ARM Programming Environment

User Manual

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ARM Programming Environment

This manual applies only to Pallas version

*Supports Pallas firmware 1.7.34 and above

*Supports ARM version 3.3.39 and above

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QKM Technology (Dongguan) Co., Ltd.

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Preface

Thank you for using our programming software ARM. This manual describes the instructions to properly use the product. Read this manual carefully before use. Keep this manual properly for future reference.

General

This manual provides detailed information on the functions, usage and other aspects of ARM so that users can fully understand and properly use the product.

Target reader

This manual applies to:

R&D Engineer	Software Engineer
Testing Engineer	Technical Support Engineer

Signs and meanings

The signs in this document clearly indicate any dangers, warnings, attentions and notes that may occur while users perform the operations described in this manual; be sure to pay attention to the following signs when they appear in this document.

The signs in this manual are described in the table below.

Signs	Description
	It indicates an imminently hazardous situation, which if not avoided, will result in death or serious injury.
	It indicates a potentially hazardous situation would occur, which if not avoided could result in person injury and damage.
	It indicates a unpredictable situation would occur, which if not avoided could result in software system damage, performance degradation, or data loss.
	It gives the description on key information and operation tips.

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Chapter 1 ARM Overview

ARM is the software programming environment suitable for robots produced by QKM Technology (Dongguan) Co., Ltd. (hereinafter referred to as QKM). Users may develop various functional software based on ARM.

1.1 Prerequisites

1) Proficient in QKM Robot Language (QRL).

2) Familiar with the mode of motion of the robot.

1.2 Product Features

Main characteristics of ARM

1) Quickly write QKM robot programs;

2) Set robot motion trajectories and parameters;

3) Easily operate QKM robots;

4) Modify robot motion parameters on line;

5) Directly comment codes;

6) Automatically complete codes;

7) Quickly look up functional codes;

8) Quickly query error messages.

Chapter 2 ARM Setup

2.1 Installation Environment

1) NET45 environment;

2) Win7, Win8, Win10 systems;

3) Memory: 2G or more.

2.2 Software Setup

Step 1 Download an ARM setup package ARM-3.X.XX-Setup-En from the official website of QKM, as shown in Figure 2-1.

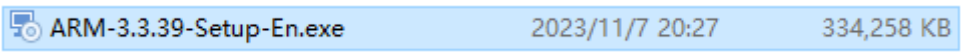


Figure 2-1 Prepare Setup Package

Step 2 Double-click the left button to install the software, as shown in Figure 2-2.

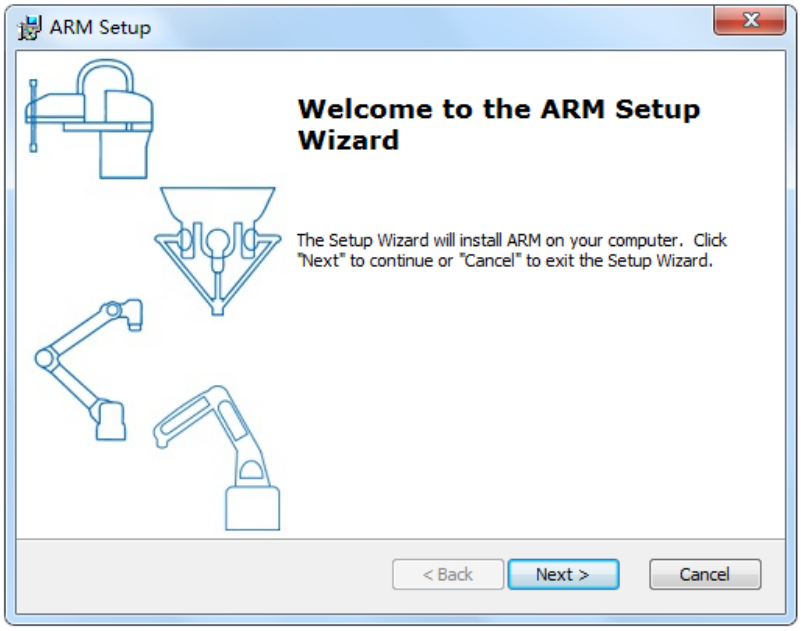


Figure 2-2 Start Setup

Step 3 Select the installation folder (recommended on non-C drive) and click on "Next", as shown in Figure 2-3.

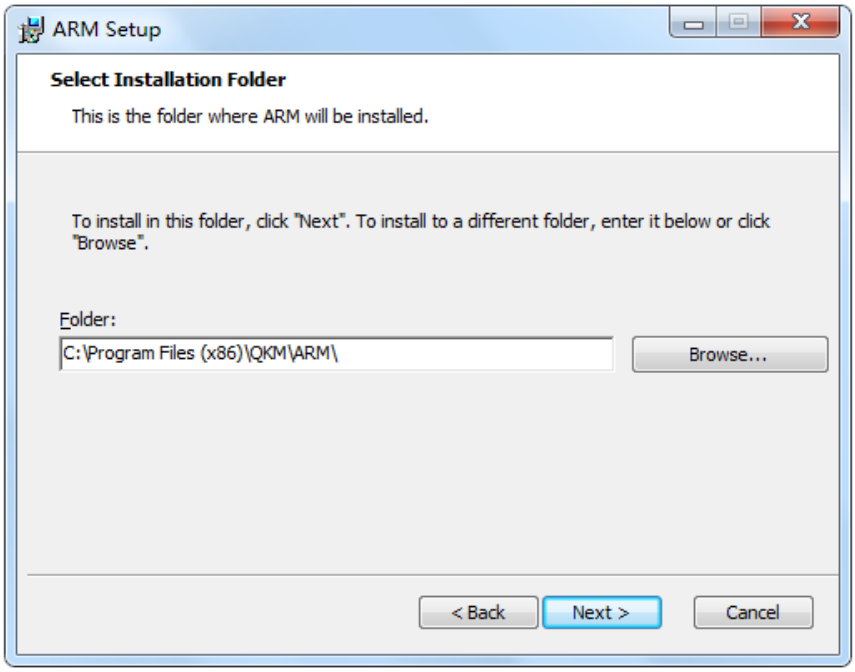


Figure 2-3 Select Installation Folder

Step 4 Click on "Install" to complete the installation.

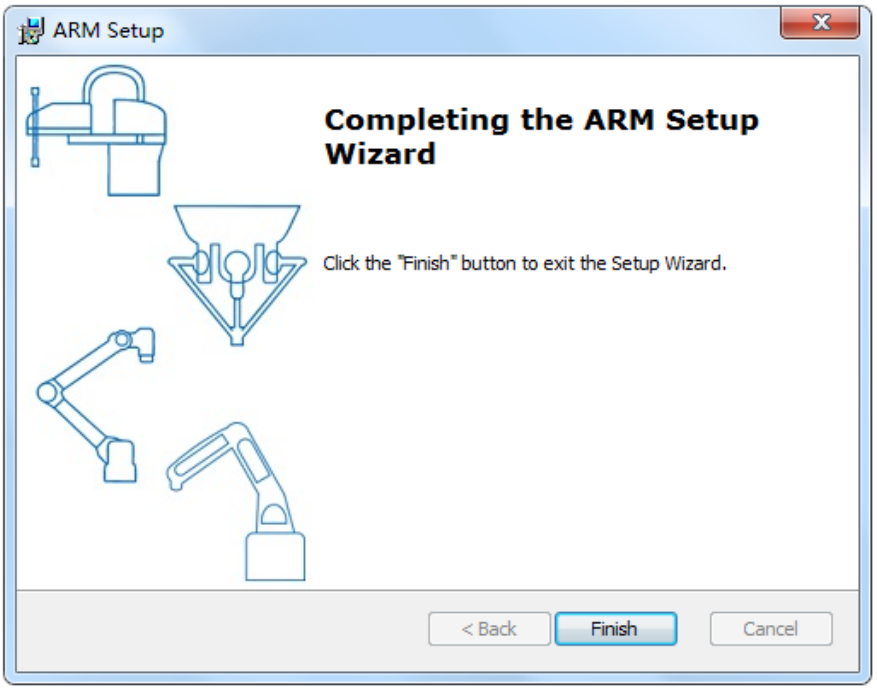


Figure 2-4 Installation Folder is Complete

Chapter 3 Introduction of ARM Functions

This chapter mainly introduces the interface and functions of ARM for users to use this software quickly and expertly.

3.1 ARM Interface

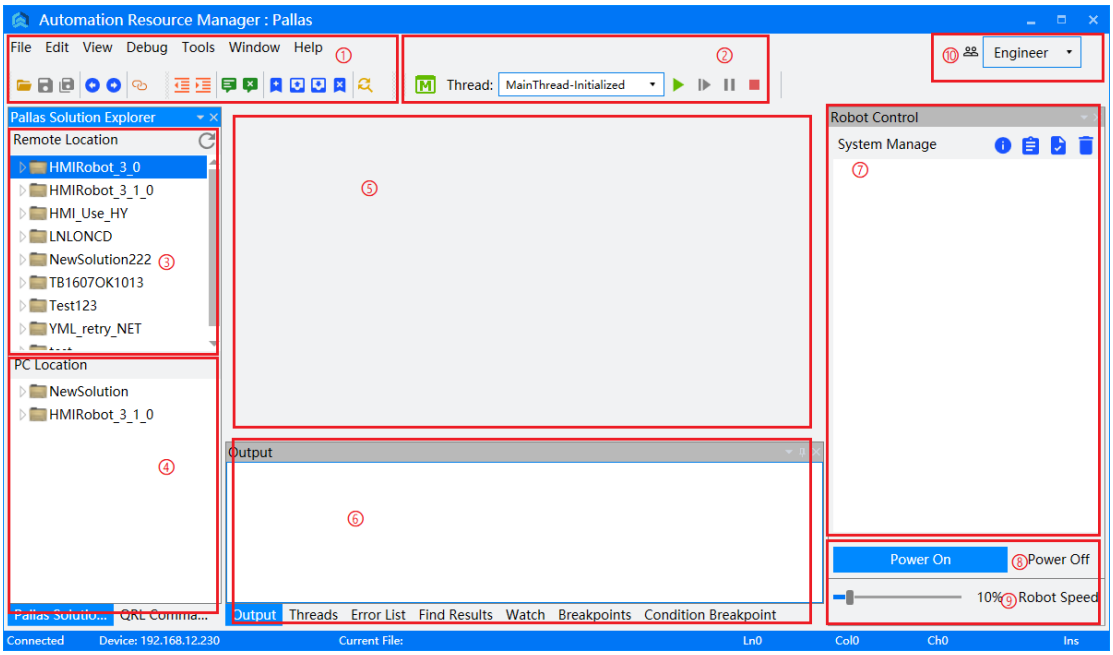


Figure 3-1 ARM Interface

① Menu bar, where all functions of the software are displayed.

② Area for switching languages, switching between Macro and QRL, running programs and changing states.

③ Flash remote location, where robot running programs, configuration files, library files, etc. are stored.

④ PC location, indicating computer disks.

⑤ Program running panel area, where programs are viewed, debugged, etc.

⑥ Robot control window, where output information of all controllers is displayed.

⑦ Output window, where the contents corresponding to selected outputs, threads, error list, find results, watch, and breakpoints are displayed.

⑧ System status window, where robot system status is displayed, and the robot can be manually enabled and disabled.

⑨ Speed displaying area, where the current robot speed is displayed, and the robot running speed can be adjusted.

⑩ Login permission, select the permission to operate the software.

3.2 Menu Bar

3.2.1 File

The file operations include New, Open, Close All, Save Current File, Save All, Print, Recent Projects, Exit, etc. In which:

Name	Function
New	Create new QRL projects
Open	Open local existing QRL projects
Close All	Close all opened QRL projects
Save Current File	Save currently opened QRL project
Save All	Save all QRL project files in the software
Recent Projects	Quickly find the recently opened or newly created QRL project in the software
Exit	Exit ARM

Table 3-1 File Operation Functions

3.2.2 Edit

The basic edit functions include Undo, Redo, Cut, Copy, Paste, Delete, Select All, Find and Replace, etc.

Name	Function
Undo	Undo the current edit

Redo	Redo the previously undone content
Cut	Cut the currently selected content
Copy	Copy the currently selected content
Paste	Paste the copied or cut content to the current line
Delete	Delete the line on which caret is located
Select all	Select all current contents
Find and Replace	Quickly find and replace objects

Table 3-2 Edit Functions

3.2.3 View

The view functions include Project Manager, Class View, Output, Find Results, Threads, Error, Find, Watch, Breakpoints, etc.

Name	Function
Project Manager	Manage QRL projects in ARM
Class View	Quickly find various classes required for programming to facilitate project development
Output	Output various information that needs to be displayed during program running
Find results	Display information that matches your search
Threads	Display thread status in window
Error	Display information of error list in window
Find	Display information of results found in window
Watch	Display information of monitored variables in window
Breakpoints	Display information of running program breakpoints in window

Table 3-3 View Functions

3.2.4 Debug

The debug functions include Compile, Set Breakpoints, Remove Breakpoints from Current File, Remove All Breakpoints from Project, and Remove All Breakpoints from Solution.

Name	Function
Connect or disconnect	Connecting or disconnecting a robot
Scan Robot	Scan the robots in the current LAN
Compile	Compile QRL programs
Set Breakpoints	Set breakpoints in program
Remove Breakpoints from Current File	Remove all breakpoints from current .ql file
Remove All Breakpoints from Project	Remove all breakpoints from current project
Remove All Breakpoints from Solution	Remove all project breakpoints from associated solution

Table 3-4 Debug Functions

3.2.5 Tools

The tool functions include Macro Command Window, Jog Manual, I/O Setting, Tool Frame Calibration, Module Parameter, CM Wizard, Fixed Camera Calibration, Visual Tool Calibration, Modbus TCP Wizard, Data Logger, Battery Wizard, Pallas Firmware Update, Quick Debug, User Control, Latch Manager, Options, etc.

Module	Title	Function
Parameter Settings	IDN Configuration	Viewing and Setting IDN Parameters
	I/O Setting	Set I/O interface
	Global Variables	Monitor global variables set for modifying programs
	Latch Manager	Set latch signal trigger parameters

	Modbus TCP	Configure Modbus TCP parameters
Coordinate Settings	Tool Frame	Calibrate and manage tool coordinate system
	User Frame	Calibrate and manage user coordinate system
Robot Controls	Jog Control	Control robot manual interface
	Interference Zone	Set and manage the interference zone of the robot
	Home Calibration	Calibrate the home of the robot
Robot Application	Conveyor Manager	Configure conveyor parameters, calibrate conveyor, teach at points, etc.
	VotF Wizard	Configure VotF parameters
Vision Tool	Vision Tool Calibration	This function is not complete and currently not supported
Debugging and Analyzing Tool	Macro Command Debugger	Send and debug macro command
	Data Logger	Collect robot data and analyze the data
	System Diagnostics	Version detection, device diagnosis, and SD card repair
	Communications Assistant	Debugging robot communication (TCP/UDP/serial port) function
Other	Firmware Upgrade	Upgrade robot firmware and configuration files
	Boot Configuration	Set Dedicated I/O

Table 3-5 Tool Functions

3.2.6 Window

The window functions include theme option.

Name	Function
Theme	Users can set theme colors according to their personal habits
Layout	Restore software default layout
Options	Functions such as setting Chinese and English, setting default layout, and opening logs

Table 3-6 Window Functions

3.2.7 Help

The help functions include View Help, About ARM, etc.

Name	Function
View Help	Quickly switch to Precise Documentation Library for facilitating development
Technical support	Provide technical support information
About ARM	View current software version information

Table 3-7 Help Functions

3.2.8 Shortcut key

Signs	Name	Function
	Open	Open target QRL projects
	Save Current File	Save currently opened file
	Save All	Save all opened files
	Navigate Backward	Navigate backward in caret mode

Signs	Name	Function
	Navigate Forward	Navigate forward in caret mode
	Quick Connect or Disconnect	Quickly connect to or disconnect from mechanical arm
	Decrease Indent	Decrease indents of selected lines
	Increase Indent	Increase indents of selected lines
	Comment Selected Lines	Comment selected lines
	Uncomment Selected Lines	Uncomment selected lines
	Switch Tabs on Current Line	Add or cancel tabs to current line
	Move to Previous Tab	Move caret to previous tab
	Move to Next Tab	Move caret to next tab
	Clear All Tabs	Clear all tabs from current file
	Replace and Find	Quickly replace or find objects
	Macro Mode	Currently in macro mode
	QRL Mode	Currently in QRL mode
	Start	Start target Macro/QRL projects
	Continue	Continue target Macro/QRL projects
	Pause	Pause target Macro/QRL projects

Signs	Name	Function
	Stop	Stop target Macro/QRL projects
	Step Into	Step into after starting program debug or running to endpoint
	Step Over	Step over after starting program debug or running to endpoint
	Step Out	Continue to run program after step into, step over, or breakpoint.

Table 3-8 Introduction of Shortcut Keys

3.2.9 Output Window

1. Output

Display outputs from the program during compilation or execution, as shown in Figure 3-2 .

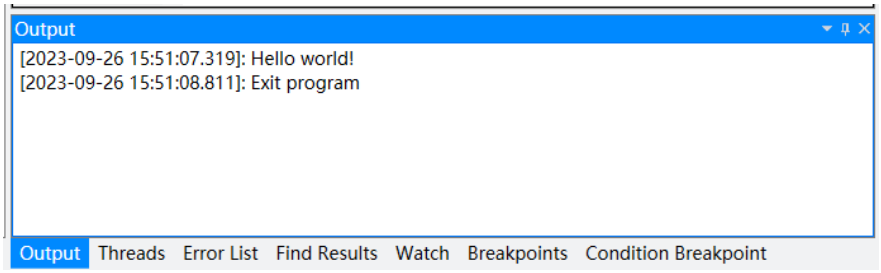


Figure 3-2 Output

2. Threads

Display threads being executed and their status, as shown in Figure 3-3.

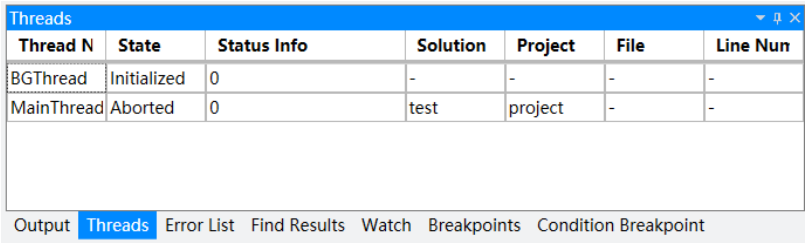


Figure 3-3 Threads

3. Error List

Display all error codes, descriptions and the number of lines where the codes are located in the file during program compilation, as shown in Figure 3-4.

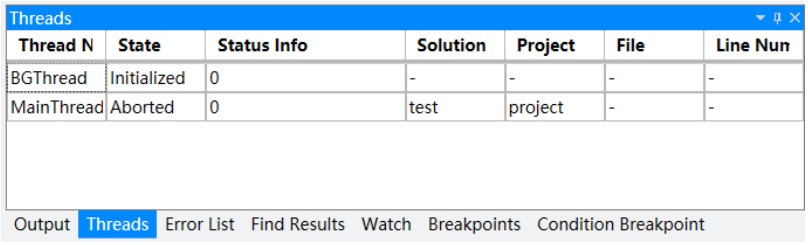


Figure 3-4 Error List

4. Find Results

Display the line and total number of project files where the finding is located, as shown in Figure 3-5.

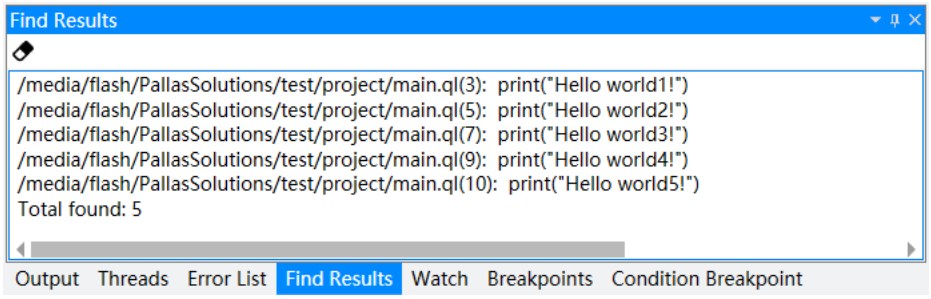


Figure 3-5 Find Results

5. Watch

Monitor the execution of specified thread variables in the program, as shown in Figure 3-6.

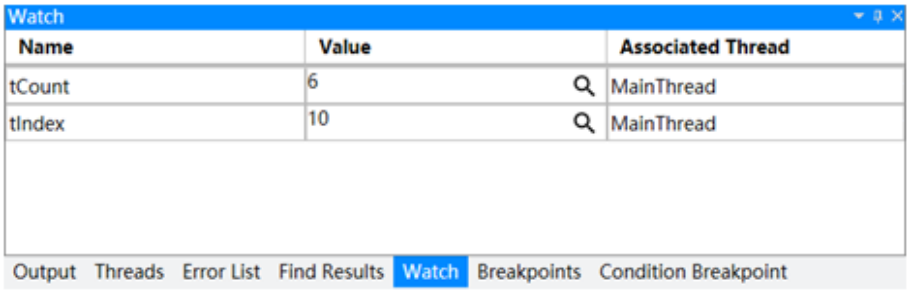


Figure 3-6 Run a Specified Program

6. Breakpoints

Display the file location of each breakpoint (including tabs and breakpoints) in the project. as shown in Figure 3-7.

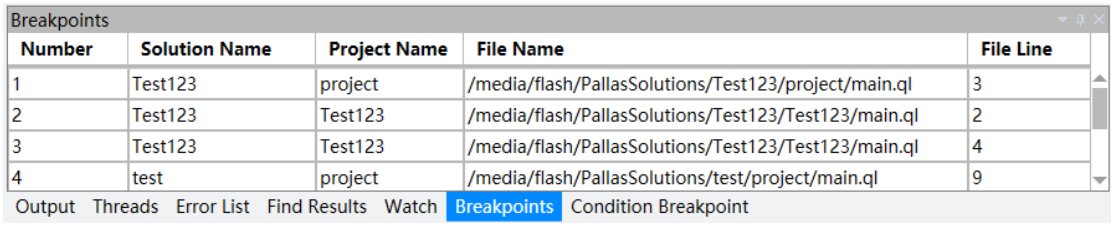


Figure 3-7 Breakpoints

7. Condition Breakpoints

Suspend programs being executed by adding thread interruption judgment conditions. When a running program meets the conditions, it will automatically be suspended.

