DOBOT Nova Series (Compatible with DSC) Hardware User Guide

Original Instructions

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SHENZHEN DOBOT CORP LTD | China

Nova can be customized in color. For reference purposes, this manual illustrates the product using the standard blue. Please refer to the actual product you receive for details.

Disclaimer

To the maximum extent permitted by applicable law, the products described (including its hardware, software and firmware, etc.) in this document are provided **AS IS**, which may have flaws, errors or faults. DOBOT makes no warranties of any kind, express or implied, including but not limited to, merchantability, satisfaction of quality, fitness for a particular purpose and non-infringement of third party rights. In no event will DOBOT be liable for any special, incidental, consequential or indirect damages resulting from the use of our products and documents.

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 may happen 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

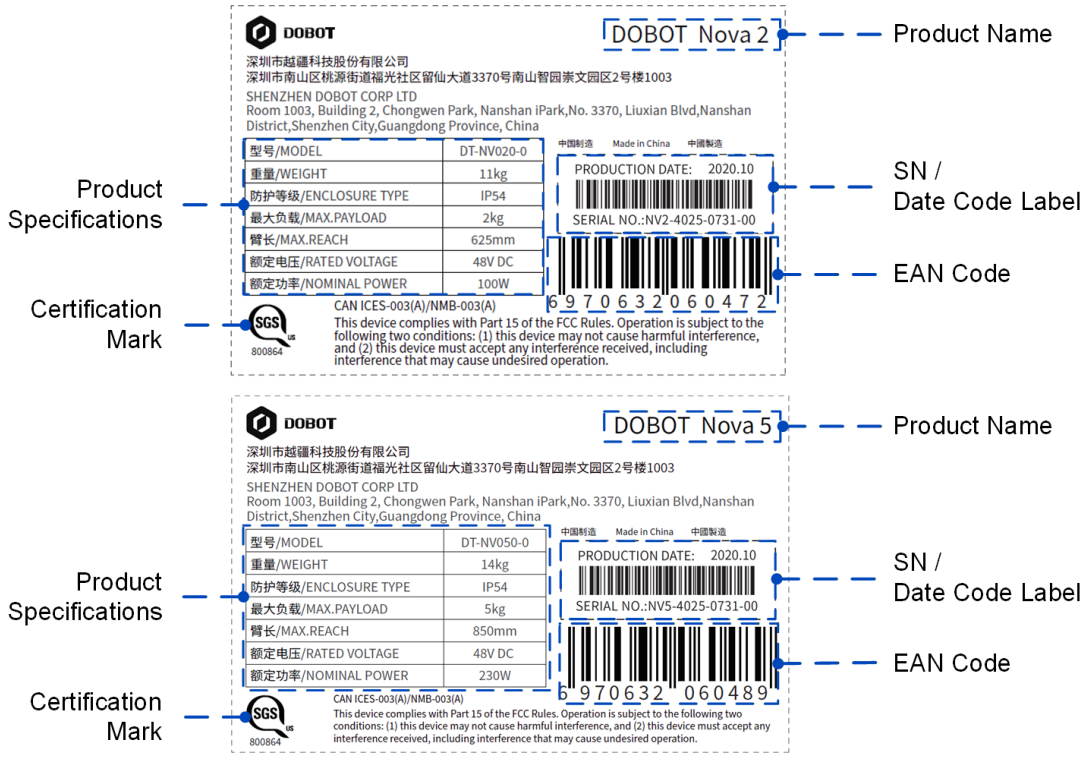
Purpose

This document describes the functions, technical specifications, installation guide of DOBOT Nova series collaborative robot, making it easy for users to fully understand and use it.

Scope of application

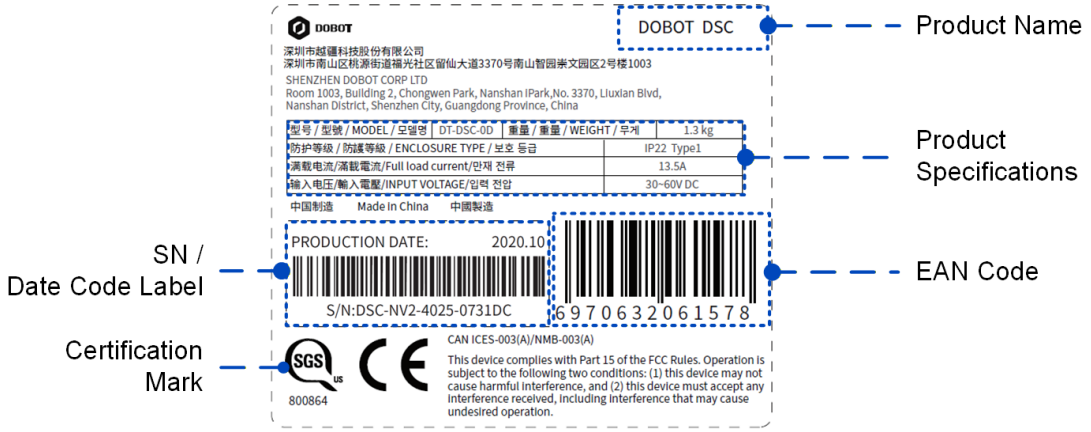
- **Robot arm:** DOBOT Nova 2, DOBOT Nova 5

  You can find the model of robot on the right-top corner of the nameplate on the robot base.



- **Controller:** DOBOT DSC

  You can find the model of the controller in the upper right corner of the nameplate on the controller.



Intended audience

This document is intended for:

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

Related documents

Document	Description	Download link
DobotStudio Pro User Guide	Explains how to use the robot control software, DobotStudio Pro.	Visit the Download Center to search by document name or filter by product series.
DOBOT TCP_IP Remote Control Interface Guide	Describes how to use the secondary development interface based on TCP/IP protocol. In addition to the document, you can also access multi-language development DEMOs from Github.	
DOBOT Bus Communication Protocol Guide (EtherNetIP_Profinet)	Introduces the usage of the robot's bus communication functions (EtherNetIP/Profinet).	
DOBOT Collaborative Robot Teach Pendant User Guide	Explains how to use the Teach Pendant that accompanies the collaborative robot.	
DOBOT DSC Controller User Guide	Describes the functions, technical specifications, and installation guide of the DSC controller.	

Revision history

Date	Version	Revised content
2026/06/23	V1.2	Added descriptions regarding functional safety and applicable standards.
2026/04/01	V1.1	Added a description that the robot arm will lose power during emergency stop.
2025/12/22	V1.0	The first release

Symbol conventions

The symbols that may be found 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 arm damage.
NOTICE	Indicates a potentially hazardous situation which, if not avoided, could result in robot arm damage, data loss, or unanticipated result.
NOTE	Provides additional information to emphasize or supplement important points in the main text.

Contents

1. Safety

1.1 Responsibility

1.1.1 Responsibility and norms

The information in this document does not cover designing, installing and operating a complete robot system, nor does it cover all peripheral equipment that may affect the safety of the complete system. The complete system must be designed and installed in accordance with the safety requirements set forth in the standards and regulations of the country where the robot is installed.

The integrators of DOBOT are responsible for ensuring that the applicable safety laws and regulations in the country concerned are observed and that any significant hazards in the complete robot application are eliminated. This includes, but is not limited to:

- Performing a risk assessment for the complete robot system.
- Adding safety machines and mechanisms based on the risk assessment, including but not limited to building a proper safety circuit to achieve safe stop.
- Setting up the appropriate safety settings in the software.
- Ensuring that the user will not modify any safety measures.
- Validating that the total robot system is designed and installed correctly.
- Specifying instructions for use.
- Marking relevant signs and contact information of the integrators on the robot.
- Archiving relevant technical files.

1.1.2 Limitation of liability

Any safety information provided in this document should not be considered as a warranty from DOBOT. The robot may cause injury or damage even if all safety instructions are observed.

1.2 Intended use

DOBOT Nova series robots are commercial robots only for general commercial use, such as processing or delivering food and other goods through end tools.

DOBOT Nova series robots are equipped with special safety mechanisms including collision detection. These mechanisms are purposely designed for human-robot collaboration, but only intended for non-hazardous applications after risk assessment, where tools, products, environment and other machines have been demonstrated to be incapable of significant risk through application-specific risk assessments.

Any use or application other than the intended use is not permitted:

- Do not use in potentially explosive environments.
- Do not use in vacuum environments.
- Do not use for transporting people or animals.
- Do not use in life-critical applications.
- Do not use without performing a risk assessment.
- Do not use beyond the specified ratings or limits.
- Do not use as a climbing aid.

- Do not use underwater.

1.3 Risk assessment

As the robot is a **semi-finished machinery**, the integrator is responsible for conducting a risk assessment of the overall system after integration. It is recommended that integrators perform a risk assessment based on ISO 12100 and ISO 10218-2 and refer to the Technical Specification ISO/TS 15066 for integration guidance.

The risk assessment should consider all workflows during the robot's entire lifecycle, including but not limited to:

- Teaching the robot during the setup and development process.
- Maintenance and repairs.
- Robot installation.

The risk assessment must be completed **before the robot is powered on for the first time**, including but not limited to confirming the safety function settings and evaluating whether additional emergency stop buttons or other protective measures are required.

When performing the risk assessment, the integrator should focus on the following safety functions:

- Collision detection sensitivity settings: Limiting the force applied during a collision between the robot and the operator.
- Robot and tool pose limitations: Reducing the risk of the robot and tools colliding with the operator, especially in specific body areas such as the head and neck.
- Speed limit: Limiting the robot's operating speed to reduce safety risks.

The integrator must set permissions and passwords to prevent unauthorized personnel from modifying the safety function configurations.

When conducting a risk assessment for collaborative robot applications, the integrator must consider potential collision risks caused by human error, including:

- The severity of potential collisions.
- The probability of potential collisions.
- The likelihood of avoiding potential collisions.

If the robot is installed in a non-collaborative application where its built-in safety functions cannot effectively eliminate safety risks (e.g., using hazardous tools), the integrator must consider adding additional protective measures (e.g., safety barriers or safety lasers) during the risk assessment.

The integrator must consider potential risks including but not limited to:

1. Cuts from sharp edges and points on the end tools or end effector connectors.
2. Cuts from sharp edges and points on obstacles in or near the robot's workspace.
3. Scrapes caused by contact with the robot.
4. Sprains or fractures resulting from collisions between heavy payloads on the robot's end and hard surfaces.
5. Consequences of loose bolts securing the robot or end tool.
6. Consequences of items falling off the end tool.
7. Consequences of incorrectly pressing the emergency stop button of other equipment.
8. Consequences of unauthorized changes to the safety function configurations.

For robot emergency stop time and distance, please refer to the "Emergency stop time and distance" section.

1.4 Pre-use assessment

Before using the robot for the first time or after any modifications are made, testing must be conducted to ensure that all safety inputs and outputs are correctly connected and functioning properly:

1. Test whether the emergency stop button and user emergency stop input can trigger an emergency stop.
2. Test whether the protective stop input can halt the robot's motion. If a protective stop reset input is configured, test whether this input must be activated before the robot can resume operation.
3. If a reduced mode input is configured, test whether this input can switch the robot to reduced mode (reduced-speed operation).
4. If the teach pendant is selected and the three-position switch enable function is configured, verify that in manual mode the robot remains enabled only when the three-position switch is maintained in the middle position.
5. Test whether the system connected to the emergency stop status output can detect the output change and respond accordingly.
6. If other safety outputs are configured, test whether the system connected to the corresponding output can detect the output change and respond accordingly.

1.5 Safety warning sign

The following safety warning signs may appear on the product, and their meanings are 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.
ELECTRICITY	Indicates a potentially dangerous electrical situation that, if not avoided, could result in injury, death, or serious damage to the equipment.
HOT 	May cause dangerous hot surface, if touched, may cause personal 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 arm damage.
NOTICE	Indicates a potentially hazardous situation which, if not avoided, could result in robot arm damage, data loss, or unanticipated result.

Symbol	Description
⚠ CAUTION	Indicates a situation that, if not avoided, could result in personnel injury or damage to the equipment. For items marked with such signs, depending on the specific situation, there is sometimes a possibility of significant consequences

1.6 General safety

Follow the safety instructions below when starting and using the robot for the first time.

DANGER

- The robot control system is an electrically powered device. Non-professionals should not modify the circuit, otherwise, it may result in robot damage or personal injury.
- Strictly comply with local laws and regulations when operating the robot. The safety precautions described in this document serve only as a supplement to local safety standards.
- Use the robot within the specified environmental conditions. Operating beyond the rated specifications and load conditions may shorten the robot's lifespan or even damage it.
- Ensure that the robot is operated under safe conditions and there is no harmful object around the robot.
- Avoid frequently powering the robot on and off, as this may degrade the performance of the main circuit components inside. If repeated power cycling is necessary, limit it to no more than once per minute.

HOT

- The robot and controller generate heat during operation. Do not operate or touch the robot while it is running or immediately after it stops.
- Turn off the power and wait one hour for the robot to cool down.
- Do not place your fingers on the heat generating area of the controller.

NOTICE

- Personnel responsible for installing, operating, and maintaining the equipment must undergo rigorous training, fully understand all safety precautions, and master proper operation and maintenance procedures before handling the equipment.
- Unauthorized personnel without professional training must not disassemble or repair the equipment. In case of a malfunction, contact DOBOT's technical support engineer in time.
- Perform daily inspections and periodic maintenance, replacing faulty components promptly to ensure the safe operation of the equipment.
- If the equipment is scrapped, please comply with the relevant laws for the proper disposal of industrial waste to protect the environment.
- Establish safety measures (e.g., fences, ropes, or warning lines) near the robot's operating area to ensure that personnel stay out of the robot's reach while it is in operation or about to start.
- Do not enter the robot's safety zone defined by the risk assessment or touch the robot while the system is running.
- Do not expose the robot to a permanent magnetic field, as strong magnetic fields can cause damage.
- DOBOT assumes no responsibility for robot damage or personal injury caused by improper operation or failure to follow the product's instructions for use.
- Handling operations using lifting rings, cranes, or similar equipment must be conducted using appropriate and reliable lifting devices, and must be carried out by qualified personnel or those authorized by the company in accordance with local regulations.
- Make sure that there are no obstacles within 2 meters of the robot during the transportation, and personnel should stay away from the suspended robot.
- DOBOT is not responsible for any damage caused during the transportation and handling of the equipment.
- Make sure that the robot is in the packing posture before packaging, and the brakes on each axis are normal.
- Make sure that the packing area is free of obstacles to allow staff to evacuate quickly in case of emergencies.
- Secure the packaging firmly during transport to keep the robot stable.
- After removing the outer packaging, make sure that the robot maintains its original packing posture and the brakes on each axis are normal.
- Make sure that the unpacking area is free of obstacles to allow staff to evacuate quickly in case of emergencies.
- During debugging, make sure that no personnel or other equipment (including computer used for debugging) is present in the hazardous area of the machine.
- Wear appropriate personal protective equipment when necessary, such as safety helmets, safety shoes (with non-slip soles), face shields, safety goggles, and gloves. Inappropriate clothing may cause personal injury.

- Do not enter the robot’s workspace while the robot is operating, as this may result in injury to the robot or operator.
- If an abnormality occurs with the robot, ensure that the system is stopped before conducting an inspection.
- After debugging, operators must first test the system in manual mode. Once this is confirmed to be correct, switch to automatic operation.
- Before selecting automatic operation mode, all paused safety configurations must be restored to full functionality.
- If the controller needs to be restarted due to a power failure, the robot must be manually returned to the initial position of the automatic operation program before restarting automatic operation.
- Before performing maintenance, inspection, or wiring work, the power supply must be completely cut off, and a "No power supply" sign must be posted. Failure to do so may result in electric shock or personal injury.
- Observe ESD (Electrostatic Discharge) regulations when disassembling the robot or controller.
- Avoid disassembling the power supply system inside the controller. Even after the controller is turned off, high voltage may remain for several hours.
- For disassembly and repair of the robot, contact DOBOT's technical support engineer.
- Maintenance and repair work must be carried out by designated personnel, otherwise electric shock or personal injury may result.
- If the brake is manually released, the robot may move due to gravity. Therefore, when manually releasing the brake, ensure proper support for the robot and any attached tools or workpieces.
- If the power supply must be turned on while the controller door is open for maintenance or inspection, avoid direct exposure of the controller interior to strong light sources such as sunlight or spotlights, as this may cause malfunctions or errors.
- To prevent electric shock, turn off the circuit breaker and disconnect the main power before replacing any components.
- Wait at least five minutes after disconnecting the main power before replacing components.
- Component replacement must be performed by authorized personnel.
- The robot is designed and tested according to Group 1, Class A industrial, scientific, and medical (ISM) equipment standards. In household and light industrial environments, using this robot may cause radio interference, requiring protective measures.
- Do not operate the robot near strong radiation sources (e.g., unshielded RF sources), as this may interfere with normal operation.
- The maximum operating speed of the robot has been set to the optimal value at the factory. If a speed increase is required, please contact technical support to discuss potential solutions. Unauthorized adjustment of the maximum speed limit may result in issues such as joint torque exceeding permissible limits during robot movement.

WARNING

- Wear anti-static clothing and anti-static gloves before operating the equipment.
- It is prohibited to modify or remove the nameplate, instructions, icons, or labels on the equipment.
- Before operating the equipment, locate and be familiar with the emergency stop function to ensure that the robot can be stopped urgently in case of an emergency. The emergency stop function is classified as a Stop Category 1.
- Be careful when handling or installing the robot. Follow the instructions on the packaging box, place the robot gently, and position it according to the arrow markings to prevent damage.
- To ensure device and personal safety, use supplied cables.
- Make sure that both the robot and the tools are correctly and securely installed.
- Make sure that the robot has sufficient space to move freely.
- Do not continue using the robot if it is damaged.
- Any impact will release a large amount of kinetic energy, which can be much higher than during high-speed or high-load operations.

1.7 Personal safety

When operating the robot system, please strictly follow the general precautions listed below to ensure the personal safety.

WARNING

- Comply with local laws or regulations with regard to the maximum weight one person is permitted to carry.
- Do not touch the wiring terminals or disassemble the equipment while it is powered on, as this may result in electric shock.
- Make sure that the equipment is properly grounded, otherwise, it may endanger personal safety.
- Do not touch the power terminals or disassemble internal components within 10 minutes of disconnecting the robot from the power supply, as residual voltage in the internal capacitors may cause electric shock.
- Even if the controller's power switch is already in the "OFF" status, do not touch or disassemble internal components, as residual voltage in the internal capacitors may cause electric shock.
- Do not wear loose clothing or jewelry when working with the robot. Tie your long hair back behind your head.
- If the robot appears to be stationary while the equipment is running, it may be in a standby state, waiting for a start signal. In such cases, the robot should still be considered active. Do not approach the robot.

1.8 Residual risks

DOBOT have undergone rigorous safety design and testing, and a series of safety measures have been implemented to minimize risks during installation, commissioning, operation, and maintenance. However, certain **residual risks** may remain and should be handled with caution during operation:

- **Mechanical collision or pinching:**

  Unexpected collisions of mechanical components or abnormal gripping may occur during the robot's operation.

- **Electrical hazards:**

  Risks such as accidental electrical leakage may arise due to cable aging or improper installation environments.

- **Programming errors or loss of control:**

  Communication interference, incorrect parameter settings, or improper integration with other equipment could result in deviations from the intended robot actions.

- **Human operational errors:**

  Risks caused by failure to strictly adhere to operational requirements, unauthorized parameter adjustments, or untrained personnel entering the robot's motion area.

To reduce residual risks, follow these recommended practices during use:

- **Wear protective equipment:**

  Always wear safety gear such as hard hats, safety glasses, and insulated gloves, especially when entering the robot's motion area.

- **Isolate the workspace:**

  Use barriers or warning signs to prevent unauthorized personnel from entering the robot's operating range.

- **Familiarize yourself with the emergency stop button:**

  Ensure the emergency stop button is always easily accessible and press it immediately in case of emergencies.

- **Perform regular maintenance:**

  Conduct routine inspections of all robot components as specified in the manual to ensure proper functioning.

- **Authorized use only:**

  Robots should only be operated by trained and qualified personnel. Unauthorized modification of parameters or disassembly of components is strictly prohibited.

When using the robot, always operate it in strict accordance with the operational instructions and safety guidelines. DOBOT assumes no responsibility for any losses incurred due to failure to comply with these regulations.

1.9 Emergencies

1.9.1 Emergency stop device

In case of emergency, press the E-stop button to immediately halt all robot movements. According to IEC 60204-1 and ISO 13850, emergency stop devices are not safeguards. They serve as supplementary protective measures and are not intended to prevent injuries.

