Product Manual

Instructions for IRC-I4A-C Controller

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V1.2

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Table of Contents

Safety instructions

It is necessary to read and understand the contents described in this chapter before using robots.

In this Manual, the robot system refers to an integrated system integrating the industrial robot body and its controller, teach pendant, cables, software and other accessories. So, it is required to fully consider the safety precautions of the user and the system.

Nobody is allowed to modify the industrial robot without authorization from Agilebot Robotics Co., Ltd. Agilebot Robotics Co., Ltd. shall assume no responsibility for any damage to the industrial robot or its components due to the use of any other components (software, tools, etc.) not provided by Agilebot.

Agilebot Robotics Co., Ltd. assumes no responsibility for any consequences caused by misuse of the industrial robot. The misuse includes:

- Use the robot beyond the specified parameter range
- Use it as a carrier for humans or animals
- Use it as a climbing tool
- Use it in explosive environments
- Use it without safety protection

Besides safety precautions in this chapter, this Manual contains other safety instructions, which must be followed as well.

Definition of user

The operators are defined as follows:

- Operator

  Perform power-on/off operation on the robot.

  Start the robot program from the panel board.

- Robot Engineer

  Operate the robot.

  Perform teaching and programming debugging of the robot within the safety fence.

- Maintenance Engineer

  Operate the robot.

  Perform teaching of the robot within the safety fence.

  Carry out maintenance (repair, adjustment, replacement) operations on the robot.

The “Operator” is not allowed to enter the safety fence.

The "Robot Engineer" and "Maintenance Engineer" can carry out operations within the safety fence.

The operations within the safety fence include handling, setting, teaching, adjustment, maintenance, etc.

To carry out the operations within the safety fence, it is necessary to receive professional training on the robot.

When operating, programming and maintaining the robot, the operator, programmer and maintenance engineer must give a safety warning and wear at least the following protective articles.

- Work clothes suitable for operations
- Safety shoes
- Safety helmets

Definition of safety records

This Manual includes safety warnings to ensure personal safety of the users and avoid any damage to the machine tool and describes them with "Danger" and "Warning" in the main text based on their importance in safety.

In addition, relevant supplementary explanations are described as "Caution".

Before use, the user must thoroughly read the precautions described in "Danger", "Warning" and "Caution".

Identification	Definition
Danger	It indicates dangerous situations possibly resulting in serious injury or death to the user during incorrect operation.
Warning	It indicates dangerous situations possibly resulting in mild or moderate personal injury or property damage during incorrect operation.
Caution	It provides supplementary explanations outside the scope of danger or warning.

Please read this Manual carefully and keep it secure for easy reference at any time.

Warnings and precautions related to operation of the controller

Warning

Warnings and precautions related to operation of the controller

1. IRC-I4A-C is a closed structure. During design, it is required to prevent dust, oil mist and other conductive foreign objects around the controller from entering its interior. Regardless of whether the controller is running or not, its airtightness may be lost if it is not locked properly, leading to a malfunction and even possible electric shock, leakage or fire due to insulation degradation.

2. Except for maintenance engineers, nobody is allowed to open the door of the controller. So, please lock it properly.

3. To prevent electric shock, do not power on the controller while the door is open.

4. Lock the circuit breaker to prevent power-on if the controller is connected to the power source.

5. Provide more than one E-stop within reach of the operator according to the system configuration.

Make sure to connect the ground wire when the controller is connected to the power source.

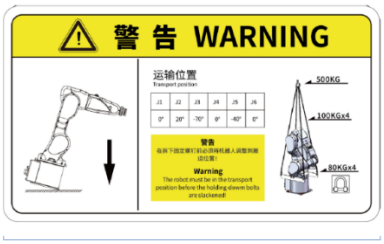
Safety warning label

Both the robot and the controller bear several safety and information labels, which contain important information related to the product. This information is very useful for all persons operating the robot system, e.g. during mounting, maintenance or operation.

The safety labels are only graphical and applicable to all languages.

> Caution
>
> It is required to observe the safety and health signs on the product label. In addition, it is also necessary to comply with the supplementary safety information provided by the system builder or integrator.

Sign	Description
	An electric shock may occur if the internally energized parts of the controller are touched when powered on.
	Operation against the instructions may result in an accident of injury and/or product damage. This is a warning message applicable to certain functional requirements.
	Grounding sign of controller
	
	Electric shock

Sign	Description
	Keep your hand away from moving parts, otherwise your hand or fingers may get stuck between the axis and the cover. The robots equipped with telescopic covers do not pose the risk of pinching hands or fingers. Therefore, they do not have this label.
	Never enter the work area while the robot is moving. Otherwise, the robot may collide with the operator. This is very dangerous and may cause serious safety issues.
	Beware of burns due to high temperature.
	Handling and hoisting
	Beware of collision in the work area.

I. Maintenance

1 Summary

This Instructions is applicable to the IRC-I4A-C controller.

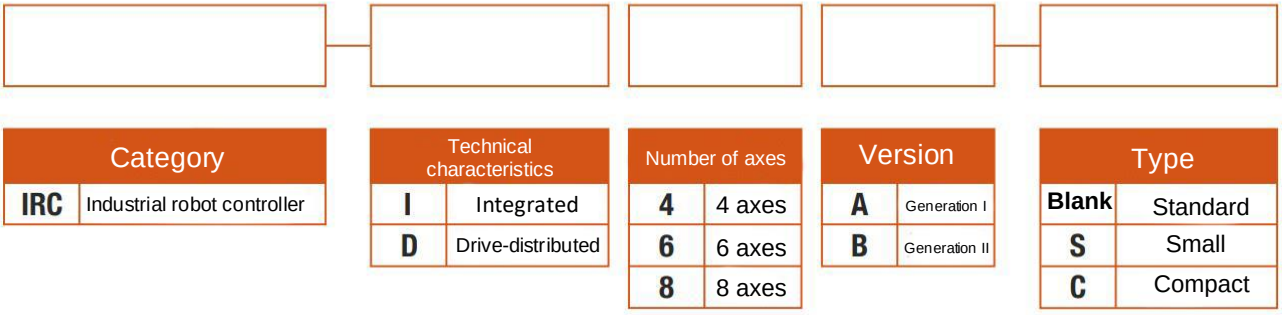
It describes the maintenance and connection of IRC-I4A-C for the robot.

Maintenance: Resolution of common faults, unit setting, adjustment and replacement methods

Connection: Methods for connecting IRC-I4A-C and the robot mechanism and peripheral devices and mounting the controller.

> ⚠ Warning
>
> Provide more than one (inclusive) E-stop within reach of the operator according to the system configuration. Please disconnect the power supply of the controller or press the E-stop when entering the range of motion of the robot.

Naming rules for robot controller



Category	
IRC	Industrial robot controller

Technical characteristics	
I	Integrated
D	Drive-distributed

Number of axes	
4	4 axes
6	6 axes
8	8 axes

Version	
A	Generation I
B	Generation II

Type	
Blank	Standard
S	Small
C	Compact

2 Structure

2.1 Appearance of controller

The appearance and components of the controller may vary slightly according to the robot, various option configurations and application programs.

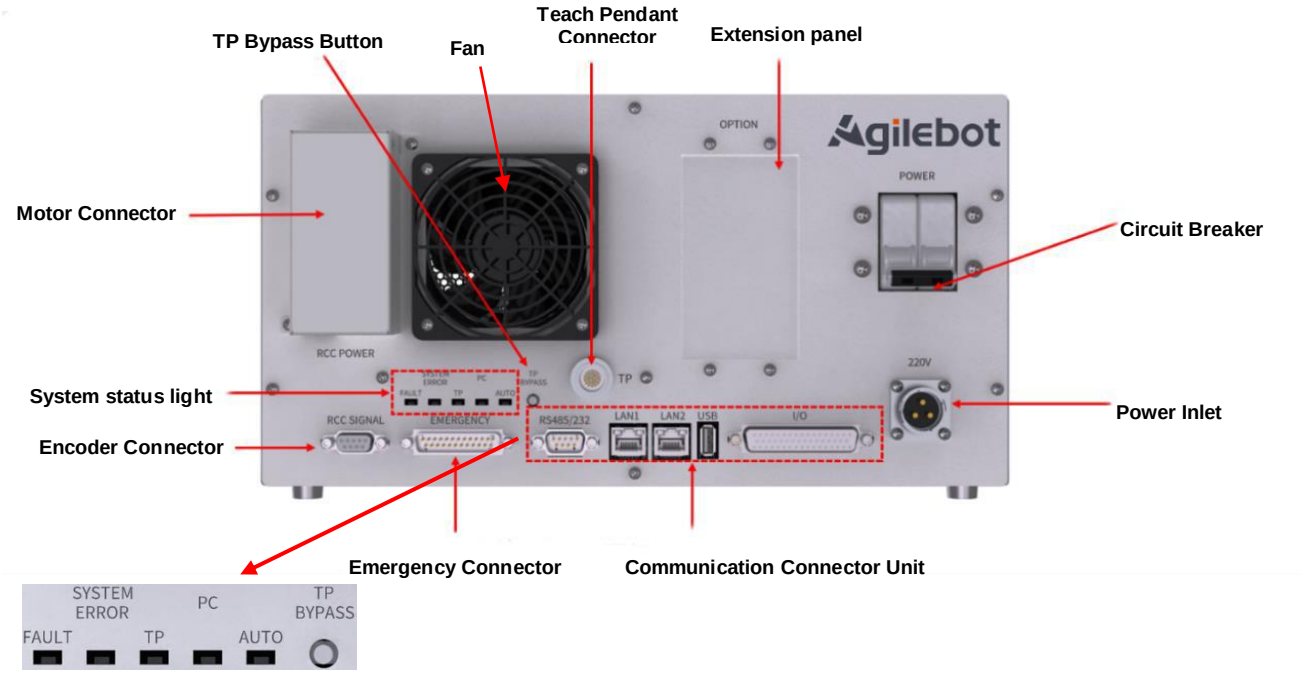
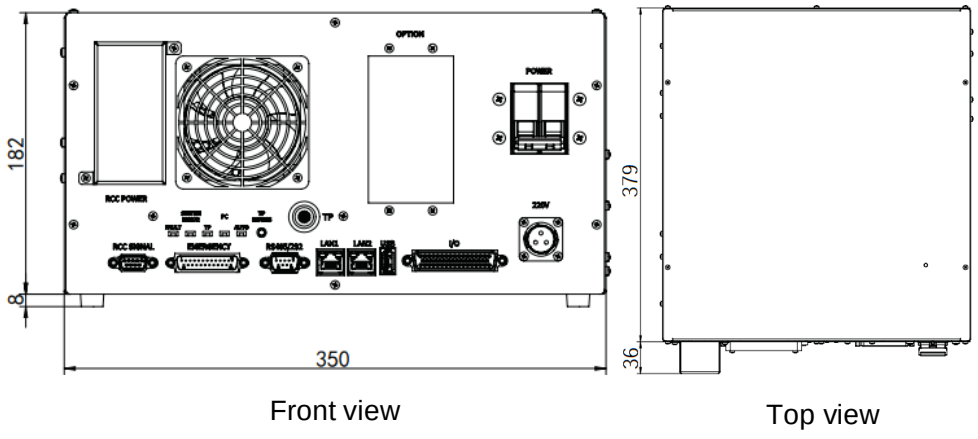


Fig. 2.1 Appearance of IRC-14A-C Controller



Front view Top view

Fig. 2.2 Dimensions of Controller

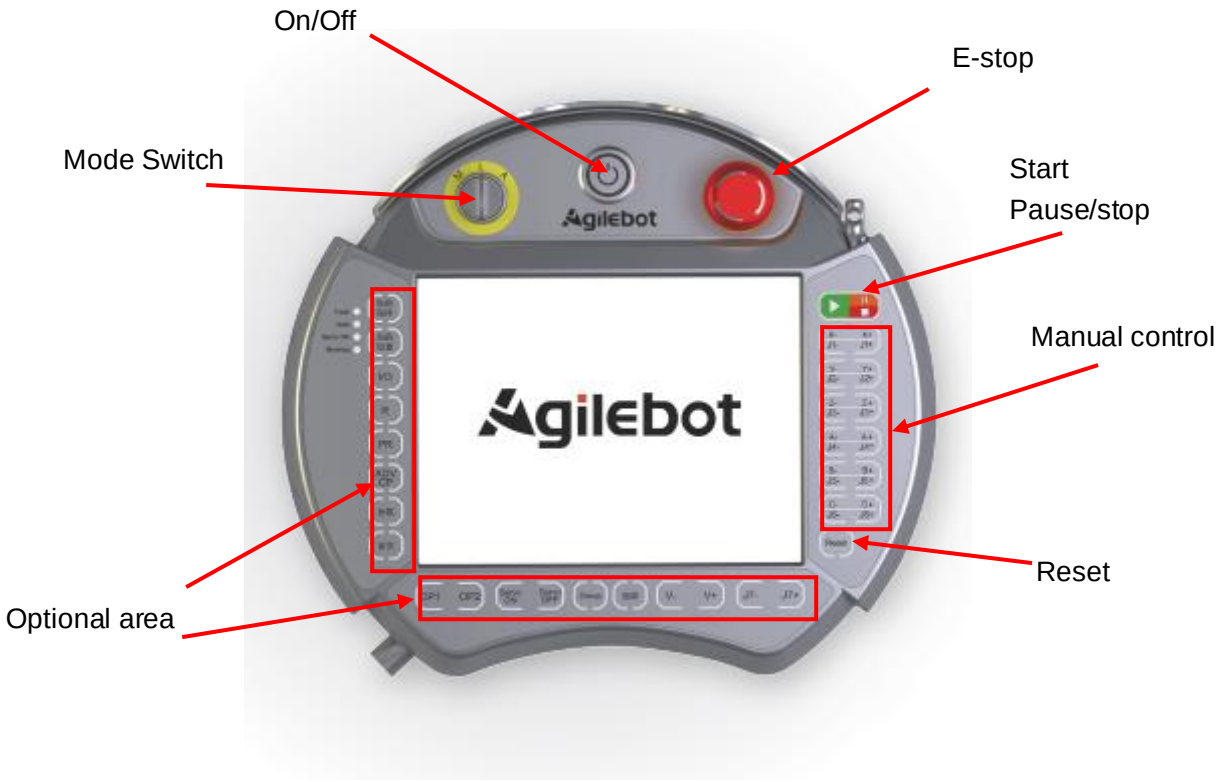


Fig. 2.3 Front View of Teach Pendant

Three-Postion Enabling Switches

Fig. 2.4 Rear View of Teach Pendant

Caution

When the USB port on the controller is used to back up related data of the robot, it is recommended to use a storage device in the FAT32 format of the USB2.0 protocol and with a capacity between 8G-32GB, such as USB flash drive, mobile hard drive, etc.

The recommended USB drive brands and models are shown in the table below:

Brand	Model	Capacity
Kingston	DTXM	32G
SanDisk	CZ73	32G

The USB memory has security features and the product requiring password authentication when accessing to the drive cannot be used.

2.2 Functions of component units

The following figure illustrates the internal structure and main component functions of the IRC-I4A-C controller.

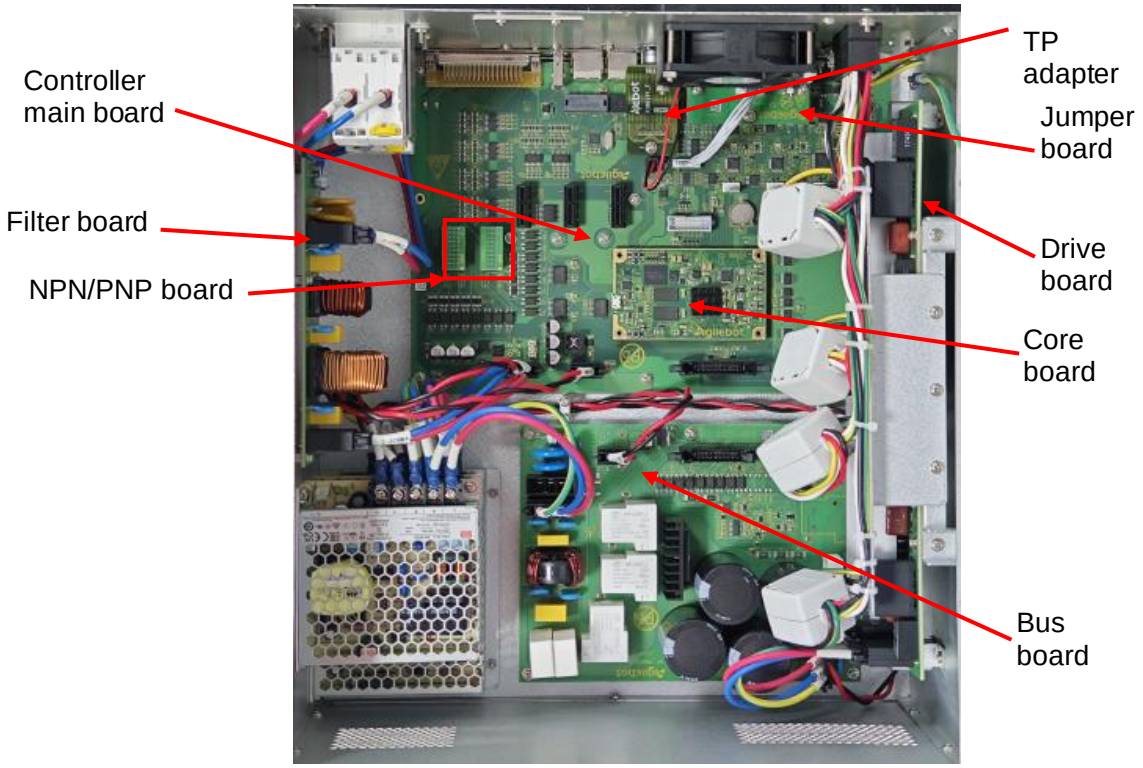


Fig. 2.5 Interior of Controller

Core board: The core circuit of main control mainly realizes servo control and motion control of the robot controller.

