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DOBOT M1 Pro Robotic Arm User Guide

Contents

DOBOT M1 Pro Robotic Arm

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Disclaimer

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Before using our product, please thoroughly read and understand the contents of this document and related technical documents that are published online, to ensure that the robot is used on the premise of fully understanding the robot and related knowledge. Please use this document with technical guidance from professionals. Even if follow this document or any other related instructions, Damages or losses will be happening in the using process, Dobot shall not be considered as a guarantee regarding all security information contained in this document.

The user has the responsibility to make sure following the relevant practical laws and regulations of the country, in order that there is no significant danger in the use of the robot.

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Preface
Purpose

This Document describes the functions, technical specifications, installation guide of Dobot M1 Pro robot, making it easy for users to fully understand and use it.
Intended Audience

This document is intended for:

- Customer
- Sales Engineer
- Installation and Commissioning Engineer
- Technical Support Engineer

Change History

Date	Change Description
2021/04/23	The first releases.
2021/07/08	Add the general security.

Symbol Conventions
The symbols that may be founded in this document are defined as follows.

Symbol	Description
⚠ DANGER	Indicates a hazard with a high level of risk which, if not avoided, could result in death or serious injury
⚠ WARNING	Indicates a hazard with a medium level or low level of risk which, if not avoided, could result in minor or moderate injury, robot damage
⚠ NOTICE	Indicates a potentially hazardous situation which, if not avoided, can result in equipment damage, data loss, or unanticipated result
📖 &NOTE	Provides additional information to emphasize or supplement important points in the main text

Security Precautions

This topic describes the security precautions that should be noticed when using this product.
Please read this document carefully before using the robot for the first time. This product needs to be carried out in an environment meeting design specification. You cannot remold the product without authorization, otherwise, it could lead to product failure, and even personal injury, electric shock, fire, etc. People who use this product for system design and manufacture must be trained by our company, relevant institution, or must have the same professional skills. The installation personnel, operators, teaching personnel, programmers and system developers of the robot must read this document carefully and use the robot strictly according to the regulations of this document strictly.

Security Warning Sign

The following safety warning signs may appear in this manual, and their meanings are as follows.

Sign	Description
DANGER	Indicates a high degree of potential danger, which, if unavoidable, will result in death or serious injury
ELECTRICITY	Dangerous power consumption will soon be caused. If it cannot be avoided, it will cause personal injury or serious injury to the equipment.
HOT	May cause dangerous hot surfaces, if touched, may cause personal injury
WARNING	Indicates that there is a moderate or low potential hazard. If it cannot be avoided, it may cause minor injuries to the equipment and damage to the equipment.
ATTENTION	Indicates a potential risk, and ignoring these texts may result in damage to the robotic arm, loss of data, or unpredictable results
NOTICE	A situation that, if unavoidable, can cause personal injury or equipment damage For items marked with such symbols, depending on the specific situation, there is sometimes the possibility of significant consequences

General Security

The following security rules should be followed when using the robot for industrial design and manufacture.
DANGER

- Robot is electrical equipment. Non-professional technicians cannot modify the circuit, otherwise, it is vulnerable to injury the device or the person.
- You should comply with the local laws and regulations when operating the robot.
  The security precautions in this document are only supplemental to the local laws and regulations.
- Please use the robot in the specified environment scope. If not, exceeding the specifications or load conditions will shorten the service life of the robot, even damage it.
- Please ensure that the robot is operated under the security conditions and there is no harmful object around the robot.

- Turning on or off the power continually may result in that the performance of the main circuit components inside the robot is degraded. If turning on or off the power continually is required, please keep frequency less than once a minute.

  NOTICE

- The personnel responsible for installation, operation and maintenance of equipment must first undergo rigorous training, understand various safety precautions, and master the correct operation and maintenance methods before they can operate and maintain equipment.

- Personnel without professional training shall not disassemble and repair the equipment without authorization. If the device fails, please contact Shenzhen Yuejiang Technology Co., Ltd technical support engineer in time.

- Be sure to carry out daily inspections and regular maintenance, and replace faulty components in time to ensure the safe operation of the equipment.

- If the equipment is scrapped, please comply with relevant laws to properly handle industrial waste and protect the environment.

- In order to prevent personnel from accidentally entering the working space of the robotic arm, be sure to set up safety fence to prevent personnel from entering the hazardous area.

- Before operating the robot, make sure that no one is inside the safety fence. When operating the robot, be sure to operate outside the safety fence.

- Do not expose the robot to permanent magnetic fields all the time. Strong magnetic fields can cause damage to the robot.

- Shenzhen Yuejiang Technology Co., Ltd. assumes no responsibility for robot damage or personal injury caused by failure to follow product instructions or other improper operations.

- Shenzhen Yuejiang Technology Co., Ltd. is not responsible for the damage caused during the transportation and handling of equipment.

- Please make sure that the robot is in the packing posture before packaging, and the brakes on each axis are normal.

- When the robot is transported, the packaging needs to be fixed to ensure that the robot is stable.

- After removing the outer packaging, please make sure that the robot maintains the original packing posture and the brakes on each axis are normal.

- During the commissioning process, it is necessary to confirm that no relevant personnel and equipment (include computer used for debugging) stay in the dangerous area of the machine.

- If necessary, wear corresponding safety protective equipment, such as safety helmets, safety shoes (with non-slip soles), face shields, protective glasses and gloves. Inappropriate clothing may cause personal injury.

- In order to prevent personnel from entering the working space of the robot arm by mistake, please set up safety barriers to prevent personnel from entering the hazardous area.

- Do not enter the working space of the manipulator at will during operating the robot, otherwise cause injury to the robot or yourself.

- When an abnormality occurs in the mechanical arm, it is necessary to ensure that the machine is stopped and then checked.

- If the controller needs to be restarted due to power failure, when restarting, the robot must be manually returned to the initial position of the automatic operation program before restarting the automatic operation.

- Before maintenance and wiring work, the power supply must be cut off, and the sign No power supply must be put on. Otherwise, electric shock and personal injury may result.

- Please contact our technical support staff for the disassembly and repair of the robot.

- Maintenance and repair work must be carried out by designated personnel, otherwise electric shock and personal injury may result.
- If the brake is manually released, the robot may move because of the action of gravity. So, when manually releasing the brake, please ensure that the robot body and the tools or workpieces installed on the robot are effectively supported.
- In order to prevent electric shock, when replacing parts, please turn off the circuit breaker in advance and cut off the main power before proceeding.
- Turn off the main power supply for 5 minutes before replacing parts.
- The replacement operation must be performed by the specified operator.
- The robot is designed and tested according to the group I class A engineering medical robot standard. In order to reduce the radio interference in in light industry or family environment, please take protective measures. RF source without shielding, otherwise, it could lead to robot abnormally.
- When the operator commissioning or operates the equipment, it shall be done in the safe space of the equipment.

WARNING

- In order to protect the equipment and personal safety, when turning off the power, please press the switch, then unplug the AC power cable. The power is disconnected by plug and socket.
- Before the operation, please wear protective clothing, such as antistatic uniform, protective gloves, and protective shoes.
- It is prohibited to modify or remove the nameplates, instructions, icons, and marks on the robot and the related equipment.
- Before operating and maintaining the robot, the personnel responsible for the installation, operation and maintenance must be trained to understand the various security precautions and to master the correct methods of operation, and maintenance.
- Be careful during the robot carrying or installing. Please follow the instructions on the packing box to put down the robot gently and place it correctly in direction of the arrow.
- Please use the matched cables when connecting a robot to internal or external equipment for personal security and equipment protection.
- Please ensure that robot and tools are installed correctly.
- Please ensure that the robot has enough space to move freely.
- If the robot is damaged, please do not continue to use it.
- Any impact will release a lot of kinetic energy, which is much higher than that under high speed and high load.

