Elite Robot User Manual

Doc. Name： EC612 User Manual

Suzhou Elite Technology Co. Ltd.

www.elibot.cn

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Original Version 4.0

Please read this manual carefully before use

Please see the chapter of version information in this manual for the product version information corresponding to the user manual of this version, and please check the actual product version information carefully before use, as to ensure consistency.

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Preface

Thank you for purchasing and using the light 6-degree-of-freedom (DOF) collaborative robot EC612 developed by the company.

The EC612, as one of the ELITE modular collaborative robot series, is an intelligent light 6-DOF modular collaborative robot launched by Suzhou Elite Robot Co., Ltd., with a payload of 12kg.The ELITE collaborative robot series takes a joint modular design, and uses a developer-oriented robot system. The user may develop his own robot control system in accordance with an application program interface provided by a ELITE collaborative robot platform. In addition, the ELITE collaborative robot is equipped with a dedicated programmable interface, in this way the user may observe a running state of the robot in real time through the interface, while implementing multiple control settings for the robot and implementing offline simulation. Accordingly, the work efficiency of the practical application may be improved greatly.

Product Composition

The detailed outbound list of one set of complete EC612 robot is shown in the table below.

Name	Quantity
Robot body	1
Control box including teach pendant	1
Power cord	1
Base (Optional)	1
User manual (disk)	1
Thin-walled wrench	1

More Information

If you require more information, please visit the website: **www.elibot.cn**

Chapter 1 Safety

1.1 Profile

This chapter introduces the safety principles and specifications that should be followed when operating the robot or the robot system. The integrator and the user must read this manual carefully, and need to mainly master and strictly comply with contents with warning labels. As the robot system is complicated and dangerous, the user must fully understand the risk of operation, and strictly comply with and implement the specifications and requirements in this manual. The user and the integrator must have sufficient safety awareness and comply with ISO 10218 *Industrial Robots - Safety Specification*

1.2 Safety Warning Symbols

The safety-related contents in this manual are illustrated with the following warning symbols. The descriptions related to the warning symbols in this manual represent the important contents, please comply with these symbols.

	Indicating an imminently hazardous electrical situation which, if not avoided, **could** result in casualties or serious damage of the equipment.
	Indicating a potentially hazardous hot surface which, if touched, **could** result in the personnel injury.

	SAFETY CAUTION: Indicating an imminently hazardous situation which, if not avoided, **could** result in casualties or serious injury.
	Indicating a potentially hazardous electrical situation which, if not avoided, **could** result in personnel injury or serious damage of the equipment.
	Indicating a potentially hazardous situation which, if not avoided, **could** result in personnel injury or serious damage of the equipment. As for the items marked with this symbol, the major consequence would probably occur sometimes in accordance with the specific situation.
	Indicating a situation which, if not avoided, **could** result in personnel injury or damage of the equipment . As for the item marked with this symbol, the major consequence would probably occur sometimes in accordance with the specific situation.

1.3 Safety Cautions

1.3.1 Overview

This manual includes the safety measures of protecting the user and preventing the machine from damage. The user **must** read all relevant descriptions in the specification and be fully familiar with the safety cautions. In this manual, we shall try to describe various situations. However, it seems impossible to record all the cases that cannot be done in accordance with so many possibilities.

1.3.2 Usage Notice

The following basic information **must** be understood and followed when starting the robot or the robot system for the first time, and other safety-related information shall be introduced in other parts of the manual. However, it seems impossible to cover all aspects. In practical application, the concrete problem needs to be analyzed in a concrete way.

	1. Please install the robot and all electrical equipments in accordance with the requirements and specification in the manual. 2. The preliminary test and inspection mustbe implemented for the robot and its protective system before using the robot for the first time or putting into production. 3. Before starting the system and equipment for the first time, you must check whether the equipment and system are complete, operate safely, and detect any damage.During the detection, that whether it is in line with the effective safety production rules and regulations of the country or the region **must** be observed, and all safety functions must be tested. 4. Make sure that all safety parameters and user programs are correct and all safety functions run normally. The person qualified to operate the robot should check each safety function. The robot cannot be started until the robot passes comprehensive and careful safety test and reaches the safety level.
	1. The professional staff are required to install and debug the robot in accordance with the installation standards. 2. Upon completion of installation and construction of the robot, the comprehensive risk assessment should be implemented again, with the document records kept. 3. Only the authorized personnel could set and change the safety parameters, and the passwords or the isolation measures **must** be used to prevent the unauthorized personnel from changing or setting the safety parameters. When the safety factors are revised, the related safety functions **must** to be analyzed. 4. When the robot is trapped in accident or runs abnormally, the emergency stop switch may be pressed to stop the action of the robot. 5. The brake is installed in the EC612 joint module, to maintain the pose of the robot arm when the power is switched off. Do not artificially switch the power supply system on and off frequently. It is recommended that the time interval of switching on and off the machine should be more than 10 seconds. 6. The EC612 has the collision detection function. When the external force of powering on the robot arm exceeds a normal force of the user's safety setting, the robot arm will stop automatically, as to prevent the robot or the operating personnel from injury due to collision. The function is dedicatedly designed by the EC612 for the safety of human-machine collaborative work. However, the robot system is required to run within the normal range, and the control box of the ELITE collaborative robot series must be used. If the user develops the controller himself/herself, the robot will not have the abovementioned function. Moreover, the user **must** be responsible for the dangerous consequence brought herefrom.

	1. The robot and the control box may generate heat during running. When the robot is working or just stops working, please do not operate or touch the robot. 2. The robot may not be cooled down after turning off the power supply within an hour. 3. Do not put your finger around the heating part of the control box.
	1. Make sure that the robot arm and tools are properly and securely installed in place. 2. Make sure that the robot arm has ample space to operate freely. 3. Never use the robot which is damaged. 4. Do not connect any safety equipment to normal I/O interface. Use safety-related interface only. 5. Make sure to implement the correct installation settings (such as the robot installation angle, mass in TCP, TCP offset, safety configuration). Save and load the installation file into the program. 6. The tool and obstacles shall not have sharp angles or pinch points. Make sure that heads and faces of all people are kept outside the reach of the robot. 7. Be aware of robot motion when using the teach pendant. 8. Any impact will release a lot of kinetic energy, which is much higher than that at high speed and high payload. 9. Combination of different machines can increase hazards or create new hazards. Always make an overall risk assessment for the complete installation. When different safety and emergency stop performance levels are needed, always choose the highest performance level. Always read and understand the manuals of all equipments to be used during installation. 10. Never modify the robot. A modification might create hazards that are unforeseen by the integrator. The authorized reassembling of the robot shall be done in accordance with all relevant service manuals of the latest versions. If the robot is changed or altered in any way, Suzhou Elite Robot Co., Ltd. will not take any responsibility. 11. Before transporting the robot, the user needs to check the insulation and the protective measures. 12. Comply with the transportation requirements when carrying the robot, as to carry carefully and avoid bumping.
	1. When the robot is combined, or works with the machines capable of damaging the robot, it is highly recommended to test all functions and the robot program separately. It is recommended to use the temporary waypoints outside the workspaces of other machines to detect the robot program. 2. Suzhou Elite Robot Co., Ltd.will not take any responsibility for the damage of the robot or personal injury due to programming errors or improper operation of the robot. 3. Do not expose the robot to permanent magnetic fields for a long time. The strong magnetic fields may damage the robot.

1.3.3 Personnel safety

When running the robot system, safety of the operating personnel must be ensured first. The general cautions are listed below, please properly take corresponding measures of ensuring safety of the operating personnel.

1. All operating personnel using the robot system should receive the training and pass the training courses hosted by Suzhou Elite Robot Co., Ltd. The user should ensure to fully grasp the safe and normative operational process and have the qualification of operating the robot. For detailed training, please contact with the company by E-mail: support@elibot.cn.

2. All operating personnel using the robot system should not wear loose clothing or jewellery when working with the robot. Long hair must be tied back when working with the robot.

3. When the equipment runs, the robot is in the state of implementing imminent action probably because the robot is waiting for a starting signal although it seems to have stopped. Even in this state, the robot should be regarded as being in action.

4. Lines should be drawn on the floor to mark the range of action of the robot, in this way the operator may know the range of action of the robot including the clamping tool (the manipulator, the tool and so on).

5. Make sure that the safety measures (for example, guardrails, ropes, or protective screens) are established near an operating area of the robot, as to protect the operator and the surrounding people. The locks should be arranged in accordance with the need so that the person outside the operating personnel in charge of operation cannot touch the power supply of the robot.

6. When using the operation panel and the teach pendant, operations cannot be implemented until the gloves are taken off as there may be operational errors if the gloves are worn.

7. In emergency and abnormal cases, such as a person is clamped or surrounded by a robot, the joint can be forced to move by pushing or pulling the robot arm hard (at least 700 N). If there is no electric drive available, the robot arm may be moved manually only in case of emergency, however the joint may be damaged.

1.4 Liabilities and Specifications

EC612, which is partly completed, may form a complete machine with other equipments. Therefore, the information in this manual neither covers how to design, install and operate one complete robot comprehensively, nor covers all possibilities of affecting safety of the peripheral equipment of the complete system. The installation safety of the complete robot shall depend on how the robot is integrated. The integrator should comply with the laws, regulations, safety specifications and standards of the country where the integrator is located to implement the risk assessment for design and installation of the complete system. The risk assessment is one of the most important tasks that the integrator must complete. The integrator may implement the risk assessment process by using the following standards for reference.

- **ISO 12100:2010** ***Safety of machinery - General principles for design - Risk assessment and risk reduction***
- **ISO 10218-2:2011** ***Robots and robotic devices - Safety requirements for industrial robots - Part 2: Industrial robot system and integration***
- **RIA TR R15.306-2014** ***Technical report of industrial robots and robot systems - Safety requirements and task-based risk assessment method***
- **ANSI B11.0-2010** ***Safety of machinery – General requirements and risk assessment***

The ELITE robot integrator should perform, but not limited to, following responsibilities:

- **Make a comprehensive risk assessment for the complete robot system.**
- **Confirm that the whole system is designed and installed accurately.**
- **Provide the user and the staff with training.**
- **Create the operation specification of the complete system and clarify the instructions of using the robot.**
- **Establish appropriate safety measures.**
- **Eliminate the hazards or minimize all hazards to acceptable levels with appropriate methods during the final installation**
- **Pass the remaining risks to the end-user.**
- **Mark the logo and contact information of the integrator on the robot**
- **Archive the related technical documents.**

For reference to applicable standards and legal guide, please visit the website: **www.elibot.cn.**

All safety-related information contained in this manual shall not be regarded as the warranty of Suzhou Elite Robot Co., Ltd. Even though all safety instructions are followed, the personnel injury

or equipment damage caused by the operating personnel may occur as well.

Suzhou Elite Robot Co., Ltd. is committed to continuously improving reliability and performance of the products, and accordingly reserves the right to upgrade the products without prior notice. Suzhou Elite Robot Co., Ltd. strives to ensure accuracy and reliability of the contents in this manual, but takes no responsibility for any errors or missing information herein.

1.5 Danger Identification

Potential interaction contacts and foreseeable misoperations between the operating personnel and the robot during normal use should be considered during risk assessment. The neck, face and head of the operators should not be exposed, as to avoid bumping. In absence of peripheral safety protective device, the risk assessment should be implemented first before using the robot, as to judge whether the related dangers constitute the unacceptable risk, for example:

- **The probable danger result from using of the sharp end effector or the tool connector.**
- **The probable danger due to handling of the toxic or other harmful substances.**
- **The danger in which a finger of the operating personnel is clamped by the robot base or the joint.**
- **The danger caused by bumping against the robot.**
- **The danger because the robot or the tool connected to the end is not fixed in place.**
- **The danger due to impact between the payload of the robot and the hard surface.**

The integrator must measure this type of risks and the related risk levels through the risk assessment, then confirm and implement the corresponding measures, as to reduce the risks to the acceptable levels. Please note that the specific robot equipment may have other major dangers.

The risk related to collaborative operation of the EC612 may be reduced to a reasonable and feasible level as far as possible by combining the inherent safety design measures applied to the ELITE collaborative robot and the safety specifications or risk assessment implemented by the integrator and the final users. Through this document, any remaining risks of the robot before installation may be passed to the integrator and the final users. If the risk assessment of the integrator measures that there is risk that may constitute the unacceptable risk to the user in its specific application, the integrator must take the appropriate risk reduction measures to eliminate or minimize the risk until the risk is reduced to the acceptable level. It is unsafe to use the robot before taking the appropriate risk reduction measures (if needed).

If the robot is installed non-collaboratively (for example, when using the dangerous tool), the risk assessment may infer that the integrator needs to connect to an additional safety device (for example, a safety starting device) when programming, as to ensure personnel and equipment safety.

1.6 Intended Use

The ELITE collaborative robot should be used on general industrial equipment only, for example, operate or fix the tool or the equipment, process or convey the parts and the products. The ELITE robot must be used only under the specified condition. For specific information about the relevant operating environment and operating conditions, please refer to the appendix.

The ELITE collaborative robot has the special safety level characteristics and may implement the collaborative operation, namely, the ELITE collaborative robot may be used in absence of the peripheral safety protective device, however, only in the case that no danger occurs in accordance with the risk assessment. Namely, on the premise that no safety protective device and the on-site sensor are used, anticipated or accidental contact between the staff and the ELITE collaborative robot or its end effector or the part would not constitute the unacceptable risk, and the anticipated or accidental contact with other objects (the tool, the equipment, the surface and so on) in the workspace would not constitute the unacceptable risk as well.

The robot controller and the robot should be used on the general industrial equipment only and cannot be applied to the application breaching the intended uses. The prohibited use includes, but are not limited to, the following situations:

- **Used in flammable and explosive environment, and other dangerous environment.**
- **Used on the device of moving or carrying human or other animals.**
- **Used on the device, such as the medical device involving in the human life.**
- **Usedon the device which greatly influences the sociality and the publicity.**
- **Used in the environment subjected to vibration, such as the vehicle and the ship.**
- **Used as the climbing tool.**

1.7 Handling of Emergency Situations

1.7.1 Emergency stop device

All motions of the robot may be stopped upon pressing the emergency stop button. The emergency stop cannot be taken as the measure of reducing the risk, however can be taken as the secondary protective device. If multiple emergency stop buttons need to be connected, the emergency stop device must be incorporated into the risk assessment of the robot application. The emergency stop button should meet the requirements of IEC 60947-5-5.

The EC612 is equipped with the emergency stop buttons on the control box and the teach pendant. The button should be pressed only when meeting the dangerous situations or emergencies, as shown in following figure. The control box is equipped with the external emergency stop button port, and the integrator or the user can use it in accordance with the actual situations.

Figure 1-1 Emergency stop button

The tool or equipment connecting to the end, if constituting the potential threat, must be integrated into the emergency stop loop of the system. If falling to comply with the caution, personal injury， serious property damage and even death may be caused.

1.7.2 Resuming from the state of emergency

All emergency stop equipments in form of button have "Locking" function. The "Lock" must be unlocked, as to end the emergency stop state of the equipments.

The "Lock" may be unlocked by rotating the emergency stop button.

Resuming from the emergency stop state is a simple and important step which can be operated only when the danger of the robot system is eliminated completely.

1.7.3 Forced emergency movement of the joints

In rare cases, one or more robot joints may need to be moved under the emergency situations, namely, the power supply of the robot is trapped in failure or the operating personnel does not want to use the power supply. In this way, the robot joints are forced to move through the following method:

Forced reverse drive: push or pull the robot arm hard (at least 700N), as to force the joints to move.

Forced manual movement of the robot arm should be operated only in case of emergency, however the joints may be damaged.

1.7.4 Over-strong-force safety protection of the robot arm

The robot arm has the over-strong-force safety protection function. When the robot arm is powered on statically, and when the operating personnel or other objects bump against the robot arm accidentally and the impact force exceeds a safety threshold, the robot arm may move along with a direction of the impact force. The function may ensure that the damage to the personnel, other objects and the robot arm is reduced when the operating personnel or other objects bump against the

robot arm.

The function may reduce the damage as a result of impact, and the risk assessment must be implemented when used for other purposes.

Chapter 2 Carrying and Cautions

When hoisting the robot, moving parts should be positioned with the appropriate measures, as not to cause the unanticipated motion which may lead to harm accordingly during hoisting and transportation. When packing and transporting, the robot should be packed in accordance with the packing standards, and the required marks should be printed outside a packing box.

When transporting, the robot should be ensured to be stable and needs to be held and fixed at an appropriate position.

The control box should be raised with a handle

When moving the robot to the installation position from the packing material of the robot, the robot should be supported until all bolts of the robot base are tightened completely.

After fixing, the robot is powered on, and the pose of the robot should be adjusted to the appropriate position with the dragged teaching function of the robot.

An original package should be kept upon completion of transportation. The packaging material should stay dry, in case of repackaging the robot in the future.

1. Make sure that your back or other parts of the body are not overloaded when raising the equipment.

2. All regional and national guides should be followed. Suzhou Elite Robot Co., Ltd. shall not be responsible for damage generating during transportation .

3. Make sure that the robot is installed in strict accordance with the installation instructions in the specification.

Chapter 3 Maintenance, Repair and Disposal

3.1 Maintenance and Repair

The maintenance and repair work must be implemented in strictly accordance with all safety instructions in this manual.

The maintenance, calibration and repair work must be operated in accordance with the latest service manual which can be searched on the supported website: www.elibot.cn. All dealers of Suzhou Elite Robot Co., Ltd. can visit the website.

After changing the control system, the robot joints or the tool, the robot and the tool zero should be re-calibrated on the spot, and the calibration operation and the result judgment method are introduced in the specification of check for zero. In addition, the parameter settings should be checked. If the parameters are backed up, the backup parameters may be imported; if the parameters are not backed up, the parameters should be set again. If the robot joints or the tool needs to be replaced, the dynamics of the robot needs to be re-identified, with the identification method introduced in the instructions of the control system.

Maintenance must be implemented by authorized system integrator or Suzhou Elite Robot Co., Ltd.When the parts are returned to Suzhou Elite Robot Co., Ltd., operation should be implemented in accordance with the provisions in the service manual.

The safety level stipulated by the maintenance and repair work must be ensured, the effective national or regional working safety rules must be followed, and all safety functions run normally must be tested.

The purpose of the maintenance and repair work is to ensure normal running of the system, or to help it return to normal status in case of the system failure. The repair work includes the failure diagnosis and practical repair.

The following safety procedure and cautions must be followed when operating the robot arm or the control box:

Safety procedure:

1. Remove the mains input cable from the back of the control box to ensure that the robot is completely powered off. Take necessary precautions to prevent other persons from re-energizing the system during the repair period. When it is powered off, re-check the system to ensure the outage.

2. Please check the earth connection before re-starting the system.

3. Please comply with the electrostatic discharge (ESD) regulations when disassembling the robot arm or the control box.

4. Avoid disassembling the power supply system of the control box. The high voltage can be remained inside the power supply system for several hours when the control box is switched off.

5. Prevent water or dust from entering into the robot arm or the control box.

Cautions:

1. Replace the parts trapped in failure with new parts with the identical part number or the corresponding parts approved by Suzhou Elite Robot Co., Ltd.

2. Reactivate all prohibited safety measures immediately upon completion of the work.

3. Record all maintenance operations in written form and save these records in the relevant technical documents of the whole robot system.

4. The control box does not have a part that the end-user can repair by himself. If maintenance or repair services are needed, please contact with the dealer or Suzhou Elite Robot Co., Ltd.

3.2 Disposal

The ELITE robot must be disposed in accordance with the applicable national laws and regulations and the national standards.

3.3 Maintenance

The safety functions of the robot must be tested at least once per year, as to ensure that the functions are correct.

Chapter 4 Quality Assurance

4.1 Product Quality Assurance

A limited warranty period of the ELITE collaborative robot is 12 months.

Suzhou Elite Robot Co., Ltd. should provide the necessary spare parts to replace or repair relevant parts if the new equipment and its components are trapped in defects resulting from manufacturing and/or poor materials within 12 months after entry into service (maximum of 15 months from shipment).

Suzhou Elite Robot Co., Ltd. shall possess the ownership of the equipment or components replaced or returned to Suzhou Elite Robot Co., Ltd.

If the product is no longer under warranty, Suzhou Elite Robot Co., Ltd. shall reserve the right of charging the customer for replacement or repair.

In case of defects of the equipment which is out of warranty, Suzhou Elite Robot Co., Ltd. shall not be responsible for any damage or loss caused therefrom, such as loss of production or damage due to other production equipments.

4.2 Disclaimer

If the equipment defect is caused by improper disposal or falling to comply with the relevant information stated in the user manual, the “Product Quality Assurance” will be invalid.

The failure caused by the following circumstances shall not be covered by the warranty:

1. Installation, wiring and connection to other control equipments are not in line with the industrial standards or not implemented in accordance with the requirements of the user manual.
2. Outside the specification or standards shown in the user manual during use.
3. This product is applied to the non-designated purposes.
4. The storage mode and operating environment are outside the specified scope (such as pollution, salt damage and dewing) of the user manual.
5. The product is damaged as a result of improper transportation.
6. Damage due to the accident or impact.
7. The non-original parts and accessories are installed.
8. Damage as a result of modification, debugging or repair of the original parts by the third party outside Suzhou Elite Robot Co., Ltd. or other integrators specified by Suzhou Elite Robot Co., Ltd.
9. Natural disasters, such as fire, earthquake, tsunamis, lightning stroke, gale and flood.
10. Failure outside the abovementioned circumstances and not caused by Suzhou Elite Robot Co., Ltd.

The following circumstances should not be covered by warranty:

1. The date of production or the start date of the warranty cannot be identified.
2. Alteration of the software or internal data.
3. The failure cannot be reproduced, or Suzhou Elite Robot Co., Ltd. cannot identify the failure.

4. This product is used on the radioactive equipment, the biological test equipment or in the dangerous use judged by Suzhou Elite Robot Co., Ltd.

In accordance with the product quality assurance agreement, Suzhou Elite Robot Co., Ltd. shall be responsible for making the commitment of quality guarantee for the defects or deficiencies occurring in the products and the parts sold to the dealers.

As for any other explicit or implied warranties or liabilities including, but not limited to, any implied warranty for marketability or specific use, Suzhou Elite Robot Co., Ltd. shall not bear the related liability to guarantee. In addition, Suzhou Elite Robot Co., Ltd. shall not be responsible for the related liabilities in allusion to any form of indirect damage or consequence generated by the related product.

Chapter 5 Robot Hardware Composition

Figure 5-1 EC612 robot system

As shown in Figure 5-1, the EC63 collaborative robot system mainly consists of the robot body, the control box (multiple types of the control boxs are optional), the base and the teach pendant. The robot body imitates the arm of human body, and totally has six rotating joints and each representing one degree of freedom. As shown in Figure 5-2, the robot joint includes a substrate (joint 1), a shoulder (joint 2), an elbow (joint 3), a wrist 1 (joint 4), a wrist 2 (joint 5) and a wrist 3 (joint 6). The substrate is used to connect the robot body with the base, and the tool/end effector is used to connect the robot with the tool. Arm tube connection between shoulder and elbow and between elbow and wrist. Through the operation interface of the teach pendant or dragged teach pendant, the user may control each joint to rotate, in this way the end/tool effector of the robot can be moved to the desired different poses.

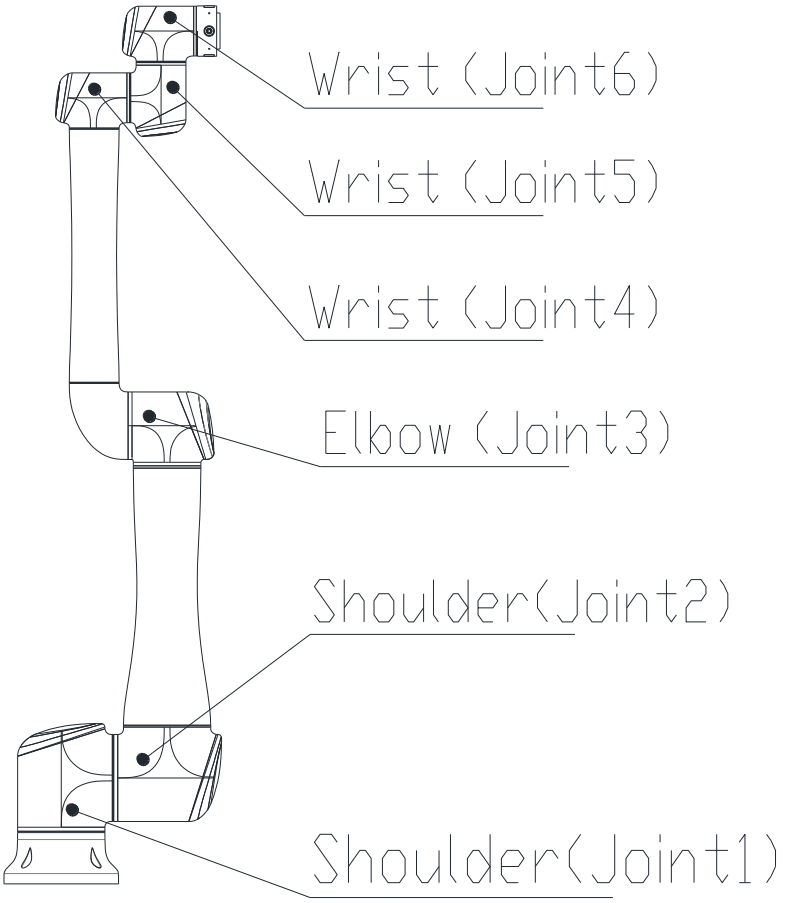


Figure 5-2 Robot joints

The control box is the main part of the control system of the EC63 collaborative robot. Please refers to the instructions of the control box in the user manual for the components inside the control box.

The EC63 provides multiple IO interfaces, and the tool flange of the robot end is equipped with four digital input and output interfaces and two analog input and output interfaces. The control box can communicate with the robot arm through the high-speed dedicated bus.

The teach pendant provides the user with a visual operation interface. The user may test, program and simulate the robot through the teach pendant, and operate the robot only through a small programming base.

Chapter 6 Robot Installation

6.1 Brief Installation Steps

The brief installation steps of the EC612 robot:
1. Confirm the workspace of the robot.
2. Install the robot body on the base.
3. Install the end/tool effector.

6.2 Important Safety Instructions

Environmental conditions for installation:
- Without corrosive gas or liquid
- Without dust or metal powder
- Without radioactive material
- Without oil mist
- Without mechanical shock and vibration
- Low humidity
- Less than 1000m above sea level
- Avoid direct sunshine (prevent the robot from being used outdoors)
- Without salt mist
- Without electromagnetic noise
- Without flammable materials

Ambient temperature: at 0 ℃ ~ 45 ℃

Operating humidity: 5%~90% (without dewing)

Bearing capacity of the floor: the robot should be installed on a hard surface. The surface should be able to bear at least ten times of the complete torsion of the base joints and at least five times of the weight of the robot arm. In addition, the surface should be free from vibration. Please refer to the appendix for the specific bearing capacity. The safety assessment must be implemented upon completion of each installation of the robot, and the instructions in Part I (Safety) should be strictly followed.

Description of installation of the additional device: if the additional components, such as the cable which is outside the range that Suzhou Elite Robot Co., Ltd. should provide, are integrated into the industrial robot, it is the user's responsibility to ensure that these components are completely unaffected and the safety functions would not be affected.

6.3 Workspace of the Robot

6.3.1 Mechanical dimensions of the robot

The mechanical dimensions diagram of the EC612 robot is shown in Figure 6-1. The range of motion of the robot must be considered during installation, as to prevent the surrounding personnel and equipment from being bumped.

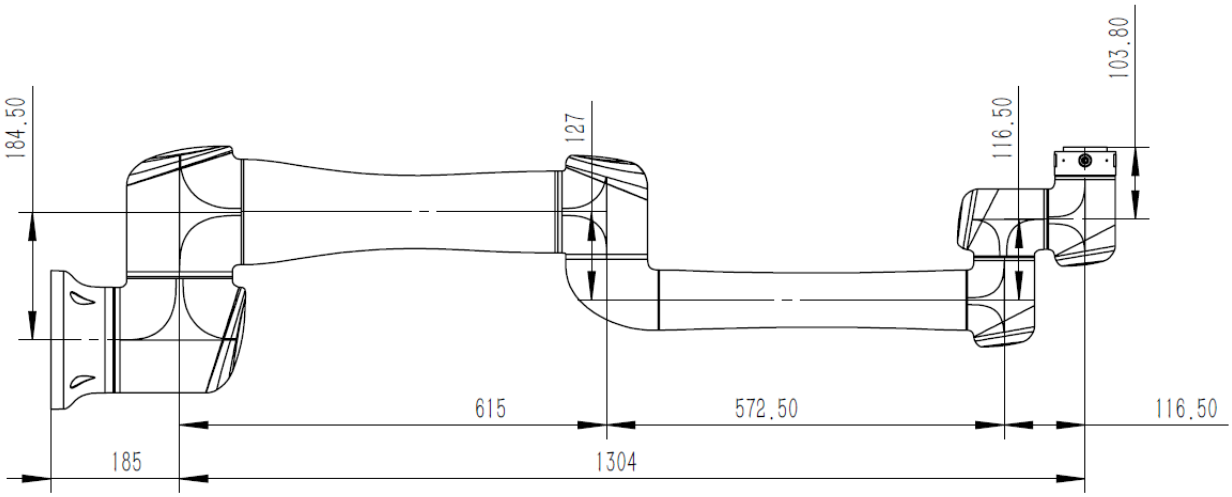


Figure 6-1 Mechanical dimensions diagram of the EC612 robot, with unit of mm

6.3.2 Range of motion of the robot

Figure 6-2 shows the range of motion of the EC612, namely, a sphere with a radius of 1304mm except the cylindrical space directly above and directly below the base. When choosing the installation position of the robot, the cylindrical space directly above and directly below the robot must be considered, as to avoid the tool from being moved toward the cylindrical space as far as possible. In addition, the rotation angle of the joints 1~6 is -175 ºto +175 ºin practical application.

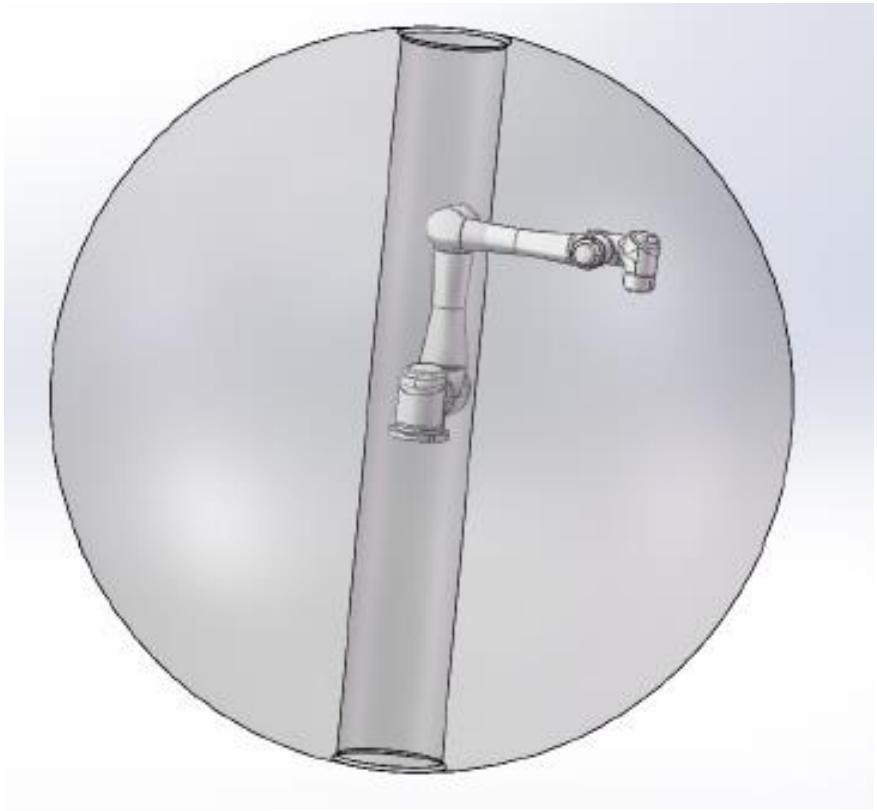


Figure 6-2 Schematic diagram of workspace of the robot

6.4 Robot Installation

The robot has the 360 °pose self-adaptive function at the installation location, and is compatible with installation, hoisting, wall mounting and other specific installation ways on the base, as shown in Figure 6-3.

