华士科技
HWASHI TECHNOLOGY

User Guide

Of 6 DOF Robotic Arm Controller

V2.2

2019.02

WWW.HWASHI.COM
www.googoltech.com

Copyright Statement

It is dangerous to get close with the machine when the machine is in operation. User should prepare plans to tackle the out of control situations. Precautions should also be made during operation. Googol Technology will not be responsible for any loss due to the damage caused by the use of the product.

Statement

Googol Technology reserves the right to modify the product and its properties without any notice in advance.

Technology will not be responsible nor compensate for any direct, indirect, consequential or liability damage caused by improper use of the product.

Contact Us

Googol Technology (HK) Ltd.

Address: Unit 1008-09, 10/F C-Bons International Center, 108 Wai Yip Street, Kwun Tong, Kowloon, Hong Kong

Tel.: +(852) 2358-1033

Fax:+ (852)2719-8399

E-mail: hkgoogol@gmail.com/ sales@googoltech.com

sales2@hwashi.com

Googol Technology (SZ) Ltd.

Address: Room W211, IER Building (PKU-HKUST High-tech Industrial Park, Nanshan District, Shenzhen, PRC (Postal Code: 518057)

Tel.: +(86) 755-26970817, 755-26970824,

Fax: +(86) 755- 26970821

E-mail: googol@googoltech.com

Web: www.googoltech.com.cn

WWW.HWASHI.COM

Googol Technology (TWN) Ltd.

Address: 7F-3, No.97, Sec. 3, Taichung Port Road, Xitun Dist., Taichung City 40755, Taiwan.

Tel.: +886-4-2358-8245

Fax: +886-4-2358-6495

E-mail: twinfo@googoltech.com

sales2@hwashi.com

Compulsion

- This manual explains the teaching, playing, programming, document editing operation, task management of the robotic arm electric control box in detail. Please read it carefully and make sure you understand before operating the robotic arm.
- For general items of safety, there is detailed description in "Chapter 1 Safety". Please study and familiarize yourself with it so that you can operate it properly.

Attention

- In order to explain in detail, the protection cover in some of the diagrams is removed. Please do make sure to put them back at their original position and then operate the machine according to the manual.

Security consideration

Please study and understand the manual and other attached information and make sure that you understand all the device knowledge, security knowledge and consideration before use (installation, operating, maintenance, overhauling).

The security considerations are classified as "Danger", "Attention", "Compulsion", and "Forbidden".

Danger	Maloperation may cause death or serious injury.
Attention	Maloperation may cause medium injury, minor wound or damage.
Compulsion	Matters that must be observed.
Forbidden	Matters that are forbidden.

Even for "Attention" items, serious consequence may occur depending on the situation. User should therefor pay attention and observe all of them.

Important	Items that do not fit "Attention" or "Danger" content. However, users must obey these for safe and efficient operation. They will be elaborated in the related sections.

Danger

- Before operating the robot, press the emergency button on the front door of the robot electric control box and make sure the servo power is disconnected (The green indicating light on the electric control box panel will go off). The purpose is

to make sure that the button works properly.


Emergency stop button

Under emergency situation, injury or device damage may occur if the robot can't be braked in time. The Emergency stop button is at the right side of the robot control box front door.

- The accident that caused emergency stop has to be got rid of before re-connecting the servo power.


Emergency status release

Robot action maloperation may cause injury.

- Please observe the following matters when teaching within the robot action range

  ✓Observe the robot from the front;
  ✓Obey operation procedures;
  ✓Know how to react when the robotic arm suddenly moves towards the user.
  ✓Make sure there is a dodging place just in case.

Robot action maloperation may cause injury.

- Please make sure there is no person within the robot action range, and the operator is in a safe location when performing the below operations:

  ✓Connecting power to the robot control box;
  ✓Operating the robot with handheld operation teaching device;
  ✓Testing motion of the robot;
  ✓Automatic playing.

Injury may occur when people fall into the robot action range and have contact with the robot. In addition, the emergency stop button must be pressed immediately in case any abnormal situations occur.

Attention

- Check the below matters before performing the robot teaching operation. Repairing or other measures should be taken in case of abnormality

  ✓Check if there is any abnormal action of the robot
  ✓Check if there is damage to the external wire covering and external packing.

- User must understand the "Warning signs" of "Robot electric control box user manual before operating the robot.

Common vocabulary definition in this book:

"GRB4016" is the trade name of Googol Technology industrial robot.

"GRB4016" consists of **robot body** and **robot electric control box**.

Table of Contents

Chapter 1 Safety

1.1 Safety assurance

The requirements for robotic arm, which include large range special motion, quick manipulation, quick motion of the arm, is different from other mechanical devices, and these may cause potential safety hazard.

Users are thus urged to read and understand the manual and other related documents, follow the rules and procedures in order to avoid equipment accidents and injuries. Users have the responsibility to ensure that the robotic arm is operated under a safe environment, and follow the national and local laws and regulations.

Compulsion

- The following rules must be observed for the teaching maintenance of the robotic arm

  ✓Law related to industrial safety and health;
  ✓
  ✓Compulsive order of industrial safety and health related law
  ✓Corresponding regulation of industrial safety and health related law

- Prepare

  ✓Safety technical regulation
  Safety management should be implemented according to the related policy.

- Observe

  ✓Safety operation of industrial robot (ISO 10218)

- Supplement

  ✓Safety management system
  Assign authorized operator and safety management personnel and provide additional safety education

The job of teaching and robot maintaining is classified as "**Dangerous operation**" under industrial safety and health law.

1.2 Specialized training

Compulsion

- Teaching and robot maintaining personnel must be trained beforehand.

  For more information regarding training please contact Googol Technology.✓Safety

operation of industrial robot (ISO 10218)

1.3 Safety precautions for operators

There is potential danger within the maximum motion ranger of the robot.

All related personnel (Safety administrator, installation personnel, operator, maintenance personnel etc.) must bear in mind that "**Safety is the first priority**" to carry out the related operation with the prerequisite of the safety of other people.

Attention

- Any dangerous operation should be forbidden within the installation site of the robot.

  Injury may occur if the robot and its peripheral equipment is touched randomly

- Please take strict safety precautions by putting related warning signs such as "Inflammable", "High voltage", "No admittance" in the factory area.

  Ignoring these warnings may cause fire, electric shock or injuries from touch the robot and other equipment randomly

- Strictly observe the following clauses

  ✓Working clothes must be worn (no baggy clothes);
  ✓No gloves should be worn when operating the robot;
  ✓No underwear, shirt or tie should be exposed from the working clothes
  ✓No big jewelry such as ear ring, ring or pendant, etc. should be worn.

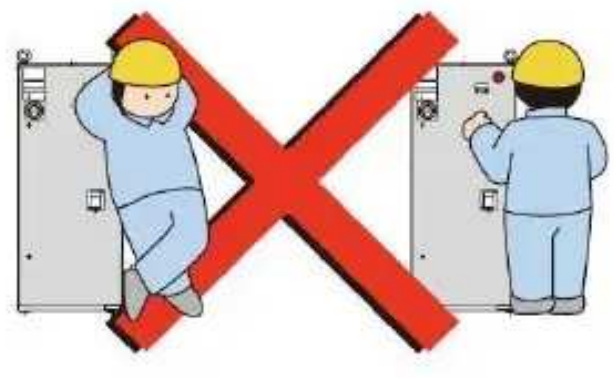
  Related safety protective equipment such as safety helmet, safety shoes (anti-slippery), mask, protection goggles and gloves can be worn if needed.

- Unauthorized personnel are not allowed to get close to the robot and its peripheral auxiliary equipment

  Not observing this reminder may get injured from touching robot electric control box, workpiece, positioning device etc.

- Never flip the axis of the **robot** by force.

  Otherwise injury may occur or the equipment may be damaged.



- Do not lean against the **robot electric control box;** do not touch the operating keys

randomly.

Otherwise the robot may produce unpredictable motion and it can cause personal injury and device damage.

- Non-staff are not allowed to touch **the robot electric control box** during operation.

  Otherwise the robot may produce unpredictable motion and it can cause personal injury and device damage.

1.4 Safety precautions of robot

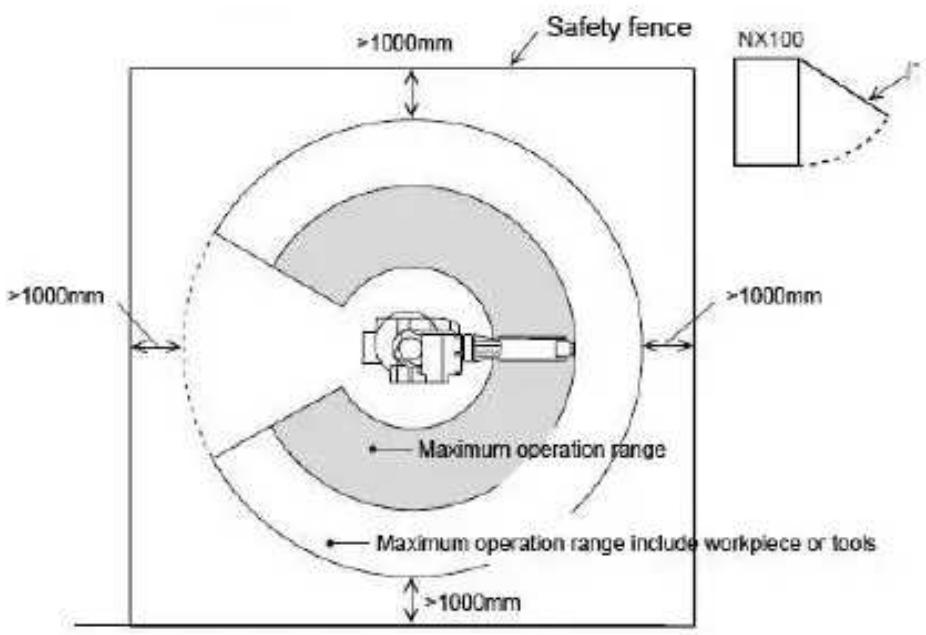
1.4.1 Installation and wiring safety

During planned installation, please make measures to ensure safety. Please observe the following items during installation:

Danger

Select an area to install the robot. Do make sure that the area to big enough such that the robot with tools will not touch the wall, safety bar or electric control box when it turns.

Otherwise the robot may produce unpredictable motion and it can cause personal injury and device damage.



- Electric device standard and inner wires rules and regulations need to be observed for earth work.

  Otherwise there is danger of electric shock and fire.

Attention

- Only authorized personnel are allowed to operate crane, lifting tools or forklift.

Otherwise it may cause personal injury or equipment damage.

- When lifting the robot with crane, please make sure to use the ring of steel cable to fasten the **robot** and make sure its position remain vertical.

  Otherwise it may cause the robot to topple and result in injury or equipment damage.

- When lifting **the robot electric control box**, please check the following items:

  ✓When lifting **the robot electric control box**, make sure it is fastened firmly to the ringbolt, then use a crane to lift it with steel cable. Also make sure the steel cable is strong enough to bear the weight of the electric control box;

  ✓Make sure the ringbolt is fixed and firm

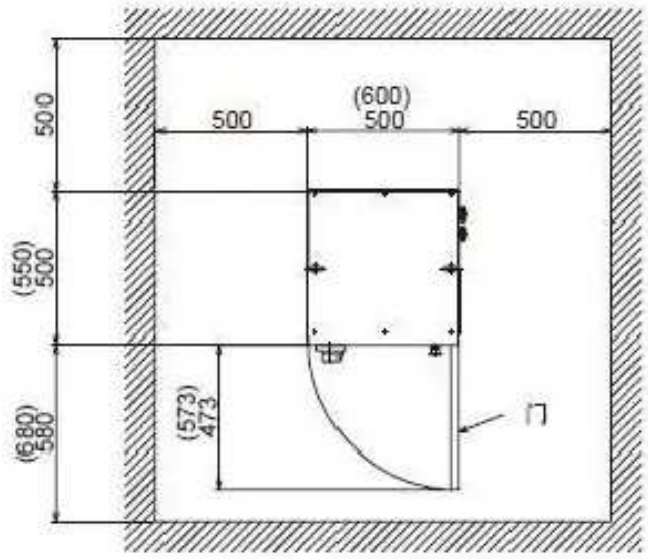
  Otherwise it may cause injury or equipment damage.

- If **the robot** needs to be left in a venue temporarily, please make sure the floor is firm and non-staff cannot touch it.

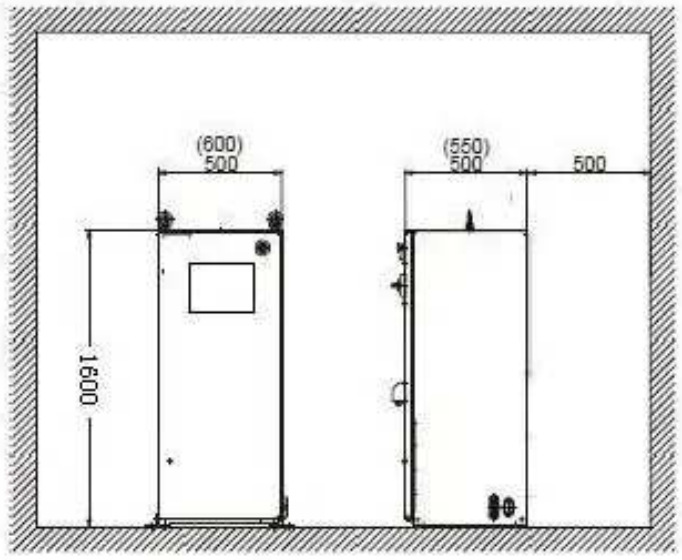
  Otherwise it may cause injury or equipment damage.

- Make sure there is enough room to repair the robot, electric control box and other peripheral equipment.

  Otherwise injury may occur during repairing



Safety distance (mm)



Appearance dimension (mm)

- **The robot** is controlled via **the electric control box**.

  To ensure safety, please manipulate it at a position where one can view the robot. Manipulating by unauthorized personnel may result in injury or equipment damage.

- **The robot electric control box** should be installed outside the safety bar of **the robot**'s motion range.

  Otherwise it may touch the robot and result in injury or equipment damage.

- For different type of robot, different sizes of screw bolt and type should be used to install the robot according the specification in the user manual.

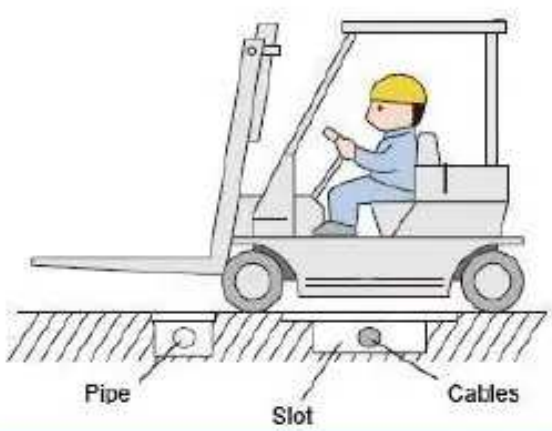
Otherwise it may cause injury or equipment damage.

- Familiarize with the wiring diagrams before wiring. Wiring should be carried out according to the wiring diagrams

  Wrong wiring or improper displacement of part will result in equipment damage or personal injury.

- Protective measures should be adopted when wiring and piping of **the robot electric control box**, **the robot** and peripheral equipment are carried out. Wires, pies and cables should be embedded in the pit or covered by protection cap to prevent them from being stepped or rolled over by folklift.

  Operator and other personnel may be tripped by open wire, cable or pipe and cause damage. It may result in abnormal motion of the robot and cause injury or equipment damage.



1.4.2 Operating zone safety

Serious accident may occur from careless operating in the working area. The following preventive measures are thus enforced:

Danger

- Safety bar should be set up around **the robot** to prevent body contact with the robot when it is power on. A warning sign of "Keep away from the operating zone" should be posted up at the entrance of the safety bar. A reliable safety interlocked must be installed at the door of the safety bar.

  Ignoring this warning will result in serious accident from touching the robot.

Attention

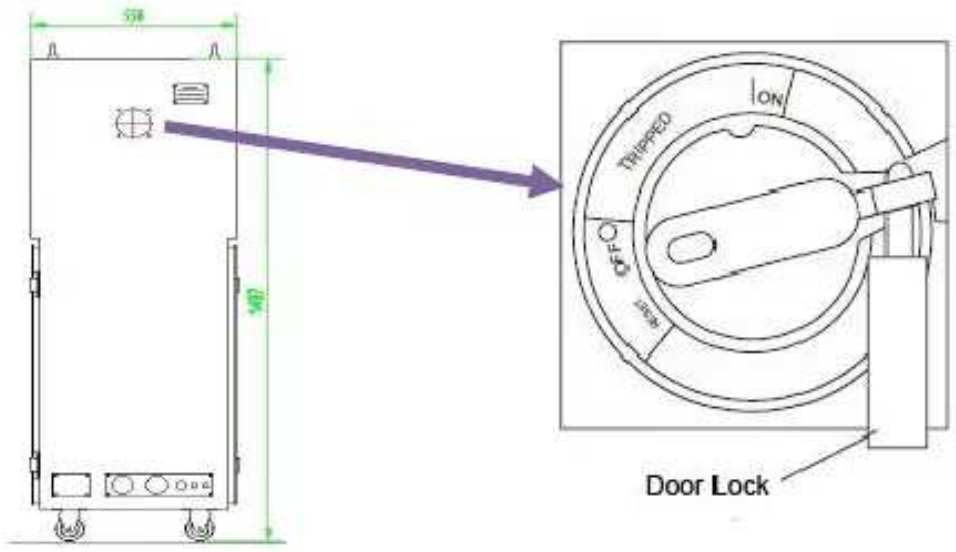
- Spare tools should be placed at appropriate area outside the safety bar.

  Do not leave tools and scattered equipment around the robot, electric control box or system (such as welding fixture). If the robot hit these articles, it may cause injury or equipment damage.

1.4.3 Operating safety

Danger

- Do turn off and lock the power of the electric control box and installed tools and hang a warning sign when installing a tool on the robot.



When power is on during installation, it may cause electric shock and abnormal motion of the robot, thus result in injury.

- Never pass the allowed range of the robot (Please refer to the technical specification part of the user manual for the allowed range of the robot).

Otherwise it may cause injury or equipment damage.

- If possible, always carry out the teaching work outside the operating zone.
- When having teaching work within the motion range of the robot, the following warnings should be observed:

  ✓Always observe from the front of the robot;
  ✓Always operate with the pre-established programs;
  ✓Always have a dodging plan in case the robot has an unpredictable move;
  ✓Ensure that there is an escape path in case of emergency.

  Otherwise injury may occur due to misoperation of the robot.

Attention

- Implement the following checking steps before robot teaching and correct the problem if any is found. Make sure other must done preparation work is ready:

  ✓Check the problems regarding robot motion;
  ✓Check if the isolation of external cable and protection cap are damaged.

Compulsion

- Robot operators and related personnel must receive associated regulations and

company strategy training.

1.5 Attentions items for moving and transferring the robot

The following safety precautions should be observed when moving and transferring the robot.

Attention

- Make sure the robot user manual accompanies the robot when it is moved or transferred.
- Please ask professional personnel to take part in the instruction of operation when moving or transferring the robot. Please ask professional personnel to take part in the instruction of operation when moving or transferring the robot.

Forbidden

- Do not make any alternation to the robot or electric control box.

  Not observing this warning may result in fire, power failure or operation error. It will cause equipment damage, personal injury and death.

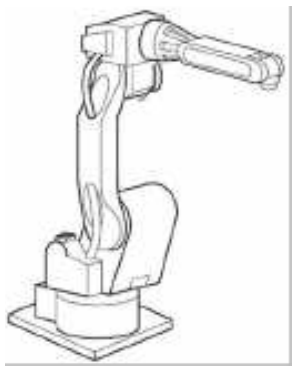
Chapter 2 Product Confirmation

2.1 Box content confirmation

Please check items against the packing list after receiving the product. Standard packing list includes the following items: (The optional items messages will be provided separately)

- Robot body
- Robot electric control box
- Control pendant
- Power supply cable (cable between robot and electric control box)
- User CD

Robot electric control box



Robot body

Control pendant

Power supply cable

User CD

Chapter 3 Installation

3.1 Transportation method

Attention

- Crane, lifting tool and folklift should be operated by authorized personnel.

  Otherwise it may cause injury or equipment damage.
- Shaking, dropping and impacting of **the robot electric control box** should be avoided during its transportation.

  Excessive vibrating or impacting of the electric control box will have detrimental effect on its performance.

3.1.1 Moving of the electric control box and robot body

Please check the following items before moving the electric control box:

✓ Confirm the weight of **the robot electric control box**, use a steel cable that has a larger load capacity than that of the weight of **the robot electric control box** for lifting.

3.1.2 Moving of the robot and electric control box with forklift

Please observe the following preventive measures when moving **the robot** and **electric control box** with forklift:

✓ Make sure there is a safe operating environment such that the electric control box can be safely moved to the installation site.
✓ Inform staff who are working in the travelling area of the folklift to pay attention to the moving **electric control box**.
✓ Avoid displacing or toppling of t**he electric control box** when moving it.
✓ Try to lower the height position of **the electric control box** when moving it.
✓ Avoid shaking, dropping or impacting **the electric control box**.

3.2 Installation site and environment

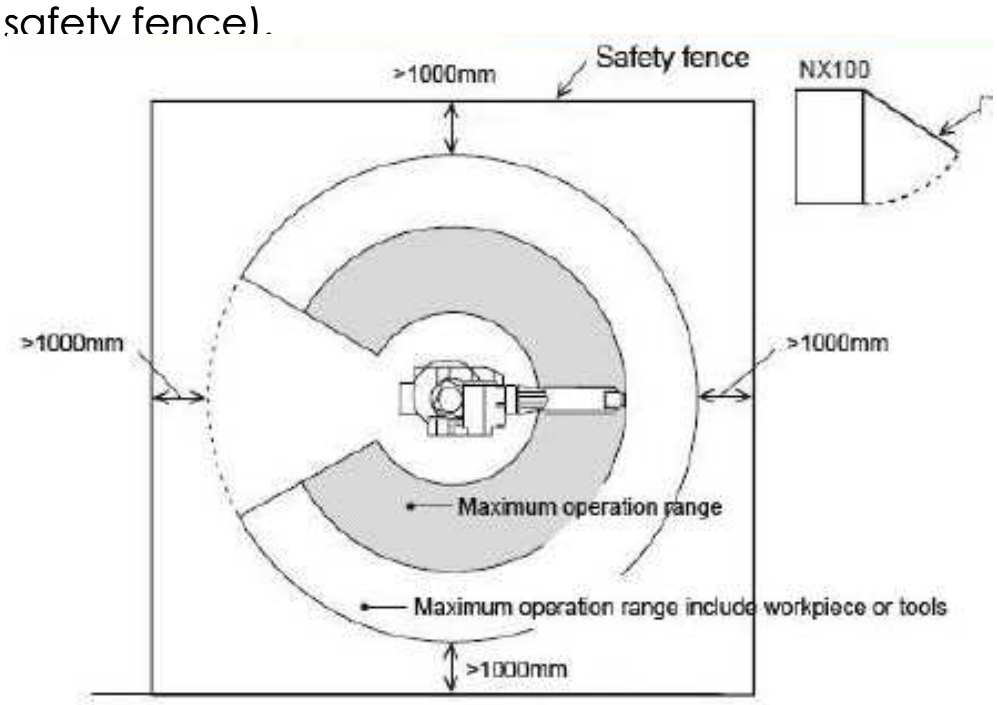
Make sure the installation site satisfies the following conditions:

✓ Environment temperature during operating should be 0° to 45° C (32° to 113° F); It should be -10° to 60° C (14° to 140° F) during moving or repairing;
✓ Humidity should be lower than the dew point (Relative humidity lower than 10%);
✓ Site with low dust, ash, fume, and water;
✓ Inflammables and corrosive liquids and gases are not allowed in the operating zone;

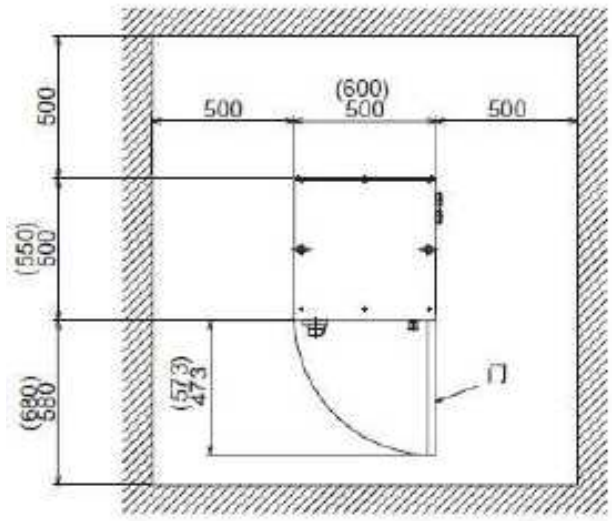
- ✓ Site with low vibrating or impacting to the electric control box. (Vibrating less than 0.5G);
- ✓ No big electrical noise source around
- ✓ No potential danger of moving device (such as folklift) bumping.

3.3 Installation position

- **The electric control box** should be installed outside the robot motion range (outside the safety fence).



- **The electric control box** should be installed at a position where the movement of the robot can be viewed.
- **The electric control box** should be installed at a position where its door can be opened conveniently for checking.



- **The electric control box** should be installed at least 500mm from the wall so that the repair passage is unobstructed.

Chapter 4 Wiring

Danger

- System must be connected to the ground electrically.

  If the equipment is not grounded, fire or electric shock may occur and cause injury.
- Main power has to be turned off before the system is grounded.

  Otherwise it may cause electric shock and injury.
- Do not touch the base boards of **the electric control box** within 5 minutes after power is cut off.

The capacitors will store the electrical energy after power is cut off. User should be careful when operating the base boards. Ignoring the warning may result in electric shock.

- Power cannot be turned on when the door is not closed. (The safety interlocking device prevents power from being turned on.)

  Otherwise it may cause fire or electric shock.
- **The electric control box** is under emergency stop mode during wiring and user is responsible for anything happens.
- Please check operating once after wiring is completed.

  Otherwise it may cause personal injury or mechanical malfunction.

Attention

- Only authorized personnel are allowed to wire.

  Improper wiring may result in fire or electric shock.
- Please wire according to the rated capacity of the user manual.

  Improper wiring may result in fire or mechanical damage
- Please make sure all the circuit connections are secure and firm.

  Loose circuit connection may result in fire and electric shock
- Do not touch the base board directly with bare hands.

  IC base board may be malfunction due to static electricity.

Chapter 4 Wiring

4.1 Main items for cable connection

The cables connecting **the electric control box** and the peripheral devices are low voltage cables; the signal cables of **the electric control box** have to be kept away from the main power circuit. High voltage power circuit should not be parallel to the signal cable of the electric control box. If it is not possible, metal tubes and metal shafts should be used to prevent electrical signal interference; if the cables must be crossed, then the power cable should be perpendicular to the signal cable.

- ✓ Confirm the socket and cable numbers to prevent damage due to wrong connection.

  Wrong connection will result in electronic equipment damage.
- ✓ All non-staff must be evacuated from the site during cable connecting; all the cables should be placed in the capped cable pits under the ground.

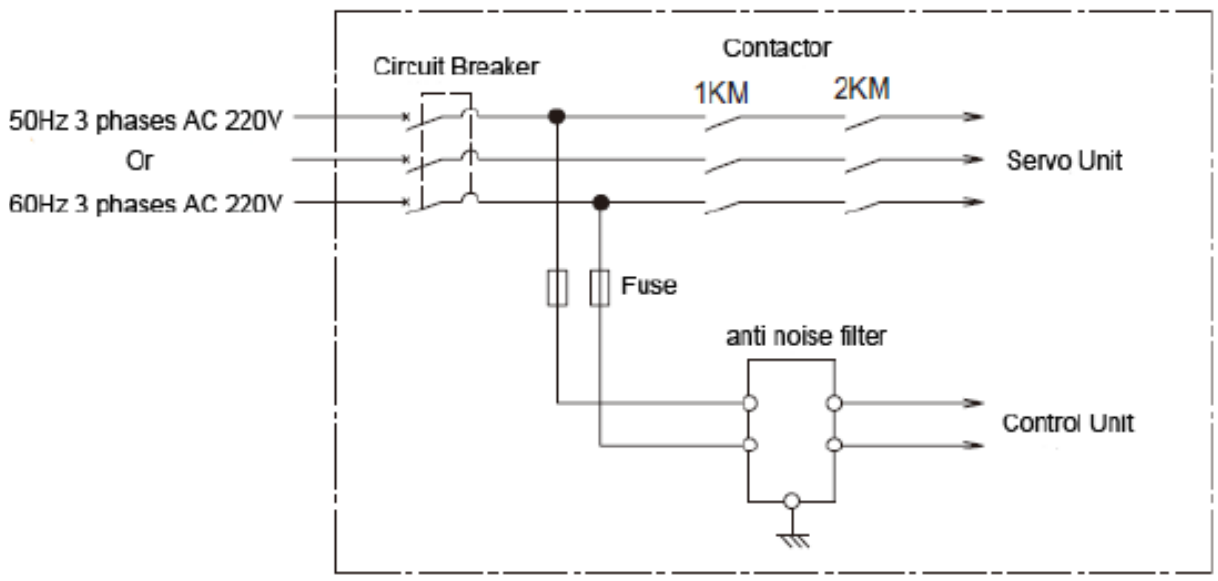
4.2 Power supply

4.2.1 Three phases power supply

Three-phase power supply is made up of AC 200V, 50Hz or AC 220V, 50Hz/60Hz.

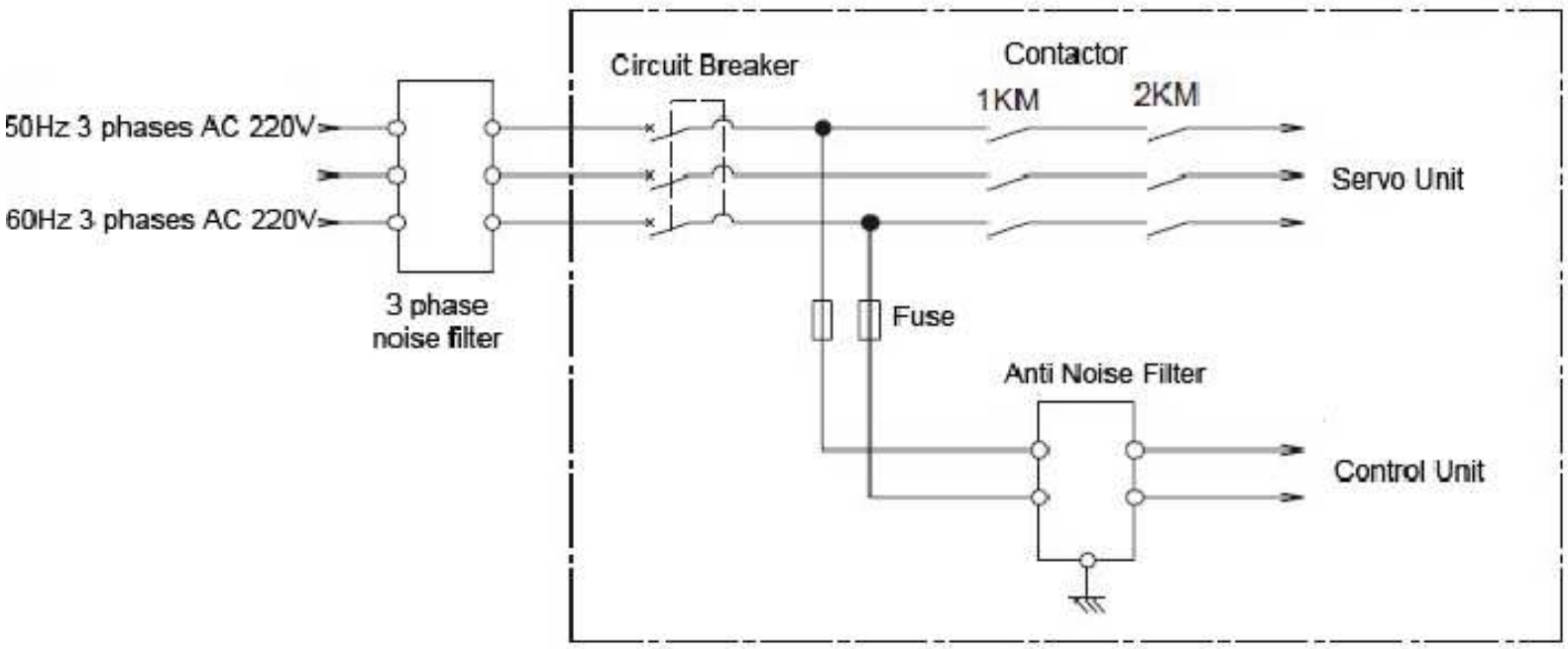
When there is temporary power frequency interruption or voltage drop, the power failure processing circuit will cut off the servo power supply.

Connect the electric control box to a stable input power supply (small voltage fluctuation).



Wiring of Power Input

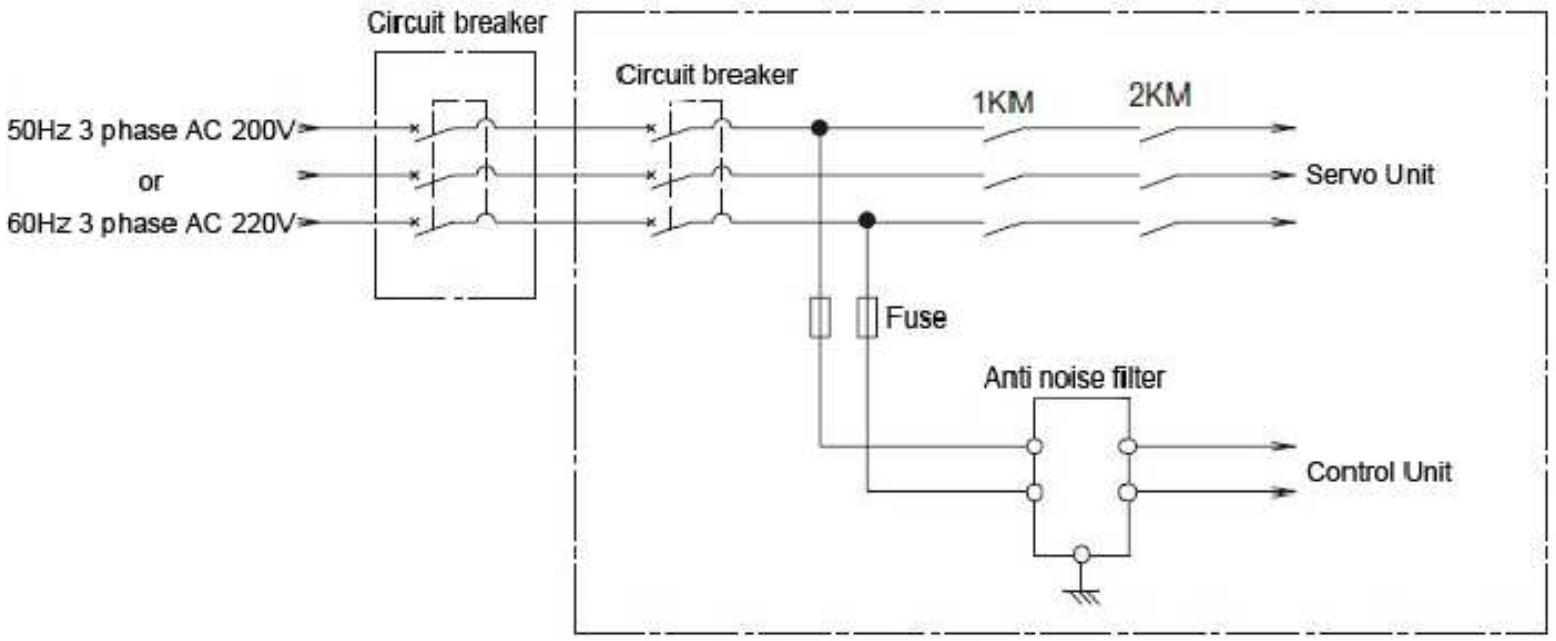
4.2.2 Installation of 3 phase noise filter



Wiring of Power Input with noise filter

4.2.3 Installation of circuit breaker

If circuit breaker is connected to the power supply of **the electric control box**, it should be able to block high frequency as it can prevent error action due to high frequency residual current of the rectifier.



Connection of circuit breaker

Chapter 5 Handheld Operation Teaching Device

This chapter introduces the layout of robot handheld operation teaching device and the function of the keys.

5.1 Handheld operation teaching device layout picture

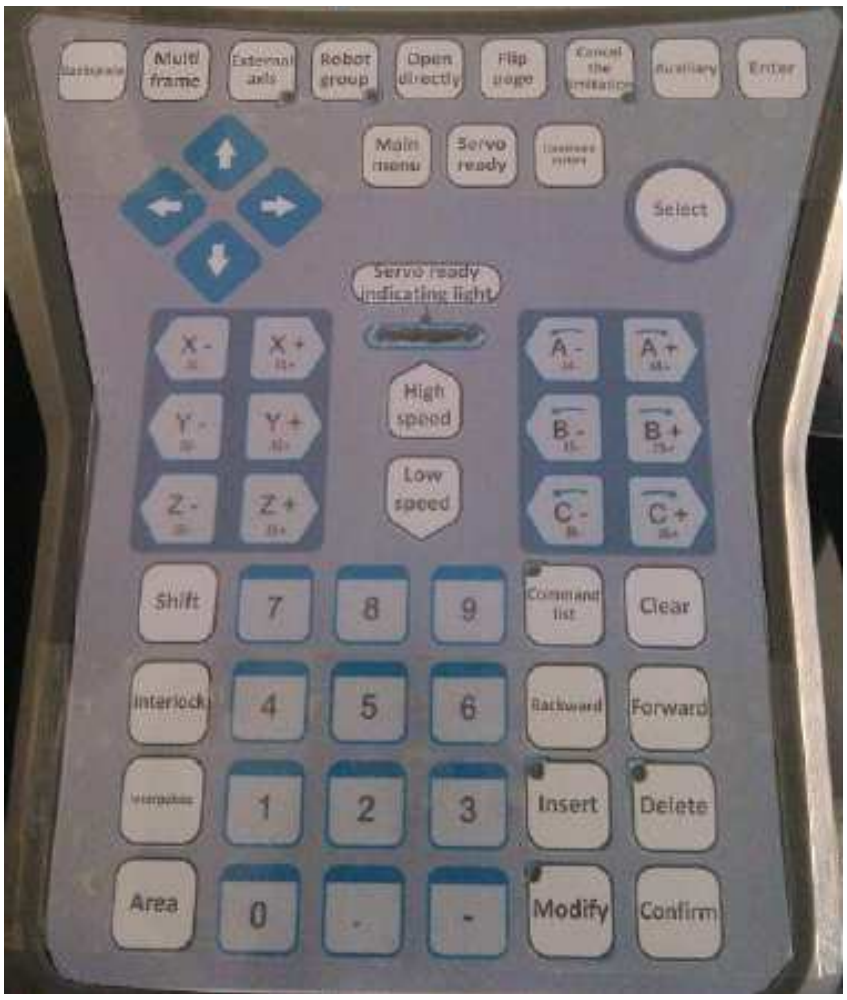


Figure 1 GRP2000 Teach Pendant

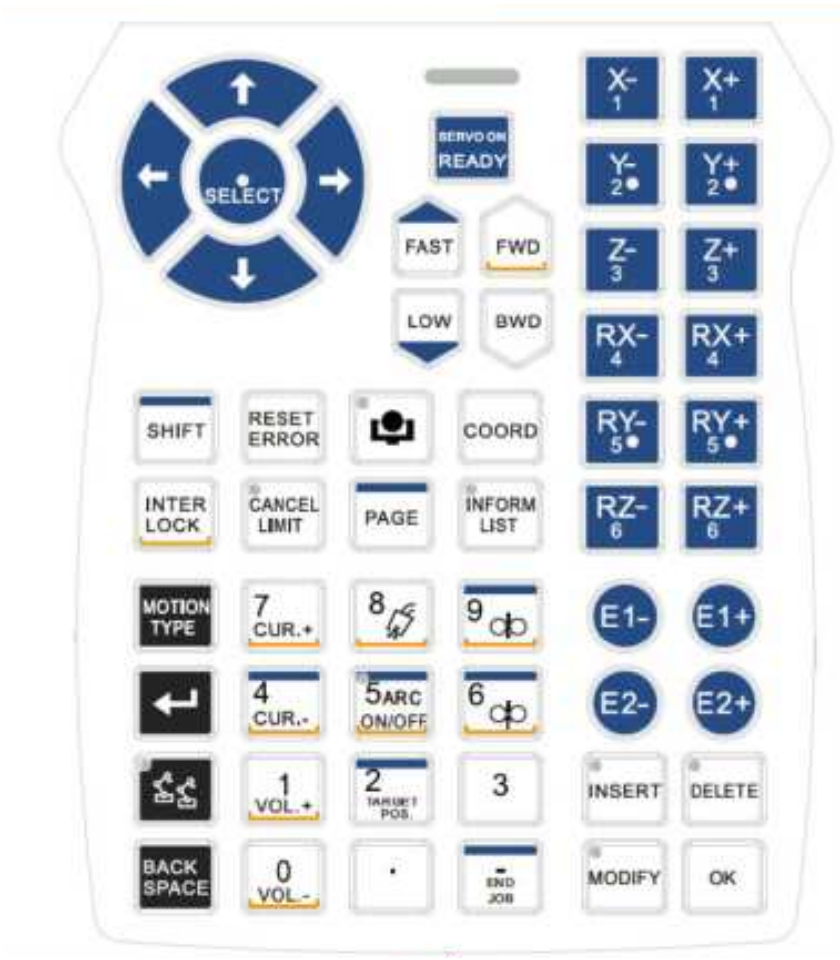


Figure 2 GRP4000 Teach Pendant

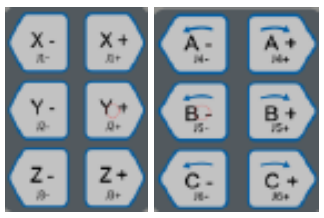
5.2 Key (button or knob) function

5.2.1 Meaning of keys (button or knobs)

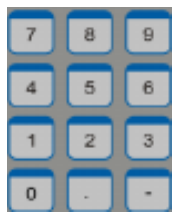
1 【】is used to represent the keys on the handheld operation teaching device: e.g. 【Emergency stop】key means the key for emergency stop.

Movement keys  are represented by 【Move up】, 【Move down】, 【Move left】, 【Move right】keys respectively.

2 For multiple key names such as axial operating key and numeric key, they are called axial operating keys and numeric keys respectively.



Axial operating keys

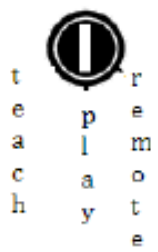


Numeric keys

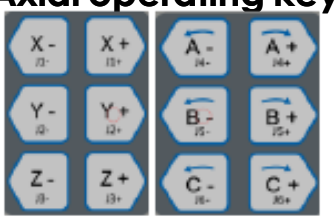
3 Multiple keys pressing: Press two keys simultaneously are represented by 【Shift】+【2】.

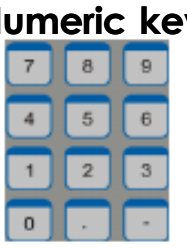
4 {} means interface key: e.g. {JOB} means JOB keys

5.2.2 Key (buttons or knobs) function description

ID	Key	Function
0	**Emergency stop button** 	**Press this key to cut off the servo power supply.** After the servo power supply is cut off, the 【Servo ready indicating light】goes off and it shows emergency stop message on the screen. After troubleshooting, release the emergency stop button so that power can be turned on again. Servo power cannot be turned on after the button is pressed. Release the emergency stop button: Rotate clockwise until it pops up. It means the 【Emergency stop button】 is released.
	Mode knob 	teach: Teaching mode The handheld operation teaching device is used for axial operating and editing (When it is in this mode, operating signal transmitted by external equipment is invalid.) play: Playing mode To play the finished teaching programs. remote: Remote mode To start the teaching program operation via external

		TCP/IP protocol and I/O.
		**Press this button and the robot will start the playing operation.** Playing mode in operation and the indicator light is on. When the robot start in play operation via the starting signal of dedicated input, the light will be on. The mode know has to be set to playing mode before pressing this button; make sure the handheld operation teaching device【Servo ready indicating light】is on.
		In teaching mode: The light will be on when the button is pressed. The robot cannot perform axial operation. In playing mode: It will enter the hold mode after the button is pressed. The light is on and the robot is in hold status. Press the【START】  button and the robot will continue to operate.
	Deadman / 3 stage switch 	**Press this button and the servo power is on.** The mode knob should be set at teach mode before operating→Click the 【Servo ready】key on the handheld operation device (【Servo ready indicating light】is in flashing status). If it is gripped tightly, the servo power will be cut off. If the 【Servo ready】key is not clicked, the servo power will not be on even when the【3-stage switch】is gripped softly.
1	**Backspace** 	**For deleting the last character when inputting them.**
2	**Multiple frame** 	Function reserved
3	**External axis** 	**Press this key to control the rotation and tilting of the positioner during welding processing.** When the number of axis that needs to be controlled exceeds 6, press this key (the indicating light of at the lower right corner of the button will be on), controlling axis 1 means controller axis 7, axis 2 means axis 8, and so on.
4	**Robot group**	Function reserved.

		
5	**Movement key** 	**Press this key and the cursor will move in the direction of the arrow accordingly.** **This key group can only be used in teaching mode.** The moving range of the cursor varies according to different screens. The operating of the commands in the submenu can be used to open the next level menu or go back to the previous level menu. Please refer to Section 6.2.3, 6.2.4 for details.
6	**Axial operating keys**  	**They are for manipulating different axes of the robot.** **It only works in teaching mode.** Two or more keys can be pressed concurrently to operate multiple axes. Robot will be operated according to the designated coordinate system and manual speed. Please make sure the preset coordinate system and manual speed are appropriate. Make sure the 【Servo ready indicating light】 is on before operating
7	**Manual speed keys** 	**Robot operating speed setting keys during manual operation.** **It only works in teaching mode.** The preset speed works when using axial operating key and resetting. There are 8 levels of manual speed: micro movement 1%, micro movement 2%, low 5%, low 10%, middle 25%, middle 50%, high 75%, high 100%. 【High speed】micro movement 1%→micro movement 2%→low 5%→low 10%→middle 25%→middle 50%→high 75%→high 100% 【Low speed】high 100%→high 75%→middle 50%→middle 25%→low 10%→low 5%→micro movement 2%→micro movement 1% The preset speed will be displayed in the status area.
8	**Shift** 	**It can be clicked with other keys simultaneously.** **This key only works in teaching mode.** 【Shift】+【Interlock】+【Clear】exit robot control software and enter operating system interface 【Shift】+【2】can view position message of motion command, click again to exit command checking function.

		【Shift】+【4】robot YZ planes automatically go to zero position. 【Shift】+【5】 robot XZ planes automatically go to zero position 【Shift】+【6】robot XY planes automatically go to zero position. 【Shift】+【9】robot can go back to zero position quickly 【Shift】+【Flip page】go back to the previous page in selecting program and program content interface For zero positioning function please refer to zero positioning section.
9	**Interlock** 	**Auxiliary key to be used with other keys.** **It only works in teaching mode.** 【Interlock】**+** 【Forward】 Perform continuous checking of program point trajectory according to program point trajectory in **program content interface**. Realize position variable checking function in **position variable interface**. For specific operation please refer to position variable. 【Shift】**+** 【Interlock】+【Clear】to exit program.
10	**Interpolate** 	MOVJ→MOVL→MOVC→MOVP→MOVS **Toggle key of robot motion interpolation mode** **It only works in teaching mode.** **The selected interpolation mode type is shown in status display area. Please refer to Status display area for details.** **Press the key once and the interpolation mode will change accordingly as below:** MOVJ→MOVL→MOVC→MOVP→MOVS
11	**Area** 	**Press this key to toggle between "Main menu" and "Common display area".** **It only works in teaching mode.**
12	**Numeric keys** 	**The numeric keys can be used to input the value and symbol of the keys.** **The keys must be used in teaching mode.** "." Is decimal point; "-" is minus sign or hyphen. Numeric keys are also used as purpose keys.
13	**Enter** 	**In the OS, pressing this key means confirmation to enter the selected folder or type the selected file.**
14	**Auxiliary** 	Function reserved.

15	**Cancel the limit** 	**Cancellation of range limit when the motion range is out of limit such that the robot can continue its motion.** **The key must be used in teaching mode.** When cancel the limit, the indicating light at the lower right corner of the button will light up. When the motion reaches the limit, the light will goes off. If there is alarm message after callellation of limit, please press the 【Clear】key and wait for the motion to be within the range limit for the next step operation.
16	**Flip page** 	**Press this key to go to the next page of program selection and program content interfae.** **This key must be used in teaching mode.**
17	**Open directly** 	**In program content page, open to view teaching message of motion commands directly.** **This key must be used in teaching mode.**
18	**Select** 	**When operate in software interface menu, "Main main" and "Submenu" can be selected.** **A command can be selected when the command list is operated.** **The key must be used in teaching mode.**
19	**Coordinate system** 	**Movement coordinate system selection of robot during manual operation.** **This mode must be used in teaching mode.** Select among axis, kinematics, world, piece, and tool coordinate system. Press once and the coordinate system will change as below: Axis→Kinematics→World→Tool→Workpiece 1→Workpiece 2. The selected coordinate system will show up in the status area.
20	**Servo ready** 	**Press this key and the servo power will be connected.** In teach mode, when this key is pressed, 【Servo ready indicating light】will flash. Hold the 【3-stage switch】of the handheld operation teaching device and the 【Servo ready indicating light】 will be on. It means the servo power is connected.
21	**Main menu** 	**Display main menu.** **This key must be used in teaching mode.**
22	**Command list**	**Press this key to display the input command list.** **This key must be used in teaching mode.**

		**User should enter program content interface before using this key.**
23	**Clear** 	**Clear "Alarm message of "Human-Machine Interaction message" area.** **This key must be used in teaching mode.**
24	**Backward** 	**Press this key and the robot will operate reversely according to the teaching program point trajectory.** **This key must be used in teaching mode.**
25	**Forward** 	**Press this key and the robot will be operated in single step according to the teaching program point trajectory when it is connected to the servo power.** **This key must be used in teaching mode.** Press 【Interlock】+【Forward】simultaneously and the robot will be operated according to the teaching program point trajectory continuously.
26	**Insert** 	**Press this key to insert new program point.** **This key must be used in teaching mode.** Press this key and the light at the upper left side of the key will light up. Press the 【Confirm】 key, complete the inserting and the light will goes off.
27	**Delete** 	**Press this key and delete the input program point.** **This key must be used in teaching mode.** Press this key and the light at the upper left side of the key will light up. Press the 【Confirm】key, complete the deletion and the light will goes off.
28	**Modify** 	**Press this key to modify the teaching position data, command parameters, etc.** **This key must be used in teaching mode.** Press this key, the light at the upper left side of the key will light up. Press the 【Confirm】key, complete the editing and the light will goes off.
29	**Confirm** 	**To be used with 【Insert】, 【Delete】or 【Modify】 key.** **This key must be used in teaching mode.** When the 【Insert】, 【Delete】or 【Modify】key lights up, press this key to confirm and complete the inserting, deleting or editing.
30	**Servo ready indicating light** 	**【Servo ready】button indicating light.** In teaching mode, press the 【Servo ready】button and the indicating light will flash. Grip the 【3-stage switch】softly and the indicating light will light up indicating that servo power has been connected.