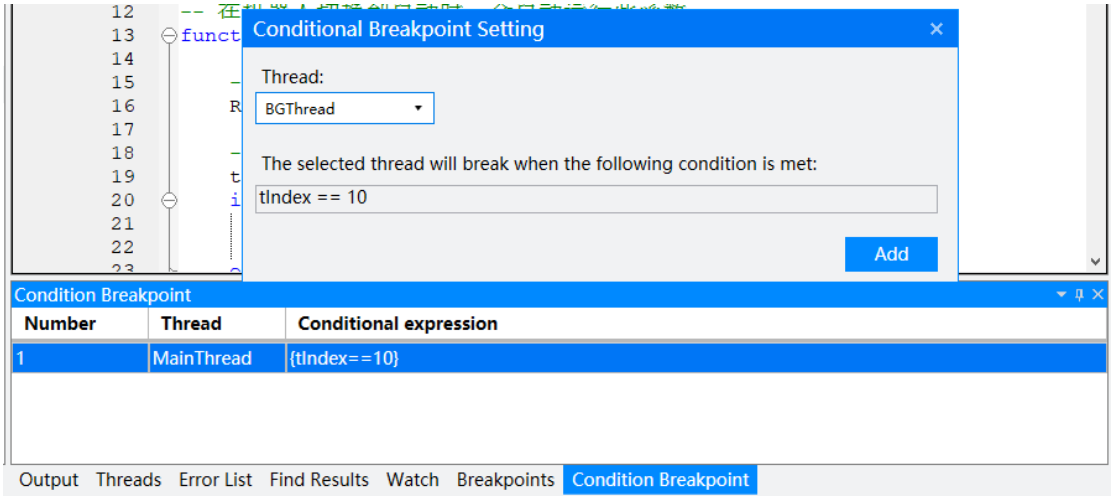


Figure 3-8 Conditional Breakpoint

3.3 Connecting Robots

Before connecting the robot, you need to set the IP address of the PC and the robot to the same network segment (the default IP address of the robot factory is: 192.168.10.120).

3.3.1 IP Modify the Computer IP

The steps to modify the IP address of the PC are as follows:
Step 1: Open the Network and Sharing Center and click Local Area Connection.

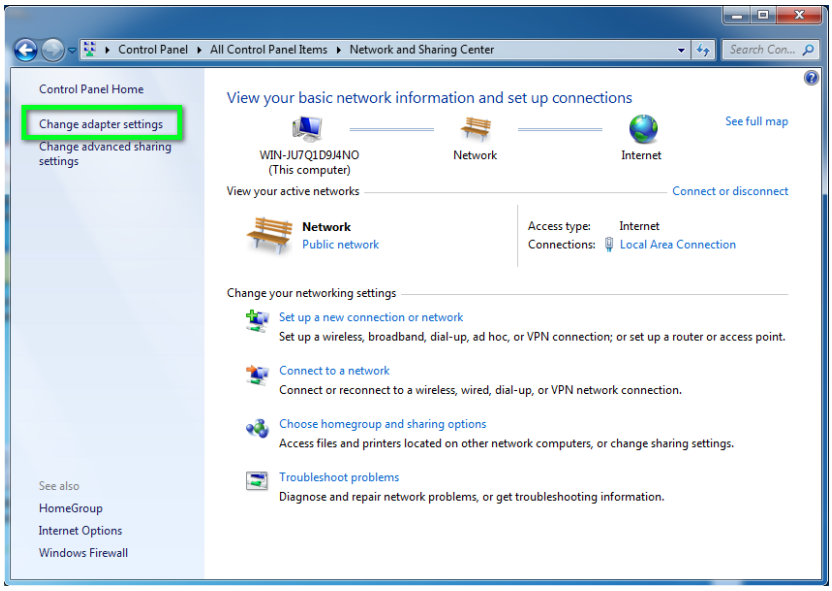


Figure 3-9 Network and Sharing Center

Step 2: In the pop-up local connection status window, click the Properties button.

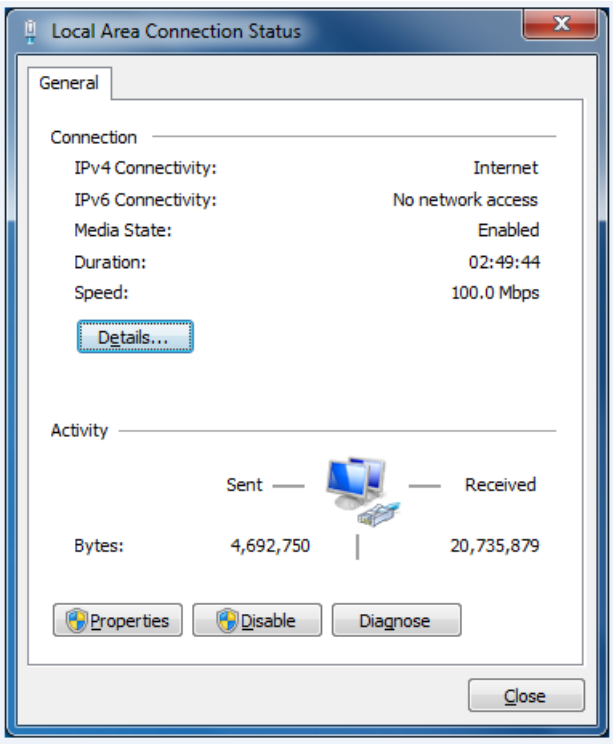


Figure 3-10 Local Area Connection Status

Step 3: In the pop-up local connection properties window, double-click Internet Protocol version 4 (TCP/IPv4).

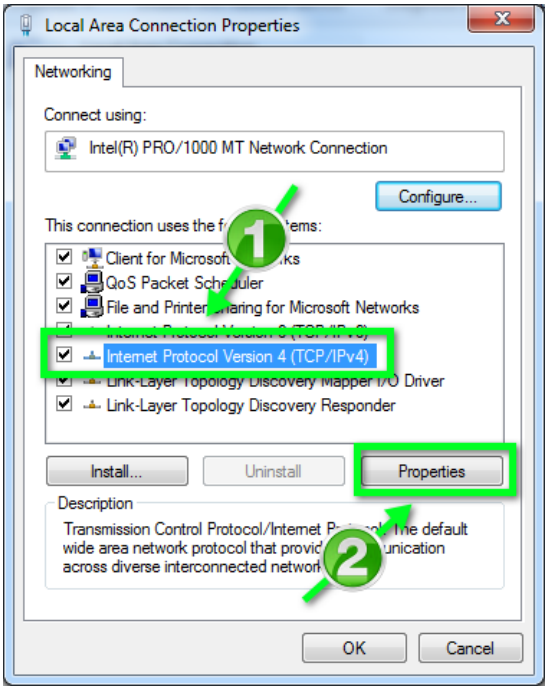


Figure 3-11 Local Area Connection Properties

Step 4: In the pop-up Internet Protocol version 4 (TCP/IPv4) property window, modify the IP address. The IP address of the PC should be in the same network segment as the IP address of the QKM robot, that is, The first three digits of the IP address are consistent, but the last digit is not. After the modification is complete, click the OK button. Complete the modification of the IP address of the PC.

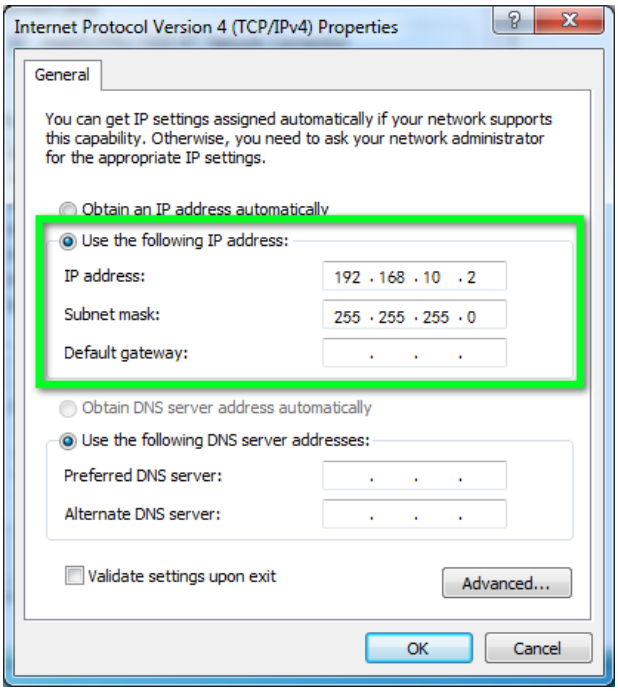


Figure 3-12 Internet Protocol Version 4 (TCP/IPv4) Properties

3.3.2 Robot Scan

Before connecting to the robot, if you do not know the robot's IP address, click the Connect icon, and click the Scan button in the pop-up Connect to Pallas dialog box. Use the IP scan function to obtain a list of currently available devices, and view the IP address of the robot you want to connect to in the list.

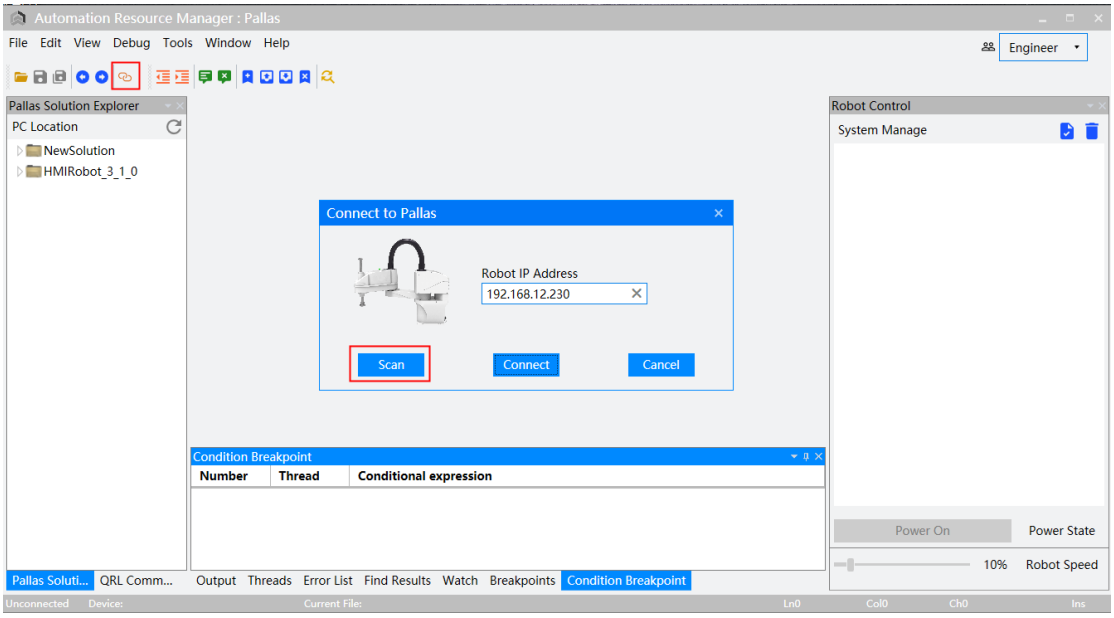


Figure 3-13 Robot Scan

In the pop-up device list interface, view the list of devices that can be connected to the current local area network. Select the robot to connect and click Select. The IP address of the robot to be connected is automatically filled in the IP address field of the Connect to Pallas dialog box.

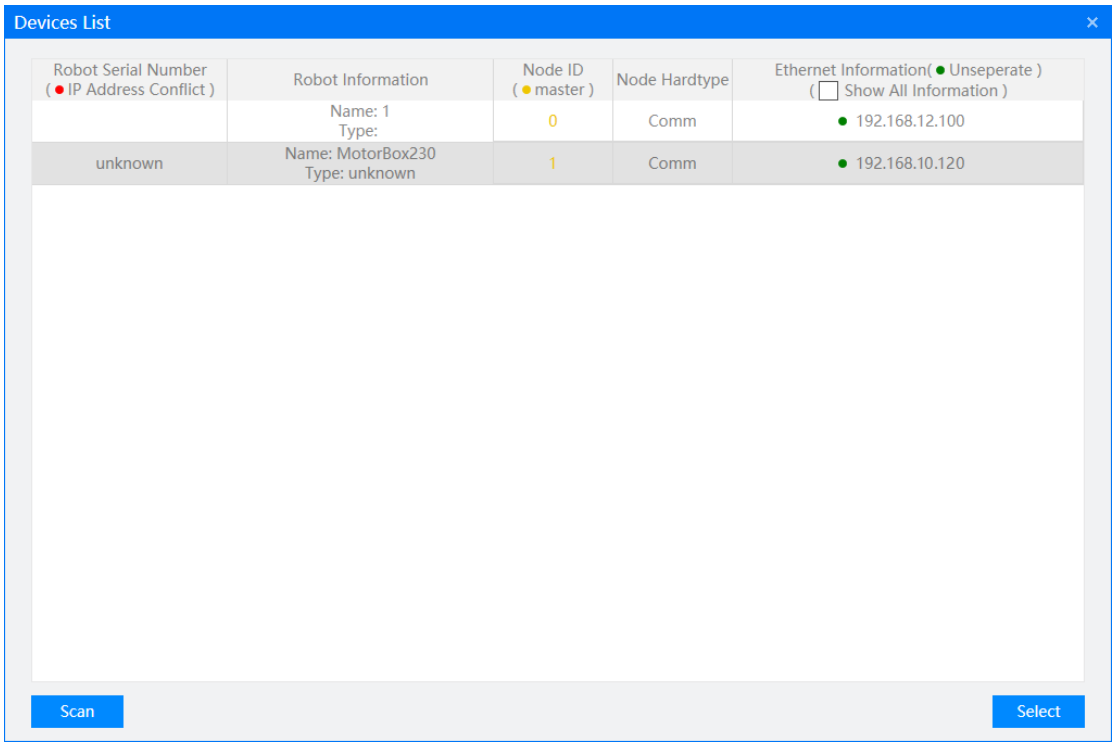


Figure 3-14 Select Robot

3.3.3 Modify the Robot IP

If you want to modify the robot IP, you can double-click the device in the device list, enter the modified IP in the IP setting column on the right, and click the Settings button to modify the selected robot's IP.

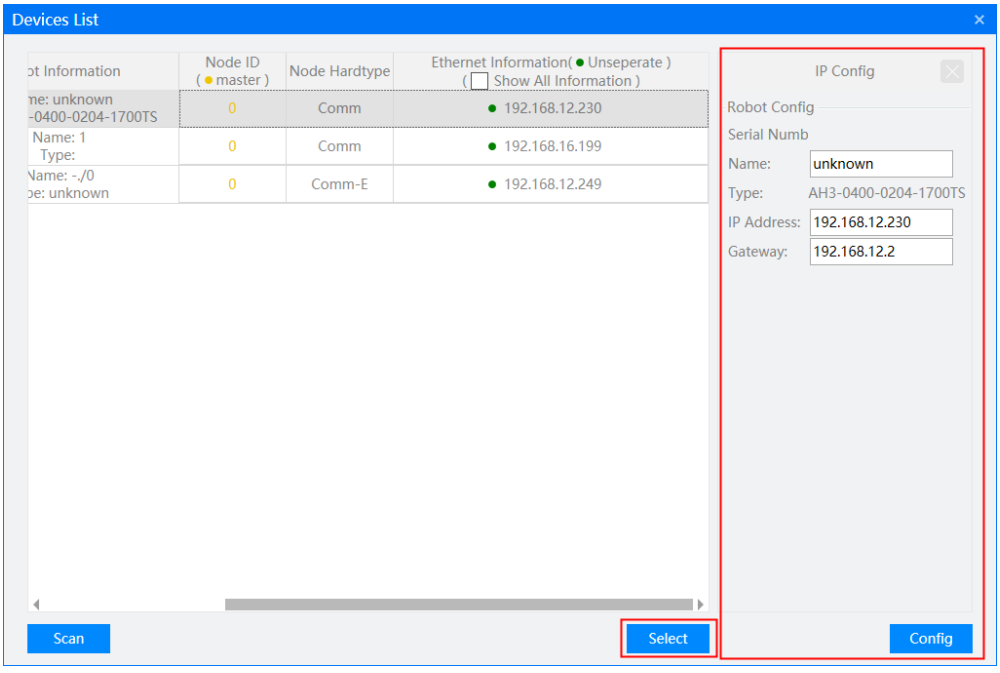


Figure 3-15 Change IP

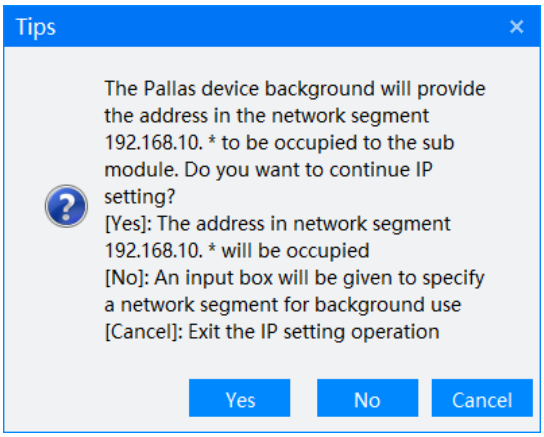


Figure 3-16 Set IP

Set the IP network segment of the submodule according to the prompt in the pop-up prompt box

Yes: The submodule IP and the robot IP are in the same network segment.

No: Enter the IP network segment of the submodule in the pop-up box.

Cancel: Cancel IP settings

Note: A robot has multiple child node devices (Comm or Cell), and each child node device occupies 2 IP addresses.

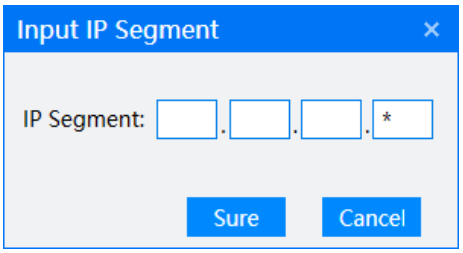


Figure 3-17 Set Network Segment

3.3.4 Connecting

After modifying the IP address of the PC, open the ARM programming software. Click the Connect icon, and in the pop-up connection window, select or manually enter the IP address of the robot to be connected, and click the Connect button.

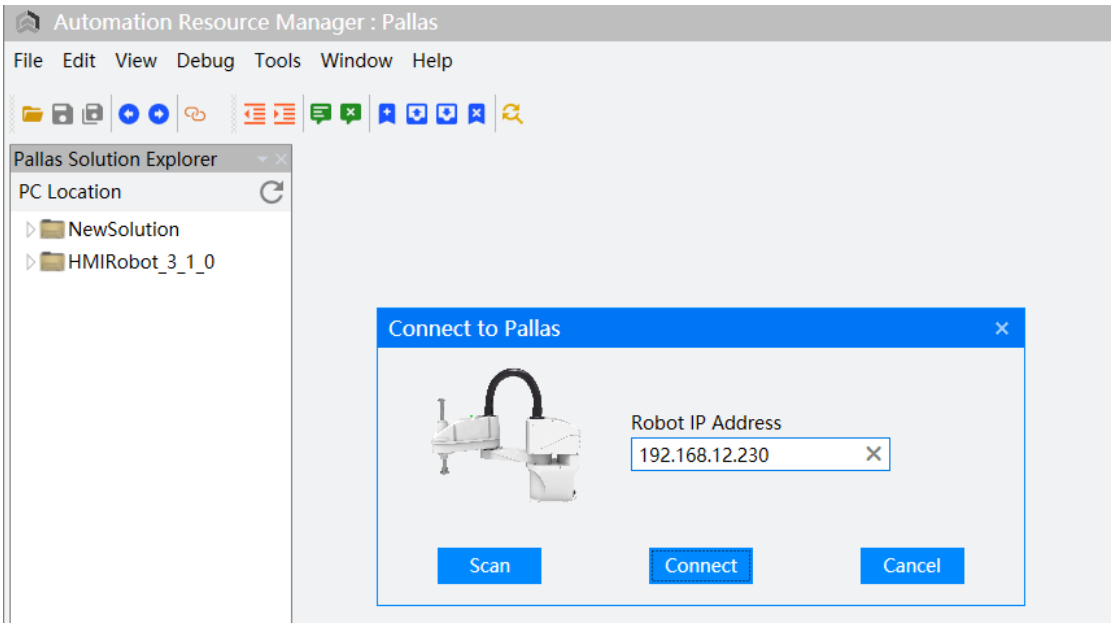


Figure 3-18 Connect to Robot

After failing to connect to the robot, a prompt window will pop up indicating a connection failure. If the connection fails, check whether the network cable connecting the PC and the robot is loose and whether the robot is powered on.

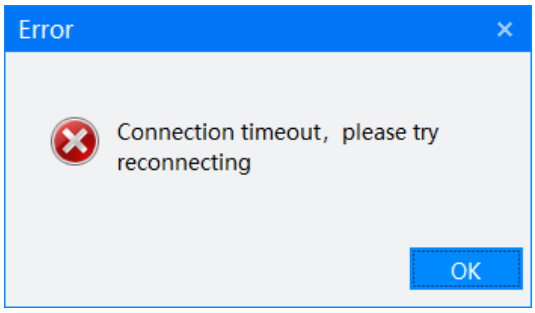


Figure 3-19 Connection Failure

After successfully connecting the robot, users can operate the corresponding application functions on the robot.

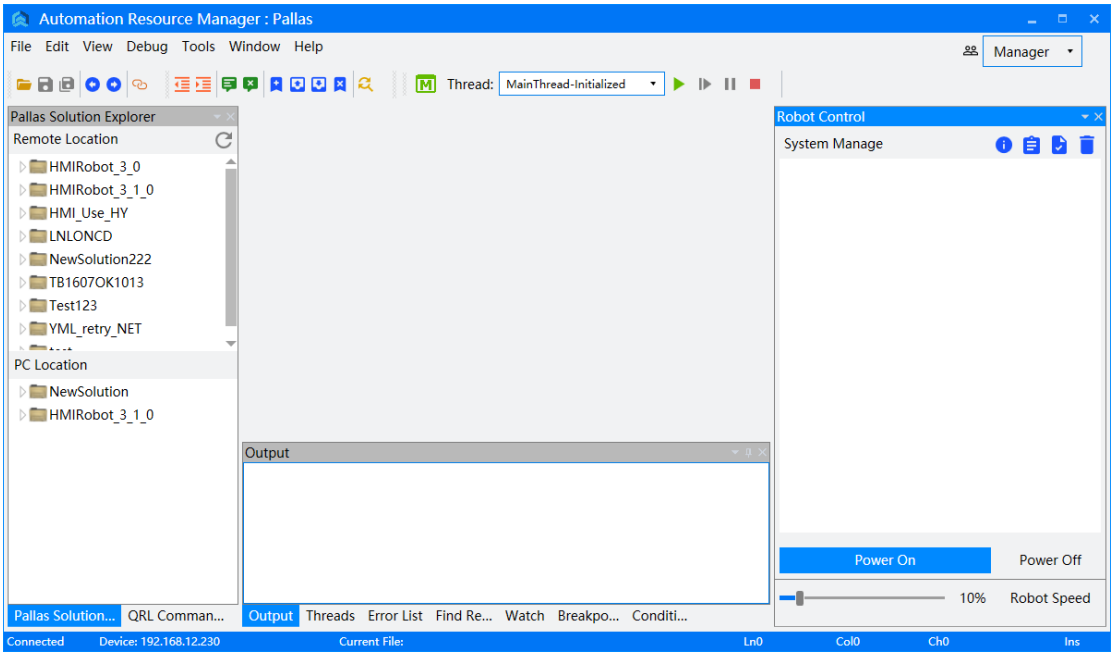


Figure 3-20 Successful Connection

3.4 Introduction to Language Mode Switching

Two modes are available: Macro and QRL.