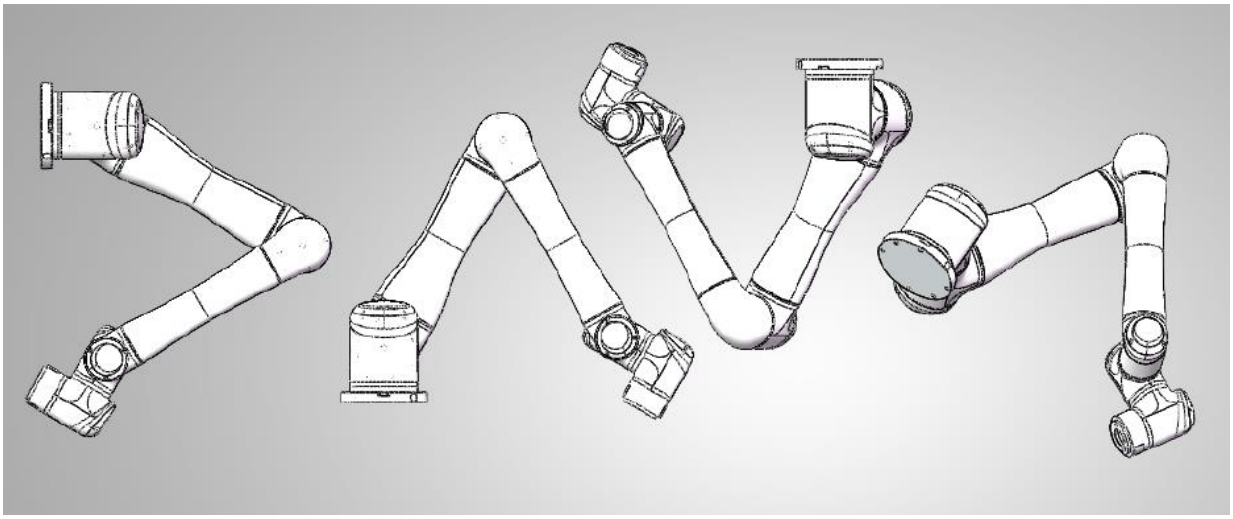


Figure 6-3 Schematic diagram of different installation poses

When installing on the base, the robot body is fixed on the base with four M8 bolts. It is recommended to install the pins with two holes, as to improve the installation accuracy. The

mechanical dimensions are shown in Figure 6-4.

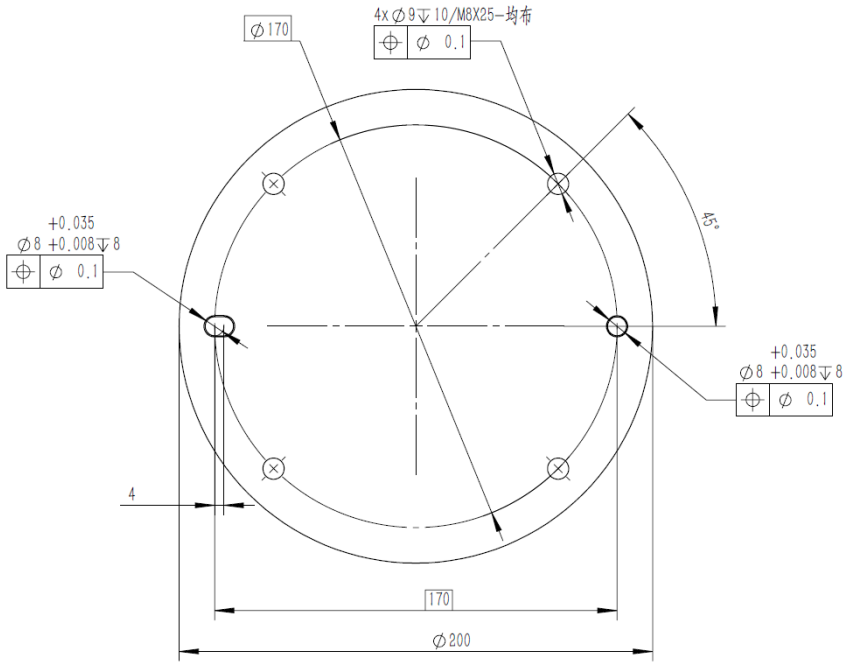


Figure 6-4 Dimensions of installation holes on the base, with unit of mm

1. When installing on the base, the robot should closely contact with a contact surface of the base, and the surface should be sufficient to bear at least 3500Nm torsional force in a selected installation direction of the base joints and a weight of at least 100kg. The surface should be free from vibration. If the robot is installed on a moving platform, an acceleration of the moving platform should be very low, and a high acceleration would trigger the collision stop function of the robot.

2. The user is recommended to use a base contact surface with strong heat dissipation performance, such as all-aluminium material. When the operating temperature is greater than 35 ℃, the user is strongly recommended to use the material with strong heat dissipation performance.

Make sure the robot arm is correctly and securely installed in place.

If soaked in water for more than a certain period of time, the robot may be damaged. The robot should not be installed in water or the humid place unless IP67 protection class is declared.

Danger of overturning: if not securely placed on the hard surface, the robot may overturn and cause damage.

Installation Requirements of the Robot Arm： The robot arm having a 12kg load runs normally without bumping against the outside, in which a center of gravity of the load is deviated from a central axis of the tool end for 100mm. Three ways of installation (forward installation, hoisting and vertical installation) are available, and it is recommended that the minimum anti-overturning force should be available at each hole position of fixing the bolt of the robot arm.

Way of installation	Normal running	Stopping in case of emergency
Forward installation	1554N±360N	1554N±2594N

Reverse installation	1754N ±360N	1754N ±2594N
Vertical installation	1554N ±360N	1554N ±2594N

6.5 Installation of the End/Tool Effector

The tool flange has four M6 threaded holes and one Φ6 positioning hole, in this way the clamp may be conveniently installed and connected to the robot end. The mechanical dimensions of the tool flange are shown in Figure 6-5.

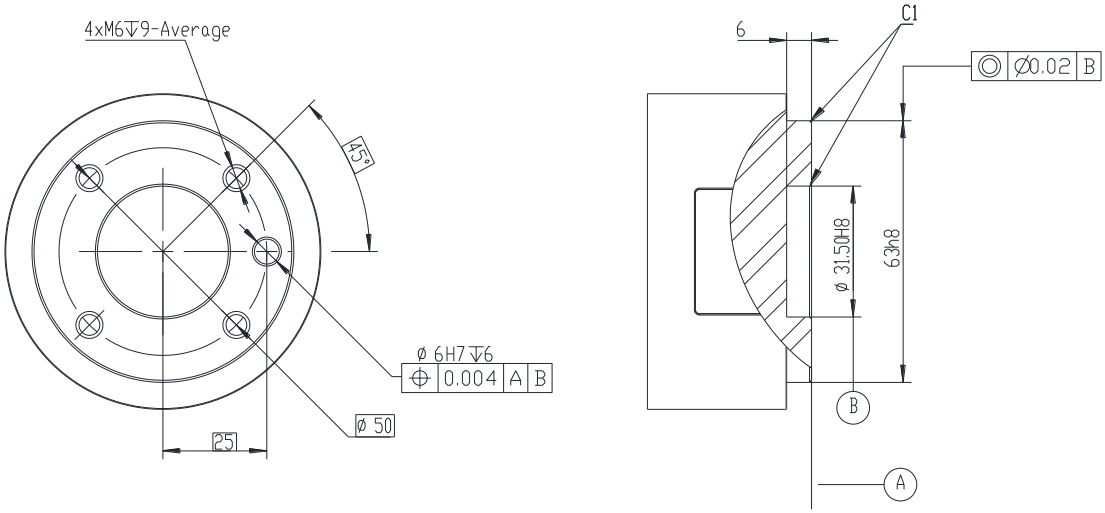
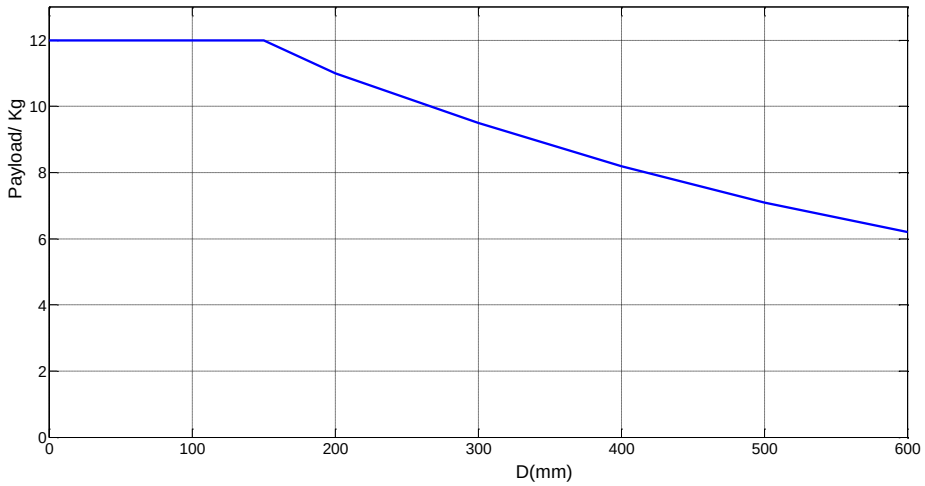


Figure 6-5 Mechanical dimensions diagram of the tool flange of the robot, with unit of mm

1. Make sure the tool is correctly and securely installed in place.

2. Make sure the tool is safely constructed such that it cannot create a hazardous situation by a dropping part unexpectedly.



A wrist payload diagram is shown above. Herein, the horizontal ordinates D respectively indicates the offset of the center of gravity. The offset of the center of gravity is the distance from the center of the flange plate of the tool/end effector to the center of gravity of the tool.

WARNING

1. The load conditions should fall within the scope shown in the chart.

2. The payload shown in the diagram indicates a maximum payload which should not exceed a maximum weight shown in the diagram under any circumstances.

3. The components inside the robot may be damaged early if the payload exceeds an allowable value.

Chapter 7 Quick Start

7.1 Installation

7.1.1 Robot installation

Take the ELITE robot out of the packing box and install it on the base. Please refer to Chapter 6 Robot Installation for the specific installation instructions.

【NOTES】

1. The control box should be placed on the ground horizontally. A 50 mm clearance should be reserved on each side of the control box to ensure smooth air circulation.
2. The teach pendant can be hung on the control box. Make sure that the cable will not cause tripping hazard.

【DANGER】

1. Make sure the control box, the teach pendant and the cables do not come into contact with liquids. The wet control box may cause casualties.
2. The control box and the teach pendant should not be exposed to the dust or the humid place exceeding the level of IP54. Pay close attention to the environment of conductive dust.

7.1.2 Cable Connection

There are two sockets at the bottom of the control box, and the corresponding cable should be inserted into the socket before use.

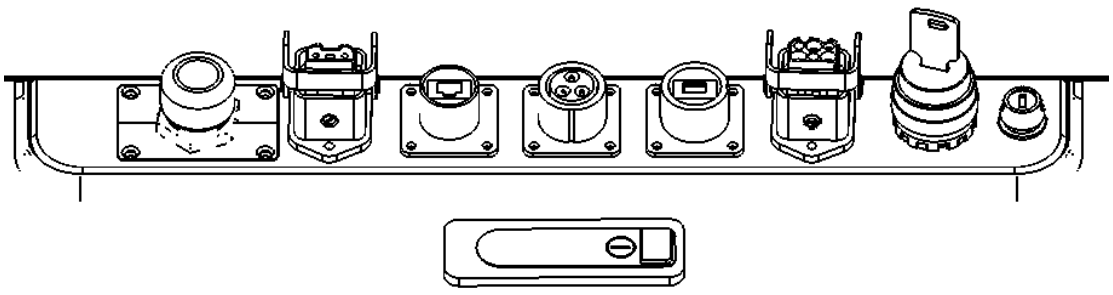


Figure 7-1 Plugs at the bottom of the control box

7.1.2.1 Connection of the robot arm to the control box

There is a heavy-load rectangular plug at the end of the robot arm cable. Insert the heavy-load

rectangular plug into the control box. Pay attention to the insertion direction, and lock the connector after tight insertion, as shown in the following figure.

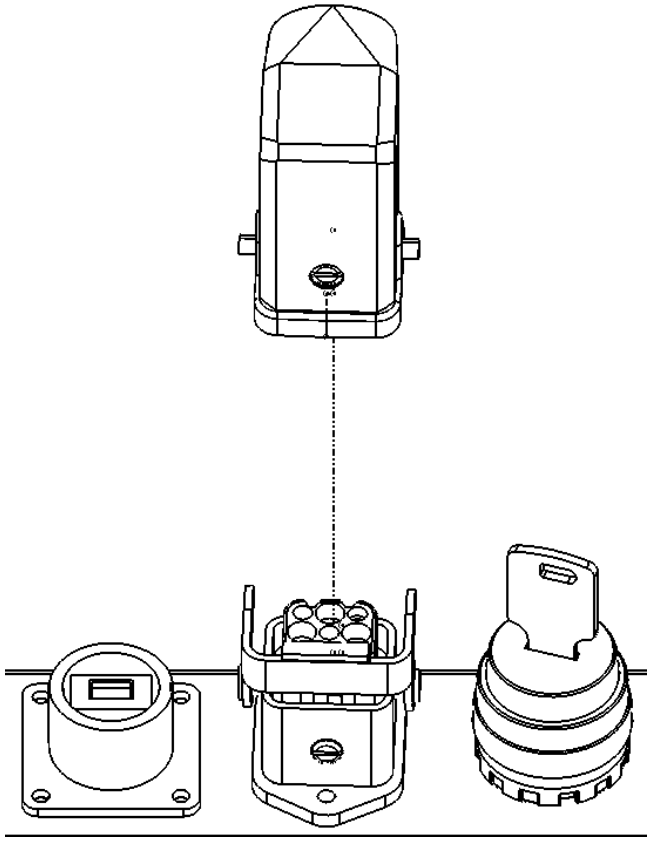


Figure 7-2 Connection of the robot cable to the control box

7.1.2.2 Connection of the control box to the mains supply

There is a heavy-load rectangular plug at the end of the mains cable of the control box. Connect the local dedicated mains cable to the heavy-load rectangular plug. Pay attention to the insertion direction, and lock the connector after tight insertion, as shown in the following figure.

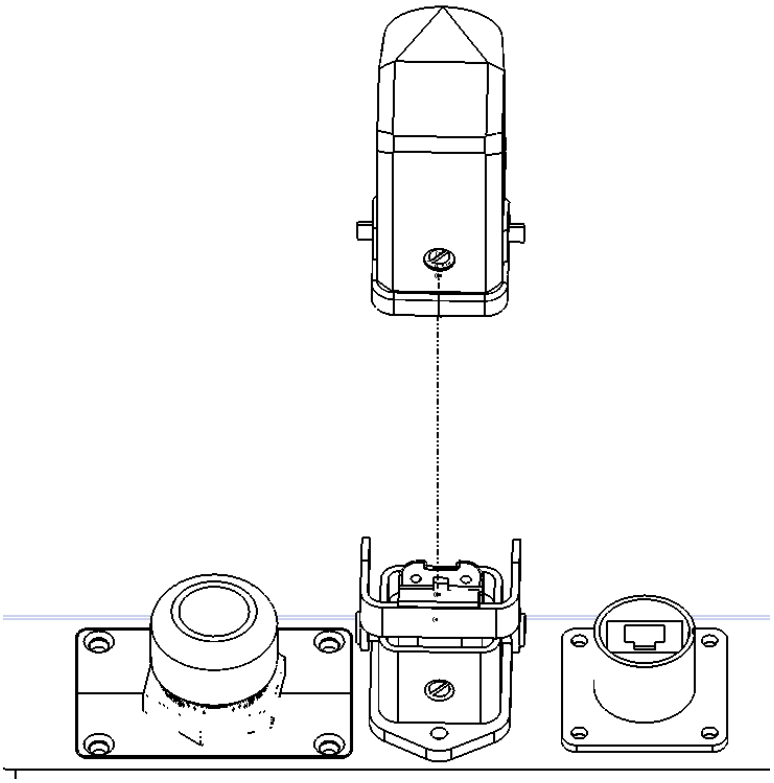


Figure 7-3 Diagram of the power interface of the control box

【DANGER】

1. Please make sure that the robot is grounded correctly (electrical connection to ground). The grounding conductor should have at least rated current of the highest current in the system.
2. Please make sure that all cables are correctly connected before the control box is powered on. Always use the original power cord correctly.

【WARNING】

1. Do not disconnect the robot cable when the robot arm is turned on
2. Do not extend or modify the original cable.

7.2 Robot Power-on

7.2.1 Preparations before power-on

- Check whether the robot is well connected with the control box.
- Check whether the teach pendant is well connected with the control box.
- Check whether the power cable of the control box is well connected.
- The power master switch of the control box is OFF when the power supply is turned off.
- The control box and the emergency stop switch of the teach pendant are in bouncing state.

- The mode selection button is positioned at the correct position.
- Make sure the robot would not contact with the surrounding personnel and the equipment.

7.2.2 System power-on

7.3 Robot Shutdown

Shutdown sequence: turn off the power supply of the robot and the teach pendant first; then turn off the power supply of an I-series control box. 1. Turn off the power supply of the robot and the teach pendant.

Normal exit: exit the program, and press the software closing button in the upper right corner of the operation interface of the teach pendant.

Forced shutdown: long press the starting button in the upper left corner of the teach pendant for about 3 seconds, to turn off a blue light; and turn off the power supply of the teach pendant and the robot. 2. Turn off the power supply of the I-series control box.

Warning: shutdown of the system by directly unplugging the power cord from the wall socket may cause damage of the file system of the robot, and accordingly lead to function failure of the robot.

Chapter 8 Electrical Interface

8.1 Overview

This chapter describes all electrical interfaces of the collaborative robot. Examples are given for most types of I/Os. The term “I/O” refers to both digital and analog control signals of an import interface.

- Controller I/O
- Ethernet
- Power supply connection
- Robot connection
- Tool I/O

The warnings and cautions in next section are related to the four groups of interfaces, please comply with these matters.

8.2 Electrical Warnings and Cautions

Observe the following warnings and cautions when the robot application is designed and installed. Furthermore, observe these warnings and cautions as well when implementing maintenance.

DANGER:

1. Never connect the safety signals to a PLC which is not a safety-related PLC with the proper safety level. Failure to follow the warning may result in serious injury or even death as certain safety stop function is invalid. please separate the safety interface signal from the general I/O interface signal.
2. All safety-related signals are constructed redundantly (two independent channels). Keep the two channels independent so that a single failure would not lead to loss of the safety function.
3. Some I/Os inside the control box may be configured as the normal I/Os or the safety-related I/Os. Please read through Section 4.3.

DANGER:

1. Make sure that all equipments which must be kept far away from water are kept dry. If the water enters into the product, please turn off the power supply and then contact with your provider for assistance.
2. Only use the original cables supplied with the robot. Do not use the robot in applications where the cables are subjected to flexing. If a longer cable or a flexible cable is needed, contact your provider.
3. A negative connector is defined as the Ground (GND) connector which is connected to a shield of the robot and the control box. All GND connectors mentioned in the text are only suitable for powering and transmitting signals. For protective earth (PE), please provide the control box with the reliable GND with the dedicated power supply socket of the control box.
4. Please be careful when installing the interface cable to the robot I/O. A metal plate on the back of the box is intended for the interface cables and connectors. Please remove the metal plate before drilling holes. Make sure that all matte sides are removed before reinstalling the metal plate. Remember to use the correct size gland.

Caution:

1. The robot has been tested in accordance with international IEC standards for electromagnetic compatibility (EMC). Disturbing signals with levels higher than those defined in the IEC standards may cause unexpected behaviors of the robot. Very high signal level or excessive exposure may damage the robot permanently. The EMC problems happen usually during welding and are usually prompted by the error messages in the log. ELITE shall not be held responsible for any damages caused by EMC problem.

2. The I/O cable for connecting the control box to other machinery and factory equipments may not be longer than 30m, unless the prolonged test are performed.

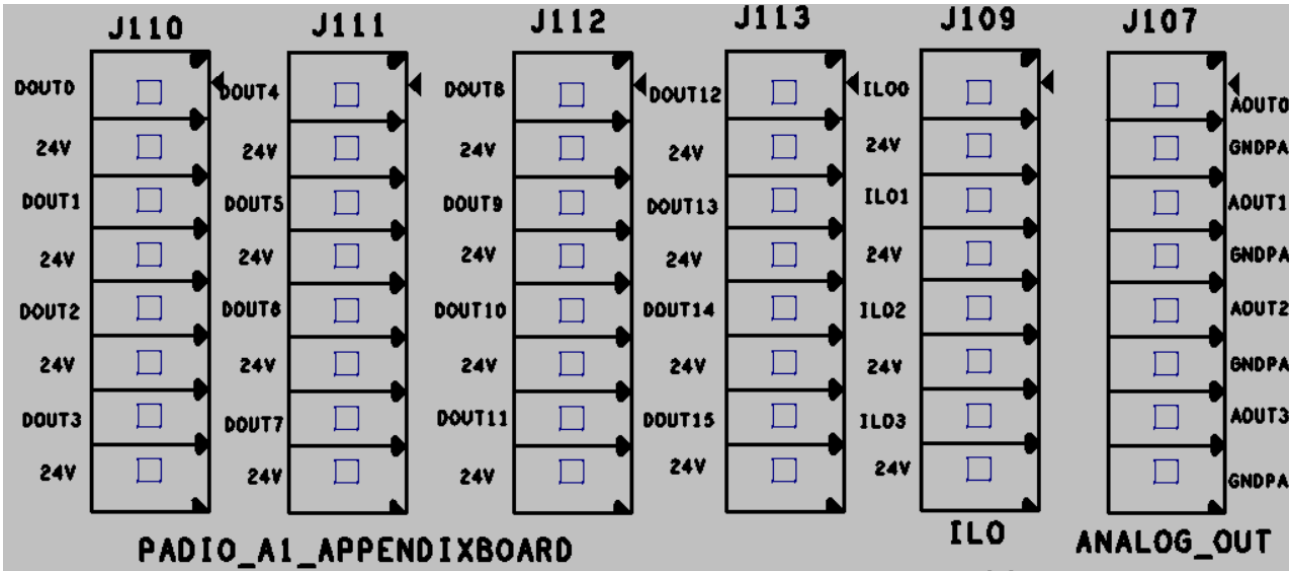
NOTE:

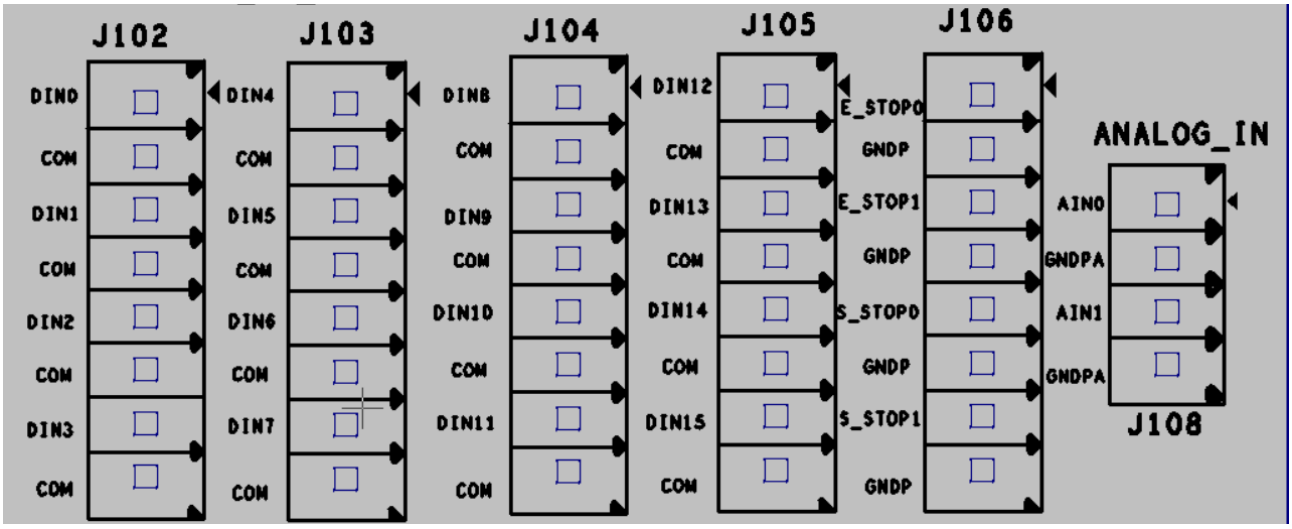
All voltages and currents are in direct current (DC), unless otherwise specified.

8.3 Controller I/O

This chapter describes how to connect the equipment to the I/O inside the control box. The I/O is extremely flexible and may be applied to various different equipments, including the pneumatic relay, the PLC and the emergency stop button.

The layout of the electrical interfaces inside the control box is shown in the following figure.





J106	Dedicated safety signals
J102,J103,J104,J105	Configurable digital input DI
J109,J110,J111,J112,J113	General purpose digital DO
J108,J107	General purpose analog I/O

The following chapters shall describe how to use the digital I/O. This section describes the common specifications that must be followed.

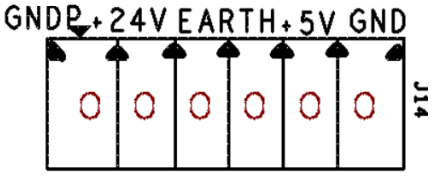
8.3.1 Common specifications of all digital I/Os

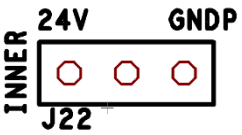
This section defines the electrical specifications of the following 24V digital I/Os of the control box.

- Safety I/O.
- Configurable I/O.
- General purpose I/O.

It is important to install the Elite robot in accordance with the electrical specifications which must be done for both two types of inputs. The internal 24V power supply shall be provided to the digital I/O, and access of the power interface shall be implemented through the J14 terminal on the IO plate via the internal 24V power supply.

The configurable I/O is defined that the digital input may be configured to two input modes including NPN and PNP, which may implement selection with J22 on the IO plate. The NPN input is default, namely, J22 short-circuit 24V and the intermediate terminal. Furthermore, the





short-circuit may be implemented for the GNDP and J22 intermediate terminal with a short circuit cap, as to configure the input as the PNP mode.

The electrical specifications of the internal power supply is shown below.

Terminal	Parameter	Min	Type	Max	Unit
Internal *24V* power supply					
[24V - GNDP]	Voltage	22.8	24	26.4	V
[24V - GNDP]	Current	0	--	4	A

The digital I/O should be constructed in compliance with IEC 61131-2. The electrical specifications are shown below.

Terminal	Parameter	Min	Type	Max	Unit
Digital output					
[DOUTx/ILOx]	Current	0	-	0.7	A
[DOUTx/ILOx]	Voltage drop	0	-	1	V
[DOUTx/ILOx]	Leakage current	0	-	0.1	mA
[DOUTx/ILOx]	Function	-	PNP	-	Type
[DOUTx/ILOx]	IEC 61131-2	-	1A	-	Type
Digital input					
[DINx]	Voltage	-3	-	30	V
[DINx]	OFF region	-2	-	2	V
[DINx]	ON region	8	-	30	V
[DINx]	Current (8-30V)	2	-	8.5	mA
[DINx]	Function	-	PNP	-	Type
[DINx]	IEC 61131-2	-	3	-	Type
Digital input/safety input					
[DINx /x_STOPx]	Voltage	-10	-	26	V
[DINx /x_STOPx]	OFF region	22	-	26	V
[DINx /x_STOPx]	ON region	-10	-	19	V
[DINx /x_STOPx]	Current (-10V-19V)	1	-	10	mA
[DINx /x_STOPx]	Function	-	NPN	-	Type
[DINx /x_STOPx]	IEC 61131-2	-	3	-	Type

NOTE:

The word “Configurable” is intended for the input which may be configured as the NPN input or PNP input.

8.3.2 Safety I/O

This section introduces the dedicated safety input. Please observe the common specifications in Section 4.3.1.

The safety device and equipment must be installed in accordance with the safety instructions and the risk assessment in Chapter 1.

All safety I/Os are paired (redundant) and two separate branches must be retained. A single failure should not cause loss of the safety function. There are two permanent inputs: emergency stop and safeguard stop.

The emergency stop input should be applied to the emergency stop equipment only. The safeguard stop input should be applied to all types of safety-related protective equipments. The functional differences are shown below.

	Emergency stop	Safeguard stop
Motion stop of the robot	Yes	Yes
Program execution	Stop	Pause
Power supply of the robot	Off	On
Reset	Manual	Automatic or manual
Frequency of use	Infrequent	Once within each cycle
Requires re-initialization	Brake released only	No
Stop category (IEC 60204)	1	2
Performance level (ISO 13849-1)	PLd	PLd

The emergency stop output and other safety I/O functions may be set with the configurable I/O.

Some examples about how to use the safety I/O are given in the section below.

DANGER:

1. Never connect the safety signals to a PLC which is not a safety-related PLC with the improper safety level. Failure to follow the warning may result in serious injury or even death as certain safety stop function is invalid. Please separate the safety

interface signal from the general I/O interface signal.

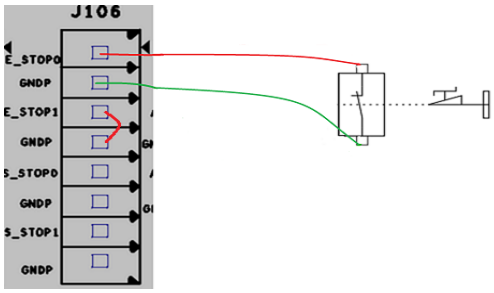
2. All safety-related I/Os are constructed redundantly (two independent channels). Keep the two channels independent so that a single failure may not lead to loss of the safety function.

3. Safety functions must be verified before putting the robot into operation. Safety functions must be tested regularly.

4. The robot installation must conform to these specifications. Failure to do so may result in serious injury or even death as the safety stop device may be invalid.

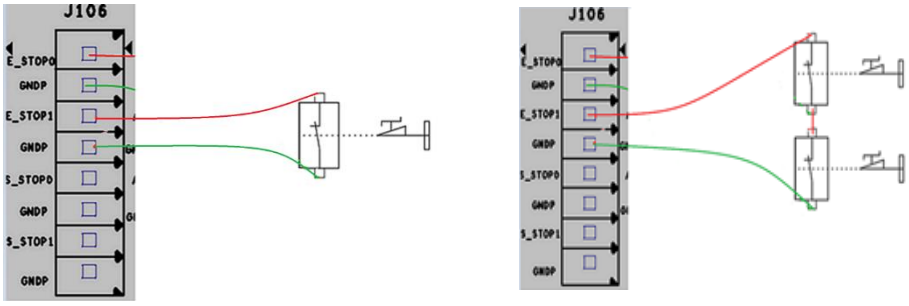
8.3.2.1 Default safety configuration

The default configuration is implemented for the delivered robot, which can be operated in absence of any additional safety equipment (the teach pendant is equipped with the emergency stop button; the equivalent circuit is shown below; and the short circuit is required to implement for E_STOP1 and GNDP when the E_STOP1 enabling is not configured in the software).



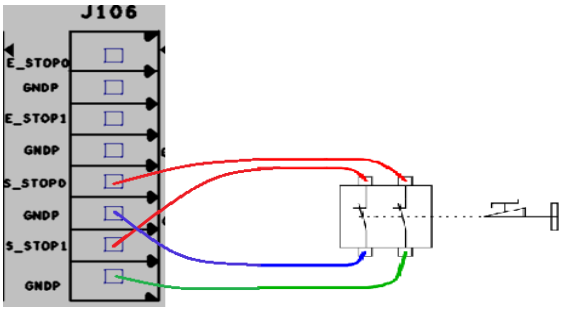
8.3.2.2 Connecting with the emergency stop button

Most applications require one or more additional emergency stop buttons. The operational principle (the E_STOP1 function enabling needs to be configured in the software) of the one or more emergency stop buttons is shown in the following figure.



8.3.2.3 Safeguard stop with automatic resume

The door switch is an example of the basic safeguard stop equipment. When the door is opened, the robot is stopped. Please refer to the figure below (the software is required to configure the safeguard stop function cooperatively).



This configuration is only intended for application where the operator cannot go through the door and close it behind him. The configurable I/O may be used to set a reset button outside the door, as to reactivate motion of the robot.

DANGER:

The robot shall resume motion automatically when the safeguard signal is re-established. Do not use this configuration if the signal can be re-established from the inside of the safety perimeter.