Controller main board: Peripheral circuits of main control, including the circuits for encoder port, IO port, Internet port, USB port, RS485, RS232 and other ports; it is integrated with safety board functions and can achieve board expansion of 2 slots.

Bus board: It realizes AC/DC conversion and provide high-voltage DC power supply for the robot.

TP adapter: It is an adapter of the TP connector to the main control board and connects TP.

EMI Filter Board: It achieves EMI noise suppression, reduces the conducted radiation of the noise generated by the robot on the power grid and suppresses external conducted interference to the robot.

Status Indicator Board: It corresponds to the function buttons on the panel.

Drive board: The motor drives the power circuit to input a weak current control signal and outputs the driving current required for motor rotation.

PNP/NPN jumper board: It can be used to select IO output attributes: When PNP corresponds to a signal trigger, the signal output line “Out” is connected to the power line “VCC”; When the NPN corresponds to a signal trigger, the signal output line “Out” is connected to the line “0v”.

2.3 Maintenance and repair

It is possible to maintain the performance of the robot in a long-term stable state through daily maintenance, regular maintenance and regular repair.

- **Daily maintenance**

  During daily operation of the system, clean and repair all parts, check for cracks or damage on each part and conduct maintenance for the following items at any time.

  Before running:

  Confirm if the teach pendant cable is excessively twisted. Please confirm if the controller and peripheral devices are abnormal.

  After running:

  Return the robot to the appropriate position and cut off the power supply to the controller after running. Confirm whether there are cracks or damages while cleaning and maintaining various parts. Clean excessive dust (if any) attached to the vent of the controller.

- **1-month maintenance**

  1) Confirm if the fan rotates normally. Clean excessive dust and other impurities (if any) adhering to the fan.

  2) Clean the dust from the interior of the controller. Wipe off any dust adhering to the fan and the transformer.

  3) Confirm that an alarm is detected after the emergency stop is input, or stop and reset the controller to confirm normal startup in order to confirm normal operation of safety functions.

  4) Open the door and check if the sealing gasket of the door is damaged or crushed.

  5) Check for any abnormal stains inside the controller. If any, please identify the cause and take necessary measures to clean them. Please check for any gaps around the sealing gasket in the locked state. Check for any gaps around the cable port.

- **Maintenance tools**

  It is recommended to prepare the following measuring instruments as maintenance tools: AC/DC voltmeter (sometimes, a digital voltmeter is required)

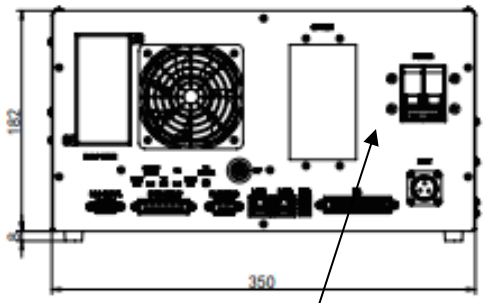
  1) Measuring instrument: AC/DC voltmeter (sometimes, a digital voltmeter is required)

  2) Oscilloscope: (frequency bandwidth above 5MHz, dual channel)

  3) Tools: Phillips screwdriver, slotted screwdriver, socket screwdriver, wire pliers, scissors and tweezers.

3 Resolution of common faults

3.1 Don't power on

Inspection and treatment	Diagram
Inspection 1: Confirm that the circuit breaker has been switched on. Treatment 1: Switch on the circuit breaker when it is not connected. Treatment 2: Check if the circuit breaker is in a trip state.	 Circuit Breaker

3.2 When the teach pendant cannot be powered on (the LED of the teach pendant does not light up)

Inspection and treatment	Diagram
Inspection 1: Confirm if the Coil Out is damaged. Inspection 2: Confirm if the pin of the TP port is damaged. Treatment 1: Check if the cable is damaged and replace it if damaged. Treatment 2: Check if the pin is damaged and replace it if damaged.	 Coil Out 

3.3 Alarm screen

Check if the robot currently has alarms and view the alarm history by the following operations.

1. In the main screen of the teach pendant, click on the tab in the red box below in Fig. 3.1 for the Active Alarm to pop up as shown in Fig. 3.2.

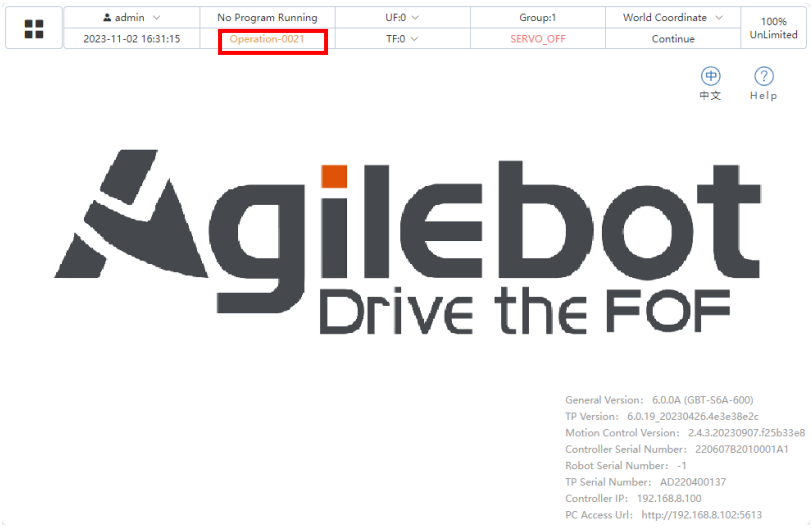


Fig. 3.1 Main Screen of Teach Pendant

2. Click on the History Event to view the Active Alarm log and the alarm history, as shown in Fig. 3.3.

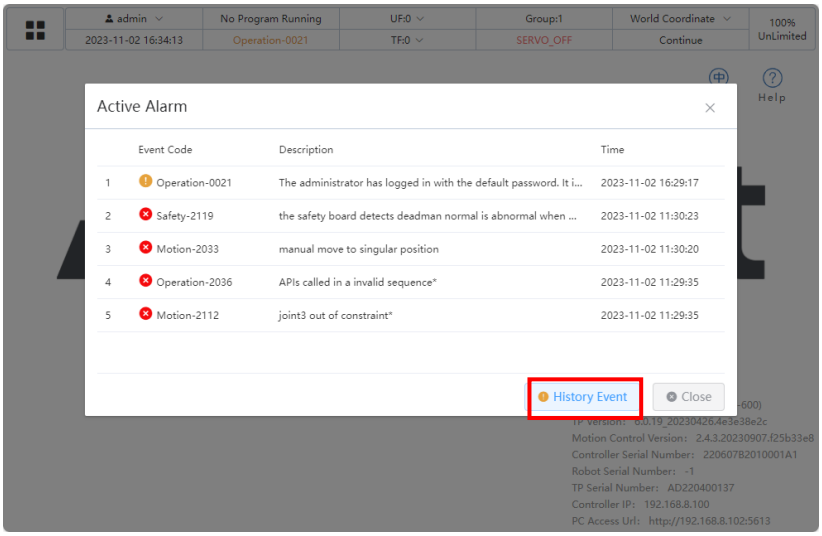


Fig. 3.2 Active Alarm Popup

3. After clicking on the History Event, Event Codes and Descriptions of all levels will pop out. Click on the red box in Fig. 3.3 to filter the event levels.

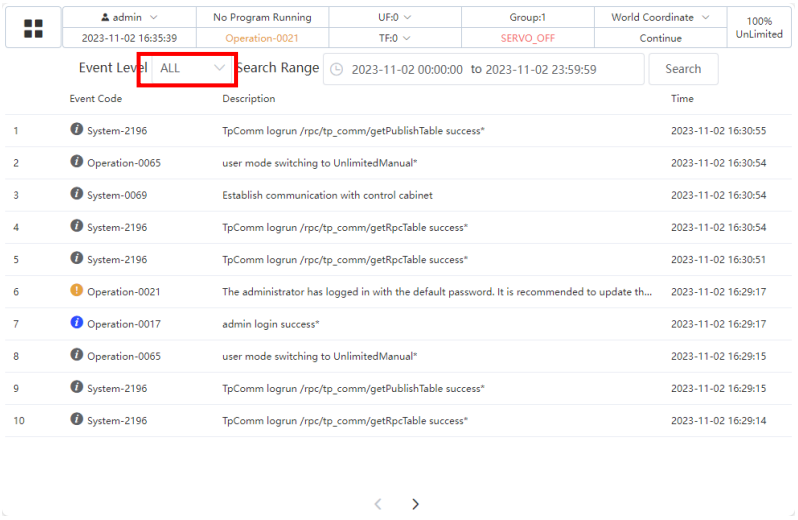


Fig. 3.3 History Event Screen

4. After filtering the event levels, you can see corresponding event descriptions as shown in Fig. 3.4.

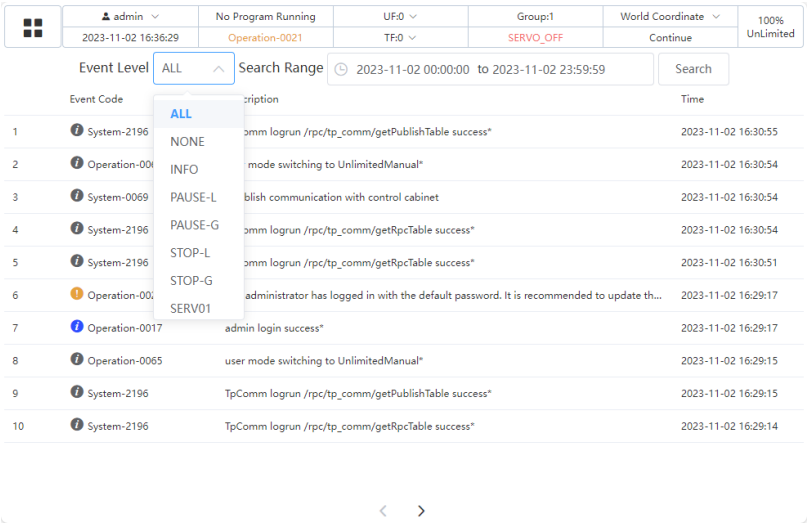


Fig. 3.4 Selection of Event Levels

3.4 Stop signal

The following table describes stop signals of the controller. The controller can stop the motion of the robot through external buttons and the means in the following table.

Stop signal	Description
External E-stop	It indicates the status of the external emergency stop signal and is pressed to stop running.
Limit switch	The device stops running when it is enabled.
Safety door	It indicates the status of the safety door. The device stops running when the safety door is opened.
Safety switch (enabling device)	It indicates whether the safety switch on the teach pendant is held in the appropriate position. When the teach pendant is valid, releasing or holding the safety switch may trigger an alarm and disconnect the power supply of the servo device.
Emergency stop of teach pendant	It indicates the status of the E-stop on the teach pendant and TRUE is displayed when it is pressed.

3.5 Zero calibration

Zero calibration is required in the following two cases.

Case 1: A zero-calibration loss alarm or zero-calibration abnormality alarm occurs.

Case 2: The motor is replaced, the battery discharged or the encoder cable disconnected.

In Case 1, only a simple zero calibration is required. In Case 2, please contact us for technical services.

Simple zero-calibration steps are listed in the following:

1. Click on the login window of the TP screen, and the screen shown in Fig. 3.5 will pop up. Click on “Name” and select "admin", enter the password "123", and then click "Confirm" to log in.

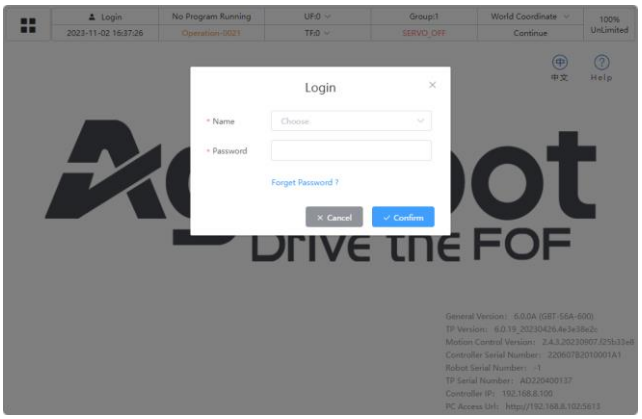


Fig. 3.5 Login Popup

2. Click on the menu icon at the upper left corner of the TP screen.

Fig. 3.6 Menu Button at Upper Left Corner

3. Click on the “System” option.

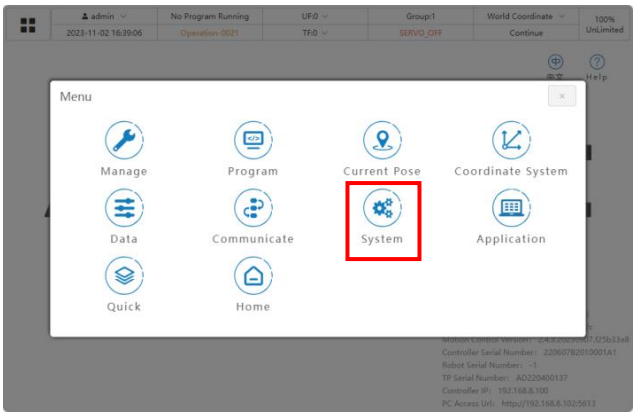


Fig. 3.7 Click on “System” in the Menu

4. Click on the “Basic Setting” option.

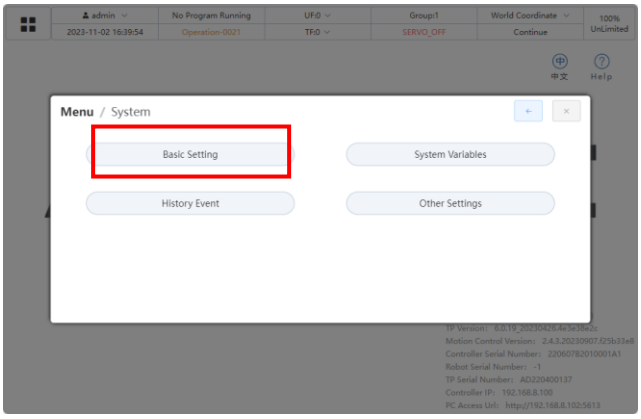


Fig. 3.8 Click on “Basic Setting” in System

5. Click on the “Encoder Calibration” option.

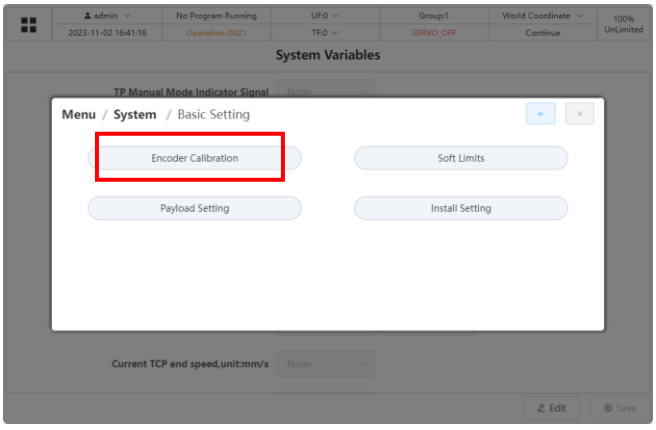


Fig. 3.9 Click on “Encoder Calibration” in Basic Setting

6. If the Status is “uncalibrated” on the calibration screen, it means that the zero-calibration information of the axis is lost and should be calibrated.

