



Hardware User Manual



JAKA Zu Series

Original Instructions (en)

File Version: V05

Robot: Zu 3, Zu 5, Zu 7, Zu 12, Zu 18, Zu 20

Control Cabinet: CAB 2.1

The definition of collaborative robots follows the ISO standards and relevant national standards to protect the safety of operators. We do not recommend applying the robots directly to cases when the operating object is a human. However, if there is a need for the robot to operate side by side with a human, the robot needs to be equipped with a safe, reliable, fully tested and certified safety protection system to protect the human, provided that the personnel safety is fully assessed by the user or application developer.

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We will regularly revise the manual, and the content may be updated without notice. Please check the factual product information carefully before reading this manual.

This manual is applicable to all products and/or services manufactured or provided by JAKA (hereinafter referred to as the “products”). The information contained in the manual is provided “as is” and is subject to the relevant laws and legislation. To the maximum extent permitted by law, this manual does not constitute any form of express or implied representation or warranty of JAKA, neither constitute a guarantee of merchantability, suitability for specific purposes, achievement of expected results, or non-infringement of the products. JAKA assumes no responsibility for any error or omission that may appear in this manual, or any accident or indirect injury arising from the use of this manual and the products described therein. Before installing and operating the product, read this manual carefully.

The pictures in this manual are for reference only.

If the robot body is transformed or disassembled, JAKA will not be responsible for after-sales services.

JAKA reminds users that they must use safety equipment when using and maintaining JAKA robots and must comply with the safety terms.

Programmers of JAKA robots and designers and debugging personnel of robot systems must be familiar with the way to program JAKA robots and install system applications.

More Information

For more product information, scan the QR code on the right to visit our official website: www.jakarobotics.com.



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Foreword

The robot pioneers in the control mode with a mobile smart terminal plus an App connected to the robot, so that one mobile terminal can match multiple robots. Operators do not need to master professional programming technology, but only need to manually guide the robot to complete the programming. In this way, human-machine collaboration is easier, which greatly improves the productivity.

JAKA Zu are intelligent, lightweight, 6-DOF modular collaborative robots, falling into the JAKA modular collaborative robot series.

Product List

When you buy a whole set of the JAKA Zu series robots, the delivery you will receive is as shown in the following table:

No.	Name	Quantity
1	Robot	1
2	Control cabinet and its key	1
3	Control stick	1
4	Control cabinet power cord	1
5	Robot connection cable	1
6	TIO cable	1
7	Product qualified certificate	1
8	After-sales service warranty card	1



NOTE

Accessories vary by robot model. Zu 3 comes with a robot connection cable, so it is not delivered with accessory 5.

Important Safety Notice

According to 2006/42/EC Machinery Directive, JAKA robot is a **partly completed machinery**, and a risk assessment must be performed for each robot installation. All safety instructions in chapter 2 must be followed.

1 Manual Instruction

1.1 About the Manual

The manual contains:

- Precautions for the use of JAKA Zu series robots
- Installation of JAKA Zu series robots
- Cleaning and maintenance of JAKA Zu series robots

1.2 Manual Reader

The manual is intended for:

- Operators
- Commissioning staff
- Maintenance staff
- Integrators

1.3 References

Documentation referred to in the manual:

- 1.7.1 JAKA App Software User Manual
- JAKA MiniCab Hardware User Manual
- JAKA Service Manual



NOTE

All documents can be found via JAKA official website www.jakarobotics.com.

1.4 Prerequisites

The reader should:

- Be trained by JAKA and have the required knowledge of mechanical and electrical installation / repair / maintenance work.
- Be trained to respond to emergencies or abnormal situations.






2 Safety Standard

2.1 Introduction

This chapter mainly introduces the safety principles and standards that should be followed while using the robot or robot system. Users should carefully read and strictly abide by the content related to safety in this manual. Operators should fully recognize the complexity and danger of the robot system, and pay special attention to the content related to warning signs.


2.2 Safety Signals and Symbols





The danger level in this manual is described with the following safety symbols. Contents related to safety should be strictly observed.

Signal	Description
	WARNING: ELECTRICITY This signal indicates a potentially dangerous power consumption situation which, if not avoided, may result in injuries to personnel or serious damage to equipment.
	WARNING This signal indicates a potentially dangerous situation which, if not avoided, may result in injuries to personnel or serious damage to equipment.
	WARNING: HOT SURFACE This signal indicates a potentially dangerous hot surface that may result in injuries to personnel if touched.
	NOTICE This signal is used to indicate important facts and conditions.
	NOTE This signal is used to indicate additional information.

2.3 Warnings and Cautions

This section focuses on the protection for operators and the relevant precautions of the first installation. Users need to read the safety warnings in this manual carefully. However, there are many possibilities, and it is impossible to cover all of them, we have described as many situations as possible herein.

Signal	Description
	WARNING: ELECTRICITY <ol style="list-style-type: none"> 1. All JAKA hardware and software must be installed/configured in strict accordance with the instructions and cautions provided in this manual. 2. The installation of the power cut-off switch should be positioned within the height range of 0.6~1.9 m (23.622~74.803 in) to facilitate prompt and convenient power disconnection in the event of an emergency. 3. Prior to the initial use of any JAKA products, a comprehensive inspection of all electrical components and safety protection systems must be conducted to verify their integrity and absence

Signal	Description
	<p>of prior damage.</p> <p>4. Operators possessing the necessary qualifications for robot operation are instructed to perform a thorough assessment of all safety functions and ensure the accuracy of parameters and programs before initiating the power supply to the robot.</p>
	<p>WARNING</p> <ol style="list-style-type: none"> 1. Technical personnel are instructed to carry out the installation and commissioning procedures for any JAKA products in strict accordance with the provided specifications. 2. Adjustment and alteration of any JAKA product parameters must be executed exclusively by authorized personnel to safeguard against unauthorized modifications by individuals lacking appropriate operating expertise. 3. It is recommended not to frequently toggle the power supply on/off. Each joint of the JAKA robot is equipped with a brake mechanism to maintain its pose for safety reasons in the event of a power failure. Brake mechanisms can be damaged during unexpected power downs. 4. In the event that the applied force on the robot surpasses a predefined threshold, triggered by JAKA's collision detection feature, it will cease its motion to prevent potential harm to the robot itself or injury to operators. Associated risks of the use of control cabinets not supplied by JAKA is solely the responsibility of the operator.
	<p>WARNING</p> <ol style="list-style-type: none"> 1. Ensure the proper installation of both the robot and its associated tools to the manufacturer's specifications. 2. Verify that there is adequate space available for unobstructed movement of the robot. 3. To prevent damage, refrain from connecting safety equipment to the standard I/O interface (use safety I/O interface). 4. Confirm the accuracy of mounting settings, including mounting angles, Tool Center Point (TCP) position, tool mass, TCP offset and the robot's safety configuration. 5. Ensure that tools and obstacles do not possess sharp corners or points and maintain a safe distance between all personnel and the robot. 6. Connecting the robot to different machinery may increase existing hazards or introduce new ones. Conduct a comprehensive risk assessment for the entire system installation. 7. Do not make modifications to the robot, as such alterations may create unforeseen hazards for which JAKA cannot be held liable. If the robot is changed or modified in any form, JAKA assumes no liability.
	<p>WARNING: HOT SURFACE</p> <ol style="list-style-type: none"> 1. Both the robot and the control cabinet generate heat during operation. Avoid contact with the robot and the control cabinet during operation and after shutdown. In both instances allow approximately 1 hour for the equipment to cool down.
	<p>WARNING</p> <ol style="list-style-type: none"> 1. When connecting external equipment that may pose a threat to the robot, it is advisable to independently check all robot functions and programs. Utilize temporary waypoints located outside the mechanical workspace to verify the robot's program. 2. Exposure to strong magnetic fields can damage the robot; hence, avoid exposing it to permanent magnetic fields. 3. Operators who use the robot system are strictly prohibited to wear loose clothes and jewelry. Those with long hair should ensure that the hair is tied back. 4. During the operation of the equipment, even if the robot appears to have stopped, it may be in

Signal	Description
	<p>a state of imminent action because it is waiting for a start signal. In such state, the robot should be regarded as running.</p> <p>5. During the operation of the robot, ensure that the connection of the control cabinet and the robot power cable are proper. It is strictly forbidden to plug or unplug the power cables and terminals while the robot is running.</p> <p>6. Warning lines should be drawn on the floor to mark the movement range of the robot so that operators can see the movement range of the robot with gripping tools (mechanic arms, tools, etc.).</p> <p>7. Ensure that safety measures (e.g., guardrails, ropes, or protective screens) are in place near the operation area of the robot to protect operators and surrounding people. Locks should be provided as necessary to make the robot power inaccessible to anyone other than the operator in charge.</p> <p>8. In emergencies or abnormal situations when a person is caught or trapped by the robot, after pressing the emergency stop button, you may push or pull its arm to force the joint to move. Manual movement of the robot without electric power is limited to emergencies and may lead to joint damage.</p>

2.4 Liability and Risk

Liability

This manual does not involve any applications of how to design, install and operate the robot, nor does it involve any peripheral equipment that may affect the security of the robot system.

It is the responsibility of the user of the JAKA robot to ensure that relevant practical national laws and regulations are followed, and that no significant hazards lie in the whole robot application.

All safety information in this manual cannot be considered as a guarantee of JAKA. Even if all safety instructions are followed, injuries or damage may still be caused by operators.

JAKA will keep improving the performance and reliability of our robots. We are not responsible for errors or omissions in this manual and reserve the right of final interpretation of this manual.

Risk

When there is interaction between operators and the robot, there is inevitably direct or indirect physical contact. When touching the robot, users must have sufficient awareness of self-protection. Users need to be cautious when using the robot. Some possible hazards are as follows:

- The robot drops and causes any injury when it is moved.
- The fastening bolts or screws of the robot get loose and cause any injury.
- During the operation, the robot pinches your fingers or collides with you.
- The robot causes any injury due to lack of prompt repair of faults.
- Potential danger when sharp-end actuators or sharp tool coupling ends are used.
- Potential injury when the robot is operated in toxic or corrosive environments.
- Robot use in a strong magnetic environment.

2.5 Usage

JAKA's robots are industrialized collaborative robots. They are suitable for the industrial environment, such as using it to manipulate equipment or fixed tools and to process or pass spare parts or products. JAKA's robots can only be used in specified conditions and environments.

JAKA's robots have safety rating features specially designed for collaborative operation, that is, the robot can work without guardrails or work with people. Collaborative operation is only suitable for danger-free applications,

that is, complete applications where tools, workpieces, obstacles and other machines have been proven not to have a significant risk following an application-specific risk assessment.

Any use or application that violates the intended use is not allowed, including but not limited to:

- Use it in an environment where dust explosion may occur.
- Use it in vacuum environment.
- Use it in medical treatment and vitally important matters.
- Use it without risk assessment.
- Use it when the performance level is assessed as unqualified.
- Operate it without the permitted operating parameters.

2.6 Risk Assessment

Robots are partly completed machines, and the way the robot is integrated plays a decisive role in whether the robot is installed safely (e.g. end effectors, communication equipment, etc.). Risk assessment is an important thing that integrators need to perform. This is required by law in many countries. It is recommended that the integrator needs to perform the risk assessment according to ISO 12100 and ISO 10218-2, with the option of using ISO/TS 15066 as additional guidance. The risk assessment performed by the integrator should consider all matters within the robot's lifetime, including but not limited to:

1. Teaching of the robot during robot installation, set-up and development.
2. Operations of the robot installation.
3. Troubleshooting and maintenance.

The risk assessment must be carried out before the robot is powered on for the first time. The risk assessment performed by the integrator to identify safety configuration settings, assess whether additional emergency stop buttons or other protective measures for specific robotic applications are required.

Proper safety configuration is especially important for the use of robots. Cobots have specific safety functions, which can be configured through settings. These functions are especially important when integrators conduct risk assessments:

1. Force limit: refers to the force required by the robot to issue a collision alarm when the robot is in contact with the external environment, showed as a percentage. The higher the percentage, the greater the force required for the robot to stop.
2. Momentum limit: refers to restricting the momentum of the robot during movement. The limit will directly affect the speed of the robot. When the momentum of the robot exceeds the limit, the robot speed will be reduced.
3. TCP speed limit: refers to limiting the absolute speed of the end TCP point during the movement of the robot. The path speed will be kept within the TCP speed limit.
4. Power limit: refers to limiting the mechanical power during the robot movement. This limit will directly affect the speed of the robot. When the mechanical power of the robot exceeds the limit, the robot speed will be reduced.

Integrators must prevent unauthorized personnel from modifying safety configurations.

When performing a risk assessment, the integrator should consider exposures due to potential misuse, i.e.:

1. The possibility of a potential collision.
2. The possibility of avoiding potential collisions.
3. The severity of the potential collision.

If the robot is installed in a non-collaborative robot application and the risk cannot be eliminated by configuring the robot's safety functions. Integrators should consider adding additional protective measures when conducting risk assessments.

JAKA identifies the following significant dangers that integrators must consider.

1. Sharp edges and sharp points on end effectors or end effector connectors stab the skin.

2. Sharp edges and sharp points on obstacles in and near the robot workspace stab the skin.
3. Bruises due to contact with the robot.
4. Sprain or fracture caused by the impact between the heavier load on the end of the robot and the hard surface.
5. Consequences caused by loose bolts or screws used to fasten robots or end effectors.
6. Consequences of items falling from end effectors.
7. Mis-operation due to different emergency stop buttons on different machines.
8. Error due to unauthorized changes to safety configuration parameters.

Information on stopping times and stopping distances are found in [3.2 Safety Stopping Time and Distance](#) and [Appendix 1: Stopping Time and Distance](#).



NOTICE

Specific robotic applications may present other significant hazards.

2.7 Pre-use Assessment

After using the robot for the first time or making any modifications, the following tests must be performed. Ensure that all safety inputs and outputs are correct and connected correctly. Test that all connected safety inputs and outputs are functioning. Ensure that the payload is configured correctly. The following tests are required:

1. Test if the emergency stop button and input can stop the robot and engage brakes.
2. Test whether the safeguard input can stop the robot motion. If safeguard reset is configured, check if activation is required before resuming motion.
3. Check whether the reduced mode input can switch the motion mode to the reduced mode.
4. Test whether the 3-position enabling device must be pressed to enable motion in manual mode and the robot is under deceleration control.
5. Test whether the emergency stop output of the system can bring the entire system into a safety state.
6. Test whether the system connected to the robot moving output, robot non-stop output, reduced mode output, or non-reduced mode output can detect output changes.
7. Test whether the payload configuration matches the current actual payload of the robot.

2.8 Emergency Stop

When an emergency occurs, press the emergency stop button to stop all the movements of the robot immediately. Emergency stop cannot be used as a risk reduction measure, but it can be regarded as secondary protection equipment and is only used in emergencies. If you need to stop the robot movement under normal circumstances, please adopt other measures. After risk assessment, if you need to install an emergency stop button, the button must meet the requirements of IEC-60947-5. The time and distance of emergency stop of JAKA's robot have been tested. See [Appendix 1: Stopping Time and Distance](#) for the test data.



WARNING

When the emergency stop button is pressed, the robot system will cut off the robot power. In this case, although the brakes between the joints will lock the joints automatically, there will still be a slight downward movement of the robot under gravity, so there is a risk of pinching or collision.

2.9 Emergency Release of the Brake



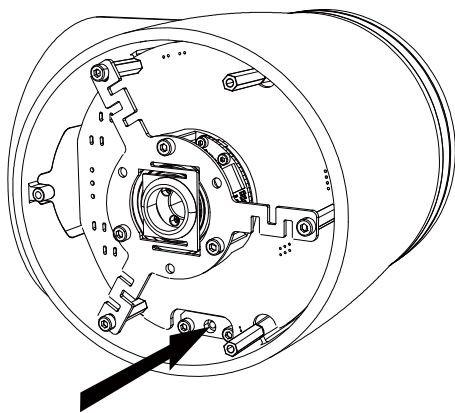
WARNING

1. If the brake is released manually, the joint of the robot may move under gravity, so it is necessary to effectively support the robot and tools or workpieces installed on the robot before manually releasing the brake.
2. At least two persons should be present when releasing the brakes.

When the robot is in emergency stop state, the power supply of the robot fails, the robot joints can be forced to move in following methods:

● Zu 3, Zu 5, Zu 7, Zu 12, Zu 18 and joint 4, 5, and 6 of Zu 20:

Remove screws fixing joint lid, remove the joint lid and press the slider in the small electromagnet (as shown in the figure below) to manually release the brake.



● Joint 1, 2 and 3 of the Zu 20:

1. When the power of the robot is connected:

- (1) Ensure the robot is powered on and disabled, open the JAKA App, go to "Manual Operation" interface, press and hold the "Backdrive" button to release the joint brake, and drag the joint to move this joint.



NOTE

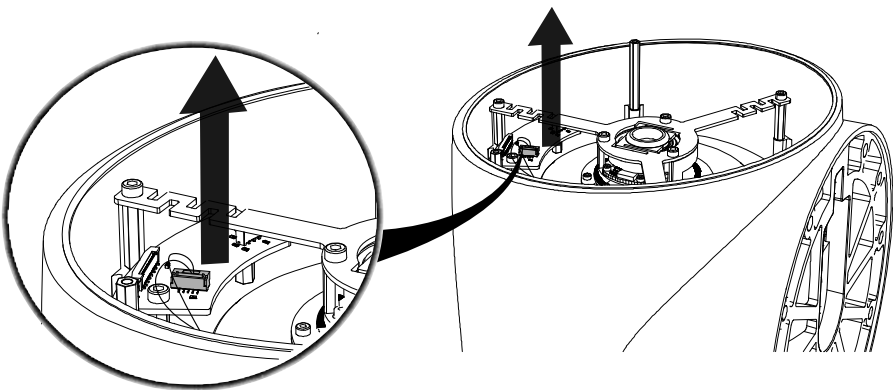
This function only supports JAKA App versions 1.7.2 and above.

- (2) Ensure the robot is powered on and disabled, press and hold the Pause/Resume button on the lid of joint 6 (refer to [9.1.1 Ring-Shaped Light](#) for its position) to release the joint brake, and then this joint can be dragged.

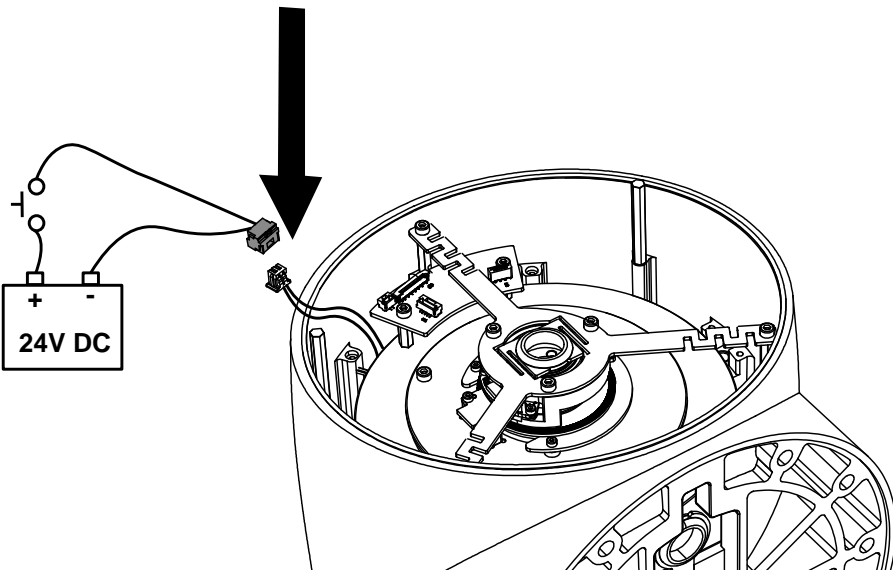
2. When the power of the robot is cut:

Unscrew the screws and washers fixing the joint lid by an Allen wrench, remove the joint lid, unplug the break wire on the driver board (position of break wire is shown in figure below), connect the 24V DC external power supply with automatic reset switch to the terminal of the brake wire, and press and hold the switch to release the joint brake (the connecting time of the external power supply should not exceed 5 minutes) Release the power switch, the joint is in the braking state.

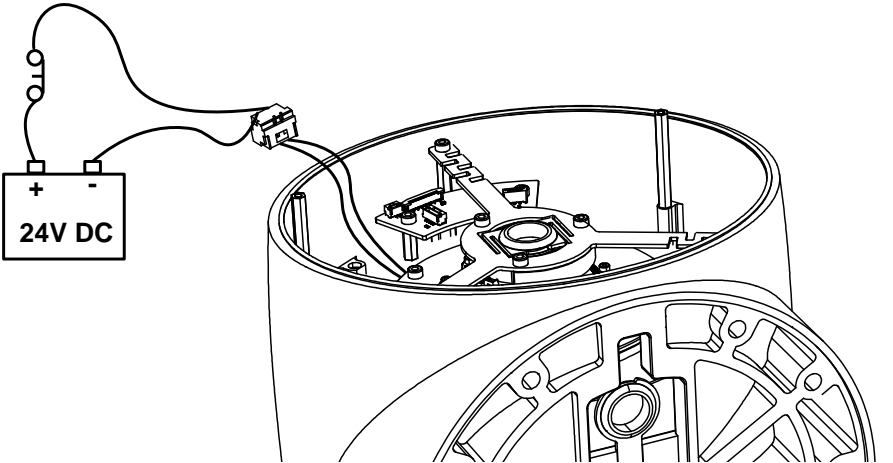
Joint 1, joint 2 of Zu 20



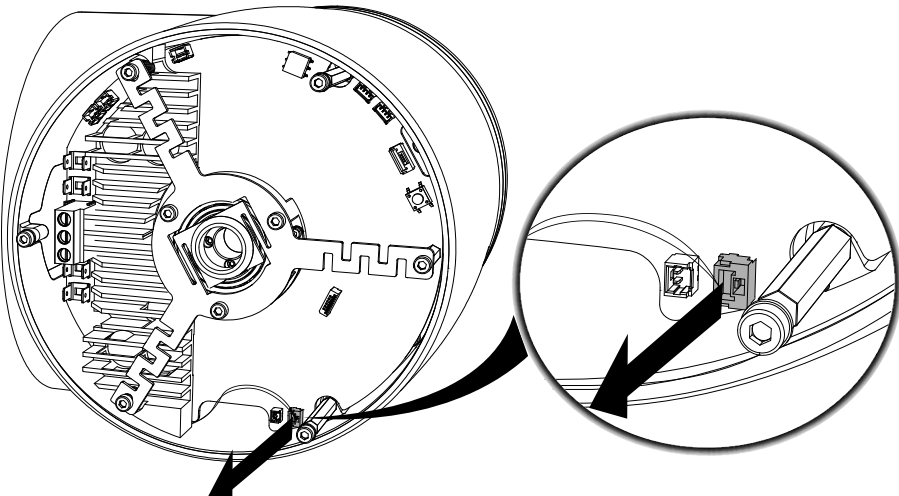
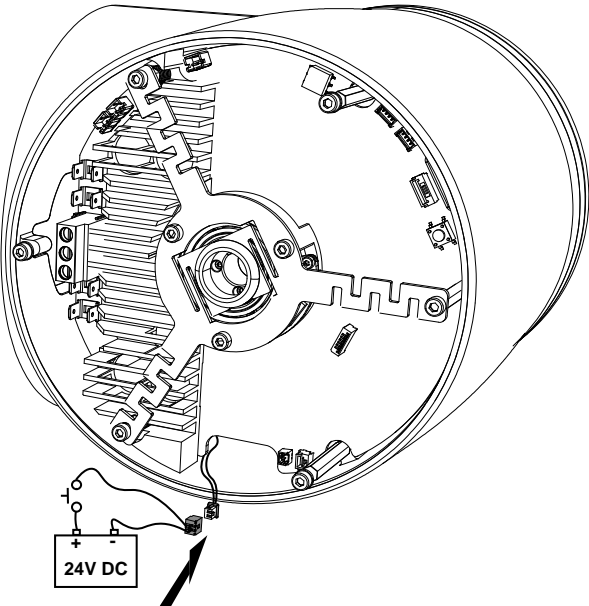
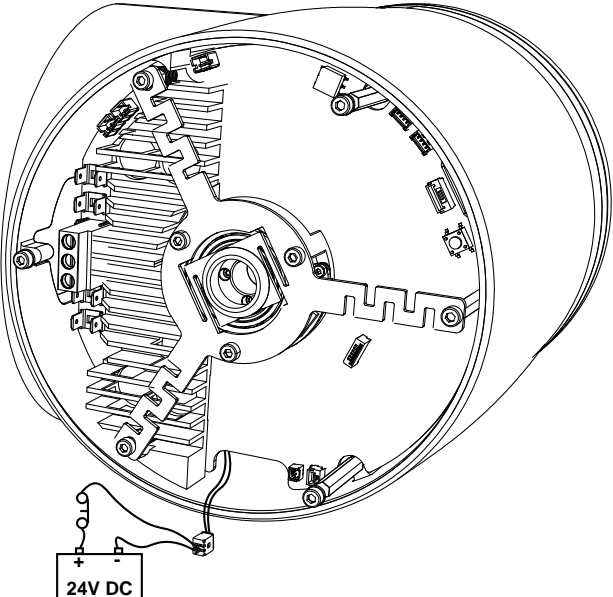
Unplug brake wire



Connect external power supply

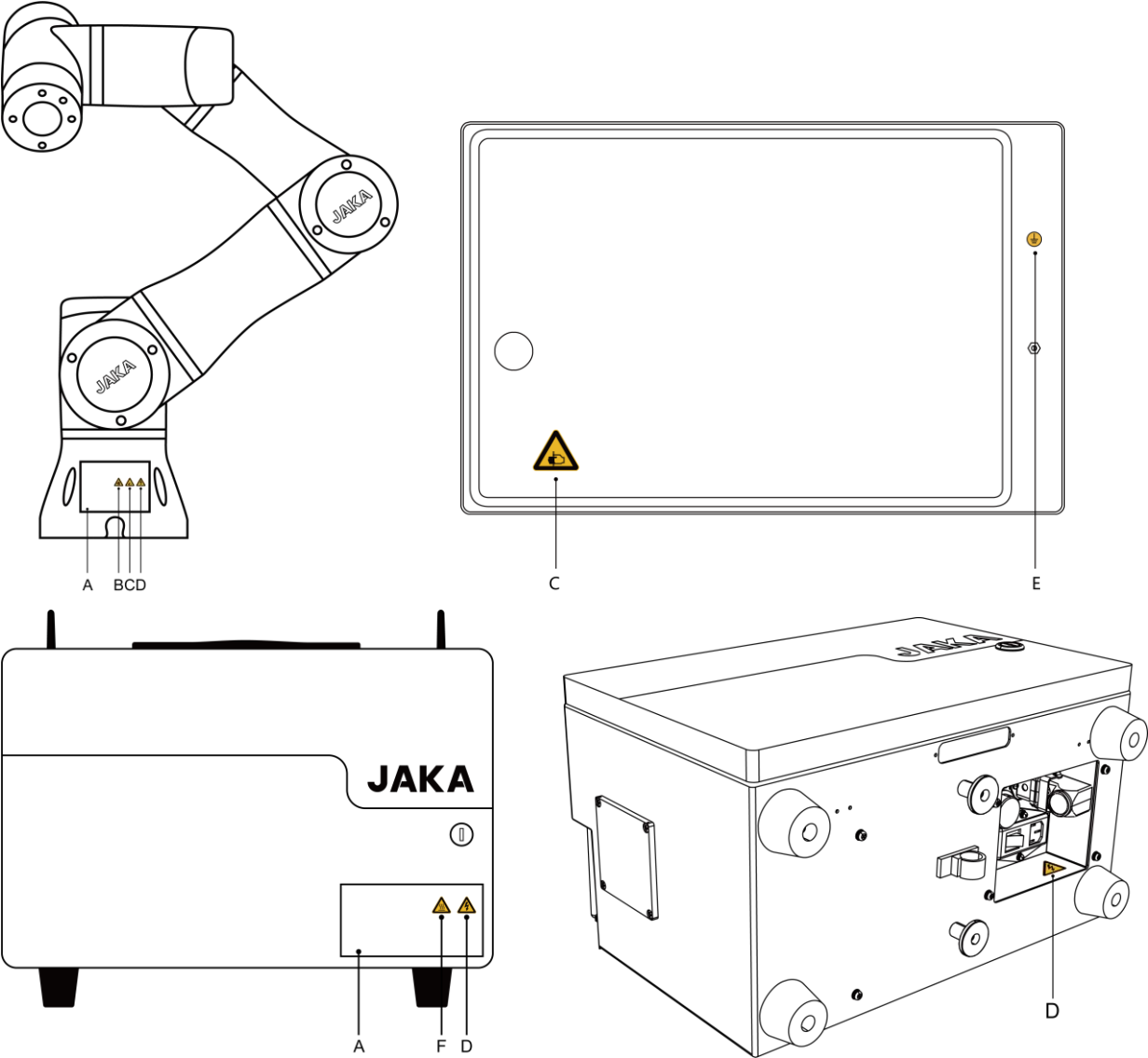










Press and hold power switch






<p>Joint 3 of Zu 20</p> 	<p>Unplug brake wire</p>
	<p>Connect external power supply</p>
	<p>Press and hold power switch</p>

2.10 Labels

The following labels are safety warning labels and product label on the robot and the control cabinet. During the operation, be sure to follow the instructions and warnings on the labels to ensure safety. Do not remove the labels casually. Handle labeled parts or units and their surrounding area with caution to avoid damage to the labels. Product labels and robot model figures are only for reference.



	Labels	Description
A	<div><div><div><div><div>JAKA</div><div>Zu 5</div><div><div>Max. Payload: 5 kg / 11.0 lbs Max. Reach: 954 mm / 37.6 inches Input: 48 VDC / 350 W (TYP) Weight: 23 kg / 50.7 lbs Enclosure Type: IP54</div></div></div><div><div><div>CE</div><div>CCC</div><div>RoHS</div><div>20</div></div></div></div><div><div><div><div></div><div>Zu5250287</div></div><div><div></div><div>2023-W 10</div></div></div><div><div>Building 6, No. 646, Jianchuan Road, Minhang District, Shanghai, China</div><div>JAKA Robotics Co., Ltd.</div></div><div><div><div></div><div></div><div>EMERGENCY MOVEMENT: PRESS THE SLIDER IN THE ELECTROMAGNET TO MANUALLY RELEASE THE BRAKE. PUSH THE JOINT TO MOVE.</div></div></div><div><div><div><div>JAKA</div><div>CAB 7</div><div><div>Input: 100-240VAC ~ 50-60Hz Output: 48VDC / 350W (TYP) SCCR: 200 A Weight: 15.4 kg / 34.0 lbs Enclosure Type: IP44</div></div></div><div><div><div>CE</div><div>CCC</div><div>RoHS</div><div>20</div></div></div></div><div><div><div><div></div><div>CAB7210045</div></div><div><div></div><div>2023-W 10</div></div></div><div><div>Building 6, No. 646, Jianchuan Road, Minhang District, Shanghai, China</div><div>JAKA Robotics Co., Ltd.</div></div><div><div><div></div><div></div></div></div></div></div><div>Product label</div></div></div></div>	

	Labels	Description
B		Beware of collision
C		Beware of pinching
D		Beware of electric shock
E		Grounding
F		Warning hot surface



NOTE

1. For the serial numbers of the robot and control cabinet, you can check their labels. The label of Zu 3 is on the robot base, the labels of other robots are on the lower arm, and the label of control cabinet is on the front cover of the control cabinet.
2. Product labels and robot model figures are only for reference, actual varies by robot model.

