Six-Axis Universal Master Arm User Manual

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Version

01（2026-09-15）

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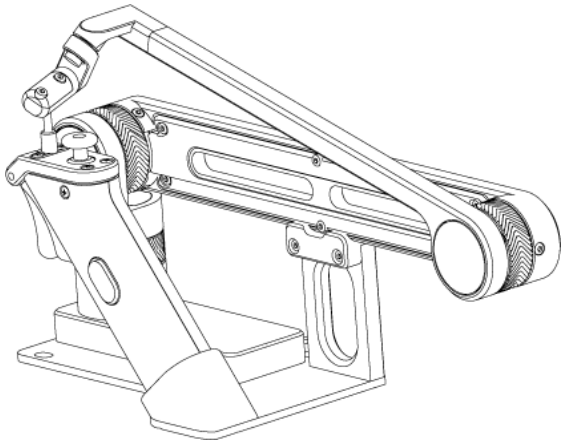
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Six-Axis Universal Master Arm

User Manual

Version 01

Updated: 2026-09-15

Contact Us: support@agilex.ai

Preface

Safety Notice Definitions

Safety notices are divided into four categories: Danger, Warning, Caution, and Note. Pay attention to all safety notices when reading this manual. Their classifications and meanings are as follows:

⛔DANGER

Failure to avoid or comply may result in serious personal injury.

⚠️WARNING

Failure to follow these safety instructions may result in severe injury, equipment damage, or major property loss.

‼️CAUTION

Failure to avoid or comply may result in minor personal injury or equipment malfunction.

📖NOTE

No direct risk of injury; information provided to improve operational efficiency, extend equipment life, etc.

Version

01 (2026-09-15)

Author: Chester

First release.

Recommendation

- Agilex College

  Continuously updated open-source examples and tutorials for all Agilex Robotics products. Welcome to learn and exchange.

  Click to visit: Agilex College

1. Safety Precautions

Before first use, please read this manual carefully to understand the operating procedures and standards. Using the product outside its intended purpose may lead to hazardous situations. Agilex Robotics provides no support for unintended use and assumes no liability for damage resulting from non-intended use.

1.1. Environmental Safety

- Conduct a thorough application risk assessment before use, covering risks related to the Universal Master Arm, controlled robotic arm, and accessories in terms of working range, motion, payload, and speed.
- Do not expose the device to strong magnetic fields for extended periods.
- Use in an environment with temperature between 0°C and 45°C and relative humidity between 15%RH and 85%RH (non-condensing).
- Do not use in environments with corrosive or flammable gases, or near combustible materials.
- Do not use near heat sources such as heaters or large wire-wound resistors.

1.2. Transportation and Storage Safety

- Before transportation, adjust the Universal Master Arm to the packing pose and place it in the original factory packaging. The factory packaging is designed based on

product characteristics to effectively absorb shock and vibration during normal transportation.

- During transportation, do not invert, throw, apply heavy pressure, or stack excessively.

1.3. Personnel Operation Safety

- Do not allow persons under 18 years of age or persons without full civil capacity to operate the device.
- Tie long hair back before operation. Wear safety goggles when entering the work area.
- During operation, both the Universal Master Arm and the controlled robotic arm must remain within line of sight.
- Operators must remain outside the maximum working range of the controlled robotic arm to ensure safety.
- Do not modify the device; modifications may cause unforeseen equipment damage and personal injury.
- If the device malfunctions, stop using it immediately, cut off the power source to avoid secondary injury, and contact qualified technical personnel. Do not attempt to handle it on your own.

2. Product Introduction

The Six-Axis Universal Master Arm is a handheld six-degree-of-freedom robotic arm teaching/6D spatial teleoperation device. It is designed for embodied AI, intelligent robotic arm, and spatial operation applications, providing spatial pose data acquisition. The overall design uses high-stiffness materials to ensure accuracy and stability of spatial pose during operation. It lowers the barrier to robotic arm operation in embodied AI and robotic arm control scenarios, providing an intuitive and cost-effective teleoperation solution.

- The product real-time captures the operator's hand position and orientation, mapping the 6D spatial pose to the target pose of the robotic arm end effector or other controlled targets.Coordinate transformation, inverse kinematics solving, and motion planning are performed on the host computer, enabling the robotic arm end to follow the operator's movements in real time.