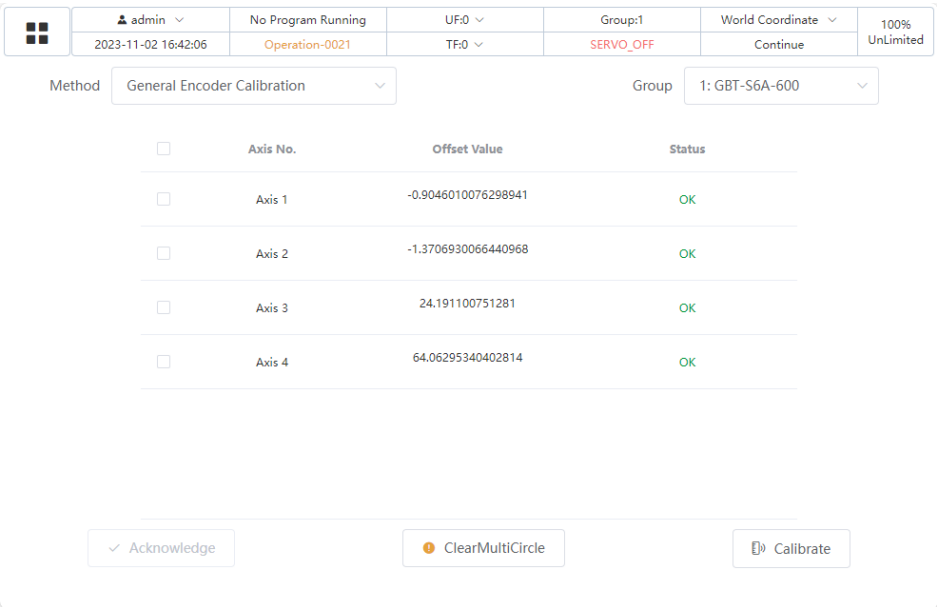


Fig. 3.10 Zero-calibration Status Screen

7. Select between “General Encoder Calibration” and “Direct Input Encoder Calibration”.

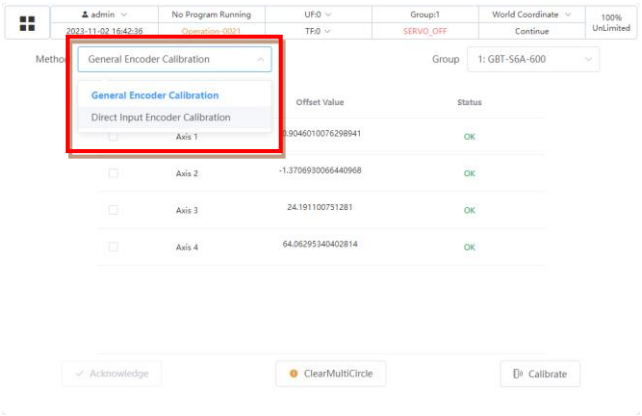


Fig. 3.11 Selecting Calibration Methods

8. Select the axis to be calibrated on the left and click “Calibrate” to perform the calibration.

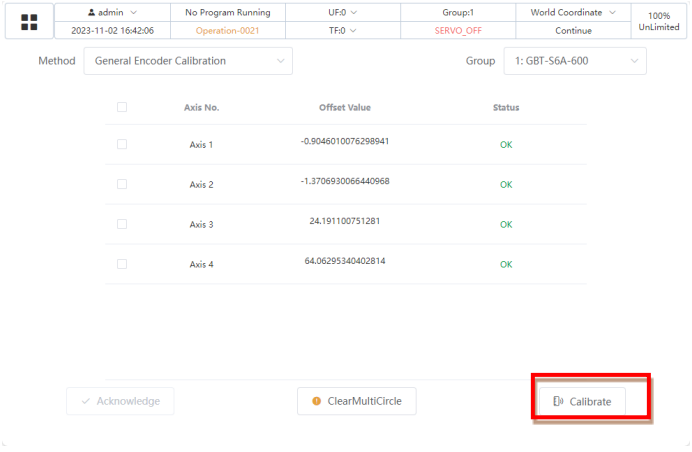


Fig. 3.12 Click “Calibrate” for Calibration

9. A prompt message indicating “Calibration success” will appear on the upper right corner after successful calibration. Click "Save" to complete the calibration.

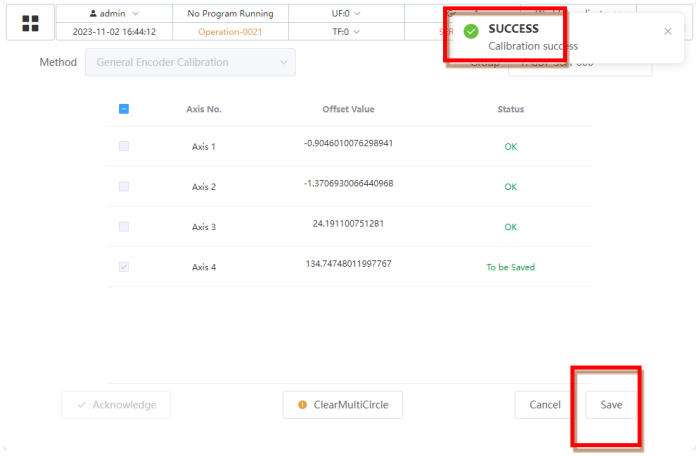


Fig. 3.13 Click “Save” to complete the Calibration

3.6 IRC-I4A-C controller without the teach pendant mode

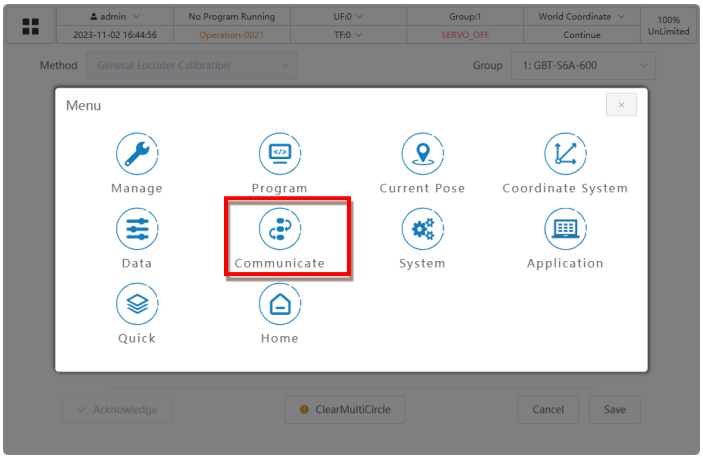
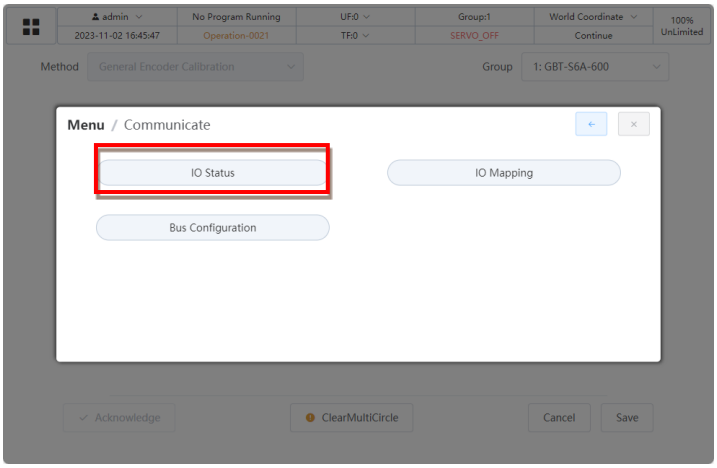
IRC-I4A-C series controllers are not standardly provided with a teach pendant and can be operated by using the virtual teach pendant software "Compass". The system status lights and TP BYPASS buttons in Fig. 2.1 are described in the table below:

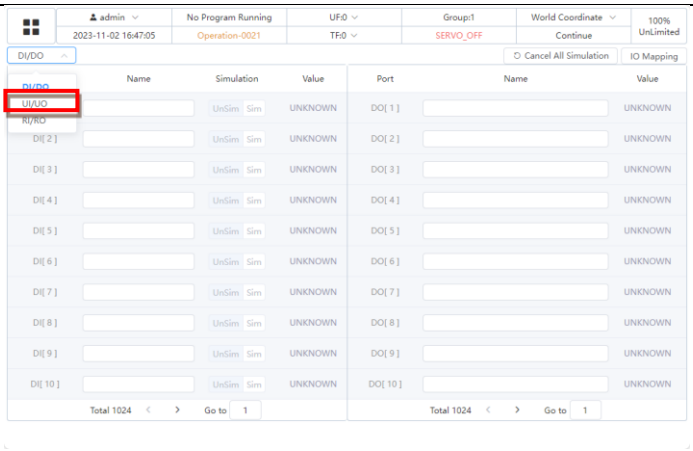
System status light and button	Function
FAULT light	It is red when the robot reports an error and does not light up if it is normal.
SYSTEM ERROR light	The system error light lights up when a high-level error occurs, namely a serious error that cannot be cleared or reset by the rest button or rest signal (usually system level).
TP light	The light is in green when the controller is inserted into the teach pendant. Otherwise, it does not light up.
PC light	The light is in green when the virtual teach pendant software “Compass” is used for operation. Otherwise, it does not light up.
AUTO light	The light is in green when the operating mode of the robot is auto run. Otherwise, it does not light up.
TP BYPASS light	Press this button to switch the robot to the auto mode after the teach pendant is pulled out, if the robot is in the manual mode before the teach pendant is pulled out.

The teach pendants of IRC-I4A-C series controllers support hot swapping. When the teach pendant is pulled out, the Fault light is in red. The robot can be used normally by external reset or by resetting through virtual teach pendant software "Compass". If a teach pendant is inserted into the IRC-I4A-C series controller and it is desirous to operate the robot through the virtual teach pendant software "Compass", it is required to switch the teach pendant to the auto mode so that Compass can be connected to the controller and have operation authorities; after Compass has the operation authority, the teach pendant loses the operation authority. At this point, the PC light is in green, while the TP light does not light up; if the teach pendant is in manual mode, Compass cannot be connected to the

controller and the teach pendant has operation authority. If no teach pendant is inserted on the IRC-I4A-C series controller, it can be directly connected to the IRC-I4A-C series controller through Agilebot Compass.

3.7 Resolution of common faults based on alarm codes

Motion-A32097 - UI servo enable is off*
Phenomenon: UI servo enable is off Result: Stop Cause: triggered by UI signal Countermeasure: Keep the UI signal at a high level. Otherwise, the low level may trigger a Class 0 stop. (1) To view the UI signal, click on the menu at the upper left corner of the TP screen, as shown below, and then click “Communicate”.      (2) On the “Communicate” screen as shown below, click “IO status” to view the IO signal.      (3) On the “IO status” screen as shown below, click on the button circled in red to view different types of signals.



(4) UI1, UI2 and UI5 should be normally closed signals as shown below.

Safety-2115 - The safety board dual channel data are not the same.*
Phenomenon: The safety board dual channel data are not the same. Result: ESTOP status Cause: error in hardware signal Countermeasure: Check if the safety circuit on the safety board is normal.

Safety-2116 - The safety board detects external stop signal.*
Phenomenon: The safety board detects external stop signal. Result: ESTOP status Cause: status of hardware signal Countermeasure: Check external ESTOP signal.

Safety-2117 - The safety board detects safety door stop signal.*
Phenomenon: The safety board detects safety door stop signal. Result: ESTOP status Cause: status of hardware signal Countermeasure: Check safety door signal.

Safety-2118 - The safety board detects limited stop signal.*
Phenomenon: The safety board detects limited stop signal. Result: ESTOP status Cause: status of hardware signal Countermeasure: Check the limit signal.

Safety-2119 - The safety board detects Deadman Normal is abnormal when in manual mode.*
Phenomenon: The safety board detects that Deadman Normal is releases in manual mode. Result: ESTOP status Cause: status of hardware signal Countermeasure: Check if the Deadman button is pressed in the manual mode.

Safety-2122 - The safety board detects TP-ESTOP signal.*
Phenomenon: The safety board detects TP-ESTOP signal. Result: ESTOP status Cause: status of hardware signal Countermeasure: Check the TP-ESTOP button.

System-2193 - Controller detects the safety board is not ready when reset operation*
Phenomenon: The robot cannot be powered on after RESET is pressed. Result: The operation fails. Cause: The safety board signal is not ready. Countermeasure: Check the alarm codes reported simultaneously and the safety board signal

Motion-2110-Motion-2115 - Joint out of constraint* (Axis 1 - Axis 6)

Phenomenon: Joint out of constraint

Result: The program cannot run continuously. It is paused and should be reset.

Cause: Input joint value exceeds the constraint.

Countermeasure: Move the robot to within the soft limit position.

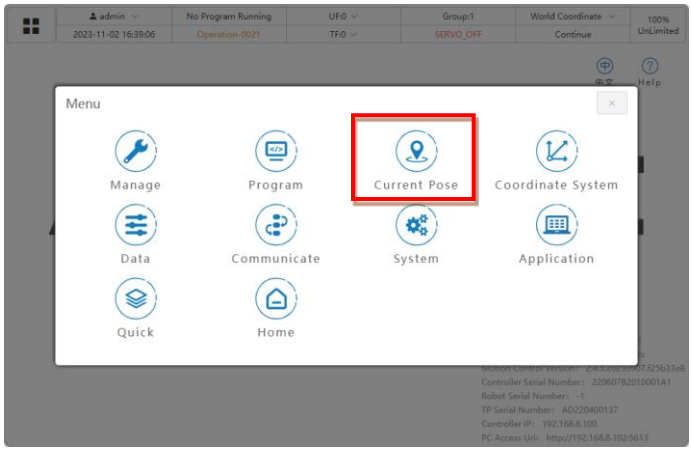
Perform the following operations when it exceeds the soft limit.

1) View current position message and soft limit position message of each axis.

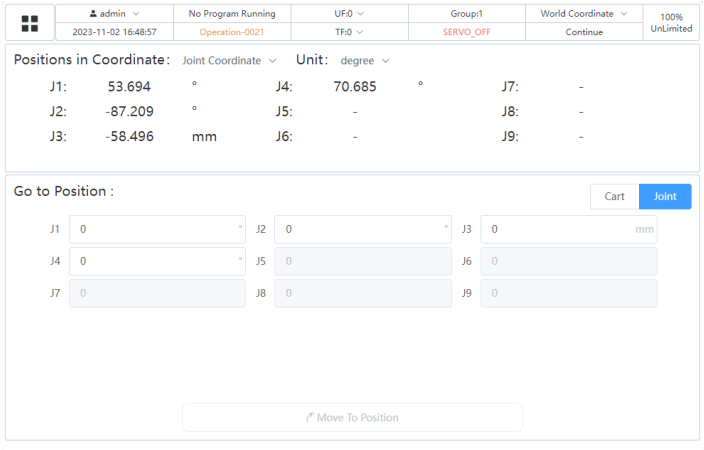
2) Implement zero calibration due to the soft limit caused by the loss of zero calibration.

Operation steps for Case 1 are as follows:

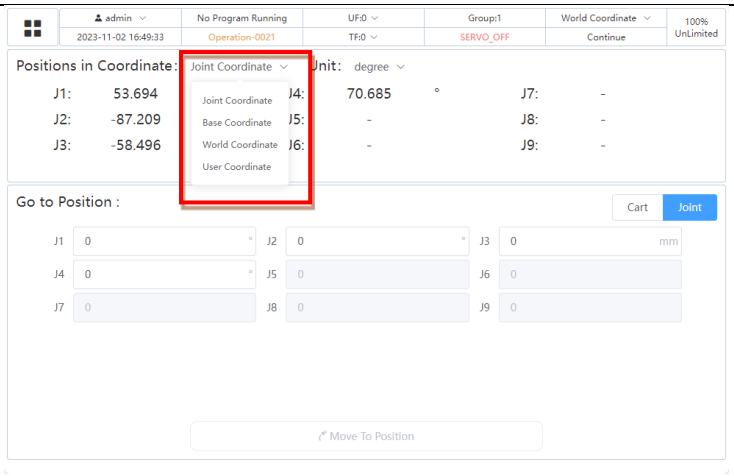
1. Click the menu button and then click “Current Pose”.



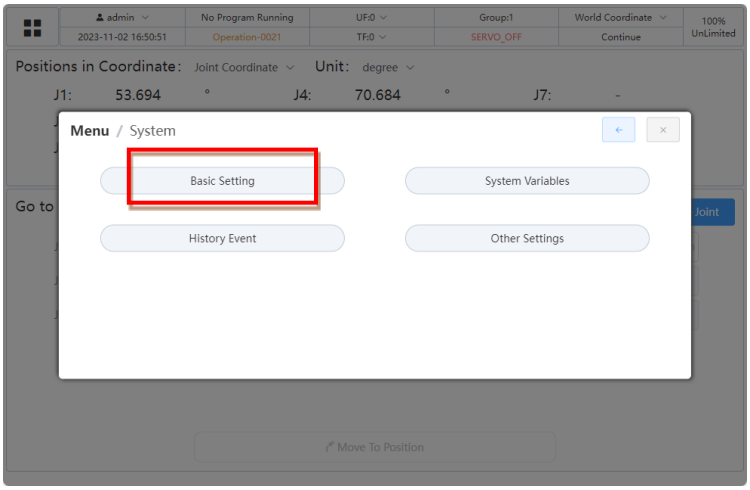
2. After clicking “Current Pose”, you can view the position information of each axis as shown below.