		In playing and remote modes, click 【Servo ready】 button and the light will be on.
31		E1 -/+ Stand for External Axis 1. E2 -/+ Stand for External Axis 2. These keys only can be used in GRP4000 Model Teach Pendant. *User need to set a parameter in 【Setting->Other->Teach Pendant Model】,Select **GRP4000.**

Chapter 6 Teaching Software Interface Introduction

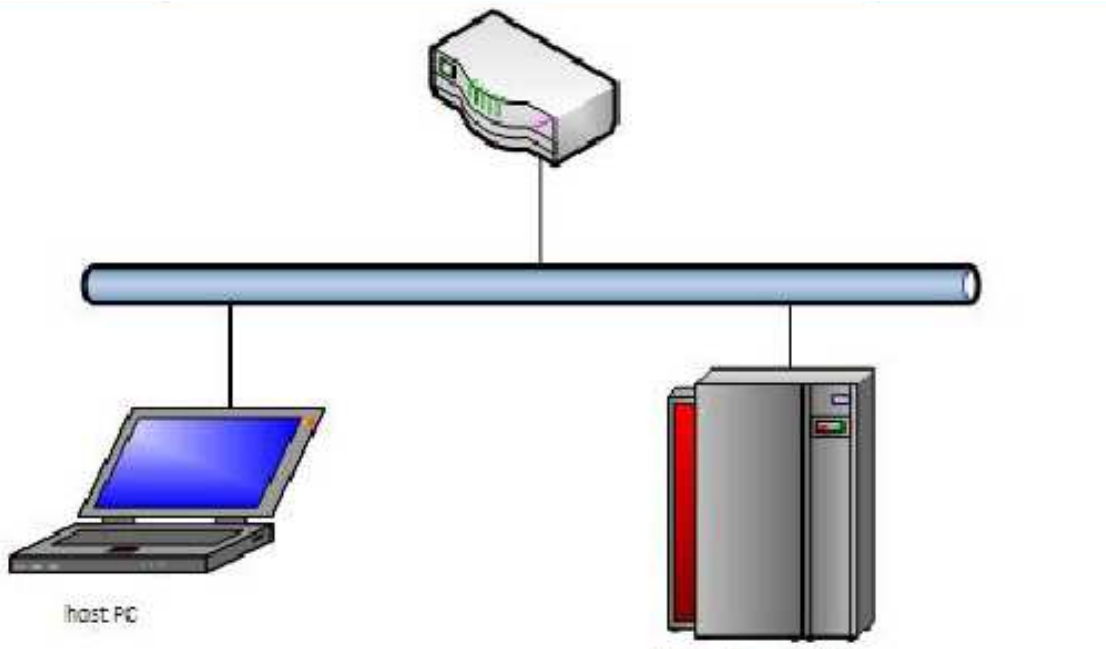
Attention

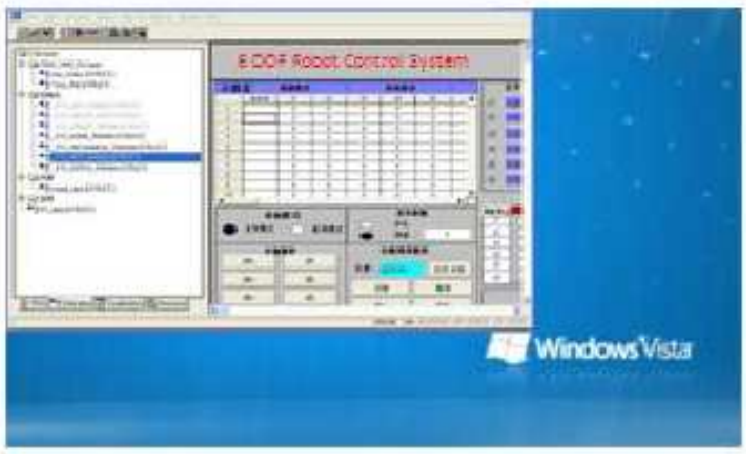
- If development of robot control program is needed, it has to be done on OtoStudio Development platform.

The platform is not free. Please contact Googoltech Technology sales personnel regarding the purchase of this software.

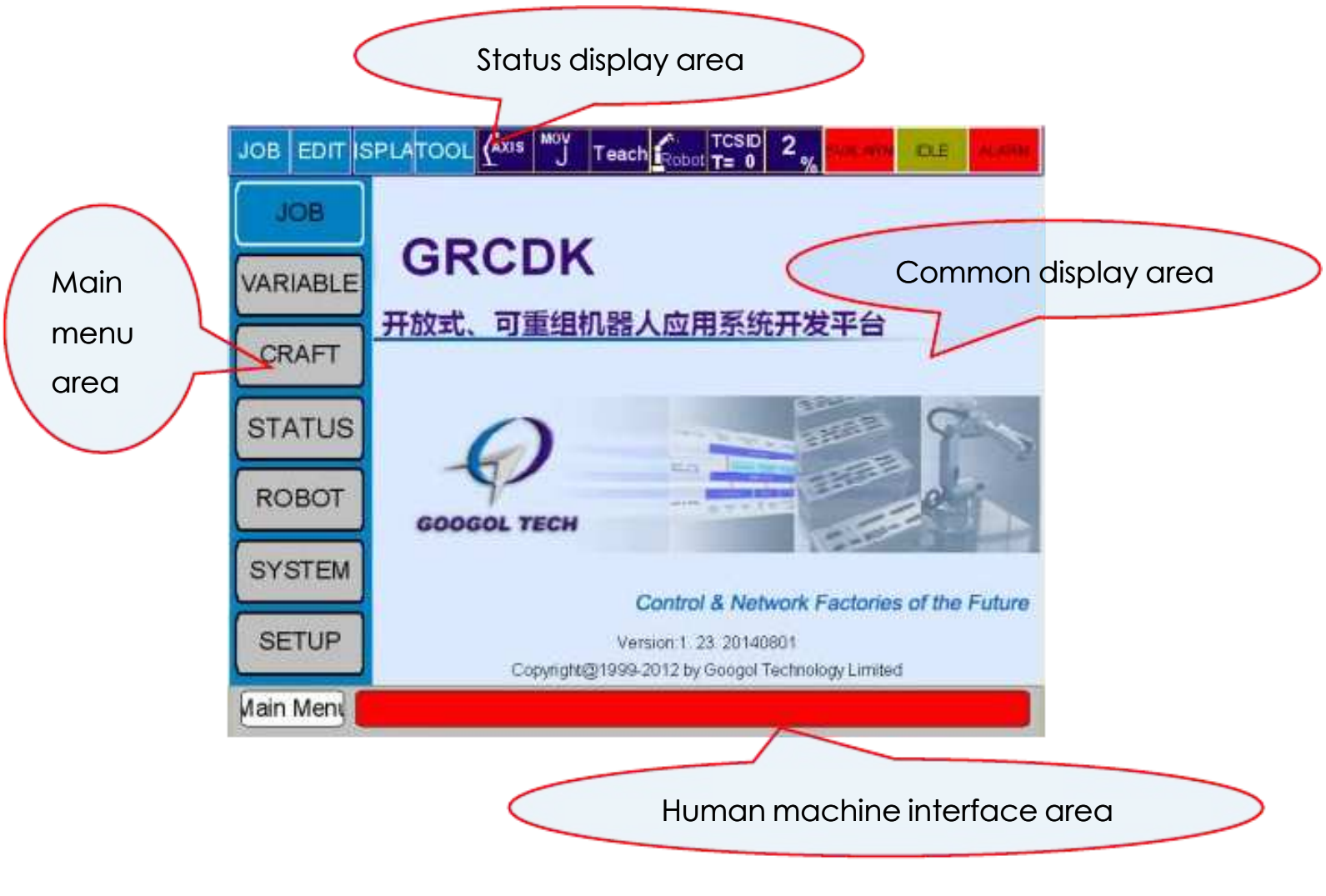
The robot teaching software adopts the OtoStudio Programming Development Platform under Windows OS (WinCE4.2)

The developing mode adopts standard developing mode of WinCE Embedded System: Program is developed in the host PC and the executable programs are downloaded to the target PC (GUC all in one embedded motion controller) via Ethernet.





The starting window of the robot control interface



{} is used to represent the menu, buttons and logos of the interface

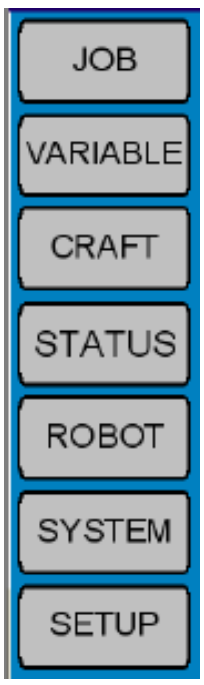
No.	Name of function area	Functions
1	Main menu area	All menus and submenus are displayed in the main menu area. Press the 【Main menu】key on the handheld operation teaching device or click the {Main menu} button of the lower left corner of the interface to display the main menu.
2	Menu area	To enter the program content, tool management function and other operation interface quickly.
3	Status display area	Display the current status of the robot electric control box. The displayed messages vary according to different status of the robot.
4	Common display area	To display and edit program files, setting, etc.
5	Human machine interaction display area	For error and operation prompts or alarm. To display motion speed of robot axial joints and end points in real time when the robot is in motion. ***The default error content is in English for the Chinese or English system. For Chinese system, if the English error***

		message is clicked, it will display Chinese prompt.

6.1 Main menu

6.1.1 Main menu

The main menu area shows every main menu options and its submenu. By pressing the 【Main menu】 key of the handheld operation teaching device or clicking the {Main menu} of the interface lower left part, user can enter the main menu area.



1 Every main menu option and its submenu are displayed in the main menu area.

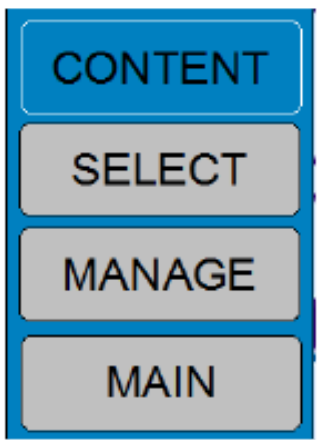
2 By pressing the 【Area】key on the handheld operation teaching device, the user can select **Main menu zone** or **Common display zone** of the area.

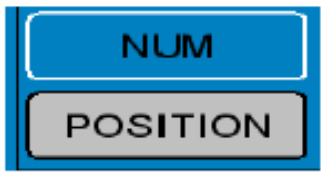
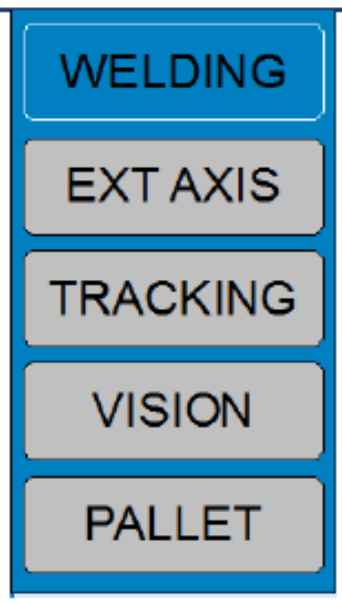
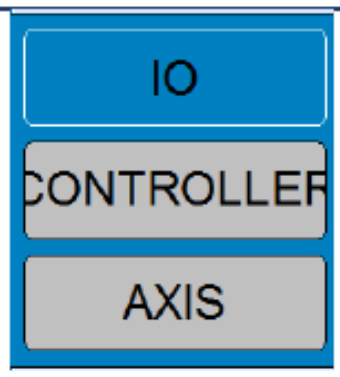
3 Press the 【Move up】or 【Move down】key to move and select the options of the main menu. The selected option will turn **blue**.

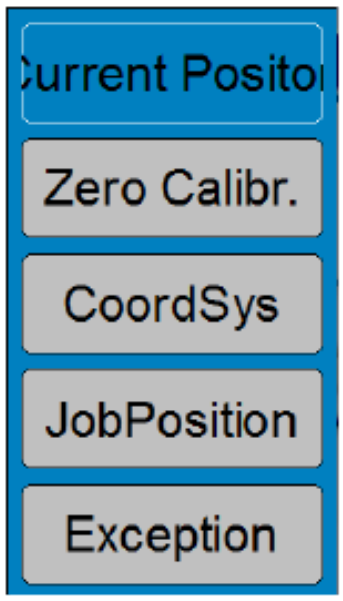
4 After selecting a specific option, press the 【Move left】or 【Move right】key, the submenu will pop up or close.

5 Press the 【Select】key on the handheld operation teaching device to select the submenu and enter the interface.

6.1.2 Submenu and function

No.	Main menu	Submenu	Function
1	JOB		1 CONTENT: Editing display program files; implement operation of program files addition, modifying, deleting; display program file content execution situation, open program 2 SELECT: Select the program file to be operated. 3 MANAGE: Manage the program files such as program file creating, deleting, renaming and copying. 4 MAIN: Setting of main program file. In

			playing mode, the default is opening the set main program when there is no chosen program.
2	VARIBALE		1. When teaching points are inserted via program command list, variable parameters can be inserted too. They are all global variables which can be used in different programs. Initial values of numeric variables can be modified while those of positional variables have to be calibrated. 2 Numeric variable (NUM): Boolean, integer, or real type variables can be used for programming editing. 3 positional variable (POSITION): Calibrating the positional variable for programing file editing purpose.
3	CRAFT		The parameter setting of welding, vision and other manufacturing process. The manufacturing process function calling will be implemented in the teaching program. If the item is for reserved extension function, the button will display in dark grey after it is selected.
4	STATUS		1 I/O status (IO): display status of system I/O and I/O module. 2 Controller axis (CONTROLLER): display active controller axis. 3 Common axis status (AXIS): display the main servo status of the controller.

5	ROBOT		1 Current Position: To display the current position pose of the robot. 2 Zero position calibration (Zero Calibr.): To calibrate the zero position of the robot 3 Coordinate system management (CoordSys): To calibrate and manage world coordinate system, piece coordinate system 1 and piece coordinate system 2. 4 Job Position (JobPosition): To calibrate and manage tool coordinate system. It supports three-point, four-point, and six-point calibration.
6	SYSTEM		1 Administrator: To set the administrator privilege. There is different operation content for different privileges. 2 Alarm History: Check the alarm history status of the robot. 3 Version: Check the version message of the main control software and its function module.
7	SETUP		1 Axial joint parameter (Joint Para): To set the parameters of the axial joint space such as change the axial joint speed, acceleration, range limit, etc. 2 Cartesian parameter (Cartesian Para): To change the Cartesian space parameters: speed, acceleration, range limit, etc. 3 Cp parameter (Cp Para): To change the Cp parameter: speed, acceleration, range limit, etc. 4 DH parameter (DH Para): To change the DH model parameter and robot model. 5 Axial control configuration (ControlConfig): To change the robot control axis parameter. 6 Other parameter (Other): To change the robot application parameter, communication IP, port, device name, etc.

6.2 Menu

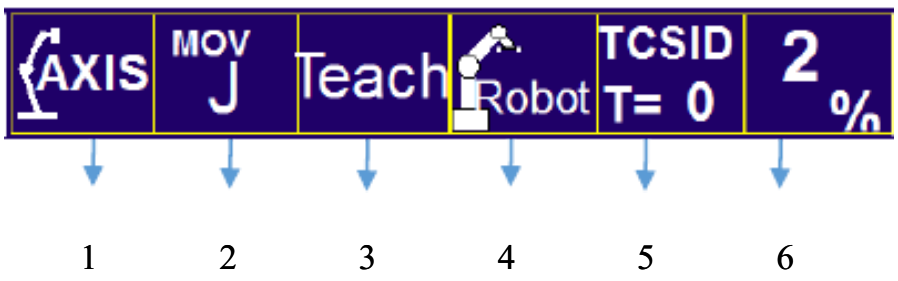
JOB: To enter the program content interface quickly.

EDIt: To edit the program quickly. Please refer the Programming editing for specific operation.

DISPLAY: To display the joint angular velocity, terminal point speed message when the teaching program is running.

TOOL: To enter the tool management interface quickly.

6.3 Status display area



1 Coordinate system display

Display the selected coordinate system. Press the 【Coordinate system】key of the handheld operation teaching device to select.

Axis coordinate system

Kinematics coordinate system

Tool coordinate system

World coordinate system

Piece coordinate system 1 

Piece coordinate system 2

2 Interpolation mode

Display the selected interpolation mode. Press the 【Interpolate】key of the handheld operation teaching device to select.

MOVJ command: axial motion

MOVP command: linear motion

MOVC command: arc motion

MOVL command: linear motion

MOVS command: irregular arc motion

3 Operation mode

Display the operation mode of the robot. Press the Mode knob of the handheld operation teaching device to switch.

Teach: Robot is under teaching operating mode.

Automatic: Robot is under automatic playing operating mode.

Remote: Robot is under remote operating mode.

4 Robot/Positioner

Switch between robot and positioner so that it can be operated via **Axial operating keys**.

5 Current tool number

To facilitate user to confirm the current tool number, there is an 11-elememt tool coordinate system

6 Speed display

Display the selected speed. Press the 【High speed】or 【Low speed】key to select.

Macro speed: 1% of maximum speed

Macro speed: 2% of maximum speed

Slow speed: 5% of maximum speed

Slow speed: 10% of maximum speed

Medium speed: 25% of maximum speed

Medium speed: 50% of maximum speed

High speed: 75% of maximum speed

High speed: 100% of maximum speed

Operating status of robot

Display the operating status of the robot.

Robot is in operating status

Robot is in idle status

Robot is in still status temporarily.

6.4 Common display area

Display the interface content. User can check and edit operation of programs and parameters.

6.5 Human machine interaction area

The human machine interaction area will turn red when there is error message. User can press the 【Clear】key to clear the error, then enter the alarm history interface to check all the past alarm message log.

When the robot is in normal motion operation, the human machine interface area will display the operating speed of the robot.

1.000	10.000	10.000	10.000	10.000	50.000	1600.000

The first 6 items show the 6-joint speed of the robot, the unit is *degree/second*; the last one is the flange terminal cable speed, the unit is *mm/second*.

Chapter 7 Quick Operation Guide

7.1 Servo power connection

Danger

- Make sure there are no people within the action range of the robot when the main power of the electric control box is turn on.

Human injury may occur from accidentally contacting the robot by ignoring this prompt. If any problem occurs, please press the **emergency stop button** immediately. The button is located at the upper left corner of the electric control box front door.

7.1.1 Main power connection

1 Flip the main power switch of the electric control box to the ON position, main power should be connected.

2 Press the green servo start button of the electric control box.

Electric control box

Electric control box panel

7.1.2 Servo power connection

Servo power connection steps are different for teaching mode, playing mode and remote mode.

In teaching mode:
Press the 【Servo ready】 key on the handheld operation teaching device and the 【Servo ready indicating light】will in blinking status. Grip the 【3-stage switch】at the back of the handheld operation teaching device softly, the 【Servo ready indicating light】will be on. Servo power has been connected.

In playing and remote modes:
Press the 【Servo ready】 key on the handheld operation teaching box, the 【servo ready indicating light】will be on. Servo power has been connected.

7.2 Servo power cut off

7.2.1 Cutting off the servo power

The servo power cutting off steps are different for teaching, playing and remote modes.

In teaching mode:
Release or **grip tightly** the 【3-stage switch】at the back of the handheld operation teaching device. The 【Servo ready indicating light】of the handheld operation teaching device will go off, which means the servo power is cut off.

Playing and remote mode:

Press the 【Servo ready】key of the handheld operation teaching device again, the 【Servo ready indicating light】will go off, which means the servo power is cut off.

Press the emergency stop button on the electric control box panel

Once the servo power is cut, it will activate the locking device, the robot will be locked and it cannot perform any operation.

The robot can be put to Emergency stop status in any modes (Teaching, Playing or Remote).

7.2.2 Cutting off the main power

After cutting off the servo power, cut off the main power.

When the main switch on the electric control box side door is flipped to the OFF position, the main power will be cut off. (Below diagram)

7.3 Selection of coordinate system

In teaching mode, select the robot motion coordinate system:

Press the 【Coordinate system】key of the handheld operation teaching device once and the coordinate system will change in the following sequence (Confirm via display of the status area):

Axis→ Kinematics→ Tool→ World→ User 1→User 2

7.4 Manual speed adjustment

In teaching mode, select the robot motion speed:

Press the 【High speed】 or 【Low speed】 key of the handheld operation teaching device once and the manual speed will change in the following sequence (Confirm via speed display of the status area).

- Press the 【High speed】key of manual speed once and the manual speed will change in the following sequence:

  micro adjustment 1%→micro adjustment 2%→low 5%→low 10%→medium 25%→medium 50%→high 75%→high 100%

- Press the 【Low speed】key manual speed once and the manual speed will change in the following sequence:

high 100%→high 75%→medium 50%→medium 25%→low 10%→low 5%→micro adjustment 2%→micro adjustment 1%

7.5 Axial operation

In teaching mode, press the **axial operation key** and each axis of the robot can move to the desired position. The motion of each axis will change according to the selected coordinate system.
Each axis will only move when **the axial operation key** is pressed and held.

Danger

- Please make sure the **emergency stop button** of the robot works properly before operating: Press the **emergency stop button** of the electric control box, the【Servo ready indicating light】goes off showing that the **emergency stop button** works.

  If the robot cannot be stopped under emergency situation, it may cause mechanical damage.

- Please observe the following warning when teaching work is performed within the action range of the robot

  ✓Always observe from the front side of the robot;
  ✓Always operate with the preset operating program;
  ✓Always prepare a dodging plan in case unpredictable action of the robot occurs;
  ✓Always prepare a retreating path in case of emergency situations.

  Improper and careless operating of the robot may cause injury.

- Before implementing the following operations, make sure there is no people within the action range of the robot and you are in a safe location.

  ➢ When the power of the electric control box is connected.
  ➢ When using the handheld operation teaching box to operate the robot.
  ➢ When playing
  ➢ When remotely controlling the robot.

If the robot collides with people entering its action range, injury will occur.

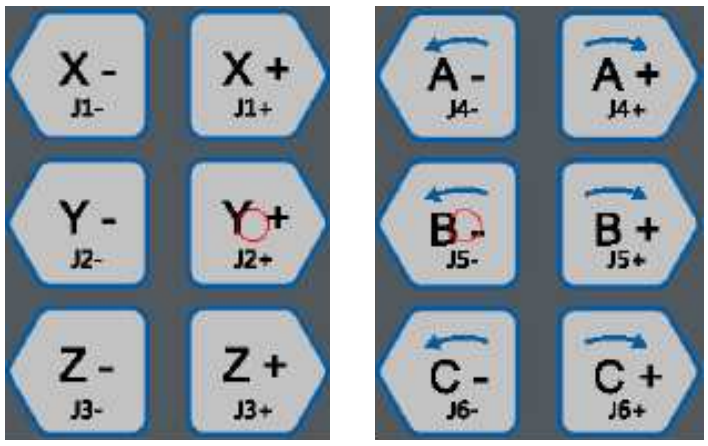
Attention

- Carry out the following checking steps before teaching **the robot**. Correct any found problems immediately and confirm that all the needful tasks are finished.

  ✓ Check if there is any abnormal problems of the robot motions;
  ✓ Check if the external insulator and cover of the cables is damaged.

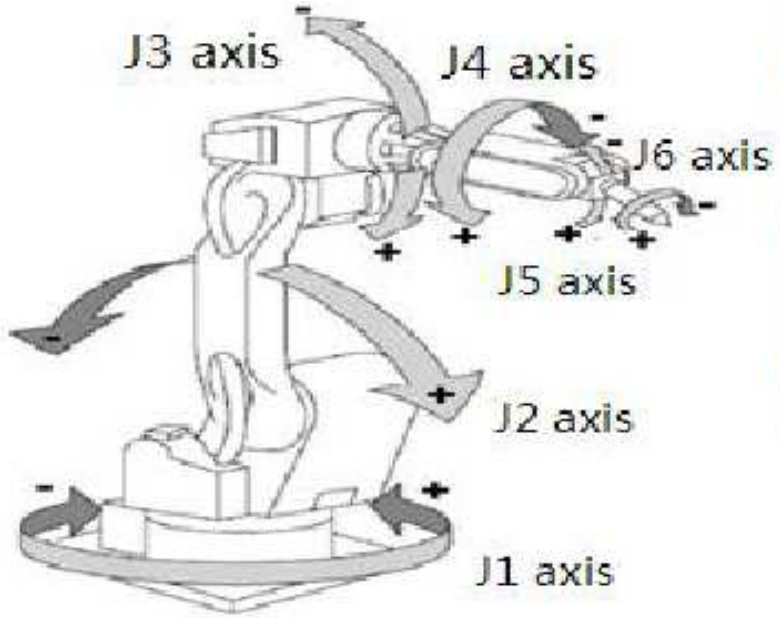
After connecting to servo power (After press the 【Servo ready】 key, grip and hold the【3-

stage switch】key and the servo indicating light will stay on), press each axial operating key on the handheld operation teaching device and each axis of the robot will generate the desired movement. The diagram below shows the action signs of axis coordinate system of each axis. Please pay attention to the axis motion speed status and adjust to appropriate speed via high/low speed keys before operating the robot.

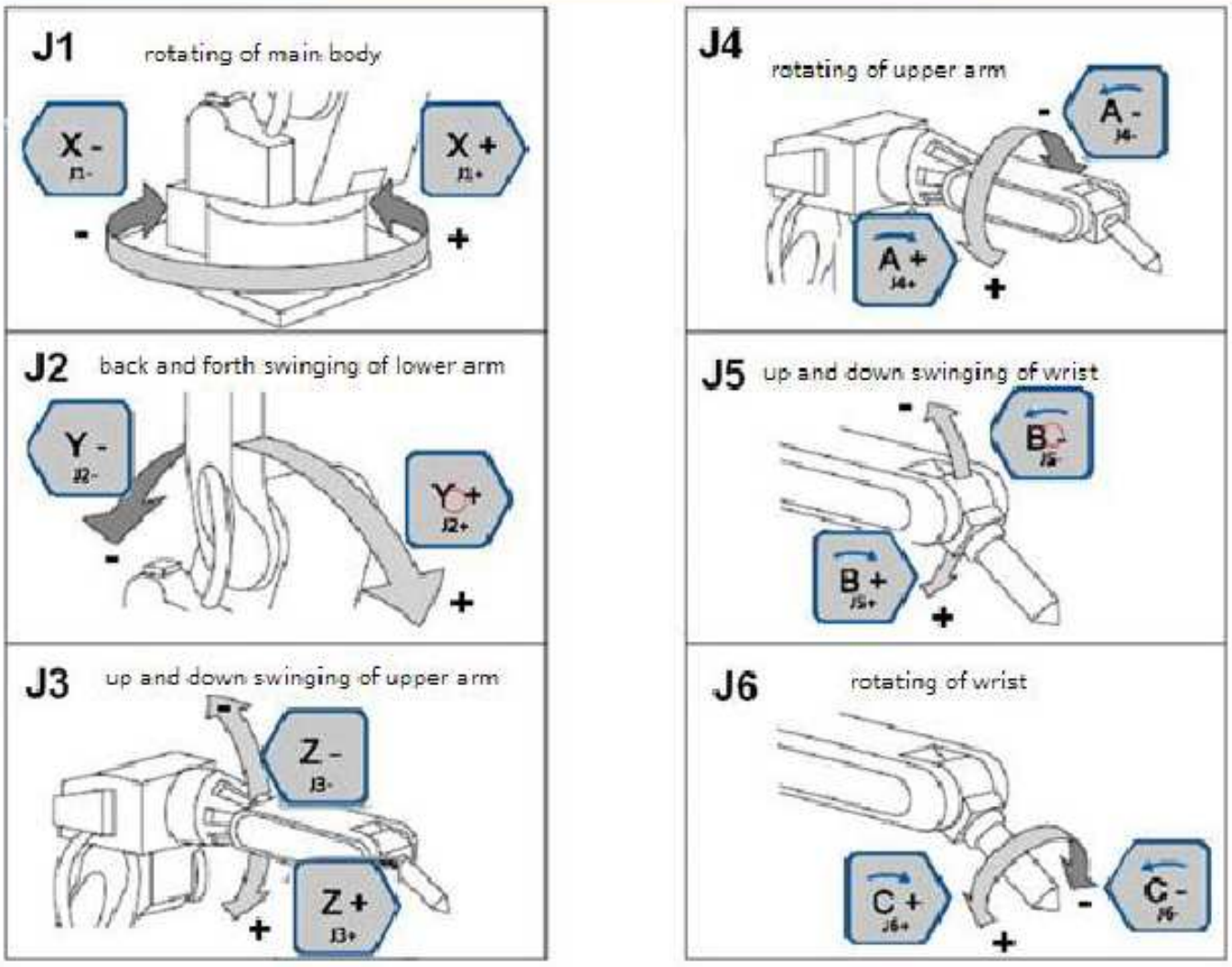


Important

✓ Please clear all the articles in the operating area before starting the robot



Rotation direction of the 6DOF robot



Rotation direction of the 6DOF robot (Each axis)

Chapter 8 Programmed Operation

This chapter describes the programmed editing operation of the robot without any robot action.

Operation of copying, deleting and renaming program can only be performed in teaching mode. All other operations which are not related can be performed

8.1 Program management

8.1.1 Entering Interface

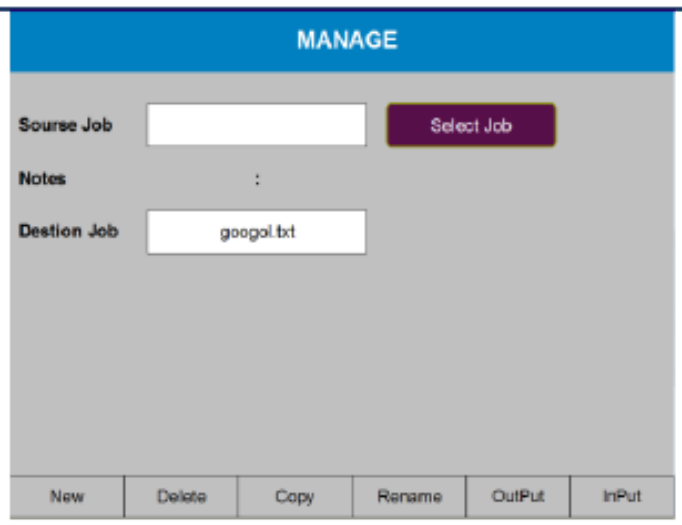
Item No.	Steps	Interface
1	Click the {Main Menu} button of the interface or press the 【Main menu】key of the handheld operation teaching device, the main menu {JOB} of the interface will turn blue.	
2	Open program submenu, press the【Move right】key of the handheld operation teaching device to open the submenu.	
3	Choose {MANAGE}. Press the 【Select】key on the handheld operation teaching device and enter the program management page.	

8.1.2 Interface introduction

Item No.	Interface content	Function
1	Source job	Select to delete, copy or rename the previous program. No manual input is allowed. User can only select existing programs
2	Destination job (Destion Job)	Input the new built, copied or renamed program names.
3	New-created (New)	Build new program For new built programs, 【NOP】 and 【END】 are added to the program content by default.
4	Delete	Delete existing program.
5	Copy	Copy existing program
6	Rename	Rename existing program

8.1.3 New created program

The operation of creating a new job:

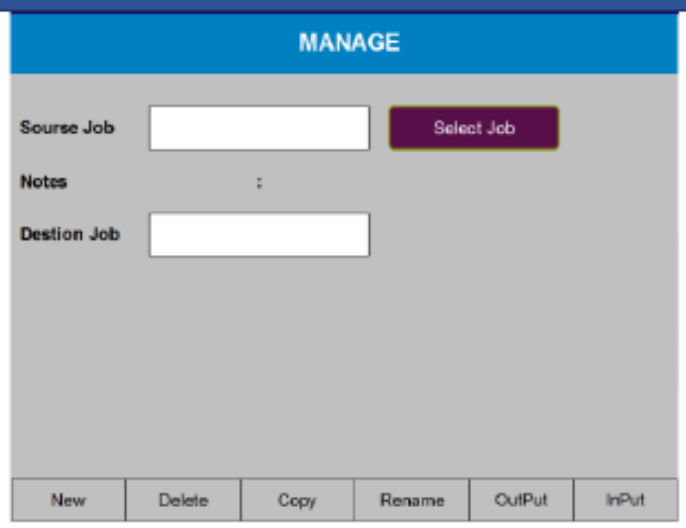
Item No.	Operating Steps	Interface
1	Input the new-built program name in {Destion Job} The name is not case sensitive, combination of characters and numbers are allowed with a maximum of 11 characters.	
2	Click the {New} button.	

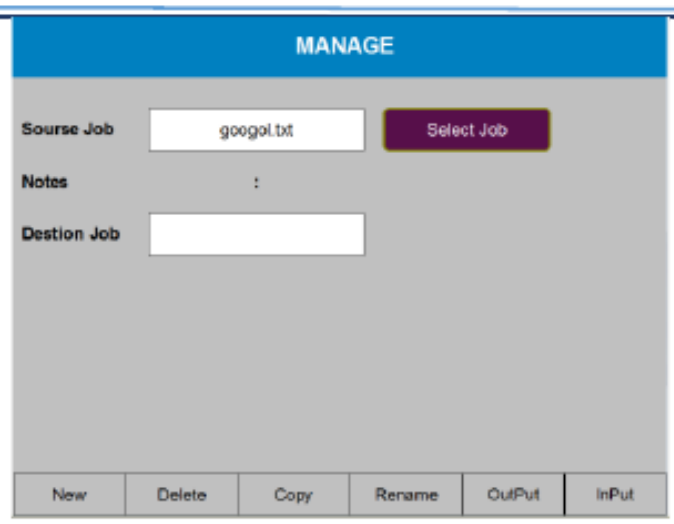
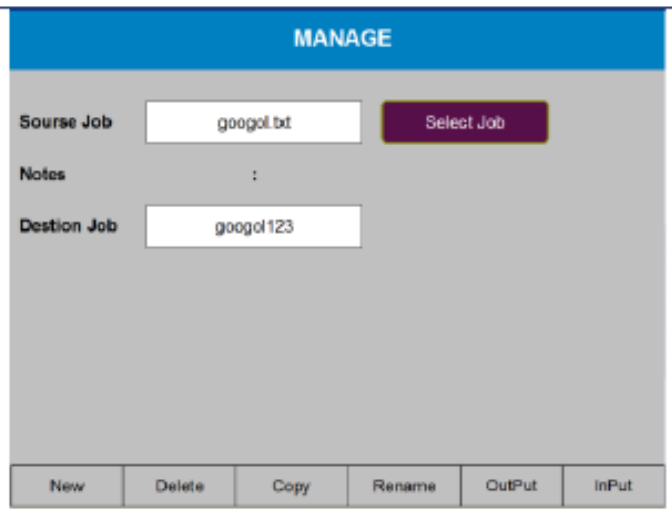
3	Enter the job content interface and create a blank job with only 2 lines: NOP and END.	

8.1.4 Copying the program

The operation of copying the exiting program and generating a new program.

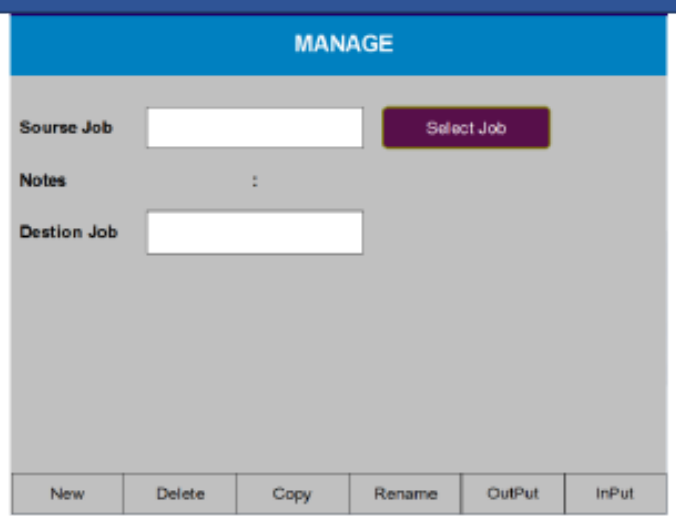
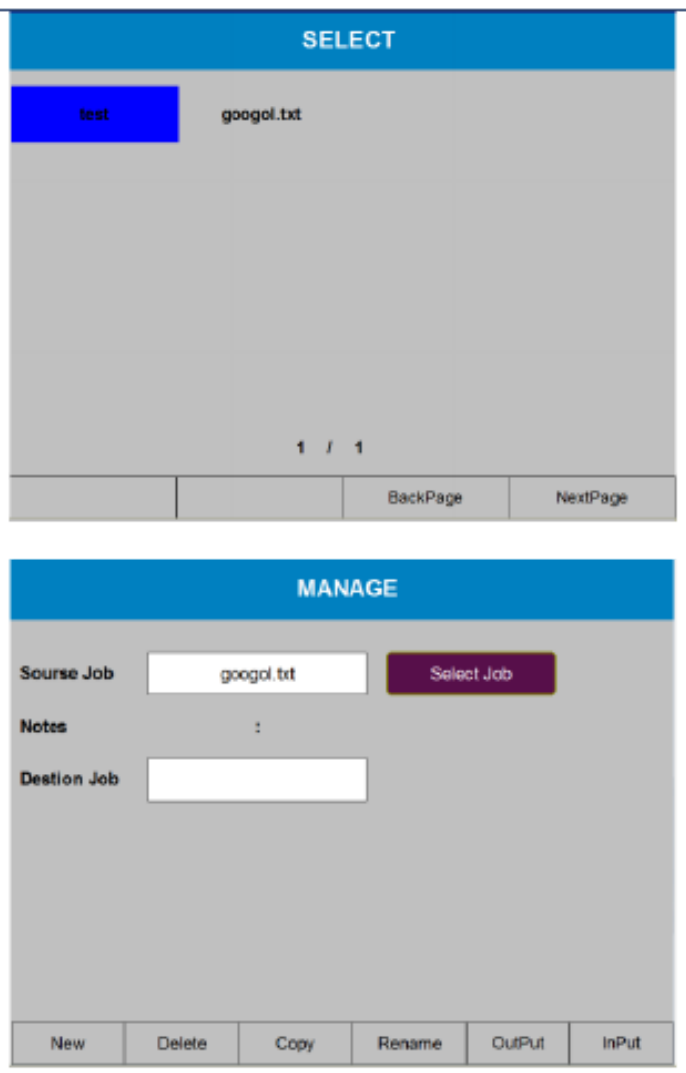
Illustration of operation steps

Item No.	Operation steps	Interface
1	Click the {Select Job} button of the interface to enter the job selecting interface.	
2	Select the copied program, press the 【Select】key on the handheld operation teaching device and return to the program management interface.	

		
3	Input the name that needs to be copied in {Destion Job}, e.g. googol123.	
4	Click {Copy} button on the interface to complete the operation.	

8.1.5 Deleting program

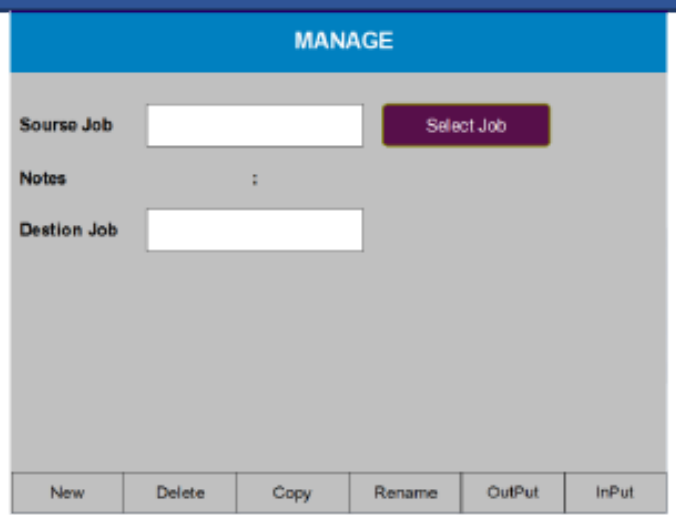
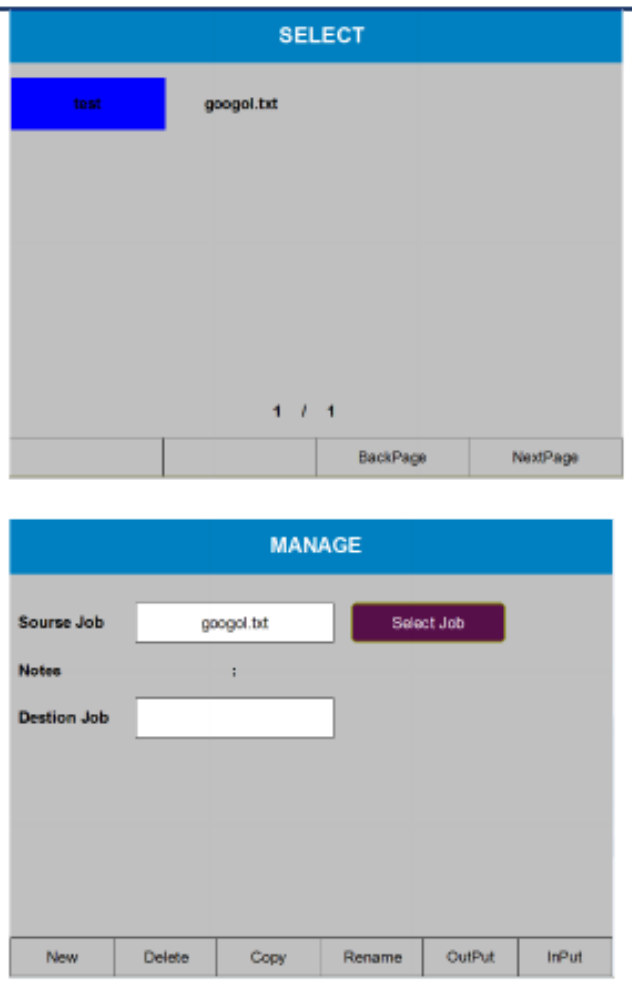
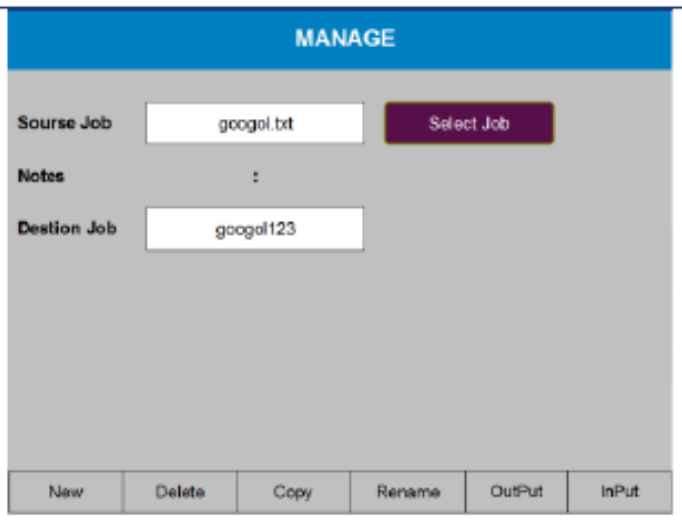
Operation of deleting an existing program

Item No.	Operation steps	Interface
1	Click {Select Job} button in the interface to enter the "Select program" interface.	
2	Press the move keys on the handheld operation teaching device and selete the program that needs to be deleted. Press the 【Select】 key on the handheld operation teaching device to return to the program management interface.	
3	Click the {Delete} button on the interface to complete the operation.	

8.1.6 Renaming the program

Rename the existing program and change its name. The operation can be performed in the program.

The operation steps are as below:

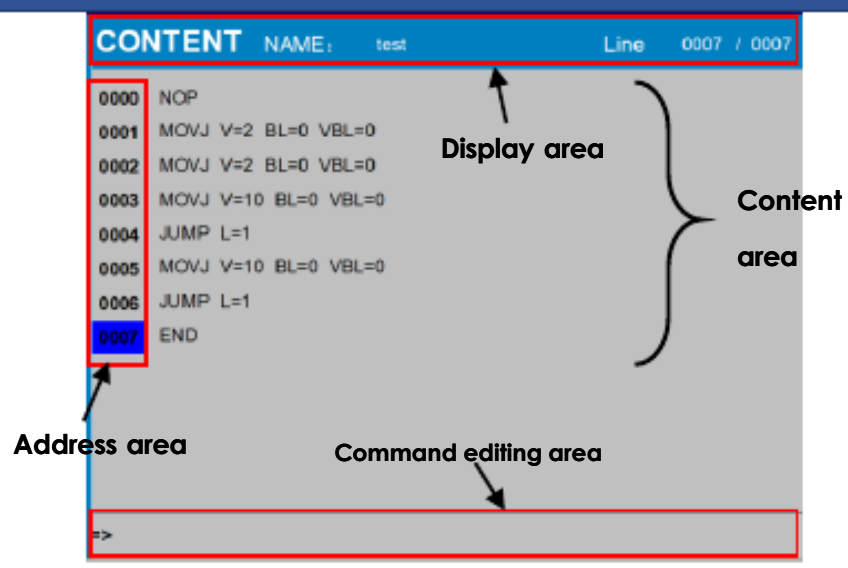
Item No.	Operation steps	Interface
1	Click the {Select Job} button in the interface to enter the “select job” interface.	
2	Press the move keys on the handheld operation teaching device and select the program that needs to be copied. Press the【Select】 key on the handheld operation teaching device to return to the program management interface.	
3	Input the new name in {Destion Job}.	
4	Click the {Rename} button on the interface to complete the operation.	

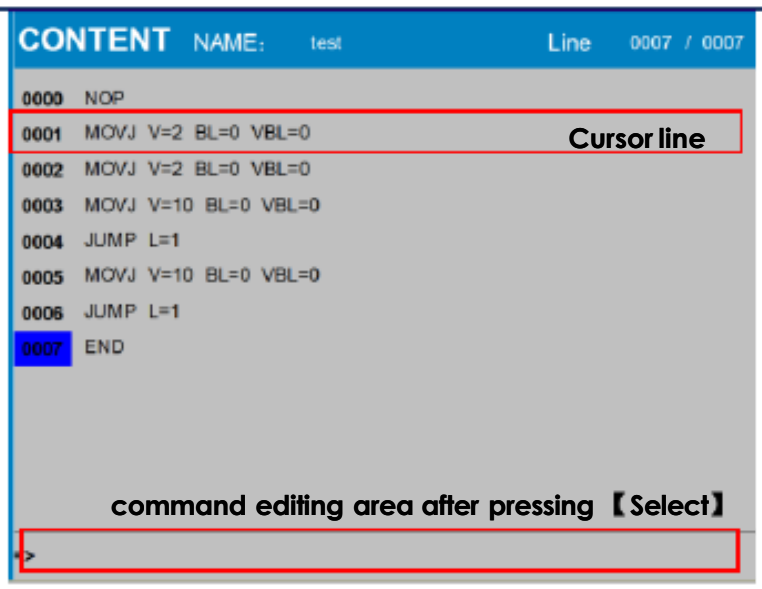
8.2 Job content

8.2.1 Entering the interface

Item No.	Operation steps	Interface
1	Click the {Main Menu} button in the interface or press the 【Main menu】 key of the handheld operation teaching device. The {JOB} of the main menu in the interface **will turn blue**.	
2	Open program submenu. Press the 【Move right】 key on the handheld operation teaching panel to open the submenu.	
3	Select {CONTENT}. Press the 【Select】 key on the handheld operation teaching device to enter the program content interface.	

8.2.2 Interface introduction

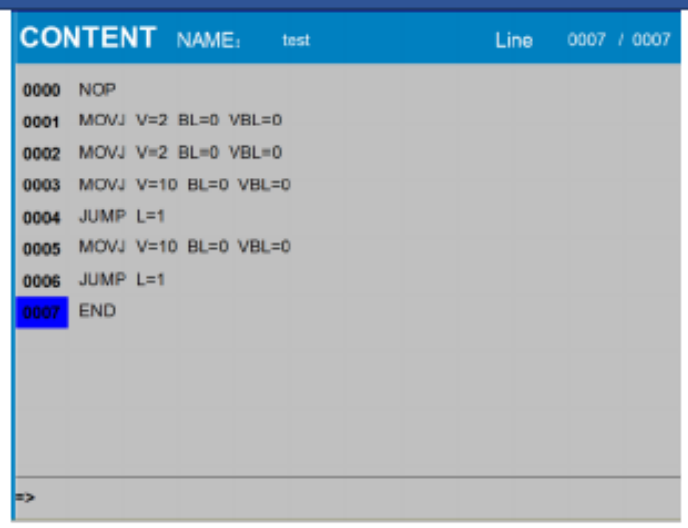
<table>
<tr><th>Item No.</th><th>Function</th><th>Function illustration</th></tr>
<tr><td>1</td><td>CONTENT</td><td> 

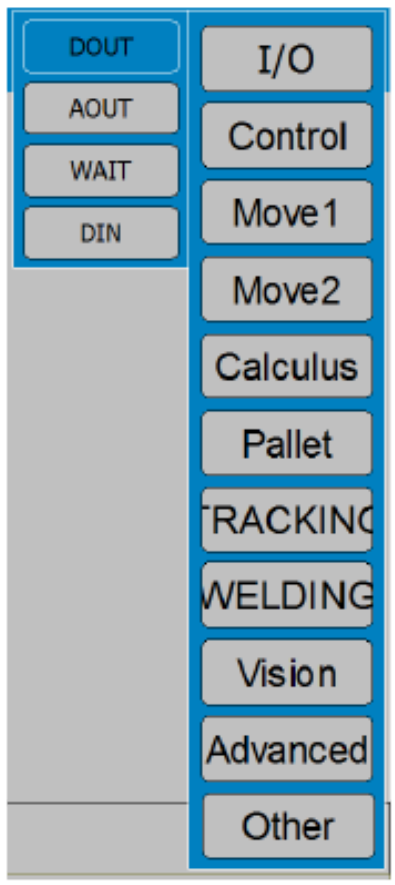
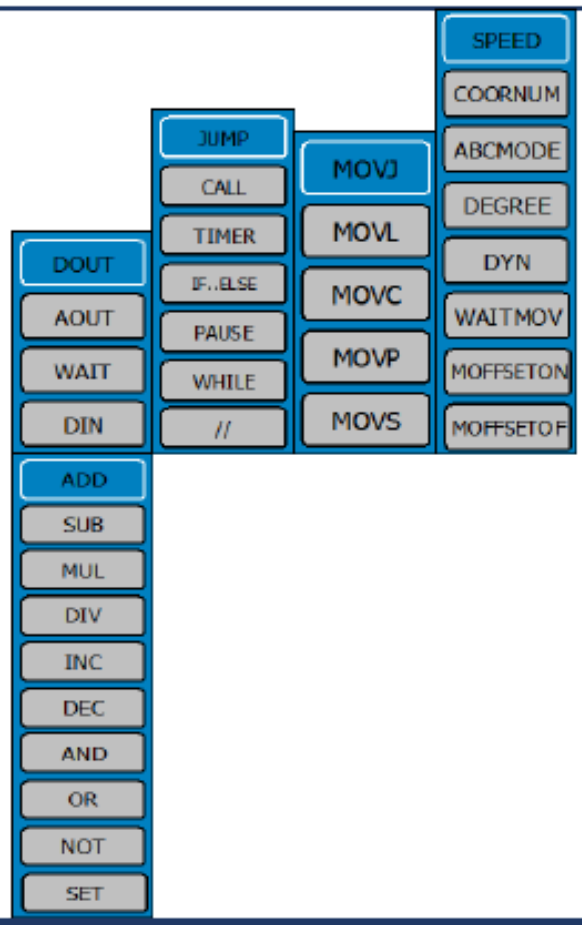
Address area: display the area of line number;
Display area: display the program name and current selected document line number;
Content area: display the program content;
Command editing area: display the selected command line for implementing line editing.</td></tr>
<tr><td>2</td><td>Move up/down</td><td>1. Press the 【Move up】 or 【Move down】 key on the handheld operation teaching device to move the program file line number up or down.
2. If there are multiple pages for the document, keep pressing the 【Move down】key when moving to the last line will open the next page.
3. If page 2 is currently displayed, keep pressing the 【Move up】key when moving to the first line will open the previous page.</td></tr>
<tr><td>3</td><td>Select</td><td> 

Press the 【Select】key on the handheld operation teaching device. Within the effective command range, select a line will enter the command editing area for editing the parameters.</td></tr>
</table>

4	Flip page	If the program is of multiple pages press the 【Flip page】 key to enter the next page, or 【Shift】+【Flip page】keys to enter the previous page.
5	Run display	Display the program running situation. During the program running process, the running line number will turn **blue**.
6	Insert Line	1 Add motion commands directly or add teaching commands via command list 2 To add motion commands directly, servo power must be connected first.
7	Delete Line	Delete the unnecessary Program Line.
8	Modify Line	Modify Program Line.
9	Teaching check	Check teaching program.

8.2.3 Command list operation

Item No.	Function and operation steps	Interface
1	Enter {JOB}-{CONTENT} interface. The program command list can only be opened in program content interface.	

2	Press the 【Command list】key on the handled operation teaching device, the program command main list will pop up. It includes the following commands: 1 I/O: DOUT, AOUT, WAIT, DIN; 2 Control: JUMP, CALL, TIMER, IF..ELSE, WHILE, PAUSE; 3 Move1: MOVJ, MOVL, MOVC, MOVP, MOVS, SPEED; 4 Move2: ACC, DCC, JERKTIME, DEGREE, ABCMODE, COORDNUM; 5 Calculus: ADD, SUB, MUL, DIV, INC, DEC, AND, OR, NOT, SET. 6 Pallet: Manufacturing process reserved. 7 TRACKING: Manufacturing process reserved. 8 WELDING: Manufacturing process reserved. 9 Vision: Manufacturing process reserved.	
3	【Command list】sub-list 1 Choose the command in the main list or sub-list using the 【Move up】or 【Move down】keys on the handheld operation teaching device to switch. 2 Open the sub-list with the 【Move left】key; Return to the main list with the 【Move right】key. Commands can be selected and output to the **command editing area** with【Select】key for modifying or inserting teaching line.	

Please refer to the Program command specification section for detailed command introduction.

