



FSWELD Intelligent Welding Control System Hardware Installation Manual (General)

Document version: V1.0.0



Foreword

Thank you for using BOCHU FSWELD intelligent welding control system!

The FSWeld intelligent welding system integrates digital twin technology, robotic control, and vision technology. It is a comprehensive solution specifically designed for arc welding applications. The system utilizes an offline programming approach driven by models and an expert database, enabling automatic generation of positioning and welding paths without the need for manual teaching.

Please note that this manual only serves as the hardware installation, wiring, and calibration instruction of the main program of FSWELD. Please refer to other manuals or contact technical support for software use and other content.

We apologize for the fact that the FSWELD you are using may differ in some respects from what is stated in this manual due to the continuous updating of system features. We make every effort to ensure that the contents of the manual are applicable, but reserve the right of final interpretation. Contents of this manual are subject to change without prior notice.

For any questions or suggestions during usage, please contact us through the information provided.

Convention Symbol Explanation

Notice: Supplementary or explanatory information for the use of this product.

Caution: If not operated as specified, it may result in minor physical injury or equipment damage.

Warning: If not operated as specified, it may lead to death or serious physical injury.

Danger: If not operated as specified, it will cause death or serious physical injury.

Safety Statement

The operation of the robot/external axis and the final welding result are directly related to the welding material, welding machine, gases used, gas pressure, and the parameters you set. Please set all parameters carefully and diligently according to your welding process requirements.

Improper parameter settings or operations may result in suboptimal welding quality, equipment damage, or even personal injury. FSWELD incorporates built-in safety features; however, both equipment manufacturers and end users are required to strictly follow all operating procedures to minimize safety risks.

BOCHU shall not be held liable for any direct or indirect losses arising from the following circumstances:

- Losses caused by misuse of this manual or the product;
- Losses due to non-compliance with safety guidelines;
- Losses resulting from force majeure events, such as natural disasters.

Additionally, welding systems in operation carry inherent risks. Users are responsible for ensuring that they have comprehensive fault handling and safety protection mechanisms. BOCHU assumes no responsibility for any incidental or consequential damages resulting therefrom.

Revision History

Version No.	Date	Description
V1.0.0	2025/06/28	Hardware installation manual for FSWELD Intelligent Welding Control System.

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Chapter 1 Overview

1.1 Product Description

The FSWeld intelligent welding system, developed by BOCHU, integrates digital twin technology, robotic control, and vision technology. It is a comprehensive solution specifically designed for arc welding applications.


The system utilizes an offline programming approach driven by models and an expert database, enabling automatic generation of positioning and welding paths without the need for manual teaching. With the self-developed welding expert software, the system supports various functions, including multi-layer multi-pass welding, continuous welding, wrap welding, automatic positioning, seam tracing, breakpoint localization, collision detection, and more. It effectively handles workpiece deformation, adapts to complex and dynamic application environments, and efficiently processes small-batch, non-standard parts.

1.2 Product Details

The FSWELD intelligent welding system primarily consists of the following components: HypTronic3 CNC Host, HPL2720E Terminal Board, BCW600P Seam Tracker, BCW020 Seam Tracker Communication Adapter, WKB Wireless Controller, Relevant cables and accessories.

Table 1-1 FSWELD Intelligent Welding System Product Details

HypTronic3 CNC Host * 1	HPL2720E Terminal Board * 1	BCW600P Seam Tracker * 1
		
BCW020 Communication Adapter * 1	WKB SW Wireless Controller * 1	Custom Seam Tracker Signal Cable * 1
		
Custom Seam Tracker Network Cable * 1	Network Cables (Several)	
		

 **Notice:** Accessories and quantities may vary depending on the selected package. The product details listed above are for reference only. Please refer to the actual delivery for final confirmation.

Chapter 2 Wiring instructions

2.1 HypTronic3 Wiring

HypTronic3 is an EtherCAT CNC Host, which is developed on the basis of EtherCAT bus technology, and has excellent performance and anti-interference capability.

2.1.1 Technical Reference

Table 2-1 HypTronic3 Technical Data

Parameter	Model	HypTronic3_HPC3830E	HypTronic3_HPC3870E
Processor		12th Intel i3 4 cores and 8 threads Base Frequency: 3.3 GHz	12th Intel i7 12 cores and 20 threads P-core Base Frequency: 2.1 GHz E-core Base Frequency: 1.6 GHz
Graphics Card		Intel UHD Graphics 730	Intel UHD Graphics 770
RAM		8GB DDR4	16GB DDR4
Network		4 × Gigabit Ethernet interfaces	4 × Gigabit Ethernet interfaces
Drive		SSD 512GB	SSD 512GB
Display		HDMI (DVI digital signal compatible)	HDMI (DVI digital signal compatible)
USB		8× USB3.0	8× USB3.0
Real Time Ethernet Protocol		ECAT integrates EtherCAT master protocol	ECAT integrates EtherCAT master protocol
Operating system		Windows 10 IOT LTSC(64-bit)	Windows 10 IOT LTSC(64-bit)
Power Supply		DC 24 V 3 A (typical), maximum 6 A	DC 24 V 3 A (typical), maximum 8 A
Power Consumption		Up to 144 W	Up to 192 W
Dimension (L × W × H)		337.4× 220.4× 70.5 mm	337.4× 220.4× 70.5 mm
Weight		2 kg	2 kg
Protection		IP20	IP20
Cooling/Temperature		Air Cooling/0 ~ 60°C	Air Cooling/0 ~ 60°C

2.1.2 Interface Layout

The interface layout of HypTronic3 is shown in the figure below.

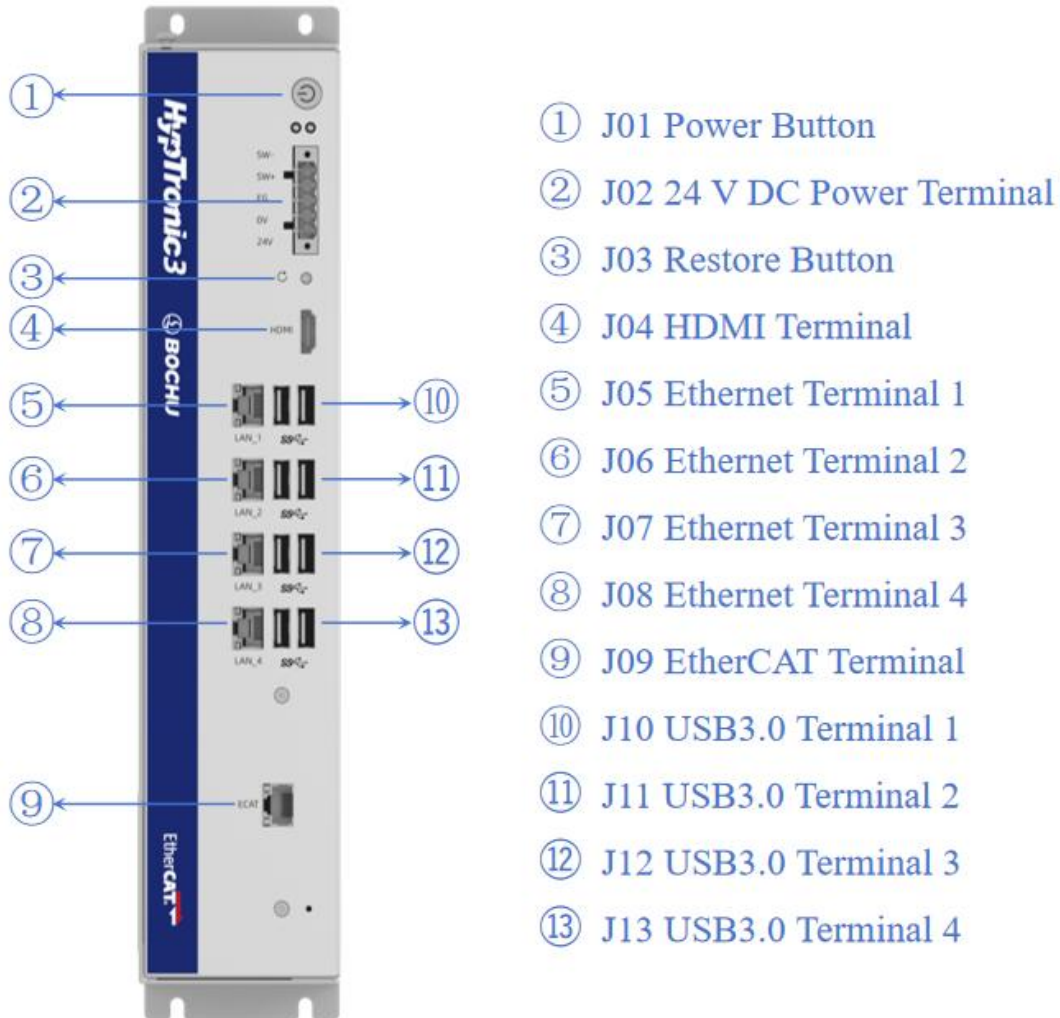


Figure 2-2 HypTronic3 interface layout

2.1.3 J01 Power Button

J01 is the power button of the host. When connected to 24 V power, the host will boot up by default, or can be turned on/off by pressing this button.

2.1.4 J02 Power Terminal

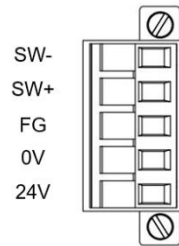


Figure 2-3 Top view of the power terminal

Detailed descriptions of the power supply terminals are shown in the table below.

Table 2-2 J02 Power Terminal

Pin	Description	Wiring Requirements
SW-	Power button, negative (0 V short-circuited)	Automatic reset switch (normally open type).
SW+	Power button, positive	
FG	Shield ground, case ground	Must be well grounded, ground wire has to be short and thick, grounding resistance no more than 4 Ω .
0 V	24 V power ground	Connect to 24 V switch power supply.
24 V	24 V power positive	

2.1.5 J03 Restore Button

J03 is the restore button of the Host. You can enter the restore interface by long pressing this key when the device is turned on. This key has an anti-touch design, and can be pressed with a screwdriver, tweezers, or others. You can also enter the restore interface by pressing the key *ALT+F3* in the BIOS interface. The detailed instructions on system restoration can be found in [2.1.10 System Restoration](#).

2.1.6 J04 HDMI Terminal

J04 is a standard HDMI interface, compatible with DVI digital signals (using HDMI to DVI adapters to connect to DVI digital interface displays), but incompatible with analog signals such as VGA, and DVI-A.

2.1.7 J05/06/07/08 Ethernet Terminal

J05/06/07/08 are standard RJ45 interfaces that can be used to connect network devices such as seam tracker, laser profiler, external network, and so on.

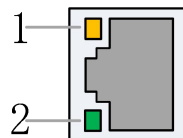


Figure 2-4 Terminal RJ45

The table below demonstrates the different connection statuses of the network terminal RJ45.

Table 2-3 RJ45 Connection Description

Label	Description	LED Color	Status	Description
1: Link	Ethernet Link Status	Orange	Off	No connection
			Blink	Connecting
			Solid	Connected
2: Speed	Ethernet Connection Speed	Green	Off	10 Mbps connection
			Off	100 Mbps connection
			Solid	1000 Mbps connection

The standard network port should be connected with a network cable as required by the equipment, and it is recommended to use a shielded network cable of category 5 or above.

2.1.8 J09 EtherCAT Communication Terminal

J09 terminal, defined as an EtherCAT interface, is a standard RJ45 interface that can be used to connect EtherCAT slaves, such as Welder and HPL2720E.

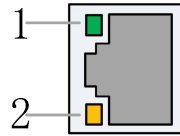


Figure 2-5 Terminal RJ45

The table below demonstrates the different connection statuses of the network terminal RJ45.

Table 2-4 Description of RJ45 connection status of network terminal

Label	Description	LED Color	Status	Description
1: Link	EtherCAT Bus Connection and Communication Status	Green	Off	No connection
			Solid	Connected, without communication
			Flashes	Connected, with communication
2: Status	EtherCAT Bus Link Status	Yellow	Off/Flashes	Not in the OP state
			Solid	in the OP state

2.1.9 J10/11/12/13 USB Terminal

J10/11/12/13 are standard USB3.0 interfaces that can be used to connect to USB devices.



Notice: When a longer USB extension cable is required, please choose an externally powered USB extension cable with a drive enhancement chip.

2.1.10 System Restoration

If the system requires to restore to factory settings due to virus or system lag caused by too many files, please follow the procedures below to restore the system:

Step 1 Restore HypTronic3.

Step 2 Upon initial startup, press and hold the **Restore** button. Release the key after the screen is on, and you will enter the restore page in Step 3.

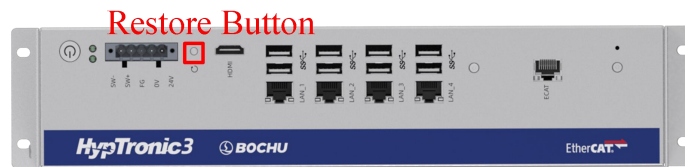


Figure 2-6 Restore Button

You can also press **Delete** to enter the BIOS interface below.

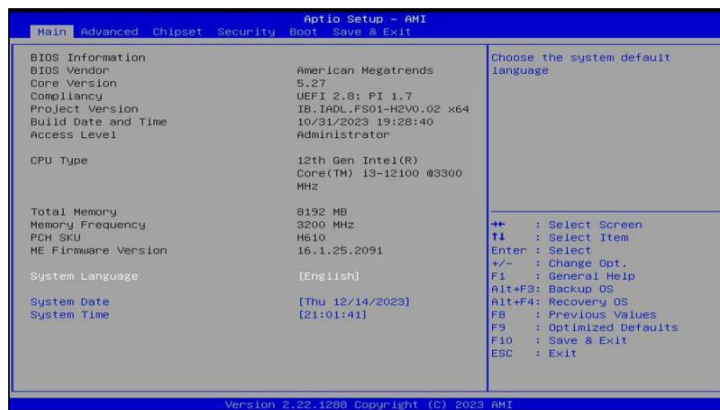


Figure 2-7 BIOS interface

By pressing the key **ALT+F3** on the BIOS page, the prompt window will show. Click **Yes** and press **Enter**, the system will be restored automatically and enter the restoration page.

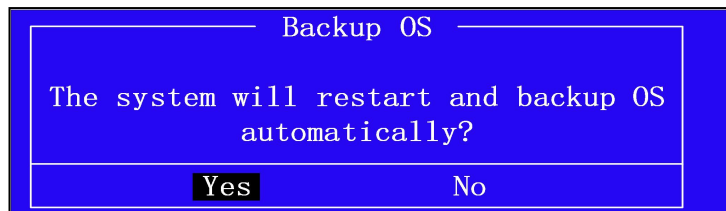


Figure 2-8 Whether to restart and back up the system

Step 3 Select *auto_restore* and press *Enter*.

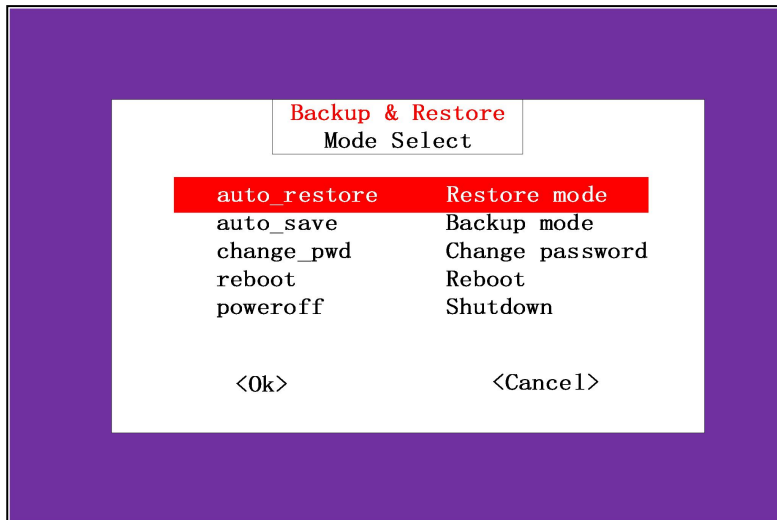


Figure 2-9 Restore page

Step 4 Select *Yes* and press *Enter*.

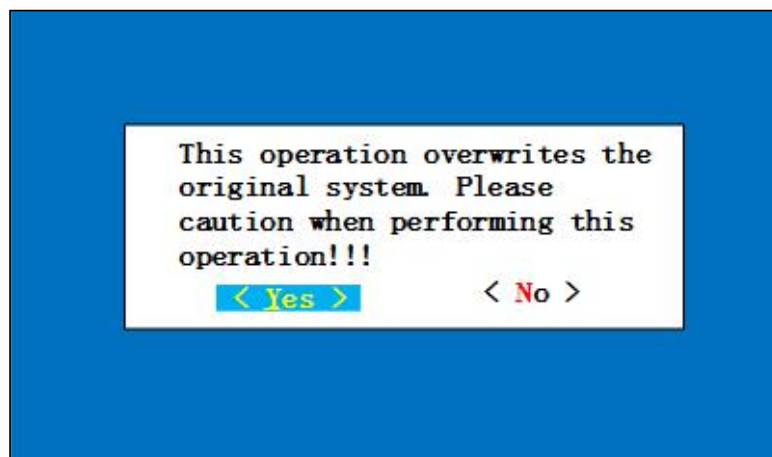


Figure 2-10 Click [Yes] to confirm

Step 5 The system starts auto-restoration, and the process will finish once the progress bar is complete.

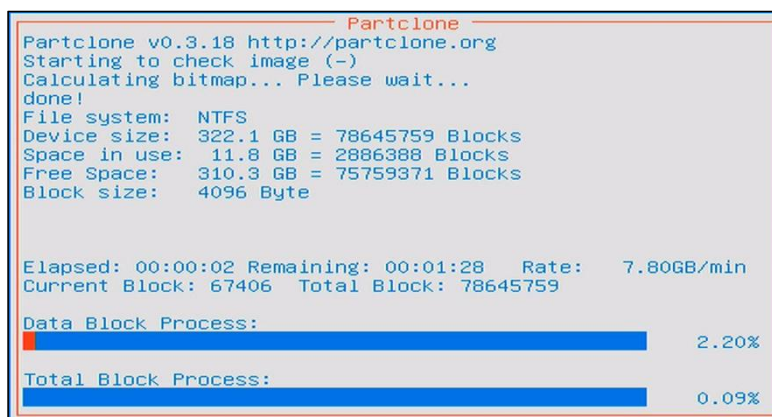


Figure 2-11 System is under restoration

2.2 HPL2720E Wiring

HPL2720E is an IO expansion board based on EtherCAT technology, supporting for the peripheral resources required by the FSWELD intelligent welding system.

2.2.1 Technical Reference

Table 2-5 HPL2720E Technical Data

Module	Qty	Description
Power	/	24V DC/3.5 A
PWM	1	Input: 24 V, ± 50 kHz, 0.3%
DA	4	Range: 0 ~ 10 V Resolution: 12 bit Accuracy: ± 20 mV
General Output	20	Logic Level: 24 V high level Current Limits: ≤ 0.7 A per channel; ≤ 2.5 A for all channels Recommended wiring: External 24 V relay connected to output port
General Input	27	24 V, active-low (valid range: < 15.6 V); The IN1, IN2, IN3 can be switched to high level active (valid range: > 5.8 V)
Working Temperature	/	0°C ~ 60°C
Humidity	/	10% ~ 90% RH(non-condensing)
Dimension (L × W × H)	/	195 mm × 118 mm × 45.2 mm(L × W × H)
Weight	/	480 g

2.2.2 Interface Layout

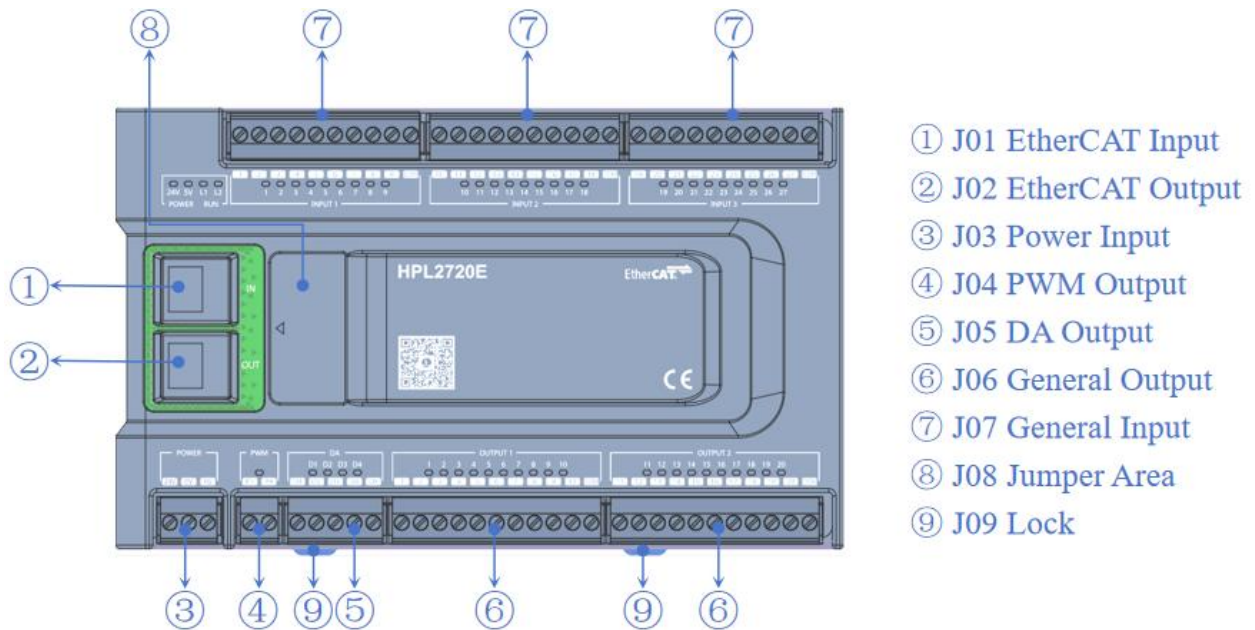


Figure 2-12 HPL2720E interface layout

2.2.3 J01 EtherCAT Input

J01 is the input terminal for EtherCAT, which shall be connected with standard RJ45 network cables.

2.2.4 J02 EtherCAT Output

J02 is the output terminal for EtherCAT, which shall be connected with standard RJ45 network cables.

2.2.5 J03 Power Input

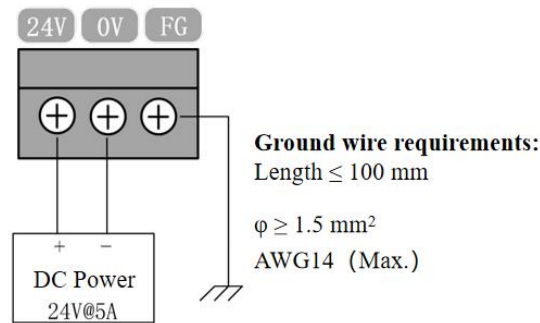


Figure 2-13 J03 power input

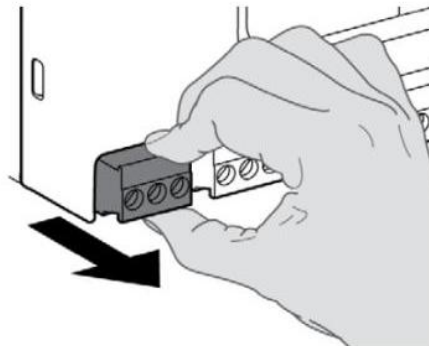


Figure 2-14 Removing the power terminal block

 **Caution:**

1. 24 V and 0 V are connected to the positive end and the negative end of the 24 V DC correspondingly. The FG pin must be securely connected to protective earth (PE).
 2. All terminals are pluggable only, and disassembly is shown in the figure above. There is no need to unplug the terminals for wiring.
-

2.2.6 J04 PWM Output

HPL2720E features 1 channel of PWM signal for laser average power control, which is 24 V. The duty cycle is adjustable from 0% to 100% with a maximum carrier frequency of 50 kHz. The signal output is shown in the figure below.

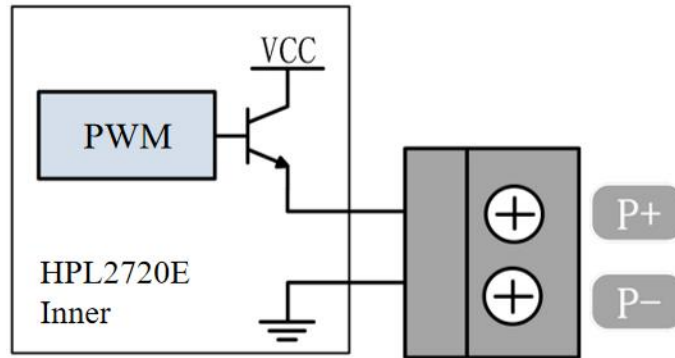


Figure 2-15 Signal output

⚠ Caution: There are dedicated enabling relays for PWM+ and PWM- signals, and there is no need for external relay for isolation.

2.2.7 J05 DA Output

HPL2720E has 4 analog outputs from 0 ~ 10 V.

Table 2-6 DA Output Parameter

Name	Description
Output Signal Range	0 ~ 10 V
Maxium Output Load Capacity	50 mA
Maximum Tolerance	+/-20 mV
Resolution	2.7 mV
Conversion Speed	400 μ s

2.2.8 J06 General Output

There are 20 high-level (24 V) outputs from OUT1 to OUT20. Through machine config tool, the 20 outputs can be configured to work as the controlled interface of *Emergency Stop*, *Welder Collision*, *Clean Torch CutWire*, etc.

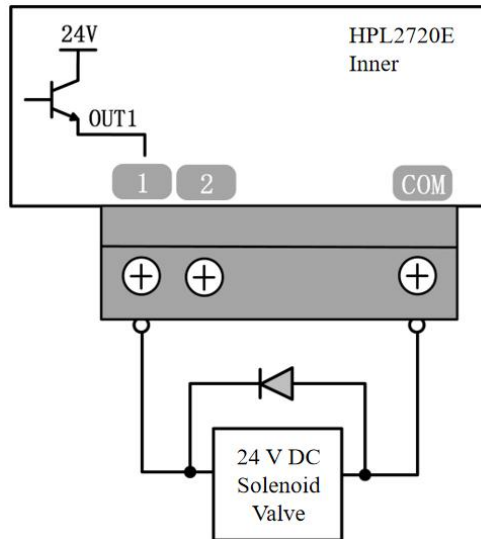



Figure 2-16 J06 General Output

 **Caution:** The total current of the output ports cannot exceed 2.5 A, otherwise the short circuit protection will be triggered.