Personal Security

When operating the robot system, it is necessary to ensure the personal safety of the operator. The general precautions are listed below, please strictly follow.

WARNING

- To reduce the risk of personal injury, please comply with local regulations with regard to the maximum weight one person is permitted to carry.
- Do not touch the terminal blocks or disassemble the equipment with the power ON. Otherwise, it may result in an electric shock

- Please confirm that the equipment is well grounded, otherwise it will endanger personal safety.
- Do not touch the terminal blocks or remove the interval circuit components in 10 minutes after the power is shut off, to avoid an electric shock since there is residual capacitance inside the robot.
- Even if the power switch of the robot is already in the OFF status, touching the terminal blocks or removing the interval circuit components is not allowed, to avoid an electric shock since there is residual capacitance inside the robot.
- When working with robots, please do not wear loose clothing or jewelry. When operating the robot, make sure that the long hair bundle is behind your head.
- If the robot appears to have stopped during the operation of the equipment, it may be because the robot is waiting for the start signal and is in the state of being about to move. In this case, the robot should also be considered to be in motion, please do not approach the robot.
- Please ensure that the robot establishes safety measures near the operation area, such as guardrails, to protect the operator and surrounding people.

Overview

Dobot Master 2nd generation robotic arm (Dobot M1 Pro for short) focuses on the light industrial market with great potential, and supports teaching, playback, script control, blockly, vision identity and other functions, which is flexibly used in intelligent sorting, circuit board soldering and other automatic production lines, so that it can become the sword to solve practical problems for light industrial users, and can also become the platform to carry the imagination of the maker. Dobot M1 Pro has the following characteristics.

- The integrated design of the driver and controller without external controller simplifies the process of the initial installation and deployment.
- Built-in calibrated servo, harmonic reducer, combined with kinematic algorithm, can make M1 pro to bring out the best of strength and speed.
- The rated load is 1.5kg, and the repeatability is ±0.02mm.
- Various I/O and communication interfaces can meet the use of users in different scenarios.

Figure 2.1 DOBOT M1 Pro

Technical Specifications

Product	DOBOT M1 Pro
Model	DT-M1-P4R15-01I
Weight	15.7kg
Max load	1.5kg
Reach	400mm
Power supply	100~240 VAC 50/60Hz
Rated voltage	DC48V
Installation	Table installation, indoor

Rated power	192W	
Repeatability	±0.02mm	
Base size	230mm*175mm	
Operation software	DobotSCStudio, DobotStudio2020	
Motion range	J1	±85°
	J2	±135°
	J3	5mm 245mm
	J4	±360°
Joint maximum speed	J1	180°/s
	J2	180°/s
	J3	1000mm/s
	J4	1000°/s
End-effector interface	DI	4
	DO	4
	RS485 (Modbus_RTU)	1
	DI	16

Base interface	DO	16
	ABZ incremental encoder (differential)	1
	Ethernet	2

	USB 2.0	2
Temperature range	Storage temperature -25℃~55℃ Working temperature 0℃~40℃	
Operating altitude range	≤ 1000 m	
Safety Standard	EN ISO 10218-1:2011 Steel wire and wire products. General. Test methods EN 60204-1:2018 Safety of machinery. Electrical equipment of machines. General requirements EN ISO 12100:2010 Safety of machinery. General principles for design. Risk assessment and risk reduction	
EMC Standard	EN 61000-6-2:2019 Electromagnetic compatibility (EMC). Generic standards. Immunity standard for industrial environments EN 61000-6-4:2019 Electromagnetic compatibility (EMC). Generic standards. Emission standard for industrial environments	

Robot Dimension

M1 Pro Dimension
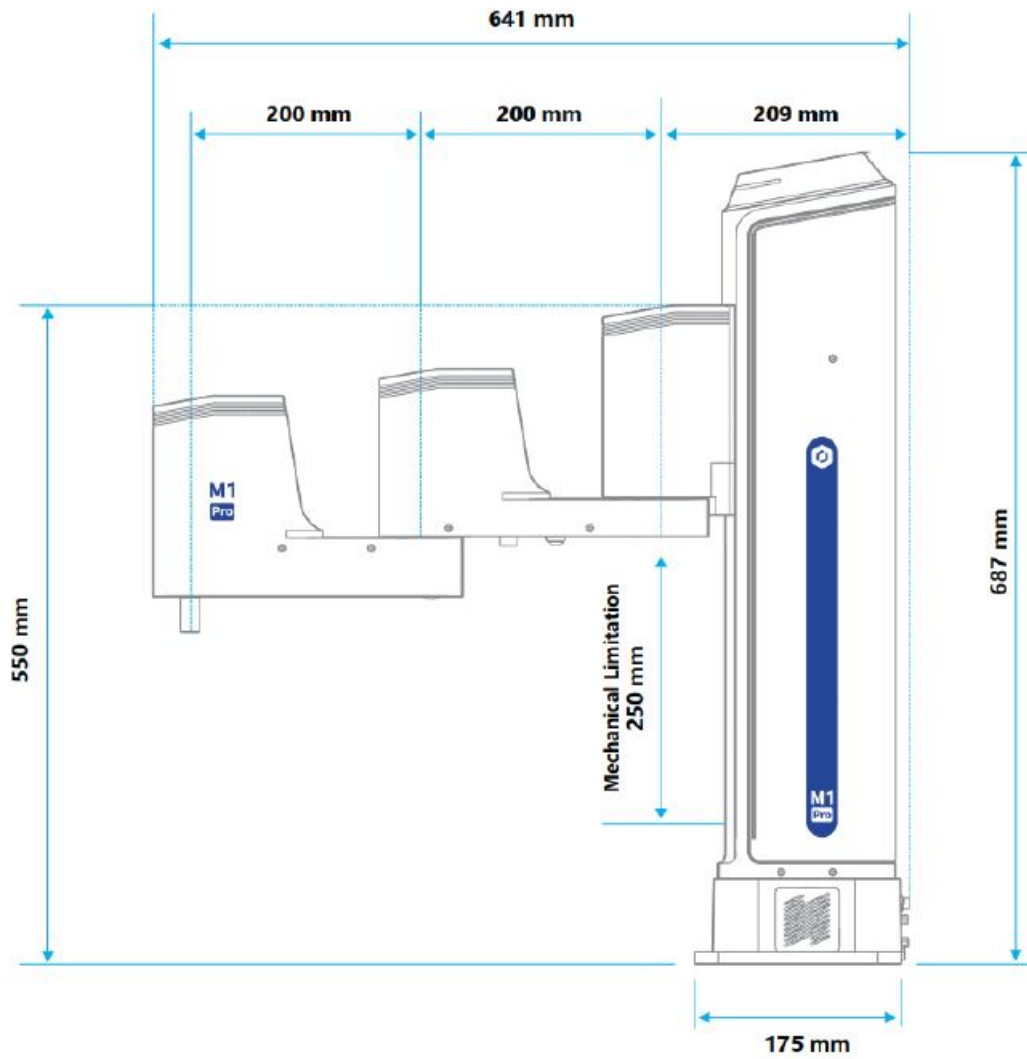Figure 2.2 shows the dimension of M1 Pro robot.

