Elephant Robotics User Manual

Panda Series Robot

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Copyright Declaration

Catalog

Overview of the manual

About the manual

Welcome to use Panda series robot and thank you for your purchase.

This manual describes the precautions for proper installation and use of the Panda series robot.

Please read this manual and other related manuals carefully before installing this robot system. After reading, please keep it in a safe place so that you can access it at any time.

Reading objects of the manual

This manual is targeted to:

- installer.
- Debugger.
- Maintenance staff.


Attention

Those who install/debug/maintain the Panda series robot must be trained in Elephant Robotics and have the mechanical and electronic knowledge required for the above work.

How to use

This manual should be used when doing the following works:

- Installation work: Move the robot to the working position and fix it to the base according to the installation instructions.
- Debugging: Debugging the robot to work status.
- Maintenance work: regular maintenance robot system to ensure its normal functioning. When the robot malfunctions due to environmental influences or improper operation of the user, or a certain component of the robot system exceeds the normal service life, the robot needs to be repaired.

Main contents of the manual

- Precautions for safe use of the robot.
- Mechanical, electrical installation and commissioning of the robot.
- Maintenance and repair of the robot.

Before the official reading of the manual

Before officially read the manual, users need to know something about it:

1，About the robot system

The robot system includes a collaborative robot body, a controller (Core control system), and a teach pendant (Panda RoboFlow operating system). It can work safely with workers and independently complete the processes of loading, unloading, testing, testing and packaging in industrial manufacturing.

2，About product warranty

During the warranty period of the delivered product, the company will only repair the failures that occur when the robot is normally used. However, in the following cases, the customer will be charged for repairs (even during the warranty period):

1) Damage or malfunction caused by incorrect use and improper use of the manual.

2) Failure caused by unauthorized removal by the customer.

3) Damage caused by improper adjustment or unauthorized repair.

4) Damage caused by natural disasters such as earthquakes and floods.

Therefore, please operate the robot in strict accordance with the instructions in this manual and related manuals.

3，About help

For any questions or suggestions on the contents of the manual, you can query on the official website of the Elephant Robotics to submit the relevant information: https://www.elephantrobotics.cn.

1 Security

1.1 Introduction

1，Introduction to this chapter

This chapter details general safety information for people who perform installation, maintenance, and repair work on Panda series robot. Please read and understand the contents and precautions of this chapter before handling, installation and use.

As described in GB 11291.1-2011, whether it is a robot manufacturer, system integrator, or individual user, it is necessary to carry out hazard identification and risk assessment before using the robot. It is required to conduct a hazard analysis to identify any hazards that may arise; and for hazards identified in hazard identification, a risk assessment should be performed to maximize personal safety and property safety.

This chapter provides a basic guide to safe use by introducing different safety alert symbols and precautions.

2，Interpretation of related terms

1) Collaborative operation

A specially designed robot that works directly with people in a defined workspace.

2) Collaborative workspace

In the safety protection space of the robot work unit, the robot and the person can complete the task at the same time in the production activity.

1.2 Safety alert symbol description

As shown in Table 1-1, this section describes the safety alert symbols used in this manual. You can find the corresponding symbols described in this chapter in other chapters, please note the meaning of these symbols and their meanings.

Table1- 1 Safety Warning Symbol Table

 Danger	Danger: A dangerous situation that is likely to result in death or serious injury if not avoided.

 Warning	WARNING: Conditions that may cause a hazard that, if not avoided, could result in personal injury or serious damage to the equipment.
 Caution Electricity	Be careful of electric shock: It may cause dangerous use of electricity. If it is not avoided, it may cause personal injury or serious damage to equipment.
 Prohibited	Prohibited: Things that are not allowed to do.
 Attention	Caution: Important things to be noted.

1.3 Hazard identification

The safety of the collaborative robot is based on the premise of proper configuration and use of the robot, and even if all safety instructions are observed, the injury or damage caused by the operator may still occur. Therefore, it is very important to understand the safety hazards of robot use, which is beneficial to prevent problems before they occur.

Tables 1-2~4 below are common safety hazards that may exist in the context of using robots:

Table1- 2 Dangerous safety hazards

 Danger	
1	Personal injury or robot damage caused by incorrect operation during robot handling.
2	Personal injury or robot damage caused because the robot is not fixed as required, for example, the screw is not screwed or tightened, and the base is not enough to stably support the robot for high-speed movement, causing the robot to tip down.
3	Failure to perform proper safety function configuration of the robot, or installation of safety protection tools, etc., may cause the safety function of the robot to fail.

Table1- 3 Warning level security risks

 Warning	
1	Play around the robot, you may be hit by a running robot, or be tripped by an obstacle such as a cable to cause personal injury.
2	Unauthorized personnel change the security configuration parameters, causing the safety function to fail or danger.
3	Scratches and punctures caused by sharp surfaces such as other devices in the work environment or robot end effector.
4	The robot is a precision machine and pedaling may cause damage to the robot.
5	If the clamp is not in place or before the power supply of the robot is turned off or the gas source is turned off (it is not determined whether the end effector firmly holds the object without falling off due to loss of power). If the clamped object is not removed, it may cause danger, such as people being injured by crashing.
6	There is a risk of accidental movement of the robot. Under no circumstances should you stand under any axis of the robot!
7	The robot is a precision machine. If it is not placed smoothly during handling, it may cause vibration and may cause damage to the internal components of the robot.

Table1- 4 Potential safety hazards that may result in electric shock

 Caution Electricity	
1	Using a non-original cable may pose an unknown hazard.
2	Contact with liquids by electrical equipment may result in a risk of electric leakage.
3	There may be an electric shock hazard when the electrical connection is incorrect.
4	Be sure to handle replacement work after turning off the power to the controller and related equipment and unplugging the power cord. If the work is performed while the power is on, it may cause electric shock or malfunction.

1.4 Safety Precautions

In general, compared with ordinary machinery, robots have the characteristics of larger working range and faster speed, so they are accompanied by the dangers that ordinary machinery does not have. When installing, using, and maintaining the robot, please pay attention to the following items shown in Table 1-5 and Table 1-6 (the followings are some of the common precautions listed):

Table1- 5 Safety precautions on acts that need to be banned

 Prohibited	
1	It is forbidden to modify the robot or use non-original accessories.
2	Untrained non-professionals are prohibited from entering the robot work area at will, pressing any button or doing other operations at will.
3	The relevant personnel shall not maintain, repair or use the robot after being affected by drinking, taking drugs or stimulating drugs.

Table1- 6 General safety precautions

 Attention	
1	Anyone responsible for installing and maintaining the robot must read and follow these safety instructions.
2	Ensure that safety measures and robot safety configuration parameters are defined as required in the risk assessment to protect programmers, operators, and bystanders.
3	Production operators should not loosen long hair (long hair must be picked up) and wear a work cap, not wearing jewelry.
4	Operators operating in conjunction with the robot must be familiar with and understand the content and exact location of the various warning signs and warning symbols on the equipment and ensure that all warning signs and warning symbols are complete and clear, and that all safety devices are secured before opening and starting the equipment. And make sure the relevant accessories are normal and no one is in a dangerous location where the equipment is activated. When the robot runs abnormally, it should be stopped immediately and the situation must be reported it in time.
5	The operator must clarify the scope of operation, commissioning, maintenance and repair. The operator is not allowed to change the operating procedures and trials at will, and other personnel are not allowed to enter the collaborative operation space and danger zone.
6	When repairing work, operators must hang the warning sign to enter the collaborative operation space.
7	When the operator enters the safety zone of the equipment protected by the safety guard door, it shall be absolutely guaranteed that the safety guard door will always open when working in the area, and the door must be in an unlocked position.
8	When the operator is in production, it should be ensured that each starting device is normal and cannot be started at will.
9	When the maintenance and operation personnel perform maintenance on the

	equipment, the main power switch must be turned off to perform maintenance work.
10	No items should be stacked in the robot working area, and no debris should be placed in the control box.
11	After the operation is completed, the safety protection door should be closed immediately, and the various switches of gas and electricity should be closed according to the procedure, and the work site should be cleaned up.
12	Do not shake the robot and hang heavy objects on the robot.
13	No dangerous behaviors or games around the robot.
14	After installing the robot, make sure the robot is fixed on a stable surface for subsequent operations.
15	Make sure that the robot does not collide with itself or other objects during running.
16	If the robot is damaged, do not continue to use it.
17	Please use the robot within the robot's parameter range and service life, otherwise it will cause serious safety problems.
18	After the emergency stop state is canceled, and before the servo power is turned on, it is necessary to remove the obstacles and faults that cause the emergency stop, and then turn on the servo power.
19	Please pay attention to the rotating shaft of the robot to prevent the cable and the air tube from being entangled. Keep a distance from the shaft to prevent hair or clothing from getting entangled.

