendant (as shown in Figure 6-13), and the robot will play back the last drag trajectory.

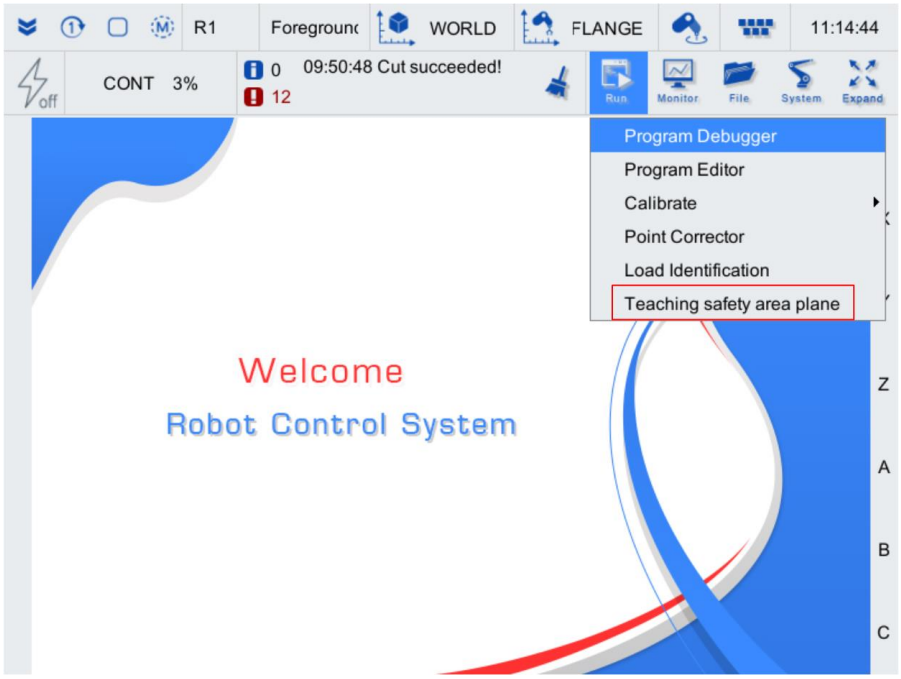


Figure 6-13 Teach pendant main interface

Notice

The program for trajectory playback is placed under/home/ae/script/, and the name format of the program is represented by the number in front of it to record the trajectory time, followed by the program generated by dragging the teaching trajectory reproduction. For example, "2021-07_25_16_002_23_fcb_record_subprog.arl" indicates that the program named "fcb_record_subprog.arl" was generated on July 25, 2021 at 16:2:23.

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