3 Safety Functions

JAKA's robot has a series of safety functions to guarantee the safety of man-machine collaboration. This chapter introduces these safety functions, and users should strictly abide by the requirements and precautions.

3.1 Stop Category

According to the IEC 60201 standard, three stop categories have been set for JAKA's robot: stop category 0 (Cat. 0), stop category 1 (Cat.1), and stop category 2 (Cat.2). Among them, Cat.0 is uncontrollable stop, while Cat.1 and Cat.2 are controllable stop.

If Cat. 0 is triggered, the power supply of the robot is immediately cut off and the robot stops running immediately.

If Cat.1 is triggered, the robot immediately decelerates to stop, and the power supply of robot will be cut off when all joints enter stand-still condition.

If Cat.2 is triggered, the robot decelerates following the programmed trajectory, eventually all joints enter stand-still condition (while the robot remains enabled).

3.2 Safety Stopping Time and Distance

Safety stopping time is the time it takes to stop the robot from the moment when the emergency stop button is pressed or a safety protection function is triggered; the stopping distance is the distance the end of the robot moves during the safety stopping time. Among them, pressing the emergency stop button falls into Cat.1, while triggering the safety protection function falls into Cat.2. During this period, the robot is still moving and may harm the personnel or other equipment. Therefore, users and integrators should consider this time and distance in risk assessment.

The test conditions are as follows:

- Reach: 100%, 66%/ 72.5%, 33%
- Speed: 100%, 66%, 33%
- Payload: See the table below

Model	Payload
Zu 3	3 kg (6.6 lb)
Zu 5	5 kg (11 lb)
Zu 7	7 kg (15.4 lb)
Zu 12	12 kg (26.4 lb)
Zu 18	18 kg (39.6 lb)
Zu 20	20 kg (44.1 lb)

See [Appendix 1: Stopping Time and Distance](#) for the respective stopping distance and time of Cat.1 and Cat.2.

3.3 Safety Mode

JAKA's robot have two configurable safety modes: the emergency stop mode and the protective stop mode.

Emergency stop: When an emergency occurs, this mode can be triggered for protection. Users can trigger the configuration via the emergency stop button on the remote stick, the EI interface on the control cabinet panel P8, and the safety IO function in the safety settings.

Protective stop: The protective stop is a stop type triggered when the controller detects an error. The protective stop can be triggered by the SI interfaces on P8 of the front panel of control cabinet, the safety I/O and safety plane function in the safety settings.

When the robot is in the emergency stop and protective stop state, its states are as follows:

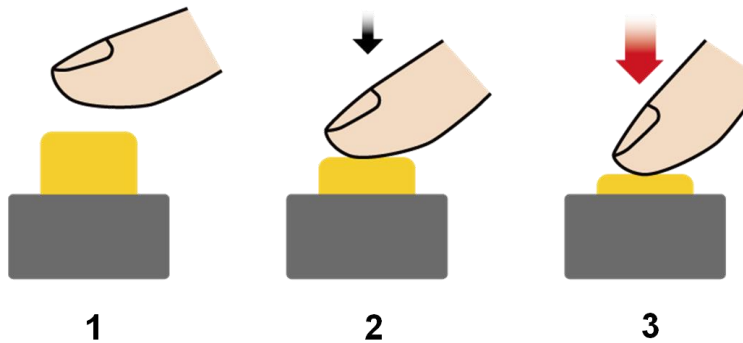
	Emergency Stop	Protective Stop
Robot movement state	Stop	Stop
Joint motor state	Stop after deceleration	Enabled
Robot power state	Power off	Power on
Program state	Stop and need to be powered again	Pause
Brake state	Braking state	Non-braking state

3.4 Three-Position Enabling Device (Optional)

JAKA's robot support a three-position enabling function, which can be used in conjunction with external three-position enable device. The standard product delivery of JAKA's robot does not include this device. The three-position enabling safety input interface is available for users and as an option for matching hardware, which the design meets the certification requirements. For this optional accessory, please contact the authorized supplier of JAKA.

When you use three-position enabling device and configure the corresponding function in the software, the robot can only be moved and controlled after the three-position switch is pressed to a middle point. See [10.5.4 Safety I/O Interfaces](#) for wiring method.

The picture of the three-position enabling switch is as follows:



The corresponding robot control states for different states of the three-position enabling switch are as follows:

	Switch State	Robot State	Manual Control	Automatic Control (Program Operation)
1	Release	Protective stop (Cat.2)	Off	When a program is running, the three-position enabling function is switched off.
2	Press lightly	Normal	On	
3	Press tightly	Protective stop (Cat.2)	Off	



NOTE

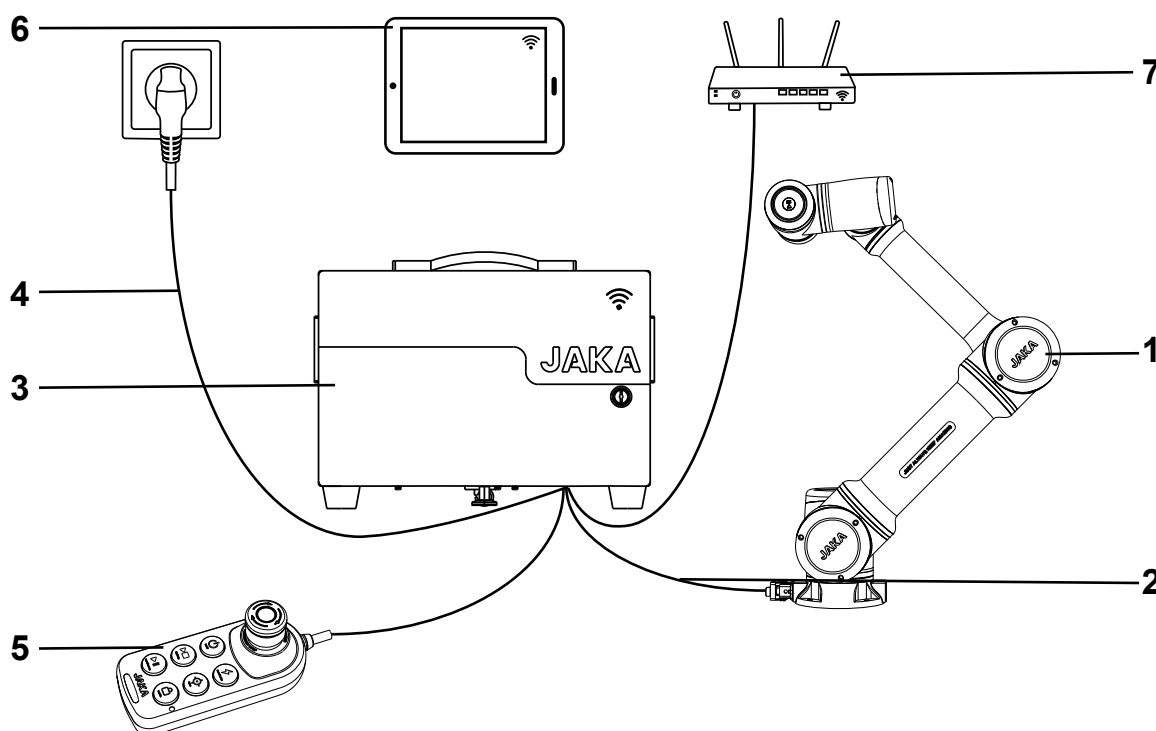
- Manual control contains dragging robot by pressing and holding the FREE button, dragging robot by pressing and holding the pause/resume button, JOG robot, and debugging function in programming interface.
- JOG refers to manually controlling robot movement in the JAKA App in the manual operation interface.

4 Quick Start Guide

Before reading this chapter, ensure that you have read in detail and fully understood the [2 Safety Standard](#), [3 Safety Functions](#).

This chapter will introduce the basic components and use methods of JAKA robots as a preliminary understanding of the robot. For detailed mechanical and electrical specifications, refer to other chapters.

4.1 Overview of the Robot System





As is shown in figure above, JAKA robot system contains following components:

- 1. Robot:** The main moving component to move as user desires. Ring-shaped light, buttons for dragging and programming, and an I/O interface for connecting tools (the TIO interface) are also arranged at the end of the body to indicate the robot's state.
- 2. Robot connection cable:** Connect the robot and the control cabinet.
- 3. Control cabinet:** The control cabinet includes the core computing components and various electrical interfaces.
- 4. Control cabinet power cord:** Provide power supply to the control cabinet.
- 5. Control stick:** Power on/off and enable/disable the robot, etc.
- 6. Operation terminal:** The user equipment for programming, set parameters, etc.
- 7. Router and network cable:** The control cabinet comes with a Wi-Fi module that allows the operation terminal to connect with the control cabinet (the Wi-Fi name is the control cabinet number) to control the robot. It is also accessible to connect the network port of the control cabinet to the router and the operation terminal to the wireless network of this router at the same time. It is recommended to configure a specialized router for the robot to prevent conflicts with other devices.

4.2 Quick Start Guide

The following table provides a brief overview for robot usage:

No.	Steps	Operations	References
1	Robot mounting	Unpack the robot. <div>  NOTE If you want to move the robot later, please keep the original packaging. </div>	
2		Take out the robot from the packaging materials.	Refer to 5 Handling
3		Transport the robot to the intended mounting location.	
4		Lift and secure the robot to the platform or foundation.	Refer to 9.6.2 Robot Mounting
5		Secure the tools on the end of the robot, if any.	Refer to 9.6.3 End Effector Mounting
6	Control cabinet installation	Unpack the control cabinet.	
7		Take out the control cabinet from the packaging materials and carry it to the vicinity of the robot. <div>  NOTE The length of robot connection cable is 6 m (36.220 in), so the distance between control cabinet and robot should be less than it. </div>	Refer to 5 Handling
8	Connect the cables	Connect the robot connection cable, control cabinet power cord, control stick cable, Ethernet cable (if any), and TIO cable (if any) in sequence.	Refer to <ul style="list-style-type: none"> 9.1.4 Robot Connection Cable Interface 10.6 Bottom Panel Interfaces 9.1.3 Tool I/O Port
9		Flip the toggle switch at the bottom of the control cabinet to turn on the power switch.	Refer to 10.6 Bottom Panel Interfaces
10		The emergency stop button on control stick is released by default, if it is pressed, please release it first.	Refer to 8 Control Stick
11	Connect the robot	Power up the control cabinet, power on and enable the robot with the control stick.	Refer to 8.1 Control Stick Control Robot
12		Connect the robot using a computer / pad / mobile phone.	Refer to JAKA App Software User Manual
13	Configure the robot	Set the mounting orientation, payloads and collision sensitivity of the robot in the JAKA App.	Refer to JAKA App Software User Manual
14	Control the robot	Enable robot to move by pressing the FREE button on the end of the robot or entering programming / manual operation interface of the JAKA App.	Refer to <ul style="list-style-type: none"> 9.1.2 Buttons JAKA App Software User Manual

5 Handling

The table below shows the joint angle of packaging orientation, the robot can automatically change to this orientation by configuring in the JAKA App. It is recommended to transport the robot in this orientation.

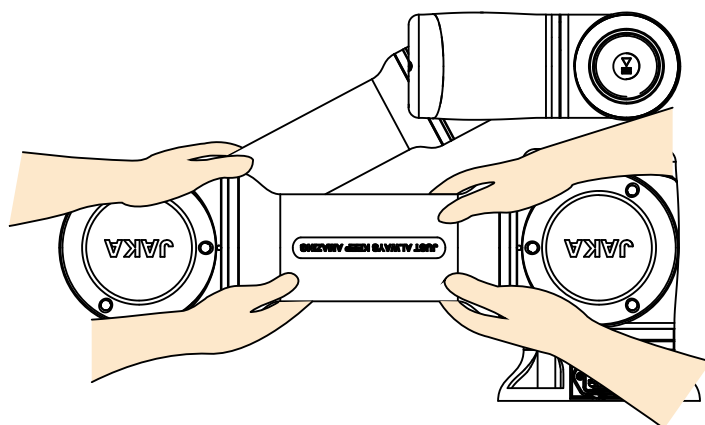
Joint 1	Joint 2	Joint 3	Joint 4	Joint 5	Joint 6
-90°	0°	148° ⁱ /152° ⁱⁱ	120°	0°	0°



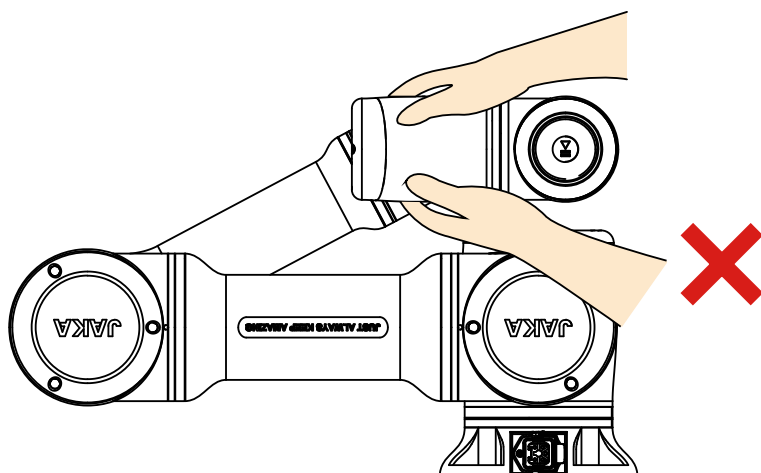
NOTE

- i. Valid for Zu 3.
- ii. Valid for Zu 5, Zu 7, Zu 12, Zu 18, Zu 20.

At least two persons are required for lifting and securing the robot during transportation. One person should hold the connection places between joint 1 and lower arm with both hands, while the other holds the connection places between joint 3 and lower arm with one hand, holds the connection places between joint 3 and upper arm with another hand, as shown in the figure below.



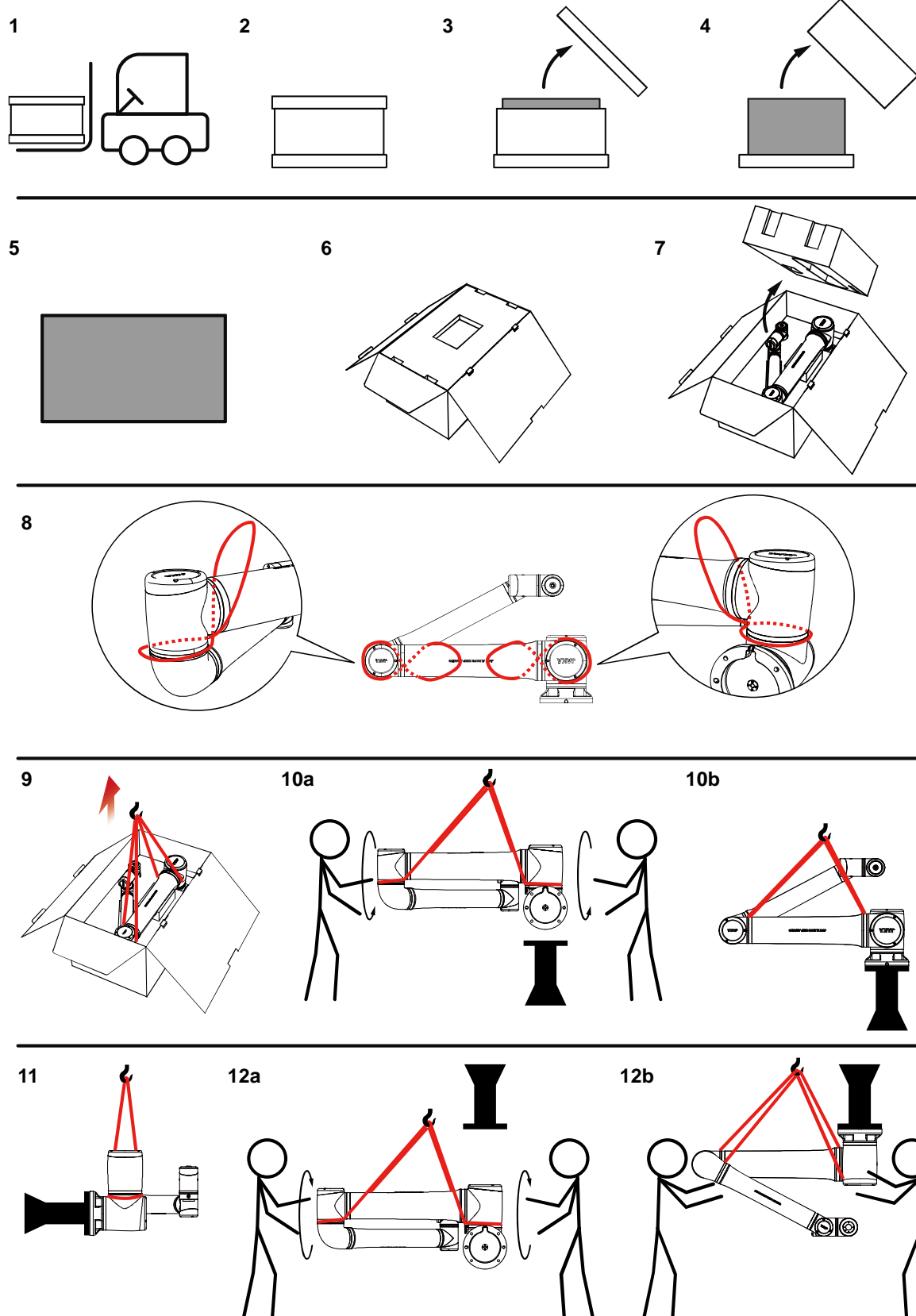
Lifting the robot by grabbing the robot's upper arm or joint 4/5/6 is strictly prohibited, as shown in the figure below. This action may cause damage to the internal structure of the robot.



There is a black handle on the control cabinet, so you can grip this handle to transport the control cabinet.

6 Lifting

Before mounting the robot, it needs to be moved to the appropriate position. For robots with heavier masses such as Zu 12, Zu 18, and Zu 20, lifting equipment should be used. The figure below shows the robot lifting orientation corresponding to different mounting methods. Please lift the robot according to the figure below.



	Description	Operations	References
1	Transport		11 Transportation
2-7	Opening the box	Remove the external foam, unwrap the carton and remove the internal foam.	
8-9	Lifting robot from box using sling	Make robot in packing orientation and take 2 straps. One end of the first strap is located at the junction between joint three and the upper arm, crossing the rope at this location, with the other end at the junction between joint three and the lower arm. One end of the second strap is located at the junction between joint one and joint two, crossing the strap at this location, with the other end at the junction between joint two and the lower arm. Once the straps are in place, use a hook to lift the two straps.	5 Handling
10a	Floor mounting	Rotate the robot so that the robot base is facing down.	9.6.2 Robot Mounting
10b		Secure the robot to the mounting plane.	
11	Wall mounting	Adjust the robot position and secure the robot to the mounting plane.	
12a	Inverted mounting	Rotate the robot so that the robot base is facing up.	
12b		Secure the robot to the mounting plane.	

The sling should conform to the following standards:

BS EN 1492-1 :2000+A1 :2008 Textile slings - Safety - Flat woven webbing slings, made of man-made fibers, for general purpose use.

BS EN 1492-2 :2000+A1 :2008 Textile slings - Safety - Round slings, made of man-made fibers, for general purpose use.

The lifting capacity if sling should be greater than 800 kg (1763.70 lb), the length of sling should be longer than 2 m (78.74 in).



WARNING

1. Carefully inspect the sling before and after each use.
2. Do not use the sling if it is cracked, ripped, or the stitching is loose.
3. Do not use the sling if there are signs of heat damage.
4. When using the sling, protect it against sharp edges and friction.
5. When lifting the robot, personnel must not, under any circumstances, be present under the sling and the robot.

7 Technical Specification

7.1 Robot Technical Specification

Model	Zu 3	Zu 5	Zu 7	Zu 12	Zu 18	Zu 20
Payload	3 kg (6.6 lb)	5 kg (11 lb)	7 kg (15.4 lb)	12 kg (26.4 lb)	18 kg (39.6 lb)	20 kg (44.1 lb)
Weight (including cables)	12 kg (26.46 lb)	23 kg (50.71 lb)	22 kg (48.50 lb)	41 kg (90.39 lb)	35 kg (77.16 lb)	68 kg (149.9 lb)
Reach	626 mm (24.64 in)	954 mm (37.5 in)	819 mm (32.2 in)	1327 mm (52.2 in)	1073 mm (42.24 in)	1780 mm (70.1 in)
Repeatability	±0.02 mm (±0.00079 in)			±0.03mm (±0.00118in)		±0.05 mm (±0.00120 in)
Degree of freedom	6					
Programming	Graphical programming, and freedrive programming					
Demonstrator type	Mobile terminal (computer/pad/mobile phone)					
Collaborative operation	Collaborative operation as ISO 10218-1: 2011					
Range of action						
Joint 1	±360°					
Joint 2	-85°~+265°					
Joint 3	±175°					
Joint 4	-85°~+265°					
Joint 5	±360°					
Joint 6	±360°					
Joint speed						
Joint 1	180 °/s	180 °/s	180 °/s	120 °/s	120 °/s	120 °/s
Joint 2	180 °/s	180 °/s	180 °/s	120 °/s	120 °/s	120 °/s
Joint 3	180 °/s	180 °/s	180 °/s	120 °/s	180 °/s	120 °/s
Joint 4	220 °/s	180 °/s	180 °/s	180 °/s	180 °/s	220 °/s
Joint 5	220 °/s	180 °/s	180 °/s	180 °/s	180 °/s	220 °/s
Joint 6	220 °/s	180 °/s	180 °/s	180 °/s	180 °/s	220 °/s
Tool typical speed	1 m/s (3.281 ft/s)	1 m/s (3.281 ft/s)	1 m/s (3.281 ft/s)	1 m/s (3.281 ft/s)	1 m/s (3.281 ft/s)	1.5m/s (4.921 ft/s)
Average power consumption	150W	350W	350W	500W	500W	750W
Peak power	1000W	2000W	2000W	3000W	3000W	/
Temperature	0~50°C (32~122°F) ⁱ					
Humidity	0~90% RH, non-condensation					
IP	IP54					IP65
Clean room	Conform to ISO 14644-1: 2015, ISO 14644-14: 2016 Class 5					/
Robot mounting	Mounting at any angle					
Tool I/O port	2 digital inputs 2 digital outputs 2 analog inputs					
Tool I/O power supply	12/24V					

Model	Zu 3	Zu 5	Zu 7	Zu 12	Zu 18	Zu 20
Tool I/O size	M8					
Tool I/O cable length	400 mm (15.748 in)					
Base diameter	129 mm (5.079 in)	158 mm (6.220 in)	158 mm (6.220 in)	188 mm (7.402 in)	188 mm (7.402 in)	246 mm (9.685 in)
Material	Aluminum alloy, PC					
Length of robot connection cable	6 m (236.220 in)					
Length of control stick cable	6 m (236.220 in)					


NOTE

i: At low environmental temperature <10°C, a warm-up phase recommended to be run with the robot. Otherwise, there is a risk that the robot stops or run with lower performance.

7.2 Control Cabinet Technical Specification

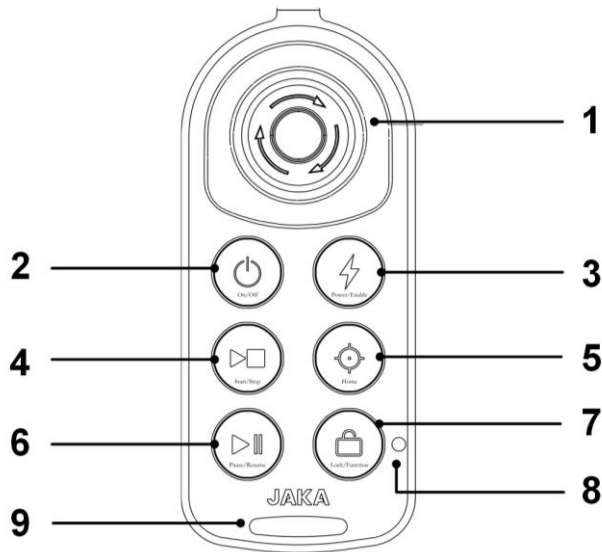
Model	CAB 3	CAB 7	CAB 12	CAB 16
Matching robot	Zu 3	Zu 5, Zu 7	Zu 12, Zu 18	Zu 20
Weight	13.5 kg (29.762 lb)	15.4 kg (33.951 lb)	18 kg (39.683 lb)	
IP	IP44			
Control cabinet I/O port	16 digital inputs, 16 digital outputs, 2 analog inputs or outputs			
Control cabinet I/O power supply	24V DC			
Communication mode	TCP/IP, Modbus TCP, Modbus RTU, PROFINET (1.7 App), Ethernet/IP (1.7 App)			
Power supply	100~240V AC, 50~60 Hz			
Length of control cabinet power cord	3 m (118.110 in)			
Size	410*235*307 mm (W*D*H) 16.14*9.25*12.09 in (W*D*H)			
Material	Plastic-sprayed carbon steel plate			
Temperature	0~50°C (32~122°F)			


NOTE

Zu series robots are used with CAB 2.1 by default. For MiniCab technical specifications, see JAKA MiniCab User Manual.

8 Control Stick

The JAKA robot comes with a control stick, which can be used to control both the robot and the control cabinet. The functions of the control stick buttons are described as follows:



	Name	Description
1	Emergency stop button	For emergency stop. Note: The emergency stop button is limited to emergencies and should not be used as regular power off equipment.
2	Power button on/off	Power on: Press the power button for 1s and release. The buzzer makes a noise, and the control cabinet is powered on. Power off: Press and hold the power button for 3s or more. The control stick beeps 6-7 times, and the control cabinet is powered off.
3	Enable button	Robot power on: Press the enable button, waiting for the ring-shaped light to turn blue, indicating that the robot is powered on. Robot power off: Press the enable button, waiting for the ring-shaped light to go off, indicating that the robot is powered off. Enable robot: When the robot is powered on, press and hold the lock button, and then press the enable button at the same time until the ring-shaped light turns green, which means the robot is enabled. Disable robot: When the robot is enabled, press and hold the lock button, and then press the enable button at the same time until the ring-shaped light turns blue, which means the robot is disabled.
4	Start/stop button	Start the program: Press the button to start the default program, execute the default program after the robot reaches the initial position of the program. Stop the program: Press to stop the program when the robot runs the program.
5	Reset button	Reset: After the robot is enabled and the robot is not executing the program. Press and hold the reset button to control the robot to return to initial orientation set in the JAKA App. Continue holding the button when the robot has moved to initial orientation, the lock indicator will turn blue.
6	Pause/resume button	Pause: During the automatic operation of the robot, press the button to pause the program.

	Name	Description
		Resume: Press the button to resume the program when the program is paused.
7	Lock button	<p>Lock the control stick: Press and hold the lock button for 3s, and the lock indicator turns orange.</p> <p>Unlock the control stick: Press and hold the lock button for 3s, and the lock indicator turns off.</p> <p>Combination function: Other buttons can be used with the lock button.</p>
8	Lock indicator	<p>Lock state: In the lock state, the indicator is orange, and all buttons except the lock button and power button are disabled. The App can control the robot.</p> <p>Unlock state: In the unlock state, the lights go out, and the control stick can be used. The App interface is gray, and you cannot use the App to control the robot.</p>
9	Control stick indicator	When powering on the control cabinet, the control stick indicator first shows red, blue and green alternately with three beeps, and then it turns orange, waiting for the control cabinet to power on. The control stick indicator is blue when the controller program is running normally. After enabling the robot, the control stick indicator will flash green.

**NOTE**

1. Once the control cabinet is powered on, the control stick will beep twice per second if any button is pressed.
2. When using the control stick to operate the robot, ensure that the robot you are operating is within your sight and follow the relevant safety guidelines to avoid any injury to personnel or equipment near the robot.

8.1 Control Stick Control Robot Steps

Steps of enabling robot are as follows:

1. **Power on control cabinet:** Press the power button. The buzzer makes a noise, and the control cabinet is powered on.
2. **Unlock the control stick:** Press and hold the lock button for 3s, and the lock indicator goes out, which means the control stick is unlocked.
3. **Power on robot:** Press the enable button, waiting for the ring-shaped light to turn blue, which means the robot is powered on.
4. **Enable robot:** When the robot is powered on, press and hold the lock button, then press the enable button at the same time until the ring-shaped light turns green, which means the robot is enabled.
5. **Lock control stick:** App cannot be operated when control stick is unlocked, you should lock control stick first. Press and hold the lock button for 3s, and the lock indicator turns orange, which means control stick is locked. You can use App now.

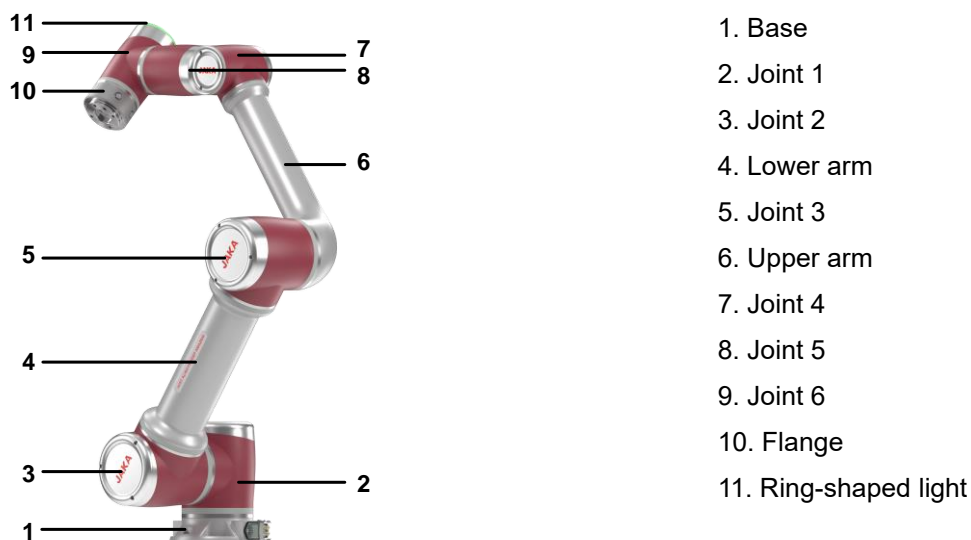
Steps of powering off control cabinet are as follows:

1. **Unlock the control stick:** Press and hold the lock button for 3s, and the lock indicator goes out, which means the control stick is unlocked.
2. **Disable robot:** When the robot is enabled, press and hold the lock button, and then press the enable button at the same time until the ring-shaped light turns blue, which means the robot is disabled.
3. **Power off robot:** Press the enable button, waiting for the ring-shaped light to turn blue, indicating that the robot is powered off.
4. **Power down control cabinet:** Press and hold the power button for 3 seconds or more. The control stick

beeps 6-7 times, and the control cabinet is powered off. After powering off the control cabinet, please do not cut off the power immediately. Wait until the control stick light goes out, and after waiting for 5 to 10 seconds, you can disconnect the power.

9 Robot

The robot contains six joints and two arms. The base is used to connect the robot to the foundation, and the tool end is used to connect the robot to the end effector. The end effector can move and rotate in the workspace of the robot. This chapter will introduce the basic precautions during the installation of each component of the robot system.