1.5 Label, nameplate introduction

1.5.1 Nameplate

There are two types of nameplates used in the robot system. The robot body and power box have different nameplates. The nameplate records some basic information about the product. It should be noted that the production number on the nameplate is unique. That is to say, each product has a unique ID, which is an important basis for distinguishing each product, and is also important information to be provided when applying for maintenance.

1.5.2 Label

Robots are high-precision equipment, and they are more dangerous than ordinary machines when they are unfamiliar or not in accordance with the manual. As shown in Figure 1-1, the labels are attached to the power box to remind the operator to read the relevant operating manual before use.

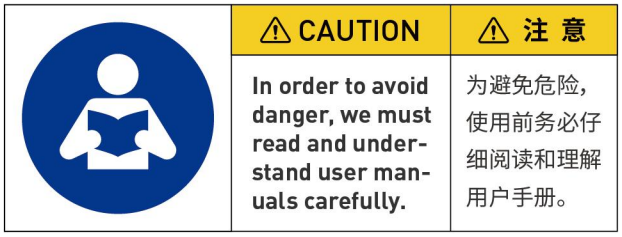


Figure 1- 1 Reading manual before the operation

The power box provides power to the entire robot system and must be operated correctly to prevent electric shock. As shown in Figure 1-2, A power-proof warning label is attached to the power box to remind the operator that there is a potential danger of electric shock to the power box, and it is required to be used correctly to prevent electric shock.

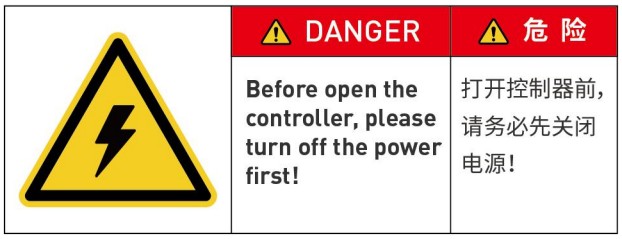


Figure 1- 2 Label to caution preventing electric shock

1.6 Avoid misuse

Please do not use the Panda series robot for the following purposes.

- Medical and life-critical applications.
- In environment that may cause an explosion.
- Used directly without risk assessment.
- Insufficient use of safety function levels.
- Inconsistent use of robot performance parameters.

1.7 Emergency stop

This section describes two types of emergency stop for robots:

- If you feel abnormal during the robot's motion, immediately press the emergency stop switch.
- When the force generated by the collision of the robot with the person or object is greater than the threshold, the robot detects the force generated by the collision, thereby stopping or moving to a certain position (collision return).

1.7.1 Emergency button

When the emergency stop button on the teach pendant is pressed, the drive will be stopped, the brake will start, the motor power will be turned off, and the electromagnetic brake will stop the robot's inertial motion, the robot will stop all

motion, the program running in Panda RoboFlow It will also be stopped.

However, during normal operation, do not press the emergency stop switch at will. If the emergency stop switch is pressed during the operation, the robot movement trajectory before stopping will be different from the trajectory during normal operation and may hit a peripheral device or the like.

When the vehicle is in an emergency stop state (normal), if the robot system is to be placed in an emergency stop state, press the emergency stop switch when the robot does not operate.

Before using the emergency stop switch, you need to know the followings:

- The emergency stop (E-STOP) switch can only be used to stop the robot in an emergency.
- To stop the robot running the program in a non-emergency situation, use the Pause or STOP command. The Pause and STOP commands will not turn off the motor. Therefore, the brake will not work.
- If user need to control the emergency stop of the robot and other equipment at the same time, you can use the external E-STOP double loop circuit (user need to short it when not in use).

1.7.2 Collision checking

During the operation of the robot, it is possible to touch people or objects. It can be protected by setting a protection threshold. The specific operation mode is as follows: When the force generated by the collision of the robot with the person or the object is greater than the threshold, the robot detects the force generated by the collision, thereby stopping or moving to a certain position (collision return).

Please note that when the protection threshold is set too high, a large force is required to stop the robot, which will reduce the sensitivity of the collision detection to a certain extent. When the protection threshold is set too low, the robot may stop when it is holding the load due to the excessive torque generated by its own motion. Please set the threshold of protection under guidance.

In addition, you can set the protection threshold for each movement and each movement of the robot, and set the two protection threshold directions including the X-Y plane (horizontal direction) and the Z plane (vertical direction).

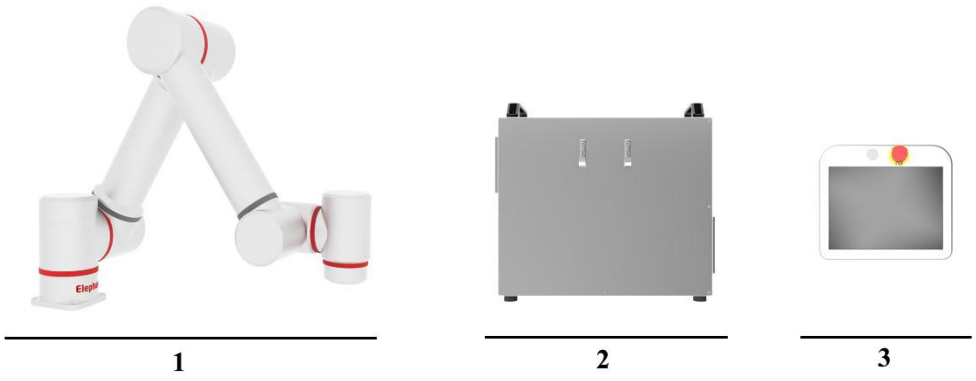
1.8 Urgent handling

 Attention	If the software pops up with a fatal error message, please activate the emergency stop quickly, write down the condition that caused the error, and contact your supplier.
	In the event of a fire, use a carbon dioxide (CO_2) fire extinguisher!

2 About product

2.1 Overview of the robot system

As shown in Figure 2-1, in the Panda series of robots, each robot system consists of three main components: the robot body (also known as the manipulator), the controller and the teach pendant.



1-The robot 2- Controller 3-Teach pendant

Figure 2- 1 Robot system

The robot body is a mechanical body used to complete various tasks of the robot system, and mainly includes a robot casing, a driving device, a transmission unit, and an internal sensor.

Compared with the heavy and multi-core cables of traditional industrial robots, the Panda series robot's drive and brakes are integrated into the robot body. This greatly reduces the number of cable cores connected from the body to the controller, and also improves the stability and anti-interference ability of the cable transmission data, and reduces the cost.

The main material of the body casing is aluminum alloy. The robot's principle of motion is a combination of rotational motions of six joints. Using kinematics and dynamics analysis, the algorithm is solved to achieve the desired motion at the end of the robot.

The controller is the structural realization of the robot control function and is a key part of determining the function and level of the robot. The controller is loaded with a power source, a computer, etc., to control the overall motion of the robot.