- Supports configurable 3D motion boundaries. When the target pose exceeds limits or commands are unreachable, the system automatically stops the robotic arm to reduce the risk of misoperation.
- Applicable to robotic arm teleoperation, algorithm research and verification, interactive demonstrations, data acquisition, and other scenarios.
- Weighs only 0.6 kg, with built-in CAN module. The main side connects to the computer via USB, reducing the need for additional adapters.
- Recommended for use with PiPER or NERO robotic arms.

2.1. Product Appearance

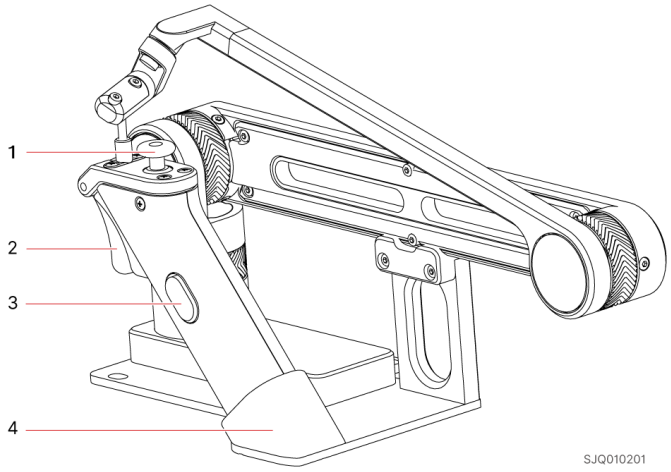
The following product appearance diagrams use the left-arm version as an example; the right-arm version is structurally symmetrical unless otherwise noted.

① Joystick

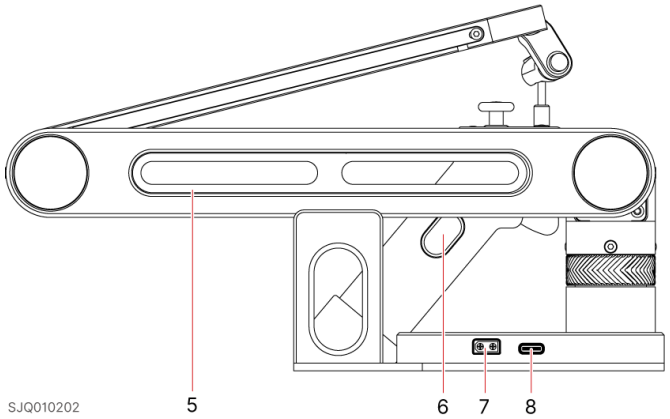
② Trigger

③ Outer-side button (reserved)

> Function not yet enabled; please use the inner-side button



④ Handle magnetic base



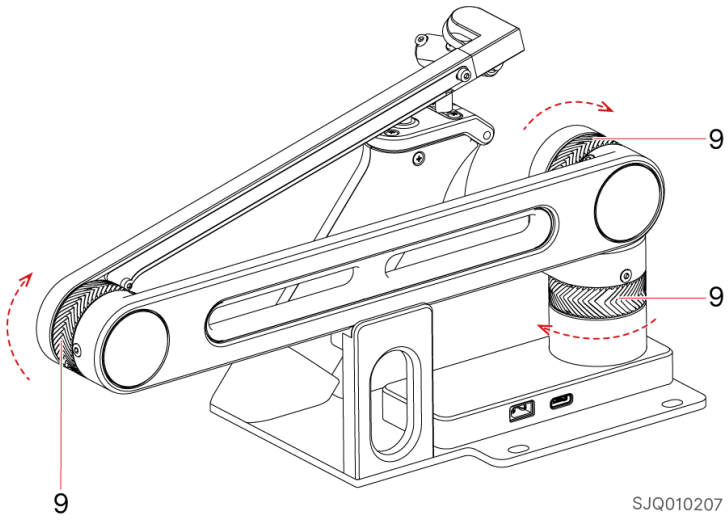
⑤ Ring status indicator

⑥ Inner-side button

⑦ Auxiliary power interface (XT30)

⑧ USB Type-C interface

Used to adjust joint tightness. Rotating in the direction of the arrow tightens (increases damping); rotating opposite to the arrow loosens (decreases damping).