2.2.9 J07 General Input

HPL2720E does not require dedicated input ports. All the input ports can be configured as the axis limit signal or origin signal. For instance, the normally open and normally closed modes of the limit and origin signals can be changed through the machine config tool. When set to normally open, the input is valid when connected to 0 V. When set to normally closed, the input is valid when disconnected from 0 V.

Photoelectric switches must be NPN-type 24 V photoelectric sensors. Magnetic switches must be NPN-type 24 V magnetic sensors. A typical wiring example is shown below:

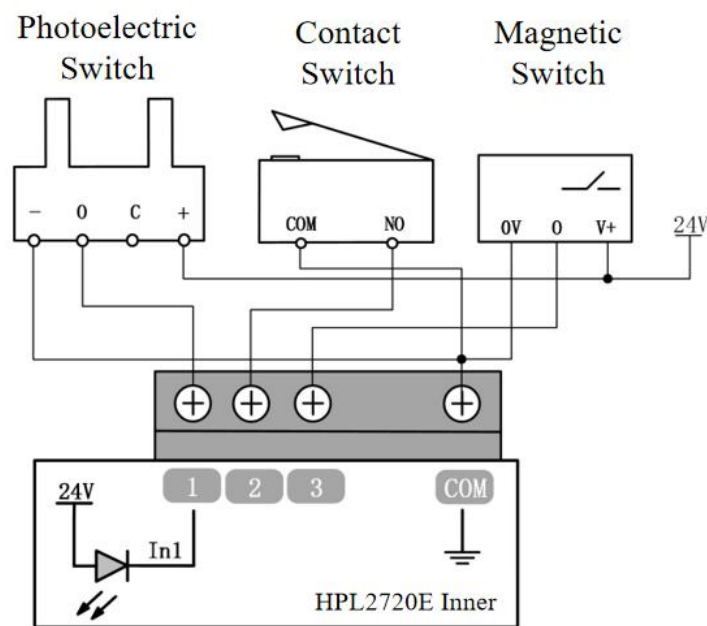


Figure 2-17 General input wiring diagram

IN1 ~ IN3 can adjust the polarity of effective level by hardware jumper.

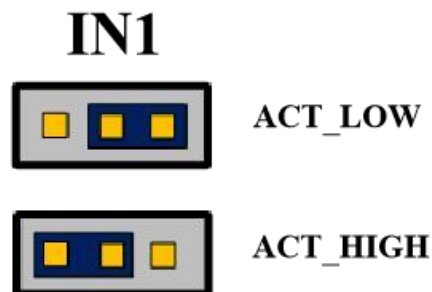


Figure 2-18 IN1 ~ IN3 adjust the polarity of effective level

- When ALM signal is ACT_LOW, low level input (0 V) is active;
- When ALM signal is ACT_HIGH, high level input (24 V) is active;

2.3 BCW Seam Tracker Wiring

The BCW seam tracker, developed by BOCHU, integrates laser and vision technology. It performs non-contact weld seam detection and start-point localization through motion scanning of robot.

 **Notice:** If BCW600P-E is used, refer to *BCW600P-E Seam Tracker Installation Manual*.

2.3.1 Technical Reference

Table 2-7 BCW600P Seam Tracker Technical Data

Parameter	Description
Laser Source Class	Class III B
Minimum Working Distance	450 mm
Maximum Working Distance	1600 mm
Optimal Working Distance	673 mm
Depth of Field	1150 mm
Minimum Field of View Width	156 mm
Optimal Field of View Width	230 mm
Maximum Field of View Width	540 mm
Average Resolution (Y-direction)	0.06 ~ 0.22 mm
Average Resolution (Z-direction)	0.30 ~ 3.41 mm
Mounting	Rear/Side Mount
Dimension (L × W × H)	150 × 45 × 138.4 mm (L × W × H)
Frame Rate	Native: 23 fps Maximum Working Distance: 84 fps Minimum Working Distance: 74 fps
Weight	1 kg
Working Temperature	0 ~ 50°C
Humidity	0 ~ 95% RH
Protection	IP64
Cooling	Air Cooling (recommended pressure: 0.1 ~ 0.2 MPa)
Arc Shield	Pneumatic Protective Cover (customized)

2.3.2 Interface Layout

The interface layout of the BCW seam tracker (model BCW600P) is shown below:



Figure 2-19 BCW600P interface layout

2.3.3 J01 Power Supply and Serial Port

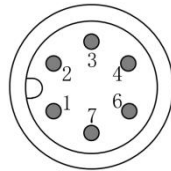


Figure 2-20 Power terminal

This port supplies power and handles serial communication between the seam tracker and the host controller. Use Bochu's standard BCW-XX hybrid drag chain cable (XX = cable length), and connect BCW600P to the **SENSOR** port on the BCW020 adapter box.

2.3.4 J02 Cooling Air Input Interface

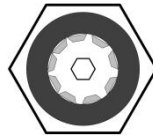


Figure 2-21 Cooling air input interface

This port is for air cooling input. When the internal temperature of the seam tracker exceeds 50°C, activate the air cooling system (recommended air pressure: 0.1 ~ 0.2 MPa) to cool key components and ensure system stability.

2.3.5 J03 Camera Communication

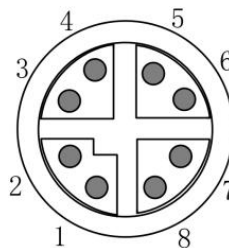


Figure 2-22 Camera communication port

This port establishes Ethernet communication between the internal camera and the host controller. Use BOCHU's standard LAN-XX towline cable (XX = cable length) to connect BCW600P to the host's Ethernet port.

If the network disconnects or fails to reach gigabit speed, inspect the RJ45 connector for foreign objects.

2.3.6 Indicator Light (L1 ~ L4)

The following is a detailed description of the connection status of the BCW600P indicator:

Table 2-8 Indicator Light Status Description

Indicator	Name	Status	Function
POWER	L1 Power Indicator	Green	Power supply normal
		Off	No lower or low voltage
		Red/Green alternating	Firmware upgrade in progress (flashes red-green 3 times after success).
LINK	L2 Communication State	Green	Communication between seam tracker and the host is normal.
		Red	Communication between seam tracker and the host fails.
CAMERA	L3 Camera State	Green	Camera operating normally.
		Red	Camera disconnected from host.
ALARM	L4 Protective Window State	Green	Acrylic protective window installed properly.
		Red	Acrylic protective window not installed.

2.4 BCW020 Wiring

BCW020 provides serial interface conversion and power supply for the BCW seam tracker.

2.4.1 Technical Reference

Table 2-9 BCW020 Technical Data

Parameter	Description
Power	24V DC/1 A
RS422 Communication	Communicates with the seam tracker and provides power.
RS232 Communication	Communicates with the HypTronic3.
Working Temperature	0°C ~ 60°C
Humidity	10% ~ 90% RH(non-condensing)
Dimension (L × W × H)	136 × 126 × 34 mm (L × W × H)
Cooling	Air Cooling

2.4.2 Interface Layout



Figure 2-23 BCW020 interface layout

2.4.3 J01 Power Input

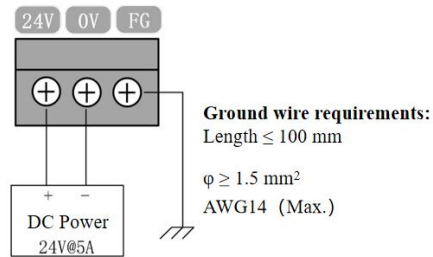



Figure 2-24 J01 power input

 **Notice:** 24 V and 0 V are respectively connected to the positive and negative poles of the DC 24V switching power supply; FG needs to be reliably connected to the ground, and the ground wire should be as short and thick as possible.

2.4.4 J02 RS232 Communication Interface

J02 is standard RS232 interface, used for communication with the HypTronic3.

2.4.5 J03 RS422 Communication Interface

Communicates with the seam tracker and provides power of 24 V/0.5 A.

2.5 Wiring diagram

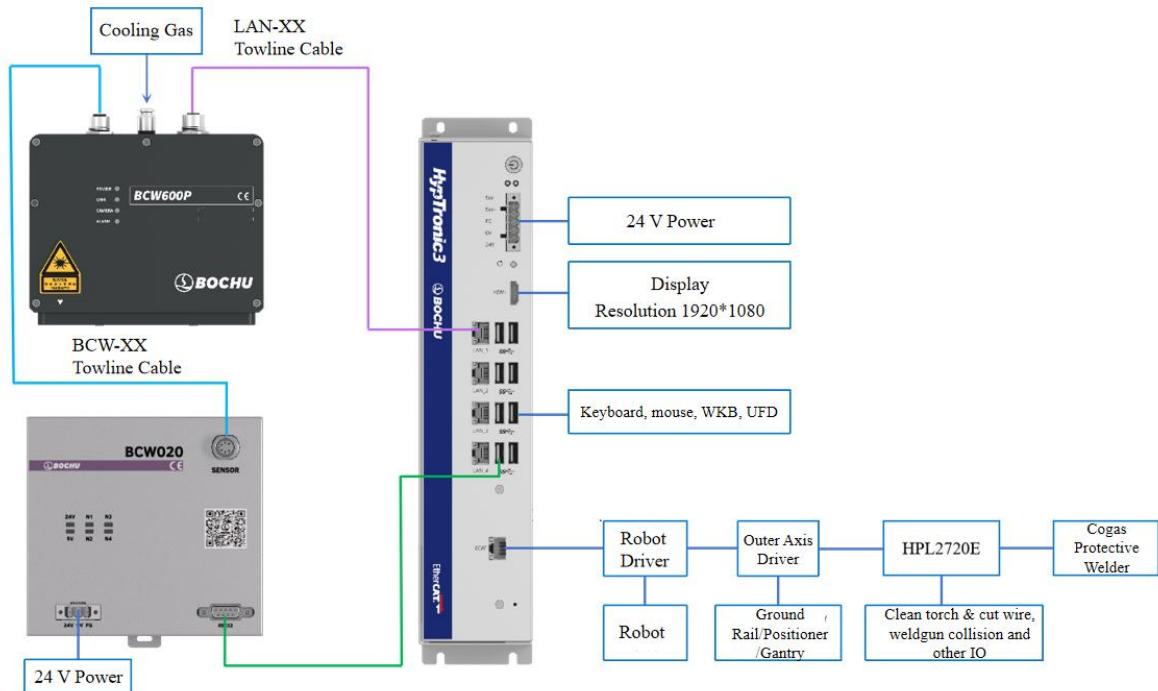


Figure 2-25 FSWELD Intelligent Welding Control System wiring



Caution:

1. The welder must be the last slave on the EtherCAT bus.
2. The selected DC power supply power needs to meet the total power consumption of the supplied equipment.
3. In the diagram, “xx” denotes cable length.

Chapter 3 System Configuration

3.1 Software Installation

Contact technical support for the CypWeld intelligent welding control software installation package. Follow the on-screen instructions to complete the installation process. When the “Completing CypWeld System Setup” window appears, click *Finish*.

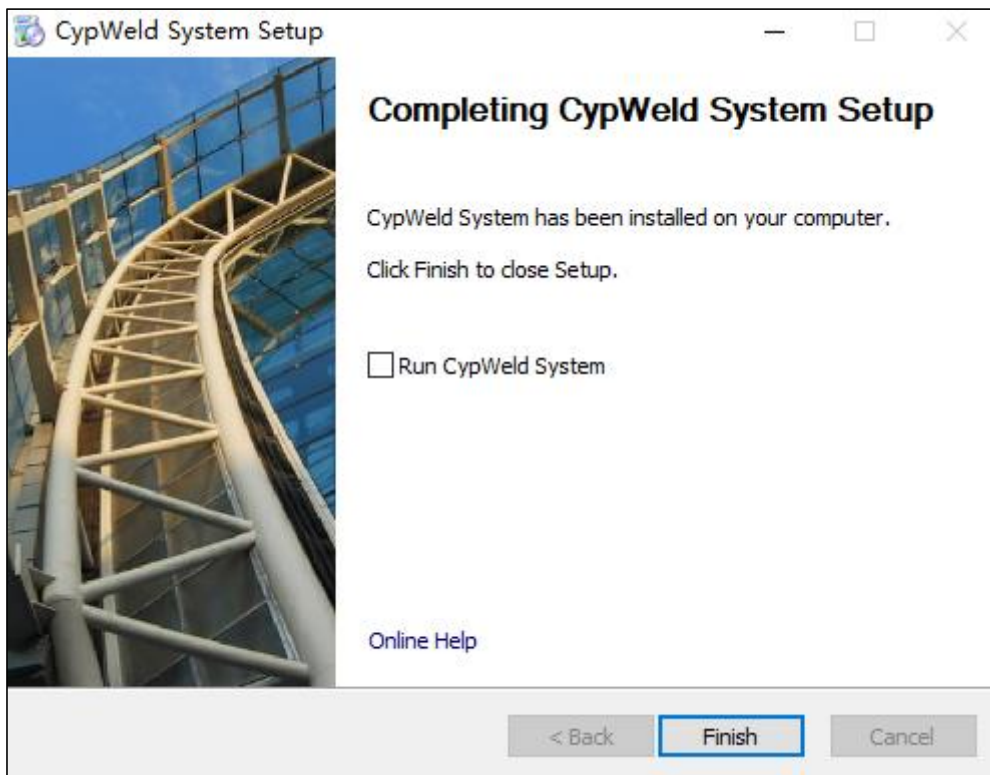


Figure 3-1 CypWeld setup complete

3.2 Platform Configuration Tool

Locate the software icon on the desktop, right-click and select *Open file location*. Double-click the *CypConfig* executable file to launch the *Platform Configuration Tool*.

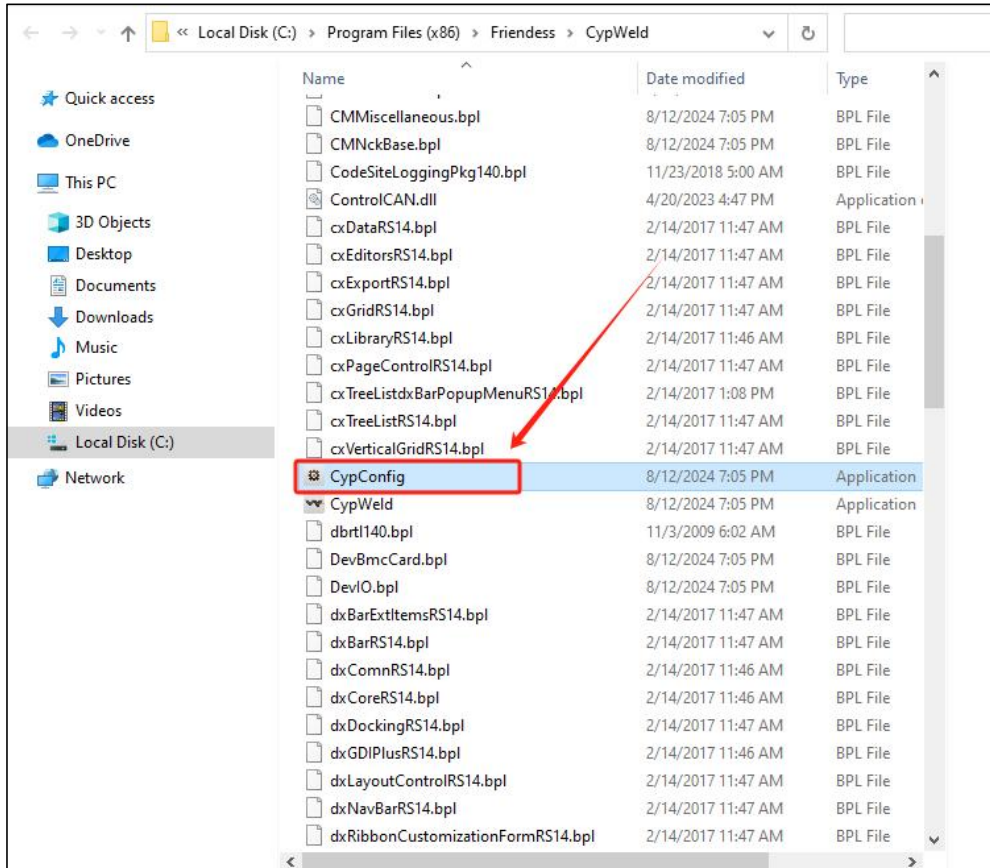


Figure 3-2 Double-click to open *CypConfig*

3.2.1 Network Scanning

Steps to perform a network scan:

- Step 1** Before a bus scan, verify that each slave station communicates in series with the host via the network cable and that power-up is successful without alarms.
- Step 2** After clicking *Scan Slave*, verify that the number of slaves displayed matches the actual number of the connected. If the number of scan results is less than the actual connected, check that the slave connections and status of the missing ones.

Step 3 Once all slaves are successfully identified, you may proceed to configure the parameters for each axis.

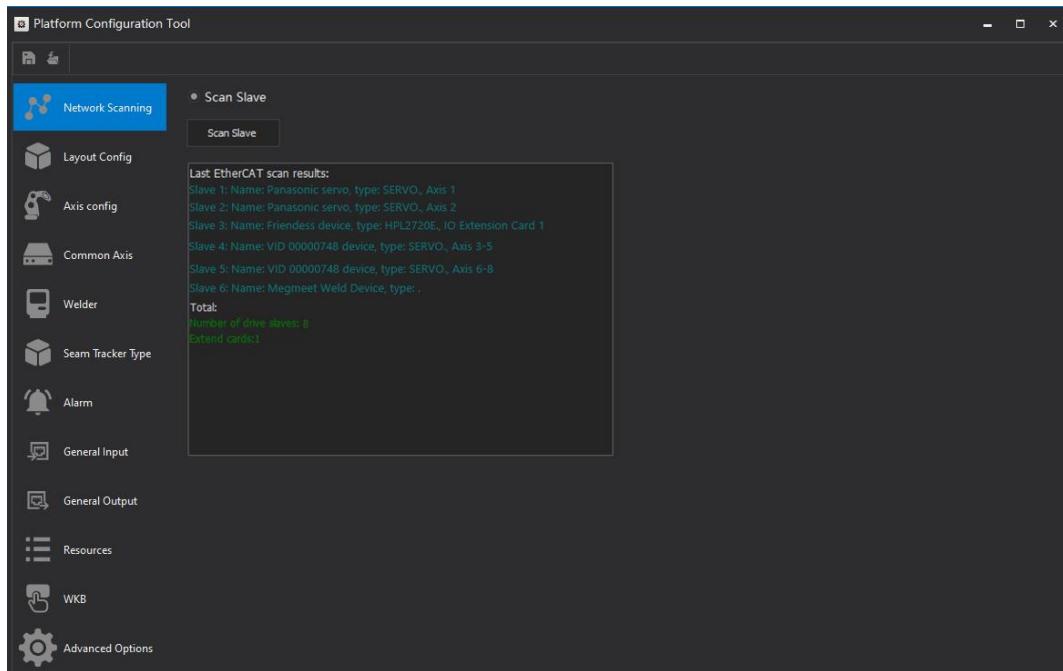


Figure 3-3 Network scanning

3.2.2 Layout Config

- **Base Config:** Select the actual base type in use, such as gantry, floor track, or fixed base.

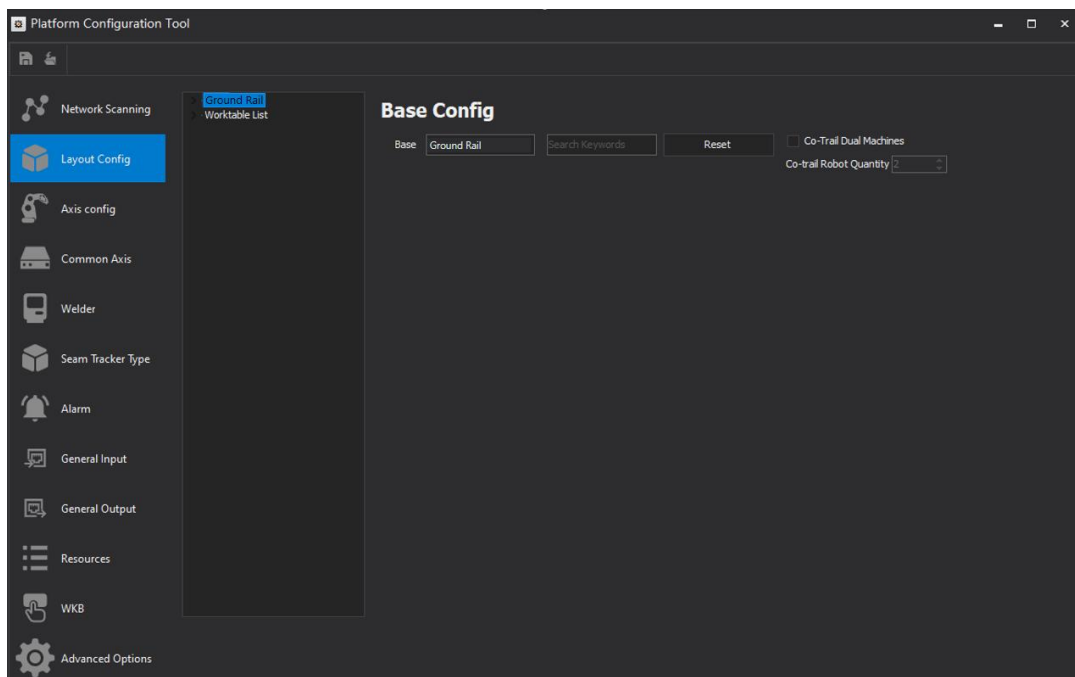


Figure 3-4 Base config

- Robot Configuration: Select the robot model, and configure the six-axis limit parameter and D-H parameters.

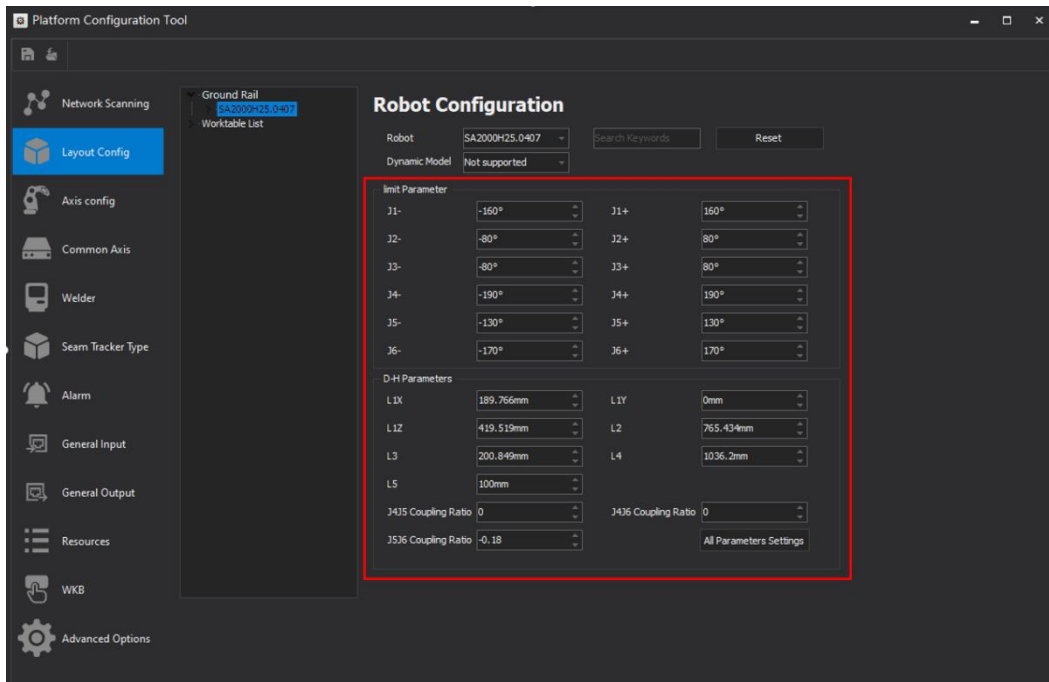


Figure 3-5 Robot configuration

■ Robot D-H Parameter Reference

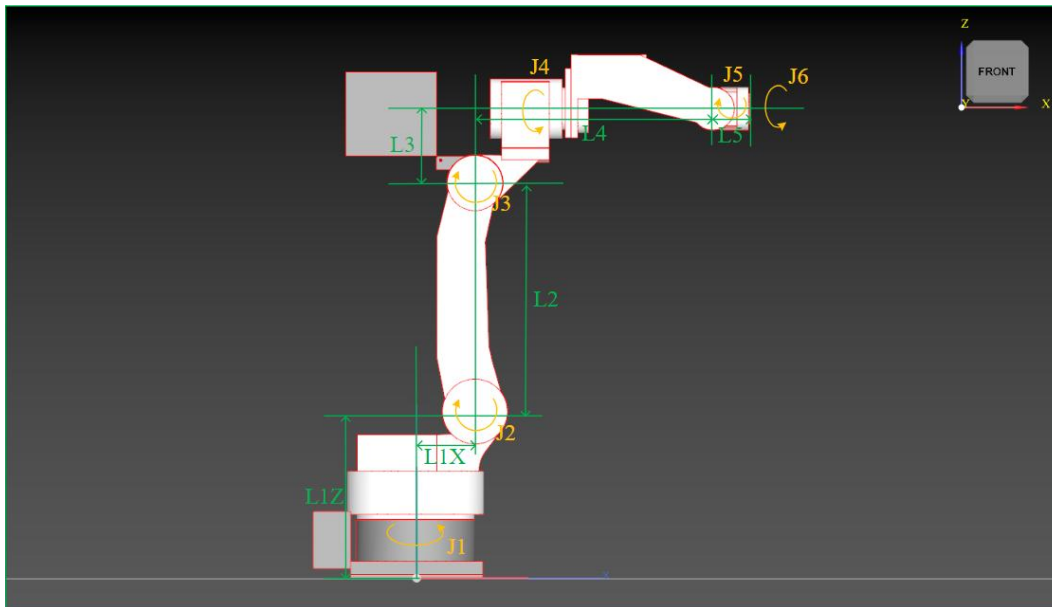


Figure 3-6 Robot D-H parameter reference - 1

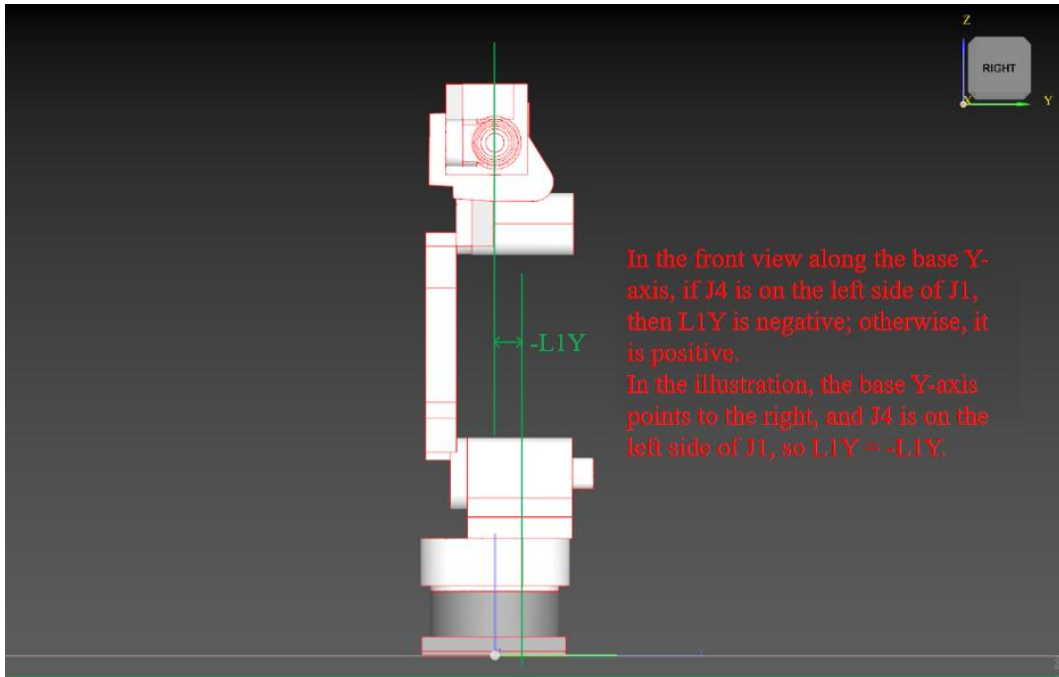


Figure 3-7 Robot D-H parameter reference - 2

- The definitions of positive and negative motion directions vary by robot model. FSWELD standardizes the direction definitions as follows: The X+ direction is defined as the direction the manipulator points in robot home position. The Z+ direction is upward (vertical). Use the right-hand rule to define the Y+ direction (into the page in the following illustration).