Based on the results of the risk assessment for your robot application, you can connect additional E-stop buttons. The E-stop button must comply with the IEC 60947-5-5 standard.

NOTICE

Pressing the emergency stop, the robot arm stops all motion and loses power.

1.9.2 Emergency recovery

The E-stop button locks when pressed and must be rotated as indicated on the button to unlock it. After unlocking, the alarm can be cleared and the robot can be re-enabled via DobotStudio Pro to recover from the emergency status.

WARNING

Operate the robot arm to recover from emergency status only after the danger to the robot system has been completely eliminated.

1.9.3 Personnel rescue in emergency situations

In rare emergency cases, you may need to move the robot arm while in an emergency stop status to rescue a trapped person. In such cases, you can:

Manually releasing the brakes

Open DobotStudio Pro and navigate to **"Settings > Safety > Joint brake"** page, click **"Edit"**, hold the joint with your hand and turn on the switch of the joint you want to move, then click **"Save"**.

Once the brake is ON, you can drag the joint to rescue the trapped person.

WARNING

When switching on the "Joint brake" function, be sure to hold the joint with your hand to prevent it from falling.

NOTICE

- The robot arm's axis limits are set via software.
- When the brake is ON, the drop distance of the robot arm during the closing process is less than 1 mm.

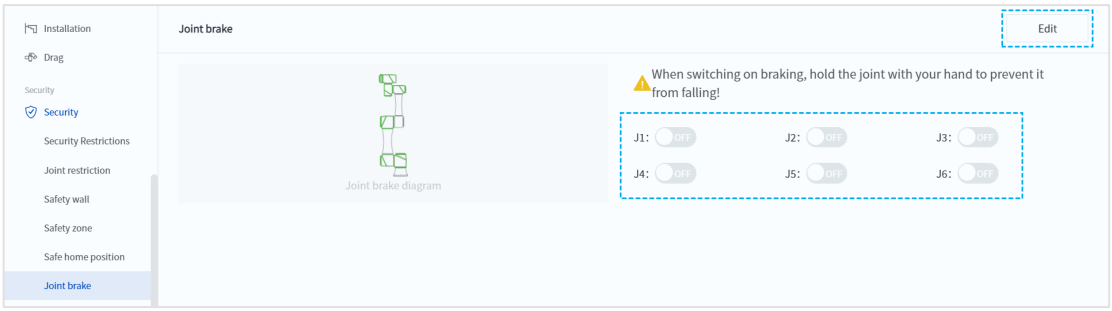


Figure 1.1 Manually release the brakes

Removing the fixing screws from robot base

Refer to Robot installation. After removing the fixing screws from the robot base, you can move the robot arm to free the trapped person.

WARNING

- Disconnect the robot from the power before removing the screws.
- Hold the robot throughout the process of removing the screws and moving the robot.

2. Product Introduction

2.1 Overview

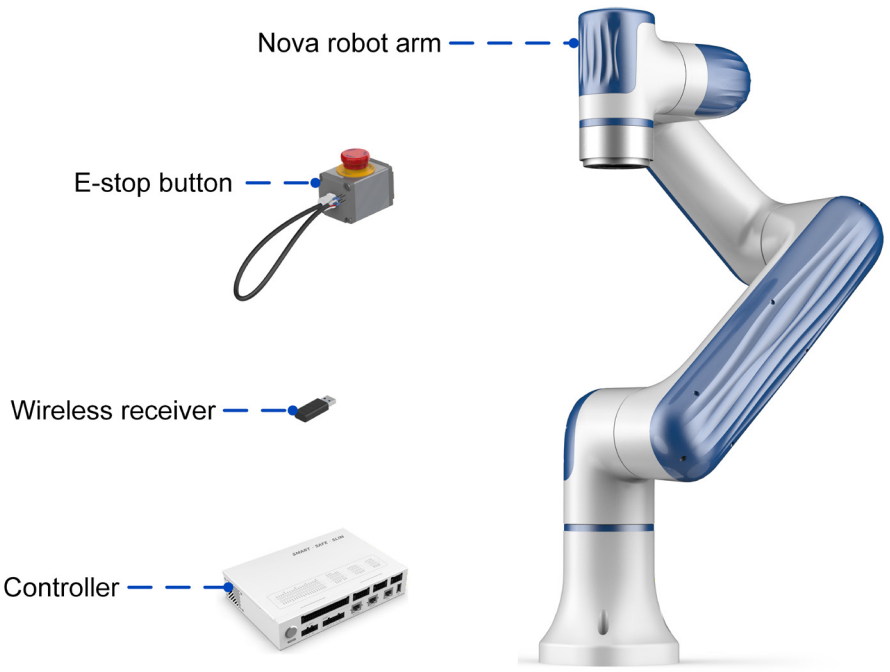


Figure 2.1 Robot system overview

The main components of the robot system include:

- **Nova robot arm:** Six-axis robot arm, main moving parts.
- **Small controller:** Core computing and electrical components.
- **E-Stop button:** Connected to the controller to enable the emergency stop function.
- **Wireless receiver (Optional):** Plugged into the controller, enabling the operation terminal to connect to and control the robot via WiFi.

In addition, the system includes an **operation terminal** (tablet, PC or teach pendant) for installing the robot's control software.

Figure 2.2 Operation terminal

2.2 Robot arm

2.2.1 Composition

As shown in Figure 2.3, the Nova series robot arm includes 6 rotary motion joints, and 2 connecting rods (upper arm and forearm). The robot's end is equipped with a hand-guiding button and an indicator light, while the tool flange side is fitted with an aviation socket.

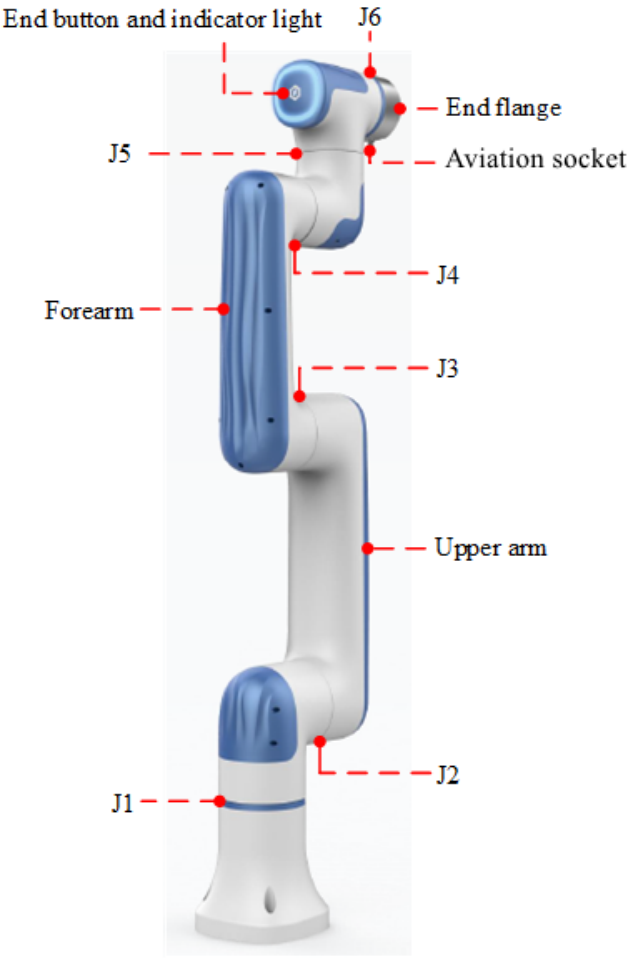


Figure 2.3 Nova series robot arm

2.2.2 End button and indicator light

The end of Nova series robot arm is equipped with a button and a ring of indicator light, as shown in Figure 2.4.

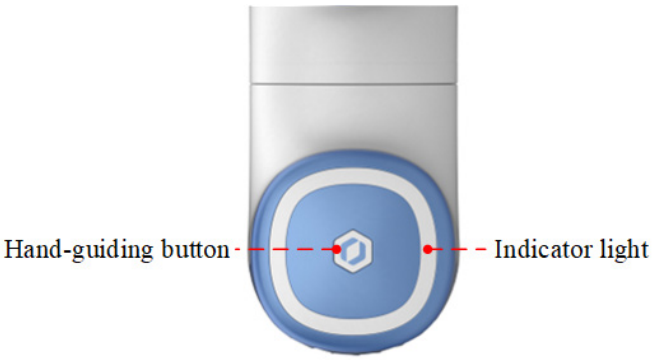


Figure 2.4 End button and indicator light

The meanings of the end indicator lights are as follows:

Indicator color	Status	Description
Blue	Steady on	The robot is powered on but not enabled
Blue	Flashing	Hand-guiding status (fast flashing indicates the robot arm is starting up / there is an abnormal connection between the robot arm and the controller)
Green	Steady on	The robot is enabled (project not running).
Green	Flashing	Automatic running status (project running)
Yellow	Steady on	Trajectory recording status
Yellow	Flashing	Trajectory playback status
Red	Steady on	The robot is in alarm status

When the robot is enabled, long-press the hand-guiding button for 3 seconds to enter drag teaching mode. After dragging the robot to the teaching point, short-press the hand-guiding button to exit drag teaching mode.

2.3 Controller

The DOBOT Nova series robot must be used in conjunction with a small controller (DSC). The appearance of these controllers is as shown below, and detailed definitions of the electrical interfaces can be found in the Electrical Characteristics.

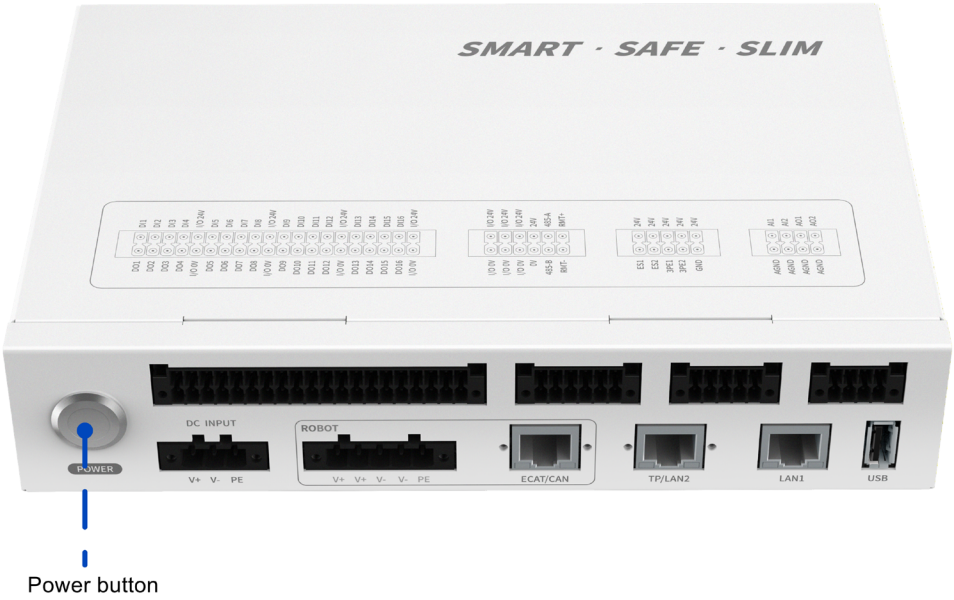


Figure 2.5 DSC small controller

After connecting the external power supply and the robot arm, briefly press and release the controller's power button to turn it on and provide power to the robot arm. A solid green light indicates the controller has successfully started.

When the controller is powered on, briefly press and release the power button again to shut it down and cut power to the robot arm. The green light turning off indicates a successful shutdown.

2.4 Operation terminal

The DOBOT Nova series robot supports control via both PC and App, as shown in Table 2.1. To enable control via WiFi, the WiFi module must be plugged into the controller.

Table 2.1 Operation terminal specifications

Terminal type	PC	Tablet (Android)
Operating system	Windows 10 (64-bit) 1809 or above	Android 10 and above
Control software	DobotStudio Pro (4.6.4.0_stable and above)	
Recommended configuration	CPU: 64-bit Intel or AMD processor (SSE4.2 or later, 2.9GHz or higher) Memory: 16G Storage: 128GB (at least 4GB available) Network card: Gigabit-NIC	CPU: 4-core, 2.0GHz or higher RAM: 4GB Storage: 32GB Screen: 8-inch

	Graphics card: 4GB, DirectX12 support Display: 1920x1080 or higher resolution	
Communication mode	LAN/WiFi	WiFi

When purchasing a DOBOT Nova series robot, you can request an optional Android tablet, or use self-prepared operation terminal as long as it meets or exceeds the recommended specifications in Table 2.1.

3. Product Characteristics

3.1 Coordinate system

3.1.1 Joint coordinate system

The joint coordinate system is determined based on all motion joints. All joints are rotational joints, as shown in Figure 3.1.

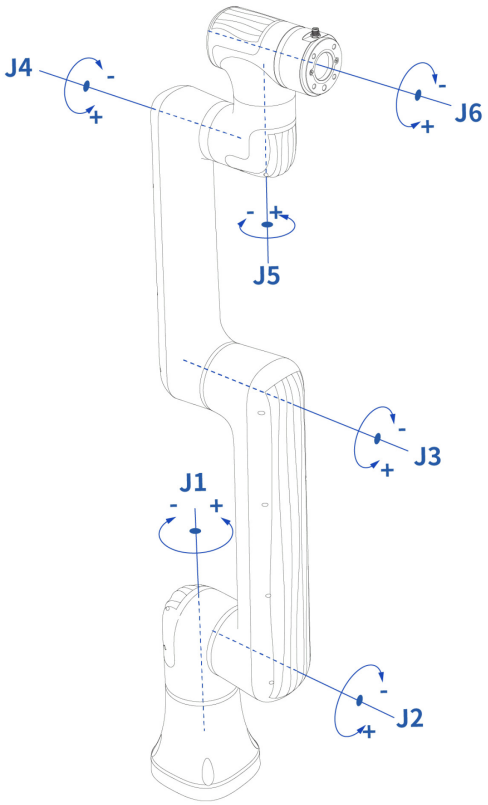


Figure 3.1 Joint coordinate system

3.1.2 User coordinate system

The user coordinate system is a user-defined coordinate system based on the workbench or workpiece. The origin and axis directions can be defined as needed to measure points within the workspace and arrange tasks conveniently. The default user coordinate system is determined based on the center point of the robot base, and Y+ direction is the routing direction of the heavy-duty cable, as shown in Figure 3.2.

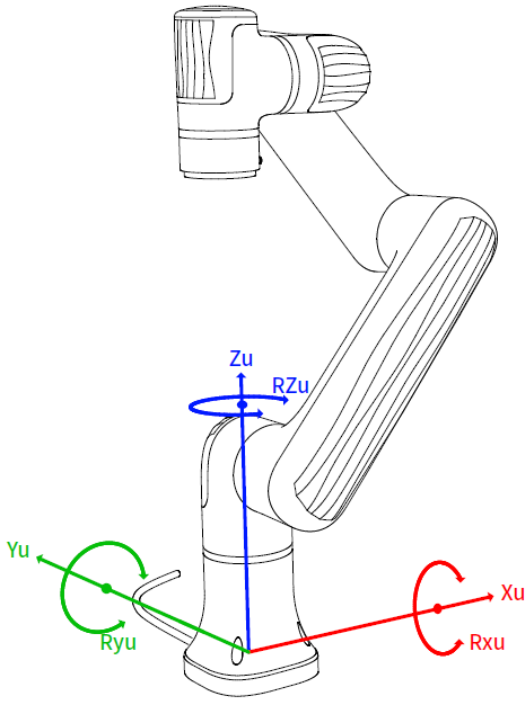


Figure 3.2 User coordinate system

3.1.3 Tool coordinate system

The tool coordinate system defines the position and posture of the Tool Center Point (TCP). Its origin and direction change dynamically based on the position and angle of the end tool. The default tool coordinate system is determined based on the center point of the end flange, with the Y+ direction facing opposite to the aviation connector, as shown in Figure 3.3.

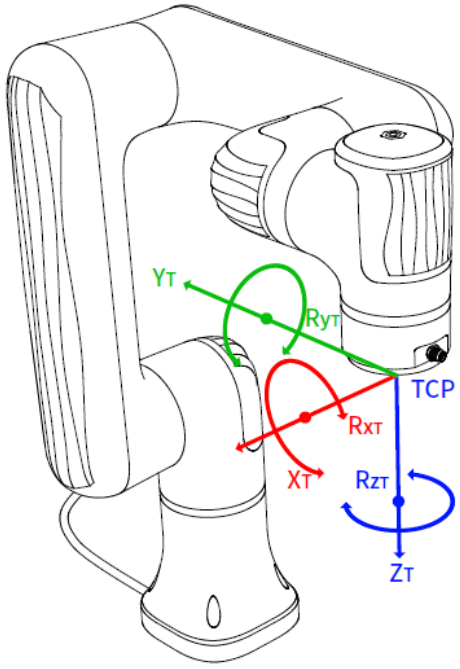


Figure 3.3 Tool coordinate system

3.2 Home posture

Each joint of the robot arm is marked with a home-posture sticker as shown in Figure 3.4. When a joint is at 0 degrees, the stickers on both sides of the joint will be perfectly aligned. When all joints are set to 0 degrees, the robot arm should be in a vertical posture, with the heavy-duty cable aligned parallel to the J2 axis and the aviation connector pointing straight upward.

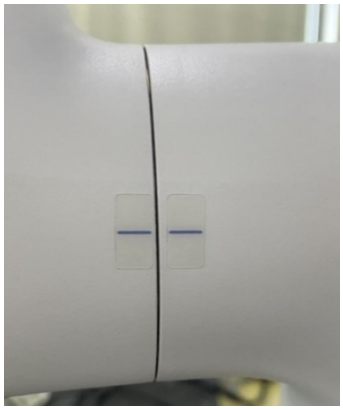


Figure 3.4 Home-posture sticker

If the home posture changes due to component replacement or collision, you can move the robot arm to a state where all the home-posture stickers of each joint are aligned. Then calibrate the home posture through DobotStudio Pro.

3.3 Singularities

When the robot moves in a linear or arc trajectory and approaches certain specific postures, an alarm will be triggered, and the robot will stop movement. These postures are referred to as singular positions or singular points.

NOTICE

- Joint motion is not affected by singular positions.
- Avoid stopping the robot near a singularity using drag mode or joint motion and then attempting linear or arc motion.

The DOBOT Nova series robot arm has three types of singularities, as described below.

3.3.1 Shoulder singularity

The singularity occurs when the intersection of the J5 and J6 axes is located in the plane formed by the J1 and J2 axes. This typically happens in the cylindrical space directly above or below the robot. Refer to the motion range in the Mechanical Specifications chapter for details about each model as shown in Figure 3.5.

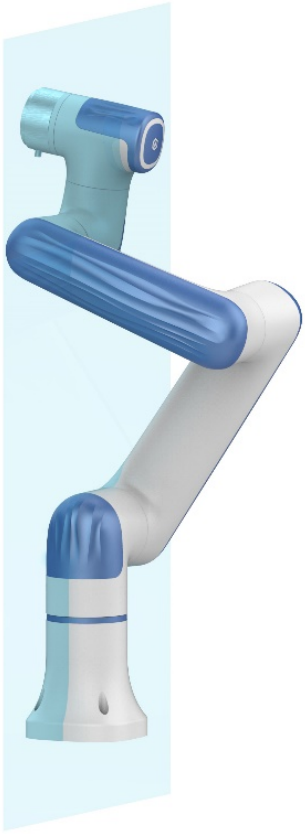


Figure 3.5 Shoulder singularity

3.3.2 Elbow singularity

The singularity occurs when J3=0°±2°, where the upper arm and forearm are parallel. as shown in Figure 3.6.

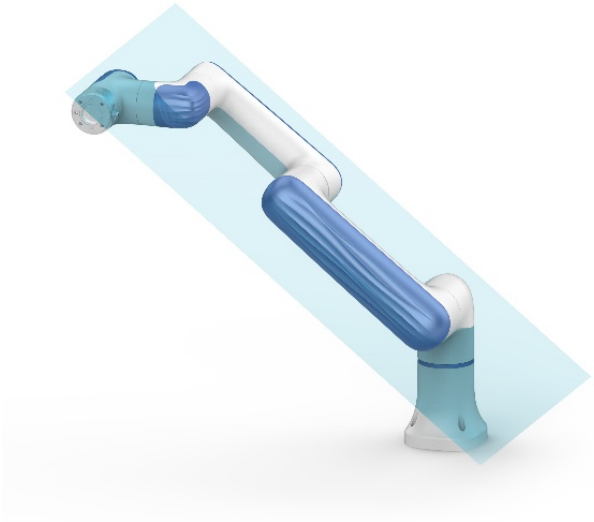


Figure 3.6 Elbow singularity

3.3.3 Wrist singularity

The singularity occurs when J5=0°±2°, where the J4 axis and J6 axis are parallel. as shown in Figure 3.7.