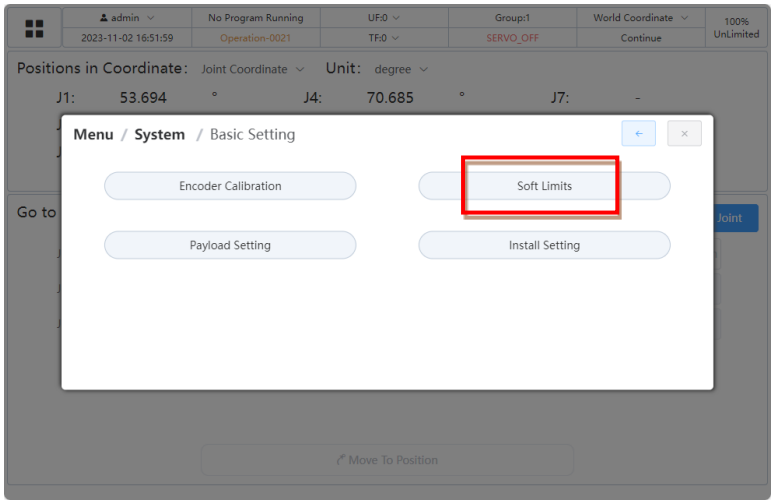
3. Switch relative coordinate systems to view the position information of each axis under different coordinate systems, as shown below.



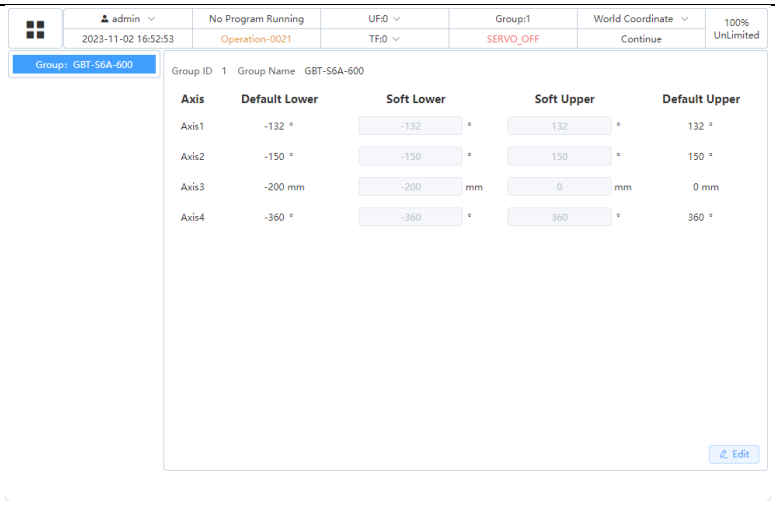
4. Click “System” as shown below, then click “Basic Setting” to show the “Soft Limits” button.



5. Click “Soft Limits” to view the soft limit positions of each axis.

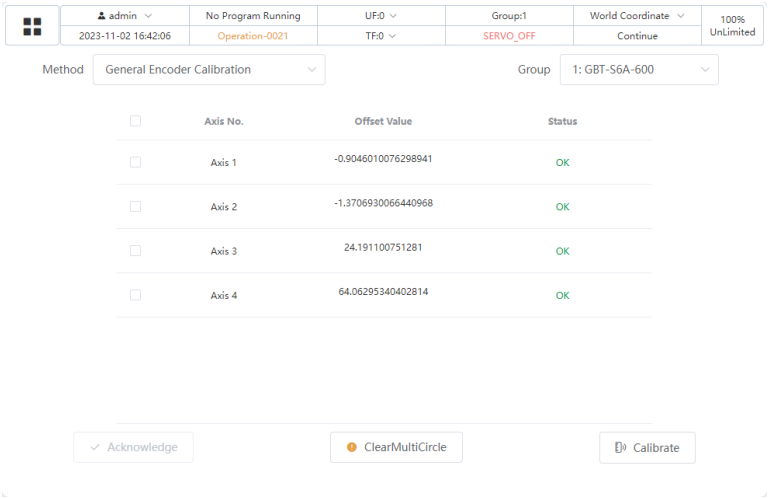


6. The Soft Lower and Soft Upper of each axis are shown as below.

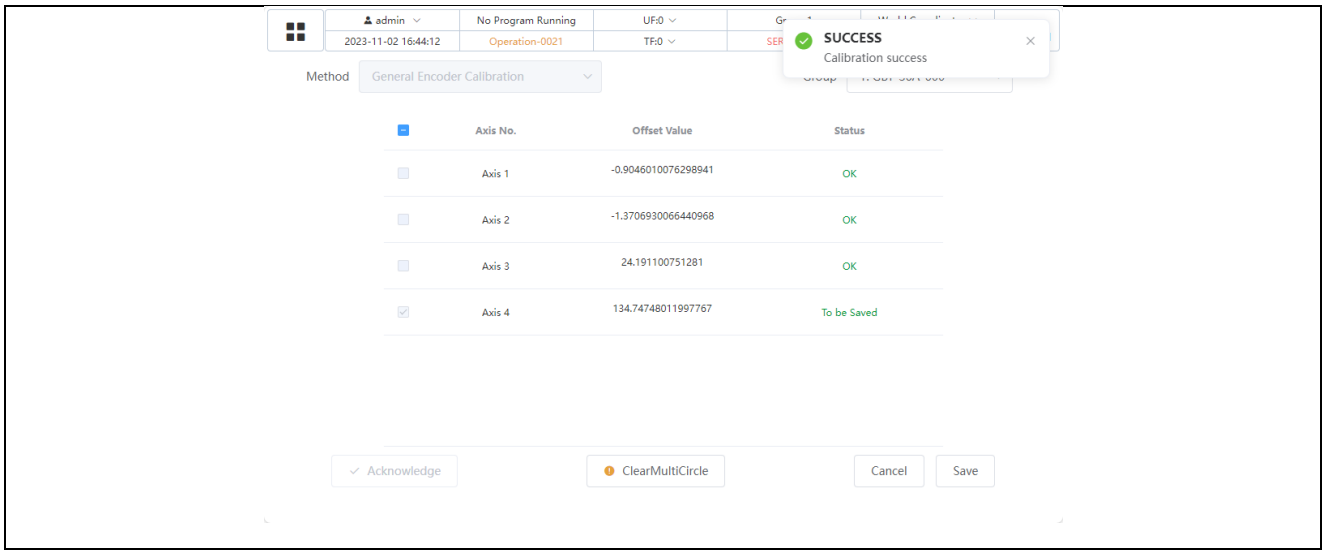


Operation steps for Case 2 are as follows:

1. The soft limit error may also be caused in case of loss of zero calibration. Click Basic Setting - Encoder Calibration to open the calibration screen. If the Status is “uncalibrated”, it should be calibrated again.



2. A prompt message indicating “Calibration success” will appear on the upper right corner after successful calibration. Click "Save" to complete the calibration.


admin
No Program Running
UF:0
2023-11-02 16:44:12
Operation-0021
TF:0
SUCCESS
Calibration success
Method
General Encoder Calibration
Axis No.
Offset Value
Status
Axis 1
-0.9046010076298941
OK
Axis 2
-1.3706930066440968
OK
Axis 3
24.191100751281
OK
Axis 4
134.74748011997767
To be Saved
Acknowledge
ClearMultiCircle
Cancel
Save

4 Replacement of units

This chapter describes the methods for replacing each unit in the controller.

Warning

When units or printed circuit boards are replaced through maintenance and repair, turn off the circuit breaker and remove the power cord. Do not touch internal units or printed circuit boards in 1 min after the circuit breaker is turned off. It is only allowed in the safe state that surrounding machines or other devices are not moving.

Warning

When replacing parts, make sure to read the Maintenance Manual in advance and proceed with the operation after fully understanding the operating steps. Operations in wrong steps may lead to unexpected accidents, resulting in damage to the robot or injury to the operator.

Caution

Please note that the parts inside the controller may be hot. Heat-resistant gloves and other protective devices should be available when it is necessary to touch the equipment in a hot state.

Caution

1) When removing the printed circuit board, make sure to avoid touching the semiconductor parts on the circuit or other parts with hands. It is required to confirm that the settings for the printed circuit board to be replaced have been correctly made.

2) After replacement, correctly adjust the printed circuit board to be adjusted.

3) The replacement of the rear panel, power unit or main board (including main board and module) may sometimes result in the loss of robot parameters, teaching data, etc. Therefore, it is necessary to back up the data in the memory card in advance.

4) Re-mount the cables removed during replacement. If unable to figure out the joints, make appropriate records before removing the cables.

4.1 Steps before replacement

Disconnect the power supply of the controller.

(1) Switch off the circuit breaker.

(2) Remove the power cable.

Power cable

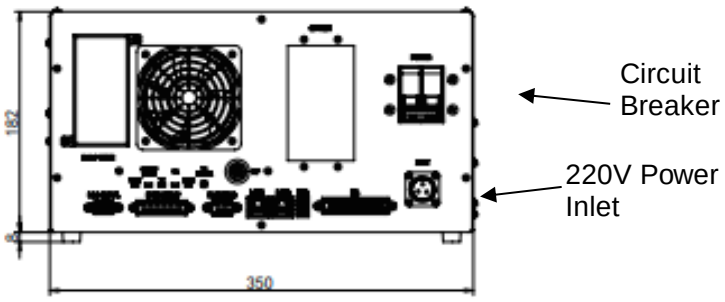


Fig. 4.1 Power Inlet

Remove the top cover of the controller.

(1) Dismantle screws on the top cover.

(2) Lift the cover upwards slowly.

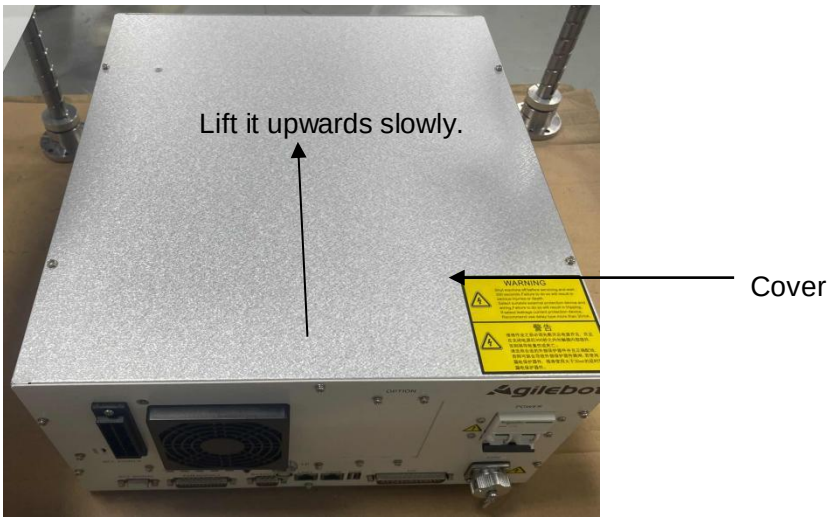


Fig. 4.2 Top Cover

4.2 Replacement of fan unit

(1) Remove the filter screen outside the fan.

(2) Dismantle M4 nuts fixing the sheet metal (for cabling).

(3) Dismantle M4 screws and then the cable. Then, it is possible to replace the fan.

(4) Mount the fan unit according to the reverse steps of removal. Note: Do not entangle the cable in the fan.

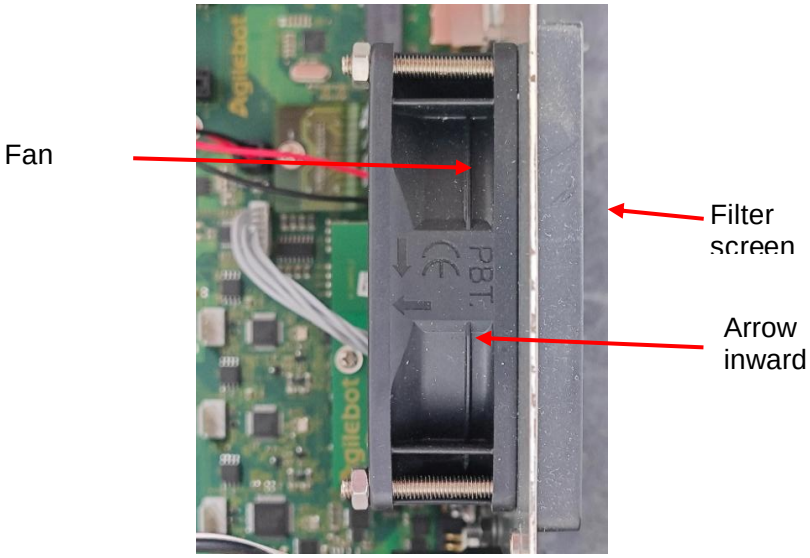


Fig. 4.3 Fan Unit

4.3 Replacement of drive board

(1) Remove the strap and magnetic ring from the fixing plate of the drive board.

(2) Dismantle M4 cross screws on the heavy-duty port.

(3) After dismantling the screws on the fixing plate, unplug cable at the connection port between the bus board and the drive board.

(4) Pull the driver board upwards.

(5) Mount the drive board according to the reverse steps of removal.

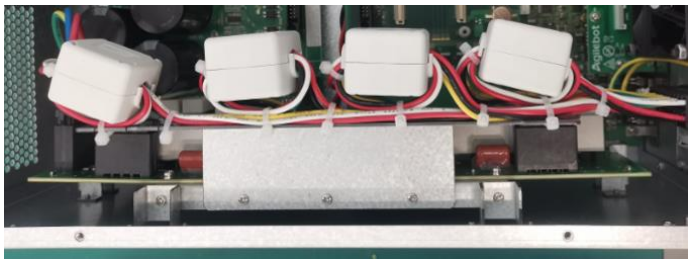


Fig. 4.4 Drive Board

4.4 Replacement of filter board

(1) Dismantle fixing screws on the filter board.

(2) Remove cables on the filter board.

(3) Mount the filter board according to the reverse steps of removal.

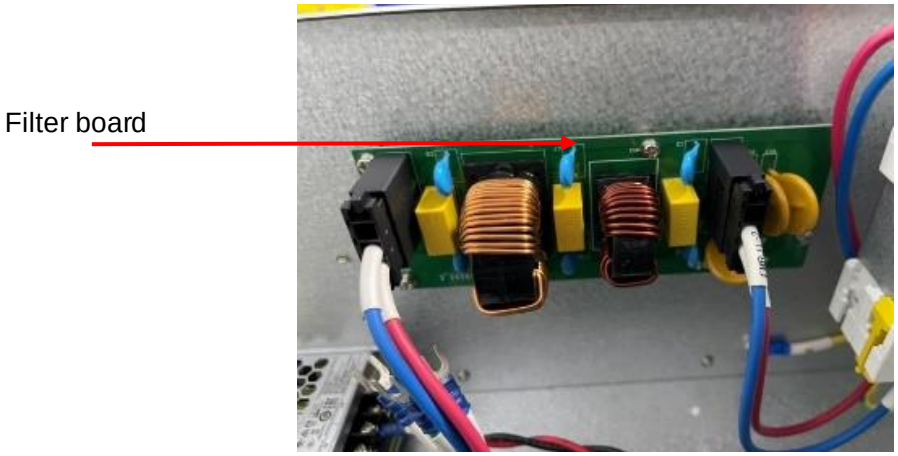


Fig. 4.5 Filter Board

4.5 Replacement of circuit breaker

(1) Dismantle fixing screws on the circuit breaker.

(2) Remove cables on the circuit breaker.

(3) Mount the circuit breaker according to the reverse steps of removal.

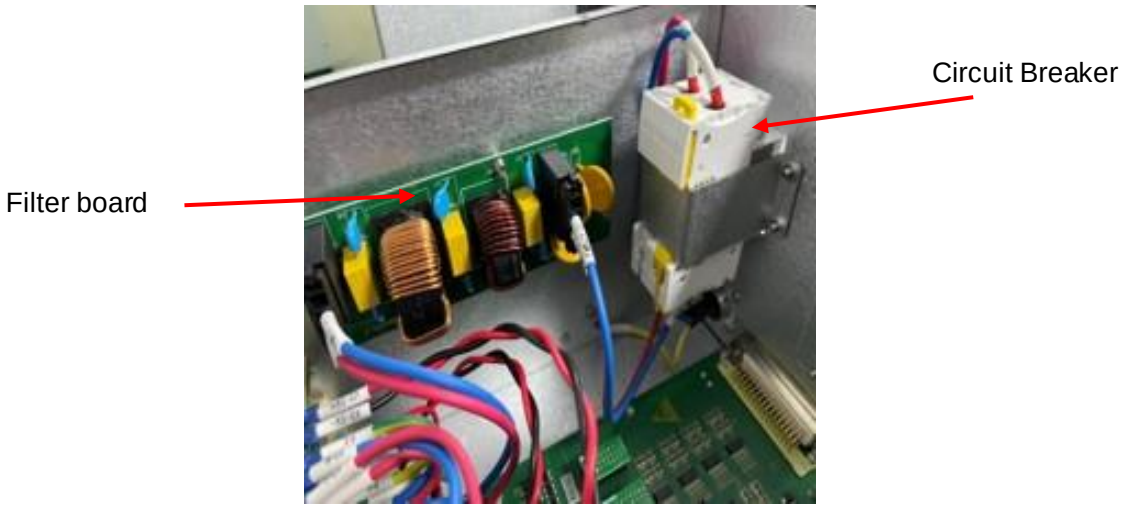


Fig. 4.6 Circuit breaker

4.6 Replacement of power input port

(1) Dismantle the screws on the power input port.

(2) Mount the power input port according to the reverse steps of removal.