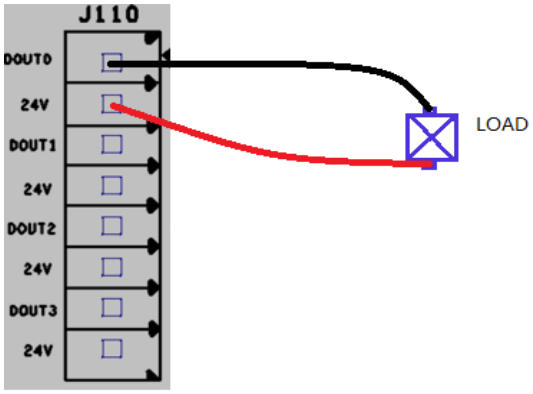
8.3.3 General purpose digital I/O

This section introduces the general purpose 24V I/O. The common specifications in section 4.3.1 must be followed. The general purpose I/O may be used to directly drive the equipment, such as the pneumatic relay, or to communicate with other PLC systems. All digital outputs may

be disabled automatically when program execution is stopped. Refer to Part II for details. In this mode, the output will always be the high level when the program does not run. Several examples are shown in the section below. The regular digital outputs are taken in these examples, however this type of outputs may also be used if the configurable output is not configured to perform the safety function.

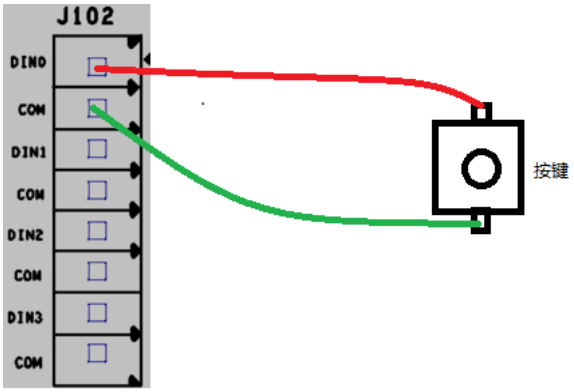
Load controlled by the digital output

This example shows a connection way of the load controlled by the digital output. See the figure below.



8.3.4 Digital input from a button

This example shows a connection way of a simple button and the digital input.



8.3.5 General purpose analog I/O

The analog I/O interface can be used to set or measure the voltage (-10V~10V) in and out of other equipments.

In order to acquire a high accuracy, it is recommended to comply with the following instructions:

• Use the GNDPA terminal closest to the I/O. The I/O pair shares a common mode filter.

• Use the same GND (0V) for the equipment and the control box. The analog I/O is not galvanically isolated from the control box.

• Use a shielded cable or twisted pair. Connect the shielded cable to the “GNDP” terminal on the “Power” terminal.

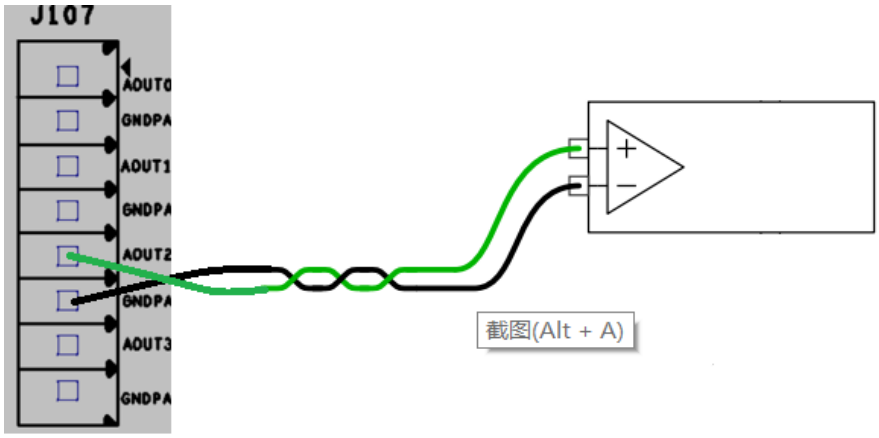
The electrical specifications are shown below.

Terminal	Parameter	Min	Type	Max	Unit
Analog input					
[AINx - GNDPA]	Voltage	-10	-	10	V
[AINx - GNDPA]	Resistance	-	100	-	Kohm
[AINx - GNDPA]	Resolution	-	12	-	bit
Analog output					
[AOUTx - GNDPA]	Voltage	-10	-	10	V
[AOUTx - GNDPA]	Resistance	-	10	-	ohm
[AOUTx - GNDPA]	Resolution	-	12	-	bit

The following example shows a way of using the analog I/O.

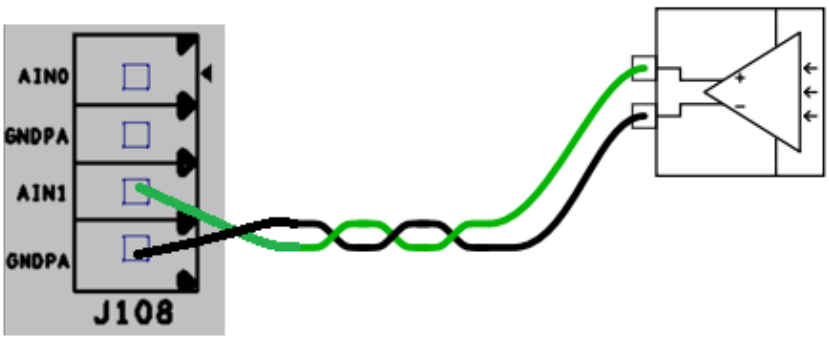
8.3.5.1 General purpose analog output

The following example illustrates how to control a welding current of a welder with an analog input.



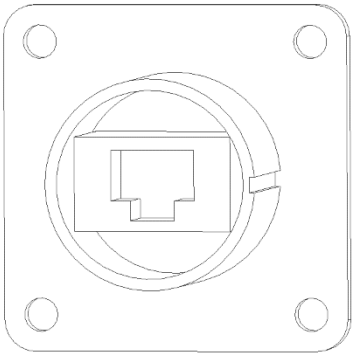
8.3.5.2 Using an analog input

This example illustrates how to connect with an analog sensor.



8.4 Ethernet

The Ethernet is provided on the top of the control box. Please refer to the figure below.



The Ethernet interface can be applied to the following applications:

• Remote access and control

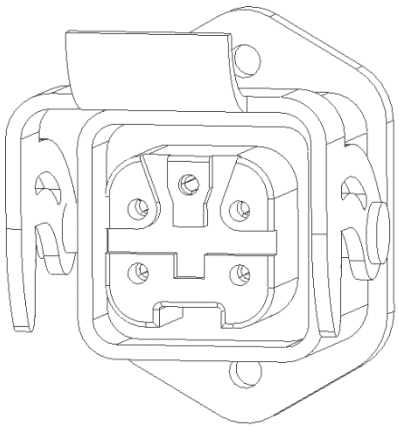
The electrical specifications are shown below.

Parameter	Min	Type	Max	Unit
Communication speed	10	-	100	Mb/s

8.5 Mains Connection

The mains cable of the control box has a standard rectangular heavy-load plug at the end. Connect the local dedicated mains socket or cable to the rectangular heavy-load plug.

In order to power on the robot, the control box must be connected to the power supply. This process must be completed by connecting with the rectangular heavy-load plug at the bottom of the control box with the corresponding wire. Please refer to the figure below.



The power supply should be equipped with at least following accessories:

• Connection to ground

• Mains fuse

• Residual current device

It is recommended to install a mains switch to the power supply of all equipments in the robot application, in order to facilitate lockout and tagout during repair.

The electrical specifications are shown in the table below.

Parameter	Min	Type	Max	Unit
Input voltage	90	-	240	VAC
External mains fuse (when the voltage is 90-130V)	32	-	64	A
External mains fuse (when the voltage is 200-240V)	16	-	32	A
Input frequency	47	-	63	Hz
Rated operating power	300	500	2400	W

NOTE:

The switch inside the NED-100D switching power needs to be switched to the gear 115V when the external mains supply is 90~130VAC.

DANGER:

1. Please make sure that the robot is grounded correctly (electrical connection to ground). Please establish the common grounding for all equipments inside the system with bolts which are unused and connected to the grounding symbols inside the control box. The grounding conductor should have at least the rated current of the highest current in the system.

2. Make sure that the input current of the control box is protected with the residual current device (RCD) and the appropriate fuse.

3. The lockout and tagout should be implemented for all power supplies when the robot needed to complete all services is installed and set. The robot I/O should not be powered by other equipments when the system is locked.

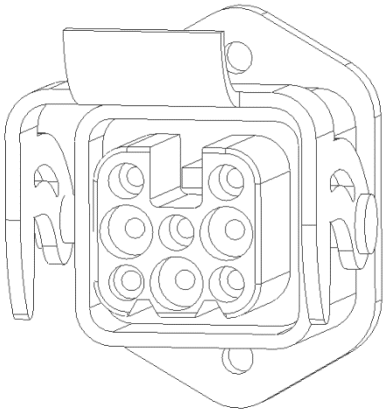
4. Please make sure that all cables are connected correctly before the control box is powered on. Always use the original power cord.

5. The operation of switching the switch inside the NED-100D switching power should be implemented before the box is not

connected with the power supply.

8.6 Robot Connection

The robot cable must be inserted into the connector on the top of the control box, as shown in the figure below. Appropriately lock the connector when the robot arm is started. The power supply of the robot must be turned off when disconnecting the robot cable.

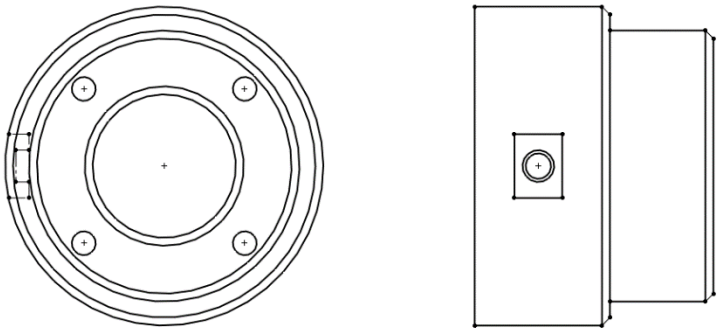


Caution:

1. Do not disconnect the robot cable when the robot arm is started.
2. Do not extend or modify the original cable.

8.7 Tool I/O

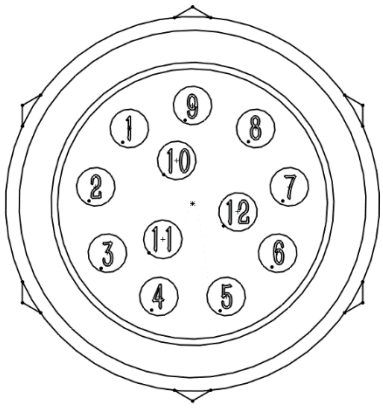
A 12-pinned connector is arranged near the tool flange of the collaborative robot end, for providing the different grippers and sensors connected to the robot with the power supply and the control signals.



NOTE:

The tool connector must be manually tightened up, with a maximum moment of force of 0.4Nm.

The following figure should be used for reference for a function list of 12 connecting pins of an aviation plug:



Note: the mode of the aviation plug is HR10A-10R-12P of HRS company

Pin No.	Function description
1	Digital ground (GND)
2	Digital output interface 1 (DO1)
3	Digital output interface 2 (DO2)
4	Digital input interface 1 (DI1)
5	Digital input interface 2 (DI2)
6	Analog input interface (AI1)

7	Analog output interface (AO1)
8	RS485+
9	RS485-
10	+24V power output
11	Blank, no connection therein
12	Blank, no connection therein

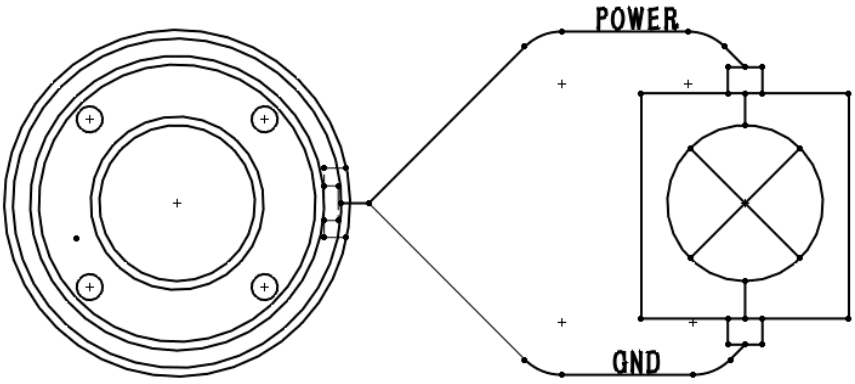
Herein, the electrical specifications of the 24V internal power supply are shown in the table below:

Parameter	Min	Type	Max	Unit
24V supply voltage	23.5	24	24.8	V
24V supply current	-	800	1000*	mA

*1000 mA for max 1 second. Maximum duty cycle: 10%. Average current should not exceed 600 mA

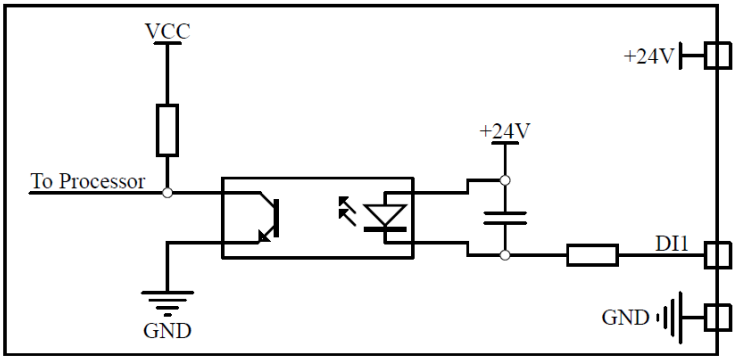
8.7.1 Tool power supply

The tool I/O of the Elite collaborative robot can provide the external tool with a 24V power supply.



8.7.2 Tool digital input

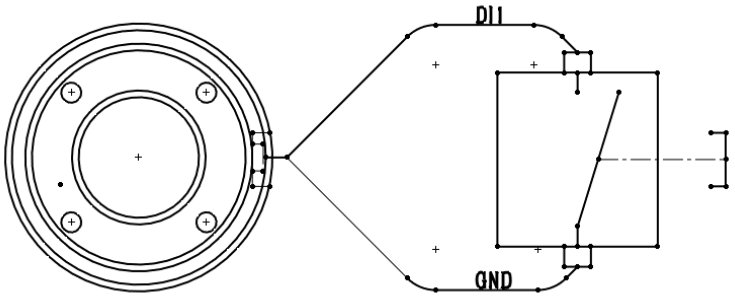
The implementation mode of the digital input interface is shown in the figure below:



The electrical specifications are shown in the table below:

Parameter	Min	Type	Max	Unit
Input voltage	-0.5	-	26	V
Logical low voltage	-	-	10	V
Logical high voltage	22	-	-	V

Using the tool digital input:
This example illustrates how to connect with a simple button.



8.7.3 Tool digital output

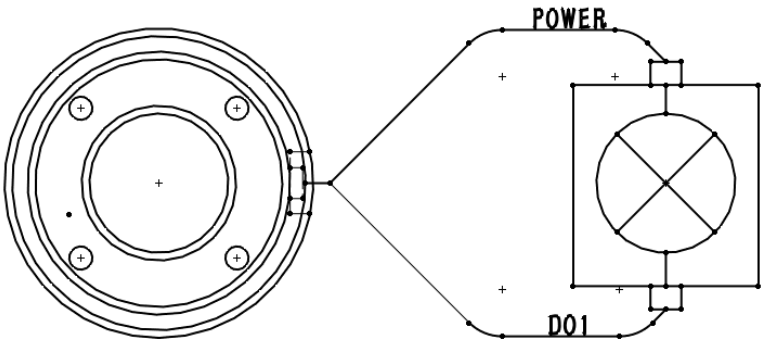
The digital output is compatible with a sinking drive mode (NPN), namely, it is in the low level state when the output port is activated; and the level state is in a high-impedance breaking state when the output port is not activated.

The electrical specifications of the digital output port are shown below:

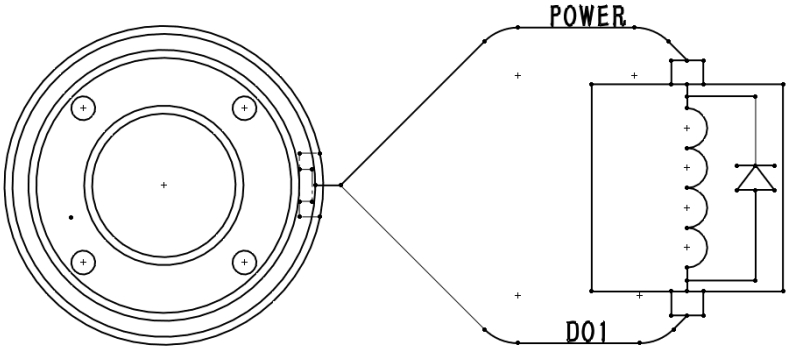
Parameter	Min	Type	Max	Unit
Voltage when open	-0.5	-	26	V
Voltage when sinking 1A at 25 ℃	-	0.19	0.24	V
Sinking current	0	600	1000	mA

Using the tool digital output

This example illustrates how to open and use a load of the internal 24V power supply:



It is recommended to use a protective diode for the inductive load, as shown in the figure below.



Caution:

Even when the load is off, voltage is still present between the power connector and the shield / ground

8.7.4 Tool analog input

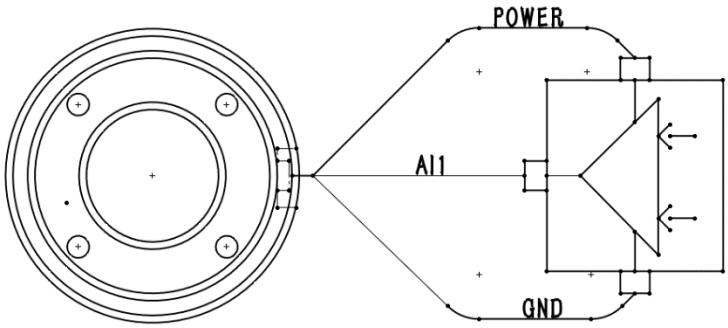
The tool analog input is a non-differential input, with voltage (0-10V). The electrical specifications are shown below.

Parameter	Min	Type	Max	Unit
Input voltage	-0.5	-	24	V
Input resistance	-	-	>100	MΩ
Resolution	-	10	-	Bit

Two examples of how to use the analog input are illustrated in the following section.

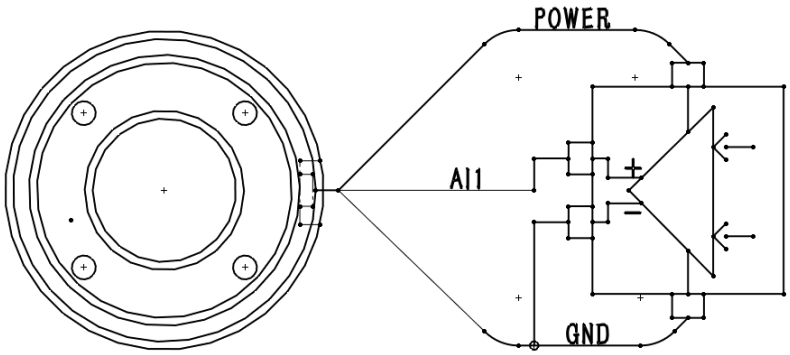
Using the tool analog input, non-differential

This example illustratesan analog sensor connection with a non-differential output.



Using the tool analog input, differential

This example illustrates an analog sensor connection with a differential output. Work in the same way as the non-differential sensor after connecting a negative output end to the GND (0V).



8.7.5 Tool analog output

The tool analog output is a non-differential output, with voltage (0-10V). The electrical

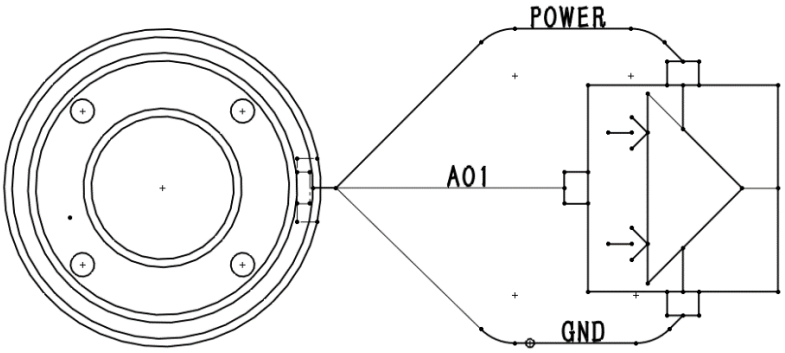
specifications are shown below.

Parameter	Min	Type	Max	Unit
Output current	-	17	-	mA
Output short circuit current	-	60	-	mA
Resolution	-	10	-	Bit

The examples of how to use the analog output are illustrated in the following section.

Using the tool analog output

This example illustrates a method of connecting to an analog signal with a non-differential output.



8.7.6 Tool communication I/O

- Signal requests: RS485 signals use internal fail-safe biasing. If the connected device is not compatible with this fail-safe, the signal biasing must either be done in the connected tool, or added externally by adding a pull-up resistor to RS485+ and a pull-down resistor to RS485-.
- The latency is 2ms to 4ms from writing in data to be sent on a robot controller to the start of sending the data on the RS485. The latency is 2ms to 4ms from the start of receiving the data on the RS485 to receiving of the data by the robot controller and the start of handling.

Baud rate	2.4k, 4.8k, 9.6k, 19.2k, 38.4k, 57.6k, 115.2k
Stop bit	1, 2
Parity bit	Null, Odd, Even

Chapter 9 Teach Pendant

The teach pendant is an important component of the ELITE robot. Through the teach pendant, the user may read log information of the robot while enabling the robot to move with a teaching way and simply programming the robot.

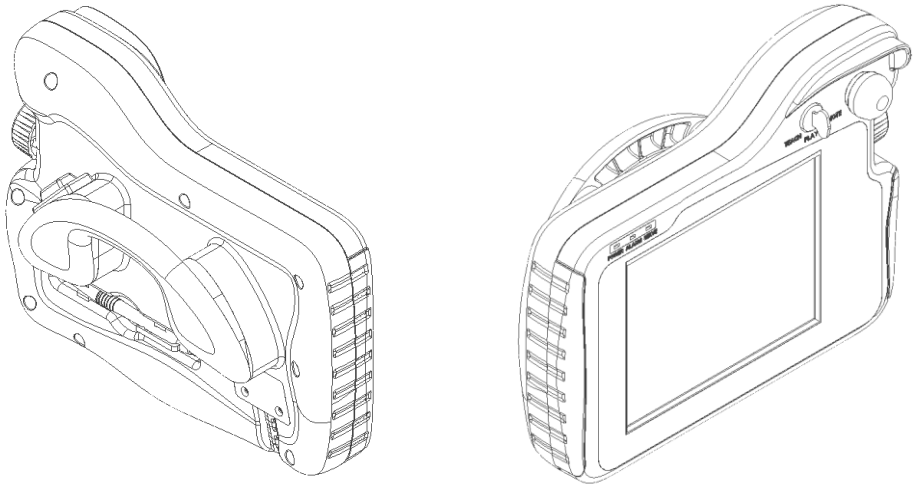


Figure 9-1 Components of the teach pendant

The teach pendant mainly includes a 8.4-inch LCD touch screen, a mains switch, an emergency stop button, a force switch and a socket for a teach pendant connecting line. The touch screen may not only show the detailed motion of the robot to the user clearly, including the position and pose parameters and so on, but facilitate operations of the user. All operations may be completed by directly clicking the screen.

The housing of the teach pendant is designed in combination with aesthetics and ergonomics, and the back thereof is equipped with a nylon rope and two hanging rings. The nylon rope is used to hold the teach pendant, and the teach pendant can be suspended on an electric control cabinet by making use of the hanging rings.

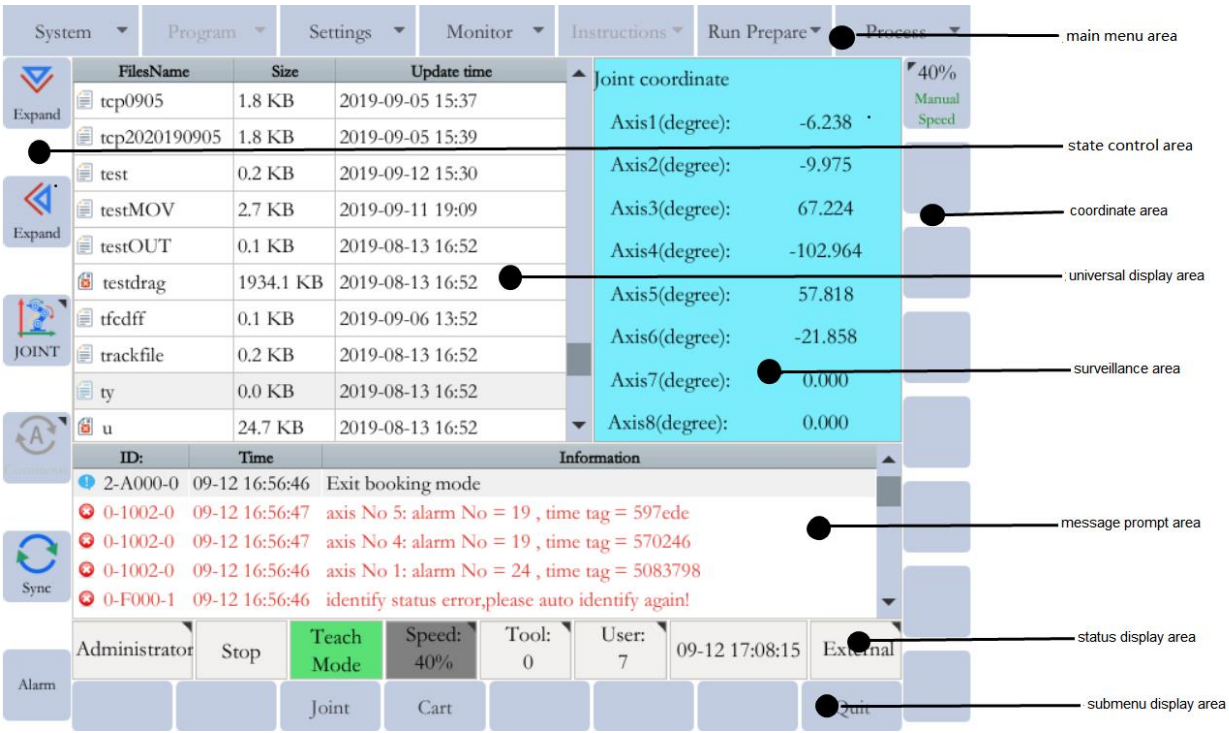
The force switch belongs to the three-position enabling switch which can implement three-position motions of avoiding the danger: OFF (release)⇒ ON ⇒ OFF (press). When the switch is ON, the teaching operation can be implemented by dragging the robot.

You can see the detailed instructions of the control system of the teach pendant in “ERC-G200 System Operation Manual”.

Note: the pictures of the following Settings are for reference only

9.1 Programming Pendant Display

Instruction
Programming pendant supports keyboard and touch operations. The status control area, coordinate area and submenu area support operations by pendant keys, while all buttons, input boxes, options, etc. can be clicked and controlled. Keyboard and click operations differ in status control area, coordinate area, and sub-menu area; Could click to switch status, pop-up dialog box, etc.; While it only changes status (no pop up dialog boxes) when using keyboard. After clicking in the input box, the number or character will be recognized automatically and corresponding full keyboard or numeric keyboard pop up. Manipulator can be operated only by pendant keys, clicking in the display interface is invalid.



1. The display part of the programming pendant is an 8-inch colored touch screen, used for displaying the manipulator operation interface that could be used for performing corresponding

operations.

2. The display interface is mainly composed of three areas (general-purpose display area, monitoring area, information prompt area) around with the main menu area, status control area, coordinate area, status display area.

3. Three display areas can be switched by pressing  button or directly clicking on the screen to switch the activation status. When a certain display area is switched focused, the background color of this area changes or a cursor bar appears. The status control area, the coordinate area and the sub-menu area changes accordingly when the display area is switched.

4. Activation status of general-purpose display area: Display blue cursor bar when the program list is displayed. The background is beige when the program is open. The background is blue when the monitoring area is activated. The blue cursor bar is displayed when the information prompt area is activated.

5. The monitoring area and information prompt area in the three display areas can be hidden. When the monitoring area or information prompt area is displayed, the general-purpose display area will be automatically reduced to half display; When the monitoring area or information prompt area is hidden, the general-purpose display area is automatically enlarged to the entire display.

6. The main menu area can only be operated by clicking on the screen.

7. The status control area, coordinate area, and sub-menu area can be switched or directly pressing by the corresponding keys outside of the screen; The button with corner mark will pop up when pressing, while it will directly switch the status when the key has no corner mark.

8. Icon or area with triangular corner mark  can be clicked, and a dialog box will pop up.

9.1.1 Main Menu Area

The main menu options are mainly used for various parameter settings, such as system setting, program editing, parameter setting, monitoring, instructions editing, operation preparation, and user process.

System		
First Level Menu	**Second Level Menu**	**Operation Authority**
Local to USB	Parameter backup	Expert user
	IO annotation backup	
	PLC backup	
	User data backup	
	Script backup/delete	
USB to Local	Parameter upgrade	Expert user
	IO annotation upgrade	
	PLC upgrade	
	User data recovery	
	Script upgrade	
	Identification file import	
System Upgrade		Expert user
System Configuration	Robot configuration	Root
	Network configuration	Root
	Language configuration	Root
Institutional Information		General user
Software information		General user

Program Edit		
First Level Menu	Second Level Menu	Operation Authority
Copy	Line copy	Expert user
	Block copy	
Cut	Line cut	
	Block cut	
Paste		
Delete	Line delete	
	Block delete	
Search		
Replace		
Logic instruction customization		
Reset		

Parameter Setting		
First Level Menu	Second Level Menu	Operation Authority
Speed parameter		Root
System parameters		Administrator
Limit parameter		Root

Servo parameter		Administrator
Institutional parameter		Administrator
Other parameters		Administrator
Permission	Switch user	General user
	Change password	Expert user

Monitoring		
First Level Menu	Second Level Menu	Operation Authority
Coordinate	Joint coordinates	General user
	Cartesian coordinates	
Variable	Variable B	
	Variable I	
	Variable D	
	Variable P	
IO	Input	
	Output	
	Virtual input	
	Virtual output	
Motor	Impulse	
	Motor speed	
	Absolute position	
Operational monitoring		

Edit Instruction		
First Level Menu	Second Level Menu	Operation Authority
Input/output instructions		Expert user
Control instruction		
Calculation instruction		
Process instruction		

Readiness for Operation		
First Level Menu	Second Level Menu	Operation Authority
Tool coordinates		Expert user
User coordinates		Expert user
Interference area		Expert user
Home position	Mechanical home position	Expert user (returnable operation) Administrator (can modify the home position)
	Program home position	Expert user
	Home position calibration	Expert user

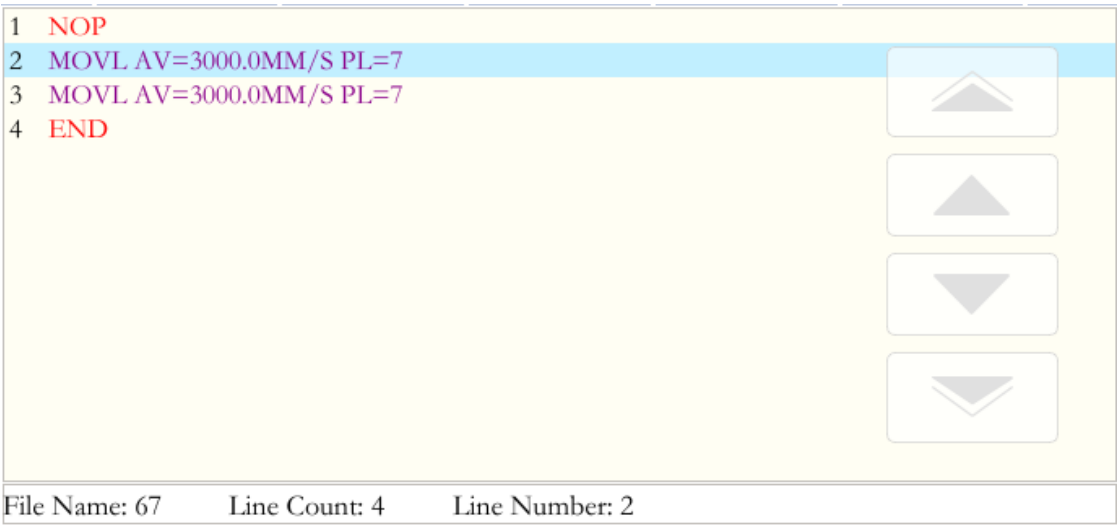
User processes
Corresponding process setting menu will display under the user processes option according to the actual configuration of the system.

9.1.2 General-purpose Display Area

The general-purpose display area is mainly used to display program list, program editing interface and various system setting interfaces. Most of the operations and settings of the system are displayed and set in this general-purpose display area. The following figure shows the interfaces active status in the general-purpose display area.