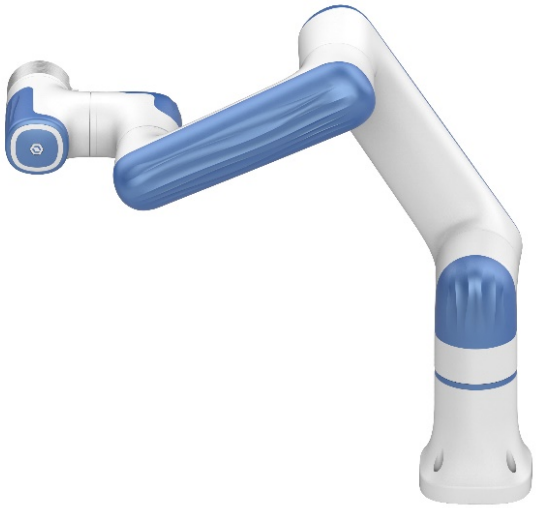


Figure 3.7 Wrist singularity

3.3.4 Recommendations for avoiding singularities

- Switch the motion type to joint motion when near a singularity.
- Add transition points in the trajectory to bypass the singularity.
- Adjust the installation posture of the robot to avoid singularities in the path. For example, switch from standard-angle mounting to hoisting or side mounting.
- Modify the length of the end tool.
- Adjust the installation angle of the end tool to bypass singularities in the path.

3.4 Emergency stop time and distance

When the J1~J3 axes trigger an emergency stop at 100% speed, maximum load and maximum arm span, the braking time and distance of each joint are shown in the table below.

For the J1 axis, the test is performed by moving horizontally, namely, the rotation axis is perpendicular to the ground.

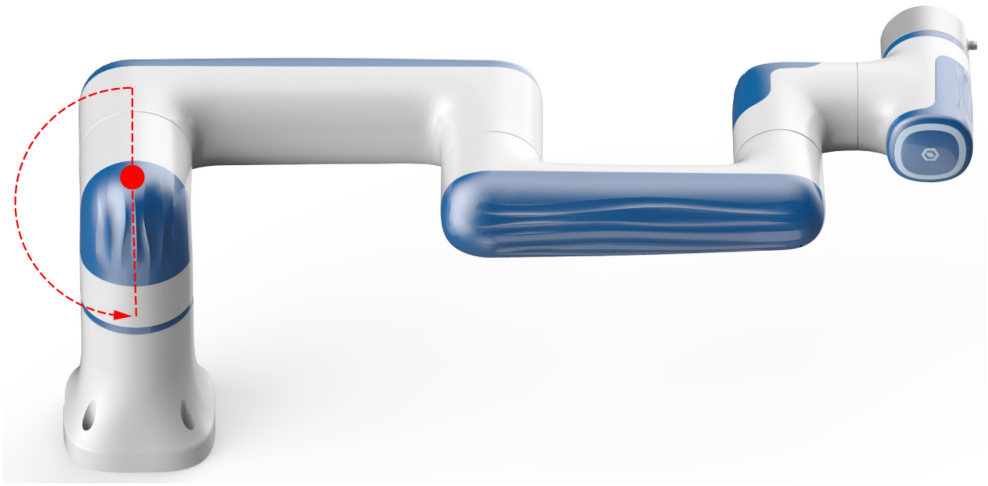


Figure 3.8 J1 Emergency stop test

For the J2 and J3 axis tests, the robot follows a vertical trajectory, namely, the rotation axis is parallel to the ground, and triggers an emergency stop when the robot moves downward.

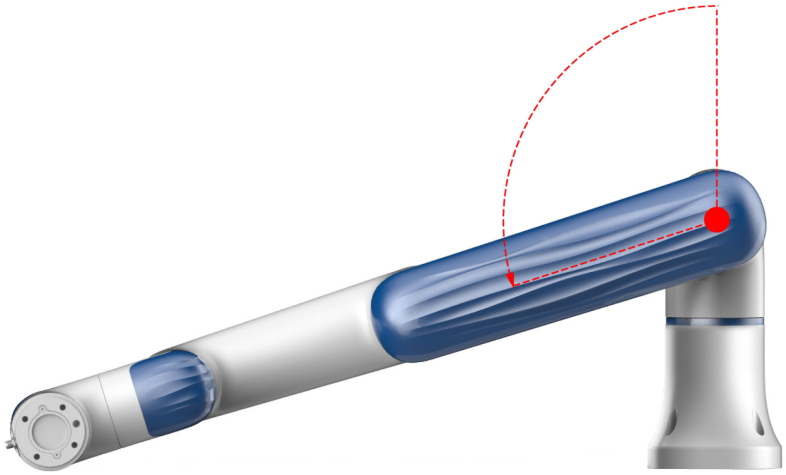


Figure 3.9 J2 Emergency stop test

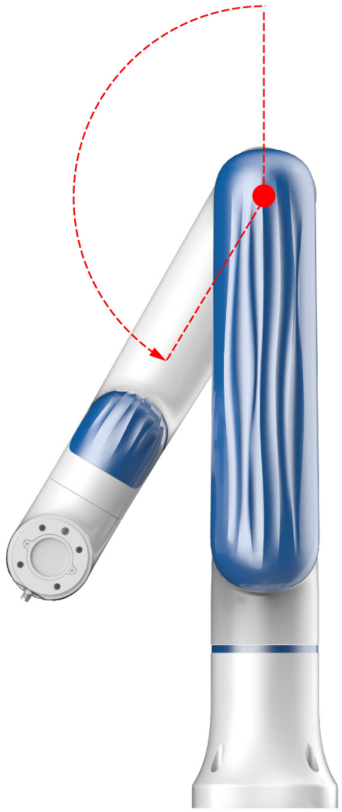


Figure 3.10 J3 Emergency stop test

The table below includes the data of some models for your reference.

Table 3.1 Emergency stop time and distance

Axis	Emergency stop time / distance	
	Nova 2	Nova 5
J1	217ms/169.02mm	179ms/158.36mm
J2	213ms/157.37mm	175ms/141.81mm
J3	227ms/102.29mm	196ms/84.70mm

4. Mechanical Specifications

All dimensions in this chapter are in millimeters (mm).

4.1 Nova 2 mechanical specifications

4.1.1 Nova 2 dimensions and workspace

When selecting the installation position for the robot, you must consider the cylindrical space directly above and below the robot, and try to avoid moving the tool into this cylindrical space. As doing so may cause the joints to rotate too fast even when the tool moves slowly, resulting in low work efficiency and making risk assessment more difficult.

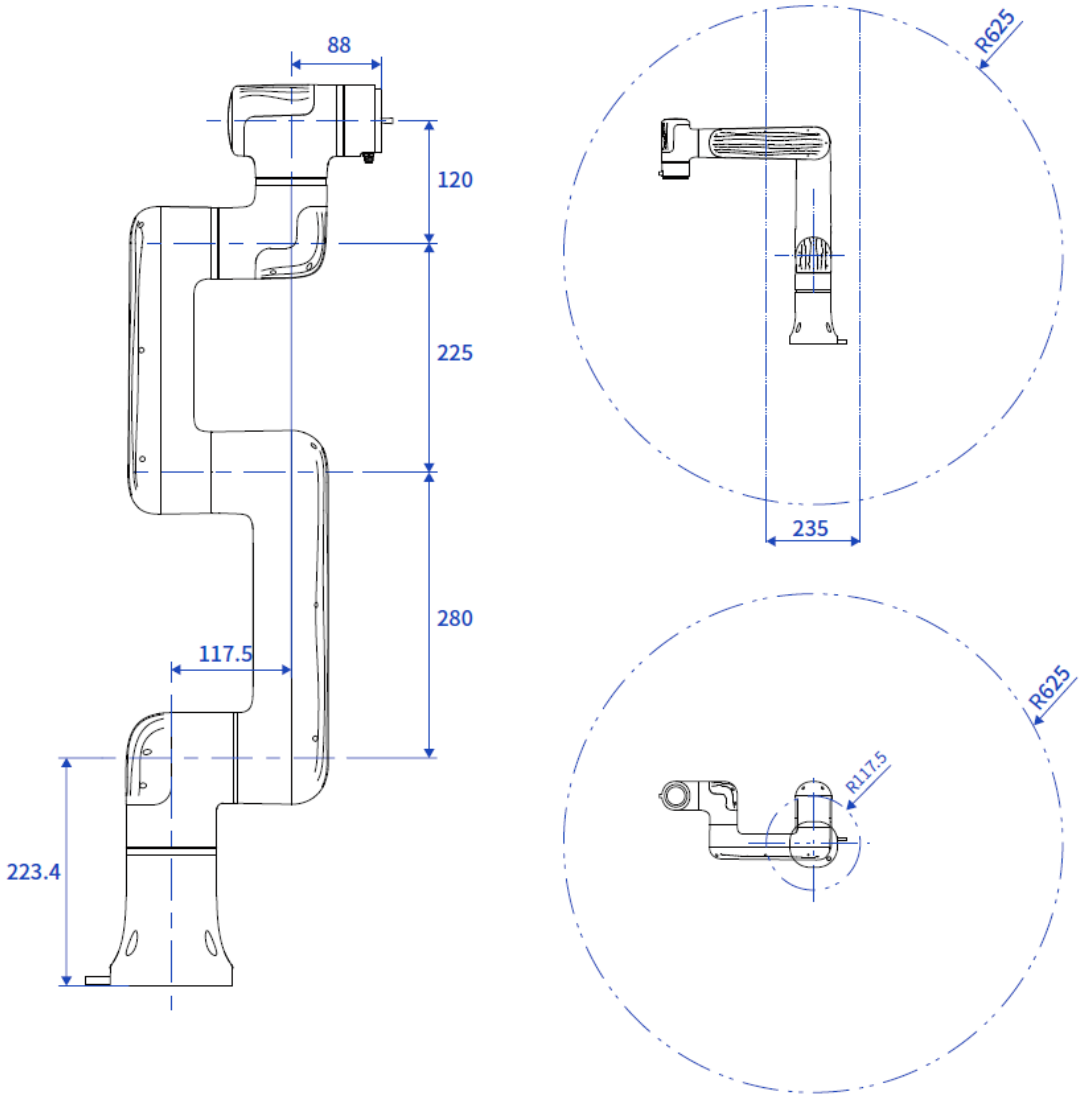


Figure 4.1 Nova 2 dimensions and workspace

4.1.2 Nova 2 base mounting dimensions

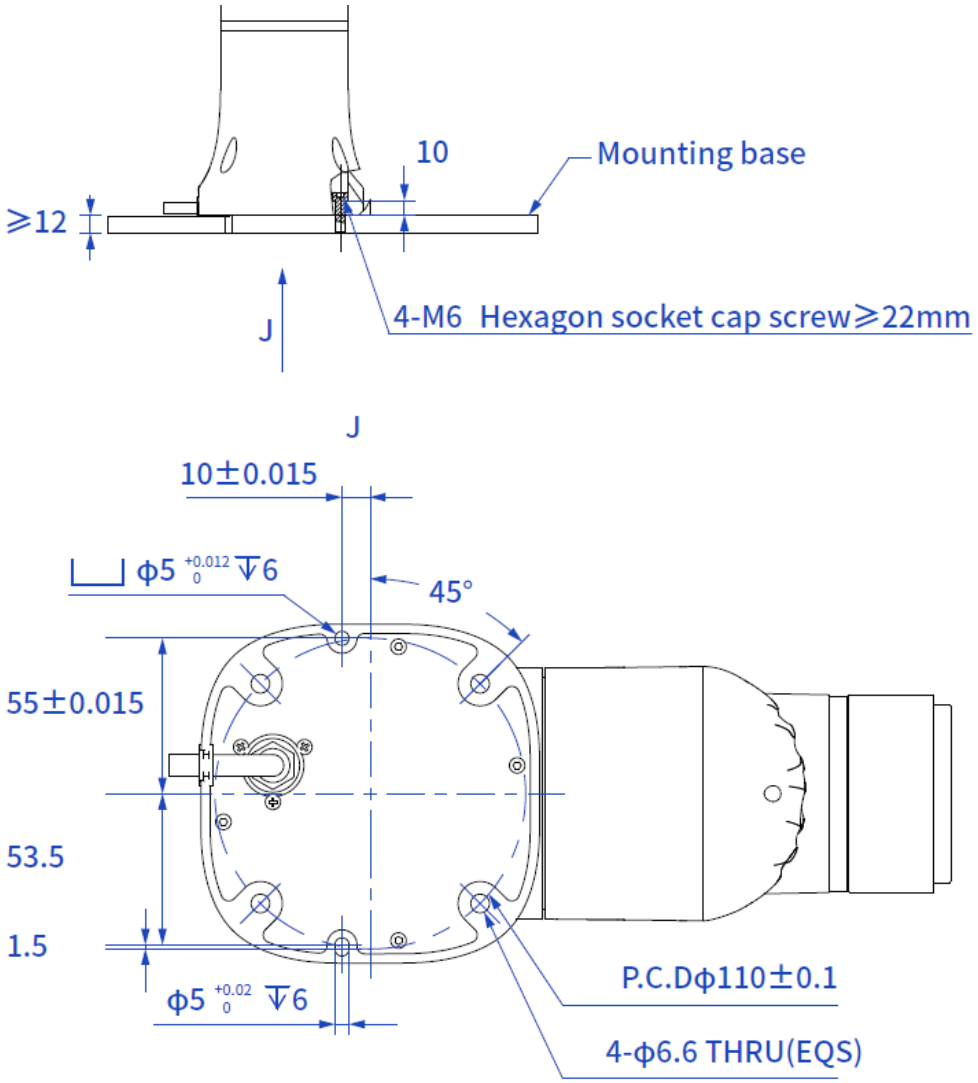


Figure 4.2 Nova 2 base mounting dimensions

4.1.3 Nova 2 end flange dimensions

The end flange dimensions of the Nova series robot are all identical. The flange design conforms to ISO 9409-1.

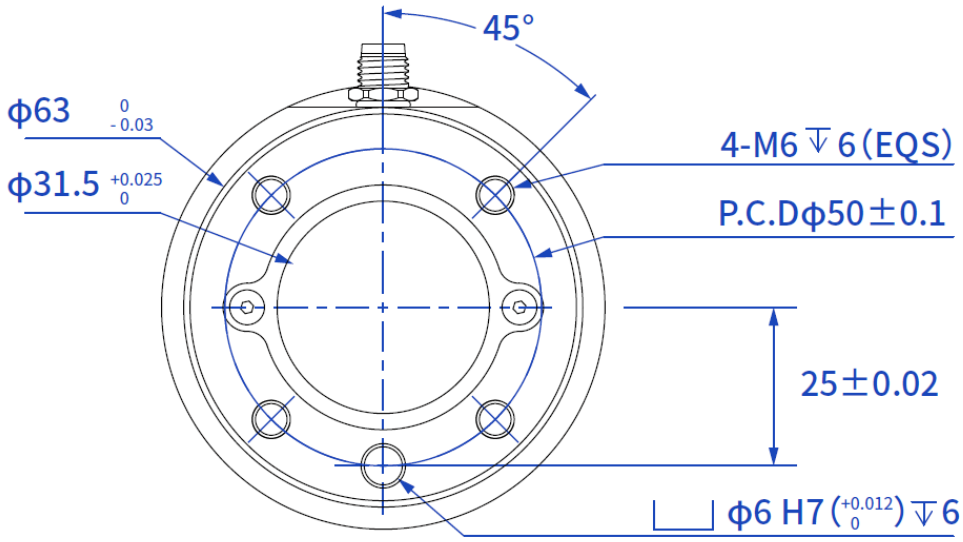


Figure 4.3 Nova 2 end flange dimensions

4.1.4 Nova 2 end load curve

The origin of the coordinate system for the end load curve is the center of the robot's end flange. X and Y represent the offset distance of the load's center of gravity from the flange center along the X and Y axes. The radial distance (r) is calculated as: $r = \sqrt{X^2 + Y^2}$. This r-value corresponds to the vertical axis (Y-axis) in the load curve graph, labeled as X, Y [cm]. The horizontal axis (X-axis) represents Z [cm], which is the distance from the load's center of gravity to the flange along the Z direction. You can evaluate the working condition of the robot according to the statistical results. For example, if the load is 1.5kg, X = 6cm, Y = 8cm, Z = 5cm, and you can get r = 10cm. The judgment steps are as follows:

- According to $r = \sqrt{X^2 + Y^2}$, calculate r = 10cm.
- Select the corresponding curve based on the load mass. For a load of 1.5 kg, locate the curve corresponding to 1.5 kg.
- Locate the (r, Z) = (10cm, 5cm) point in the load curve graph and compare it with the 1.5kg curve. If the point is below the curve, the load is within the robot's operational range (selection valid). If the point is above the curve, the load exceeds the robot's limit (selection invalid). In this example, the point is below the curve, indicating that the selected load is acceptable, and the robot can operate safely under this condition.

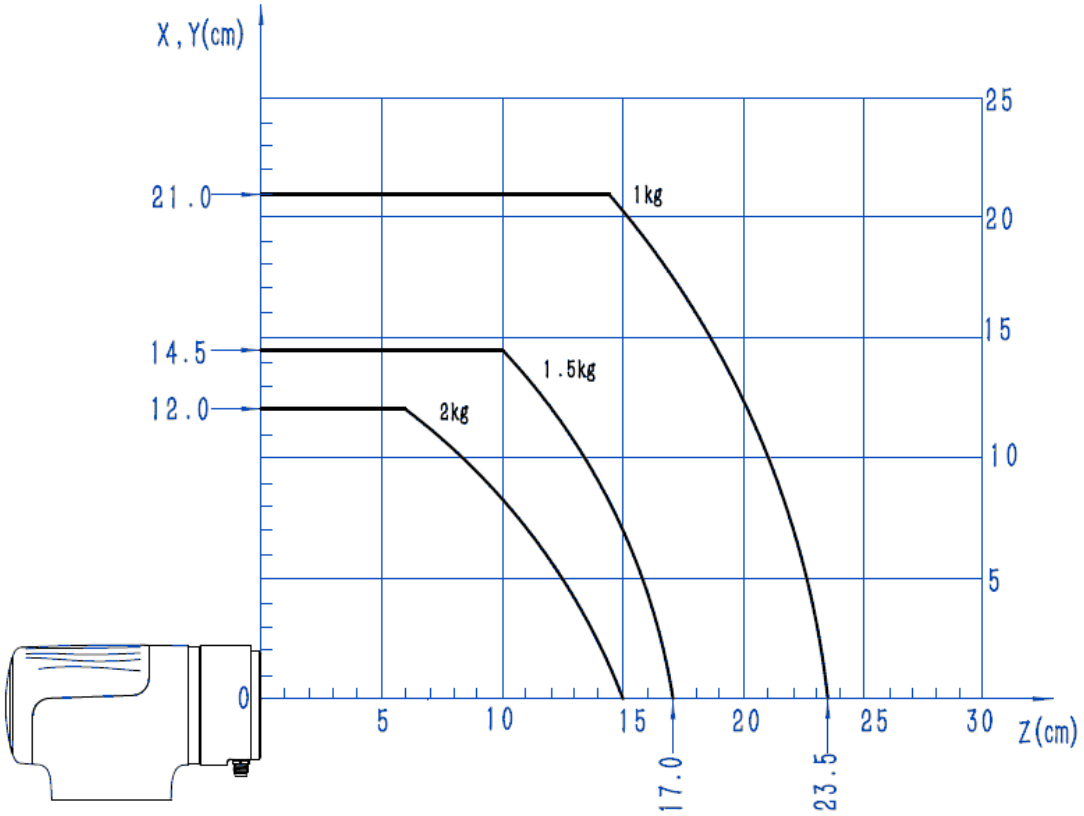


Figure 4.4 Nova 2 end load curve

4.2 Nova 5 mechanical specifications

4.2.1 Nova 5 dimensions and workspace

When selecting the installation position for the robot, you must consider the cylindrical space directly above and below the robot, and try to avoid moving the tool into this cylindrical space. As doing so may cause the joints to rotate too fast even when the tool moves slowly, resulting in low work efficiency and making risk assessment more difficult.