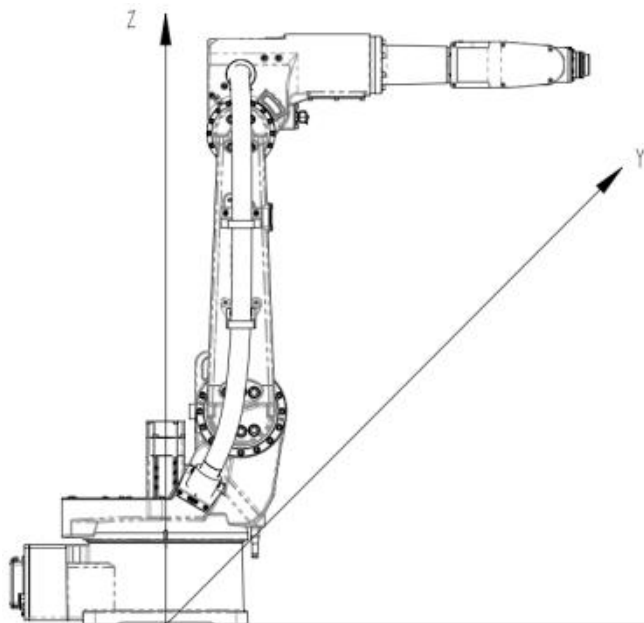


Figure 3-8 Coordinate system & motion direction - 1

- Right-hand rule: Grip the swivel axis with your right hand. Thumb points in the positive axis direction, and the curl of your fingers shows the positive rotation direction.

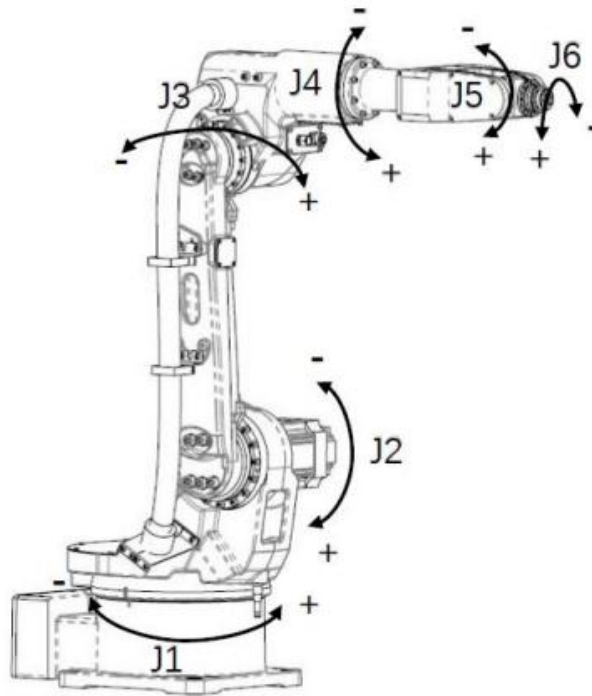



Figure 3-9 Coordinate system & motion direction - 2

 **Notice:** Ensure that when all axes are at zero position, manually jogging any single axis does not cause a collision. Otherwise, adjust the travel limits accordingly.

- Tool Configuration: Select the default welding torch.

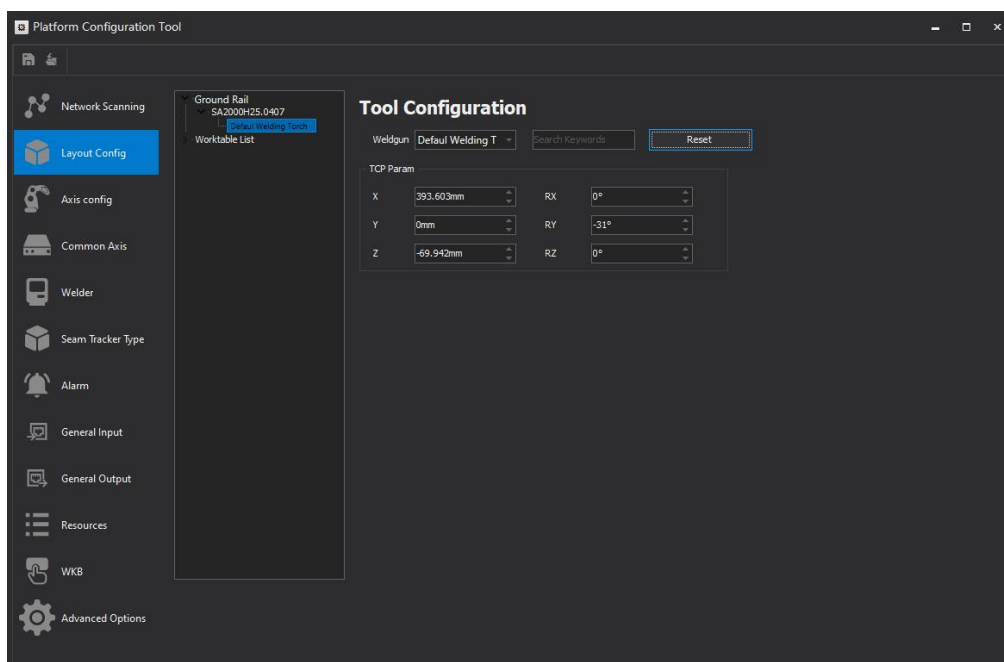


Figure 3-10 Tool configuration

- Workbench Configuration: Choose the actual worktable type, such as fixed table or positioner. If a positioner is selected:
 1. Select the axes involved, and configure the corresponding motion parameters under the **Common Axis**.
 2. Define travel limits for RY(tilt axis) and RZ(swivel axis)

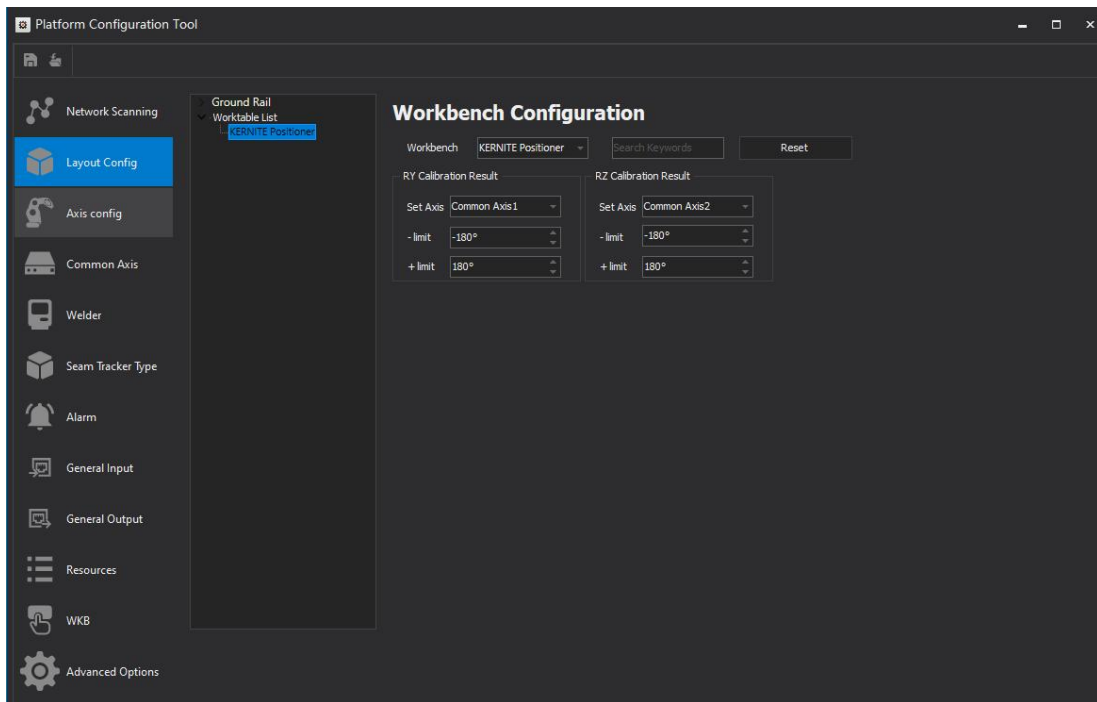


Figure 3-11 Workbench configuration

3.2.3 Axis Config

Used to configure the motion parameters of robot arms and gantry axes. Parameters in this section are primarily related to hardware such as servo drives. You may refer to the robot teach pendant for parameter values. If not available, contact the robot or drive manufacturer for detailed specifications.

- Robot Joint Axis Parameters
 - Master axis: Select the axis number displayed after network scan.
 - Reduction Ratio: Enter the ratio provided by the robot manufacturer.
 - Pulse per revolution: Set as 2^N , where N is the encoder bit resolution.
 - Max speed/acc.: Input the maximum speed and acceleration defined by the robot design.
 - Reverse Motion Dire: Determine whether to invert the motion direction of each joint based on

the right-hand rule.

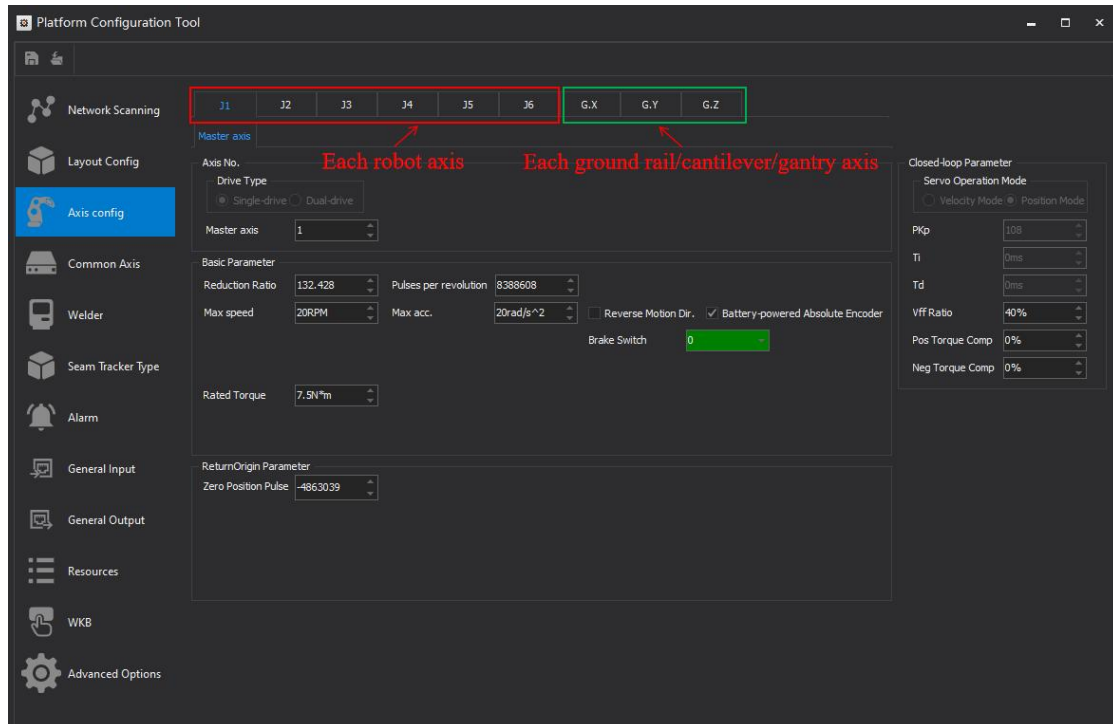


Figure 3-12 Axis config

➤ External Axis Parameters for Floor Tracks/Gantry/Cantilever Systems:

- Master axis: Select the axis number displayed after network scan.
- Pert motion:
$$\frac{\text{Module} \times \text{Teeth Number} \times \pi}{\text{Helix Angle Cosine} \times \text{Reduction Ratio}}$$
- Pulse per revolution: Set as 2^N , where N is the encoder bit resolution.
- Max speed/acc.: Input the maximum speed and acceleration defined by design.
- Reverse Motion Dire: Determine whether to invert the motion direction of each joint based on design.
- Positive/Negative Travel: Configure based on the valid travel range of each axis. (Ensure that jogging any external axis will not cause self-collision under any condition.)
- Brake Switch: Controls the brake signal for motors with brakes. Prevents unintended movement due to external force when power is off or drive is disabled. It is recommended to use the internal brake control of the drive.
- Positive/Negative Limit: Use hard limit switch signals, preferably NPN type (normally closed, low-level active) sensors.

3.2.4 Common Axis

Used to configure custom-purpose axes, such as the RY/RZ axes of positioners. Motion parameters should be set accordingly. Basic configuration steps are similar to the above and can be referenced in the tool [Axis config](#).

 **Caution:** Be sure to check *Rotation Axis Mode* if the axis is rotary.

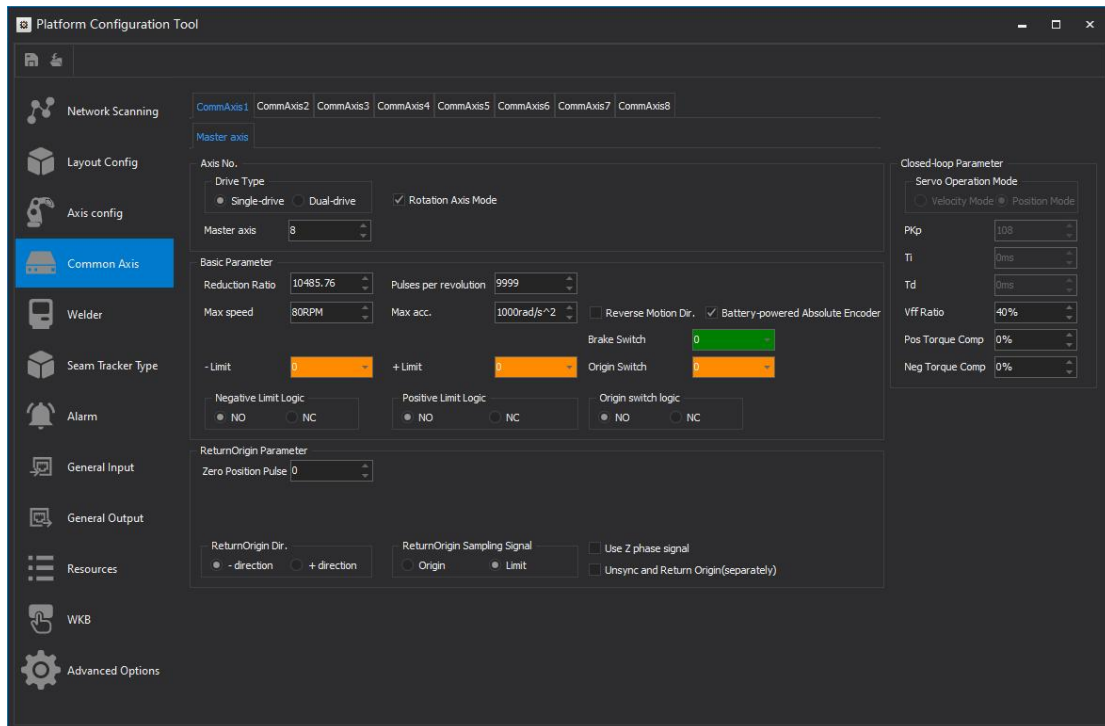


Figure 3-13 Common axis

3.2.5 Welder

Select the model of the welding machine in use.

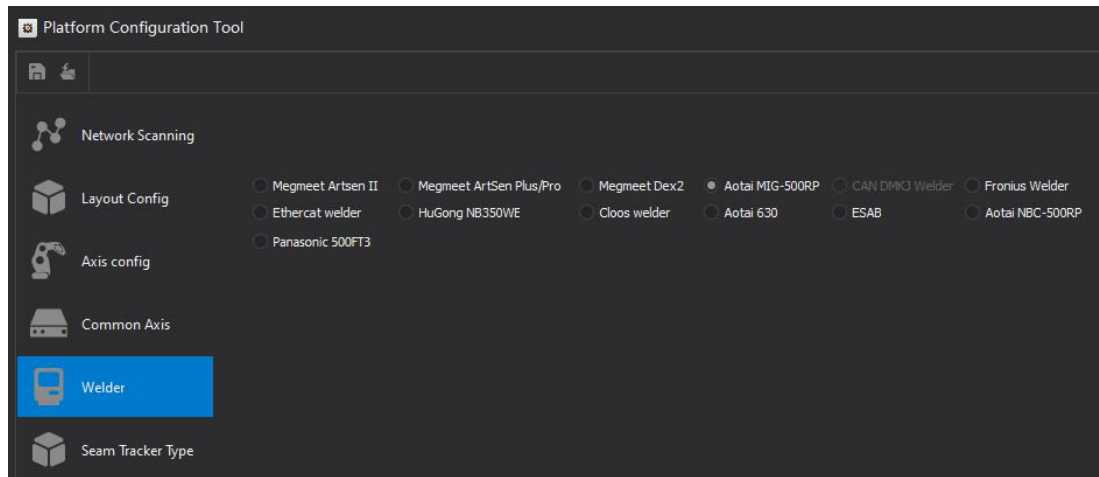


Figure 3-14 Welder



Caution: The current system only supports welding machines with EtherCAT communication.

3.2.6 Seam Tracker Type

Select *PC Seam Tracker*.

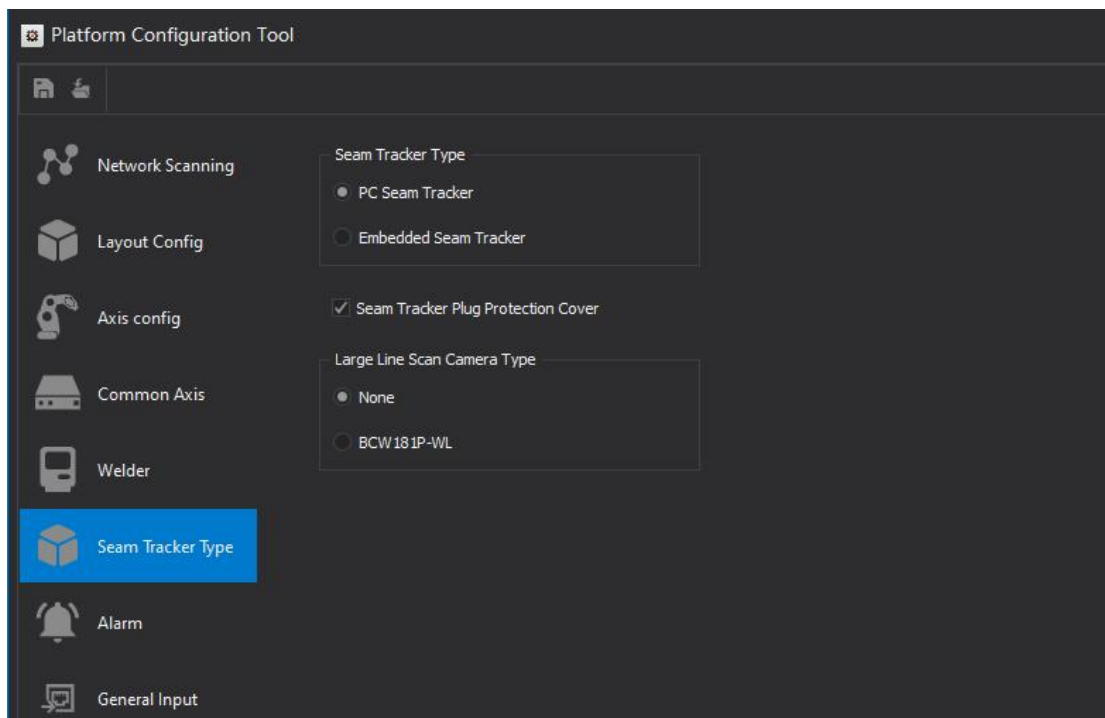


Figure 3-15 Select seam tracker type

3.2.7 Alarm

Used to configure input ports for emergency stop signals, torch collision detection, and other custom alarms/warnings.

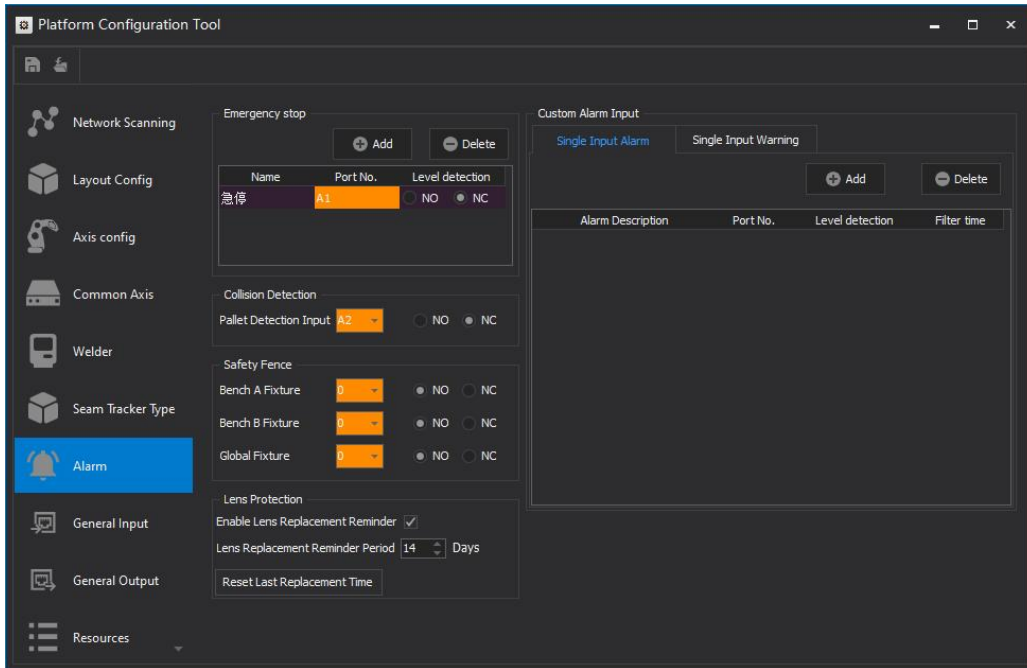


Figure 3-16 Alarm

3.2.8 General Input

Click **Select Function** to choose a function name from the drop-down list. Users can freely add a new function, then assign it to the corresponding input port and specify its logic mode (normally open/normally closed).

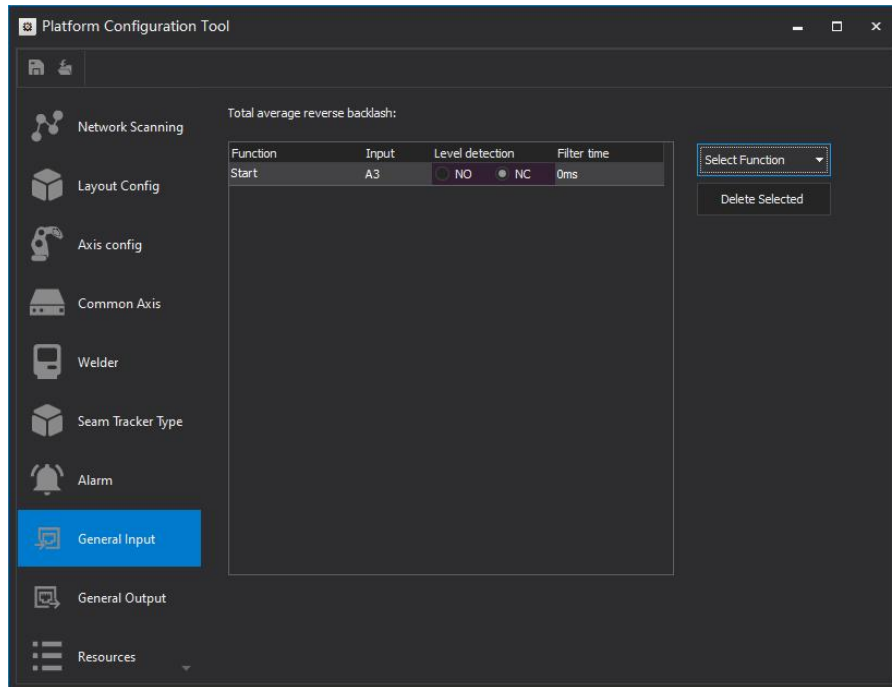


Figure 3-17 General input

3.2.9 General Output

Used to configure output ports for signals such as welding indicator, alarm buzzer, and clean torch cutwire.