Figure 2.2 M1 Pro dimension

End-effector Dimension

You can install the matching gripper, suction cup on the end of the M1 Pro for transporting and intelligent sorting. Figure 2.3 shows the dimension of end-effector.
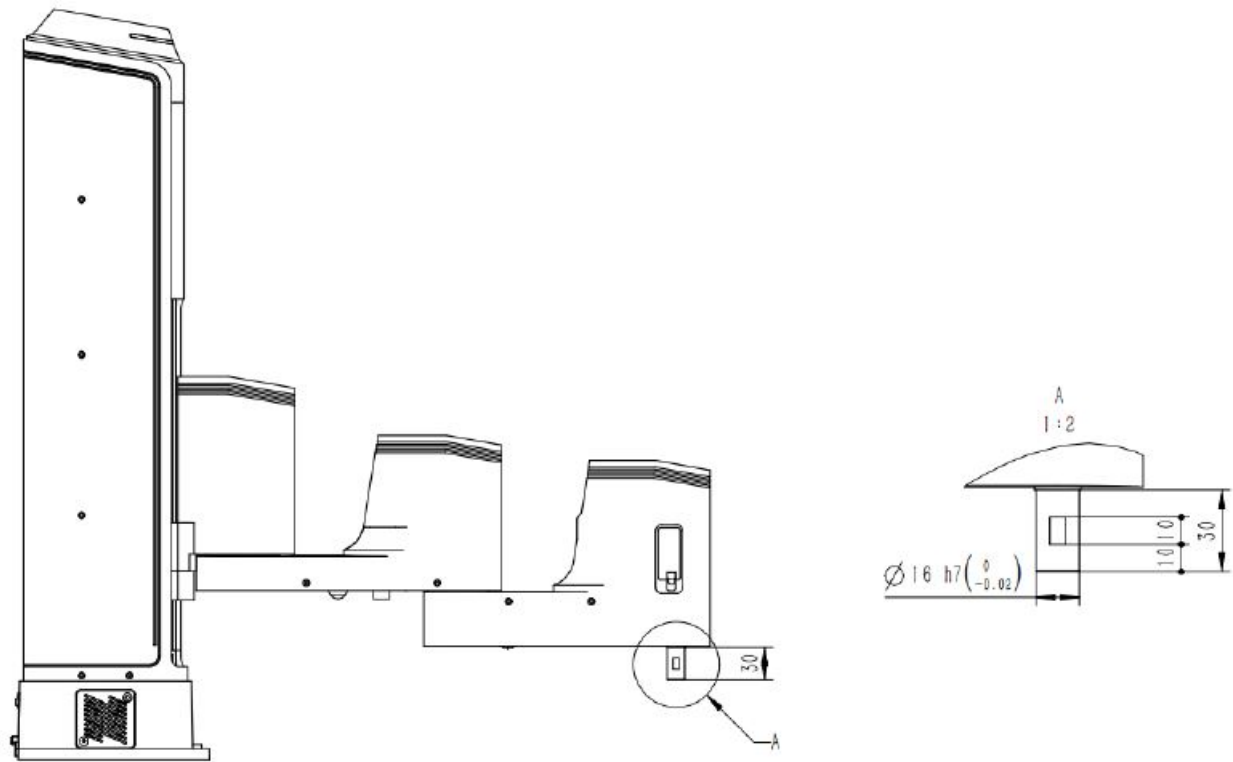
Figure 2.3   End-effector dimension

Robot Workspace
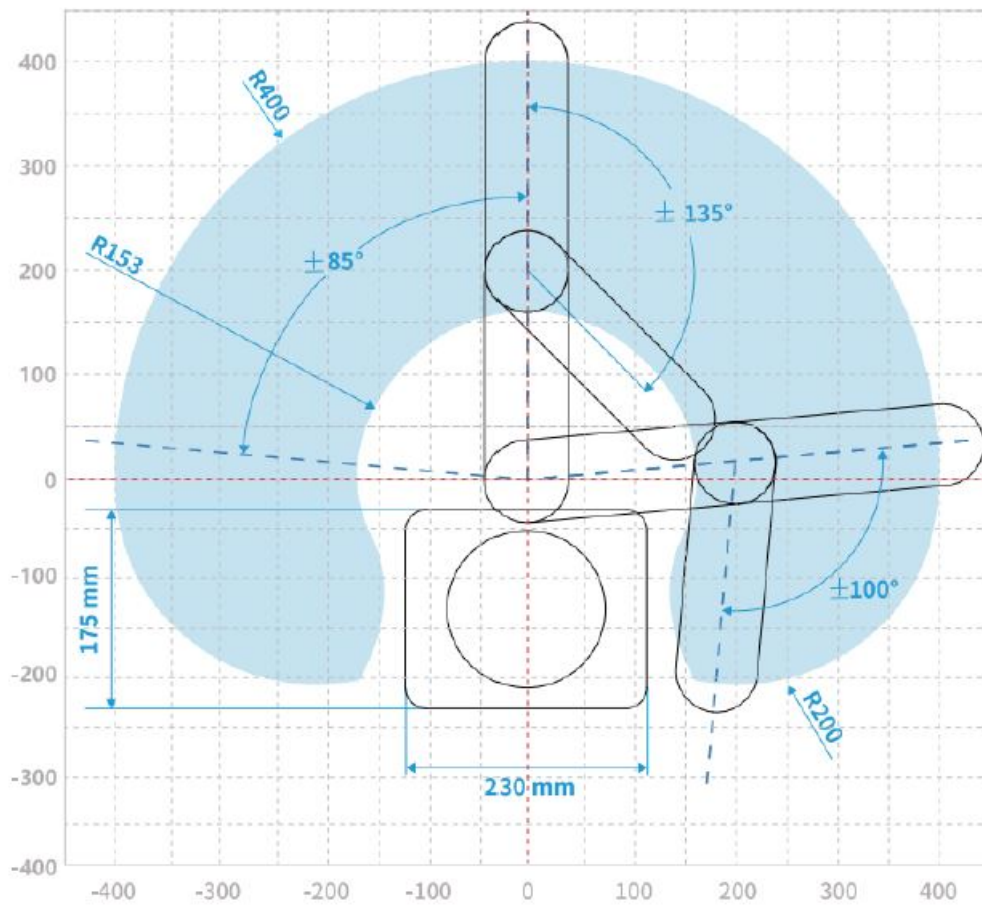Figure 2.4 shows the workspace of M1 Pro robot.

Figure 2.4　M1 Pro robot workspace

When operating the robot, be sure to operate inside the workspace.
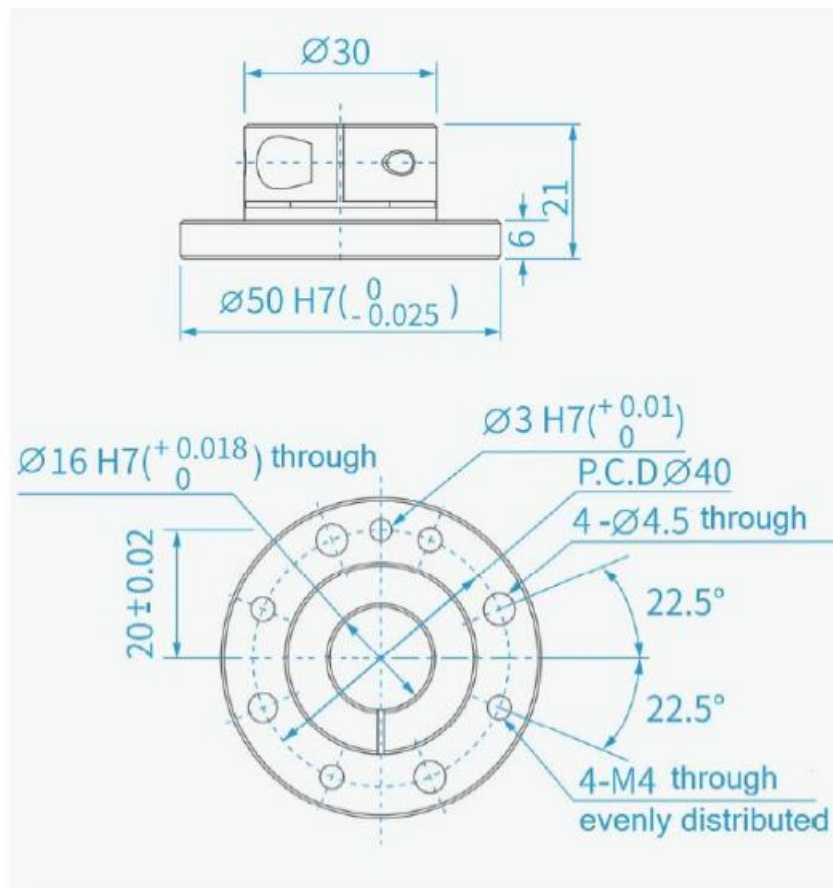
End Flange Size