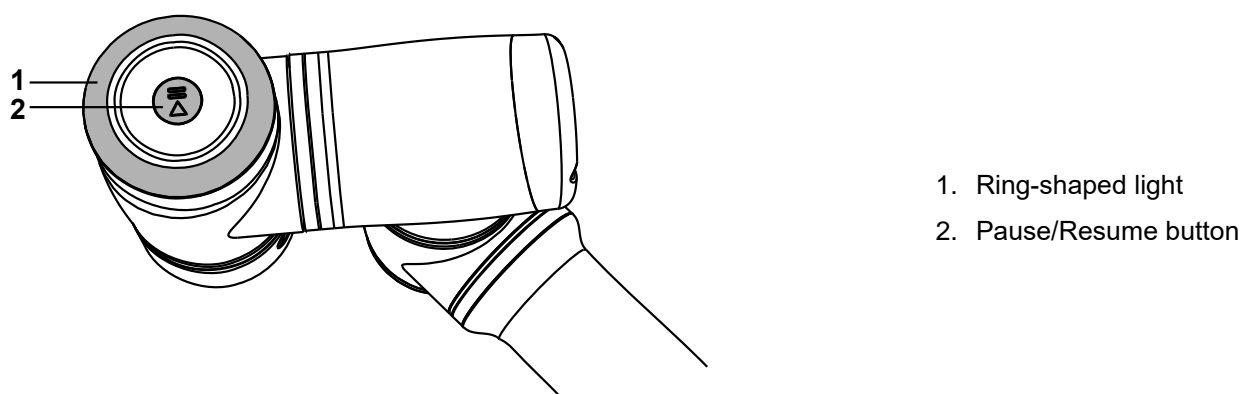
9.1 Robot Buttons and Interfaces

9.1.1 Ring-Shaped Light

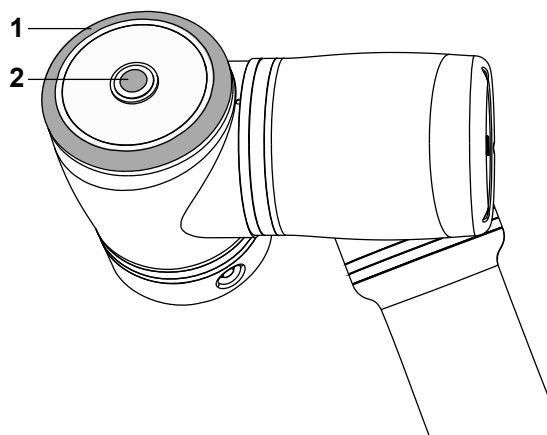
A ring-shaped light and a pause/resume button are positioned at the end of the robot.

The positions of the ring-shaped light and the button are shown in figure below, and the color meanings are shown in table below. When the robot runs a program, you may press the button at the end of the robot to pause it, and you may press again to resume.

Zu 3, Zu 5, Zu 7, Zu 12, Zu 18 ring-shaped light:



Zu 20 ring-shaped light:



1. Ring-shaped light
2. Pause/Resume button

Color	Robot State
Blue	Powered on but disabled
Green	Enabled
Red	Failure/Protective stop
Yellow	Freedrive mode
Yellow flash	Pause
Yellow flash	Single-step program debugging

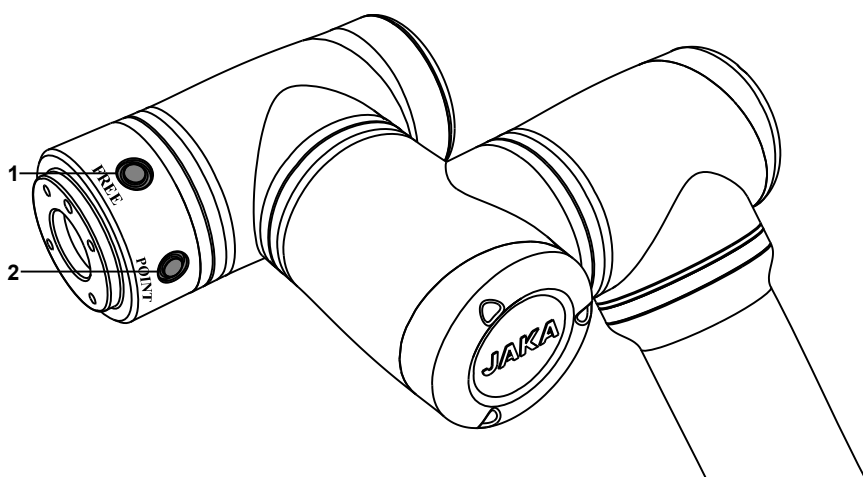


WARNING

Using the buttons at the end of the flange requires users to fully assess the possible risks of the sudden start and stop of the robot, which may cause injury to personnel or damage to the equipment.

9.1.2 Buttons

The robot is equipped with a tool I/O interface and two buttons on the flange side. The two buttons are a freedrive button (FREE) and a point recording button (POINT), as shown in figure below.



1. Freedrive button
2. Point recording button

When FREE button is pressed, the robot enters freedrive mode. You can directly drag the robot to the desired position.

The POINT button is used with the JAKA App. When this button is pressed, the corresponding position will show up in the programming interface of the App as a command (see JAKA App Software User Manual for details).



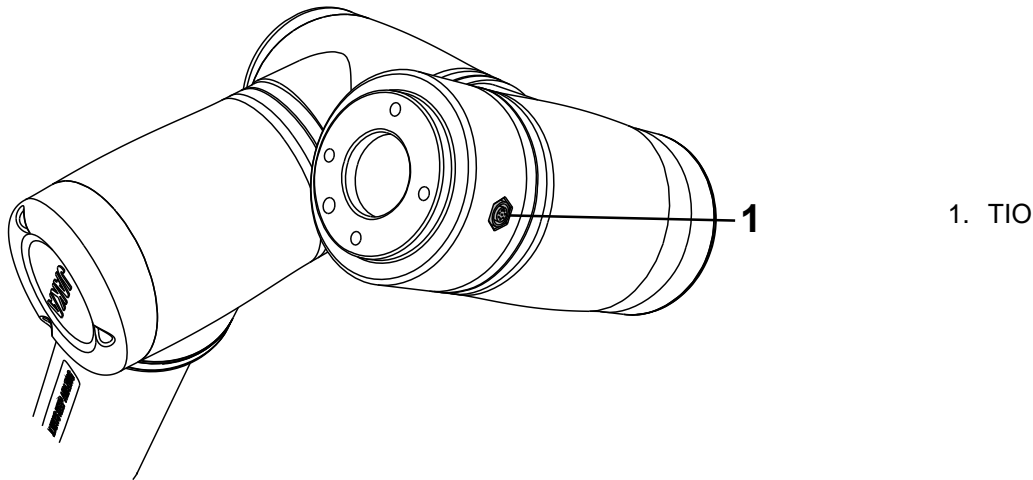
WARNING

The use of the FREE button requires users to fully assess the possible risks. They must ensure that the robot's mounting orientation, end payload, TCP, and other parameters are correctly set, otherwise it may cause injury to personnel or damage to the equipment.

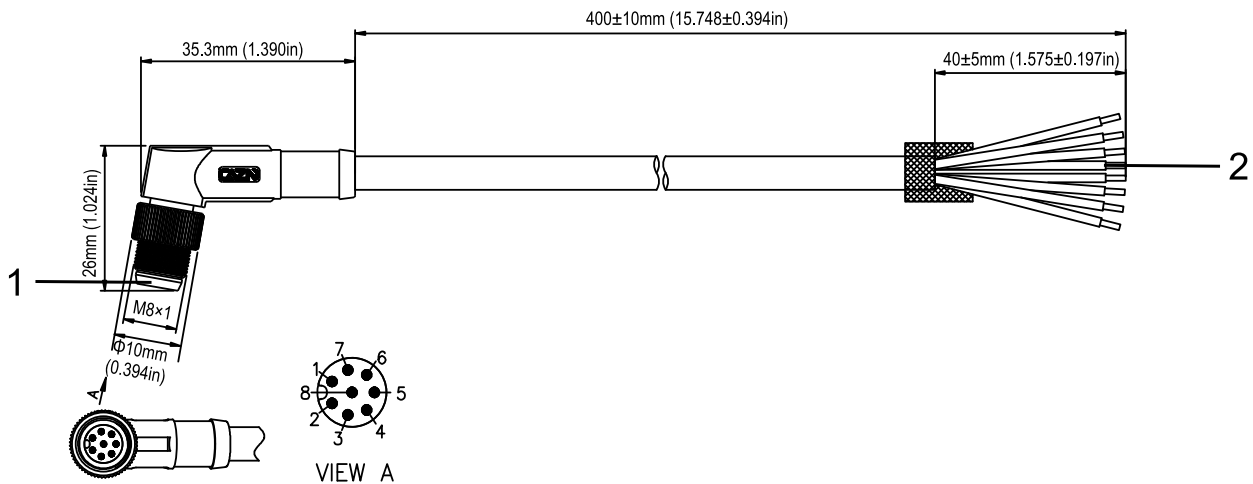
9.1.3 Tool I/O Port

The tool input and output interface are referred to as TIO, installed on the side of the flange of the robot, which contains two digital inputs, two digital outputs and two analog inputs, and can multiplex the two-channel RS485 signal at the same time. For the definition of the interface, see [9.1.3.1 Definition of End Effector Side](#).

TIO cable connector is foolproof designed. Align the raised part of the TIO connector with the concave groove on the TIO connector of the flange and insert the cable. The TIO position is as shown in the figure below.



The definition and specifications of the TIO cable are as follows.



1. Connect the robot flange.
2. Connect the end effector.

9.1.3.1 Definition of End Effector Side

The definition table of the TIO V3.0 interfaces is as follows:

Pin	Definition	I/O	Color	Description
1	+24V	-	Red	Positive electrode, 24V/12V (switchable); configurable for enabling or disabling; continuous current capacity 1A; peak output current up to 2A.
2	DI1	I	Blue	Digital input 1: configurable to be PNP or NPN input
3	DI2	I	Green	Digital input 2: configurable to be PNP or NPN input
4	DO1/RS485A_1	O	Yellow	Digital output 1: configurable to be PNP, NPN, or push-pull output; current output capability $\leq 1A$ Multiplexed as RS481 communication A+
5	DO2/RS485B_1	O	Pink	Digital output 2: configurable to be PNP, NPN, or push-pull output; current output capability $\leq 1A$ Multiplexed as RS481 communication B-
6	AIN1/RS485A_2	I	Brown	Analog input 1: detection range 0-10V Multiplexed as RS482 communication A+
7	AIN2/RS485B_2	I	White	Analog input 2: detection range 0-10V Multiplexed as RS482 communication B-
8	GND	-	Gray	24V negative electrode

9.1.3.2 Wiring of End effector Side

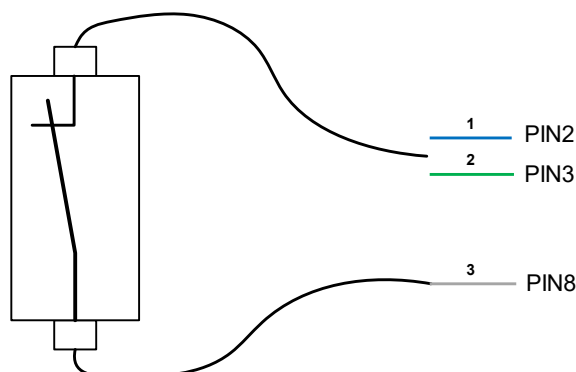
1. TIO digital input interface

TIO supports 2 DI digital input interfaces, compatible with NPN and PNP types. It can be configured in the App. For the details of operation, see JAKA App Software User Manual.

(1) Dry contact input

When the DI input is configured as NPN type:

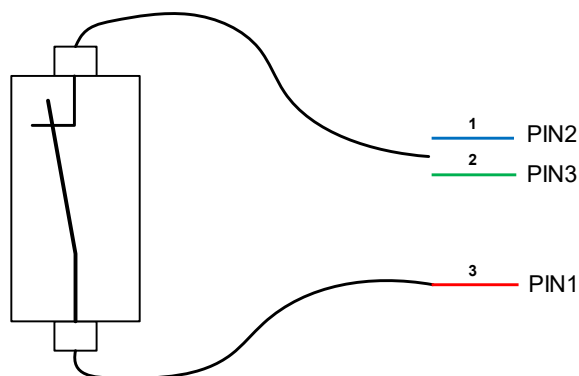
The dry contact input (switch-type input) is connected to GND of TIO (gray wire) at one end, and to the digital input (blue or green wire) at the other end.



1. Blue
2. Green
3. Gray

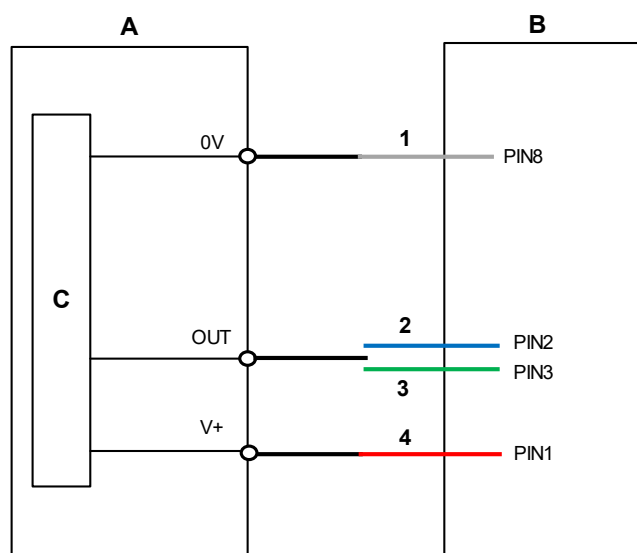
When the DI input is configured as PNP type:

The dry contact input (switch-type input) is connected to GND of TIO (gray wire) at one end, and to the digital input (blue or green wire) at the other end.



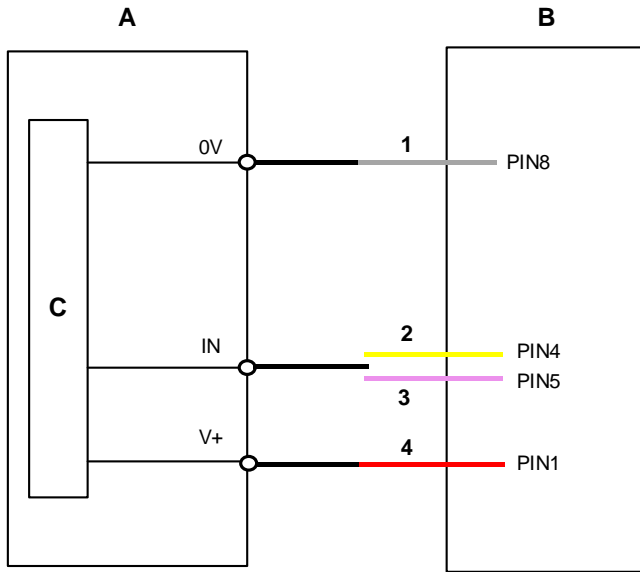
(2) Connect NPN/PNP type device

The connection method of NPN and PNP type digital input devices: V+ is connected to 24V of TIO (red wire), 0V is connected to GND of TIO (gray wire), and the signal wire is connected to the digital input of TIO (blue or green wire).



2. TIO digital output interface

When the digital output interface is NPN or PNP output, it adopts open drain output and the maximum continuous current output is 1A. Connection method: the external input interface is connected to the digital output of TIO (yellow or pink wire), V+ side of external device is connected to 24V of TIO (red wire), and 0V side of external device is connected to GND of TIO (gray wire).



A: External NPN device

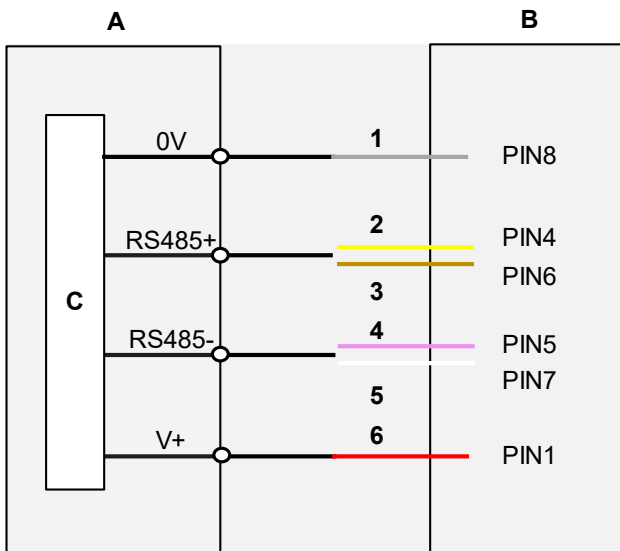
B: TIO V3

C: Main circuit

1. Gray
2. Yellow
3. Pink
4. Red

3. RS485 signal

Using the RS485 function, the wiring method: external RS485+ is connected to RS485+ of TIO (yellow or brown wire), external RS485- is connected to RS485- of TIO (pink or white wire), the V+ of external device is connected to the 24V of TIO (red wire), and 0V of external device is connected to the GND of TIO (gray wire).



A: External device

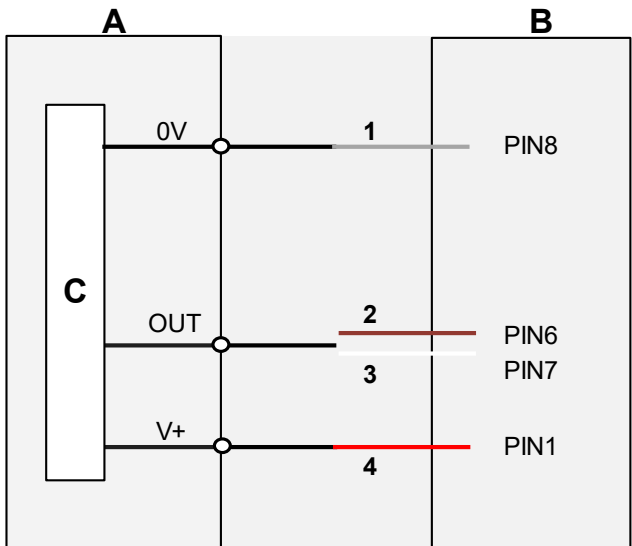
B: TIO V3

C: Main circuit

1. Gray
2. Yellow
3. Brown
4. Pink
5. White
6. Red

4. TIO analog input interface

TIO supports 2 analog voltage input interfaces. The voltage input range is 0-10V, the analog voltage positive terminal is connected to A1/A2, and the internal circuit of the negative terminal on the TIO board is grounded. The wiring method: the external analog voltage positive electrode is connected to AIN1/AIN2 of TIO (white and brown wire), and the internal circuit of the negative electrode on the TIO board is grounded. The V+ of external device is connected to the 24V of TIO (red wire), and 0V of external device is connected to the GND of TIO (gray wire).

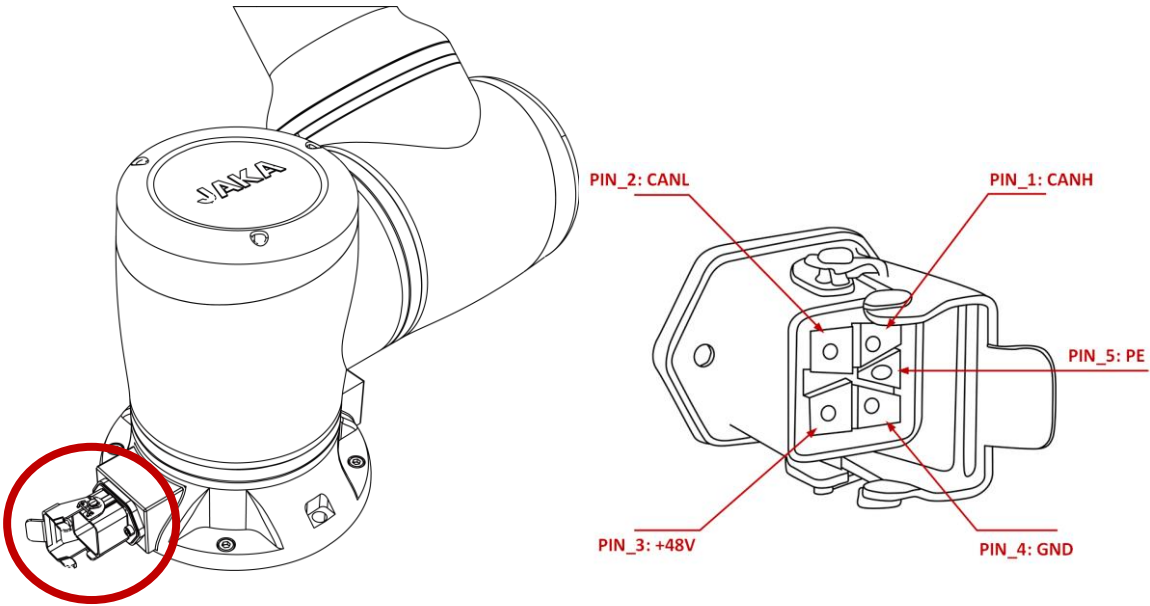


- A: External device
- B: TIO V3
- C: Main circuit
- 1. Gray
- 2. Brown
- 3. White
- 4. Red

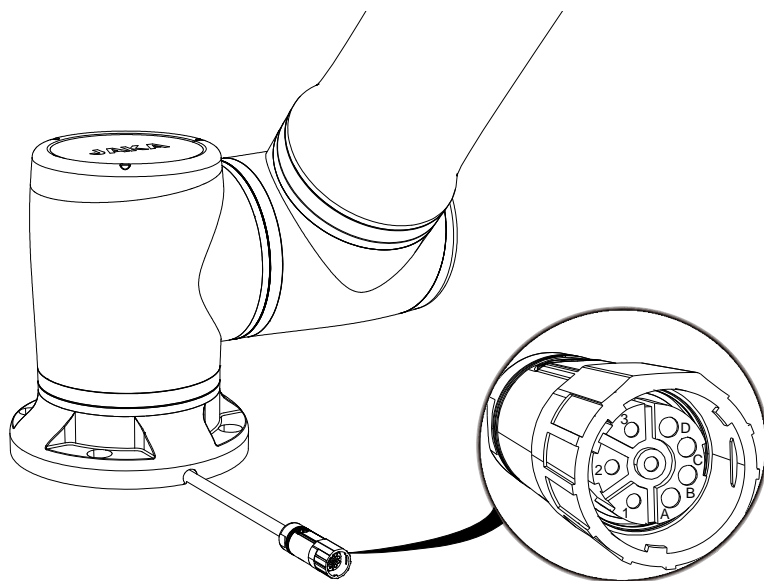
9.1.4 Robot Connection Cable Interface

Use the robot connection cable provided by JAKA to connect the robot and the control cabinet. Before powering on the robot, ensure that the connector is locked firmly. Before disconnecting the robot connection cable, the robot must be powered off. The definition of the robot connection cable connector is shown as follows.

Zu 3, Zu 5, Zu 7, Zu 12, Zu 18 robot connection cable interface:



Zu 20 robot connection cable interface:



Power cable	1	Red 48V+
	2	Yellow & Green PE
	3	Black GND
Communication cable	A	Green CANH
	B	Yellow CANL

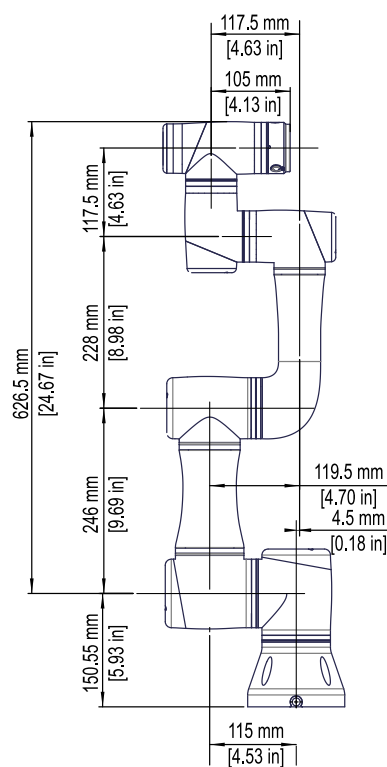


WARNING

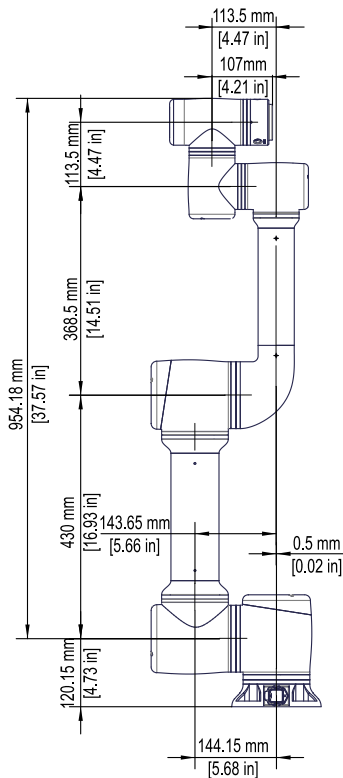
1. Do not disconnect the robot connection cable while the robot is not powered off.
2. Do not extend or modify the original cable.

9.2 Robot Size

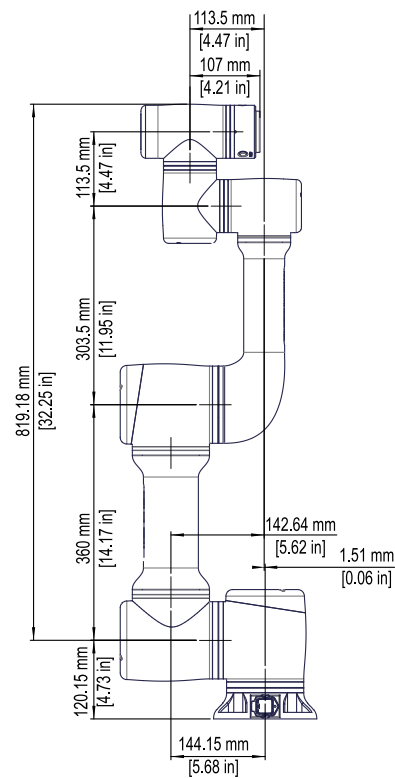
The sizes of the Zu series robots are shown below. During the installation, you must consider the motion range of the robot to avoid injury to surrounding personnel and equipment.



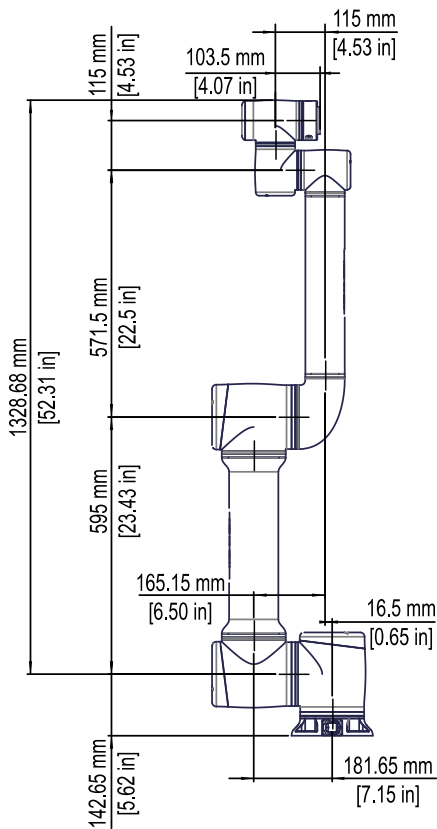
Zu 3



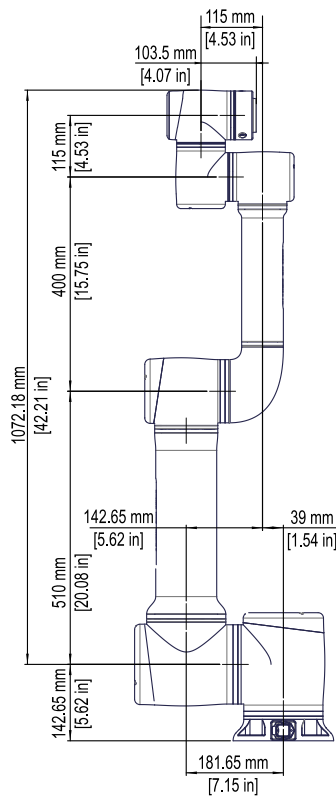
Zu 5



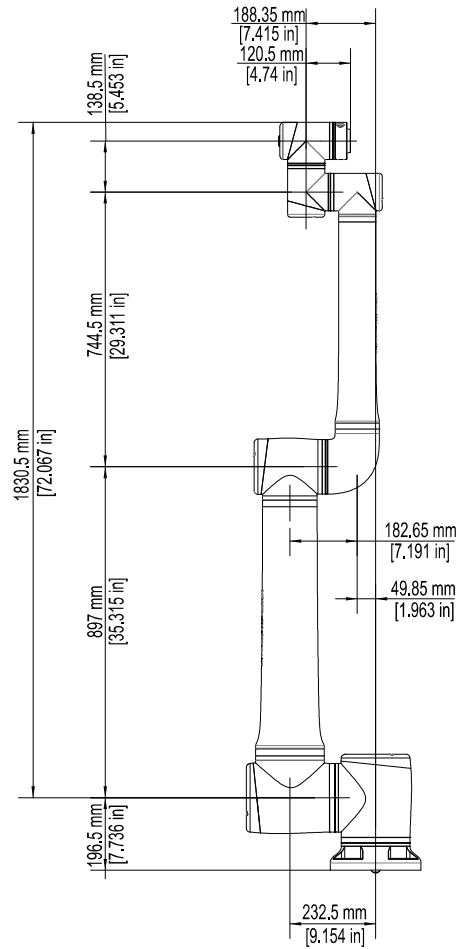
Zu 7



Zu 12



Zu 18

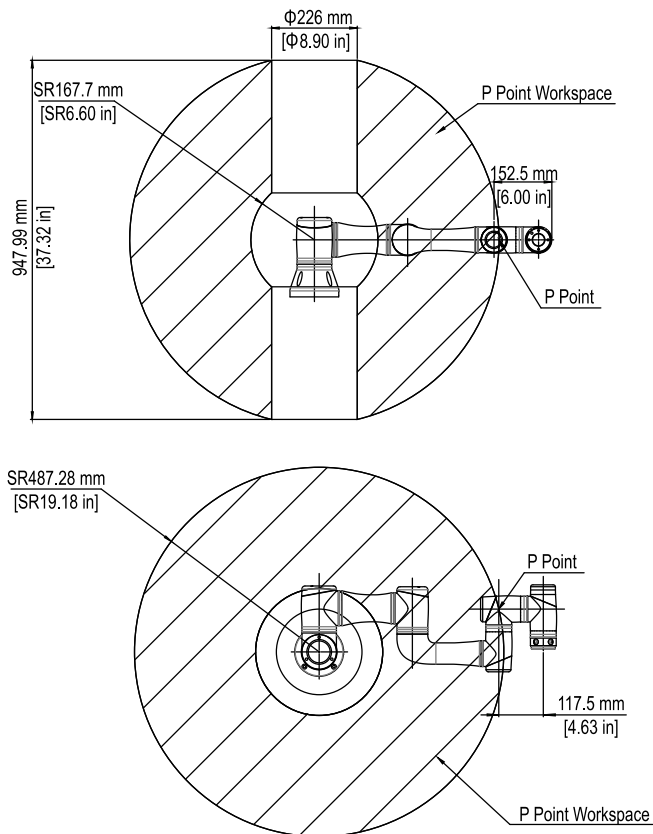


Zu 20

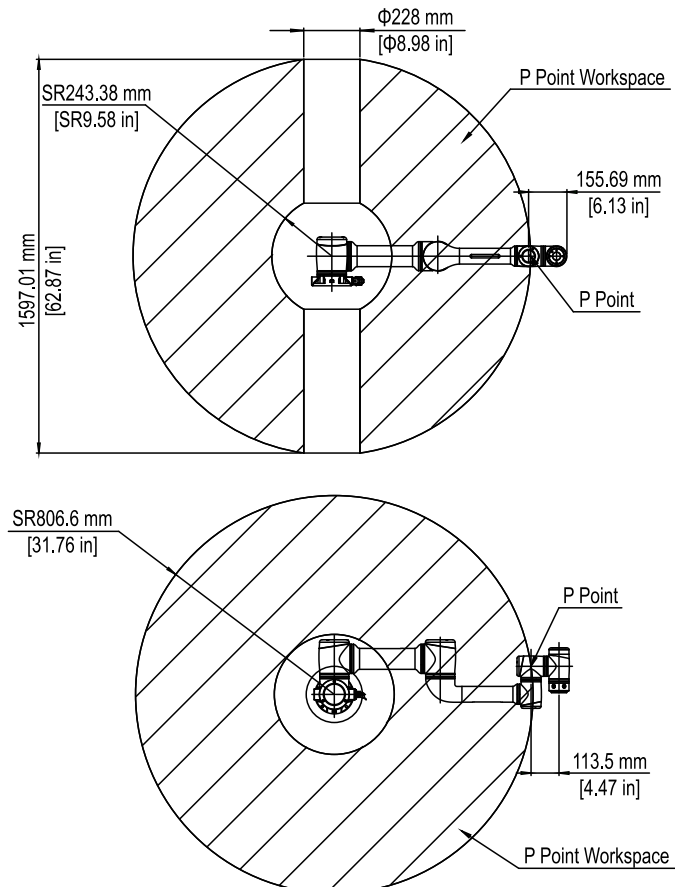
9.3 Robot Workspace

The workspaces of the Zu series robots are shown below. When you mount the robot, a cylindrical space above and below the robot must be considered. It is recommended not to move robot end into this cylindrical space. Because in this space, the robot is proximity to its singularity, which makes the joints move too fast even if the robot end moves slowly in the Cartesian space. All above will lead to the low efficiency of the robot and the difficulty in risk assessment.