8.2.4 Variable operation

When teaching points are inserted via program command list, variable parameters can be

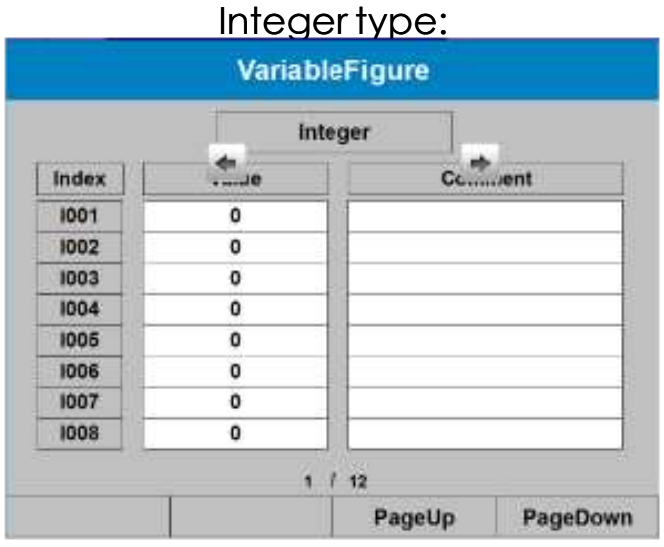
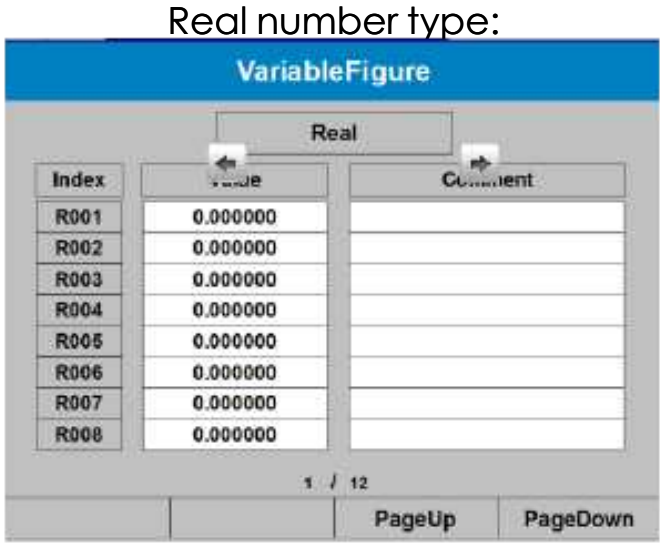
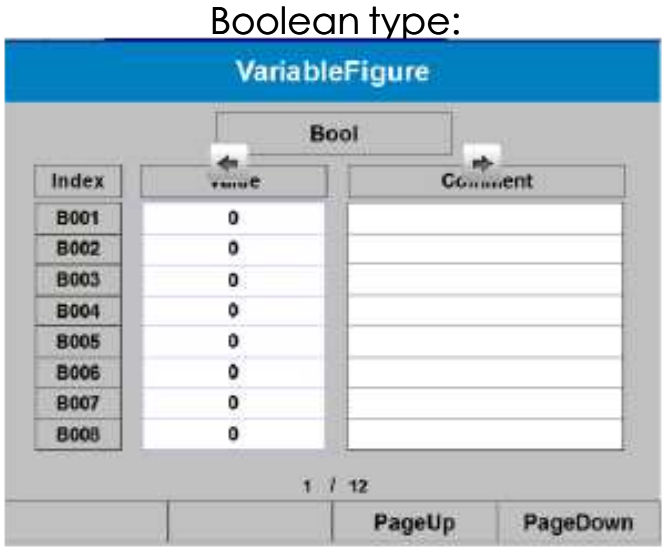
inserted too. They are all global variables which can be used in different programs. Initial values of numeric variables can be modified while those of positional variables have to be calibrated.

8.2.4.1 Numeric variable

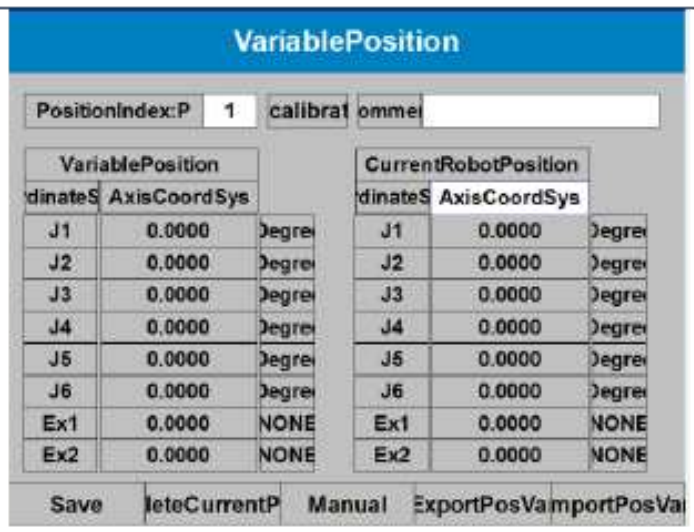
It is classified into three types (each type can save 96 variables):

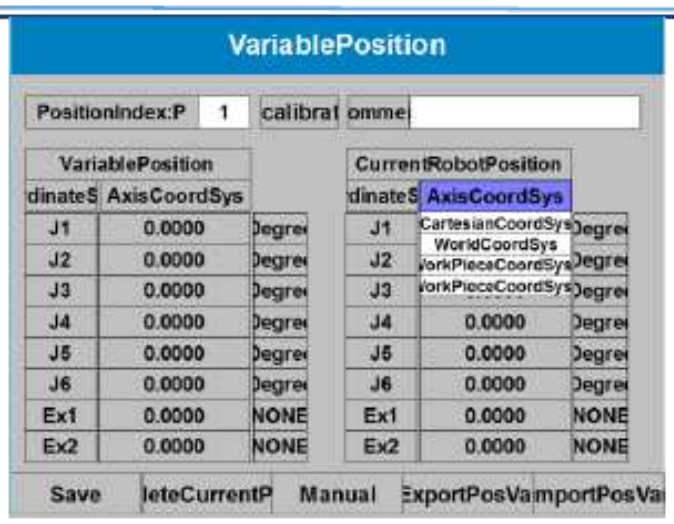
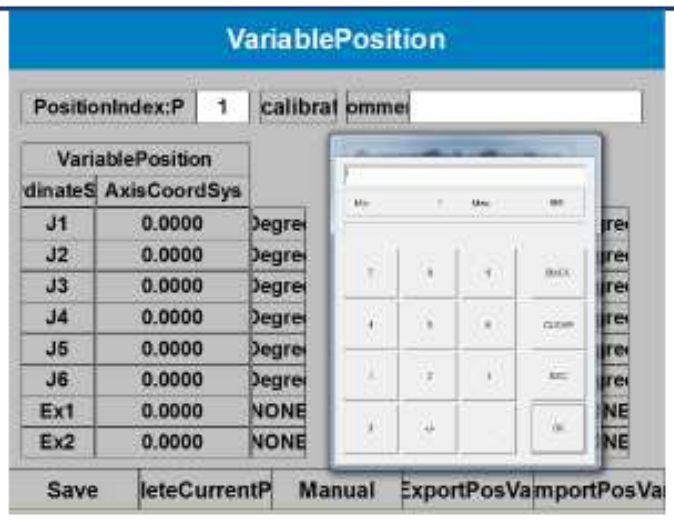
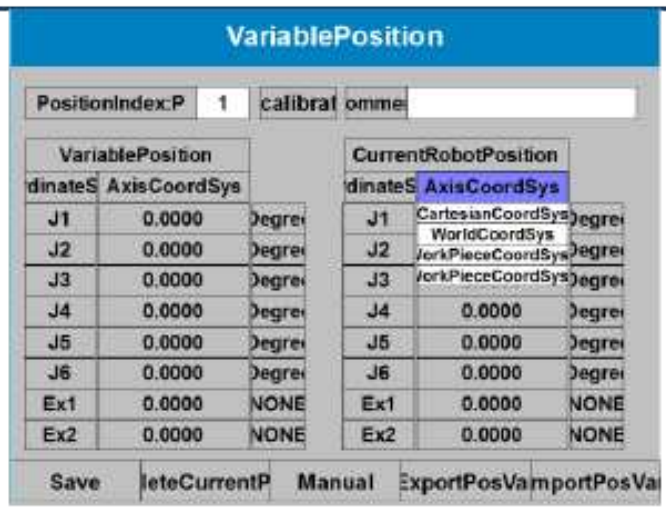
1 Integer type: Integers ranges from -2147483648 to 2147483647;
2 Real number type: Floating point numbers ranges from -1.7x10^{308} to 1.7x10^{308}
3 Boolean type: 0 or 1;

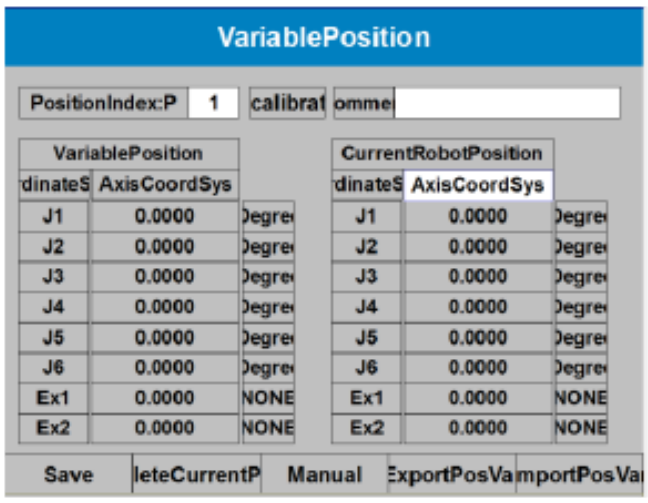
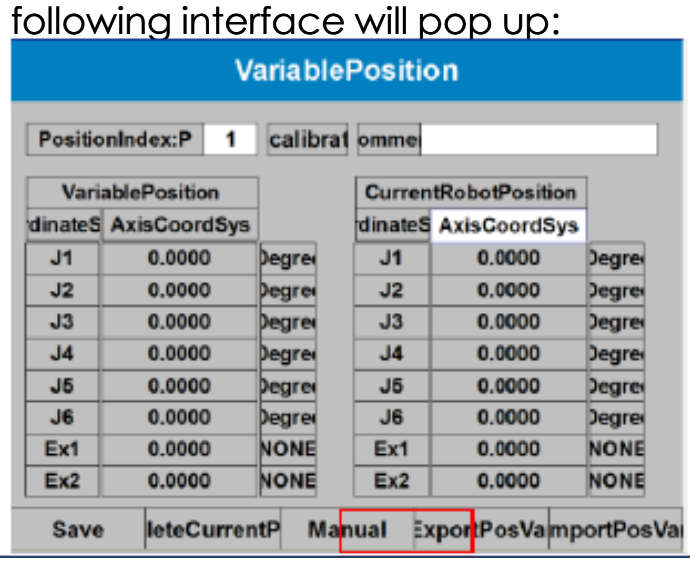
Item No.	Operation	illustration
1	Press the 【Move up】or 【Move down】keys on the handheld operation box and the {VARIABLE} will **turn blue**.	
2	Press the 【Move right】key to bring up the {VARIABLE} submenu.	
3	Press the【Move up】or 【Move down】key on the handheld operation box until the {VariableFigure} turns blue, then press the 【Select】key on the	The interface shows the integer type variable, different type of value type can be switched by clicking the arrows on the left and right ends of the {Integer type}: The data item number can be switched by clicking the {PageUp} or {PageDown} buttons on the interface;

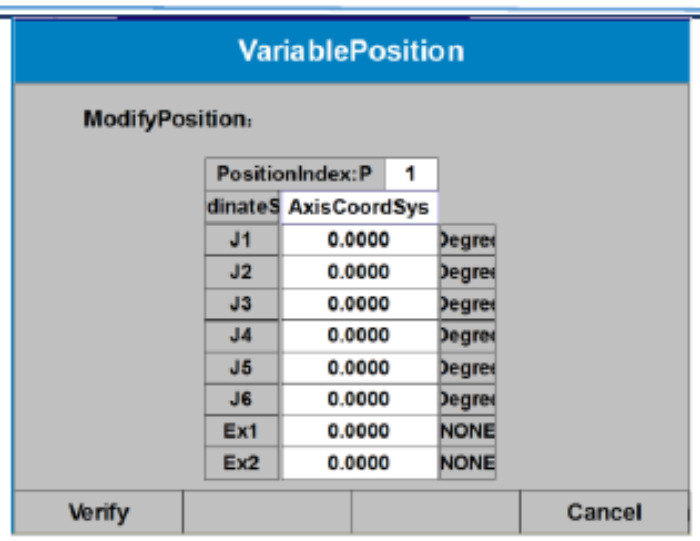
	handheld operation box.	Integer type:  Real number type:  Boolean type: 
4	Check and modify variables	The content frame shows the current datum of the variable. Click the content frame to modify the variable datum and the modified datum will be effective immediately. After restarting due to power failure, all the numeric variables will be restored to the data before power failure.

8.2.4.2 Positional variable

Item No.	Function and operation steps	Interface
1	Press the 【Move up】or 【Move down】keys on the handheld operation teaching device until the {VARIABLE} under the main menu **turns blue**.	
2	Press the 【Move right】key on the handheld operation teaching device to bring up the submenu.	
3	Press the 【Move up】or 【Move down】key in on the handheld operation teaching device until the {VariablePosition} **turns blue**, then press the 【Select】key on the handheld operation teaching device.	 {PositionIndex: P} the number on the right side represents the item number of the positional variable {calibrated} means the positional variable has been calibrated; {uncalibrated}means the positional variable has not been calibrated;

		
4	Click the input frame on the right side of the software interface {PositionIndex: P} to input the item number of the {VariablePosition} that is going to be saved. The range is 1 to 999.	
5	Switch the coordinate system of the right side to the one that is going to be saved. Only one type of coordinate system can be saved for each position point.	
6	Press the 【Servo ready】 key on the handheld operation teaching device, the 【Servo ready indicating light】 will blink.	
7	Press the 【Modify】 key on the handheld operation teaching device, the green indicating light besides the 【Modify】 key will light up.	

8	Grip the 【3-stage switch】 on the handheld operation teaching device softly and the central 【Servo ready indicating light】 on the handheld operation teaching device will light up. Press the 【Confirm】 key. After successful modifying, the green indicating light besides the 【Confirm】 key will go off and the coordinate values on the left side of the software interface will change to the current position values indicating they are saved successfully.	
9	The above method can be used to save position points. (or steps 7 and 8 can be omitted): Press the 【3-stage switch】 button at the back of the handheld operation teaching device, the central 【Servo ready indicating light】 will light up. Click the {Save} button on the software interface, the coordinate values on the left side of the software interface will change to current position values indicating they are saved successfully.	
10	Modify the current positional variable manually.	**Note**: User must know the consequential impact of the operation before implementing the operation: Press and hold the {Manual} button for more than 3 seconds and the following interface will pop up: 

		 The content that can be modified via touch screen includes coordinate system and coordinate messages of the 8 axes. After modifying, press the {Verify} button for over 3 seconds for them to work. Press the {Cancel} button to go back;
11	Clear the current positional variable message	Note: Clear the current position point will change the current position datum to 0, and position pint will be classified as {uncalibrated}
12	Check positional type variable	After calibration, press the 【3-stage switch】 at the back of the handheld operation teaching device and the 【Servo ready indicating light】 will light up. Press 【Interlock】+ 【Forward】at the same time to move to the calibrated position from the current position. Under MOVJ interpolation mode, use MOVJ mode to move to the position point; under other interpolation modes, use MOVP mode to move to the calibrated position point. Please make sure that there is no obstacle between the current position and the position calibrated by the positional type variable.

8.2.5 Program modifying

8.2.5.1 Program point insertion

➢ **Insertion during motion process**

- A motion command point can be inserted during the motion process. The motion command point by this insertion method is temporary program point (i.e. the current position point message is indexed into the teaching program, but it is different from the positional variable as it doesn't have an item number. It can be called out repeatly). Motion insertion command mode: MOVJ V=25 BL=0. (V=XX, XX is speed percentage and can be modified; BL=XX, XX is transitional section length and can be modified). For specific command introduction please refer to Program command specification in motion commands.

Step 1 Move the cursor to the program point that is going to be inserted.

Step 2 Connect to servo power. Press the 【Servo ready】key, grip the 【3-stage switch】softly to connect the robot to the servo power.

Step 3 Select speed (Press 【High speed】 or 【Low speed】key) and interpolation mode (Press the 【Interpolate】key) to move the robot until it reaches the predetermined position.

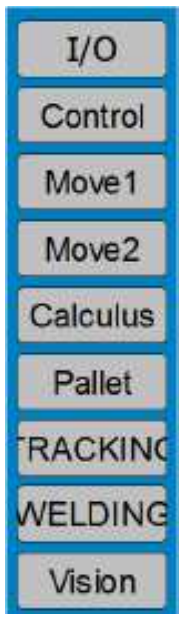
Step 4 Press the 【Insert】 key on the handheld operation teaching device and the green ligh besides it will light up

Step 5 Press the 【Confirm】key on the handheld operation device to complete the addition of the program point.

- **Insertion using command list**

- Commands in the command list can be inserted. They include I/O commands, control command, motion commands, operation commands. For specific command introduction please refer to Program command specification under motion command. If variables are used during command insertion, initial values of variable need to be assigned. Please refer to Variable operation section for details.

Step 1 Move the cursor to the program point that needs to be inserted.
Step 2 Press the 【Command list】key on the handheld operation teaching device, the command list menu will pop up on the right side as in the diagram:



Step 3 Press the 【Move up】or 【Move down】key on the handheld operation teaching device, select the required command, press the 【Select】 key and the command will appear int eh command editing area.

Step 4 The modified command parameter is the required parameter.

Touch the parameter that needs to be amended in the command editing area and modify the value or command in the pop-up interface.

Step 5 Press the 【Insert】 key on the handheld operation teaching device, and the green light besides the key will light up.

Step 6 Press the 【Confirm】key on the handheld operation teaching device and program point addition is complete.

8.2.5.2 Modifying the program point

8.2.5.2.1 Operation step

Step 1 Move the cursor to the program point that needs to be edited.

Step 2 Press the 【Select】key on the handheld operation teaching device and select the command display in the command editing area.

Step 3 Modify the required parameter in the command editing area.

Touch the parameter that needs to be amended in the command editing area and modify the value or command in the pop-up interface.

Step 4 Press the 【Modify】key on the handheld operation teaching device, the green light besides the key will light up.

Step 5 Press the 【Confirm】key on the handheld operation teaching device and the program point modifying is complete.

8.2.5.3 Deleting the program point

Step 1 Move the cursor to the program point that needs to be deleted.

Step 2 Press the 【Delete】 key on the handheld operation teaching device and the green light on the upper left side of the hey will light up

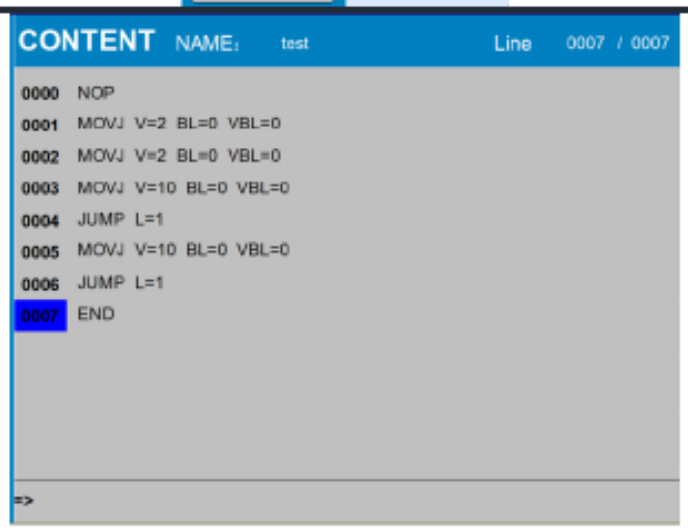
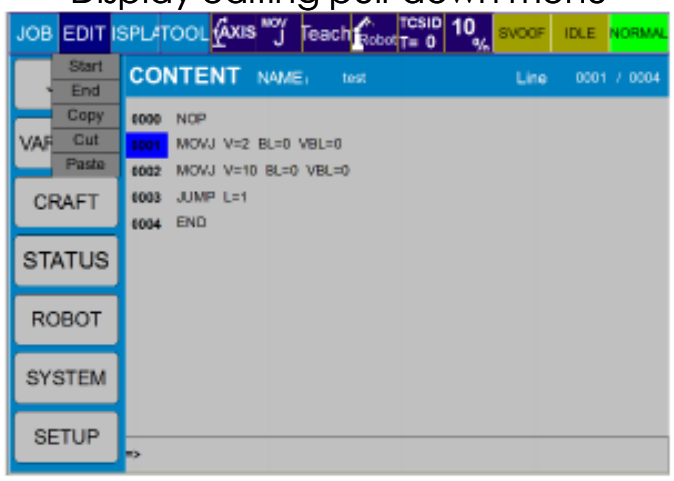
Step 3 Press the 【Delete】 key on the handheld operation teaching device

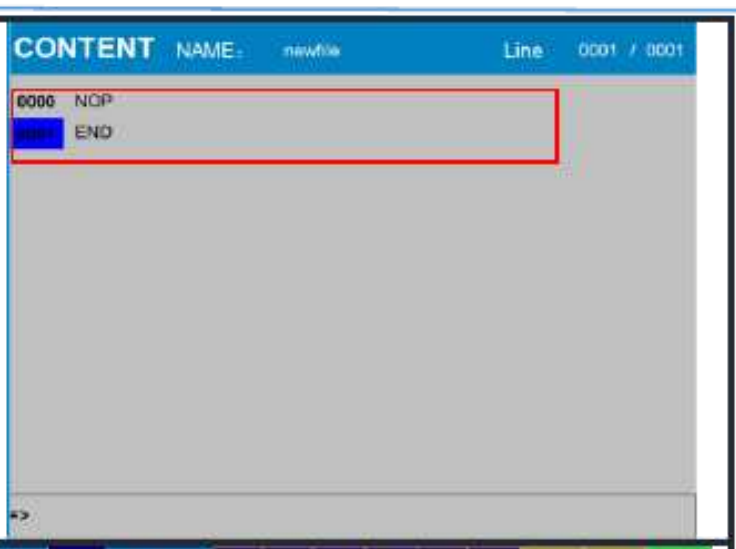
8.2.6 Editing of programs

The editing function of programs allows it to perform operations such as selecting multiple lines, copying, cutting and pasting

8.2.6.1 Editing range selection

Program range has to be selected before cutting and pasting operation.

Step 1	Enter {JOB}-{CONTENT} interface.	
Step 2	Move the cursor to the first line of that is to be selected;	
Step 3	Select {EDIT} of menu;	Display editing pull-down menu 
Step 4	Click {Start} button in the interface;	

Step 5	Move the cursor to the last line that is to be selected	
Step 6	Click {EDIT}-{End} of the menu, the selected line IDs will turn blue indicating multiple lines selection is successful.	

8.2.6.2 Copying

Please select the copy range before copying

Step 1	Click the {EDIT} item of the menu.	
Step 2	Click the {Copy} button in the editing menu, select the content to be put into the buffer area.	

8.2.6.3 Cutting

Please select the copied area before cutting.

Step 1	**Click the** {EDIT} item of the menu.	

Step 2	Select the {Cut} button of the editing menu, select the content in the zone that is to be deleted, and put it into the buffer zone.	

8.2.6.4 Pasting

Please select copied or cut part before pasting

Step 1	Select the line to be inserted in the {CONTENT} interface, the pasting operation will paste prior to the selected line, while the original command will move down.	
Step 2	Click the {EDIT} item of the menu.	
Step 3	Select {Paste} in the editing menu to insert the buffer area data before the selected line.	 

8.2.7 Checking of programs

Implement single step check for finished program to ensure the saftty of robot motion.

Step 1 Select the teaching program that is going to be checked.

Step 2 Press the 【Servo ready】key on the handheld operation teaching device and grip the 【3-stage switch】softly to connect to servo power.

Step 3 Press the 【Forward】or【Backward】key on the handheld operation teaching device to realize the program file forward or backward checking.

Step 4 Press 【Interlock】+【Forward】keys to realize program file forward checking continuous forward checking.

8.3 Program selection

Item No.	Function and operation steps	Interface
1	Select {JOB} in main menu. If it can be selected, press the 【Main menu】key or click the {Main Menu} button in the interface.	
2	Open job submenu, press the 【Move right】 key on the handheld operation teaching device to open the submenu.	
3	Select {Select Job}, press the 【Select】key on the handheld operation teaching device to enter the program selection interface.	

4	Operation of selecting program interface: Switch the selected program file name with【Move up】,【Move down】, 【Move left】 or 【Move right】 key on the handheld operation teaching device. The selected one will be displayed in blue. If there are multiple pages, press the 【Flip page】key on the handheld operation teaching device or the {next page} button on the interface to open the next page. Press the 【Shift】 + 【Flip page】keys on the handheld operation teaching panel or the {PageUp} button on the interface to open the previous page. Ope the selected content of the program. Press the 【Select】key on the handheld operation teaching panel to open the selected program document and enter the program content page.

8.4 Main program

Item No.	Function and operation steps	Interface
1	Select {JOB} in the main menu. If it cannot be selected, press the 【Main menu】 key on the handheld operation teaching panel or click the {Main Menu} button on the low left corner of interface page.	
2	Click the 【Move right】key on the handheld operation teaching device to open the submenu.	
3	Click the 【Select】 key on the handheld operation teaching device to enter the main program page.	

4	Main program interface Program files can be moved by using the 【Move up】, 【Move down】, 【Move left】or 【Move right】keys on the handheld operation teaching device. If there are multiple pages, press the 【Flip page】key on the handheld operation teaching device to flip to the next page. Press the 【Shift】+ 【Flip page】 keys to open the previous page.	

Chapter 9 Coordinate System

This chapter introduces Axis Coordinate System (ACS), Kinematics Coordinate System (KCS), World Coordinate System (WCS), Tool Coordinate System (TCS), and Piece Coordinate System (PCS) (Two Piece Coordinate Systems (PCS1 and PCS2) are used in the program. PCS1 is fixed while the function of PCS2 is reserved for advanced system applications. When these advanced functions are not used, PCS2 coordinate system can be used as PCS1).

Three-point method is used to calibrate the coordinate system. By calibrating three points that are not on a straight line, PCS and WCS can be taught. In addition, an additional offset point O0 can be set to locate the origin of teaching PCS or WCS to the designated position. To ensure the teaching accuracy, the poses of tool ends are suggested to be consistent (User can manually input to modify the coordinate date directly).

Three different methods of TCS which are three-point method, four-point method and six-point method can be used to teach TCS. The TCS values can be input manually too. User can teach and save 10 different TCS data (the 0th TCS datum cannot be modified so if it is being used it means the program doesn't need to use TCS).

9.1 Robot axis and coordinate system

9.1.1 Types of coordinate system

When implementing axial operation of the robot, the following types of coordinate systems can be used:

ACS

Axis Coordinate System (ACS): It is a pure rotational coordinate system set up with mechanical zero points of each axis as origins. Each axis can rotate independently or interlocked.

KCS

Kinematic Coordinate System (KCS): It is the coordinate system for forward and backward kinematics modeling of robot. It is the basic Cartesian coordinate system of robot and can be called Base Coordinate System (BCS) or KCS. The robot tool tips TCP can perform translation motion along the X, Y, and Z axes, and rotation motion around the X, Y, and Z axes under this coordinate system.

TCS

Tool Coordinate System (TCS): The effective direction of the tool held by the robot wrist

flange plate is regarded as Z axis, while the origin is defined as the TCP (tool center point) of the tool. When tool is not installed on the robot, the TCS is established at the robot flange plate end face center point of the robot, while the Z axis direction is perpendicular to the flange plate end face pointing to the front direction. When the robot is in motion, the TCS will move with TCP. User can select to teach motion under TCS. The teaching motion of TCS includes translational movement along the X, Y, and Z axes of TCS and rotational movement around the X, Y, and Z axes. User can save 32 self-defined TCS.

WCS

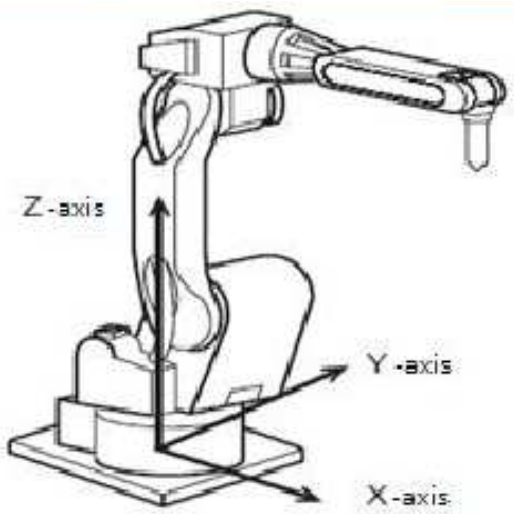
World Coordinate System (WCS): WCS is the same as Cartesian coordinate system. It is the reference coordinate system of other Cartesian coordinate system (KCS and PCS). By default, when there is no WCS teaching configuration, there is no position offset and pose change between WCS and KCS so they will coincide. User can teach WCS via "Coordinate system management" interface. Robot TCP can perform translational movement along X, Y, and Z axes, as well as rotational movement around X, Y, and Z axes of WCS. User can save 32 self-defined WCS.

PCS1

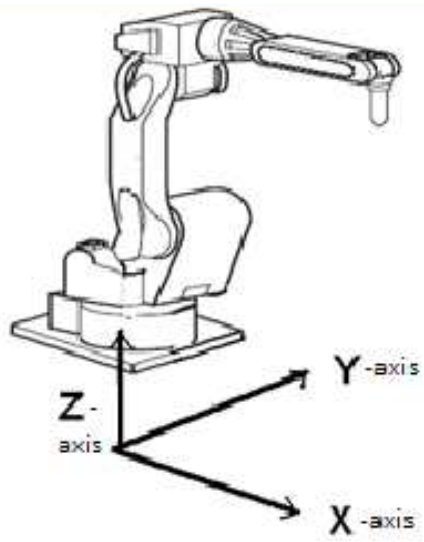
Piece Coordinate System 1 (PCS1): There are two independent PCSs and PCS1 is the first set of PCS. It is a Cartesian coordinate system built under WCS. It facilitates the user to switch to multiple identical workpieces under WCS. Furthermore, after teaching TCS, the robot TCP translational and rotational movements of TCS can reduce the difficulty of the teaching job. User can save 32 self-defined PCS1. It is mainly used in regular robot applications. These coordinate systems are fixed PCSs from teaching generating.

PCS2

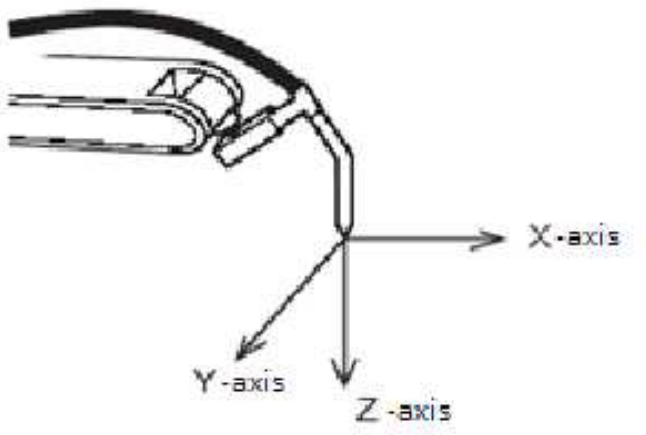
Piece Coordinate System 2 (PCS2): There are two independent PCSs and PCS2 is the second set of PCS. In general applications, the functions of the second set are identical with those of the first send. In advanced application such as synchronous traced picking, two-axis positioning platform, the coordinate system of some item numbers of the second set PCS will be used as internal synchronous traced purpose. For specific messages, please refer to the related advanced application manual. For general application, the second PCS can support user to save 32 self-defined PCS.



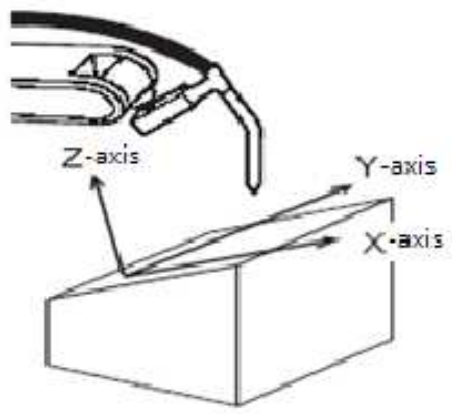
Kinematics Coordinate System (KCS)



World Coordinate System (WCS)

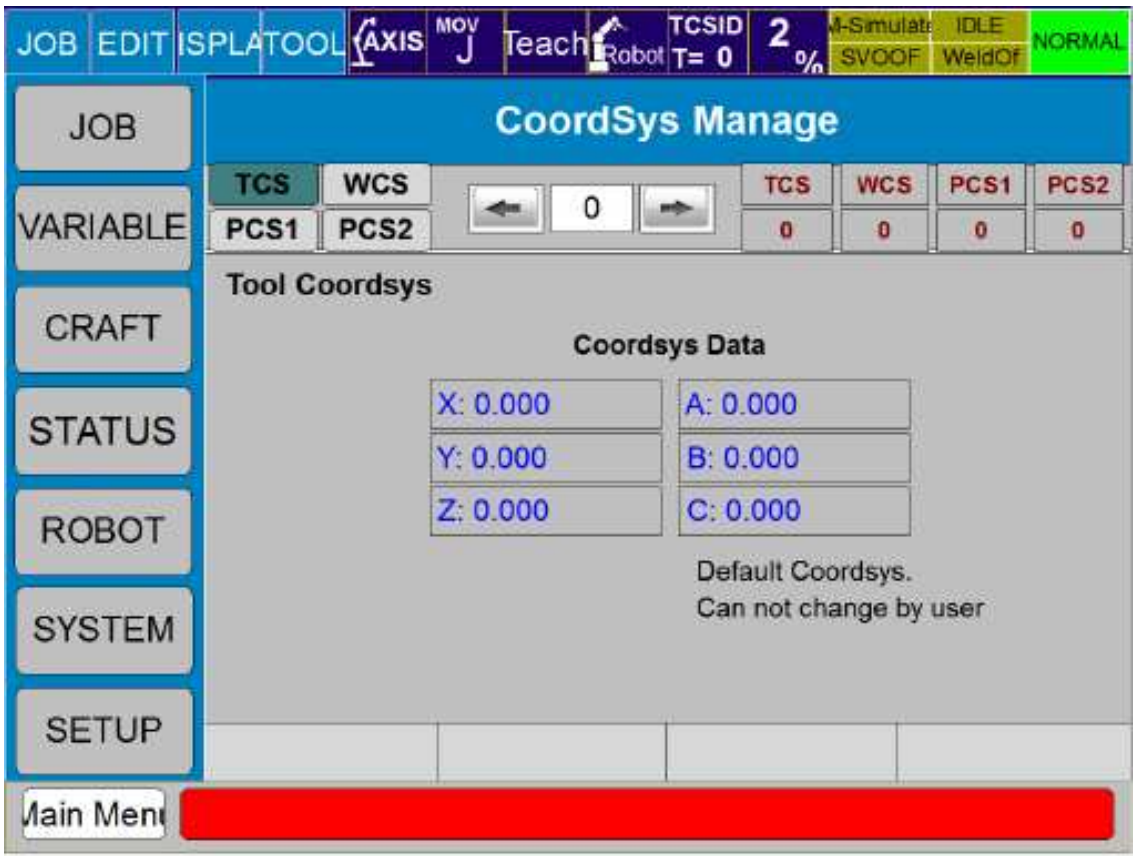


Tool Coordinate System (TCS)



Piece Coordinate System (PCS)

9.1.2 Coordinate system management interface introduction



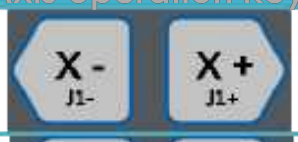
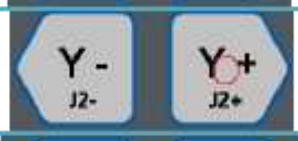
The coordinate management interface is shown in the above picture. User can implement various kinds of management work such as teaching calculation, manual switching, modifying, and teaching position points checking of TCS, WCS, PCS1, PCS2 in this interface.

User can enter this interface via "ROBOT"->"CoordSys" menu, or by clicking the "TOOL" button in the upper part of the interface in teaching mode.

9.2 Axis coordinate system

Under the teaching mode, when the coordinate system is set as ACS, J1, J2, J3, J4, J4, and J6 of the robot will move respectively. Please refer to the below table for the action of each axis when the axis operation key is pressed:

Axis action of ACS

Axis name		Axis operation key	Action
Base axis	Axis J1		Left/right gyration of the body
	Axis J2		Back/forth movement of the lower arm
	Axis J3		Up/down movement of the upper arm
Wrist axis	Axis J4		Wrist gyration of the upper arm.
	Axis J5		Up/down movement of wrist

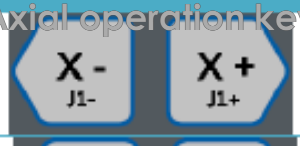
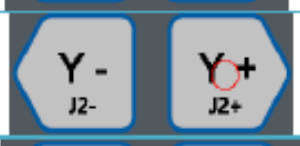
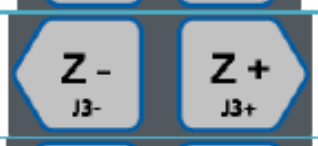
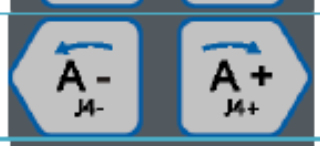
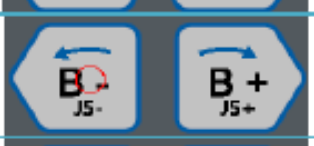
	Axis J6			Gyration of the wrist

Robot will move according to composite action when two or more axis operation keys are pressed simultaneously. However, when two keys of opposite direction in the same axis are pressed at the same time (such as [J1-]+[J1+]), there will be no axis action.

9.3 Kinematics Coordinate System, KCS

In teaching mode, the robot tool end TCP parallel translates along the X, Y, Z axes of the KCS and rotates around the X, Y, and Z axes when the coordinate system is set as KCS. Please refer to the below table for the action of each axis when axial operation keys are pressed:

Axis action of KCS

Name of axis		Axial operation key	Action
Translation axis	X-axis		Parallel translation movement along X-axis of KCS
	Y-axis		Parallel translation movement along Y-axis of KCS
	Z-axis		Parallel translation movement along Z-axis of KCS
Rotation axis	Rotation around X-axis		Rotation movement around X-axis of KCS
	Rotation around Y-axis		Rotation movement around Y-axis of KCS
	Rotation around Z-axis		Rotation movement around Z-axis of KCS

Robot will move according to composite action when two or more axial operation keys are pressed simultaneously. However, when two keys of opposite direction in the same axis are pressed at the same time (such as [X-]+[X+]), there will be no axis action.

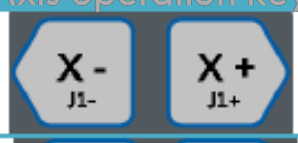
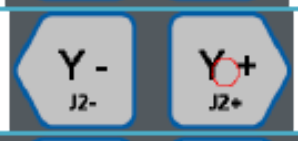
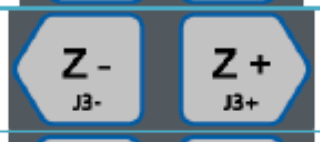
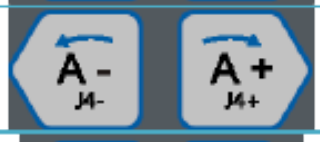
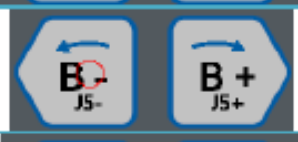
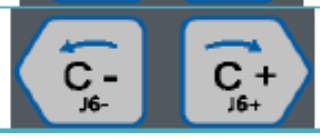
9.4 World Coordinate System, WCS

9.4.1 Axis action

In teaching mode, the robot tool end TCP parallel translates along the X, Y, Z axes of the

WCS and rotates around the X, Y, and Z axes when the coordinate system is set as WCS. Please refer to the below table for the movement of each axis when axial operation keys are pressed:

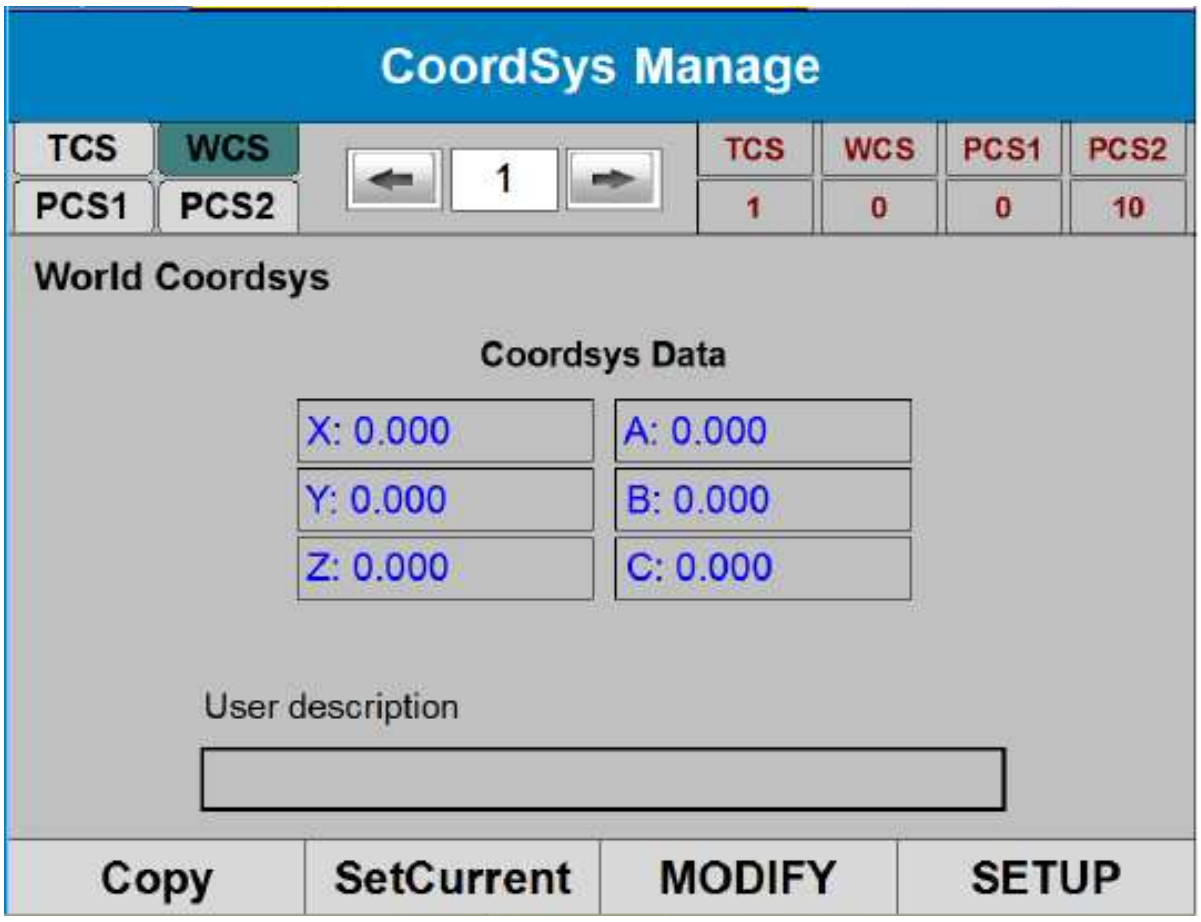
Axis action of WCS

Name of axis		Axis operation key	Action
Translation axis	X-axis		Parallel translation motion along X-axis of WCS
	Y-axis		Parallel translation motion along Y-axis of WCS
	Z-axis		Parallel translation motion along Z-axis of WCS
Rotation axis	Rotation around X-axis		Rotation motion around X-axis of WCS
	Rotation around Y-axis		Rotation motion around Y-axis of WCS
	Rotation around Z-axis		Rotation motion around Z-axis of WCS

When two or more axis operation keys are pressed simultaneously the robot will perform composite action. However, when two keys of opposite direction in the same axis are pressed at the same time (such as [X-]+[X+]), there will be no axis action.

9.4.2 WCS calibration

The calibration of WCS management main interface is shown below. User can enter the interface through the submenu {CoordSys} under menu {ROBOT} or via {TOOL} button of the main interface to enter the coordinate system calibration management interface quickly.



WCS management interface

Coordinate system type and coordinate system item number selection

The upper right part of the coordinate system management interface is the **coordinate system selection option tabs**. User can select the coordinate system (TCS, WCS, PCS1, PCS2) that needs to be manipulated through the tabs. For each coordinate system such as WCS, there is a 32 coordinate system datum queue for each coordinate system. The 0-10 index list below the tabs is for facilitating user to select the elements of the coordinate system queue. The default coordinate system data with index list number 0 means it is the datum when the coordinate system is not used (User cannot change the coordinate system datum of index number 0). When user selects index number 0, the calibration button on the interface can't be operated. However, user can change the coordinate system data of index numbers 1-32. The right part of the option tab shows the currently used coordinate system item number of the robot system in real time.

The middle part of the coordinate system management interface shows the selected item number of the data, and the annotation of the coordinate system by user.

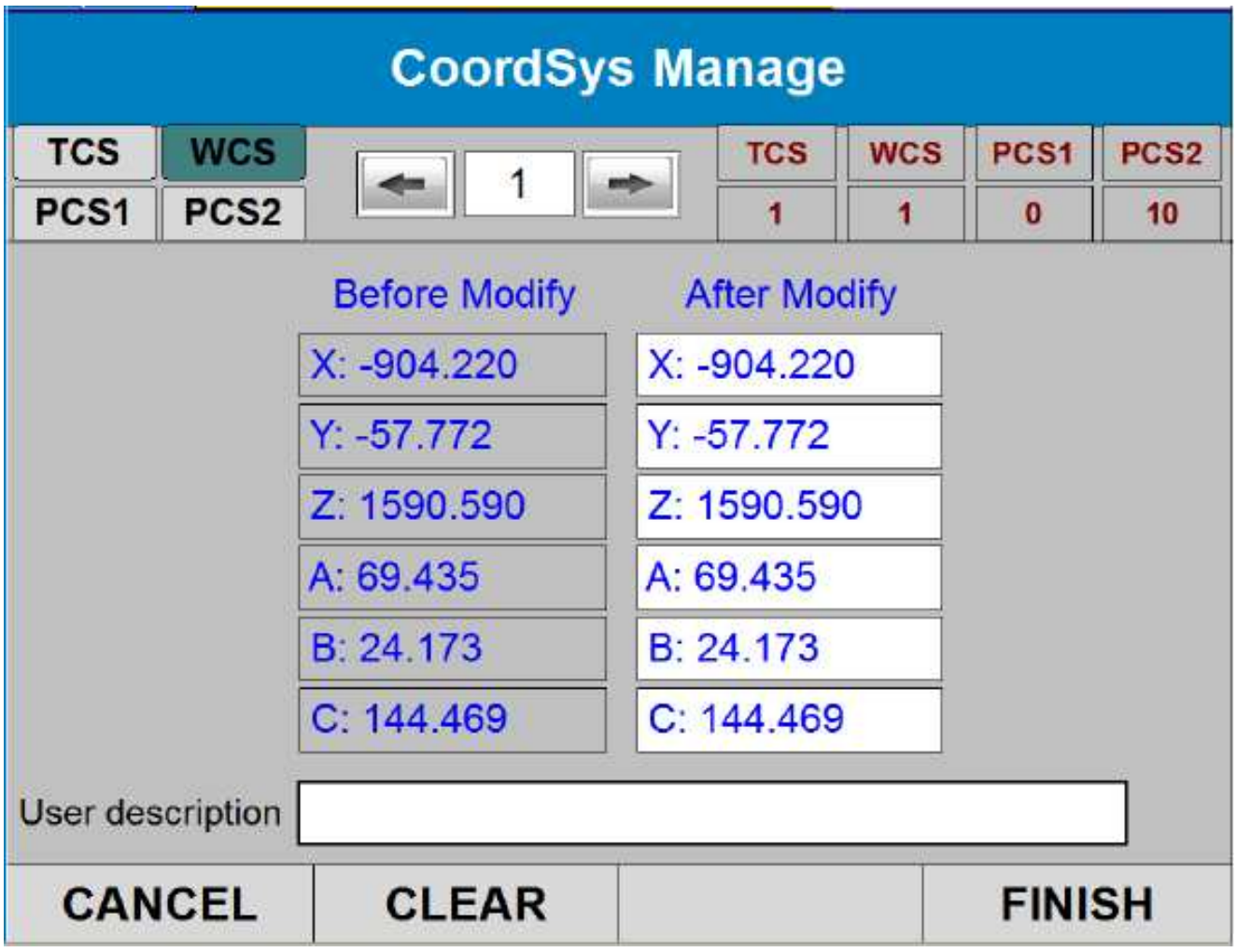
There are four function buttons in the lower part.

{Copy} is used to copy the selected (X, Y, Z, A, B, C) data of the coordinate system. After data are copied successfully, user can modify the data manually and perform copy operation in the interface.

Chapter 9 Coordinate System

When the currently used coordinate system item number of the robot system is different from that of the user selected operation, the second button {Set as current} will be effective. User can set the currently operated coordinate system as the robot coordinate system by pressing and holding the {SetCurrent} button for 1 second.

{MODIFY} button can be used to modify the coordinate system data manually. The manual modifying operation interface is shown below:



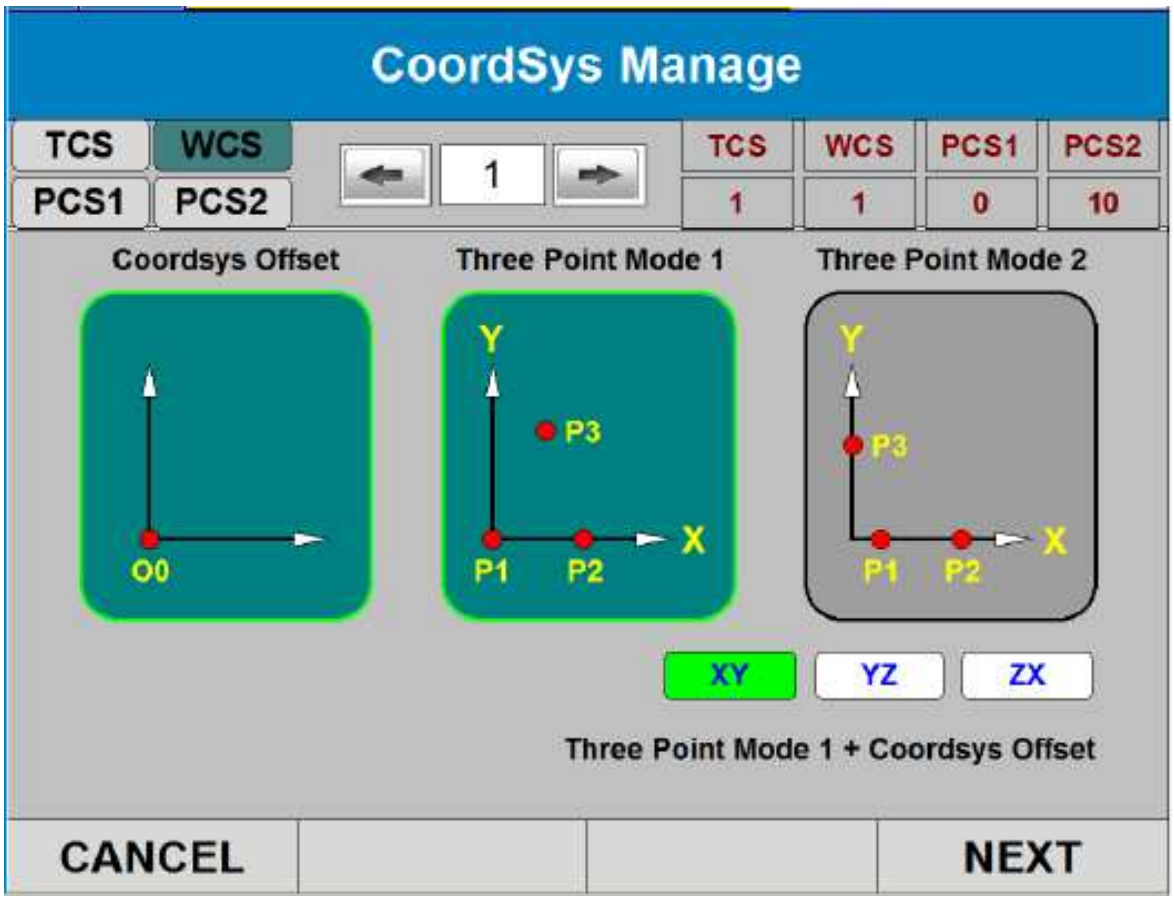
Coordinate system manual modifying management

User can clear the data of the coordinate system in the interface, input the expected data manually, or paste copied data from coordinate system of other item numbers. User can input annotation corresponding to the coordinate system data in the {User description} field.