FilesName	Size	Update time
demo	0.0 KB	2019-08-31 17:53

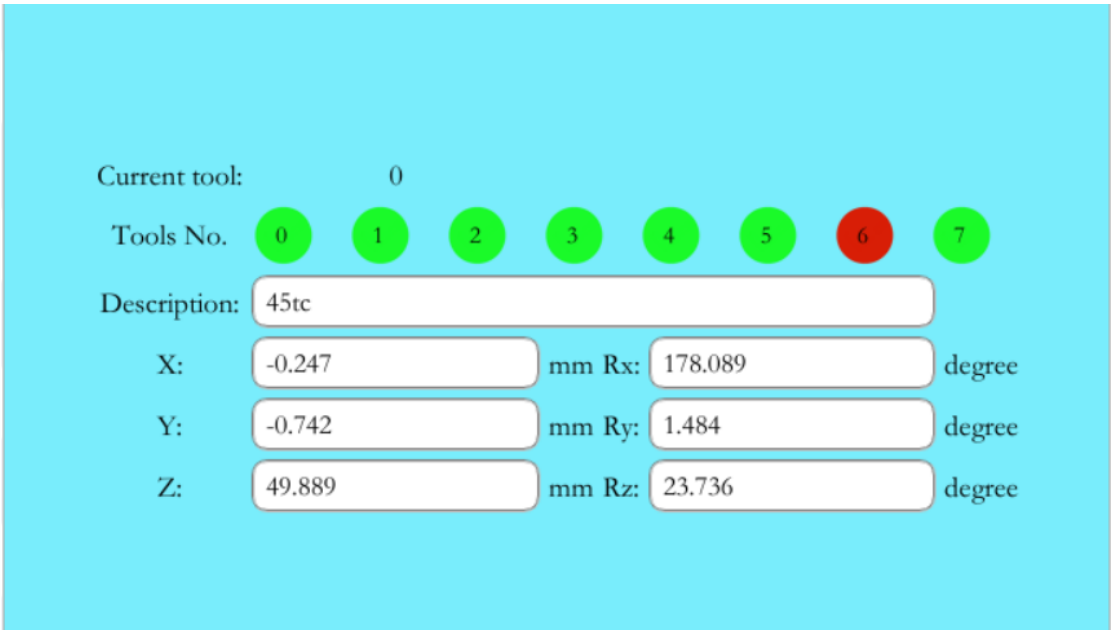
Program list



Program editing

	Value	Notes
1	Absolute e···	Not used
2	Expert user	Default user privilege level at starting-up
3	100	Normal brightness
4	50	Half brightness
5	300000	Half light time
6	100	Lock screen time

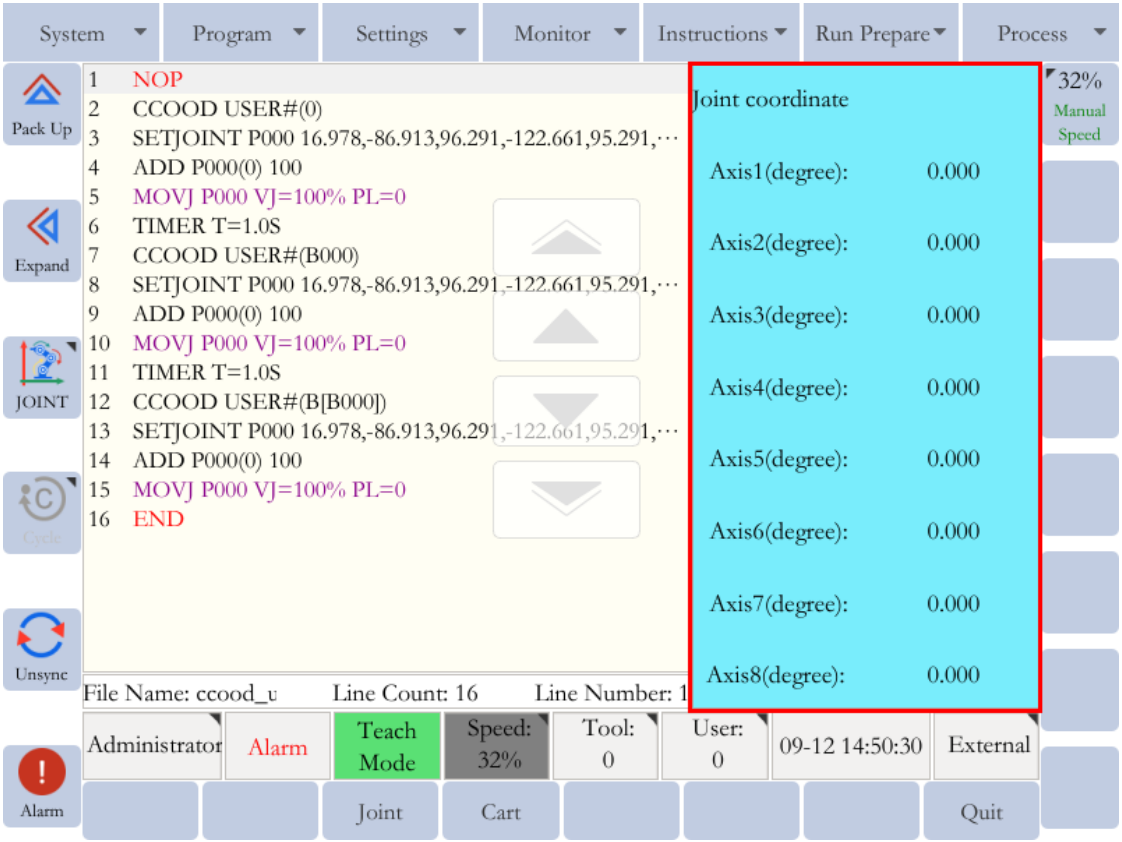
Speed parameter setting



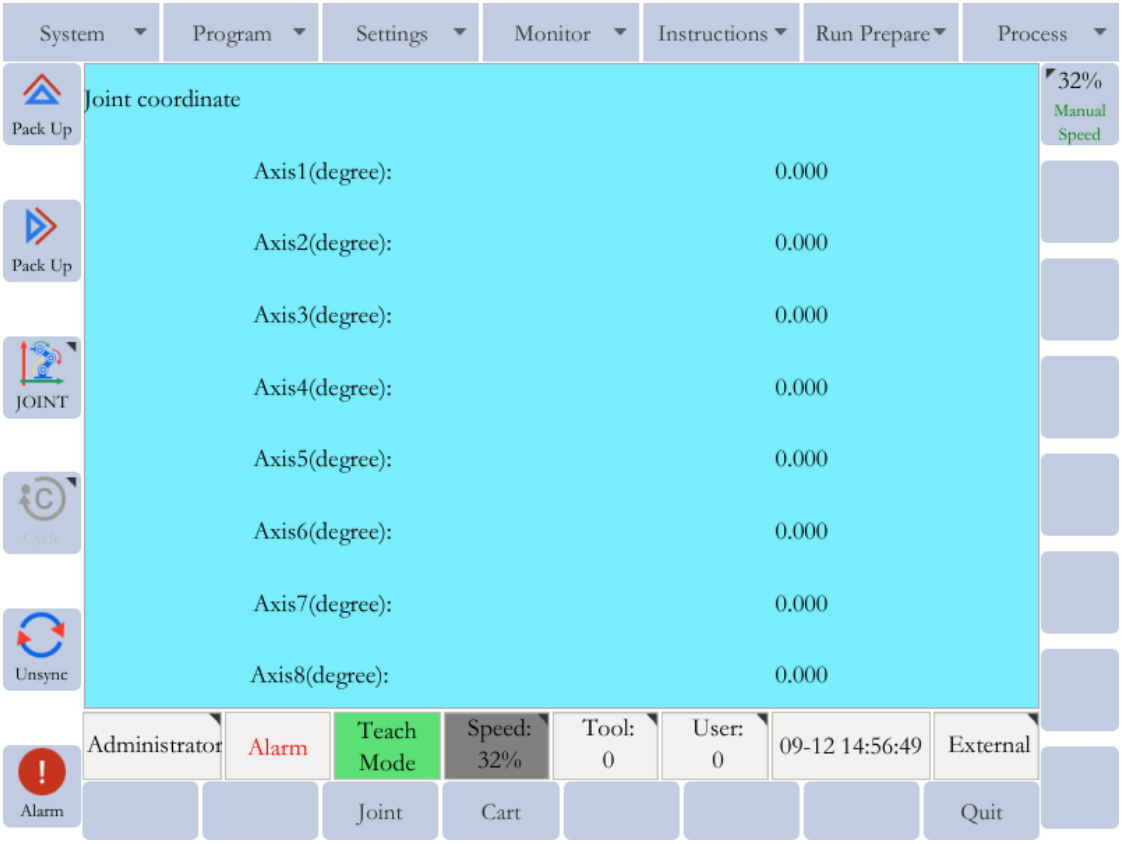
Tool coordinate setting

9.1.3 Monitoring Area

The monitoring area is mainly used to display the robot coordinates, variable values, IO port status, motor running status, etc. All the options under the “Monitor” menu are displayed in the monitoring area, as shown in the following figure (the half-width display and full-frame display of the monitoring area).



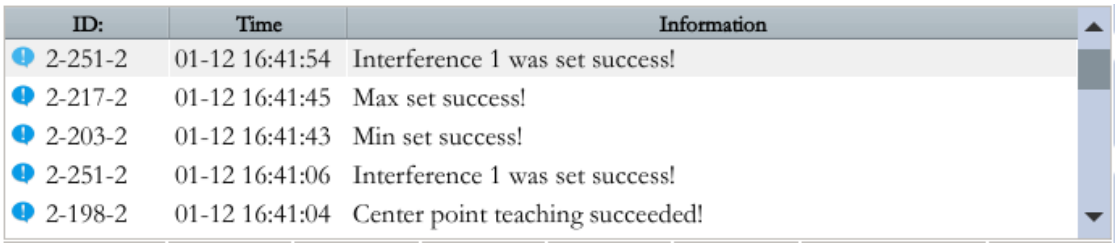
Half display of the monitoring area



Full display of the monitoring area

9.1.4 Information Prompt Area

The information prompt area is mainly used to display work information, alarms, prompts, records of the manipulator.



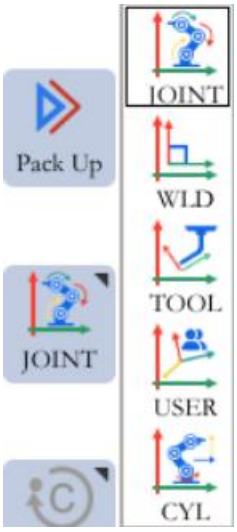
9.1.5 Status Control Area

The status control area mainly contains state control related to the robot, such as area folding/unfolding, coordinate system selection (joint, cartesian, tool, user, cylinder), operation cycle selection (single step, single cycle, continuous cycle), synchronized / unsynchronized state switching, reset, etc.

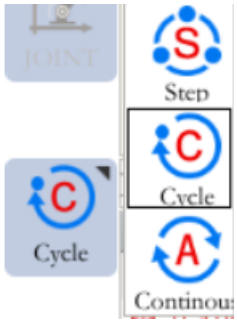
The area can be operated by directly clicking the icon or clicking the corresponding button. The coordinate and operation cycle need to be selected finally in the pop-up window and can only be operated by clicking the icon.

：Information prompt area expands and collapses；

：monitoring area expands and collapses；



：Coordinate system selection, can only be operated in TEACH mode；



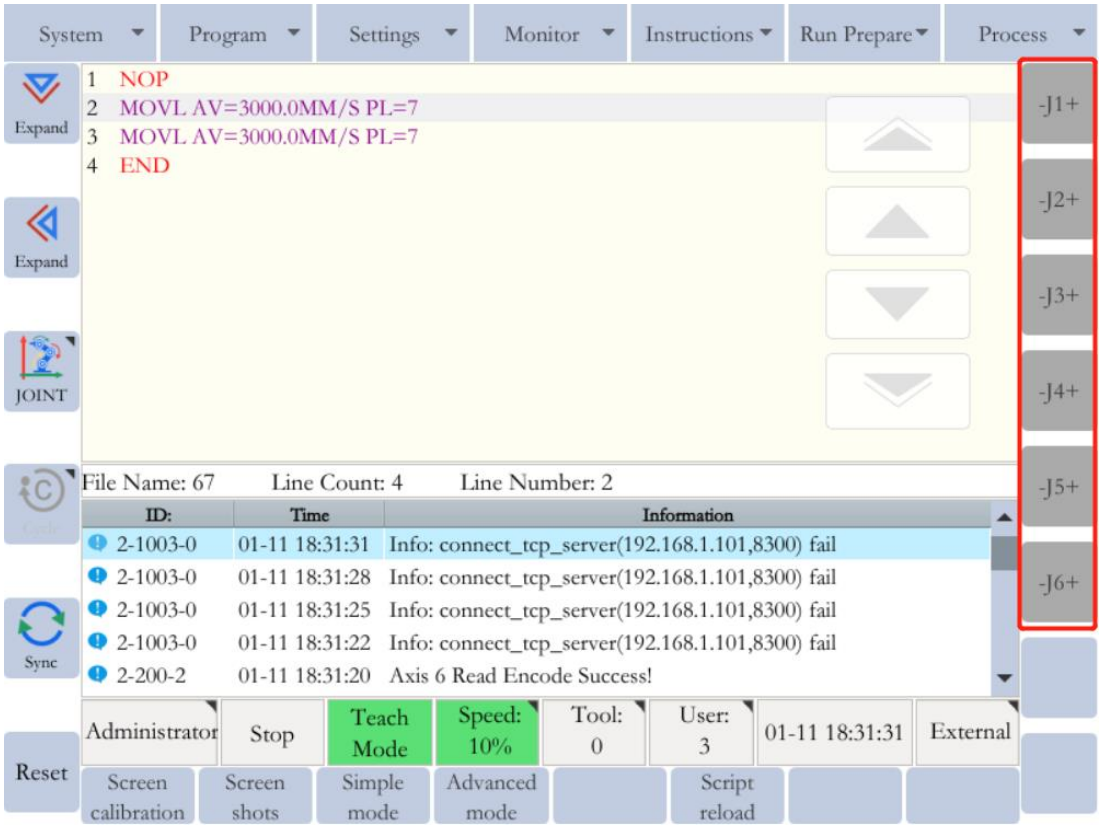
：Operation cycle selection, can only be selected in PLAY mode；

：Sync / Unsync button；

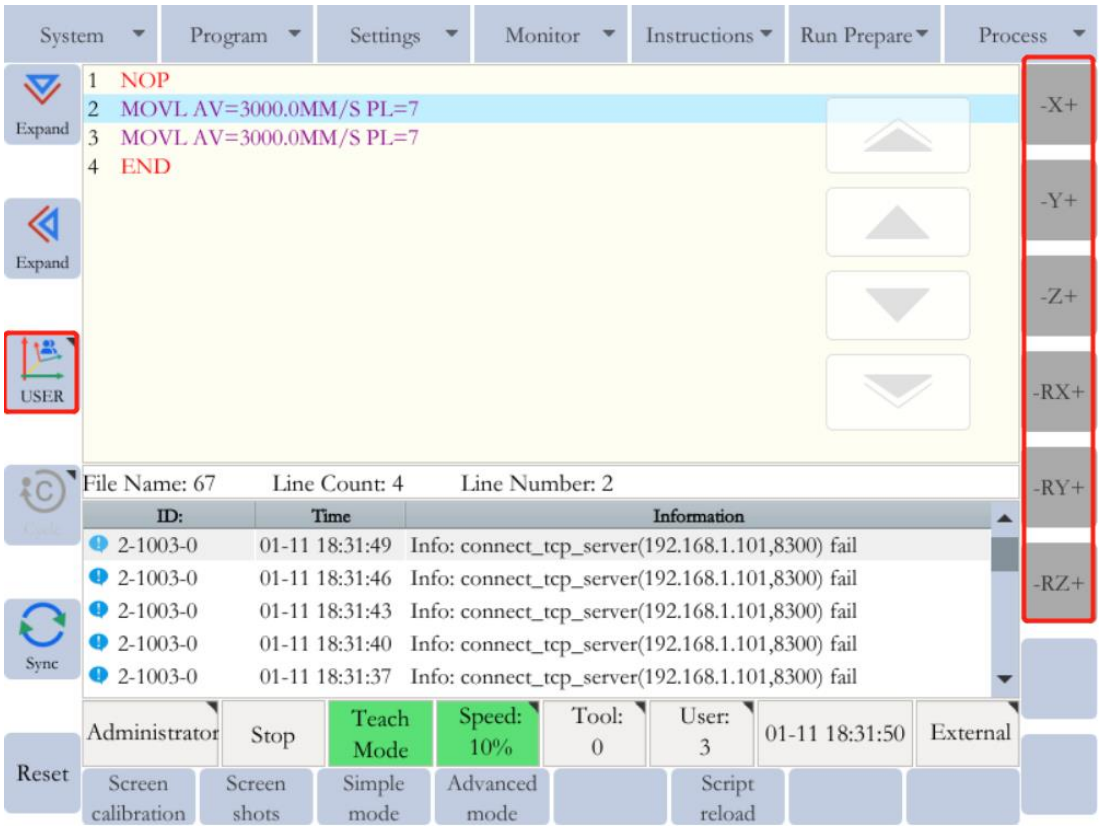
：Alarm reset button；

9.1.6 Coordinate Area

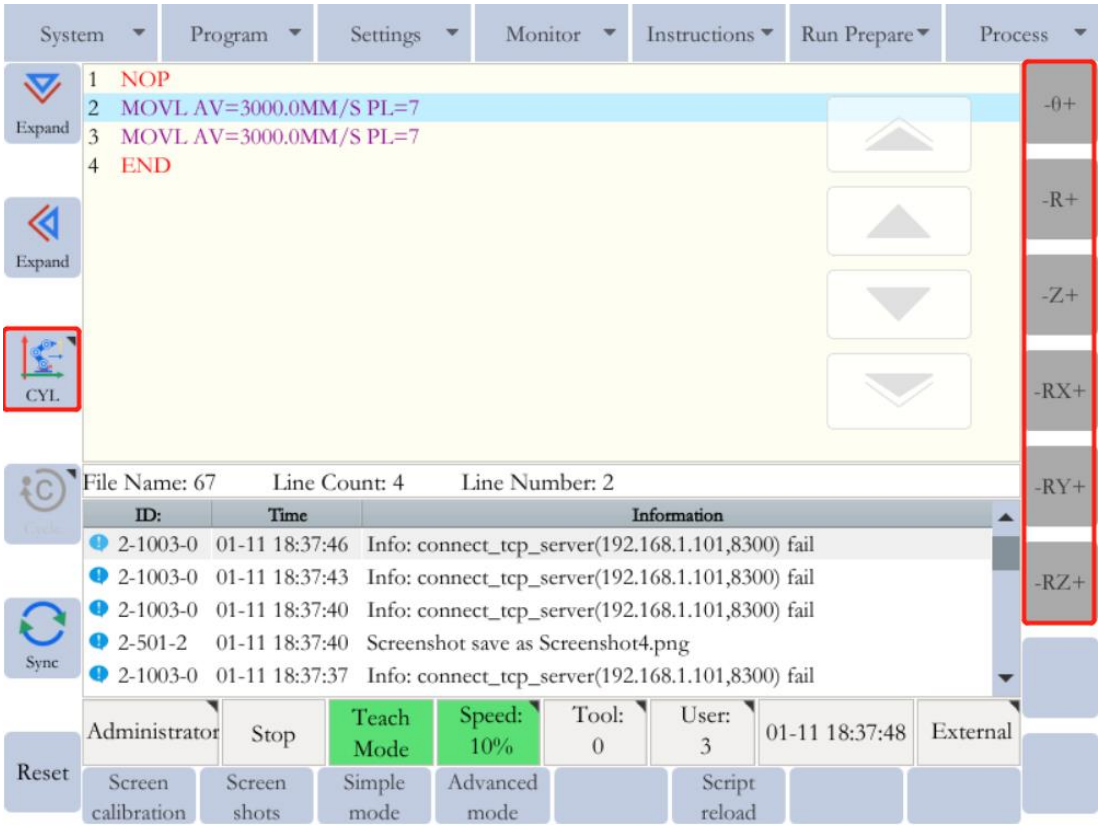
The coordinate area will display the corresponding icon according to the selected coordinate system. The icon of the coordinate area can only be displayed when the servo is enabled，For "joint coordinates", display from top to bottom are -J1+、-J2+、-J3+、-J4+、-J5+、-J6+；For "Cartesian/Tools/User Coordinates", display from top to bottom are -X+、-Y+、-Z+、-RX+、-RY+、-RZ+；For "Cylinder Coordinates", display from top to bottom are -θ+、-R+、-Z+、-RX+、-RY+、-RZ+.



Joint coordinates



Cartesian / User / Tool coordinates



Cylindrical coordinates

9.1.7 Status Display Area

The status display area is mainly used to display the current status of the robot, including permissions, running status/mode/speed, current tool coordinate number, current user coordinate number, system time, external axis, etc., as shown below.

Permissions: Display the current permissions, can open the permission settings window by touching screen;

Running status: Display the current running status of the robot, including stop, pause, run, alarm, etc.;

Running mode: Display the current running mode of the robot, including TEACH, PLAY, REMOTE mode;

Speed: Display the current speed. The same speed in PLAY and REMOTE mode while a separate speed in TEACH mode, you can click to pop up the speed control window;

Current tool coordinate: Display the current tool coordinate number, which can be open by

clicking the tool coordinate setting page；

Current user coordinate: Display the current user coordinate number, which can be open by clicking the user coordinate setting page；

System time: Display the current time of the system, click to pop up the modify system time page；

External axis: If the system is configured with an external axis option, click to open the external axis setting page；

9.1.8 Submenu Area

The submenu area is mainly used as an auxiliary button for the focus area, which changes depending on the focus area. The submenu area can be operated by clicking the icon or by the corresponding key. The submenu area shows as below when program list is focused.

9.2 Robot Axes and Coordinates Systems

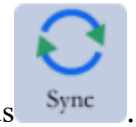
9.2.1 Basic Operations

9.2.1.1 Security Confirmation

Before operating, please read the chapter “Note for Safe Operation” of this manual again to eliminate the potential dangers of the manipulator system and peripheral equipment to the surrounding environment.

9.2.1.2 Alarm Confirmation

After the system powered on, the alarm should be confirmed first. After eliminating the alarm, press the [RESET] button in the status control area of the pendant to clear the alarm. Confirm the status of the “Synchronized/Unsynchronized” button in the status control area and status can be switched by pressing that button. The axis operation of the manipulator must be in

the “Synchronized” status 

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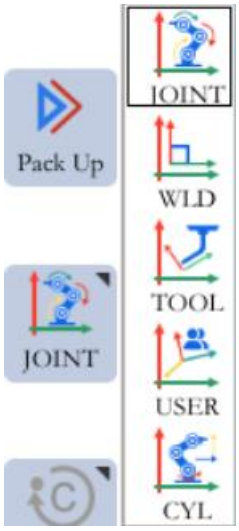
9.2.1.3 TEACH Mode Selection

The axis operation can only be performed in TEACH mode (turn the key in the upper right corner of the pendant to the middle position).

9.2.1.4 Coordinate System Selection

Press the coordinate option icon of the status control area, will pop up the menu which displays the options of [JOINT], [CARTESIAN], [TOOL], [USER], [CYLINDER], and then select the coordinate system.

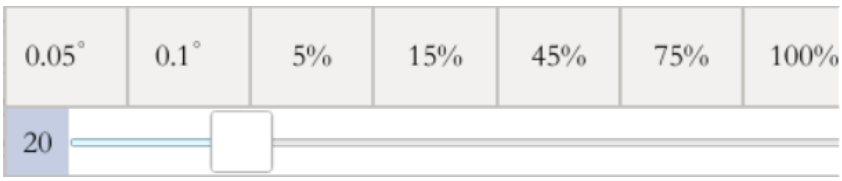


9.2.1.5 Speed Selection

The speed contains manual (teach) speed, play speed and remote speed. The play speed and remote speed are the same. There are three ways to adjust the speed:

(1) Loosen the enable switch, press the coordinate area 

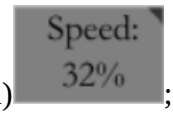
, select the speed icon or drag the slider to adjust speed directly in the pop-up dialog box.



(2) Press the area 

in the status display area and select or drag the slider to adjust the speed in the pop-up dialog box. When the speed of the area is within 0.05-30%, the icon is

displayed in green (safe speed) 

. When the speed is within 31%-70%, the icon is gray (normal speed) 

; when the speed is within 71%-100%, the icon is displayed in Red (alert speed) 

.

(3) Press the speed adjustment button  on the right side of the pendant directly to adjust the running speed.

9.2.1.6 Servo on

First confirm that there is no alarm and the status control area is displayed as “Synchronized”. In TEACH mode, hold the enable switch (middle position) on the back of the programming pendant. At this time, the SERVO indicator in the upper left corner of the programming pendant is on. In PLAY mode, press the servo enable button 

in the bottom right corner of the programming pendant. At this time, the SERVO indicator in the upper left corner of the programming pendant is on. In REMOTE mode, the servo is turned on automatically.

9.2.1.7 Axis Operations

In the TEACH mode with the servo on, pressing an axis key in the teach mode makes it possible to move the respective axis of the manipulator and station to a desired position. The motion of each axis depends on the specified coordinate system.

9.2.2 Coordinate Systems and Axis Operations

9.2.2.1 Joint Coordinates

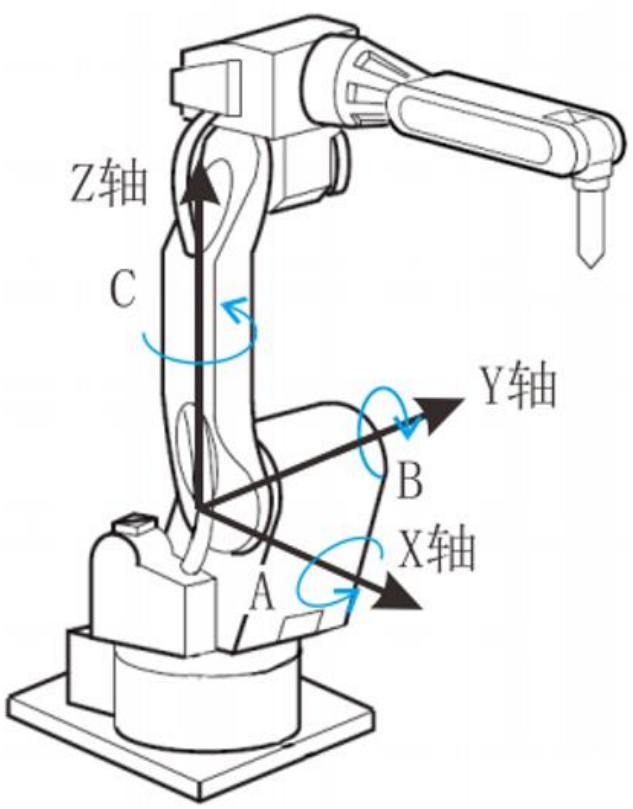
The manipulator moves independently along each axis, and the coordinates used is the joint coordinates. The joint coordinates are set and cannot be changed when the manipulator debugging completes. The positive direction of each axis is marked at the joint of the manipulator.

9.2.2.2 Cartesian Coordinates

Robot's Cartesian coordinates is also called the geodetic coordinates. The direction of the Cartesian coordinates of each manipulator type is different, and the position of the corresponding Cartesian coordinate origin is also different.

After setting the manipulator's parameters, the origin and direction of the Cartesian coordinates are determined, and the direction of the Cartesian coordinates cannot be modified.

In a non-singular position, the manipulator can move parallel to the X-, Y-, or Z-axes. When using a manipulator of 6 axes, rotation Rx, Ry, Rz can also be performed, Rx rotates around the X axis, Ry rotates around the Y axis, and Rz rotates around the Z axis respectively, following the right-hand rule. Taking a manipulator of 6 axes as an example, the directions of motion are as shown below.



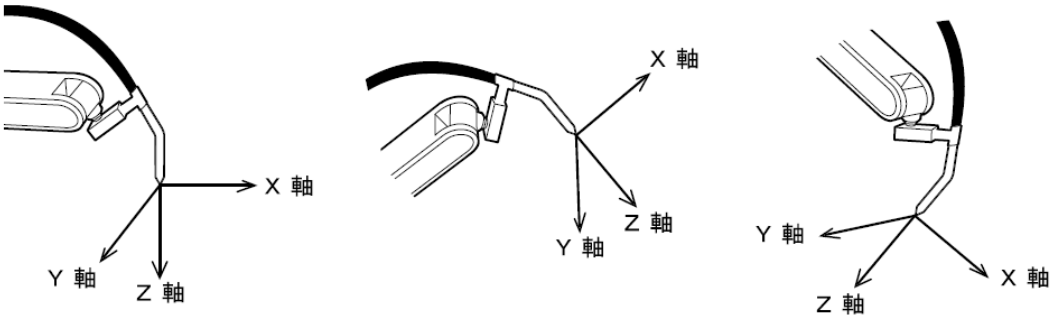
9.2.2.3 Tool Coordinates

The tool coordinates are defined at the tip of the tool, assuming that the effective direction of the tool mounted on the manipulator wrist flange is the Z-axis. Therefore, the tool coordinates axis direction moves with the wrist.

In tool coordinates motion, the manipulator can be moved using the effective tool direction

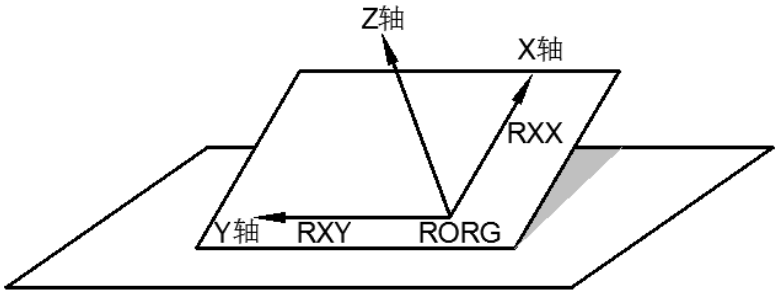
as a reference regardless of the manipulator position or orientation. These motions are best suited when the manipulator is required to move parallel while maintaining the tool orientation with the workpieces.

User can set the tool coordinates number 0-7 according to the actual tool conditions.

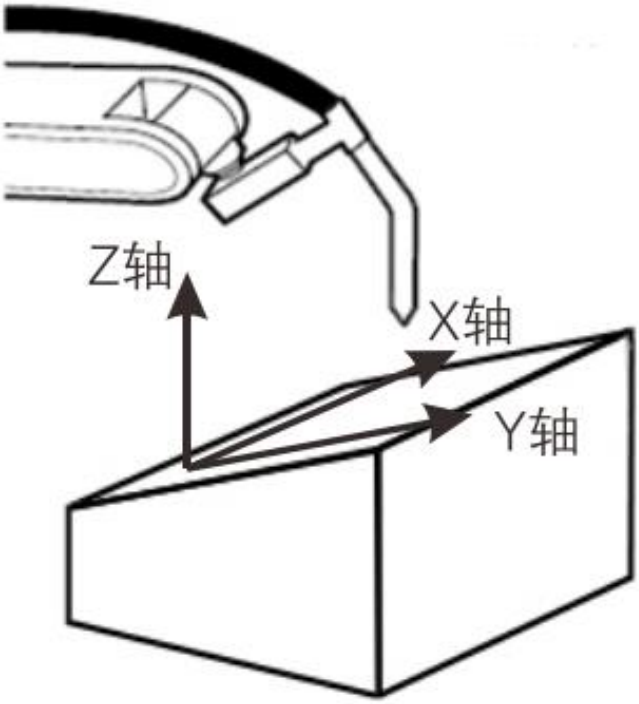


9.2.2.4 User Coordinates

The user coordinates are defined by teaching the manipulator three points, and the manipulator moves parallel to each axis of the coordinates which are set by the user.