Figure 2.5 End flange size

Stop Time and Angle

The Max. stop time and angle of axis J1, J2, J3 and J4 at the max speed, load and arm stretch are shown below.

Table 2.2 Stop time and angle

Axis	Max. stop angle °	Max. stop time ms
J1	9.6	103
J2	9.4	102
J4	36.5	100
Axis	Max. stop distance mm	Max. stop time ms
J3	43	104

Zero Calibration Description

After some parts (motors, reduction gear units) of the robot have been replaced or the robot has been hit, the origin of the robot will be changed. You need to reset the origin. For details, please see DobotSCStudio User Guide (M1 Pro Robot).

When the robot leaves the factory, moving robot to the factory point can reduce the robot space, easy to pack and transport. Figure 2.6 shows the factory point. The robot has 4 joints, respectively J1, J2, J3 and J4, please see 2.8.2.1 Joint Coordinate System for explanation of joints. The joint angles corresponding to the factory point are: J1= 0°, J2= 0°, J3= 0mm, and J4= 0°. Adjust joint Angles by jog or programming. For details, please see DobotSCStudio User Guide (M1 Pro Robot).
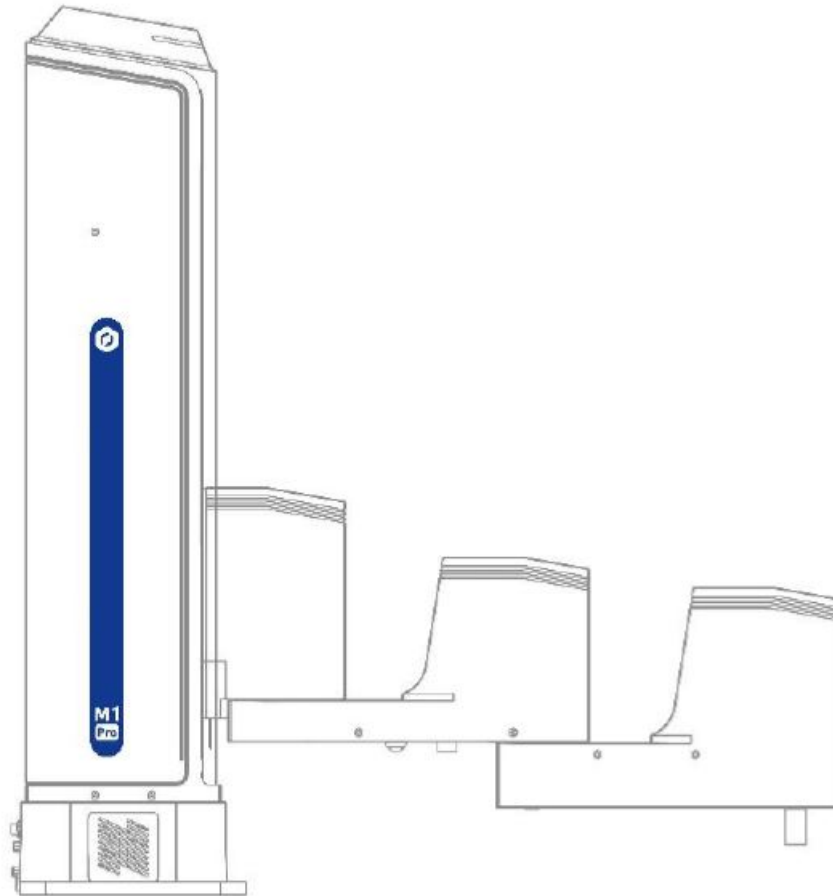

Figure 2.6   Factory point

Product Features

Arm Orientation

With two types of the arm orientation (lefty hand orientation and righty hand orientation), M1 Pro can move to nearly any position and orientation within a given work envelope. You need to specify the arm orientation when M1 Pro is moving. If you fail to do so, M1 Pro may move following an unexpected path, resulting in interference with peripheral equipment. The arm orientations are shown in Figure 2.7 and Figure 2.8.
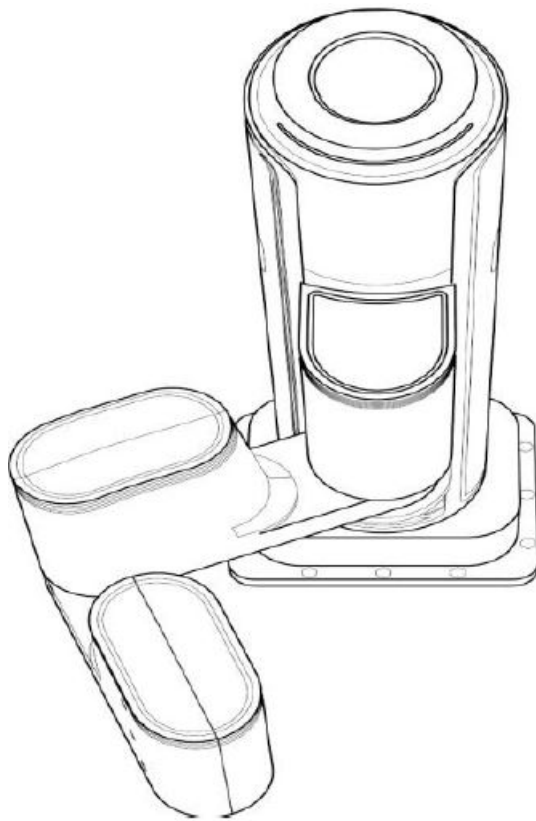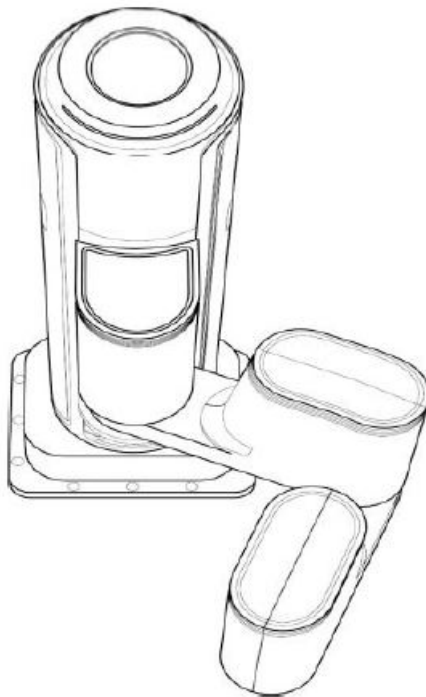
Figure 2.7 Righty hand orientation

Figure 2.8 Lefty hand orientation

Coordinate System

Joint Coordinate System

The Joint coordinate system is determined by the motion joints.