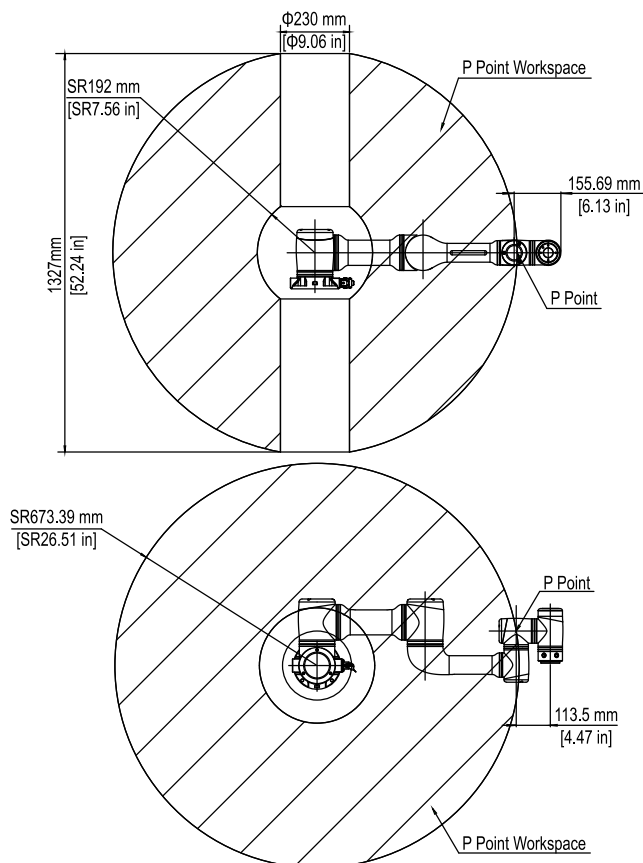
1. Zu 3 workspace



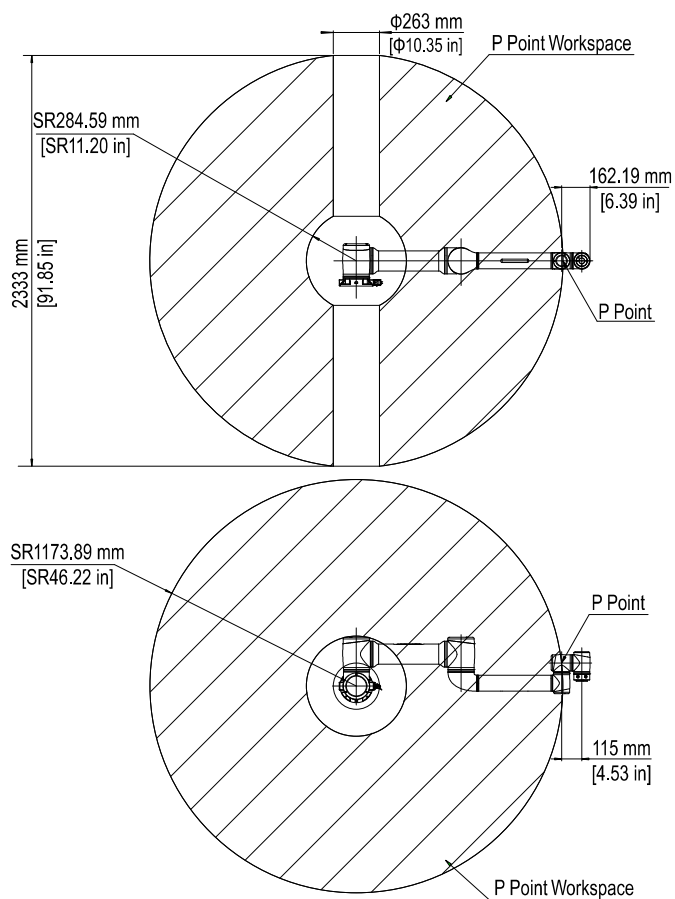
2. Zu 5 workspace



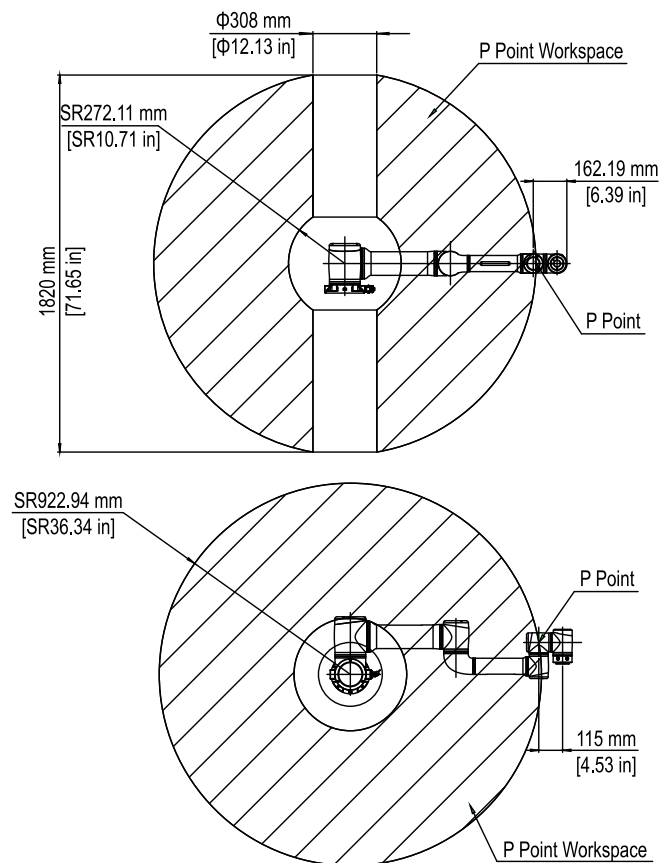
3. Zu 7 workspace



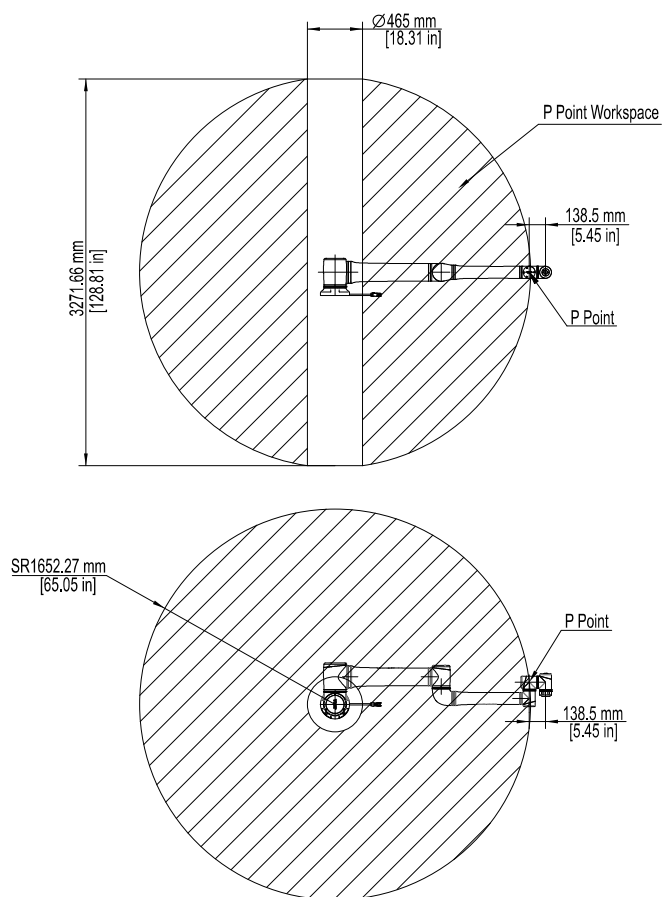
4. Zu 12 workspace



5. Zu 18 workspace

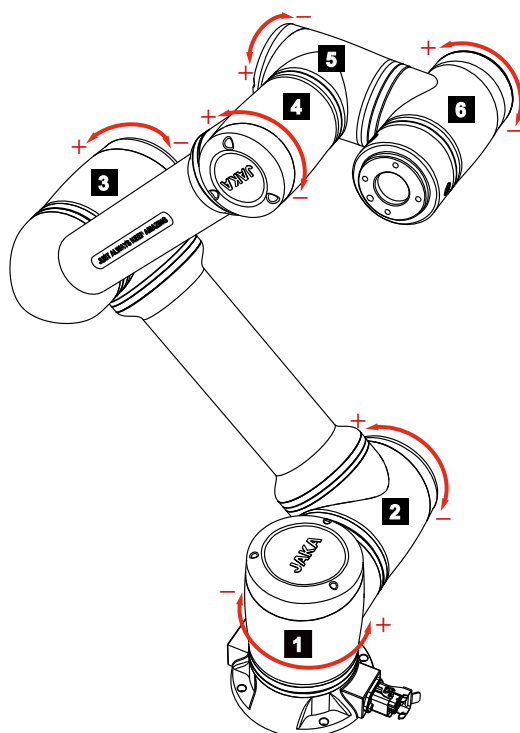


6. Zu 20 workspace



9.4 Robot Rotation Direction

See [7.1 Robot Technical Specification](#) for robot rotation range. The rotation direction is as follows:



9.5 Robot Singularity

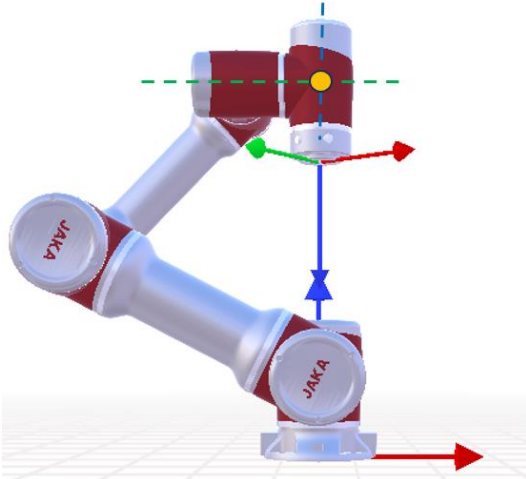
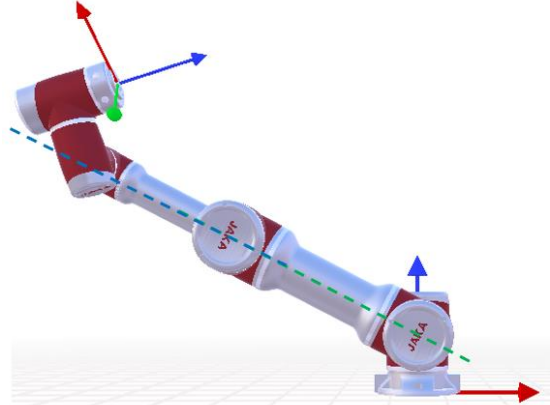
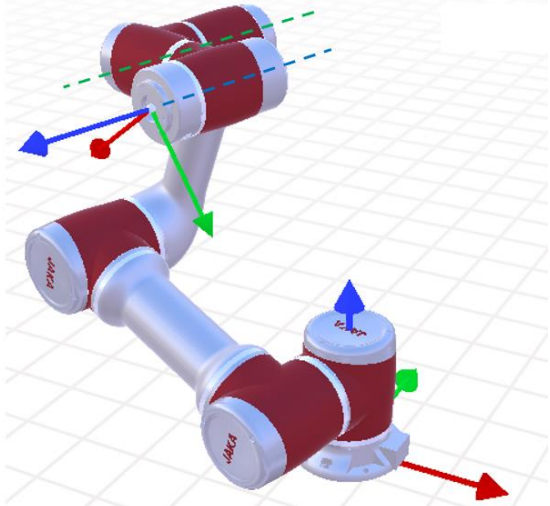
When a robot is at a singularity, the following effects occur:

1. At singularities, robots cannot move in one or more directions.
2. Near the singularity, the robot cannot find a suitable set of joint angles for the TCP to move to the desired position.
3. Near the singularity, the robot joint should move at high speed to achieve the desired TCP speed.
4. Intense movements near singularities will result in accidents and shorten the lifespan of robot joints.

Singularities are positions described in Cartesian space that have no impact on MoveJ. When the robot is at a singularity, replace the Cartesian movement by MoveJ if the motion can be achieved by MoveJ. If there is singularity in the middle of the robot's motion path, you can change the robot's trajectory to bypass the singularity. You can also change the robot's mounting position or the size of the end effector to change the value of Cartesian points in the robot's joint space.

The JAKA Zu series robots have three types of singularities: shoulder singularities, elbow singularities and wrist singularities. Descriptions and avoidance methods of the singularity are in the table below.

Name	Description	Example
Shoulder singularity	When the axes intersection of the joint 5 and joint 6 lies on the plane of axes of the joint 1 and joint 2, the robot is at shoulder singularity.	

Name	Description	Example
Ways to avoid shoulder singularity	<p>Ensure that robot TCP is not directly above the robot base. TCP cannot reach the positions directly above the robot and shoulder singularities during approaching this position are the result.</p> <p>Do not use MoveL when the joint 1 difference between two points is around 180°. When the difference is about 180°, the robot reaches shoulder singularity. You can use MoveJ to avoid singularity or set an intermediate transition point outside the shoulder singularity range.</p>	
Elbow singularity	When the joints 2, 3 and 4 are coplanar or when the joint 3 is 0° , the robot is at elbow singularity.	
Ways to avoid elbow singularity	When the robot is at elbow singularity, it indicates that the target position is close to the limits of the working range of the robot. At this point, it is necessary to adjust the robot mounting position or extend the length of the end effector.	
Wrist singularity	When the joint 4 and joint 6 are collinear or when the joint 5 is 0° , the robot is at wrist singularity.	
Ways to avoid wrist singularity	The wrist singularity typically occurs in movements with orientation changes. Therefore, in cases of considerable orientation change, it is advisable to prioritize MoveJ and do not use Cartesian motions such as MoveL or MoveC.	

9.6 Robot Mounting

9.6.1 Safety Instructions



WARNING

1. Ensure that the robot is installed correctly and safely.
2. The installation surface must be vibrant proof with enough loading capacity.



WARNING

1. Ensure that the end effector is installed correctly and safely.
2. Ensure the tool's safety to prevent any accidental falling of parts that could pose a danger.



WARNING

1. Ensure that the control cabinet and cables are not exposed to liquids. A damp control cabinet can pose a risk of electric shock or even death to personnel.
2. The control cabinet must not be exposed in an environment with dust or humidity levels exceeding IP44. Pay close attention to environments with conductive dust.

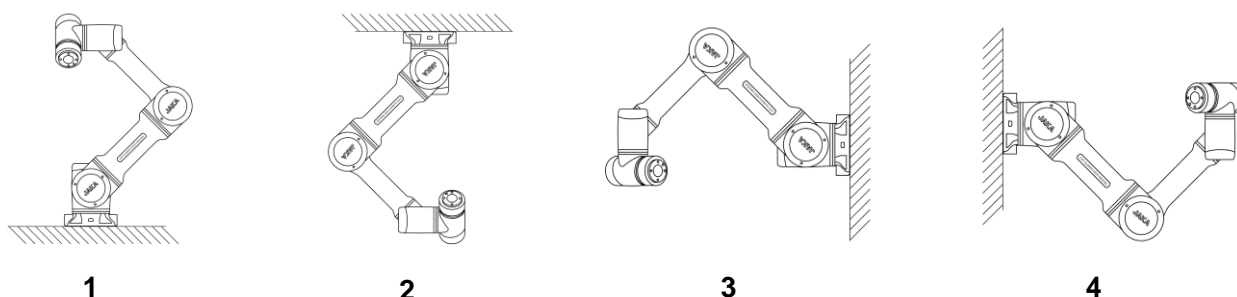


WARNING

If the robot is submerged in water for an extended period, it may be damaged. Robots should not be installed in water or a humid environment.

9.6.2 Robot Mounting

The robot can be mounted at any position and supports mounting in any direction including inverted, floor, and wall mounting. Several typical mounting methods are shown in figure below:



1. Floor mounting 2. Inverted mounting 3-4. Wall mounting

The mounting requirements are as follows:

Use screws (see the table below for details) to mount the robot through four holes (see table below) on the robot base. If you need to accurately adjust the position of the robot, you can reserve 2 nail holes (see table below) on the installation plane and locate it with nails. You can also buy a standard foundation as an accessory. Install the robot on a steady, vibrant proof surface, which should be able to support at least 10 times the maximum torque (see table below) of the robot base and at least 5 times the weight of the robot. The recommended thickness of the robot's installation plane shall be no less than 20 mm (0.787 in), and the surface shall be made of steel. In addition, try to avoid directly mounting the robot on an empty box, which can easily cause resonance and make abnormal noise. If the robot is installed on a linear actuator or mobile platform, the acceleration of the mounting base should be very low, because high acceleration will cause the robot to give a false alarm of collision and stop.



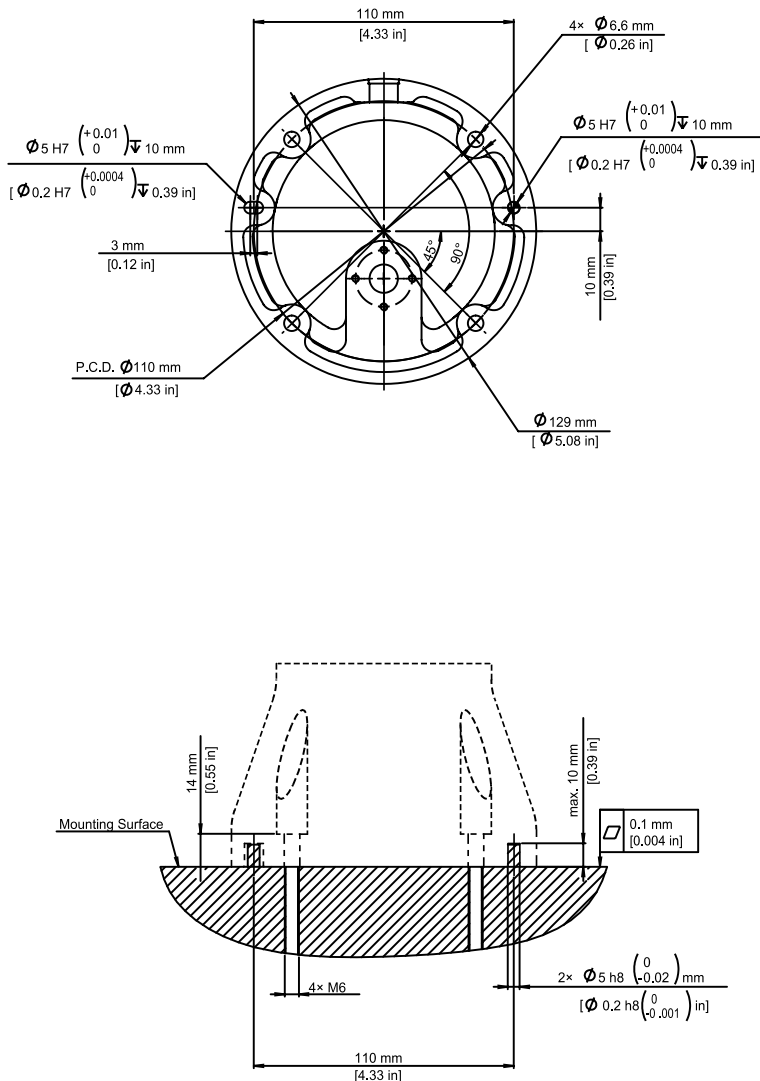
WARNING

Do not connect the power during the robot mounting process.

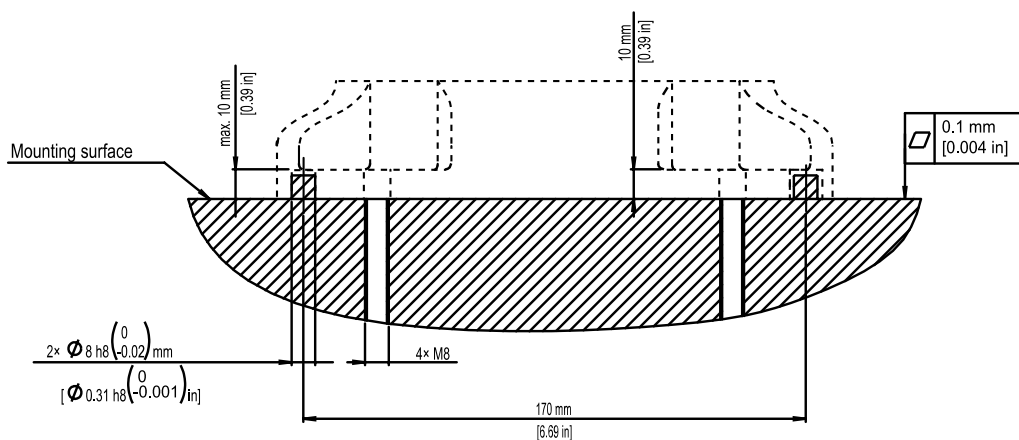
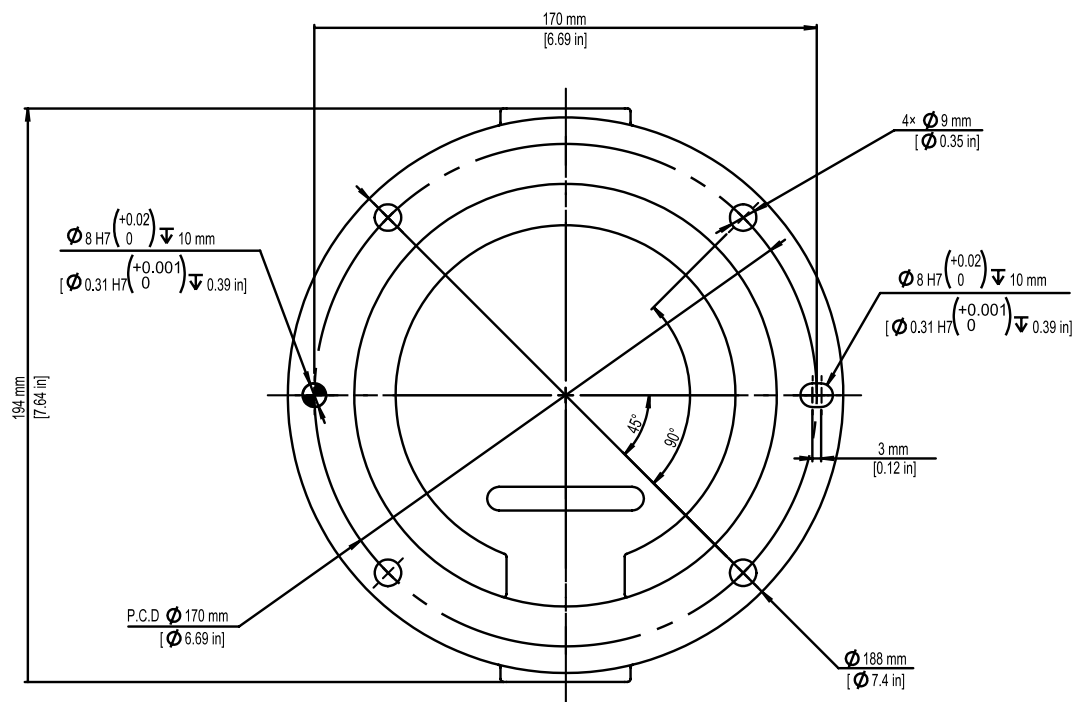
Model	Screw Size	Screw Quantity	Recommended Tightening Torque	Mounting Torque	Surface	Through Hole	Pin Hole
Zu 3	M6	4 pcs	15 Nm 132.761 lbf·in	900 Nm 7965.666 lbf·in		Φ6.6 mm Φ0.260 in	Φ5 mm Φ0.197 in
Zu 5	M8		40 Nm 354.030 lbf·in	3000 Nm 26552.22 lbf·in		Φ9 mm Φ0.354 in	Φ8 mm Φ0.315 in
Zu 7				3800 Nm 33632.812 lbf·in			
Zu 12							
Zu 18							
Zu 20	M12		130 Nm 1150.596 lbf·in	10400 Nm 92047.696 lbf·in		Φ13 mm Φ0.512 in	Φ12 mm Φ0.472 in

The mounting drawing of the robot is shown in figure below.

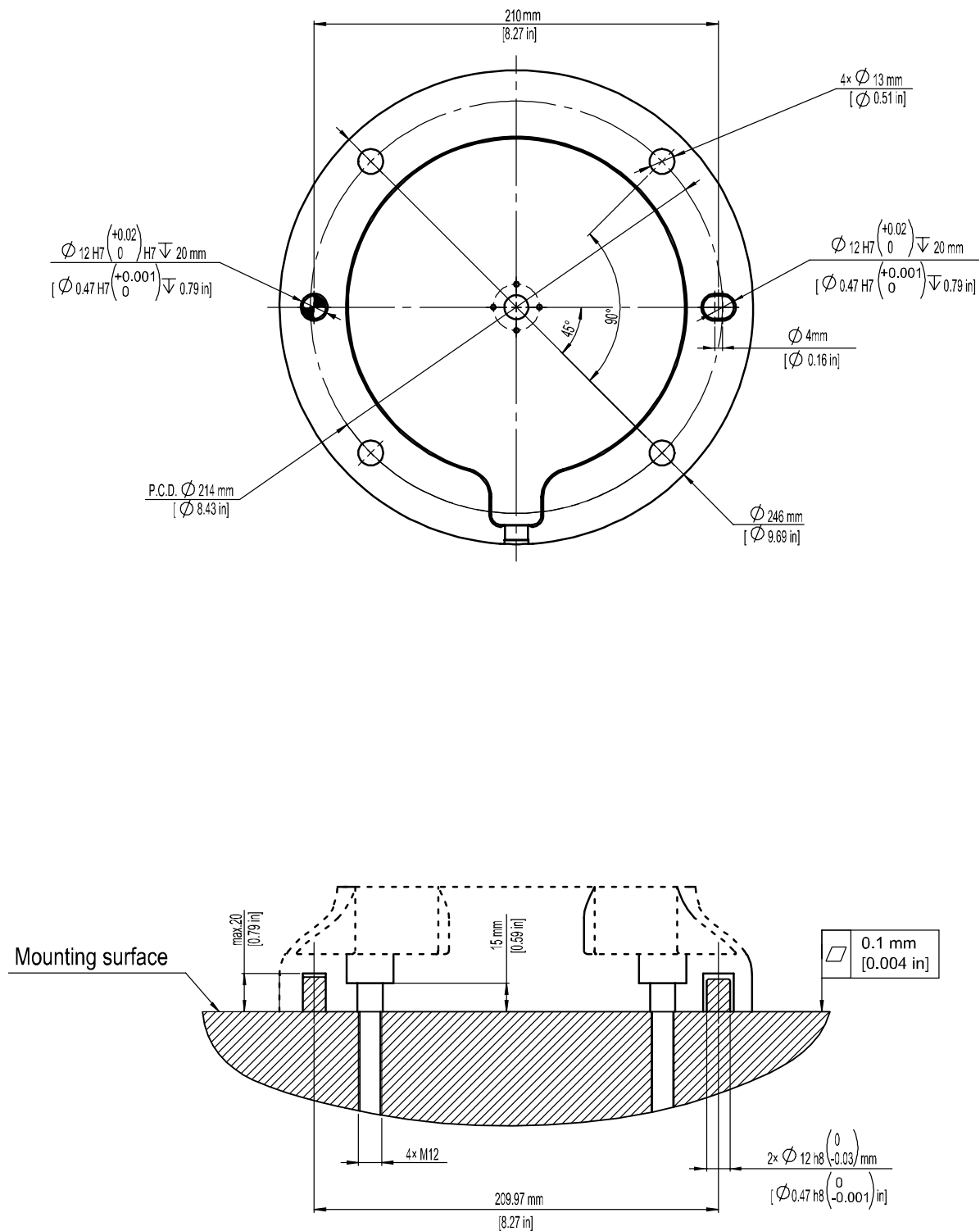
1. Zu 3 base drawing



3. Zu 12, Zu 18 base drawing



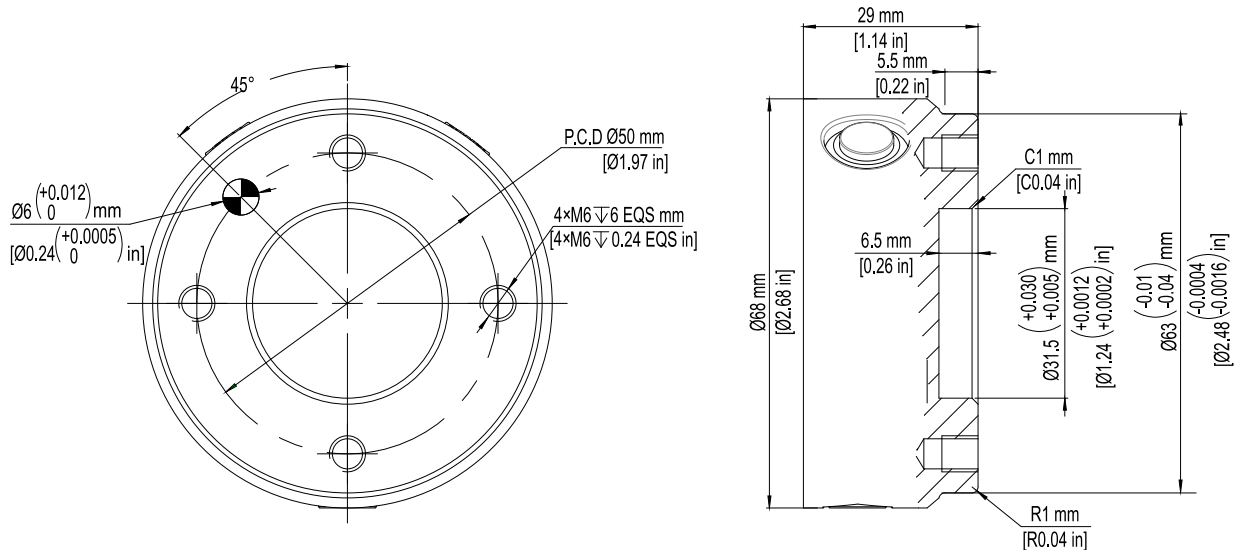
4. Zu 20 base drawing



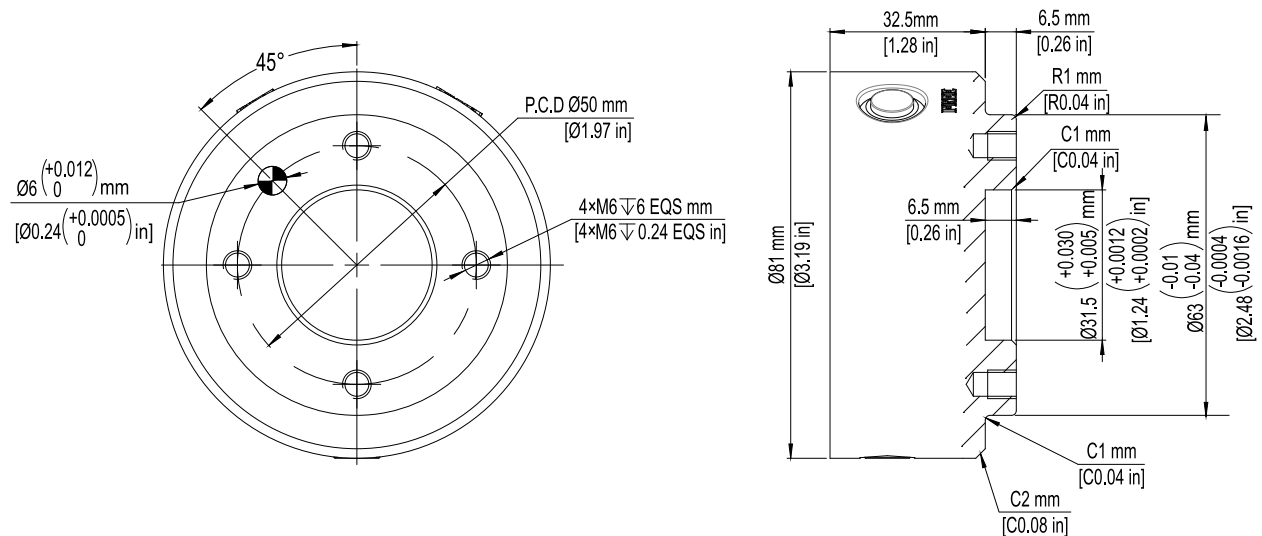
9.6.3 End Effector Mounting

The Zu series robots tool flange have four M6 screw holes, which can be used to connect the end-effector to the robot. When you mount screws into these screw holes, the screws need to be fastened with a torque of 13 Nm (115.05 lbf·in). If you need to adjust the position of the end effector accurately, you can drill $\varnothing 6$ mm (0.236 in) nail holes on the flange and secure it with nails. According to ISO9409-1: 2004, the location pin hole center shall be aligned with the mechanical interface coordinate system (ISO 9787:2013)+Xm, and our product is offset 45° clockwise on this basis.