When the {FINISH} button is pressed, the refreshing of the coordinate system data can be realized. When the {CANCEL} button is pressed, the manual modifying of the coordinate system data will be canceled.

By clicking the {Set} button of the coordinate system management main interface, user can enter the coordinate system teaching calibration management interface.

User has to select the calibration method first when starting the coordinate system calibration as shown in the below figure:



Three-point method mode and XY/YZ/ZX plane selection

When {Three Point Mode 1} is used, the three teaching points are: origin P1, a point P2 on the X-axis (Y-axis or Z-axis) positive axis direction, a point P3 on the plane XY (plane YZ or plane ZX). For this teaching method, the origin of the coordinate system is at point P1, positive direction of X-axis (Y-axis or Z-axis) is pointing to point P2 from point P1, and P3 is located on the position direction side of Y axis (Z-axis or X-axis).

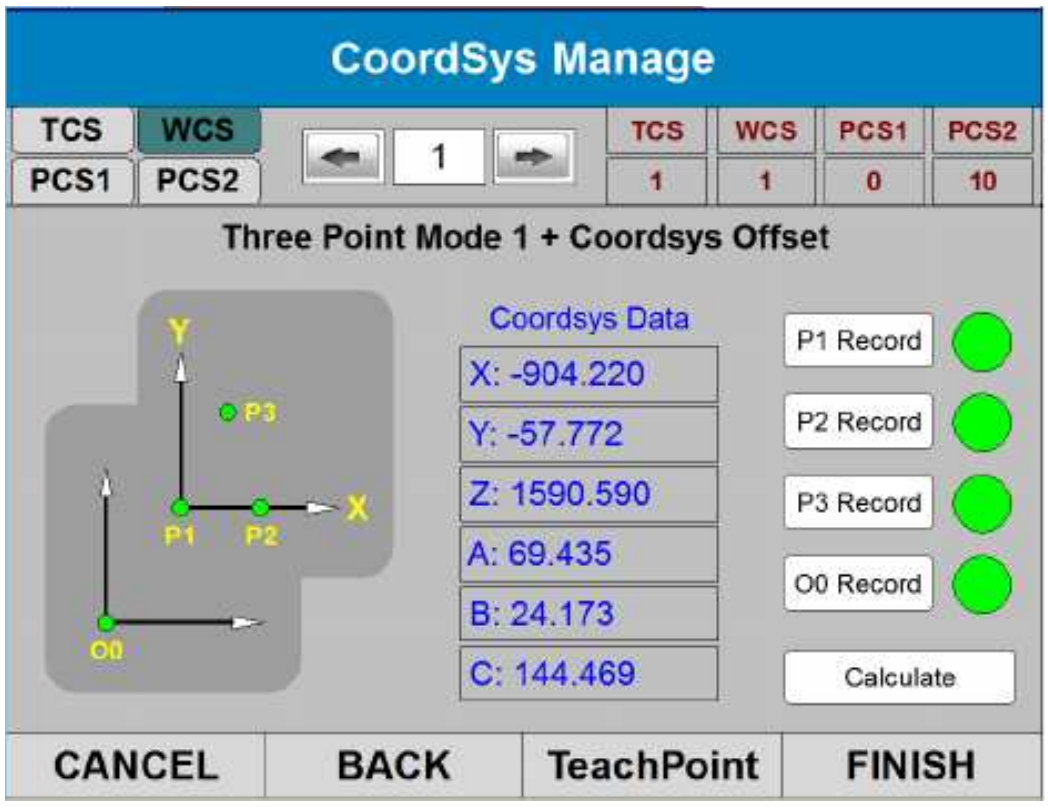
When {Three Point Mode 2} is used, the three teaching points are: a point P1 and another point P2 on the X-axis (Y-axis or Z-axis), a point P3 on Y-axis (Z-axis or X-axis). The line is perpendicular to P1P2 and passes P3, of which the foot point is the origin of the coordinate system. For this teaching method, the positive direction of X-axis (Y-axis or Z-axis) is pointing to point P2 from point P1, and point P3 is located on the positive Y-axis (Z-axis or X-axis).

Furthermore, user can add a point O0 to record the coordinate origin offset position point. This position point is optional. When the user needs to use this function, the origin of the above two coordinate systems can be shifted to the recorded O0 position point.

User can also select to record one coordinate origin offset position point O0. By doing this the origin will be shifted to the teaching recorded O0 position point, and the pose of the coordinate system will remain unchanged.

User can select the teaching coordinate system plane by pressing the {XY}, {YZ}, {ZX} buttons in the interface.

After selecting the teaching method, click {Next step} to enter the coordinate point record interface as shown below:



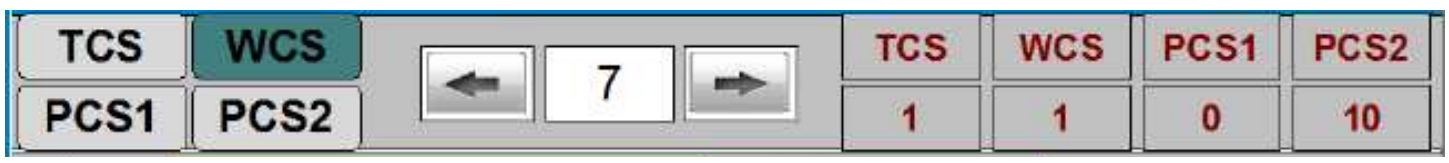
Coordinate system teaching records

According to the various teaching method selected, 1, 3 or 4 record buttons may appear in the interface. All the indicating lights besides the record buttons must turn green before entering the coordinate system for calculation operation is allowed. Otherwise, the "Calculate" button will not appear.

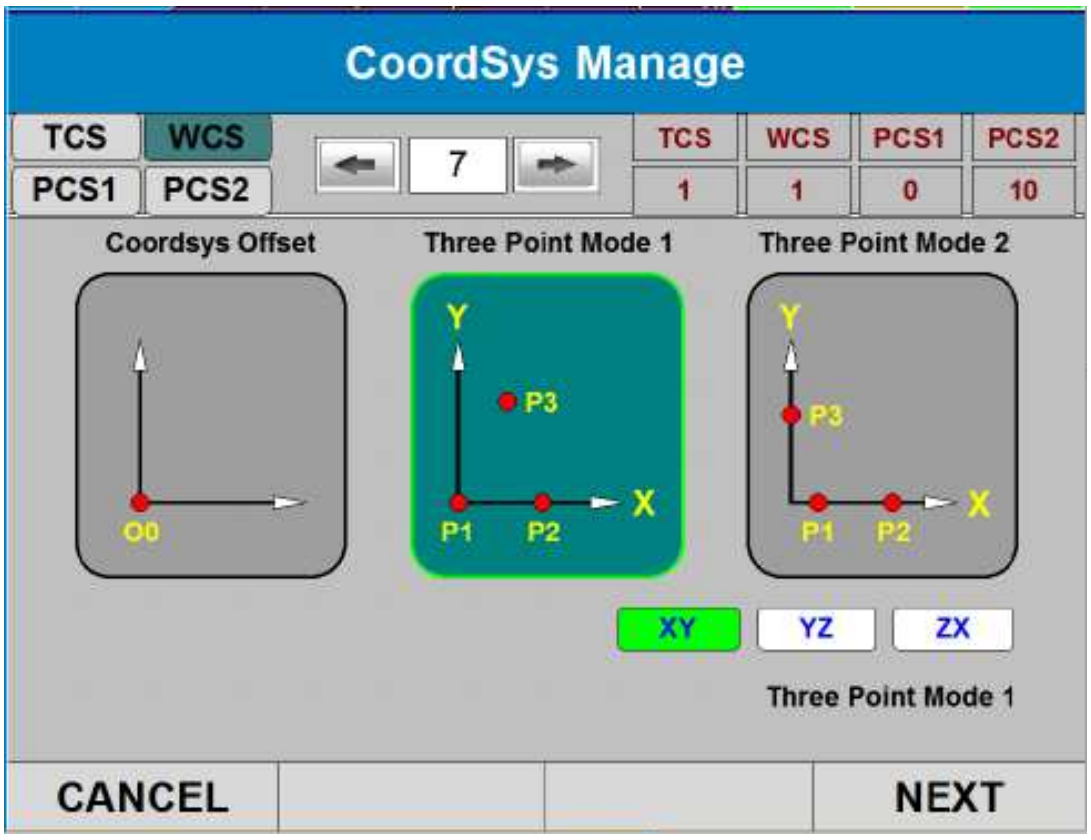
When recording position points data, please make sure it is in the servo power connected status. The corresponding record button should be pressed and held for over 2 seconds until the indicating light besides the record button turns green. If position point P is recorded, press and hold the corresponding {P record} button for 2 seconds. The datum in P record will be cleared and the adjacent indicating light will turn grey. The datum needs to be re-recorded (P represents any arbitrary point P1, P2, P3 or O0).

As an example, if user selects the "Three Point Mode" to teach the number 7 coordinate system of WCS, the steps are as follows:

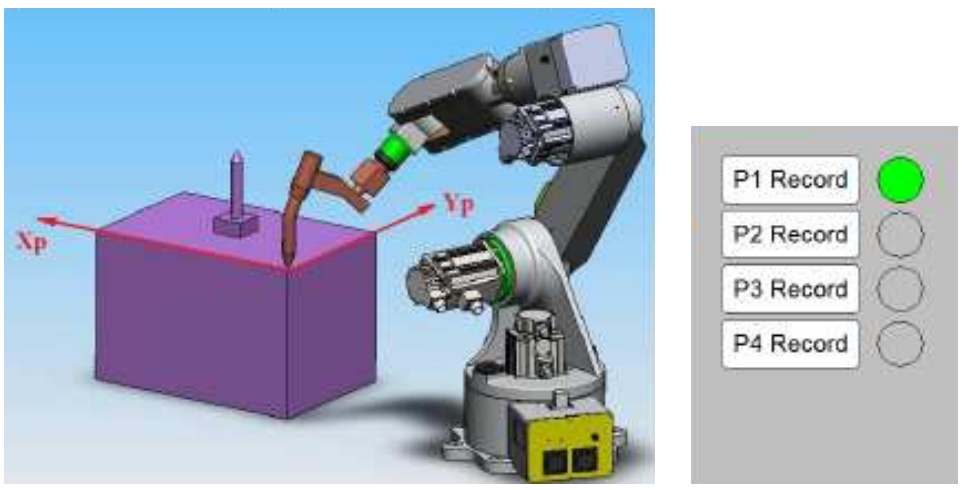
Step 1: Select WCS and number 7 coordinate system from the coordinate system option tab, then click {Set} button to enter the interface.



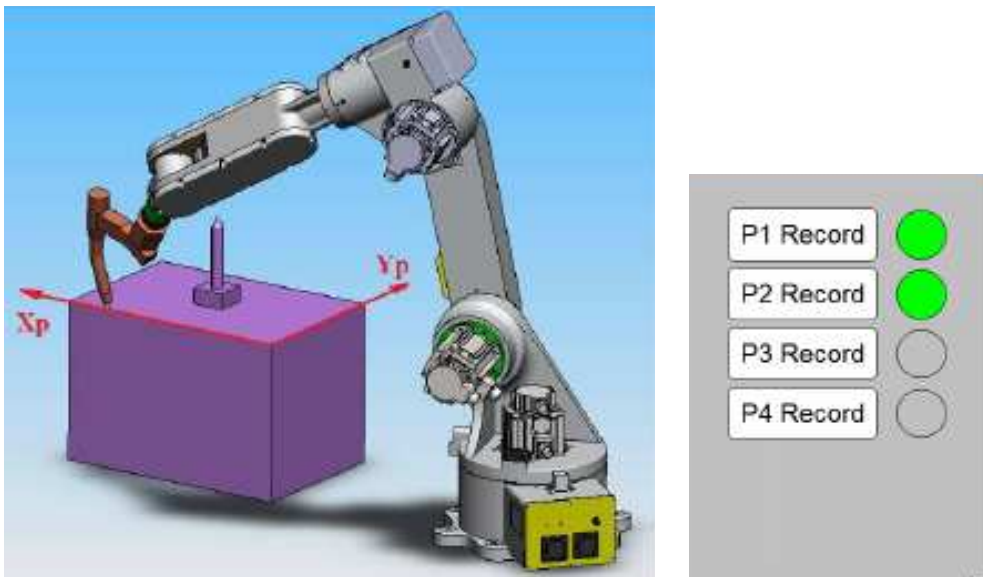
Step 2: Make sure {Three Point Mode 1} is in selected status, and the origin offset function is not used; Use XY plane method. Click {NEXT} to enter the position point record interface.



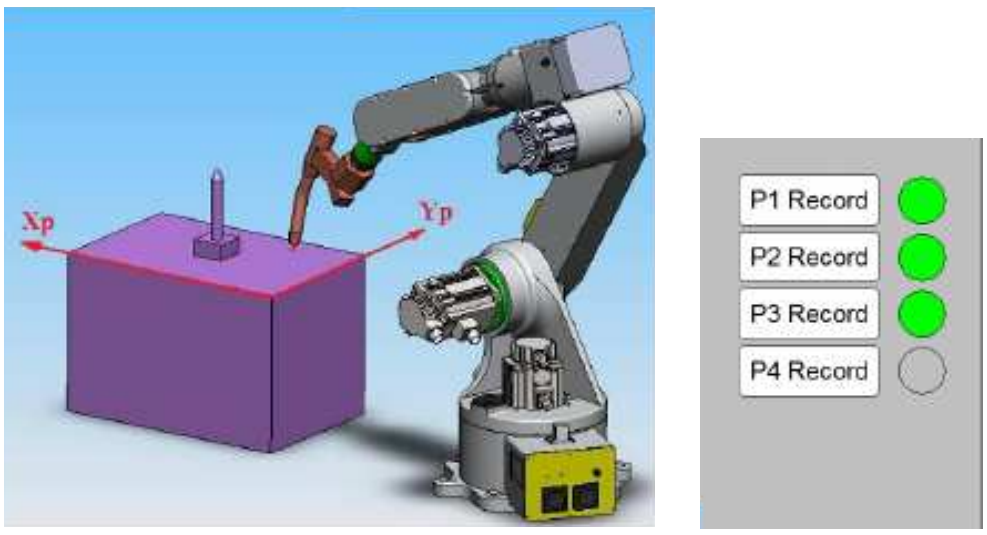
Step 3: Move the TCP to the origin of the coordinate system that is to be set, and keep the servo power in connected status. Click and hold the {P1 record} button until the record complete indicating light turns green, record the point as P1 position point;



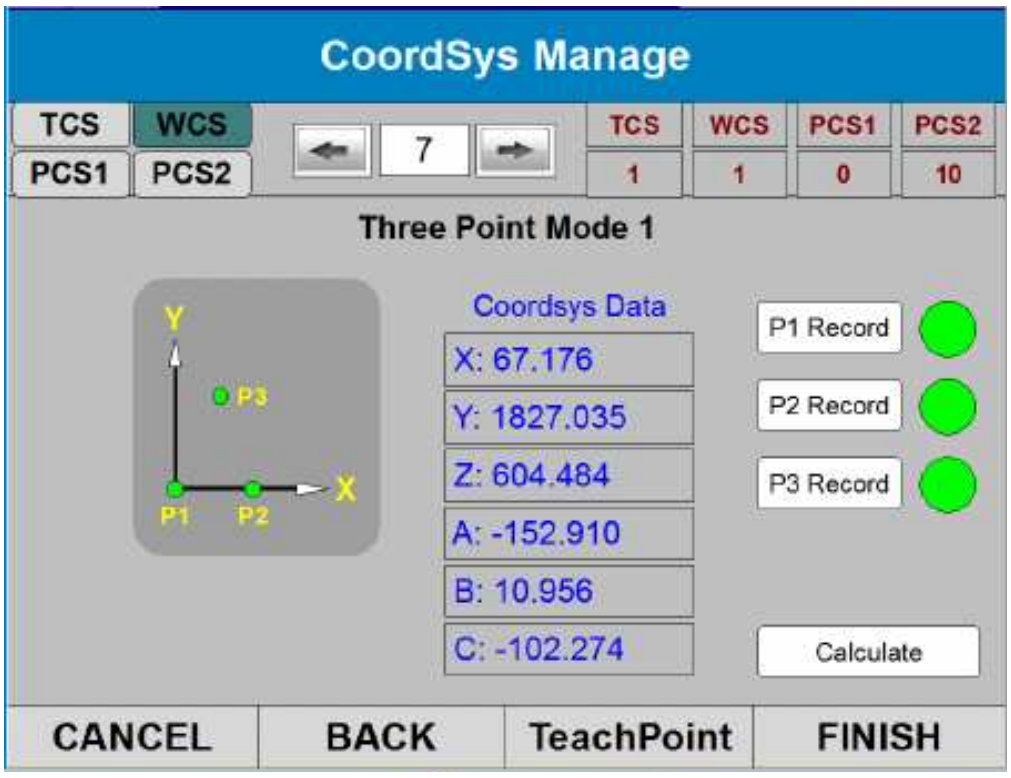
Step 4: Move the TCP to the X-axis positive direction of the coordinate system that is to be set, and maintain the servo power in connected status. Click and hold the {P2 record} button until the record complete indicating light turns green, record the point as P2 position point;



Step 5: Move the TCP to a point on the positive Y-axis of the XY plane to be set, and keep the servo power in connected status. Click and hold the {P3 record} button until the record complete indicating light turns green, record the point as P3 position. After point P3 is recorded successfully, the "Calculus" button will appear and it is operable now.

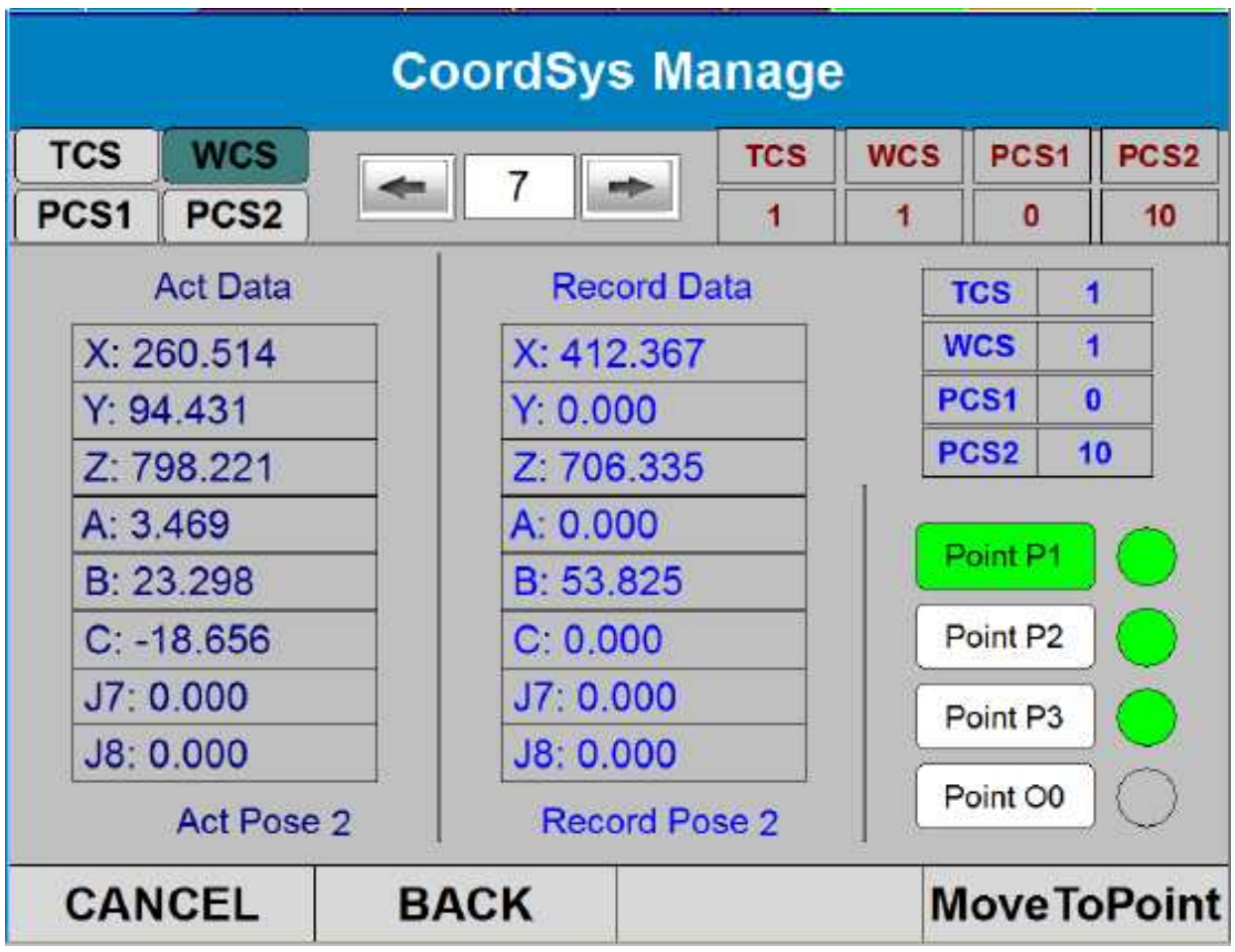


Step 6: Click the {Calculate} button to finish the coordinate system data calculation.

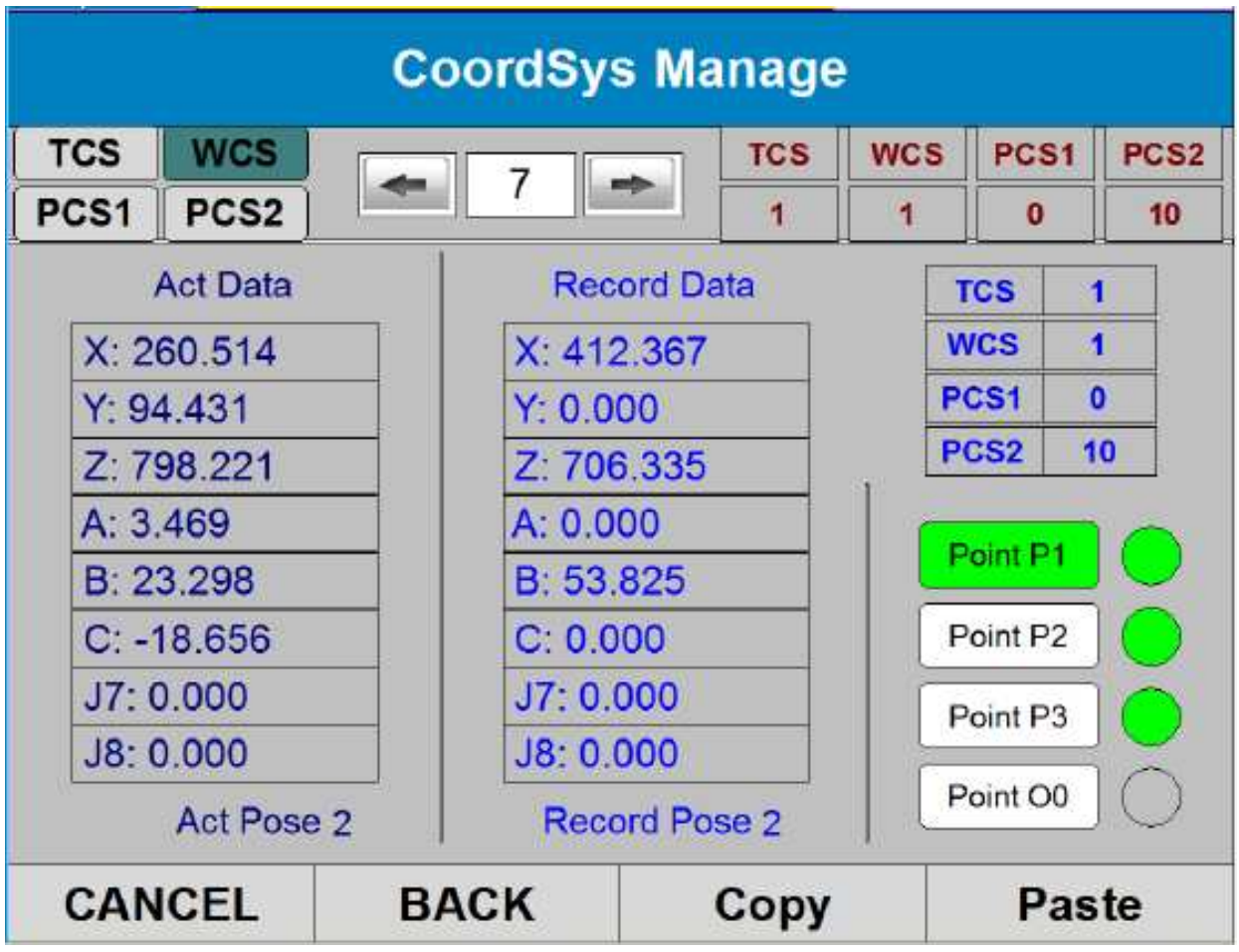


Step 7: Click the {FINISH} button to save the recorded teaching position point coordinate and calculated coordinate system data, and return to the coordinate system management main interface.

In position point record interface, click {TeachPoint} button to enter the teaching point management interface as shown in the below diagram. In this interface, user can check the recorded position point data, and move the robotic arm to the designated record point. To carry out this operation, a recorded position point such as {P1 position point} is selected. The robot is put to servo enabled status. The {MoveToPoint} button will appear. User can click the button manually and the robotic arm will move towards the designated position point in linear motion mode. Please note that when the real time coordinate data interface bottom part - "Real time pose" display and the record point coordinate data lower part - "Record point pose" are inconsistent, the robotic arm will not move towards the motion record point. System will report pose inconsistency error. As under this situation motion needs to pass the singularity point of the robot, such as the 5th axis of the 6-axis robot passes through zero point position.



When the robot system is not in servo enabled status, the bottom part of the teaching point management interface will change like the below diagram. When user selects a calibrated position point of a record, the selected position point coordinate will be copied as a backup; Note: Any arbitrary copied position point data of any index number in WCS can be pasted to another different index number in WCS, but not PCS1, PCS2 or TCS; Copied Data in PCS1 or PCS2 can be used freely within these two coordinate systems, but not in WCS or TCS; Copied data in TCS can only be used in TCS.



At this point, all the setting work of number 7 WCS has been completed. User can operate the robot manually in teaching mode (in re-calculated defined WCS).

Attention

- In order to improve the accuracy of the WCS, the pose of teaching points P1, P2, and P3 should remain unchanged – It is better to use translation motion to teach these three points in Cartesian space (i.e. to move in translation motion along XYZ axes of KCS, WCS, PCS1, PCS2, TCS, but not rotational motion around XYZ axes or single joint rotation in ACS). In addition, the three points should not be too close so that the teaching coordinate can reflect the actual coordinate system more accurately. The same requirement applies to that in PCS1 and PCS2.

9.5 Tool Coordinate System, TCS

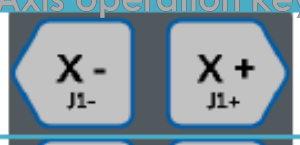
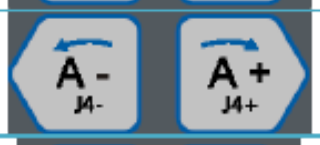
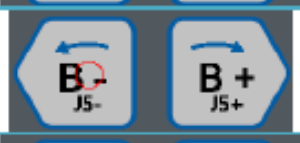
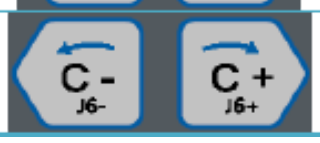
The tool administration interface is mainly used for the administration of robot tip flange

installed tool.

9.5.1 Axial action

When it is configured as TCS, the robot control points will translate parallel to X, Y, and Z axes. Please refer to the following table for the action of each axis when the axial operation keys are pressed and held:

Axis action of TCS

Name of axis		Axis operation key	Action
Translation axis	X-axis		Parallel translation motion along the X-axis of TCS
	Y-axis		Parallel translation motion along the Y-axis of TCS
	Z-axis		Parallel translation motion along the Z-axis of TCS
Rotation axis	Rotation around X-axis		Rotation motion around the X-axis of TCS
	Rotation around Y-axis		Rotation motion around the Y-axis of TCS
	Rotation around Z-axis		Rotation motion around the Z-axis of TCS

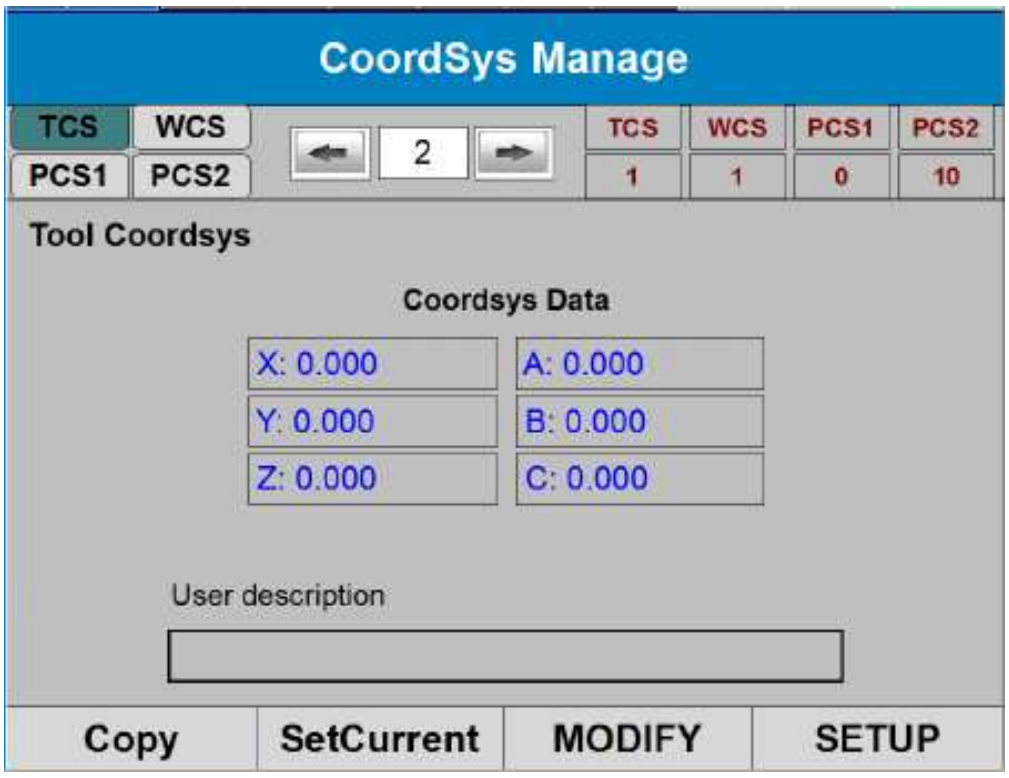
When two or more axis operation keys are pressed simultaneously the robot will perform composite action. However, when two keys of opposite direction in the same axis are pressed at the same time (such as [X-]+[X+]), there will be no axis action.

The effective direction of the robot wrist flange holding the tool is defined as Z-axis in TCS. The origin is defined as the tool center point (TCP). The pose of the TCS changes according to the movement of the wrist.

The movement in TCS is with reference to the effective direction of the tool and not related to the position and pose of the robot. It is therefore suitable for parallel translation motion operation of tool pose (workpiece that doesn't change the tool pose).

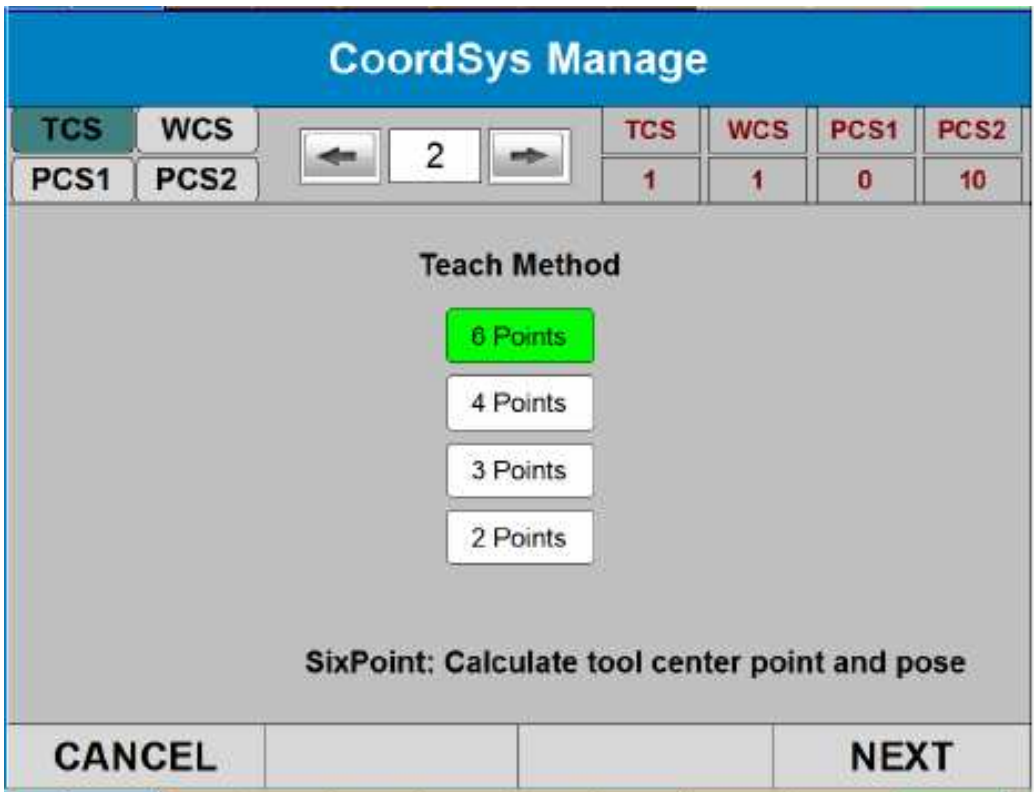
9.5.2 Tool coordinate system calibration

The tool coordinate system calibration administration interface is shown below. User can enter the calibration interface via the submenu {Coordinate System Manage} under the menu {ROBOT}.



The TCS management main interface is identical with that of the WCS, user performs copy, modify, set current and other operation with selected item number of TCS.

Click {SETUP} button to enter the TCS calibration setup operation interface



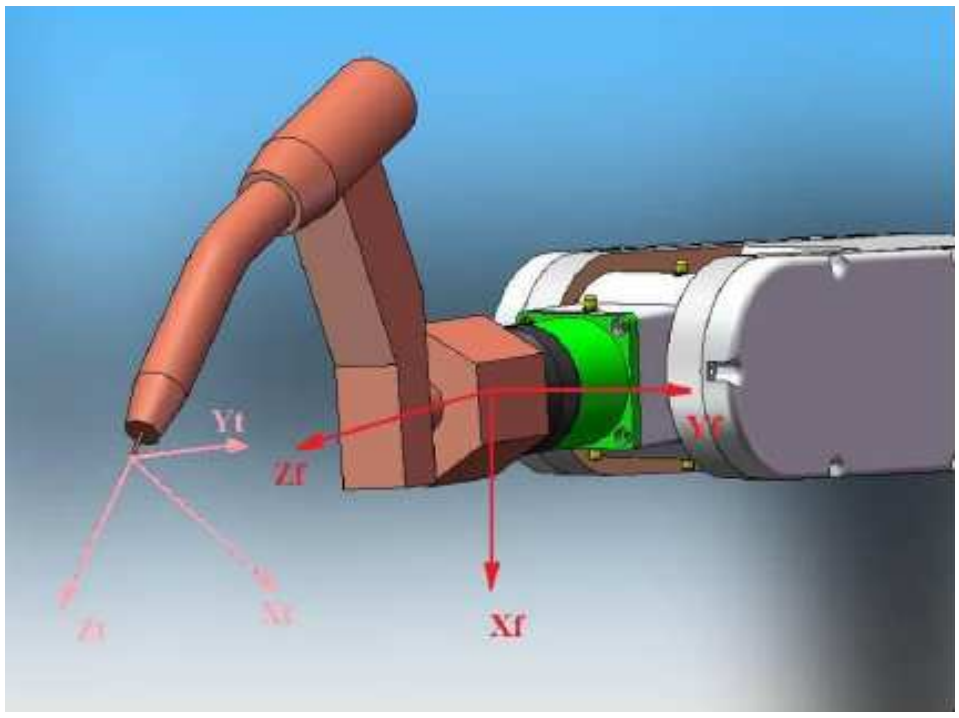
Depending on different robot types, the TCS calibration method includes {2 Points}, {3 Points}, {4 Points} and {6 Points}. The SCARA 4-axis robot or Delta 3-axis (or 4-axis) robot usually uses {2 Points} to calibrate its flange, while the conventional 6-axis robot can use all the 4 methods for TCS calibration.

{6 Points} can teach the position offset and pose component of the 6-axis robot TCP together; {4 Points} can only calculate the position offset value of the 6-axis robot TCP, but not the pose component; {3 Points} can calculate the TCP pose component of the 6-axis robot,

but not the position offset value. {6 Points} is the actually the combination application of {4 Points} and {3 Points}. The first four recorded position points of {6 Points} adopt {4 Points} to calculate the TCP position offset, while the last three position points adopt {3 Points} to calculate the tool TCP pose component.

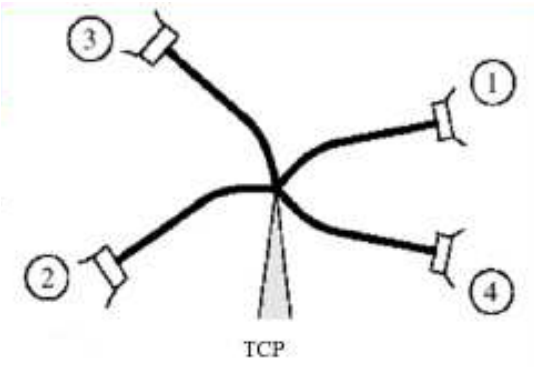
{2 Points} is a quick and convenient teaching method for TCP position and pose. When this method is adopted, a known tool (or no tool is used) is used to move the TCP to a confirmed position and pose, and the known position and pose value is recorded as P1 position point; the tool that needs to be aligned and calibrated will then be installed in the flange end face, it un-calibrated TCP is moved to the previously recorded point P1, and its pose will be identical to that of P1. It is recorded as point P2. The system will automatically calculate the un-calibrated robot flange position offset and pose component according to these two position points.

The coordinate system of the robot tip flange and its installed tool is shown in the below diagram:



The operation and principle of {2 Points} are relatively simple so it will not be introduced in detail. Below is the calibration steps for common {3 Points}, {4 Points} and {2 Points} of 6-axis robot.

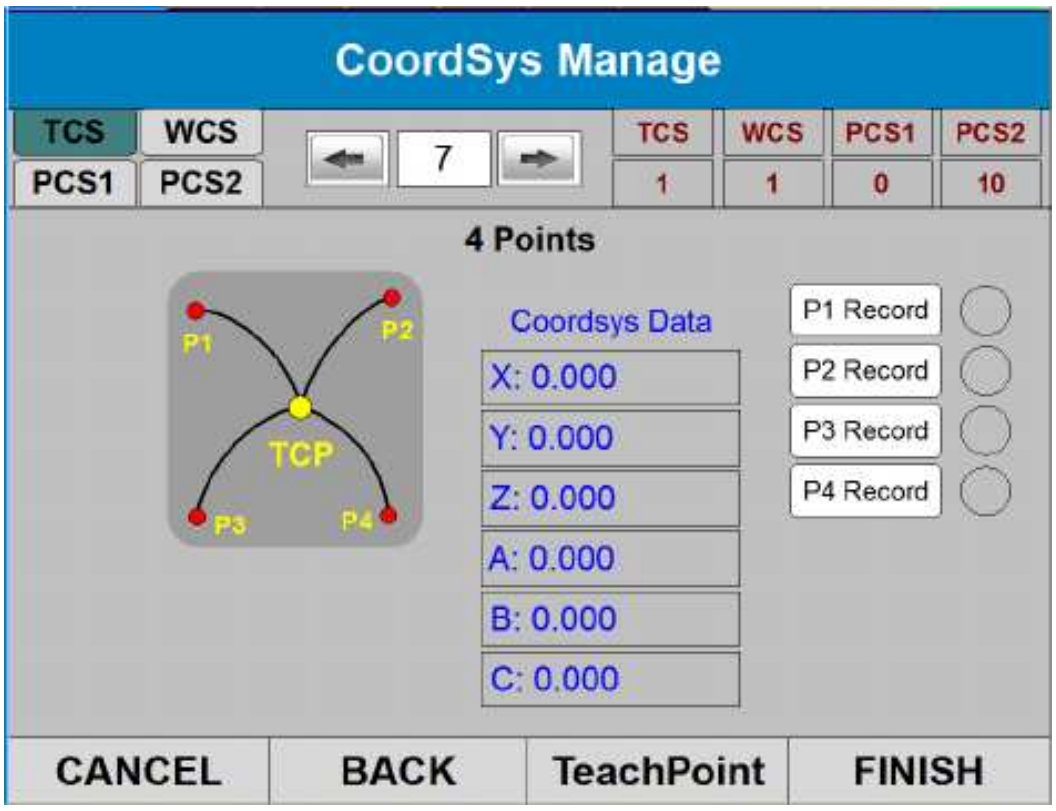
When using the four-point method, a reference point is approached from four arbitrary different directions with the TCP of the tool that is going to be tested. The reference point can be selected randomly, but it must be fixed. The TCP is calculated by the robot controller from four different flange positions. The four flange positions of the robot TCP movement to reference points must be scattered with enough distance so that the calculated TCPs are accurate enough.



Four-point method diagram

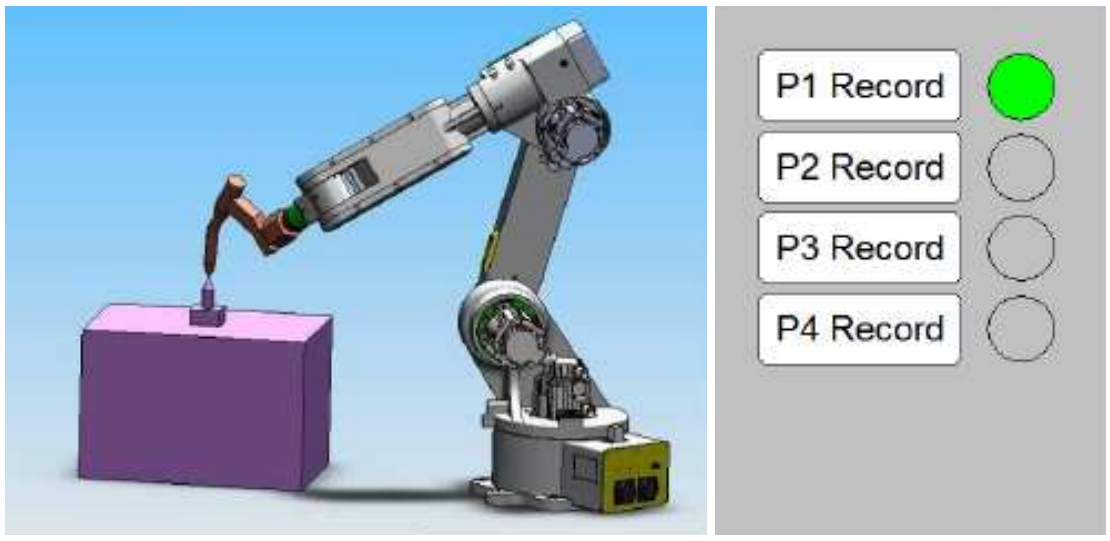
Steps for four-point teaching and calculating TCP position:

Step 1: Select the coordinate system index number that is going to be refreshed, e.g. number 7 TCS in this example, select four-point method teaching mode.



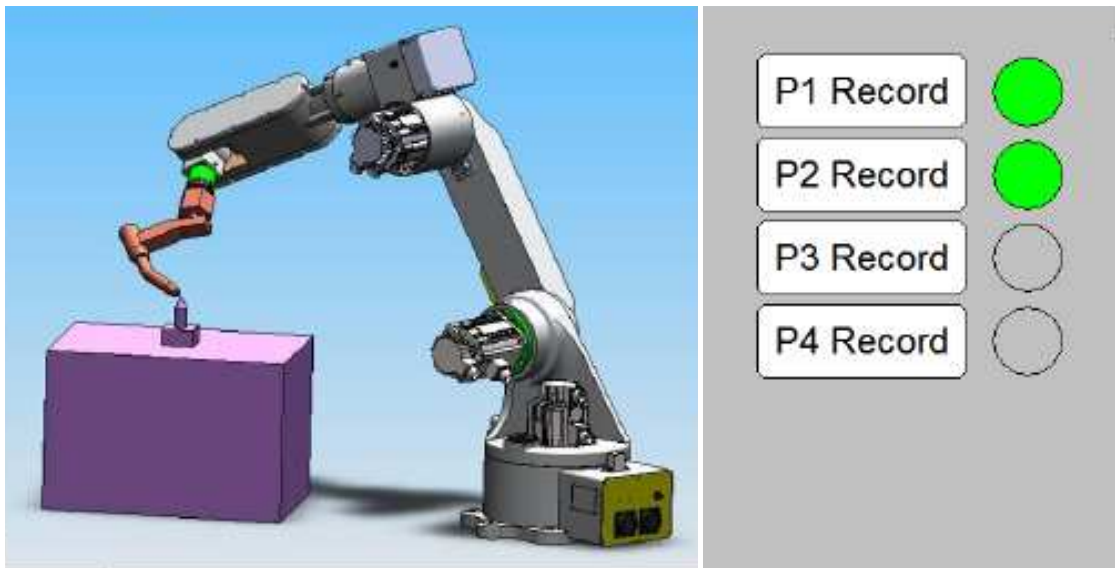
Four position points needs to be recorded for four-point method.

Step 2: A fixed reference point is approached from the first direction with the TCP of the tool that is going to be tested. Press the {P1 Record} button with the servo power connected to record the first position point. The record button is of delay trigger type and needs to be pressed and held for about 2 seconds for it to become effective. The indicating light besides the button will change from grey to green after point P1 is recorded. If it's re-recorded, then it will change from green to grey, then green.



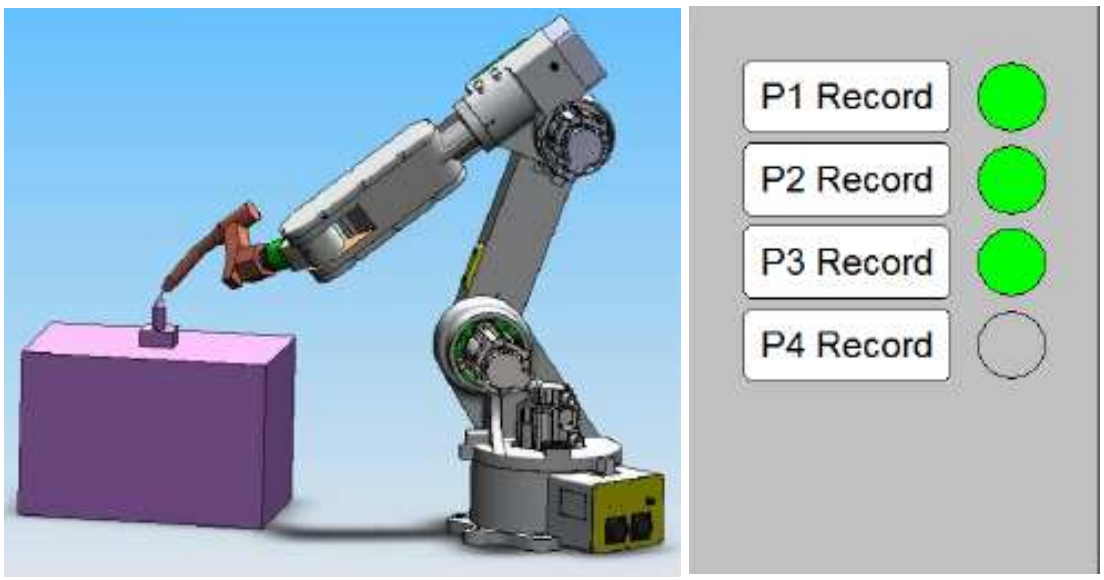
Teaching record point P1

Step 3: A fixed reference point is approached from the second direction with the TCP of the tool that is going to be tested. Press the {P2 Record} button with the servo power connected to record the second position point. The record button is of delay trigger type and needs to be pressed and held for about 2 seconds for it to become effective. The indicating light besides the button will change from grey to green after point P2 is recorded. If it's re-recorded, then it will change from green to grey, then green.



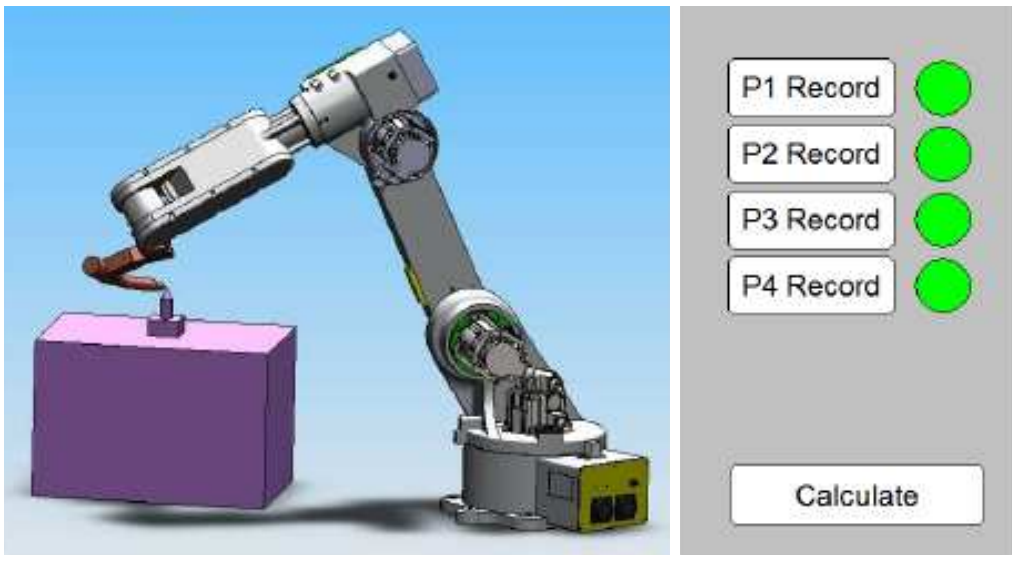
Teaching record point P2

Step 4: A fixed reference point is approached from the third direction with the TCP of the tool that is going to be tested. Press the {P3 Record} button with the servo power connected to record the third position point. The record button is of delay trigger type and needs to be pressed and held for about 2 seconds for it to become effective. The indicating light besides the button will change from grey to green after point P3 is recorded. If it's re-recorded, then it will change from green to grey, then green.



Teaching record point P3

Step 5: A fixed reference point is approached from the fourth direction with the TCP of the tool that is going to be tested. Press the {P4 Record} button with the servo power connected to record the fourth position point. The record button is of delay trigger type and needs to be pressed and held for about 2 seconds for it to become effective. The indicating light besides the button will change from grey to green after point P4 is recorded. If it's re-recorded, then it will change from green to grey, then green.



Teaching record point P4

Step 6: After the recording of four positions points of {4 Points} is complete, the {Calculate} button will appear and be operable. Click the {Calculate} the TCP position data will be automatically calculated and the result will be displayed. The "Calculate" button is a delay-triggered type one. It needs to be pressed and held for about 2 seconds before it becomes effective.

Note: If two or more identical position points for four-point method are recorded, the calculation cannot be successful and the program will report error.

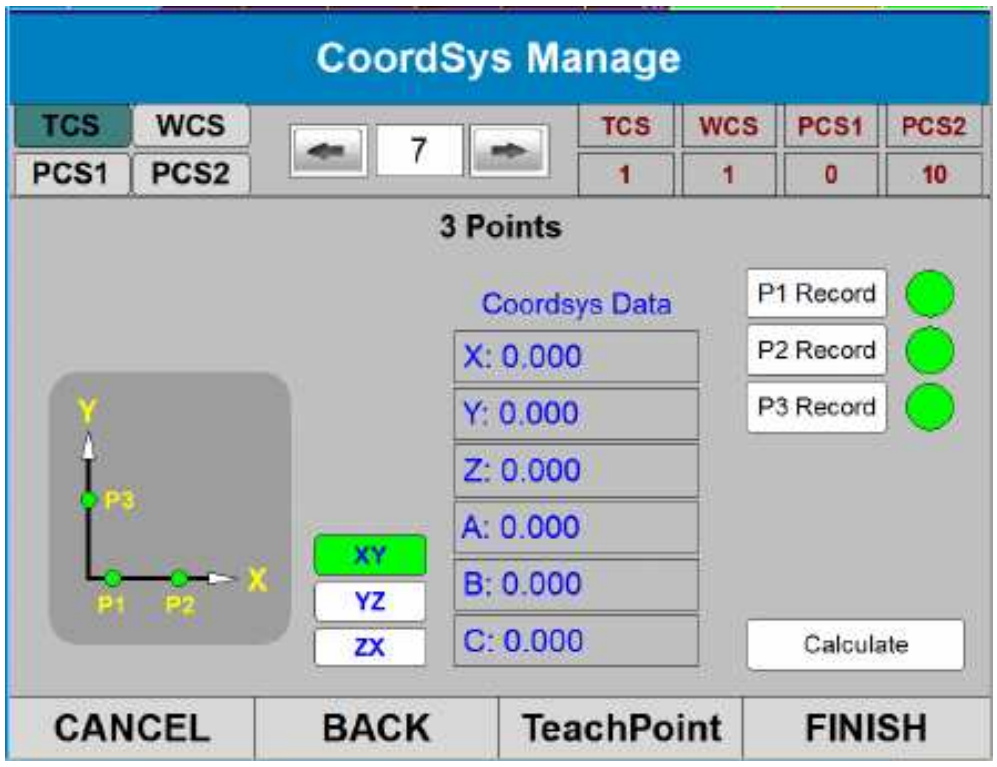
Step 7: Click {FINISH} button, save the recorded teaching position points coordinate and calculate the coordinate system data, return to the coordinate management main interface.