The teach pendant is the main interface of human-computer interaction, and its internal part is composed of a touch screen display, a control circuit board and some components. The robot can be programmed and operated by

using a teach pendant.

Simply, if the robot system is like a human, then the controller is like a human brain, controlling the robot body (like a human hand) to perform tasks, and the teach pendant is the human-machine interface that the robot system communicates with people.

2.2 Robot

2.2.1 Characteristics of the robot

The Panda series robot have the advantages of short deployment time, easy operation, safe use and convenient expansion of peripheral equipment, which can greatly shorten the deployment time of the factory for automation project transformation and reduce the total cost of deployment. The specific description is as follows:

1，Easy to deploy

In order to shorten the transformation cost and deployment time of the automated production line, the Elephant Robotics's products are mainly oriented to the upgrade and transformation of independent stations compared to the traditional robotic deployment of the entire automated production line. The customer or system integrator can choose the adapted end effector, radar or camera to match the robot.

2，Easy operation

Panda RoboFlow and our automated solutions help engineers design a stand-alone workstation as soon as possible to install end-executing systems, stands, cameras and other equipment. And dragging the teach function can help users shorten the teaching time and simplify the debugging steps.

3，Easy to program

Panda RoboFlow provides users with graphical programming capabilities to help users get up and running quickly, even without a programming foundation.

4，Safe and reliable

In addition to the common safety collision detection, Panda series cooperative robots can also be equipped with safety equipment such as safety vision, laser radar and grating to ensure a stable and reliable safe working environment.

2.2.2 Model

There are two robots in the Panda series, namely Panda 3 and Panda 5. The model name is shown in Table 2-1.

Table 2- 1 Model description table

Panda	3/5
Panda series	Load capacity 3kg/5kg

2.2.3 Robot joint introduction

The Panda 3 Collaboration Robot is a robot with a load of 3kg and a range of 550mm. The Panda 5 Collaboration Robot is a robot with a load of 5kg and a range of 850mm. Their repeat positioning accuracy is ±0.05mm. These two robots are used in independent work: for loading, unloading, testing, testing and packaging. They can work safely with workers.

The schematic diagram of the robot body is shown in Figure 2-2.

The mechanical body of the Panda series robot can be thought of as an open-chain multi-link mechanism. The start link is the base of the robot, the end link is connected to the end effector, and the adjacent links are connected by a joint. The Panda series robot is a 6-degree-of-freedom industrial robot consisting of 6 links and 6 joints (axes). When numbered, the base is called the link 0 and is not included in the six links. The link 1 is connected to the base by the joint 1, the link 2 is connected to the link 1 through the joint 2, and so on.

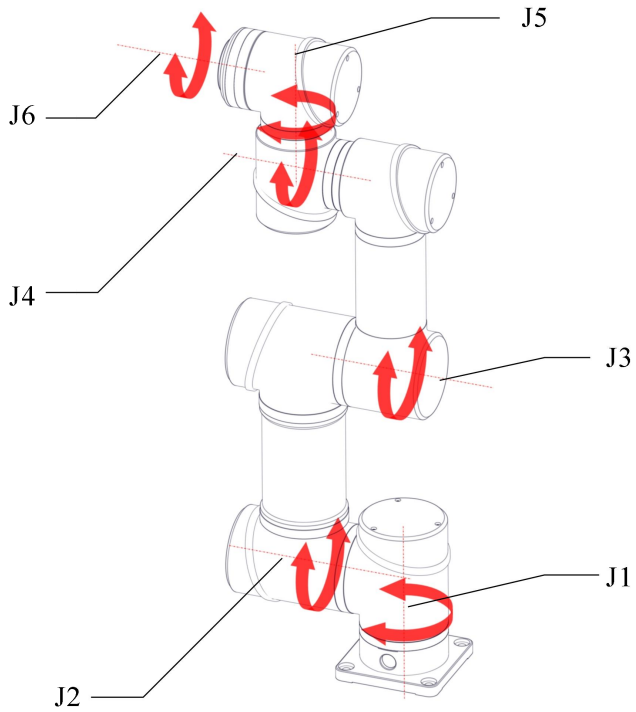


Figure 2- 2 Schematic diagram of the robot

The flange can be used to connect an end effector, such as an electric gripper or a pneumatic suction cup.

2.3 Scope of work

The working space of the Panda 3 and Panda 5 robots is shown in Figure 2-3~4. The effective working range of the robot is 550mm and 850mm respectively. Please measure the actual range according to the range of motion of the robot before using the robot to avoid the consequences of insufficient arm length or collision.

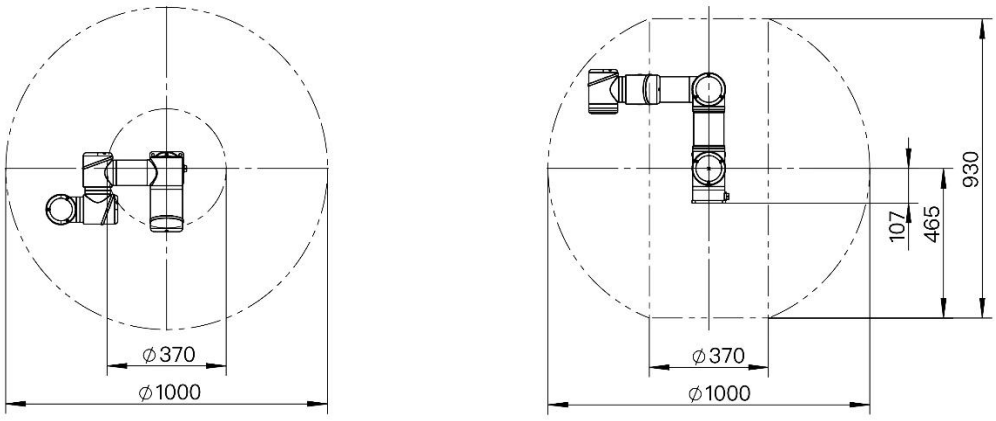


Figure 2- 3 Schematic diagram of the Panda 3 workspace

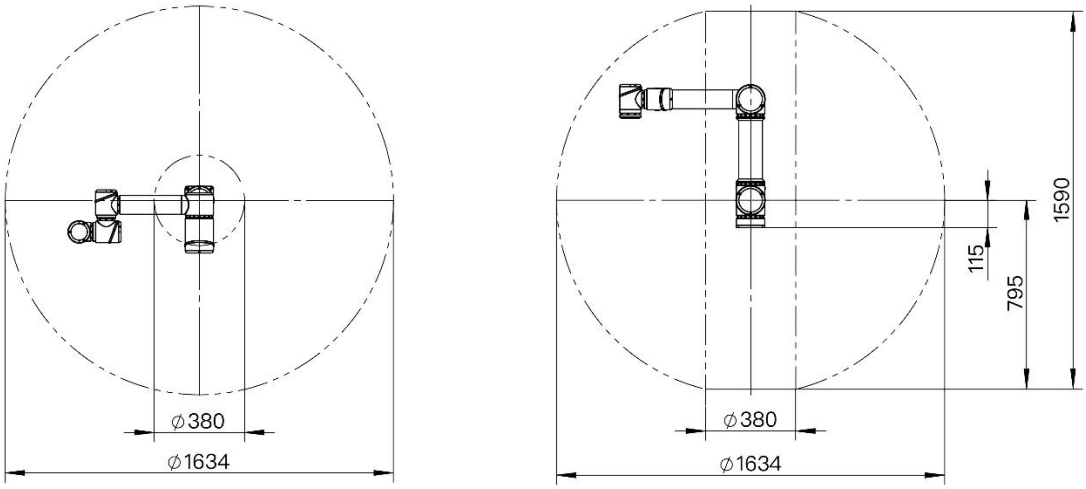


Figure 2- 4 Schematic diagram of the Panda 5 workspace

2.4 Active load

The Panda 3 robot is rated at 3kg and can operate under loads of 3kg and below. The Panda 5 robot is rated at 5kg and can operate under loads of 5kg and below. As the load moves further and further away from the J6 flange position, its payload will become smaller and smaller.