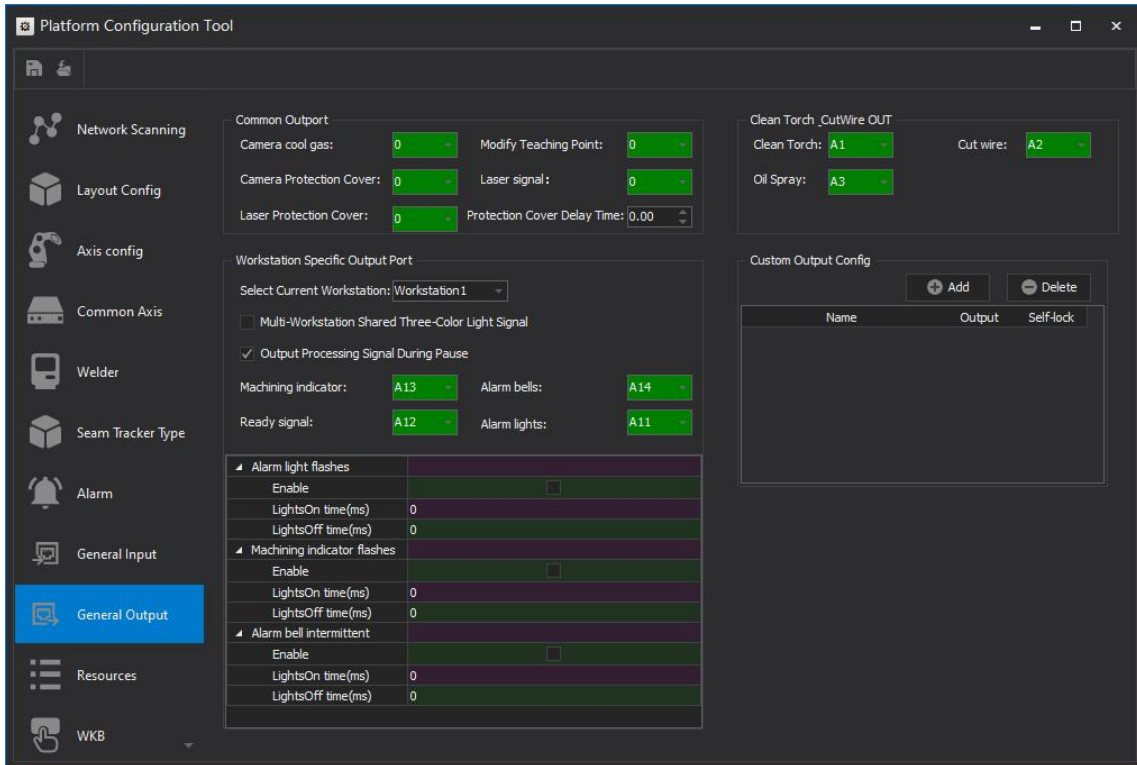


Figure 3-18 General output

Follow the steps below to configure the torch cleaning and wire cutting station:

- Step 1** According to the actual wiring position on HPL2720E, open *Platform Configuration Tool* → *General Output*, and configure the output port. After configuration, save and close the tool.
- Step 2** Open CypWeld, click *Tool* → *Parameter Settings* → *CleanTorch_CutWire Setting* to enter the *CleanTorch & CutWire Setting* interface.
- Step 3** Activate *Enable Auto CleanCut*, and sequentially teach and finish operations include *Record safety position*, *Record CleanTorch position*, *Record CutWire position*, and *Record SprayOil position*.

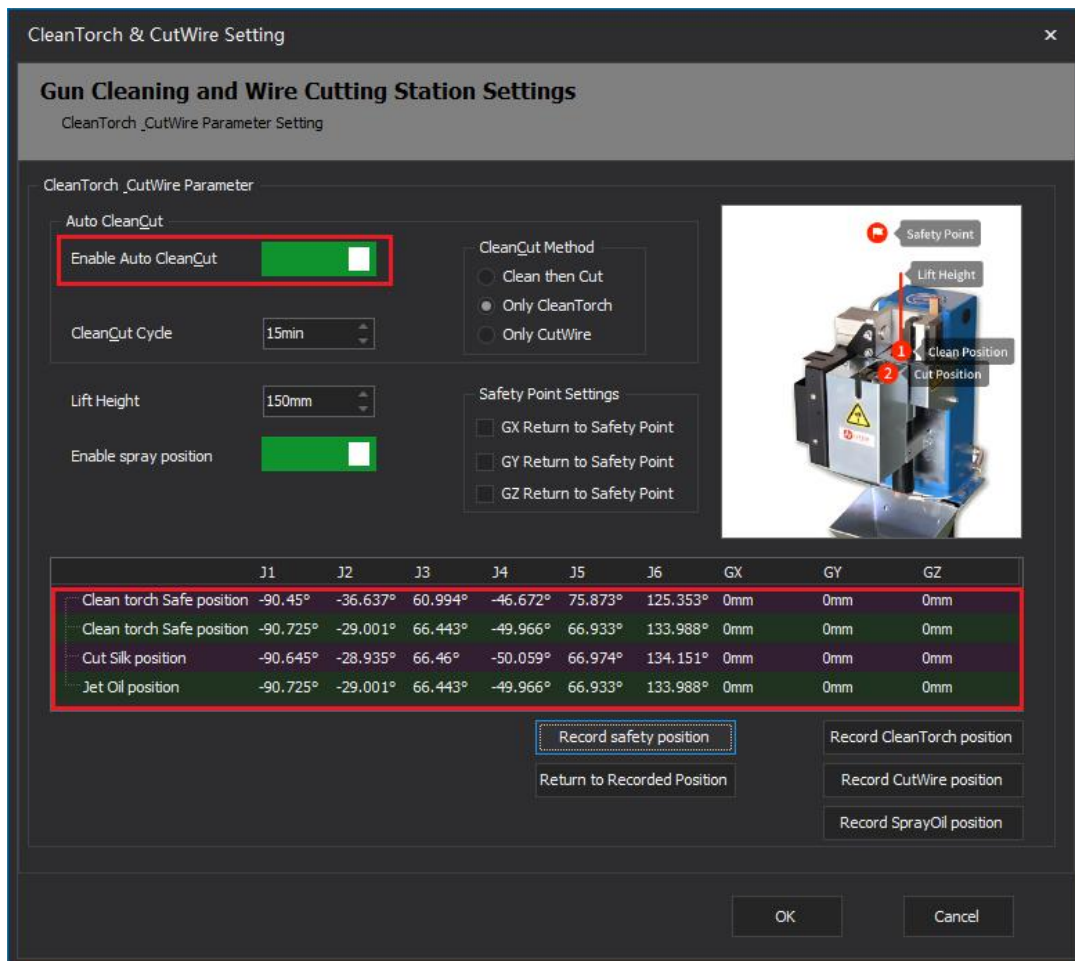


Figure 3-19 *CleanTorch & CutWire Setting* interface

Step 4 Navigate to *PLC Process* → *Execute Custom PLC* → *Clean Torch/Cut WeldingWire* to enter the PLC interface. Use the default process, then click *Import Preset Process* → *Save*. (PLC Process password: 61259023)

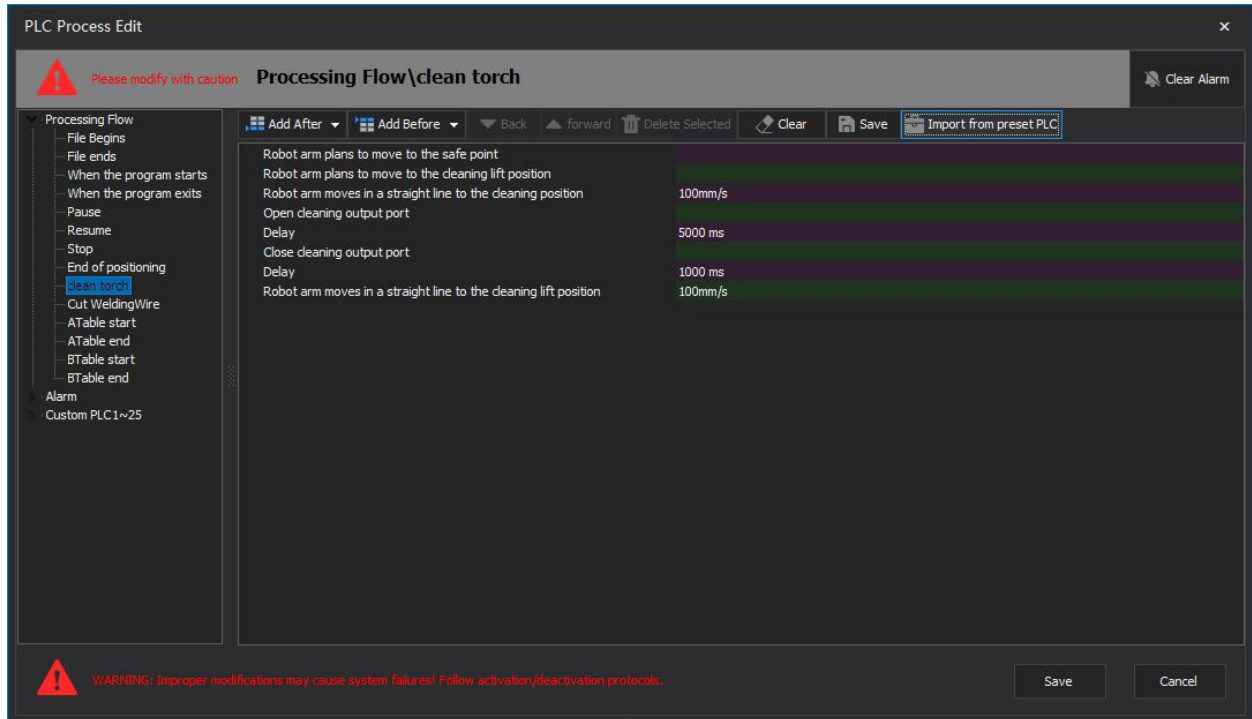


Figure 3-20 Clean torch PLC

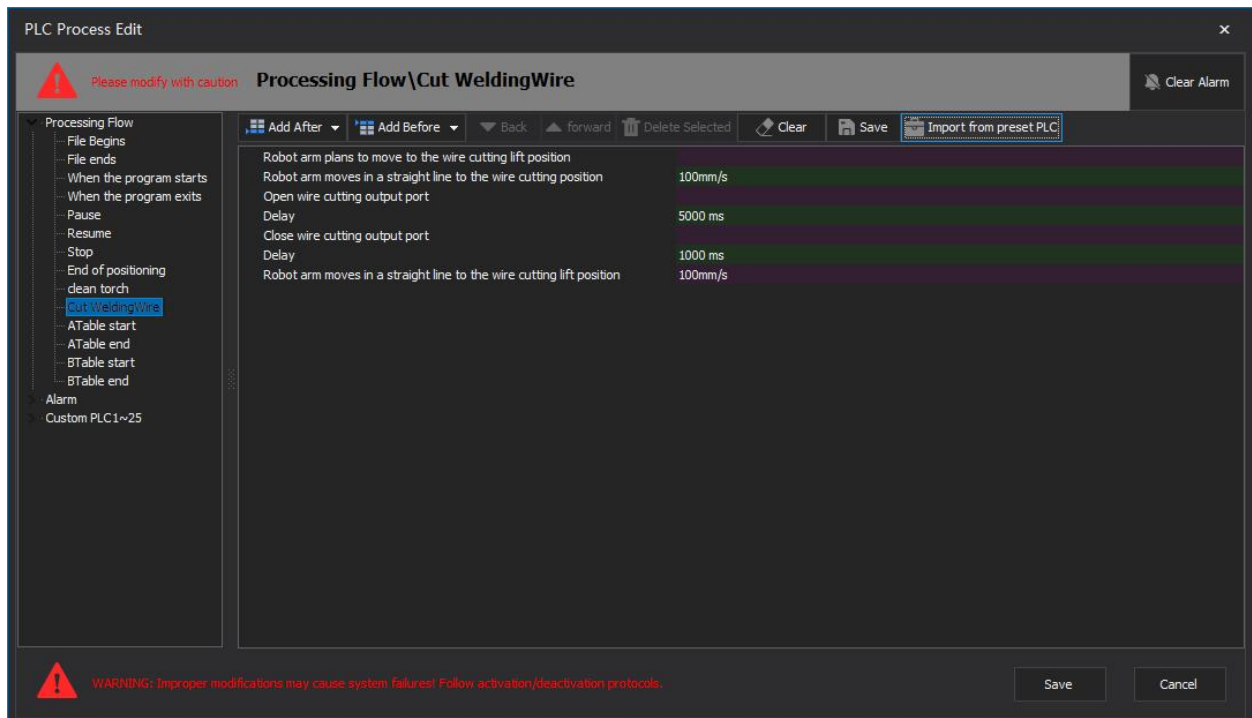


Figure 3-21 Cut weldingwire PLC

Step 5 Use the *CleanCut Cycle* setting to enable automatic operation, or manually trigger the process via PLC.

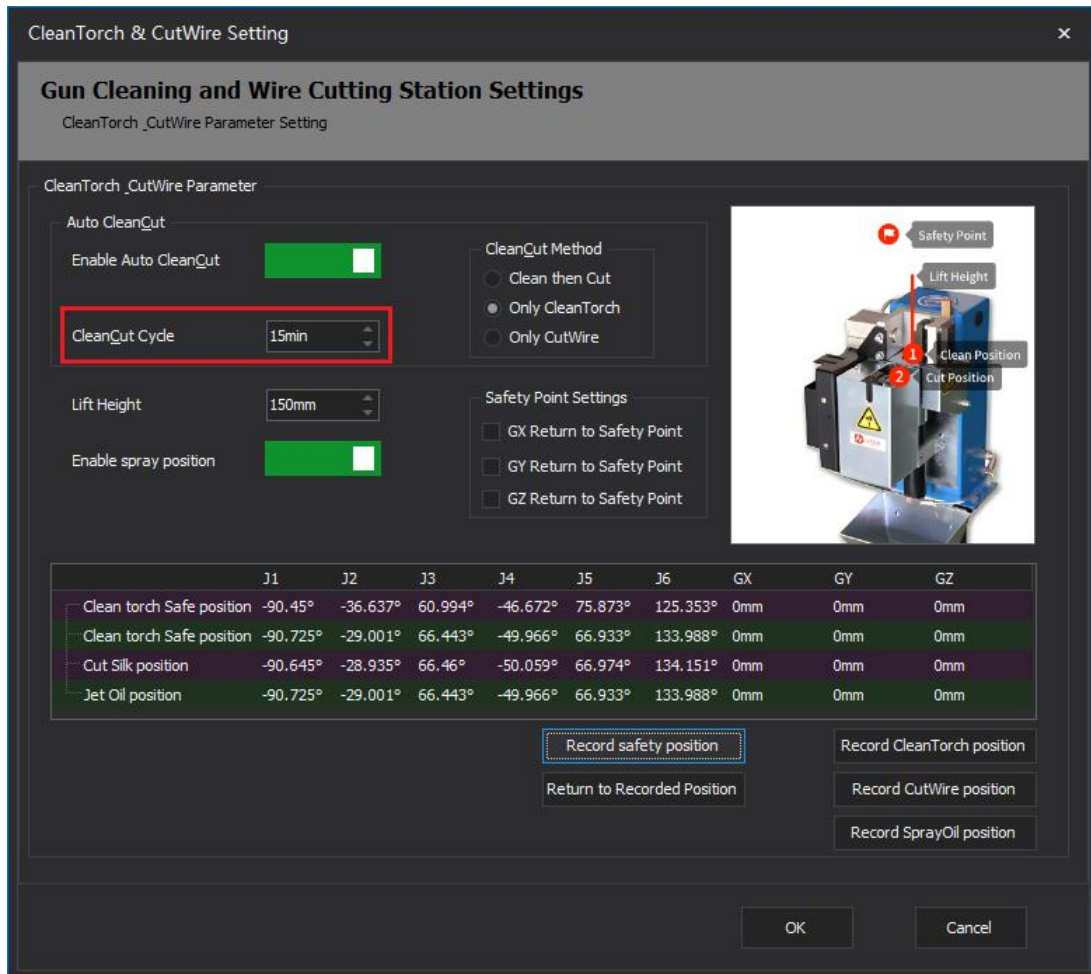


Figure 3-22 CleanCut Cycle setting

3.2.10 Resources

This table allows users to review and rename custom I/O and general axis resources.

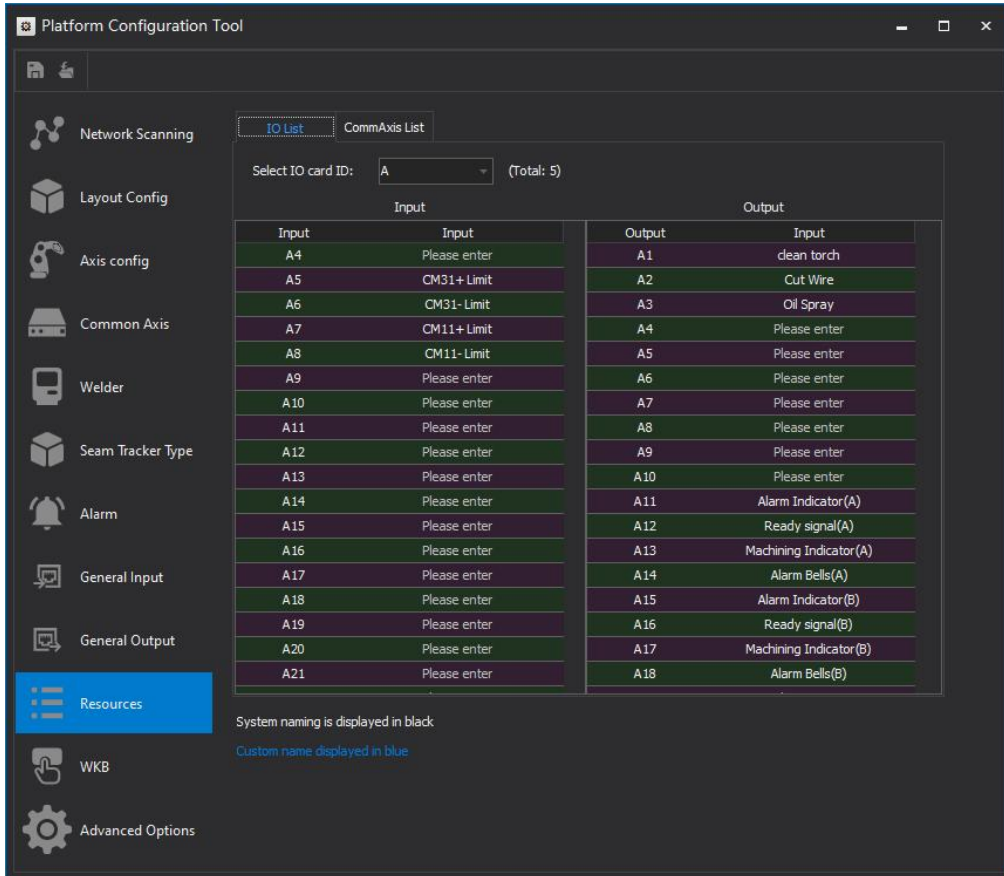


Figure 3-23 Resources

3.2.11 WKB

Configure the custom function keys on the wireless controller, such as breakpoint locating and breakpoint setting.



Figure 3-24 WKB

Chapter 4 System Calibration

4.1 TCP Calibration

Follow the steps below to perform TCP calibration:

Step 1 Prepare a calibration tool with a pointed tip (e.g., a tetrahedron calibration piece). Place the tool stably within the robot's working range with the tip facing upward.

Step 2 Go to *Tool* → *Parameter Settings* → *TCP/Zero-Point Calibration* to open the TCP calibration interface.

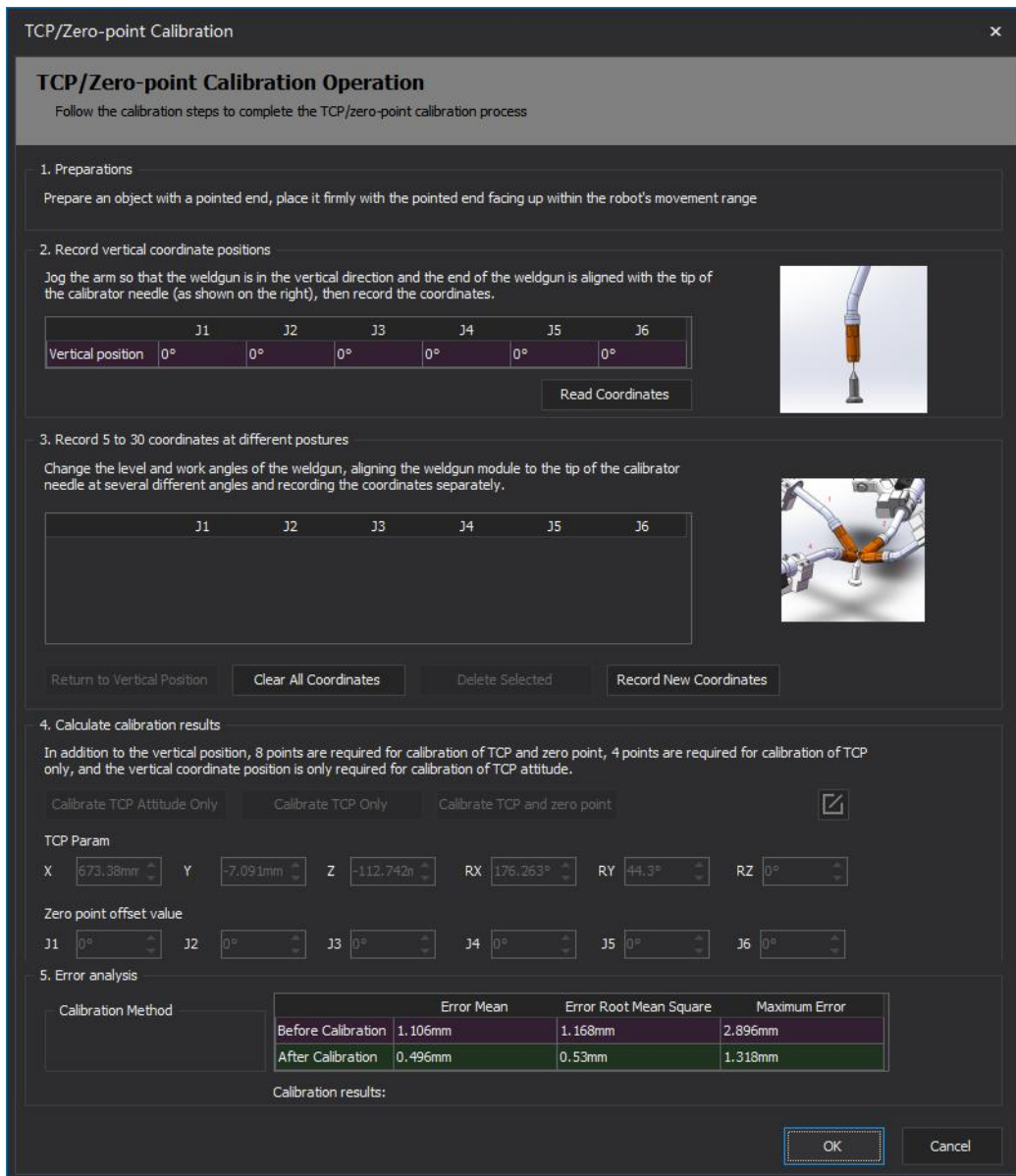


Figure 4-1 TCP calibration interface

Step 3 Record vertical coordinate positions. Use a 25 mm TCP calibration tip (if unavailable, a welding wire can be used instead by adjusting the stick-out to 25 mm). Jog the arm so that the weldgun is in the vertical direction and the end of the weldgun is aligned with the tip of the calibrator needle, then record the coordinates.



Figure 4-2 Weldgun vertical and tip aligned with calibration point

2. Record vertical coordinate positions

Jog the arm so that the weldgun is in the vertical direction and the end of the weldgun is aligned with the tip of the calibrator needle (as shown on the right), then record the coordinates.

	J1	J2	J3	J4	J5	J6
Vertical positi	-8.501°	-47.006°	47.516°	5.176°	45.651°	-1.853°

Read Coordinates

Figure 4-3 Record vertical coordinate positions

Step 4 Record coordinates at different postures. Change the horizontal and pitch angles of the weldgun, aligning the weldgun module to the tip of the calibrator needle at four different angles, and select and record coordinates as P1 to P4 for each pose.

3. Record 5 to 30 coordinates at different postures

Change the level and work angles of the weldgun, aligning the weldgun module to the tip of the calibrator needle at several different angles and recording the coordinates separately.

	J1	J2	J3	J4	J5	J6
P1	-4.261°	15.978°	-7.565°	-2.926°	99.037°	13.58°
P2	10.434°	-8.21°	17.808°	-17.545°	83.743°	-57.598°
P3	-9.682°	-35.615°	37.843°	3.622°	70.438°	-174.005°
P4	-23.252°	-4.646°	14.523°	16.615°	86.527°	88.85°

Return to Vertical Position Clear All Coordinates Delete Selected Coordinates Record New Coordinates

Figure 4-4 Record coordinates at different postures

Step 5 If only 4 points are calibrated, click *Calibrate TCP Only* → *OK*. If zero point calibration is also required, record at least 8 points and click *Calibrate TCP and zero point* → *OK*.