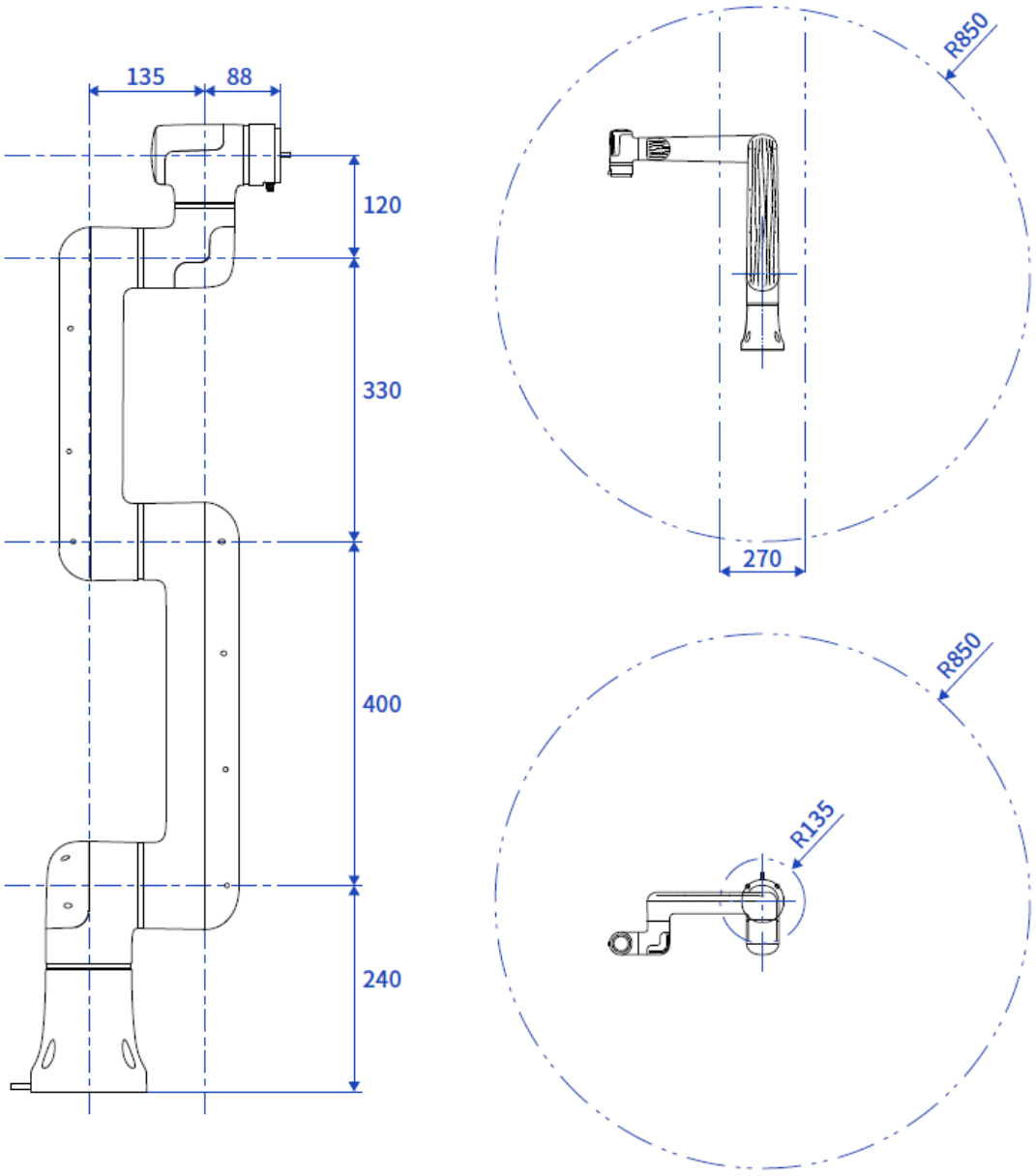


Figure 4.5 Nova 5 dimensions and workspace

4.2.2 Nova 5 base mounting dimensions

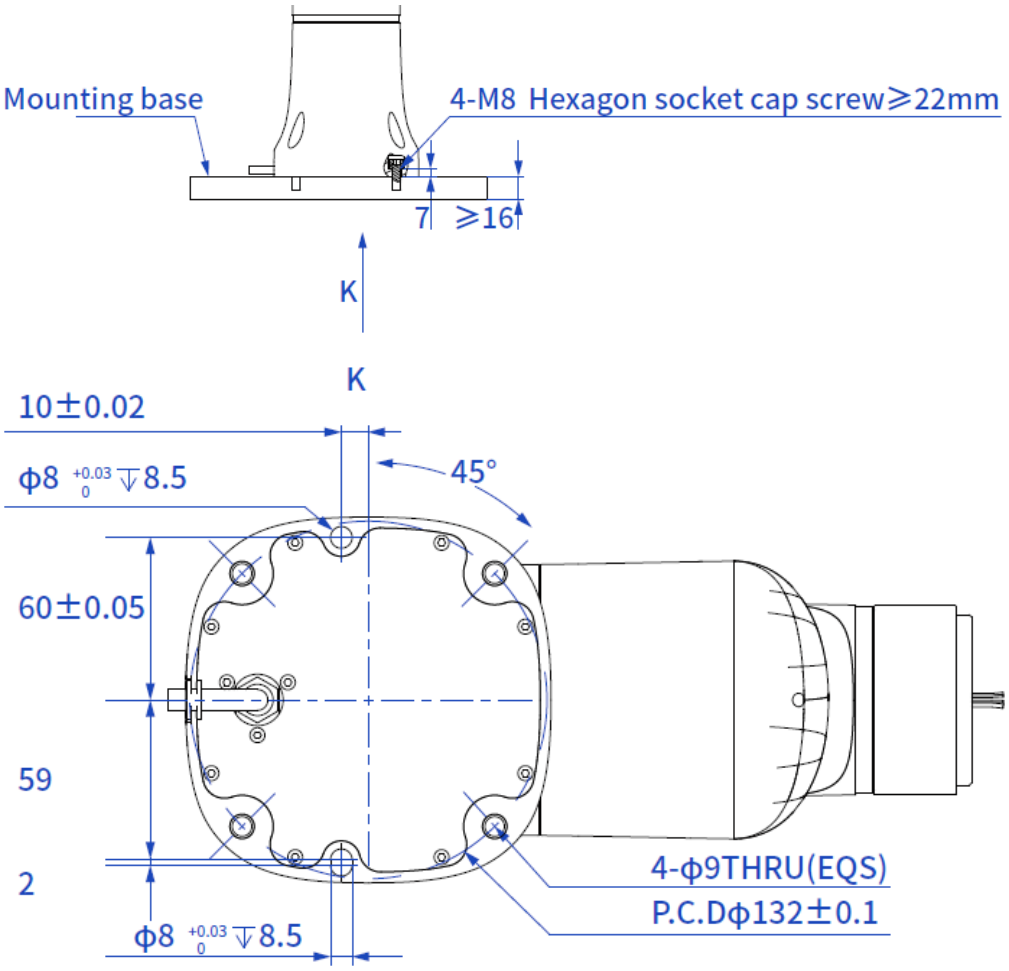


Figure 4.6 Nova 5 dimensions and workspace

4.2.3 Nova 5 end flange diemensions

The end flange dimensions of the Nova series robot are all identical. The flange design conforms to ISO 9409-1.

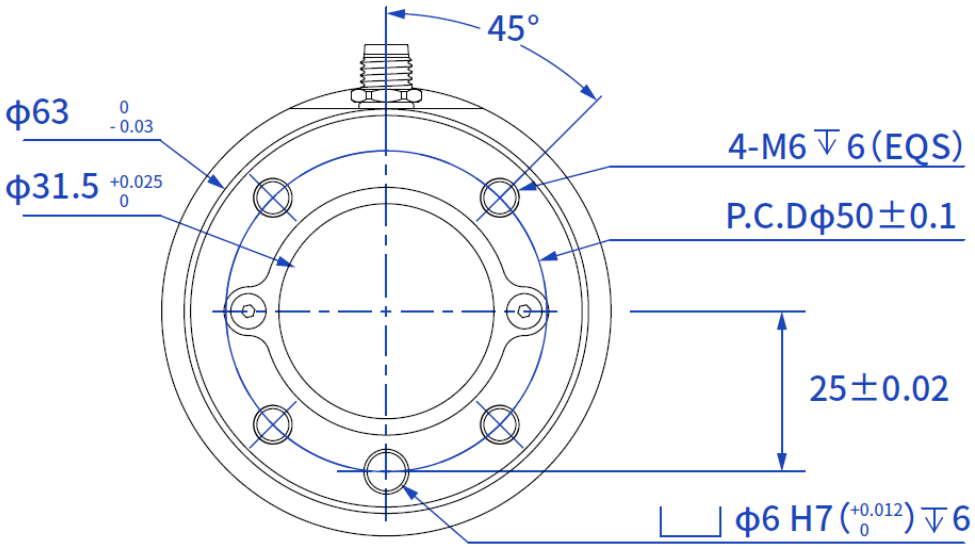


Figure 4.7 Nova 5 end flange diemensions

4.2.4 Nova 5 end load curve

The origin of the coordinate system for the end load curve is the center of the robot's end flange. X and Y represent the offset distance of the load's center of gravity from the flange center along the X and Y axes. The radial distance (r) is calculated as: $r = \sqrt{X^2 + Y^2}$. This r-value corresponds to the vertical axis (Y-axis) in the load curve graph, labeled as X, Y [cm]. The horizontal axis (X-axis) represents Z [cm], which is the distance from the load's center of gravity to the flange along the Z direction. You can evaluate the working condition of the robot according to the statistical results. For example, if the load is 3.8kg, X = 6cm, Y = 8cm, Z = 5cm, and you can get r = 10cm. The judgment steps are as follows:

- According to $r = \sqrt{X^2 + Y^2}$, calculate r = 10cm.
- Select the appropriate curve based on the load weight. Since the load is 3.8kg, use the 4kg curve as a reference.
- Locate the (r, Z) = (10cm, 5cm) point in the load curve graph and compare it with the 4kg curve. If the point is below the curve, the load is within the robot's operational range (selection valid). If the point is above the curve, the load exceeds the robot's limit (selection invalid). In this example, the point is below the curve, indicating that the selected load is acceptable, and the robot can operate safely under this condition.

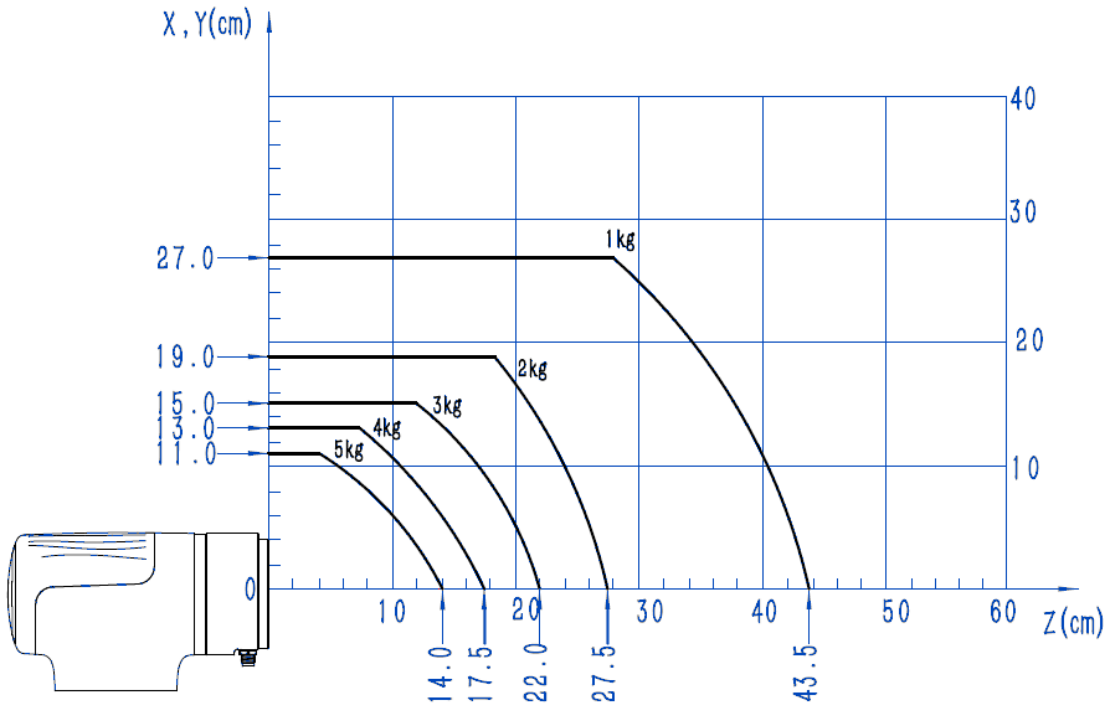


Figure 4.8 Nova 5 end load curve

4.3 Controller dimensions

All dimensions provided in this section are specified in millimeters.

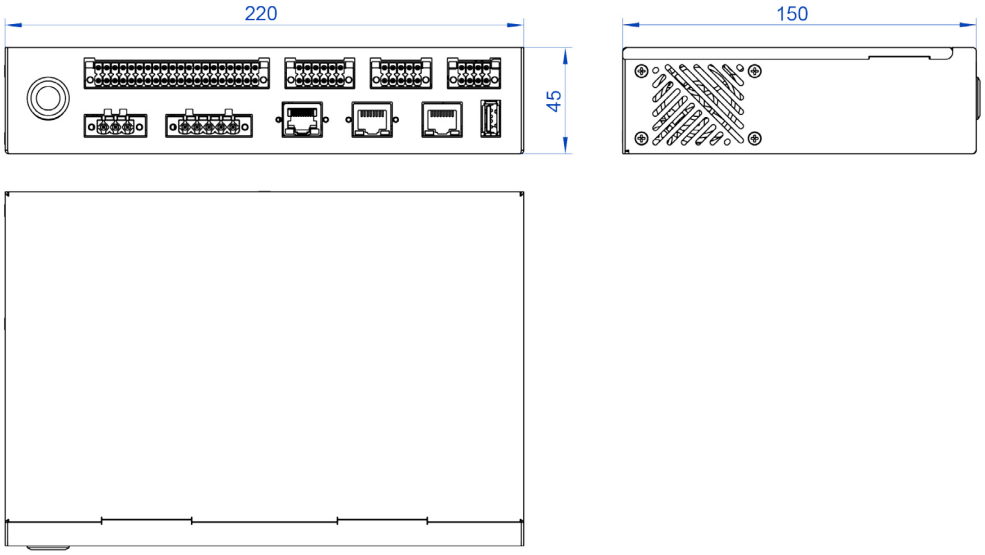


Figure 4.9 DSC controller dimensions

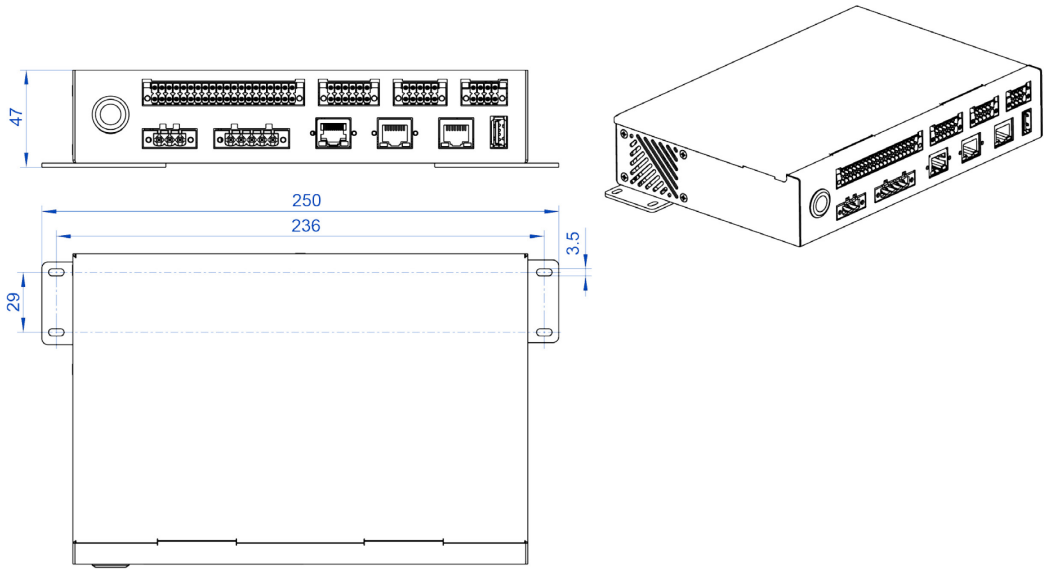


Figure 4.10 DSC horizontal mounting dimensions

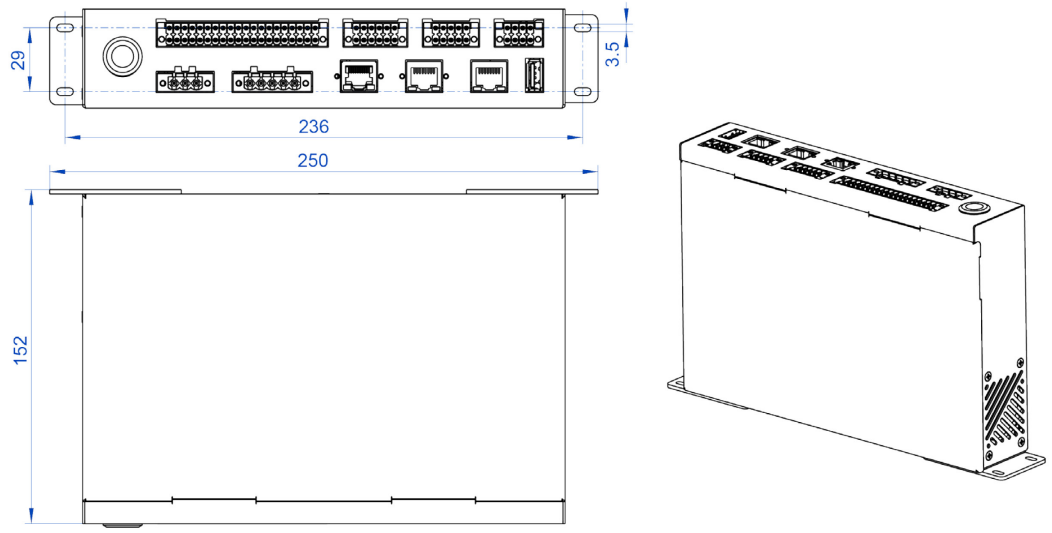


Figure 4.11 DSC vertical mounting dimensions

5. Electrical Characteristics

5.1 Electrical warnings and precautions

When designing and installing robot applications, please strictly follow the warnings and precautions listed below.

WARNING

The following warnings must be observed when designing and installing safety signal-related functions, as failure to do so may result in the loss of safety functions and cause injury or death.

- Never connect safety signals to a non-safety PLC with an inappropriate safety level. Always separate safety signals from regular I/O signals.
- All safety signals must use a dual-channel redundant design, with both channels remaining independent. This ensures that if one channel fails, the safety function will still be maintained.

WARNING: ELECTRICITY

- Make sure that the equipment is protected from water ingress. If water gets into the equipment, disconnect the power and contact technical support. Do not reconnect the power until the issue is resolved.
- Only use the robot's original cables and avoid bending the cables.
- Make sure that the power supply connected to the controller is properly grounded and avoid leaving the grounding prong of the power plug floating.

NOTICE

- The robot has passed electromagnetic compatibility (EMC) tests according to relevant standards. Electromagnetic interference exceeding these standards may affect the robot's behavior. Extremely high signal levels or excessive exposure to electromagnetic fields may cause permanent damage to the robot. DOBOT assumes no responsibility for any damage caused by EMC issues beyond the standards.
- The length of I/O cables used to connect the controller to other machinery or equipment should not exceed 30 meters unless confirmed feasible through on-site testing. If necessary, use shielded cables.

5.2 DSC controller interface

5.2.1 Interface overview

The electrical interfaces of the DSC controller are concentrated on the front panel, with their layout shown in the figure below.