Step 8: Click the {SetCurrent} button and use the newly calculated TCP tool as flange tip tool. Up to here, all the steps are finished. TCS calculation and switch is successful. Various types of robot motion can be performed in the new tool.

Note: Only the TCP relative to the position offset value of the robot tip flange installed side can be determined for using four-point method. If the user needs to teach the determined tool pose **component, then three-point method is also needed or six-point method is used directly.**

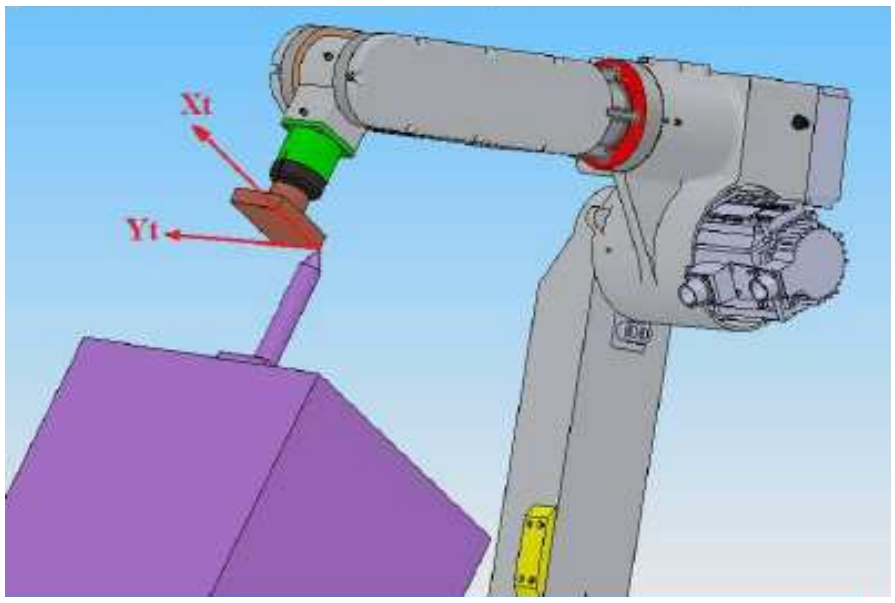
The steps for the pose component of {3 Points} teaching and computing TCS are as below:

Step 1: Select the item number of the TCS that needs to be modified or refreshed, e.g. number 7 TCS; Select 3-point method operation mode. In this working mode, 3 position points are needed to be recorded (points P1, P2 and P3). In addition, user needs to select the plane for the teaching points as shown below (plane XY, i.e. teaching points P1 and P2 are used to ensure the X-axis direction of TCS, while point P3 is in the positive Y-axis of the TCS XY plane. As the 3-point method is for the confirmation of TCP pose component, the teaching XY plane is only required to be parallel to the actual TCS XY plane. It doesn't have to be in the TCS XY plane. Point P1 is the selected point in the X axis of the XY teaching plane. It doesn't have to be the TCP point (origin of TCP). It is the same for points P2 and P3.



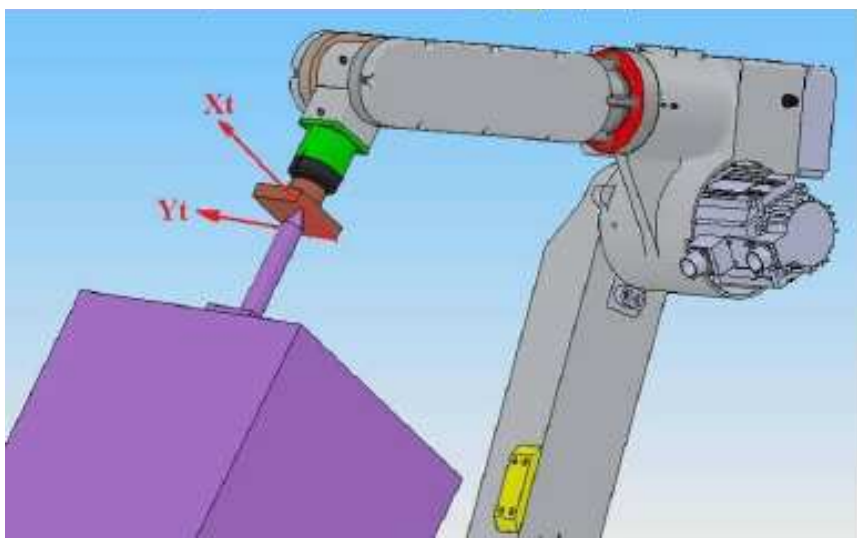
Selecting 3-point method operation mode

Step 2: As shown in the below diagram, first record the first point, i.e. point P1, of the X-axis in TCS.



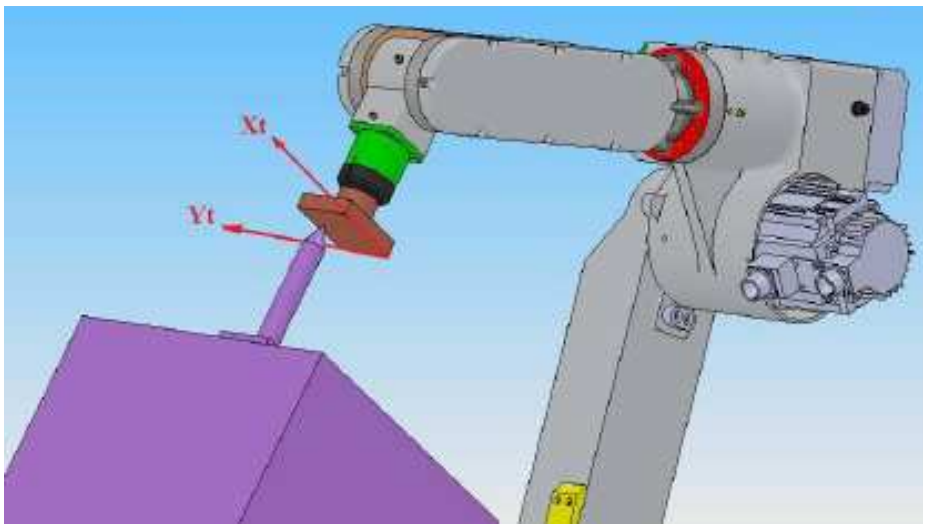
Recording point P1 (first point P1 on the positive direction of X-axis)

Step 3: Record the second point P2, of the X-axis on TCS.



Recording point P2 (second point P2 on the positive direction of X-axis)

Step 4: Record a point P3 in the positive direction of Y-axis on plane XY.



Recording point P3 (A point in the positive direction of Y axis on plane XY)

Step 5: Click the {Calculate} button, the program will generate TCS pose data according to the recorded points P1, P2, and P3, and refresh the TCS pose component of the selected item number.

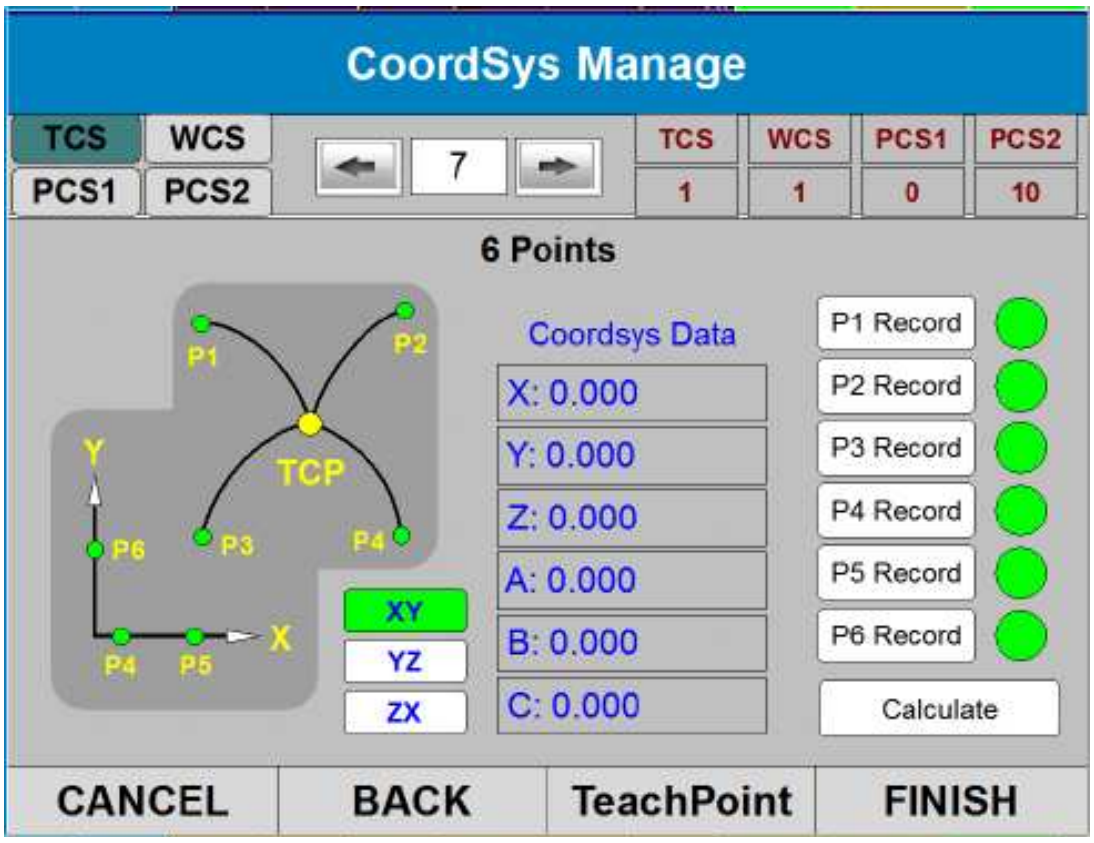
Note that when 3-point method (the three position points that needs to be recorded) is used to determine the tool pose, these three position points can only be taught via the translation movement in Cartesian space (i.e. translation movement in space XYZ of KCS, WCS, PCS1, PCS2, TCS but not rotation movement in space XYZ or single axis rotation movement under ACS). There should not be any rotation movement of pose teaching or the pose component of TCS cannot be computed and error warning will be prompted.

The 6-point method is the integration of the 4-point method and 3-point method. Points P1, P2, P3, and P4 need to be taught in 4-point method, while points P1, P2, and P3 need to be taught in 3-point method. The combination of 4-point method + 3-point method needs to teach 7 data points to determine the final position and pose components of the tool. When point P1 of 4-point method and 3-point method is coincided as a common point P, it becomes 6-point method. When 6-point method is adopted, point P4 is the actual TCP point of the TCS, so if plane XY (YZ or ZX) is adopted for teaching, then plane XY (YZ or ZX) must be the actual of TCS XY plane, not a plane parallel to plane XY (YZ or ZX). Point P5 must be a point on the positive X-axis (Y or Z axis) of actual TCS. Point P6 must be a point on the positive Y-axis (Z or X axis) in the actual TCS plane XY (YZ or ZX).

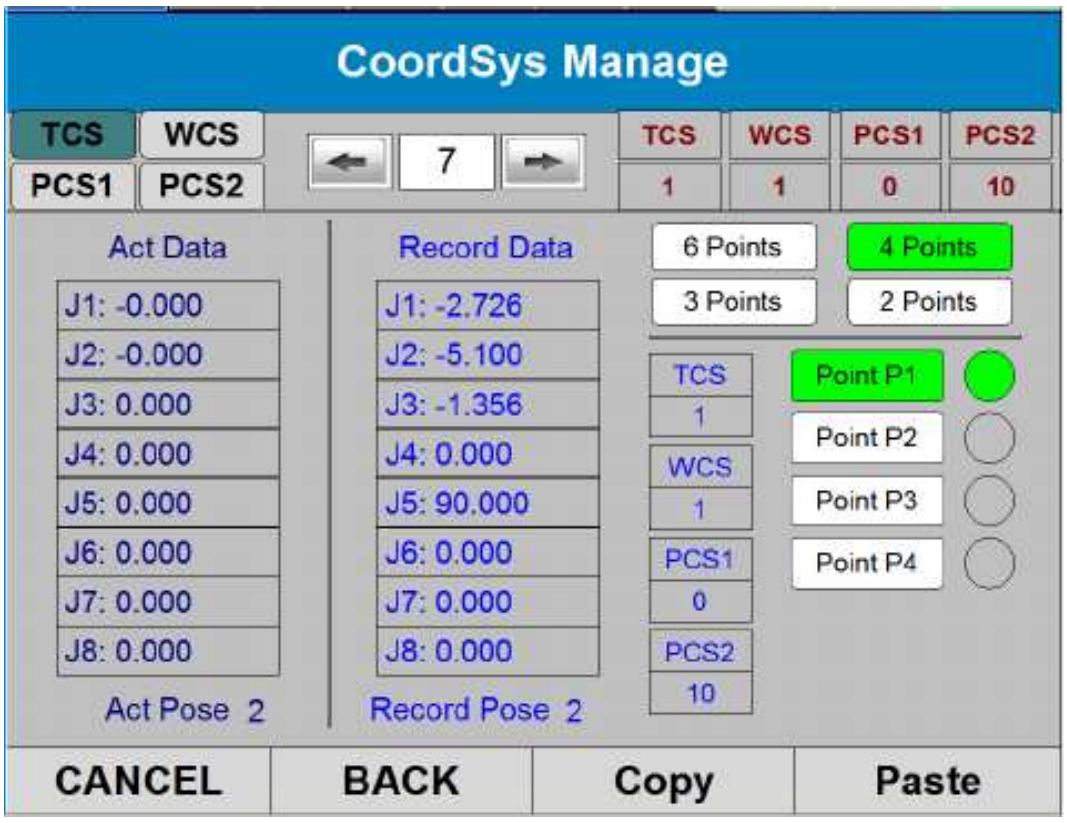
Note that when 6-point method is adopted to teach TCS, the pose of the three position points P4, P5, and P6 must be identical under KCS. Position points P5 and P6 can only be taught with parallel translational movement in Cartesian space (i.e. translational movement in

space XYZ under KCS, WCS, PCS1, PCS2 or TCS but not rotational movement in space XYZ or single joint rotational movement under ACS). There should not be any rotational movement of pose teaching or the pose component of TCS cannot be computed and error warning will be prompted.

The 6-point method teaching interface is shown below. Six points P1 to P6 are needed to be taught. User can refer to the teaching method of 4-point method for points P1 to P4 while that of 3-point method for points P5 and P6.

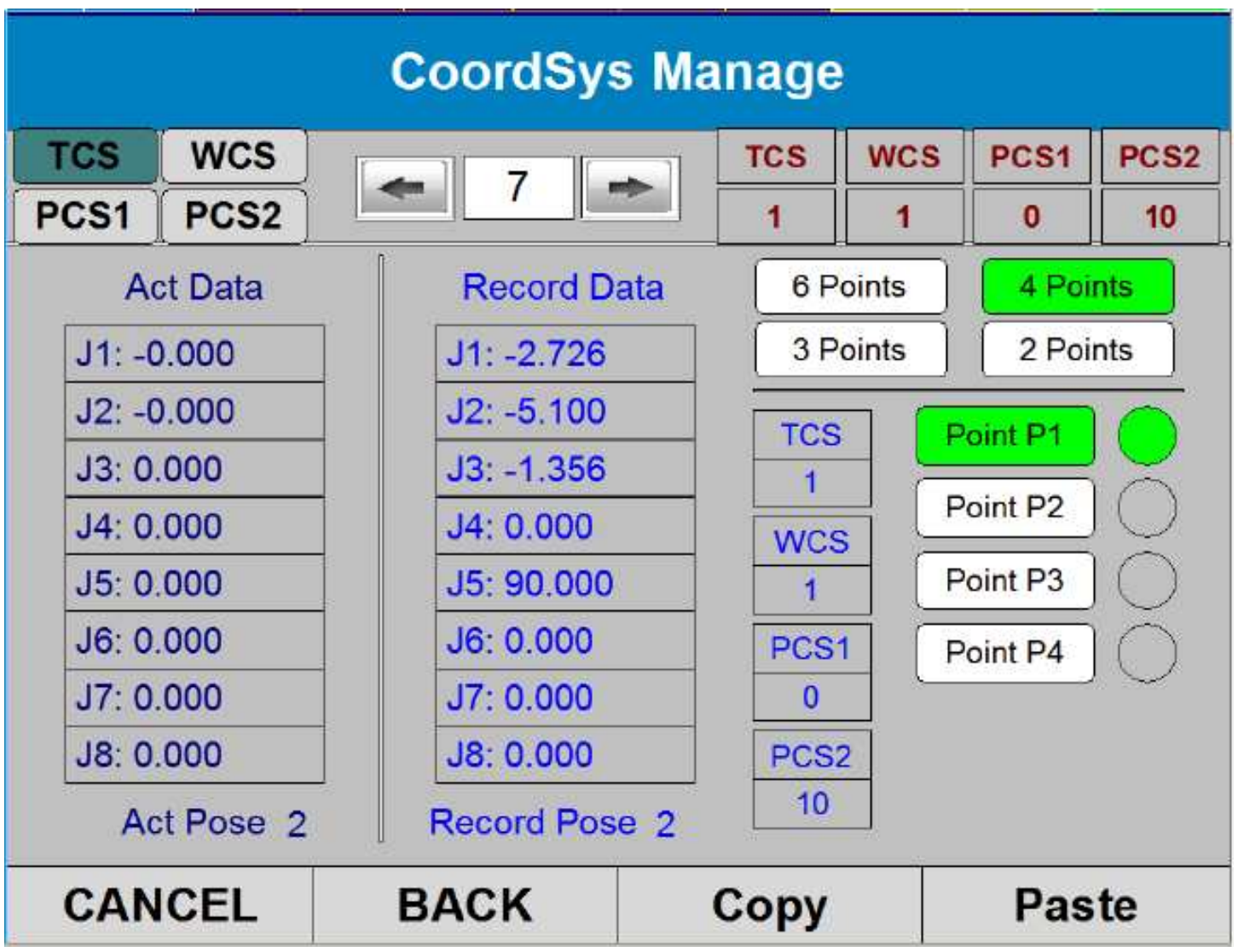


6-point method calibrating management interface is adopted for TCS



Teaching point management

In position point record interface, user can click the {Teaching point} button to enter the teaching point management interface. As shown in the above diagram, user can check the recorded position point data, and manipulate the robot to the designated record point. To carry out this operation, first select the recorded position point such as {P1 position point}, and make the robot in servo enabled status. The {MotionDestyPoint} button will appear. When user clicks the button manually, the robot will move towards the position point in straight line. Note that when the "actual pose" displaying at the bottom part of the real time coordinate data interface and the "record point pose" displaying at the bottom part of record point coordinate data are inconsistent, the robot cannot move towards the motion record point. System will report pose inconsistency error as the motion needs to pass the singular position point of the robot, for example, the 5th axis of the 6-axis robot will pass the zero point positon.



Teaching point management

When the robot is not in the servo enabled status, the buttons at the bottom part of the teaching point management interface will change as shown in the above diagram. When user selects a calibrated recording position point by clicking the {Copy data} button, the selected position point coordinate will be copied as a backup; When user click {Paste data},

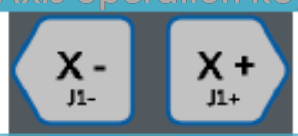
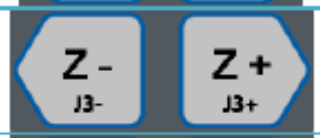
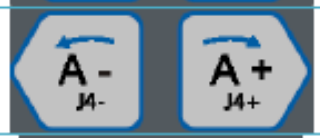
the copied position point data in {Copy data} will be pasted to the designated position points, Note: Any copied position point in any arbitrary WCS item number can be pasted to another item number of WCS, but can't be pasted to that of PCS1, PCS2 or TCS; The one from PCS1 or PCS2 can be used within any PCS1 or PCS2 item number, but can't be used in WCS or TCS; The one in TCS can be used in TCS only. {2 Points}, {3 Points}, {4 Points}, and {6 Points} of TCS can be interchanged when using.

9.6 PCS (PCS1 or PCS2)

9.6.1 Axis action

Under teaching mode, when the coordinate system is set as PCS1 (PCS2), the TCP of the robot translates in parallel with the X, Y, and Z axes of the PCS1 (PCS2) and rotates around the X, Y, and Z axes of the PCS1 (PCS2). When the axis operation keys are pressed, please refer to the below table for the action of each axis:

Axis action of PCS

Name of axis		Axis operation key	Action
Translation axis	X-axis		Parallel translation in X-axis of PCS1 (PCS2)
	Y-axis		Parallel translation in Y-axis of PCS1 (PCS2)
	Z-axis		Parallel translation in Z-axis of PCS1 (PCS2)
Rotation axis	Rotation around X-axis		Rotation motion around the X-axis of PCS1 (PCS2)
	Rotation around Y-axis		Rotation motion around the Y-axis of PCS1 (PCS2)
	Rotation around Z-axis		Rotation motion around the Z-axis of PCS1 (PCS2)

When two or more axis operation keys are pressed, the robot will perform composite action. However, if [X-]+[X+] keys of opposite directions in the same axis are pressed, there will be no axis action.

9.6.2 Example of TCS application

When configuring TCS for multiple clamp platforms, it is easier to operate manually.

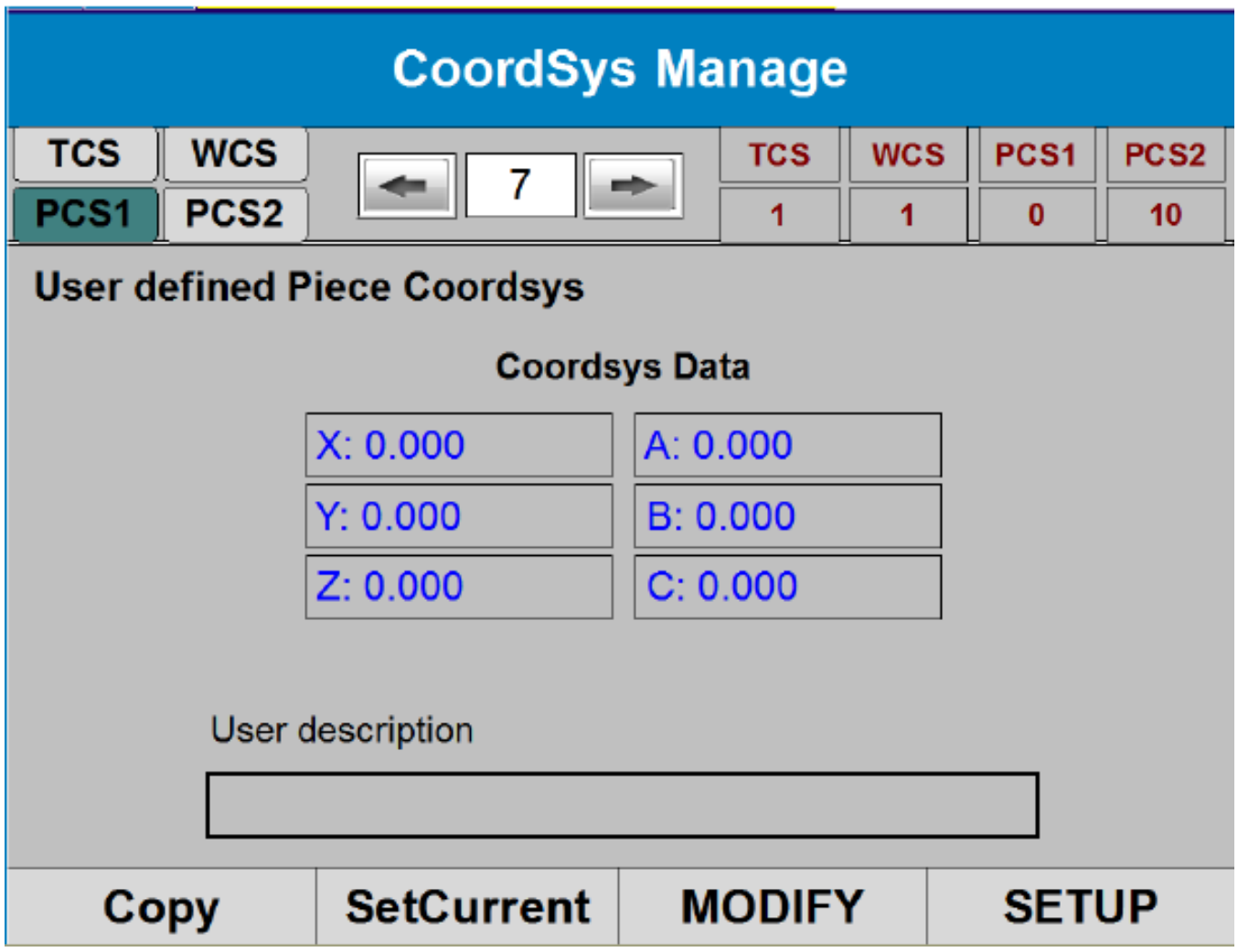
When performing placing or palletizing operation, if the TCS is configured on the tray, it will be easier to configured offset increment during parallel translational movement.

The moving direction of the conveyer belt can be assigned as the axis direction of TCS

during synchronous transmitting motion.

9.6.3 TCS calibration

The calibration management main interface of PCS1 (PCS2) is shown below. User can enter the interface via submenu {coordinate system management} under menu {ROBOT} and select PCS1 (PCS2) optional tab. The calibration process of PCS1 (PCS2) is identical to that of WCS. Please refer to the WCS calibration section for details.



9.7 Operation space monitoring

When the robot is in operation, there are usually some restrictions such as obstacles. (robot cannot bump into obstacles; robot motion is restricted in an area; or an I/O signal output to inform the peripheral devices is required when the robot enter a specific area, etc.) To satisfy these requirements, operation space monitoring function is provided in the robot system.

The operation space monitoring mainly targets three types of space: obstacle, operation area, and monitoring area.

Obstacle: It is a defined geometric body within the robot operation space. The tip of the robot cannot enter into the area. Once it enters, the robot will brake immediately and alarm will be triggered. When it comes close to the boundary area of the obstacle, it will reduce to a safe speed. The system supports a maximum of 32 defined obstacles. The entering of any activated obstacle range by the tip of the robot will trigger emergency braking and alarming.

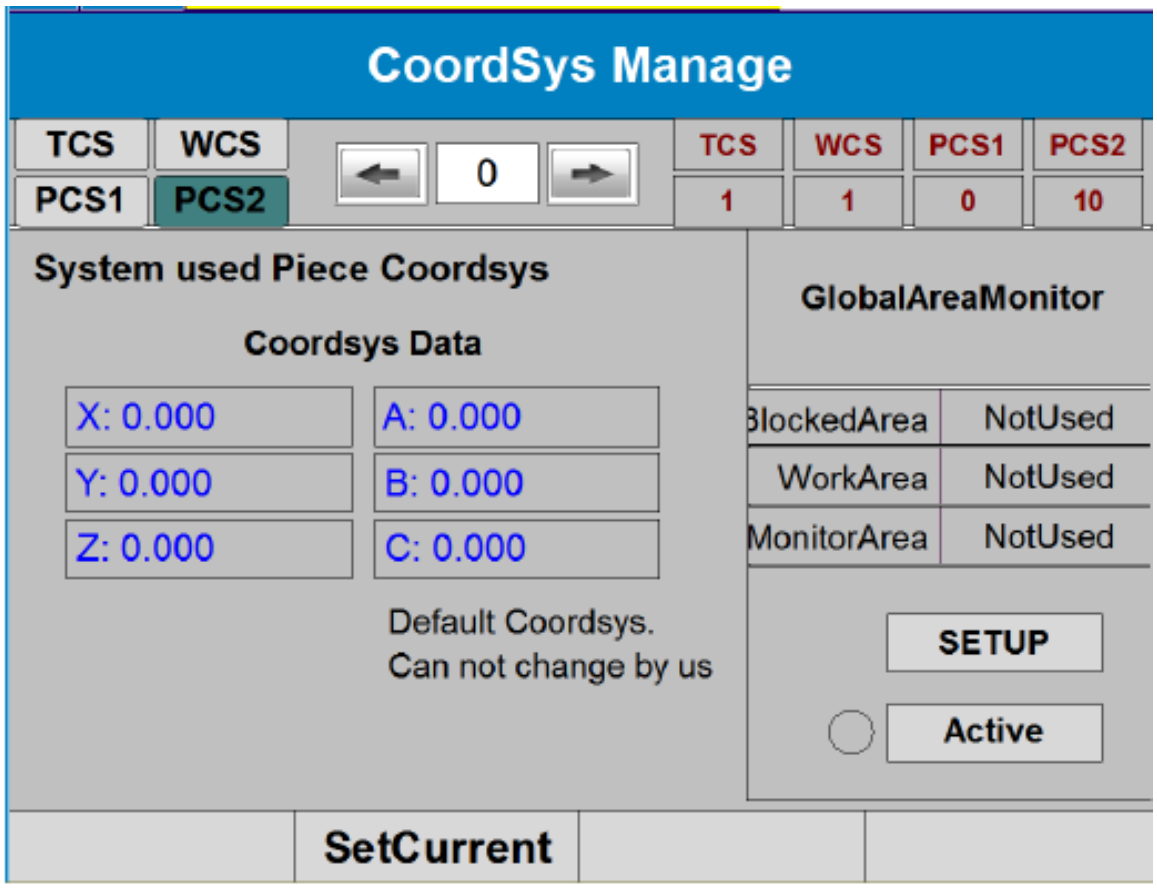
Operation area: It is a defined geometric within the robot operation space. The tip of the

robot can only move within this range, otherwise it will trigger emergency braking and alarming. When the tip falls out of range, it will decelerate to a safe speed. The system supports up to 32 defined operation areas.

Monitoring area: It is a defined geometric body within the robot operation space. The existence of the geometric body space will not affect the actual robot movement. When the tip of the robot enters the geometric body range, the system will trigger to output an I/O signal. The signal can be used by peripheral devices to monitor the space position status of the robot. The system can support up to 32 monitoring areas.

9.7.1 Operation space monitoring setup

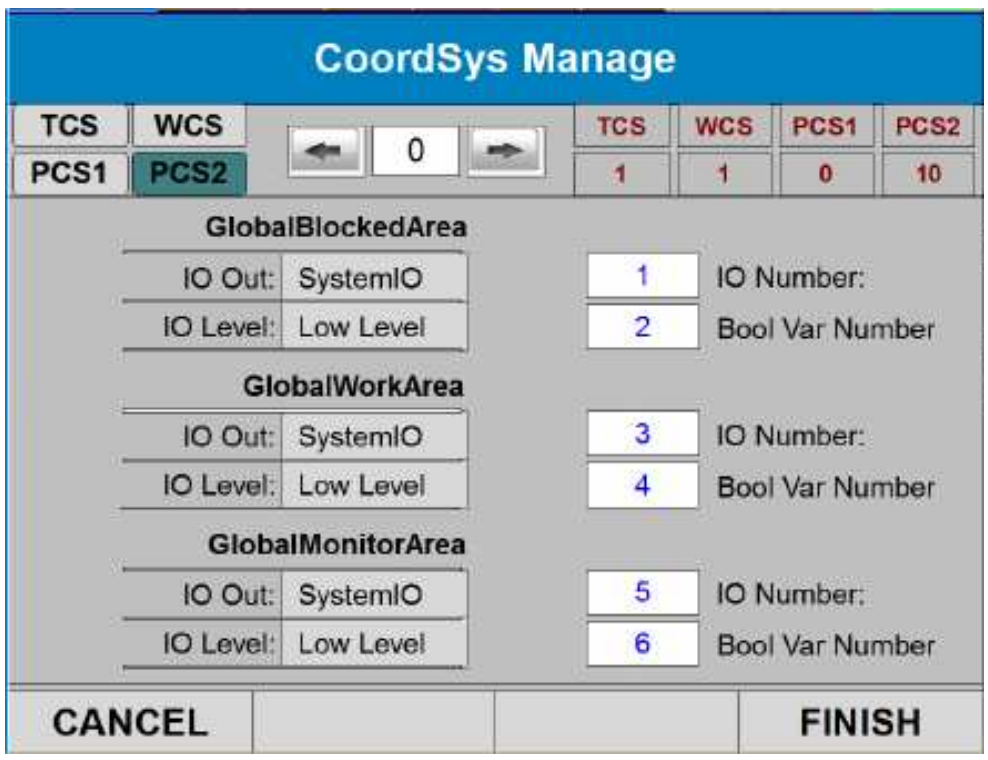
Obstacle, operation area and monitoring area are all geometric targets established in PCS2. Select {CoordinateSysMan} submenu under {ROBOT} menu to enter the coordinate system management main interface, pick {PCS2} tab as shown in the below diagram:



When **0 is selected as the coordinate item number of PCS2**, the operation monitoring interface will be like the below diagram:

{Activate} button is used to activate the launching of operation space monitoring function. Only when the activation indication light turns green, the operation space monitoring function (monitoring function of obstacle, operation area and monitoring area) will be launched.

{Setup} button is used to enter the space monitoring parameter setup interface as shown in the below diagram:



{Overall obstacle area}: When the robot tip enters any arbitrary activated obstacle area, the I/O point signal at this area will be output, and a designated BOOL type variable value setting will become (TRUE). If IO signal output is not required, please set the (IO point item number) to (-1). If BOOL type variable value output is not required, please set the (BOOL variable item number) to (0).

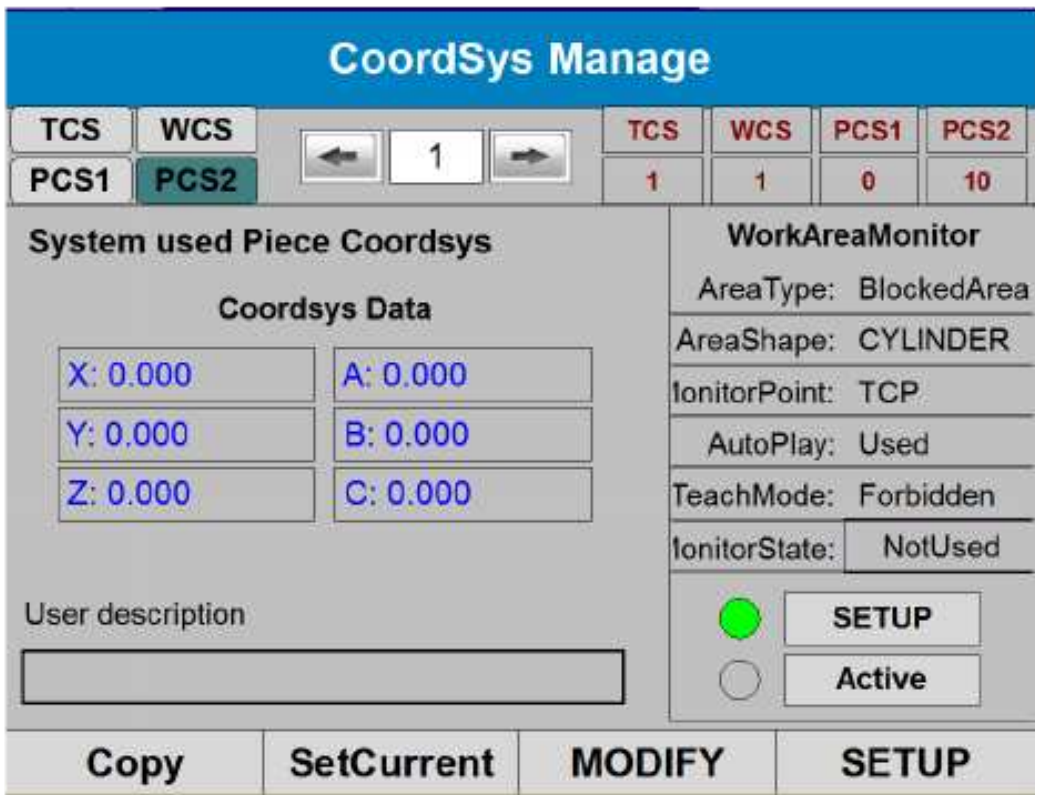
{Overall operation area}: When the robot tip leaves all the activated operation areas, the

I/O point signal here will be output, and a designated BOOL type variable value setting will become (TRUE). If IO signal output is not required, please set the (IO point item number) to (-1). If BOOL type variable value output is not required, please set the (BOOL variable item number) to (0).

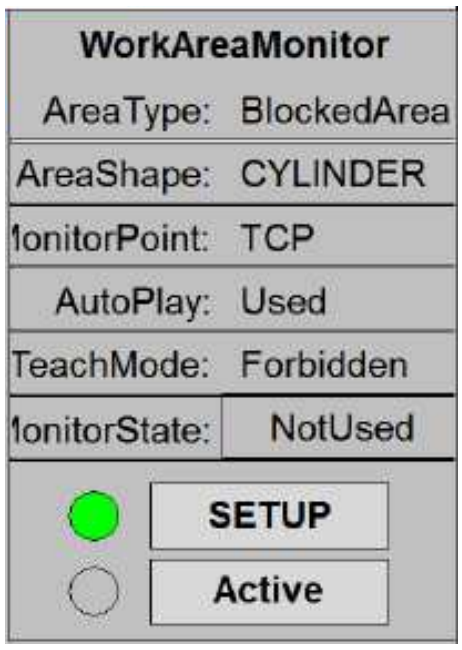
{Overall monitoring area}: When the robot tip enters any arbitrary activated monitoring area, the I/O point signal at this area will be output, and a designated BOOL type variable value setting will become (TRUE). If IO signal output is not required, please set the (IO point item number) to (-1). If BOOL type variable value output is not required, please set the (BOOL variable item number) to (0).

When I/O point signal is output, user can assign to output via terminal board or extension I/O module, and high level or low level signal.

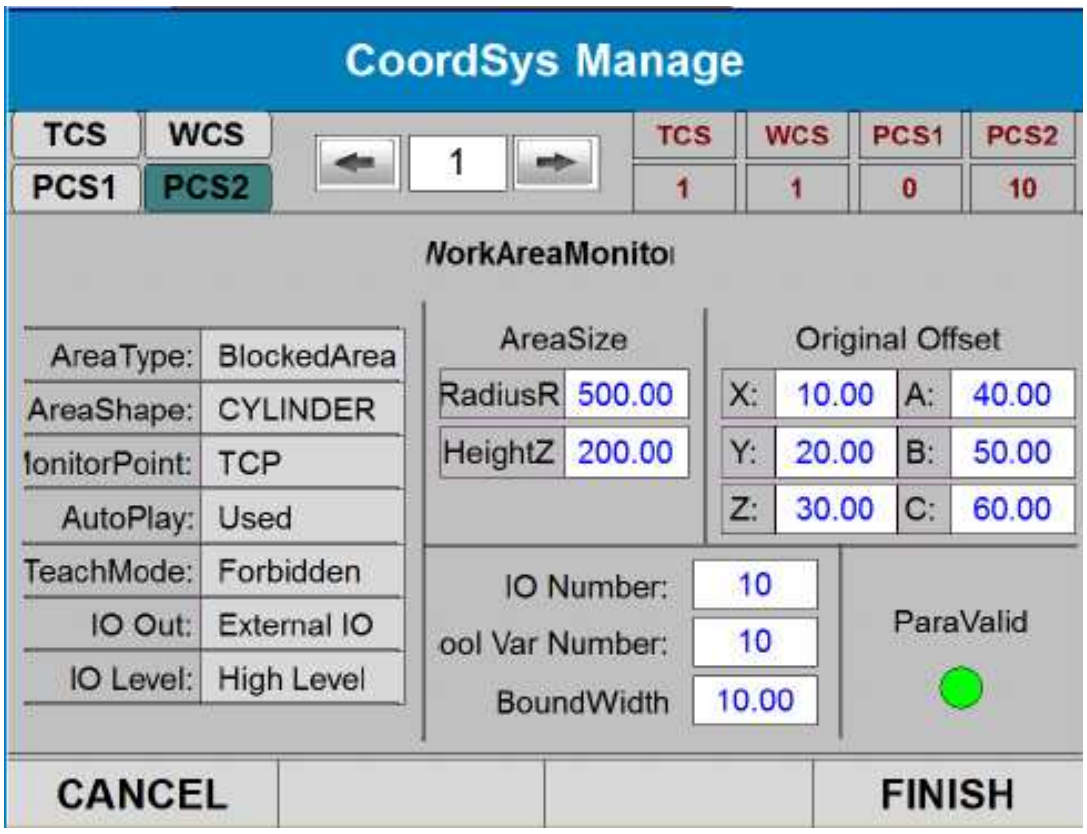
When **0 is not selected as the coordinate item number of PCS2**, the operation space monitoring interface is shown in the below diagram:

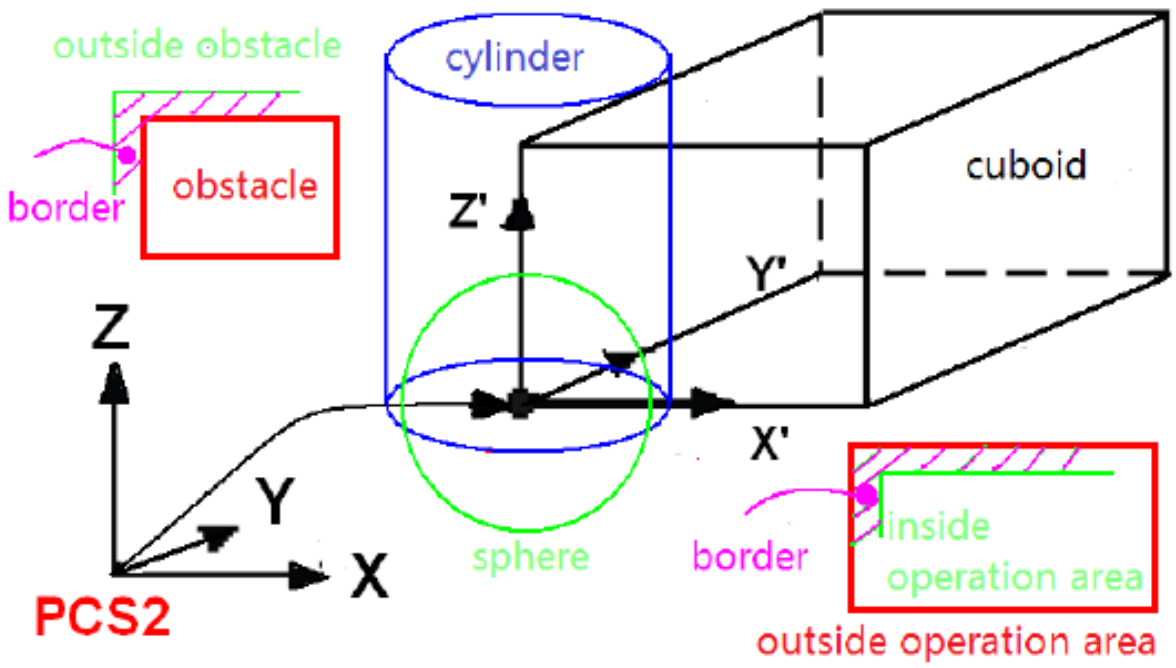


Since {Obstacle}, {Operation area} and {Monitoring area} targets are all established on the foundation of PCS2, so when user selects a designated item number of PCS2, {Obstacle}, {Operation area}, and {Monitoring area} target can be established in PCS2.



As shown in the above diagram, the green indicating light besides the {SETUP} button means the parameter of the operation space monitoring target is effective. User can launch the real time monitoring function by click the {Activate} button. If the system has launched the monitoring to the operation space target, the indicating light besides the {Activate} button will turn green. Click the {Setting} button and the system will enter the below shown {Operation space monitor} setting interface:





The related parameters of this interface are explained below:

Area type: {Not configured}, {Obstacle}, {Work area}, {Monitoring area}

Area shape: {Not configured}, {Cuboid}, {Cylinder}, {Sphere}

Monitoring point: {Not configured}, {TCP}, {flange center}

Automatic mode: {Enabled}, {Forbidden}
Teaching mode: {Enabled}, {Forbidden}

I/O output: {Terminal board}, {Extension I/O module}

Output level: {High level}, {Low level}

Area type parameters are used to configure monitoring targets as obstacle, work area or monitoring area; area shape ones are used to set up the geometric shapes of the monitoring targets; monitoring point ones are used to configure whether to monitor the TCP of the robot or the robot flange TCP; automatic mode or teaching mode ones are used to set whether the monitoring functions are launched; I/O input and output trigger voltage ones are used to output designated I/O signals when the monitoring area is triggered.

Area dimension parameters are used to set the geometric dimension of the monitoring area. Length, width, and height are allowed to be set for cuboid area; radius and height are allowed to be set for cylinder area; radius is allowed to be set for sphere area.

Area origin offset parameters are used to set the position displacement and angle rotation of the geometric coordinate system origin of the monitoring target with respect to the established PCS2 origin.

I/O point item number ones are used to set the item number of the output signal when the monitoring target is triggered. The valid value is 0 to 15. If outputting of I/O point signal is not required, the item number should be set to -1.

BOOL variable item number ones are used to set the output designated BOOL variable value to be TRUE when the monitoring target is triggered. The valid value of the parameter is f1 to 96. If outputting of BOOL variable value is not required, the item number should be set to 0.

Safe border width parameter is valid for obstacle or work area, but not monitoring area. It assigns a deceleration area. When the robot enters the area, the robot system will adopt a lower moving speed. The safe border of the obstacle is outside the geometric body of the obstacle while that of the work area is inside the geometric body of the work area.

When all the parameters are validly set, the {Parameter valid} indicating light in the interface will turn green.

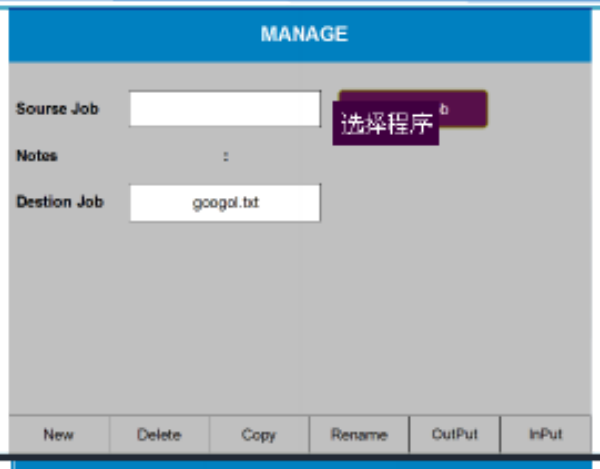
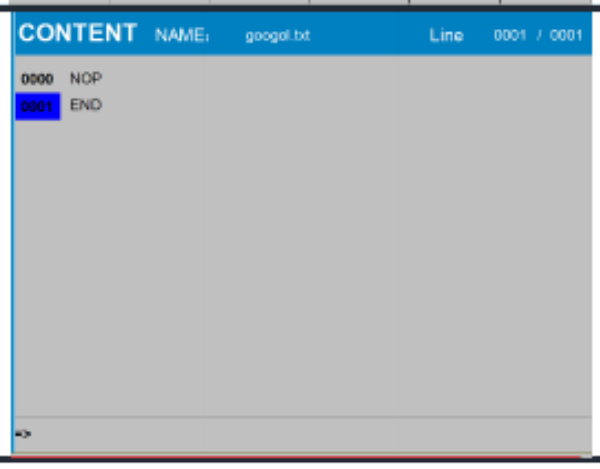
Click the {FINISH} button to complete and save the parameter setting.

Chapter 10 Teaching

10.1 Preparation work before teaching

Steps for creating a new teaching program:

1	Make sure the mode knob of the handheld operation teaching device is turned to 【Teach】 so that it's in teaching mode.	
2	Press the 【Servo ready】 button on the handheld operation teaching device. The 【Servo ready indicating light】 will start to blink.	
3	Press the 【Move up】 or 【Move down】 keys to make the {JOB} turn **blue**.	
4	Press the 【Move right】 key on the handheld operation teaching device to open the submenu. Then press the 【Select】key to enter the program management interface.	
5	Input the name of the program file that is going to be created in {Destion Job}.	

6	Click the {New} button on the interface and the operation is successful.	
7	Enter the program content interface, create a blank program with two lines NOP and END.	
8	Grip the 【3-stage switch】 at the back of the handheld operation teaching device and the servo power is connected.	

10.2 Basic steps of teaching

In order for the robot to conduct playing, its motion commands must be complied to a program. The commands of controlling robot motions are moving commands. In moving commands, the position that the robot has been to, the interpolation mode, play speed are recorded.

The commands are explained as below:

MOVJ V=25 BL=0 : Move with 25% of the maximum speed in ACS mode.

MOVL V=25 BL=0 : Move with 25% of the maximum speed in KCS mode.

MOVC P1=001 BL=0 : The center point of arc motion (The first default point is the previous point)

MOVC P2=002 BL=0 : The last point of arc motion

SPEED SP=60 : Adjust the speed to 60% of maximum speed (default 50%), Valid for all motion commands (This speed is teaching document global speed)

COORD_NUM COORD=TCS NUM=1 : Switch the TCS to 1.

DOUT DO=1 VALUE=0: Reset the first common output point.

TIMER T=1000 : Delay 1 second.

WAIT DI= 2 VALUE=1 : Wait for second common input point. Continue to run if it is 1 (trigger)

IF DI= 1VALUE=0 THEN

CALL PROG= 1 : Call the sub-program named 1

END_IF : Call the sub–program named 1 when the first input point is 0.

JUMP L=0001 : Program just to first line.

Please refer to Program command specification for detail command analysis.

10.2.1 Teaching a program

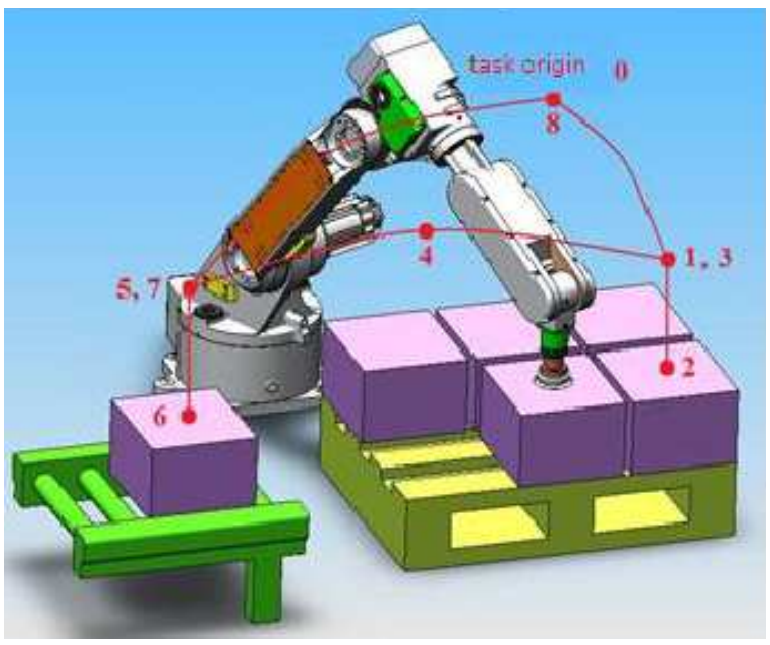
Danger

- During the process of teaching from the previous program point to the next program point, do not switch to different coordinate system.

  Otherwise it may result in abnormal movement of the robot.

Program is the operation content of robot using operation procedures description of robot language.

Let's say we input the below robot transportation procedure for moving the workpiece point A to point B. This program consists of 9 program points (0 to 8).