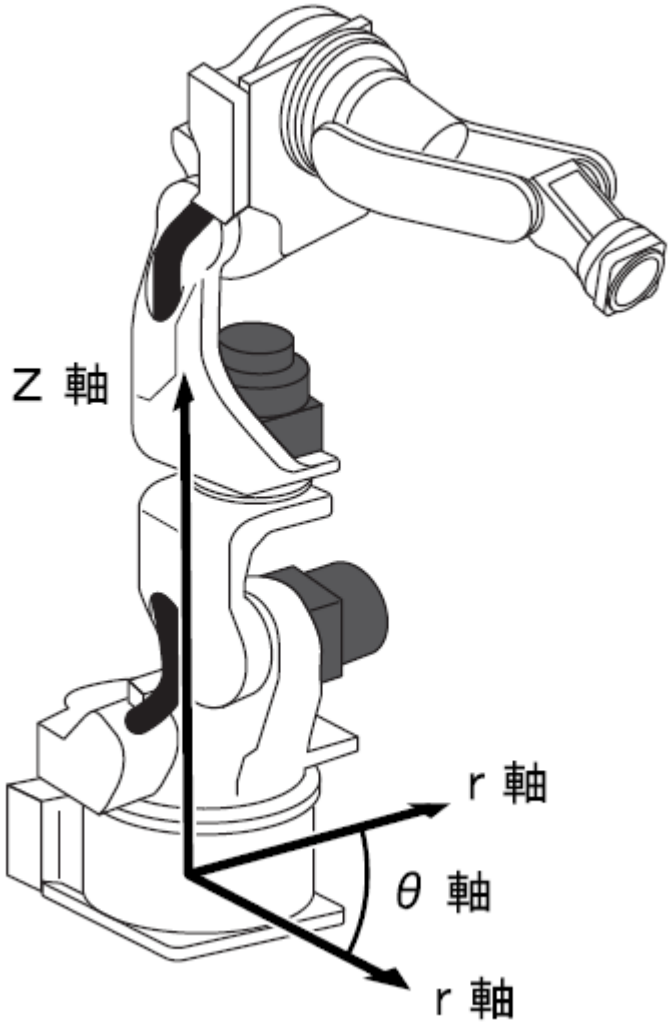


The user can set the user coordinates number 0-7 as needed.



9.2.2.5 Cylindrical Coordinates

In the cylindrical coordinates, the manipulator rotates around the Z axis of the body or moves parallel to the Z axis at right angles. The θ-axes, R-axes and Z-axes directions of the cylindrical coordinates are shown as below.

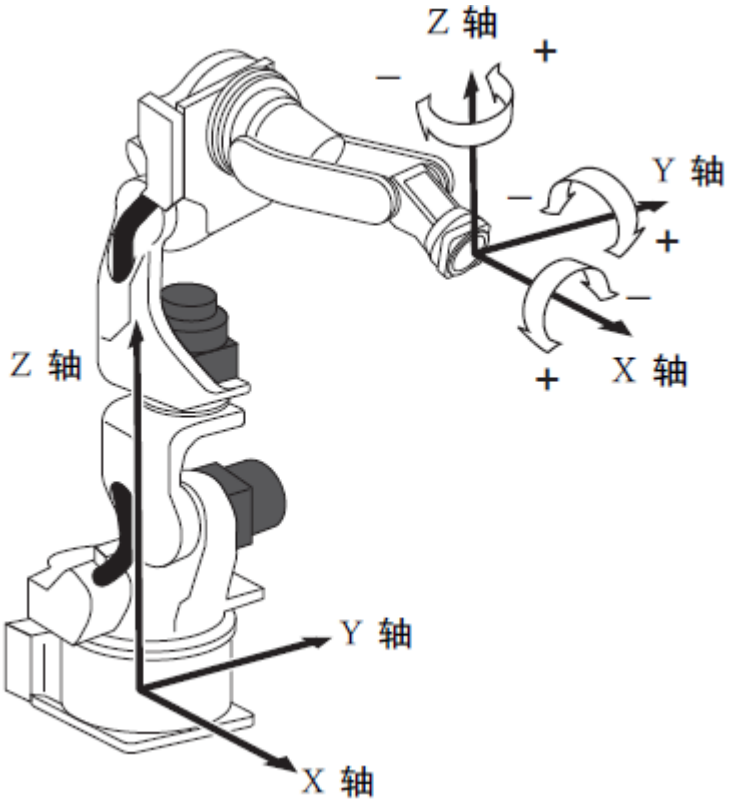


9.2.2.6 Control Points Remain Unchanged

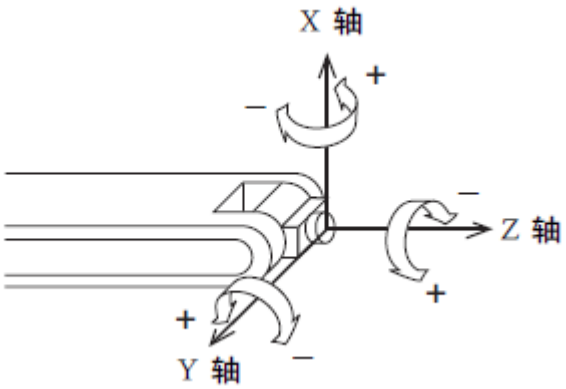
The operation in which the control point remains unchanged means that the position of the tool tip point (control point) is not changed, and only the axis operation of the tool posture is changed. Turning of each wrist axis differs in each coordinate system.

In Cartesian or cylindrical coordinates, wrist axis rotations are based on the X-, Y-, or Z-axis.

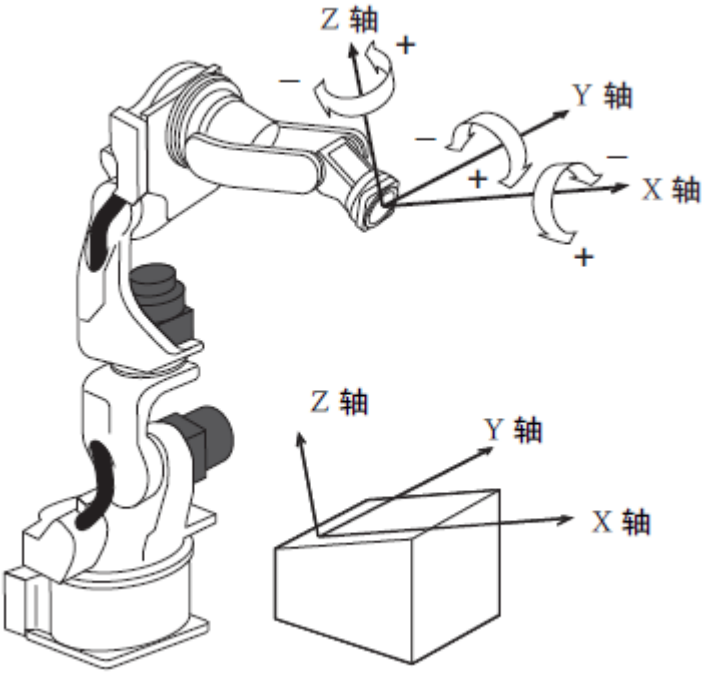
In the Cartesian/cylindrical coordinates, the X-, Y-, and Z-axis of the body are used as the reference for the rotate motion.



In tool coordinates, wrist axis rotations are based on X-, Y-, or Z-axis of the tool coordinates.



In user coordinates, wrist axis rotations are based on X-, Y-, or Z-axis of the user coordinates.



9.3 Teaching

9.3.1 Preparation for Teaching

Before teaching, please verify the emergency stop buttons are normal. If the manipulator is used for the first time, you need to verify the mechanical zero.

9.3.1.1 Emergency Stop Buttons Verification

Before using the manipulator, please verify all the emergency stop buttons on the control cabinet and the teach pendant are function correctly. Verify the emergency stop button is pressed, ensure the servo power supply is disconnected and whether the manipulator alarms. When an external emergency stop button is connected, you should also ensure that the emergency stop button is valid.

9.3.1.2 Mechanical Zero Verification

Each point data of the manipulator is the angle value related to each axis based on the mechanical zero point. If there is deviation for the mechanical zero point, all the points will be wrong, so the mechanical zero point must be verified before operating the manipulator.

Each robot has a fixed mechanical zero point (the zero-point mark on each axis of the robot).

After performing the zero-return operation, please observe whether the mark of each axis overlaps. For the specific mechanical zero return operation, please refer to Section9.8.4.1.

9.3.1.3 Program File Operations

When the program list is focused in the programming pendant, the options for program file operation appear in the submenu area, as shown below.

All points and instructions of the teaching process are stored in the program file, so you should first familiarize with the various operations of the program file before teaching.

New: Press [NEW], the dialog box will pop up, user can select [FOLDER], [FILE] or [CANCEL]. Press [FILE], the dialog box for inputting the file name will pop up, enter the file name, press [OK]. The required file will be created successfully.

Rename: Select the program that need to be renamed in the program list and press [RENAME]. Enter the required new file name in the pop-up dialog box and press [OK].

Delete: Select the program that needs to be deleted in the program list and press [DELETE]. In the pop-up confirmation prompt box, press [OK] to delete, press [CANCEL] to cancel deletion; the previously opened program is in activated status and cannot be deleted, you can delete it by opening another program first.

Copy: Select the program you want to copy in the program list and press [COPY]. Enter the required new file name in the pop-up dialog box and press [OK].

Move: The move operation is to move the program file into or out of one folder. Select the program file to be moved and press [MOVE]. Select the destination folder and press [OK].

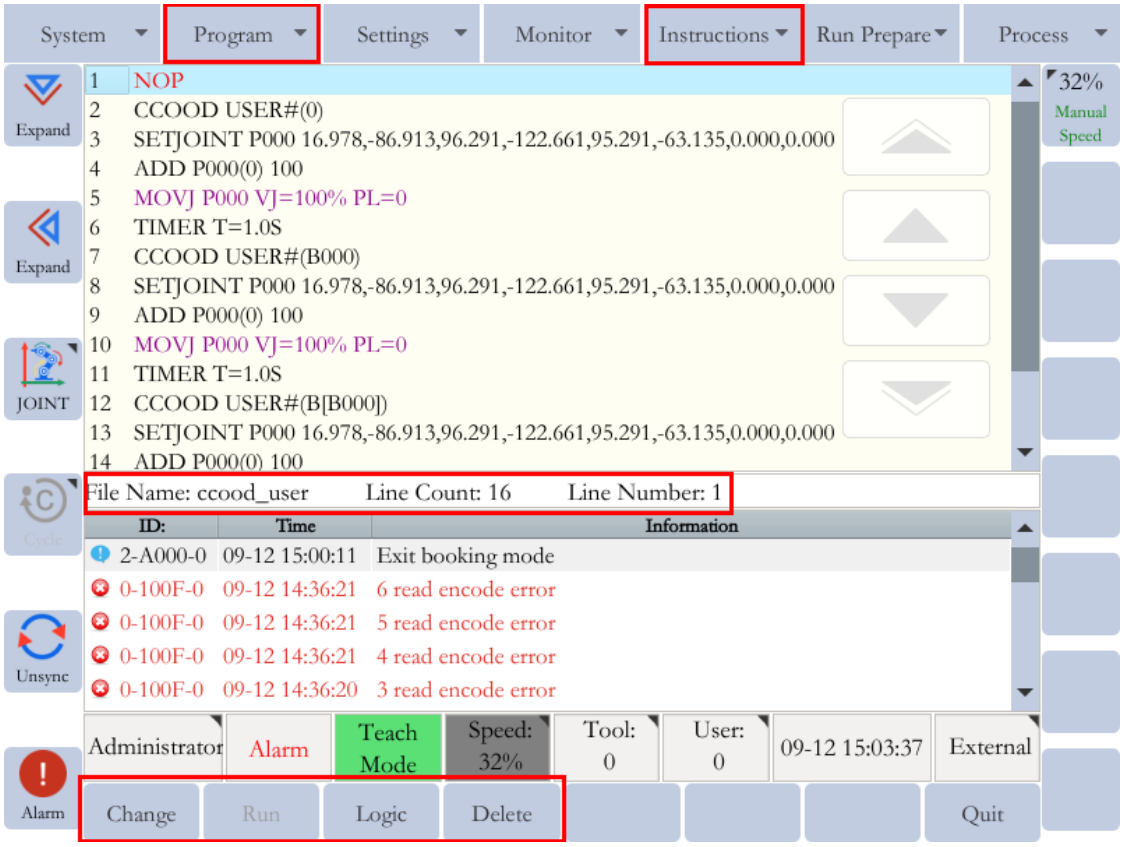
Open: Select the program and press [OPEN] to open the program in the program editing page.

Backup: When the controller has a USB device connection, select the program to be backed up and press [BACKUP]. The program will be saved to the USB device.

Open USB Device: When the controller has a USB device connection, press [OPEN USB] to display the existing program in the USB. Select the desired program file and press [USB TO LOCAL] in the sub-menu bar. The file will be imported successfully.

9.3.2 Teaching Procedure

9.3.2.1 Teaching Window



Open the program file and enter the program editing page. After entering the teaching window, the [PROGRAM EDITING] and [EDITING INSTRUCTIONS] in the main menu bar are enabled. The current file name, the total number of lines, and the current line number will be displayed at the bottom of the general-purpose display area. The sub-menu displays the corresponding program editing options. Each program file starts with “NOP” and ends with “END”. The line where the cursor locates will be displayed in blue.

9.3.2.2 Interpolation Type and Play Speed

When performing the manipulator playback operation, the method of determining the trajectory between two points is called the interpolation method.

The speed of motion between two points is called the play speed.

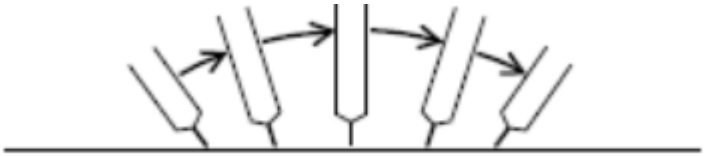
The destination position, the interpolation method, the play speed, etc. are registered in the move instruction.

- Joint Interpolation

The joint interpolation is used when the manipulator does not need to move in a specific path toward the next step position. When the joint interpolation is used for teaching a robot axis, the move instruction is MOVJ. For safety purposes, use the joint interpolation to teach the first step.

- Linear Interpolation

The manipulator moves in a linear path from one taught step to the next. When the linear interpolation is used to teach a robot axis, the move instruction is MOVL. Linear interpolation is used for work such as welding. The manipulator moves automatically changing the wrist position as shown in the figure below.



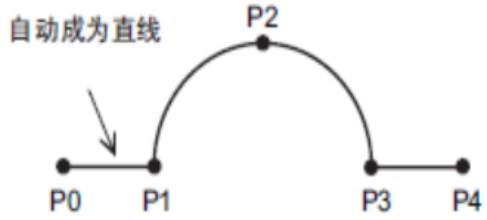
- Circular Interpolation

The manipulator moves in an arc that passes through three points. When circular interpolation is used for teaching a robot axis, the move instruction is MOVC.

When a single circular movement is required, teach the circular interpolation for three points, P1 to P3, as shown in the following figure. If joint or linear interpolation is taught at P0, the point before starting the circular operation, the manipulator moves from P0 to P1 in a straight line.

Point	Interpolation Type	Instruction
P0	Joint or Linear	MOVJ MOVL
P1-P3	Circular	MOVC

P4	Joint or Linear	MOVJ MOVL

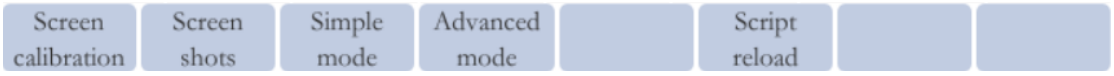


9.3.2.3 Teaching Steps

There are two types of program instruction mode in this system: normal mode and advanced mode. The normal mode is used by default after booting.

In the normal mode, only the basic items for each instruction are available for editing. After enabling the advanced mode, all the extensions will be displayed when inserting program instructions. Select the appropriate mode according to your requirements.

The instruction mode can be switched as follows: When pressing and holding [WINDOW SWITCHING KEY] in the program editing page, two new options will appear in the submenu area: [NORMAL MODE] and [ADVANCED MODE]. Then press the desired option to switch the instruction mode.



The electronic handwheel is disabled by default in the program editing page after booting. Push the electronic handwheel inward to switch between the enable mode and the disable mode.

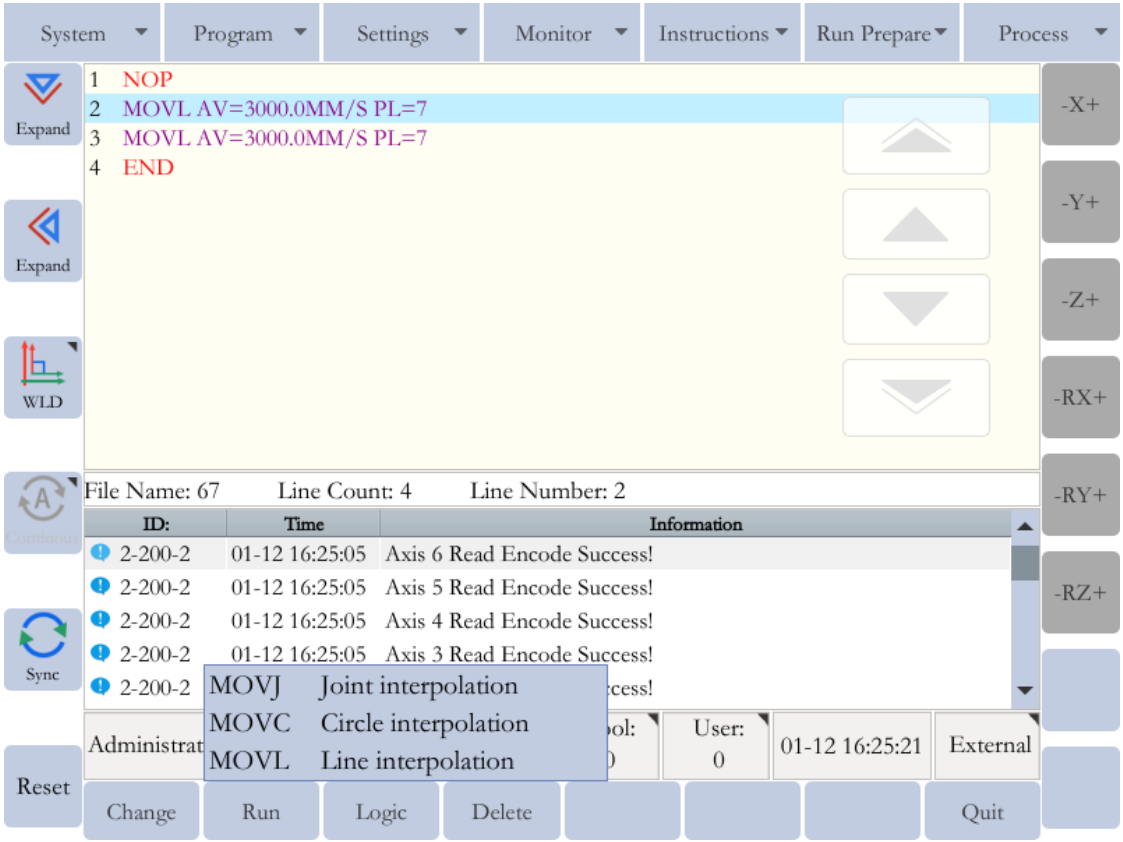
- Inserting Move Instructions

Whenever one step is taught, one move instruction is inserted. When inserting a move instruction without using P variables, the current position of the manipulator is recorded into the move instruction. The detailed procedures are as follows:

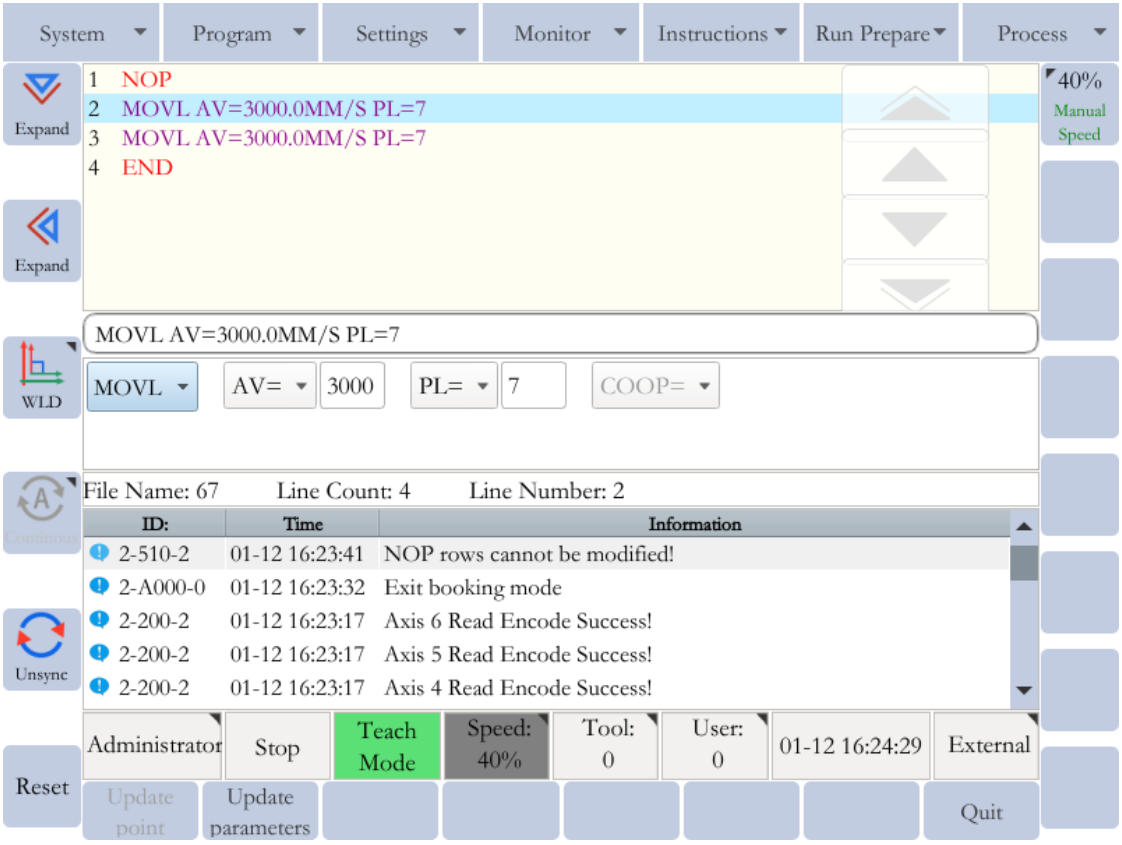
1) Move the manipulator to the desired position using the axis key.

2) Move the cursor on the line immediately before the position where a move instruction to be inserted.

3) When holding the Enable switch and the SERVO ON lamp is lit, press [MOVE INSTRUCTION] in the submenu area and select the desired interpolation type in the pop-up window.



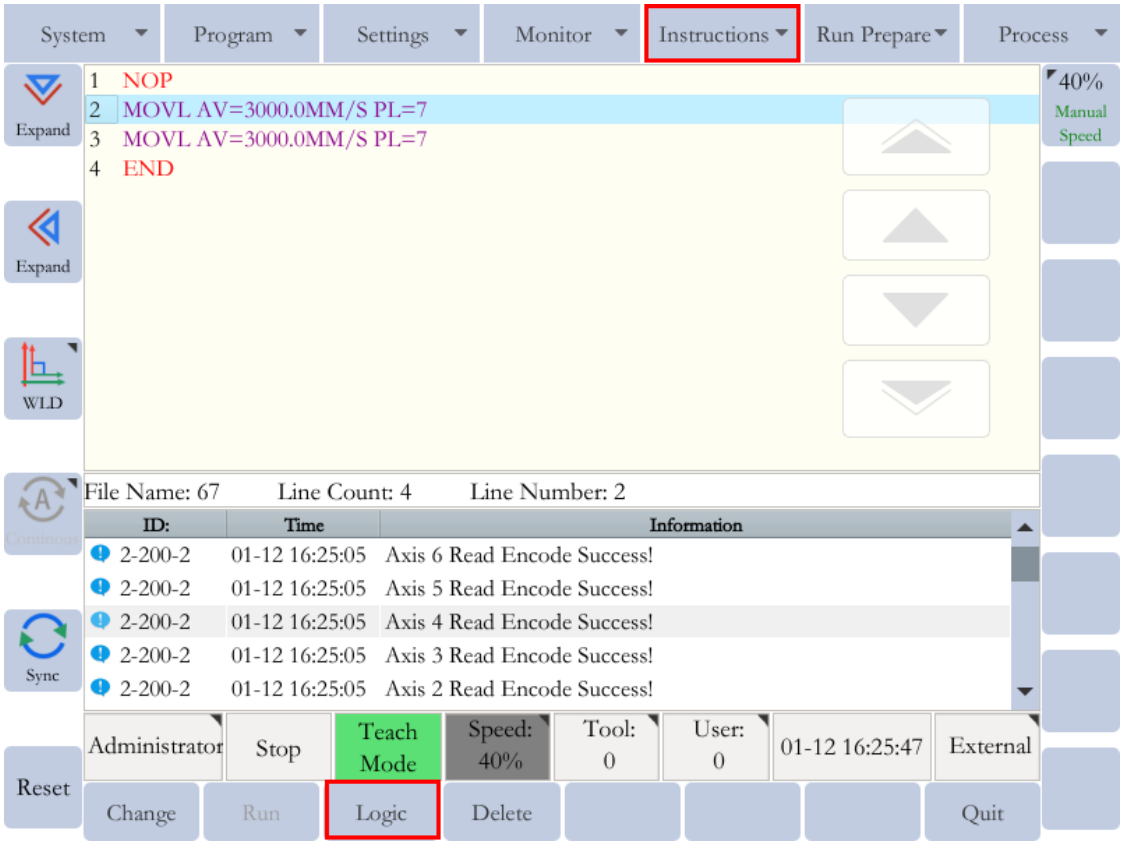
4) After selecting the move instruction, edit the contents of its additional items and press [OK] to insert it. The Enable switch must be hold when inserting the move instructions. Otherwise, the move instruction cannot be inserted.



- Inserting Other Instructions

The methods of inserting other instructions except the move instruction are identical. In the program editing page, move the cursor on the line immediately before the position where the instruction to be inserted. Then press [EDIT INSTRUCTIONS] under the main menu or [QUICK INSTRUCTIONS] in the submenu area to select the instruction to be inserted. After editing the additional items, press [OK] to insert the instruction.

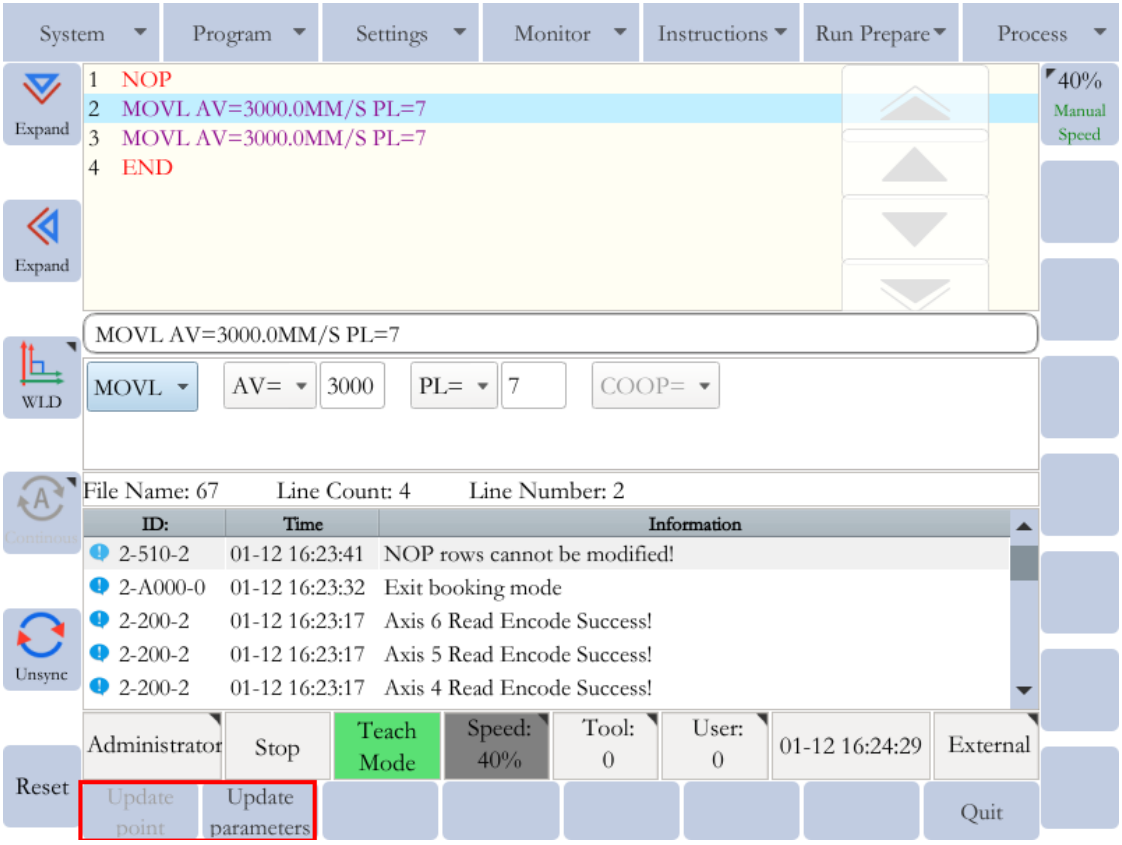
[QUICK INSTRUCTIONS] in the submenu area contains only part of the instructions, and all instructions can be found by pressing [EDIT INSTRUCTIONS] under the main menu. Select the appropriate one according to your requirements.



- Modifying Instructions

Select the instruction to be modified in the program editing page. Then press [MODIFY] in the submenu area, and the instruction editing window will pop up.

For the non-motion instructions, only [UPDATE PARAMETERS] can be used. After modifying the instruction, press [UPDATE PARAMETERS] to use the modified instruction. Press [CANCEL] to exit the modification operation.



For the move instructions, two options can be used in the submenu area: [UPDATE POINT] and [UPDATE PARAMETERS]. [UPDATE PARAMETERS] can only update the additional items of the move instruction, and cannot modify the point data. [UPDATE POINT] can record the current position of the manipulator into the instruction while modifying the addition items. [UPDATE POINT] can be used only when holding the Enable switch.

9.3.2.4 Checking Steps

After completing the program editing, the manipulator can be moved ahead in step number sequence manually, in order to check in advance whether the motion paths of the manipulator are correct.

- Forward Operation

The forward operation can be used to move the manipulator to the position of the taught steps in order to check whether the position is appropriate.

1) Switch to TEACH mode using the mode switch.

2) Set manual speed at an appropriate level for safety.

3) Scroll the handwheel to select the instruction to be executed in the program.

4) Hold the Enable switch to turn on the servo. continuously press the [PROGRAM START] button  on the bottom right corner of the programming pendant, the manipulator will move to the step point and stop. Release the [PROGRAM START] button, the manipulator will slow down and stop.

5) When the manipulator reaches the target step point, the information prompt area will display the following message: “The manipulator reaches the target point”.

- Precautions When Using Forward Operation

1) [PROGRAM START] button should be released when you are willing to stop the manipulator. You can also directly release the Enable switch or press [EMERGENCY STOP] button in an emergency, the manipulator will stop immediately with a large vibration instead.

2) The forward operation in TEACH mode can only execute the move instruction. The non-motion instructions can only be executed in PLAY mode.

9.3.2.5 Editing Programs

When editing the program, the [Program Edit] option under the main menu provides many convenient and quick operations: copying, cutting, pasting, deleting, searching, replacing, customizing quick instructions, resetting, etc.

- Copying

There are two types of copy operations: [LINE COPY] and [BLOCK COPY]. [LINE COPY] only copies the instruction line selected by the cursor (Note that the NOP and END lines cannot be copied). Press [BLOCK COPY], and the dialog box will pop up for specifying the range of the instruction lines to be copied. Press [OK] to complete the copy operation.

- Cutting

There are two types of cut operations: [LINE CUT] and [BLOCK CUT]. [LINE CUT] only cuts the instruction line selected by the cursor (Note that the NOP and END lines cannot be cut). Press [BLOCK CUT], and the dialog box will pop up for specifying the range of the instruction lines to be cut. Press [OK] to complete the cut operation.