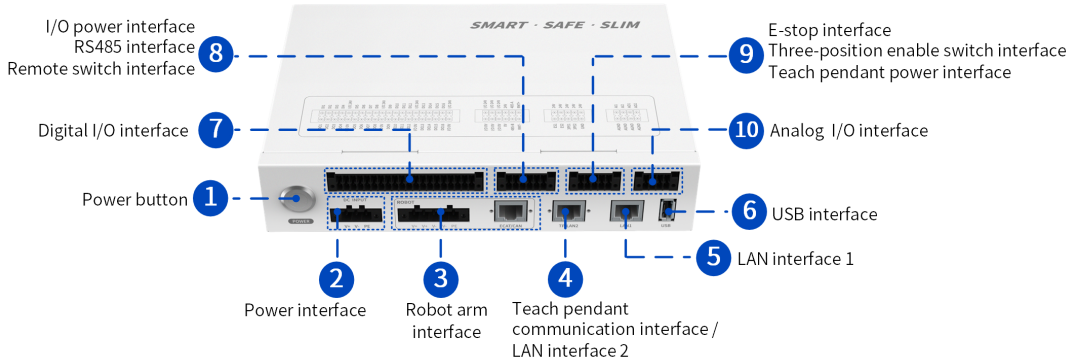


Figure 5.1 Interfaces on the controller

No.	Description
①	Controller power button (Maintained button). After connecting the controller to the external power supply, briefly press and release the power button to start the controller. When the controller is powered on, briefly press and release the power button again to shut down the controller and power off the robot arm. **NOTE** The user can also utilize a remote switch to power the controller on or off.
②	Power interface, used to connect an external power supply to provide power to the controller.
③	Robot arm interface. Used to connect the robot arm's heavy-duty cable for power supply and communication.
④	This interface is used to connect a teach pendant via an adapter cable, or to function as a LAN interface for connecting a computer for debugging purposes, or for connecting other external devices that use TCP/IP or Modbus TCP protocols. The default IP address for LAN2 is 192.168.200.1.
⑤	LAN1 interface. Default IP address: 192.168.5.1. This interface can be used to connect a computer for debugging or to connect other external devices using TCP/IP or Modbus TCP protocols. Only the IP address of LAN1 can be modified through the control software DobotStudio Pro.
⑥	USB interface, used for WiFi module connection.
⑦	Digital I/O interface, used for connecting external devices. For details, please refer to the Digital I/O interface section.

No.	Description
⑧	I/O power interface. For details, please refer to the I/O power interface instruction. RS485 interface. For details, please refer to the RS485 interface instruction. Remote switch interface. For details, please refer to the Remote switch interface instruction.
⑨	E-stop interface, refer to the Emergency stop interface for details. Three-position enable switch/teach pendant power interface. For details, please refer to the Teach pendant interface section.
⑩	Analog I/O interface, used for connecting external devices. For details, please refer to the Analog I/O interface section.

5.2.2 Power interface

It connects to an external DC power supply to provide power to the controller. For the CRA series robot arm, you need to provide your own 30 – 60 V DC power supply (48 V recommended).

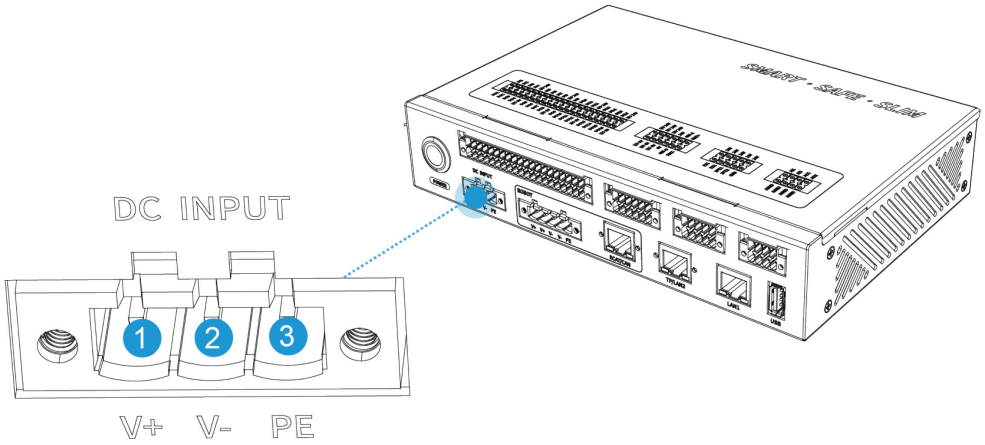


Figure 5.2 Power interface

Pin	Name	Definition
①	V+	DC 48V power positive (+)
②	V-	DC 48V power negative (-)
③	PE	Protective earth

5.2.3 Robot arm interface

It connects to the heavy-duty receptacle on the robot arm base via a heavy-duty cable, providing both power and communication to the robot arm.

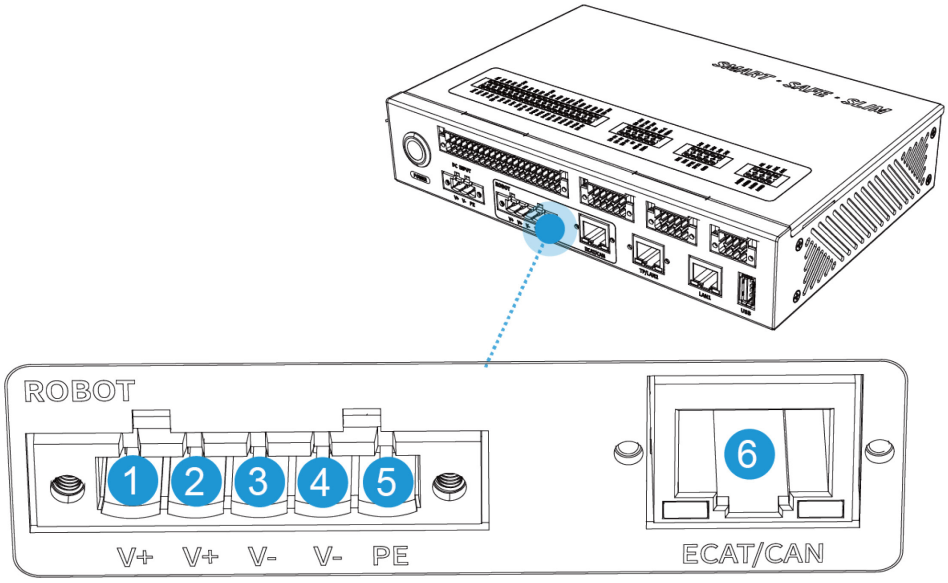


Figure 5.3 Robot arm interface

Pin		Name	Definition
Robot arm power interface	①	V+	DC 48V power positive (+)
	②	V+	DC 48V power positive (+)
	③	V-	DC 48V power negative (-)
	④	V-	DC 48V power negative (-)
	⑤	PE	Protective earth
Robot arm communication interface	⑥	ECAT/CAN	Receive/Transmit data

The pin definitions for the ECAT/CAN communication interface are as follows:

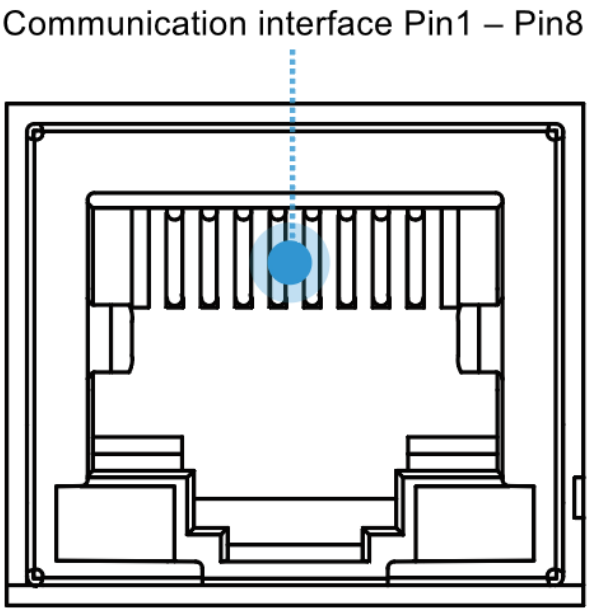


Figure 5.4 ECAT/CAN pin definitions

Pin	Name	Definition
Pin1	TD+	Transmit data+
Pin2	TD-	Transmit data-
Pin3	RD+	Receive data+
Pin4 / Pin5	--	Reserved
Pin6	RD-	Receive data-
Pin7	CANH	CAN High
Pin8	CANL	CAN Low

5.2.4 Teach pendant interface

Connect to interface ① (teach pendant communication interface), and pins 5 to 10 of interface ② (used for three-position enable switch and teach pendant power supply) via a teach pendant adapter cable.

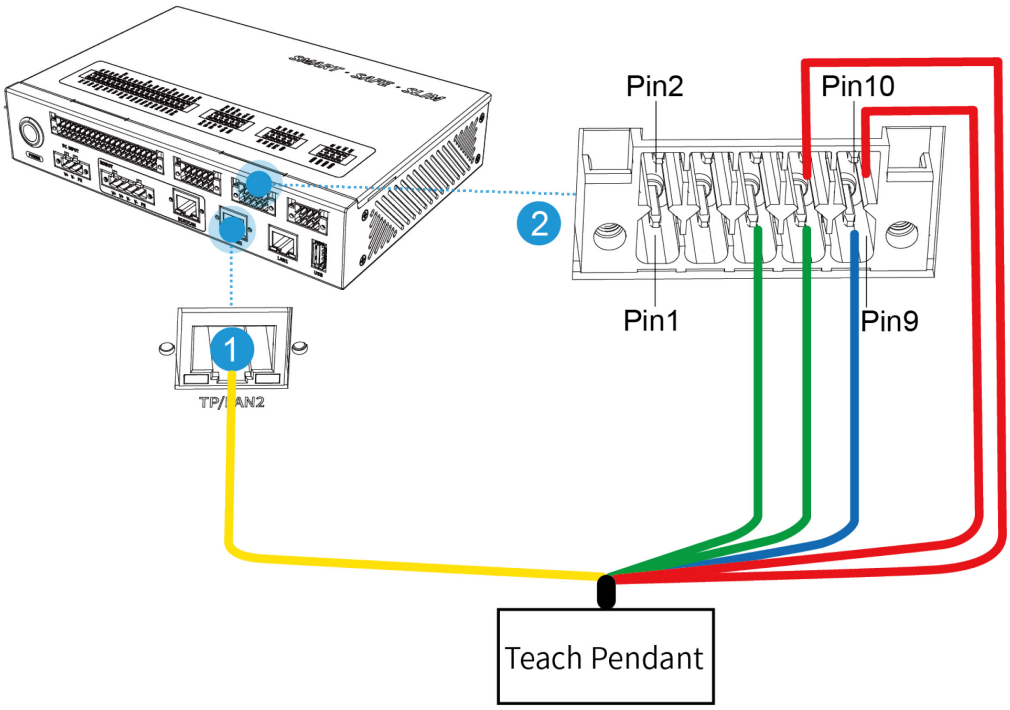


Figure 5.5 Teach pendant interface

Pin		Name	Definition
①		TP/LAN2	Teach pendant communication interface
②	Pin5	3PE1	Reserved for teach pendant three-position enable switch (Connect to either pin 6 or pin 8 for 24V)
	Pin6	24V	
	Pin7	3PE2	
	Pin8	24V	
	Pin9	GND	Reserved for power supply
	Pin10	24V	

NOTE

Pins 1 to 4 of interface ② are designated for the E-stop button. See Emergency stop interface section for details.

5.2.5 LAN interface

The small controller is equipped with two LAN interfaces for TCP/IP and Modbus TCP communication.

The LAN1 interface has a default IP address of 192.168.5.1, which can be modified via the control software. For details, please refer to the control software's user guide.

The LAN2 interface has a default IP address of 192.168.200.1 and currently does not support modification.

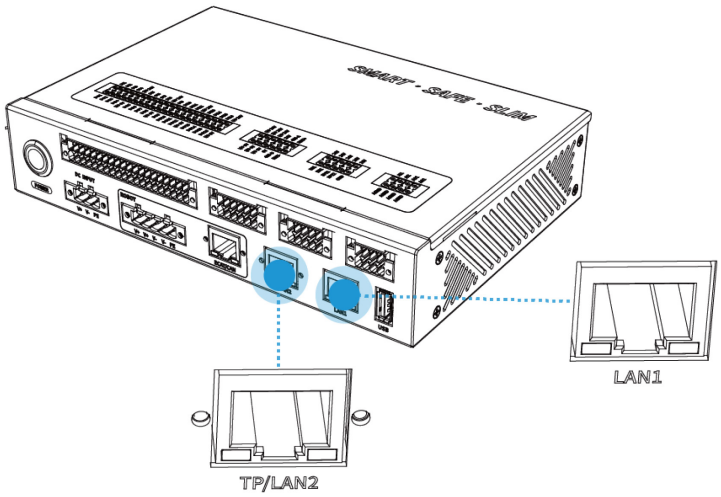


Figure 5.6 LAN interface

5.2.6 USB interface

The DSC is equipped with one USB interface for connecting a wireless receiver.

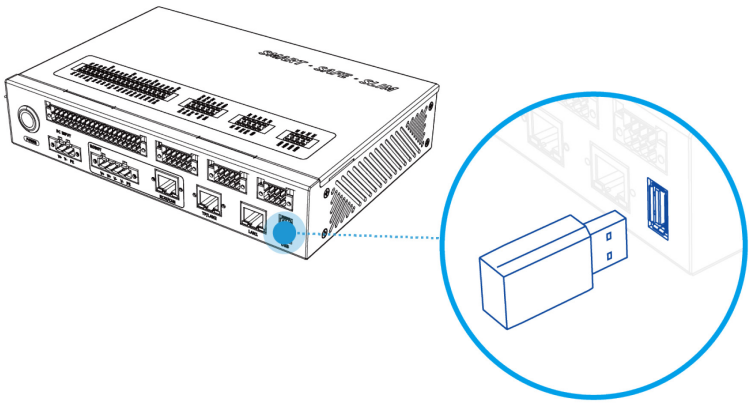


Figure 5.7 USB interface

5.2.7 I/O power interface

The I/O interface can be powered by either an internal or external 24 V power supply.

Table 5.1 I/O interface supply specifications

Interface	Parameter	Min	Typical value	Max	Unit
Internal 24V power supply					
24V-0V	Voltage	23	24	25	V
	Current	0	-	2	A
External 24V power supply					
External power supply	Voltage	20	24	29	V
	Current	0	-	3	A

When using the internal power supply, short-circuit the 0V and 24V pins to the nearest I/O 0V and I/O 24V pins respectively (factory default: short-circuited), as shown in the figure below.

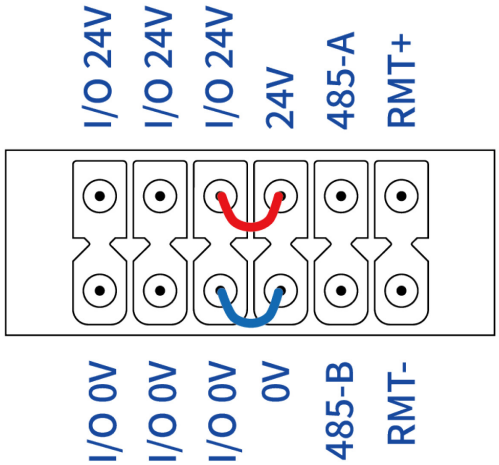


Figure 5.8 I/O with internal power

If a higher total output current is required, an external 24 V power supply can be connected as shown in the figure below. The external and internal power supplies are isolated and will not interfere with each other.

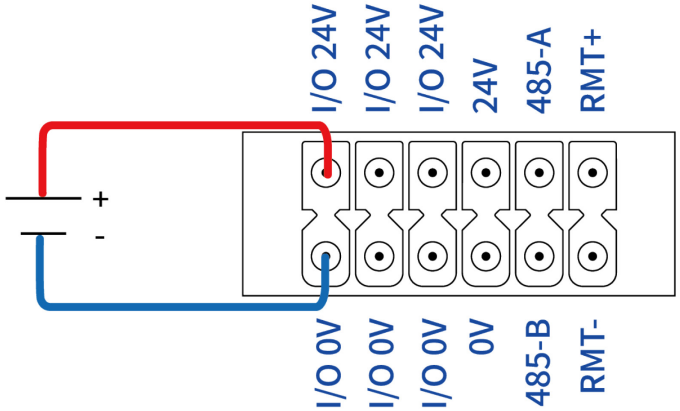


Figure 5.9 I/O with external power

NOTE

All subsequent chapters are based on the premise that the I/O power is connected. Instructions for I/O power wiring will not be repeated.

5.2.8 Digital I/O interface

16 channels for digital input and 16 for output, dedicated to reading and writing digital signals as shown below.

The default type for digital signals is PNP, but it can be configured to NPN using the control software.

When using the built-in I/O power supply, the voltage is 24V, with a total output current of up to 2A and a maximum single channel output of 0.5A. It supports external power supply, with a maximum current of up to 3 A.

All interfaces with identical silkscreen labels are functionally identical. Any available interface can be selected for connection during wiring.

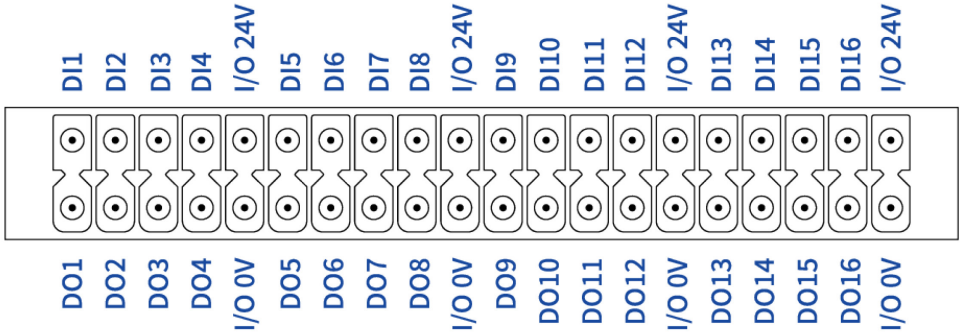


Figure 5.10 Digital signal interfaces

Digital I/O interface specifications

Interface	Parameter	Min	Typical value	Max	Unit
Digital input (DI1 – DI16)					
DIx	Voltage	-3	-	30	V
	OFF range	-3	-	5	V
	ON range	20	-	30	V
	Current (ON range)	2	-	4	mA
	Type	-	NPN/PNP	-	-
Digital output (DO1 – DO16)					
DOx	Current	0	-	0.5	A
	Voltage drop	0	-	0.5	V
	Leakage current	0	-	0.1	mA
	Type	-	NPN/PNP	-	-

DI wiring instruction

1. DI connected to a simple switch: The wiring diagram is shown in the figure below. Either the PNP or NPN wiring method can be selected based on field requirements.

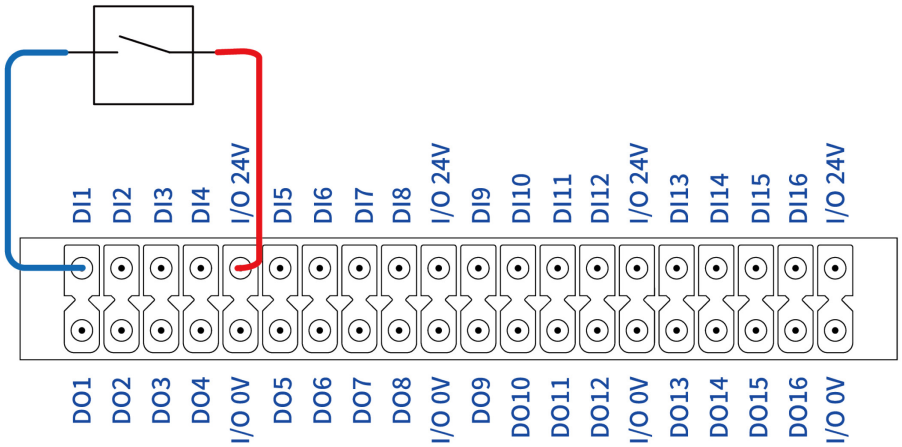


Figure 5.11 DI connected to a simple switch (PNP wiring method)

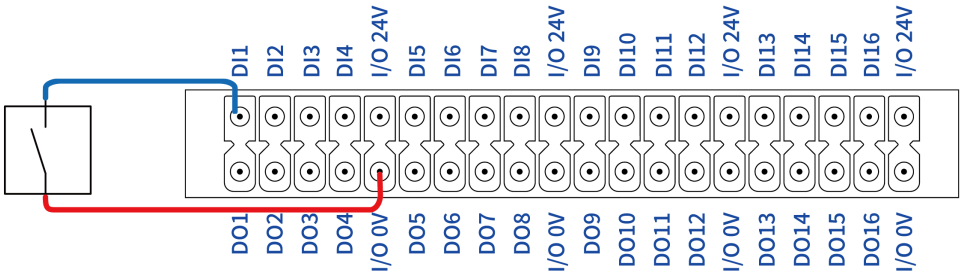


Figure 5.12 DI connected to a simple switch (NPN wiring method)

2. DI connected to external PNP/NPN three-wire sensor: The wiring method is the same; you only need to switch between PNP and NPN modes using the control software.
   - If the three-wire sensor is powered by the controller, V+ and V- need to be connected to the I/O 24V and I/O 0V of controller. The wiring configuration is shown in the figure below.