Figure 2.9 shows the Joint coordinate system of a M1 Pro robot. All the joints are rotating joints.

M1 Pro contains four joints.

- J1, J2, and J4 are the rotating joints, which are located and oriented in the horizontal plane. And their axes are parallel to each other. The positive direction of these joints is counter-clockwise.
- J3 is the moving joint, which is used for the movement of the end effector in the perpendicular plane. The positive direction of J3 is vertical upward.
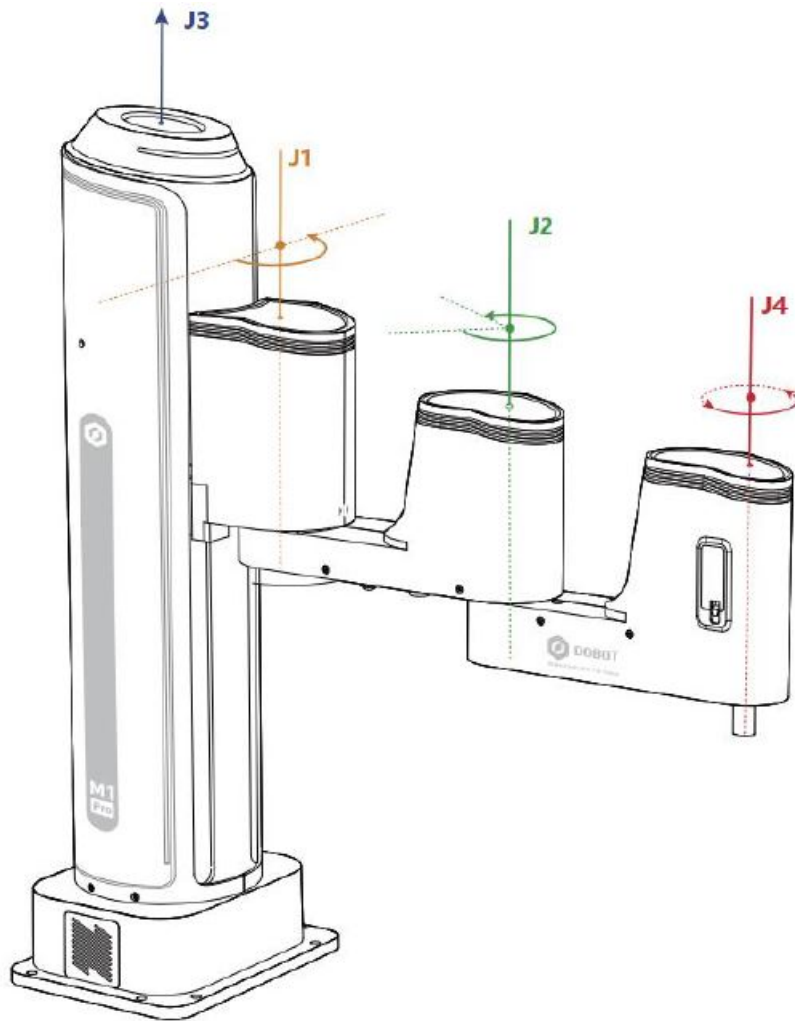

Figure 2.9   Joint coordinate of a M1 Pro robot

Base Coordinate System
The Base coordinate system is determined by the base. Figure 2.10 shows the Base coordinate system of M1 Pro robot.

- The origin is the axes center of the motor of Rear Arm where Rear Arm is dropped to the bottom of the Z-axis screw.
- The direction of X-axis is perpendicular to the base forward.
- The direction of Y-axis is perpendicular to the base leftward.
- The direction of Z-axis is vertical upward, which is based on the right-hand rule.
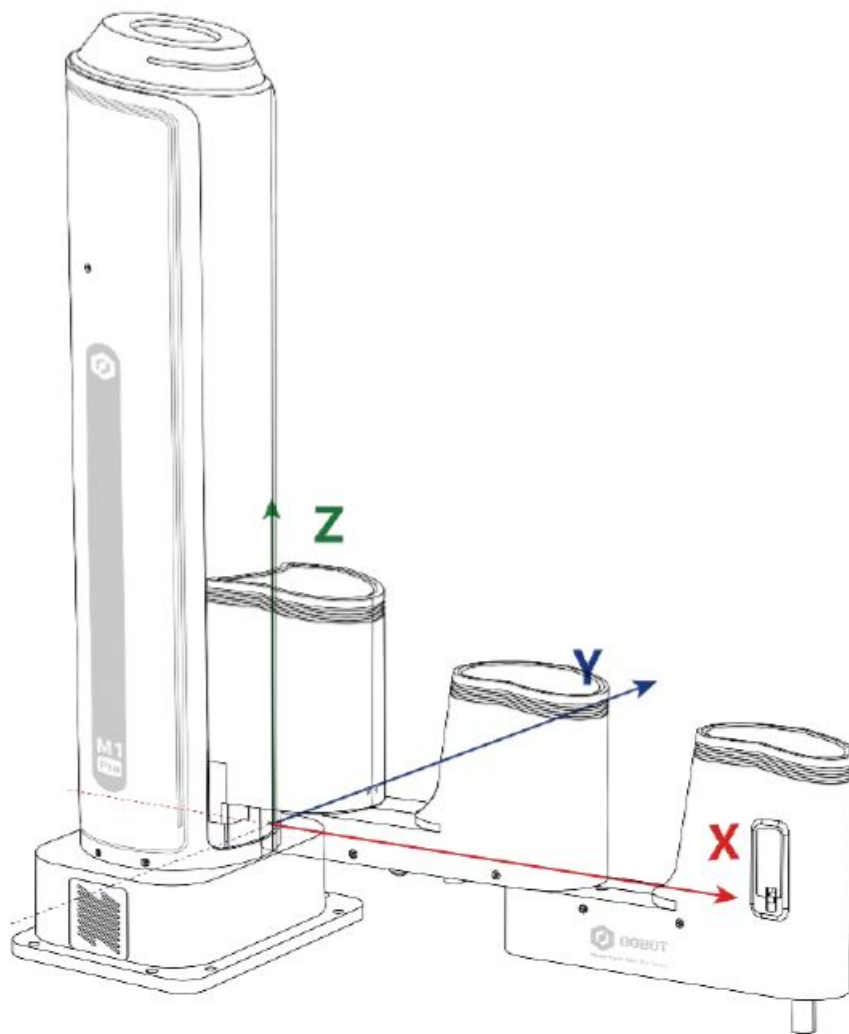
Figure 2.10   Base coordinate system of M1 Pro robot

Tool Coordinate System

Tool coordinate system is the coordinate system that defines the distance and rotation angle of the offset, of which the origin and orientations vary with the position and attitude of the workpiece located at the robot flange. The 10 types of tool coordinate systems can be defined. Tool 0 coordinate system is the predefined Tool coordinate system which is located at the robot flange without end effector and cannot be changed. And the others can be customized by users. Figure 2.11 shows the default Tool coordinate system of a M1 Pro robot.