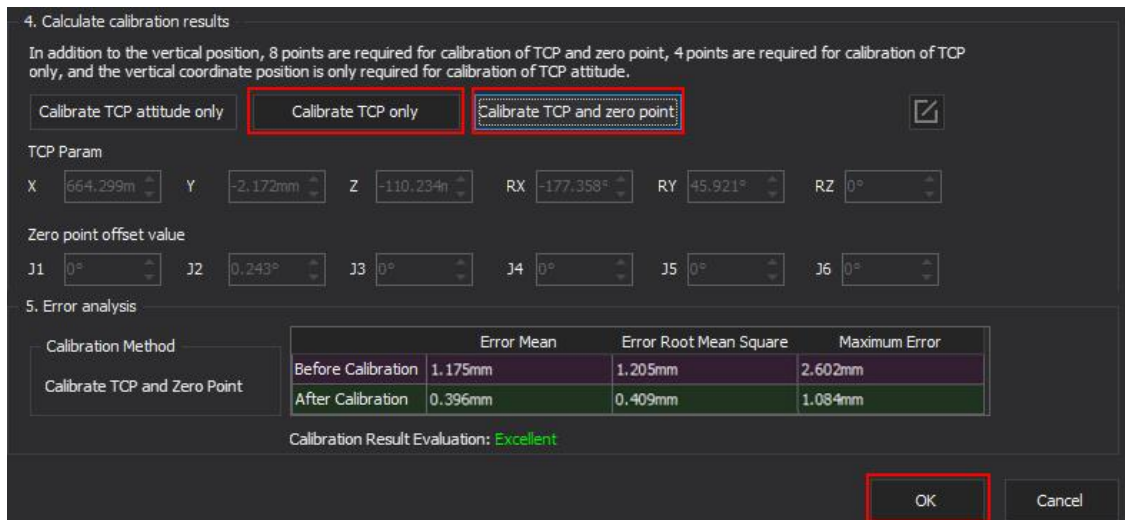


Figure 4-5 Calculate calibration results



Notice: Only click once to calculate the TCP result. Multiple clicks may affect the accuracy.

Step 6 Accuracy verification. Adjust the robotic arm so that the welding gun's end effector points vertically towards the tip of the calibration tool. Move the joints J4 to J6 incrementally in the world coordinate system to perform circular motions around a point. Observe the maximum linear distance between the welding gun's end effector and the tip of the calibration tool during the circular motion. This distance represents the maximum TCP error (typically within 1 ~ 1.5 mm, depending on robot brand).

4.2 Seam Tracker Eye-Hand Calibration

4.2.1 Eye-Hand Calibration Workflow

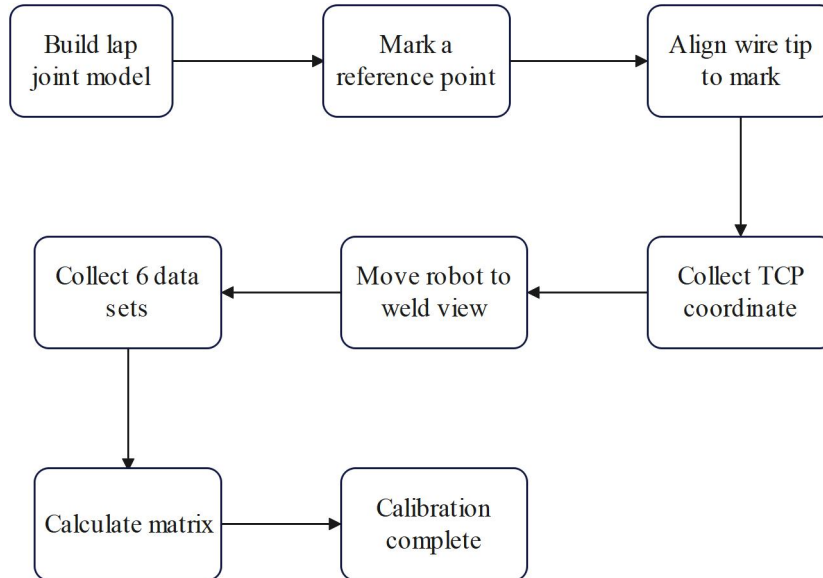


Figure 4-6 *Eye-Hand Calibration* workflow

4.2.2 Eye-Hand Calibration Operation Instructions

Follow the steps below to perform *Eye-Hand Calibration*:

Step 1 Build a physical model of a lap joint weld seam (a regular triangular pyramid is used as a demo in the following steps):

1. Method 1: Use thin metal plates to build a lap joint, and draw a mark line perpendicular to the plate edge on the top plate.

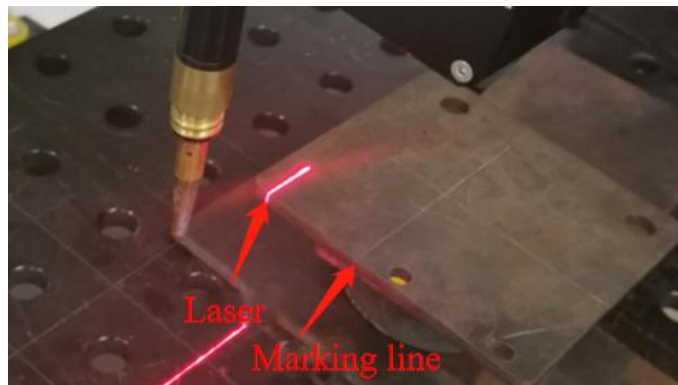


Figure 4-7 Lap joint weld seam using thin metal plates

2. Method 2: Use a regular triangular pyramid as the calibration reference. The intersection of the mark line and the plate, along with the tip of the pyramid, are used as mark points during calibration.

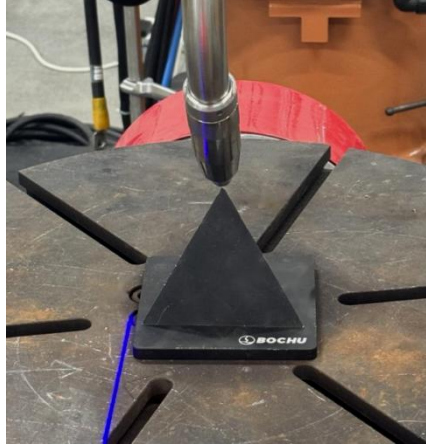


Figure 4-8 Triangular pyramid as a recognition model

Step 2 Adjust the robot's pose to align the laser line emitted by the seam tracker parallel to the reference line, and ensure that the lower surface of the seam tracker is parallel to the board surface.

! Notice: During the entire eye-hand calibration process, robot movements should only be performed in the world coordinate system, and the end-effector pose must remain unchanged. Only J1+, J1-, J2+, J2-, J3+, J3- jogging in world coordinates is allowed.

Step 3 In CypWeld, go to *Seam Tracker* → *Calib* to open the eye-hand calibration interface. Click *Select Template* to choose from *Lap Joint*, *Tetrahedron*, or *Disc*.

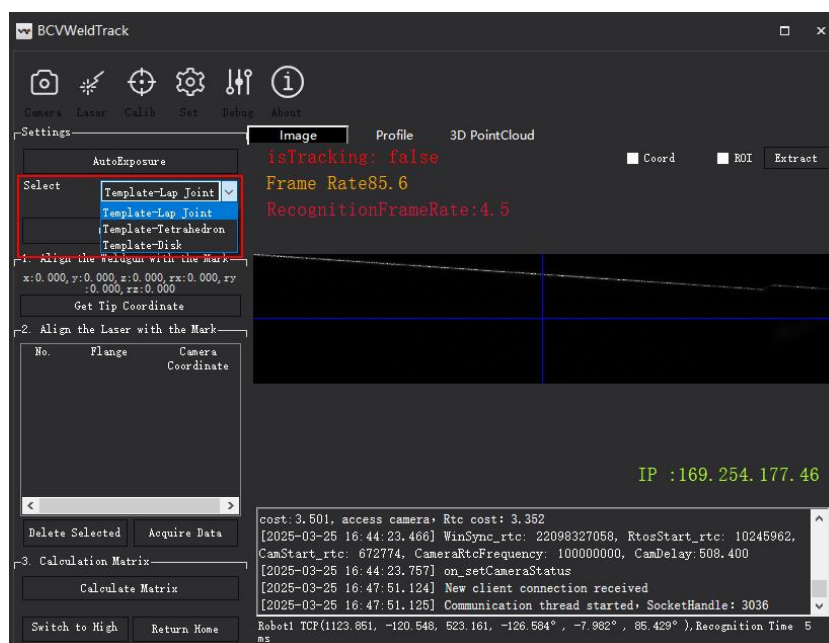


Figure 4-9 Selecting a calibration template

Step 4 Get tip coordinate. In the world coordinate system, move the robot so that the TCP point or welding wire tip aligns exactly with the mark point. Click *Get Tip Coordinate*.



Figure 4-10 Get tip coordinate

Step 5 Move the robot while observing the seam tracker window. When the red cross appears in all six positions shown below and the mark point is aligned with the laser line, click *Acquire Data* for each of the six positions.

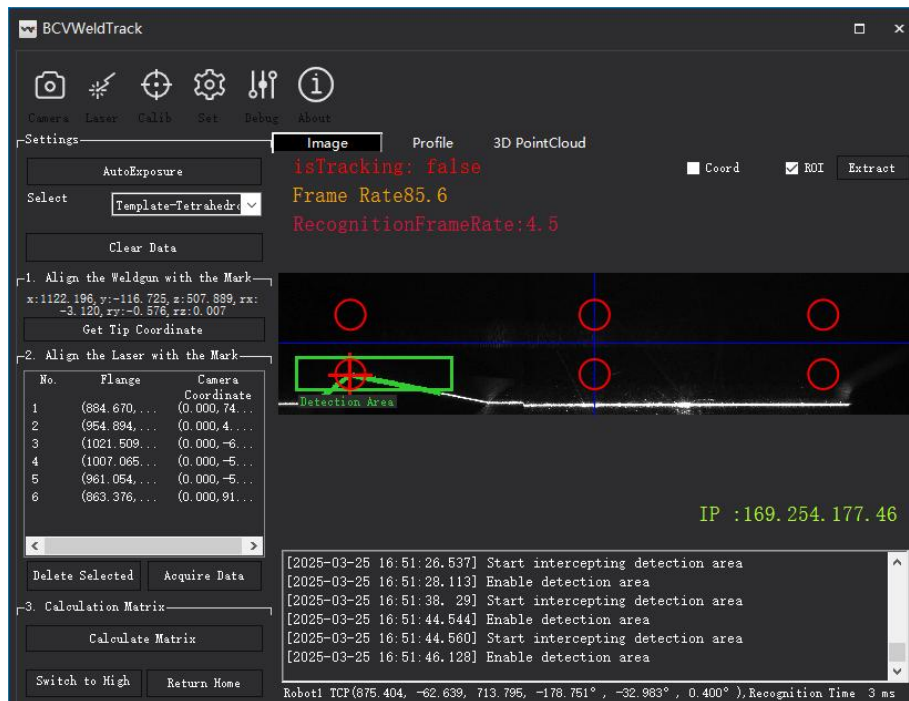


Figure 4-11 Aligning laser line with mark point

Notice: If the image is unclear and the mark point cannot be detected in the window, click *Auto Exposure*.

Step 6 Once all six data points have been collected, click **Calculate Matrix** to complete low visibility eye-hand calibration. Results will be shown in the log panel.

The result must meet the following accuracy requirements:

- Low visibility deviation < 1 mm.
- High visibility deviation < 8 mm.

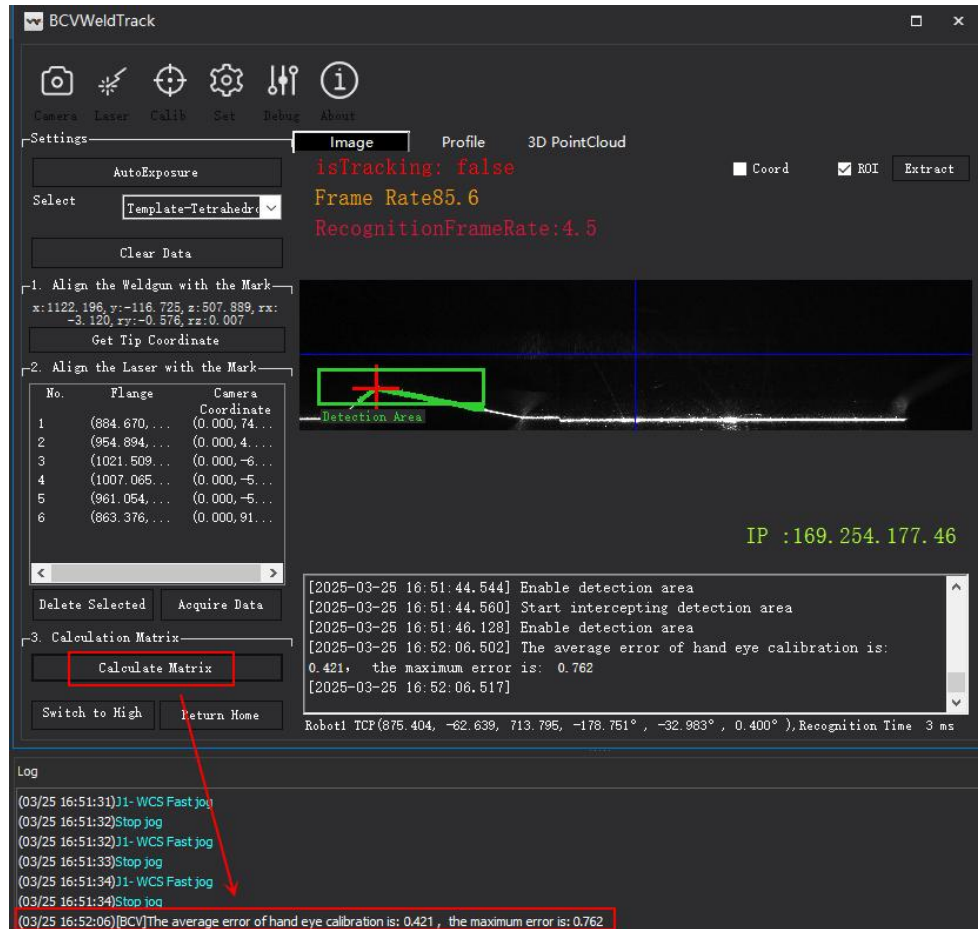


Figure 4-12 Calculate matrix

Step 7 Click **Switch to High Visibility**, and repeat the above steps to complete high visibility eye-hand calibration.



Notice: High visibility may not work well with thin lap joints or triangular pyramids due to limited recognition. A calibration surface with significantly different height may be required.

Step 8 Seam tracker eye-hand calibration accuracy verification. Open **Tool** → **Debug Tool** → **Seam Tracker Precision Debug**. Move the robot until the mark point overlaps with the laser. Click **Record Recognized Coordinate** → **Start Motion**, and observe the deviation between the torch tip and the mark point at the end of the movement.

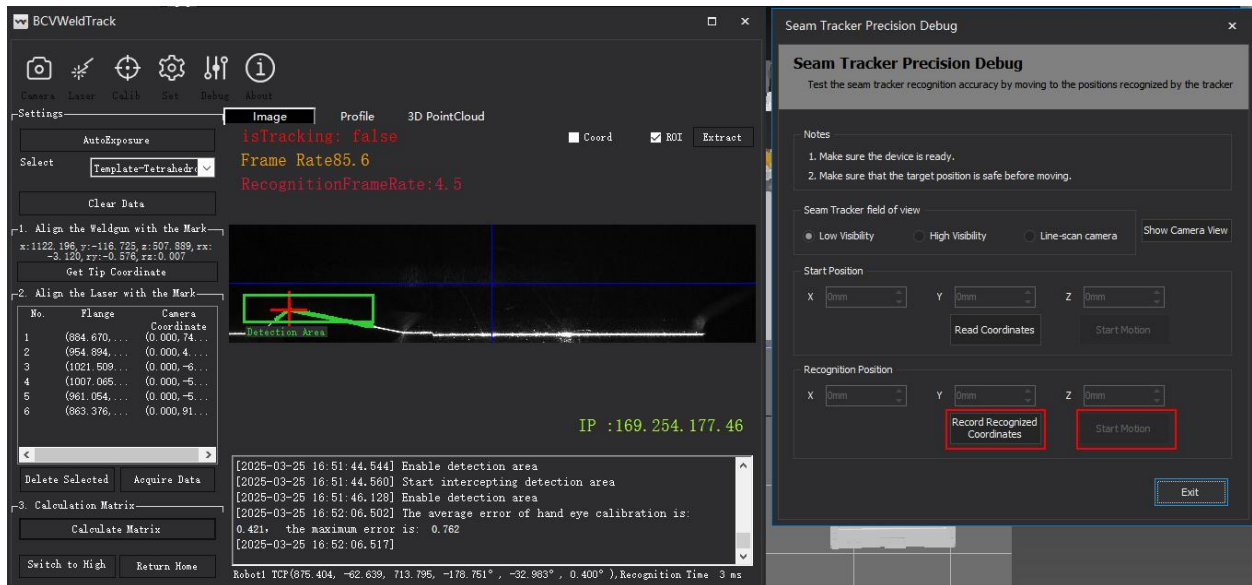


Figure 4-13 Seam tracker eye-hand calibration accuracy verification.

 **Caution:**

1. Before accuracy verification, check the robot travel speed (recommended to be slower than 100 mm/s).
2. Before clicking **Start Motion**, please hold the WKB wireless controller to avoid collision.

4.2.3 Auto Eye-Hand Calibration

The auto eye-hand calibration steps are as follows (this feature is not available during initial installation):

Step 1 Ensure there are no obstacles around the calibration area. Place the triangular pyramid at a location roughly half a meter from the robot base, with a height close to or lower than the robot base. If the mark point is too high (e.g., near or above the worktable), manually lower the table to ensure successful path planning.

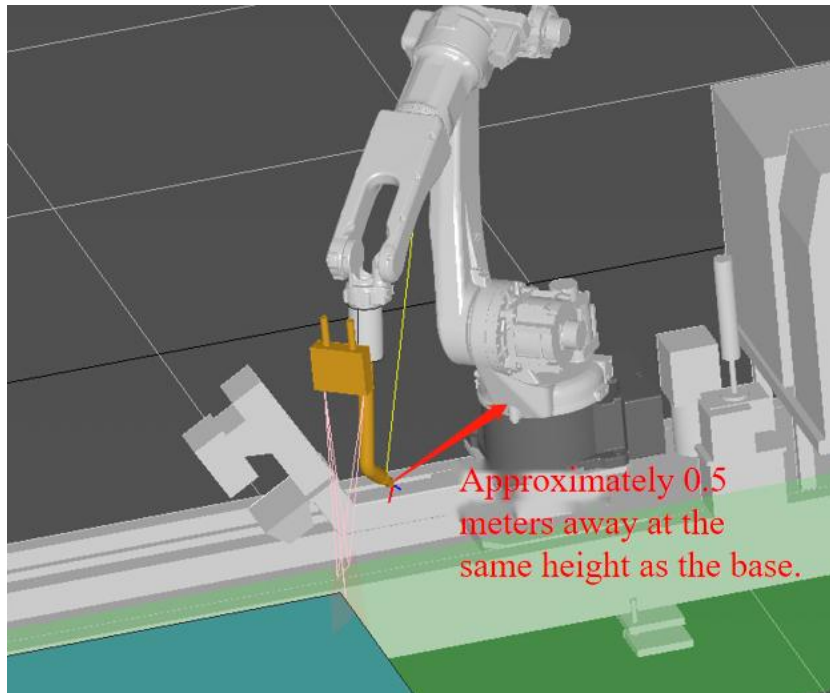


Figure 4-14 Confirm placement

Step 2 Adjust the robot posture so that the underside of the camera is as parallel as possible to the base of the tetrahedron.

Step 3 Open *Tool* → *Parameter Setting* → *Auto Eye-Hand Calibration*. In the world coordinate system, jog the robot so that the TCP point or wire tip aligns with the tip of the tetrahedron, then click *Record Coordinates*.

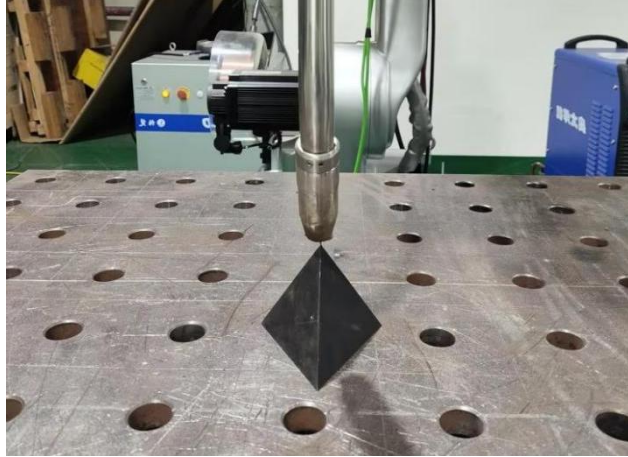


Figure 4-15 TCP point aligns with tetrahedron tip

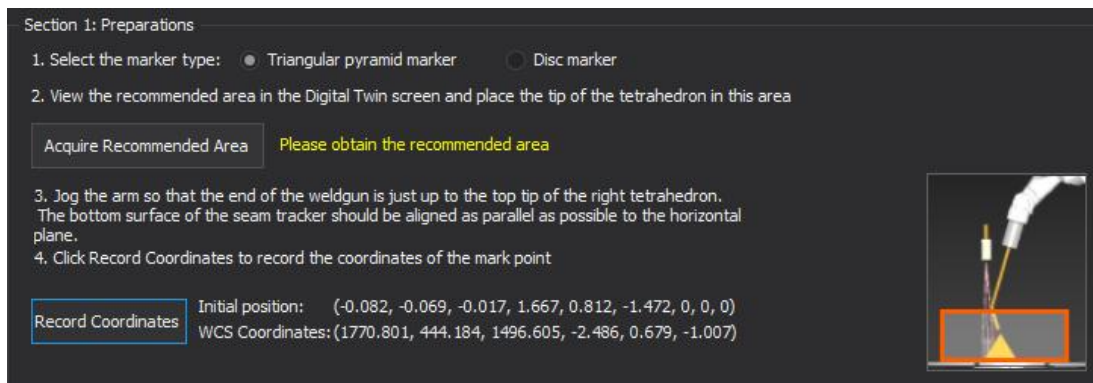


Figure 4-16 Automatic calibration-record coordinate

Step 4 Select *Only Calibrate EyeHand* → *Line-Scan Camera* → *Start Calibration* (Zero-point calibration can only be done using low visibility). If *Only Calibrate EyeHand* is selected, the robot will perform 6 automatic scans. If *Calibrate both EyeHand and Robot Zero* is selected, the robot will perform 20 automatic scans.

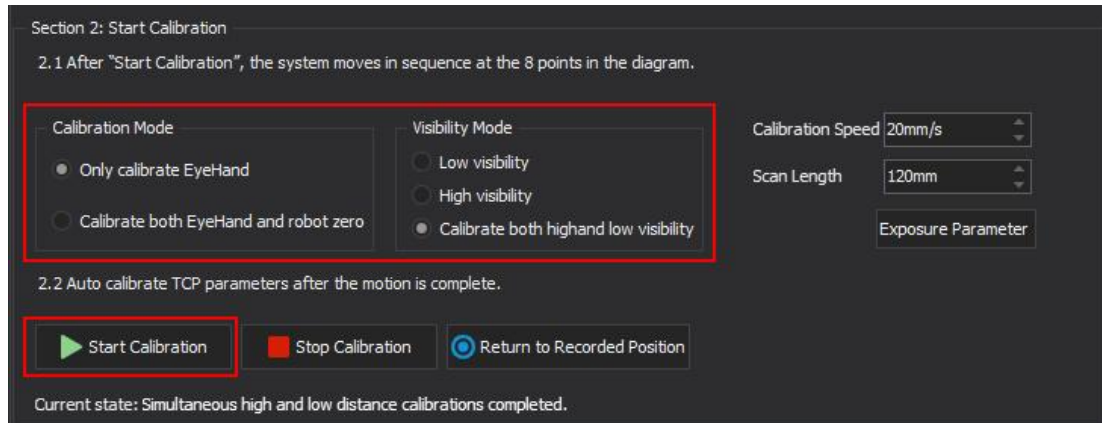


Figure 4-17 Auto eye-hand calibration

Step 5 After both high and low visibility calibrations are completed, verify hand-eye calibration accuracy.

1. Go to *Seam Tracker* → *Calibration*, and change the template to *Tetrahedron*.
2. Open *Tool* → *Debugging Tool* → *Seam Tracker Precision Debug*, and set the field of view to *Low Visibility*. Jog the robot until the tetrahedron tip is visible in the tracker's field of view and the mark point is recognized. Click *Record Coordinates* and *Record Recognized Coordinates*, then click *Start Motion* under *Recognition Position*.

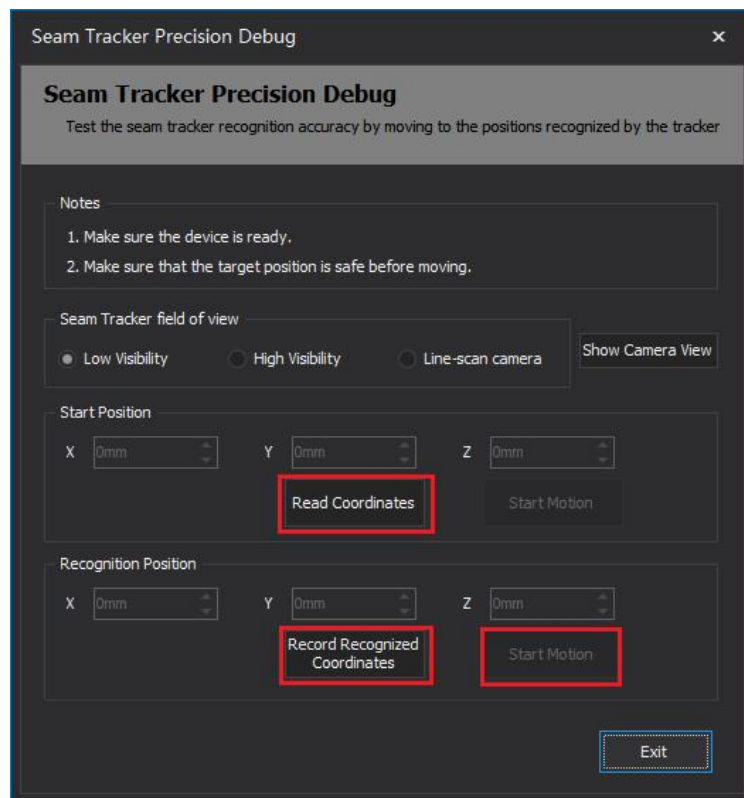


Figure 4-18 Seam tracker precision debug

 **Caution:**

1. Auto eye-hand calibration requires an existing eye-hand matrix. For first-time setup, manual calibration is still required.
2. If zero-point calibration is needed, perform low visibility calibration first, then perform high-visibility calibration separately.