Macro: QKM robot macro language. In Macro mode, Users can send Macro language to the robot through the upper computer program to achieve corresponding logical functions.

QRL: QKM robot programming language. In QRL mode, the robot can directly run the QRL programs stored in it to implement corresponding logic functions.

Click the language mode switching button to switch between Macro and QRL.

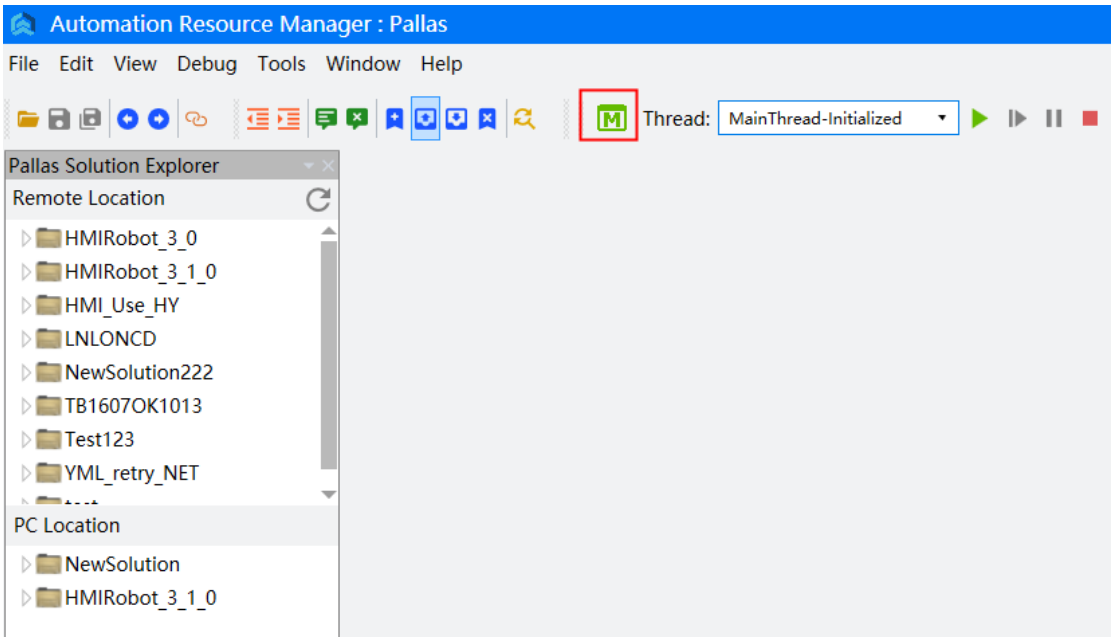


Figure 3-21 Macro Mode

In Macro mode, the robot system will pause or stop according to the error level after an error is reported. At this time, the robot cannot execute some Macro commands.

Users can change the system status according to the actual situation.

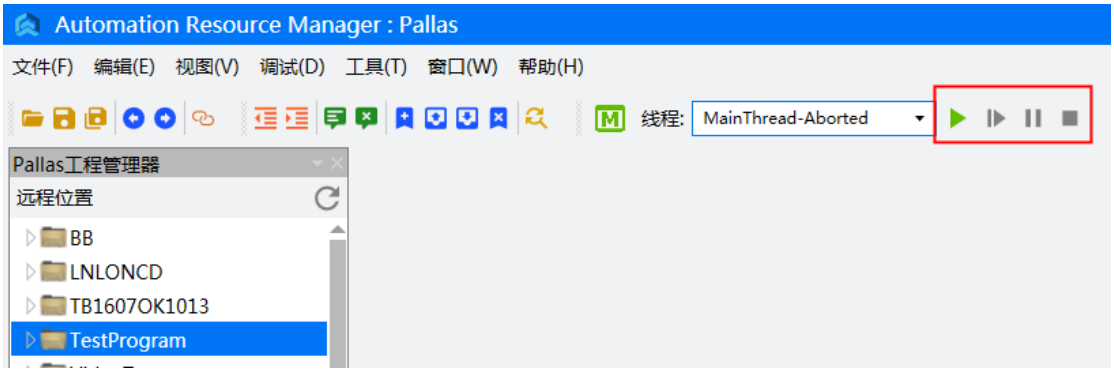


Figure 3-22 Robot System Status in Macro Mode

In most cases, QRL mode is used to write QRL programs to meet relevant application requirements.

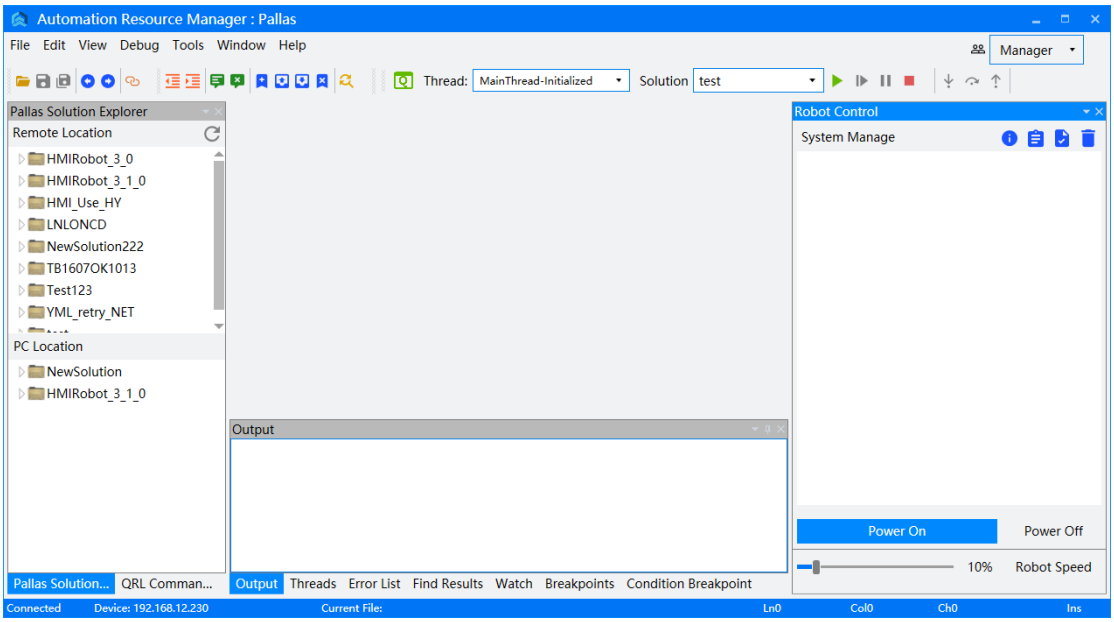


Figure 3-23 QRL Mode

MainThread: Select the corresponding project and select MainThread under Threads to start the program.

BGThread: Background thread is a special thread that is not affected by the status of the robot device and will always run. Right click on the QRL project to run as a background thread, select Set as Background Thread from the pop-up menu, and select BGThread from the Thread menu to start the program.

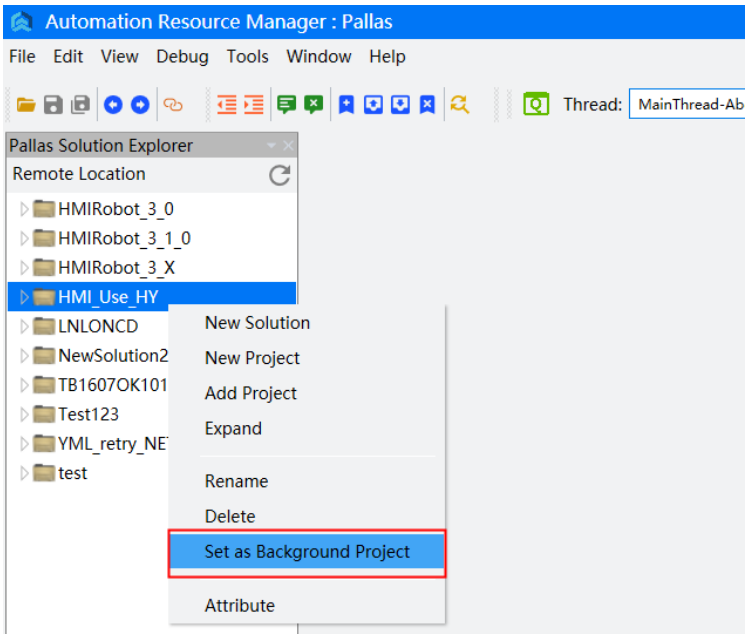


Figure 3-24 Set as Background Project

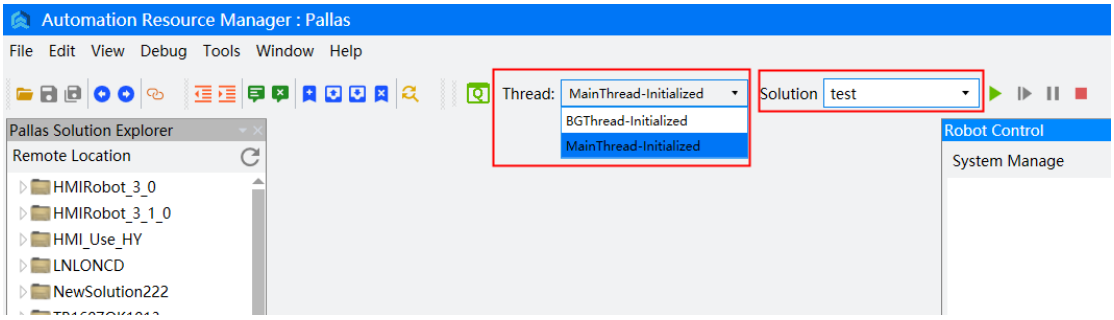


Figure 3-25 Start QRL Project

3.5 Login Permissions

In the upper right corner of the software interface, you can select the permissions to operate the software.

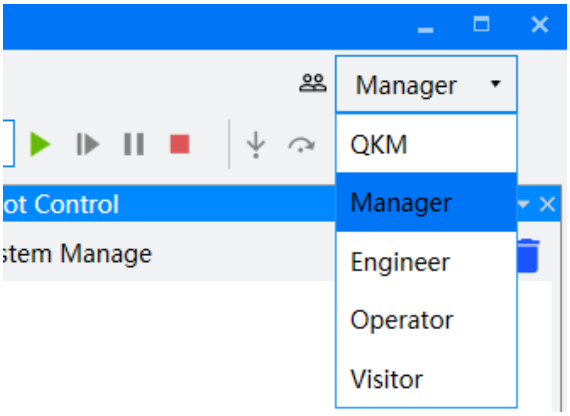


Figure 3-26 Select Permissions

Click on the corresponding permission and enter the password corresponding to the permission in the pop-up box to log in and operate the robot with this permission. After checking "Auto Login", the next time the software starts, it will automatically log in to the previous login permission.

QKM: Has all permissions for the software and can view and modify passwords for other permissions.

Manager: Has all permissions except for modifying passwords.

Engineer: Has the authority to operate and control robots, but cannot perform firmware upgrades or other operations on devices.

Operator: Only has operation permissions and can start and stop the robot, but cannot modify operating parameters.

Visitor: Only allowed to view the status of the robot, unable to operate the robot.

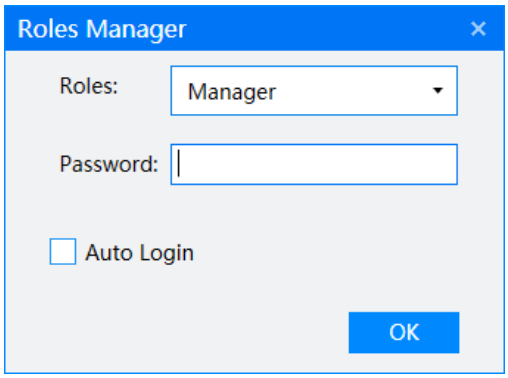


Figure 3-27 Login

Note: The password for administrators and those with lower permissions than administrators are 12345678 by default. It can be modified through the manufacturer's permissions. If you need manufacturer's permissions or to modify the password, please contact QKM's after-sales personnel.

3.6 Robot Control Panel

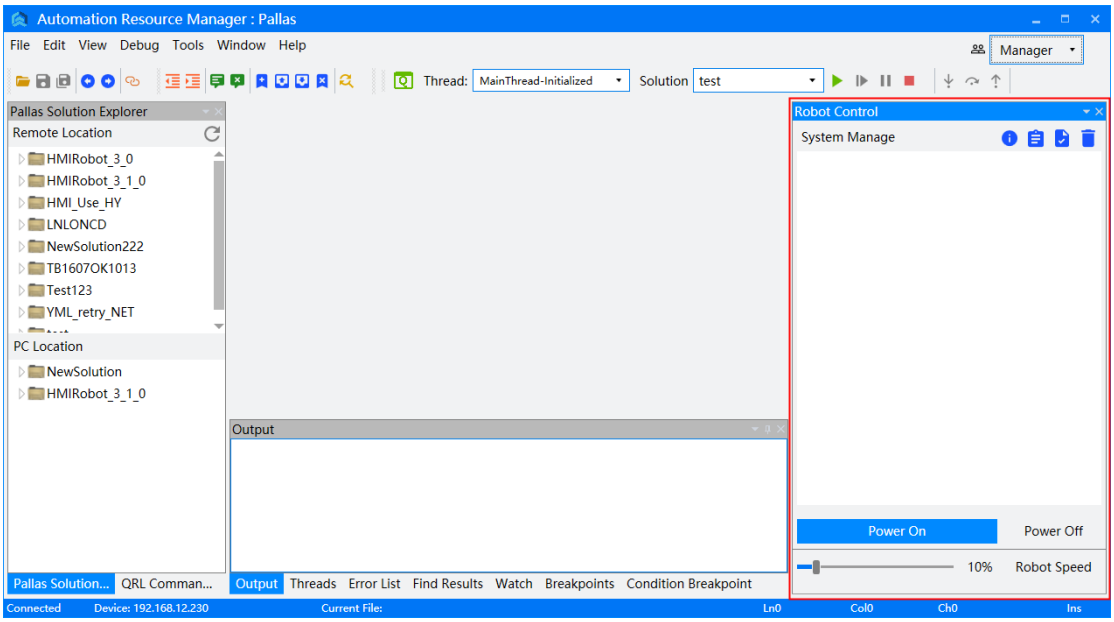


Figure 3-28 Robot Control Panel

In Robot Control panel, users can perform the following operations:

(1) View firmware version of robot system;

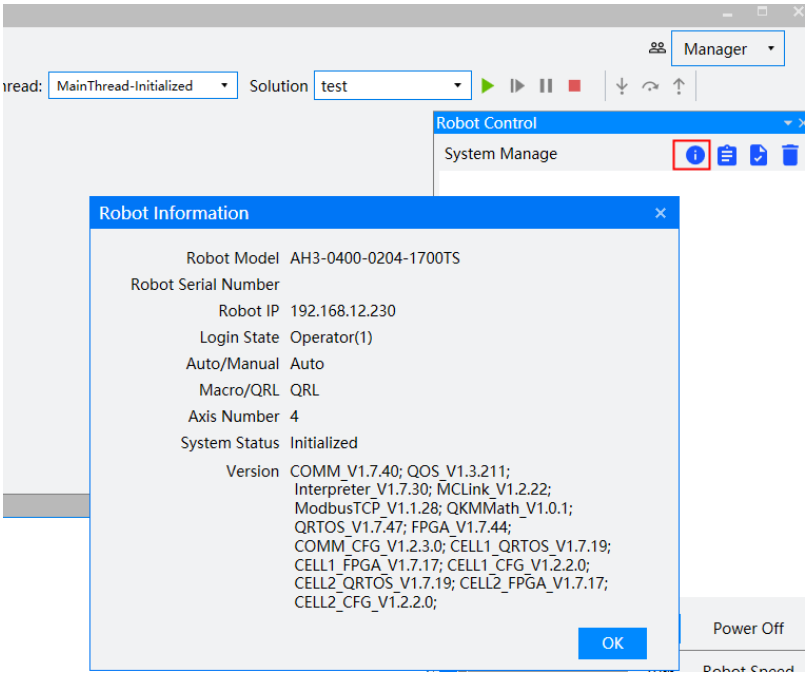


Figure 3-29 Robot Information

(2) View robot system logs;

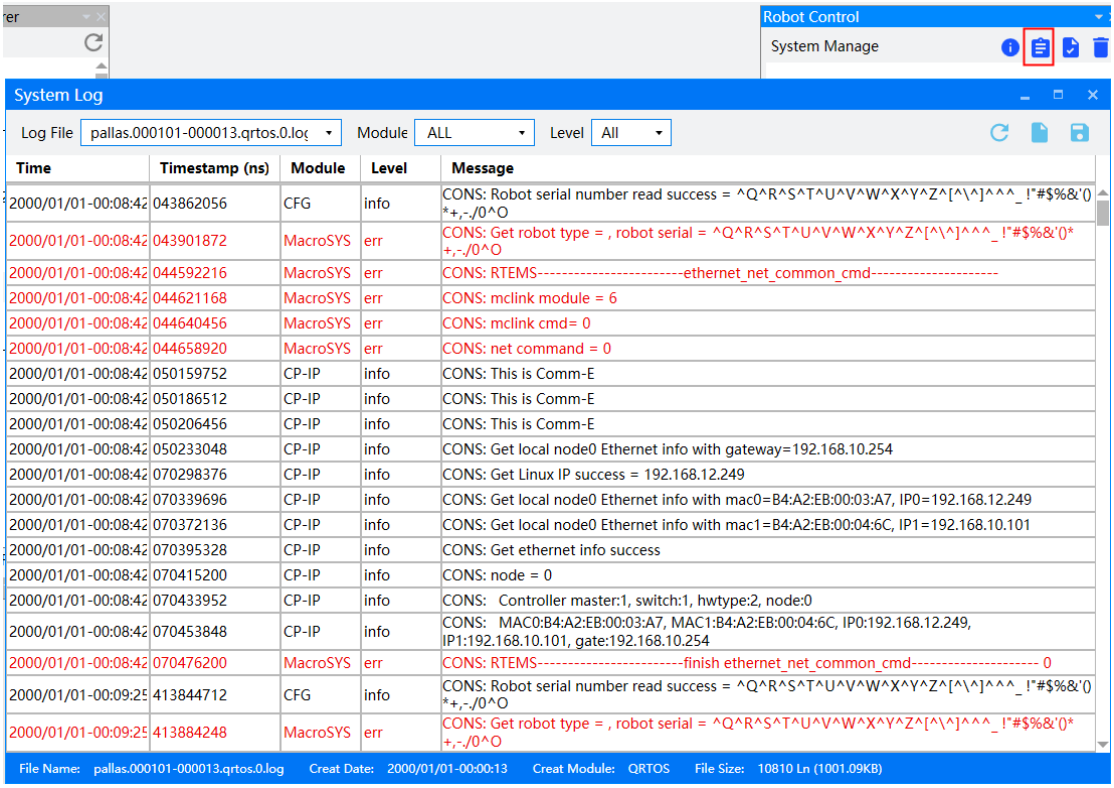


Figure 3-30 System Log

(3) View robot system error messages;

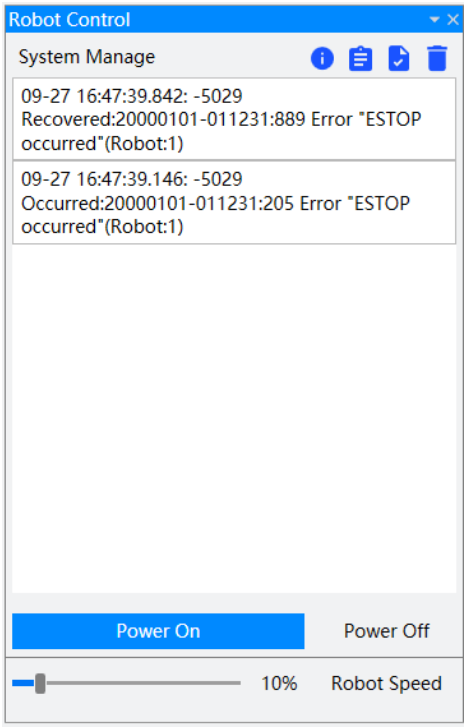


Figure 3-31 System Information

(4) Monitor power-on state and robot speed, and perform operations of power-on/off, adjusting robot speed.

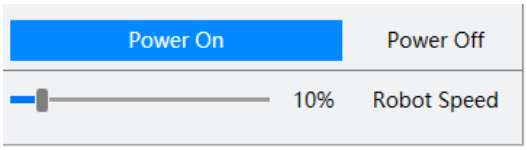


Figure 3-32 Simple Operations

3.7 Introduction of Common Tools

3.7.1 IDN Configuration

Users can modify some system parameters of the robot through the IDN parameter configuration interface. Select IDN parameter configuration under the menu bar tool options.

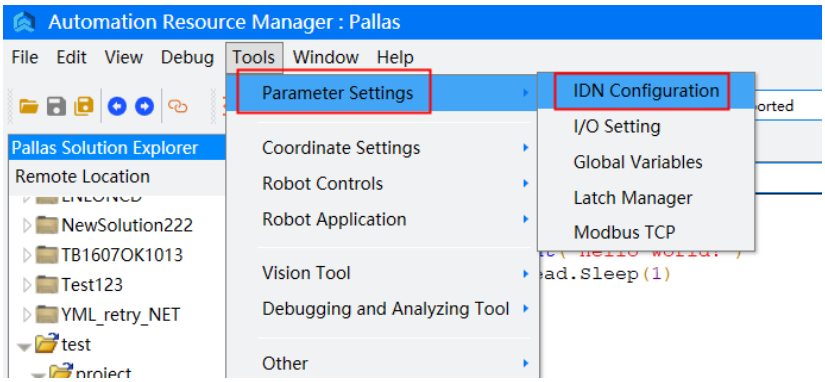


Figure 3-33 Select IDN Configuration

Users can modify the robot's motion parameters, control parameters, workspace, system settings, fan detection and other parameters in the IDN parameter configuration interface, and support modifying unlisted IDN parameters through the custom settings interface.