⑨ Joint damping adjustment wheel

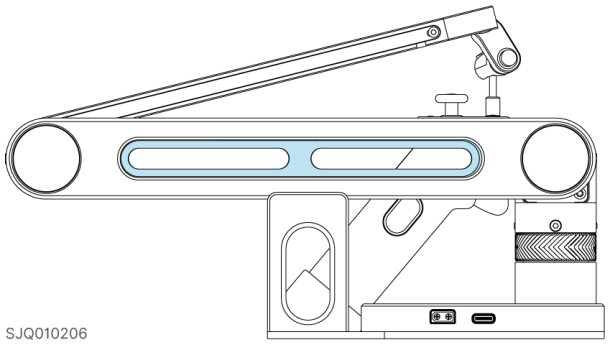
2.2. Button Functions

> 📖NOTE
> Inner-side buttons refer to the buttons on the right side of the left-arm Universal Master Arm handle, and the buttons on the left side of the right-arm Universal Master Arm handle.

Table 2-1 Inner-side button functions

Action	Response
Double-click	Enable/disable teleoperation
Long press	Reset handle joints and home the robotic arm

2.3. Indicator Definitions



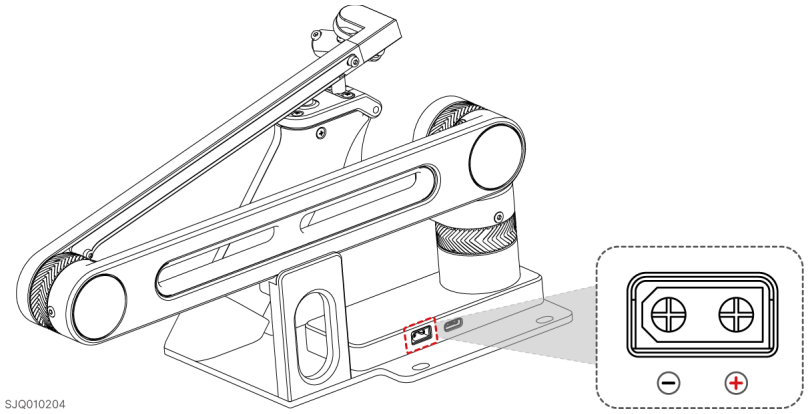
Blue indicator light: normal operating state

Table 2-2 Indicator Definitions

Color	State	Meaning
White	Steady on	Joystick and trigger enter calibration mode. During calibration, the indicator gradually turns green based on calibration progress. After auto-detection completes, it returns to blue
Green	Steady on	Universal Master Arm is calibrating
Blue	Steady on	Universal Master Arm is in a normal operating state

2.4. Interfaces

The auxiliary power interface (XT30) is recommended for a 24V DC power supply.