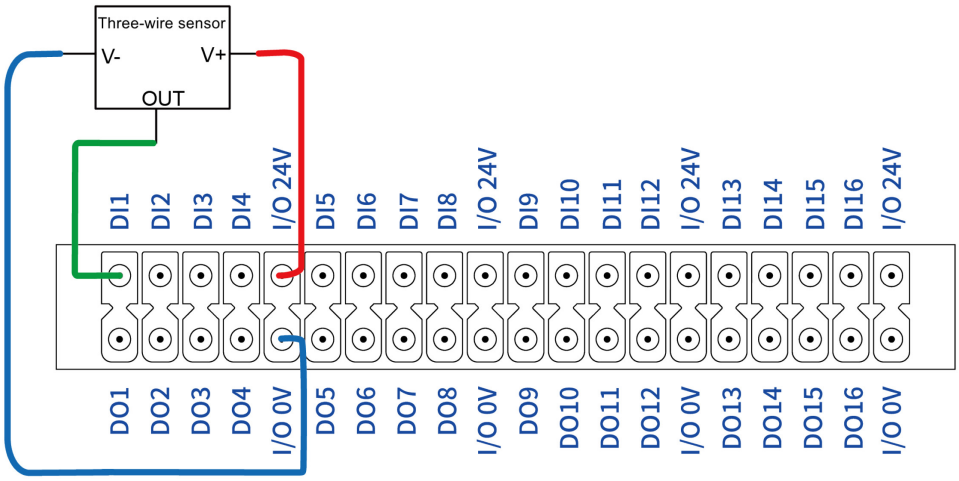


Figure 5.13 DI connected to a three-wire sensor (powered by controller)

- If the three-wire sensor is powered by an external power source, the negative terminal of the external power source needs to be connected to the I/O 0V of the controller. The wiring configuration is shown in the figure below.

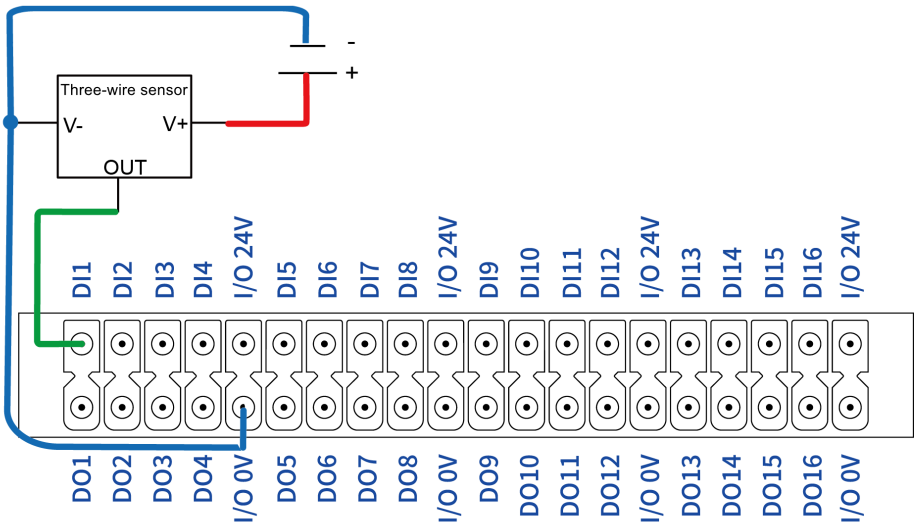


Figure 5.14 DI connected to a three-wire sensor (externally powered)

DO wiring instruction

The DO is set to PNP by default but can be configured to NPN through the control software. If the configuration in the control software is opposite to the load wiring (for instance, the software is set to PNP, but the load wiring is NPN), the load will not function properly.

- For DO configured as PNP, the wiring method to connect an external load is shown in the diagram below.

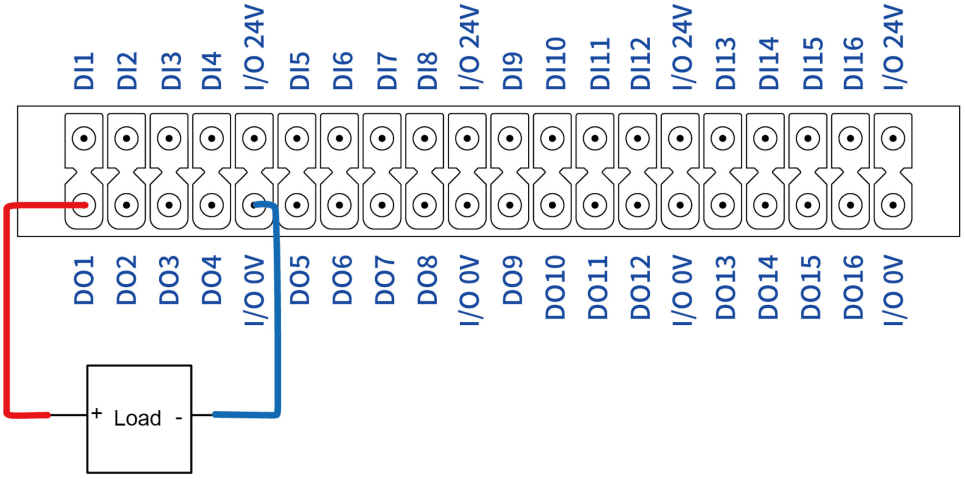


Figure 5.15 PNP-type DO connected to external load

- For DO configured as NPN, the wiring method to connect an external load is shown in the diagram below.

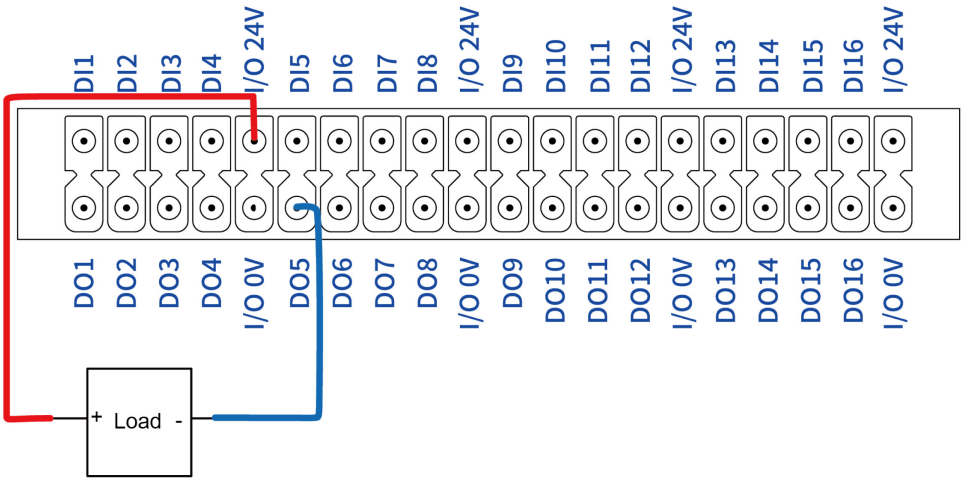


Figure 5.16 NPN-type DO connected to external load

It is recommended that there be a minimum interval of 15ms between two DI signals or two DO signals.

5.2.9 Analog I/O interface

The analog input/output interface provides two channels each for analog signal input and output.

Analog signals support either voltage (0 – 10V) or current signals (4 – 20mA), with the default set to voltage signals. You can configure it to current signals using control software. To enhance the accuracy of analog signals, it is recommended to use shielded cables or twisted pairs for connections.

Analog I/O interface specifications

Interface	Parameter	Min	Typical value	Max	Unit
Analog input (Voltage mode)					
AIx	Voltage	0	-	10	V
	Resistance	-	14.7	-	kΩ
	Resolution	-	12	-	Bit
Analog input (Current mode)					
AIx	Current	4	-	20	mA
	Resistance	-	499	-	Ω
	Resolution	-	12	-	Bit
Analog output (Voltage mode)					
AOx	Voltage	0	-	10	V
	Current	4	-	20	mA
	Resistance	-	150	-	Ω
	Current	-	12	-	Bit
Analog output (Current mode)					
AOx	Current	4	-	20	mA
	Current	-	12	-	Bit

AI wiring instruction

The wiring diagram for connecting AI interfaces to the device under test (DUT) is shown in the figure below.

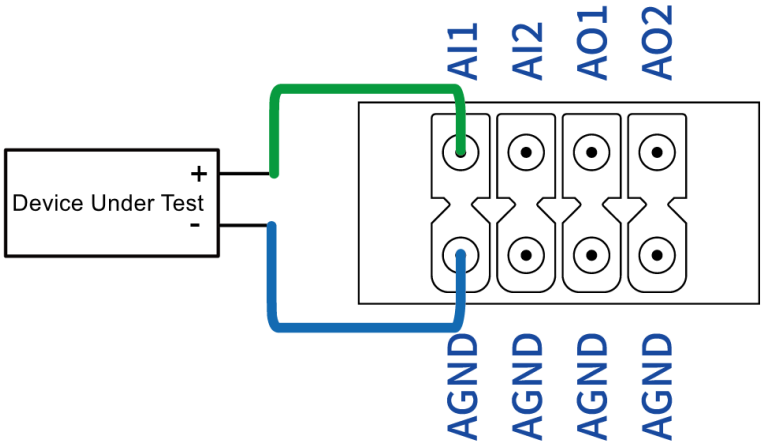


Figure 5.17 AI connected to Device Under Test

AO wiring instruction

The wiring diagram for connecting AO interfaces to an external load is shown in the figure below.

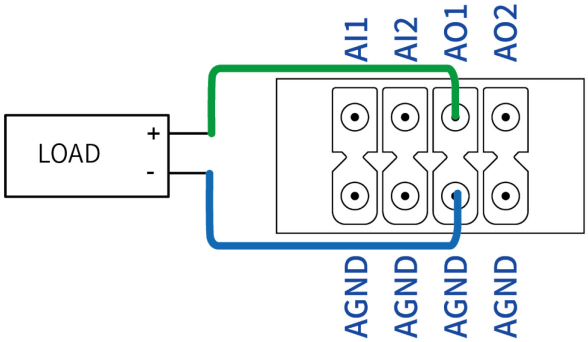


Figure 5.18 AO connected to external load

5.2.10 RS485 interface

The RS485 interface is primarily used for Modbus RTU communication. When connecting to an external device (e.g., a PLC), connect the 485A (or 485+) and 485B (or 485-) interfaces of both devices correspondingly. The ground wire should also be connected based on the actual field conditions.

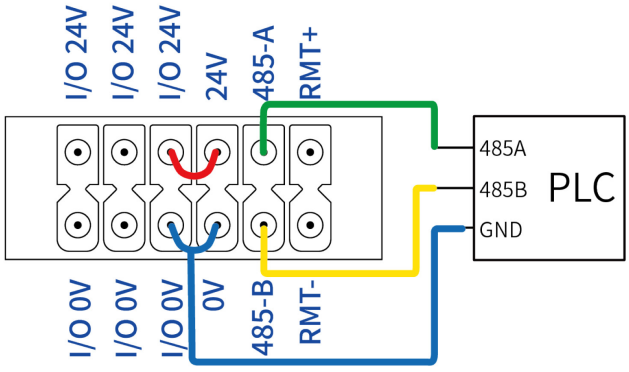


Figure 5.19 RS485 connected to PLC

5.2.11 Remote switch interface

The remote switch is used for the remote power-on/off operation of the controller. Before use, ensure the controller's power button is in the pressed (ON) position. When the remote switch is closed (circuit completed), the controller powers OFF. When the remote switch is open (circuit broken), the controller powers ON. The wiring method for connecting an external switch is shown in the figure below.

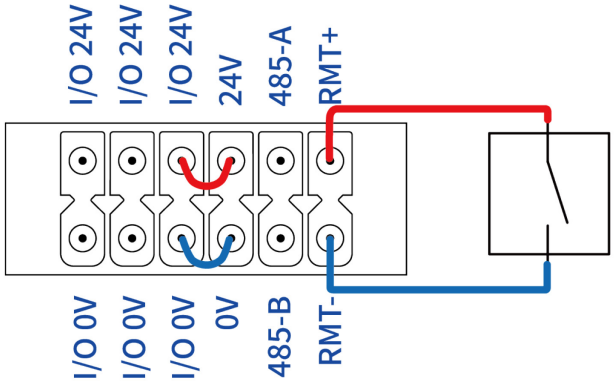


Figure 5.20 Remote switch wiring

5.2.12 Emergency stop interface

Connect the E-stop button for the emergency stop control of the robot arm.

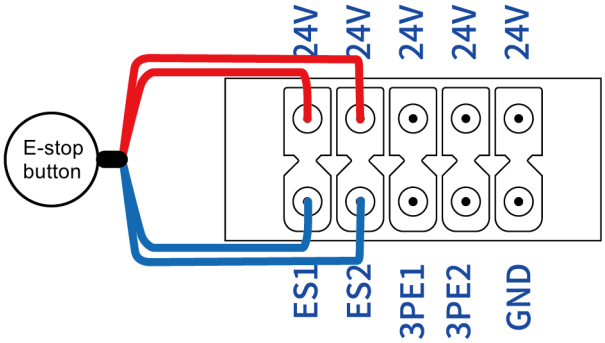
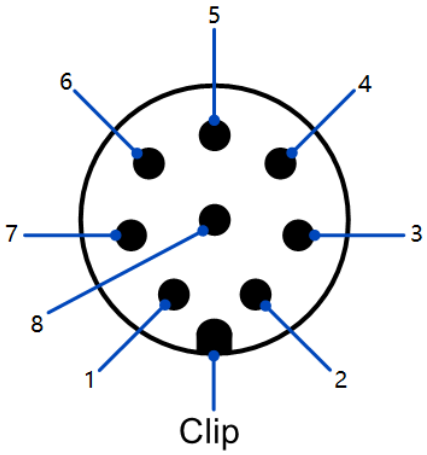


Figure 5.21 Wiring for E-stop button

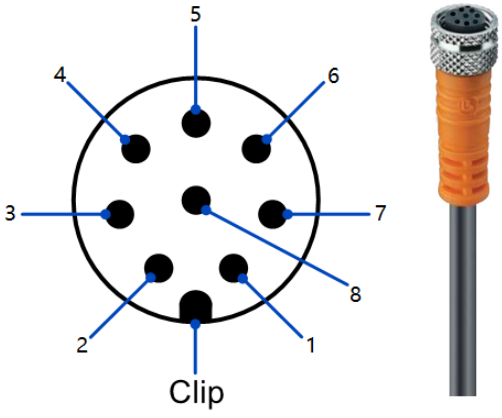
5.3 Interface on the robot end

The end interface is an aviation connector located on the side of the robot arm's end flange. The pin layout and definitions are as follows.



Pin	Name	Definition
1	485A	485A
2	485B	485B
3	DI_2	Digital input 2
4	D1_1	Digital input 1
5	24V	24V output
6	DO_2	Digital output 2
7	DO_1	Digital output 1
8	GND	GND

The cable used for the tool I/O is specified by DOBOT (model: Lutronic FP-222460). The pin layout and wiring definitions for the cable are as follows.



Pin	Cable color	Definition
1	White	485A
2	Brown	485B
3	Green	Digital input 2
4	Yellow	Digital input 1
5	Gray	24V output
6	Pink	Digital output 2
7	Blue	Digital output 1
8	Red	GND

The 24V output of the tool I/O has a maximum current of 2A (duration not exceeding 1 second), and the digital input is of PNP type.

When using an external simple switch circuit as the DI input source, the wiring method is as follows.

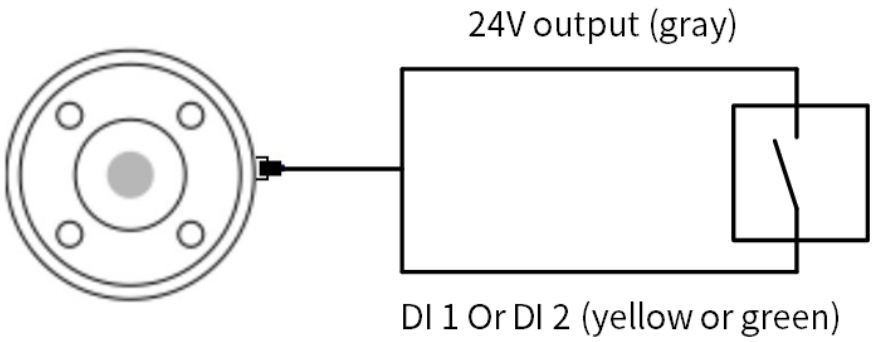


Figure 5.22 Tool DI connected to simple switch

When using a PNP three-wire sensor as the DI input source, the wiring is shown below.

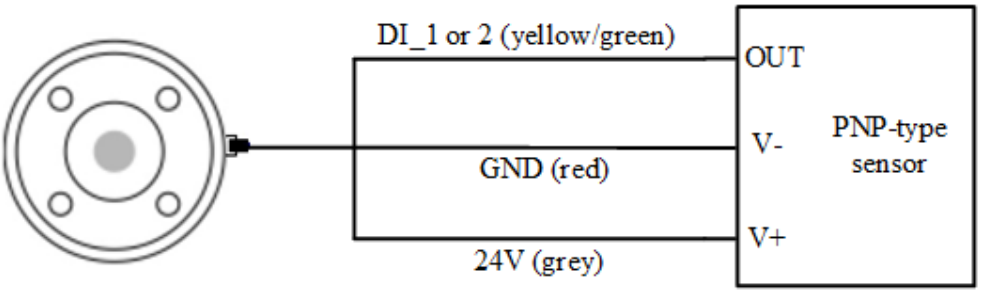


Figure 5.23 Tool DI wiring (three-wire sensor)

The digital outputs of the end I/O can be changed between PNP and NPN types via Dobotstudio Pro, with a single-channel output current ≤ 400 mA and a total output current also not exceeding 400 mA. The wiring method is as follows.

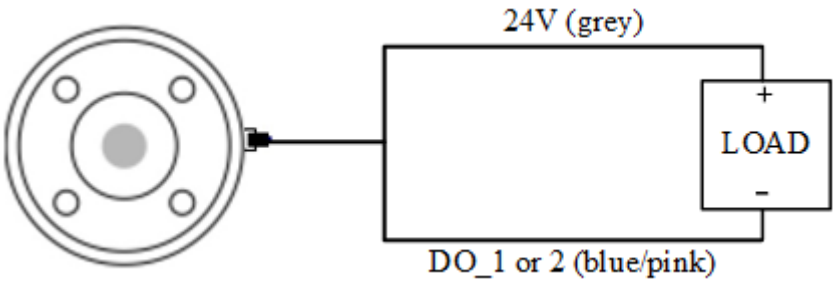


Figure 5.24 Tool DO wiring

6. Transportation

6.1 Transportation precautions

The robot arm should be restored to its packing posture before transportation. This can be set in DobotStudio Pro (refer to *DobotStudio Pro User Guide* for details). Use the original packaging for transportation.

During transportation, ensure that the robot arm remains stable and is securely fastened.

During transportation and long-term storage, maintain an ambient temperature range of -20°C to +55°C, with humidity ≤95% and no condensation.

When removing the robot from its packaging and moving it to the installation position, hold the robot arm with your hand until all base mounting bolts are fully tightened.

After transportation, store the original packaging in a dry place for future repacking and transportation.

WARNING

- Ensure that operators do not strain their backs or other body parts while lifting the equipment. Use appropriate lifting equipment if necessary.
- DOBOT assumes no responsibility for any damage incurred during transportation.
- Strictly follow the installation instructions when installing the robot.

6.2 Unpackaged transportation

When moving the robot arm from its packaging to the installation position or relocating it, follow these handling guidelines:

- If the robot arm is not in the packing posture, restore it to the packing posture first.
- When handling and installing the robot, hold the robot arm with your hand until all base mounting bolts are fully tightened.

7. Installation and Use

7.1 Installation environment

To maintain the performance of the controller and robot arm and ensure safe use, please place the controller and robot arm in an environment that meets the following conditions.

NOTICE

Please make sure that the installation environment meets the following conditions to avoid potential damage.

- Install indoors with good ventilation.
- Keep away from excessive vibration and shock.
- Keep away from direct sunlight and radiant heat.
- Keep away from dust, oil mist, smoke, salinity, metal powder, corrosive gases, and other contaminants.
- Do not use in a closed environment. A closed environment may cause the controller to overheat and shorten its service life.
- Keep away from flammable.
- Keep away from cutting and grinding fluids.
- Keep away from sources of electromagnetic interference.