Note: **This function requires Manager and above permissions.**

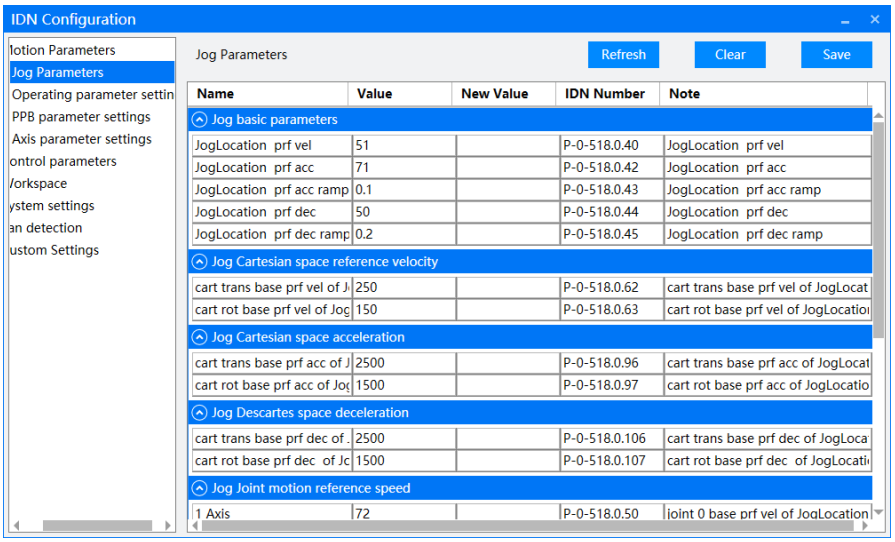


Figure 3-34 IDN Parameter Configuration

3.7.2 I/O Setting

Users can monitor I/O status and perform I/O setting operations in I/O Setting interface. Select I/O Setting under Tools in the menu bar.

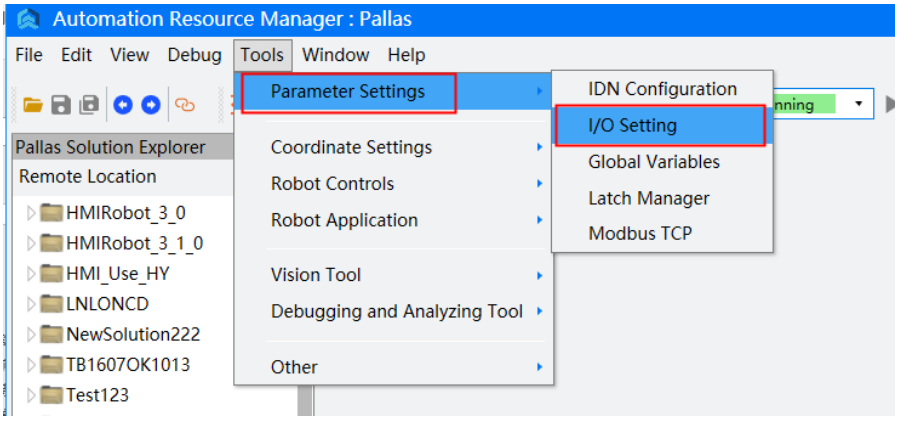


Figure 3-35 Select I/O Setting Interface

Users can monitor and perform all digital inputs, digital outputs and high-speed inputs on System Group page, and perform custom grouping in I/O Setting interface.

Note: **If I/O is configured as dedicated I/O, I/O status cannot be set through this interface (Refer 3.7.17 for configuration method)**

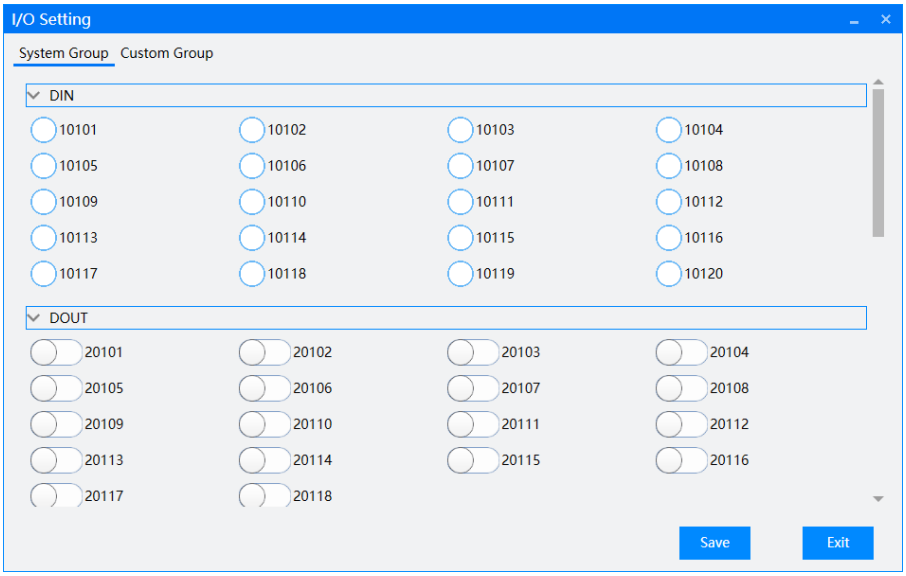


Figure 3-36 I/O Setting Interface

Users can make some remarks on I/O in the I/O remark box for easy identification of I/O. Upon completion, click the Save button to save the remarks.

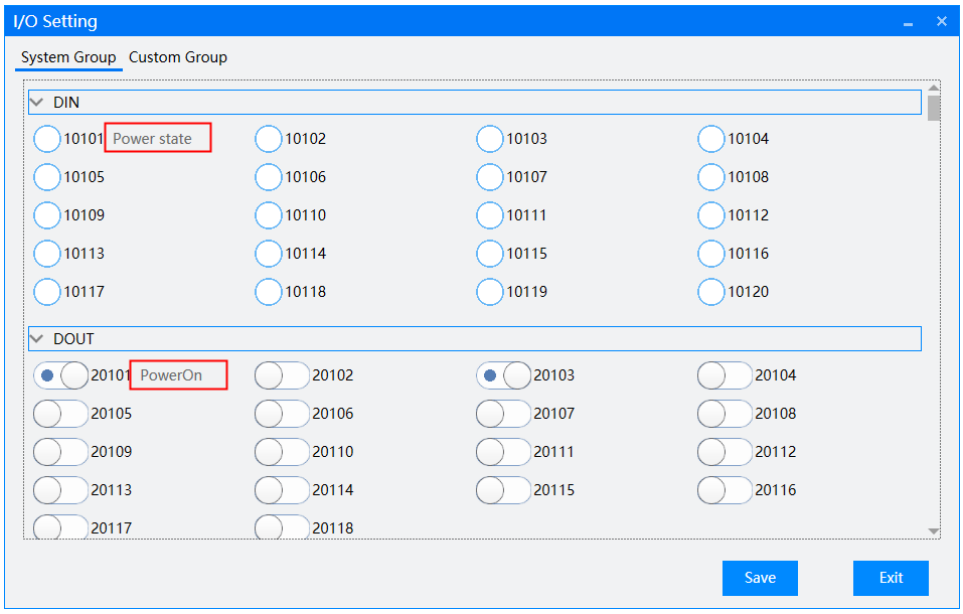


Figure 3-37 Remark Name of I/O

Users can monitor and operate I/O signals.

Right-click the corresponding signal to enable the signal to enter a forced state (on which a lock sign is marked), and then click the corresponding signal to turn it on or off. Right click a signal in forced state to take the signal out of the forced state.

The input signal 10101 is normally on; the input signal 10102 is normally off; the input signal 10105 is forcibly off; and the input signal 10106 is forcibly on.

The output signal 20101 is normally on; the output signal 20102 is normally off; the output signal 20105 is forcibly off; and the output signal 20106 is forcibly on.

Note: **Before starting a robot program, handle signals in forced states. If the robot program does not have functions called for clearing signals in forced states, the signals will be forcibly on or off.**

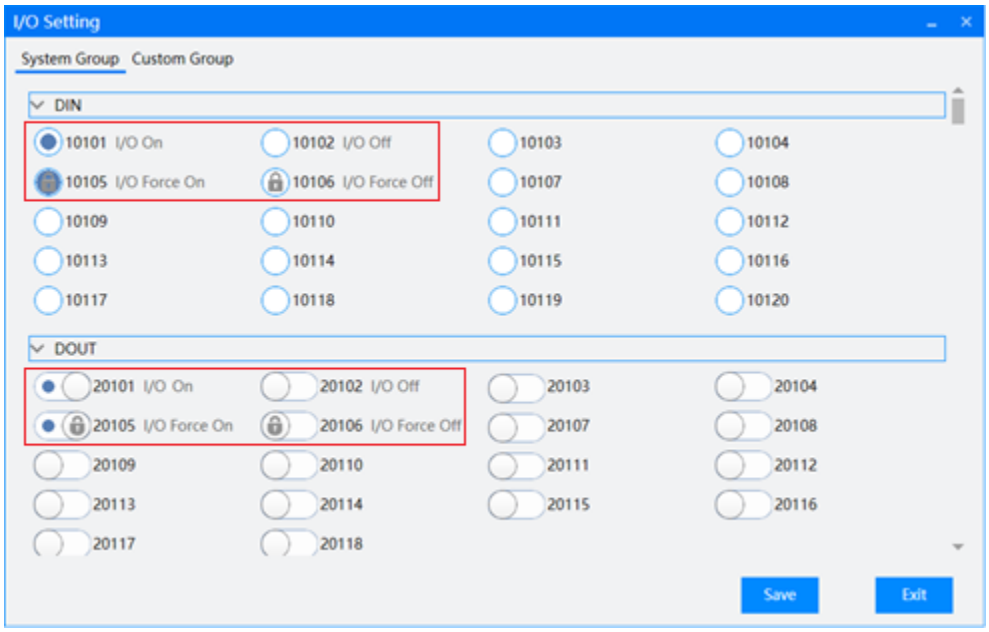


Figure 3-38 Monitor and Operate I/O

Users can create corresponding I/O custom groups according to I/O used by project in Custom Group of I/O Setting interface for monitoring and operating I/O used by project.

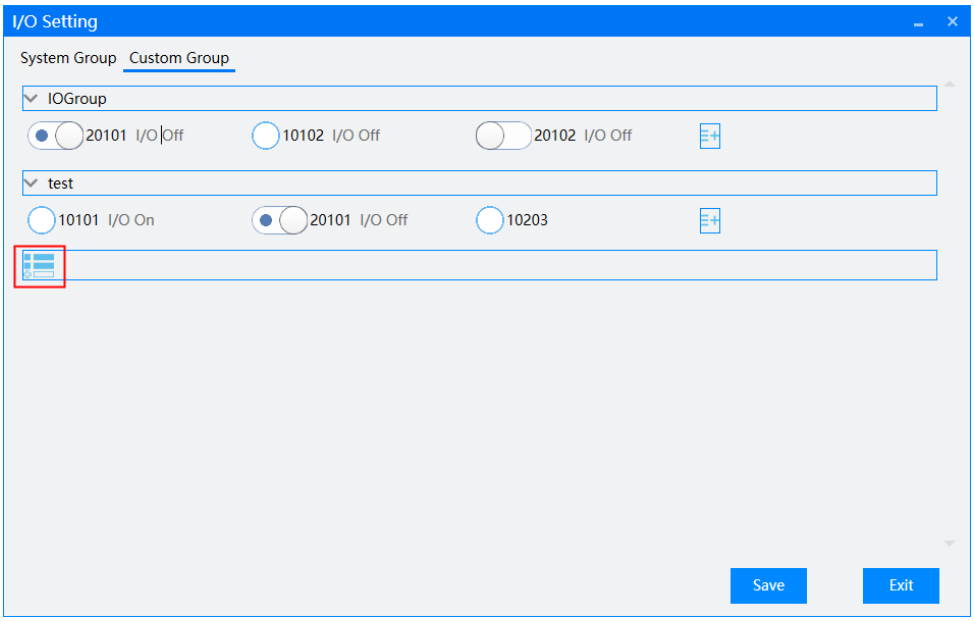


Figure 3-39 Create Custom Groups

3.7.3 Global Variables

Users can monitor, modify, and annotate global variables in the global variable interface. Select Global Variables under the menu bar tool options to open the Global Variables window.

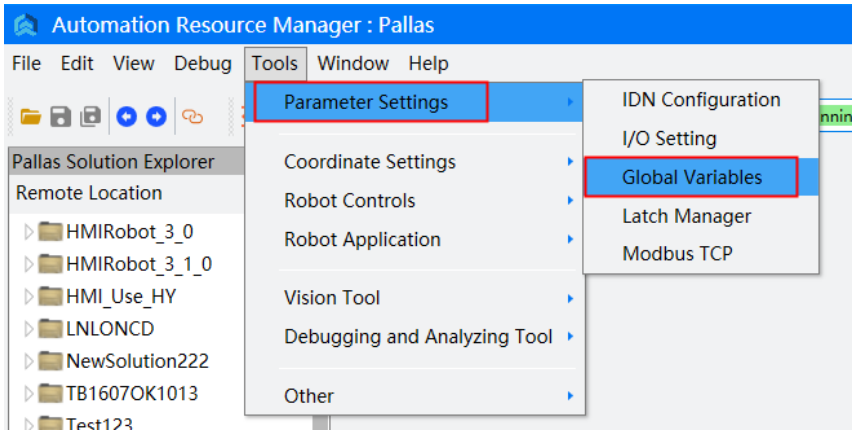


Figure 3-40 Select Global Variables

After opening the global variable interface, you can view the values of GBool, GInt, GDouble, and GString global variables in the interface, set corresponding notes, and add commonly used global variables to favorites for easy use.

Note: **After modifying the shared variable, click the save button. After the robot is powered off and restarted, the modified content will be retained.**

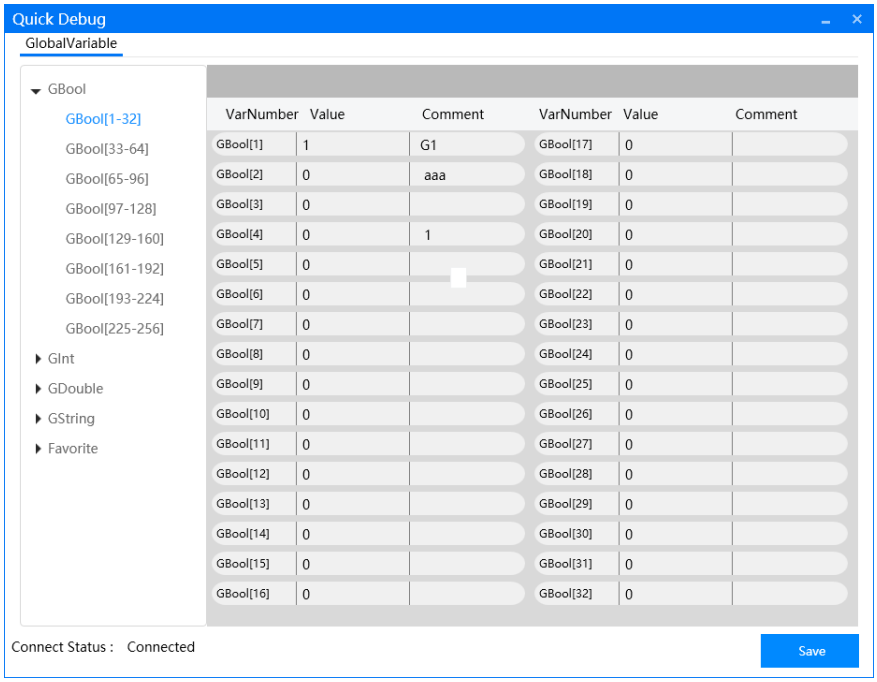


Figure 3-41 Global Variables Interface

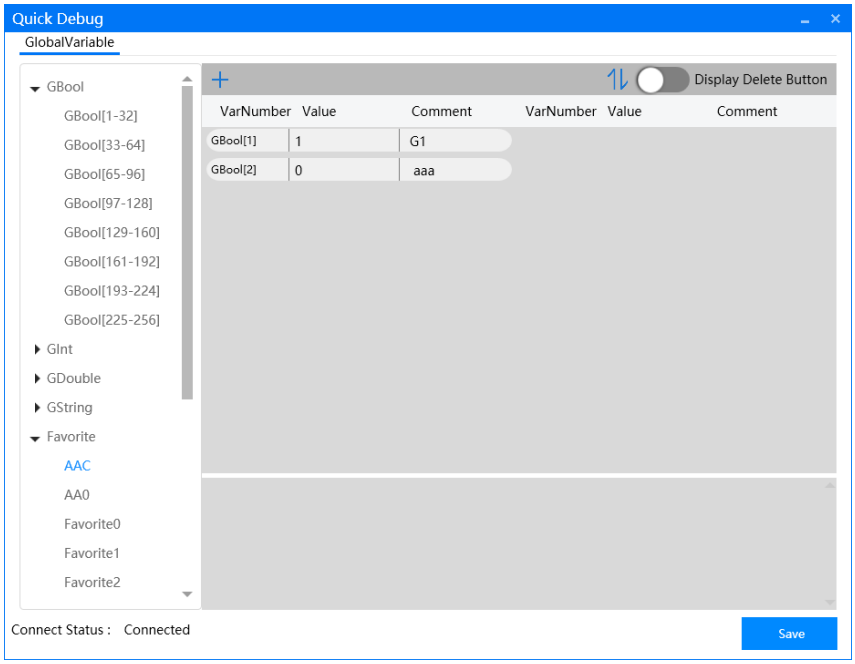


Figure 3-42 Global Variables Favorite

3.7.4 Latch Manager

Users can add and manage Latches in the Latch management interface. Select Latch Management under the menu bar tool options to open the Latch Management window.

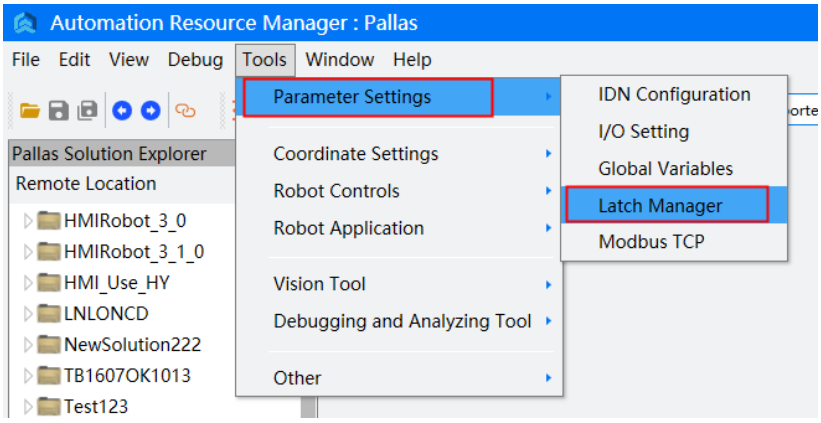


Figure 3-43 Latch Manager

After opening the Latch management interface, you can create Latch signals in the interface and manage the created Latches to view their triggering status.

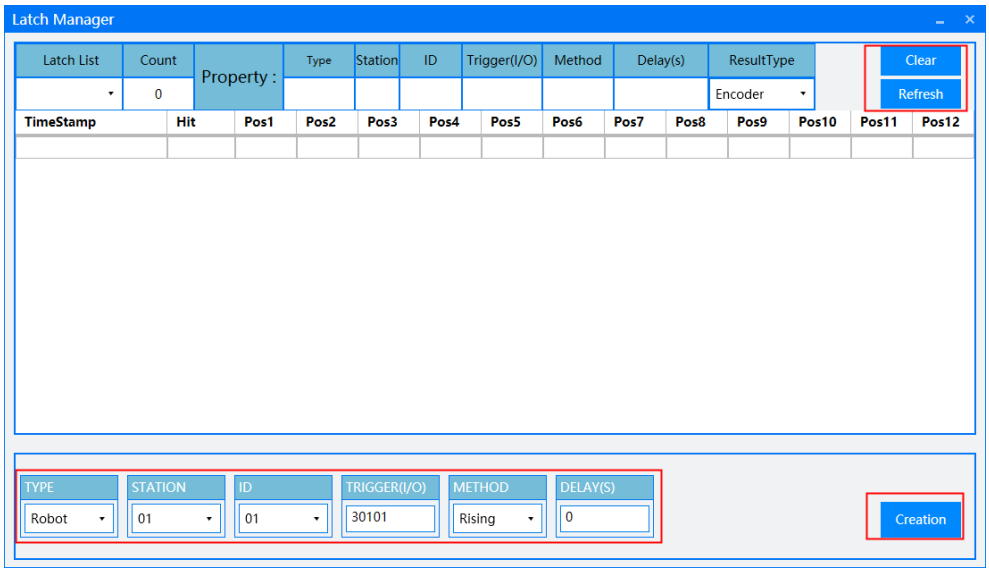


Figure 3-44 Latch Manager Interface

3.7.5 Modbus TCP

Users can configure the parameters of the robot Modbus TCP Master Station in Modbus TCP Wizard interface, and perform I/O mapping interaction with the remote I/O module as Modbus TCP Slave Station. Select Modbus TCP Wizard under Tools in the menu bar.

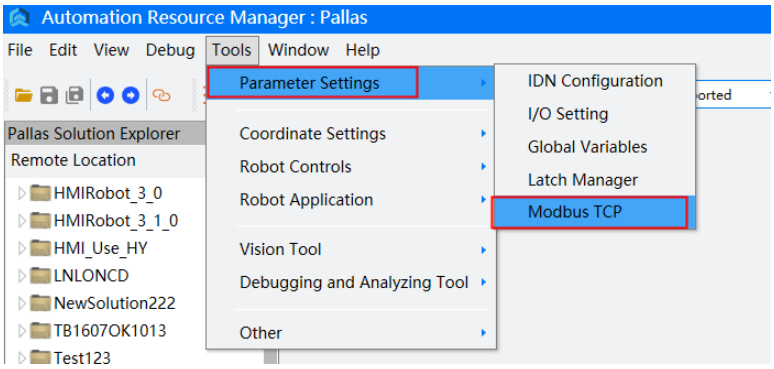


Figure 3-45 Select Modbus TCP Wizard Interface

In the Modbus TCP Wizard interface, users can modify parameters as needed

Common parameters, which will take effect on all Modbus TCP nodes after modification:

Scan time: The time interval for scanning Modbus device data.

Scan timeout: If the Robot is not communicated with the Modbus device for more than this time, it is considered that the connection is disconnected. Note that this time needs to exceed the scan time.

I/O partition quantity: The maximum I/O quantity displayed for each I/O grouping. If

the quantity mapped by a node exceeds this setting, it will be divided into multiple I/O groupings.

I/O Continuity: After setting I/O continuity, the signals mapped by multiple nodes will be displayed in one I/O grouping until the grouping exceeds the limit of I/O segmentation before being displayed in the next grouping.

Modbus node: One node corresponds to one remote I/O module, and users need to add or delete nodes according to the actual situation.

IP address: IP address of remote I/O modules.

Server DI start address: Start address of input signals that need to be mapped.

DI number: Number of input signals that need to be mapped.

Server DO start address: Start address of output signals that need to be mapped.

DO number: Number of output signals that need to be mapped.

Scanner enable: Check to enable the interaction function of the robot ModbusTCP Master Station; uncheck to disable the interaction function of the robot ModbusTCP Master Station. Upon checking, related I/O correspondence will be generated for users to view.

Upon parameter setting, click the Apply button. Parameter settings will take effect after restart.