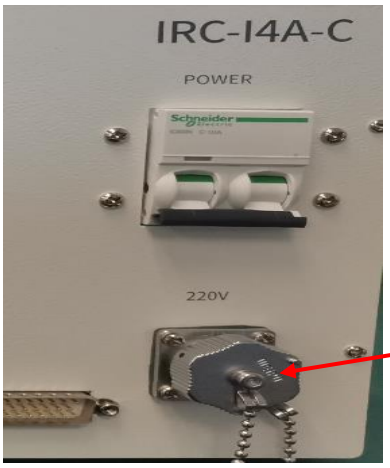


Fig. 4.7 Power Input Port

4.7 Replacement of AC-DC Power Supply

(1) Remove the cable at the bottom right of the filter board.

(2) Remove the nut M4 on the grounding post in front of the AC-DC Power Supply.

(3) Remove the cable.

(4) Remove the nut behind the power supply and the fixing screws from the outside of the box to remove the power supply.

(5) Remove three power supplies successively by the same steps. The AC-DC Power Supplies have been disassembled.

(6) Mount 3 AC-DC Power Supplies according to the reverse steps of removal.

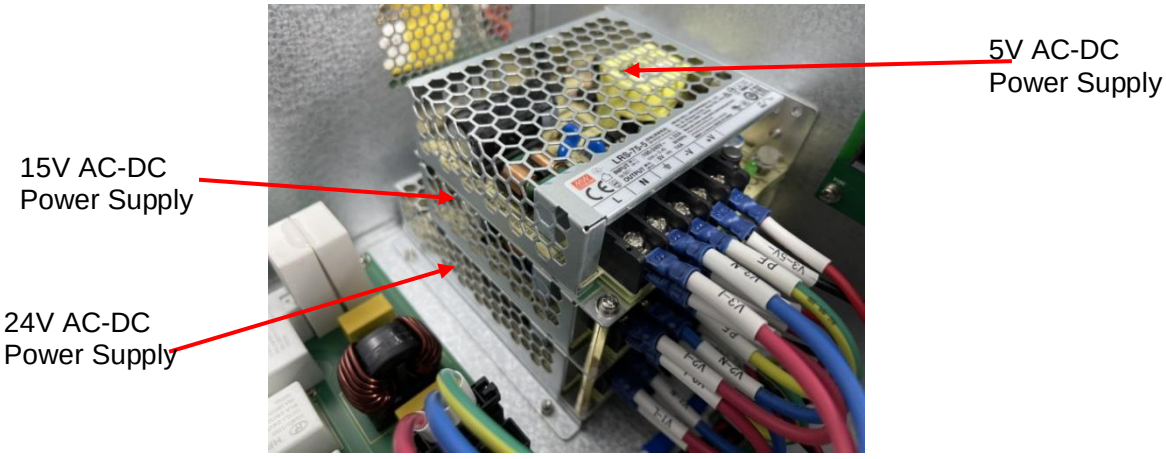


Fig. 4.8 AC-DC Power Supply

4.8 Replacement of PNP/NPN jumper board

(1) Confirm whether it is PNP or NPN. An arrow on the jumper board indicates the mounting direction.

(2) Pull it out upwards directly.

(3) Mount the jumper board according to the reverse steps of removal.

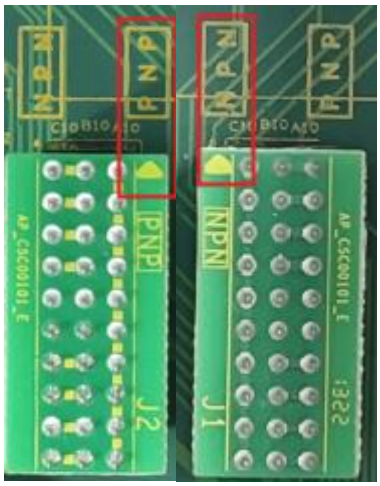


Fig. 4.9 IO Jumper Board (Left: PNP, Right: NPN)

4.9 Replacement of core board

(1) Dismantle M3 cross screws on the core board.

(2) Pull it upwards from the controller main board.

(3) Mount the core board according to the reverse steps of removal.

Core board

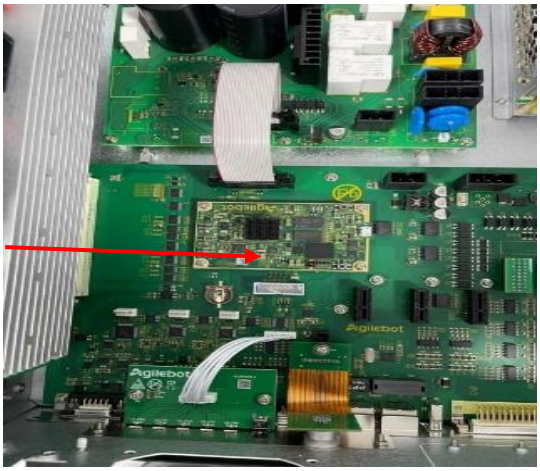


Fig. 4.10 Core Board

4.10 Replacement of TP flexible adapter

(1) Dismantle the fan unit firstly before removing the TP flexible adapter. Please refer to Section 4.2 for details.

(2) Disassemble the fan and then unscrew the TP port from the outside.

(3) Unscrew the fixing screws on the TP flexible adapter.

(4) Unscrew the fixing screws and pull the adapter upwards

(5) Mount the TP flexible adapter according to the reverse steps of removal.

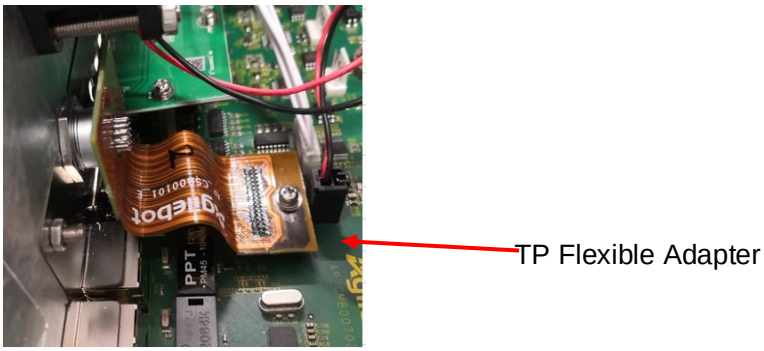


Fig. 4.11 TP Flexible Adapter

4.11 Replacement of keyboard

(1) Dismantle the fan unit firstly before removing the keyboard. Please refer to Section 4.2 for details.

(2) Disassemble the fan and then remove the screws on the keyboard.

(3) Unscrew the screws to remove the keyboard.

(4) Remove the keyboard and then copper studs below.

(5) Mount the keyboard according to the reverse steps of removal.

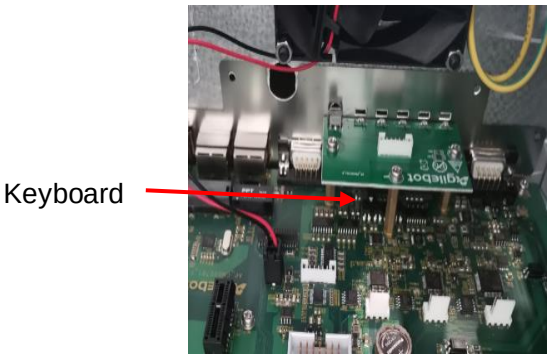


Fig. 4.12 Keyboard

4.12 Replacement of bus board

(1) Remove the fan unit firstly and then the bus board. Please refer to Section 4.2 for details.

(2) After disassembling the fan, remove the keyboard and the TP flexible adapter, as detailed in Sections 4.10 and 4.11.

(3) After disassembling the fan, keyboard and TP flexible adapter, remove the driver board. Please refer to Section 4.3 for details.

(4) After the removal, first unscrew the nylon screws next to the horn plug FPC with an M3 screwdriver and then remove surrounding screws.

(5) Mount the bus board according to the reverse steps of removal.

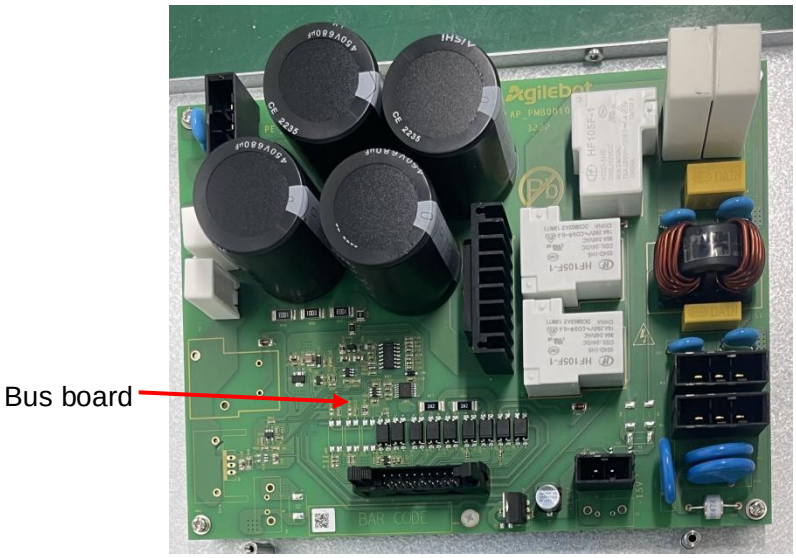


Fig. 4.13 Bus Board

4.13 Replacement of controller main board

(1) Dismantle the fan unit firstly before removing the controller main board. Please refer to 4.2 for details.

(2) After disassembling the fan, remove the keyboard and the TP flexible adapter, as detailed in Sections 4.10 and 4.11.

(3) After disassembling the fan, keyboard and TP flexible adapter, remove the driver board. Please refer to Section 4.3 for details.

(4) After that, unscrew all 12 screws with an M3 screwdriver.

(5) After the screws are removed, the controller main board can be taken out.

(6) Mount the controller main board according to the reverse steps of removal.

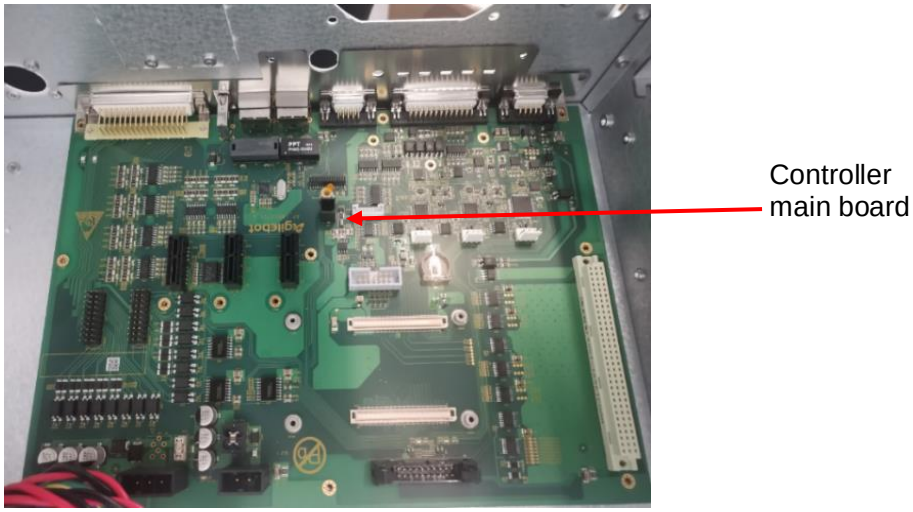
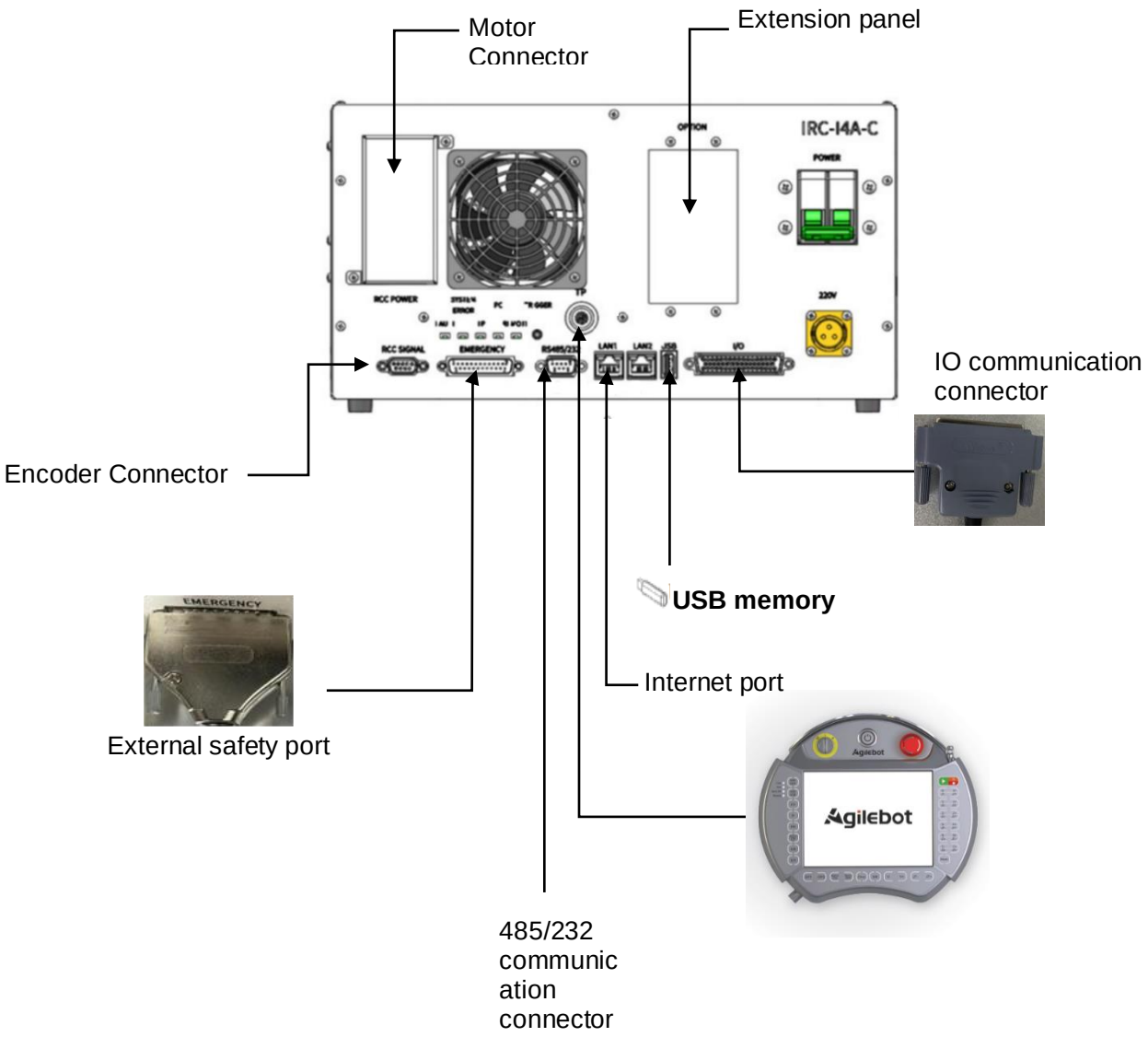


Fig. 4.14 Controller Main Board

II. Connection

1 Summary

1.1 System configuration



1.2 External ports

The following diagram describes the connection ports on the front panel of the IRC-I4A-C controller.

> ⚠ Caution
>
> Before connecting the connector to the controller, make sure to check for dirt or damage. Please clean the components or replace damaged ones.

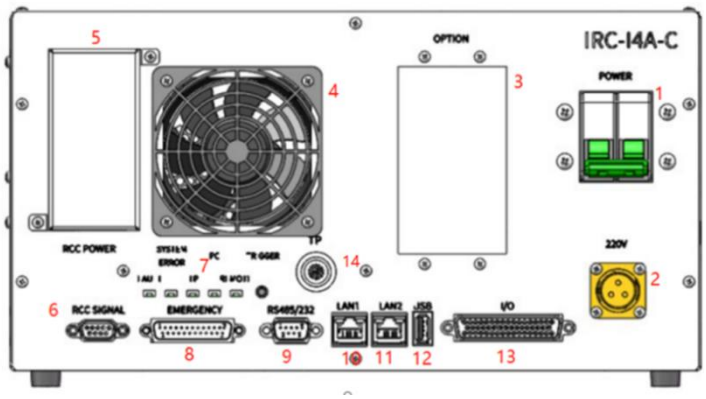


Fig. 1.1 Front View of Controller

S/N	Part name	Function
1	Circuit Breaker	On/Off of the control system
2	AC220V power input port	220V AC power input port
3	Reserved expansion board slot	Blank at present
4	Fan	Controller cooling
5	Power Inlet	RCC POWER, power output
6	Encoder port	RCC SIGNAL, encoder output port
7	TP Bypass Button	Unplug TP in the ON state
8	External safety port	External safety signal adapter for safety signal control
9	485/232 communication connector	For serial communication
10	Communication connector	LAN1, an Ethernet port of the controller, which can communicate with the TCP/IP port of the robot.
11	Debug port	LAN2, an Ethernet port of the controller, used for debugging

S/N	Part name	Function
12	USB port	For USB backup
13	IO port	24 DI, 16 DO ports
14	TP port	For connecting the teach pendant

Warning

The IO port on the robot controller and the external safety (emergency stop circuit) ports do not support hot swapping. Otherwise, it may cause damage to the fuse inside the robot controller!