2.5 Technical Parameter Table

The specifications parameters of the Panda series robot are shown in Table 2-2.

Table 2- 2 Technical Parameter

Robot		
Robot version / Parameter name	Panda 3	Panda 5
Payload	3kg	5kg
Reach	550mm	850mm
Degrees of freedom	6	
Working range	±360°	±360°
Axis maximum speed	J1/J2/J3：180° /sec	J1/J2/J3：150° /sec
	J4/J5/J6：208° /sec	J4/J5/J6：208° /sec
Tool speed	1m/sec	1m/sec
Weight	17kg	24.5kg
Position repeatability	±0.05mm	
Dimensions robot base	123mm×123mm	
Programming mode	Graphical programming	
IP classification	IP54	
Typical power consumption	160W	260W
Materials	Aluminium alloy， Rubber	
Operating temperature range	0-50℃	
Collaboration operation	Test in accordance with： EN ISO 13849:2008 PL d EN ISO 10218-1: 2011-Clause 5.4.3	
Noise	<70dB	
Robot mounting	Any angle	
Relative humidity	5%-95%	
Controller		
Size （L×W×H）	545mm×285mm×433mm	
Weight	25kg	
Power supply	AC 110-240V，50-60Hz	
IP classification	IP40	
Certificate	CE certificate	
Interface and openness	SDK(Python, C++,JAVA),API,ROS	
I/O ports	Digital Input:16	

	Digital Ouput:16
I/O power supply	24V 2A
Communication	TCP/IP
Teach Pendant	
Size（L×W×H）	255mm×230mm×90mm
Weight	1.8kg
Screen resolution	1024×768
IP classification	IP20
Screen size	10.4″

3 Environment and installation

3.1 Transportation and storage

Since the robot is a precision device, please pay special attention to the protection of the device during transportation.

 Attention	Avoid applying external force to the robot's body and motor.
	When transporting the robot over long distances, it is necessary to fix it to the handling device to prevent the robot from tipping over. If necessary, use the packaging at the time of delivery.
	If the robot produces condensation during transportation/storage, turn the power on after removing condensation.

When transporting before installation, in principle, lifting equipment such as bridge crane should be used. Since the mass of the main body is not heavy, manual handling can also be considered without lifting equipment. Pay attention to safety when handling by hand, and take it with care to avoid damage to the equipment.

 Attention	Please use heavy lifting equipment such as driving as much as possible, and be careful of the people standing around to prevent the machine from rolling over.
	When carrying the Panda 3 or Panda 5 robot manually, the number of personnel must not be less than two.
	The robot is a precision device, so avoid excessive vibration and shock when handling.
	The weight of the Panda 3 robot body is 17 kg. The weight of the Panda 5 robot body is 24.5 kg.
	If the sling is used to lift the robot, in order to avoid the appearance damage of the robot, place a thick cloth in the place where the sling is in direct contact, and try to avoid the person standing under the robot body being lifted.
	The robot cable and power must be disconnected before handling.

The storage environment temperature of the robot is +0°~+50°, and a special person shall be responsible for keeping it.

3.2 Open box examination

When the packing box is in place, please confirm that the robot package is intact. If there is any damage, please contact the logistics company and our company in time.

After unpacking, check the actual items in the box according to the list of

items.

3.3 Working environment and conditions

Please set up the robot system in the environment that meets the requirements stated in table 3-1, in order to play / maintain the performance of the machine and use it safely.

Table 3- 1 Working environment and conditions

Temperature	0℃~+50℃
Relative humidity	20%~70%
Indoor and outdoor requirements	Indoor
Other environmental requirements	- Avoid sun exposure. - Keep away from dust, oil smoke, salt, iron filings, etc.. - Keep away from flammable, corrosive liquids and gases. - Do not come into contact with water. - Do not transmit shocks, vibrations, etc. - Keep away from sources of strong electromagnetic interference.

3.4 Installation

3.4.1 Installation requirements

The actual weight of the Panda 3 robot is 17kg. The actual weight of the Panda 5 robot is 24.5kg. Considering the movement of the robot, the center of gravity will move as the robot moves. Therefore, the robot needs to be fixed on a solid base to be used normally. Base weight requirements: fixed base, or mobile base.

- The installation angles of the robot include vertical, inverted, side mounted angles, etc.
- Table 3-1 shows the installation environment.
- The installation position must not be less than the working range of the robot.

3.4.2 Installation

1，Interface size of robot base

The pedestal fixing hole is the interface that fixes the robot to other bases or planes. The specific hole size is shown in Figure 3-2. It is 4 through holes with a diameter of 9 mm, which can be fixed with M8 bolts (M8 bolts and matching gaskets and nuts are installed in the package).

Table 3- 2 Specifications of robot base fixing screw

Bolt specification	M8
Bolt length	Select based on the thickness of the platform of the base mounting robot
Strength	12.9
Tightening torque	28Nm (recommended using a torque wrench for fastening)

The specific hole size is shown in Figure 3-1. Make sure that there is a corresponding threaded hole on the fixed base before installing.

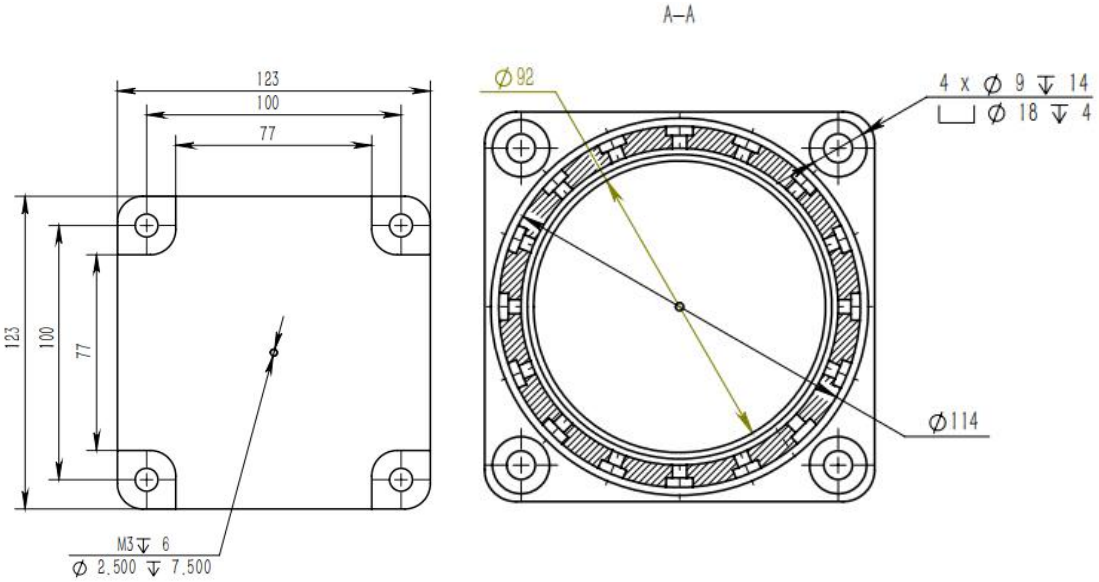


Figure 3- 1 The specific hole size

2， Mount the robot on the base

Before you officially install, please confirm:

- The environment to be installed complies with the requirements of Table 3-1.
- The installation position is not less than the working range of the robot, and there is enough space for installation, use, maintenance and repair.
- Place the stand in the proper position.
- Installation related tools are ready, such as screws, wrenches, etc.

After confirming the above, move the robot to the mounting surface of the base, adjust the position of the robot, and align the fixing hole of the robot base with the hole on the mounting surface of the base.