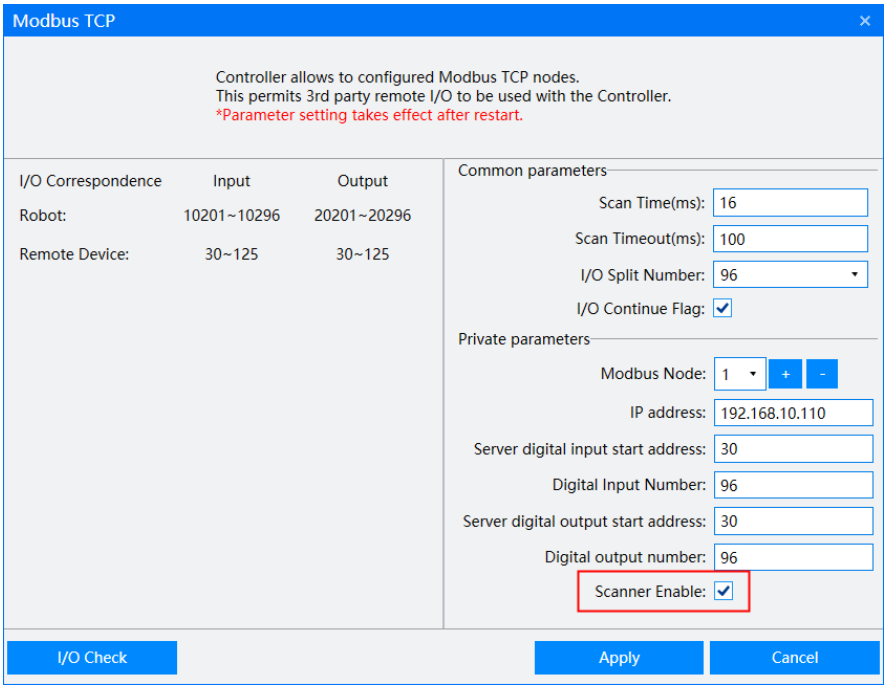


Figure 3-46 Modbus TCP Wizard Interface

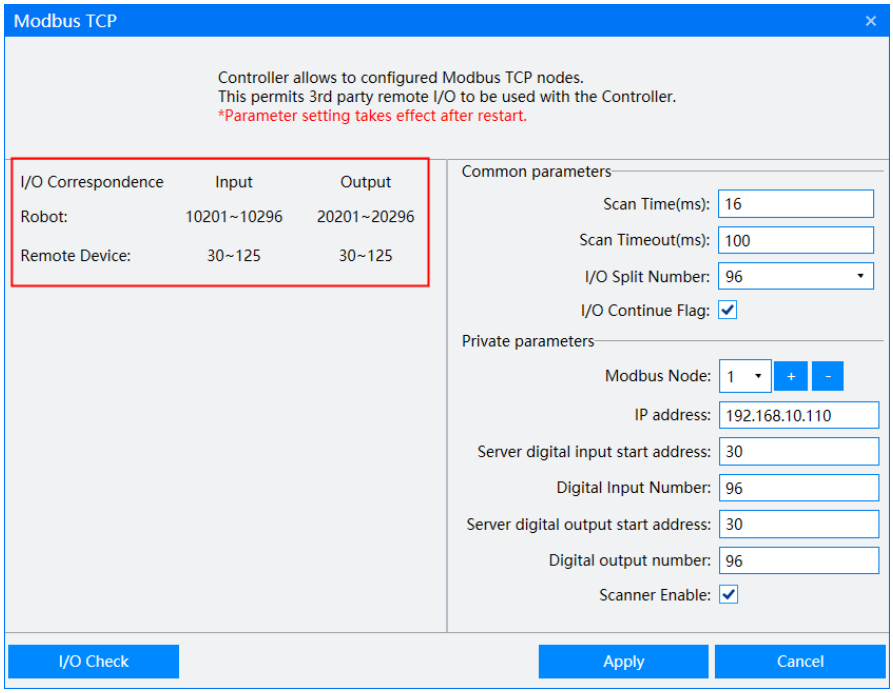


Figure 3-47 I/O Correspondence in Modbus TCP Wizard Interface

3.7.6 Tool Frame

Users can calibrate the TCP (Tool Center Point) tool coordinate system of the robot in Tool Frame Calibration interface. Select Tool Frame Calibration under Tools in the menu bar.

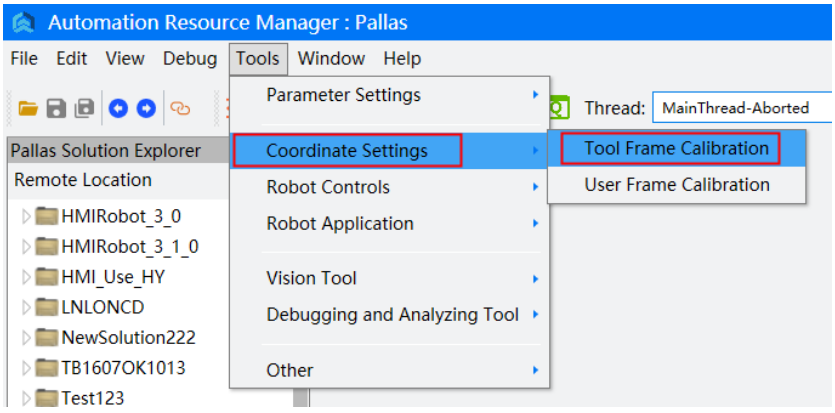


Figure 3-48 Select Tool Frame Calibration Interface

In Tool Frame Calibration interface, users can calibrate the TCP tool coordinate system of four-axis robot and six-axis robot respectively.

Users can perform calibration in Teach or Calculate mode.

Teach mode: After entering the Teach mode, users move the robot according to the steps in the wizard on Tool frame calibration interface and record the location

information to complete the calculation on the TCP tool coordinate system.

Calculate mode: After entering the Calculate mode, users only need to input the required location information to complete the calculation on the TCP tool coordinate system.

Set Tool: Set the currently selected tool coordinate to the robot's tool coordinate.

Save: Save the tool coordinates of the current interface so that they still exist after power outage and restart.

Calibrate: Open the tool coordinate calibration interface and recalibrate the selected tool coordinates.

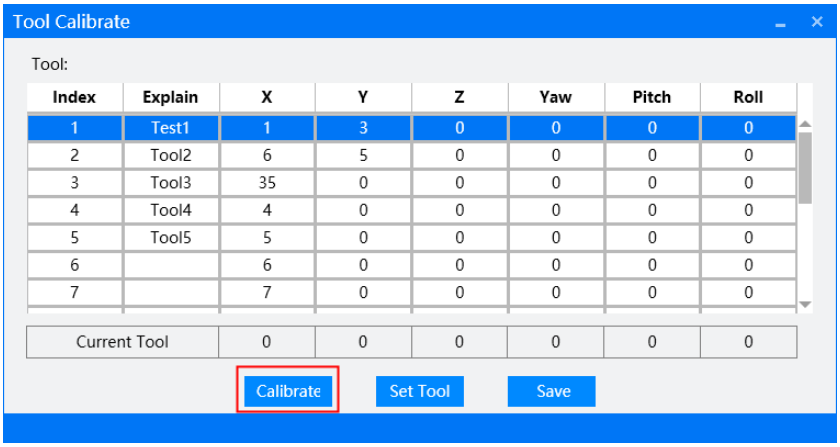


Figure 3-49 List of Tool Coordinates

Step 1 Select <Teach Mode>, and select <TCP Two-Point Method> or <TCP Four-Point Method> by robot type. Four-axis robot is used as an example herein, so select <TCP Two-Point Method>, and click <Sure> button.

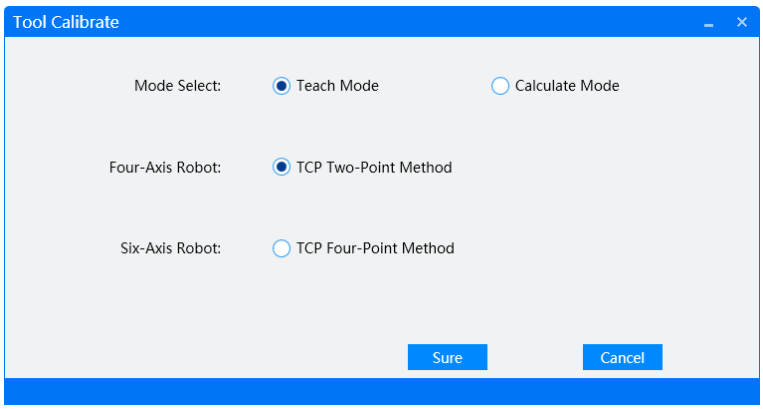


Figure 3-50 Tool Frame Calibration Interface

Step 2 Fix the calibration fixture at any position within the working range of the robot. Move the robot to enable the center of its end fixture (or sucker) to contact the center

of the calibration fixture. Click <Record> and <Next> buttons.

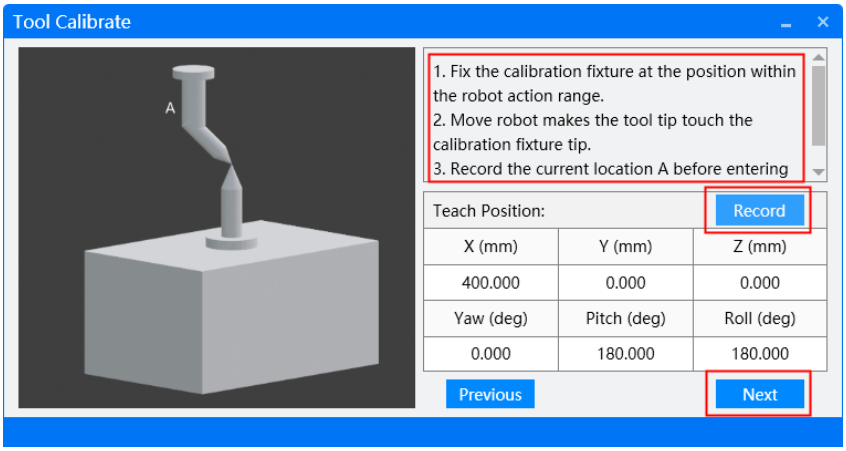


Figure 3-51 Record Location A

Step 3 Lift the Z-axis and rotate it. Ensure that the difference between the Roll value of the robot and that of Location A recorded for the first time is more than 30 °. Move the robot again to enable the center of its end fixture (or sucker) to contact the center of the calibration fixture. Click <Record> and <Next> buttons.

Figure 3-52 Record Location B

Step 4 Click the <Calculate> button to calculate the tool coordinates of the robot end fixture (or sucker). Click the <Sure> button to end calibrate.

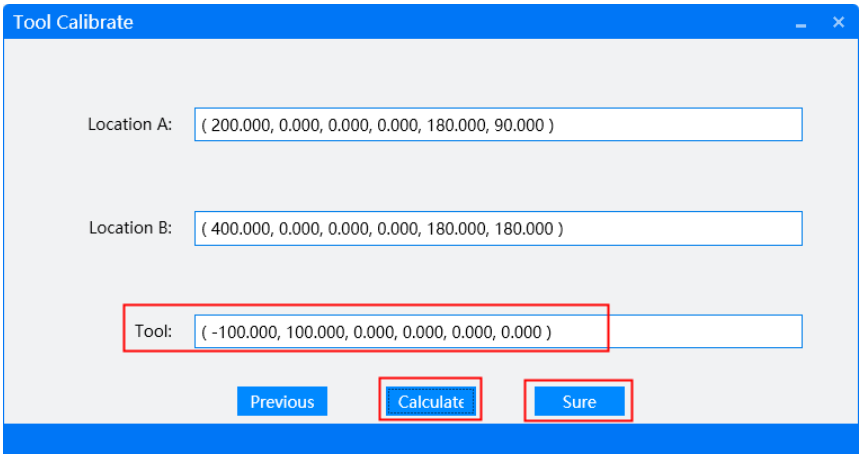


Figure 3-53 Calculate Tool Coordinates

3.7.7 User Frame

Users can calibrate the robot user coordinate system in the User Frame Calibration interface. Select User Frame Calibration under the menu bar.

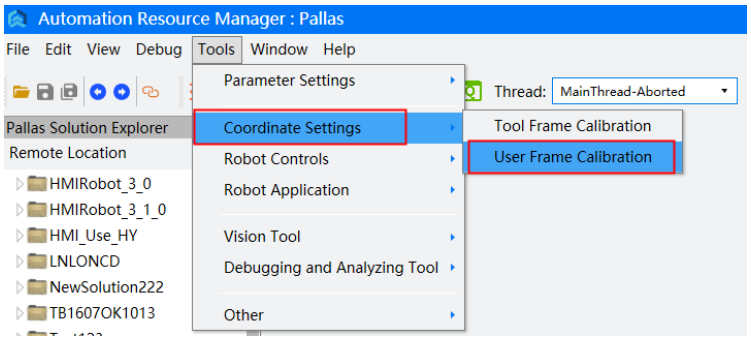


Figure 3-54 User Frame

Open the User Frame Calibration interface, select the user coordinate to be calibrated in the left user coordinate series table, and manually write the points on the three user coordinate systems shown in the figure through teaching or manual writing. Click Calculate to calculate the current user coordinate system.

Settings: Use the current user coordinates.

Save: Save the current user coordinates to the robot, but do not use them.

Set and Save: Use the current user coordinates and saving to the robot

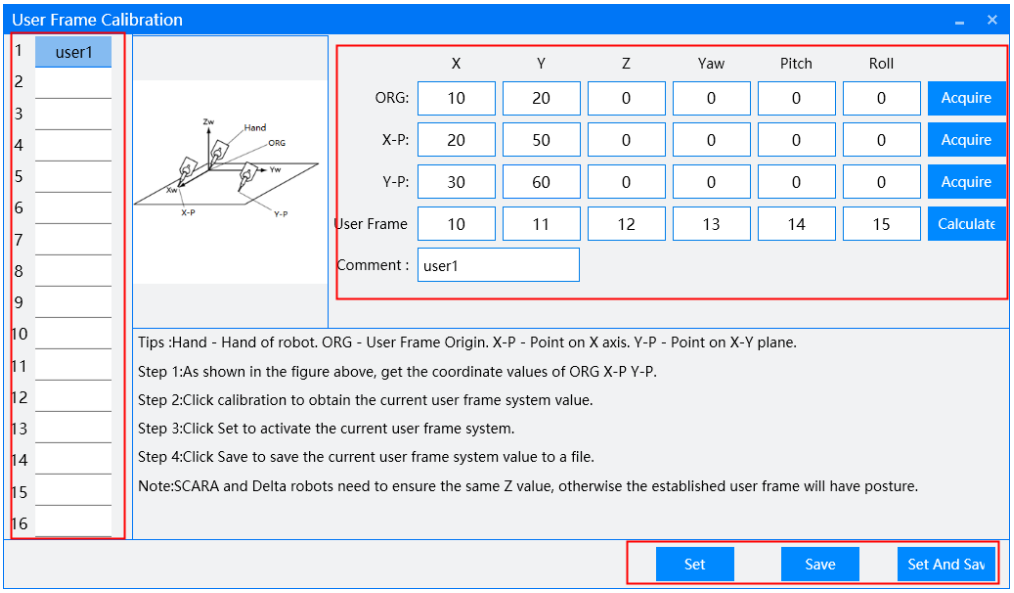


Figure 3-55 User Frame Coordinate

3.7.8 Jog Control

Users can move the robot in Jog Control interface. Select Jog Control under Tools in the menu bar.

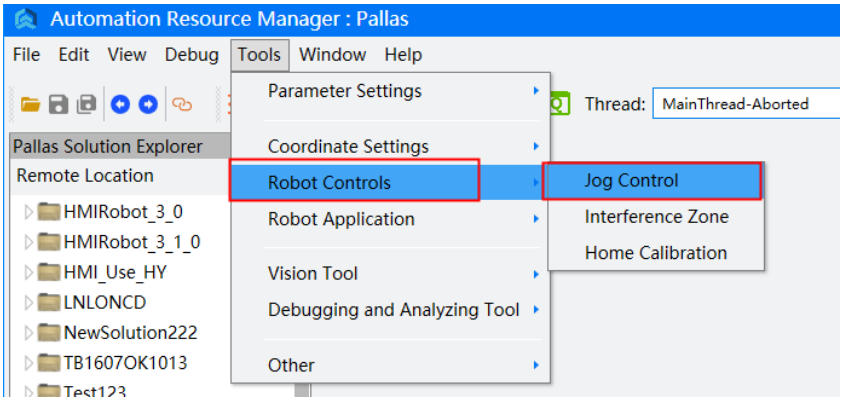


Figure 3-56 Select Jog Manual Interface

In Jog Control interface, you can monitor and control the following robot parameters in real time:

(1) Current Cartesian coordinates and axis coordinates;

(The Yaw and Pitch from Cartesian coordinates of a four-axis robot is 0 and 180 respectively, and remain unchanged; the J5 and J6 from joint coordinates of a four-axis robot are both 0, and remain unchanged.)

(2) Current TCP coordinates;

(3) Current Config information.

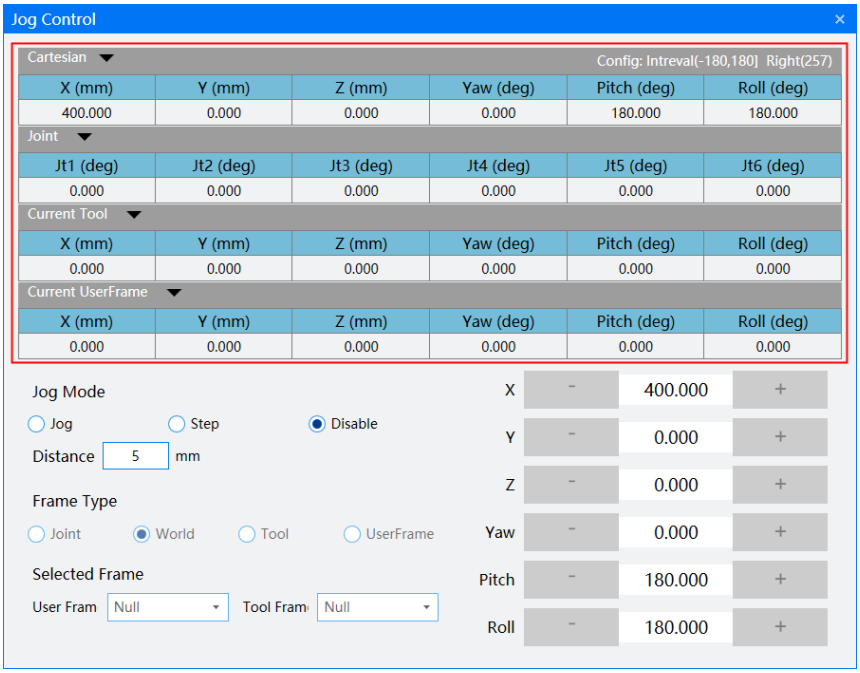


Figure 3-57 Coordinate Display in Jog Control Interface

The Config contains two parts, one is the real robot config, and the other is the region limit for joints with a motion range exceeding 360 °.

The robot supports 4 regions, defined as follows:

192: All joints with a motion range of more than 360 ° for robots are between (-540 °,-180 °];

256: All joints of the robot with a range of motion exceeding 360 ° are between (-180 °,180 °];

320: All joints of the robot with a range of motion exceeding 360 ° are between (180 °,540 °];

0: All joints of the robot with a range of motion exceeding 360 °are in different ranges.

The four-axis robot supports two configurations, defined as follows:

Right-hand: RIGHTY (0x0001)

Left-hand side: LEFTY (0x0002)

Six-axis robot supports 8 configurations

config	wrist	elbow	shoulder
21	flip	up	right
22	flip	up	left
25	flip	down	right

26	flip	down	left
37	nonflip	up	right
38	nonflip	up	left
41	nonflip	down	right
42	nonflip	down	left
15	wrist singularity		
51	elbow singularity		
60	hand singularity		

Table 3-9 Six-axis Robot Config

Status value	hexadecimal	decimalism
right shoulder	0x01	1
left shoulder	0x02	2
up elbow	0x04	4
down elbow	0x08	8
flip	0x10	16
nonflip	0x20	32
status value	hexadecimal	decimal

Table 3-10 Six-axis Robot Status Value

The final Config value of the robot is obtained by adding the region value to the config value.

※Be sure to perform control in Macro mode, otherwise an error will be reported.

In Jog Manual interface, you can continuously move the robot or jog the robot in Cartesian coordinate system, axis coordinate system, tool coordinate system, or user coordinate system.

Note: **Make sure that the robot is powered on and homed before controlling the**

robot to move. Otherwise, an error message will appear and the robot cannot be moved. To ensure safety, reduce the system speed before controlling the robot to move.

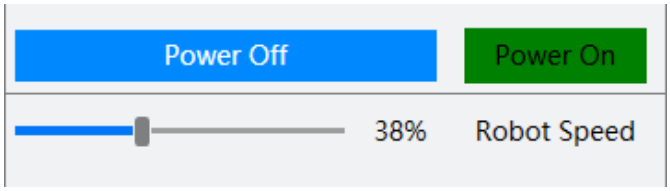


Figure 3-58 Simple Operations

Continuous movement operation in Cartesian coordinate system (tool coordinate system):

Select Step under Jog Mode and Tool (tool coordinate system) under Frame Type. Long press the "+" button beside the X, Y, Z, Yaw, Pitch and Roll, the robot will move in the positive direction of the Cartesian coordinate system (tool coordinate system). Long press the "-" button, the robot will move in the negative direction of the Cartesian coordinate system (tool coordinate system). Release the button, the robot will stop moving.

Continuous movement operation in axis coordinate system

Select Step under Jog Mode and Axis Coordinate System under Frame Type. Long press the "+" button beside J1, J2, J3, J4, J5 and J6, the robot will move in the positive direction of the corresponding axis. Long press the "-" button, the robot will move in the negative direction of the corresponding axis. Release the button, the robot will stop moving.

Jog in Cartesian coordinate system (tool coordinate system):

Select Jog under Jog Mode and Tool (tool coordinate system) under Frame Type. Write the jog value in Distance (with a unit of mm in Cartesian coordinate system) to jog the robot. Click the "+" button beside the X, Y, Z, Yaw, Pitch and Roll, the robot will jog the corresponding distance in the positive direction of the Cartesian coordinate system (tool coordinate system). Click the "-" button, the robot will jog the corresponding distance in the negative direction of the Cartesian coordinate system (tool coordinate system). After jogging the corresponding distance, the robot will stop moving.

Jog in axis coordinate system:

Select Jog under Jog Mode and Axis Coordinate System under Frame Type. Write the jog value in Distance (with a unit of degree in axis coordinate system) to jog the robot.

Click the "+" button beside the X, Y, Z, Yaw, Pitch and Roll, the robot will jog the distance in the positive direction of the corresponding axis. Click the "-" button, the robot will jog the distance in the negative direction of the corresponding axis. After jogging the corresponding distance, the robot will stop moving.

3.7.9 Interference Zone

1. Application scenario:

1). During the process of space movement, robots may encounter some areas that need to be avoided, and the areas to be avoided need to be set as the interference zone of the robot.

2). When the robot cooperates with external equipment for operation, when specific conditions are required for the machine to be allowed to enter the operation area, it is necessary to set the operation area as the interference zone of the robot.

3). When multiple robots work together, a certain area is the working position of multiple robots, and it needs to be set as the interference area of multiple robots to reasonably plan the sequence of multiple robots' operations.