2 Connection with devices

2.1 Connecting cables of the robot

The connecting cables between the robot and the controller include power cables and signal cables.

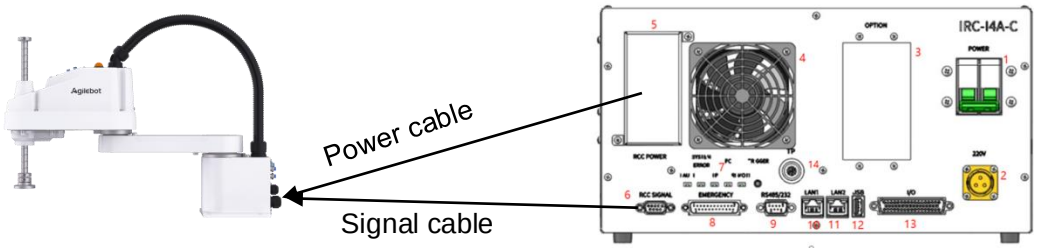


Fig. 2.1 Connection between Robot and Controller

> ⚠ Caution
>
> Ground the controller before startup. Otherwise, the risk of electric shock exists.

2.2 Cables of teach pendant

The teach pendant connector on the IRC-I4A-C controller is located at the front of the controller. Before connecting the connector to the controller, make sure to check for dirt or damage. Please clean the components or replace damaged ones.

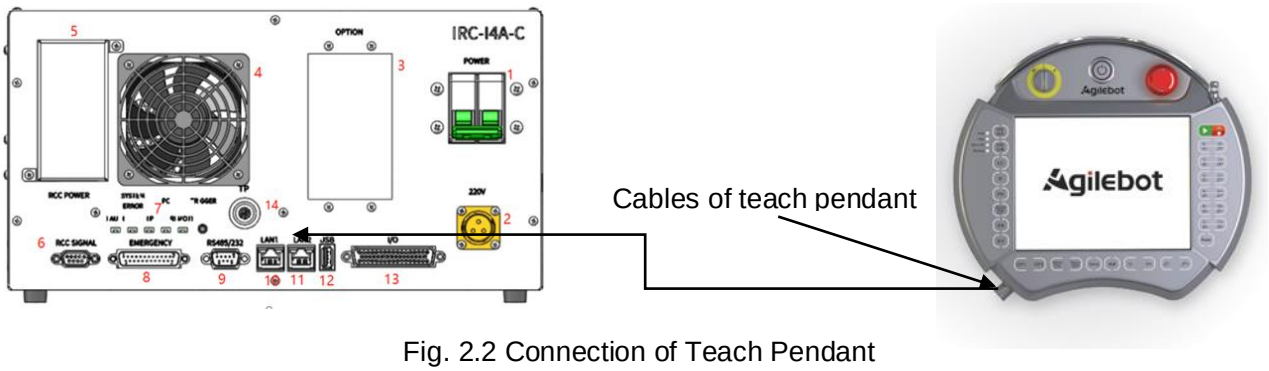


Fig. 2.2 Connection of Teach Pendant

Method for connecting the teach pendant:

S/N	Operation	Precautions
1	Find the teach pendant socket connector on the controller or panel board.	The controller must be in an Off state.
2	Align and insert the quick connector.	Align the red dot on the teach pendant plug with the one on the controller port.

2.3 Preparation of power cable

Connect the power cable on IRC-I4A-C, or use accessories provided by us, or the user should prepare them independently. Prepare the power cable according to the following requirements. Connect the power side according to the user's device.

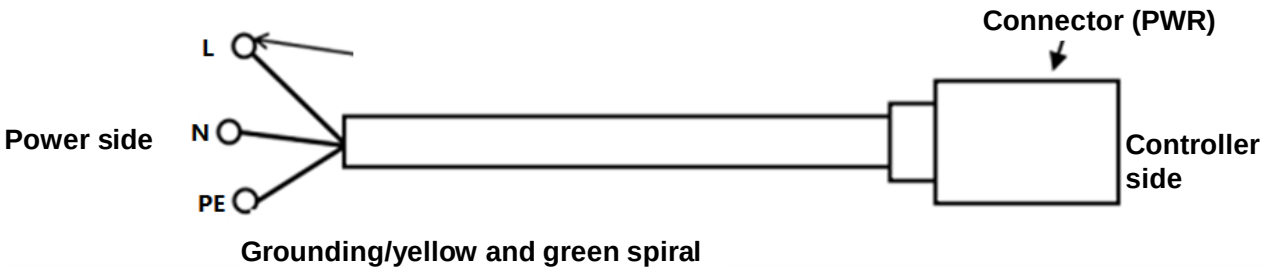


Fig. 2.3 Connection of Power Cable

The specifications of power cables are shown in the table below:

Cable number	Name	Specification	Standard	Length	Outside diameter	Minimum bend radius
RVVP,3*2.5mm^2, red/blue/yellow green	Cables outside single-phase power cabinet	4010300001	JB8734.5-2016	5m	10.5mm	63mm

Caution

It is required to observe any local standards and regulations regarding insulation and cross-sectional area.

2.4 Grounding and shielding connection

The following figure shows two examples of grounding and shielding methods.

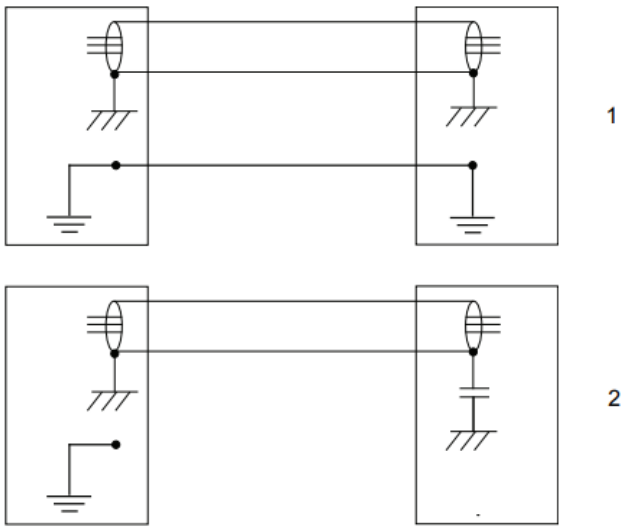


Fig. 2.4 Grounding Connection

Example 1: If all components are well grounded, the best shielding effect can be achieved by grounding all shielding layers at both ends of all components.

Example 2: If the cable ends are not well grounded, a noise suppression capacitor can be used. The shielding of two cables must be connected as shown in the figure, but not to the base of the device.

2.5 Elimination of interference

For internal relay coils and other components possibly causing interference inside the controller, their interference is eliminated through offset. External relay coils and other components must be c lighted in the same manner. The following figure shows the specific method. Please note that the closing time of the DC relay may increase after offset, especially if a diode is connected through a coil. The varistor can achieve a shorter closing time. Mutual offset of coils can extend the lifespan of the controller switch.

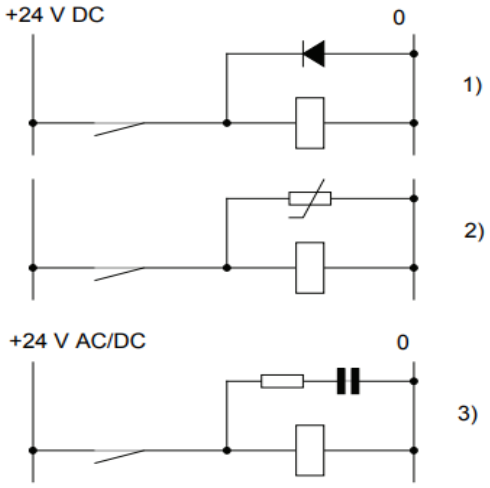


Fig. 2.5 Elimination of Interference

1. As for the specifications of the diode, the same current as the relay coil and the voltage equivalent to twice power supply should be used.
2. As for the specifications of the varistor, the same energy as the relay coil and the voltage equivalent to twice power supply should be used.
3. When AC voltage is adopted, a maximum voltage of >500 V and a nominal voltage of 125 V should be used for the component. The resistance should be 100 Ω and the capacitance should be 1W 0.1-1 μ F (usually 0.47 μ F).

2.6 About power protection device

The robot generates high-frequency leakage current during operation, which sometimes causes the leakage circuit breaker or leakage protector of the controller's power supply to trip. Therefore, such false tripping is to be avoided when selecting leakage circuit breaker or leakage protector.

During mounting and operation of the robots, it is required to install an independent power protection device for each robot. A circuit breaker with leakage protection is a common choice for such protection. Specification & parameters of circuit breakers: 2P; 10A or above; type C trip curve. Specification & parameters of leakage protectors: leakage current limit of 30mA.

2.7 About On/Off time of circuit breaker

The controller may not start when the circuit breaker repeatedly turns on or off the power supply in a short period of time.

Turn on the power of the controller in more than 10s after it is disconnected.

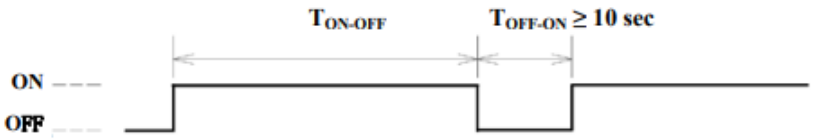


Fig. 2.6 Timing Diagram of Circuit breaker

2.8 Connection of external emergency stop signals

During system building, confirm that the robot is stopped through all safety signals and take care to avoid incorrect connections if safety signals, such as safety plug and safety door signals, are connected.

Without an I/O wiring adapter module, a safety plug should be connected if the external emergency input or safety barrier signals are invalid.

3 Peripheral devices

3.1 Ports of peripheral devices

The peripheral device ports of IRC-I4A-C are divided into IO board and safety board. IO board signal with 24 DI, 16 DO.

Fig. 3.1 External IO Board

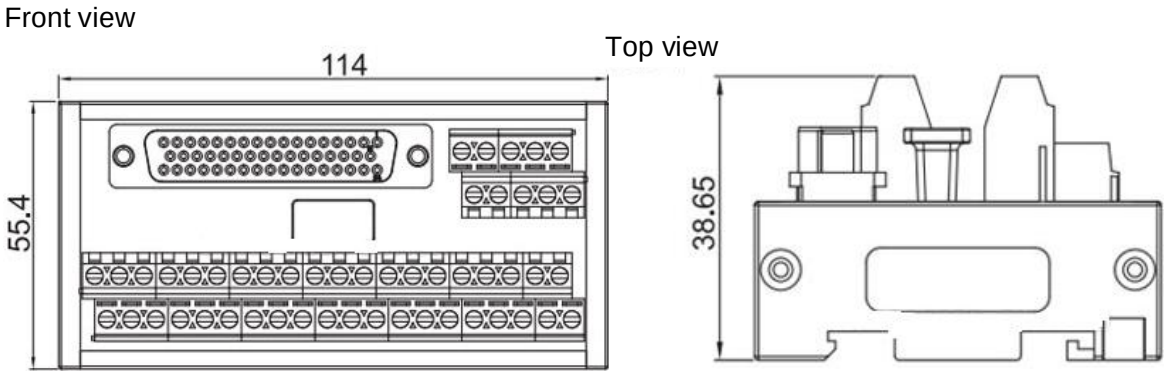


Fig. 3.2 Dimensions of External IO Board

IRC-I4A-C has two types of controllers: NPN and PNP. The external IO boards used in these two controllers are the same, but the wiring methods are different.

IO board wiring method of NPN controller:

The ports 1, 18 and 34 are connected to 24V; the ports 15, 16, 48 and 49 to 0V.

IO board wiring method of PNP controller:

The ports 1, 18, 34, 16 and 49 are connected to 0V; the ports 15 and 48 to 24V.

Port No.	Signal name	Port No.	Signal name	Port No.	Signal name
1	DI 1~8 common port	18	DI 9~16 common port	34	DI 17~24 common port
2	Input Port 1	19	Input Port 9	35	Input Port 17
3	Input Port 2	20	Input Port 10	36	Input Port 18
4	Input Port 3	21	Input Port 11	37	Input Port 19
5	Input Port 4	22	Input Port 12	38	Input Port 20
6	Input Port 5	23	Input Port 13	39	Input Port 21
7	Input Port 6	24	Input Port 14	40	Input Port 22
8	Input Port 7	25	Input Port 15	41	Input Port 23
9	Input Port 8	26	Input Port 16	42	Input Port 24
10	Output Port 1	27	Output Port 6	43	Output Port 12
11	Output Port 2	28	Output Port 7	44	Output Port 13
12	Output Port 3	29	Output Port 8	45	Output Port 14
13	Output Port 4	30	Output Port 9	46	Output Port 15
14	Output Port 5	31	Output Port 10	47	Output Port 16
15	DO_PS_IN 1	32	Output Port 11	48	DO_PS_IN 2
16	DO 1~8 common port	33	NC	49	DO 9~16 common port
17	24V	/	/	50	0V

Table 3.1 Definition of IO Board Wire Sequence

Fig. 3.3 External Safety Board

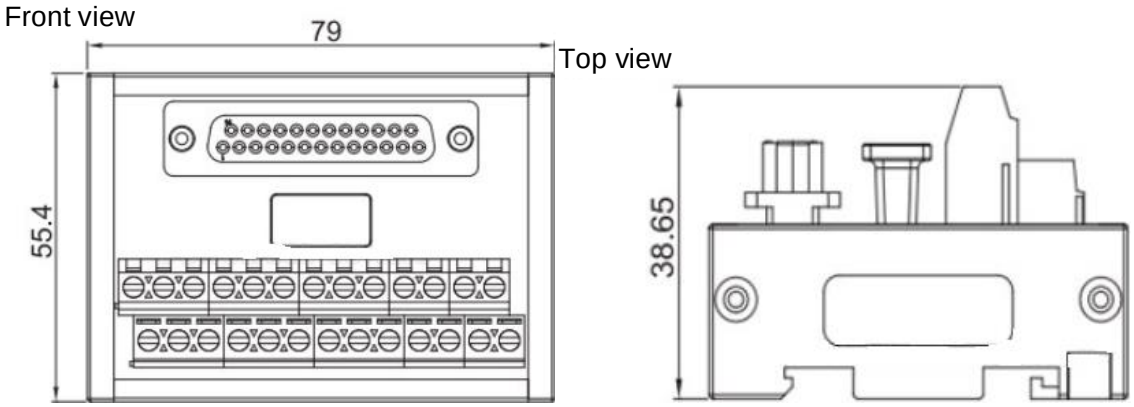


Fig. 3.4 Dimensions of External Safety Board

Fig. 3.5 Safety Plug

If safety signals are not used in practical applications, it is required to insert the safety plug into the safety port. If some safety signals are used, the safety signals unused should be short-circuited.