Warning	When adjusting the position of the robot on the mounting base, please avoid pushing the robot directly on the mounting surface of the base to avoid scratches.
	When manually moving the robot, please try to avoid applying external force to the weak part of the robot body to avoid unnecessary damage to the robot.

After aligning the holes, align the screws with the holes and tighten.

Danger	As long as the robot is not yet firmly mounted on the base, the robot may be in danger of falling over. Please keep the balance of the robot.

3，Place controller, teach pendant

The outline of the controller as shown in Figure 3-2.

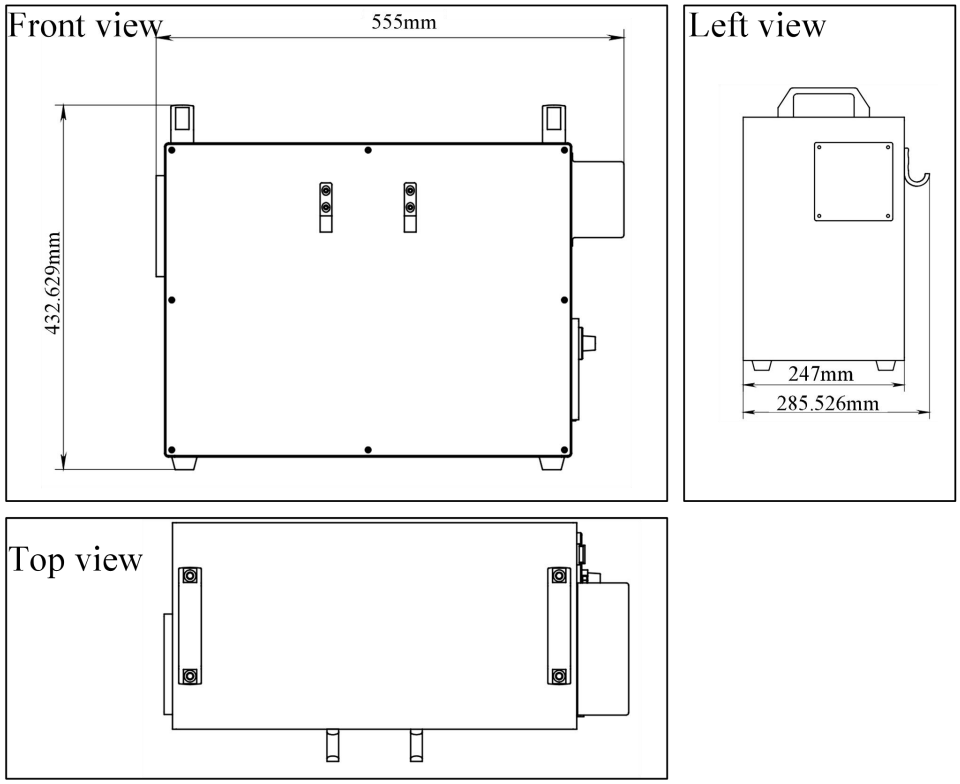


Figure 3- 2 Controller dimensions

Please determine the placement position according to the actual size of the controller. Note that there should be no items to block the cooling fan of the controller, so as not to affect the heat dissipation effect. A better heat dissipation effect is beneficial to improve the working life of the controller.

There are four foot cups in the base of the robot controller for smooth placement of the controller. For the position of the specific cup, please refer to

the following figure. Please place the controller smoothly to prevent the machine from tilting and injuring people or objects.

The teach pendant can be hung on the side of the robot controller or placed on top of the controller.

Attention	When placing the robot controller, be careful not to keep its distance from the robot body beyond the length of the connecting cable.
	Choose the placement position of the controller, try to avoid possible problems such as the controller being bumped or close to the wall not conducive to heat dissipation.

Figure 3- 3 Installation diagram

4，Install the end effector to the robot flange

The end effector is a device specially designed and installed at the mechanical interface for the robot to perform its tasks. For example, grippers, wrenches, welding torches, spray guns, etc.. The specific flange size is shown in Figure 3-4.

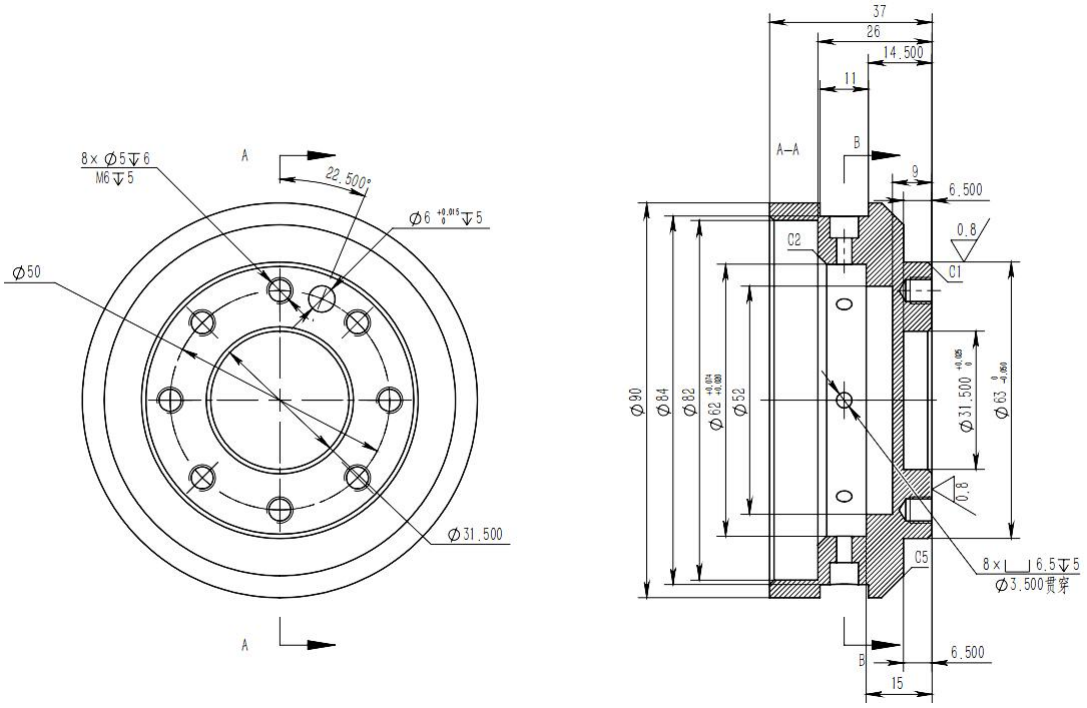


Figure 3- 4 Flange size

To install the end effector to the robot flange, there are two cases. One is that the end effector interface corresponds to the flange mechanical interface size; the other is to use the adapter that meets the size requirements of the connection interface for connection.

3.5 Electrical connections

3.5.1 Cable connection

There are three cable lines used in the robot system. The specific information is shown in Table 3-3.

Table 3- 3 Main cables of the robot

Type	Connection	Length	Use description
Controller power cord	External power supply - controller	2m	Power supply to the entire robot system.
Teach pendant	Controller - teach pendant	4m	Provide controller-demonstration information exchange channels.
Controller-Robot Connection Cable	Controller-robot	4m	Mainly to drive the robot motor, collect and analyze the encoder information.

Attention	The original cable must be used.
	The cable interface is generally easy to damage. Do not use brute force or vigorously shake when plugging or unplugging. It is easy to cause the interface to

	loose or deform. Please insert and remove it carefully after alignment.