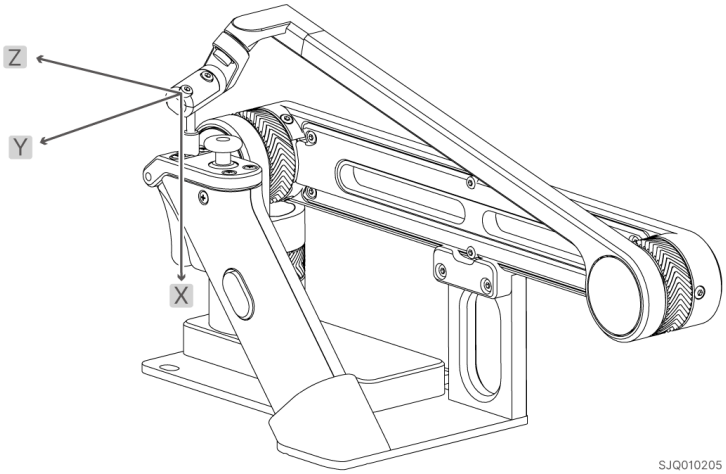


Interface

2.5. Coordinate System and Joints

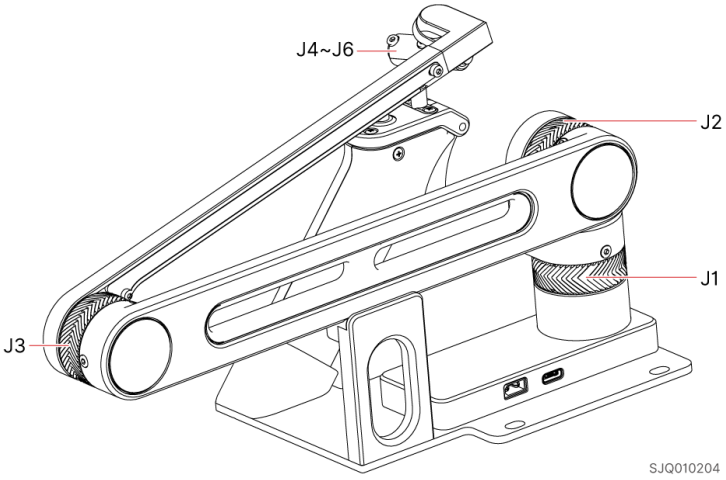
2.5.1. Coordinate System

The current pose of the robotic arm end does not directly use the absolute pose of the Universal Master Arm handle. Instead, it is based on the **initial pose of the robotic arm end**, superimposed with the **increment of the Universal Master Arm handle relative to its initial pose**, and then transformed via the homogeneous transformation from "handle coordinate system → robotic arm end coordinate system."



Coordinate

2.5.2. Joints



Joints

> 📖NOTE
>
> J4 to J6 are all mapped to rotatable spherical joints at the end.

2.6. Specifications

Table 2-3 Basic parameters

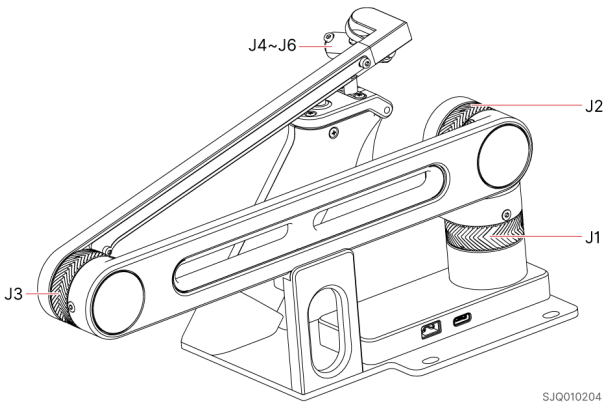
Item	Parameter	Remarks
Operating voltage	5V	USB powered
Rated power	⩽5W	USB powered

External power (auxiliary)	12V~30V DC	XT30
Joystick channels	2	–
Joystick resolution	1%	±1% linearity: when the joystick is smoothly pushed from one end to the other, the maximum deviation between its actual output signal and the ideal straight line does not exceed ±1% of total travel.

Table 2-4 Hardware parameters

Item	Parameter	Remarks
Folded dimensions L×W×H	260mm × 110mm × 145mm	–
Maximum arm reach	500mm ± 5mm	–
Workspace	Hemisphere ⩾505mm	–
Maximum handle movement angle	±180°	Dead points and hand occlusion areas exist, cannot rotate multiple turns
Weight	600g ± 25g	–

Table 2-5 Joint motion range

Joint	Parameter	Diagram
J1	Range: ±145°	J4, J5, J6 are spherical joints  joints
J2	Range: 0~180°	
J3	Range: 0~170°	
J4	Range: ±135°	
J5	Range: ±135°	

J6	Range: ±135°

Table 2-6 Software parameters

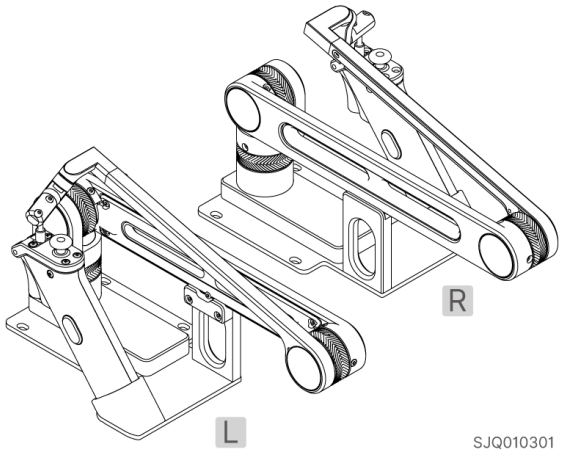
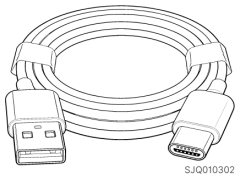
Item	Parameter	Remarks
Teaching method	Heterogeneous teleoperation based on end-point mapping	–
Output DOF	6-axis	Coordinates + attitude angles
Repeatability	Max error: • Rx：1.2° • Ry：2.1° • Rz：1.1°	Reflects stability when returning to the same position
Interface type	• USB Type-C • XT30	–