1. Zu 3 flange drawing



2. Zu 5, Zu 7 flange drawing



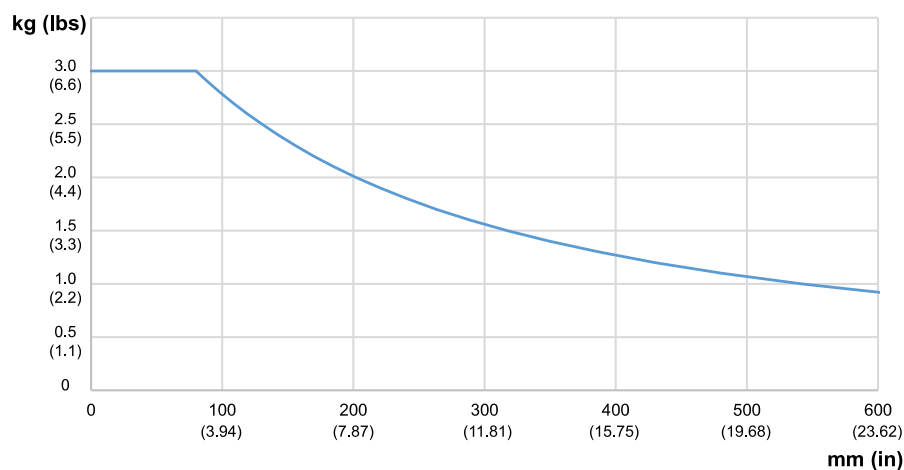
9.6.4 Maximum Payload

The maximum payload of the robot is related to the offset of the gravity center, and degree of the offset is related to the distance between the center of robot end flange and the payload centroid. Figures below show the relation between the payload and the offset of the gravity center:

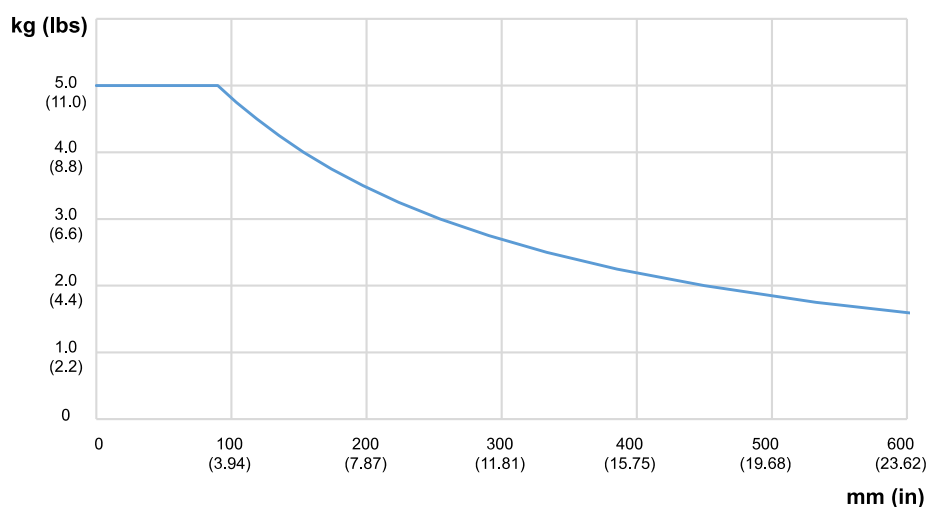
X: Center of gravity offset

Y: Payload

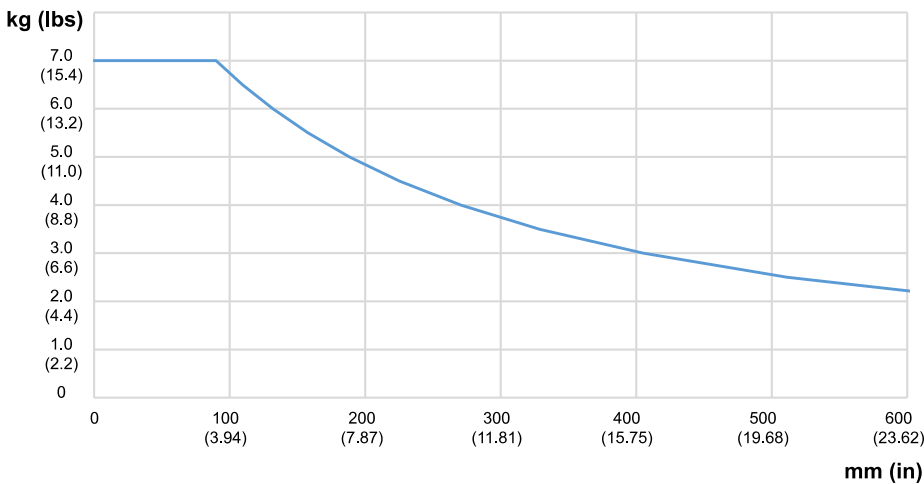
1. Zu 3 payload offset



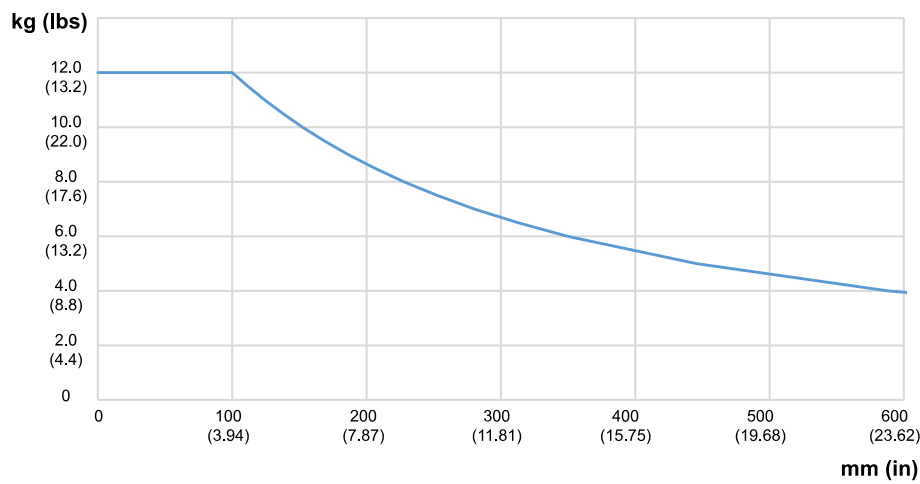
2. Zu 5 payload offset



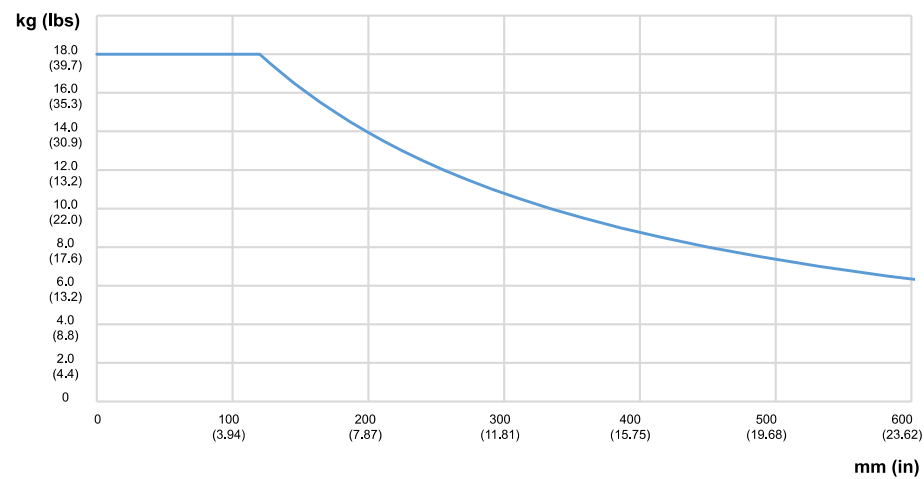
3. Zu 7 payload offset



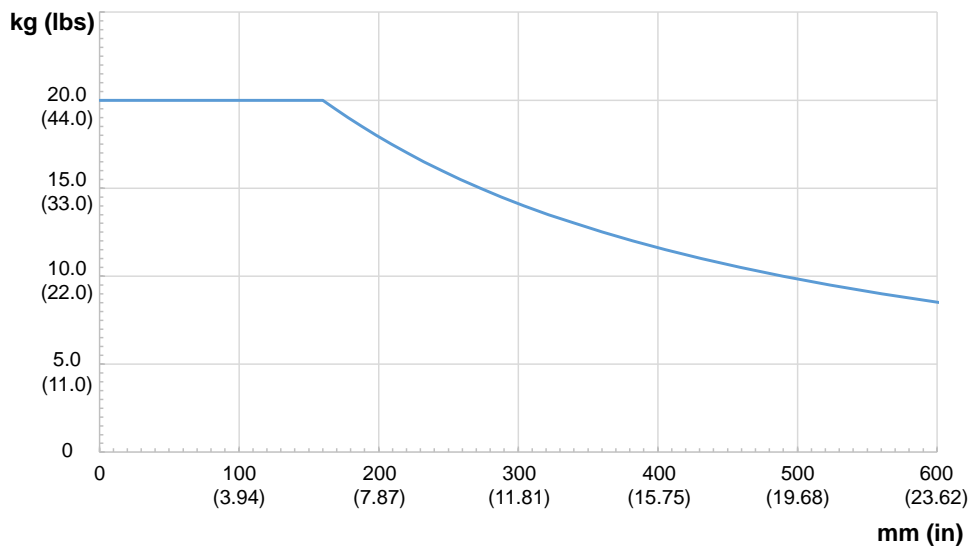
4. Zu 12 payload offset



5. Zu 18 payload offset



6. Zu 20 payload offset



NOTE

Offset distance is the center of gravity distance from the center of the flange.

10 Control Cabinet

10.1 Introduction

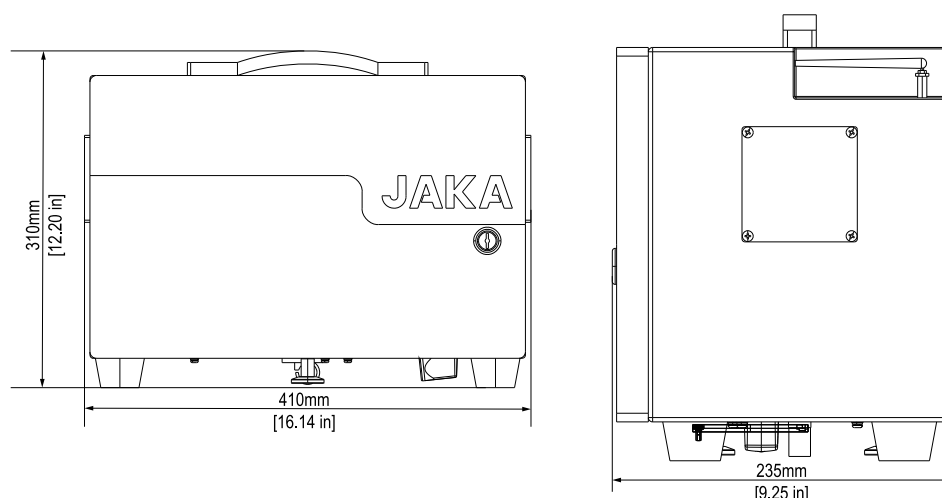
This chapter describes all the electrical interfaces of the control cabinet.

These interfaces contain:

- Front panel interface of the control cabinet
- Bottom interface of the control cabinet

10.2 Control Cabinet Size

The size of control cabinet is as follows.



10.3 Electrical Warnings and Precautions

When designing and installing robot applications, you must obey the following warnings and precautions. The implementation of maintenance must also comply with these warnings and precautions.



WARNING

1. Do not connect safety signals to non-safe PLCs with inappropriate safety levels. If you do not obey the warning, severe injuries or even death may be caused by the dysfunction of a safety stop function. Separate the safety I/O from the general I/O.
2. All safety-related signals are constructed redundancy (two independent channels). Keeping two channels separate can ensure that the safety function will not be lost when a single failure occurs.
3. For the introduction of the I/O function in the control cabinet, refer to [10.5 Front Panel Interfaces](#).



WARNING: ELECTRICITY

1. Please ensure that all water-sensitive devices remain dry. If water gets into the product, cut off the power in time and contact your supplier.
2. Use original cables to connect the robot. Do not use robots in applications that need to bend cables. Contact your supplier if longer or flexible cables are needed.
3. For protective earth (PE), use the screw connectors in the control cabinet marking the earth symbol. The grounding conductor shall at least have the current rating of the highest current in the robot system.
4. When connecting cables on the I/O of the control cabinet, open the cabinet door, remove the

metal board of the cable hole, and ensure that the I/O cable avoids rubbing with the edge of the cable hole.



WARNING

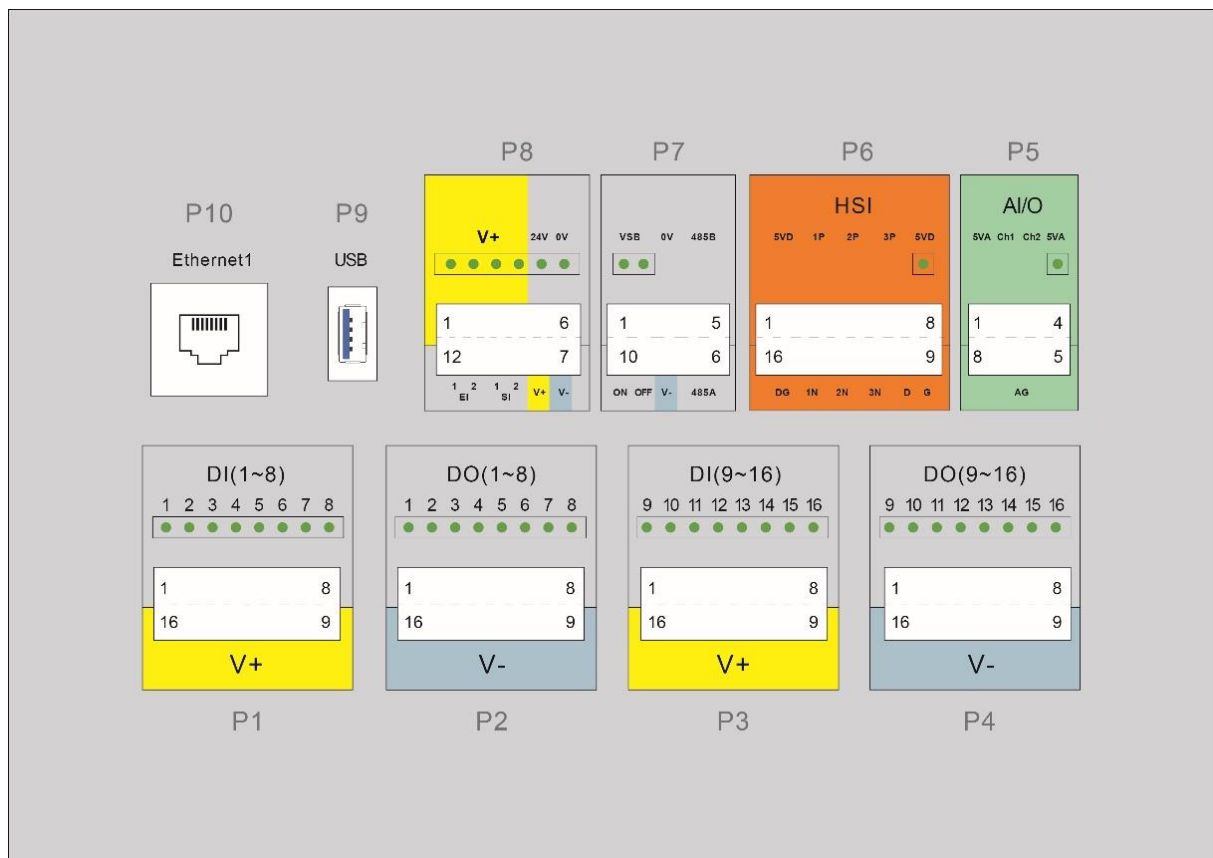
1. The robot has been tested according to international IEC standards for Electromagnetic Compatibility (EMC). Interference signals beyond the standard will cause abnormal behaviors of the robot. Very high signal levels or excessive exposure can damage the robot permanently. JAKA will not be held responsible for any damages caused by EMC problems.
2. The length of the I/O cable to connect the control cabinet and other machinery and factory equipment must not be longer than 30 meters unless the result of the extension test shows the feasibility. Use shielding cables if necessary.

10.4 IPC Configuration

CPU	Intel(R) Celeron(R) CPU J1900 1.99 GHz
RAM	DDR3L 2 GB
Hard drive	64 GB
Interface	1x USB 3.01, 3x USB 2.0, 2x Ethernet, 1x VGA, 1x HDMI

10.5 Front Panel Interfaces

The front panel interface of the control cabinet is placed at the first layer after the control cabinet door is opened, including 16 digital inputs (P1 and P3), 16 digital outputs (P2 and P4), two configurable analog interfaces (P5), a set of high-speed interfaces (P6), remote switching and RS485 interfaces (P7), safety function interfaces (P8), USB3.0 interface (P9) and Ethernet interface (P10), and the USB interface (P9) is retained for internal use. If needed, contact the technical support personnel of JAKA.



10.5.1 Definition of Front Panel Interfaces

No.	Name	PIN	Terminal	Function
P1	DI (1-8) 8 digital inputs	1	DI1	Digital input 1, PNP type, active high
		2	DI2	Digital input 2, PNP type, active high
		3	DI3	Digital input 3, PNP type, active high
		4	DI4	Digital input 4, PNP type, active high
		5	DI5	Digital input 5, PNP type, active high
		6	DI6	Digital input 6, PNP type, active high
		7	DI7	Digital input 7, PNP type, active high
		8	DI8	Digital input 8, PNP type, active high
		9-16	V+	Isolated power supply, input, and positive electrode, and short jumper is connected to the internal 24V by default.
P2	DO (1-8) 8 digital outputs	1	DO1	Digital output 1, PNP type, ≤1A continuous current output ability
		2	DO2	Digital output 2, PNP type, ≤1A continuous current output ability
		3	DO3	Digital output 3, PNP type, ≤1A continuous current output ability
		4	DO4	Digital output 4, PNP type, ≤1A continuous current output ability
		5	DO5	Digital output 5, PNP type, ≤1A continuous current output ability
		6	DO6	Digital output 6, PNP type, ≤1A continuous current output ability
		7	DO7	Digital output 7, PNP type, ≤1A continuous current output ability
		8	DO8	Digital output 8, PNP type, ≤1A continuous current output ability
		9-16	V-	Isolated power supply, input, and negative electrode, and short jumper connected to the internal GND by default.
P3	DI (9-16) 8 digital inputs	1	DI9	Digital input 9, PNP type, active high
		2	DI10	Digital input 10, PNP type, active high
		3	DI11	Digital input 11, PNP type, active high
		4	DI12	Digital input 12, PNP type, active high
		5	DI13	Digital input 13, PNP type, active high
		6	DI14	Digital input 14, PNP type, active high
		7	DI15	Digital input 15, PNP type, active high
		8	DI16	Digital input 16, PNP type, active high
		9-16	V+	Isolated power supply, input, and positive electrode, and short jumper is connected to the internal 24V by default.
P4	DO (9-16) 8 digital outputs	1	DO9	Digital output 9, PNP type, ≤1A continuous current output ability
		2	DO10	Digital output 10, PNP type, ≤1A continuous current output ability
		3	DO11	Digital output 11, PNP type, ≤1A continuous current output ability
		4	DO12	Digital output 12, PNP type, ≤1A continuous current output ability
		5	DO13	Digital output 13, PNP type, ≤1A continuous current output ability
		6	DO14	Digital output 14, PNP type, ≤1A continuous current output

No.	Name	PIN	Terminal	Function
				ability
		7	DO15	Digital output 15, PNP type, ≤1A continuous current output ability
		8	DO16	Digital output 16, PNP type, ≤1A continuous current output ability
		9-16	V-	Isolated power supply, input, and negative electrode, and short jumper connected to the internal GND by default.
P5	AI/O	1, 4	5VA	Analog power 5V output, 100mA (max)
		2	Ch1	Analog input/output channel 1, configurable functions
		3	Ch2	Analog input/output channel 2, configurable functions
		5-8	AG	Analog power AGND
P6	HSI	1, 8	5VD	Digital power 5V output, 100mA (max)
		2, 3	1P	Differential signal 1 input positive terminal/encoder A+
		14, 15	1N	Differential signal 1 input negative terminal/encoder A-
		4, 5	2P	Differential signal 2 input positive terminal/encoder B+
		12, 13	2N	Differential signal 2 input negative terminal/encoder B-
		6, 7	3P	Differential signal 3 input positive terminal/encoder Z+
		10, 11	3N	Differential signal 3 input negative terminal/encoder Z-
		9, 16	DG	Digital power GND, isolated from the internal GND
P7	-	1, 2	VSB	Internal power 5V, 100mA (max), available for remote on/off
		3	0V	Internal GND (internal 24V, 12V, 5V reference GND)
		4, 5	485B	RS485 Communication 485B
		6, 7	485A	RS485 Communication 485A
		8	V-	Isolated power supply, input, and negative electrode, and short jumper connected to the internal GND by default.
		9	OFF	Remote Off signal input, active high (24V)
		10	ON	Remote On signal input, active high (24V)
P8	-	1-4, 8	V+	Isolated power supply, input, and positive electrode, and short jumper is connected to the internal 24V by default.
		5	24V	Internal 24V output positive electrode, 1.5A (MAX)
		6	0V	Internal 24V output negative electrode
		7	V-	Isolated power supply, input, and negative electrode, and short jumper connected to the internal GND by default.
		9	SI2	Protective stop function input 2; the default short jumper is connected to V+
		10	SI1	Protective stop function input 1; the default short jumper is connected to V+
		11	EI2	Emergency stop function input 2; the default short jumper is connected to V+
		12	EI1	Emergency stop function input 1; the default short jumper is connected to V+
P9	-	-	USB	Internal debugging interface
P10	-	-	EtherNet1	Three-position enabling device network port

10.5.2 Wire Specifications

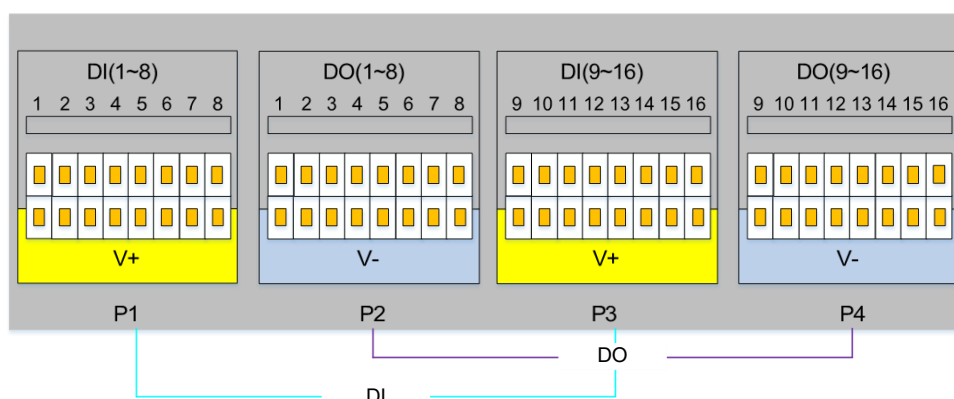
When wiring on the front panel of the control cabinet, choose wires that meets the following specifications.

Interface	Terminal Model	Recommended PIN Connector	Wire
P1_16PIN	DEGSON: 15EDGKNHB-3.5-	China: E0512	UL1007#20AWG

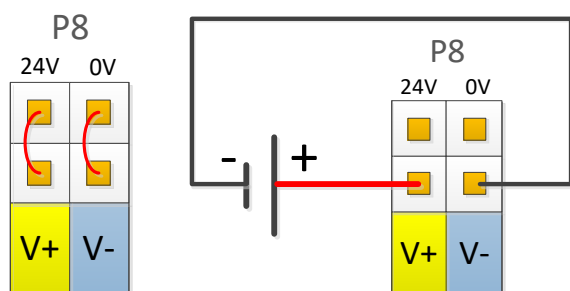
Interface	Terminal Model	Recommended PIN Connector	Wire
P2_16PIN	16P-14-10A (H)	International: PHOENIX AI 1-12 RD-Ferrule	Length < 30 m (1181 in)
P3_16PIN			
P4_16PIN			
P5_8PIN	DEGSON: 15EDGKNHB-3.5-8P-14-10A (H)		
P6_16PIN	DEGSON: 15EDGKNHB-3.5-16P-14-10A (H)		
P7_10PIN	DEGSON: 15EDGKNHB-3.5-10P-14-10A (H)		
P8_12PIN	DEGSON: 15EDGKNHB-3.5-12P-14-10A (H)		

10.5.3 Digital I/O Interfaces

The following are the electrical specifications for the 24V digital I/O in the control cabinet. The design of the digital I/O follows IEC 61131-2. The control cabinet supports the 16 digital inputs and outputs.



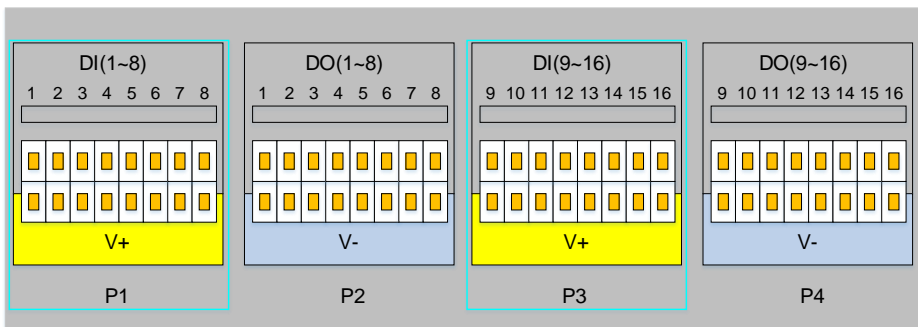
Digital I/O can be powered by the 24V power supply in the control cabinet and supports 1.5A peak output (the output is stopped when overloading, the recommended output is less than or equal to 1A). If the user needs a larger power output, it can power the V+ power supply with external "power", which supports a maximum current of 1.2A per channel. When using the external 24V power supply, you need to unplug the jumpers of 0V and 24V on the P8 and the jumper of the 0V on the P7. 24V is the internal power supply +, and 0V is the internal GND. V+ is the positive electrode of all digital I/O interfaces, and V- is the negative one. The default configuration is the connection to the internal power supply.



Connect internal power

Connect external power

10.5.3.1 Digital Input (DI)



The control cabinet is equipped with 16 PNP type digital inputs (active high) (DI1-DI16), which support isolated signal input. The level signal meets the standard of IEC61131-2 (Type1/2/3) and is used to detect the input signal voltage level state.

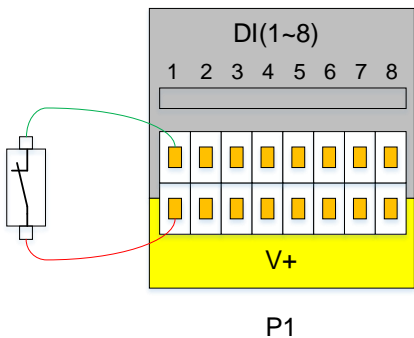
V+ Voltage	Low Level	High Level
24V	0-11V	15-30V

V+ supports external 10-35V power input, and the internal 24V power supply is connected by default. When connecting external power, the jumpers should be unplugged.

Users can also short it to V+ through buttons or switches.