2. Function Introduction:

1). The robot will automatically pause when it reaches the interference zone position.

2). When the robot is in the interference zone, it will output a DOUT signal.

3. Function usage:

1). Open the tool and select the Interference Zone under the tool options in the menu bar.

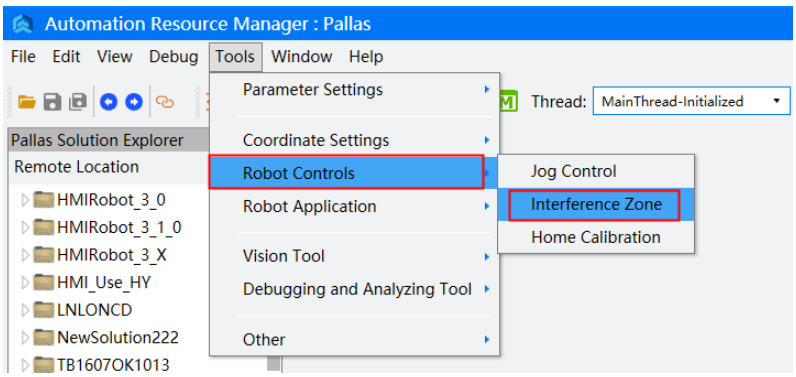


Figure 3-59 Interference Zone

2). Open the interference zone setting interface, select the interference zone to be set in the left interference zone list, set the shape attributes of the interference zone, and

set the attributes such as whether the interference zone is enabled, effective range, and activation method on the right. Select settings to avoid the robot in the interference zone and prevent collisions between the robots.

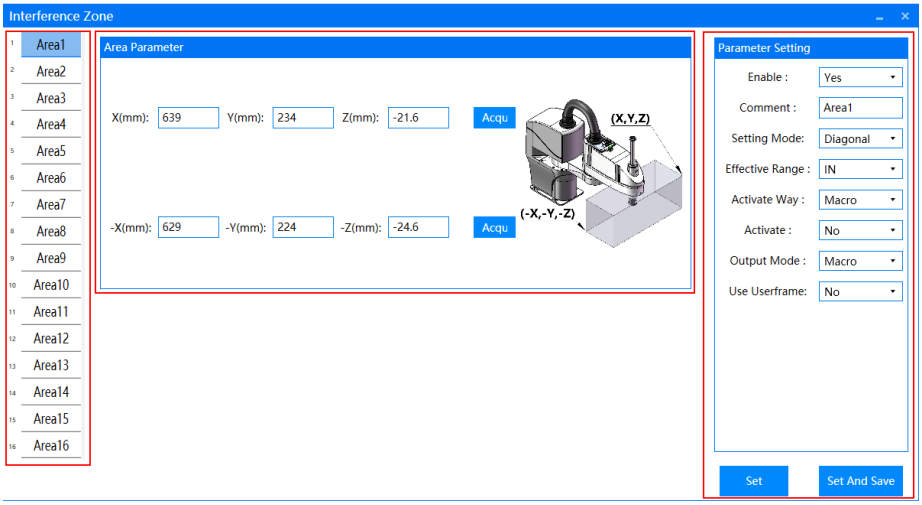


Figure 3-60 Interference Zone Interface

4. Explanation of interference zone parameters:

Currently, Pallas robots offer up to 16 sets of custom configurations for interference zones.

1). Enable

Interference zone switch, selection Yes: the interference zone is valid and can be configured with interference zone parameters; Select No: The interference zone is invalid.

2). Comment

Explain the interference zone for easy user differentiation.

3). Setting Mode

Diagonal

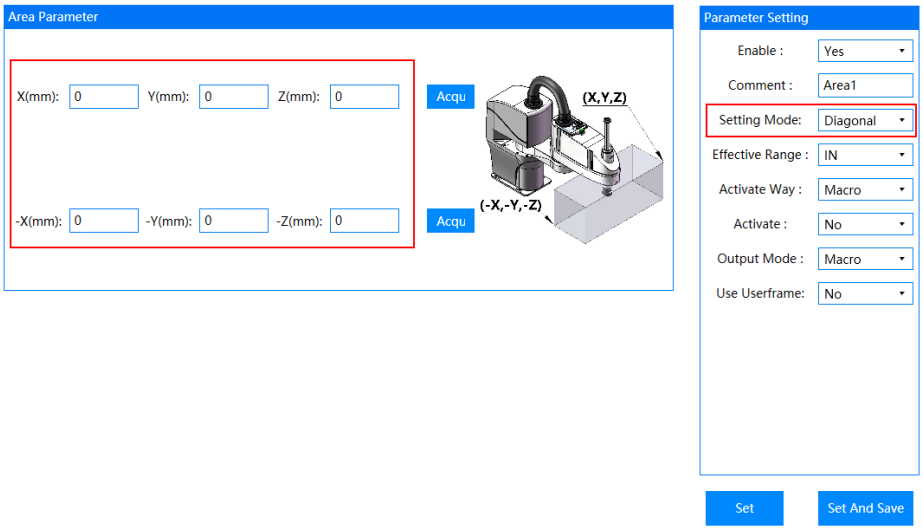


Figure 3-61 Diagonal Method of Interference Zone

a) Determine a rectangle area by setting two points.

b) Move the robot to a specific position, click the get button, and the robot will automatically record the current position.

d) The two point data for determining the cuboid area is based on the user coordinate system.

When no is selected in the setting user coordinate system in the settings attribute, the default user coordinate system of (0,0,0,0,0,0) is used by default.

When selecting Yes in the Set User Coordinate System section of the Settings Properties section, the corresponding user coordinate system needs to be filled in the 'User Coordinate System Settings page. When the filled data is (0,0,0,0,0,0), the same effect as selecting No in the User Coordinate System section is achieved

Center

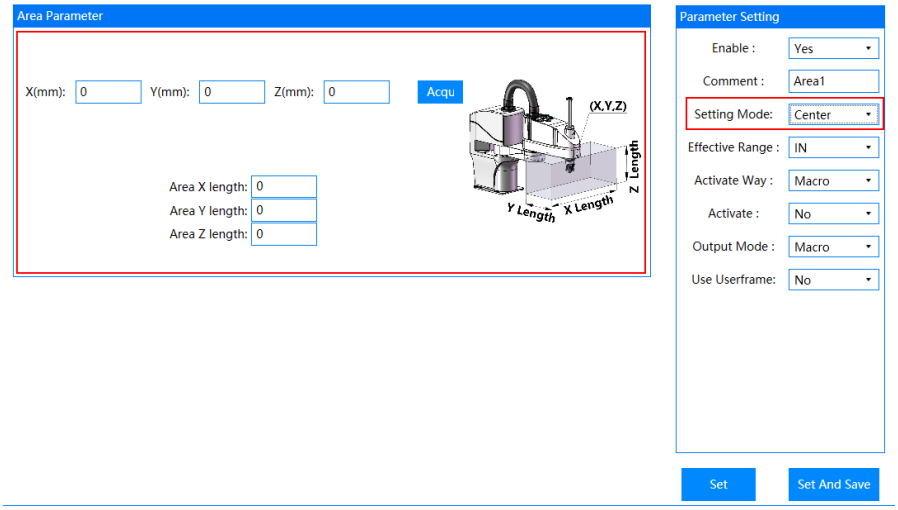


Figure 3-62 Center Method of Interference Zone

a) Determine a cuboid area by setting a point and the length in the X, Y, and Z directions.

b) Move the robot to a specific position, which is the center of the cuboid area. Click the get button, and the robot will automatically record the current position.

c) The determination of a point data in the cuboid area is based on the user coordinate system.

When no is selected in the setting user coordinate system in the settings attribute, the default user coordinate system of (0,0,0,0,0,0) is used by default.

When selecting Yes in the Set User Coordinate System section of the Settings Properties section, the corresponding user coordinate system needs to be filled in the User Coordinate System page. When the data filled in is (0,0,0,0,0,0,0), the effect is the same as selecting No in the User Coordinate System section.

4). Effective Range

IN

The set cuboid area is the interference area, and the cuboid area has the function of interference area.

OUT

The outside of the set cuboid area is the interference area, and the outside of the cuboid area has the function of interference area.

5). Activation Way

After setting the interference zone parameters, it is necessary to activate the interference zone in order for the interference zone to function as interference zone function 1: when the robot enters the interference zone, stop the robot's action

There are four activation methods: Macro, I/O, Macro+AutoRetry, I/O+AutoRetry.

·Macro

Select the macro command activation method, and in the Activate option below, select "Yes" to activate the interference zone.

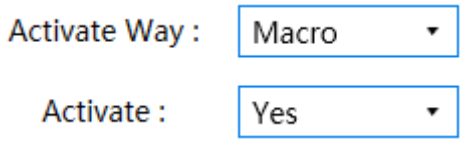


Figure 3-63 Macro Activation Way

·I/O

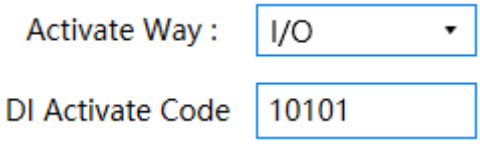


Figure 3-64 I/O Activation Way

Select the I/O activation method and fill in the correct digital input signal in the DI activation number option below, such as 10101. When there is a signal in 10101, the interference zone can be activated.

It should be noted that using I/O to activate the interference zone cannot use the forced I/O function. The I/O signal must be a digital input signal, and high-speed input signals can also be used, but soft I/O cannot activate the interference zone.

·Macro+AutoRetry

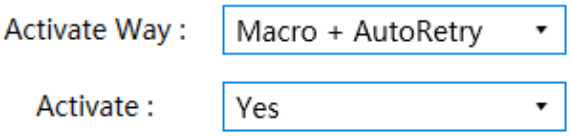


Figure 3-65 Macro+AutoRetry Activation Way

Select the Macro+AutoRetry activation method, and in the Activate option below, select "Yes" to activate the interference zone.

Configure Macro+AutoRetry retry, when the interference zone is not activated, the

robot in the interference zone can automatically restore its previous motion.

·I/O+AutoRetry

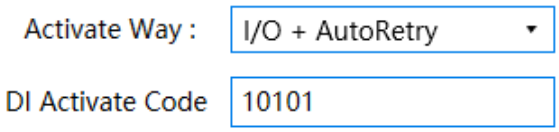


Figure 3-66 I/O+AutoRetry Activation Way

Select the I/O+AutoRetry activation method, and fill in the correct digital input signal in the DI activation number option below, such as 10101. When there is a signal in 10101, the interference area can be activated

It should be noted that using I/O to activate the interference zone cannot use the forced I/O function. The I/O signal must be a digital input signal, and soft I/O cannot activate the interference zone

Configure I/O+AutoRetry, so that when the interference zone is not activated, the robot in the interference zone can automatically restore its previous motion.

6). Output Mode

·Macro

When the interference zone is activated, you can use Zone.Get 1 to obtain the activation status of the interference zone and check whether the interference zone is activated. The 1 in the Zone.Get 1 command represents the interference zone with a sequence number of 1

·I/O

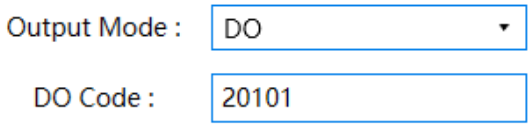


Figure 3-67 I/O Output Mode

When the interference zone is activated, the system will automatically output a digital output signal, which can be determined based on the status of the digital output number set below (whether it is open) to determine whether the interference zone is activated.

It should be noted that the DO output number can only be set for digital output signals, and soft I/O cannot be set.

When the interference zone is enabled, as long as the robot is within the interference zone, regardless of whether the interference zone is activated or not, the DO output signal will be output as 1.

7). Use UserFrame

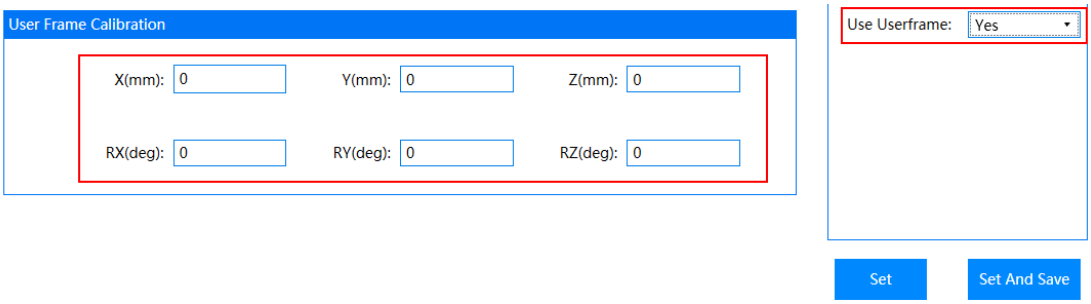


Figure 3-68 Use User Frame

Note: **Choosing the user coordinate system will affect the position of the interference area cuboid area set. The position data within the cuboid area is based on the user coordinate system. When the user coordinate system data is all 0, the effect is the same as selecting No.**

3.7.10 Home Calibration

Users can select the home calibration function under the menu bar tool options to recalibrate and calibrate the robot's zero point.

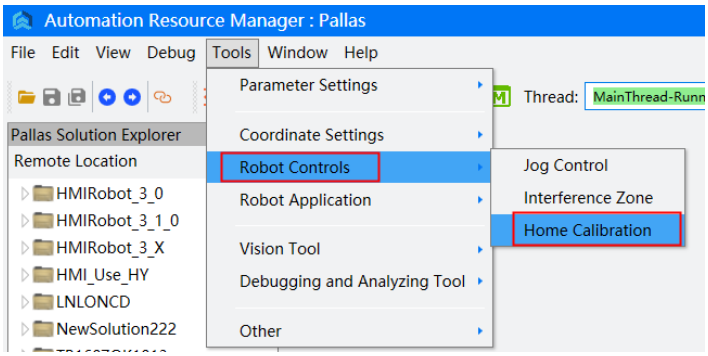


Figure 3-69 Select Home Calibration

Open the home calibration interface, select the robot model and calibration method to be calibrated, obtain the values of each axis encoder of the current robot through the Get Encoder Value button, and click the Calculate button to calculate the home position of the current robot.

Select the axis to recalibrate the home, and use the write button to write the calculated

home into the robot.

The calibration method currently supports both rough and accurate calibration.

Accurate: Use the calibration fixture provided by QKM to calibrate and obtain the encoder values according to the precise calibration method of the model, and then click the Calculate and Write buttons in sequence.
Rough: Turn each joint of the robot to the zero position, obtain the encoder value, and then click the calculate and write buttons in sequence.

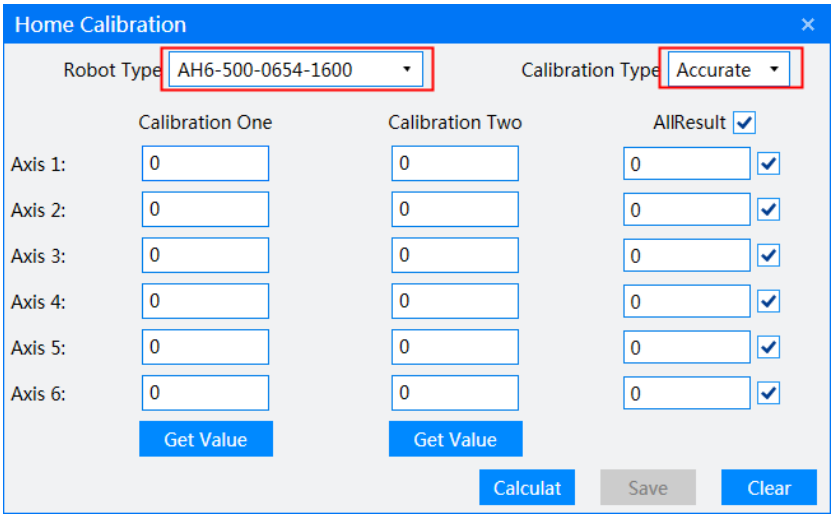


Figure 3-70 Home Calibration Interface

3.7.11 Conveyor Manager

Refer to the Conveyor Management Manual.

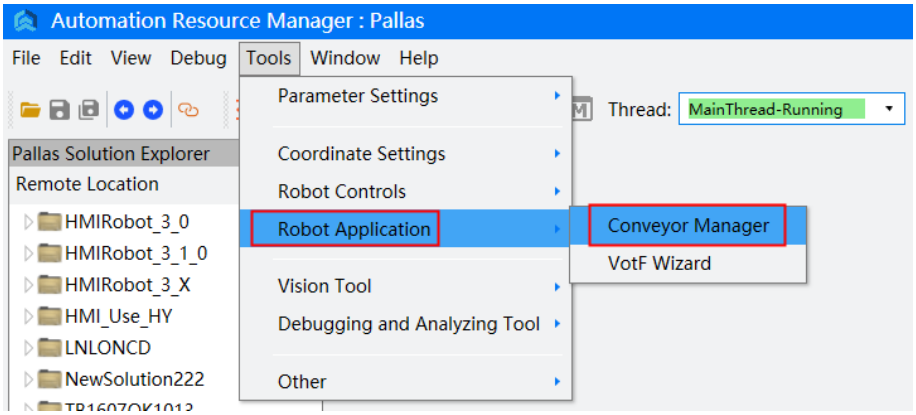


Figure 3-71 Select Conveyor Manager

3.7.12 VotF Wizard

Refer to the VotF Management Manual

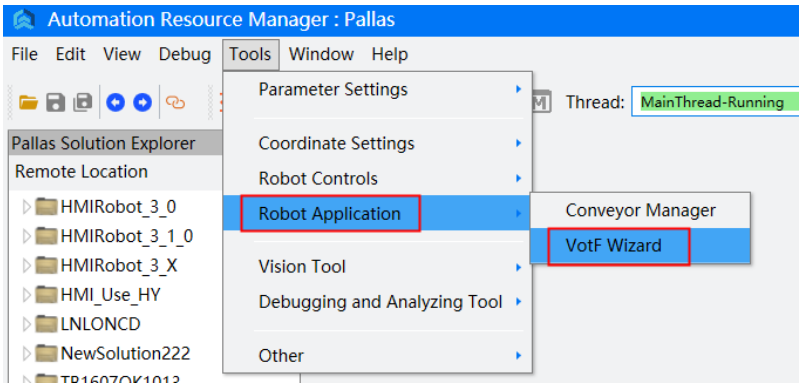


Figure 3-72 Select VotF Wizard

3.7.13 Macro Command Debugger

Users can send macros from Macro Command Window to the robot to enable its corresponding functions. Select Macro Command Window under Tools in the menu bar.

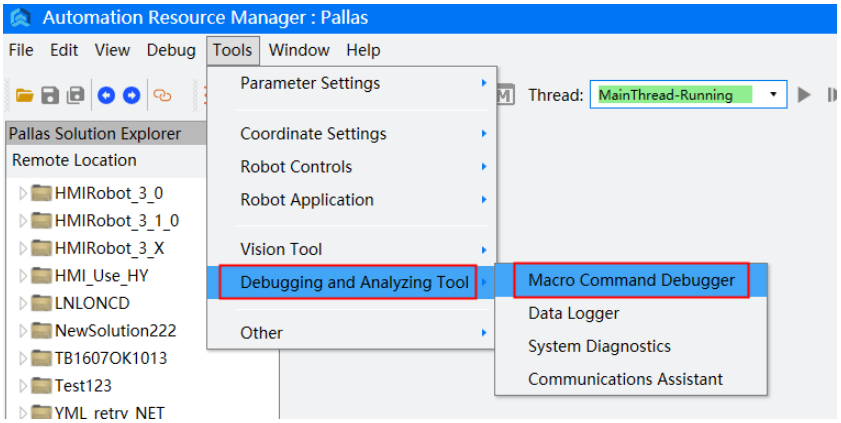


Figure 3-73 Select Macro Command Window

Open Macro Command Window, enter a corresponding macro command in the command input area, and click the Run button, then the robot can execute the input macro command.

Users can query the sending and receiving status of macro commands in the output area. Users can also query the description of macro commands in the Macro Command Manual, and double-click the corresponding macro command to automatically input it into the command input window.

For details, please refer to the "QKM Robot Command Manual".

Note: **Some macro commands can only be executed in Macro mode, and some can be executed in both QRL mode and Macro mode. Refer to Section 3.5 Robot**

system status in macro mode during operation.

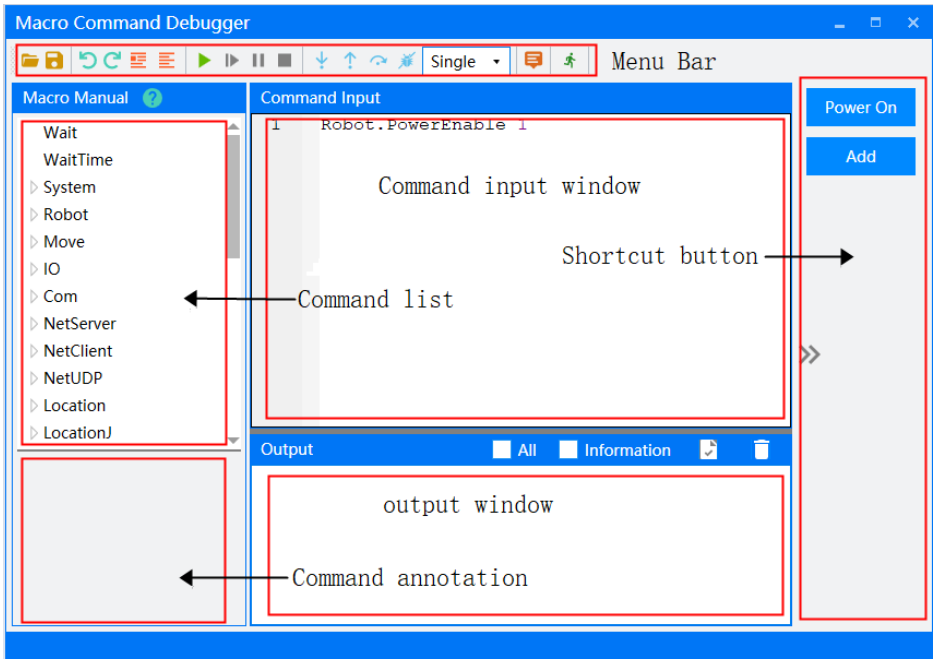


Figure 3-74 Macro Command Window

3.7.14 Data Logger

Users can select a data collection analyzer under the menu bar tool options. Through the data collection analyzer, robot data can be collected for statistical analysis, facilitating the debugging of robots.