The complete program content is:

MOVJ P=1 V=25 BL=0	(Task origin)
MOVJ P=2 V=25 BL=0	(First point)
MOVL V=5 BL=0	(Second point)
DOUT DO=1 VALUE=1	(Gripping command specific I/O depends on the actual situation operation)
MOVL P=2 V=10 BL=0	(Select the same point as that of first point for the third point)
MOVJ V=50 BL=0	(Fourth point)
MOVJ P=3 V=50 BL=0	(Fifth point)
MOVJ V=10 BL=0	(Sixth point)
DOUT DO=1 VALUE=0	(Loosen clamp command specific I/O depends on

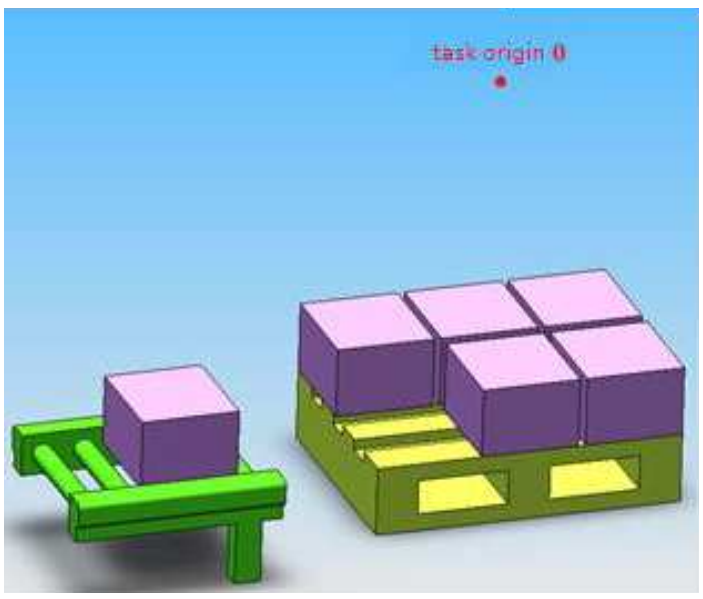
MOVJ P=3 V=20 BL=0	the actual situation operation) (Seventh point)
MOVJ P=1 V=100 BL=0	(Eighth point)

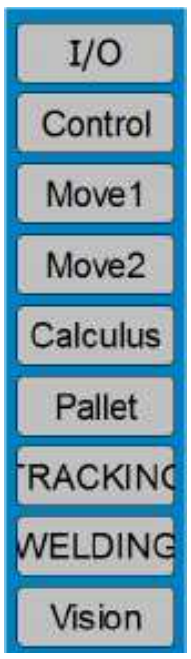
10.2.2 Calibration of position point

The repeat position points of the document can be pre-calibrated. Please refer to Position variable operation for specific calibration method. For example, points 0 and 8 are recorded repeat as P1, points 1 and 3 are recorded as P2, points 5 and 7 are recorded as P3.

10.2.3 Program point 0- Starting position

Move the robot to a position that it can't touch the surrounding objects, input program point 0.





1 Press the 【Command list】 key on the handheld operation teaching device, the command list menu will pop up at the right side like the right diagram:

2 Press the 【Move down】 key on the handheld operation teaching device. After {Move 1} **~~turns blue~~**, press the 【Move right】 key to open the {Move1} sub-list.
After MOVJ turns blue, press the【Select】key and the command will appear in the command editing area.

3 Modify the command parameter to the required parameter, configure speed, use default position point ID (1). (P1 must be taught in advance)

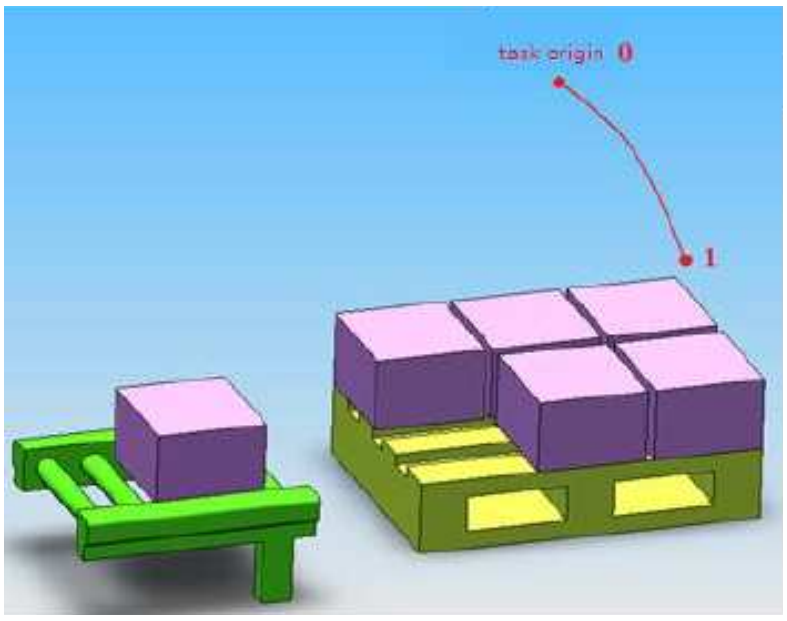
4 Press the 【Insert】 key on the handheld operation teaching device, the insert green light will light up. Press the 【Confirm】 key and the command insert program file will be recorded in the list

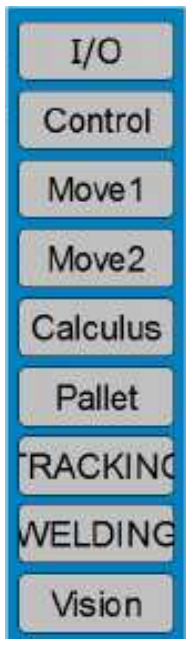
The list content will be displayed as:

MOVJ P=1 V=25 BL=0 (Task origin)

10.2.4 Program point 1-mPosition around gripping (Before gripping)

Determine the gripping pose.





Position point 1 must be selected such that the robot will not interfere with the direction and position with the workpiece when they come close. (It is usually right above the gripping position)

1 Press the 【Command list】 key on the handheld operation teaching device, the command list menu will pop up at the right side like the right diagram:

2 Press the 【Move down】 key on the handheld operation teaching device. After {Move1} turns blue, press the 【Move right】key to open the {Move1} sub-list.
After MOVJ turns blue, press the【Select】key and the command will appear in the command editing area.

3 Modify the command parameter to the required parameter, configure speed, and modify the default position point ID to 2. (P2 must be taught in advance)

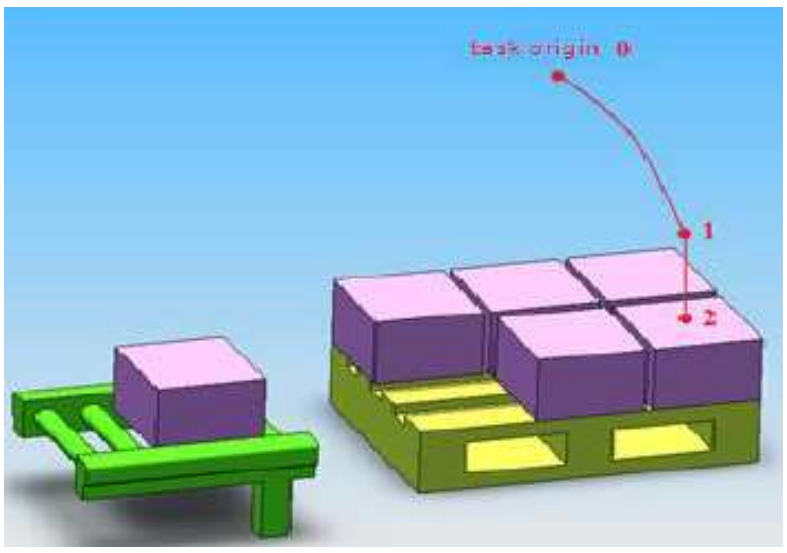
4. Press the 【Insert】 key on the handheld operation teaching device, the insert green light will light up. Press the 【Confirm】 key and the command insert program file will be recorded in the list.

The list content will be displayed as:

MOVJ P=1 V=25 BL=0 (Task origin)

MOVJ P=2 V=25 BL=0 (First point)

10.2.5 Program point 2- gripping position



1. Set up motion speed, select lower speed when it is close to gripping position.

2. It is suggested to use KCS mode when it is close to gripping point 2. Press the 【Coordinate system】key on the handheld operation teaching device to switch the coordinate system to KCS. Move the robot to gripping position 2 under KCS with axis operation key.

3. Use linear interpolation mode when recording the 2 points of the program. Press the 【 Interpolate 】key on the handheld operation teaching device to switch the interpolation mode to linear interpolation mode.

4. Press the 【Insert】key on the device, the insert green light will light up. Press the 【Confirm】key to insert the command into the program file record list.

5. Maintain the pose of program point 2. Press the 【Command list】 key and the command list will pop up: Select the DOUT command in the 【I/O】 and perform the corresponding I/O parameters setup.

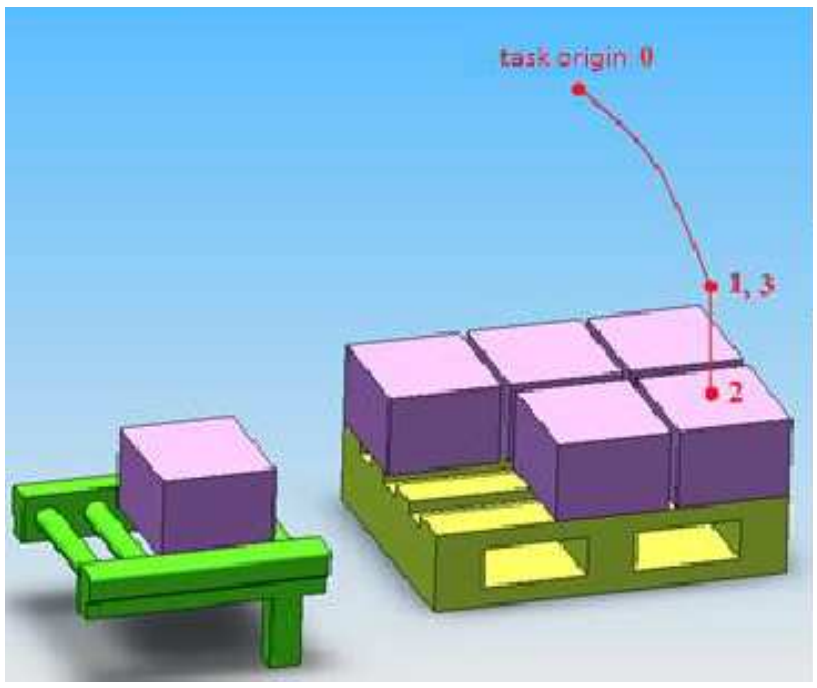
6. Press the 【Insert】key followed by the 【Confirm】key to insert the grip operation command. (Specific I/O operating depends on actual situation operating for this step)

The list content will be displayed as:

MOVJ P=1 V=25 BL=0	(Task origin)
MOVJ P=2 V=25 BL=0	(First point)
MOVL V=5 BL=0	(Second point)
DOUT DO=1 VALUE=1	(Specific I/O of gripping command depends on actual situation operating)

10.2.6 Program point 3-Same as program point 1 (After gripping)

Decide the retreat holding point after gripping.



Program point 3 is usually right above the gripping position. It is generally at the same position of program point 1. Set up the motion speed, select a lower speed when it is close to the gripping position.

1. Press the 【Command list】key on the handheld operation teaching device and the command list menu will pop up at the right side like the right diagram:

2. Press the 【Move down】key. After {Move1} turns blue, select 【Move right】key to open the {Move1} submenu. After MOVL turn blue, press 【Select】key and the commands will appear in the command editing area.

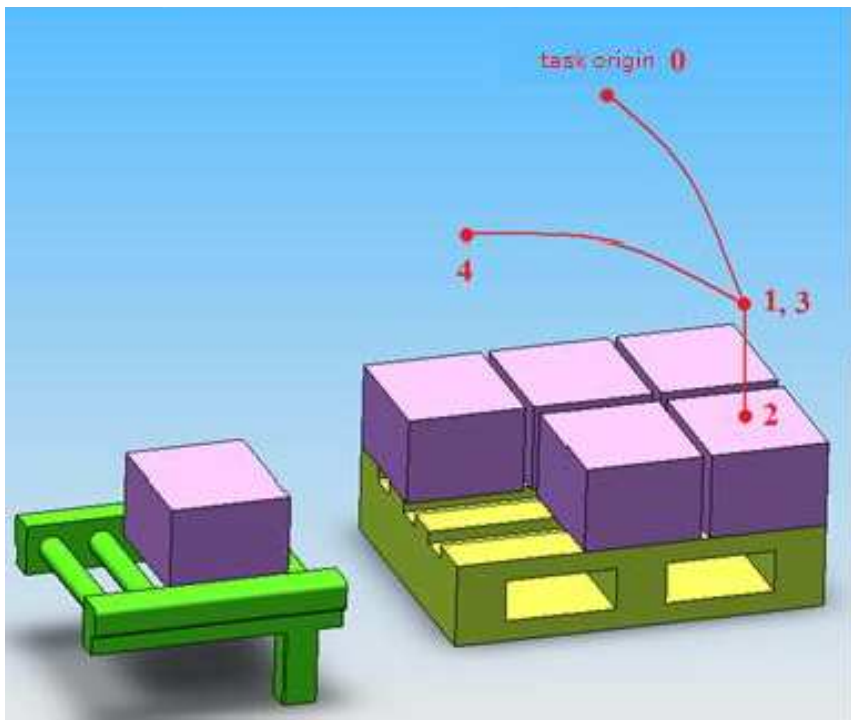
3. Modify the command parameters to the required values. Set up speed and modify the position point ID to 2 (P2 must be taught in advance).

4. Press the 【Insert】key and the "insert" green light will light up. Press the 【Confirm】key and the command will be inserted into the program file record list.

The list content will be displayed as:

MOVJ P=1 V=25 BL=0	(Task origin)
MOVJ P=2 V=25 BL=0	(First point)
MOVL V=5 BL=0	(Second point)
DOUT DO=1 VALUE=1	(Specific I/O of gripping command depends on the actual situation operation)
MOVL P=2 V=10 BL=0	(Selecting the same points for third point and first point)

10.2.7 Program point 4- Middle auxiliary position



Program point 4 is selected such that it won't interfere with the direction and position of the peripheral devices and tools. A point above the middle point of the safe position is usually selected.

1. Set motion speed, a higher speed can be selected.

2. Move the robot to a safer position 4 with axis operation keys.

3. Joint or linear interpolation can be used when recording the 2 points of the program. Press the 【Interpolate】key to switch the interpolation mode to joint interpolation mode.

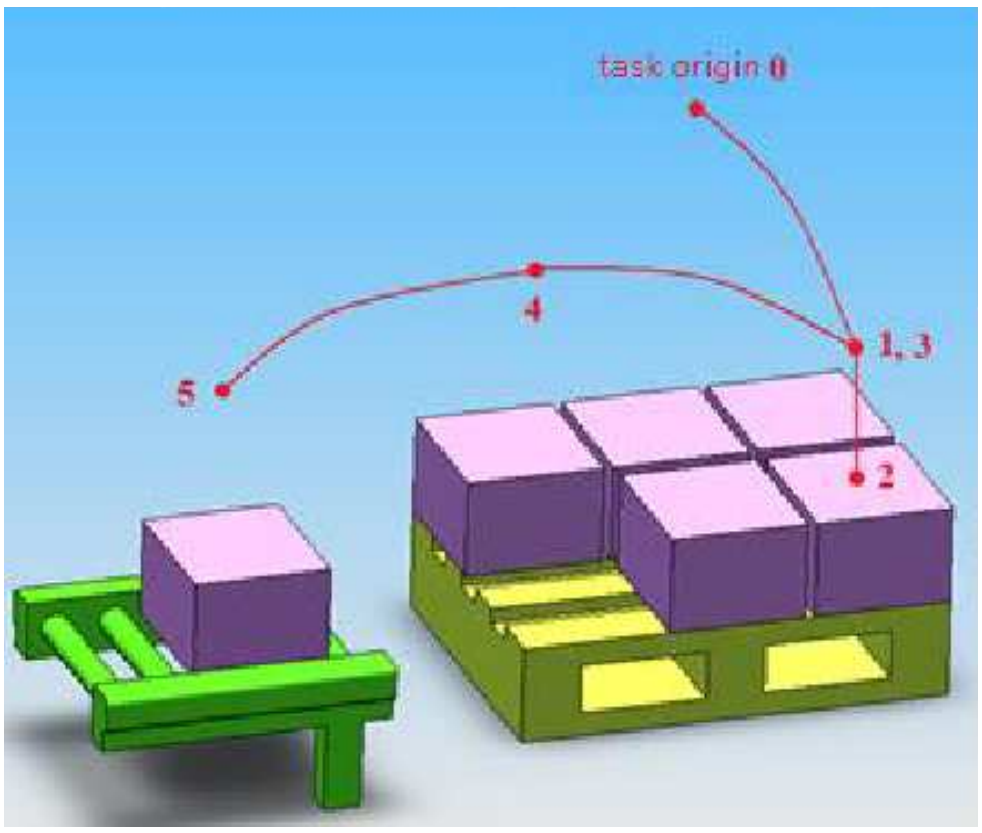
4. Press the 【Insert】 key and the "insert" green light will light up. Press the 【Confirm】 key and the command will be inserted into the program file record list.

The list content will be displayed as:

MOVJ P=1 V=25 BL=0	(Task origin)
MOVJ P=2 V=25 BL=0	(First point)
MOVL V=5 BL=0	(Second point)
DOUT DO=1 VALUE=1	(Specific I/O of gripping command depends on the actual situation operation)
MOVL P=2 V=10 BL=0	(Third point is selected such that it is the same as the first point)
MOVJ V=50 BL=0	(Fourth point)

10.2.8 Program point 5- Around placing position (Before placing)

Decide the placing pose.



Higher speed can be used during the process of moving from program point 4 to program point 5. The direction and position of the action of the robot must be selected such that it won't interfere with the workpiece when they come close. (It is usually right above the gripping position)

1. Press the 【Command list】key on the handheld operation teaching device and the command list menu will pop up at the right side as shown in the right diagram:

2. Press the 【Move down】 key, after the {Move1} turns blue, press the 【Move right】 key to open the {Move1} submenu. After MOVJ turns blue, press the 【Select】 key and commands will appear in command editing area.

3. Modify command parameters to required parameters, set speed and modify the position point ID to 2 (P2 must be taught in advance).

4. Press the 【Insert】 key and the "insert" green light will light up. Press the 【Confirm】 key and the command will be inserted into the program file record list.

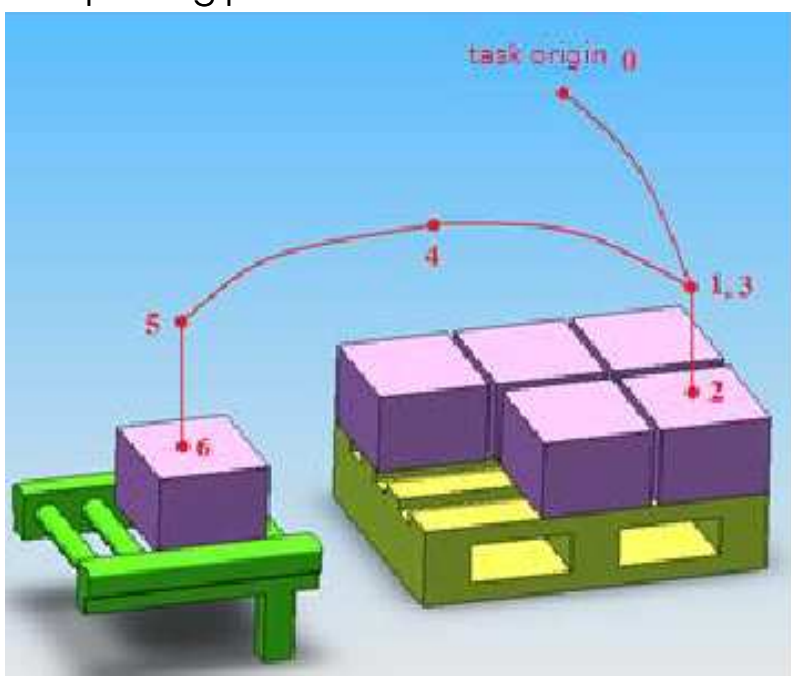
The list content will be displayed as:

MOVJ P=1 V=25 BL=0	(Task origin)
MOVJ P=2 V=25 BL=0	(First point)
MOVL V=5 BL=0	(Second point)
DOUT DO=1 VALUE=1	(Specific I/O of gripping command depends on the actual situation operating)

MOVL P=2 V=10 BL=0	(Third point is selected such that it's the same as the first point)
MOVJ V=50 BL=0	(Fourth point)
MOVJ P=3 V=50 BL=0	(Fifth point)

10.2.9 Program point 6 – Placing position

Determine the implemented placing point



1. Set motion speed, select lower speed when it is close to gripping position.

2. It is suggested to use KCS when it is close to gripping point 6. Press the 【Coordinate system】 key on the handheld operation teaching device to switch the coordinate system to KCS mode. Move the robot to gripping position point 6 in KCS with axis operation keys.

3. Linear interpolation mode is used when recording 6 points of the program. Press the 【Interpolate】 key to switch the interpolation mode to linear interpolation mode.

4. Press the 【Insert】 key and the "insert" green light will light up. Press the 【Confirm】 key and the command will be inserted into the program file record list.

5. Maintain the pose of program point 6. Press the 【Command list】 key and the command list will pop up: Select the DOUT command in the 【I/O】 and perform the corresponding I/O parameter setting.

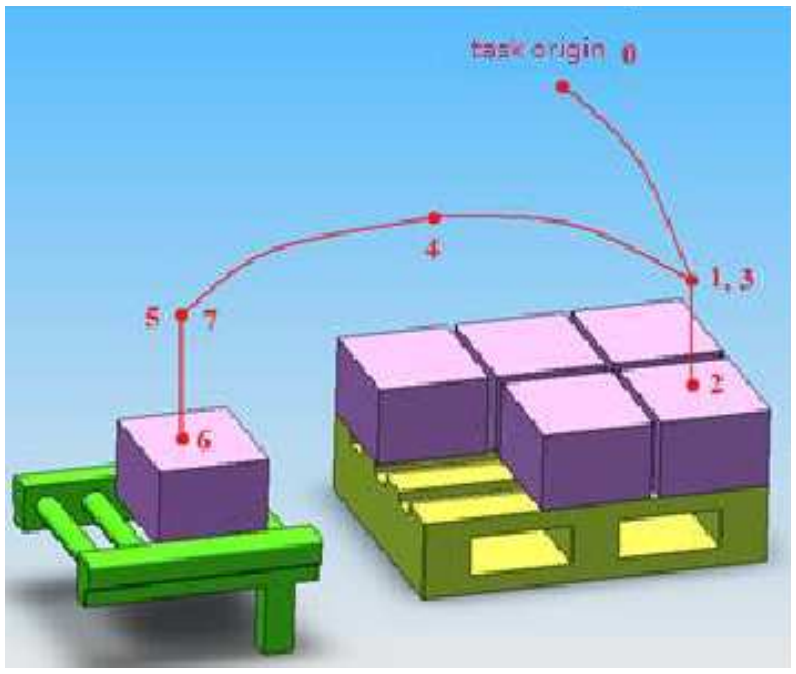
6. Press the 【Insert】 key followed by the 【Confirm】 key, grip operation commands can then be inserted. (The specific I/O of the operating depends on the actual situation for this step)

The list content will be displayed as:

MOVJ P=1 V=25 BL=0	(Task origin)
MOVJ P=2 V=25 BL=0	(First point)
MOVL V=5 BL=0	(Second point)
DOUT DO=1 VALUE=1	(Specific I/O of gripping command depends on the actual situation operating)
MOVL P=2 V=10 BL=0	(Third point is selected such that it is identical to the first point)
MOVJ V=50 BL=0	(Fourth point)
MOVJ P=3 V=50 BL=0	（Fifth point）

MOVJ V=10 BL=0 DOUT DO=1 VALUE=0	(Sixth point) (Specific I/O of loosening the grip command depends on the actual situation operation)

10.2.10 Program point 7 – Around placing position (After placing)



Program point 7 is usually right above the gripping position. It is in the same position as that of program point 5. Set the motions, select a lower speed when it is close to the gripping position.

1. Press the 【Command list】key on the handheld operation teaching device. The command list menu will pop up at the right side as shown in the right diagram:

2. Press the 【Move down】key to make {Move1} turn blue. Then press the 【Move right】to open the {Move1} submenu. After MOVL turns blue, press the 【Select】key and the command will appear in the command editing area.

3. Modify the command parameters to the required parameters, set the speed and modify the position point ID to 3 (P3 must be taught in advance).

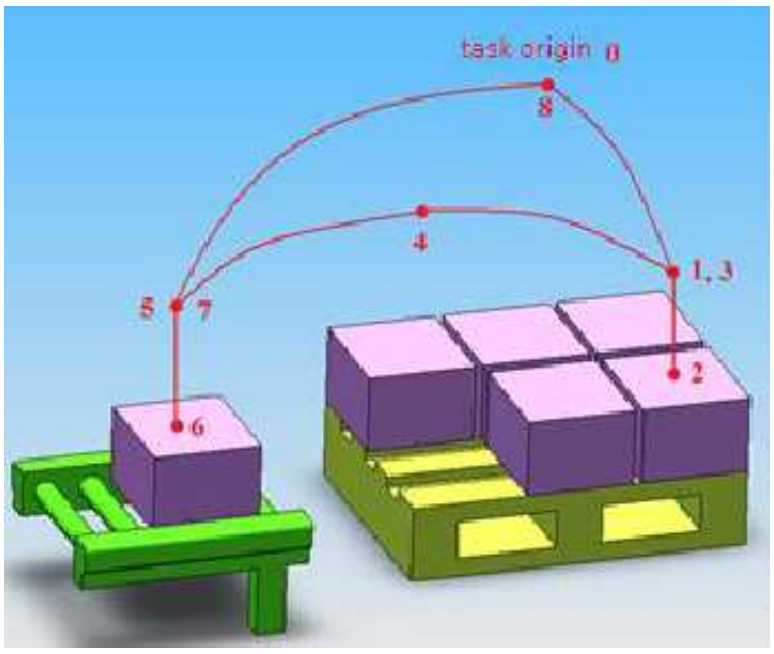
4. Press the 【Insert】key, the "insert" green light will light up. Press the 【Confirm】key and the command will be inserted into the program file record list.

The list content will be displayed as:

MOVJ P=1 V=25 BL=0	(Task origin)
MOVJ P=2 V=25 BL=0	(First point)
MOVL V=5 BL=0	(Second point)
DOUT DO=1 VALUE=1	(Specific I/O of gripping command depends on the actual situation operating)
MOVL P=2 V=10 BL=0	(Third point is identical to first point)
MOVJ V=50 BL=0	(Fourth point)
MOVJ P=3 V=50 BL=0	(Fifth point)
MOVJ V=10 BL=0	(Sixth point)
DOUT DO=1 VALUE=0	(Specific I/O of loosening grip command

	depends on the actual situation operating)
MOVJ P=3 V=20 BL=0	(Seventh point)

10.2.11 Program point 8 – Superposition of initial program point and final program point



We try to set the program point 8 of final position at the same position as program point 0 of initial position.

1. Press the 【Command list】 key on the handheld operation teaching device, the command list menu will pop up at the right side as shown in the right diagram:

2. Press the 【Move down】key to make the {Move1} turn blue. Then press the 【Move right】key to open the {Move1} submenu. After MOVJ turns blue, press the 【Select】key and the command will appear in the command editing area.

3. Modify the command parameters to the required ones, set the speed, use default value 1 as position point ID. (P1 must be taught in advance)

4. Press the 【Insert】key, the "insert" green light will light up. Then press the 【Confirm】key and the command will be inserted into the program file record list.

The list content will be displayed as:

MOVJ P=1 V=25 BL=0	（Task origin）
MOVJ P=2 V=25 BL=0	(First point)
MOVL V=5 BL=0	(Second point)
DOUT DO=1 VALUE=1	(Specific I/O of gripping command depends on the actual situation operating)
MOVL P=2 V=10 BL=0	(Third point is identical as the first point)
MOVJ V=50 BL=0	(Fourth point)
MOVJ P=3 V=50 BL=0	(Fifth point)
MOVJ V=10 BL=0	(Sixth point)
DOUT DO=1 VALUE=0	(Specific I/O of loosening grip command depends on the actual situation operating)
MOVJ P=3 V=20 BL=0	(Seventh point)

MOVJ P=1 V=100 BL=0 (Eighth point)

10.3 Trajectory confirmation

Attention

- Trajectory confirmation must be implemented after trajectory teaching is done. All the surrounding obstacles have to be cleared during the confirmation process.
- Always stay alert. Make sure the emergency stop button on the electric control box can be pressed when any malfunction occurs.

After inputting the action program of the robot, run the program to check if all the program points are working properly.

Step 1	Move the cursor to program point 1 (Line 0001).
Step 2	Press and hold the 【Forward】 key, the robot will execute the selected line command (Before the program point finishes executing, release the key to stop motion while hold to continue the motion). Confirm if the program points are correct via the actions of the robot. After finishing one line, release the key, then press and hold the 【Forward】 key again to execute the next program point.
Step 3	After confirming the program points, move the cursor to the beginning of the program.
Step 4	Finally test the continuous action of all the program points. Press 【Interlock】 and 【Forward】 keys, the robot will continuously play all the program points. It will stop after one cycle.

Chapter 11 Playing and Remote

Playing is the process of running the teaching program again.

11.1 Playing

11.1.1 Preparation before playing

Important

- Please make sure there are no people around before operating

11.1.2 Steps of playing

1. Enter {JOB} - {Select Job}, select the program that is going to be taught, enter the program content interface.

2. Set the mode knob on the handheld operation teaching device to 【Play】 so that it is in playing mode. Check to make sure the upper left status display icon shows Automatics.

3. Press the 【Servo ready】 key to connect to the servo power.

4. Press the 【Start】 key. The robot will execute the teaching program for one cycle and then stop.

5. For playing speed, the overall speed of playing can be modified via SPEED commands (Modify in teaching mode).

11.1.3 Stopping of playing

Press the 【Hold】 key to pause playing. Press the 【Start】 key again to resume playing.

11.2 Remote

Important

In order to run from the program header, please perform the following operation.

- With servo ready, press the 【Shift】and 【9】keys to reach 0.

Chapter 11 Playing and Remote

Operation steps:

1. Rotate the handheld operation teaching device mode knob to 【Remote】position.

2. Check the program upper left corner status display icon to make sure it is switched to remote 

.

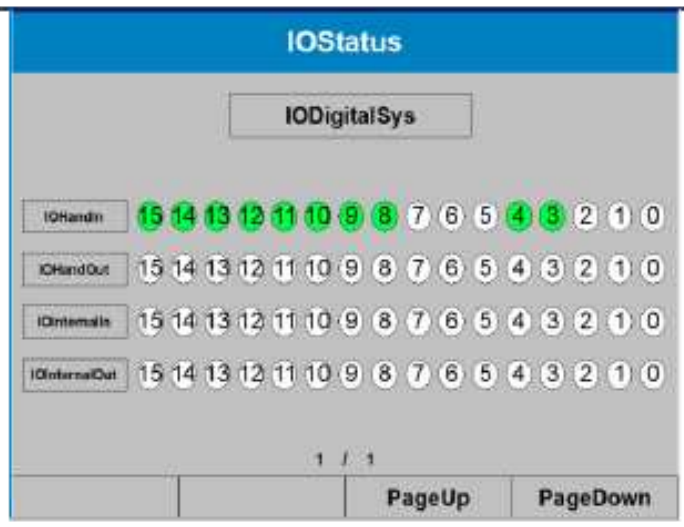
3. Press the 【Servo ready】key and make sure the robot is ready.

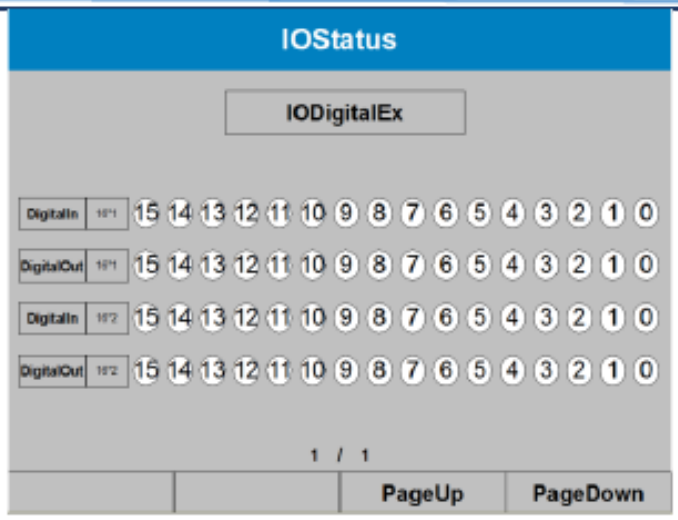
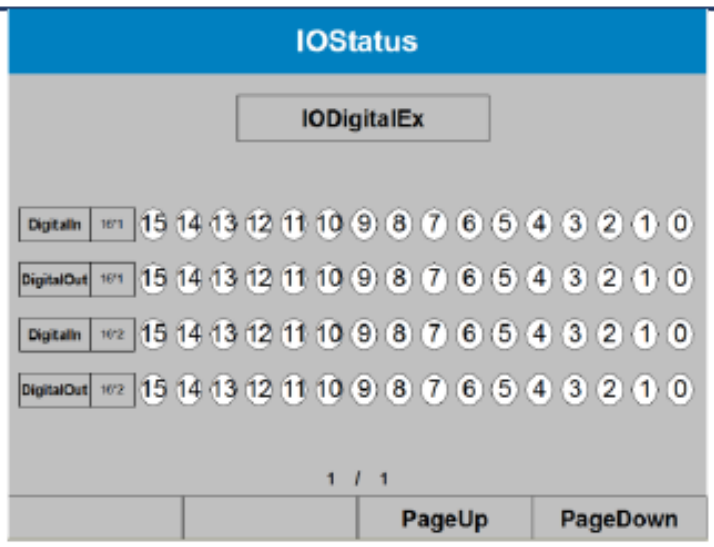
4. Robot enters remote mode. Commands can be given to the robot via external I/O or TCP protocol.

Chapter 12 System

12.1 Inquiry

12.1.1 I/O Status

Item No.	Operation	Illustration
1	Press the 【Move up】 or 【Move down】 on the handheld operation teaching device key such that the {STATUS} under main menu **turns blue**.	
2	Press the 【Move right】 key to bring up the submenu.	
3	Press the 【Move up】or 【Move down】 key so that the {IO} turns blue. Then press the 【Select】 key	 The interface shows the current I/O status of {IODigitalEx}. Click the arrows at the two sides of the {IODigitalEx} to switch between {IODigitalEx} and {IOAnalogEx}. When there are over two I/O modules of the same type, Click {PageUp} and {PageDown} to flip pages.

4	System digital module (IODigitalEx)	 Handheld box input: Handheld operation teaching device digital input module; Handheld box output: Handheld operation teaching device output module; Terminal board input: Terminal board digital input module; Terminal board output: Terminal board digital output module; For the input point, the I/O point shows green when there is external input; For the output point, the I/O point shows green when there is output. Manual output can be implemented by clicking the corresponding I/O points.
5	Extension digital module	 Digital input: Extension digital input module Digital output: Extension digital output module The numbers at the right side of {IODigitalIn} and {IODigitalOut} represent the number of the I/O groups. For the input point, the I/O point shows green when there is external input; For the output point, the I/O point shows green when there is output. Manual output can be implemented by clicking the corresponding I/O points.

6	The Extension analog module	 Analog input: Extension analog input module; Analog output: Extension analog output module; The numbers at the right side of {analog input} and {analog output} represent the number of I/O nodal points; For input point, the "Current value" shows the analog magnitude of the current input; For output point, the "Current value" shows the analog magnitude of the current output. Manual output can be implemented by set a designated output value, then click "Enable".

12.1.2 Controller status

Item No.	Operation	Illustration
1	Press the【Move up】or【Move down】key on the handheld operation teaching device to make the {STATUS} under the main menu **turn blue**.	

2	Press the 【Move right】 key to bring up the submenu.	
3	Press the 【Move up】key or 【Move down】key to make the {CONTROLLER} under main menu turn blue, then press the 【Select】key.	AxisStatusValue Axis 1 16#57420862 Axis 2 16#57420862 Axis 3 16#57420862 Axis 4 16#57420862 Axis 5 16#57420862 Axis 6 16#57420862 Ex 1 16#57420062 Ex 2 16#57420062 The interface shows the current status of each controller axis and is represented in hexadecimal numbers as shown in the above diagram: The “16#” of “16#0” means it is a hexadecimal number. For the definition of specific values, please check the controller programming manual

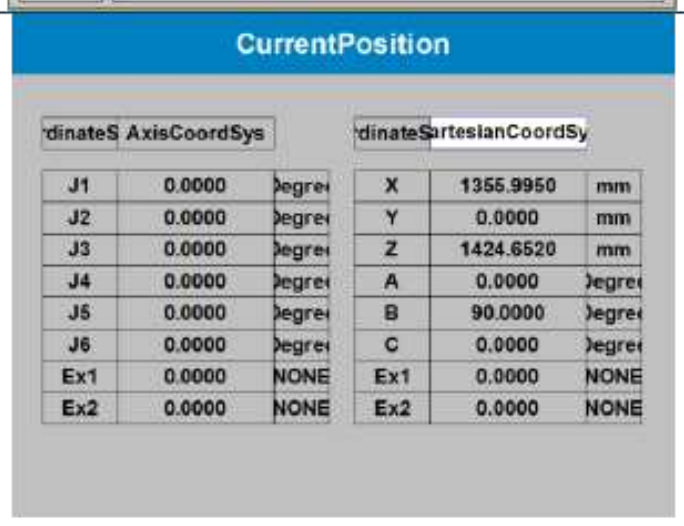
12.1.3 Common axis status

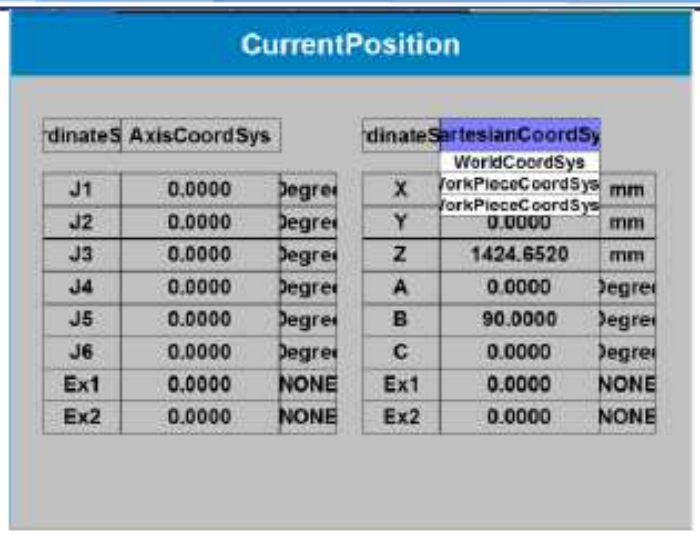
Item No.	Operation	Illustration
1	Press the 【Move up】 or 【Move down】key on the handheld operation teaching device or press the 【Move down】key to make the {STATUS} under main menu **turn blue**.	

2	Press the 【Move right】 key to bring up the submenu.	
3	Press the 【Move up】or 【Move down】key to make the {AXIS} under main menu turn blue, the press the 【Select】 key.	 The interface shows the current status of the drive, and the definition is as below: Servo enable: When the drive servo is enabled, the corresponding status indicating light is green, otherwise it is white; Planned motion: When the controller starts motion planning the corresponding status indicating light will be green, otherwise it is white; Motion in position: When the servo motor moves to a designated position, the corresponding status indicating light is green, otherwise it is white; Driver alarm: When the driver produces alarm the corresponding status indicating light is red, otherwise it is white; Following error alarm: When the controller monitors the following error of the servo motor exceeds the set value the corresponding status indicating light is red, otherwise it is white; Positive limit alarm: When the servo motor moves to the positive limit of the controller, the corresponding status indicating light is red, otherwise it is white; Negative limit alarm: When the servo motor moves to the negative limit of the controller, the corresponding status indicating light is red, otherwise it is white.

Chapter 12 System

12.2 Current position

Item No.	Operation	Illustration
1	Press the 【Move up】 or 【Move down】 key on the handheld operation teaching device to make the {ROBOT} under the main menu **turn blue**.	
2	Press the 【Move right】 key to bring up the submenu.	
3	Press the 【Move up】or 【Move down】key to make the {Current Position} under the main menu **turn blue**, then press the 【Select】 key.	 Current position pose of the robot is shown in the interface



The desired coordinate system to be displayed can be selected by clicking the input frame at the right side of the {Coordinate System} on the software interface

12.3 Zero position calibration

Zero position calibration interface is mainly used for the calibration of robot's zero point of each joint motion. The interface will display the robot joint's zero position calibration status. When the calibration of a specific joint is done, the corresponding status display will be green. When all the joints are calibrated, the {All} indicating light will light up. User can select a specific joint or multiple joints, and click {RecordRefPos} button to record the current encoder data as zero point data (Press and hold the button for 2-3 seconds). The robot can only perform full-function motion when the zero point data of all the joints are calibrated. Otherwise it can only perform joint point motion.

Danger

- Press the emergency button and confirm the servo is cut before operating the robot.

  If the robot can't be stopped in emergency situation, there may be injury or device damage

- When performing teaching in the maximum range of robot point P, please observe the following items:

✓ Observe the robot from the front.
✓ Obey operation procedure.
✓ Make sure there is a way of escape in case of emergency situation.

Injury may occur in case of error operation of the robot.

- Please make sure there are no people within the maximum action range of the robot, and the operator is in a safe position before performing the below tasks:

- Connecting the power of the electric control box.
- Operating the robot via teaching software.

Injury may occur when people enter the action range of the robot or have contact with the robot.

- Press the emergency stop button immediately when any abnormality occurs.

The emergency button is located at the right side of the electric control box front door.

- If action of the robot is performed before zero point calibration, it will lead to uncertain direction motion of each robot axis.

It may cause injury and device damage.

Attention

- Before robot teaching operation, please check the below items and repair or take necessary measures in case of any abnormality.

✓ If there is any abnormal robot action.
If there is any damage of external wiring covering.

12.3.1 Zero point calibration

Important

No teaching and playing operation can be performed before origin position calibration.

- For multiple robot system, origin position calibration must be done for each robot.

The origin position calibration is the comparison operation of the robot position with the absolute encoder position. The origin position calibration is performed before the robot leaves the factory. It has to be performed again under the following situations:

- Battery or absolute encoder is changed.
- Store memory is deleted.
- When the robot hits the workpiece and the origin is deviated. (There is a decent probability)

Origin position:
The "0" pulse position of each axis is called origin. The pose at this moment is called origin

position pose. It is the final position when the robot returns to zero.

12.3.2 Alarm phenomenon of origin position deviation

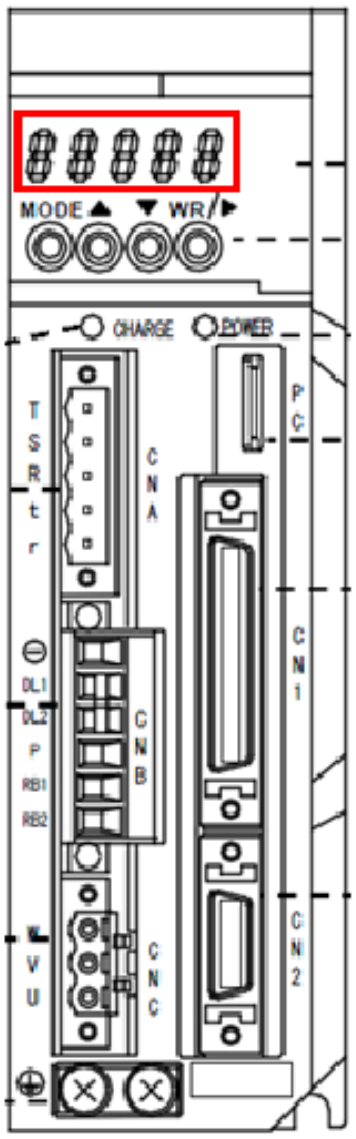
Take Sanyo Denki drive as an example:

When installing the robot for the first time, the axial origin may shift during the transportation process or after impacting.
In the above situations, servo can't be opened for robot axis via software after power on the electric control box.

Important

- It is recommended in the above situations, before powering on the robot (i.e. powering on the electric control box), open the back door of the electric control box and observe the status of the 6 drives.

When power is connected for the first time, the drive LED should display "三" under normal condition. If there is alarm status, then alarm reset operation of the drive has to be performed.



12.3.3 Removing the drive alarm signal

When the battery voltage of the absolute encoder drops below 3.6V, battery should be exchanged.

- When the frequency of power on/off is high or the motor is used for the long time, the lithium battery life will be shortened.

Method for changing the backup battery of the absolute encoder:

1. Turn on the control power of the servo drive.
2. Notice the model number of the lithium battery. [Sanyo Denki recommended battery model: AL-00494635-01]
3. Open the rear cover of the robot.
4. Remove the battery connector.
5. Take out the lithium battery and replace a new one.
6. Notice the connector direction and install the connector.
7. Close the front cover of the servo drive.

When changing battery under control power off status, the absolute encoder may over-revolve and the counter (position data) will be unstable. If this happens, turn off the control power of the drive and the alarm (battery abnormality). Then reset the encoder and remove the alarm status after alarm adjustment.

12.3.4 Robot reset calibration method

Attention

- When coupling relationship exists among joint axes, such as common robot coupling relationship between fifth axis and sixth axis, fifth axis must be at the zero point position before the recorded zero point data of the sixth axis becomes effective. Thus the zero point data of the sixth axis must be recorded when the fifth axis is located in zero position. If coupling relationship doesn't exist, then the zero point of each axis can be calibrated independently. The zero point of a certain axis will not affect the zero position of other joints.

- When zero point calibration of all the axes that are going to be used (main body axis and auxiliary extension axis) are done, the "All" indicating light in zero point calibration interface will turn green indicating the calibration is done. The robot can perform motion under Cartesian space.

After removing encoder zero point drift alarm, mechanical zero point position of each axis and software record calibration of the robot must be implemented immediately.

Mechanical zero point calibration: Refer to the below method. Each axis will move to the mechanical reference zero point via single axis motion.

Software record calibration: When the 6 axes return to mechanical reference zero point via single axis motion, user needs to enter factory reset of the software to re-record the zero point

positions and make sure the software zero point positions corresponds to the hardware ones.

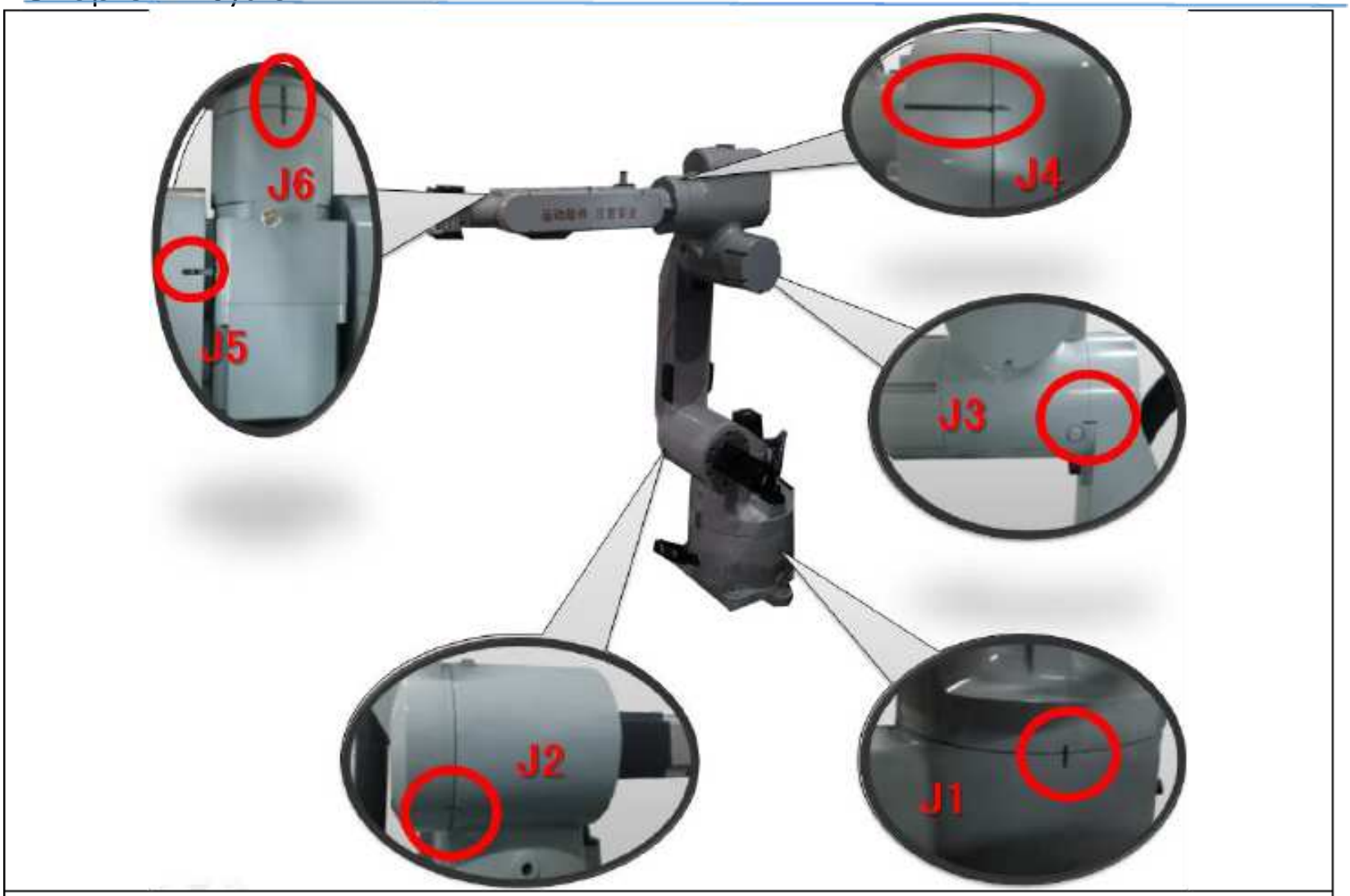
Operation procedure

Step 1: Open software, enter {ROBOT} – {Zero calibr} interface:

Step 2: Under "ACS mode", 

the pose when each joint of the robot is at the zero point, the lower arm is at vertical status, while the forearm and wrist part (fifth joint) are at horizontal status. The zero point interface is considered during the robot main body design process (e.g. groove, ruling, scale, etc.).

The pose of the mechanical zero point of the robot under normal circumstance is shown below:



Step 3: Adjust the position pose

Step 4: Select the axis to be calibrated. "Please select the recorded zero position reference point axis to be calibrated" area is the **user interaction area**. User can select the axis number of the zero position datum to be recorded in this area (such as first axis 1). User can select to record zero position data of multiple axis at the same time, or select to record the zero position datum of one axis. When the corresponding axis number selection number is pressed, the button will be green.

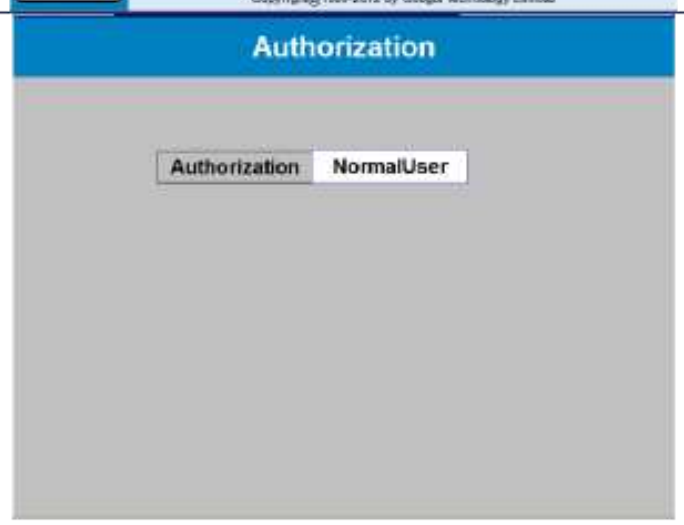
Step 5: Press and hold the {RecordRefPos} RecordRefPos button (for about 3 seconds) until the indicating light of the axis number selection button changes from green to grey. It means the zero point datum of the corresponding axis has been recorded successfully. Only the zero point datum of the selected axis number will be refreshed.

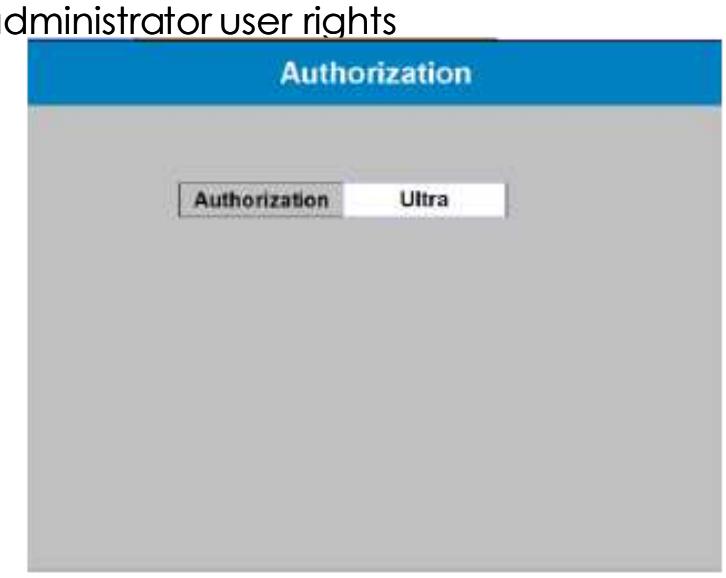
Step 6: Check if the calibration is successful. "Zero position calibration status of each axis" area displays the zero calibration status of each axis of the robot. Digital indicating light 1 to 8 refers to number 1 to 8 axes. Number 1 to 6 axes are the robot body interpolation axes, while number 7 to 8 axes are extension axes. When the zero position of the corresponding axis is calibrated successfully, the corresponding digital indicating light will turn green. Otherwise, it will be grey. When all the axes (body axes and auxiliary extension axes) are calibrated, the "All" indicating light will turn green indicating the zero position data calibration of the robot has been completed. The robot can move under Cartesian space.