tool 0

tool 1
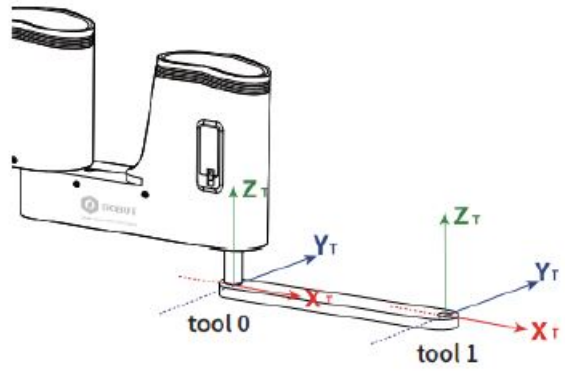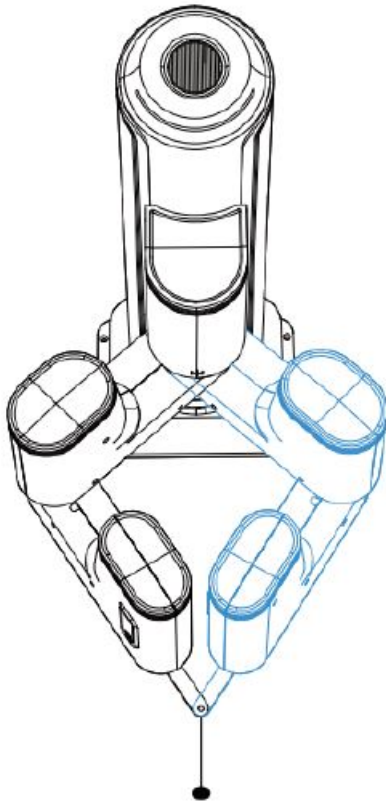
User Coordinate System

The User coordinate system is a movable coordinate system which is used for representing equipment like fixtures, workbenches. The origin and the orientations of axes can be defined based on site requirements, to measure point data within the workspace and arrange tasks conveniently.
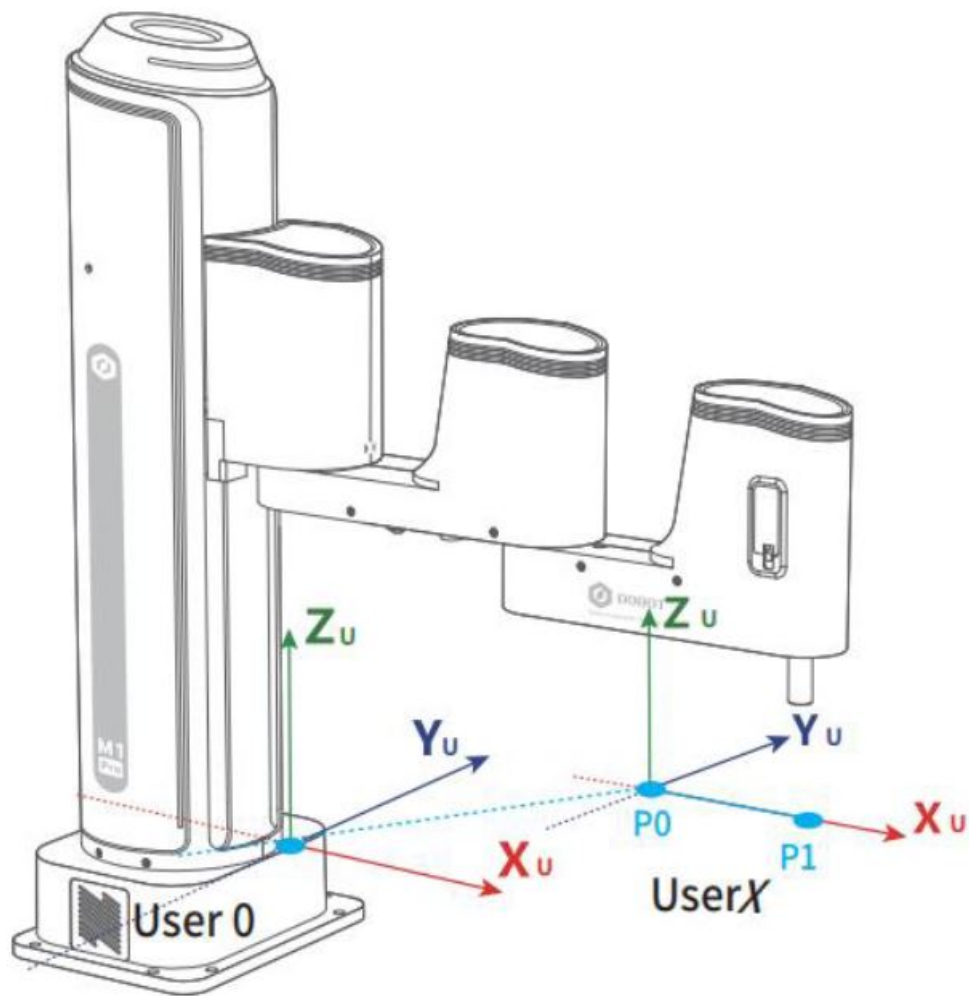
Figure 2.12 The default User coordinate system of M1 PRO robot

Electrical Specifications

Interface of Base

External Interface Board Description
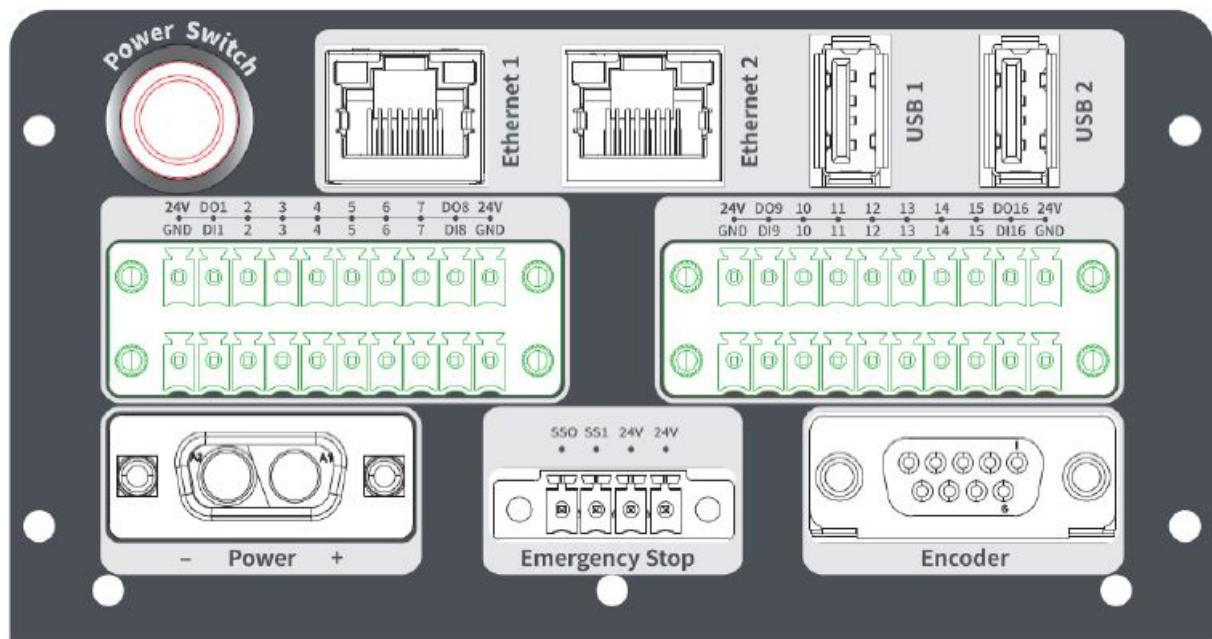Figure 3.1 shows the interface board of the Base. Table 3.1 lists the description.