4.3 Assembly Matrix Calibration

4.3.1 Ground Rail Assembly Matrix Calibration

Step 1 Go to *Tool* → *Parameter Settings* → *Assembly Matrix Calibration* to open the *Ground Rail Assembly Matrix Calibration* interface.

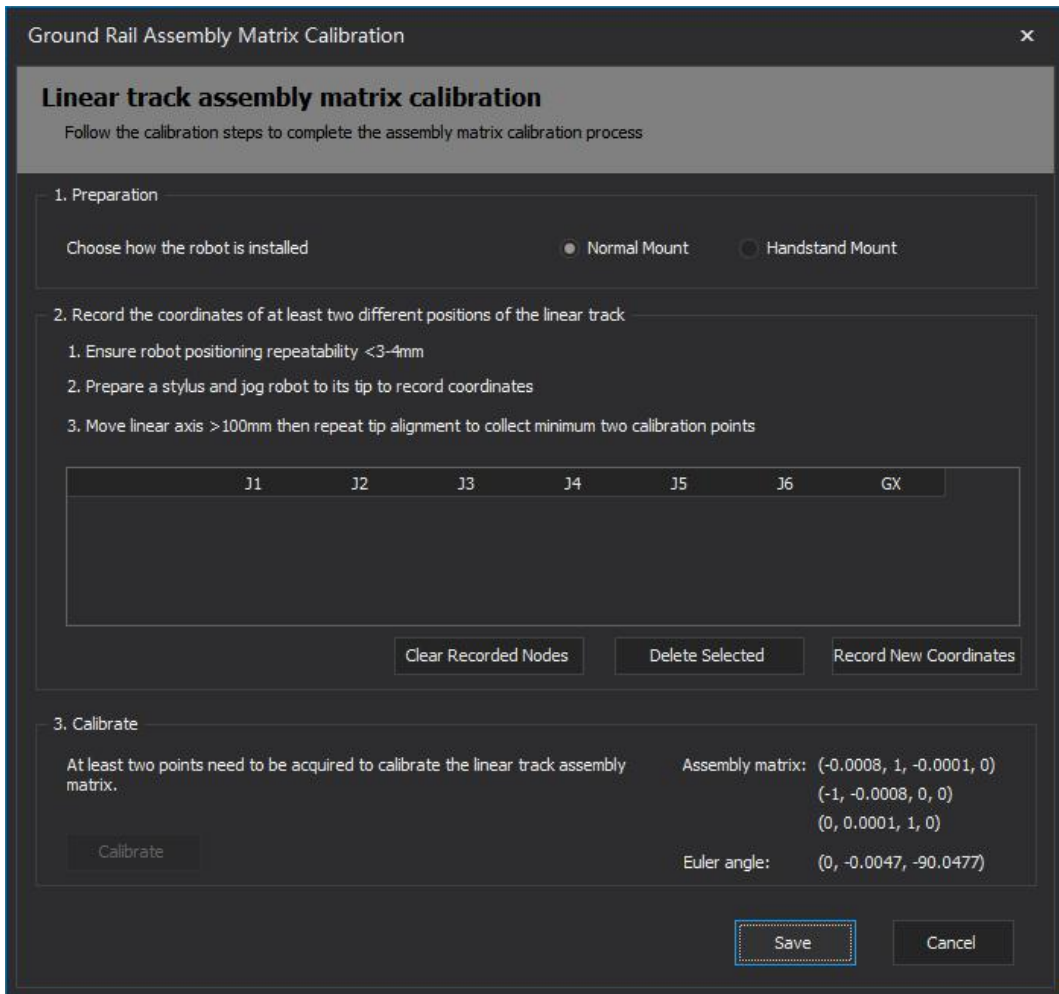


Figure 4-19 Assembly matrix calibration

Step 2 Place a tetrahedron beside the robot’s ground rail within the robot’s reach. Select the robot installation method.

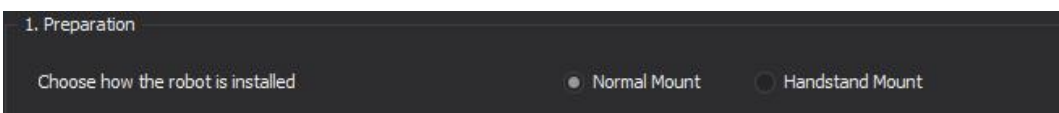


Figure 4-20 Choose how the robot is installed

Step 3 Record position.

1. Jog the TCP tip to the tip of the tetrahedron and click **Record New Coordinates**.
2. Jog the GX axis, move it for more than 1000 mm, then jog the TCP tip back to the same tetrahedron tip, and click **Record New Coordinates** again. Repeat this step to record at least two points.

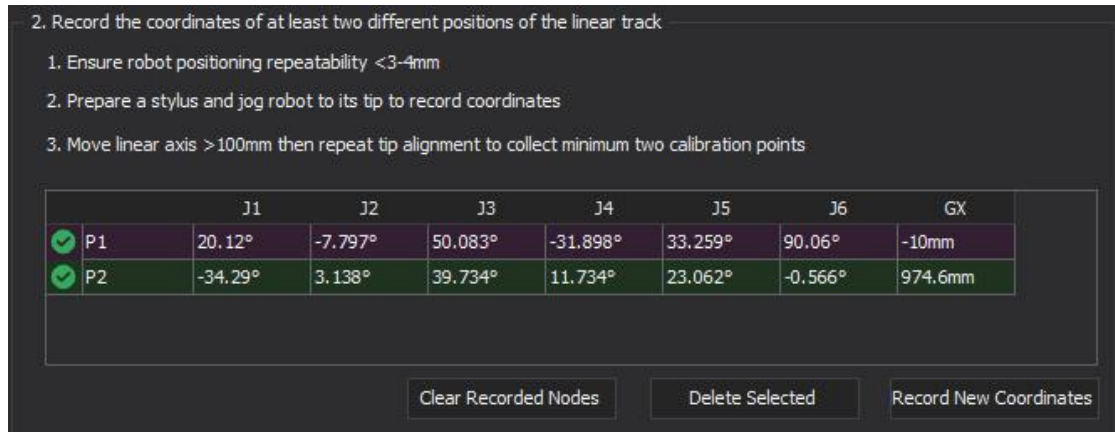


Figure 4-21 Record position

 **Notice:**

1. For single ground rail setups, the GX axis must move over 1000 mm. For 9-axis setups, calibration of three external axes is required, and each ground rail must move at least 100 mm.
2. If GY/GZ axes are involved, repeat step 3 for each, ensuring robot posture remains unchanged throughout.

Step 4 Click *Calibrate*, and click *Save* once the assembly matrix and euler angle change. When a pop-up appears indicating the assembly matrix has taken effect, the calibration is complete.

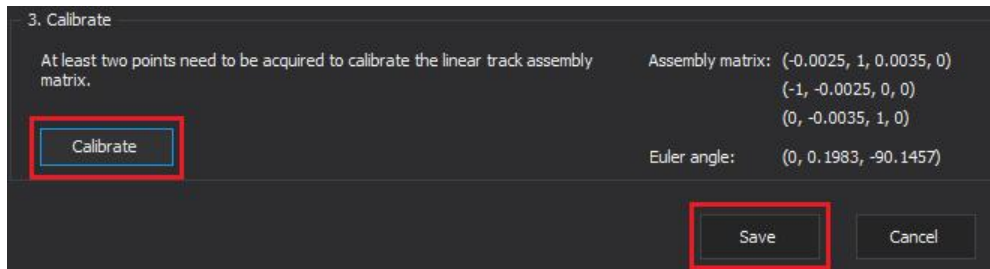


Figure 4-22 Calibrate

Step 5 Accuracy verification. Go to *Tool* → *Debugging Tool* → *Zero-Space Jog* to open the zero-space jog interface and verify accuracy. For external axis movement of 1 m, the maximum linear deviation should be within 2 mm.

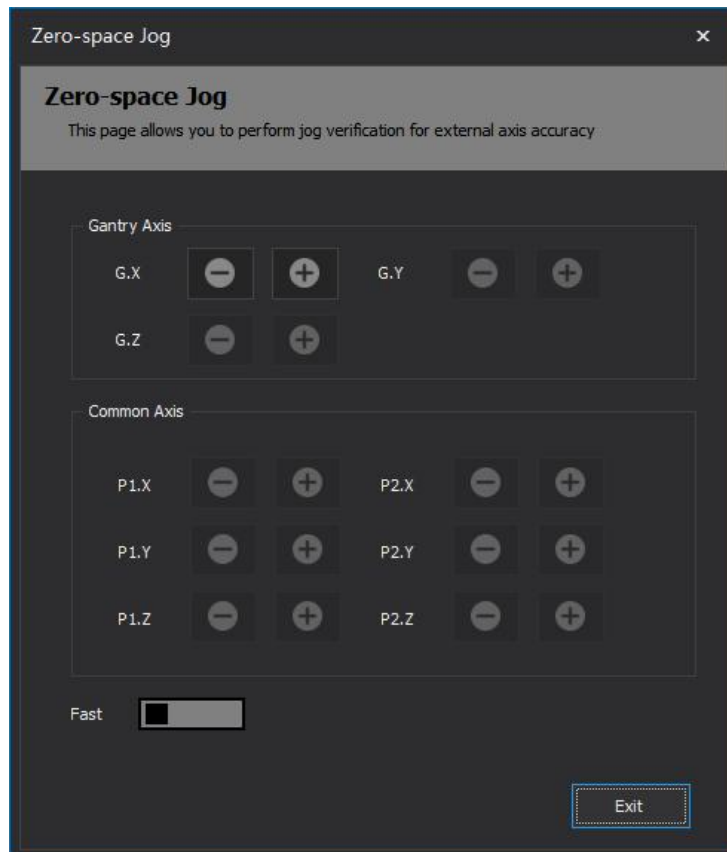


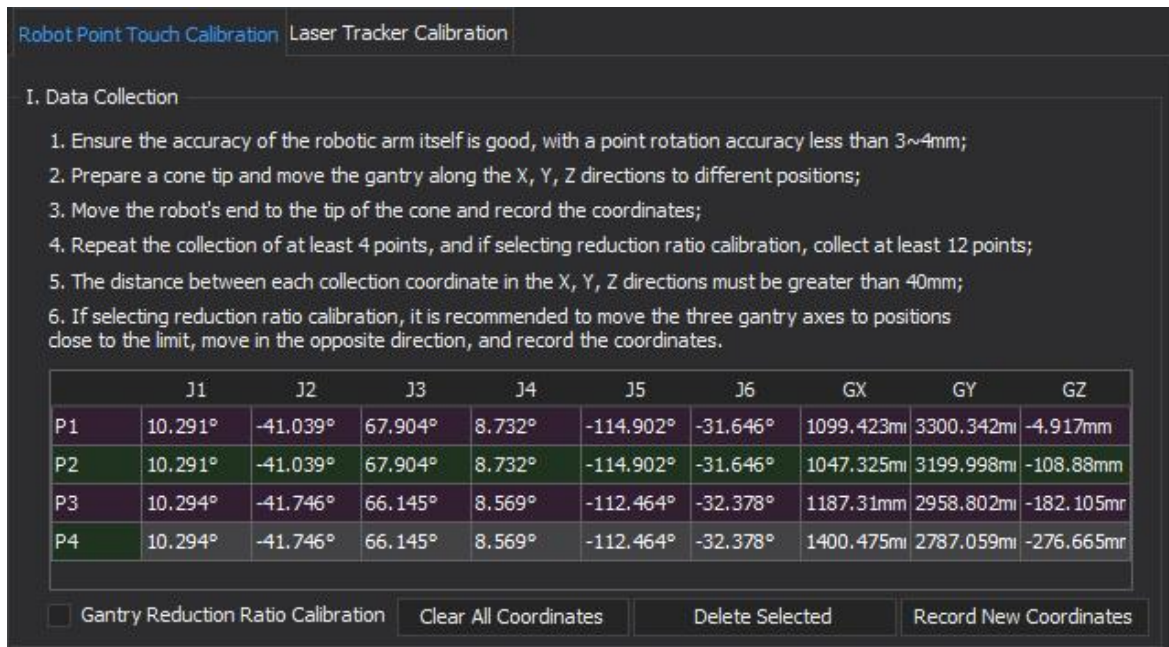
Figure 4-23 Zero-space jog

4.3.2 Gantry Assembly Matrix Calibration

Step 1 Go to *Tool* → *Parameter Settings* → *Assembly Matrix Calibration* to open the *Assembly Matrix Calibration* interface. Place a tetrahedro within the robot’s reach.

Step 2 Record position.

1. Jog the TCP tip to the tip of the tetrahedron and click **Record New Coordinates**.
2. Move the gantry along the X, Y, and Z axes to different positions, then jog the TCP tip back to the same pyramid tip, and click **Record New Coordinate** again. Repeat to collect at least 4 position records.



Robot Point Touch Calibration Laser Tracker Calibration

I. Data Collection

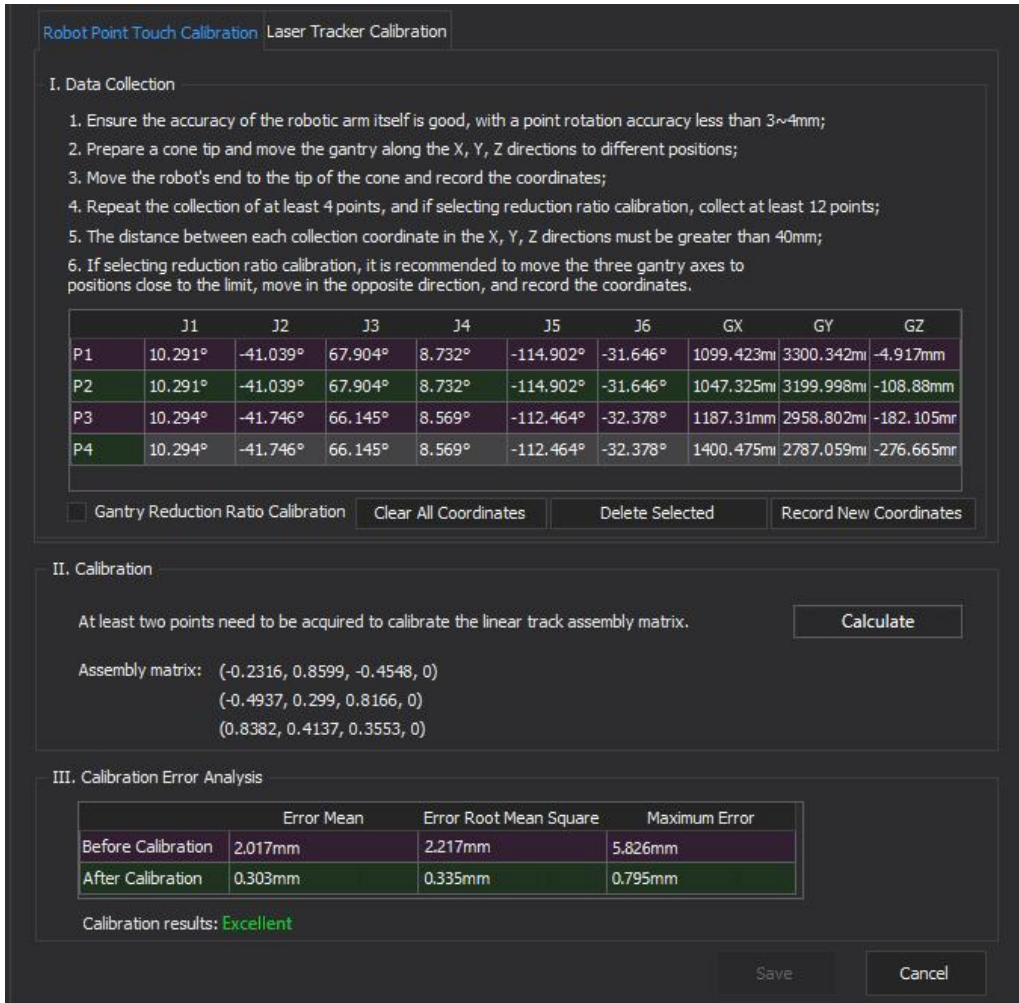
1. Ensure the accuracy of the robotic arm itself is good, with a point rotation accuracy less than 3~4mm;
2. Prepare a cone tip and move the gantry along the X, Y, Z directions to different positions;
3. Move the robot's end to the tip of the cone and record the coordinates;
4. Repeat the collection of at least 4 points, and if selecting reduction ratio calibration, collect at least 12 points;
5. The distance between each collection coordinate in the X, Y, Z directions must be greater than 40mm;
6. If selecting reduction ratio calibration, it is recommended to move the three gantry axes to positions close to the limit, move in the opposite direction, and record the coordinates.

	J1	J2	J3	J4	J5	J6	GX	GY	GZ
P1	10.291°	-41.039°	67.904°	8.732°	-114.902°	-31.646°	1099.423m	3300.342m	-4.917mm
P2	10.291°	-41.039°	67.904°	8.732°	-114.902°	-31.646°	1047.325m	3199.998m	-108.88mm
P3	10.294°	-41.746°	66.145°	8.569°	-112.464°	-32.378°	1187.31mm	2958.802m	-182.105mr
P4	10.294°	-41.746°	66.145°	8.569°	-112.464°	-32.378°	1400.475m	2787.059m	-276.665mr

Gantry Reduction Ratio Calibration

Figure 4-24 Repeat to collect 4 position records

Step 3 Click *Calculate*. If the assembly matrix changes and the result is deemed excellent, click *Save* to complete calibration.



Robot Point Touch Calibration Laser Tracker Calibration

I. Data Collection

1. Ensure the accuracy of the robotic arm itself is good, with a point rotation accuracy less than 3~4mm;
2. Prepare a cone tip and move the gantry along the X, Y, Z directions to different positions;
3. Move the robot's end to the tip of the cone and record the coordinates;
4. Repeat the collection of at least 4 points, and if selecting reduction ratio calibration, collect at least 12 points;
5. The distance between each collection coordinate in the X, Y, Z directions must be greater than 40mm;
6. If selecting reduction ratio calibration, it is recommended to move the three gantry axes to positions close to the limit, move in the opposite direction, and record the coordinates.

	J1	J2	J3	J4	J5	J6	GX	GY	GZ
P1	10.291°	-41.039°	67.904°	8.732°	-114.902°	-31.646°	1099.423mi	3300.342mi	-4.917mm
P2	10.291°	-41.039°	67.904°	8.732°	-114.902°	-31.646°	1047.325mi	3199.998mi	-108.88mm
P3	10.294°	-41.746°	66.145°	8.569°	-112.464°	-32.378°	1187.31mm	2958.802mi	-182.105mm
P4	10.294°	-41.746°	66.145°	8.569°	-112.464°	-32.378°	1400.475mi	2787.059mi	-276.665mm

Gantry Reduction Ratio Calibration

II. Calibration

At least two points need to be acquired to calibrate the linear track assembly matrix.

Assembly matrix: (-0.2316, 0.8599, -0.4548, 0)
 (-0.4937, 0.299, 0.8166, 0)
 (0.8382, 0.4137, 0.3553, 0)

III. Calibration Error Analysis

	Error Mean	Error Root Mean Square	Maximum Error
Before Calibration	2.017mm	2.217mm	5.826mm
After Calibration	0.303mm	0.335mm	0.795mm

Calibration results: **Excellent**

Figure 4-25 Calculate assembly matrix

Step 4 Accuracy verification. Go to *Tool* → *Debugging Tool* → *Zero-Space Jog* to open the zero-space jog interface and verify accuracy. For external axis movement of 1 m, the maximum linear deviation should be within 2 mm.

4.4 Delay Calibration

4.4.1 System Delay Auto Measurement

Step 1 Go to *Tool* → *Parameter Settings* → *System Delay Measurement* to open the measurement interface. Ensure that all mechanical axes are in the homed position.

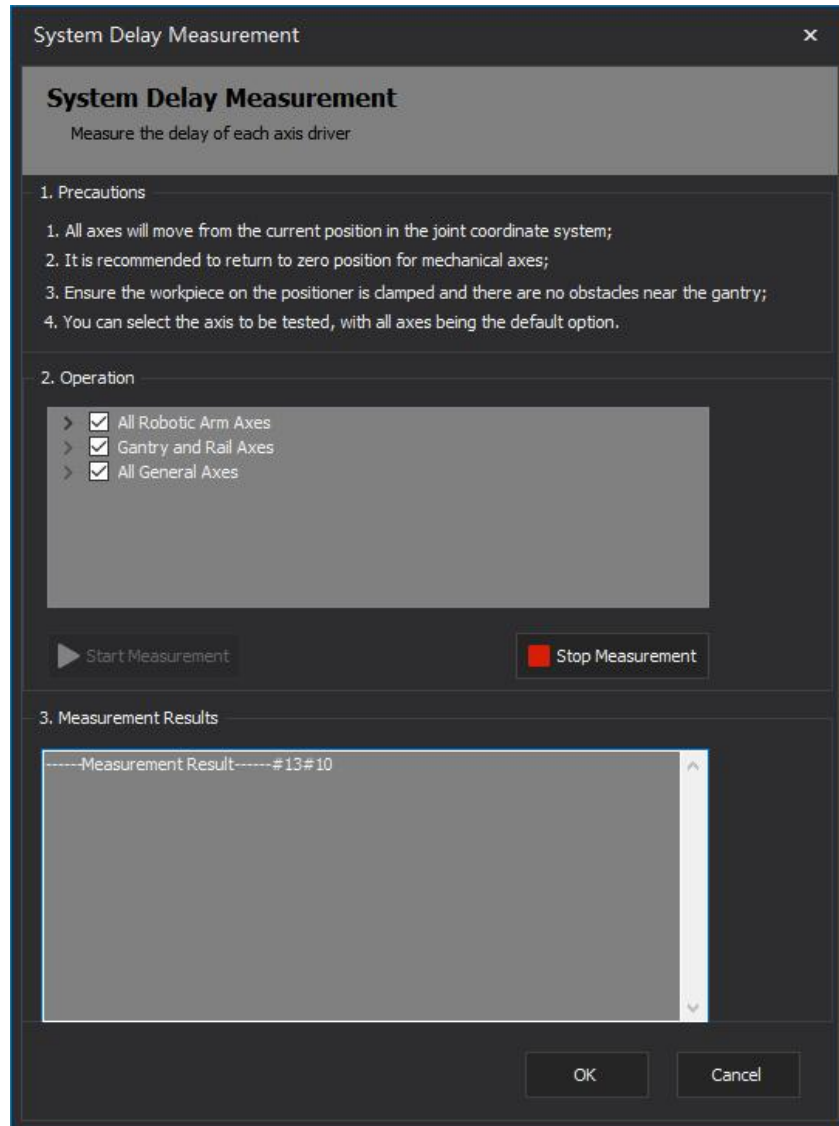


Figure 4-26 System Delay Measurement interface

Step 2 Make sure the surrounding area is free of obstructions. By default, all axes are selected. Click *Start Measurement*.

Step 3 The results panel will display the delay measurement results for each axis. If *Valid Calculation Result* is shown, the measurement was successful.

Step 4 Compensation. Go to *Procedure Parameter* → *Global Procedure* → *Phase delay in sampling*, and input the measured system drive delay into the corresponding field.

 **Notice:** System delay measurement may result in the following three scenarios.

1. No result: This may be due to mismatched speed units between the drive and the system. Adjust the encoder type of the drive to ensure consistent units.
2. Result is unavailable: Caused by inconsistent delays across components. Adjust the drive delay (consult the drive manufacturer). The delay difference between axes should be within 5 ms.
3. Valid result: Enter the final result into the *Sampling Phase Delay* field. If using an AOTAI welding machine, add 40 ms to the result before inputting it.

4.4.2 Drive Delay Manual Calibration

Step 1 Go to *Tool* → *Monitoring Tool* → *Real-Time Curve Monitoring* to open the real-time curve monitoring interface.

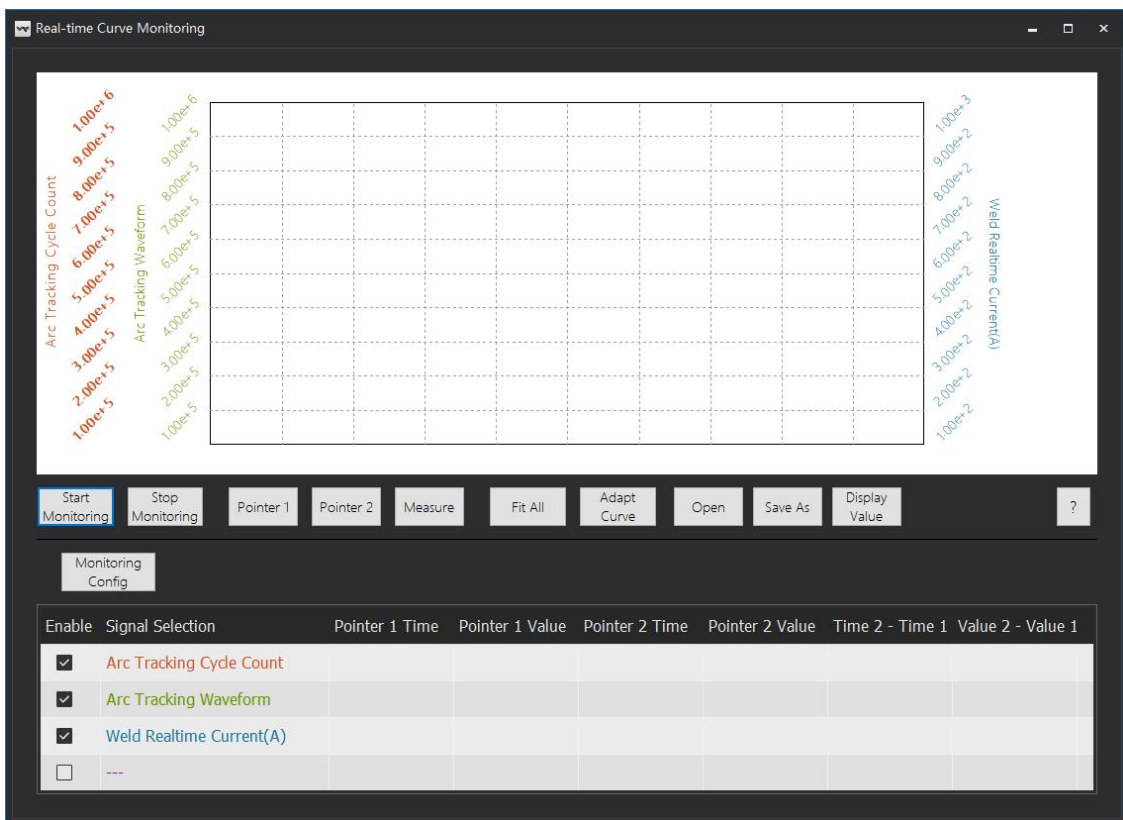


Figure 4-27 Real-time curve monitoring

Step 2 Monitoring Config: Configure the monitor to display command position and feedback position for each robot axis and related external axes.