Chapter 12 System

12.4 System message

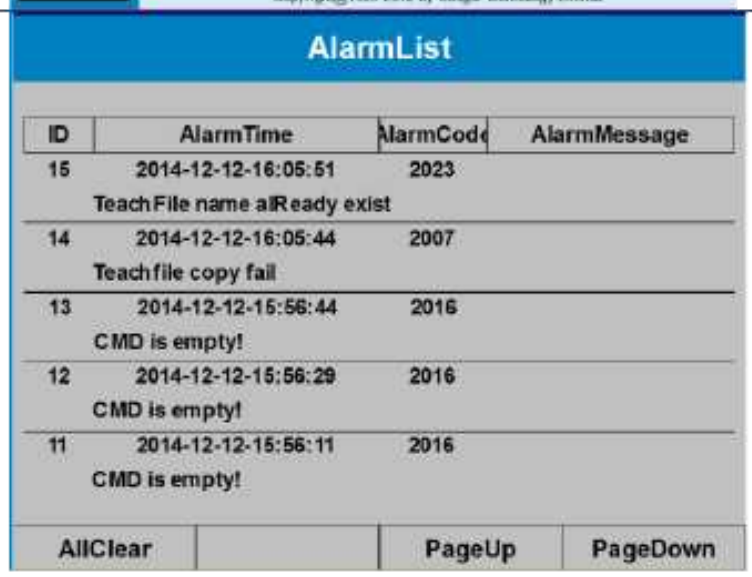
12.4.1 User rights

Item No.	Operation	Illustration
1	Use the 【Move up】 or 【Move down】key of the handheld operation teaching device to make the {SYSTEM} under the main menu **turn blue**.	
2	Call up the submenu with the 【Move right】key on the handheld operation teaching device.	
3	Select {Administrator}.	 Interface displays the current robot operation user rights
4	Click the input frame on the right side of the software interface {NormalUser} to select the rights that is going to be selected;	 Select “Administrator user”

		 Click the blank on the right of the software interface {NormalUser} Input password: 999999 to switch to the administrator user rights  “Factory setting” is for software test before leaving the factory. Please do not operate this under normal condition.

12.4.2 Alarm history

Item No.	Operation	Illustration
1	Press the 【Move up】 or 【Move down】 key to make the {SYSTEM } under the main menu **turn blue**.	

2	Press the 【Move right】 key on the handheld operation teaching device to call up the submenu.	
3	Press the 【Move up】or 【Move down】 key to make the {Alarm History} under the main menu **turn blue**. Then press the 【Select】key on the handheld operation teaching box.	 The interface display the alarm time, alarm code and alarm message.

12.4.3 Version message

Item No.	Operation	Illustration
1	User the 【Move up】 or 【Move down】 key on the handheld operation teaching device to make the {SYSTEM} under main menu **turn blue**.	
2	Use the 【Move right】key on the handheld operation teaching device to call up the submenu.	

3	Select 【Version】 to enter the interface.	

12.5 Parameter setting

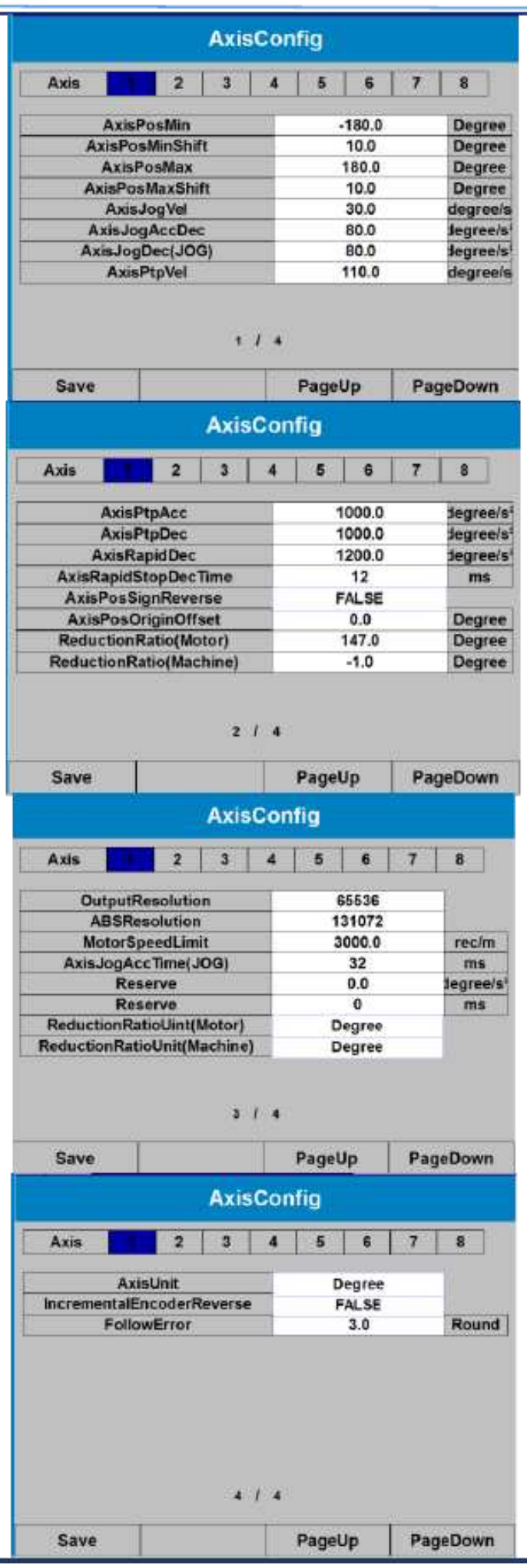
Item No.	Operation	Illustration
1	User the 【Move up】or 【Move down】key on the handheld operation teaching device to make the {SETUP} under main menu **turn blue**.	
2	Use the 【Move right】key on the handheld operation teaching device to call up the submenu.	

		 Click the digits of the number input keyboard to input the required data, then click "confirm"
3	User the 【Move up】or 【Move down】key on the handheld operation teaching device to make the {SETUP} under main menu **turn blue**.	

12.5.1 Axis parameter setting

12.5.1.1 Interface

Item No.	Operation	Illustration
1	Select {Joint Para}	

2	Click {PageUp} or {PageDown} button to flip back and forth	

12.5.1.2 Parameter illustration

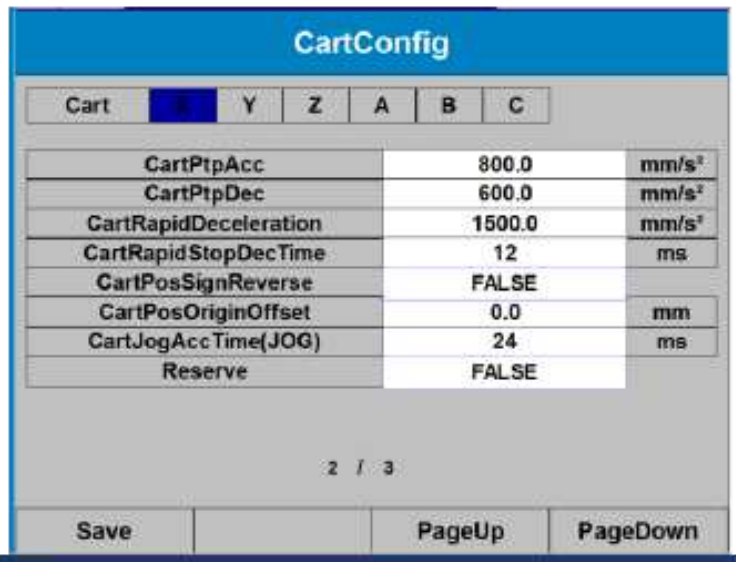
Item no.	Parameter name	Unit	Value range	Illustration
1	Joint motion lower limit	Degree	Related to robot hardware structure: Please set up the parameter according to the actual hardware	Minimum value of joint motion range;
2	Joint motion lower limit offset	Degree	Greater or equal to 0 and smaller than the joint motion lower limit	Offset value of joint motion range minimum value;
3	Joint motion upper limit	Degree	Related to robot hardware structure: Please set up the parameter according to the actual hardware	Maximum value of joint motion range;
4	Joint motion upper limit offset	Degree	Greater or equal to 0 but smaller than the joint motion upper limit	Offset value of joint motion range maximum value;
5	Joint motion speed upper limit (JOG)	Degree/s	Great than 0 and smaller than the motor allowed rotating speed peak value	The maximum value of jog axis operation key motion speed under axis coordinate system;
6	（JOG）Joint motion acceleration	Degree/s^2	Greater than 0 and smaller than 360	The maximum value of jog axis operation key motion acceleration under axis coordinate system;
7	（JOG）Joint motion deceleration (JOG)	Degree/s^2	Greater than 0 and smaller than 360	The maximum value of jog axis operation key motion deceleration under axis coordinate system;
8	Joint motion speed upper limit (MOVJ)	Degree/s	Greater than 0 and smaller than motor allowed rotating speed peak value	Joint motion speed maximum value of command MOVJ;
9	Joint motion acceleration (MOVJ)	Degree/s^2	Greater than 0 and smaller than 1080	Joint motion acceleration maximum value of command MOVJ;
10	（MOVJ）Joint motion	Degree/s^2	Greater than 0 and smaller than	Joint motion deceleration maximum value of command

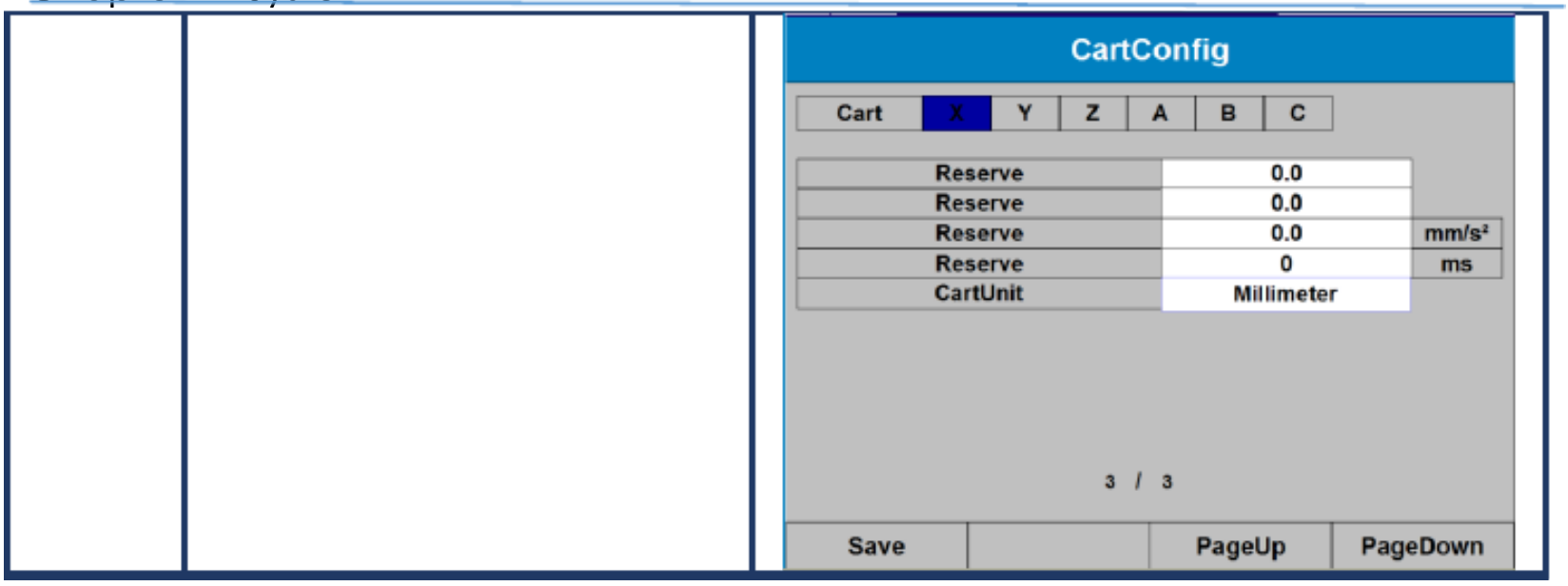
	deceleration (MOVJ)		1080	MOVJ;
11	Joint motion emergency stop deceleration	Degree/s^2	Greater than 0 and smaller than 36000	The deceleration of joint motion command (MOVJ) under emergency stop condition.
12	The jerk time of joint motion emergency stop	ms	Greater than 0 and smaller than 50	The jerk time of joint motion command (MOVJ) under emergency stop condition.
13	Reversing of joint motion		Valid / Invalid	User defines if the joint rotation direction is in opposite direction to the system internal robot model.
14	Joint motion zero point offset	Degree	Greater than 0 but smaller than 360	User defines the offset value of the joint zero point and system internal robot model.
15	Reduction ratio (motor end) / reduction ratio (Execution end)	1	0 is not allowed	The ratio of motor end rotation angle and execution end rotation angle (Allowed value is either + or – to change the joint motion direction).
16	Motor feedback pulse	1		The required control pulse counts for 1 revolution of motor. The motor feedback pulse counts must be equal to the control pulse counts.
17	Absolute encoder line number	1		The resolution of absolute encoder. For example, the resolution of 17-bit encoder is 131072.
18	Maximum rotating speed of motor	Rev / min	Greater than 0 and smaller than 6000	The maximum rotating speed. Exceeding this speed is not allowed in actual operation.
19	Joint motion jerk time (JOG)	ms	Greater than 8 but smaller than 200	The jerk time parameter during JOG motion.
20	Reduction ratio (motor end) unit	Degree		Reduction ratio (motor end) unit. Only “degree” unit can be used.
21	Reduction ratio (execution end) unit	Degree mm		Reduction ratio (execution end) unit. It can be classified as rotation mechanism (degree) and translation mechanism (mm) according to mechanical structure
22	Joint motion unit	Degree mm		It can be classified as rotating mechanism (degree) and translation mechanism according to mechanical

				structure, or be left blank.
23	Incremental encoder negation			Reserved parameter

12.5.2 Cartesian parameter setting

12.5.2.1 Interface

Item No.	Operation	Illustration
1	Select {Cartesian Para}	
2	Click {PageUp}, {PageDown} button to flip page back and forth.	 



12.5.2.2 Parameter illustration

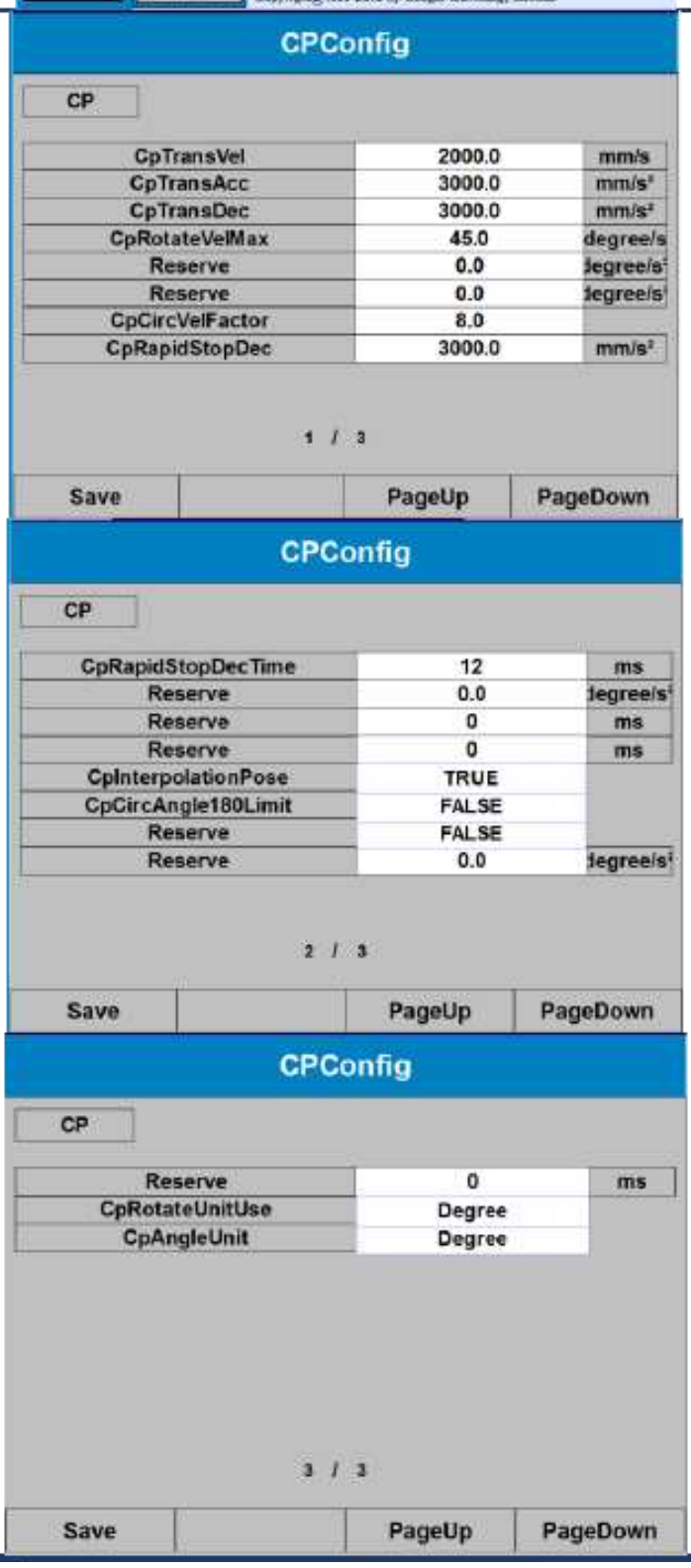
Item no.	Parameter name	Unit	Value range	Illustration
1	Cartesian motion lower limit	mm	Related to robot hardware structure: Please set up the parameter according to the actual hardware	Minimum value of motion range under Cartesian coordinate system;
2	Cartesian motion lower limit offset	mm	Greater or equal to 0 and smaller than the Cartesian motion lower limit	Offset value of motion range distance minimum value under Cartesian coordinate system;
3	Cartesian motion upper limit	mm	Related to robot hardware structure: Please set up the parameter according to the actual hardware	Maximum value of motion range under Cartesian plane;
4	Cartesian motion upper limit offset	mm	Greater or equal to 0 and smaller than the Cartesian motion upper limit	Offset value of motion range distance maximum value under Cartesian coordinate system;
5	Cartesian motion speed upper limit (JOG)	mm/s	Cart1, Cart2, Cart3 are greater than 0 and smaller than 250; Cart4, Cart5, Cart6 are greater than 0 and smaller than 30;	Maximum value of jog axis operation key motion speed under Cartesian coordinate system;
6	Cartesian motion acceleration/deceleration (JOG)	mm/s^2	Cart1, Cart2, Cart3 are greater than 0 and smaller than 2000; Cart4, Cart5, Cart6 are greater than 0 and smaller than 360;	Maximum value of jog axis operation key motion acceleration under Cartesian coordinate system;
7	Cartesian motion speed upper limit (MOVP)	mm/s	Cart1, Cart2, Cart3 are greater than 0 and smaller than 4000; Cart4, Cart5, Cart6 are greater than 0 and	Maximum value of motion speed under command MOVP;

			smaller than 360;	
8	Cartesian motion acceleration (MOVP)	mm/s^2	Cart1, Cart2, Cart3 are greater than 0 and smaller than 4000; Cart4, Cart5, Cart6 are greater than 0 and smaller than 360;	Maximum value of motion acceleration under command MOVP;
9	Cartesian motion deceleration (MOVP)	mm/s^2	Cart1, Cart2, Cart3 are greater than 0 and smaller than 4000; Cart4, Cart5, Cart6 are greater than 0 and smaller than 360;	Maximum value of motion deceleration under command MOVP;
10	Cartesian motion emergency stop deceleration	mm/s^2	Greater than 0 and smaller than 36000	Deceleration of Cartesian motion command (MOVP) under emergency stop condition.
11	Cartesian motion emergency stop jerk time	mm	Greater than 0 and smaller than 50	Jerk time of Cartesian motion command (MOVP) under emergency stop condition.
12	Cartesian motion negation		Valid/invalid	User defines if the joint rotation direction is in opposite direction to the system internal robot model.
13	Cartesian motion zero point offset	Degree	Greater 0 and smaller than 360	User defines the offset value of the joint zero point and system internal robot model.
14	Cartesian motion jerk time (JOG)	mm	Greater 8 but smaller than 200	Jerk time parameter of JOG motion.
15	Cartesian space unit	mm, degree		mm for XYZ component, degree for ABC component

Chapter 12 System

12.5.3 CP setting

12.5.3.1 Interface

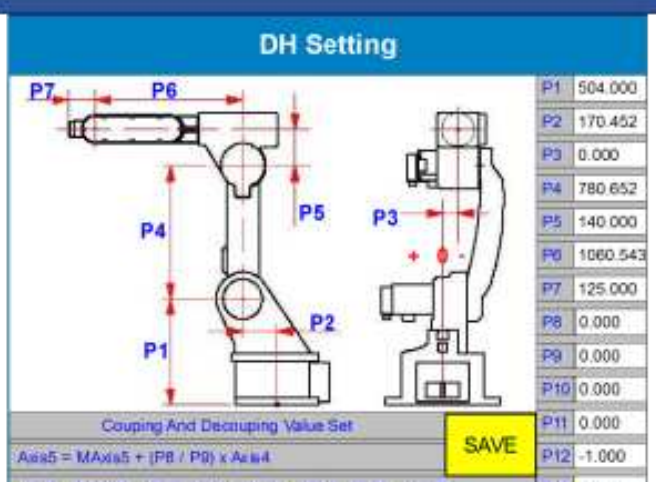
<table>
<tr><th>Item No.</th><th>Operation</th><th>Illustration</th></tr>
<tr><td>1</td><td>Select {Cp Para}</td><td> 
</td></tr>
<tr><td>2</td><td>Click {PageUp}, {PageDown} to flip pages back and forth.</td><td> 
</td></tr>
</table>

12.5.3.2 Parameter illustration

Item no.	Parameter name	Unit	Value range	Illustration
1	CP moving speed upper limit	mm/s	Greater than 0 and smaller than 2000	CP (MOVC, MOVL) maximum value of consecutive trajectory motion speed;
2	CP moving acceleration	mm/s²	Greater than 0 and smaller than 2000	CP (MOVC, MOVL) maximum value of consecutive trajectory motion acceleration;
3	CP moving deceleration	mm/s²	Greater than 0 and smaller than 2000	CP (MOVC, MOVL) maximum value of consecutive trajectory motion deceleration;
4	CP pose maximum rotating speed	Degree/s	Greater than 20 and smaller than 180	CP (MOVC, MOVL) maximum value of pose synchronous interpolation speed during consecutive trajectory motion
5	CP arc and BL segment speed coefficient	1	Greater than1 and smaller than 50	The maximum speed allowed of the arc segment trajectory cannot exceed the product of the coefficient and the arc radius.
6	CP moving emergency stop deceleration	mm/s²	Greater than 0 and smaller than 25000	The deceleration used by CP command under emergency stop condition.
7	CP moving emergency stop jerk time	ms	Greater than 0 and smaller than 50	The jerk time used by CP command under emergency stop condition.
8	CP motion pose and interpolation		Valid/Invalid	Whether the CP pose will remain unchanged during CP command execution.
9	CP pose rotation unit	Degree, radian		The unit of CP pose parameter can only be degree or radian.
10	CP arc motion unit	Degree, radian		The unit for DEGREE command (for MOVC)

12.5.4 DH parameter setting

12.5.4.1 Interface

Item No.	Operation	Illustration
1	Select {DH Para}	

12.5.4.2 Parameter illustration

Item no.	Parameter name	Unit	Illustration
1	P1~P7	mm	Please fill in all the parameter message according to the diagrams.
2	P8/P9	1	Coupling ratio between axis 4 and axis 5
3	P10/P11	1	Coupling ratio between axis 6 and axis 4
4	P12/P13	1	Coupling ratio between axis 6 and axis 5

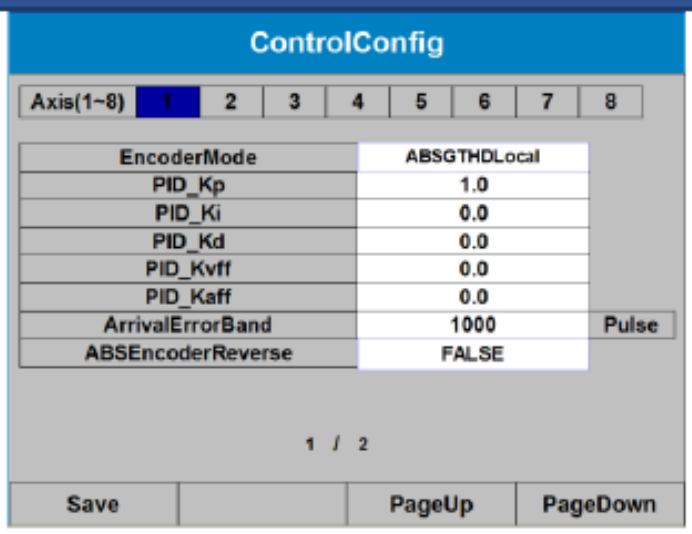
Coupling ratio parameter calculation formula:

$$Axis5 = MAxis5 + (P8 / P9) \times Axis4$$

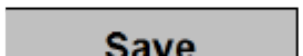
$$Axis6 = MAxis6 + (P10 / P11) \times Axis4 + (P12 / P13) \times Axis5$$

12.5.5 Control parameter setting

12.5.5.1 Interface

Item No.	Operation	Illustration
1	Select {ControlConfig}	

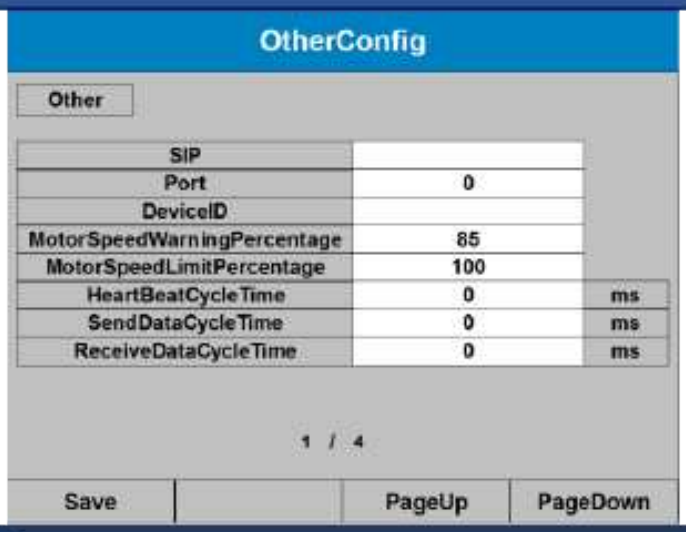
12.5.5.2 Parameter illustration

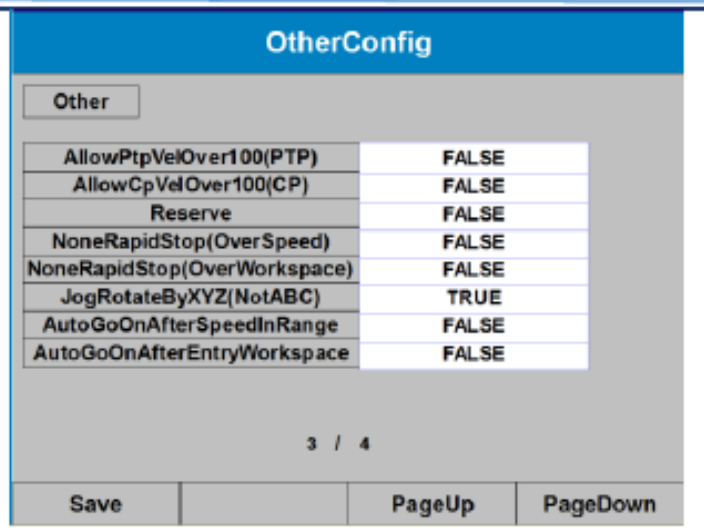
Item no.	Parameter name	Illustration
1	Encoder type	Select the corresponding encoder model in the pull down menu (such as GTHD absolute, Sanyo Denki absolute, Yaskawa M2 absolute etc.). 

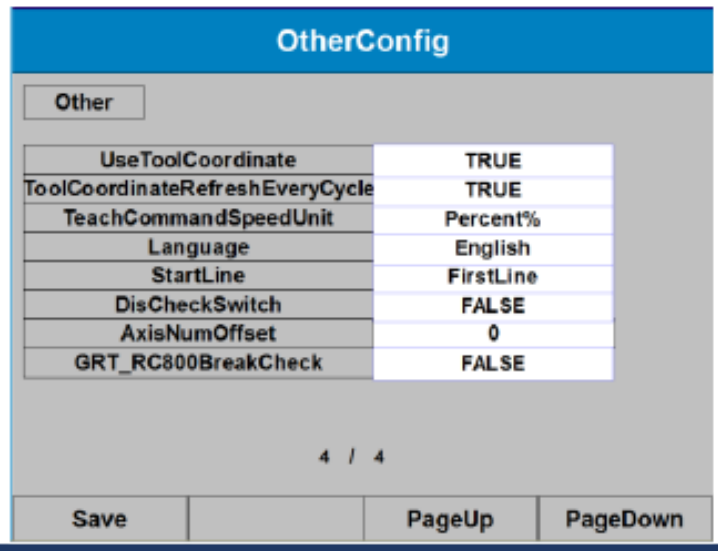
		PageUp PageDown
2	PID_Kp	Position ratio constant
3	PID_Ki	Position integral constant
4	PID_Kd	Position differential constant
5	PID_Kvff	Speed feedforward coefficient
6	PID_Kaff	Acceleration feedforward coefficient
7	Positioning error band	When the position follow error exceeds this value, the system will be stopped emergently.
8	Absolute encoder negation	Selection of absolute encoder direction. When the increment direction of control pulse is in opposite direction to the increment direction of absolute value reading, the parameter will be set as valid.
9	Positioning time	Reserved parameter
10	Absolute encoder reading	Absolute encoder reading serial port (com0: USB to serial port, com1: generic GUC, com2: N455).

12.5.6 Other parameter setting

12.5.6.1 Interface

Item No.	Operation	Illustration
1	Select {Other}	





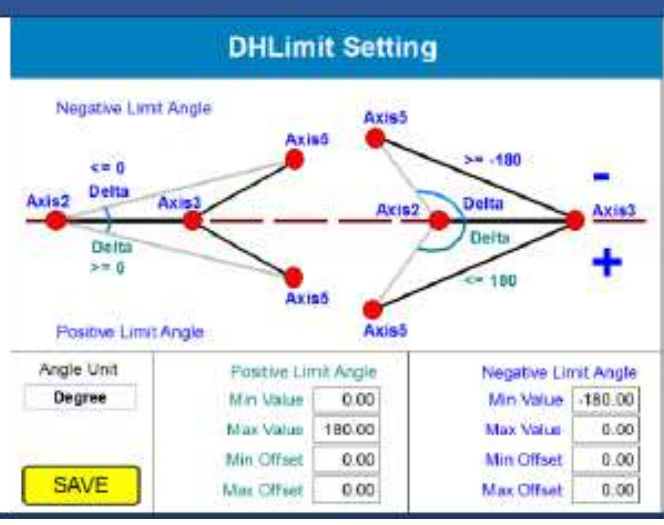
12.5.6.2 Parameter illustration

Item no.	Parameter name	Value range	Illustration
1	Server IP		IP address of server connecting to robot;
2	Server port		Port of server connecting to robot;
3	Device number		Device number of robot
4	Motor speed alarm percentage	Greater than 0 and smaller than 100	When the motion speed of the motor reaches the assigned percentage of the maximum speed, the system alarm will be activated.
5	Motor speed emergency stop percentage	Greater than 0 and smaller than 150	When the motion speed of the motor reaches the assigned percentage of the maximum speed, the system will be stopped immediately; 1.5 times of motor ultimate speed is allowed, but not exceeding 6000rpm.
6	Number of planned axis		Number of axis used in robot model. For example, the value is 6 for 6-axis robot.
7	Number of auxiliary axis	0、1、2 0,1,2	Number of external extension axis.
8	JOG world coordinate system	Valid, invalid	Pose revolves around ABC (Euler angle) or XYZ axes.

Chapter 12 System

12.5.7 DH limit parameter

Limit range of robot pose can be confirmed by setting the joint +/- angle range (DH limit parameter):

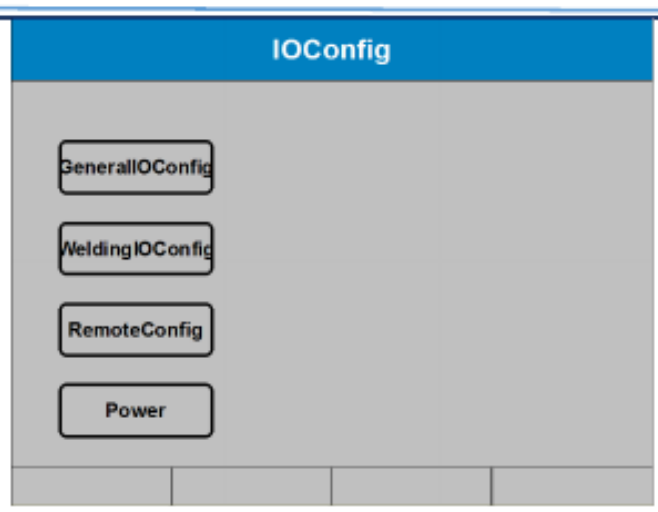
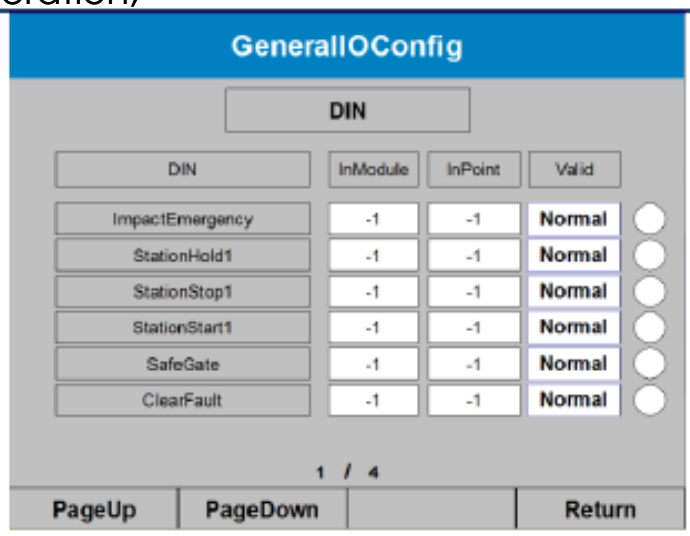
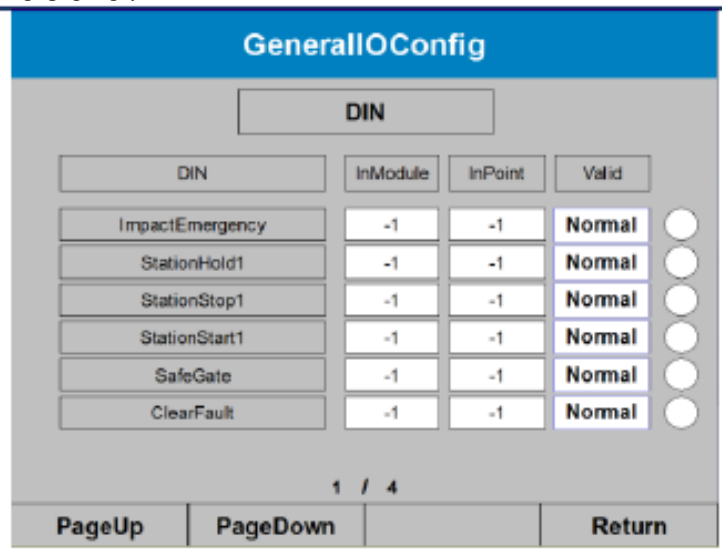
Item No.	Operation	Illustration
1	Select {DHLimiSetting}	

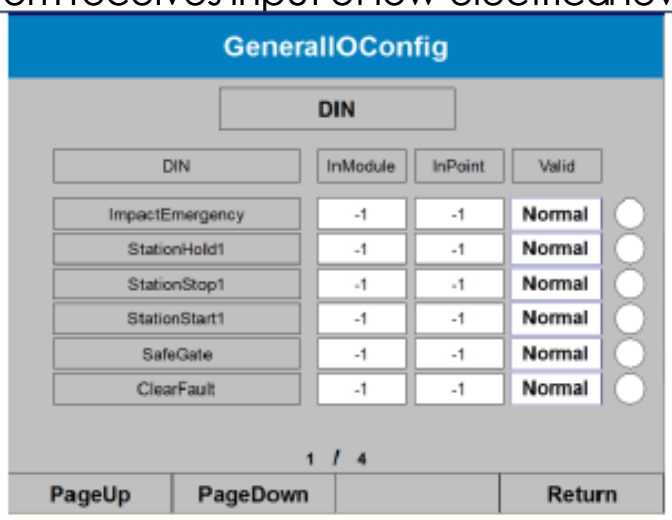
12.5.8 I/O configuration

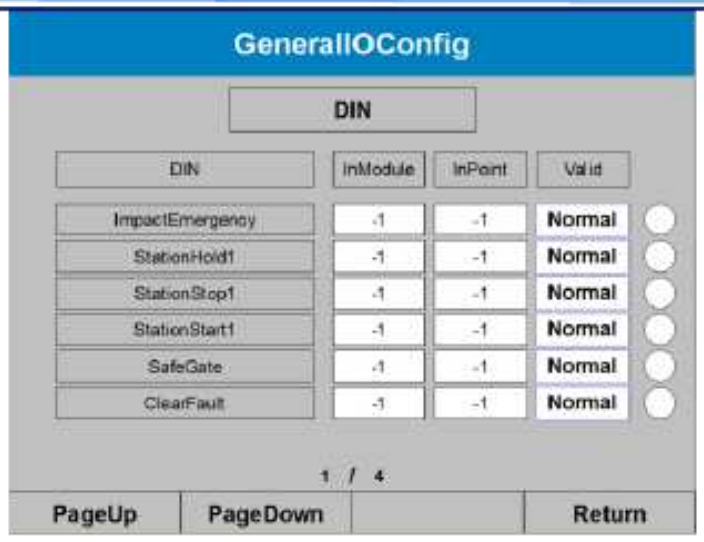
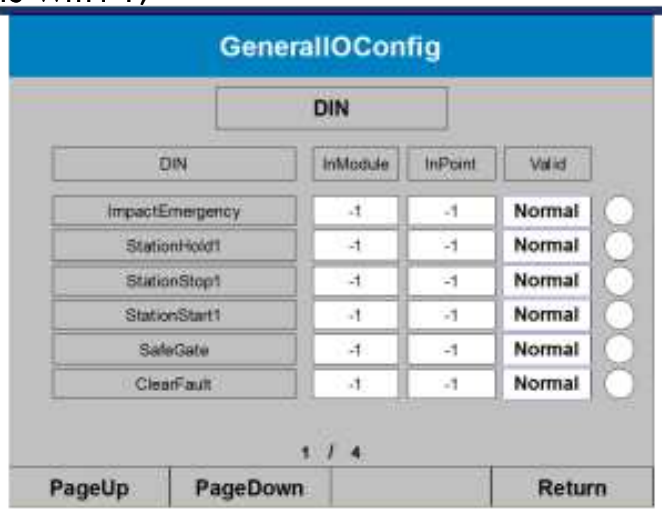
To select I/O configuration, user has to change the permission setting to factory reset first.

12.5.8.1 Interface

Item No.	Operation	Illustration
1	Select {I/O Config} Select {SETUP} under main menu interface→call up the submenu via the 【Move right】 key on the handheld operation teaching device, then pick I/O configuration→Click confirm to enter;	

2	User can select {GeneralIOConfig}, {WeldingIOConfig}, {RemoteConfig} respectively	 General I/O configuration: I/O used in general condition; Welding I/O configuration: I/O used in welding manufacturing process; Remote configuration: I/O used in remote operation;
3	Take common configuration as an example, click the {GeneralIOConfig} button	 Click the arrows on the left/right of {DIN} to switch to {DOUT}, {AIN}, or {AOUT}; “-1” in module configuration means the signal is not configured; “0” in module configuration means the signal is the point position of the terminal board.
4	Digital input (DIN)	 Input module: For the input module that is configured with the input point, -1 means

		terminal board, extension module starts with 1; Input point position: For the input point position that is configured with the input point, 16-digit input module corresponds to 0-15, 8-digit input module corresponds to 0-7; Effective electrical level: (1) Selecting {high electrical level} means signal is triggered when the system receives input of high electrical level; (2) Selecting {low electrical level} means signal is triggered when the system receives input of low electrical level;
5	Digital output (DOUT)	 Output module: The output module that is configured with the output point, 0 represents the output point of the terminal board, extension module starts with 1; Output point position: The output point position that is configured with the output point, 16-digit output module corresponds to 0-15, 8-digit output module corresponds to 0-7; Effective electrical level: (1) Selecting of {high electrical level} means when the system outputs the signal, the output point outputs high electrical level; (2) Selecting of {low electrical level} means when the system outputs the signal, the output point outputs low electrical level;

6	Analog input (AIN)	 Input module: The analog input module that corresponds to the signal. Extension module starts with 1;
	Analog output (AOUT)	 Output module: The analog output module that corresponds to the signal. Extension module starts with 1;

Different input parameters can be configured to different I/O triggering point according to client's requirement. (User has to define the signal source of the I/O signal). Take digital input as an example, user can position the input module (-1: **none**, 0: **terminal board**, 1: **extension I/O module number 1**, 2: **extension I/O module number 2** etc) and input point position (The signal is located at the assigned position of input module: 8-digit output module corresponds to 0-7, 16-digit module corresponds to 0-15).

12.5.8.2 Parameter illustration

The I/O points of the system section configuration are as below:

General I/O:

Item no.	I/O type	Parameter name	Illustration
1	Digital input	Collision avoidance signal	After collision with the robot is detected, robot will stop immediately when signal is triggered;
2	Digital input	External pause	To pause robot motion externally. Robot will pause

2	Digital input	External pause	running teaching files after signal is triggered;

3	Digital output	Output red light	Signal is output when there is abnormality of the robot
4	Digital output	Output yellow light	Signal is output when robot is under other conditions
5	Digital output	Output green light	Signal is output when robot is running teaching files.

Remote I/O

Item no.	I/O type	Parameter name	Illustration
1	Digital input	Turn on servo enabled in remote mode	Trigger the signal in remote mode to turn on robot servo enabled;
2	Digital input	Turn off servo enabled in remote mode	Trigger the signal in remote mode to turn off robot servo enabled;
3	Digital input	Remote mode emergency stop	Trigger the signal in remote mode to stop the robot immediately;
4	Digital input	Start in remote mode	Trigger the signal in remote mode to start running the teaching file;
5	Digital input	Pause in remote mode	Trigger the signal in remote mode to pause running the teaching file;
6	Digital input	Clear error in remote mode	Trigger the signal in remote mode to execute clearing error command;
7	Digital input	Teach file 1 in remote mode	Under remote mode, the three signals use binary mode to select teaching file names, for example: Teaching file 1 is triggered in remote mode; Teaching file 2 is triggered in remote mode; Teaching file 3 is not triggered in remote mode Means selecting file name “3”;
8	Digital input	Teach file 2 in remote mode	
9	Digital input	Teach file 3 in remote mode	
10	Digital output	Remote mode status	Signal output of robot when it’s in remote mode;
11	Digital output	Remote mode idle	Signal output of robot when it’s in pause status
12	Digital output	Operate in remote mode	Signal output of robot when it’s in operating teaching file status
13	Digital output	Alarm in remote mode	Signal output of robot when it’s in abnormal alarming;

Welding manufacturing process I/O:

Item no.	I/O type	Parameter name	Illustration
1	Digital input	Successful signal of arc starting	This signal input represents arc starting of the welding machine is successful;
2	Digital input	Normal signal of welding machine	This signal input means the welding machine works normally’

3	Digital input	Not enough shielding gas	This signal input means there is not enough shielding gas;
4	Digital input	Not enough welding wire	This signal input means there is not enough welding wire;
5	Digital input	Wire sticking	This signal input means welding wire sticking;
6	Digital output	Arc starting	Robot sends out the arc starting command to the welding machine via this signal;
7	Digital output	Wire feeding	Robot sends out the wire feeding command to the welding machine via this signal;
8	Digital output	Wire withdrawing	Robot sends out the wire withdrawing command to the welding machine via this signal;
9	Digital output	Gas checking	Robot sends out the air valve opening command to the welding machine via this signal;
10	Analog input	Input current	This signal means the welding current fed back to the robot by the welding machine;
11	Analog input	Input voltage	This signal means the welding voltage fed back to the robot by the welding machine;
12	Analog output	Output current	This signal means the welding current sent to the welding machine by the robot;
13	Analog output	Output voltage	This signal means the welding voltage sent to the welding machine by the robot;

Chapter 13 Convenient Functions

13.1 Automatic homing

Press the 【Shift】and 【9】 keys on the handheld operation teaching device continuously to enable the robot to return to home position quickly.

13.2 Automatic alignment function

Automatic alignment function illustration: This function can only be used in KCS, WCS, TCS, PCS. The automatic alignment function is the motion rotation component position of automatic alignment of integral multiple of 90 degrees when revolving around a specific axis, such as -180°, -90°, 0°, 90°, 180°. There is a constraint for the use of this function, i.e., the current orientation component revolving around the axis should be close to the expected target value. The range is +/- 10°. For example, in KCS, the current pose component value around the Z axis is 87.537°, the expected final teaching position of Z axis is 90°. It is hard to teach to position of 90.00° precisely by pointing the rotational pose component. As 90°-87.537°=2.463°, 2.463° falls in the range. User can press 【Shift】and 【6】keys with servo power connected. The TCP around the Z axis of KCS rotational component will be automatically adjusted to 90.00°.

The automatic alignment function of the coordinate axes of TCS with other coordinate axes of other Cartesian coordinate system (KCS, WCS, PCS1, PCS2) can be fulfilled. For example, if the user wants the current Z axis of the TCS to be parallel with the closest coordinate axes (X, Y, Z axes) in KSC, then he just needs to implement automatic alignment processing of X and Y axes in KCS. After the above two alignment processing, the Z-axis of TCS will automatically align in the direction with a certain stand axis of KCS (same direction or opposite direction depends on which axis of the KCS is closest to the Z-axis of TCS before alignment.

For safety purpose, the maximum angle of automatic alignment is 10°. (It can be processed if the angle exceeds 10°).

Axis operation key	Action
【Shift】+【4】	Select the rotational component of coordinate axis revolving about X-axis to align with integral multiple of 90°.
【Shift】+【5】	Select the rotational component of coordinate axis revolving about Y-axis to align with integral multiple of 90°.
【Shift】+【6】	Select the rotational component of coordinate axis revolving about Y-axis to align with integral

【Shift】+【6】	axis revolving about Y axis to align with integral multiple of 90°.

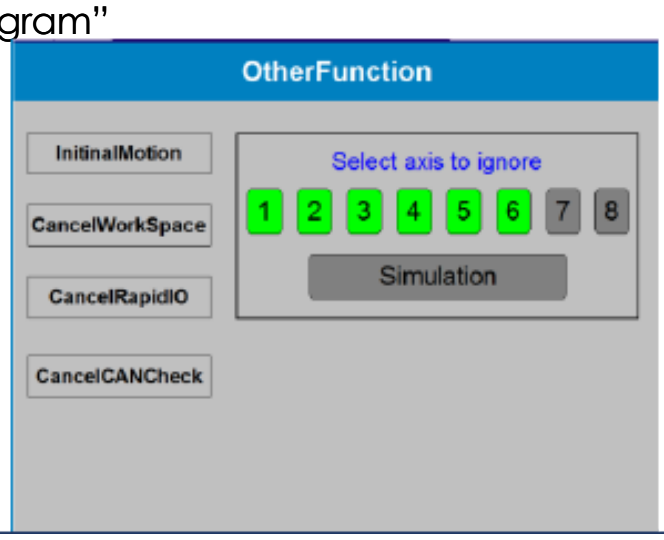
Chapter 13 Convenient Functions

13.3 Abnormality treatment

User can reset motion control, cancel range display, simulate axis. The specific operation procedures are as below:

Item No.	Operation	Illustration
1	Press the 【Move up】or 【Move down】 key on the handheld operation teaching device to enable the {ROBOT} under main menu **<u>turns blue</u>**.	
2	Press the 【Move right】 key on the handheld operation teaching device to call up the submenu.	
3	Press the 【Move up】 or 【Move down】 key on the handheld operation teaching device to make the {Exception} **<u>turn blue</u>**, then press the 【Select】 key.	 1. Click {InitialMoton} to restart the motion controller and initialize the robot parameter configuration; 2. When the robot moves outside the motion space, click {CancelWorkSpace} to make it turn blue, and the limitation on working space will be canceled. After the robot moves inside the working space, the

		{CancelWorkSpace} button will

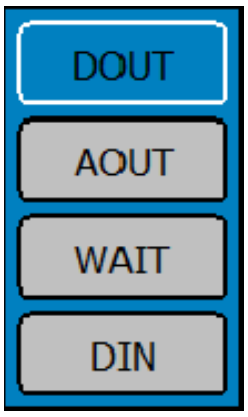
		automatically be restored; 3. When the robot forbids its movement due to triggering of emergency stop I/O, click {CancelCANCheck} to make it turn blue and the limitation will be canceled. After the robot moves to a safe position, click {CancelCANCheck} to restore the button and restart the emergency stop I/O function. 4. When the robot is in "teaching mode" and "playing mode", there is a need for some axes to enter simulation mode without connecting to servo power. The specific steps are as below: Click Number key "1" to "8" under "Select the required simulation axis number" and the corresponding number will turn green indicating that specific axis has entered the simulation mode. To exit the simulation mode for the same axis, click the corresponding key and the key will turn grey indicating that axis has exited the simulation mode; Click "simulate all axes" and when it turns green, it means all the axes have entered simulation mode simultaneously. Click again to exit the simulation mode for all the axes as in the diagram" 

13.4 Quick program exit

In teaching mode, press the 【Shift】+【Interlock】+【Clear】 keys will enable to robot to exit the interface.

Chapter 14 Program Command Specification

14.1 I/O command



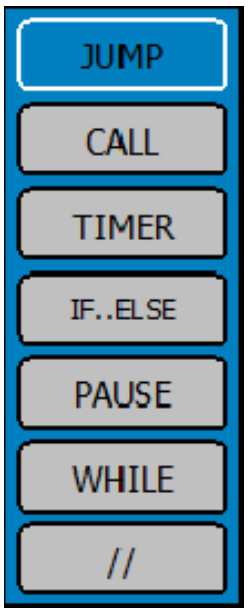
I/O command illustration

Command	Function illustration	Application example	Parameter illustration
DOUT	I/O output point reset or set	DOUT D0= 1.1 VALUE=1 means to output the remote I/O of a group to the second out point of the module. The bit is set as 1.	D0=<I/O module bit> Illustration: A.B is assigned to the I/O module bit A=0: The output point on the terminal board. A=1~16: The remote output I0 module of a specific group. B: A specific I/O on the module, with the value range from 0 to 15. Value=<bit> Bit assigned illustration: 0 or 1.
AOUT	Analog IO output	AOUT A0=1 VALUE=15 means to output 15% of maximum analog to the second analog I/O point.	AO=<Analog module bit> Illustration: Analog I/O corresponds to 0 to 2048 module bit are assigned to analog module bits Value=<Analog output percentage>. Illustration: Value range is 0 to 100.
WAIT	Wait for I/O input point signal	Wait DI= 1.1 VALUE=0 means waiting for the first group remote I/O to input to the second input point of the module with a value of 0.	DI=<I/O module bit> Illustration: A.B is assigned to I/O module bit A=0: The input point on the terminal board A=1~16: The remote input I/O module of a specific group number B: The I/O number on the module of a specific group. The value range is 0~15. VALUE=<Bit> Illustration: 0 or 1 is assigned to the bit.
DIN	The I/O input signal is	DIN B= 1 DI=0 means the first I/O input point value is read to B001 of Boolean	B B=<Variable number> Illustration: 1~96 is assigned to the

	read to	variables	variable number.

	the Boolean variable.		DI=<I/O module bit> Illustration: A.B is assigned to the I/O module bit A=0: the input point on the terminal board. A=1~16: The remote input I/O module of a specific group number. B: The I/O number on the module of a specific group. The value range is 0~15.