 Caution Electricity	Be sure to make replacement after turning off the power to the controller and related equipment and unplugging the power cord. If the work is performed while the power is on, it may cause electric shock or malfunction.
	Be sure to connect the AC power cable to the power plug. Do not connect directly to the factory power supply. Turn off the power to the robot system by unplugging the power cord. It is extremely dangerous to work when the AC power cable is connected to the factory power supply, which may result in electric shock and malfunction of the robot system.
	Be careful not to bend the cable forcibly to avoid applying a load to the cable. Also, do not place heavy objects on the cable and forcibly bend or pull the cable. Failure to do so may result in damage to the cable, disconnection, or poor contact, electric shock or improper system operation.
	Before wiring, turn off the power of the controller and related devices and pull up the warning sign (eg, do not turn on the power). Wiring under power-on conditions is extremely dangerous and may result in electric shock and malfunction of the robot system.
	Please ensure that the ground wire connection is reliable, otherwise it may cause fire or electric shock.

3.6 System startup debugging

After the installation and connection work is completed, user need to plug in the power cord, turn on the power switch, press the system start button of the teach pendant. After that, user should observe whether the display button of the teach pendant is lit. If the light is on, it means the installation is successful, you can go to the next step. Otherwise user need to check if an important step is missing. If it is unsuccessful according to the manual, it may cause a malfunction during transportation. Do not disassemble the parts by yourself. Please contact a professional for disposal.

Robot system boot flow chart as shown in Figure 3-5. Please strictly follow the manual, otherwise the warranty will not be available if the robot is damaged due to improper operation.

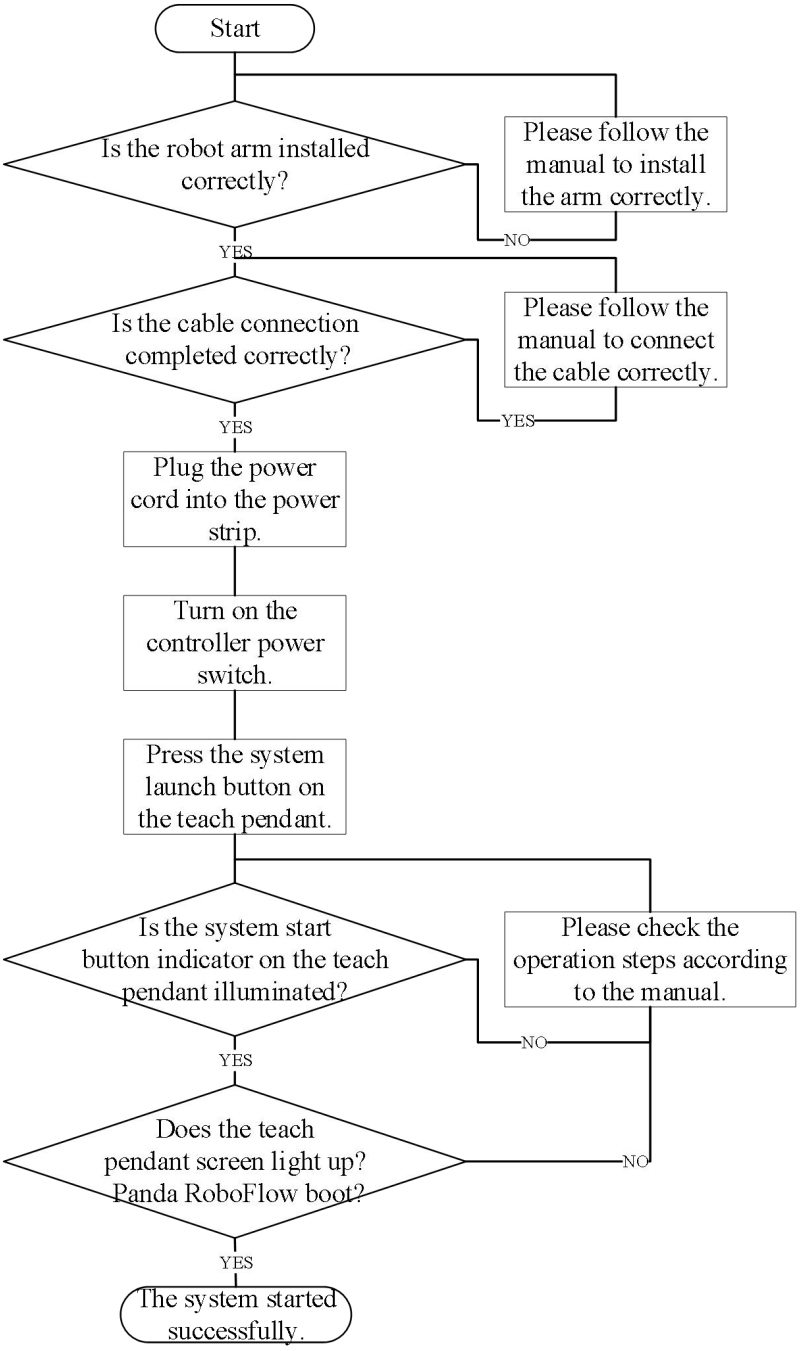
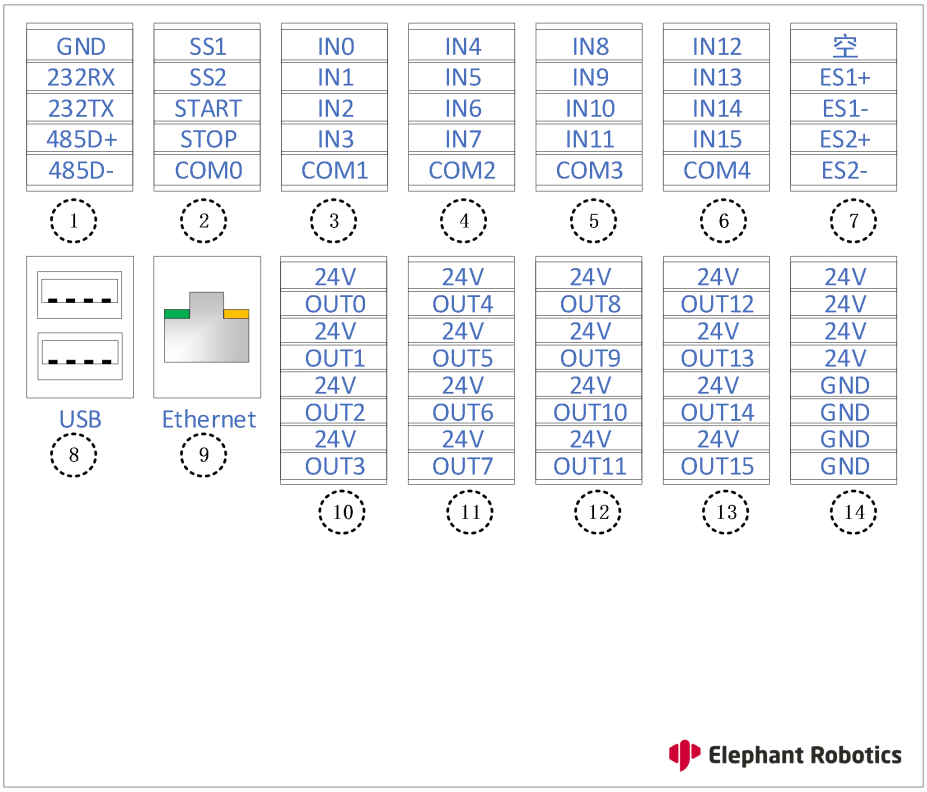


Figure 3- 5 Robot system boot flow chart

3.7 IO Board

3.7.1 IO board introduction

Figure 3-6 shows the IO board port of the Panda series robot. Port details are shown in Tables 3-4~8.



1- Serial port	2- External control port	3- Digital input 0~3	4- Digital input 4~7
5- Digital input 8~11	6- Digital input 12~15	7- External E-STOP port	8-USB port
9- Ethernet interface	10- Digital output 0~3	11- Digital output 4~7	12- Digital output 8~11
13- Digital output 12~15	14- DC power port		

Figure 3- 6 IO board port description

The Panda series robot provides common communication interfaces, power interfaces, general purpose IO ports, and dedicated IO ports. Among them, the universal IO port includes 16 digital input signals and 16 digital output signals for interaction with other devices, and together with other devices constitute an important part of the automation system.