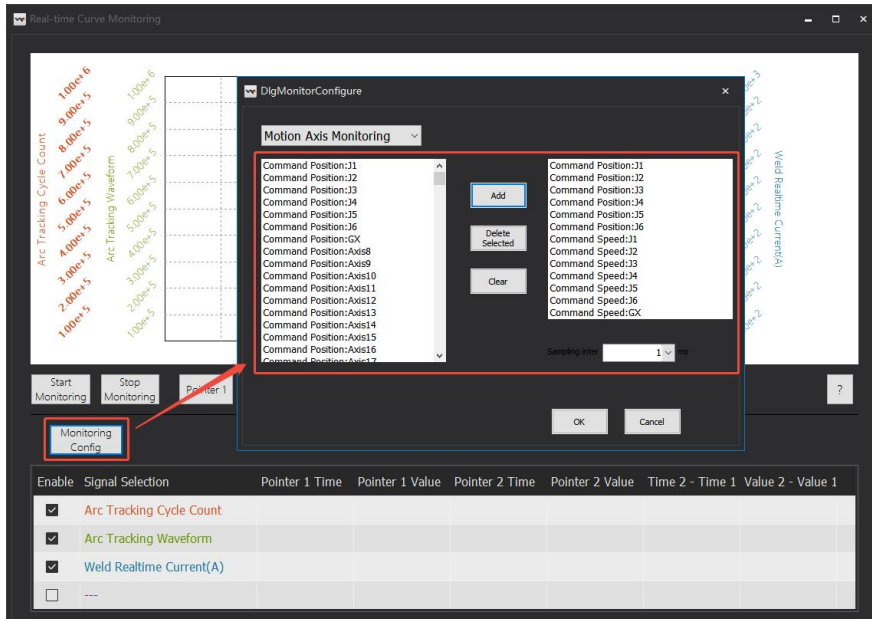


Figure 4-28 Monitoring config

Step 3 Click **Start Monitoring**, and jog each axis (robot and external) one at a time.

Step 4 Stop monitoring and analyze the curve. Select **Pointer1** and click a point on the curve. Select **Pointer 2**, click another point on the curve where the feedback position value is aligned with the command position value from pointer 1. Record the time difference between **Pointer 2** and **Pointer 1**. Repeat this process to record the delay time for each axis.

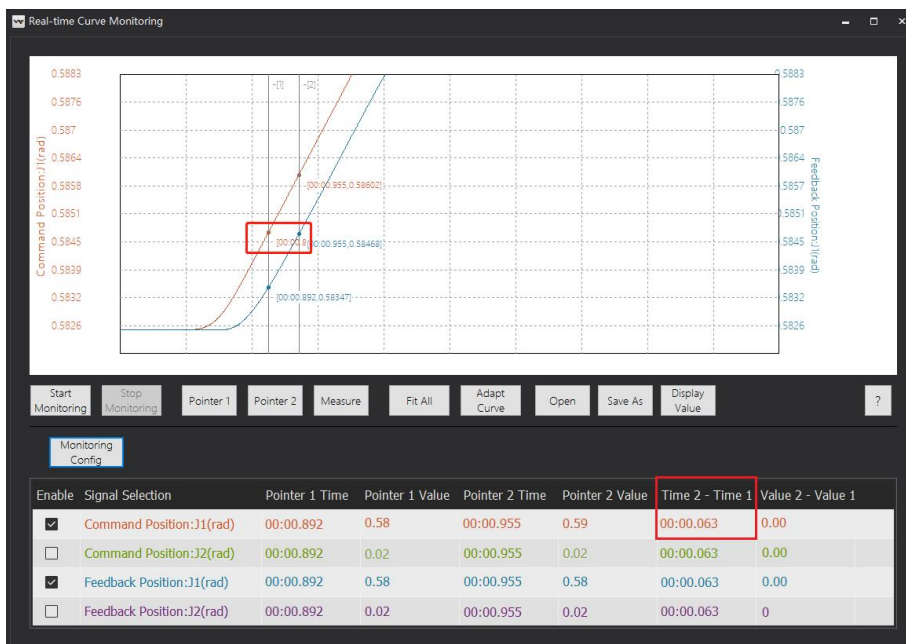
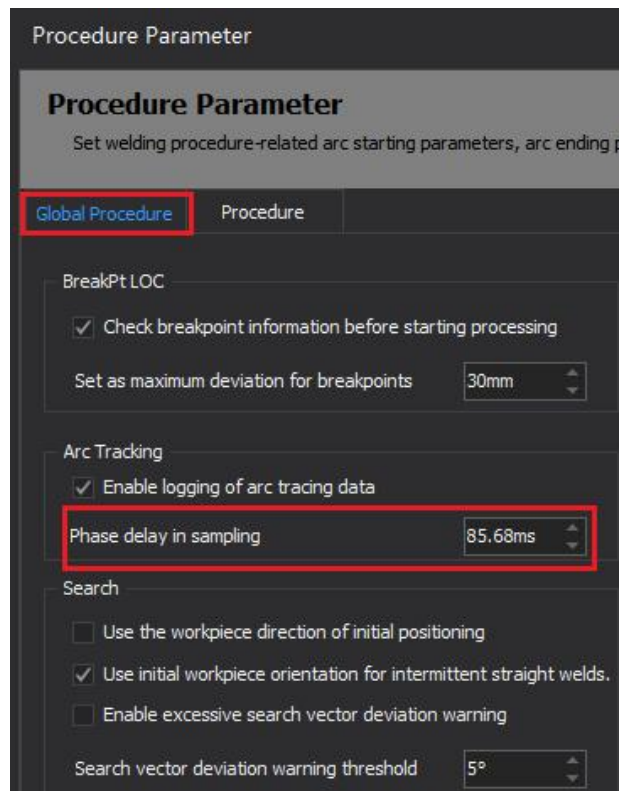


Figure 4-29 Curve analysis

Step 5 Delay correction. If any axis shows a delay significantly different from the others, adjust the *Moving Average Filter Constant* (the parameter name varies by brand; contact the drive manufacturer for specific details).

Step 6 Compensation. Go to *Procedure Parameters* → *Global Procedure* → *Phase Delay in Sampling*, and input the measured system drive delay into the corresponding field.



Procedure Parameter

Procedure Parameter

Set welding procedure-related arc starting parameters, arc ending p

Global Procedure Procedure

BreakPt LOC

Check breakpoint information before starting processing

Set as maximum deviation for breakpoints 30mm

Arc Tracking

Enable logging of arc tracing data

Phase delay in sampling 85.68ms

Search

Use the workpiece direction of initial positioning

Use initial workpiece orientation for intermittent straight welds.

Enable excessive search vector deviation warning

Search vector deviation warning threshold 5°

Figure 4-30 Input compensate

Chapter 5 Precautions

5.1 Power Supply Specifications

Power supply is critical to maintaining the normal operation of the system. A power failure or malfunction can directly lead to system shutdown or even equipment damage. In welding systems, whether using 380 V or 220 V AC power, or 24 V and 12 V DC power, proper wiring and electrical isolation are especially important!

5.1.1 Power Supply Cable Specifications

The current-carrying capacity of power cables varies depending on the brand, material, and environmental conditions. Power cable diameter should be selected based on the power requirement. The following table provides a reference between cable diameter and power output:

Table 5-1 Cable Diameter vs. Power Output

Cable Spec (mm ²)	Cross Section (mm ²)	25°C Copper Wire Ampacity (A)	Single-Phase 220 V Load Power (W)	Three-Phase 380 V Load Power (W)
1.5	1.38	15	3300	9476.8
2.5	1.78	25	5500	13163.2
4	2.25	32	7040	16848.8
6	2.85	45	9900	23693.6
10	7*1.35	60	13200	31591.2
16	7*1.7	80	17600	42121.6
25	7*2.14	110	24200	57917.6

5.1.2 BOCHU System Power Requirements

The FSWELD system require the following input power specifications:

Table 5-2 Power Requirements for FSWELD System Components

Product	Voltage	Power Requirements
HypTronic3	24 V	Max. 120 W
BCW020	24 V	Max. 20 W
HPL2720E	24 V	Max. 120 W

 **Danger:**

1. Always turn off the power supply before performing wiring operations, or before connecting/disconnecting any cables or connectors.
2. Never connect or disconnect live connectors, as doing so may result in serious equipment damage or even personal injury.
3. Use professional-grade 24 V switching power supplies from qualified suppliers that meet the total power demand of the FSWELD system. Poor-quality or underpowered supplies may compromise system stability or cause permanent damage to the equipment.

5.2 Grounding Specifications

5.2.1 Overview

- **Ground:** Ideally refers to a physical entity with zero potential and zero impedance, without any voltage drop. In practice, a grounding electrode or a group of conductive materials is used to form a reliable electrical connection with the earth. Multiple grounding points may be interconnected underground.
- **Grounding:** The act of connecting part of a system or device to the ground through a grounding wire.
- **Grounding wire:** The conductor that connects to the grounding electrode.
- **Purpose of grounding:** A safety measure to ensure proper functioning of electrical equipment and protect personnel safety. This section focuses on ensuring stable and reliable operation of the equipment.

5.2.2 Ground Rod Specification



Figure 5-2 Ground rod

- Ground Rod Structure:
 - Outer layer: Carbon steel.
 - Inner core: Alloy steel.
 - Thread section: Stainless steel.
- Grounding Requirements:
 - Welding systems must use galvanized grounding screws.
 - Grounding wires must be at least 10 mm² copper or 16 mm² aluminum.
 - Resistance between the grounded metal body and the main grounding point should be $\leq 0.1 \Omega$.
 - Independent ground wires must be as short and thick as possible, with a ground resistance not exceeding 4 Ω .

5.2.3 Grounding Specification

- Multi-point Grounding: Use a star topology for connections; daisy chaining (serial connection) is not recommended.

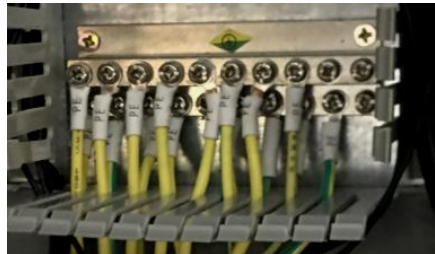


Figure 5-3 Multi-point grounding

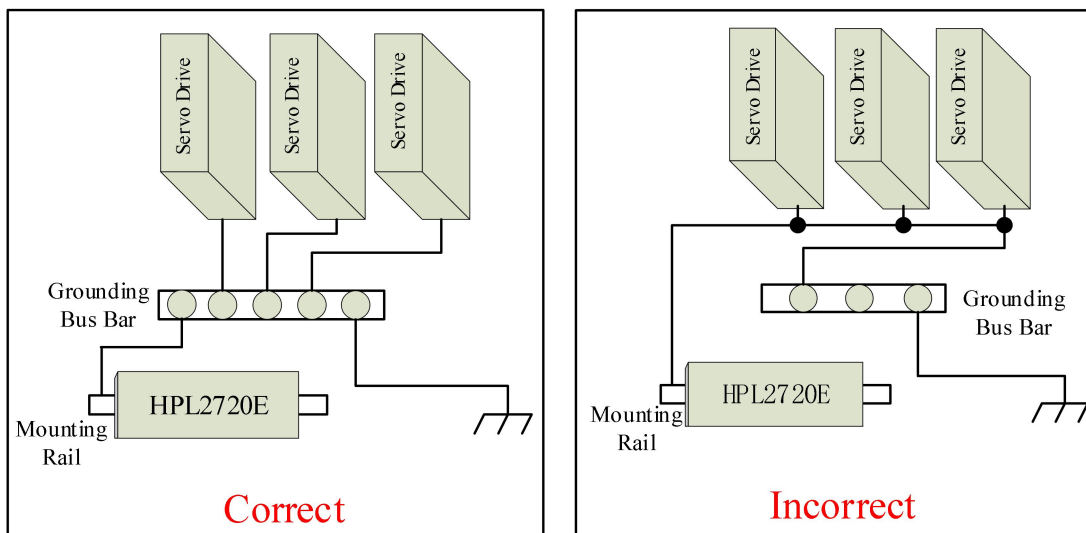


Figure 5-4 Multi-point grounding sample

- **Isolated Grounding:** Required for power and signal systems, and for interference-prone components such as servo drives and solenoid valves.

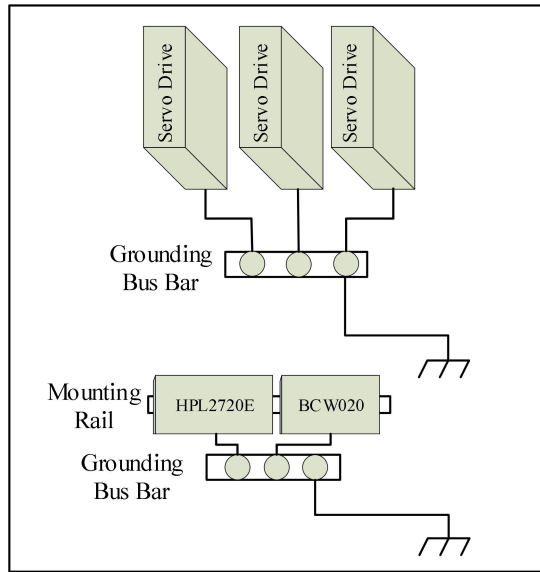


Figure 5-5 Isolated grounding

- **Single-Ended and Double-Ended Grounding:** Choose based on the actual signal.

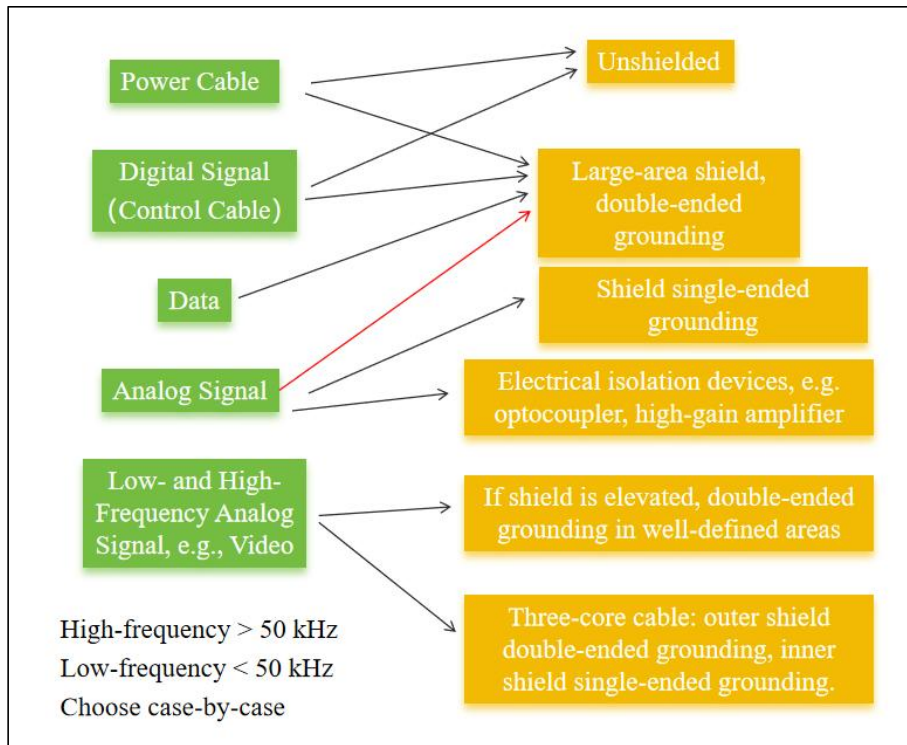



Figure 5-6 Each type of signal has a corresponding grounding method

Table 5-3 Applicable Scenarios of Single-Ended vs. Double-Ended Grounding

Single-Ended Grounding	Double-Ended Grounding
Effective for low-frequency interference	Effective for digital signals and high-frequency interference
More effective for low frequency interference sensitive circuits (analog circuits)	Some analog modules also require dual grounding

 **Notice:** These guidelines are for reference only. Whether single-ended or double-ended grounding is used should be based on actual field performance and system stability requirements. Choose the approach that solves the problem and ensures reliable operation.

5.3 Cable Routing Specifications

Improper wiring may lead to system instability and continuous errors. Reasonable wiring and proper electrical cabinet layout are critical for long-term stable operation of the system.

5.3.1 Separation of Power and Signal Wiring

- Keep cables as short as possible: To minimize antenna effects, all cables should be kept as short as possible.
- Separation of power and signal systems:
 - Power wiring (e.g., servo motor power lines) and signal wiring (e.g., encoder cables, Ethernet cables) must be strictly separated by a minimum distance of 300 mm.
 - A rigid physical barrier between the two is highly recommended. Do not route power and signal cables in the same cable tray.
 - Power circuits must be equipped with appropriate short-circuit protection and filtering devices.



Figure 5-7 Power and signal wiring separation

- Isolation of Interference Sources
- Interference-heavy devices such as servos and solenoid valves:
 - Must be physically separated from FSWELD system components by at least 300 mm. Use rigid dividers if possible.
 - Should have independent power supply and cabling paths. Signal lines must never share cable trays with power lines from interference-heavy devices.

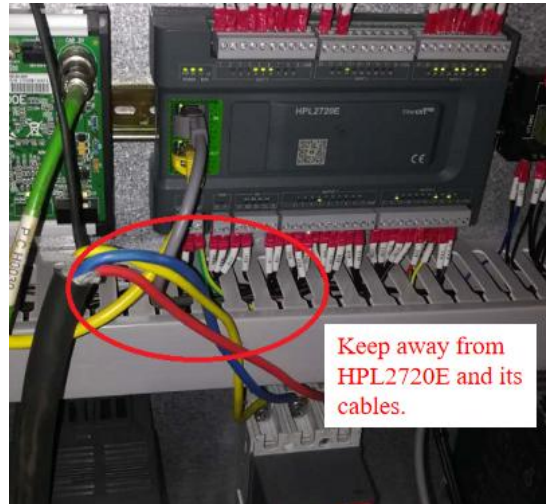


Figure 5-8 Incorrect example: Interference-prone devices not isolated from FSWELD components.

⚠ Notice: FSWELD system components (such as CypTronic_PRO-E, CypTronic_Plus, HPL2720E, BCW500, and BCW020) are all low-voltage devices and should be laid out and wired away from high-voltage equipment and noisy loads.

5.3.2 Cable Routing Specifications

➤ Parallel and Crossed cable routing:

- Cables should be arranged in parallel wherever possible. Cable bundles and conduits should be routed neatly and in straight lines.
- If crossing is unavoidable, cables should intersect at 90° angles to minimize electromagnetic interference (EMI). Maintain a minimum spacing of 200 mm between power and signal cables. If spacing cannot be ensured, use shielding measures such as shielded cable trays or grounded metal plates between them.

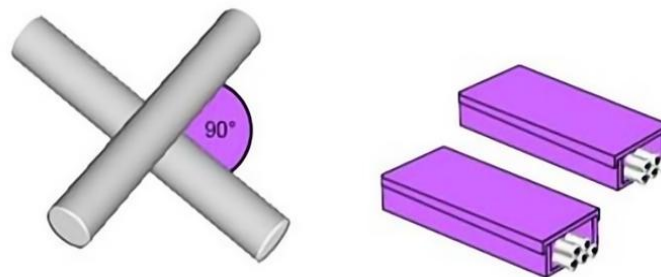


Figure 5-9 Crossed vs. parallel cable routing

- Input cables should enter the electrical cabinet from the same side. Wiring should avoid forming current loops to prevent antenna effects. Current loops between the signal source, transmission line, and load can create magnetic field antennas, causing interference. Such situations must be avoided during wiring. The wiring schematic is shown below:

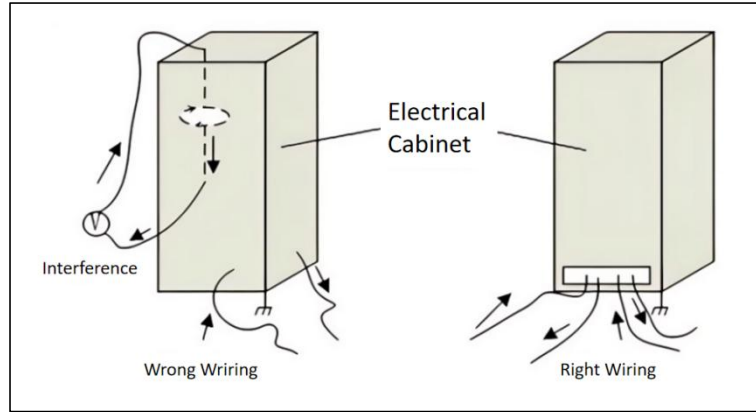


Figure 5-10 Connection and labeling

- All terminals must be securely fastened to prevent arcing.
- Each cable should be clearly labeled with accurate and legible markings.
- When using BOCHU-provided cables, select the appropriate cable type and length for the layout. Avoid excess bundling or coiling of unused cable.

5.3.3 Towline Cable Routing

- When removing preassembled cables from coils, straighten the cable along the tangent direction to prevent twisting. This should be done before installation, allowing internal tension to relax and helping the cable retain its shape. Due to manufacturing tolerances, cables may naturally have slight helical printing along the sheath; this is normal and should not be forced straight.

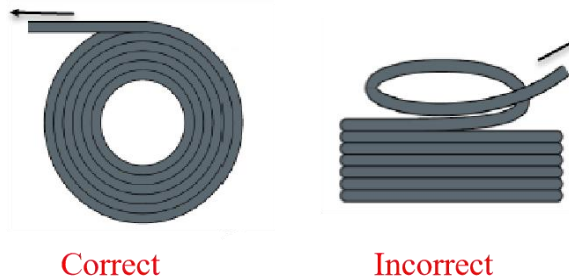
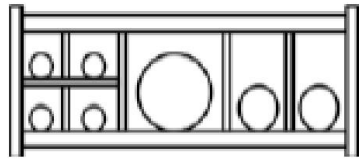
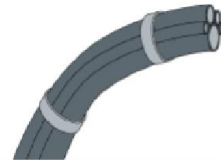


Figure 5-11 Cable releasing

- In tight spaces, never allow cables to twist during installation. Twisting stresses the internal structure and may accelerate failure. Over time, twisting may reverse (untwist) during movement, causing internal conductors to fracture.
- Lay cables loosely and flat inside the drag chain without crossing or overlapping. Use dividers to separate individual cables. Maintain at least 10% of the cable diameter as spacing between adjacent cables or dividers.



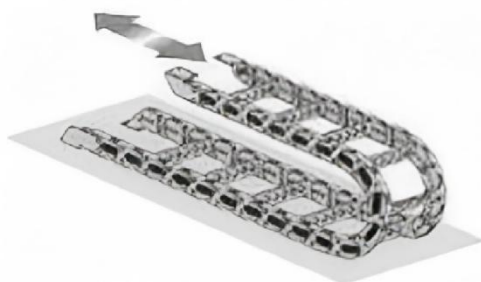
Correct



Incorrect

Figure 5-12 Drag chain laying

- The cables should be symmetrically installed based on their weight and size. Heavier or thicker cables should be placed on the outer section of the drag chain; lighter or thinner cables should be positioned on the inner section. Alternatively, cables can be arranged in descending order of diameter, from inside to outside. Avoid stacking cables on top of each other without dividers, as this can cause friction and crosstalk between cables.
- In vertically hanging chains, allow for extra slack due to cable elongation during movement. After initial operation, check if cables run smoothly through the centerline of the drag chain; adjust as necessary. For self-supporting chains, secure cables firmly at the moving and fixed ends using proper clamps recommended by the drag chain manufacturer. Avoid tightly bundling cables with zip ties—especially in high-acceleration environments, while ensuring that cables are not secured or bundled to moving parts of the drag chain. Ensure a generous buffer zone between the fixed point and the bending segment to prevent excessive stress or tight curvature during motion.



Self-supporting



Sliding

Figure 5-13 Self-supporting/sliding drag chain

- It is recommended to fix the cable on the moving point for sliding drag chains. A small cable protection zone is required at the fixing point. (Refer to the instructions from the drag chain supplier).
- Please ensure that the cable runs along the center area with the desired bending radius. Do not apply tension to the cable (do not pull it too tightly), otherwise the friction inside the drag chain will cause the cable sheath to wear; do not let the cable be too loose in the drag chain, otherwise it will easily cause abrasion of the cable and the inner wall of the drag chain, or tangled with other cables.

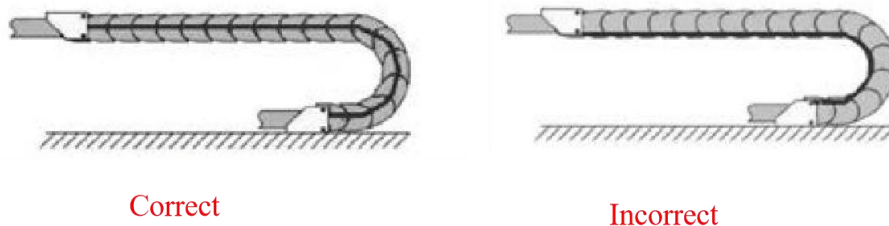


Figure 5-14 Drag chain laying

- If the cable does not run smoothly, check whether it is twisted along the longitudinal axis during operation. The cable should slowly rotate at a certain fixed point until it runs freely.
- Given the size of cables and drag chains, their length characteristics vary considerably. During the first few hours, the cable naturally elongated. For drag chains, it takes more hours for this to happen. Such a large discrepancy can be remedied by regularly checking the cable installation locations. It is recommended to do regular inspections, every three months for the first year and at every maintenance thereafter. This includes checking that the cables are completely free to move within the intended bending radius and making adjustments if necessary.
- Keep cable bundles straight and aligned as much as possible.
- If dividers are unavailable, install spacers between cable bundles at intervals to prevent entanglement.

- Separate power cables (high voltage) from signal cables (low voltage). As shown in the figure below: Place power cables near the outermost edge of the drag chain. Place air tubes, water pipes, and optical fibers in the middle layer. Place signal cables toward the innermost side of the drag chain.