Figure 3.1　Interface board of the base

Table 3.1 Interface description

screen printing	Description
Ethernet1	Ethernet interface The default IP address is 192.168.1.6, which cannot be modified. It can be used for software debugging on the upper computer
Ethernet2	Ethernet interface For connecting to external equipment. The default IP address is 192.168.2.6, which can be modified.
USB1	USB interface For connecting WiFi module, updating firmware, etc
USB2	USB interface For connecting WiFi module, updating firmware, etc
Encoder	Encoder interface For connecting to the conveyor belt for dynamic tracking
Power Switch	For controlling the robot power on and off
Emergency Stop	Emergency stop interface
Power	Power interface For connecting to DC 48V power supply

screen printing	Description
I/O	I/O interface

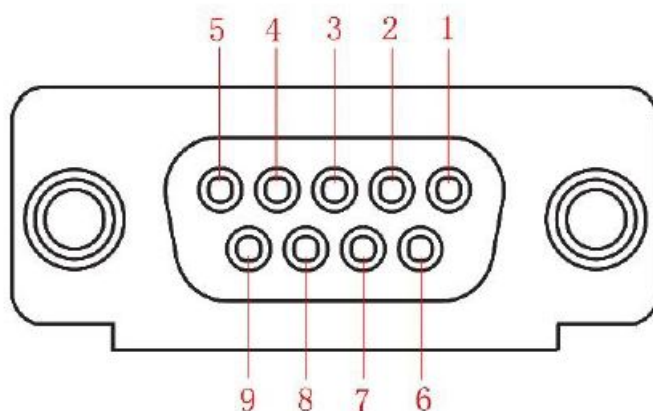The Encoder interface of the M1 Pro is shown in Figure 3.2 Table 3.2 lists the description of Encoder interface.

Figure 3.2   Encoder interface

Table 3.2 Encoder Interface description

No.	1	2	3	4	5	6	7	8	9
Description	ABZ_A+	ABZ_A-	ABZ_B+	ABZ_B-	ABZ_Z+	ABZ_Z-	5V	0V	unused

A robot controller contains I/O interfaces, for connecting to external equipment, such as PLC, etc. These I/O interfaces provide 16 digital inputs, 16 digital outputs, as shown in Figure 3.3.
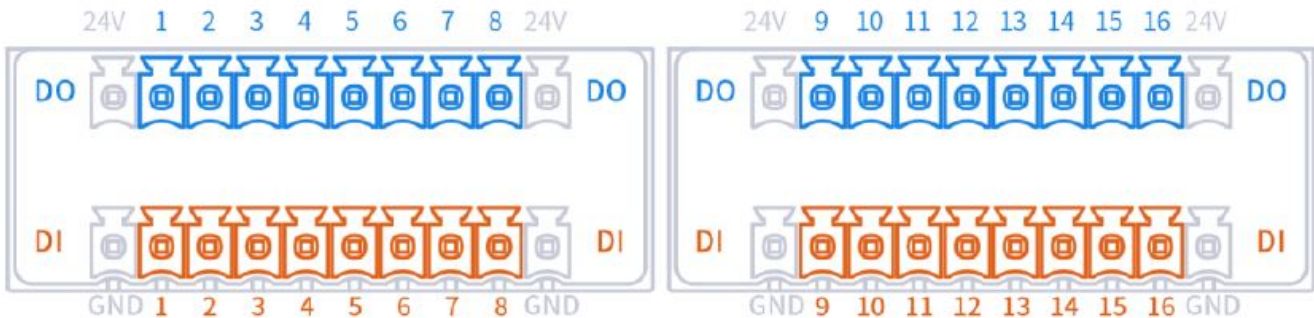

Figure 3.3   I/O interface

NOTE

- The output current of every DO can't exceed 500mA.
- The total current can't exceed 2A.

Digital Input
Figure 3.4 shows the simple digital input circuit and Table 3.3 lists the technical specifications.
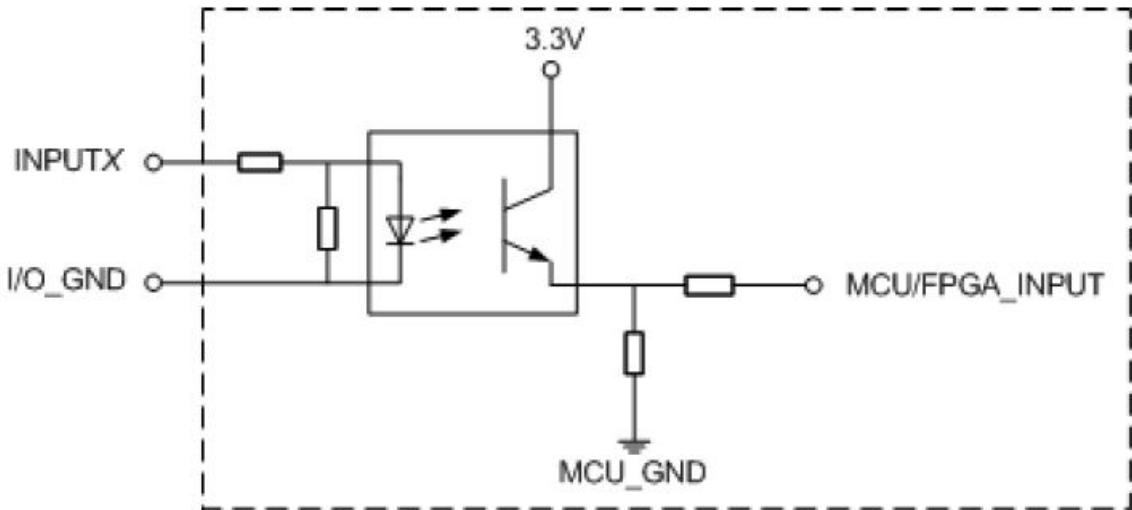

Figure 3.4   Simple digital input circuit

Table 3.3 Technical specifications

Item	Specification
Input channel	16 channels
Connection method	Europe type terminal
Input type	PNP
Input voltage (DC)	24V±10%
Isolation method	Optical coupling isolation

Digital Output

Figure 3.5 shows the simple digital output circuit and Table 3.4 lists the technical specifications.
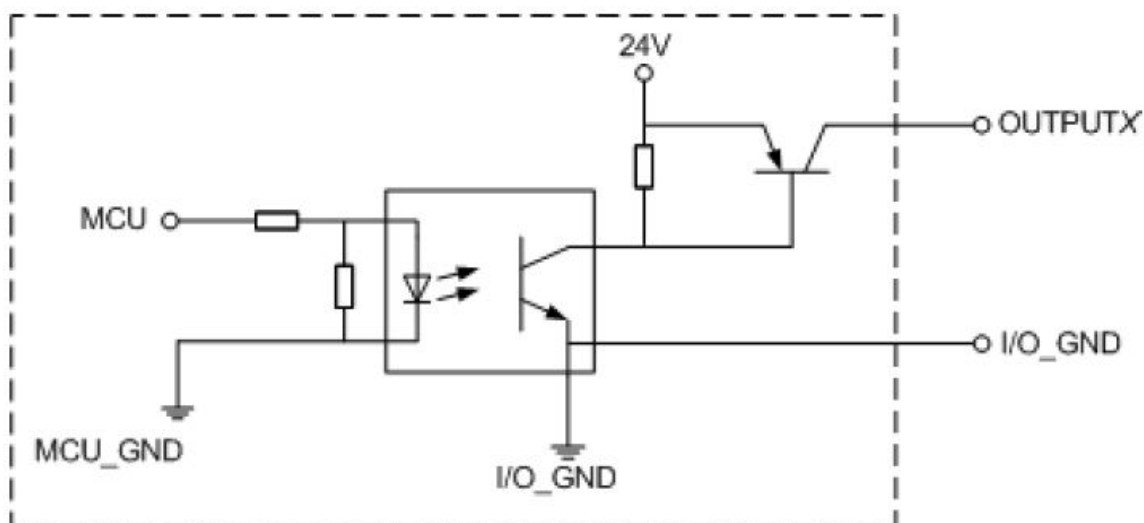
Figure 3.5   Simple digital output circuit

Table 3.4 Technical specifications

Item	Specification
Output channel	16 channels
Connection method	Europe type terminal
Output type	PNP
Power supply (DC)	24V±10%
Load current of single channel	500mA
Output current	2A
Isolation method	Magnetic isolation

End-effector I/O Interface Description

The end-effector I/O interfaces of the M1 Pro include a RS485 interface, 4 digital inputs and 4 digital outputs, as shown in Figure 3.6, Table 3.5 lists the description of End-effector I/O interface.