Wiring for different types of input signals is different. The specific connection method is as follows (take DI1 as an example, same as DI2-DI16):

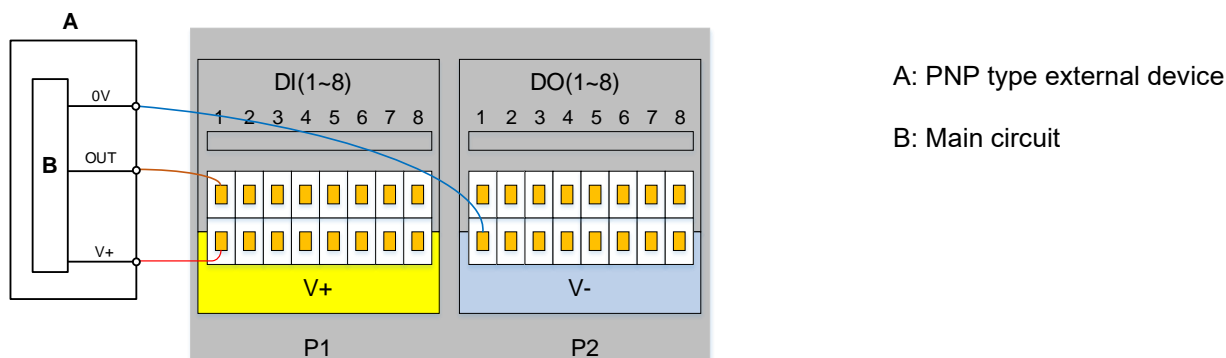
1. Dry contact signal as input



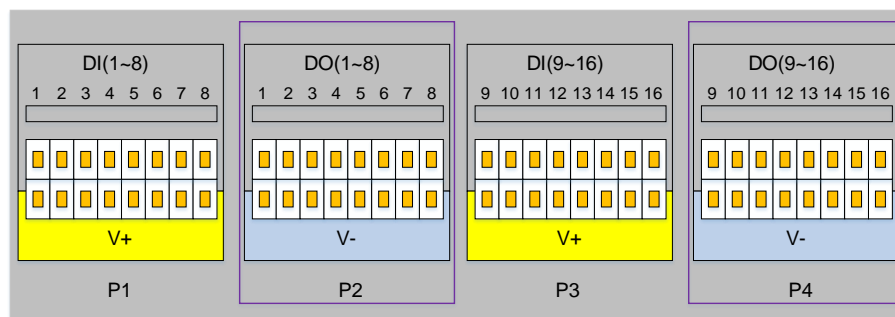
When the dry contact is input, one wire is connected to V+, and the other is connected to the DI specified channel. When the circuit is connected (as shown in the figure, the switch or relay is turned on), the corresponding indicator on the panel is on. The corresponding indicator will light on in the JAKA App at the same time.

2. PNP signal as input

The PNP input wiring method is shown in figure below (take DI1 as an example, same as DI2-DI16), with the power wire V+ connected to the terminal V+, the OUT-signal wire to the specified DI channel, and the 0V wire to the panel V-. When a signal is triggered, the corresponding indicator light on the panel is on. The corresponding indicator will light on in the JAKA App at the same time.



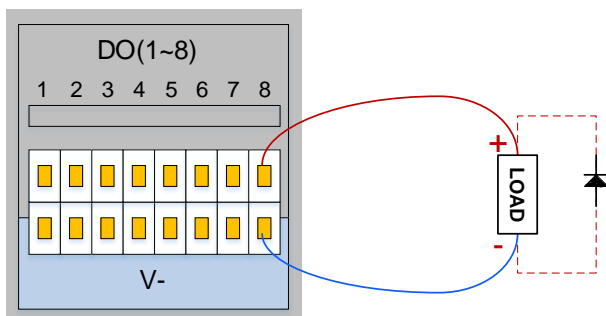
10.5.3.2 Digital Output (DO)



The control cabinet is equipped with 16 digital PNP signal outputs (DO1-DO16), which support isolated signal output.

High-side output is used internally, and its maximum continuous current can reach 1A. But when the V+ shorts by default to the internal 24V power supply, the 24V power current is limited to 1.5A.

The wiring of digital output wiring is shown in the figure below (take DO8 as an example, same as others):



Digital outputs can be controlled through the DO function in the App. The current of one DO is 1A, the total current cannot exceed 1.5A.



NOTICE

It is recommended to use protective diodes (such as the relay, electromagnet, and DC motor) for inductive load.

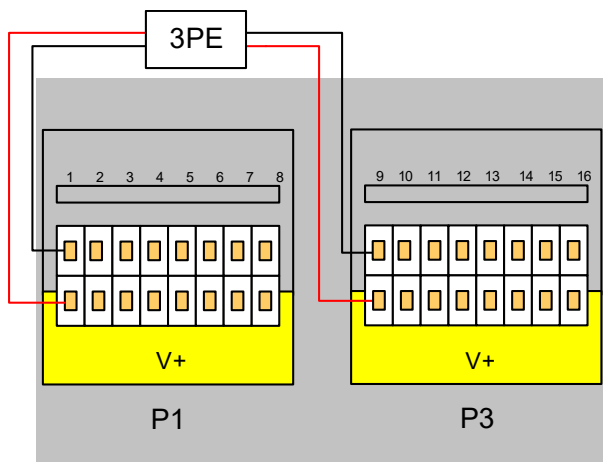
10.5.4 Safety I/O Interfaces

To configure the safety functions of the robot, the digital I/O interfaces P1 to P4 on the control cabinet can be set up as dedicated safety I/O. The electrical specifications refer to [10.5.3 Digital I/O Interfaces](#).

Safety I/O is designed with dual redundancy, where a failure in one channel will not compromise the safety functions. Therefore, when wiring, both paired safety I/Os should be connected simultaneously. For example, when connecting DI1, DI9 must be connected simultaneously. The pairing relationship for safety I/O is as follows:

DI	DO
DI1& DI9	DO1& DO9
DI2& DI10	DO2& DO10
DI3& DI11	DO3& DO11
DI4& DI12	DO4& DO12
DI5& DI13	DO5& DO13
DI6& DI14	DO6& DO14
DI7& DI15	DO7& DO15
DI8& DI16	DO8& DO16

For example, when you are configuring the three-position enabling (3PE) function (see JAKA App Software User Manual), the wiring is as follows (take DI1&DI9 as an example, same as others):



The wiring for other safety functions is the same as that for the three-position enabling function.

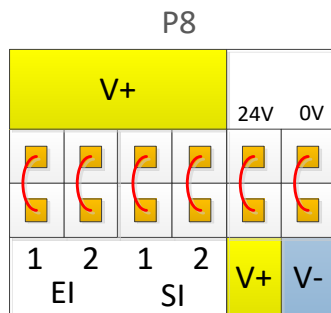
10.5.5 Safety Interfaces

The control cabinet has two types of safety interfaces, and users can configure emergency stop and protective stop functions by them. EI and SI stand for emergency stop and protective stop respectively, both of which are redundant. When either signal is active, the corresponding safety function can be enabled. Emergency stop and safety stop are both designed with dual-channel configurations. If you intend to use external safety devices, please select devices that support dual-channel design.

Users can access security doors, security light curtains, sensors, etc., according to actual safety requirements.

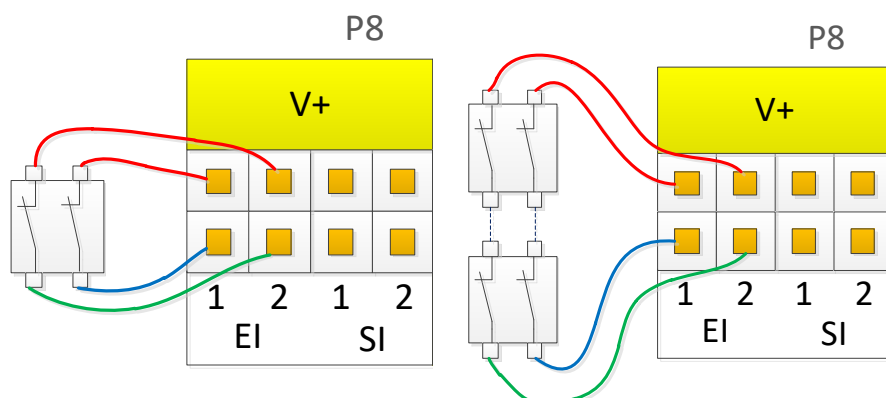
1. Default safety configuration

The robot can be operated without any additional safety equipment. The EI1-2 and SI1-2 is short connected to the V+, while the V+ shorts to 24V. The V- shorts to 0V, indicating that the 24V power supply is internally provided by the control cabinet.



2. Emergency stop switch

In most applications, to facilitate the safety-related operations, one or more additional emergency stops or a protective stop switch is needed. Wiring is shown in figure below. The V+ and V- can also be connected to the external 24V power supply.



It is possible to operate the robot without the control stick. In this case, you need to connect an additional emergency stop device. You can use the EI interfaces on the front panel of the control cabinet to connect the emergency stop switch to ensure safety.

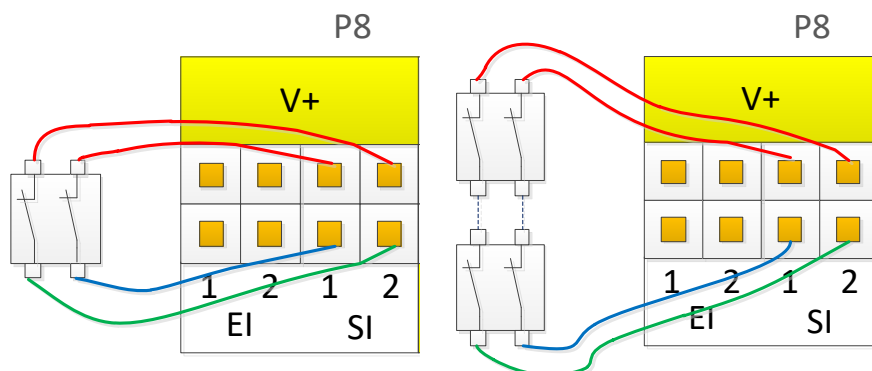


WARNING

1. If the control stick is detached or disconnected from the robot, the emergency stop button is no longer active. You must remove the control stick from the vicinity of the robot.

3. Protective stop switch

The protective stop function supports automatic recovery. The door switch is an application case of the protective stop device. When the door is open, the robot stops.

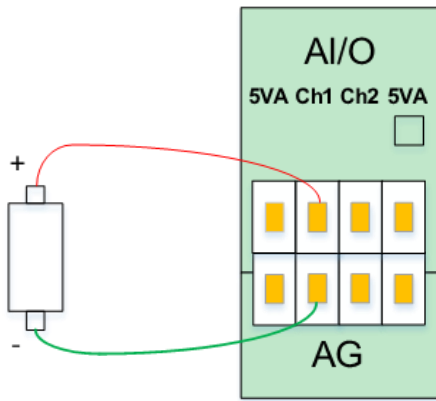


10.5.6 Analog I/O Interfaces

With the 2 analog input and output interfaces (Ch1, Ch2), the mode can be configured:

1. Current signal input: 4-20mA;
2. Current signal output: 0-20mA;
3. Voltage signal input/output: 0-10V.

Wiring method (take Ch1 as an example, same as Ch2):



The analog I/O interfaces of JAKA's control cabinet can be configured to be in different working modes through the JAKA App (0-10V input by default). For high accuracy, it is recommended to obey the following instructions:

- Use the AG terminal closest to this analog I/O.
- Use the same grounding for the device and the control cabinet. The analog I/O and the control cabinet do not perform potential isolation.
- Use shielding cables or twisted pairs. Connect shielding layer to the “AG” terminal on the “power” terminal.
- When using the equipment working in the current mode. The sensitivity of the current signal is lower than the interface.

10.5.7 High Speed Interfaces

P6 high speed interface (HSI) can be connected to an external encoder for conveyor belt and other applications. For detailed use, contact JAKA's technicians to get support.

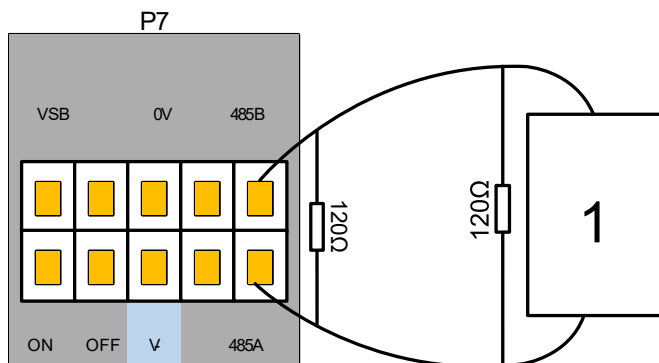
10.5.8 RS485 Interfaces

RS485 interfaces can realize communication between devices, which are the 4, 5, 6, and 7 interfaces of P7. Among them, 4 and 5 are RS485B, 6 and 7 are RS485A. Thus, the 4 and 5 interfaces connect to RS485B interface of external devices, and 6 and 7 interfaces connect to RS485A interface of external devices. The following figure takes one of the wiring methods as an example.

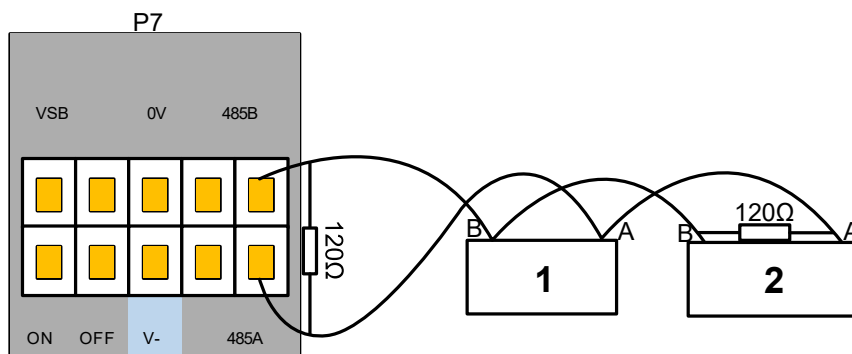


NOTE

It is recommended to connect the 120 Ω resistor to the ends when wiring. YAGEO MF0207FTE52-120R type resistor is recommended.



1, 2: External devices



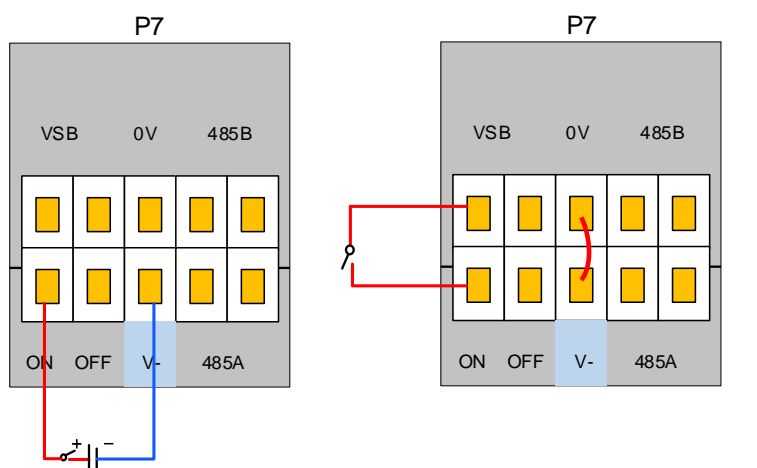
10.5.9 Remote ON/OFF Interfaces

Using remote on/off interfaces, you can power on/off the control cabinet when you do not use the JAKA App or the control stick. It is commonly used for controlling the control cabinet by connecting it to the PLC.

It is effective when it receives 24V power supply (the reference GND is V-). The remote on/off interface has the same function as the power button of control stick.

Users can short the on/off interface to 12V power or VSB interface.

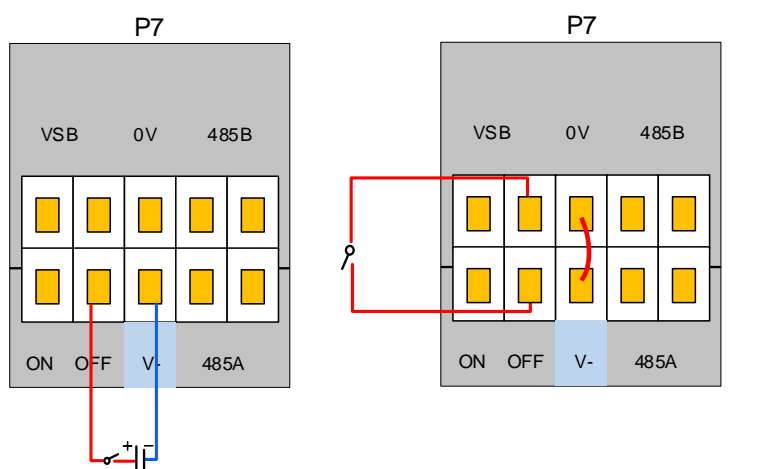
1. The wiring of remote on control is as follows:



Connect external power

Connect internal power

2. The wiring of remote off control is as follows:



Connect external power

Connect internal power

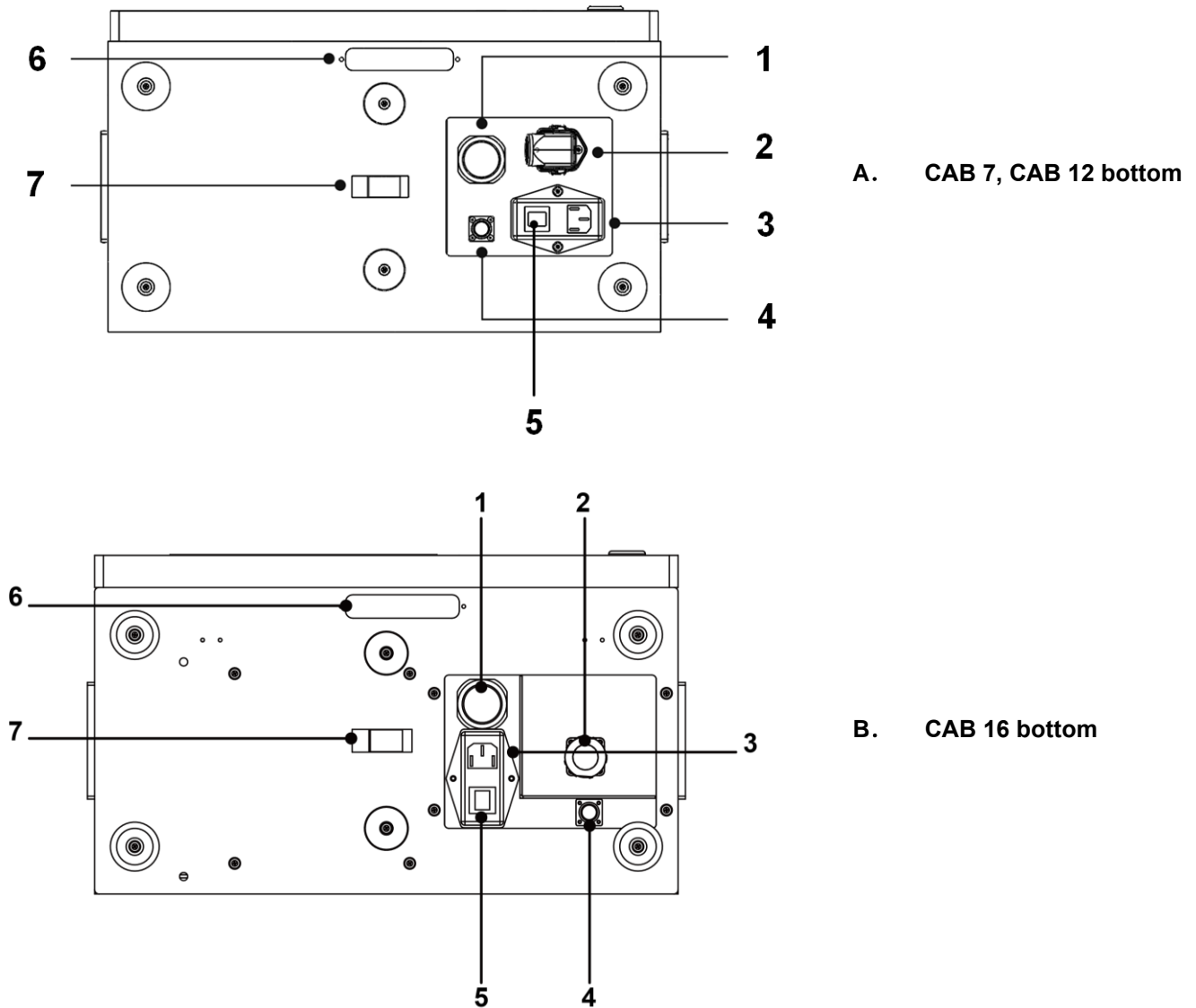


NOTICE

Remote on and off interfaces cannot be short at the same time.

10.6 Bottom Panel Interfaces

The bottom panel of the control cabinet includes following items:

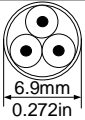


- 1. Ethernet interface:** Gigabit network port, configured for dynamic IP usage.
- 2. Robot connection cable interface:** Connection interface between the robot arm and the control cabinet.
- 3. Power cord interface:** Connection interface to the external AC power outlet.
- 4. Control stick cable interface:** Connection interface to the control stick.
- 5. Rocker switch:** Power supply control switch.
- 6. Cable routing passthrough slot:** Dedicated channel to guide external device cables.
- 7. Cable fixing ring:** Used to keep cables in place.

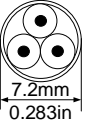
10.6.1 Power Adaptation

Different countries and regions have different standards, and JAKA supports corresponding plugs when products are exported overseas.

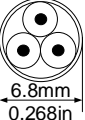
1. China Standard Plug (National Standard): 3 I-shaped flat-pin plug

Cable Standard	Core Size	Length	Cable OD	Rated Value	Frequency	Cable Material	LN Insulation Level
RW	3×1.0 mm ² 3×0.002 in ²	3000±50 mm 118.11±1.97 in		10A 250V	50 Hz	PVC	2 kV 1 min 50 Hz

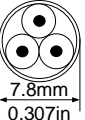
2. European Standard Plug (European Standard, German Standard): F/E universal plug

Cable Standard	Core Size	Length	Cable OD	Rated Value	Frequency	Cable Material	LN Insulation Level
H05W-F	3×1.0 mm ² 3×0.002 in ²	3000±50 mm 118.11±1.97 in		10A 250V	50 Hz	PVC	2 kV 1 min 50 Hz

3. British Standard Plug (British Standard): G-shaped plug

Cable Standard	Core Size	Length	Cable OD	Rated Value	Frequency	Cable Material	LN Insulation Level
H05W-F	3×1.0 mm ² 3×0.002 in ²	3000±50 mm 118.11±1.97 in		10A 250V	50 Hz	PVC	2 kV 1 min 50 Hz

4. American Standard Plug (American Standard): B-shaped standard plug

Cable Standard	Core Size	Length	Cable OD	Rated Value	Frequency	Cable Material	LN Insulation Level
SJT	3×1.0 mm ² 3×0.002 in ²	3000±50 mm 118.11±1.97 in		10A 250V	60 Hz	PVC	2 kV 1 min 50 Hz



NOTE

Robots exported to Japan are equipped with American standard plugs.

10.6.2 Power Connection

The control cabinet power cord is attached to the robot. One end of the cable is a 3-flat-pin plug inserted to the 3-pin socket on the bottom panel of the control cabinet, and the other end is a triangular plug, which is inserted to the corresponding mains socket as per the safety assessment regulations. The 3-flat-pin socket has switches and fuses. The switches can only be used when the control cabinet is powered down, which is used to completely disconnect the power from the control cabinet. The fuse equipped in the switch is set as 10A by default.

The power supply should be equipped with at least:

- Grounding
- Mains power fuse
- Residual current circuit breaker
- Power plug lock

Refer to IEC60204 Safety of Machinery - Electrical Equipment and UL508A Safety Standard for Industrial Control Panels. To prevent personnel injury or property loss caused by the unreasonable release of dangerous energy, it is recommended that the plugs of all equipment in the application of the robot are equipped with power plug locks to lock and tag them during maintenance.



WARNING

1. Ensure that the robot is grounded properly (electrical grounding).
2. Ensure that the input current of the power to the control cabinet is protected by the residual current device (RCD) and appropriate fuses.
3. After completing all the installation settings of the robot required by the service, all power supply units need to be locked and tagged. When the system is locked, other devices should not power any part of the robot.
4. Ensure that all the cables are connected correctly before the control cabinet is powered on. Use the original power cords correctly.
5. Ensure that the power plug locks are used for locking during maintenance.

11 Transportation

Please use the original packaging to transport the robot. If you want to move the robot later, please keep the original packaging.

When the robot is lifted, corresponding measures should be taken for positioning to avoid damage caused by accidental movement. Refer to [6 Lifting](#) for detailed steps.

When moving the robot from its packaging to the installation position, it should be supported by at least 2 persons until all screws at the robot base are securely fastened.



WARNING

1. Ensure that the back or other body parts of the operators are not overloaded when the equipment is lifted. Use appropriate lifting equipment. JAKA is not responsible for damage incurred during the transport of the equipment.
2. Please comply with the relevant lifting regulations in each region and country.
3. Ensure that installation instructions are strictly followed when the robot is installed.



NOTICE

If the robot is transported without using its original packaging, all warranties will be voided.

12 Maintenance

All safety instructions in this manual must be strictly followed for maintenance work. For more detailed maintenance instructions, please refer to the JAKA Service Manual.

The repair must be performed by an integrator authorized by JAKA or by JAKA's personnel.

After-sales service contact information: E-mail: support@jaka.com.

12.1 Safety Instructions

After the maintenance, check to ensure the safety level required by the service. Valid national or local safety laws and regulations must be observed during the check. At the same time, check if all safety functions are functioning properly.

The purpose of maintenance is to ensure the normal operation of the system, or to help the system return to normal operation in the event of a failure. The maintenance includes fault diagnosis and actual maintenance.

The following safety procedures and warnings must be followed during the operation of the robot or the control cabinet:



WARNING

1. It is forbidden to modify any information in the software safety configuration. If the safety parameters are changed, the entire robot system should be considered as a new system, which means that all safety examination processes, such as risk assessment, must be updated.
2. Replace a failed component with a new one with the same component number or an equivalent approved by JAKA.
3. Reactivate all disabled safety measures immediately after the work is completed.
4. Record all maintenance operations and save them in technical documents related to the entire robot system.



WARNING

1. Remove the power cord from the bottom of the control cabinet to ensure that it is completely powered down. Disconnect other energy sources connected to the robot or the control cabinet. Take necessary precautions to prevent others from energizing the system during maintenance.
2. Check the ground connection before re-powering the system.
3. Observe the ESD regulations when disassembling the robot or the control cabinet.
4. Avoid disassembling the power supplies inside the control cabinet. High voltage may remain in the power supply system for several hours after the control cabinet is powered down.
5. Avoid water or dust entering the robot or the control cabinet.

12.2 Storage Conditions

1. Storage temperature: -10~50°C (14~122°F)

For long-term storage, to maintain the robot system reliability, it is recommended to keep the temperature within 25±10°C (59~95°F). Avoid sudden temperature changes if possible. (10°C/h (50°F/h) and above).

2. Storage humidity: 20% RH~85% RH

For long-term storage, to maintain robot system reliability, it is recommended to keep the humidity within 45%~65%. Keep away from dew condensation or mildew.

3. Anti-static

It is easy to generate static when kept in extremely dry conditions. The shock of electrostatic discharge may damage the semiconductor. Please store the robot system in an anti-static bag.

4. Other environmental conditions

Please keep robot system in an environment that does not produce poisonous gas, dirt, and dust. Do not place heavy objects on it during storage.

13 Disposal

This section contains information to handle potentially dangerous components and potentially hazardous materials.

JAKA products contain components in different materials. During decommissioning, all materials should be dismantled, recycled, or reused responsibly, according to the relevant laws and industrial standards.

1. EU RoHS

JAKA robots are produced with restrictions on the use of hazardous substances to protect the environment; they comply with the definition of the EU RoHS Directive 2011/65/EU. The substances restricted by RoHS include mercury, cadmium, lead, chromium VI, polybrominated biphenyls and polybrominated diphenyl ethers.

2. EU WEEE

Fee for disposal and handling of electronic waste of JAKA robots sold on the German market is prepaid to DPA-system by JAKA. Importers in countries covered by the European WEEE Directive 2012/19/EU must make their own registration to the national WEEE register of their country. A list of national registers can be found here: <https://www.ewrn.org/national-registers/national-registers>.

The following symbol indicates that the product must not be disposed of as common garbage. Handle each product according to local regulations for the respective content.



3. EU RoHS

The following symbol shows the information to hazardous substances and the environmental protection use period of JAKA products according to Management Methods for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products (SJ/T 11364-2014).



The orange icon indicates that this product contains certain hazardous substances. The '20' in the icon represents the environmental protection period. It can be used during the environmental protection period and should be recycled after exceeding that time.

The table below shows the name and content of toxic and hazardous substances in the product.

Part Name	Pb	Hg	Cd	Cr (VI)	PBB	PBDE
Metal parts	x	o	o	o	o	o
Plastic parts	o	o	o	o	o	o
Electronic	x	o	o	o	o	o
Electrical contacts	o	o	o	o	o	o
Cables & cabling accessories	o	o	o	o	o	o

**NOTE**



1. The table is made according to SJ/T 11364.
2. o indicates that the concentration of hazardous substance in all the homogeneous materials for this part is below the limit as stipulated in GB/T 26572.
3. x indicates that the concentration of hazardous substance in at least one of the homogeneous materials for this part is above the limit as stipulated in GB/T 26572.

14 Design Standards and Certification


14.1 Certification Description

14.1.1 Third-Party Certification

The robot is certified by the following inspection bodies.

	Body	Description
	SGS	The JAKA robot has passed the safety certification of the notified body, SGS, which complies with the EU machinery directive 2006/42/EC.
	KCs safety	The JAKA robot has been evaluated as compliant with the KCs safety standard.

14.1.2 Manufacturer Test Certification

	Body	Description
	JAKA	The JAKA robot undergoes continuous internal factory tests and type testing procedures.

14.1.3 Declaration According to EU Directives

JAKA robot has been certified according to the following directives.

Name	Description
2006/42/EC	Machinery Directive (MD)
2014/35/EU	Low Voltage Directive (LVD)
2014/30/EU	Electromagnetic Compatibility (EMC)
2014/53/EU	Radio Equipment Directive (RED)

The JAKA robot meets the basic requirements of the CE-MD, CE-LVD, CE-EMC and CE-RED directives.



NOTE

1. Robots are covered by both the MD and LVD directives. Based on the MD directive, only MD is required to be evaluated, but the harmonized standards of LVD are used simultaneously to ensure electrical safety when conducting MD assessments.
2. EMC is mainly used to ensure compliance of robot without Wi-Fi module, EMC compliance of robot with Wi-Fi module is included in RED.
3. Certificates and declarations can be found on the official website www.jakarobotics.com.

15 Warranties

15.1 Product Warranty

Without prejudice to any indemnity agreement that the user (customer) may reach with the distributor or retailer, the manufacturer shall give the user (customer) “product warranty” according to the following terms: If there is any defect due to manufacturing and/or material faults within the warranty period promised under the contract signed by JAKA, JAKA shall provide necessary spare components, the user (customer) shall send personnel to replace spare components, and replace or repair related components with new ones that reflect the latest technical level. If the equipment defect is caused by improper treatment and/or failure to follow the relevant information described in the user manual, this “Product Warranty” is invalid. This “Product Warranty” does not apply to or extend to maintenance carried out by authorized distributors or users (customers) themselves (e.g. installation, configuration, software download). The purchase receipt, together with the date of purchase, shall be required as evidence for invoking the Warranty. The warranty must be submitted within two months of the Warranty default becoming evident. JAKA has the ownership of the equipment or components that are replaced or returned to JAKA. Any other claim arising out of or relating to the equipment is excluded from the scope of the Warranty. Nothing in this Warranty shall attempt to limit or exclude a Customer’s Statutory Right, nor the manufacturer’s liability for death or personal injury resulting from its negligence. The duration of the Warranty shall not be extended by services rendered under the terms of the Warranty. Insofar as no Warranty default exists, JAKA reserves the right to charge the customer for replacement or repair. The above provisions do not imply a change in the burden of proof to the detriment of the customer.

15.2 Disclaimer

JAKA is committed to continuously improving the reliability and performance of the products, and therefore reserves the right to upgrade them. The products may be changed without notice. JAKA strives to ensure the accuracy and reliability of the contents in this manual but is not responsible for any error or omission herein.