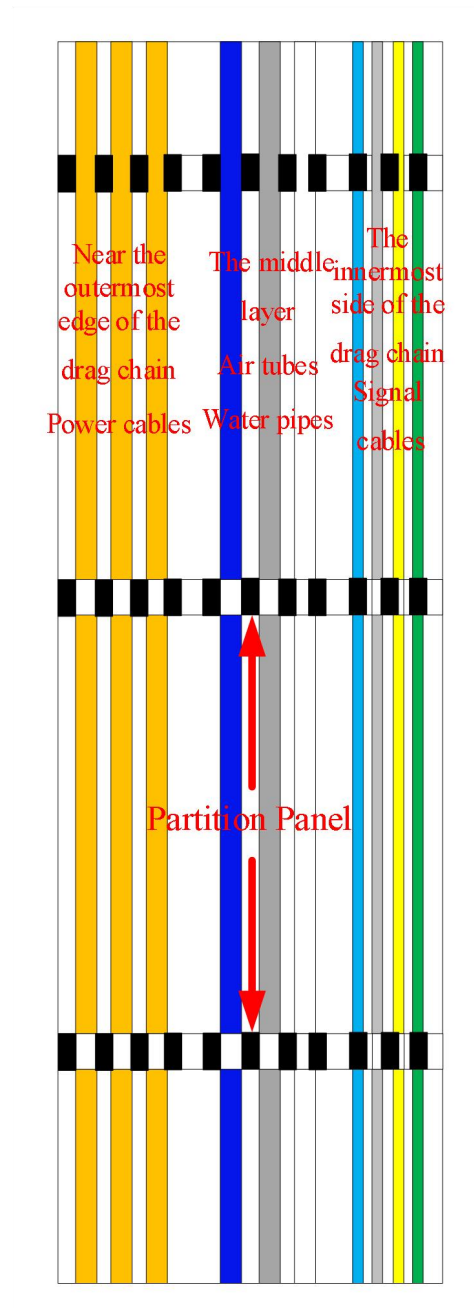


Figure 5-15 Drag Chain Cable Routing Layout

5.3.4 Cable Routing Specifications for BCW Series Devices

This section provides recommended cable layout practices for seam tracking devices mounted on robotic arms. Other BCW series products (such as molten pool monitoring systems) should follow similar routing patterns.

Improper cable routing during axis movement—such as allowing cables to wrap around the robotic arm—may result in cable damage or even device failure, as shown below:

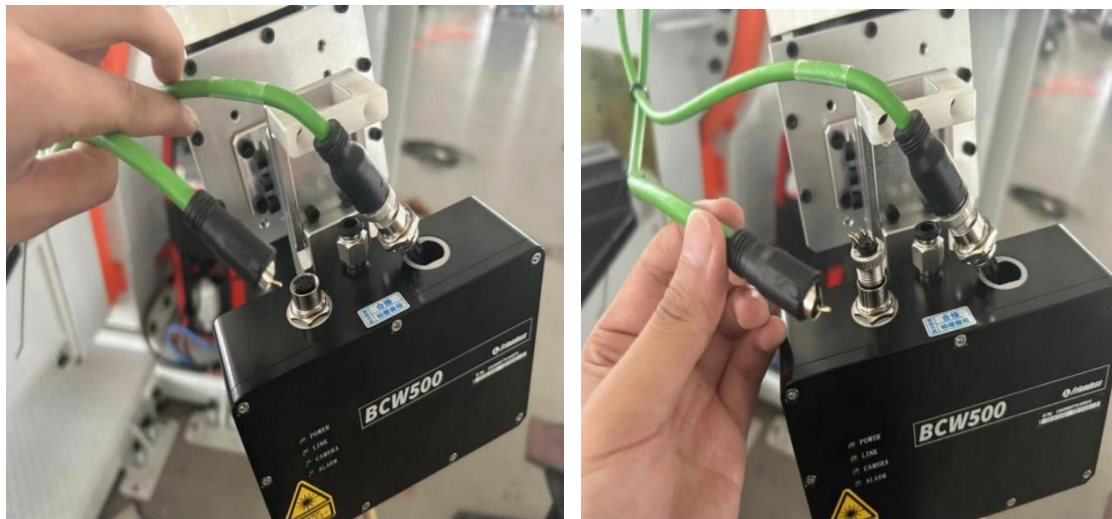


Figure 5-16 Seam tracker damage

To improve cable reliability and reduce the risk of failure during on-site operation, the following guidelines are recommended.

➤ General cable routing principles:

Secure at least six anchor points along the robotic arm. Recommended points include:

- Seam tracker bracket clamp
- Weld gun sleeve between joints 4 and 5
- Two wire supports on the linkage between joints 4 and 5
- Two additional points on the J2 upper arm

Bundle the two drag chain cables with electrical tape where possible, and treat them as a unified harness throughout the layout. The first four anchor points are mandatory. The two anchor points on the upper arm can be adjusted according to the site conditions.

➤ Detailed routing instructions:

- Bracket Clamp (1st Anchor Point): Route both cables through the clamp opening, or secure them on top of the clamp using zip ties.
- Weld Gun Sleeve (2nd Anchor Point): Maintain a cable length of approx. 70 cm between the weld gun sleeve and the previous bracket clamp. Secure the cables with zip ties near the rear end of the sleeve, keeping the cable orientation facing upward.

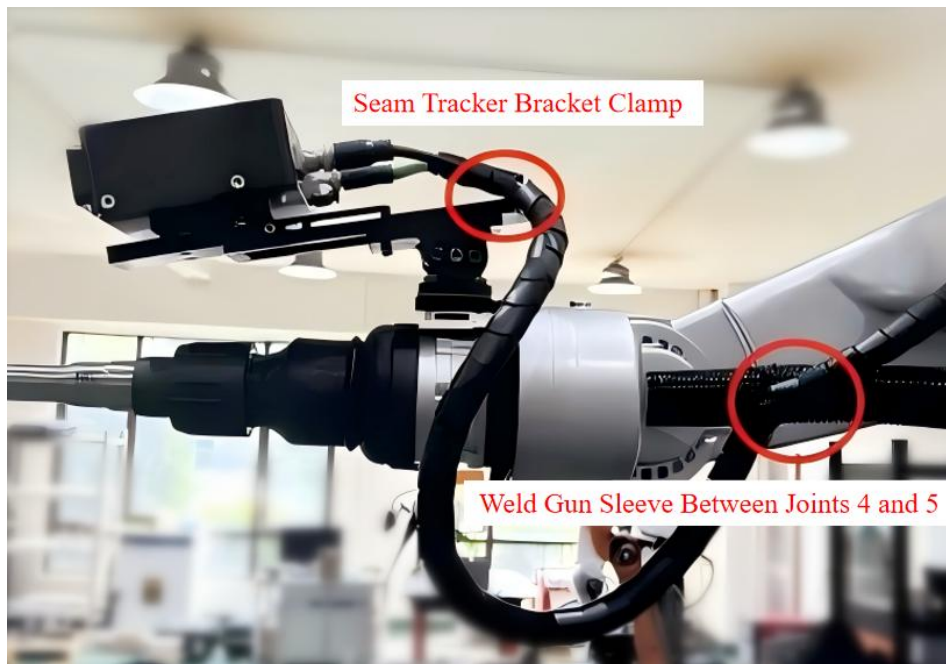


Figure 5-17 Clamp and weld sleeve anchor points

- Linkage Wire Supports (3rd & 4th Anchor Points): Add wire supports on the linkage between joints 4 and 5 (highlighted in red below). Secure cables to the supports and route them along the linkage, from the weld gun sleeve to the supports.

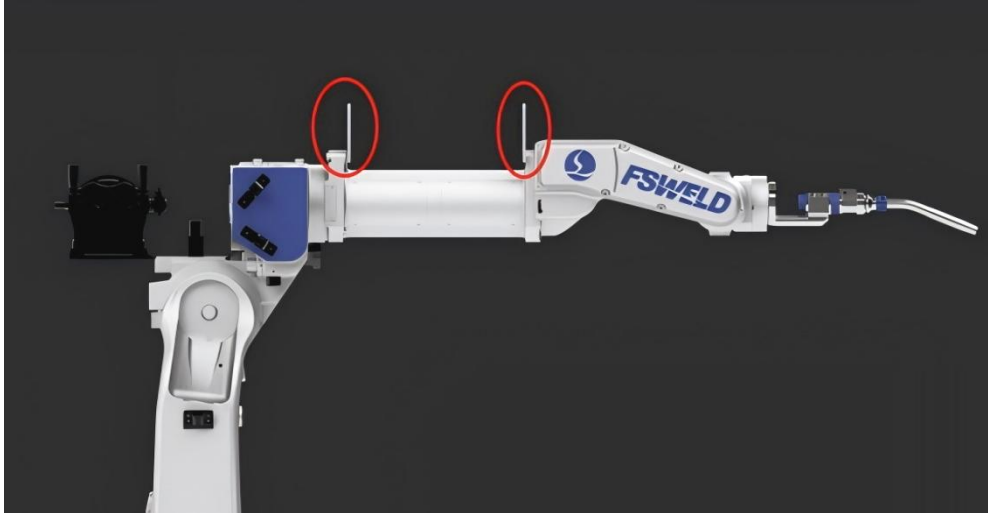


Figure 5-18 Joint 4 & 5 linkage supports

- Upper Arm Anchor Points (5th & 6th Anchor Points): Consider the full range of motion for joint J3. Follow the path indicated by arrows below; maintain a cable length of 50 ~ 60 cm between the wire support and the first anchor point on the upper arm.

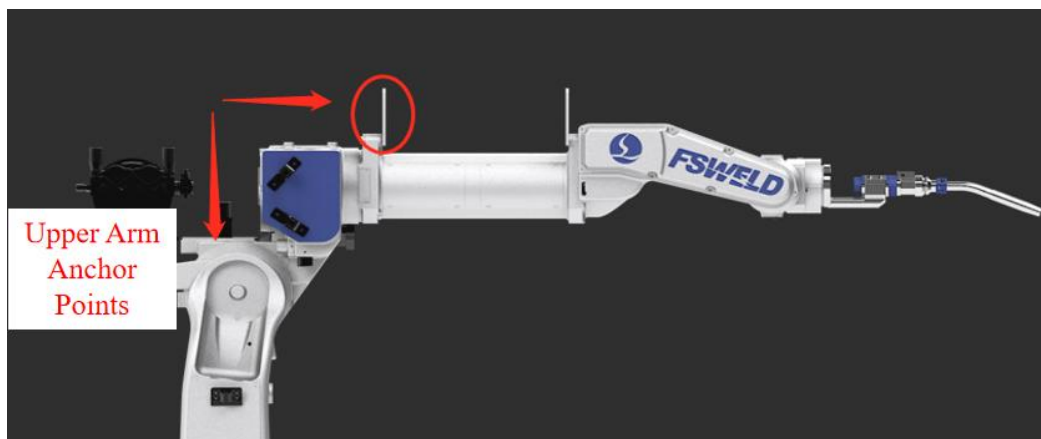


Figure 5-19 Cable path along the J2 upper arm

➤ Actual routing:

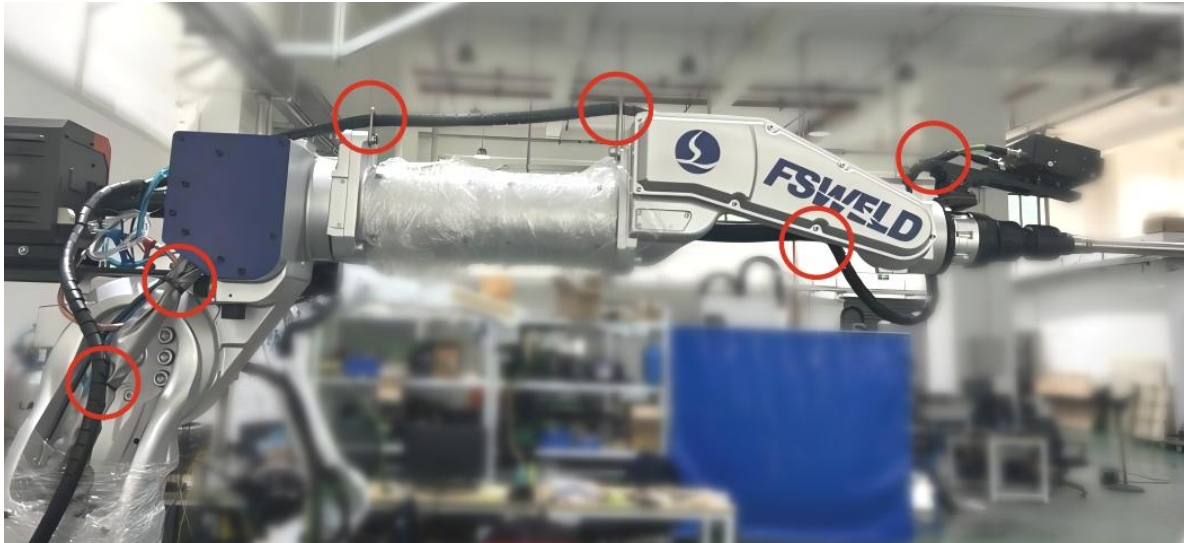


Figure 5-20 Actual routing

 **Notice:** Other BCW products (such as molten pool monitoring) should reference the same cable layout and routing strategy used for seam trackers.

5.4 Others

5.4.1 Cable Handling and Transportation Instructions

- After unboxing, both ends of the cable should be placed inside the coil to prevent connector damage during transportation.



Figure 5-21 Proper cable transport packaging

- Do not drag cables across the floor to prevent abrasion to the cable jacket or connectors.

5.4.2 Precautions for Drag Chain Installation

- Do not remove RJ45 dust caps: Always keep the dust cap on the RJ45 (crystal) connector. Secure the RJ45 end and leave enough slack in the cable; insert the circular connector end through the drag chain.



Figure 5-22 RJ45 connector with dust cap



Figure 5-23 Damage of RJ45 connector without dust cap



Notice: To remove the dust cap, the latch should be pressed.

- During installation, ensure no metal shavings enter the circular connector port, which may cause abnormal connections.



Figure 5-24 Circular connector

5.4.3 Device Interconnection Guidelines

- Before connecting devices, inspect both ends of the cable to ensure no foreign objects are present. Clean if necessary.
- The bending radius at the connector should exceed the minimum bending radius (typically 8 times of the cable's outer diameter). Undersized bends may damage internal conductors and significantly reduce cable lifespan.

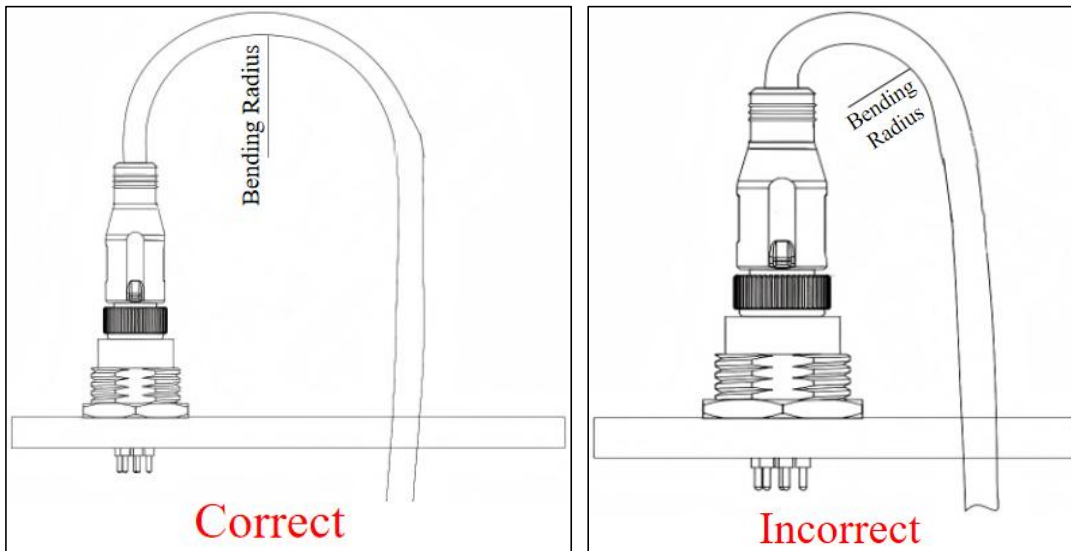


Figure 5-25 Proper bending radius

- Ensure enough cable slack behind the connector to avoid excessive twisting and to allow for stress relief.

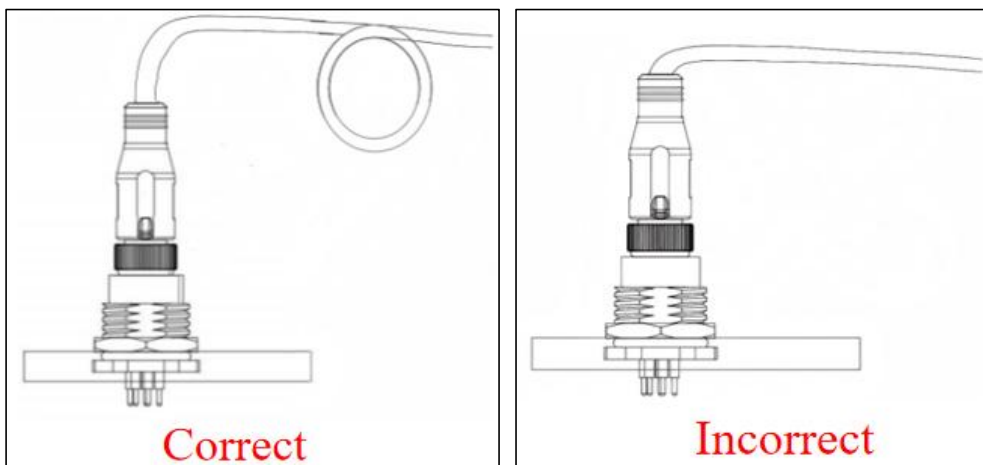


Figure 5-26 Cable slack behind connector


Chapter 6 Safety Declaration

The welding system alone does not meet the ISO 10218 safety standard for industrial robots. It must be used with a safety module and enabling device (e.g., safety pendant). Any legal liability caused by operating the system without these components is not covered under product warranty.

Refer to the following instances for safety control.

6.1 Recommended Safety Devices

- Safety Controller: CHENZHU CZSR8901-2A4S
- Enabling Pendant: IDEC HT4P-SLSPL-R0005
- Safety Light Curtain: LNTECH SND2440-PNP-Z

 **Notice:** If alternative safety components are used, they must be certified with a relevant safety rating (e.g., PL or SIL) or comply with applicable standards (e.g., ISO 13850 for emergency stop switches).

6.2 Wiring Diagram of Safety Devices

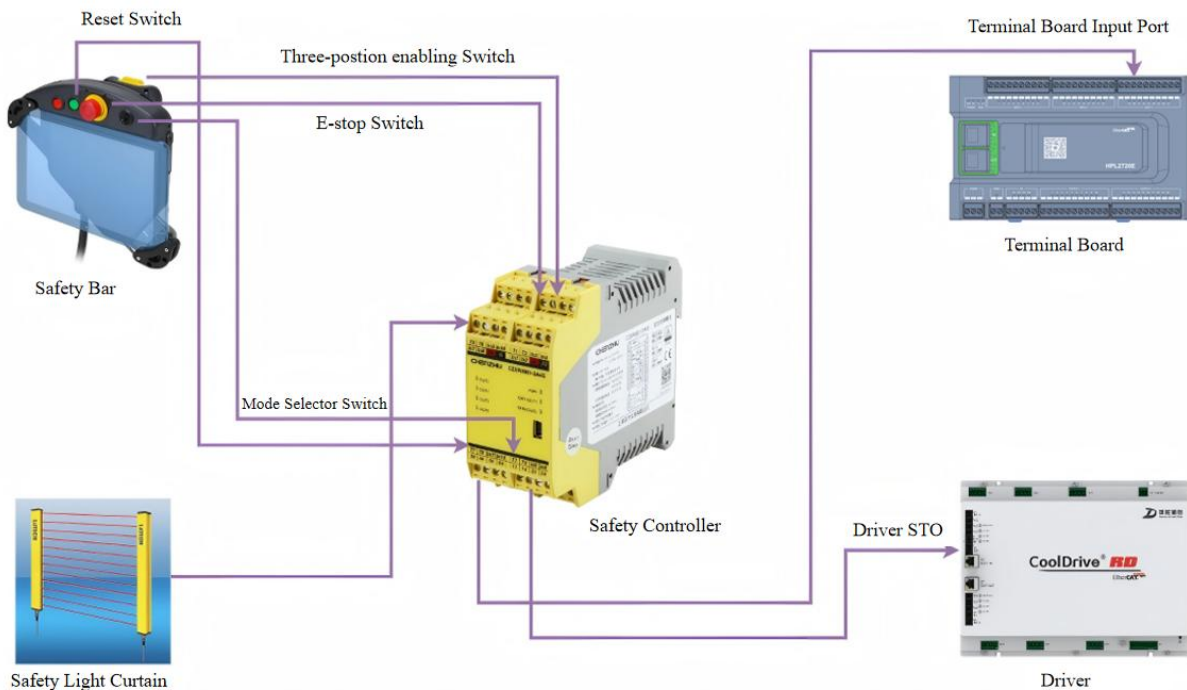


Figure 6-1 Wiring diagram of safety devices

6.3 Safety Design Concept

- Use safety light curtains to define safe and hazardous zones. The robot operating area should be considered hazardous.
- Ensure emergency stop switches function at all times to bring the system into a safe state.
- When in a non-safe state, the system should cut power to the drives via the STO (Safe Torque Off) circuit.
- Use a selector switch to differentiate between manual and automatic modes:
 - Manual Mode: Operators may enter the hazardous zone. The light curtain is bypassed. The system only operates when the enabling switch is held in the middle position.
 - Auto Mode: No entry is allowed into the hazardous zone. The enabling switch is bypassed.
- The CypWeld system reads the current mode status via the HPL2720E terminal board.

6.4 Application Scenarios

- Manual Mode (selected within safe zone):
 - Ensure E-stop is released. Hold the 3-position enabling switch in the center position to power on STO and enable robot movement.
 - In emergencies, either of the following will stop the robot:
 - ◆ Press the E-stop (STO is cut, robot stops).
 - ◆ Release or fully press the enabling switch (STO is cut, and the robot stops).
- Auto mode:
 - Ensure E-stop is released. All personnel must remain outside the hazardous zone. Press the reset switch to enable STO and resume operation.
 - If a person enters the hazardous, STO is cut, and the robot halts.
 - If E-stop is pressed, STO is cut, and the robot halts.

6.5 Safety Logic Topology

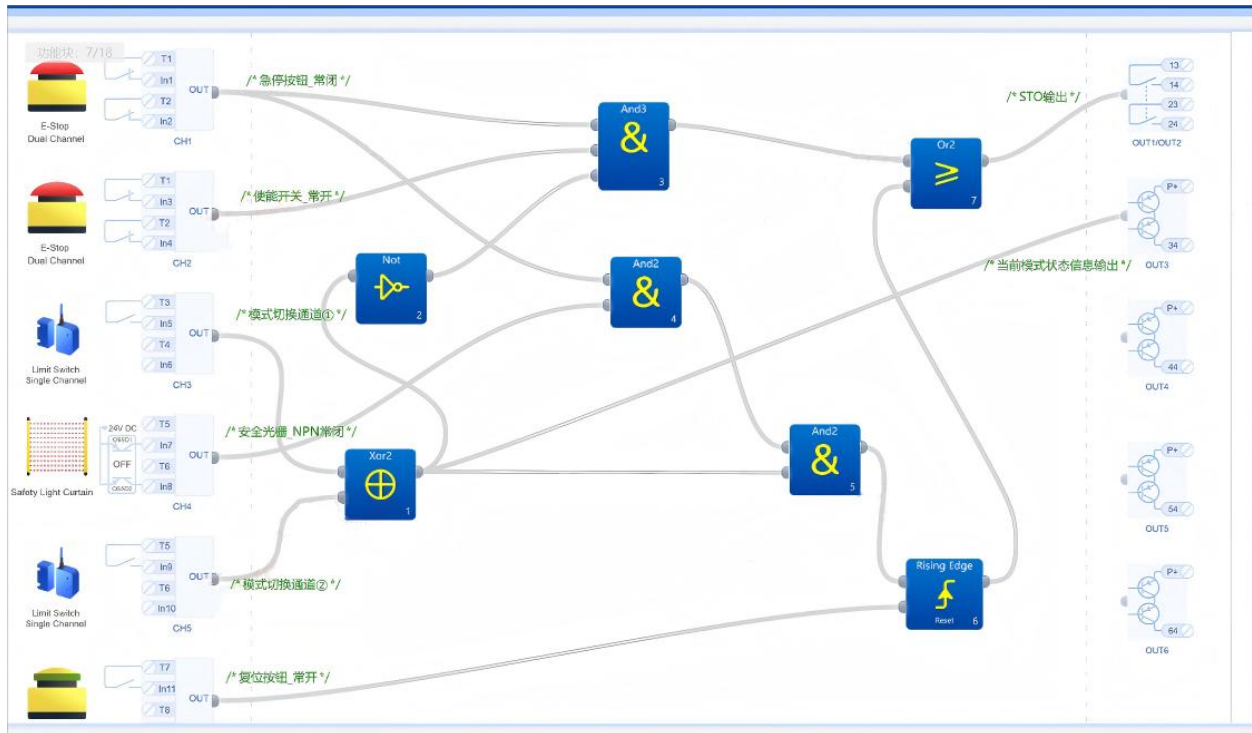


Figure 6-2 Safety logic topology

6.6 Line Laser Safety Instructions

- Do not look directly at the laser beam, or redirect your eyes or close them if needed.
- Avoid observing the laser with optical instruments like telescopes or magnifying lenses.
- Do not place mirrors or other reflective objects within the laser path.
- Avoid exposure of skin or eyes to laser radiation.
- Always wear laser safety goggles in designated laser operation areas. Do not look directly into the direct and reflected light of the laser, even if wearing protective goggles.
- Avoid directing the laser at high-reflectivity materials. If unavoidable, adjust the angle to minimize reflection hazards.
- Disable the laser when not in use.
- Follow this manual and relevant local standards/regulations to ensure safe and proper use. Misuse may result in personal injury, electric shock, or radiation exposure.



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