Table 2-7 Environmental parameters

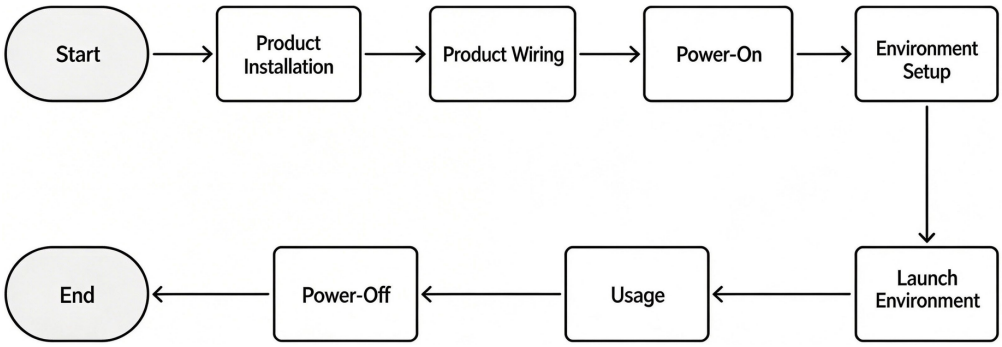
Item	Parameter
Operating temperature range	0℃~45℃
Storage temperature range	-10℃~+60℃
Protection rating	IP22
Operating humidity	15%RH~85%RH
Non-operating humidity	10%RH~90%RH

3. What's in the Box

Table 3-1 Package contents

Item	Quantity	Diagram
Universal Master Arm	Depending on your selected configuration, the package includes one of the following: • Left arm ×1 • Right arm ×1 • Dual arm ×1 pair	
USB Type-A to USB Type-C cable (1m)	One cable per Universal Master Arm	

4. Workflow Diagram



Workflow

5. Product Installation

5.1. Planning Installation Space

Plan sufficient space for operation, maintenance, and cable routing. Ensure the mounting surface is flat and stable; screw holes are reserved in the base mounting holes.

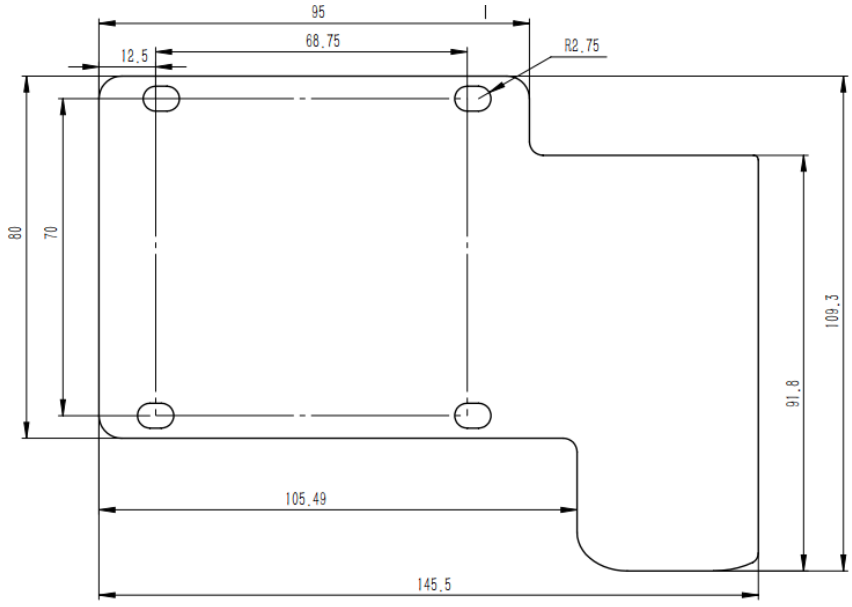
⚠WARNING

- Prioritize safety and always take appropriate measures to prevent the movable platform from tipping over
- Use the Universal Master Arm only in environments compliant with IP22 protection rating. Do not use or operate it in environments exceeding this rating

5.1.1. Base Space

Desktop installation: Refer to the base dimension diagram below. Reserve desktop space no smaller than the base outline dimensions to install the Universal Master Arm. Clamp fixation is recommended.

Mobile platform installation: Design hole spacing according to 70.00mm × 68.75mm.