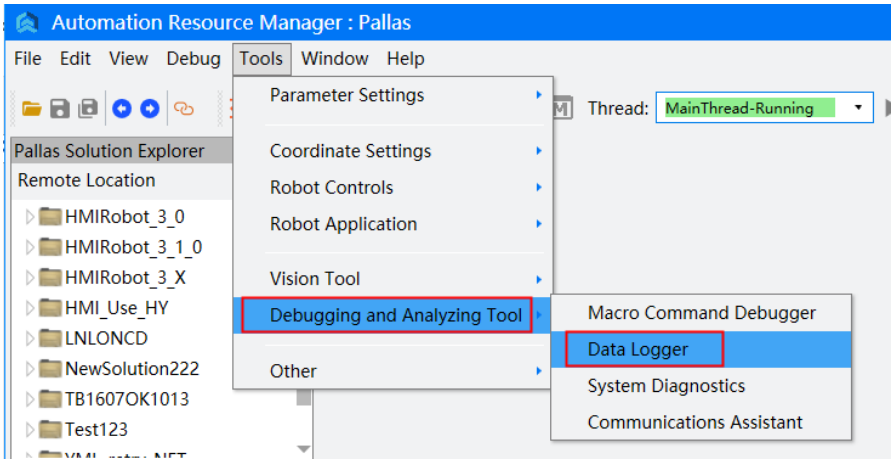


Figure 3-75 Select Data Logger

Open the data logger, select the data to be collected, trigger method and content, collection location, collection time, and other information in the data collection interface, and click Start Collection to collect the data of the current robot.

1) Location: Choose to collect data for Comm or Cell.

2) Set trigger type and trigger value.

Start Now: Immediately start collecting after clicking on 'start'.

Trigger Start: Start collection when triggering conditions are met.

Trigger Segment Acquisition: Stop collection when the triggering conditions are met first and then not met.

Trigger End: Endcollection when triggering conditions are met.

3）Set Trigger Value

Start Now: Offset time not supported.

Trigger Start: Forward bias, collect a section of data before triggering.

Trigger Segment Acquisition: Backward bias, collecting a section of data after triggering ends.

Trigger End: Backward bias, collecting a section of data after triggering ends.

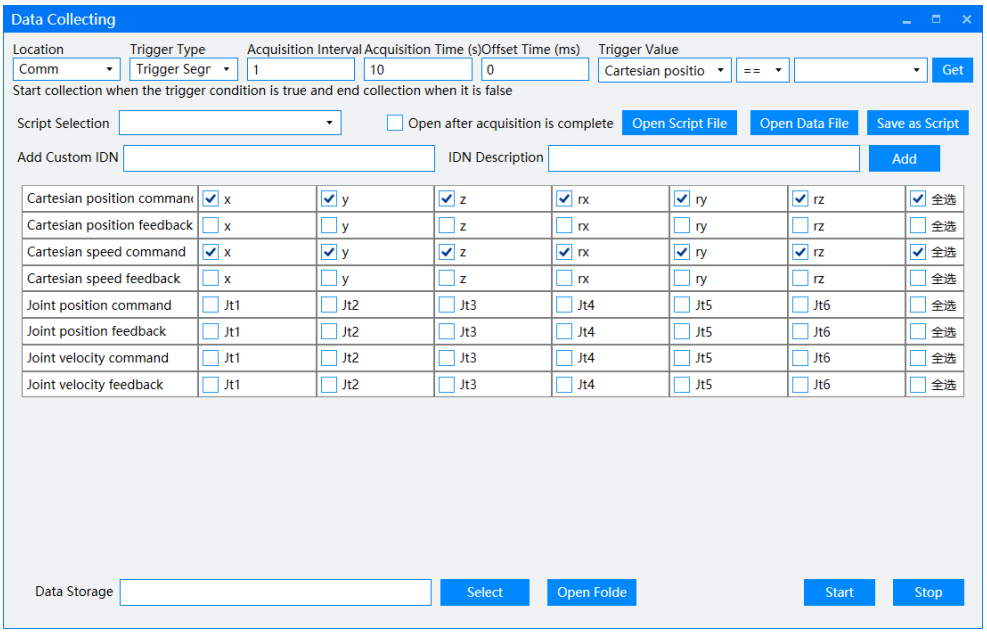


Figure 3-76 Data Logger Interface

4） Script Selection: The data collector is equipped with multiple commonly used collection scripts. You can select existing scripts from the Common Script selection drop-down box, or you can save the current collected content to the Common Script by clicking the Save as Common Script button, which is convenient for next use.

After the collection is completed, select "Open" or click the "Open Data File" button to open the collected data in the data collection analyzer, display a list and waveform of the data, and use the mouse and buttons to zoom in and out on local data.

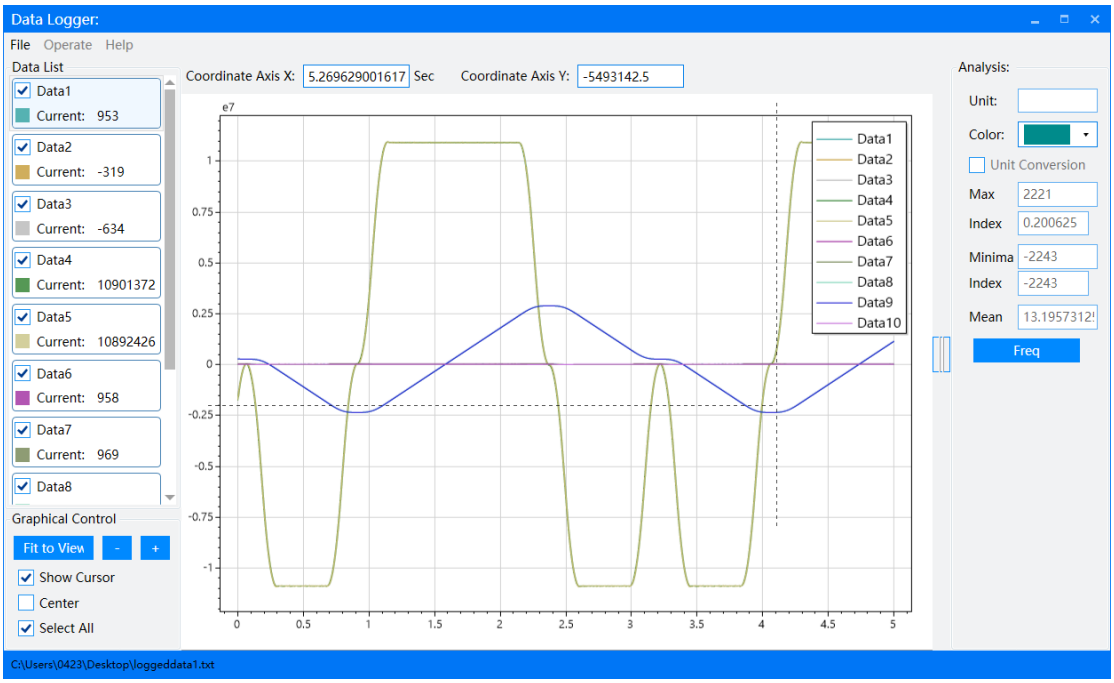


Figure 3-77 Data Interface

Click the spectrum analysis button to perform Fourier transform on the currently selected data and display the spectrum after Fourier transform.

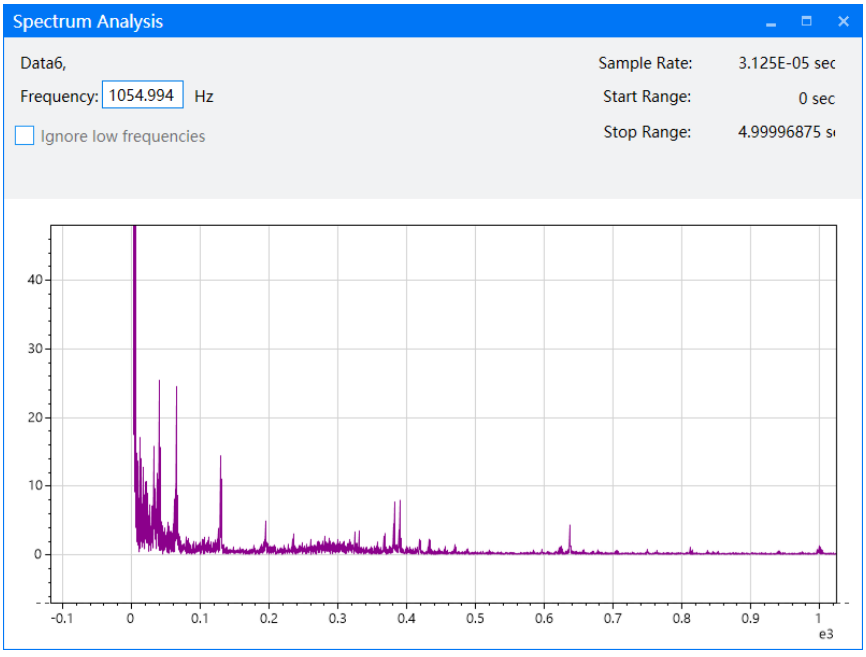


Figure 3-78 Freq Interface

3.7.15 System Diagnostics

Users can select system diagnosis under the menu bar tool options. Through the system diagnosis function, they can view the current firmware version of the robot and diagnose the robot.

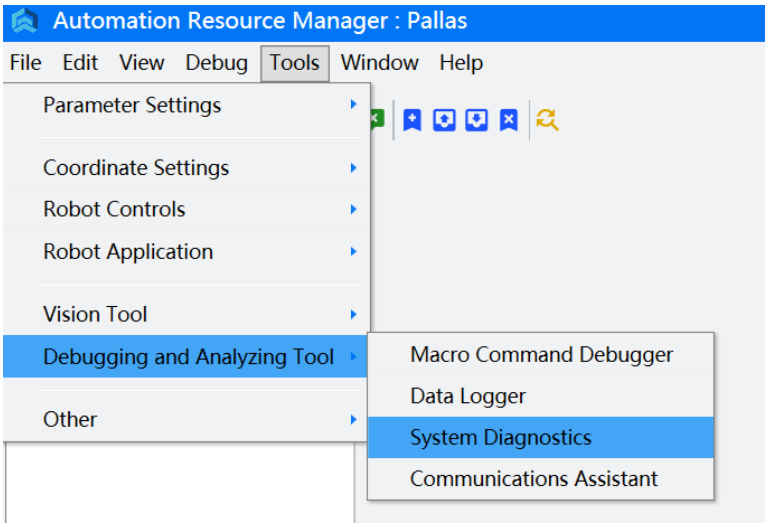
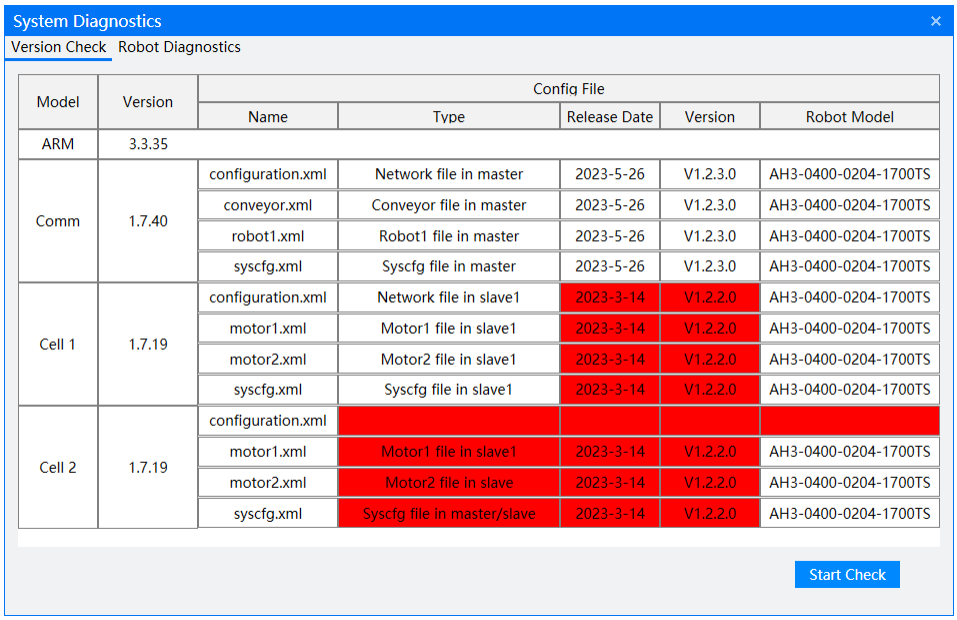


Figure 3-79 System Diagnosis

On the version detection page, click the start detection button to perform version detection on the current ARM, robot's Comm, Cell, and configuration files. If there is any version mismatch, a prompt will be give.



Model	Version	Config File				
		Name	Type	Release Date	Version	Robot Model
ARM	3.3.35					
Comm	1.7.40	configuration.xml	Network file in master	2023-5-26	V1.2.3.0	AH3-0400-0204-1700TS
		conveyor.xml	Conveyor file in master	2023-5-26	V1.2.3.0	AH3-0400-0204-1700TS
		robot1.xml	Robot1 file in master	2023-5-26	V1.2.3.0	AH3-0400-0204-1700TS
		syscfg.xml	Syscfg file in master	2023-5-26	V1.2.3.0	AH3-0400-0204-1700TS
Cell 1	1.7.19	configuration.xml	Network file in slave1	2023-3-14	V1.2.2.0	AH3-0400-0204-1700TS
		motor1.xml	Motor1 file in slave1	2023-3-14	V1.2.2.0	AH3-0400-0204-1700TS
		motor2.xml	Motor2 file in slave1	2023-3-14	V1.2.2.0	AH3-0400-0204-1700TS
		syscfg.xml	Syscfg file in slave1	2023-3-14	V1.2.2.0	AH3-0400-0204-1700TS
Cell 2	1.7.19	configuration.xml				
		motor1.xml	Motor1 file in slave1	2023-3-14	V1.2.2.0	AH3-0400-0204-1700TS
		motor2.xml	Motor2 file in slave	2023-3-14	V1.2.2.0	AH3-0400-0204-1700TS
		syscfg.xml	Syscfg file in master/slave	2023-3-14	V1.2.2.0	AH3-0400-0204-1700TS

Figure 3-80 Version Check

On the system diagnosis page, you can view the current servo alarm and encoder

alarm of the robot, and clear the encoder alarm. You can view the values of each axis and encoder, and repair and format the SD card.

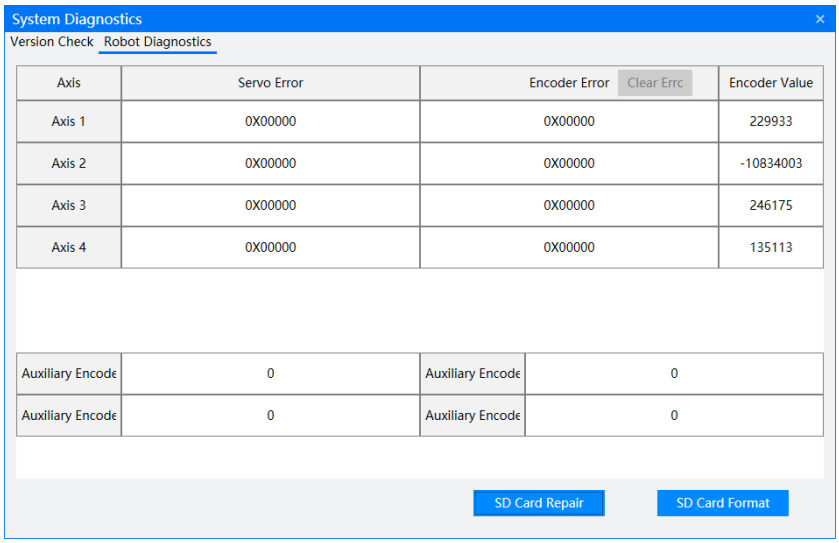


Figure 3-81 Robot Diagnosis

3.7.16 Communications Assistant

Users can select Communication Assistant under the menu bar tool options to open the network serial port debugging tool, establish TCM, UDP, or serial port communication with the robot, and facilitate debugging of communication functions.

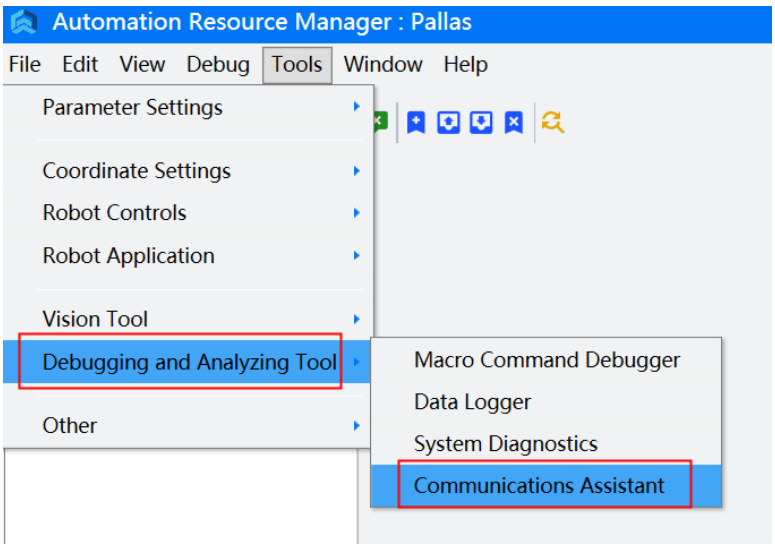


Figure 3-82 Select Communication Assistant

Open the Network/Serial Debugging Assistant, where you can select protocol types such as TCP client, TCP server, UDP, and serial port. After selecting a communication protocol and establishing a connection, the robot can be controlled to send data in the data sending window, and the data received by the robot can be viewed in the data log

window.

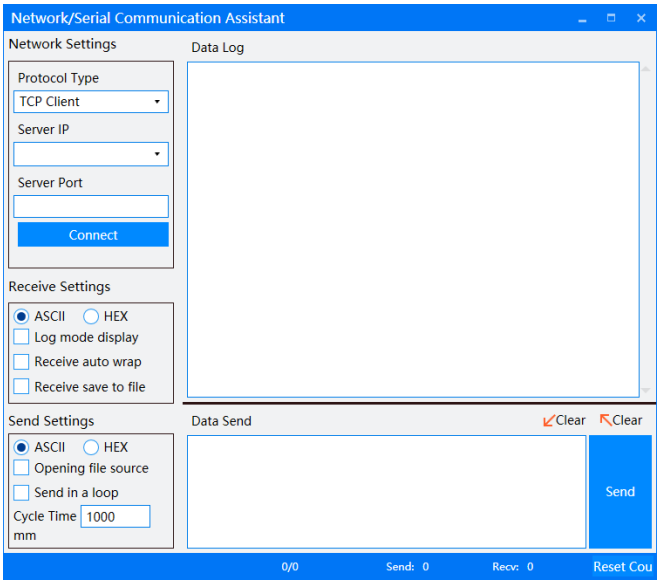


Figure 3-83 Communication Assistant

3.7.17 Firmware Upgrade

Users can select Firmware Upgrade under the menu bar tool options, open the Firmware Upgrade window, and upgrade the firmware and configuration files of the robot.

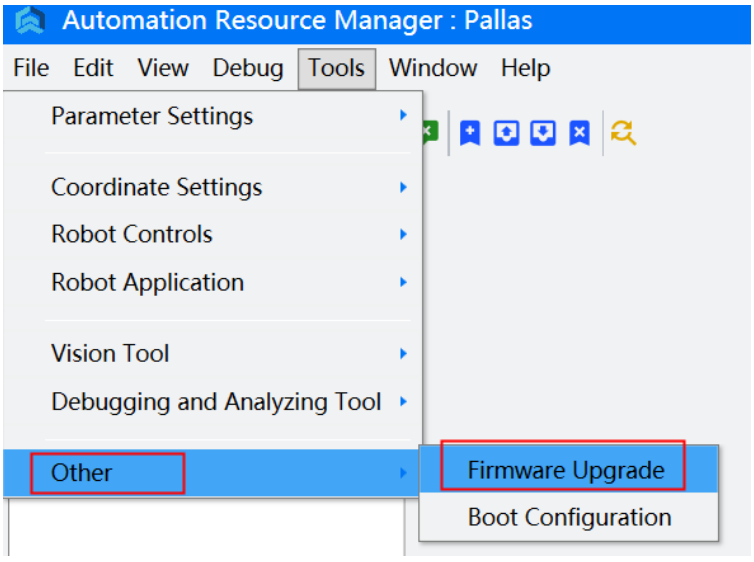


Figure 3-84 Select Firmware Upgrade

After selecting the upgrade firmware, click the button to select the folder where Comm firmware and Cell firmware are located, select the Cell that need to be upgrade, and click the upgrade button to perform a one click upgrade of the firmware.

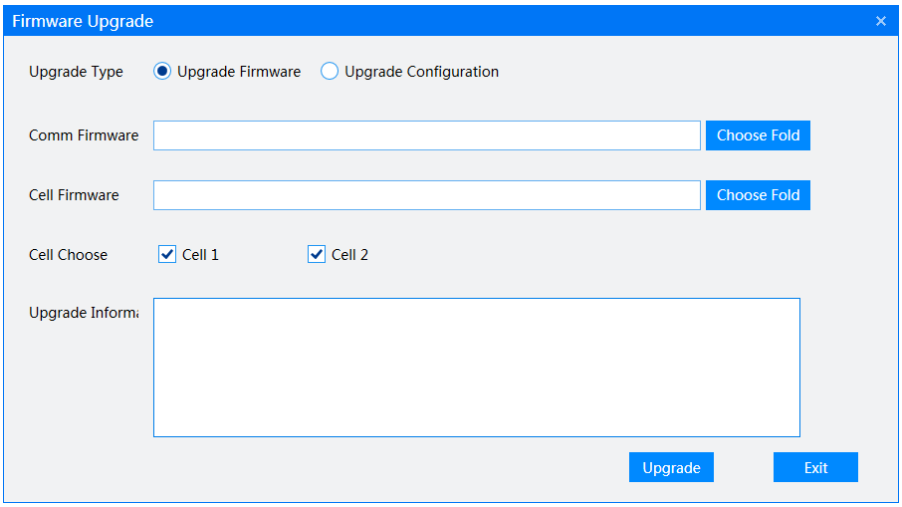


Figure 3-85 Upgrade Configuration

After selecting the upgrade configuration file, select the configuration files for Comm and each cell respectively to upgrade the configuration file. When upgrading, check the option to Tick “Reserved ADC” can reserve the zero point and other information of the original configuration file.

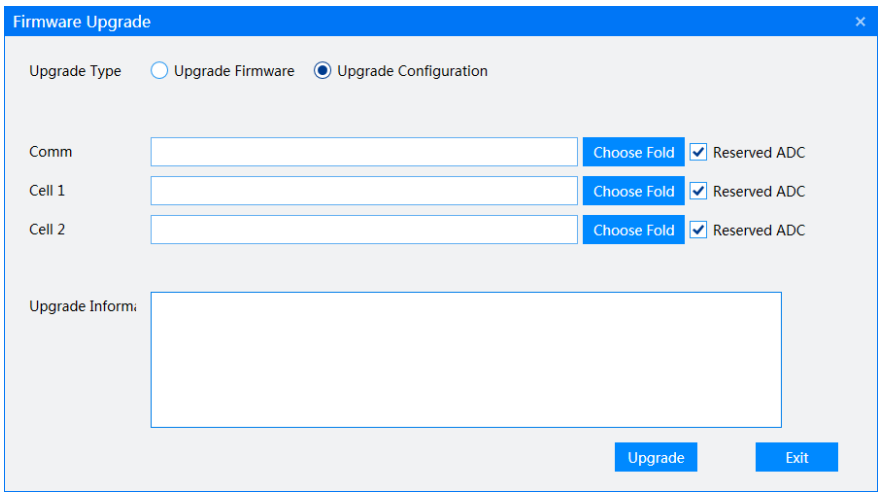


Figure 3-86 Upgrade Configuration

Note: **When upgrading Cell firmware or configuration files, it is necessary that the Cell's IP and the robot are in the same network segment, otherwise the upgrade will fail.**

3.7.18 Boot Configuration

Users can select boot configuration under the menu bar tool options, set the dedicated I/O of the robot, and start the self start program after startup.