For example, the user can use the digital output signal to control the electric jaws installed on the output flange, or connect to the PLC for signal interaction.

1，Communication port

As shown in Table 3-4, the IO board provides three communication methods, namely serial communication, USB communication, and Ethernet network port communication.

Table 3- 4 IO port description table 1（Communication port）

No.	Type	Port	Definition	Description
1	Serial port	0	GND	Signal ground（RS232）
		1	232RX	Receive data（RS232）
		2	232TX	Send data（RS232）
		3	485D+	Receive data（RS485）
		4	485D-	Send data（RS485）
8	USB port	-	USB1	USB port 1
		-	USB2	USB port 2
9	Ethernet interface	-	Ethernet	Ethernet interface

1) Serial communication: The serial port sends and receives bytes in bits. It's simple and able to communicate over long distances.

In this IO board, serial communication is divided into RS232 and RS485. The former occupies the first three ports of the terminal block, and the latter occupies the last two ports. RS232 is full-duplex, the serial port can receive data while using one line to send data while using another line. RS485 is half-duplex, and only one point can be sent at any time. Therefore, the transmitting circuit must be controlled by an enable signal.

RS485 and RS232 are only differences in the physical protocol of communication (interface standard) . RS485 adopts differential transmission mode, and RS232 is single-ended transmission mode. But the communication program doesn't have much difference.

Users can choose one according to actual needs.

2) USB port

Users can use the USB interface to copy program files, or use the USB interface to connect peripherals such as mice and keyboards.

3) Ethernet interface

Users can use the Ethernet interface for communication between the PC and the robot system, or for Ethernet communication with other devices.

2，Control signal port

As shown in Table 3-5, the IO board provides the control signal port.

Table 3- 5 IO port description table 2（Control signal port）

No.	Type	Port	Definition	Description
2	External control port	0	SS1	Emergency stop control signal 1
		1	SS2	Emergency stop control signal 2
		2	START	START
		3	STOP	STOP
		4	COM0	Common port 0
7	External emergency stop port	0	Null	Undefined
		1	ES1+	External emergency stop control signal 1
		2	ES1-	
		3	ES2+	External emergency stop control signal 2
		4	ES2-	

With these ports, external devices can control the system's emergency stop loop. It is also possible to control the start and stop of the program. These ports make it easy for the user to control the robot system as a link in the automatic control system.

3，Digital input ports

As shown in Table 3-6, there are general-purpose digital input ports. The Panda series robot provides 16 digital input signals.

Table 3- 6 IO port description table 3（Digital input ports）

No.	Type	Port	Definition	Description
3	Digital input port 0~3	0	IN0	Digital input signal 0
		1	IN1	Digital input signal 1
		2	IN2	Digital input signal 2
		3	IN3	Digital input signal 3
		4	COM 1	Common port 1
4	Digital input port 4~7	0	IN4	Digital input signal 4
		1	IN5	Digital input signal 5
		2	IN6	Digital input signal 6
		3	IN7	Digital input signal 7
		4	COM 2	Common port 2
5	Digital input port 8~11	0	IN8	Digital input signal 8
		1	IN9	Digital input signal 9
		2	IN10	Digital input signal 10
		3	IN11	Digital input signal 11
		4	COM 3	Common port 3
6	Digital input port 12~15	0	IN12	Digital input signal 12
		1	IN13	Digital input signal 13

		2	IN14	Digital input signal 14
		3	IN15	Digital input signal 15
		4	COM 4	Common port 4

It should be noted that the input common terminal needs to be connected to the DC 24V power supply. The input port can be active high or active low depending on the common configuration.

4，Digital output ports

As shown in Table 3-7, there are general-purpose digital output ports. The Panda series robot provides 16 digital output signals.

Unlike the input port, the internal DC 24V provides 24V directly. The output is valid at 0V. The peripherals form a complete loop by connecting the two ends (output signal and common port), and the peripherals can be controlled by controlling the state of the outputs.

Table 3- 7 IO port description table 4（Digital output ports）

No.	Type	Port	Definition	Description
10	Digital output port 0~3	0	24V	DC 24V
		1	OUT0	Digital output signal 0
		2	24V	DC 24V
		3	OUT1	Digital output signal 1
		4	24V	DC 24V
		5	OUT2	Digital output signal 2
		6	24V	DC 24V
		7	OUT3	Digital output signal 3
11	Digital output port 4~7	0	24V	DC 24V
		1	OUT4	Digital output signal 4
		2	24V	DC 24V
		3	OUT5	Digital output signal 5
		4	24V	DC 24V
		5	OUT6	Digital output signal 6
		6	24V	DC 24V
		7	OUT7	Digital output signal 7
12	Digital output port 8~11	0	24V	DC 24V
		1	OUT8	Digital output signal 8
		2	24V	DC 24V
		3	OUT9	Digital output signal 9

		4	24V	DC 24V
		5	OUT10	Digital output signal 10
		6	24V	DC 24V
		7	OUT11	Digital output signal 11
13	Digital output port 12~15	0	24V	DC 24V
		1	OUT12	Digital output signal 12
		2	24V	DC 24V
		3	OUT13	Digital output signal 13
		4	24V	DC 24V
		5	OUT14	Digital output signal 14
		6	24V	DC 24V
		7	OUT15	Digital output signal 15

5，DC power port

As shown in Table 3-8, the IO board provides an internal DC 24V for the user to use.

Table 3- 8 IO port description table 5（DC power port）

No.	Type	Port	Definition	Description
14	DC power port	0	24V	Internal DC power supply 24V
		1	24V	
		2	24V	
		3	24V	
		4	GND	Internal DC power supply GND
		5	GND	
		6	GND	
		7	GND	

3.7.2 IO port principle and application

1，Digital input port

As shown in Figure 3-7, the input signal is driven through the current-limiting resistor R to allow the internal circuit to detect it. The difference between the PNP input and the NPN input is that one end of the PNP input is connected to 0V, and one end of the NPN input is connected to 24V.

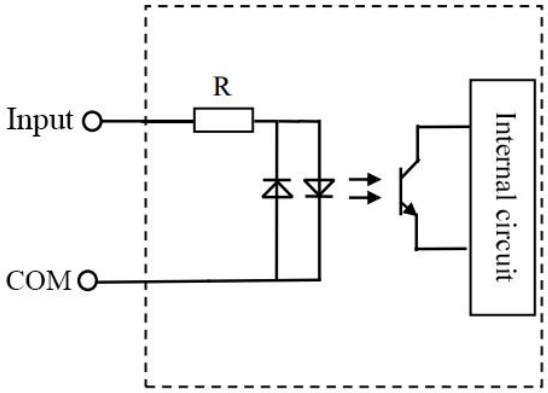


Figure 3- 7 Digital input port schematic

Figure 3-8 shows an example of an input connection application. When the common port is connected to 24V, once an external device inputs 0V, the input signal is in the High state, otherwise it is in the Low state. vice versa.