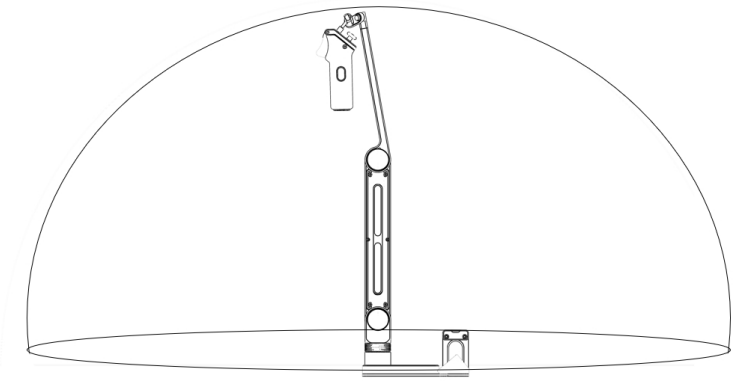


Base Dimensions Drawing (Unit: mm)

5.1.2. Operating Space

The maximum arm reach of the Universal Master Arm is **505mm**. For safety, before operation, reserve a hemispherical area centered on the device with a radius of at least

505mm. Ensure no objects are within this range to avoid collisions that could cause danger.



Operating Space

5.2. Product Installation

Prerequisites

Inspect the Universal Master Arm appearance to confirm no deformation, damage, or other abnormalities.

> ⚠WARNING
> Always prioritize safety. Take appropriate measures to prevent the support platform from shaking or tipping, and maintain a safe distance from the controlled robotic arm.

Procedure

Step 1: Place the Universal Master Arm on the installation surface. The surface must be flat and clean.

Step 2: Use 4 screws of size M4~M6 to tighten the base, or secure it with a clamp.

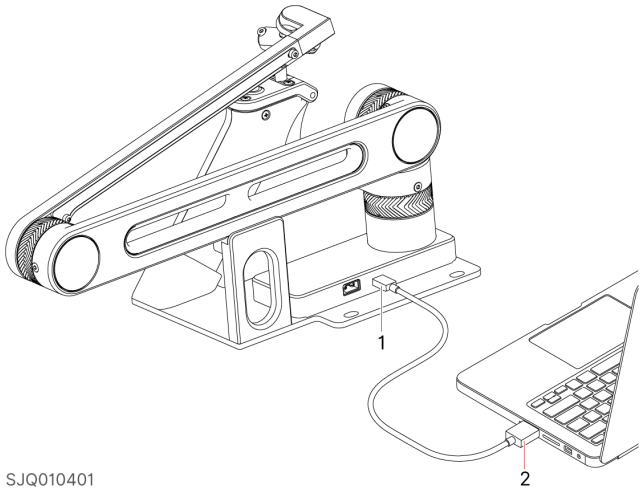
End

5.3. Product Wiring

Procedure

Step 1: Take the provided data cable and connect the USB Type-C end to the interface on the right side of the Universal Master Arm.

Step 2: Connect the USB Type-A end to the computer interface to establish a connection, simultaneously providing power and communication.



① USB Type-C

② USB Type-A

📖NOTE

- If data communication becomes unstable during extended use, connect a stable power supply through the auxiliary power interface (XT30) to ensure stable data transmission
- If multiple Universal Master Arms are used and the computer's built-in USB ports are insufficient, a docking hub can be used

‼CAUTION

The auxiliary power interface (XT30) only supports 12V~30V DC input. Be sure to use within this range; 24V DC input is recommended. Exceeding this voltage range may cause equipment damage or abnormal operation.

End

6. Usage and Development

6.1. Power-On

DANGER

If the robotic arm experiences collision, loss of control, or other emergency risks during operation, immediately trigger the robotic arm's designated hardware emergency stop or stopping device. Do not rely on the Universal Master Arm handle double-click, ROS service, or homing operations.

WARNING Confirm before power-on:

- If condensation has formed, power on only after condensation has completely dissipated
- The robotic arm is securely fixed, and cables are correctly connected
- No personnel, obstacles, or cable interference exist in the work area and planned homing path
- The robotic arm's designated hardware emergency stop or stopping device is functional