7.2 Unpacking

Upon unpacking, check the attached shipping list to ensure that all items are included. If anything is missing, please contact your supplier.

7.3 Robot installation

7.3.1 Installation platform requirements

- When installing the robot, it must be securely fixed to a stable base. The base should be able to withstand at least 10 times the maximum torque of the J1 joint and at least 5 times the weight of the robot arm.
- If the robot arm is installed on a linear axis or a movable platform, the acceleration of the platform should be low, as high acceleration may trigger the robot's collision detection mechanism, causing it to stop.
- If the connection cable between the robot and the controller needs to pass through a cable hole on the installation surface, the diameter of the cable hole should be no less than 30 mm.
- The Nova series robot supports both bottom cable routing and side cable routing.

For side cable routing, the recommended distance between the cable routing hole and the robot base should be no less than 120mm (Calculated using L+8D, where L = 40 mm, the length of the Ethernet cable's RJ45 connector; D = 9.1 mm, the diameter of the cable).

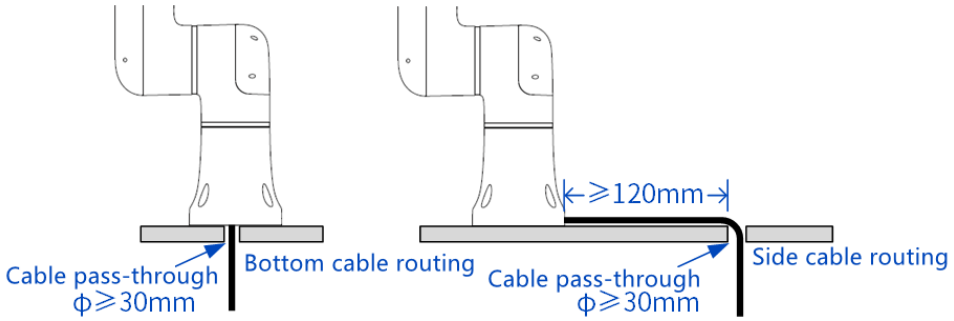


Figure 7.1 Nova connection cable routing

7.3.2 Robot installation

The Nova series robot support 360° mounting at any angle. The figure below shows several typical installation postures.

> **NOTE**
>
> The installation angle on the far left is the standard mounting angle. When installing the robot in a non-standard mounting angle, you need to calibrate the mounting angle through DobotStudio Pro after power-on. For details, refer to *DobotStudio Pro User Guide*.

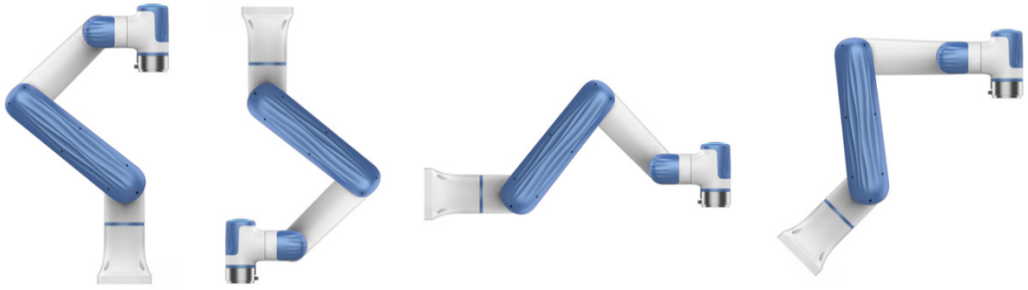


Figure 7.2 Nova robot installation posture

When installing the robot, position the mounting holes on the installation platform according to the base dimension. Then, secure the robot base to the platform using bolts. The specific dimensions of the robot base can be referenced from Mechanical Specifications. Be sure to observe the following during installation.

- During transportation, ensure that the robot is stable and properly secured in its position.
- When moving the robot arm from its packaging to the installation position, hold the robot with your hand until all bolts on the base are tightened.
- During installation, ensure the robot is properly aligned and positioned. The robot base must be secured to the platform using 4 hex bolts M6 (Nova 2) / M8 (Nova 5) (ISO898-1: 2013, property class: 12.9) and tightened with a torque of 20 N•m.
- For wall-mounted or upside-down installations, safety measures must be taken to prevent the robot base from falling.

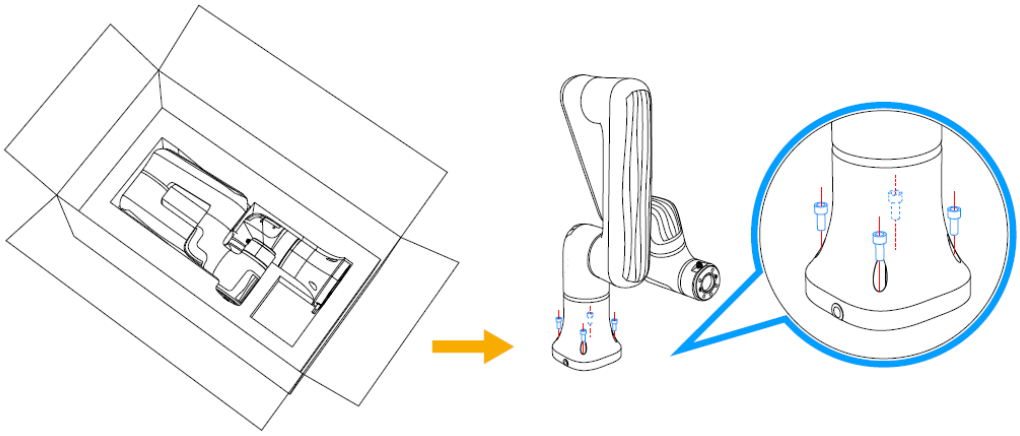


Figure 7.3 Base installation

7.3.3 DSC controller installation

The DSC controller supports both horizontal and vertical installation. A minimum clearance of 50 mm must be maintained on all sides except the mounting surface to ensure sufficient heat dissipation.

- **Horizontal installation**

  Attach the two side mounting brackets from the accessory kit to the bottom of the controller. Then, place the controller horizontally on a flat and stable surface. Secure it using M3*4 cross recessed countersunk head screws.

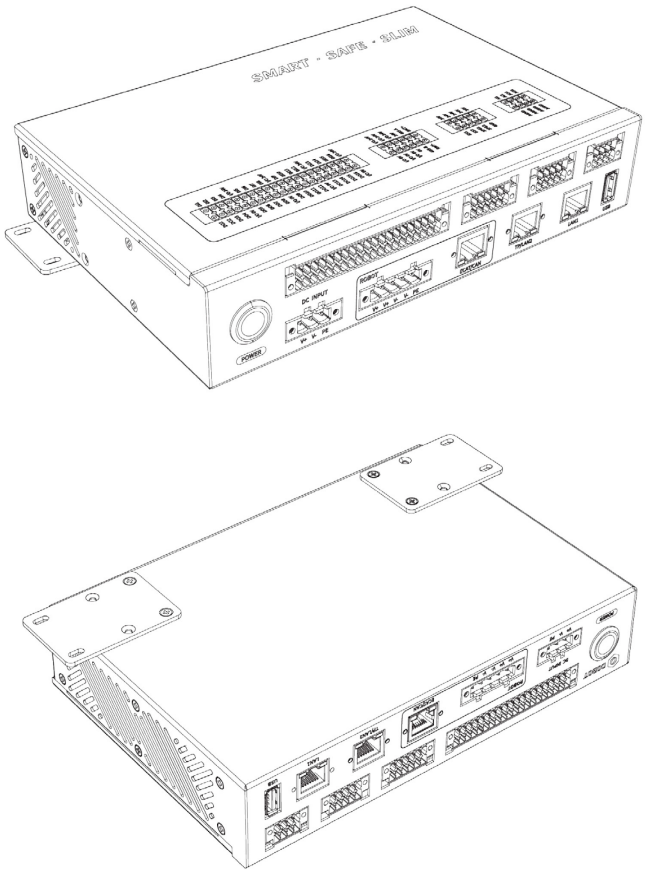


Figure 7.4 Horizontal installation

- **Vertical installation**

  After installing the two side fixing brackets from the accessory kit onto the rear of both sides of the controller, place the controller vertically on a flat and stable mounting surface. Secure it using four M3*4 cross recessed countersunk head screws.

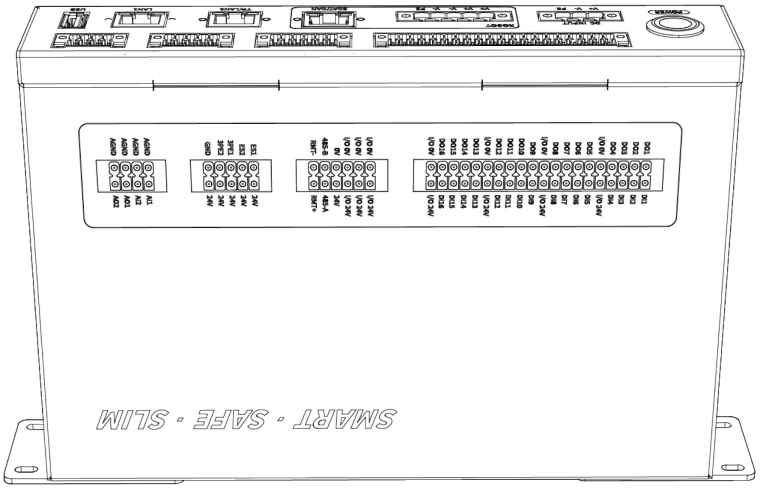


Figure 7.5 Vertical installation

7.3.4 Tool installation

The robot's end flange is equipped with four M6 threaded holes, which can fix the tool to the end of the robot arm. To ensure precise alignment of the tool, the reserved Φ6 positioning holes can be used. The detailed dimensions of the end flange for the Nova series robot can be found in the Mechanical Specifications.

7.4 Cable connection

7.4.1 Precautions

NOTICE

- The specifications and installation method of the external cables should comply with local laws and regulations.
- Do not disassemble the robot by yourself, as this may result in electrical leakage.
- Make sure that the device is properly grounded.
- Do not bend the cable excessively, otherwise it may cause poor connections or cable breakage.
- Before connecting external devices, make sure the power outlet of the control system is disconnected. If not disconnected, may result in electric shock or device failure.
- To ensure device and personal safety, use supplied cables.
- After connection, make sure that there are no loose screws or exposed cables inside the device.

NOTICE

- The specifications and installation method of the external cables should comply with local laws and regulations.
- Do not disassemble the robot by yourself, as this may result in electrical leakage.
- Make sure that the device is properly grounded.
- Do not bend the cable excessively, otherwise it may cause poor connections or cable breakage.
- Before connecting external devices, make sure the power outlet of the control system is disconnected. If not disconnected, may result in electric shock or device failure.
- To ensure device and personal safety, use supplied cables.
- After connection, make sure that there are no loose screws or exposed cables inside the device.

7.4.2 Connect the DSC controller

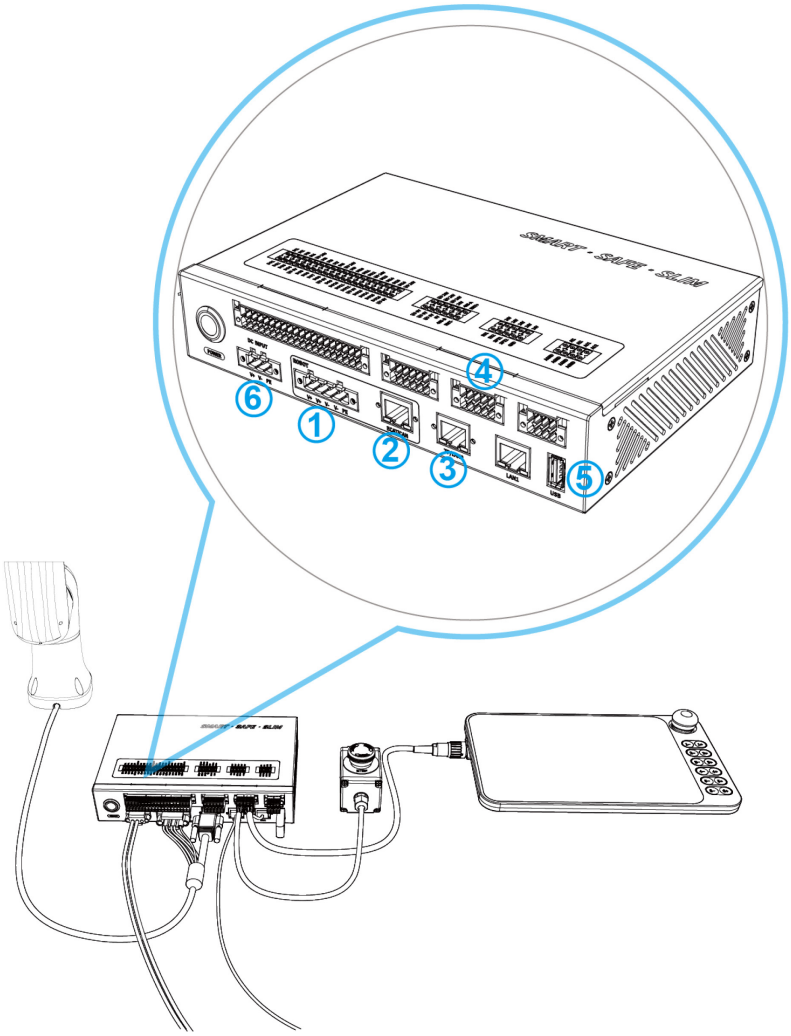


Figure 7.6 Cable connection

1. **Connecting the heavy-duty cable:** To connect the robot arm, insert the heavy-duty connector into the interface on the robot arm base (NOTE: some robot models come with a pre-attached heavy-duty cable), and connect the opposite end to the robot arm interface on the controller. Specifically, connect the power wires to the power interface (①) via the terminal block, and insert the communication cable into the ECAT/CAN interface (②), ensuring all cable labels match the controller's silkscreen and securely tightening all terminal screws after wiring.
2. **Connecting the teach pendant (Optional):** Connect the teach pendant to the controller using the adapter cable. Plug the RJ45 connector into the TP/LAN2 Ethernet interface (③), and connect the three-position enable switch / teach pendant power to the corresponding interface (④) via the terminal block. Ensure labels on the cable end match the controller's silkscreen markings, then securely tighten all terminal screws after wiring.
3. **Connecting the E-stop button:** Connect the E-stop button (included with the controller) to the E-stop interface (④) on the controller via the terminal block. Ensure all cable end labels match the controller's silkscreen markings, then securely tighten all terminal screws after wiring.
4. **Connecting the wireless receiver (Optional):** Insert the wireless receiver into the USB interface (⑤) on the controller.
5. **Connecting the DC power supply:** Connect the DC power supply (required for CRA series robot arm; to be provided by yourself) to the power interface (⑥) on the controller.

7.5 Power-on and debugging

After turning on the external power supply, press the power button on the controller. Once the indicator lights on both the end of robot arm and the controller turn solid blue, you can connect to the robot using the operation terminal, enable it, and jog it for debugging.

For detailed operation instructions, refer to *DobotStudio Pro User Guide*. Precautions for connecting to DobotStudio Pro are as follows:

- A wired connection is recommended for communication between the robot and the DobotStudio Pro software. Wired connections improve communication security, help reduce latency, prevent interference from other devices on the internal network, and ensure that data is not intercepted by unauthorized devices.
- If an internal network is used, keep only essential devices on that network and isolate the robot's network from office or home networks.

> **NOTICE**
>
> If the network is not isolated, the robot will be exposed to a complex internal network environment, making it vulnerable to cyberattacks that could lead to data leaks or downtime.

- It is recommended to use a gateway with a firewall and configure it properly to restrict communication between external devices and the robot, ensuring that only whitelisted devices can communicate with the robot. This enhances the security of the robot's network environment.

NOTICE

Without firewall protection, the robot will face a more complex network environment and greater security risks.

- Prevent password leaks. It is recommended to raise user awareness of network security through internal training sessions. Avoid transmitting or storing sensitive information such as SSH passwords or Wi-Fi credentials via social media or email.
- Improve users' ability to identify phishing attacks and suspicious links, establish an emergency response plan, and define a clear vulnerability reporting process. If a vulnerability is found, contact DOBOT technical support promptly, share the vulnerability details, and seek a solution.

8. Maintenance

Maintenance and repairing must be performed in compliance with all safety instructions in this document.

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 follow the instructions below:

- 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.

8.1 Safety instructions

The following safety procedures and warnings must be observed when operating the robot arm or controller:

NOTICE

- Replace faulty components with new components of the same model or equivalent components approved by DOBOT.
- Reactivate all deactivated safety measures immediately after completing maintenance work.
- Record all repairs and save them in the technical document associated with the robot system.
- Remove the main input cable from the back of the robot to ensure it is fully powered off. Take necessary precautions to prevent others from reconnecting the system power during maintenance.
- Observe ESD regulations when disassembling the robot.
- Prevent water or dust from entering the interior of the robot.

8.2 Robot maintenance

To ensure the robot maintains high performance over the long term, regular maintenance checks must be conducted. The personnel in charge of the maintenance must develop a maintenance plan and carry out the necessary tasks. The inspection items are listed in the table below.

Table 8.1 Inspection items

Period			Inspection item	Inspection details
Daily	3 months	6 months		
√			Robot cleaning	Wipe off dirt, dust, cutting residue on the body with water

Period			Inspection item	Inspection details
Daily	3 months	6 months		
				or 10% alcohol
		√	Joint bolts	Check the torque of exposed bolts based on the specified tightening torque table
	√		Tool mounting bolts	Check the torque based on the specified tightening torque table
√			Motor	Confirm abnormal heating or sound
√			Brake	Check whether the robot arm or end-effector will fall when the servo is powered off
	√		Reducer	Check abnormal vibration, noise, and oil leakage
		√	Cables	Inspect power cables, heavy-duty cables, and IO cables to ensure stable connections and check for wear or damage on the cable sheathing.

The bolt tightening torques are shown in Table 8.2.

Table 8.2 Screw tightening torques

Nominal thread diameter	Outer hexagonal bolt (joint)	Inner hexagonal bolt (12.9)	Inner hexagonal bolt (rear cover)
3 mm	2 Nm	2.4 Nm	0.7 Nm
4 mm	4 Nm	4.5 Nm	-
5 mm	7.5 Nm	9 Nm	-
6 mm	15 Nm	18 Nm	-
8 mm	-	37 Nm	-

The tightening torques vary depending on the type of bolt or base material. If not listed in the table, please contact DOBOT technical support.

NOTICE

For a list of wearable parts, please contact DOBOT technical support.

9. Disposal and Environment Protection

DOBOT robots must be disposed of in accordance with the applicable national laws, regulations and standards.

The following symbol indicates that the product must not be disposed of as general waste.

10. Warranty

10.1 Product warranty

Without prejudice to any claim agreement that the user (customer) may reach with the distributor or retailer, the manufacturer shall guarantee the quality of the products to the customer in accordance with the terms and conditions below:

If defects caused by manufacturing and/or improper material occur in a new device and its components within 12 months (15 months at most if the shipping time is included) after the device is put into use, DOBOT shall provide the necessary spare part, and the user (customer) shall offer personnel to replace the spare part, using another part that represents the latest technology level to replace or repair the related part.

If the device defects are caused by improper handling and/or failure to follow the relevant information set out in the User Guide, the warranty is invalid.

This warranty does not apply to or extend to maintenance (e.g. installation, configuration, software download) performed by the authorized distributer or customer.

The user (customer) must provide the purchase receipt and the purchase date as valid evidence for the warranty. Claims under this warranty must be made within two months of the apparent failure to perform the product warranty.

The ownership of the device or components that are replaced or returned to DOBOT shall remain with DOBOT. Any other claims arising from or related to the device are not covered by this warranty.

Any items in this product warranty do not intend to limit or exclude the legal rights of the customer or to limit or exclude the liability of the manufacturer for the personnel casualty resulting from its negligence. The duration of this product warranty shall not be extended due to the services provided under the product warranty terms. Under the principle of not violating the warranty, DOBOT reserves the right to charge customers for the replacement or maintenance. The foregoing does not imply a change in the burden of proof to the detriment of the client. If there are defects on the device, DOBOT shall not be liable for any damage or loss arising therefrom, including but not limited to loss of production or damage to other production device.

10.2 Disclaimer

DOBOT is committed to improve the reliability and performance of its products, and as such reserves the right to upgrade products without prior notice. DOBOT strives to ensure the contents of the User Guide are precise and reliable, but takes no responsibility for any errors or missing information.