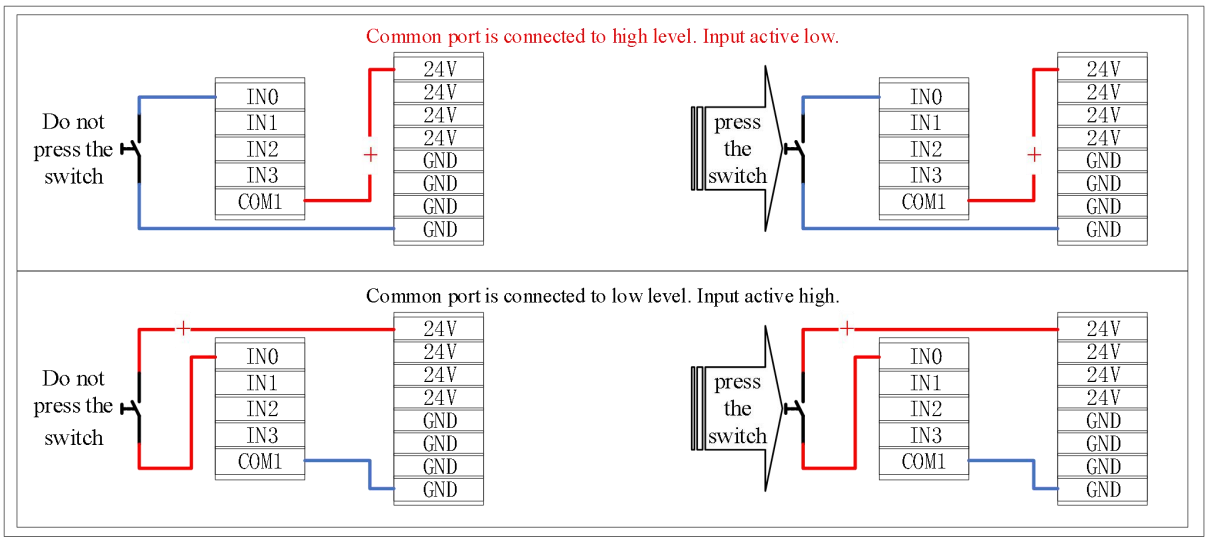


Figure 3- 8 Input application example diagram

2，Digital output port

As shown in Figure 3-9, the output is an NPN output. When the control signal is high, the triode is activated and the output is connected to GND. When the control signal is low, the triode is blocked and the output is in a floating state.

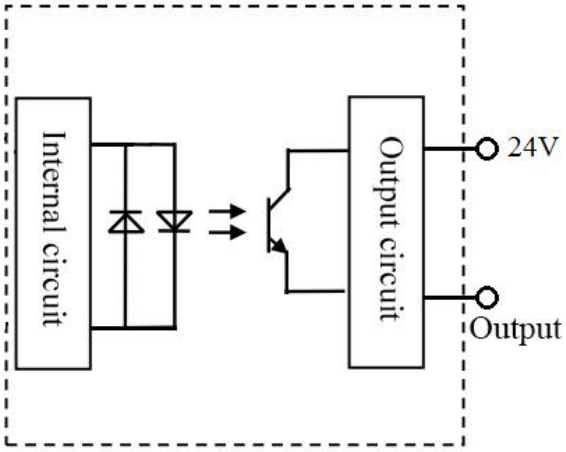


Figure 3- 9 Digital output port schematic

Figure 3-10 shows an example of an output connection application.

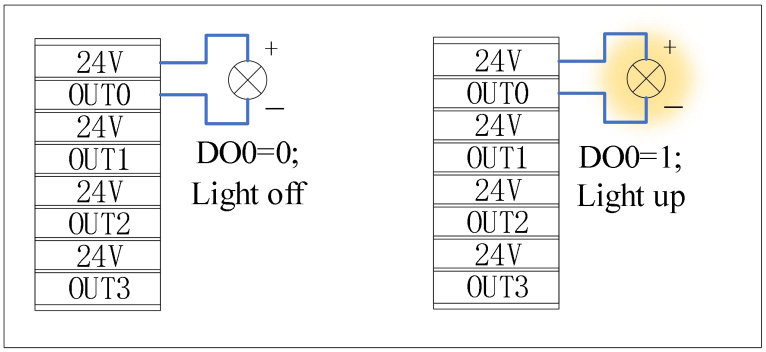


Figure 3- 10 Output application example diagram

4 Calibration

If the parts of the robot (motor, reducer, timing belt, etc.) are replaced, there will be a deviation between the origin stored by each motor encoder and the origin stored by the controller, and the correct positioning cannot be performed. The origin is the reference of the robot coordinate system. Without the origin, the robot cannot judge its position. Therefore, in order to obtain the highest possible absolute positioning accuracy, the robot must be calibrated (the operation where the two origin positions are the same is called calibration) .

Robots are specially calibrated before they leave the factory. Generally, recalibration is required in the following cases:

- After replacing the parts of the robot (motor, reducer, timing belt, etc.).
- Collision with the work-piece or environment.
- Move the robot joints without being under the control of the controller.
- Replace the encoder data backup battery.
- Other conditions that may cause zero point loss.

5 Maintenance

5.1 On the safety of maintenance

When the robot has been running for a period of time, it is necessary to carry out necessary maintenance to ensure that the robot's function is normal.

- Be sure to perform robot maintenance by trained personnel.
- Personnel trained in safety refer to those that have been regulated by national laws and regulations.
- Personnel who are trained in the safety when engaged in industrial robot-related business (training on knowledge, operation, teaching, etc. of industrial robots, knowledge of business operations such as inspections, and related laws and regulations).
- The company's training is for those who have completed the installation training and maintenance training.

Before maintenance, please read “Safety on Maintenance”, this manual and related manuals, and perform maintenance based on a thorough understanding of safety maintenance methods.

 Warning	Do not randomly change any information in software security configuration (such as force limits). If the safety parameters change, the entire robot system should be considered a new system, which means that all safety audit processes, such as risk assessment, must be updated.
	Do not remove any parts unless otherwise stated in this manual. The maintenance steps shall be strictly adhered to according to the content. If wrong disassemble or maintenance is performed, not only will the robot system malfunction, but it may also cause serious safety problems. In addition, self-disassembly during the warranty period will lose the warranty qualification.
	Be sure to confirm the robot's action after replacing the parts outside the robot's action area. Otherwise, the robot before the action confirmation may perform unexpected actions and may cause serious safety problems.
	All disassembled robots need to be recalibrated.
	If you have not received training, keep away from the robot when the power is on. Also, do not enter the action area. Even if you see that the robot seems to stop moving, the robot that is powered on may accidentally operate and may cause serious safety problems.
	Before entering the normal operation, please confirm that the emergency stop switch and the safety guard switch are in normal operation. If the switch does not operate normally, the safety function cannot be performed in an emergency, which may result in serious injury or serious damage, which is very dangerous.

Be sure to perform maintenance, replacement, and wiring work after turning off the power to the controller and related equipment and unplugging the power cord. Failure to do so may result in electric shock or malfunction.

5.2 Maintenance plan

In order for the robot to maintain efficient performance over the long term, regular maintenance is required. The maintenance personnel must prepare an overhaul plan and strictly implement it. The maintenance plan for the Panda series robot is shown in Table 5-1.

Table 5- 1 Maintenance schedule

No.	Contents	Equipment		Routine	1 month	3 months	6 months	12 months
1	Inspection	Robot appearance		√				
2		Cable interface			√			
3		Motor, reducer						√
4		Cable harness	external		√			
5			internal				√	
6		Screw	surface		√			
7			internal				√	
8	Clean	Whole robot		√				
9	Replacement	Lubricating oil		Replace when the gear unit needs to be replaced.				

5.3 Who to contact

1, System integrator

You can directly contact the system integrator responsible for installing and commissioning the Panda series robot.

2, Supplier

You can contact the supplier of Elephant Robotics in your region. For specific supplier information, please visit the official website: www.elephantrobotics.cn.

3, Official website

You can check out on the official website of the Elephant Robotics (www.elephantrobotics.cn) for more information.

6 Repair

When the robot malfunctions, do not continue to operate. Please immediately contact the operator who has received the prescribed training to perform fault analysis, so as to clearly grasp the phenomenon and determine what components are abnormal.

Matters on repair, inspection, adjustment, etc. of the robot must be carried out by an authorized system integrator or agent. Please contact a professional for disposal. Do not disassemble the robot at will. See section 5.3 for contact details.

When contacting, please prepare the following items in advance:

- Controller name, serial number.
- Robot name, serial number.
- Description of problem (Preferably with pictures, log information etc.).