Figure 3.6   End-effector I/O interface

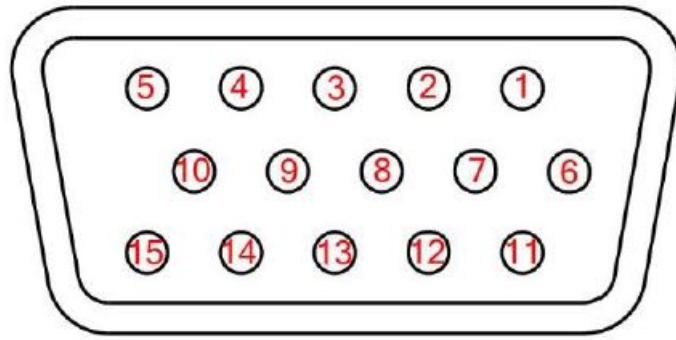**Table 3.5 End-effector I/O interface description**

No.	1	2	3	4	5	6	7	8
Description	24V	DO17	DO18	DO19	DO20	unused	unused	unused
No.	9	10	11	12	13	14	15	
Description	RS485 A	RS485 B	DI17	DI18	DI19	DI20	0V	

Installation

Installation Environment

To maintain the controller and robot performance and to ensure the safety, please place them in an environment with the following conditions.

- Install indoors with good ventilation.
- Keep away from excessive and shock.
- Keep away from direct sunlight.
- Keep away from dust, oily smoke, salinity, metal powder, corrosive gases, and other contaminants.
- Keep away from flammable.
- Keep away from cutting and grinding fluids
- Keep away from sources of electromagnetic interference.
- When the robot is installed, corresponding measures should be taken for positioning. You must use six hexagon socket bolts M6 (GB/T 3098.1-2010) and tighten the base of the robot with 17 N • m torque.
- When the robot is installed, the robot must be fixed on a sufficiently strong base. The base must be able to withstand the reaction force of the robot during acceleration and deceleration and the static weight of the robot and the workpiece.

Installation Location

The stability of a robot depends on the installation. You can design the platform according to the size of the hole of the base and the real environment for mounting a robot. And the installation height of the robot should be above 0.6 meters. The platform must not only bear the robot but also bear the dynamic force by the maximum acceleration. Note the following before mounting the robot.

- Design the platform according to the robot's workspace, and ensure that the robot moves without interference.
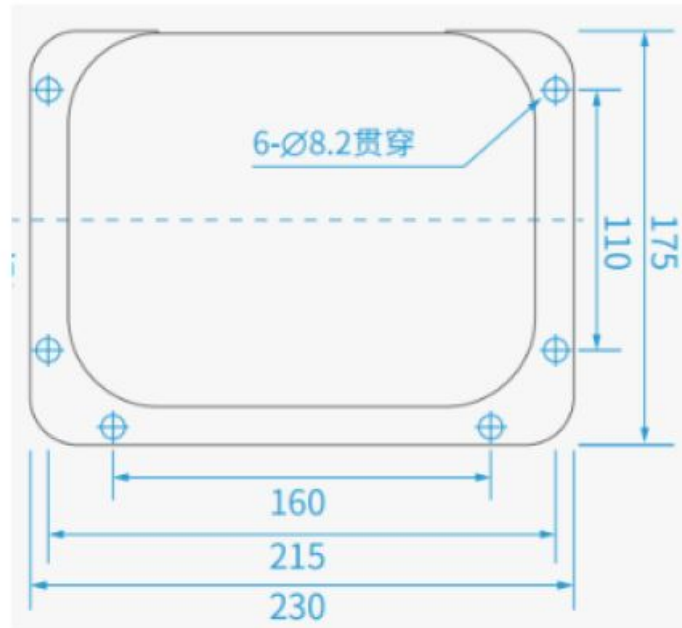- Keep the platform level which is used to mount a robot.

Figure 4.1   Robot base size

Maintenance and Repair

Maintenance and repairing must be performed in compliance with all safety instructions in this manual.
The purpose of maintenance and repairing is to ensure that the system is kept operational, or to return the system to an operational state in the event of a fault. Repairing includes troubleshooting in addition to the actual repair itself.

Repairing must be performed by an authorized system integrator or Dobot staff. Robots or parts returned to Dobot should be as the following instructions.

- Remove all parts that do not belong to Dobot.
- Before returning to Dobot, please make a backup copy of the files. Dobot will not be responsible for the loss of programs, data or files stored in robot.
- The robot should move to the package point before returning to Dobot. For details, please see2.7Factory point.

Safety Instructions

The following safety procedures and warnings must be observed during the operation of the robot or controller:

- Replace faulty components using new components with the same article number or equivalent components approved by Dobot.
- Reactivate any deactivated safety measures immediately after the repairing is completed. Record all repairs and save them in the technical document with the robot system. Remove the main input cables from the back of the robot to ensure that it is completely unpowered. Take necessary precautions to prevent other persons from powering on the system during the repair period.
- Observe ESD regulations during the disassembly of the parts of the robot.
- Prevent water and dust from entering the robot.

Body Maintenance

In order for the robot to maintain high performance for a long time, a maintenance check must be carried out. The person in charge of overhaul must prepare an overhaul plan and carry out an inspection. The overhaul items is shown below.

Table 5.1 Overhaul item

Cycle			Overhaul Item	Overhaul essential
Daily	3 month	6 month		
√			Robot clean	Wipe off dirt, dust, cutting residue on the body

				with water or 10% alcohol
√			Cable, cable protective cover	Observe the moving part of the cable, check whether the cable is damaged, whether there is local bending or distortion; Check whether the cable protective cover is damaged, etc.
	√		Joint bolts	Check the torque based on the specified tightening torque table (Push aside the rubber to check)
√			Tool mounting bolts	Check the torque based on the specified tightening torque table

√				Motor	Abnormal heating or sound confirmation
√				Brake	Check whether the robot arm or end-effector will fall when the servo is powered off
	√			Synchronous belt	Check whether the synchronous belt is worn out, elongated, broken, etc.

Table 5.2 lists the bolted tightening torque table.
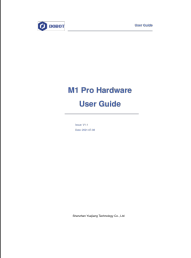
Table 5.2 Bolted tightening torque table

Bolt size	Hexagon sock-et head cap scre	Hexagon socket counter sunk flat can head screw	Hexagon screw (rubber part)
2.5 mm	0.7 N•m		–
3 mm	2 N•m	–	1.2 N•m
4 mm	4 N•m	2 N•m	–
5 mm	9 N•m	–	–

The tightening torques will vary depending on the type of base metal or bolt. When not specified, please contact Dobot technical engineer.
In addition, overhauls are required every 10,000 hours of operation time or every 3 years. If you are not clear

about the maintenance processes, please contact Dobot technical engineer.

Documents / Resources

	DOBOT M1 Pro Robotic Arm [pdf] User Guide M1 Pro, Robotic Arm

References

Manuals+,