Pin No.	Function	Signal description
1	24V	Internal power supply 24V
2	ESTOP11	CH1 input of external emergency stop
3	ESTOP12	CH1 grounding point of external emergency stop
4	0V	Internal power supply 0V
5	24V	Internal power supply 24V
6	SD11	CH1 input of safety door
7	SD12	CH1 grounding point of safety door
8	0v	Internal power supply 0V
9	24V	Internal power supply 24V
10	SDB11	CH1 input of safety door bypass
11	SDB12	CH1 grounding point of safety door bypass
12	0V	Internal power supply 0V
13	/	Reserved
14	24V	Internal power supply 24V
15	ESTOP21	CH2 input of external emergency stop
16	ESTOP22	CH2 grounding point of external emergency stop
17	0V	Internal power supply 0V
18	24V	Internal power supply 24V
19	SD21	CH2 input of safety door
20	SD22	CH2 grounding point of safety door
21	0v	Internal power supply 0V
22	24V	Internal power supply 24V
23	SDB21	CH2 input of safety door bypass
24	SDB22	CH2 grounding point of safety door bypass
25	0V	Internal power supply 0V
PE	Grounding	Grounding

Table 3.2 Definition of Safety Board Wire Sequence

3.2 Ports and connection of peripheral devices

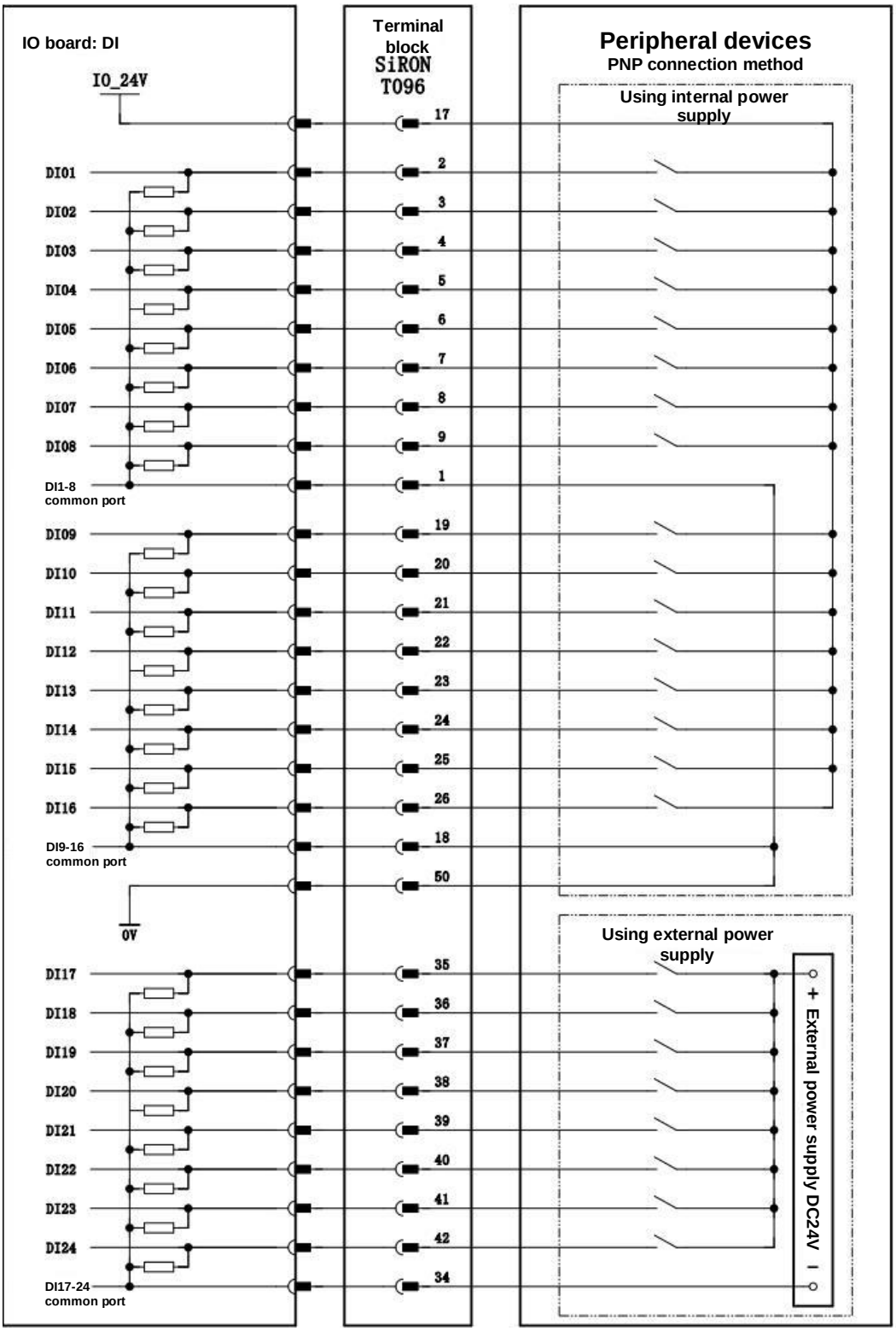


Fig. 3.6 Connection of DI Signals (PNP)

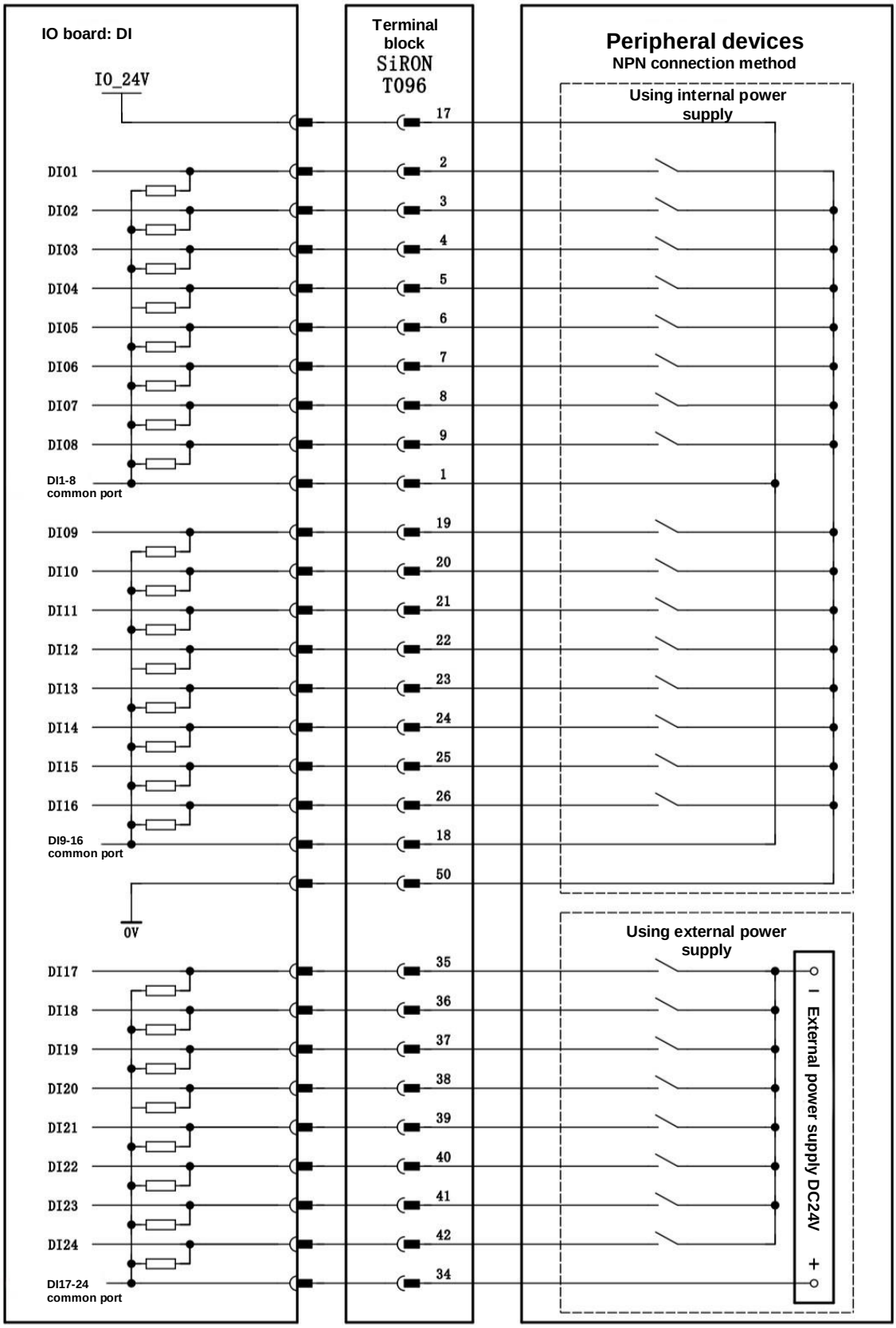

IO board: DI
IO_24V
DI01
DI02
DI03
DI04
DI05
DI06
DI07
DI08
DI1-8 common port
DI09
DI10
DI11
DI12
DI13
DI14
DI15
DI16
DI9-16 common port
0V
DI17
DI18
DI19
DI20
DI21
DI22
DI23
DI24
DI17-24 common port
Terminal block
SiRON
T096
17
2
3
4
5
6
7
8
9
1
19
20
21
22
23
24
25
26
18
50
35
36
37
38
39
40
41
42
34
Peripheral devices
NPN connection method
Using internal power supply
Using external power supply
External power supply DC24V
+
-

Fig. 3.7 Connection of DI Signals (NPN)

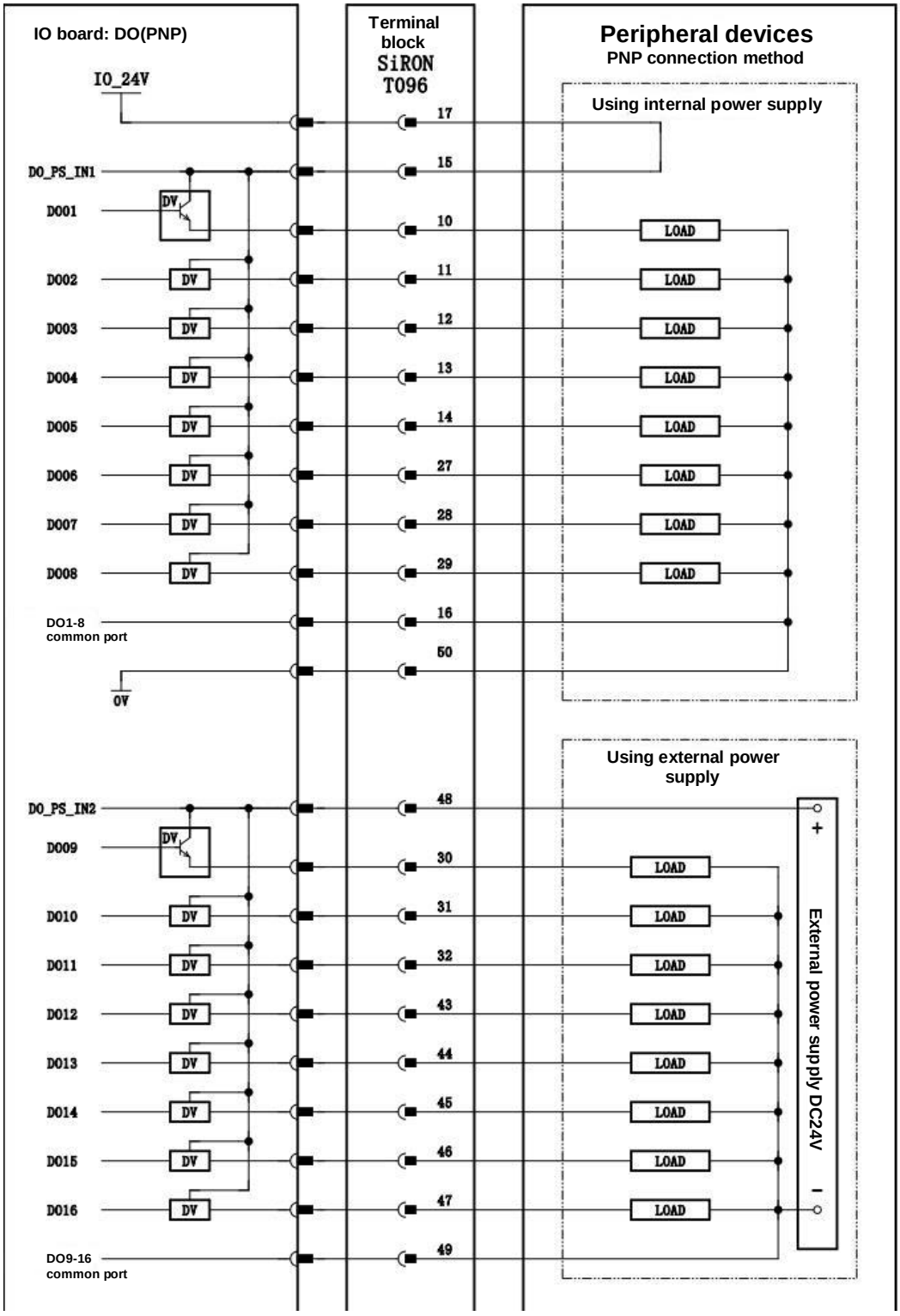


Fig. 3.8 Connection of DO Signals（ PNP）

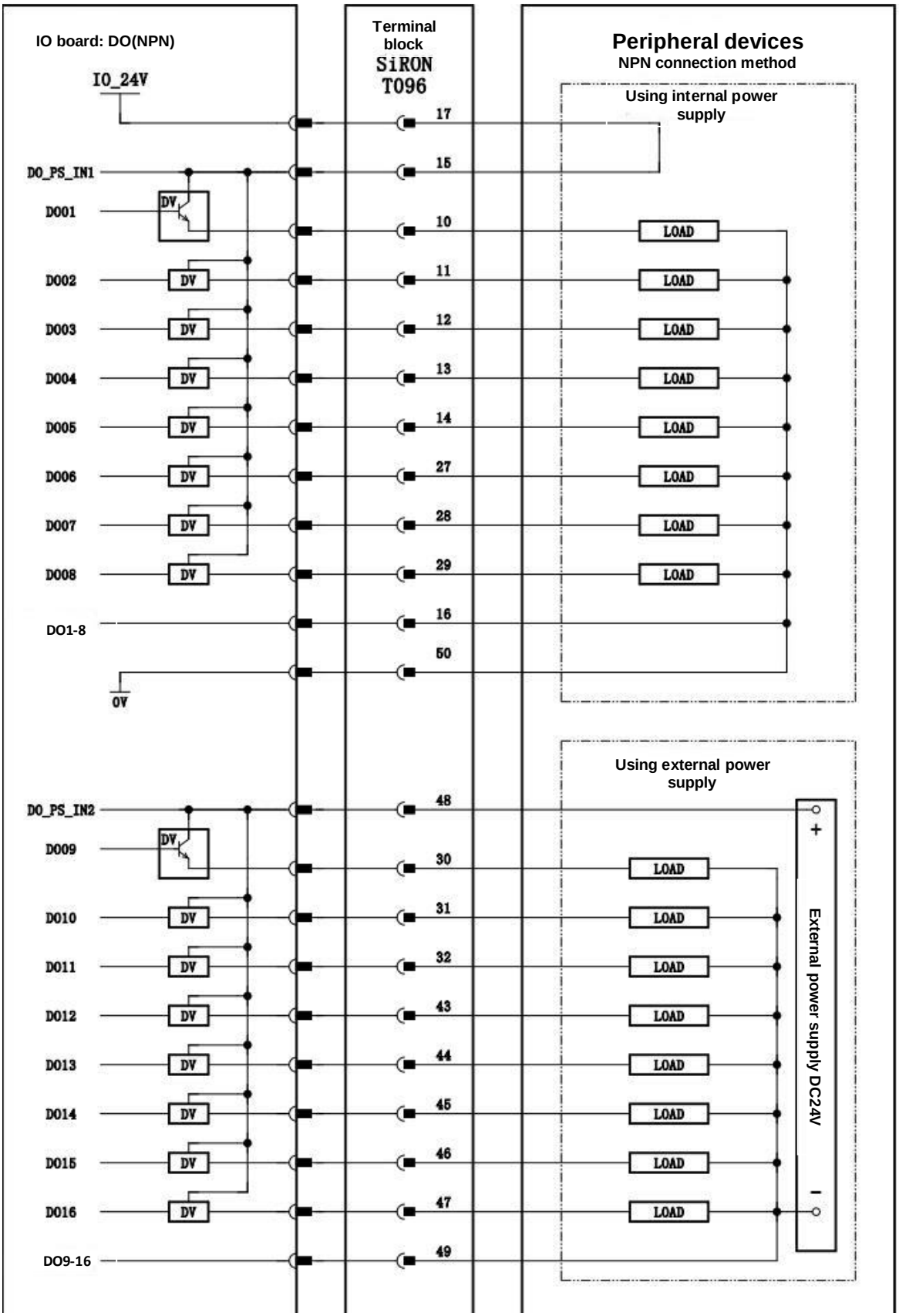
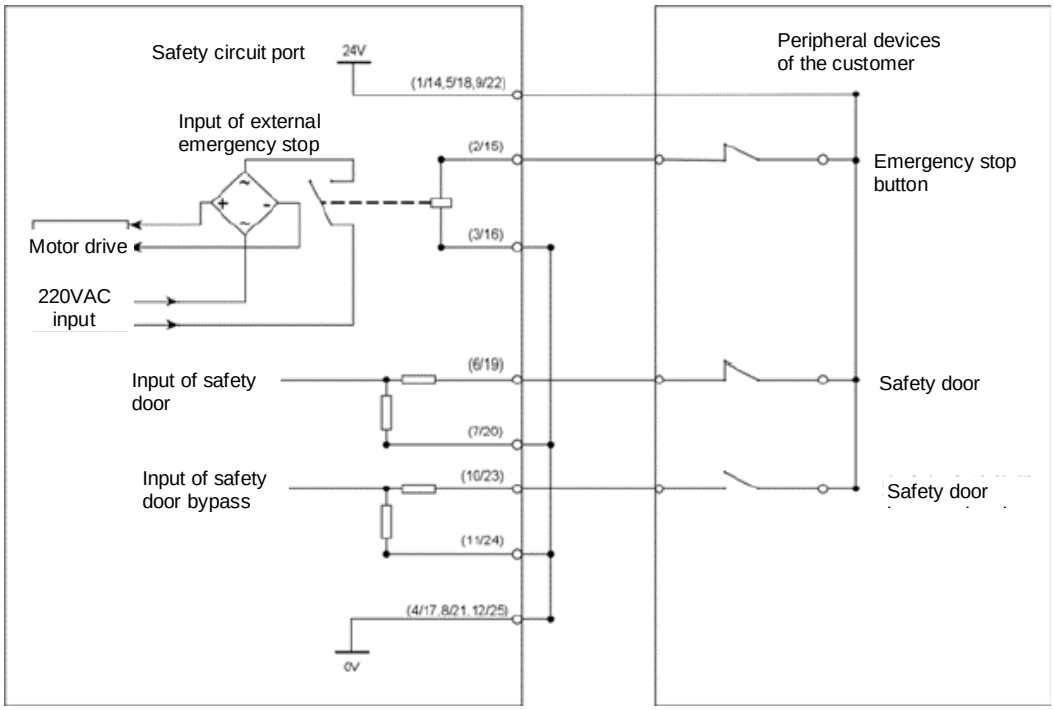


Fig. 3.9 Connection of DO Signals (NPN）

3.3 Connection between safety board and peripheral devices

The safety circuit can offer two power supply modes: internal 24V power supply and external 24V power supply.

The internal 24V power supply is used as shown in the following figure.



The external 24V power supply is used as shown in the following figure.

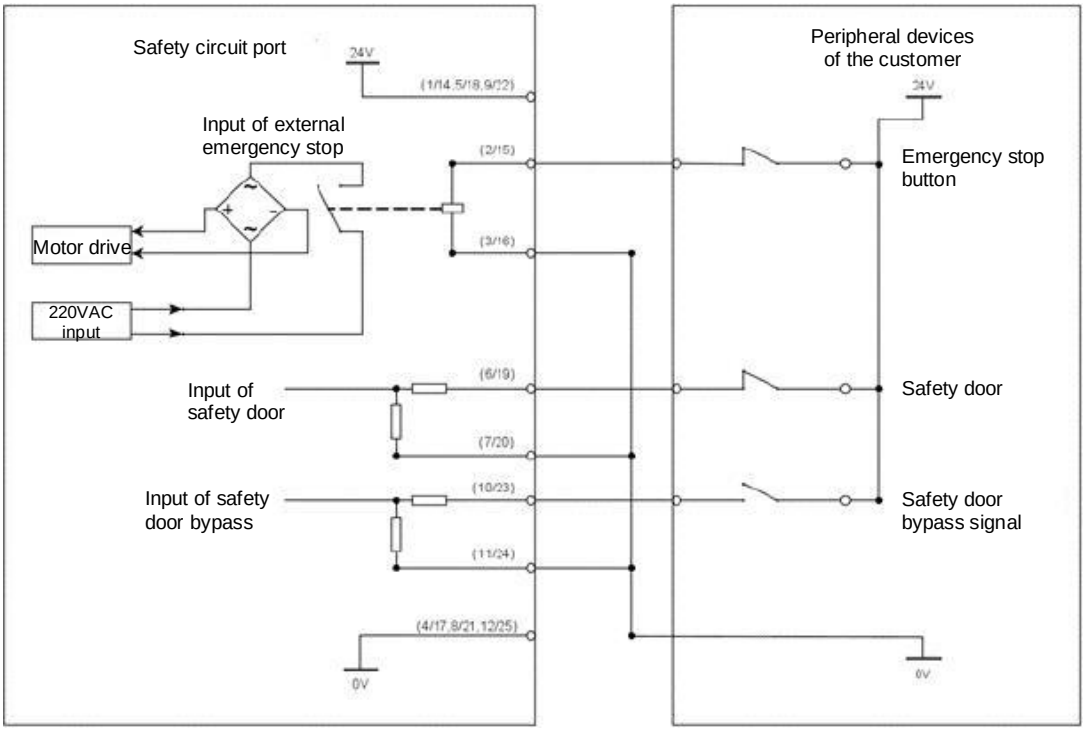


Fig. 3.10 Connection of External Safety Signal

3.4 Connection of communication device (Ethernet port)

The IRC-I4A-C controller is provided with standard Ethernet RJ45 ports and supports multiple protocols, and two Internet ports are interconnected internally.

Caution

Please consult various device manufacturers for the construction of the network or the operating conditions of the devices other than robot controller (HUBs, transceivers, cables, etc.). It is required to fully consider that the network constructed is not affected by other noise sources. The noise sources of power lines and motors should be electrically separated from network cables sufficiently and it is necessary to connect the ground wires of each device. In addition, it is necessary to note that high and insufficient grounding impedance may sometimes lead to communication barriers. The communication tests should be carried out for confirmation after equipment setting and before formal operation.

We cannot guarantee normal operation of devices (other than robot controller) due to network failures.

4 Handling and mounting

4.1 Handling method

Handle the robot body in a stationary mode.

(1) Fix the base to the wooden bracket with four wood screws.

(2) Put the screw rod into the limit hole.

(3) Put the controller into the box.

(4) Move the box to the handling area with care.

Fig. 4.1 Fixing of Robot Body

Fixing and handling of controller

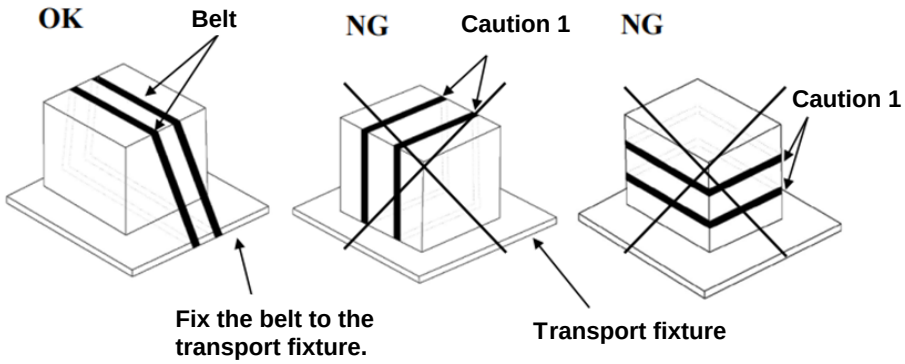


Fig. 4.2 Fixing of Controller

> ⚠ Caution
>
> If being tied too tightly to the controller, the belt may damage the sealing gasket of the door, and the damaged state of the sealing gasket may not be restored after removal of the belt. When used, it may be impossible to ensure the airtightness of the controller.
>
> Please use cushioning materials to avoid exerting pressure on the cable and the cover of the cable port.

4.2 Mounting method

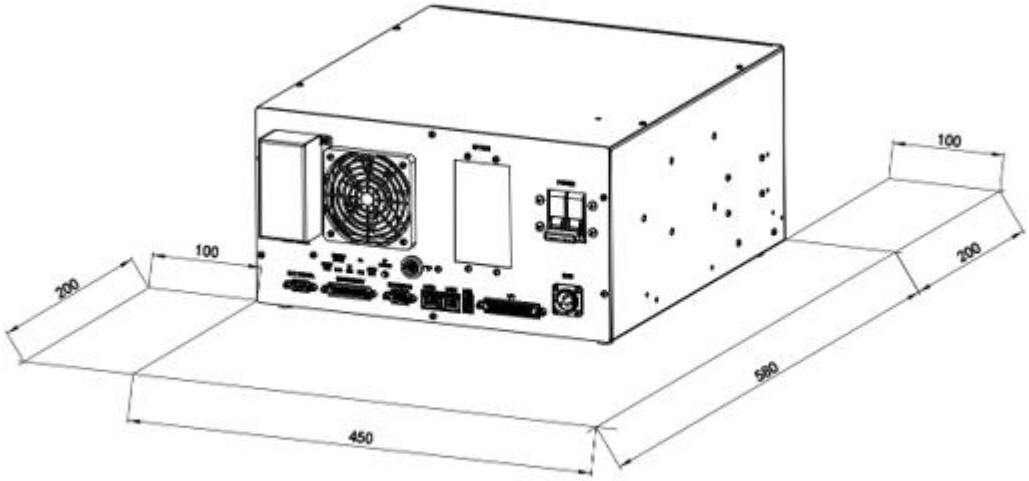


Fig. 4.3 Mounting of Controller

- If mounted on a desktop (without a rack), the controller requires 100mm free space on the left and right.
- The controller requires 200mm free space on the back to ensure proper cooling. Never place the user's cable on the fan cover on the back of the controller. Otherwise, it may inspection difficult and result in insufficient cooling.

Caution

Please ensure the above areas for the purpose of maintenance and heat dissipation.

Please mount the controller in a well-ventilated and open space. Mounting in a closed space may cause such issues as ineffective cooling, high temperature, lower reliability or malfunction of the controller.

4.3 Mounting conditions

During operation, the IRC-I4A-C controller may generate electromagnetic interference to the outside, which mainly affects peripheral devices by conduction and radiation. In non-industrial environments, the electromagnetic interference generated by the controller may affect peripheral devices occasionally. So, do not use this controller in residential areas.

If it is required to use this controller in residential areas, special measures should be taken to reduce electromagnetic interference to prevent the electromagnetic interference generated from affecting normal operation of peripheral devices.

This controller will not malfunction due to harmonics generated in general industrial environments, but it may be problematic when the connected power supply contains large harmonics. In this case, a stable power supply device should be provided.

Item	Requirements
Operating ambient temperature	Temperature: 5~40 ℃ Humidity: 20%~95% (30 ℃) (without condensation)
Storage temperature and humidity	Temperature: -5~40 ℃ Humidity: ≤ 95% RH (30 ℃)
Transport temperature and humidity	Temperature: -25~70 ℃ Humidity: ≤ 95% RH (40℃)
Vibration	Sinusoidal vibration: In accordance with the *Industrial Robots - Acceptance Rules* (JB/T 8896-1999), the vibration displacement is 0.75mm at 5-25Hz and 0.15mm at 25-55Hz and the vibration continues for 3min at each point; Random vibration: It meets the ISTA 1H standard and the vibration acceleration is $0.01g^2$/Hz at 4-100Hz and 0.001 g^2/Hz at 200Hz; Grms=1.14g, and the bare machine vibrates for 30min per X/Y/Z axial direction.
Impact	The maximum impact must not exceed the acceleration of 15g and its duration must be longer than 11ms.
Degree of Protection	IP20
Altitude	1000m and below

4.4 Adjustment and confirmation items during mounting

Item	Contents
1	Check internal and external appearance of the controller.
2	Check if the fixing screw terminals have been properly connected.
3	Confirm the insertion status at mounting positions of connectors and printed circuit board.
4	Connect the cables of the controller and the mechanism.
5	Switch off the circuit breaker and connect the power cable.
6	Confirm the input power voltage.
7	Confirm the port signal between the controller and the robot mechanism.
8	Confirm and set all parameters.
9	Confirm the motion of each axis under manual feed.
10	Confirm the conditions of control port signals of peripheral devices.

Appendice

A. List of Specifications

Overall unit			
Description of material	**Material No.**	**Description of model and specification**	**Note**
Integrated light	2020500020	AD17KC-22/DC24VY; integrated light; yellow; 24VDC; φ22	
Panel-mounted interface	2030100007	MSDD08-1-CAT5E; panel RJ45 port	
Integrated button	2020500018	LA130-16J-11; metal button; 24VDC;1NO1NC;φ16	
IRC-I4A-C Controller Core Board	404AP_CCB00601_E0002	AP_CCB00601_E/90x54mm/V0.2/	
IRC-I4A-C Controller Main Board	404AP_CMB00703_E0001	AP_CMB00703_E/190x276mm/V0.1/	
S6A 400W Customized Driver Board	404AP_DMB00502_E0001	AP_DMB00502_E/300x120mm/V0.1/	
IRC-I4A-C DC-Bus Power Board	404AP_PMB00102_E0001	AP_PMB00102_E/200x140mm/V0.1/	
IRC-I4A-C EMI Filter Board	404AP_FMB00202_E0001	AP_FMB00202_E/73x243mm/V0.1/	
IRC-I4A-C TP Flexible Adapter	404AP_CSB00101_E0002	AP_CSB00101_E/30x85mm/V0.2/	
IRC-I4A-C keyboard	404AP_CSA00701_E0001	AP_CSA00701_E/70x25mm/V0.1/	
IRC-I4A-C jumper board PNP	404AP_CSC00101_E0002	AP_CSC00101_E/25.4mmX12.7mm/V0.2/PNP/	
IRC-I4A-C jumper board NPN	404AP_CSC00101_E0001	AP_CSC00101_E/25.4mmX12.7mm/V0.1/NPN/	
IRC-I4A-C Encoder Management Board	404AP_EMB00104_E0001	AP_EMB00104_E/90X90mm/V0.1/	
Circuit breaker	2020100002	IC65N-C10; A9F18210; circuit breaker; 2P; 10A;	
Fan	2020600010	ME80252V1-000C-A99; fan; 80*80*25; 24VDC	

Fan accessories	2020600012	ZHJ41-80; fan filter screen; 80*80; black filter screen	
AC-DC Power Supply	2020400008	LRS-100-24; AC-DC Power Supply; flat mounting; 220VAC; 100W; 24VDC/4.5A	
AC-DC Power Supply	2020400009	LRS-75-15; AC-DC Power Supply; flat mounting; 220VAC; 75W; 15VDC/5A	
AC-DC Power Supply	2020400010	LRS-75-5; AC-DC Power Supply; flat mounting; 220VAC; 75W; 5VDC/14A	
Battery	2020400003	CR1220; button lithium battery; 3V	
Cables inside the single-phase power cabinet	4010300002	SN-2019-GBT-030; internal wiring of 220V power cabinet; single phase; 3×2.5mm^2; 0.3m	
Sheet metal assembly of IRC-I4A-C controller	10202IRC-I4A-C0101	IRC-I4A-C;0101; sheet metal assembly of IRC-I4A-C controller; aluminum-zinc-plated plate; panel painting + silk screen printing	
Radiator of I4A driver board	10302C020AIRC-I4A-C.13100	IRC-I4A-C.13;0100; radiator of I4A driver board; 6061-T6; intrinsic oxidation	
Finished pre-wire	2010300003	CPCBK26-07ND; white FPC; 150mm	
Finished pre-wire	2010300004	CPCBD25-01NS; horn plug FPC; 150mm	
Power cable inside IRC-I4A-C controller	4010300013	80210024; power cable inside I4A controller; applicable to S3A/S6A series	

B. Meaning of control system I/O signals of peripheral devices

The following table lists the system I/O signals for the ports of the peripheral devices on IRC-I4A-C.

List of UI/UO signals						
UI[1]	Servo_Enable Servo enable signal (it can be used as an alarm signal of instantaneous stop peripheral software; or after pausing, it turns off the servo-holding brake to make a complete stop)	Servo_Enable is usually ON. When the peripheral upper computer does not want the robot to move or when power is switched on, it is switched to OFF. It is used for safety locking. In the OFF state, the system performs the following processing: 1. Issue an alarm and then disconnect the servo power supply. 2. Instantly stop the robot (Class 0 stop) and suspend the execution of the program. 3. The servo cannot always be enabled. The bypass is ON.		UO[1]	CMDENBLE Allow peripheral devices to control the status signals of the robot.	ON indicates that peripheral device control is enabled, while OFF means that peripheral device control is disabled. Output high level when the following conditions are met: 1. UI[5] is ON. 2. The Key Switch is in "Auto" mode. 3. UO[3] is OFF.
UI[2]	Pause_Request Pause signal	Pause signal. It is usually ON. In the OFF state, the system performs the following processing: It is planned to slow down and stop the executing action and to suspend the execution of the program. The bypass is ON.		UO[2]	Paused	"Paused" status signal. When the program execution status is "Paused", this signal is ON (i.e. the robot is paused).
UI[3]	Reset Alarm reset signal	Release the alarm, power on the servo and effectively generate a Reset request at a high level.		UO[3]	FAULT	When an alarm occurs in the system, this alarm signal is output and can be reset by RESET. Note: This signal is not output when the system issues a warning type alarm.
UI[4]	Start & Restart Program start/resume signal	Start or restart the program (depending on whether the program status is “Aborted” or “Pause”) and its function is the same as the Start button on TP. Take the effective falling edge to start or restart the		UO[4]	Program Running Program running signal	ON indicates that the program is running; OFF indicates that no program is running.

		program.			
UI[5]	Abort Program Program abort signal	Request to terminate a program in execution or paused state. It is usually ON. In the OFF state, the system performs the following processing: The alarm bar indicates a program abort request and the program enters the abort mode. If the program is still running, immediately stop the robot's action and then abort the program. It is similar to an "aborted" alarm. Allow to enable and teach the servo, but not to manually or automatically execute programs. The bypass is ON.	UO[5]	Servo Status	This signal is set to high level when the robot operation status is "Working", "On Standby" or "Servo ON". It is at lower level under “Servo-OFF”.
UI[6]	Selection Strobe Trigger signal	It is only valid when the "Program Start Mode" is set to "Start by Main Program Number" or "Simple Start Mode by Main Program Number". Read the trigger signal for selecting the program to be executed. When it is ON, read the input of Program Selection 1-6 and select the program to be executed. Note: This signal is ignored when a program is executing (running or paused).	UO[6]	Selection Check Request	It is only valid when the "Program Start Mode" is set to "Start by Main Program Number" or "Simple Start Mode by Main Program Number".
UI[7]	MPLCS Start	It is only valid when the "Program Start Mode" is set to "Start by Main Program Number" or "Simple Start Mode by Main Program Number". It is a start signal of program number selection.	UO[7]	MPLCS Start Done	It is only valid when the "Program Start Mode" is set to "Start by Main Program Number" or "Simple Start Mode by Main Program Number".
UI[8]-UI[13]	Program Selection 1-	It is only valid when the "Program Start Mode" is	UO[8]-UO[13]	Selection Confirm	It is only valid when the "Program Start Mode"

	6	set to "Start by Main Program Number" or "Simple Start Mode by Main Program Number". The 6-digit binary number of the program number is converted to a decimal number, which is the start number of the main program to be executed.			1-6	is set to "Start by Main Program Number" or "Simple Start Mode by Main Program Number". After receiving the Selection Strobe signal, the robot controller may read the status of UI[8]-UI[13] and feed it back to the upper level for confirmation.

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