- Pasting

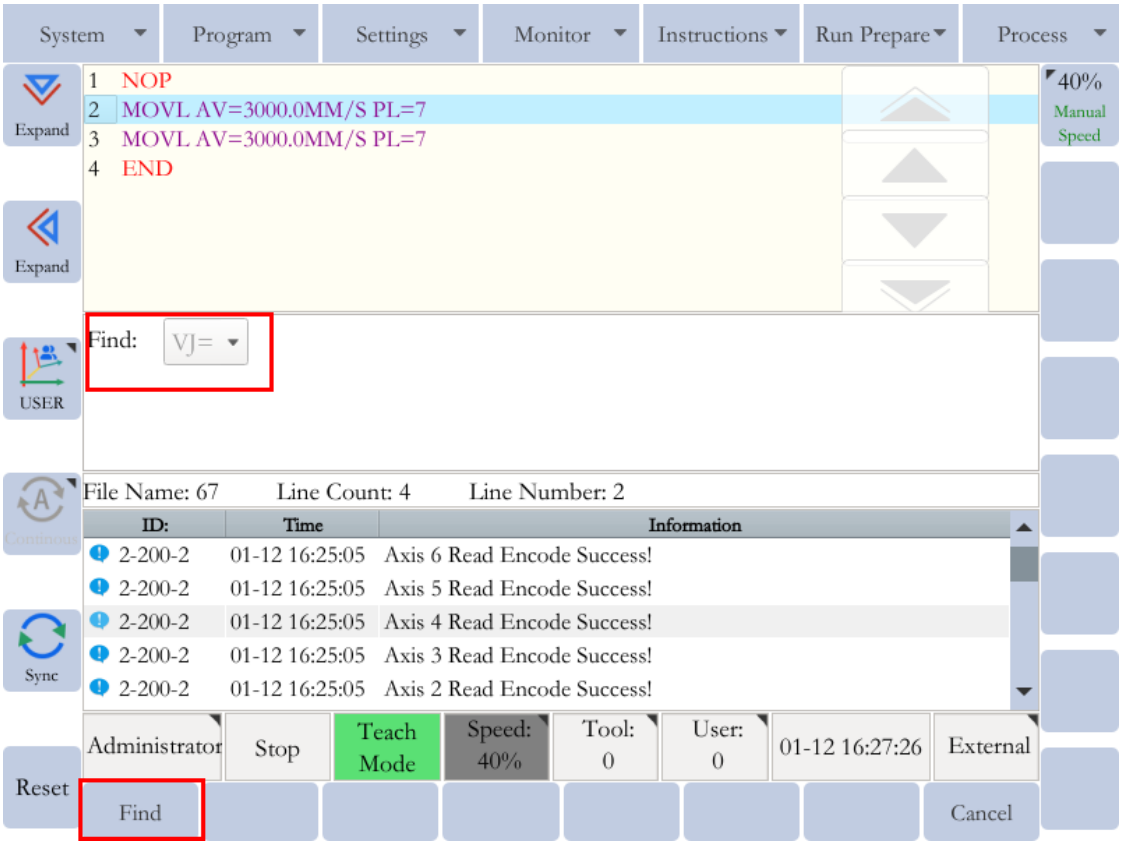
After performing a copy operation or a cut operation, move the cursor to the line immediately before the desired position in the program editing page. Press [PASTE] to complete the paste operation. Note that the instruction lines are inserted in the next line of the cursor line.

- Deleting

There are two types of delete operations: [LINE DELETE] and [BLOCK DELETE]. [LINE DELETE] only deletes the instruction line selected by the cursor (Note that the NOP and END lines cannot be deleted). Press [BLOCK DELETE], and the dialog box will pop up for specifying the range of the instruction lines to be deleted. Press [OK] to complete the delete operation.

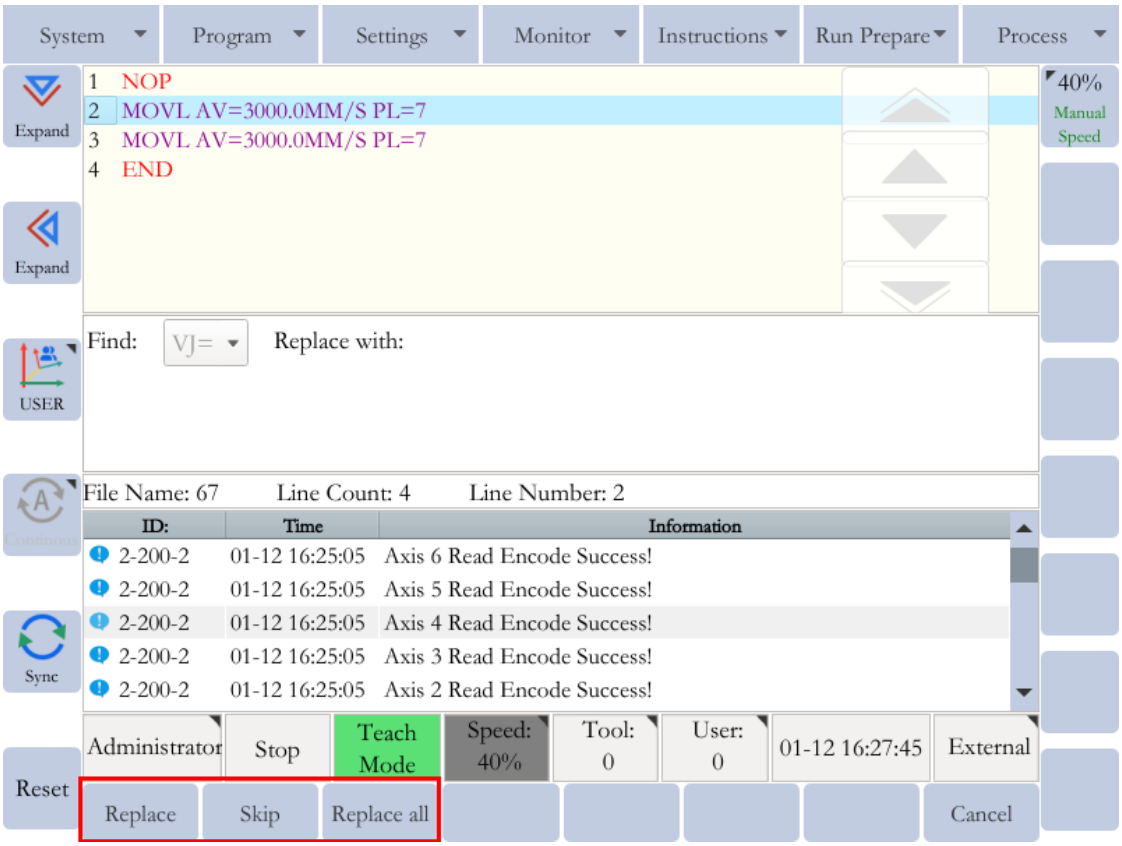
- Searching

Press [SEARCH] and the search window will pop up. The items can be searched are the additional items of each instruction. Note that the items displayed for each instruction in the normal instruction mode and advanced instruction mode are different. Select the item to search, and input the corresponding value. Then press [SEARCH] in the submenu area to find the instruction line that meets the requirements in the current program. The cursor will move to the line automatically.



- Replacing

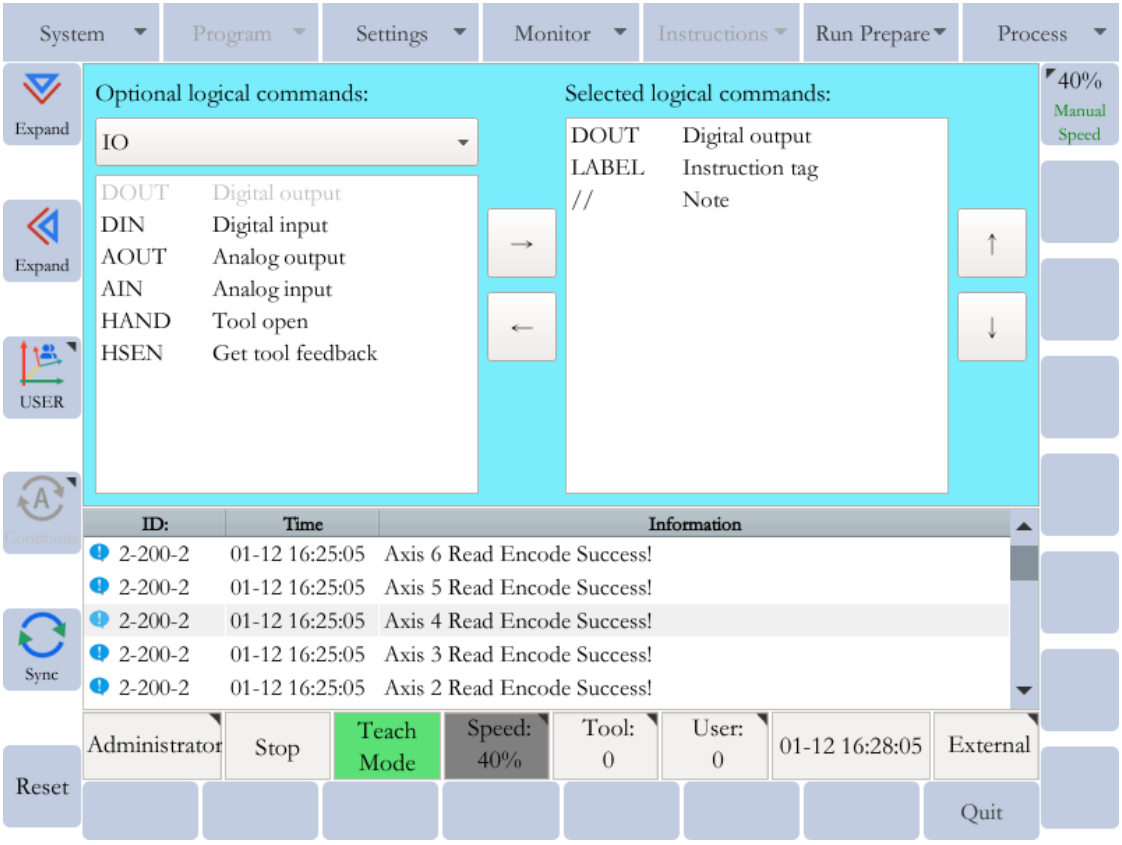
The replace operation is used to replace the additional item value that meets the search requirements with the given value. Press [REPLACE], then the submenu area displays three new options: [REPLACE], [SKIP] and [REPLACE ALL]. [REPLACE] can be used to sequentially replace the value of the matching item with the specified value one by one. [SKIP] can be used to skip the current matching item. [REPLACE ALL] can be used to replace the values of all matching items in the program with the specified value at once.



- Customizing Quick Instructions

In the program editing page, [QUICK INSTRUCTIONS] in the submenu area can be pressed to customizing the quick instructions for editing the program. The frequently used instructions can be added to the quick instructions for easy use.

Press [CUSTOMIZING QUICK INSTRUCTIONS] to enter the customizing page. Select the desired instruction in the left instruction selecting window, and press the right arrow to add the selected instruction to quick instructions. Select the desired instruction in the right quick instruction window, and press left arrow to remove the selected instruction.



- Resetting

If a failure occurs during the welding process or in the reservation mode, the program needs to be reset before re-execution. [RESET] under the [PROGRAM EDIT] menu can be pressed to reset the system status.

9.3.3 List of program instructions

Instruction Group	Instruction	Description
I/O Instructions	DOUT	Digital output.
	MOUT	Virtual digital output.
	DIN	Digital input.
	PULSE	Pulse output.
	AOUT	Analog output.
	AIN	Analog input.
Control Instructions	CCOOD	Specify the coordinate.
	JUMP	Jump to the specified label.
	CALL	Call a subprogram.
	AXISDISABLE	Axis prohibition of movement.
	LABEL	Instruction tag.
	TIMER	A timer.

	//	A comment.
	RET	Subprogram return.
	PAUSE	Program pause.
	WAIT	Wait.
Calculation Instructions	CLEAR	Clear the variable.
	INC	Variable plus one.
	DEC	Variable minus one.
	SET	Variable assignment.
	SETJOINT	Position assignment.
	ADD	Add operation.
	SUB	Subtraction operation
	MUL	Multiplication operation.
	DIV	Division operation.
	MOD	Mod operation.
	AND	Logic AND operation.
	OR	Logic OR operation.
	NOT	Logic NOT operation.
	XOR	Logic XOR operation.
	GETPOS	Get the current position of manipulator.
	MFRAME	Establish a coordinate.
	DIST	Calculate the distance between the two points.
Move Instructions	MOVJ	Joint interpolation.
	MOVC	Circular interpolation.
	MOVCA	Circular interpolation.
	MOVL	Linear interpolation.
	MOVML	Micro-interpolation.
Arc welding instruction	ARCON	Arc begins.
	ARCOFF	Arc stops.
	ARCSET	Welding condition setting.
	ARCCTE	End gradient welding condition setting.
	ARCCTS	Start gradient welding condition setting.
	WVON	Swing welding begins.
	WVOF	Swing welding stops.
	STITCHON	Open tungsten inert gas welding.
	STITCHOFF	Close tungsten inert gas welding.

9.4 Playback

9.4.1 Preparation

Before performing playback operations, confirm that the program to be executed is correct and that there are no person or obstacles present in the work envelope of the manipulator.

9.4.1.1 Selecting Programs

Playback is the act of executing a taught program.

Before playback operation, first select the program to be executed in the program list, and press [OPEN] in the submenu area to open the program. Then move the cursor to the starting line where the program is executed. Generally, the program is executed from the NOP line.

9.4.1.2 Selecting Operation Cycles

Switch to PLAY mode, press the icon in the status control area to select one of three types of manipulator operation cycles:

SINGLE STEP: Executes one step (instruction) at a time.

SINGLE CYCLE: Executes a program once. The program will be executed again if [PROGRAM START] button is pressed.

CONTINUOUS CYCLE: Repeats a program continuously.

Please select the appropriate one according to your requirements.

9.4.1.3 Modifying Play Speed

The TEACH mode and PLAY mode use different speed values. After switching to PLAY mode, the speed can be modified to an appropriate level by following the instructions shown in Section 9.2.1.

9.4.2 Playback Operation

9.4.2.1 Startup

After completing all above preparations, first press [SERVO ENABLE] button 

on the bottom right corner of the programming pendant. The SERVO ON lamp lights up when the

servo is enabled. Then press [PROGRAM START] button  , and the program starts running automatically.

9.4.2.2 Modifying Speed in Play Mode

When the program is executed in PLAY mode, [SPEED CONTROL] buttons are invalid and the speed value cannot be modified. If speed adjustment is required in this mode, first press [PROGRAM PAUSE] button  to pause the program. Then change the speed value and press [PROGRAM START] button to resume the program execution.

9.4.2.3 Stop and Restart

- Program Pause Operation

In PLAY mode, if the program pause operation is executed, the program will pause at the current line, and the moving manipulator will slow down and stop.

There are two ways to pause the program:

1) Press [PROGRAM PAUSE] button on the programming pendant.

2) Use the external input signal. The program pause operation will be executed when the input "EXT-HD" of the dedicated IO board is valid.

- Emergency Stop Operation

If the emergency stop operation is executed, the servo power will be turned OFF and the manipulator will stop immediately.

There are three methods for executing emergency stop operation:

1) Press [EMERGENCY STOP] button on the programming pendant.

2) Press [EMERGENCY STOP] button on the cabinet.

3) Use the external input signal. The emergency stop operation will be executed when the input "EXT-SP" of the dedicated IO board is invalid.

After an emergency stop, first correct the cause of the alarm and then reset [EMERGENCY STOP] button. After that, the alarm reset and program start operations for programming pendant

can be conducted.

Note: After the emergency stop, the program call relations between the main program and the subprogram will be cleared.

- Stop Caused by Alarm

Except for program pause and emergency stop, when other system alarms occur during program runtime, the program execution will be stopped, and the manipulator will stop immediately. The programming pendant will display an alarm message simultaneously.

- Other Stops

In addition to the above stop methods, there are two ways to stop the program:

1) The mode switch is switched from PLAY mode to TEACH mode.

2) The PAUSE instruction is executed in the program.

9.5 User Processes

The ERC-G200 control system includes user processes such as arc welding, reservation, external axes, laser tracking, scripting, vision, tracking, palletizing, stamping, etc., which can be enabled in “System - System Configuration - Manipulator Configuration”.

The configuration and operation instructions for above user processes are not described in detail in this manual. Please refer to the corresponding application manual for more information.

9.6 Monitoring

The monitoring options in the main menu area are mainly used to view the current working status of the manipulator and the variables of various data types. The system can monitor the following contents: coordinates, variables, IO (input and output), motor, reservation, operational monitoring, etc.

9.6.1 Coordinates

The coordinate monitors are used to monitor coordinate data, including joint coordinates and

Cartesian coordinates.

Joint coordinate	
Axis1(degree):	0.000
Axis2(degree):	-90.000
Axis3(degree):	0.000
Axis4(degree):	0.000
Axis5(degree):	90.000
Axis6(degree):	0.000
Axis7(degree):	0.000
Axis8(degree):	0.000

Cartesian:	
X:	370.273
Y:	1.407
Z:	309.647
RX:	16.648
RY:	-3.688
RZ:	89.939

9.6.2 Variables

The variable monitor page displays 4 types of variables: B, I, D, and P. The data formats and number ranges for the variables are described as follows:

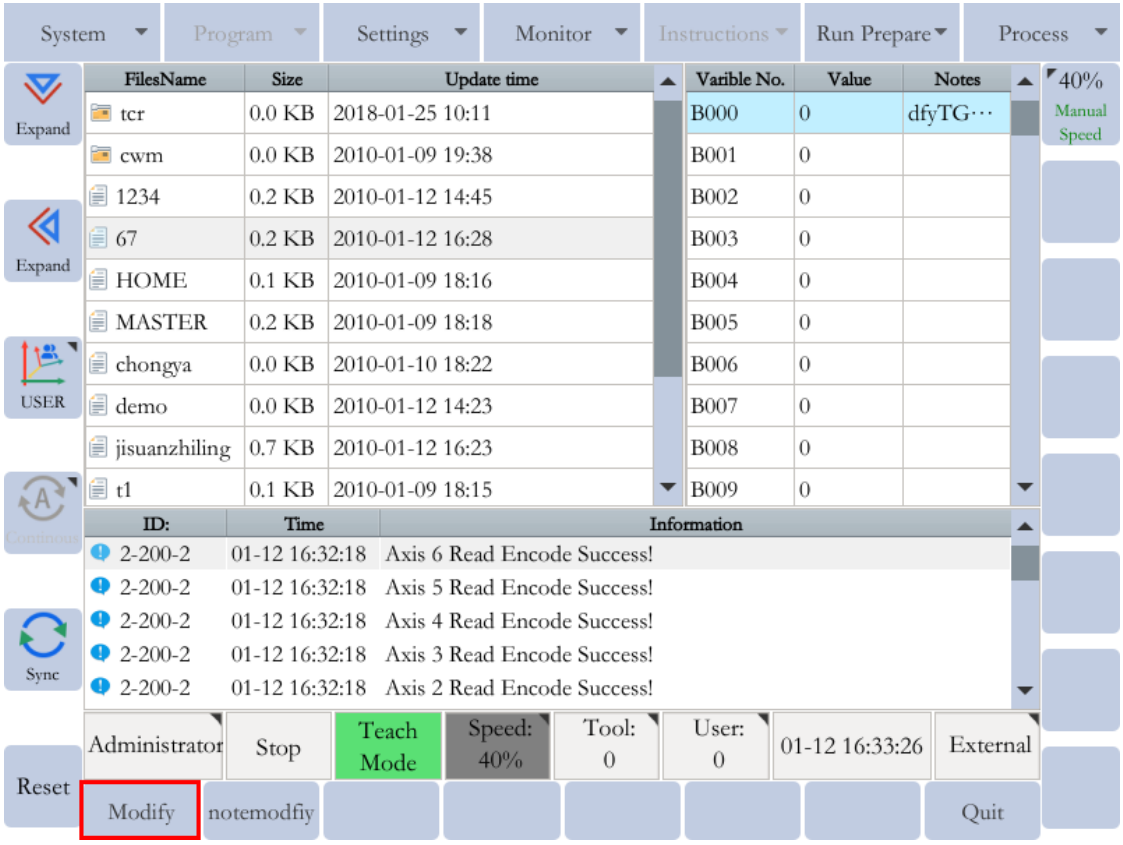
B: Byte Type, B000 - B255 (256);

I: Integer Type,I000 - I255 (256);

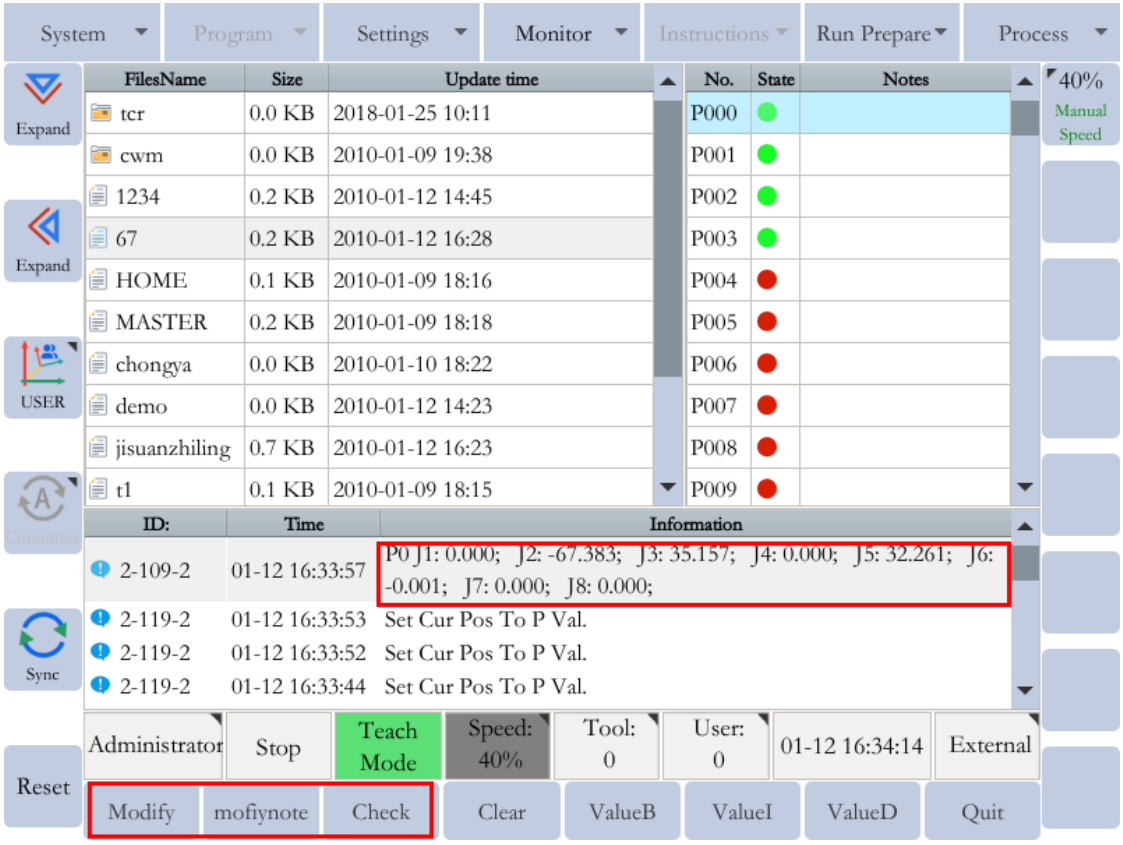
D: Double Type,D000 - D255 (256);

P: Position Type,P000 - P255 (256).

In the variable monitor page, the user can switch between different variable types by pressing the buttons in the submenu area. Select the target variable by the cursor, and press [MODIFY] button in the submenu area to input the required value in the pop-up box. Note that the values in the variable monitor page can only be modified in TEACH mode.

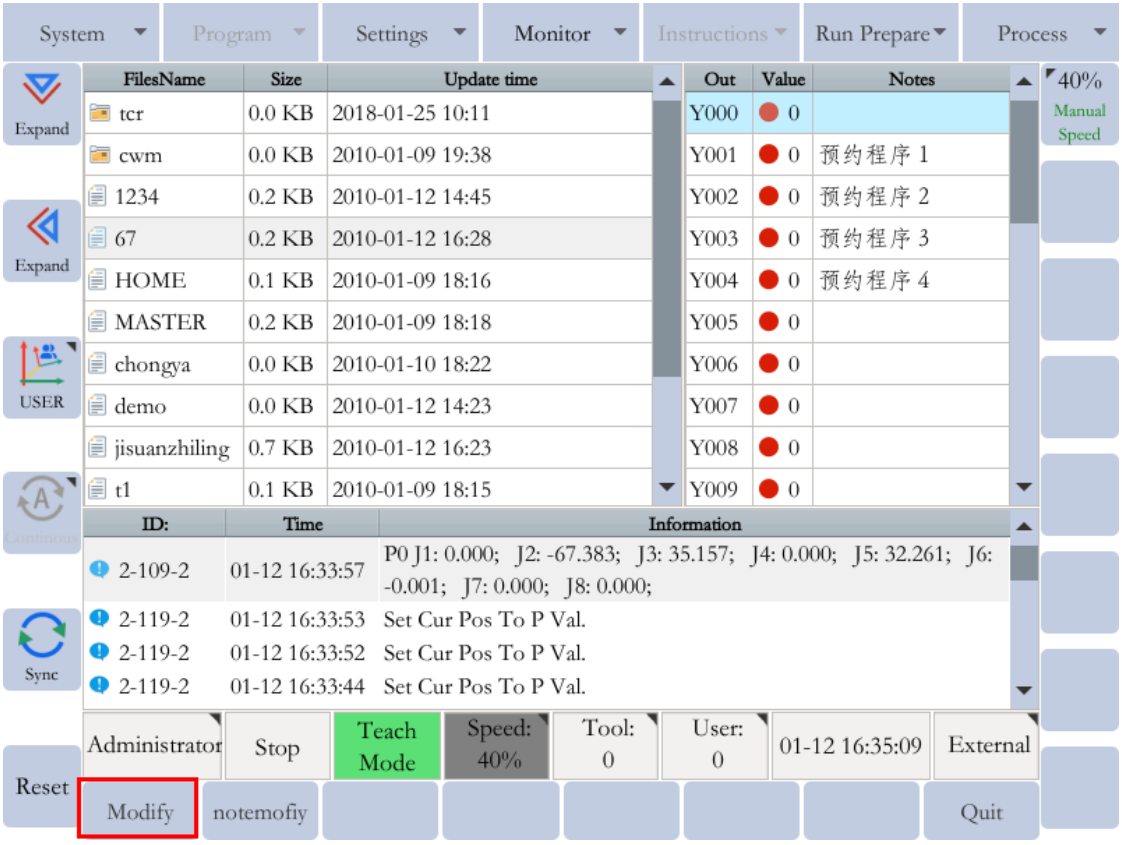


The P variable is the position type variable. Select the desired P variable using the cursor in the variable monitor page. Press [VIEW] to view its value in the information prompt area. Press [CLEAR] to reset it to the default value. Press [MODIFY] to record the current joint coordinates into the variable.



9.6.3 IO

The IO monitor page includes four options: input, output, virtual input, and virtual output. Select the desired option to open the corresponding monitor page. The user can switch between the four options in the submenu area quickly.



The inputs and virtual inputs can only be used to monitor the state changes. The states of the outputs and the virtual outputs can be modified. Note that the outputs and the virtual outputs with red labels are used by the system, and their states cannot be modified. For example, in the output monitor page, select Y000 using the cursor and press [MODIFY] in the submenu area to reverse its state. Its value will become 1 from 0, or become 0 from 1.

9.6.4 Motor

The motor monitor page includes three options: pulse, motor speed and absolute position. The pulse monitor page displays three items: the sending pulse counting, the feedback pulse counting and the difference. For pulse motors, if there is a movement position deviation, you can monitor the changes of various values on this interface to find out the cause. This monitor option is hardly used by the general users.

Axis	Send pulse	Feedback pulse	Difference
Axis1:	7008	0	7008
Axis2:	5860	0	5860
Axis3:	-6536	0	-6536
Axis4:	2942	0	2942
Axis5:	3494	0	3494
Axis6:	2772	0	2772
Axis7:	0	0	0
Axis8:	0	0	0

In the motor speed monitor page, the real-time rotational speed of each axis can be viewed according to the actual requirements.

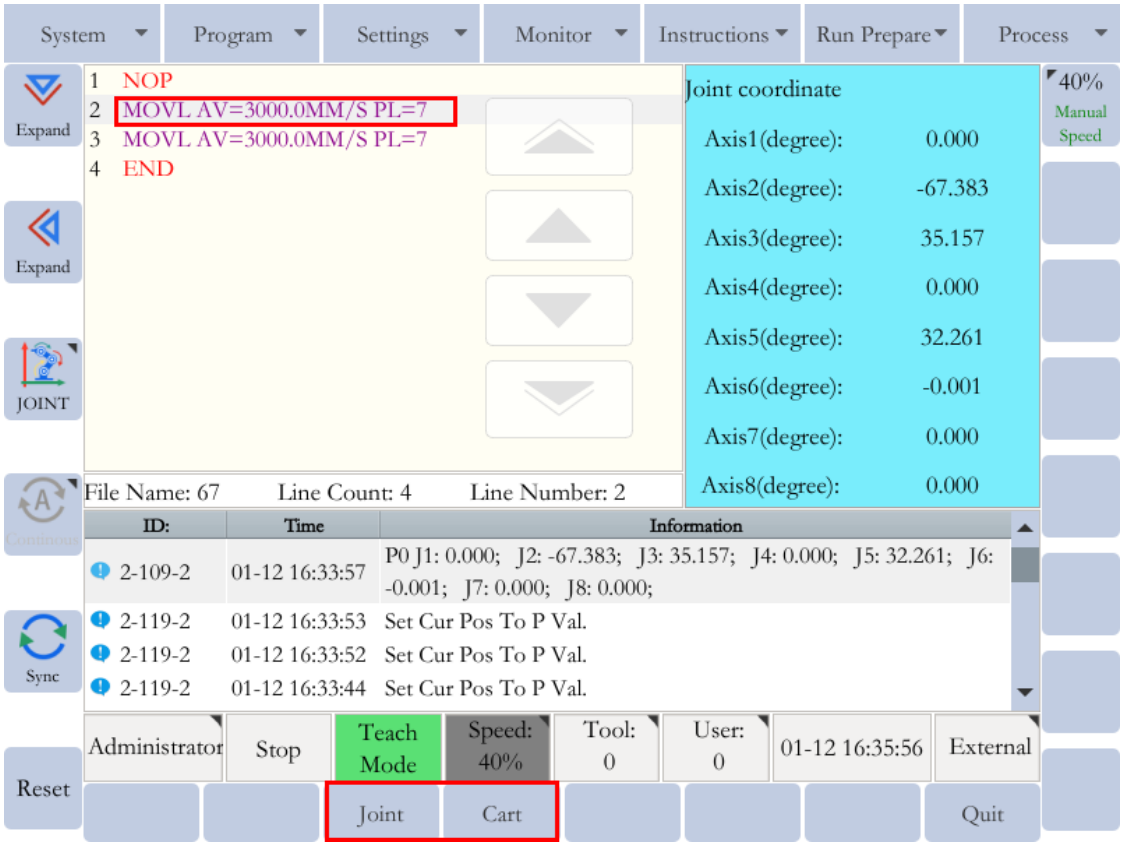
Axis	Speed	Max speed
Axis1:	0	0
Axis2:	0	0
Axis3:	0	0
Axis4:	0	0
Axis5:	0	0
Axis6:	0	0
Axis7:	0	0
Axis8:	0	0

In the absolute position monitor page, the pulse counting at the current position for the motor of each axis can be viewed according to the requirements.

	Current position	Home position	Difference
1 axis:	0	0	0
2 axis:	0	0	0
3 axis:	0	0	0
4 axis:	0	0	0
5 axis:	0	0	0
6 axis:	0	0	0
7 axis:	0	0	0
8 axis:	0	0	0

9.6.5 Operational Monitoring

In the operational monitor page, the coordinate values at the current position and the coordinate values of the target point recorded in the move instruction can be viewed. The joint coordinates are displayed by default, which can be switched to the Cartesian coordinates by pressing [JOINT/CARTESIAN] button in the submenu area. In the program editing window, use the cursor to select the desired move instruction, and the coordinate values of the target point corresponding to the instruction will be displayed in the operational monitor page.



9.7 Convenient Functions

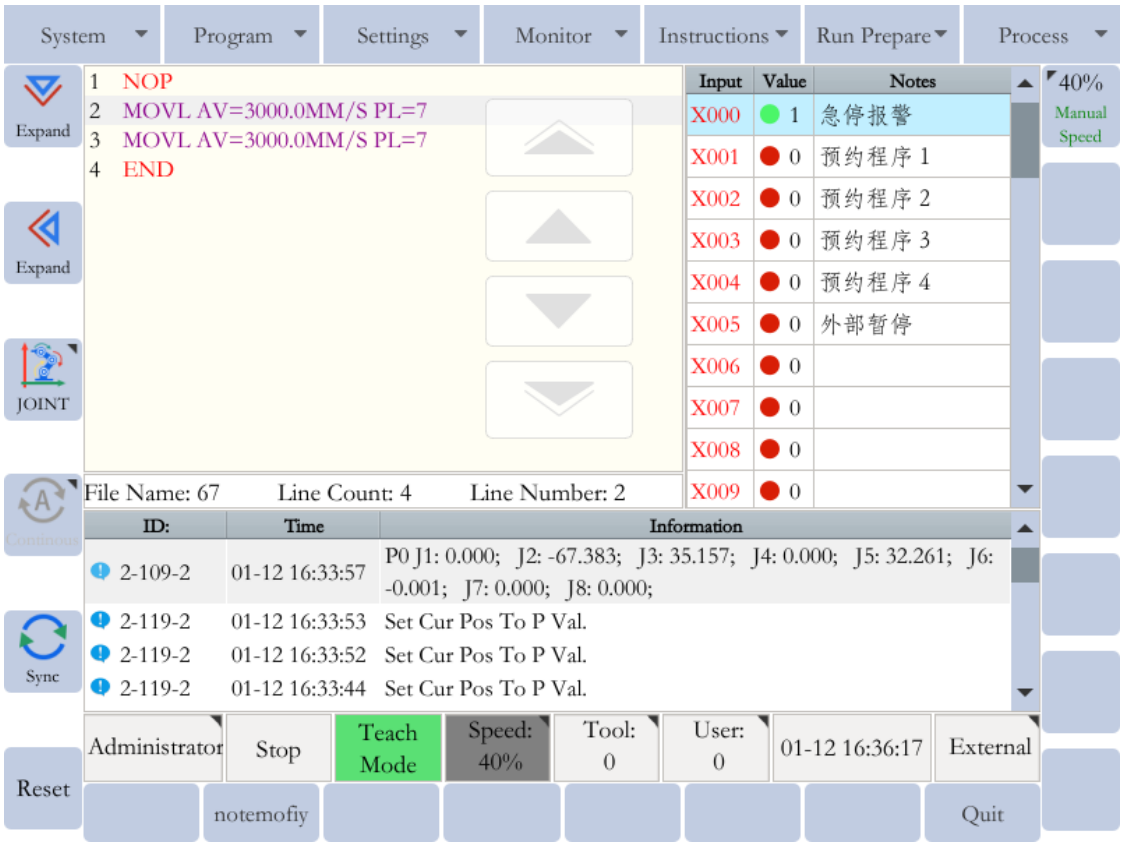
9.7.1 Key Combination Function

In this system, press and hold [WINDOW SWITCH] button  , several additional options will appear in the submenu area, which are corresponding to different convenient functions. The conventional key combination functions include screen validation,

screenshot, normal mode, advanced mode, etc. There are different key combination functions for different user processes, which can be used according to the actual requirements.

9.7.2 Multi-Window Function

Some windows in the system can be displayed in both full size mode and half-size mode. The selected window can be expanded towards the desired direction by pressing [Expand Up / Down] and [Expand Left / Right] buttons. Therefore, the multiple windows can be displayed during the program execution, which is convenient for debugging the program.



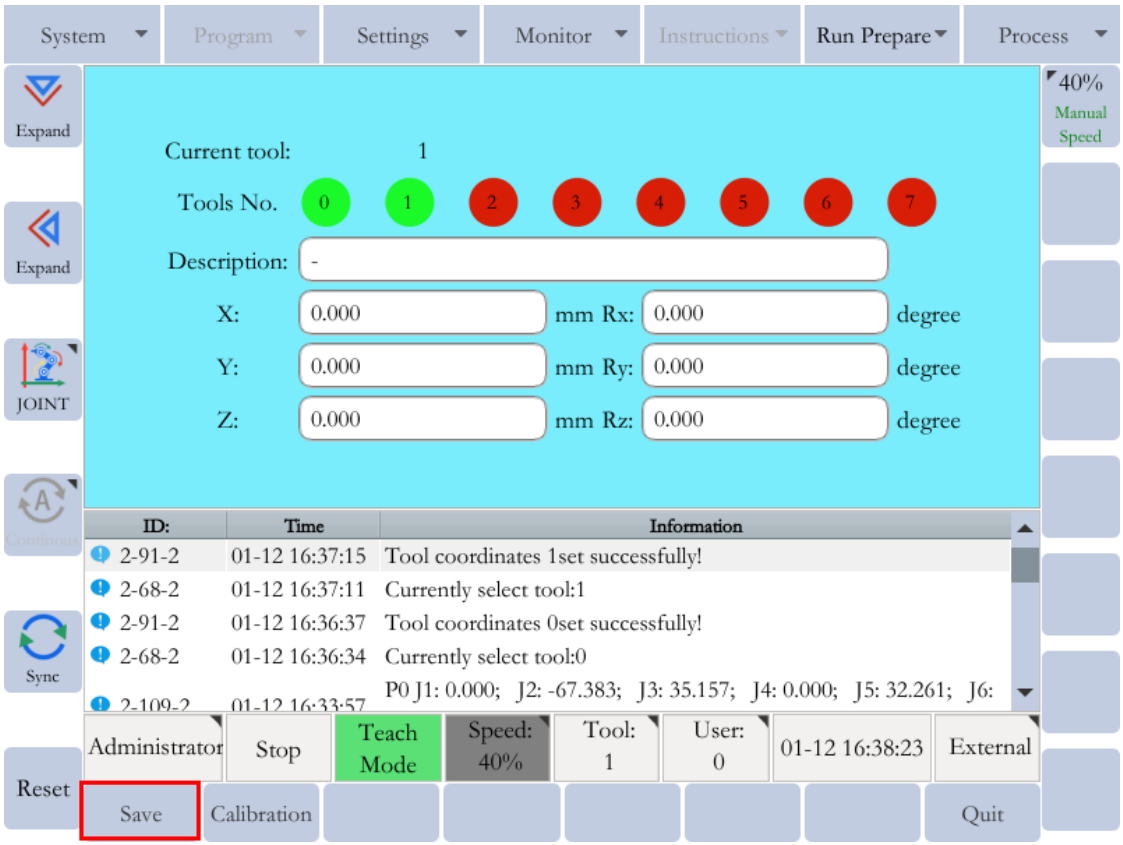
9.8 System Setup

9.8.1 Tool Coordinates Setting

To ensure that the manipulator can perform motion type operations such as linear and circular motion type correctly, accurate dimensional information on tools such as torches, tools, and guns must be registered and the position of the TCP must be defined. The tool coordinates

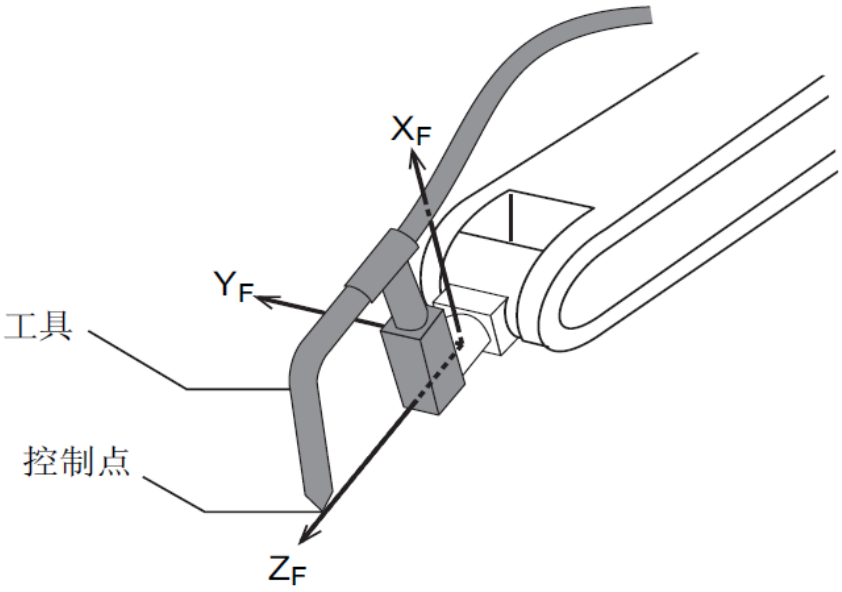
are established by registering the coordinates of the TCP and the tool angle in the flange coordinates of the manipulator. After that, the TCP is automatically calculated and registered in the tool file.

There are 8 tool coordinates numbered from 0 to 7 can be set in the system. Go to the page of "Readiness for operation - Tool coordinates", and select the tool coordinate number. The TCP can be calculated by inputting the tool coordinate values (the position of TCP and the tool angle) in the flange coordinates or performing the seven-point tool calibration.

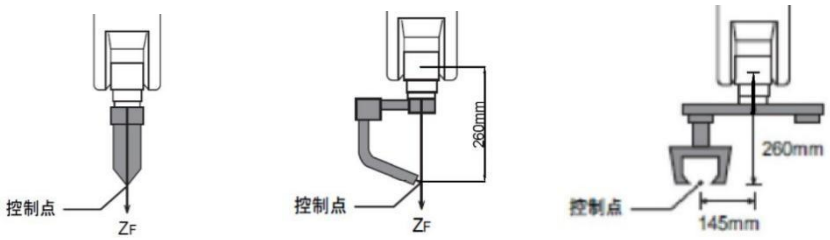


9.8.1.1 Registering Tool Coordinate Data

When the number input operation is used for registering the tool coordinate, input the TCP of the tool in the flange coordinates.



Three cases corresponding to the tool A, B and C are given as examples for registering the coordinate data, as shown in the figures below.



tool A tool B tool C

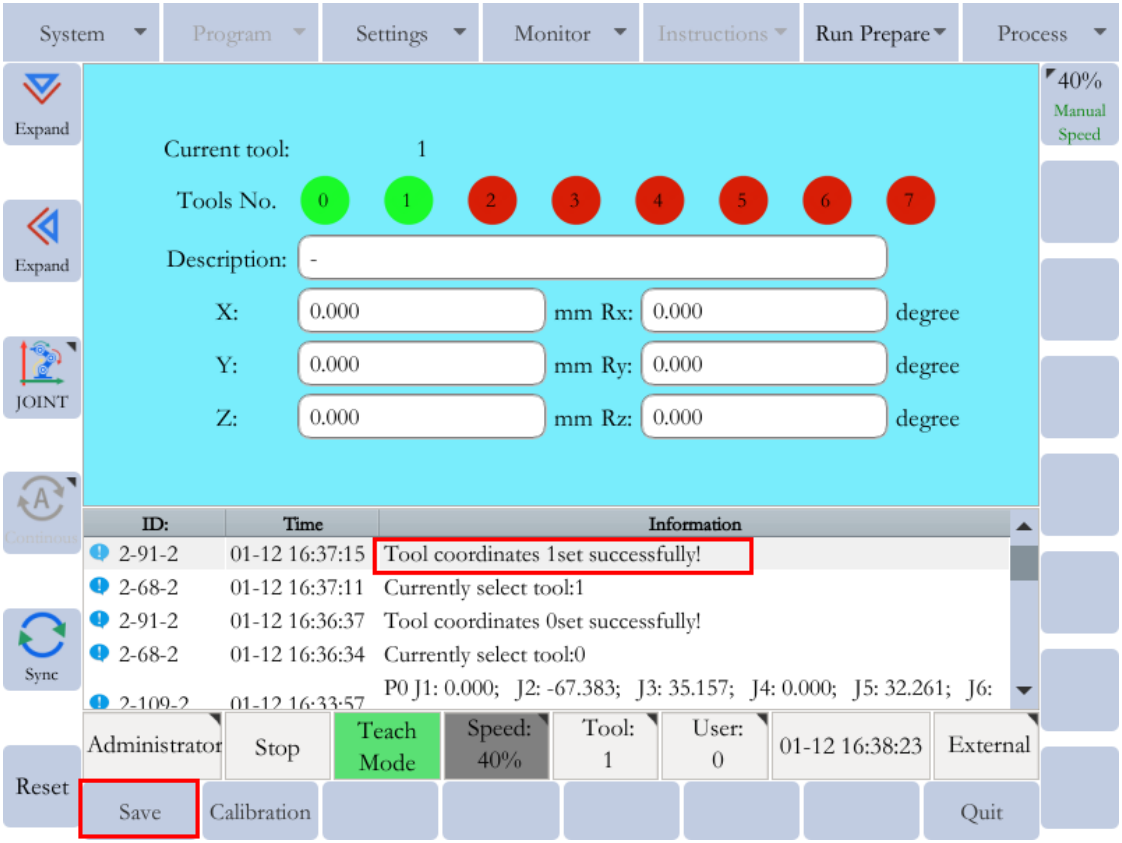
- Cases of Tool A, B:

  X, Y, Rx, Ry, Rz are 0, and Z is 260.

- Cases of Tool C:

  X, Rx, Ry, Rz are 0, Y is 145, and Z is 260.

Enter the value into the coordinate input box, and press [SET] button in the submenu area. Then the information prompt area will display the following message: "The tool coordinate is successfully set!"

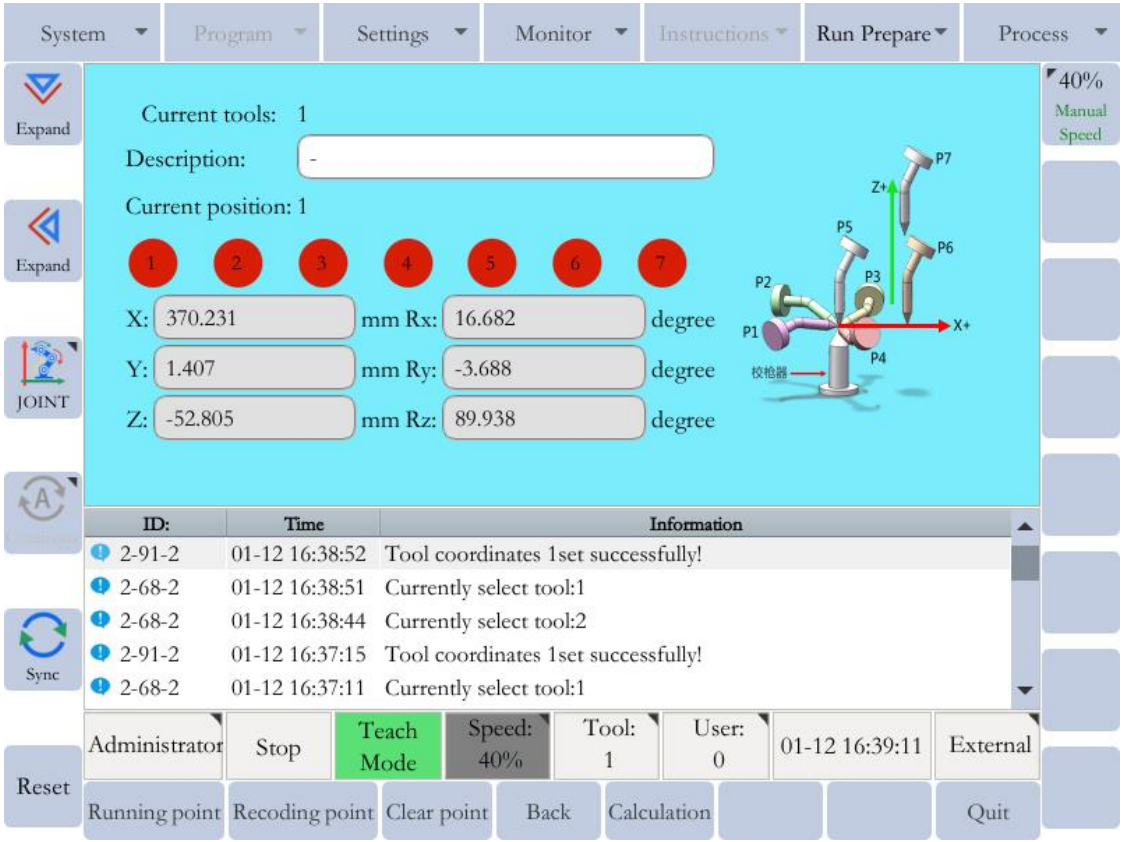


9.8.1.2 Seven-point Tool Calibration

In order to perform the seven-point tool calibration, seven points with different postures must be taught with the TCP as the reference point. The tool dimensions are automatically calculated on the basis of these seven points.

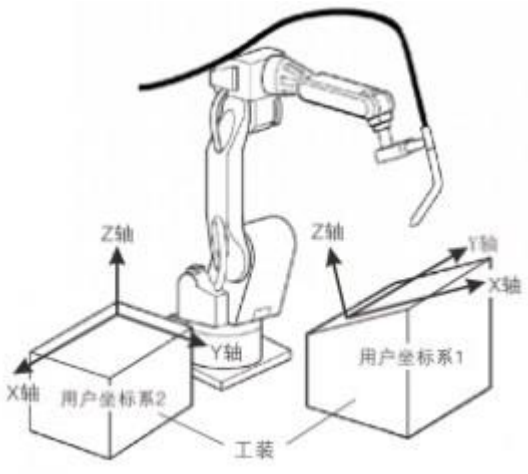
In the page of tool coordinates, press [CALIBRATE] in the submenu area to enter the seven-point tool calibration window. Then record seven points numbered from P1 to P7 according to the schematic diagram. For the five points from P1 to P5, the TCP should always be the same point (e.g., the tip of the calibration cone), and each angle must be arbitrary. Accuracy may decrease when pose setting is rotated in a constant direction. The points P6 and P7 are used to define the X-axis direction and the Z-axis direction of the tool coordinate.

First select the target point in the window, then press [RECORD] to record the current position of the manipulator. After that, the color corresponding to the point will change from red to green. Record the seven points respectively. After selecting the taught point, [RUN POINT] button can be pressed to move the manipulator to the point, and [CLEAR POINT] button can be used to clear the point data. After teaching all points, press [CALCULATE] to generate the desired tool coordinate.

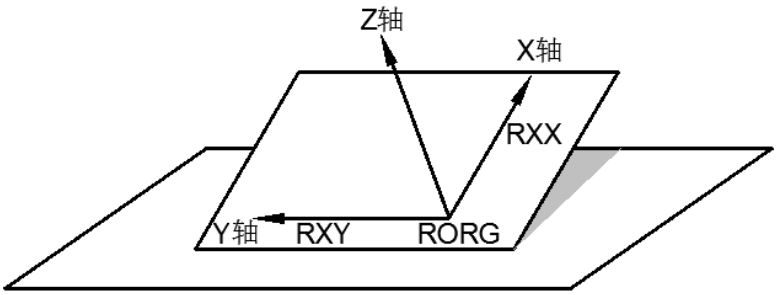


9.8.2 User Coordinates

The user coordinate settings allow easy teaching and programming in various situations. When multiple positioners are used, manual operation can be simplified by setting the user coordinates for each fixture, as shown in the following figure.

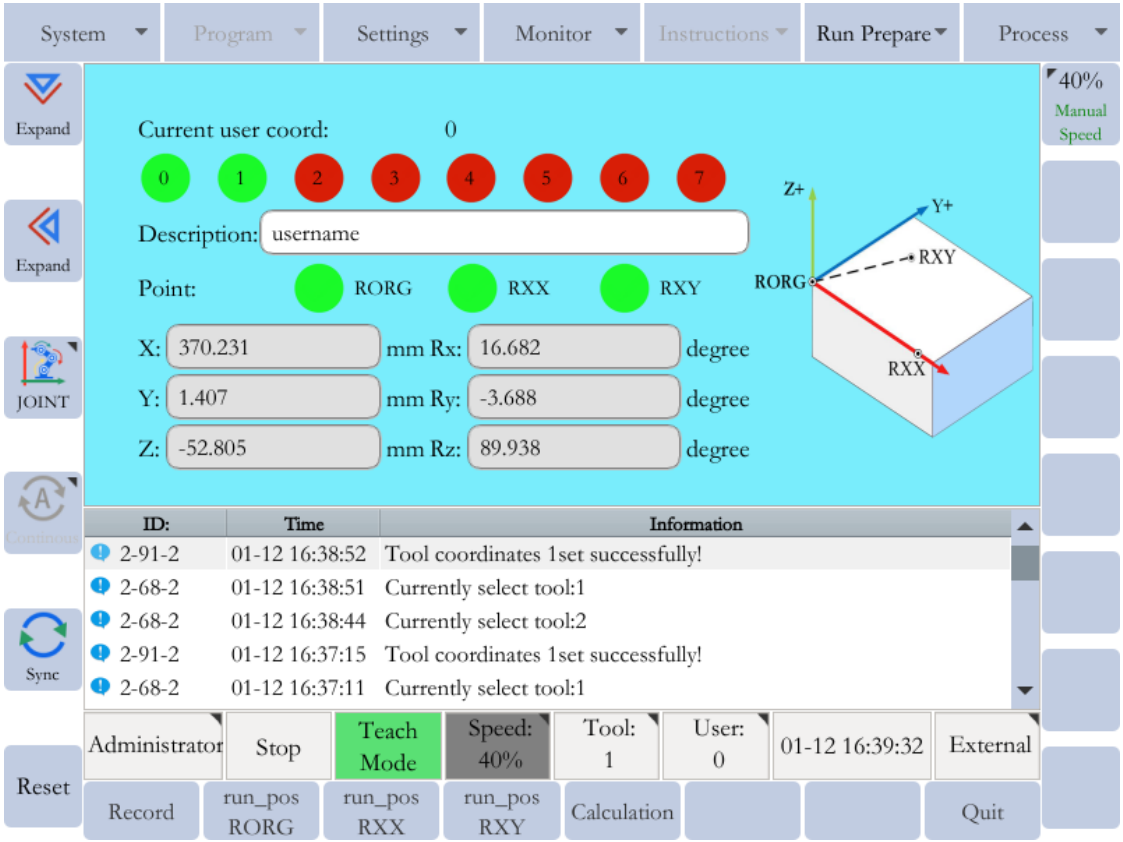


User coordinates are defined by three points that have been taught to the manipulator through axis operations. These three defining points are RORG, RXX, and RXY, as shown in the diagram below. These three points of positional data are registered in a user coordinate file.



User coordinate definition: RORG is the home position, and RXX is a point on the X-axis. RXY is a point on the Y-axis side of the user coordinates that has been taught, and the directions of Y- and Z-axes are determined by point RXY. Note that it is important that the two points RORG and RXX be taught accurately.

Go to "Readiness for Operation - User coordinates" to open the user coordinate setting page. First select the user coordinate number to be set. Then select one of the three defining points and press [RECORD] button in the submenu area after moving the manipulator to the desired position. The color corresponding to the taught point will change from red to green. After recording all three points, press [CALCULATE] button to generate the desired user coordinate. When holding the Enable switch, [RUN RORG], [RUN RXX] and [RUN RXY] in the submenu area can be used to move the manipulator to the corresponding point.



9.8.3 Interference Area

The interference area is a function that prevents interference between multiple manipulators or the manipulator and peripheral device. The area can be set up to 16 areas. There are two types of interference areas:

- Cubic Interference Area
- Axis Interference Area

9.8.3.1 Cubic Interference Area

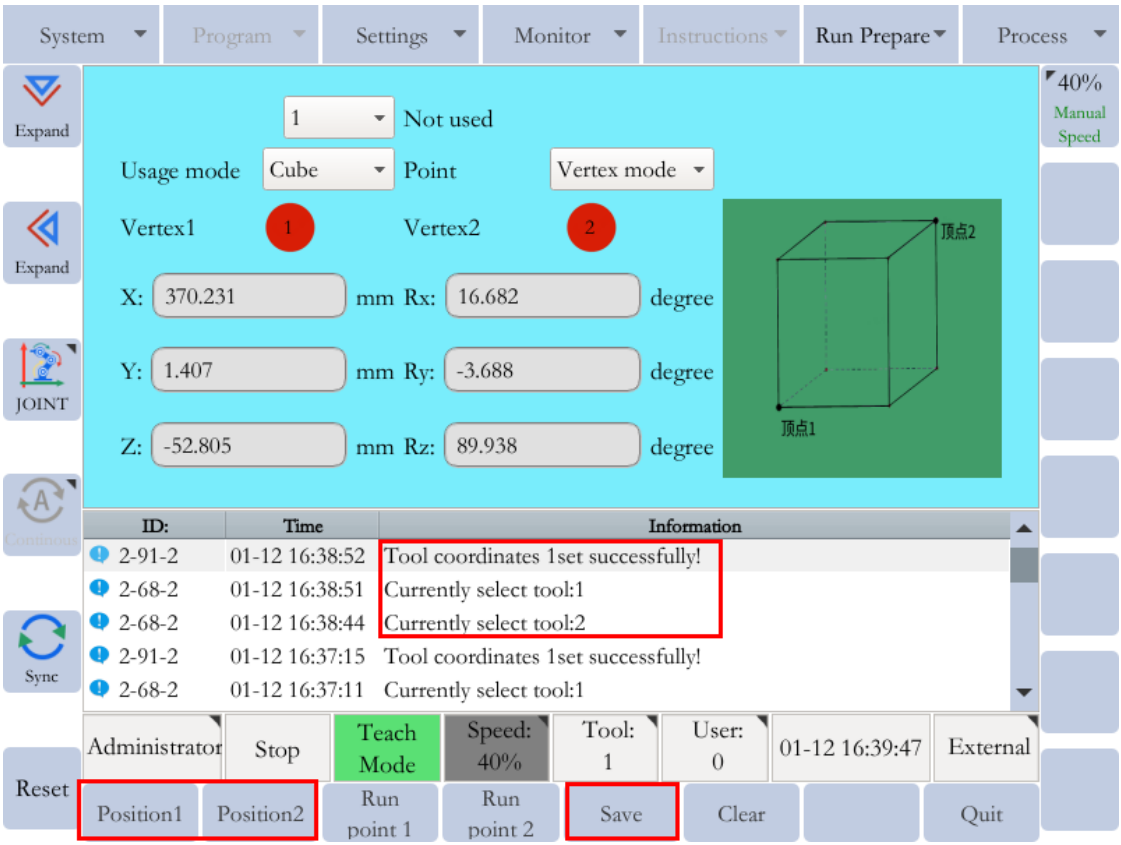
This area is a rectangular parallelepiped which is parallel to the base coordinate (Cartesian coordinate). The system judges whether TCP of the current position of the manipulator is inside or outside this area, and outputs this status as a signal. (ON: inside, OFF: outside)

There are two ways to set cubic interference areas, as described in the following:

(1) Teaching Corner

Move the manipulator at the maximum and minimum value positions of the cube corner using the axis keys, and record them respectively. Then press [SAVE] button in the submenu area,

and the target cubic interference area will be set successfully.



(2) Number Input of the Side of Cube and Teaching Center

Move the manipulator to the center point of the cube using the axis keys and record it. Then enter the length, width, and height of the cube, and press [SAVE] button in the submenu area.

9.8.3.2 Axis Interference Area

The axis interference area is a function that judges the current position of each axis and outputs a signal. Once the maximum and minimum values have been set at the plus and minus sides of the axis to define the working range, a signal indicating whether the current position of the axis is inside or outside this range is output. (ON: inside, OFF: outside)

In the interference area setup page, select "Axis" for the usage mode. Then select the axis number, and move the axis to the minimum and maximum points using the axis keys. Record the points and press [SET] in the submenu area.

9.8.3.3 Signal Corresponding to Interference Area

The output signals of the interference area 1 to 16 are corresponding to the virtual outputs M440 to M455 respectively. If the signal needs to be output to the external device, the corresponding virtual output should be mapped to the actual output Y by modifying the PLC program.

9.8.4 Home Position

The "Readiness for Operation - Home position" menu includes three options: mechanical home position, program home position, and home position calibration.

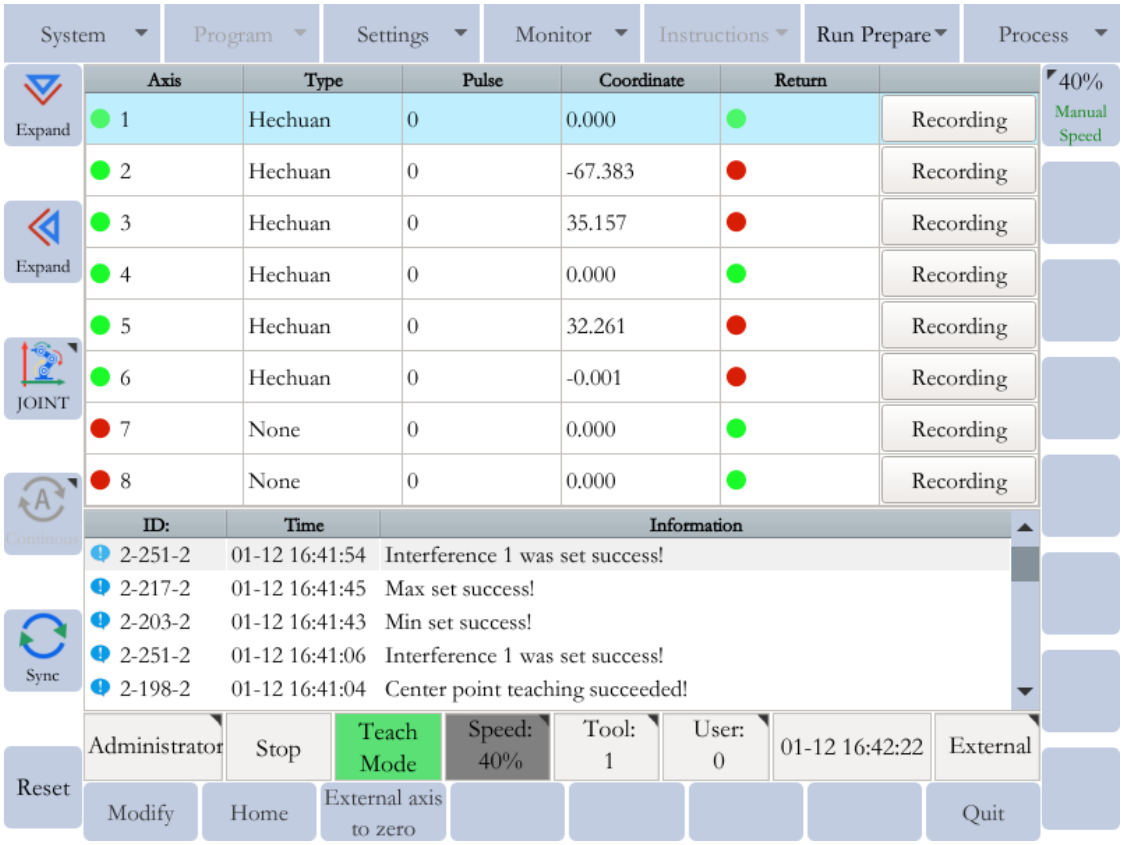
9.8.4.1 Mechanical Home Position

Although the mechanical home position is calibrated prior to shipment at the factory, the following cases require the calibration to be performed again.

- Change in the combination of the manipulator and cabinet.
- Replacement of the motor or absolute encoder.
- Mechanical home position deviation caused by hitting the manipulator against a

workpiece, etc.

To calibrate the mechanical home position, use the axis keys to calibrate the home position mark on each axis so that the manipulator can take its posture for the home position by pressing [RECORD] button for each axis in the mechanical home position page. The calibration can also be directly completed by modifying the pulse counting at the mechanical home position.

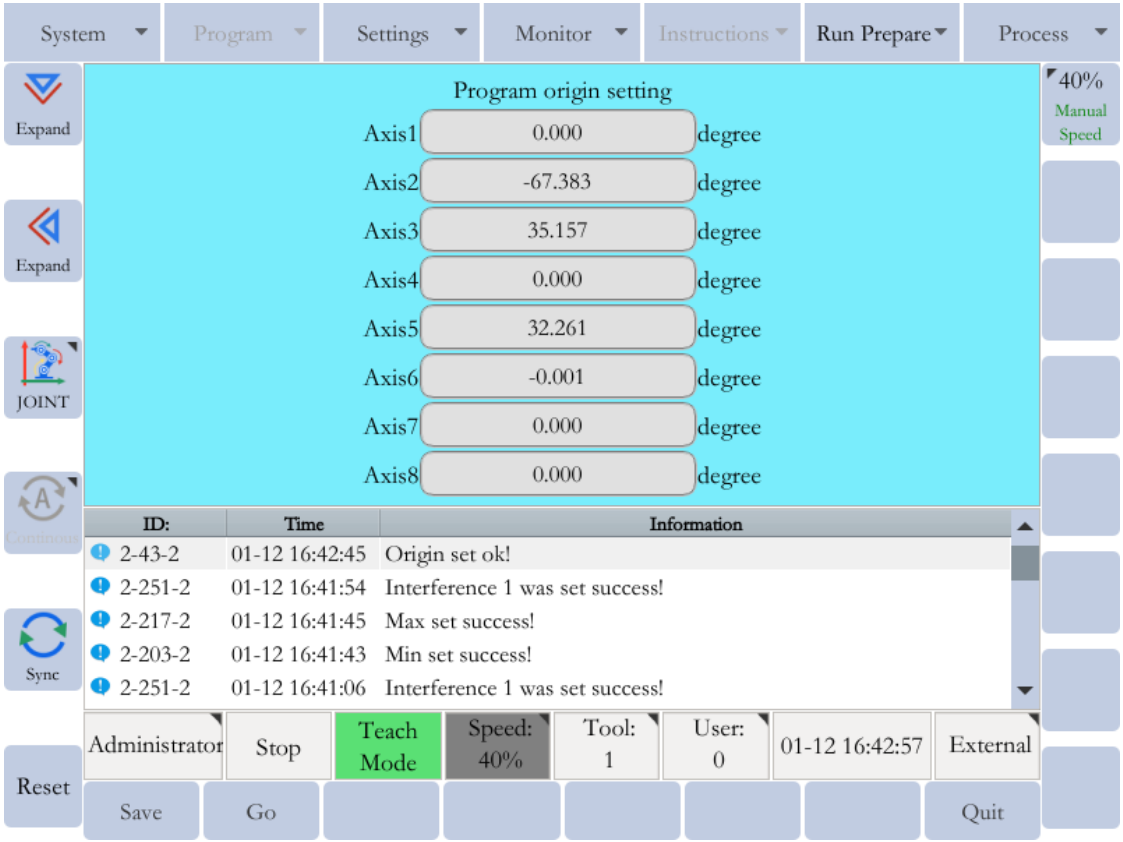


For the detailed instructions of setting mechanical home position, please refer to the chapter of setting mechanical home position in << Initial Configuration Manual >>.

9.8.4.2 Program Home Position

The program home position is the reference point for manipulator operations. It prevents interference with peripheral device by ensuring that the manipulator is always within a set range as a precondition for operations such as starting the line.

In the page of setting program home position, press [SET] button to set the current position of the manipulator as the program home position. When the manipulator is located at the program home position, the value of the virtual output M401 is 1, and the special output signal "Home" is valid. The program home position can be set and used according to the requirements of the production line.



9.8.4.3 Home Position Calibration

The mechanical home position of the manipulator body and the accuracy of TCP can be calibrated by using the home position calibration function. The operation procedures can be described as follows:

(1) Create a program with 20 positions which must be taught with the TCP as the reference point, and the TCP can be defined by the tip of the calibration cone.

(2) Go to "Readiness for Operation - Home Position – Home Position Calibration".

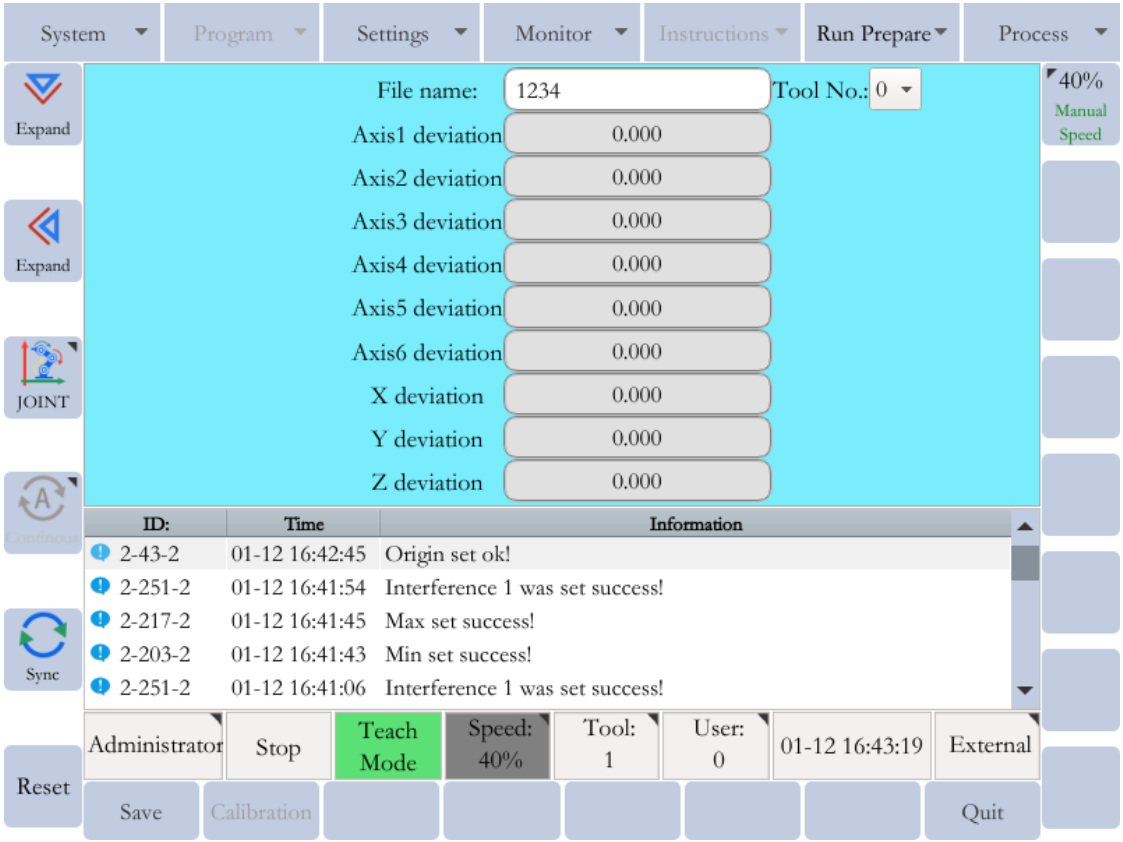
(3) Select the above program and the tool number that needs to be calibrated.

(4) Press [Set] button, and if the calibration data is valid, the information prompt area will display the following message: "The mechanical home position is calibrated successfully!

(5) Press [CALIBRATE] button.

(6) Go back to "Readiness for Operation - Home Position - Mechanical Home Position".

(7) Hold the Enable switch, and press [RETURN HOME] to move the manipulator back to the mechanical home position. Then press [RECORD] to record the home position for each axis respectively.



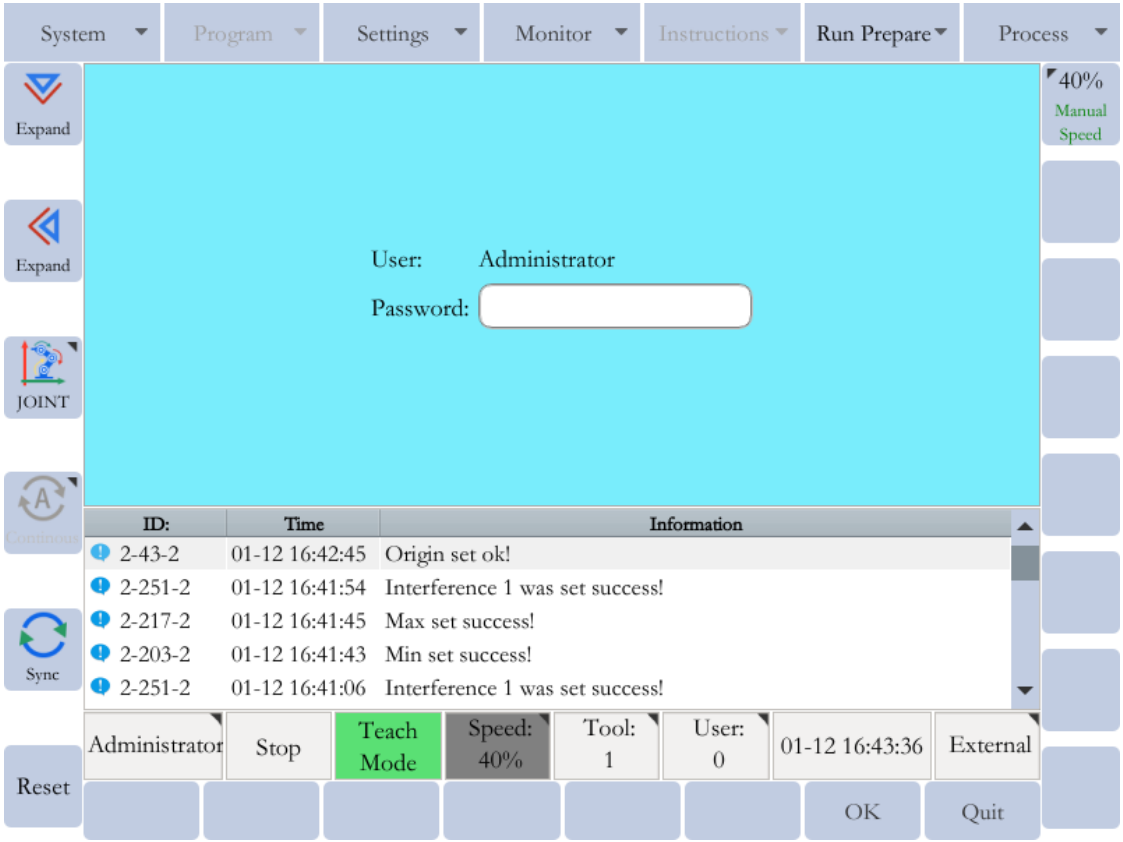
For the detailed setting instructions, please refer to << ERC-G200 Mechanical Home Position Calibration Manual >>.

9.8.5 Authority

There are two options under the "Settings - Authority" menu: switching users and changing password.

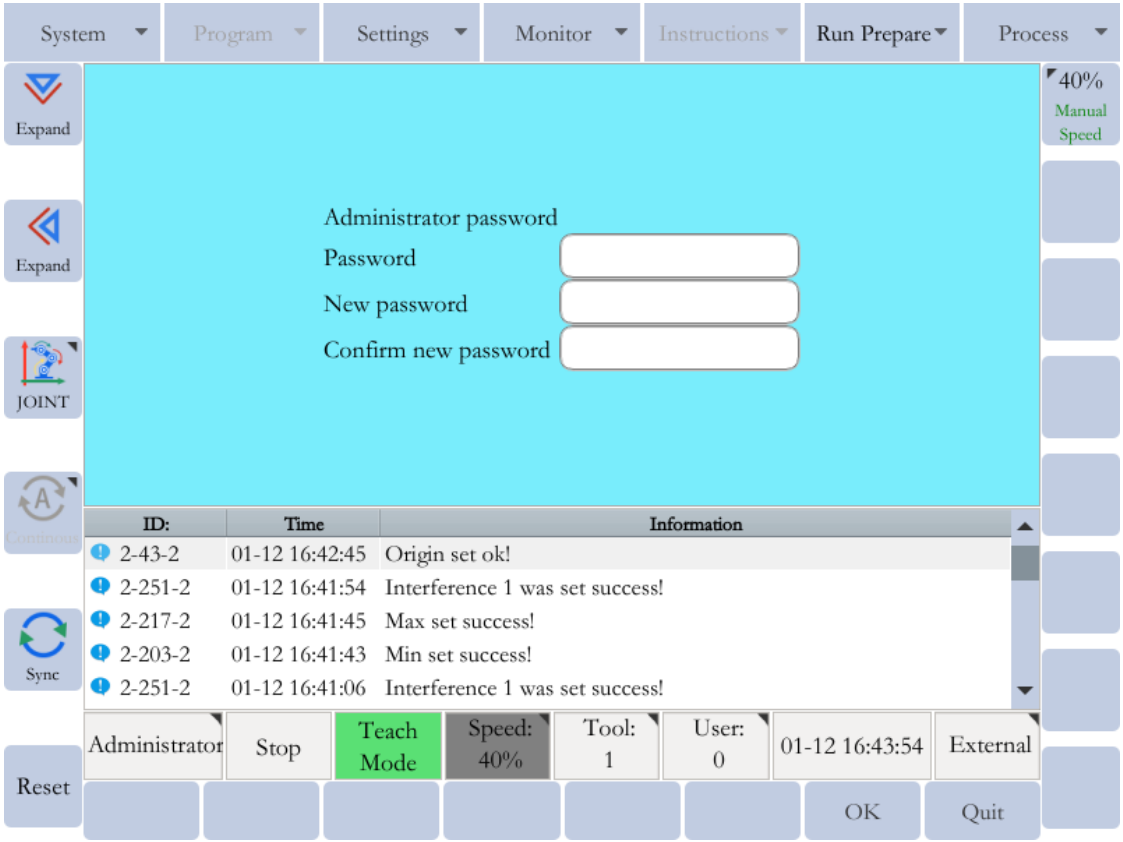
9.8.5.1 Switching users

The system provides four types of user authorities: general user, expert user, root and administrator. The user authorities required by the options in the operating system are provided in section 1.4.1. In the page of switching users, enter the password of the current user authority, then press [OK] to switch user authorities.



9.8.5.2 Changing Password

The password of the current user authority can be modified in the page of changing password. Enter the previous password and the new password at the given locations, and press [OK] to change the password.



9.8.6 Speed Parameters

In the page of "Settings - Speed Parameters", the following parameters can be set: the maximum and minimum rotational speeds of each axis, the maximum and minimum speeds for moving in straight line, the maximum and minimum posture angle speeds, the speed of returning to the home position, the joint acceleration time, etc. Generally, the factory default values can be used for the parameters in this page, which most users do not need to set.

9.8.7 Limit Parameters

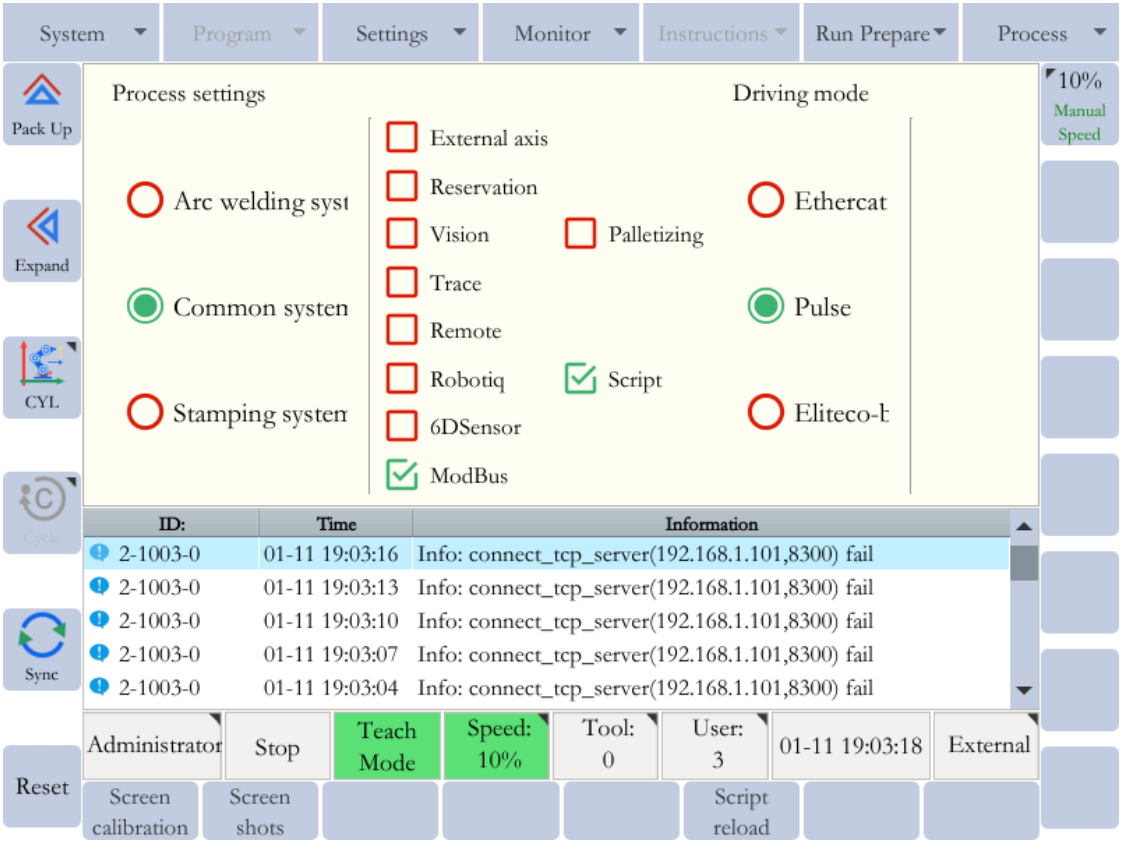
In the page of "Settings - Limit Parameters", the maximum and minimum angular position of each axis can be set as the joint soft limits. If one of the joint positions is out of the soft limits during the operation, the manipulator will stop immediately and give an alarm. The limit parameters are set to the default values when shipping from the factory. Note that the soft limits cannot be expanded in order not to damage the manipulator body. However, the limit range can be reduced according to the actual requirements.

9.8.8 System Configuration

The "System - System Configuration" menu includes three options: robot configuration, network configuration and language configuration.

9.8.8.1 Robot Configuration

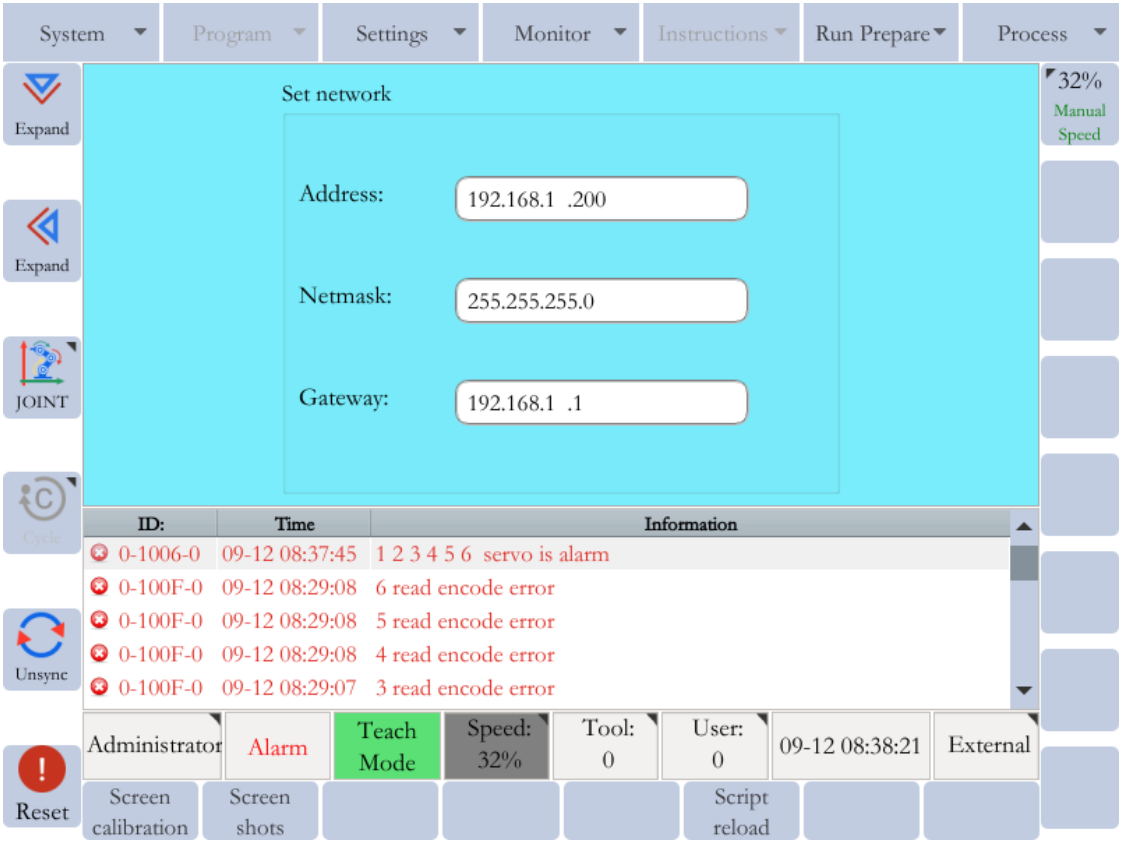
The robot process settings, additional function selections and drive mode settings can be configured in the robot configuration page, as shown in the figure below.



After finishing the robot configurations, press [SET] button, and the users will be prompted to decide whether to restart the system. Then press [OK] button, all the settings will take effect after the restart. Generally, all above settings are configured successfully when shipping from the factory, and the users do not need to set them.

9.8.8.2 Network Configuration

The network configuration is mainly used to change the IP address, subnet mask and gateway of the system controller. All above parameters can be modified in the network configuration page, as shown in the figure below. After the modifications, press [SET] button, and the changes will take effect immediately.



9.8.8.3 Language Configuration

The current system supports two display languages: Simplified Chinese and English. Select the language configuration, and choose Simplified Chinese or English in the popup window. Press [OK] button, and the selected language will take effect after the restart.

9.9 Backup and Upgrade

The backup and upgrade operations of the system software are simple, fast, and convenient, which only need an ordinary USB flash disk. After preparing the USB flash disk according to the upgrade or backup requirements, insert it into the USB port of the controller (for the collaborative robot, the USB port is on the surface of the cabinet), and simply a few operations on the programming pendant can complete the backup or upgrade of the system software.

9.9.1 Software Information

Under the "System - Software Info" menu, the basic information, detailed information and registration information of the system software can be viewed.

9.9.1.1 Basic Information

The basic information includes the IP address of the controller, the software version number and the system version number. The software information page displays the basic information by default.

9.9.1.2 Detailed Information

Press [DETAILED INFORMATION] in the submenu area to display the detailed information page, where the version number and the compilation time of the system components can be viewed.

9.9.2 Local to USB

The "System - Save to USB" option includes parameter backup, IO annotation backup, PLC backup, user data backup and script backup / delete.

Parameter Backup: Backup all parameter settings, including speed parameters, system parameters, limit parameters, servo parameters, mechanism parameters, and other parameters.

IO Annotation Backup: Backup comment files for input, output, virtual input and virtual output.

PLC Backup: Backup system PLC program files.

User Data Backup: Include parameter backup, IO annotation backup, and PLC backup. In addition, backup all program files, user coordinates files, tool coordinates files, user processes files and screenshots, etc.

Script Backup/Delete: Backup or delete script files.

When performing "Save to USB" operation, if there is no folder called "rbctrl" in the root directory of the USB flash disk, the system will automatically generate the folder and save the backup file in it. If the folder exists in the root directory, the backup file will be saved in it directly.

9.9.3 Local from USB

The "System - Load from USB" option includes parameter upgrade, IO annotation upgrade, PLC upgrade, user data recovery, script upgrade, and identification file import.

When performing "Load from USB" operation, a folder named "rbctrl" must be created in the root directory of the USB flash disk. After placing the upgrade file in the folder, the upgrade operation can be performed. If the folder does not exist, the alarm with the message "Failed to load the upgrade file" will be given by the system when performing the upgrade operation.

9.9.4 System Upgrade

9.9.4.1 System Upgrade

System upgrade can be performed when the software needs to be updated or system failures occur. The existing user data should be backed up before the system upgrade. Note that the mechanical home position is not included for user data backup. Thus, take a photo or screenshot of the mechanical home position page before the system upgrade.

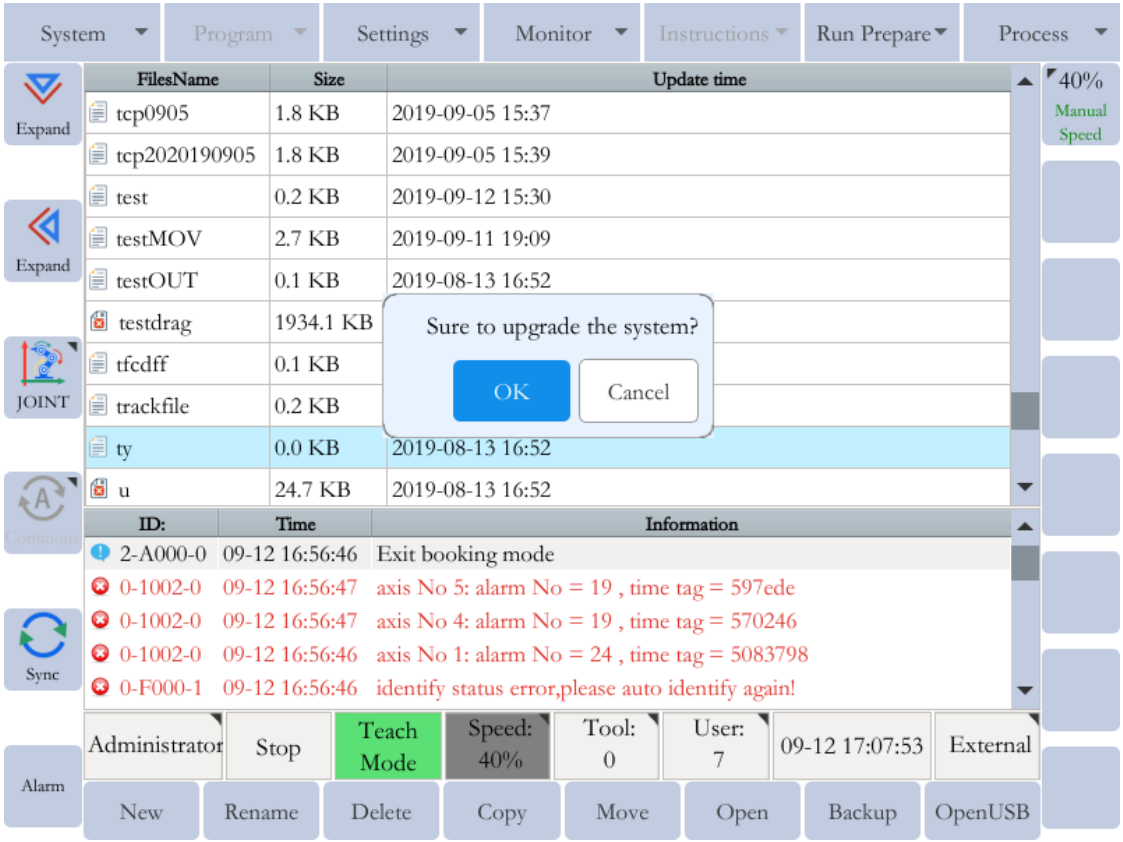
The detailed upgrade procedures are as follows:

(1) Prepare a USB flash disk and copy the system upgrade file "firmware.bin" to its root directory;

(2) Insert the USB flash disk into the USB port of the controller or the collaborative robot cabinet;

(3) Go to "System - Save to USB" and select "User Data Backup" to back up the user data;

(4) Go to "System - System Upgrade", then press [OK] button and wait several minutes. The system will check the firmware and be upgraded automatically. It will restart the system after successful upgrade.



9.9.4.2 Firmware Upgrade

The firmware upgrade is peculiar to the collaborative robot and the detailed upgrade procedures are as follows:

(1) In the root directory of the USB flash disk, create a new folder named "rbctrl" and copy the firmware upgrade file into it;

(2) Insert the USB flash disk into the USB port of the collaborative robot cabinet, and a USB device icon will be displayed in the coordinate area of the programming pendant screen;

(3) Go to "System - System Upgrade", and a dialog box with the message "Confirm System Upgrade" will pop up. After pressing [OK] button, the system will give the message "Please select the content that needs to be upgraded". Then select "Upgrade Firmware";

Appendix

A Glossaries

Stop Category 0: The robot motion is stopped immediately when the power supply of the robot is turned off. It is an uncontrolled stop, where the robot may deviate from the programmed path as each joint may brake as fast as possible. This protective stop may be used when a safety-related assessment limit is exceeded, or when a fault occurs in the safety-related assessment part of the control system. For more information, please refer to EN ISO13850:2008 or IEC60204-1:2006.

Stop Category 1: The robot motion is stopped with power available for the robot to achieve the stop, and the power supply is turned off when the stop is achieved. It is a controlled stop, where the robot will comply with the programmed path. The power is turned off after one second or once the robot stands still. For more information, please refer to EN ISO13850:2008 or IEC60204-1:2006.

Stop Category 2: It is defined as a controlled stop with power available to the robot. The robot stops all motions within one second. Through the operation of the safety-related assessment control system, the robot may stay at the stop position. For more information, please refer to IEC60204-1:2006.

Diagnostic coverage (DC): It is used to measure effectiveness of the diagnosis which is implemented to achieve the assessed performance level. For more information, please refer to EN ISO13849-1:2008.

Integrator: The integrator is an organization designing the final installation of the robot. The integrator is responsible for implementing the final risk assessment, and must make sure that the final installation comply with the local laws and regulations.

Mean time to dangerous failure (MTTFd): The MTTFd is defined as a value acquired by calculation and detection which are implemented to achieve the assessed performance level. For more information, please refer to ENISO13849-1:2008.

Risk assessment: The risk assessment is the whole process of identifying all risks and reducing these risks to an appropriate level. The risk assessment should be recorded and archived.

please refer to ISO 12100 for details.

Performance level (PL): The PL is a discrete level which is used to specify the ability of each safety-related part in the control system to implement the safety function under foreseeable conditions. PLd is a second highest reliability classification, meaning that the safety function is extremely reliable. For more information, please refer to EN ISO13849-1:2008.

B Certification and Detection

Through verification and evaluation of the quality management system and the sample type test of the enterprise by the third party certification organization, the product EC612 of the company is confirmed to be in line with the specific requirements and have the ability of producing the qualified products continuously and steadily, with the written confirmation. The description is as follows:

The EC612 has passed detection and certification of multiple well-known international third party organizations, and has acquired the EU CE certification and Korean KC certification. The product safety has achieved the international leading level.

The EC612 has passed the robot performance test of National Robot Testing and Assessment Center (Headquarters) of China; and the performance indexes have exceeded most of the domestic brands and achieved the standard of the traditional industrial robot, and have been gradually narrowing a gap with the top international brands.

The EC612 robot has passed the EU CE certification, and the product is in line with all relevant requirements of the EU CE directive:

Low-voltage Directive (LVD) 2006/95/EC

Machinery Directive (MD) 2006/42/EC

Electro Magnetic Compatibility Directive (EMC) 2004/108/EC

EN ISO 10218-1:2011

EN ISO 12100: 2010

EN ISO 13849-1: 2008

EN 60204-1: 2006+A1: 2009

The EC612 robot has been certified and tested by the official authority of Korea, has passed Korean KC certification, and is in line with all relevant requirements of the certification standards of Korea.

The EC612 robot has been certified and tested by National Robot Testing and Assessment

Center (Headquarters) of China, has passed the CR certification and is in line with all relevant requirements of the CR certification standards regarding the collaborative robot. The test standards are as follows:

GB 5226.1-2008, GB 11291.1-2011

GB/T 15706-2012

GB/T 17799.2-2003, GB 17799.4-2012

The EC612 robot is subjected to the robot performance test implemented by National Robot Testing and Assessment Center (Headquarters) of China, and the test basis and standards are as follows:

GB/T 12642-2013 *Industrial robots -- Performance criteria and related test methods*

C Stopping Time and Stopping Distance

Stopping distance and stopping time of stop category 0

The table below shows the stopping distance and the stopping time measured when the stop category 0 is triggered. These measuring results correspond to the following configurations of the robot:

- Extension: 100% (the robot arm is completely extended horizontally)
- Speed: 100% (the general speed of the robot is set as 100%, and the robot moves at a joint speed of 180 °/s)
- Payload: a maximum payload (12kg) that can be handled by the robot connected to TCP.

The Joint 0 test was carried out by performing a horizontal movement, where the rotational axis was perpendicular to the ground. During the Joint 1 and Joint 2 tests, the robot followed a vertical trajectory, where the rotational axes were parallel to the ground, and the stop was performed while the robot was moving downward.

	Stopping distance (rad)	Stopping time (ms)
Joint 0 (base)	0.21	350
Joint 1 (shoulder)	0.21	350
Joint 2 (elbow)	0.21	350

D Reference Standards

The robot is designed by using the following standards for reference:

Standard	Definition
2006/42/EC:2006	Machinery Directive: Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)
2004/108/EC:2004	EMC Directive: Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC
EN ISO 13850:2008	Safety of machinery: Emergency stop - Principles for design
EN ISO 13849-1:2008	Safety of machinery: Safety-related parts of control systems - Part 1: General principles of design
EN ISO 13849-2:2012	Safety of machinery: Safety-related parts of control systems - Part 2: Validation
EN ISO 12100:2010	Safety of machinery: General principles of design, risk assessment and risk reduction
EN ISO 10218-1:2011	Industrial robots: Safety Note: Content equivalent to ANSI/RIA R.15.06-2012, Part 1
ISO/TS 15066: 2016	Safety requirements for collaborative industrial robot Robots and robotic devices —Collaborative robots

E Technical Specifications

Robot type	EC612
Weight	31kg
Maximum payload	12kg
Reach	1304mm
Joint speed	120 °/s to 224 °/s
TCP speed	1m/s
Repeated positioning accuracy	0.03mm
Control box IO	16 digital in, 16 digital out, 2 analog in and 4 analog out
Tool IO	2 digital in, 2 digital out, 1 analog in and 1 analog out
IO power supply	The control box is 24V 2A, and the tool end is 24V 0.8A
Communication with control box	TCP/IP 100Mbit, IEEE 802.3u, 100BASE-TX, compatible with Modbus TCP. RS485, compatible with Modbus RTU.
Tool Communication	RS485
Protection class	IP54
Typical power consumption	500W
Temperature	0-50 ℃
Power supply	85-265VAC，50-60Hz 18-72VDC
Anticipated service life	25000 hours

F Alarm Information and Description of Routine Problems

See the detailed instructions of the control system for the alarm information.

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