14.2 Control command



Control command illustration

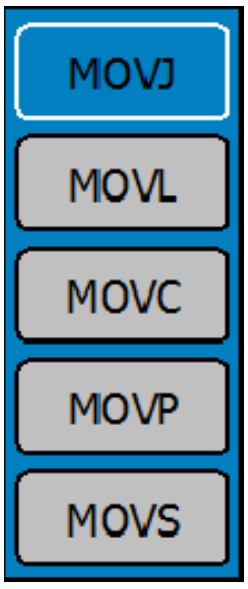
Command	Function illustration	Application example	Parameter illustration
JUMP	JUMP command	means to jump to the first line	L L=<Line number> Illustration: The value of the line number should be smaller than the current line number of JUMP.
CALL	Call up the sub-program command	CALL PROG= 1 means to call up the sub-program with program file name 1	PROG=<Program name> Illustration: Program name must be the program name of existing program file. Recursive looping calling is not allowed.
TIMER	Delay sub-program	Example: TIMER T= 1000 means delaying by 1000ms	T=<Time> Illustration: Time range is 0 to 4294967295 ms.

IF…ELSE	Judge statement	IF I=001 EQ I=002 THEN
		Program 1
		ELSE
		Program 2
		END_IF
		means if judgment element 1 (integer variable I001) and
			Judgment element 1: I=<Variable number>
			Illustration: The range of variable number is 1 to 96.
			I=Integer variable
			B= Boolean variable
			R=Real variable

		judgment element 2 (integer variable I002) are equal then execute program 1, otherwise execute program 2.	Judgment condition: <EQ> The following judgment conditions can be selected: EQ: Equal to LT: Less than LE: Less than or equal to GE: Greater than GT: Greater than or equal to NE: Not equal to
			Judgment element 2: I=<Variable number> Illustration: Rang of variable number is 1 to 96. The variable type of judgment element 2 should be the same as that of 1. I=Integer type B=Boolean type R=Real type
WHILE	Enter looping if condition is satisfied. Otherwise withdraw from looping.	WHILE I=001 EQ I=002 DO Program END_WHILE When judgment element 1(integer variable I001) is equal to judgment 2 (integer variable I002), execute the program, otherwise withdraw from lopping.	Judgement element 1: I=<Variable number> Illustration: Range of variable number is 1~96. I=Integer variable B=Boolean variable R=Real variable
			Judgment condition: <EQ> The following judgment conditions can be selected: EQ: Equal to LT: Less than LE: Less than or equal to GE: Greater than GT: Greater than or equal to NE: Not equal to
			Judgment element 2: I=<Variable number> Illustration: Range of variable number is 1 to 96, variable type of judgment element 2 should be the same as that of 1. I=Integer variable B=Boolean variable R=Real variable
PAUSE	Pause	PAUSE	Illustration: In single step teaching mode, this statement will be skipped (not be executed). In playing mode, press the 【start】key on the handheld operation teaching panel to resume executing.

Chapter 14 Program Command Specification

14.3 Move 1 command



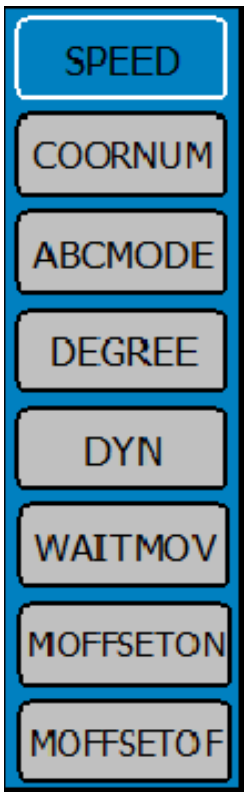
Motion command speed calculation method illustration:

Command	Function illustration	Application example	Parameter illustration
MOVJ	Move to the target position by joint interpolation mode	Example 1: MOVJ V= 25 BL=0 VBL=0 Move to the target position by joint interpolation mode. Press【insert】followed by【confirm】in servo connection status. Example 2: MOVJ P=1 V=25 BL=100 VBL=0 Move to the target position P by joint interpolation mode. Point P is the pre-taught position point of position variable. 1 represents the item number of that point.	V=<Motion speed percentage> Illustration: Range of motion speed percentage is 1 to 100 with a default value of 25.
			P P=<Position point> Illustration: The value range of P is 1 to 1019. (1~999 are used for calibrating the position point, while 1000~1019 are used for the automatic obtained stacking position points during stacking motion. As there is no such parameter in example 1, it means the calibrated position point used during motion process is the target position. As there is parameter of point P in example 2, it means the position point is the calibrated point in position variable.
			BL=<Transition section length> Illustration: Transition section length with unit of mm. The length cannot exceed half of the total motion length. If BL=0, it means this transition section has not been used.
MOVL	Move to the target position by linear interpolation	Example 1: MOVL V=25 BL=0 VBL=- Move to the target position by linear interpolation mode. Press【insert】followed by	

	mode. (It is used when trajectory requirement is relative high but not speed requirement such as arc welding industry	【confirm】 in servo connection status. Example 2: MOVL P=1 V=25 BL=100 VBL=0 Move to the target position P by joint interpolation mode. Point P is the pre-taught position point of position variable. 1 represents the item number of that point.	VBL=<Transition section speed> Set up the transition section speed with commands MOL, MOVC, MOVS. Value range is 0 to 100 Value of 0 means there is no transition section speed.
MOVC	Move to the target position by arc interpolation mode. Three-point arc method is used. The point in front of the arc is the first point. Two MOVC are middle points and target point.	MOVL V= 25 BL=0 VBL=0 MOVC V=25 BL=0 VBL=0 MOVC P=1 V= 25 BL=0 VBL=0 Move to the target position P by arc interpolation mode. Point P is the pre-taught position.	
MOVS	Move to the target position by irregular arc interpolation mode	MOVL V= 25 BL=0 VBL=0 MOVS P=1 V= 25 BL=0 VBL=0 Move to the target position P by irregular arc interpolation mode. Point P is the pre-taught position.	
MOVP	Move to the target position by point-to-point linear interpolation mode. It is used when high speed is required but not trajectory. For example: Forwarding industry.	MOVP V= 25 BL=0 VBL=0 Move to the target position by point-to-point linear interpolation mode. Press 【insert】 followed by 【confirm】 in servo connecting status. MOVP P=1 V=25 BL=100 VBL=0 Move to target position P by point-to-point linear interpolation mode. Point P is the pre-taught position point in position variable. 1 is the item number of the point.	

Chapter 14 Program Command Specification

14.4 Move 2 command



Function command illustration:

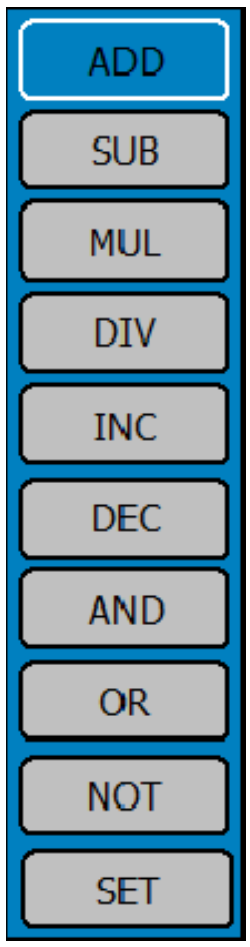
Command	Function illustration	Application example	Parameter illustration
SPEED	Adjust the speed percentage of the motion command following the statement	SPEED SP= 70 means the overall speed is adjusted to 70%.	SP=<Acceleration percentage> Illustration: Value range is 1 to 100. If SPEED command is not called up, the program default value is 20%.
DYN	Adjust the acceleration, deceleration, jerk time of the motion commands following the statement	DYN ACC= 60 DCC= 60 J= 50 means motion commands following the statement are set as below: acceleration percentage: 60%; deceleration percentage: 60%, jerk time: 50ms.	ACC=<Acceleration percentage> Illustration: Value range of acceleration percentage is 1 to 100, with default value of 10%.
			DCC=<Deceleration percentage> Illustration: Value range of deceleration percentage is 1 to 100, with default value of 10%.
			J=<Jerk> Illustration: Value range of jerk is 8~800mm, with default value of 128.

DEGREE	。 Set the arc degree. It is ineffective after motion completes.	DEGREE DR=360 MOVL V= 25 BL=0 VBL=0 MOVC V=25 BL=0 VBL=0 MOVC P=1 V= 25 BL=0 VBL=0 means travel in the 360-degree arc trajectory formed by the above three points with 25% of maximum speed.	DR=<Arc angle> Illustration: Arc degree value range is greater than 1 degree.
ABCMODE	Adjust the operation mode of robot pose. There are 3 operation modes for ABC that user can choose. It is effective for motion commands following the current command until a new ABCMODE command appears.	ABCMODE ABC= STANDARD means ABC mode runs in standard mode. Routine: ABCMODE ABC= STANDARD MOVL P=1 V= 25 BL=0 VBL=0 MOVL P=2 V=25 BL=0 VBL=0 ABCMODE ABC= FOLLOW MOVL P=3 V=25 BL=0 VBL=0 Points P1, P2 runs in STANDARD mode while point P3 runs in FOLLOW mode.	ABC=< ABC operation mode> Illustration: ABC mode refers to the interpolation motion mode of the trajectory followed by pose the during MOVL, MOVC command motion. There are three generating modes for pose following: STANDARD: The MOVL and MOVC commands adopt standard end point, i.e., user teaches the target pose, robot will move from current position to the target position with pose towards the teaching target pose interpolation motion. When the robot moves to the target position, the pose will also reach the teaching target pose value. UNCHANGE: Interpolation program will ignore user's teaching target pose value. No matter what the user teaches what kind of target pose, MOVL and MOVC command will keep the pose unchanged during the motion process. FOLLOW: MOVL command will keep the pose unchanged during motion process (keep the starting point pose unchanged). MOVC command will process slightly different in FOLLOW mode. Interpolation program will generate a new target pose according to the current starting point pose and arc degree. The generation of new target pose is in accordance with generation of pose value of the arc angle of the current starting point pose revolving around the arc center axis.
COORDNUM	Select coordinate system number (User	COORD_NUM COOR= TCS NUM=2 means the number 2 coordinate system is selected for TCS.	COORD=<Coordinate system> Illustration: The following coordinate systems can be selected: WCS-World coordinate system

	can select	Routine:	TCS-Tool coordinate system

	WCS, TCS, PCS1,PCS2).	COORD_NUM COOR= TCS NUM=1 MOVL P=1 V= 25 BL=0 VBL=0 MOVL P=2 V=25 BL=0 VBL=0 COORD_NUM COOR= TCS NUM=2 MOVL P=3 V=25 BL=0 VBL=0 Points P1 and P2 are run in number 1 TCS, point P3 is run in number 2 TCS.	PCS1-Piece coordinate system 1 PCS2-Piece coordinate system 2 NUM=<Coordinate system ID> Illustration: The range for coordinate ID assigned is 1 to 10.
WAITMOV	Wait for motion to complete	WAITMOV DIS=10 Motion is treated as complete when the distance from destination is 10mm. Routine: MOVL P=1 V= 25 BL=50 VBL=0 DOUT DO=1.2 VALUE=1 WAITMOV DIS=10 MOVL P=2 V=25 BL=0 VBL=0 When point P1 moves to 50mm from target point, number 1.2 output point starts to output. When it is 10mm from target point, it starts to transits to point P2.	DIS=<distance from destination>

14.5 Algorithm command



Algorithm command illustration:

Command	Function illustration	Application illustration	Parameter illustration
ADD	Add datum 1 and datum 2, and store the result into datum 1 variable.	ADD I=001 I=002 Add integer variables I001 and I002, and store the result into I001.	I=<Variable ID> datum 1 Illustration: I=represents integer variable of the following types: I: integer variable R: real variable P: position variable Variable ID means variable number range value is 1 to 96
			I=<Variable ID> datum 2 Illustration: I=<Variable ID> datum 1 Illustration: I=represents integer variable of the following types: I: Integer variable R: Real variable P: Position variable Variable ID represents variable number. Range value for integer and real variable is 1 to 96, while that for position variable it is 1 to 999.
SUB	Subtract datum 2 from datum 1, and store the result into datum 1 variable.	SUB I=001 I=002 Subtract integer variables I002 from I001, and store the result into I001.	I=<Variable ID> datum 1 Illustration: I=represents integer variable of the following types: I: Integer variable R: Real variable P: Position variable Variable ID represents variable number. The range value for integer and real variable is 1 to 96, while

			I=<Variable ID> datum 2 Illustration: I=represents integer variable of the following types: I: Integer variable R: Real variable P: Position variable Variable ID represents variable number. The range value for integer and real variable is 1 to 96, while that for position variable is 1 to 999.
MUL	Multiply datum 1 by datum 2, and store the result into datum 1 variable	MUL I=001 I=002 Multiply integer variables I001 and I002, and store the result into I001.	I=<Variable ID> datum 1 Illustration: I=represents integer variable of the following types: I: Integer variable R: Real variable Variable ID represents variable number with value range of 1 to 96.
			I=<Variable ID> datum 2 Illustration: I=represents integer variable of the following types: I: Integer variable R: Real variable Variable ID represents variable number. The value range of integer and real variables is 1 to 96.
DIV	Divide datum 1 by datum 2, and store the result into datum 1 variable.	DIV I=001 I=002 Divide integer variables I001 by I002, and store the result into I001.	I=<Variable ID> datum 1 Illustration: I=represents integer variable of the following type: I: Integer variable R: Real variable Variable ID represents variable number with variable range of 1 to 96.
			I=<Variable ID> datum 2 Illustration: I=represents integer variable of the following types: I: Integer variable R: Real variable Variable ID represents variable number. The value range of integer and real variables is 1 to 96.
INC	Increase the assigned variable value by 1.	INC I=001 Add 1 to the integer variable I001, and store the result into I001.	I=<Variable ID> datum Illustration: I=represents integer variable Variable ID represents variable number with range value of 1 to 96.
DEC	Decrease the assigned variable value by 1	DEC I=001 Subtract 1 from the integer value I001, and store the result into I001.	I=<Variable ID> datum Illustration: I=represents integer variable Variable ID represents variable number of value range 1 to 96.
AND	Obtain logic “AND” of	AND B=001 B=002 Obtain logic	B=<Variable ID> datum Illustration: 1 B=represents Boolean variable

	datum 1	"AND" of	Variable ID represents the value number with

	and datum 2, and store the result into datum 1.	Boolean variables B001 and I002, and store the result into I001.	range value of 1 to 96. B=<Variable ID> datum 2 Illustration: B=Boolean variable Variable ID represents value number with range value of 1 to 96.
OR	Obtain logic "OR" of datum 1 and datum 2, and store the result into datum 1.	OR B=001 B=002 OR B=001 B=002 Obtain logic "OR" of Boolean variables B001 and I002, and store the result into I001.	B=<Variable ID> datum Illustration: 1 B=represents Boolean variable Variable ID represents variable number with range value of 1 to 96. B=<Variable ID> datum 2 Illustration: B=represents Boolean variable Variable ID represents variable number with range value of 1 to 96.
NOT	Obtain the logic "NOT" of datum 2 and store the result into datum 1.	NOT B=001 B=002 Obtain the negation of Boolean variable B002 and store the result into I001.	B=<Variable ID> datum 2 Illustration: B=represents Boolean variable Variable ID represents variable number with range value of 1 to 96. B B=<Variable ID> datum 2 Illustration: B=represents Boolean variable Variable ID represents variable number with range value of 1 to 96.
SET	Datum 2 is assigned to datum 1.	SET B=001 B=002 The value of Boolean variable B002 is stored into Boolean variable B001.	I=<Variable ID> datum 2 Illustration: I=represents integer variable of the following types: B: Boolean variable I: Integer variable R: Real variable P: Position variable Variable ID represents variable number, with range value of integer and real variables of 1 to 96, while that of position variable of 1 to 999.

Chapter 15 Error Message

15.1 Error message

Error messages refer to the warnings prompts up when the method of operating the handheld operation teaching device or accessing the external devices (PC, PLC) is wrong. When errors occur, user has to get rid of the errors after confirming the content. There are two ways to get rid of the errors:

- Press the 【Clear】 key on the handheld operation teaching device.
- Press the {InitialMotion} button in {ROBOT}-{Exception}

- Error is different from alarm. Not like alarms, of which user can continue operate, errors must be got rid of first.

When multiple errors occur, they will be shown in the message display area. Enter {SYSTEM} – {Alarm History} to check the error messages.

15.2 Error list

15.2.1 First level error

15.2.1.1 Errors related to axis motion status management and encoder data management

Error code	Error message	Error analysis	Solution
998	Axis[x] ABS encoder value is ZERO(0)	Absolute encoder reading of Axis x is 0. x: axis number	➢ Refresh the absolute encoder reading at zero point calibration interface; ➢ Reboot the system
999	Referenced failure or out of workspace, only axis JOG mode can run	Failure to find zero point or out of workspace. Only JOG mode is allowed to operate the robot.	After last shutdown, the motor encoder battery has been taken out, or the encoder cable was exd; Robot joint position is out of workspace range; Cannot read the current absolute encoder data properly Approach: If the zero point is lost due to the current position of the robot is out of workspace range, move the robot to within the range of the joint space, and click “Refresh data” in the zero position calibration interface to get back the zero position data; For other situations, click the “Refresh data” button to reread the absolute encoder data or re-calibrate the zero point.

			zero point.

1000	MessageBuffer is full, Please Reset Errors	Error message queue buffer area is full. Errors need to be cleared.	Please resolve and reset to clear the error and alarm messages.
1001	Interpolation Task Init failure	System internal error, timeout error.	Operation cross boundary error. Press 【Clear】 key to reset the error.
1002	➢ Direct kinematics error, division by 0; ➢ Requested Cartesian positon out of work space - too far.	Kinematics computation error. Target position point is unreachable.	System internal error. Please re-teach the target position point.
1003	No correct configuration is available	Configuration item parameter error.	Interpolation program cannot complete reading configuration parameters normally. Maybe some items of the configuration parameters are configured abnormally. Please check the parameter configuration of the files to see if any items are abnormal.
1004	GT command return wrong value. This is a series warning, according to GT Motion Controller.	GT command call up alarm.	GT commands cannot be properly executed due to hardware wiring. Approach: First reboot control system. If problem persists, check the hardware wiring.
1005	Internal error, Please contact supplier engineers	Internal error, controller hardware.	Please contact technical personnel of supplier.
1011	Axis [x] encoder read error	Axis x encoder reading failure	There is encoder data reading error when recording zero position data. Please check the wiring of absolute encoder to see if they are connected properly, and if the encoder reading mode (such as serial port setting) is configured properly.
1012	Encoder write error	Absolute encoder writing error	Maybe other processes are using the file. Please reset system error and try again.
1013	Encoder file open error	Opening encoder file error	Maybe other processes are using the file. Please reset system error and try again.
1014	Axis[x] COM part open error	COM port of Axis X opening failure	Absolute encoder reading serial port configuration error, or serial port is closed abnormally. Restart or re-set the proper serial port number.
1021	Axis[x] Power on error	Abnormality occurs during driver servo power on/off	Reset error message, wait for several seconds of delay and connect servo power again.
1022	Axis[x] get status error	Abnormality occurs when controller	Press [Clear] button to reset the error message. If abnormality occurs frequently, reboot the system.

		obtains driver status.	

1023	Axis[x] Alarm.	Driver axis alarm Abnormality occurs.	Please reset driver error. If error alarm cannot be canceled by [Clear] button. Please reboot system. Please refer to driver alarm list to check the specific alarm reason of the driver.
1024	Axis[x] follow error	Driver follow error exceeds the allowed limit of motion controller	Check the reducer and hardware to see if they are jammed. Check to see if the motor brake is opened properly. Please re-set or re-adjust the driver parameter to make sure that gain and stiffness satisfy actual hardware requirement. Or re-adjust acceleration/deceleration and other dynamics limit parameters.
1025	Axis[x] positive limit error	Driver positive limit exceeds limit	Please close positive limit parameter during PLC axis configurating (GTS800.CFG). Don't use +/- limit of PLC level.
1026	Axis[x] negative limit error	Driver negative limit exceeds limit.	Please close positive limit parameter during PLC axis configurating (GTS800.CFG). Don't use +/- limit of PLC level.

15.2.1.2 Configuration file related error message list

Error code	Error message	Error analysis	Solution
1100	A config is in processing	System internal error currently in processing	Please try to click "Clear" button to reset the error.
1102	Number of kinematic axis must = x	Number of kinematics interpolation axis error	Number of linkage interpolation kinematics axes must be limited to 2 to 6 axes. ("number of planned axes x parameter with respect to 6-axis robot should be 6)
1103	Number of auxiliary axis must >= 0 and <= 2	Number of auxiliary axis exceeds limit	Maximum number of auxiliary axis is 2. If it is not in use, it should be set to 0. ("Number of auxiliary axis" parameter configuration)
1105	Choose Px[x] >0	Robot DH structure model parameter exceeds limit	Please set proper DH parameter according to the model structure of robot. (P1 to P13 parameter of DH configuration page).
1106	Choose unit of RatioUnitOfMotor[x] = DEGREE or RADIAN	。 Select the deceleration rate converting factor unit of motor end	Select the motor rotating angle unit (radian or degree)
1107	➢ Choose unit of RatioUnitOfActuator[x] = DEGREE or RADIAN ➢ Choose unit of	Select the deceleration rate converting factor unit of robot executing end	Select the executing structure unite (radian, degree or mm) (If executing structure is linear motion format).

	RatioUnitOfActuator[x] = MILLIMETER		

1108	Choose MotorSpeedMaxLimit[x] <= xxx	Please set the maximum speed limit of motor properly.	Please set the maximum speed limit of each motor axis within the range. xxx is the calculated speed by the program according to the maximum speed of the motor.
1109	MotorSpeedWarningPercentage must be >= 1	Motor alarm speed percentage must be greater than 1 (1%)	Please set the alarm speed percentage parameter within the range.
1110	Choose MotorIncrPerRound[x] >0	Joint x incremental encoder resolution setting exceeds limit	Please set the below parameter (greater than 0) Motor feedback pulse (p/r)
1111	Choose EncoderIncrPerRound[x] > 0	Joint x absolute encoder resolution setting exceeds limit	Please set the below parameter (greater than 0). The absolute encoder datum when the motor rotates for revolution can be obtained via serial port communication..
1112	Choose unit of KinLimit[x] = DEGREE or RADIAN	If kinematics range limit is used and unit setting is abnormal	Please set the kinematics range parameter unit properly.
1113	KinLimitMax[x] = ***wrong value***, Choose KinLimitMax[1] <= PI	Kinematics limit range setting exceeds limit	Please set the parameter correctly according to the error message.
1114	Choose KinLimitMinShift[x] >= 0	Kinematics limit safety offset value setting exceeds limit	Please set the parameter properly according to the error message. The motion limit safety offset value should be greater than 0.
1115	Choose KinLimitMaxShift[x]>=0	Kinematics limit safety offset value setting exceeds limit	Please set the parameter correctly according to the error message.
1116	Choose unit of Axis[x] = DEGREE or RADIAN	The unit of Axis x is wrongly set	Whether the joints are used and joint unit is correct. For example, Axes 1 to 6 should be used for 6-axis joint robot. "Joint motion unit" parameter
1117	Choose AxisPosMin[x]+ AxisPosMinShift[x] < AxisPosMax[x]- AxisPosMaxShift[x]	Joint motion range setting exceeds limit	Please set the limit position and safety offset value of the axis properly. Must satisfy "Joint motion upper limt - joint motion upper limit offset >= joint motion lower limit + joint motion lower limit offset.
1118	Choose AxisPosMinShift[x] > 0	Joint motion range safety offset value setting exceeds limit	Please set the parameter "Joint motion lower limit offset" to greater than 0.
1119	Choose AxisPosMaxShift[x] > 0	Joint motion range safety offset value setting exceeds limit	Please set the parameter "Joint motion lower limit offset" to greater than 0.
1120	Choose AxisRapidDeceleratio	Joint emergency brake deceleration	Please set the emergency brake parameter. It should be limited between 0

	n[x] > 0	parameter setting exceeds limit	to 6PI Rad/s² (i.e. 1080 degrees/s²). "Joint motion emergency stop

			deceleration" setting is within correct range.
1121	Choose AxisRapidJerkTime[x] > 0	"Joint emergency brake jerk time" parameter setting exceeds limit	Please set "Joint emergency jerk time" parameter correctly. The parameter should be set between 0-50ms.
1122	Choose AxisJogVel100Percent [x] <= ***xxxValue***	Speed setting of joint x exceeds limit in JOG mode.	Please set the correct joint jog speed. "Joint motion speed upper limit (JOG)" parameter. The joint jog speed must be less than 30 degrees/s (or 250mm/s), and the joint jog speed parameter should be limited to within 0.5 of the motor maximum speed to prevent jog speeding. For example, if the motor speed is 3000rpm, deceleration ratios is 100, motor speed limit setting is 80% For 3000*0.80*360/60/100*0.5, the maximum joint jog speed is limited to 30 degrees/s.
1123	Choose AxisJogAcc[x] > 0	Acceleration setting of joint x exceeds limit in JOG mode	Please set the joint jog motion acceleration/deceleration parameter correctly. It should be limited between 0 to 360 degrees/s². "Joint motion acceleration/deceleration (JOG)" parameter. 3000*0.95*360/60/100
1124	Choose AxisPtpVel100Percent[x] <= ***xxxValue***	100% speed value setting of joint x exceeds limit in MOVJ mode.	Please set the MOVJ command maximum speed "joint motion speed upper limit MOVJ" parameter. Speed of joint PTP motion (MOVJ) must be greater than 0, and within speed limit range. For example, if the motor speed is 3000rpm, the speed limit setting is 95%, deceleration ratio is 100, then the maximum speed of PTP is limited to: 3000*0.95*360/60/100
1125	Choose AxisPtpAcc100Percent [x] > 0	100% acceleration value setting of joint x exceeds limit in MOVJ mode.	Please set the "Joint motion acceleration (MOVJ)" parameter correctly. The acceleration value of joint PTP motion (MOVJ command) should be limited between 0 to 1080.
1126	Choose AxisPtpDec100Percent [x] <= ***xxxValue***	100% deceleration value setting of joint x exceeds limit in MOVJ mode.	Please set the "Joint motion deceleration (MOVJ)" parameter correctly. The deceleration value of joint PTP motion (MOVJ command) should be limited between 0 to 1080.
1127	➢ Choose unit of Cart[x] = DEGREE or RADIAN ➢ Choose unit of Cart[x] = MILLIMETER	Unit in Cartesian space is set wrongly.	Please set correctly "Cartesian space unit" parameter is set wrongly. The first 3D of Cartesian space is translation motion along X, Y, Z directions; while the second 3D of Cartesian space is rotation motion around X, Y and Z axes.
1128	Choose CartPosKCSMin[x] +	Upper/lower limits range of Cartesian	Please set Cartesian space motion range parameter correctly.

	CartPosKCSMinShift[x] < CartPosKCSMax[x] -	space setting exceed limit	Cartesian space motion range is set wrongly. The following requirements must be

	CartPosKCSMaxShift[x]		satisfied: Cartesian motion upper limit - Cartesian motion upper limit offset >= Cartesian motion lower limit + Cartesian motion lower limit offset
1129	Choose CartPosKCSMinShift[x] > 0	Cartesian motion lower limit offset setting exceeds limit	Please set correctly: "Cartesian motion lower limit offset" parameter. Parameter is set incorrectly. The parameter must be greater than 0.
1130	Choose CartPosKCSMaxShift[x] > 0	Cartesian motion upper limit offset setting exceeds limit	Please set correctly: "Cartesian motion upper limit offset" parameter. Parameter is set incorrectly. The parameter must be greater than 0.
1133	Choose CartRapidDeceleration[x] <= ***xxxValue***	Cartesian motion emergency stop deceleration speed setting exceeds limit	"Cartesian motion emergency stop deceleration" parameter. Cartesian space motion MOVP command emergency brake deceleration parameter is set incorrectly: The first 3D translation motion parameter "Cartesian motion emergency stop deceleration" must be limited between 0-5000; while the second 3D rotation motion must be limited between 0-4PI in radian unit (Degree unit is 0-720).
1134	Choose CartJogVel100Percent[x]>0	Cartesian motion speed upper limit (JOG) setting exceeds limit	Please set correctly: "Cartesian motion speed upper limit (JOG)" parameter. Cartesian space jog motion speed parameter setting incorrect: "Cartesian motion speed upper limit (JOG)": the first 3D translation component must be limited between 0 to 250; while the second 3D rotation component must be limited between 0-PI/6 (0 to 30 degrees).
1135	Choose CartJogAcc[x]>0	Cartesian motion acceleration/deceleration (JOG) setting exceeds limit	Please set correctly: "Cartesian motion acceleration/deceleration (JOG)" parameter Cartesian space jog motion acceleration /deceleration parameter is set incorrectly: "Cartesian motion acceleration/deceleration (JOG)": the first 3D translation component must be limited between 0-2000; while the scond 3D rotation component must be limited between 0-2PI (0 to 360 degrees).
1136	Choose CartPtpVel100Percent[x]<=***xxxValue***	Cartesian motion speed upper limit (MOVP) setting exceeds limit	Please set correctly: "Cartesian motion speed upper limit (MOVP)" parameter Cartesian space PTP motion speed parameter setting incorrect:

			"Cartesian motion speed upper limit (MOVP)": the first 3D translation component

			must be limited between 0-4000; while the second 3D rotation component must be limited between 0-2PI (0 to 360 degrees).
1137	Choose CartPtpAcc100Percent[x]<= ***xxxValue***	Cartesian motion acceleration (MOVP) setting exceeds limit	Please set correctly: "Cartesian motion acceleration (MOVP) parameter Cartesian space PTP motion acceleration parameter is set incorrectly: "Cartesian motion acceleration (MOVP)": the first 3D translation component must be limited between 0-4000, while the second 3D rotation component must be limited between 0 to 2PI in radian unit (0 to 360 degrees).
1138	Choose CartPtpDec100Percent[x]<= ***xxxValue***	Cartesian motion deceleration (MOVP) setting exceeds limit	Please set correctly: "Cartesian motion deceleration (MOVP)" parameter. Cartesian space PTP motion deceleration parameter setting error: "Cartesian motion deceleration (MOVP)": the first 3D translation component must be limited between 0 to 4000; while the second 3D rotation component must be limited between 0 to 2PI in radian unit (0 to 360 degrees).
1139	Choose CpRapidTransDec > 0	CP motion emergency stop deceleration setting exceeds limit	Please set correctly: "CP continuous motion emergency brake deceleration" parameter CP continuous motion emergency brake deceleration parameter is set incorrectly. The parameter must be set to be greater than 0 and smaller than 2500.
1140	Choose CpTransVel100Percent <= ***xxxValue***	CP motion speed upper setting exceeds limit	Please set the maximum translation speed of CP continuous motion correctly: "CP motion speed upper limit" Maximum translation speed of CP continuous motion is set between 0 to 2000 (unit is mm/s).
1141	Choose CpTransAcc100Percent > 0	CP motion acceleration setting exceeds limit	Please set the maximum translation acceleration of CP continuous motion correctly: "CP motion acceleration" Maximum translation acceleration of CP continuous motion is set between 0 to 2000 (unit is mm/s^2).
1142	Choose CpTransDec100Percent <= ***xxxValue***	CP motion deceleration setting exceeds limit	Please set the maximum translation deceleration of CP continuous motion correctly: "CP motion deceleration" Maximum translation deceleration of CP continuous motion is set between 0 to 2000 (unit is mm/s^2).

1143	Choose CpRapidTransJerkTime	CP motion emergency stop	Please set the emergency brake jerk time parameter correctly:

	> 0	jerk time setting exceeds limit	"CP motion emergency stop jerk time" Maximum emergency brake jerk time parameter of CP continuous motion is set incorrectly. It should be set between 0 to 50 (unit is ms). It is suggested to be set at around 10.
1145	➢ Choose CpRotateVel >= 30 AND <= 180 Deg/s ➢ Choose CpRotateVel >= 0.53 AND <= 3.14	CP motion speed upper limit (pose) setting exceeds limit	Please set the rotation component speed parameter of CP continuous motion correctly: "CP motion speed upper limit (pose)" Rotation speed parameter of CP rotation component during CP continuous motion is set incorrectly. It should be set between 0 to 2PI in radian unit (0 to 360 degrees).
1149	Choose Cp Circ and Blending Vel factor >= 1(smooth) and <= 50(fast)	CP arc and BL transition section speed coefficient setting exceeds limit	Please set the CP arc and smooth transition segment speed coefficient correctly: "CP arc and BL transition segment speed coefficient" The parameter setting range is 0.0 to 50.0. The higher the parameter, the higher the CP arc and smooth transition section speed.
1150	Choose CycleTime > 0	Interpolation cycle parameter setting is incorrect	The error is system internal error. Please contact supplier to resolve it.
1151	Internal Error	System internal parameter setting is incorrect	Please contact technical engineer of supplier.
1152	DIRECT KINEMATICS Error	Error occurs when system implements direction kinematics calculation according to file	Please check parameters to see if there is abnormal item.
1153	Choose CP rotate unit = RADIAN or DEGREE	CP trajectory pose rotation unit error, or CP arc angle unit error	Please set CP pose rotation or CP arc angle unit to "Degree" or "Radian".
1154	CartRapidJerkTime[x] set error	笛卡尔空间下x The emergency brake jerk time setting of x component in Cartesian space exceeds limit	Must be greater than 0.
1155	Choose AxisJogDec[x] <= ***xxxValue***	Deceleration of joint x setting in JOG mode exceeds limit	Please set the deceleration of Cartesian jog motion (JOG) correctly.
1156	Choose AxisJogJerkTime[x] <= ***xxxValue***	The jerk time value of joint x setting in JOG mode exceeds limit	Modify the jerk time value in MOVJ mode so that it is within the range. Factory reset is needed. Set-joint space parameter setting
1157	Choose CartJogDec[x] >0	Deceleration of Cartesian space x	Must be greater than 0.

		component setting in JOG mode	

		exceeds limit.	
1158	Choose CartJogJerkTime[x] > 8ms	Jerk time of Cartesian space x component setting in JOG mode is incorrect	Jerk time of Cartesian space x component setting in JOG mode is incorrect. Please set the parameter correctly (must be greater than 8ms).
1160	Calculate from encoder value to axis value error	从Error in calculating the joint position point from encoder value	Error in calculating the joint position point from encoder value. Please check if motor deceleration, encoder resolution and other parameters are set correctly.

15.2.1.3 Motion interpolation convention error code

Error code	Error message	Error analysis	Solution
1200	Axis[x] out of axis workspace	Robot is out of workspace in KCS or Cartesian mode	Click {Robot}-{Abnormality handling}-{retum to workspace}, move the joint to within work space manually. It goes out of workspace during motion process (Cartesian motion range, axis joint motion range, kinematics limit range etc.)
1201	Axis[x] Motor speed limit crossing	Axis x motor speed exceeds limit.	Since the motor has braked and stopped emergently, the speed has gone back to within the range. User just needs to reset the error, modifies the program or file to avoid the motor speed from exceeding the limit.
1202	Motion mode unknow	Motion mode error, motion mode cannot be recognized	Motion mode of interpolation program received from main task cannot be recognized (System internal error) Please contact engineer of supplier to resolve the problem.
1205	Coordinate system change error	System internal error, coordinate system switching is abnormal	Please contact engineer of supplier to resolve the problem.
1206	The pose is not possible, forearms too short	System internal error, kinematics calculation error	Please contact engineer of supplier to resolve the problem.
1207	Pose cannot reach, inverse kinematic error	Kinematics calculation error. Target position point cannot be reached	System internal error: Only one orienation is allowed when robot is moving under Cartesian coordinate system. Pose change is not allowed (Switching among forward wrist, reverse wrist, left shoulder, right shoulder, upper arm, lower arm and other modes).
1208	Singular point error. The pose is a dangerous pos	Singular point error	Please set the trajectory position point correctly to avoid appearance of singular point during Cartesian trajectory motion process. 6-axis joint robot singular point error: the fifth joint is at horizontal status and the centers of the fourth and sixth axes are collinear. Under

			this situation, the robot loses one freedom of motion and will result in abnormal motion.

			Thus motion cannot be performed in Cartesian coordinate system.
1211	Coordsys is not supported	The selected coordinate system is not supported under current motion mode	The selected coordinate system is not supported under current motion mode.

15.2.1.4 Jog motion errors

Error code	Error message	Error analysis	Solution
1300	JogPercentage > 100 is not allowed	The speed percentage parameter of joint jog motion setting exceeds limit	Please set the jog percentage parameter correctly. The parameter is set over 100%. It must be set between 0 to 100.
1301	ABC discontinuity during JOG CART in KCS	Pose motion is abnormal under Cartesian coordinate system	Please check the jog parameter under Cart mode in the file. The abnormality of the pose motion under Cartesian coordinate system will cause the pose motion to be discontinuous.
1302	JOG coordsys is invalid	Coordinate system is invalid under JOG mode	The coordinate system is invalid under JOG mode.

15.2.1.5 PTP motion errors and abnormality

Error code	Error message	Error analysis	Solution
1400	PtpPar.PTPTransPercentage =***xxxValue***	PTP translation speed percentage parameter setting exceeds limit	Please set the PTP motion command correctly. Speed percentage parameter is not allowed to exceed 100% under PTP mode (MOVJ and MOVP commands).
1401	ABC discontinuity in PTP mode	Pose motion is abnormal under Cartesian coordinate system	Please check the parameter under Cart mode and the parameter of MOVP command in the file. They may cause the pose motion to be discontinuous.
1404	Choose PtpPar.TargVel[x] > 0	MOVP speed setting exceeds limit	Please set the speed parameters of MOVP and MOVJ commands correctly. The motion speed of MOVP and MOVJ commands must be set between 0.0 to 100.0.
1405	PtpPar.TargAcc[x] must >0	Acceleration settings of MOVP and MOVJ commands exceed limit	Please set acceleration parameters of MOVP and MOVJ commands correctly. They must be set between 0.0 to 100.0.
1406	Choose PtpPar.TargDec[x] >= 0	Deceleration settings of MOVP and MOVJ commands exceed limit	Please set acceleration parameters of MOVP and MOVJ commands correctly. They must be set between 0.0 to 100.0.

1407	PtpPar.TargJerkTime[x] must >= 8ms	Jerk time time parameter settings	Please set the jerk time time parameters correctly.

		of MOVP and MOVJ commands exceed limit	The jerk time time parameters of MOVP and MOVJ commands are set incorrectly. The parameter must be greater than the corresponding emergency brake jerk time time parameter. MOVJ command corresponds to "Joint emergency brake jerk time" parameter while MOVP command corresponds to "Cartesian motion emergency stop jerk time" parameter.
1408	PTP targpos coordsys is invalid	The target position point Cartesian coordinate system of MOVP and MOVJ commands is invalid	The target position point Cartesian coordinate system of MOVP and MOVJ commands is invalid.

15.2.1.6 CP continuous motion error and abnormality

Error code	Error message	Error analysis	Solution
1500	CpMovPercentage > 100 is not allowed!	Operating speed setting under CP mode (MOVL and MOVC commands) exceeds limit	Please set the CP motion command correctly Speed percentage parameter is not allowed to exceed 100% under CP mode (MOVL and MOVC commands)
1501	Total CP segment length too long.	Internal error	Please contact supplier to resolve the problem. System internal error, total CP segment length for continuous processing is too long.
1502	CP blending max percentage must >= 1 and <= 99	System internal error	Please contact supplier to resolve the problem. Abnormality of smooth transition segment of CP command takes up length of CP command.
1503	CP blending distance must >= 0.0	Smooth transition segment parameter of CP command setting exceeds limit	Please set the CP motion command correctly. Smooth transition segment parameter of CP command setting error. The smooth transition segment must be greater or equal to 0.
1504	CP moving JerkTime must > CpRapidJerkTime	Jerk time parameter of CP motion command setting exceeds limit.	Jerk time parameter of CP motion command setting error. The jerk time of CP command must be greater than the "CP motion emergency stop jerk time" parameter.
1505	CP moving velocity must > 0.0	CP motion command speed parameter setting exceeds limit	Please set the speed parameters of MOVL and MOVC commands settings correctly. CP motion command speed parameter setting error. The motion speed of MOVL and MOVC commands must be set between 0.0 to 100.0

			to 100.0.
1506	CP moving acc	CP motion	Please set the acceleration parameter of

	must > 0.0 and <= 100.0	command acceleration parameter setting exceeds limit.	MOVL and MOVC commands correctly. CP motion command acceleration parameter is set incorrectly. The acceleration of MOVL and MOVC commands must be set between 0.0 to 100.0.
1507	CP moving dec must < CpRapidMovDec	CP motion command deceleration parameter setting exceeds limit.	Please set deceleration parameters of MOVL and MOVC commands correctly. CP motion command deceleration parameter setting error. The motion deceleration of MOVL and MOVC commands must be smaller than the deceleration value during emergency stop.
1508	There are some errors, CP cannot run!	CP execution error	CP execution error, please click "Clear" button to clear the error.
1510	CpPar.PathSmoothFactor is not allowed < 1	CP path smooth factor parameter setting exceeds limit	Please contact supplier to resolve the problem.
1512	CP queue is full !	CP queue is full	Please try to insert a MOVJ or MOVP command to interrupt and empty the current CP command queue. New CP commands cannot be inserted into the CP queue. There are too many CP commands showing up in a row.
1513	Circle parameters calculate error	Arc parameters calculation error	Valid arc trajectory cannot be generated from the given arc parameters. Please re-teach the arc trajectory points.
1514	CP circ angle cannot < 0.0!	CP arc trajectory angel setting value must be greater than 0	Central angle of the arc cannot be smaller than 0 during arc motion.
1515	CP pose interpolation error	CP pose interpolation calculation error	CP pose interpolation calculation error
1516	Coordsys of CP target is invalid	Coordinate system of CP target position point is invalid.	Coordinate system of CP target position point is invalid.

15.2.1.7 Coordinate system management and tool management errors and abnormality

Error code	Error message	Error analysis	Solution
1600	Error OF PCS2 Assignment: PCS2 CoordSys Index Must >= 0 AND < 10	Coordinate system index number setting exceeds limit	Please set the coordinate system index number correctly. Coordinate system assigned value error. The coordinate system index number must be between 0 to 10 inclusively.
1601	Warning: you must record point O0	Coordinate system data points record	Please record the necessary data points data before calculating the coordinate

		incomplete	system data. Points P1, P2, P3 or (and) O0 is/are not recorded.

1602	Cannot record O0 position	Position point O0 is recorded abnormally	Please re-record position point O0.
1603	Cannot record P1 position	Position point P1 is recorded abnormally	Please re-record position point P1.
1604	Cannot record P2 position	Position point P2 is recorded abnormally	Please re-record position point P2.
1605	Another point is in recording, try again	Position point P3 is recorded abnormally	Please re-record position point P3.
1606	Coordsys file open error	Coordinate system file open failure	Kinematics coordinate system data file open or set up error. Maybe the file is used by other processes. Please reset the error. If the error appears frequently, please shut down the system and reboot it.
1607	Coordsyd data read error.	Coordinate system data file read error	Please reset the error. If the error occurs frequently and cannot be resolved, please try rebooting the system.
1608	Coordsys Calculate Error, Point ***Px*** and ***Py*** too CLOSE	Teaching points P1, P2, P3 and O0 are too close.	Enough distance is required among points P1, P2, P3, and O3 for correct calculation. Please re-teach and re-record the position points data according to error message.
1609	Tool Calculate Error, Point ***Px*** and ***Py*** too CLOSE	Recorded position points of teaching are too close	Recorded position points P1, P2, P3, P4, P5, and P6 are too close. Program cannot calculate TCS data accurately according to the teaching position points data. Please re-teach and re-record the related position points data according to error messages.
1610	Cannot record P1 position	Position point P1 recording error	Please re-record position point P1.
1611	Cannot record P2 position	Position point P2 recording error	Please re-record position point P2.
1612	Cannot record P3 position	Position point P3 recording error	Please re-record position point P3.
1613	Cannot record P4 position	Position point P4 recording error	Please re-record position point P4.
1614	Cannot record P5 position	Position point P5 recording error	Please re-record position point P5.
1615	Cannot record P6 position	Position point P6 recording error	Please re-record position point P6.
1616	Warning: record points P1, P2, P3 and P4	Teaching points recording incomplete	Please record the necessary data point data. (Record position points P1, P2, P3, P4, P5, and P6 based on teaching method).
1617	Coordsys data cannot be refreshed in autorun mode	Coordinate system cannot be refreshed manually in autorun mode	Coordinate system cannot be refreshed manually in auto run mode.

15.2.1.8 Tracking and other manufacturing process module error message

Error code	Error message	Error analysis	Solution
1701	Tracking config data file open error	Synchronous belt configuration file open failure	Tracking data file set up or open failure. File maybe used by other processes. Please reset the error. If the error appears frequently, please try to shut down the system and reboot it.
1702	Tracking interface number error	Synchronous belt item number configuration exceeds limit	Number of synchronous belt supported cannot exceeds 8.
1703	Tracking object out of max work area.	Tracked object exceeds maximum tracking gripping work space	The object being tracked and gripped exceeds maximum range of tracking and grapping work space
1704	Camera detected objects number error	Too many objects detected by camera	Remove some objects waiting to be checked. The camera can detect maximum of 10 objects simultaneously.
1705	Conveyor resolution must not equal zero.	Assembly line encoder resolution setting failure	Encoder resolution cannot be equal to 0.
1706	Tracking point is invalid	Tracking and grapping position point invalid	Tracking conveyor is not activated; Grapping point is not activated correctly; Please re-check Tracking setting.
1707	There is no tracking objects active	There are no tracking objects in active status currently	There are no tracking objects in active status currently. There is no object to be tracked and gripped to execute the tracking and grapping operation.
1708	'Point M and Point N too close, Must > 20mm AND 20 Pixel	The distance between points M and N must exceeds 20mm and be greater than 20 pixels	Teaching vision resolution operation error. The two teaching position points are too close. They need to be re-calibrated.
1709	Encoder latch enable signal not detected, Encoder value record failure	Encoder latch signal is not detected	Encoder latch signal is not effective. Encoder data are not latched correctly. Please check if the encoder latch I/O are connected properly.
1710	Object compare buffer is full	Tracking object matching buffer area is full	Object filtering and matching buffer area is full. Please check if visual field range magnitude setting is appropriate.
1711	Conveyor mode not supported	Synchronous belt mode not supported	The synchronous belt tracking mode is not support by the system currently.
1750	Ext axes config data file open error	Extension axes configuration file open error	Extension axes configuration file open fails.
1751	Ext axes config error	Extension axis (Positioner) configuration process error	Extension axes (Positioner) configuration process error

15.2.1.9 Other system error message

Error code	Error message	Error analysis	Solution
1998	PtData error	System internal error: Controller data transmitting error	System internal error: If the error occurs frequently, please try to shut down the system and reboot it. If problem still cannot be resolved, please contact supplier.

15.2.2 Second level error

These are errors of lower level. They are related to operation.

Error code	Error message	Error analysis	Solution
2001	Program content listshow error	Teaching file error, cannot be opened.	Please check program file and see if the format is correct. Data cannot be opened normally.
2002	No ID position point	Position point not taught	Check position points and re-record the required position point messages.
2003	Teachfile excute error	Teach file error, cannot execute	Check the program file to see if there is error or it is an empty file.
2004	ListInsert not allowed before nop	Inserting command in the first line is not allowed	Line inserting before NOP is not allowed. Please re-select the line to be inserted.
2005	ListInsert check invalid	Insertion error, command invalid	Please check parameter and re-operate.
2006	TeachFile excute need reset	Reset is required during program file execution process.	Turn the mode know to teaching mode, click the 【Cancel】 button on handheld operation teaching device to cancel errors.
2007	Teachfile edit fail	Program file editing failure	Teaching editing fails. Please re-execute operation.
2008	Teachfile insert error	Program file inserting line error.	Inserting parameter invalid. Please re-operate.
2009	Teachfile delete error	Program file deleting line error.	Program file deleting is not allowed. Please re-operate.
2010	Teachfile modify error	Program file modifying error.	Program file modifying is not allowed or input parameter error during modifying. Please re-operate.
2011	Teachfile not find	Program file name doesn't exist.	Program file name doesn't exist.
2012	Cannot find folder	Program file folder doesn't exist.	Program file folder doesn't exist. Please check if the folder has been deleted. Folder saved path: harddisk\CPAC\techfiles file folder.
2013	Teachfile ID not allowed	Executing the operation with selected ID during inserted, deleting or modifying program point is not allowed.	Please select other lines to operate.

2014	TeachFile not allowed select	Operating in current line not allowed.	Selecting of NOP or END lines are not allowed. Please select other lines to operate.

2015	Unknown handbox work mode	Mode error. Mode message cannot be read normally by handheld operation teaching device	Mode knob I/O connection error. I/O function module cannot be operated normally.
2016	List edit para null	Parameter null not allowed	Check if parameter input is null.
2017	Modify ID not equal select ID	Modified line number and selected line number don't match.	When executing line movement operation during modifying, the modified line is not the selected line.
2018	Copy/cut first line not allowed	Copying/cutting of first line is not allowed.	First line cannot be "NOP" line. Please re-select.
2019	Copy/cut end line not allowed	Copying/cutting of end line is not allowed.	End line cannot be smaller than first line. End line cannot be greater than file length. Please re-operate.
2020	Edit copy error	Copying not successful	First line and last line are not selected. Please re-operate.
2021	Edit cut error	Cutting not successful	First line and last line are not selected. Please re-operate.
2022	Edit paste error	Copying/pasting not successful, No data in buffer area	First line and end line are not selected. Copying or is not executed or there is no data in cutting operating buffer area. Please re-operate.
2023	Teachfile name already exist	File name already exists.	Please rename so that the files will not duplicate.
2024	Emergency stop button pressed	Emergency stop button is pressed.	If servo enabled is needed again, the emergency stop buttons on the handheld operation teaching device and electric control box needed to be released.
2025		The inserted position variable ID doesn't exist	Check the position variable to see if teaching is successful.
2026	Teachfile not selected	Teaching file of main program setting cannot be found in playing mode	Enter "Select program interface" to select the required program, then re-play.
2027	Anti-collision Emergency stop IO triggered	User-defined anti-collision I/O triggered.	Check to see if the anti-collision I/O is triggered. After confirming it is triggered, if user needs to operate the robot, enter 【Robot】-【abnormal situation handle】 interface to cancel the alarm.
2028	Hand IO communication error	Handheld box I/O communication error.	Check the handheld box I/O module to see if communication is normal.
2029	Hand IO check error	Handheld box I/O check error.	
2030	External IO communication error	External I/O communication error	
2031	External IO check error	External I/O check error	
2032	Position var is	No record for the	Please enter 【Variable】-【Position

2032	Position var is valid	No record for the operated position variable	Please enter【Variable】-【Position variable】interface to record the position variable.

2033	Number of MOVC must be even	MOC must show up in pairs	MOC must show up in pairs.
2034	Station Emergency stop IO triggered	Station emergency stop I/O triggered.	Please check the station emergency stop I/O signal, or check the I/O configuration interface to see if there is configuration error.
3035	Backvel or Weldvel error	Abnormal welding speed or back speed	Welding speed or back speed is abnormal.
2036	Missing ArcOn Or ArcOff	ARCON or ARCOFF commands are missing	Please check teaching files.
2037	MOVJ or MOVP Not allowed between ARCON and ARCOFF	MOVJ or MOVP commands are not allowed between ARCON and ARCOF commands.	Please check teaching files.
2038	Arc breaking restart Speed must greater than 0	Broken act restarting speed must be greater than 0	Broken act restarting speed must be greater than 0.
2039	SeachError: NO MOVL before SEARCHMOT	There is no MOVL command before SEARCHMOT command	Please check teaching files.
2040	Weld search on no original position	Search for	Search for
2041	WVON/WVOF or OFFSETON/OFFSETOF or SEARCON/SEARCOF not matched	WVON/OF,OFFSETON/OF,SEARCON/OF commands don't match.	Check teaching commands.
2042	Index Para is invalid	Parameter range incorrect	Check teaching parameter.
2043	Weld Search Error, sensor not triggered	Search for	Switch to status I/O interface, check sensor signal to see if it is normal.
2044	Motor Power Error	No power supply	Check to see if the power supply and emergency buttons are pressed.
2045	External and handbox workmode not matched	External work mode and handheld box work mode don't match.	Check if the teaching and remote can correspond.
2046	VP ID not find in Vision data	VPID cannot be found in vision data	Click【Display】-【Track message】 to enter vision interface, check the received vision data.
2047	Pallet Matrix generate error	Pallet matrix generation error. The layer number or layer workpiece is 0.	Please check he parameter setting It's either the calculated layer height is 0 or the module is incorrect.