Appendix Technical Specifications

Appendix A Robot technical specifications

Product name		Nova 2	Nova 5
Weight		11 kg	14 kg
		24.3 lb	30.9 lb
Rated load		2 kg	5kg
		4.4 lb	11 lb
Working radius		625 mm	850 mm
		24.6 inch	33.5 inch
Max working speed		1.6 m/s	2 m/s
		63 inch/s	78.7 inch/s
Joint working range	J1	±360°	±360°
	J2	±180°	±180°
	J3	±156°	±160°
	J4	±360°	±360°
	J5	±360°	±360°
	J6	±360°	±360°
Max joint speed	J1	135°/s	100°/s
	J2	135°/s	100°/s
	J3	135°/s	100°/s
	J4	135°/s	100°/s
	J5	135°/s	100°/s
	J6	135°/s	100°/s
Tool IO	DI	2 channels	2 channels
	DO	2 channels	2 channels
	RS485	Support	Support
Repeatability		±0.05 mm	±0.05 mm
IP rating		IP54	IP54

Noise	65 dB(A)	70 dB(A)
Ambient temperature	0℃ – 50℃	0~50℃
Typical power consumption	100 W	230 W
Maximum power consumption	250 W	770 W
Installation mode	Any angle	Any angle
Cable length①	3 m	3 m
	118.1 inch	118.1 inch
Material	Aluminum alloy, ABS	Aluminum alloy, ABS

① : Cable length from robot arm to controller

Appendix B Controller technical specifications

Product name		DOBOT DSC
Size		220 mm*150 mm*45 mm (8.66 inch*5.91 inch*1.77 inch)
Weight		1.3 kg (2.87 lb)
Input power		30–60V DC
IO power	Voltage	24V
	Current	Built-in power supply: Max 2A, external power supply: Max 3A, single channel current: Max 0.5A
General I/O interface	DI	16 channels (NPN or PNP)
	DO	16 channels (NPN or PNP)
	AI	2 channels, voltage/current mode, 0–10V, 4–20mA
	AO	2 channels, voltage/current mode, 0–10V, 4–20mA
Safety I/O interface	SI	16 channels (DI/DO configured via control software)
	SO	
Remote power on/off		Supported
Communication interface	Ethernet interface	2 interfaces, used for teach pendant, TCP/IP, Modbus TCP, Ethernet/IP, and Profinet communication
	USB	1 interface, used for Wi-Fi module connection
	RS485	1 interface, used for RS485 and Modbus RTU communication
Environment	Temperature	0℃ – 50℃
	Humidity	≤ 95%, non-condensing
IP rating		IP22
Cooling method		Fan cooling
Teaching method		Teach pendant, PC, APP

Appendix C Functional Safety

C.1 Safety requirements

The safety functions generally comply with EN ISO 10218-1 and specifically meet the following requirements.

When a safety-related control system is required, the safety-related components shall be designed so that:

- A single fault in any component does not lead to the loss of the safety function.
- Where reasonably practicable, a single fault is detected at or before the next demand on the safety function.
- When a single fault occurs, the safety function remains operational, and the system remains in a safe state until the detected fault is rectified.
- All reasonably foreseeable faults shall be detected.

This requirement is considered equivalent to Category 3 as described in ISO 13849-1. Category 3 is typically achieved through redundant circuits, such as dual-channel. The safety functions and the robot controller comply with Performance Level d (PLd) according to ISO 13849-1.

C.2 Stop categories

According to IEC 60204-1, the Nova series robots provide three stop categories: Stop Category 0, Stop Category 1, and Stop Category 2. Stop Category 0 is an uncontrolled stop, while Stop Category 1 and Stop Category 2 are controlled stops.

- When Stop Category 0 is triggered, the robot’s power is cut off immediately, and the robot stops instantaneously.
- When Stop Category 1 is triggered, the robot decelerates to a stop. After the robot stops, power to the robot is disconnected.
- When Stop Category 2 is triggered, the robot decelerates to a stop along its programmed trajectory. After stopping, the robot remains enabled.

C.3 Overview

The Nova series robot system features 30 safety functions, designed and tested in accordance with the following standards:

- IEC 60204-1:2018+A1:2025
- ISO 13849-1: 2023
- ISO 13849-2:2012

Safety functions can be divided into the following four categories:

- Safety SI (Safe Input) Category
- Safety SO (Safe Output) Category
- Safety Limit Category
- Other

Category	SF	Name	Stop Category	Response Time	Stop Distance	Assessment Result
Safety SI	SF1	Emergency Stop (System)	Stop category 1	≤300ms	≤300mm	PLd/Cat. 3
	SF2	Emergency Stop (User)	Stop category 1	≤300ms	≤300mm	PLd/Cat. 3
	SF3	Safeguard Stop	Stop category 2	≤500ms	≤500mm	PLd/Cat. 2
	SF4	Safeguard Stop Reset Input	Stop category 2	≤500ms	≤500mm	PLd/Cat. 2
	SF5	Reduced Mode Input	Stop category 1	≤300ms	≤300mm	PLd/Cat. 2
	SF6	Mode Switch Input (Manual/Auto)	Stop category 2	≤500ms	≤500mm	PLd/Cat. 2
	SF7	3-Position Enabling Device Input	Stop category 1	≤300ms	≤300mm	PLd/Cat. 2
Safety SO	SF8	Emergency Stop Status Output	DO output low level	≤10ms	NA	PLd/Cat. 3
	SF9	System Emergency Stop Status Output	DO output low level	≤10ms	NA	PLd/Cat. 3
	SF10	Safeguard Stop Status Output	DO output low level	≤10ms	NA	PLd/Cat. 3
	SF11	Reduced Mode Status Output	DO output low level	≤10ms	NA	PLd/Cat. 2
	SF12	Moving Status Output	DO output low level	≤10ms	NA	PLd/Cat. 2
	SF13	Not Stopping Status Output	DO output low level	≤10ms	NA	PLd/Cat. 3
	SF14	Safe Home Position Output	DO output low level	≤10ms	NA	PLd/Cat. 2
Safety Limit	SF15	Joint Position Limit (Soft	Stop category 1	≤300ms	≤300mm	PLd/Cat. 2

Category	SF	Name	Stop Category	Response Time	Stop Distance	Assessment Result
		Axis Limiting)				
	SF16	Pose Limit (Safety Zone)	Stop category 1	≤300ms	≤300mm	PLd/Cat. 2
	SF17	Joint Speed Limit	Stop category 1	≤300ms	≤300mm	PLd/Cat. 2
	SF18	TCP Speed Limit	Stop category 1	≤300ms	≤300mm	PLd/Cat. 2
	SF19	TCP Speed Limit in Teaching Mode	Stop category 1	≤300ms	≤300mm	PLd/Cat. 2
	SF20	Momentum Limit	Stop category 1	≤300ms	≤300mm	PLd/Cat. 2
	SF21	Stopping Time Limit	Stop category 0	≤300ms	≤300mm	PLd/Cat. 2
	SF22	Stopping Distance Limit	Stop category 0	≤300ms	≤300mm	PLd/Cat. 2
	SF23	Power Limit	Stop category 1	≤300ms	≤300mm	PLd/Cat. 2
	SF24	TCP Force Limit	Stop category 1	≤300ms	≤300mm	PLd/Cat. 2
	SF25	Joint Torque Limit	Stop category 1	≤300ms	≤300mm	PLd/Cat. 2
	SF26	TCP Position Deviation Limit	Stop category 1	≤300ms	≤300mm	PLd/Cat. 2
Other	SF27	Start/Restart Interlock	Stop category 1	≤300ms	≤300mm	PLd/Cat. 2
Safety SI	SF28	Normal Stop	Stop category 1	≤300ms	≤300mm	PLd/Cat. 3
Other	SF29	Hand-Guided Control (Drag Teaching)	Stop category 1	≤500ms	≤500mm	PLd/Cat. 2
Other	SF30	Hold-to-Run Control	Stop category 2	≤500ms	≤500mm	PLd/Cat. 2

C.4 Detailed description

- **SF1 System Emergency Stop**
  - The robot can be triggered into emergency stop state via the emergency stop button or the emergency stop switch on the teach pendant, performing a Category 1 stop.
  - The system emergency stop input is set by default to a normally closed signal with a high level. A low level on either channel triggers the robot into emergency stop state.
  - When the safety controller detects that the emergency stop button has been pressed, it notifies the servo to perform an emergency stop and monitors the stopping time. If the stopping time exceeds the stopping time limit, a Category 0 stop is executed.
- **SF2 User Emergency Stop**
  - The robot can be triggered into emergency stop state via the user emergency stop input signal in Safety SI, performing a Category 1 stop.
  - The user emergency stop input is set by default to a normally closed signal with a high level. A low level on either channel triggers the robot into emergency stop state. The emergency stop logic is the same as that of the system emergency stop.
  - Any DI can be configured for this function, but both channels must be configured simultaneously.
- **SF3 Safeguard Stop**
  - The robot can be triggered into safeguard stop state via the safeguard stop input signal in Safety SI, performing a Category 2 stop.
  - The safeguard stop input is set by default to a normally closed signal with a high level. A low level on either channel triggers the robot into the safeguard stop state. In this state, starting a program is not allowed if no program is running, and any running program will be paused.
  - Any DI can be configured for this function, but both channels must be configured simultaneously.
- **SF4 Safeguard Stop Reset**
  - Used in conjunction with the safeguard stop signal:
    - When no reset signal is configured, the robot program automatically resumes running after the safeguard stop signal is cleared.
    - When a reset signal is configured, after the safeguard stop signal is cleared, the safeguard stop reset must be triggered first, followed by clicking "Resume" for the robot program to automatically continue running.
  - The safeguard stop reset input is set by default to a normally open signal with a high level. A rising edge on both channels triggers the reset of the safeguard stop state, and the time interval between the two channel triggers must be ≤ 100 ms.
  - Any DI can be configured for this function, but both channels must be configured simultaneously.
- **SF5 Reduced Mode**
  - The robot can be triggered into reduced mode via the reduced mode input signal in Safety SI.
  - In reduced mode, the robot's motion speed and safety limits switch to the values

configured for reduced mode (i.e., reduced parameters). The robot monitors and alarms according to these reduced parameters. When an alarm is triggered, a Category 1 stop is executed.

- The reduced mode input is set by default to a normally closed signal with a high level. A low level on either channel triggers the robot into reduced mode. When the input returns to high level, the robot exits reduced mode and enters normal mode.
- Any DI can be configured for this function, but both channels must be configured simultaneously.

- **SF6 Manual/Auto Mode Switch**
  - When the manual/auto mode switch function is enabled in the safety settings, the robot can be switched between manual and auto modes via the manual/auto mode switch input signal in Safety SI. A low level on either channel triggers the robot to enter manual mode. When both channels are at high level, the robot enters auto mode.
  - Any DI can be configured for this function, but both channels must be configured simultaneously.
  - Once this function is configured, disabling the manual/auto mode function in the settings will prompt the user that it cannot be disabled.
- **SF7 3-Position Enabling**
  - In manual mode, the robot can be triggered into the enabled state via the 3-position enabling input signal in Safety SI. A low level on either channel triggers the robot into the disabled state, while a high level on both channels triggers the enabled state. The characteristics of the external 3-position enabling device are identical to those of the 3-position enabling switch on the teach pendant when it is set to the enabled state.
  - The 3-position enabling signal is not active in automatic mode.
  - Any DI can be configured for this function, but both channels must be configured simultaneously.
- **SF8 Emergency Stop Status Output**
  - When the robot is in the emergency stop state, the emergency stop status output signal in Safety SO outputs a low level; otherwise, it outputs a high level.
  - Any DO can be configured for this function, but both channels must be configured simultaneously.
  - The maximum output current per channel is 500 mA (this applies to all single-channel outputs described below).
- **SF9 System Emergency Stop Status Output**
  - When the robot is in the system emergency stop state, the system emergency stop status output signal in Safety SO outputs a low level; otherwise, it outputs a high level.
  - Any DO can be configured for this function, but both channels must be configured simultaneously.

    NOTE: This signal is primarily used when interlocking two safety devices to prevent the emergency stop state from becoming locked and unrecoverable.
- **SF10 Safeguard Stop Status Output**
  - When the robot is in the safeguard stop state, the safeguard stop status output signal in Safety SO outputs a low level; otherwise, it outputs a high level.

- Any DO can be configured for this function, but both channels must be configured simultaneously.

- **SF11 Reduced Mode Status Output**
  - When the robot is in the reduced mode state, the reduced mode status output signal in Safety SO outputs a low level; otherwise, it outputs a high level.
  - Any DO can be configured for this function, but both channels must be configured simultaneously.
- **SF12 Moving Status Output**
  - When one or more joints of the robot move faster than 1°/s (excluding drag teaching mode), the robot is considered to be in the moving state. In this state, the moving status output signal in Safety SO outputs a low level; otherwise, it outputs a high level.
  - Any DO can be configured for this function, but both channels must be configured simultaneously.
- **SF13 Not Stopping Status Output**
  - When the robot is in automatic mode and the program is not paused, the robot is considered to be in the not stopping state. In this state, the not stopping status output signal in Safety SO outputs a low level; otherwise, it outputs a high level.
  - Any DO can be configured for this function, but both channels must be configured simultaneously.
- **SF14 Safe Home Position Status Output**
  - When the robot is within ±10mm of the safe home position set by the control software, the safe home position status output signal in Safety SO outputs a high level; otherwise, it outputs a low level.
  - Any DO can be configured for this function, but both channels must be configured simultaneously.
- **SF15 Joint Position Limit**
  - The robot uses proper motion planning to prevent each joint from exceeding the allowable motion range set by the control software.
  - If a joint exceeds its allowable motion range, a safety controller alarm is triggered and a Category 1 stop is executed.
- **SF16 Safety Zone Limit**
  - Two types of safety zones can be defined: alarm safety zone and reduced safety zone.
    - When configured as an alarm safety zone, the robot uses proper motion planning to prevent the currently active TCP from entering the unsafe zone. If the TCP enters the unsafe zone, a safety controller alarm is triggered and a Category 1 stop is executed.
    - When configured as a reduced safety zone, if the robot enters the unsafe zone, it switches to reduced mode, and the safety controller monitors the robot using reduced mode parameters.
  - Two methods are available for defining the robot's safety zone:
    - Safety Wall: When configured as a physical wall (alarm wall) or a virtual wall (reduced wall), the positive direction of the wall is the safe zone, and the opposite direction is the unsafe zone.
    - Safety Zone: When configured with "Alarm" or "Reduced" behavior, the

positive direction of the safe side is the safe zone, and the opposite direction is the unsafe zone.

- **SF17 Joint Speed Limit**

  During automatic program execution, the robot uses proper motion planning to prevent joint speeds from exceeding the safety limits set by the control software. If any joint speed exceeds the safety limit, a safety controller alarm is triggered and a Category 1 stop is executed.

- **SF18 TCP Speed Limit**

  - During automatic program execution, the robot uses proper motion planning to prevent TCP speed from exceeding the safety limit set by the control software. If TCP speed exceeds the safety limit, a safety controller alarm is triggered and a Category 1 stop is executed.
  - Normal mode and reduced mode each have their own set of safety limits, which are applied for monitoring and alarm purposes.

- **SF19 TCP Speed Limit in Manual Mode**

  In manual mode, the robot uses proper motion planning to prevent TCP speed from exceeding the safety limit set by the control software. If TCP speed exceeds the safety limit, a safety controller alarm is triggered and a Category 1 stop is executed.

- **SF20 Momentum Limit**

  - During automatic program execution, the robot uses proper motion planning to prevent the total momentum of the robot from exceeding the safety limit set by the control software. If the total momentum exceeds the safety limit, a safety controller alarm is triggered and a Category 1 stop is executed.
  - Normal mode and reduced mode each have their own set of safety limits, which are applied for monitoring and alarm purposes.

- **SF21 Stopping Time Limit**

  - During automatic program execution, the robot uses proper motion planning to ensure that when an alarm stop is triggered at any point, the stopping time does not exceed the safety limit set by the control software. If the actual stopping time exceeds the safety limit, a safety controller alarm is triggered and a Category 0 stop is executed.
  - Normal mode and reduced mode each have their own set of safety limits, which are applied for monitoring and alarm purposes.

- **SF22 Stopping Distance Limit**

  - During automatic program execution, the robot uses proper motion planning to ensure that when an alarm stop is triggered at any point, the stopping distance does not exceed the safety limit set by the control software. If the actual stopping distance exceeds the safety limit, a safety controller alarm is triggered and a Category 0 stop is executed.
  - Normal mode and reduced mode each have their own set of safety limits, which are applied for monitoring and alarm purposes.

- **SF23 Power Limit**

  - Based on the power safety limits set by the control software, the robot calculates the allowable fluctuation range of the actual torque at each joint and limits the actual torque magnitude to prevent the sum of power calculated from the difference between the planned torque and the actual torque at each joint from exceeding the safety limit. If the deviation between actual power and planned power exceeds the safety limit, a safety controller alarm is triggered and a

Category 1 stop is executed.

- Normal mode and reduced mode each have their own set of safety limits, which are applied for monitoring and alarm purposes.

- **SF24 TCP Force Limit**
  - Based on the TCP force safety limits set by the control software, the robot calculates the allowable fluctuation range of the actual torque at each joint and limits the actual torque magnitude to prevent the sum of TCP force calculated from the difference between the planned torque and the actual torque at each joint from exceeding the safety limit. If the deviation between actual TCP force and planned TCP force exceeds the safety limit, a safety controller alarm is triggered and a Category 1 stop is executed.
  - Normal mode and reduced mode each have their own set of safety limits, which are applied for monitoring and alarm purposes.
- **SF25 Joint Torque Limit**

  The robot continuously monitors the actual joint torque values. If the torque exceeds the safety limit, a safety controller alarm is triggered and a Category 1 stop is executed.
- **SF26 TCP Position Deviation Limit**

  The robot continuously monitors the deviation between the actual TCP position and the target TCP position. If the deviation exceeds the safety limit, a safety controller alarm is triggered and a Category 1 stop is executed.
- **SF27 Start/Restart Interlock**

  When starting or restarting, the robot is in the disabled state and cannot run automatically. To start the robot, you must first enable it and then press the run button. After enabling, the safety controller continuously monitors the deviation between the actual position and the target position of each joint via the encoder. If the deviation exceeds the safety limit, a safety controller alarm is triggered and a Category 1 stop is executed.
- **SF28 Normal Stop**
  - The robot can be triggered into the stop state via an external button, performing a Category 1 stop.
  - The normal stop input is set by default to a normally closed signal with a high level. A falling edge on either channel triggers the robot into the normal stop state.
  - When the safety controller detects that the external button has been pressed, it notifies the servo to perform a Category 1 stop and monitors the stopping time. If the stopping time exceeds the stopping time limit, a Category 0 stop is executed.
- **SF29 Hand-Guided Control (Drag Teaching)**
  - The robot can only enter hand-guided control mode when it is in a Category 2 stop state.
  - When the hand-guided control button is pressed, the robot can be manually moved. When the button is released, a Category 2 stop is executed.
  - In hand-guided control mode, the TCP speed is limited to the user-configured value, with a maximum upper limit of 250 mm/s.
  - In hand-guided control mode, position limits remain in effect.
- **SF30 Hold-to-Run Control**
  - When the hand-guided control button is pressed, the robot can be manually

moved.

- When the button is released, a Category 2 stop is executed.

Appendix D Applicable Standards

Safety Standards	UL 1740 4th Edition, Revised August 11, 2023: Standard for Safety for Robots and Robotic Equipment NFPA 79-2024, Dated December 21, 2023: Electrical Standard for Industrial Machinery CAN/CSA Z434-14 (R2019), Reaffirmed 2019: Industrial robots and robot systems ANSI/RIA R15.06-2012: American National Standard for Industrial Robots and Robot Systems - Safety Requirements CSA C22.2 No. 301:23, Rev. September 2023: Industrial electrical machinery EN ISO 10218-1:2011 Robots and robotic devices - Safety requirements for industrial robots - Part 1: Robots; EN 60204-1:2018+A1:2025 Safety of machinery - Electrical equipment of machines - Part 1: General requirements; EN ISO 12100:2010 Safety of machinery - General principles for design - Risk assessment and risk reduction; ISO/TS 15066:2016 Robot and Robotic Devices - Collaborative Robots; EN ISO 13849-1:2023 Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design ISO 13849-2:2012 Safety of machinery - Safety-related parts of control systems Part 2: Validation
EMC Standards	EN IEC 61000-6-2:2019 Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments; EN IEC 61000-6-4:2019 Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments EN 55011:2016+A1:2017+A2:2021: Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement