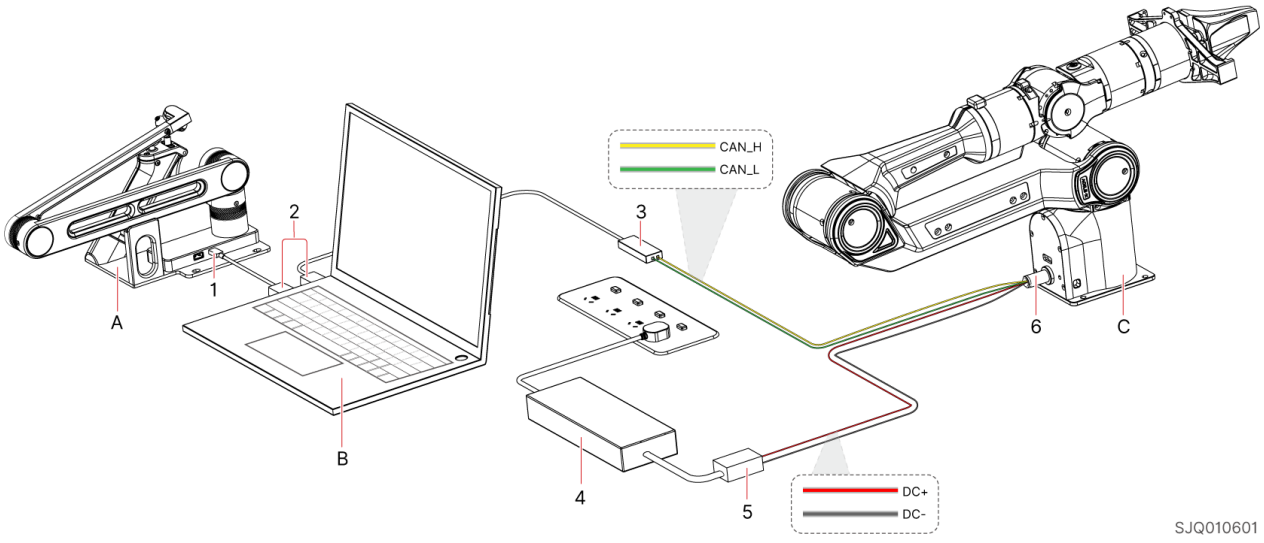
Sequence

a. Power on the robotic arm

b. Boot the industrial computer

Overall Wiring Diagram

The following uses the Universal Master Arm connected to a PiPER robotic arm as an example.



Ⓐ Six-axis Universal Master Arm　　Ⓑ Industrial computer　　Ⓒ Robotic arm

① USB Type-C	② USB Type-C	③ USB-CAN converter
④ AC-DC power adapter	⑤ XT30 connector	⑥ Aviation plug

6.2. Environment Setup

Preparation

Ensure unobstructed access to GitHub. Required repositories:

- ① UMA_Control
- ② UMA_SDK

Procedure

The following uses the Universal Master Arm connected to a PiPER robotic arm as an example.

Step 1: Prepare the environment. Visit link ① above to enter the UMA_Control repository.

Step 2: Install system dependencies according to the README instructions and complete workspace construction.

Step 3: Configure the CAN interface based on the actual wiring.

Step 4: Launch the software and verify that the node running status, Universal Master Arm data, and robotic arm feedback are normal.

End

6.3. Launching the Environment

The following uses a normally mounted PiPER single arm as an example.

Procedure

Step 1: Execute the command; the script will automatically activate the tego environment and load ROS 2 and the workspace.

```
cd ~/UMA
bash src/UMA_Control/UMA_bringup/scripts/start_single_piper_cpp.sh
```

Step 2: Open another terminal, load the ROS environment, and check.

```
source /opt/ros/humble/setup.bash
source ~/UMA/install/setup.bash

ros2 node list
ros2 topic echo /UMA_r/handle_state --once
ros2 topic echo /right_handle_pose --once
ros2 topic echo /feedback/joint_states_right --once
```

Step 3: You can see the robotic arm driver, IK, and Universal Master Arm bridge nodes, and receive corresponding data. The startup log should include relevant entries.

```
side=right, installation_pos=horizontal
```

End

6.4. Power-Off

The following steps apply when the system is normal and the robotic arm is controllable.

Procedure

Step 1: Double-click the inner-side button of the Universal Master Arm to disable teleoperation, and confirm that the robotic arm stops following.

Step 2: Confirm that the robotic arm and its gripper are in a suitable state for power-off, and properly handle any held load.

Step 3: Press `Ctrl` + `C` in the terminal where the software was launched, and wait for the program to exit and return to the command line.

> ⛔DANGER
> If the robotic arm experiences collision, loss of control, or other emergency risks during operation, immediately trigger the robotic arm's designated hardware emergency stop or stopping device. Do not rely on the Universal Master Arm handle double-click, ROS services, or homing operations.

> ‼CAUTION
> - `Ctrl` + `C` is only used to exit the software (close the entire program) and cannot replace the hardware emergency stop.
> - In normal non-emergency use, follow the program shutdown procedure.

Step 4: Power off the robotic arm and Universal Master Arm according to the corresponding hardware instructions.

Step 5: If disconnection is needed, disconnect the USB–CAN and other connections.

End

7. Maintenance and Troubleshooting

7.1. Routine Maintenance

Table 7–1 Routine Maintenance

Item	Action	Frequency
Universal Master Arm cleaning	Use a wet wipe or wrung–out damp cloth to clean dust, dirt, and oil stains	As needed
Screw tightening	Check all external screws for looseness	Every 3 months

Long–Term Storage Maintenance

- It is recommended to perform at least once a year: power on and run the Universal Master Arm program, rotating all joints at least 90° in each direction, repeated 5 times.
- Pre–use check: After long–term storage, before reusing, be sure to perform a test run to confirm normal operation.

7.2. Storage

After use, return the Universal Master Arm to zero, power off, and store it in the original packaging box.

Storage environment requirements: temperature –10°C ~ 60°C, relative humidity 15%RH ~ 85%RH (non–condensing).

!!CAUTION

If condensation forms during transportation or storage, power on only after the condensation has completely dissipated.

7.3. Common Troubleshooting

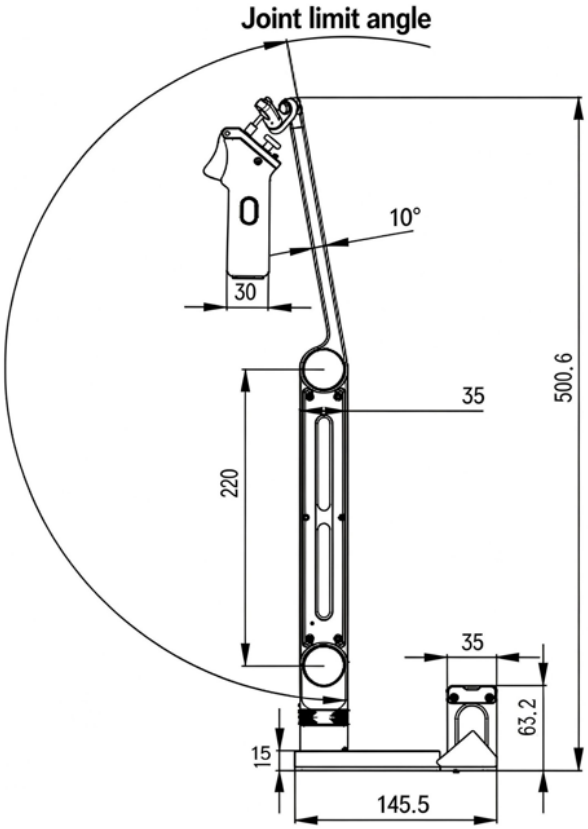
Table 7-2 Quick reference

Symptom	Possible Cause	Solution
pyAgxArm not found	Dependencies not installed in the tego environment	Install in this environment according to the README and re-run the import check
No handle data	• Device not powered on • CAN not enabled • Wiring error	Check power supply, interface name, baud rate, and wiring
No IMU data	• Device has not yet sent IMU data • Communication abnormality	Check power supply and reception status; restart the program normally if necessary
Left-side topics not found after PiPER startup	Right side is enabled by default	Query using /tego_r and right_* topics, or explicitly switch to the left side
Teleoperation status fluctuates repeatedly	• Duplicate control instances • Service response or status communication abnormality	Check nodes and startup terminals, keep the correct instance, and review logs
Service does not exist	• Node not started • Incorrect service name	Use ros2 service list to query actual service names
Homing ineffective	• Teleoperation still enabled • Missing feedback • Home configuration mismatch	• Disable teleoperation • Check feedback, homing list, and error logs

Universal Master Arm data present but robotic arm does not move	• Driver exited or not enabled • Feedback abnormality	Check driver node, logs, and robotic arm status

Appendix

A. Drawings



Arm Reach Drawing (Unit: mm)

B. Abbreviations

Abbreviations	Full Name	Meaning

IMU	Inertial Measurement Unit	Integrates sensors such as gyroscopes to detect device tilt angle, rotational angular velocity, etc., enabling attitude calculation and motion perception
DC	Direct Current	–