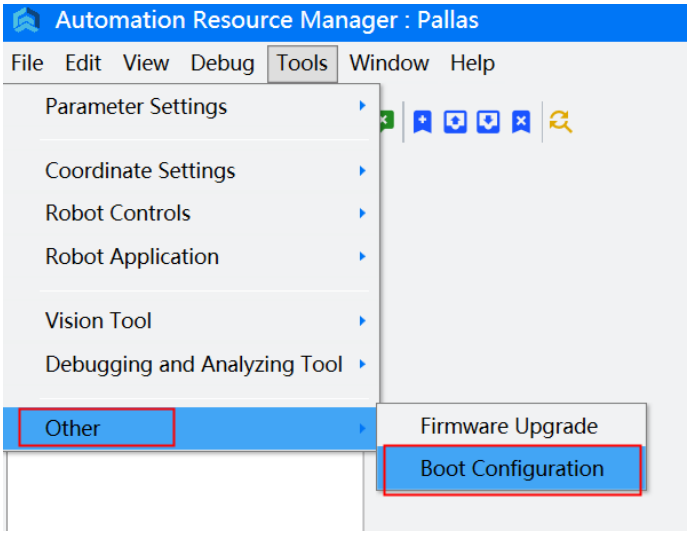


Figure 3-87 Select Boot Configuration

Control I/O supports digital input, high-speed input, and virtual I/O (Modbus TCP/DIO, etc.), and can be triggered by force. Control I/O includes the following:

- Start I/O: When the rising edge occurs, control the start of the thread with the "selected" attribute.
- Stop I/O: When the rising edge occurs, control the termination of threads with the "selected" attribute.
- Pause I/O: When the rising edge occurs, control the thread with the "selected" attribute to pause.
- Continued I/O: When the rising edge occurs, the thread with the "selected" attribute is controlled to continue.
- Servo control I/O: control the servo to power on at the rising edge and power off at the falling edge.

Note: In QRL mode, the main thread has the "selected" attribute by default, and other threads need to add this attribute before they can be controlled by I/O. In Macro mode, the main thread has the "selected" attribute.

The status display I/O supports digital output and virtual I/O. The status display I/O includes the following:

- Servo status I/O: After the servo is powered on, there is a signal, and after the servo is powered off, there is no signal.
- Start output I/O: When the main thread is in a non-terminating state, there is a signal, the main thread terminates, and there is no signal.

- Pause output I/O: The main thread is in a paused state with a signal, and the main thread is in a non- paused state without a signal.
- Abnormal state I/O: After triggering an exception, there is a signal, and after the exception is resolved, there is no signal.
- Program self-starting configuration, configuring the self-starting content of the robot after it is turned on.

Main program self-starting: configure whether to automatically start the last running QRL program after booting.

- Background thread self-starting: configure whether to start the background thread after booting.
- Mode switching: configure whether to switch to Macro or QRL mode after booting.

Note: After enabling the program self-starting, the mode switching can only use the QRL mode.

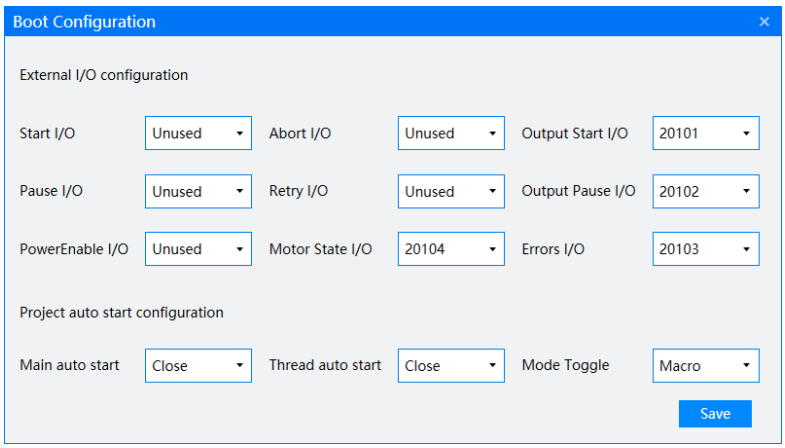


Figure 3-88 Boot Configuration

Chapter 4 ARM Programming

4.1 Create QRL Projects

Step 1 Select New - >Pallas Project under File in the menu bar.

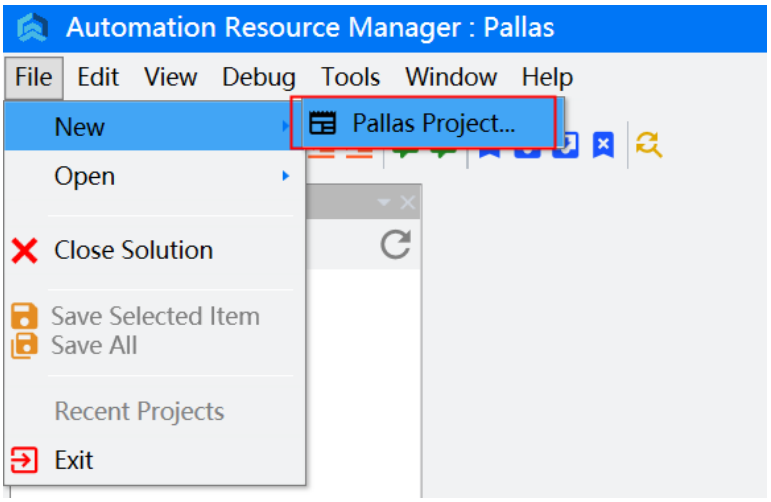


Figure 4-1 Select New - Pallas Project

Step 2 In the new solution window, select the solution template to create, fill in the name of the QRL solution, and select the location where the QRL program will be saved.

The names must not start with numbers or programs cannot be named with pure numbers. Use them in text format, otherwise ARM will prompt that projects cannot be created.

Users can save QRL programs in PC or robot Flash. To save in PC, users need to select a save path. To save in robot Flash, users need to save them in the path specified in robot Flash.

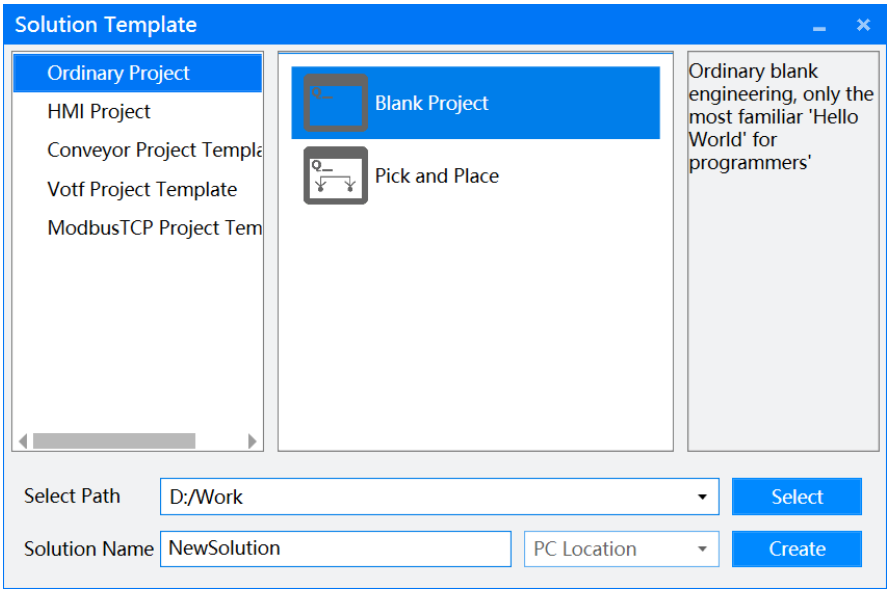


Figure 4-2 New Solution

4.2 Load QRL Programs

Step 1 Select Open - >Pallas Project under File in the menu bar.

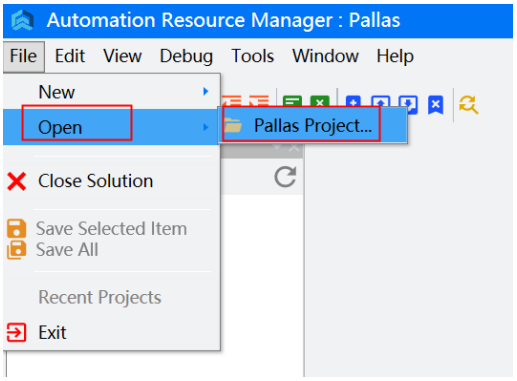


Figure 4-3 Select Open - Pallas Project

Step 2 Select the QRL program folder to be opened, select the solution.qsln file, and click Open. At this point, the QRL program file will be loaded on the local interface. Users can double-click to open the program file to edit and modify it.

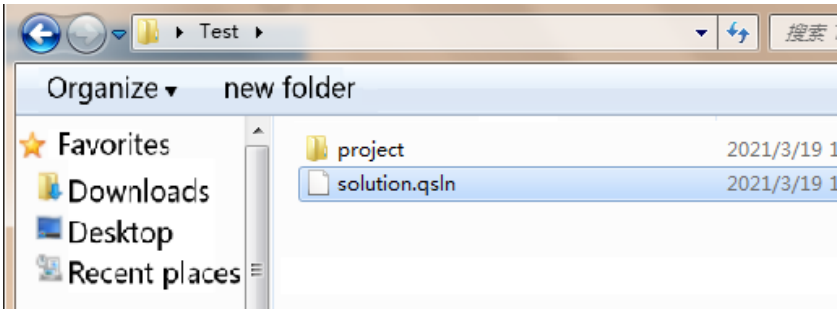


Figure 4-4 Select a QRL program

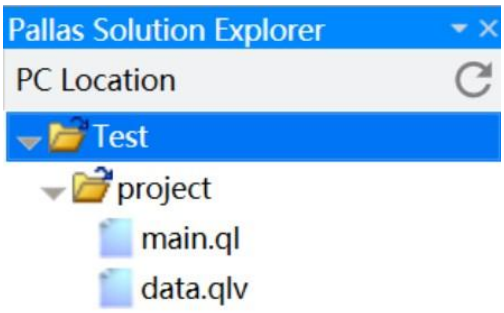


Figure 4-5 Local location

In addition, you can directly drag a QRL program folder from PC to local location, and the QRL program file will be loaded on the local interface.

Step 3 If you need to run a QRL program in robot Flash, then Drag the QRL program file directly from a local location to a remote location, or directly from the PC folder to a remote location.

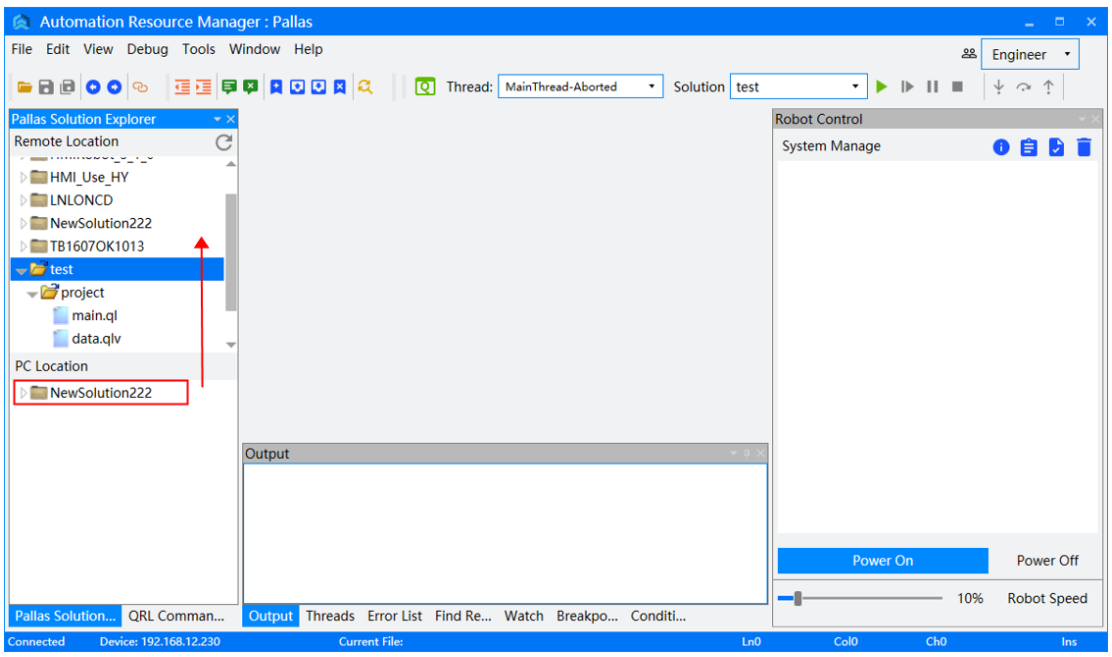


Figure 4-6 Load to Remote Location

If the user needs to save the QRL program in the robot Flash to the PC, they can directly drag the QRL program file from the remote location to the local location. After dragging, select the saved PC path in the pop-up dialog box.

In the pop-up dialog box, you can select the location to save it by clicking the 'Select' button, or you can select a history path in the download history path as the save location.

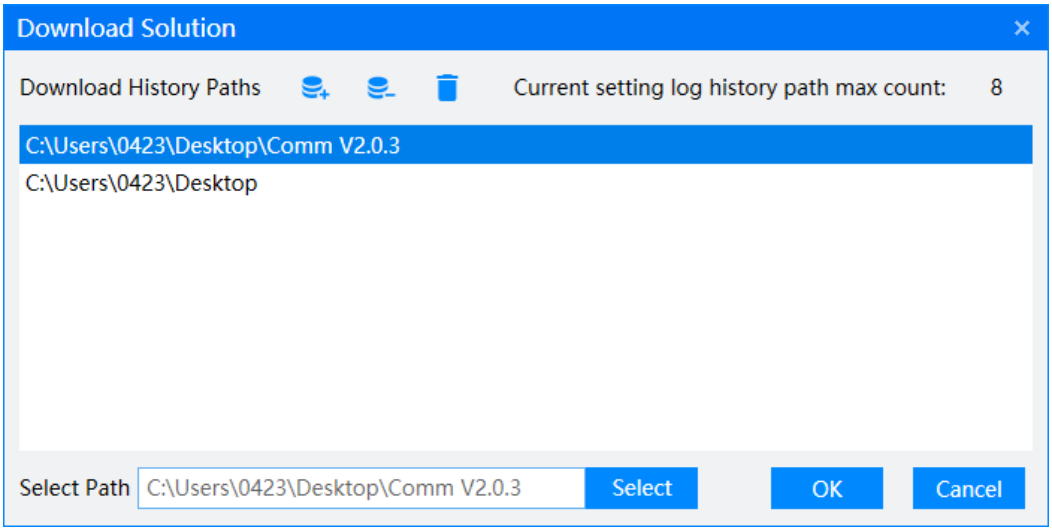


Figure 4-7 Download Solution

The selected path will be automatically added to the history path. You can also modify the history path by clicking the Add and Delete buttons at the top for easy selection and use.

4.3 QRL Program File

QRL program files include those with extensions .ql and .qlv.

.ql file: QRL codes are saved.

.qlv file: Robot location and speed information is saved.

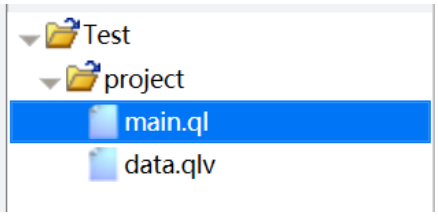


Figure 4-8 QRL Program Files

In some cases, users may create multiple .ql and .qlv files in QRL programs to save QRL codes. Right-click the project folder and select New Item. Create corresponding files according to the actual situation.

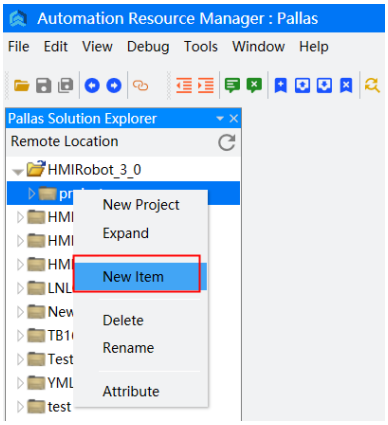


Figure 4-9 New Item

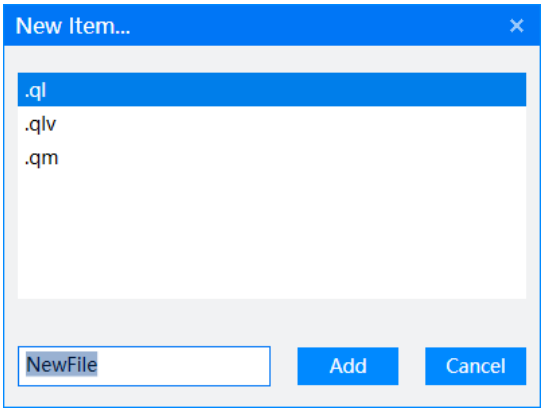


Figure 4-10 Create File

ql file:

Double-click a ql file to open it. Users can modify QRL codes in the ql file.

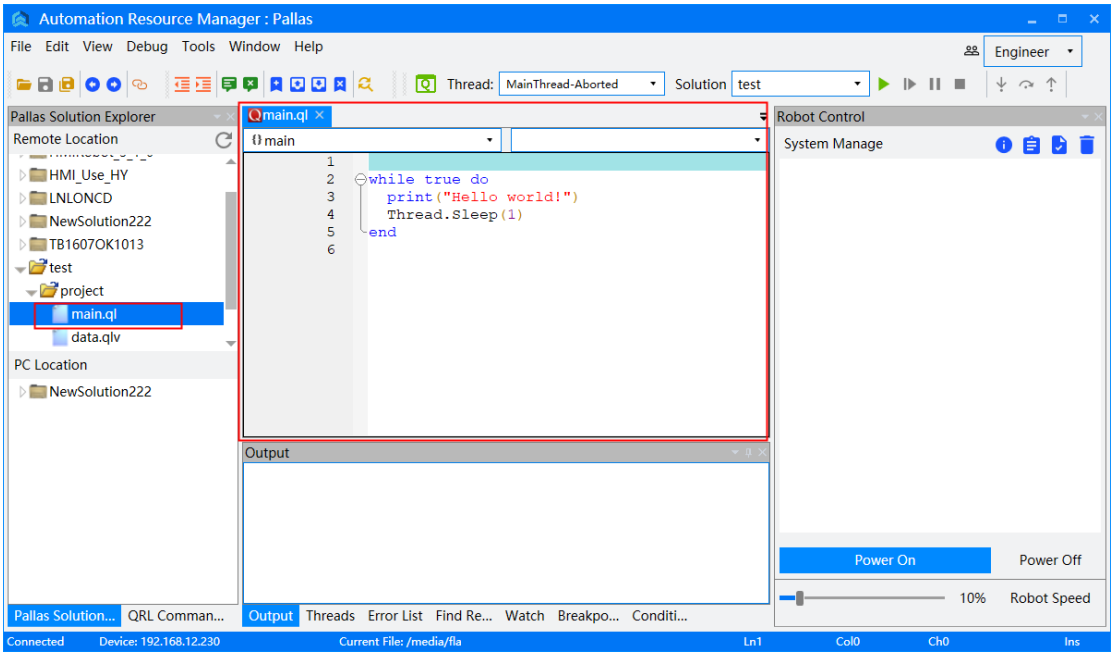


Figure 4-11 Open a ql file

qlv file:

Double-click a qlv file to open it. Users can create, save and modify location and speed information in the qlv file. Users can move the robot to the corresponding location by checking linear motion or joint motion in the qlv file.

The information of location and speed in qlv file can be directly called in ql file.

4.4 Run QRL Program

Before using the main thread to run the QRL program, enable the robot to be in QRL mode, and QRL programmes that need to be run are saved in the robot Flash.

Select the program in Solution dialog and click the Start button, the QRL program will run. When the QRL program is running, click the Stop button to stop running it.

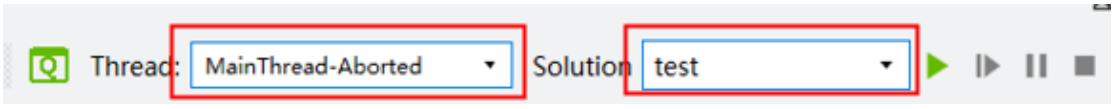


Figure 4-12 Select and Run QRL Program

Thread status description

Running: Running now

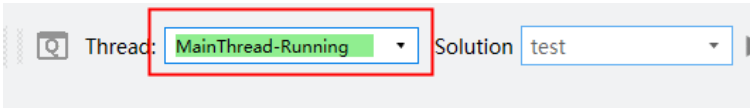


Figure 4-13 Thread Running Status

Aborted: Aborted status, indicating that the thread is not running or has completely stopped running.

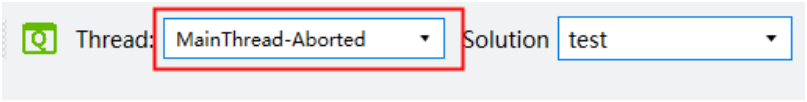


Figure 4-14 Thread Aborted Status

Stopped：In the paused state, the thread will stop running. You can control the thread to continue running by clicking the Continue button.

Figure 4-15 Thread Stopped Status

4.5 Run Background Thread

The background thread is a special thread, and the QRL program launched through the background thread is not affected by the status of the robot device and will always run.

Figure 4-16 Set Background Thread

Right click on the QRL project that you want to run as a background thread, select Set as Background Thread from the pop-up menu, and select BGThread in the thread to

start the program.

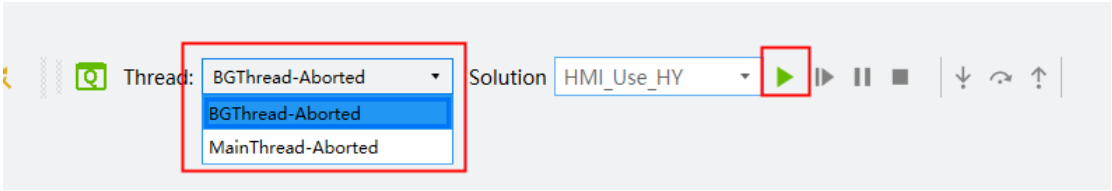


Figure 4-17 Run Background Thread

Note: Thread and motion related instructions cannot be executed in the background thread.

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