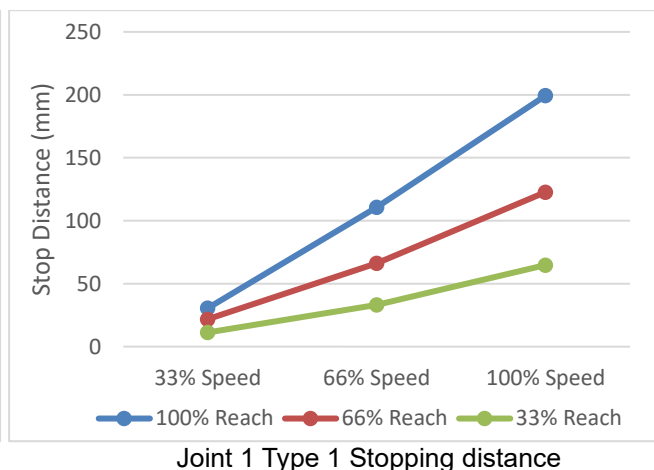
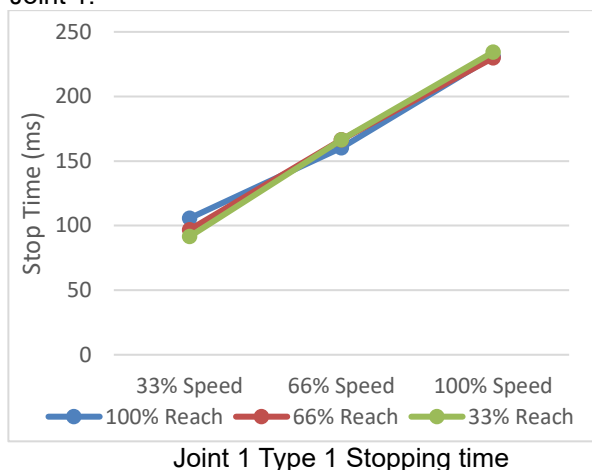
Appendix

Appendix 1: Stopping Time and Distance

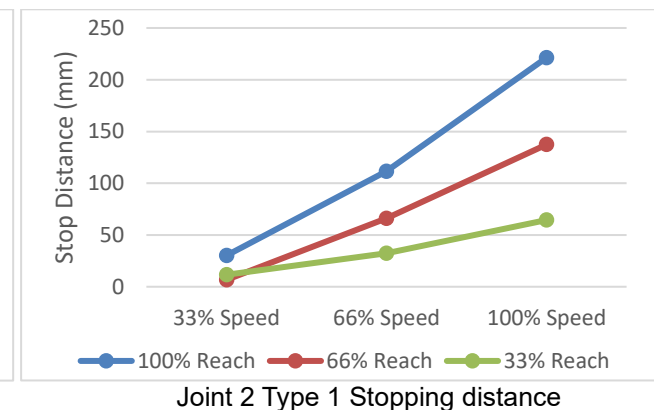
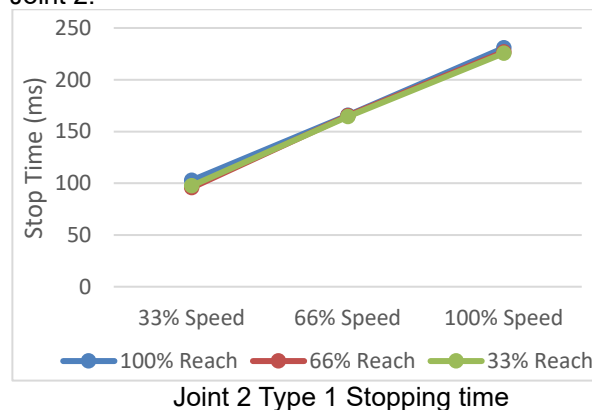
1. Zu 3 stopping time and distance

Table of type 1 stopping time and distance

Joint 1:



Joint 2:



Joint 3:

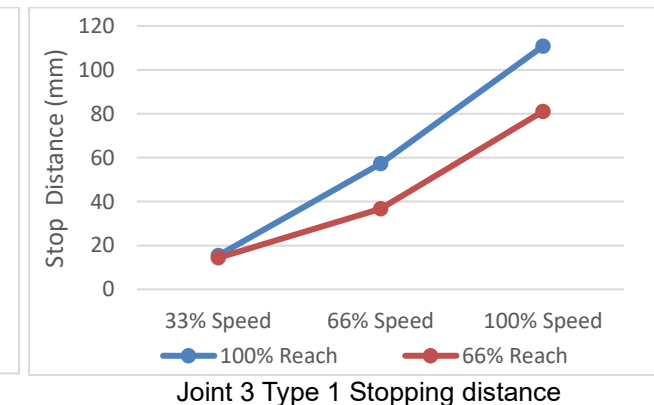
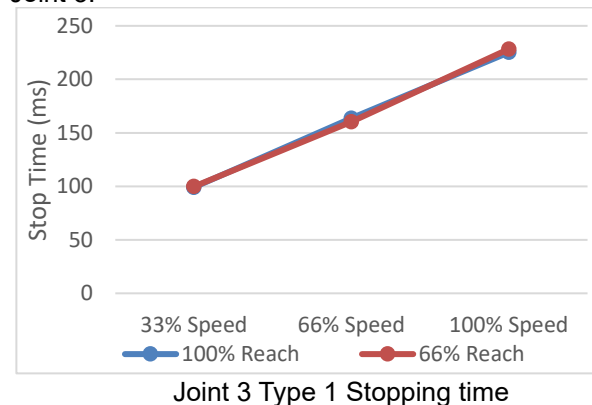
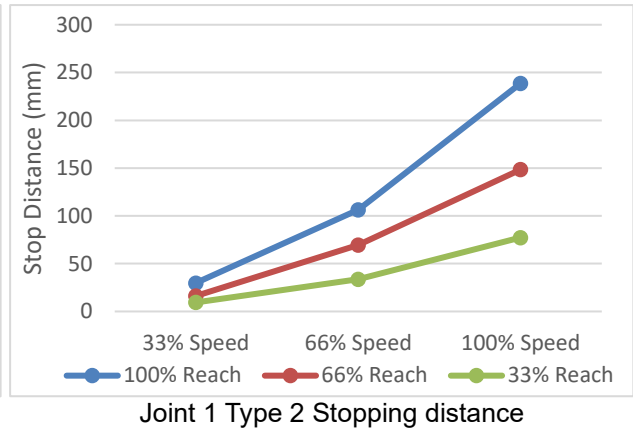
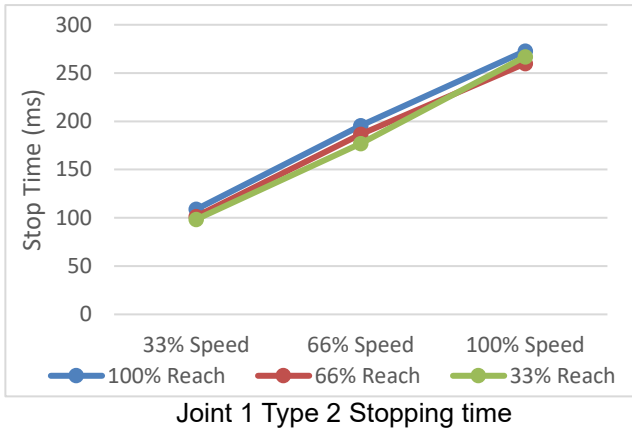
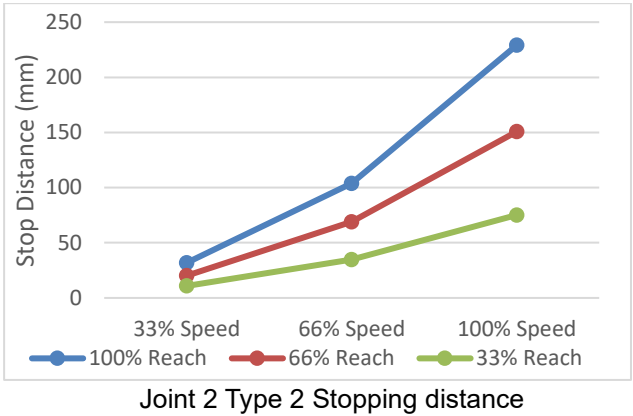
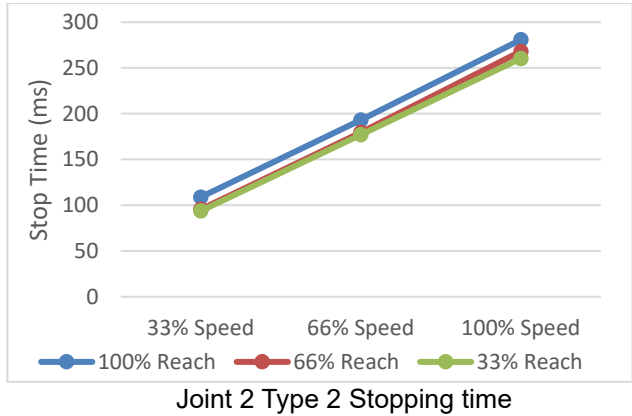


Table of type 2 stopping time and distance

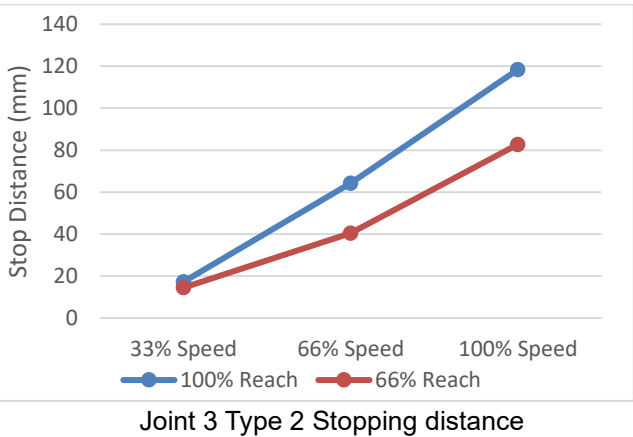
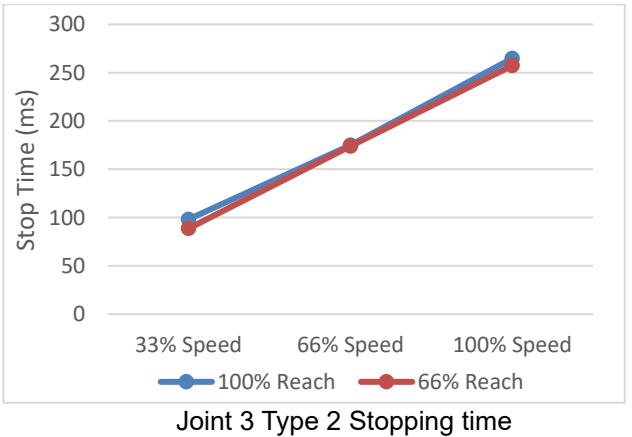
Joint 1:



Joint 2:



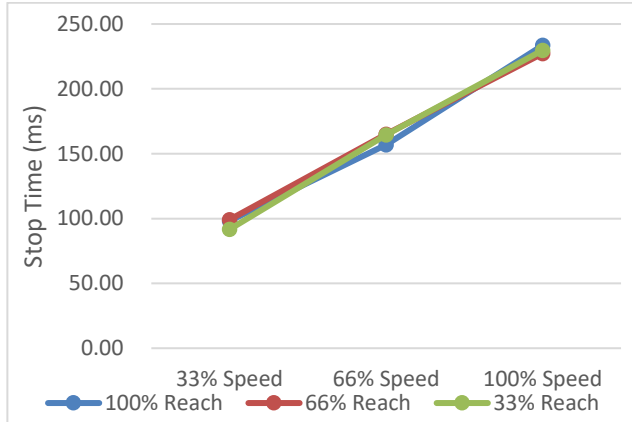
Joint 3:



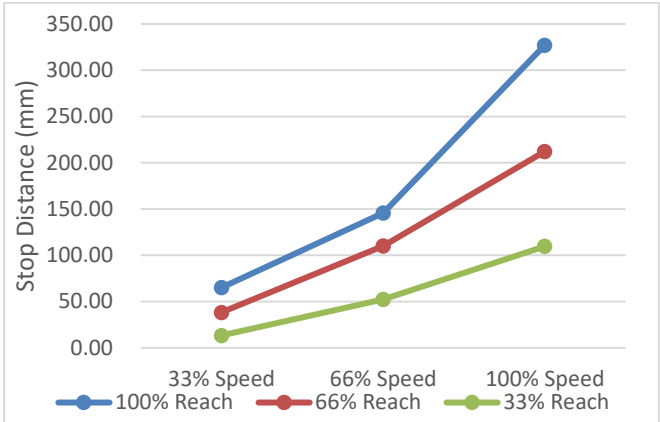
2. Zu 5 stopping time and distance

Table of type 1 stopping time and distance

Joint 1:

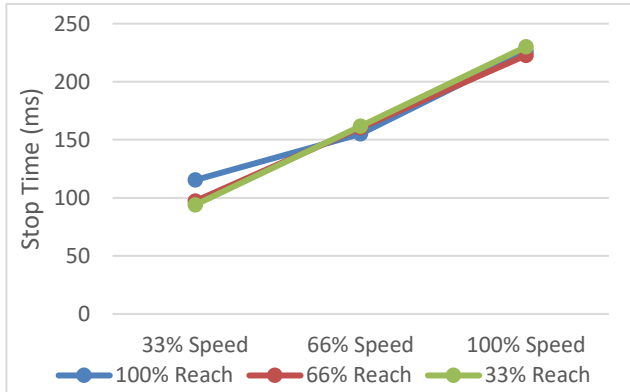


Joint 1 Type 1 Stopping time

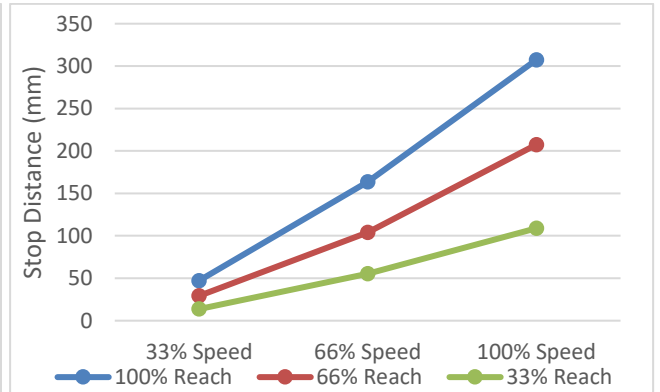


Joint 1 Type 1 Stopping distance

Joint 2:

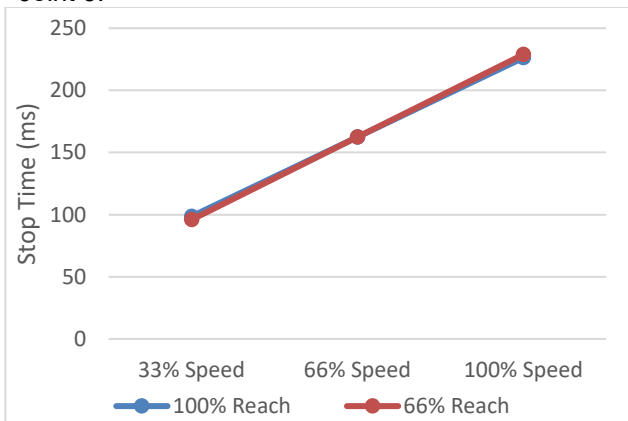


Joint 2 Type 1 Stopping time

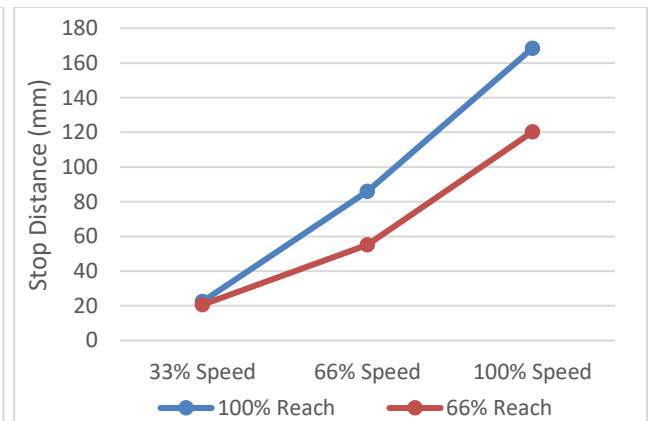


Joint 2 Type 1 Stopping distance

Joint 3:



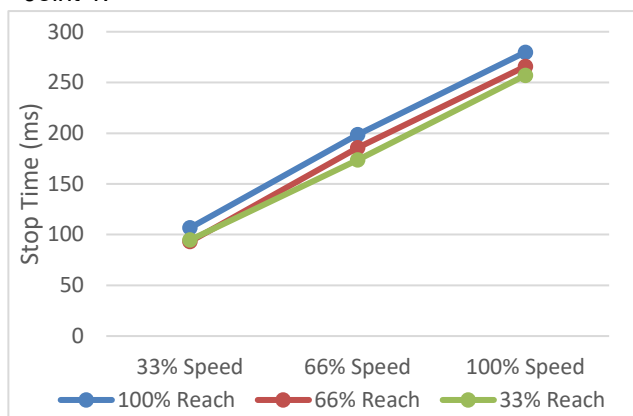
Joint 3 Type 1 Stopping time



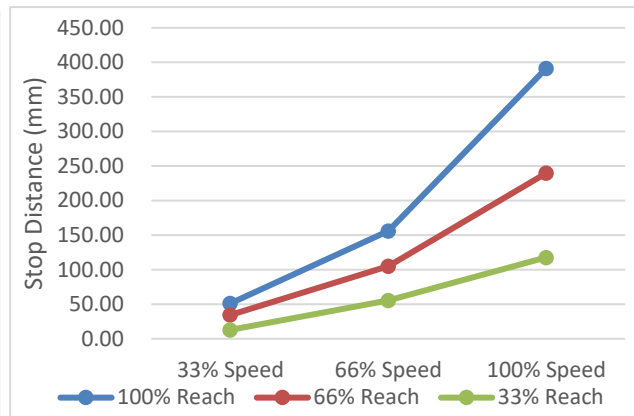
Joint 3 Type 1 Stopping distance

Table of type 2 stopping time and distance

Joint 1:

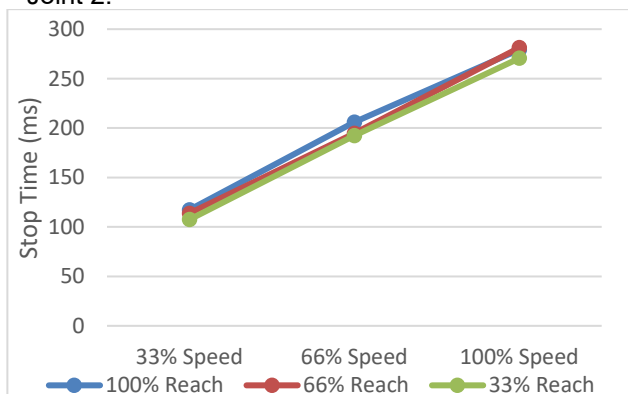


Joint 1 Type 2 Stopping time

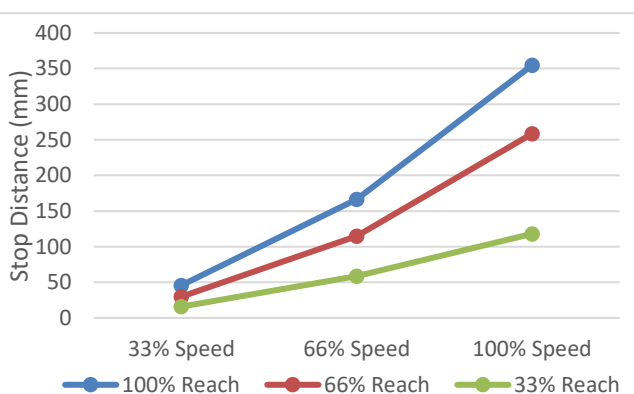


Joint 1 Type 2 Stopping distance

Joint 2:

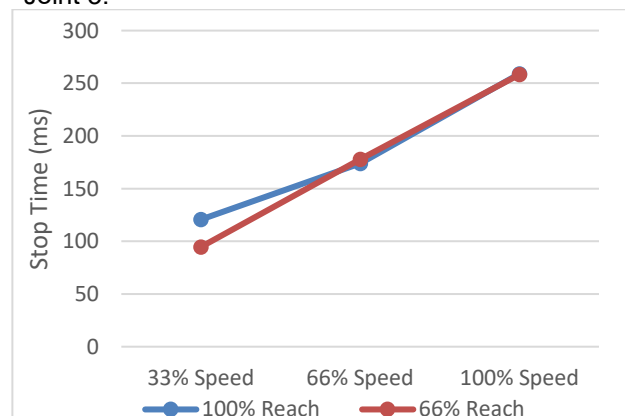


Joint 2 Type 2 Stopping time

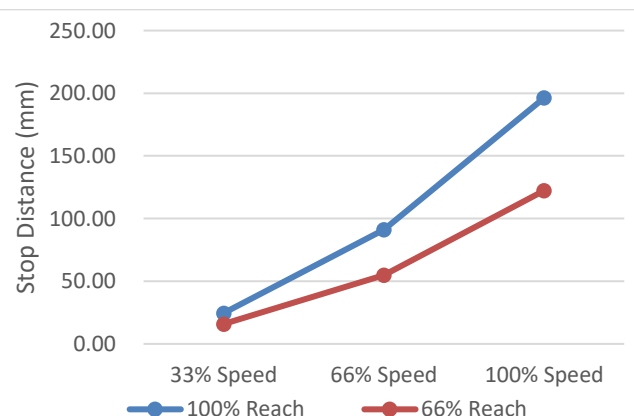


Joint 2 Type 2 Stopping distance

Joint 3:



Joint 3 Type 2 Stopping time

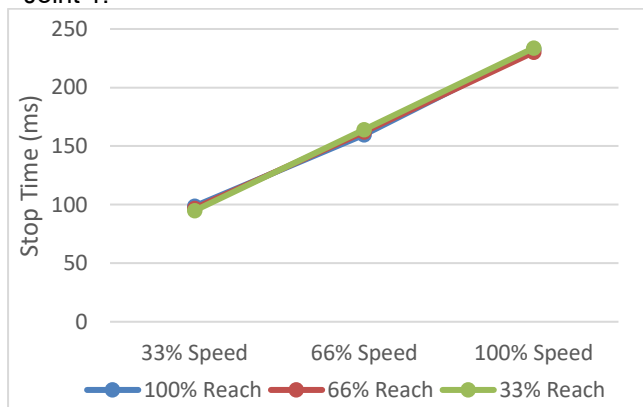


Joint 3 Type 2 Stopping distance

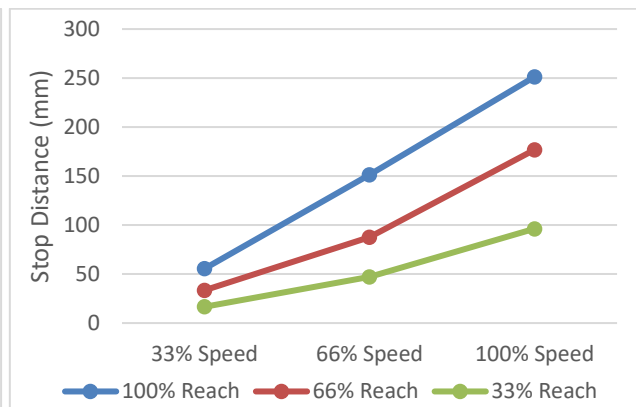
3. Zu 7 stopping time and distance

Table of type 1 stopping time and distance

Joint 1:

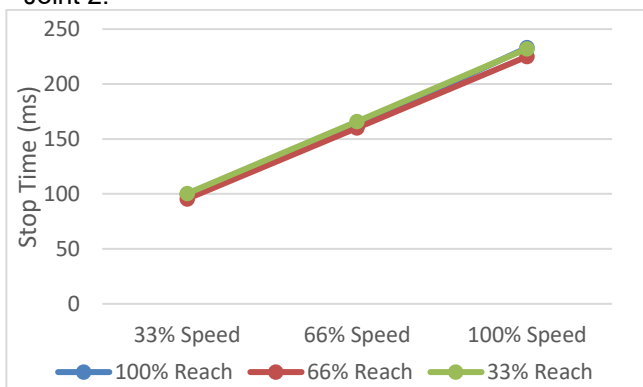


Joint 1 Type 1 Stopping time

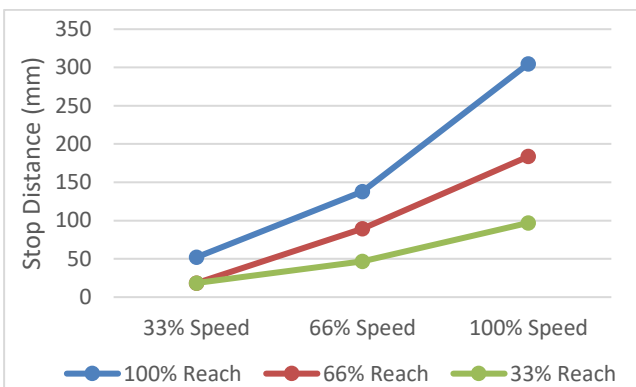


Joint 1 Type 1 Stopping distance

Joint 2:

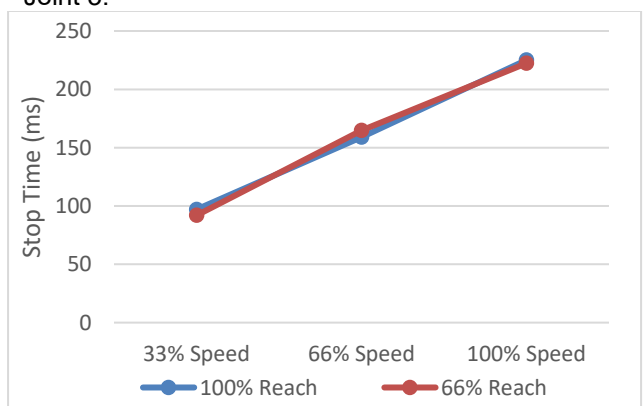


Joint 2 Type 1 Stopping time

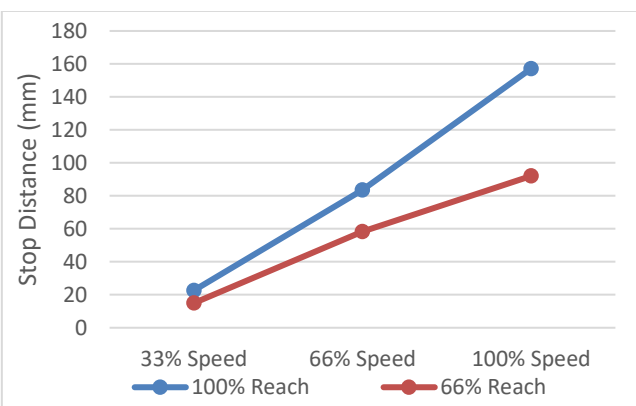


Joint 2 Type 1 Stopping distance

Joint 3:



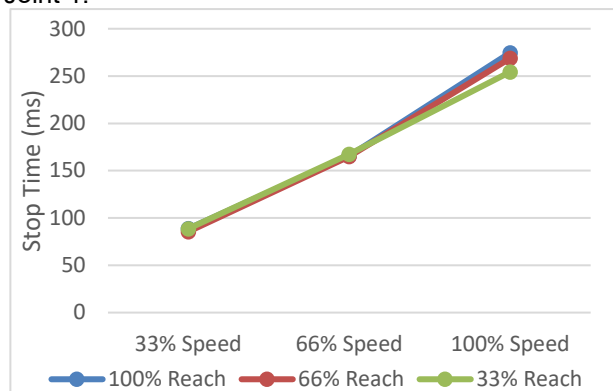
Joint 3 Type 1 Stopping time



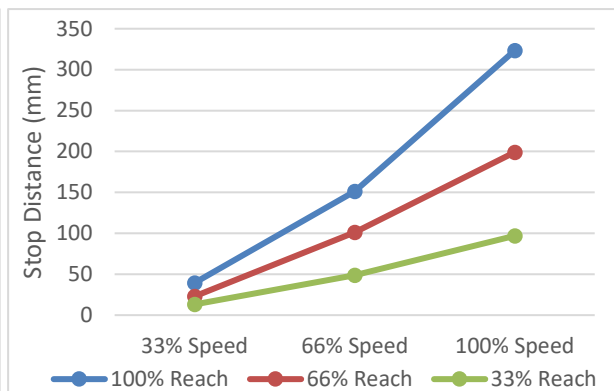
Joint 3 Type 1 Stopping distance

Table of type 2 stopping time and distance

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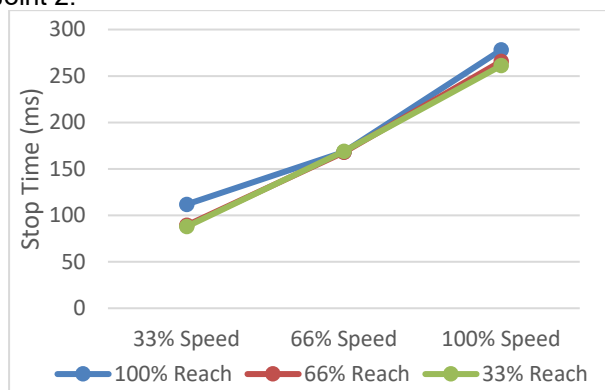


Joint 1 Type 2 Stopping time

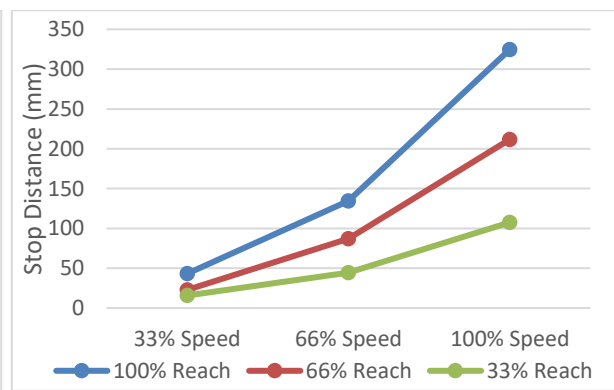


Joint 1 Type 2 Stopping distance

Joint 2:

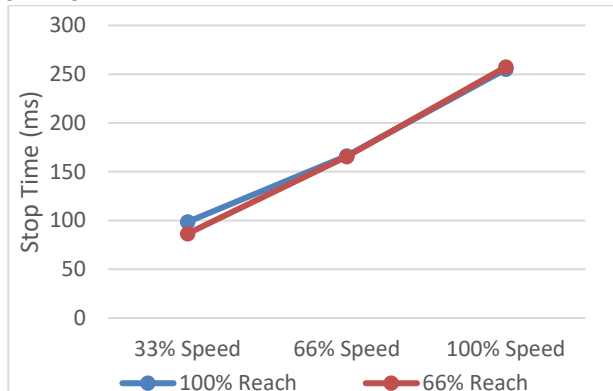


Joint 2 Type 2 Stopping time

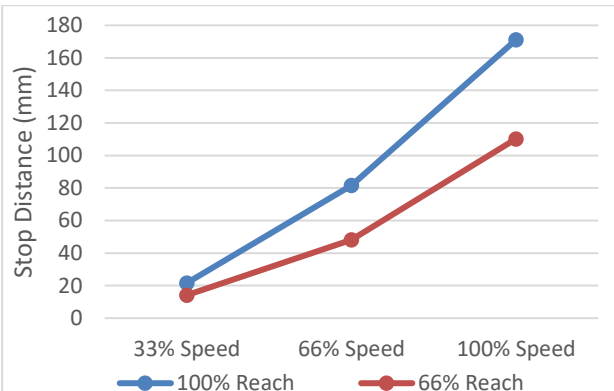


Joint 2 Type 2 Stopping distance

Joint 3:



Joint 3 Type 2 Stopping time

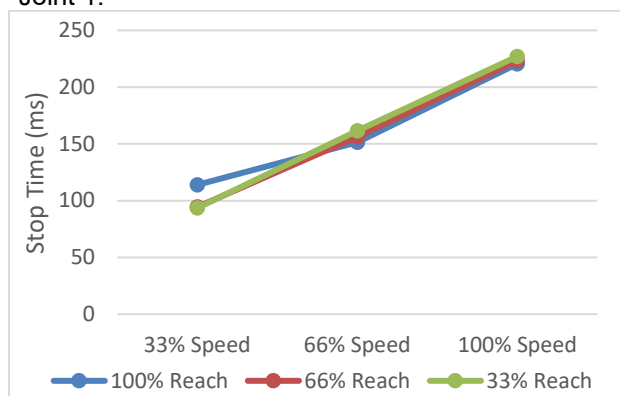


Joint 3 Type 2 Stopping distance

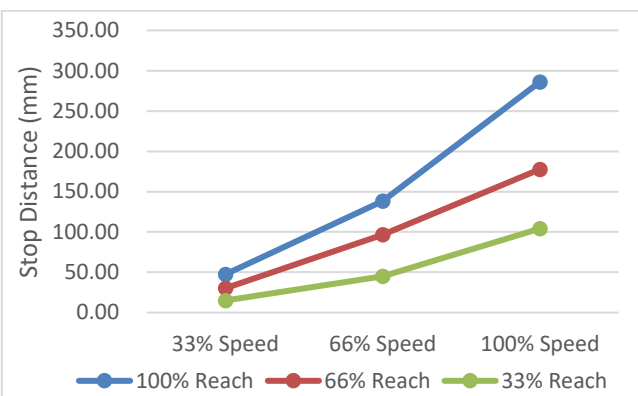
4. Zu 12 stopping time and distance

Table of type 1 stopping time and distance

Joint 1:

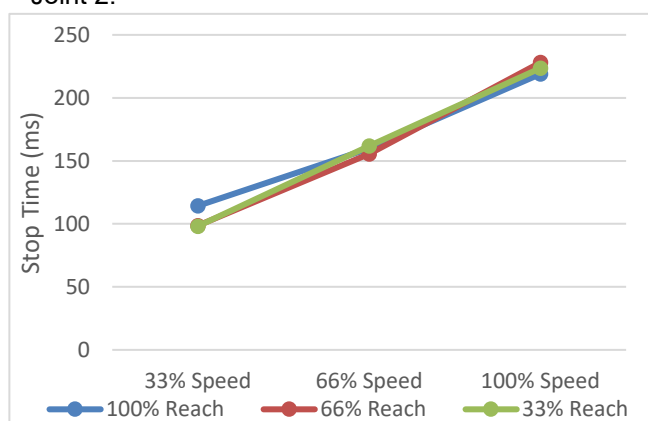


Joint 1 Type 1 Stopping time

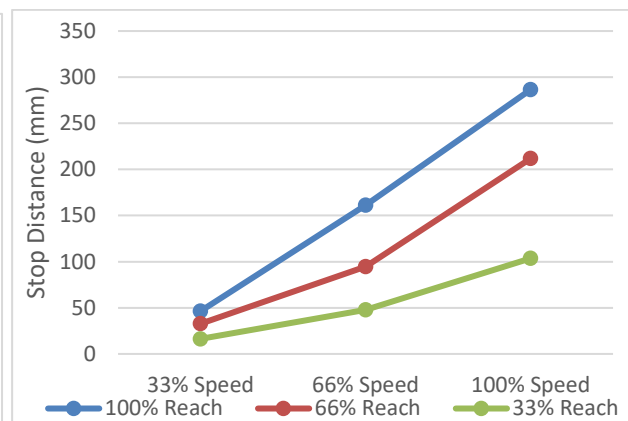


Joint 1 Type 1 Stopping distance

Joint 2:

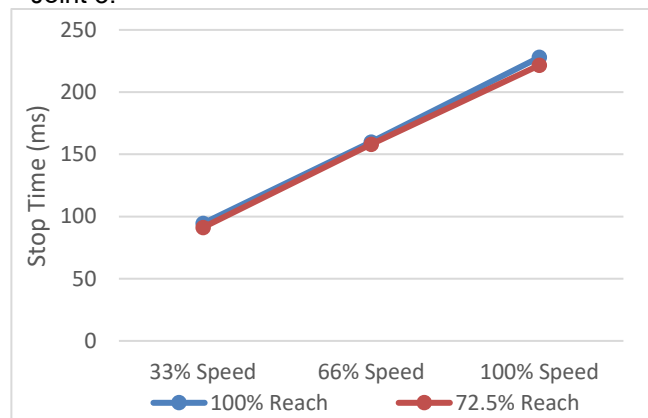


Joint 2 Type 1 Stopping time

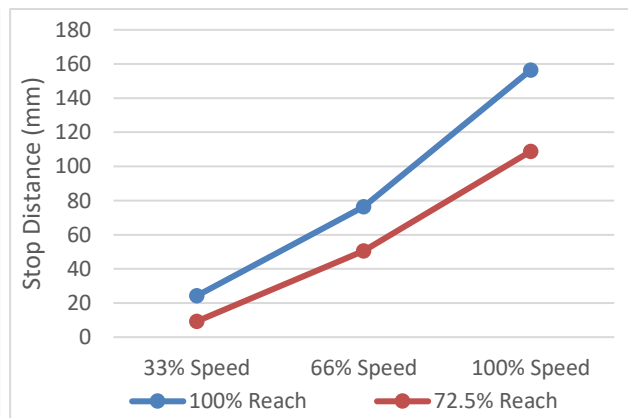


Joint 2 Type 1 Stopping distance

Joint 3:



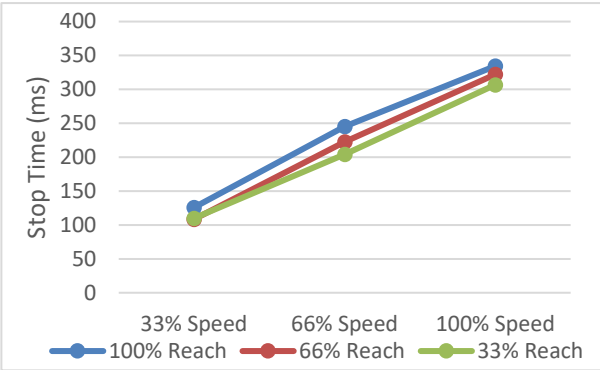
Joint 3 Type 1 Stopping time



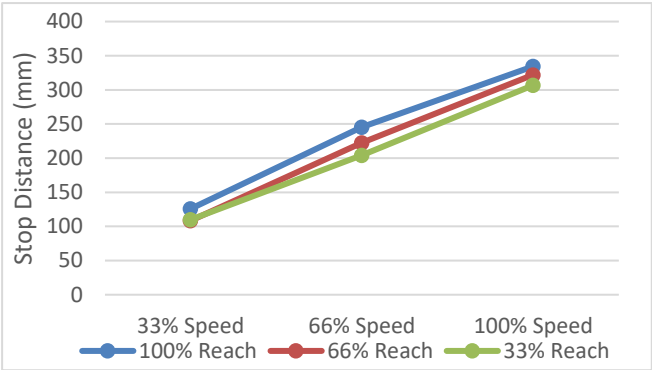
Joint 3 Type 1 Stopping distance

Table of type 2 stopping time and distance

Joint 1:

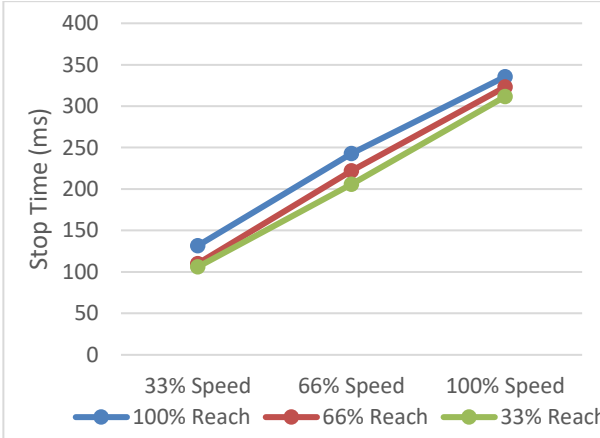


Joint 1 Type 2 Stopping time

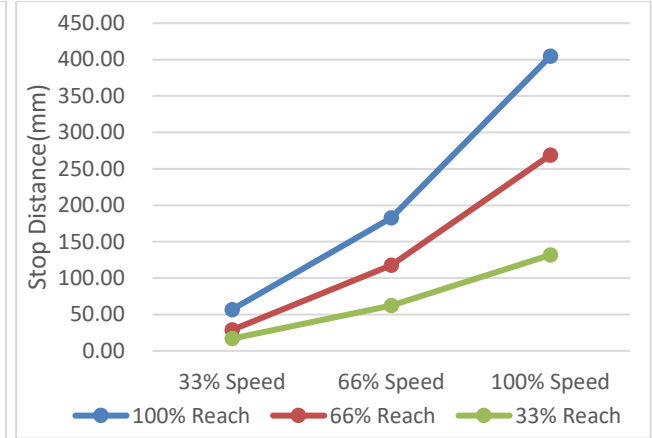


Joint 1 Type 2 Stopping distance

Joint 2:

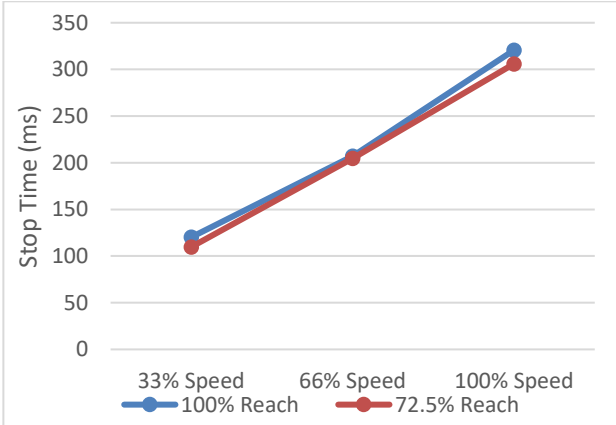


Joint 2 Type 2 Stopping time

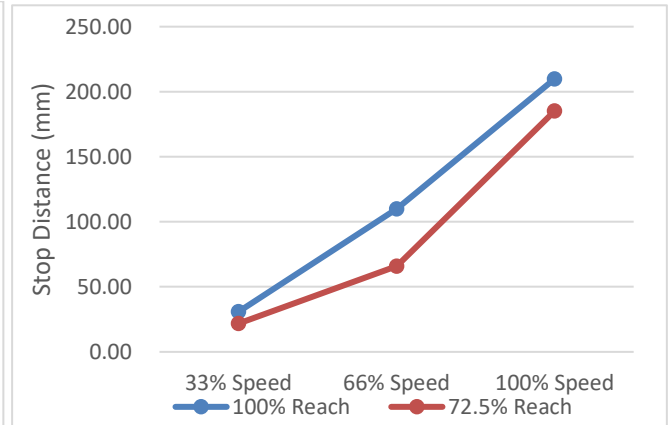


Joint 2 Type 2 Stopping distance

Joint 3:



Joint 3 Type 2 Stopping time

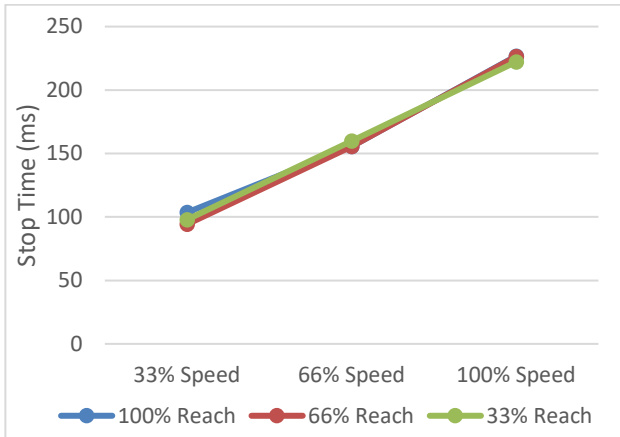


Joint 3 Type 2 Stopping distance

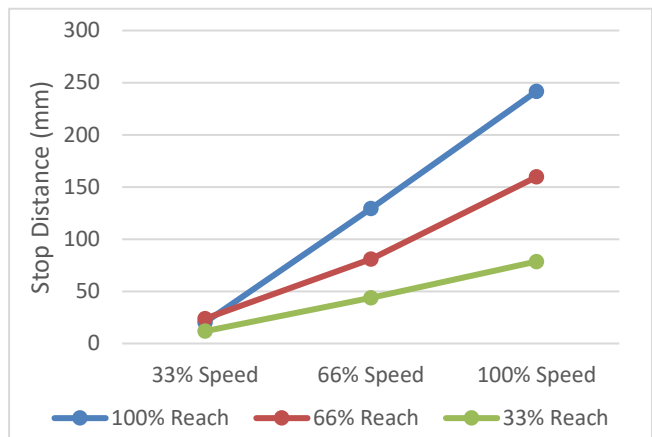
5. Zu 18 stopping time and distance

Table of type 1 stopping time and distance

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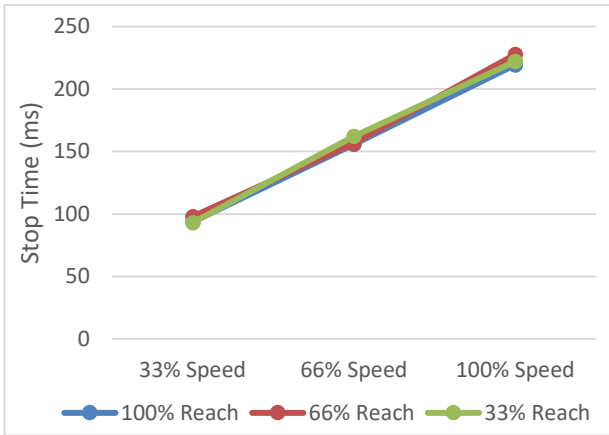


Joint 1 Type 1 Stopping time

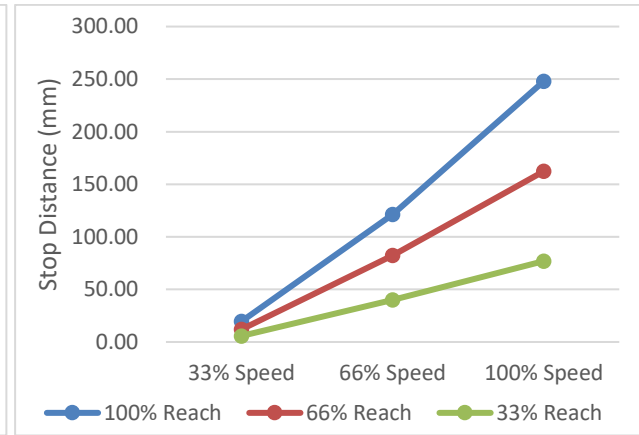


Joint 1 Type 1 Stopping distance

Joint 2:

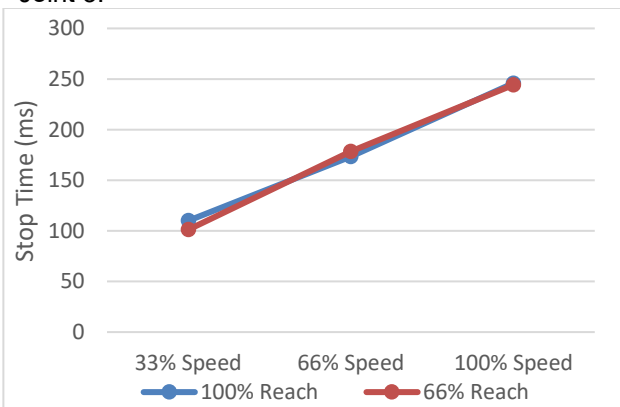


Joint 2 Type 1 Stopping time

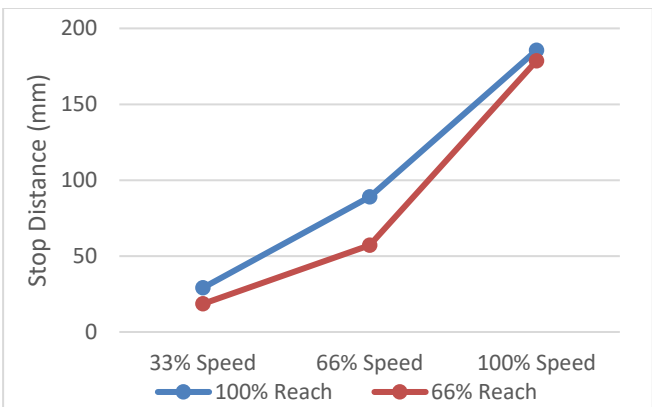


Joint 2 Type 1 Stopping distance

Joint 3:



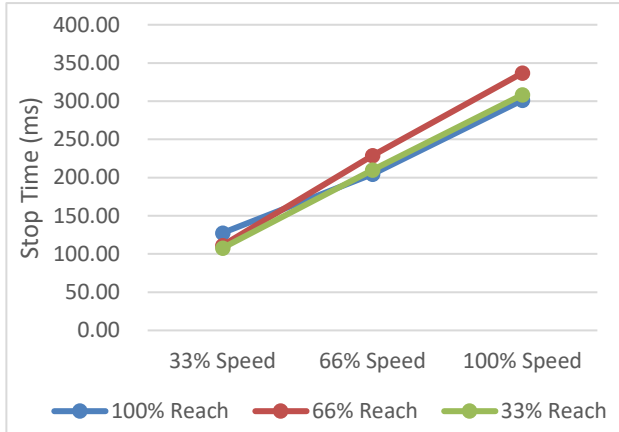
Joint 3 Type 1 Stopping time



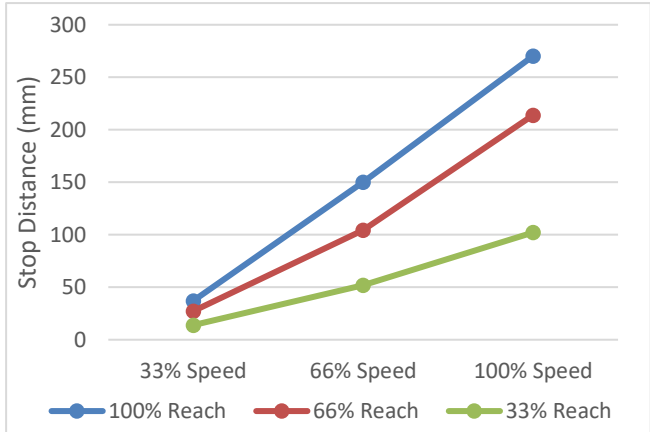
Joint 3 Type 1 Stopping distance

Table of type 2 stopping time and distance

Joint 1:

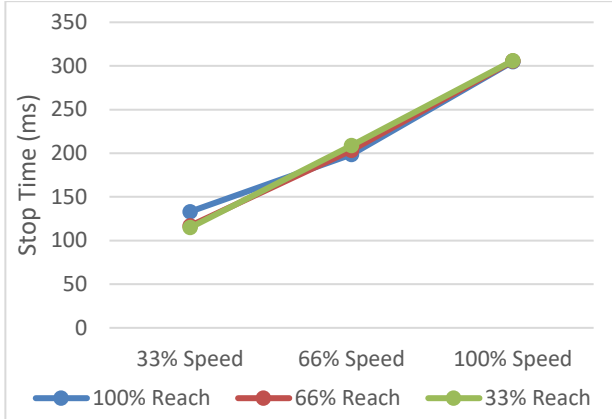


Joint 1 Type 2 Stopping time

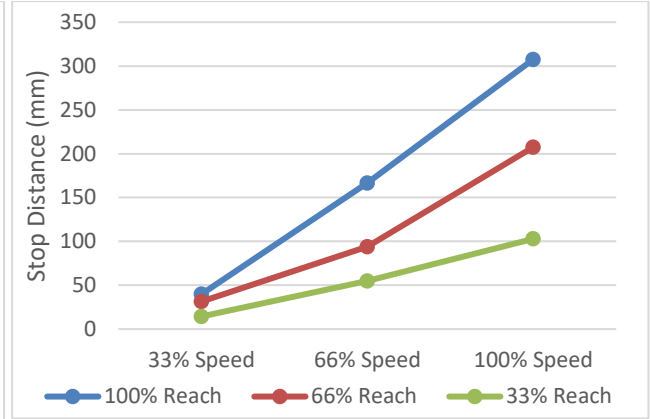


Joint 1 Type 2 Stopping distance

Joint 2:

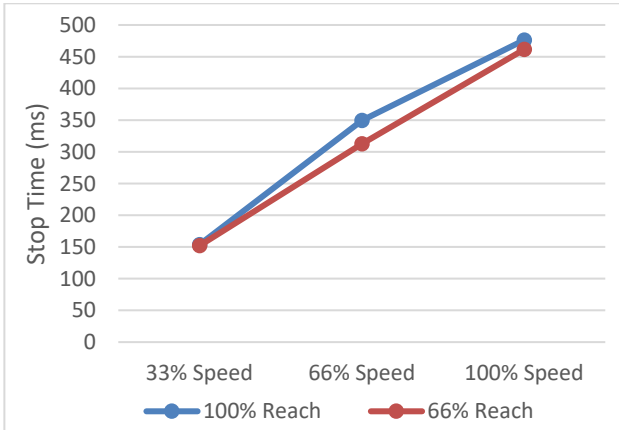


Joint 2 Type 2 Stopping time

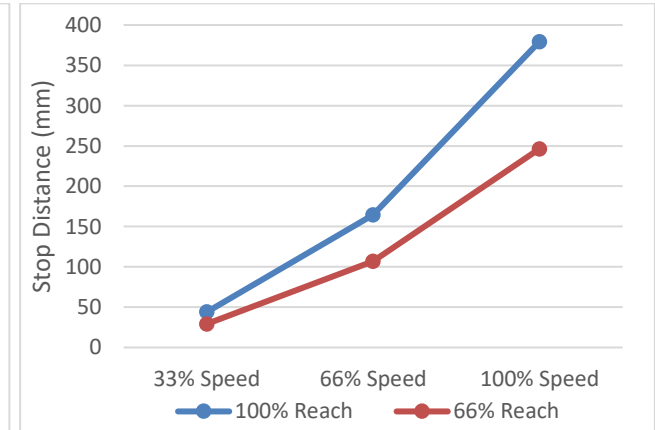


Joint 2 Type 2 Stopping distance

Joint 3:



Joint 3 Type 2 Stopping time

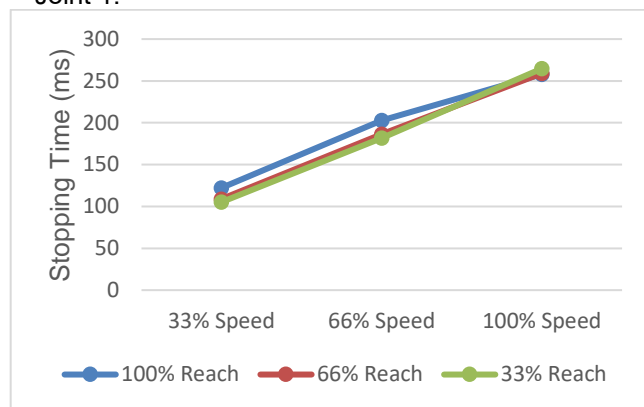


Joint 3 Type 2 Stopping distance

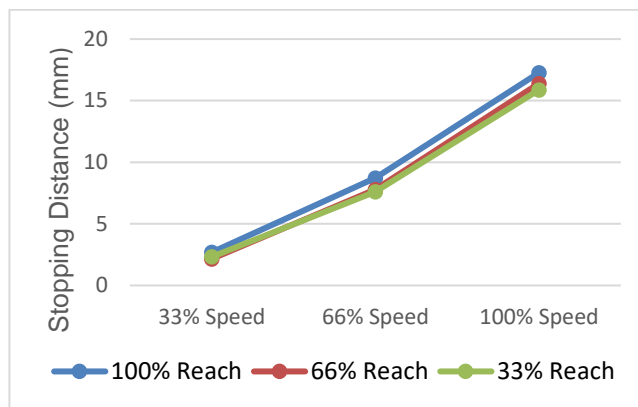
6. Zu 20 stopping time and distance

Table of type 1 stopping time and distance

Joint 1:

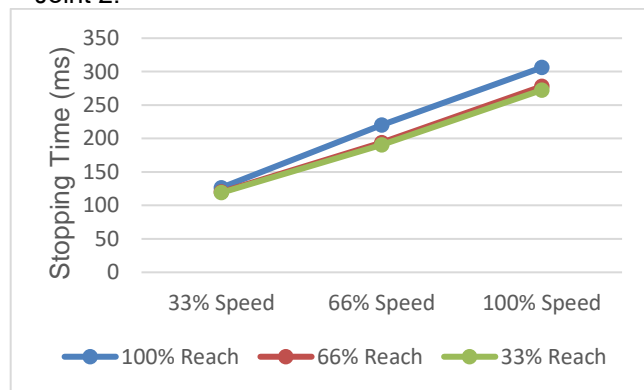


Joint 1 Type 1 Stopping Time

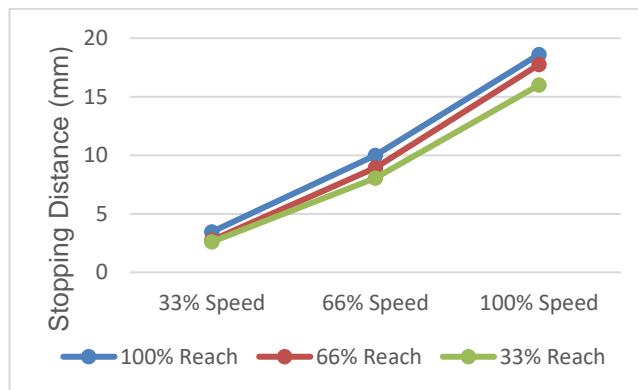


Joint 1 Type 1 Stopping Distance

Joint 2:

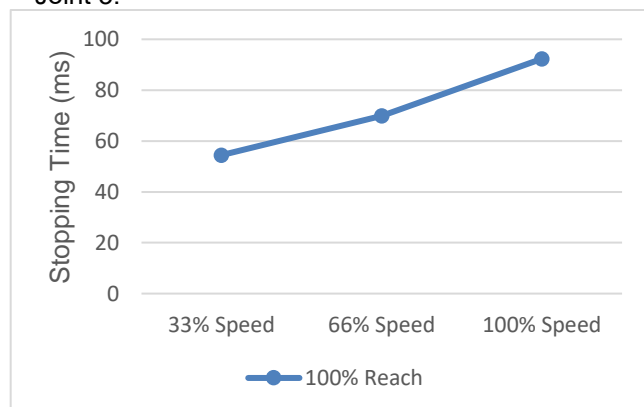


Joint 2 Type 1 Stopping Time

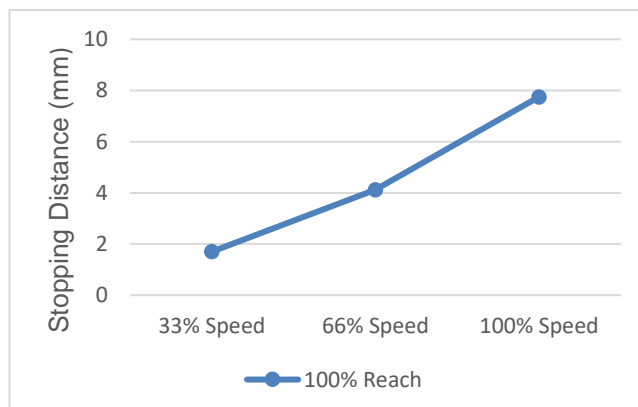


Joint 2 Type 1 Stopping Distance

Joint 3:



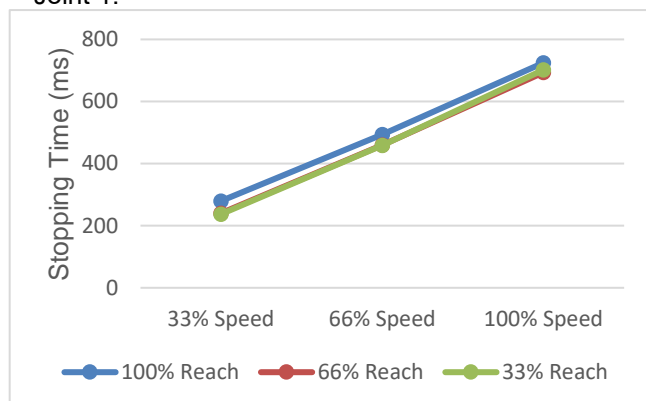
Joint 3 Type 1 Stopping Time



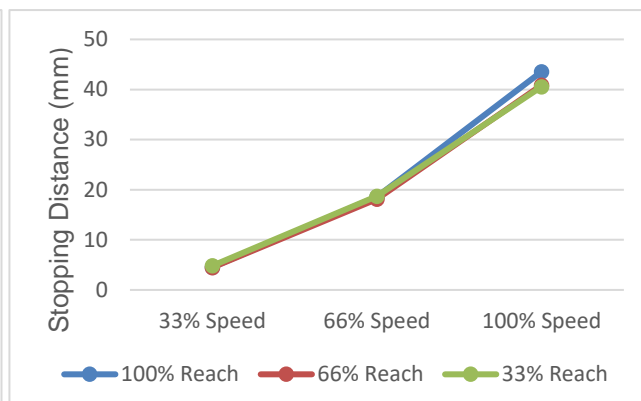
Joint 3 Type 1 Stopping Distance

Table of type 2 stopping time and distance

Joint 1:

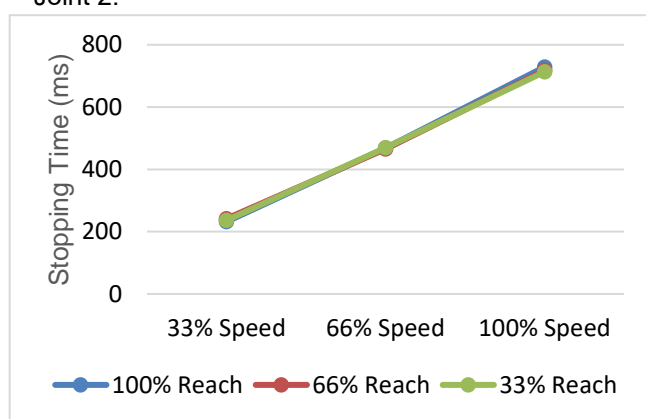


Joint 1 Type 2 Stopping Time

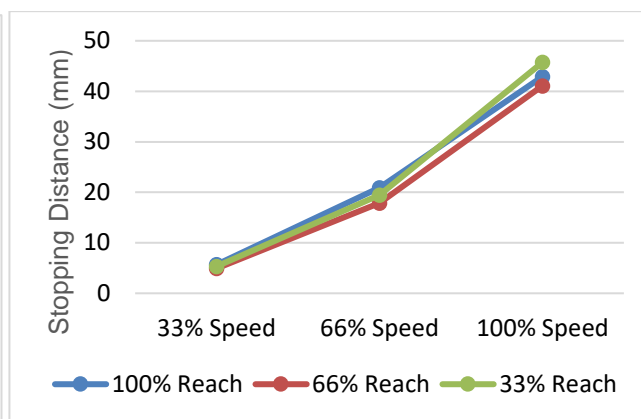


Joint 1 Type 2 Stopping Distance

Joint 2:

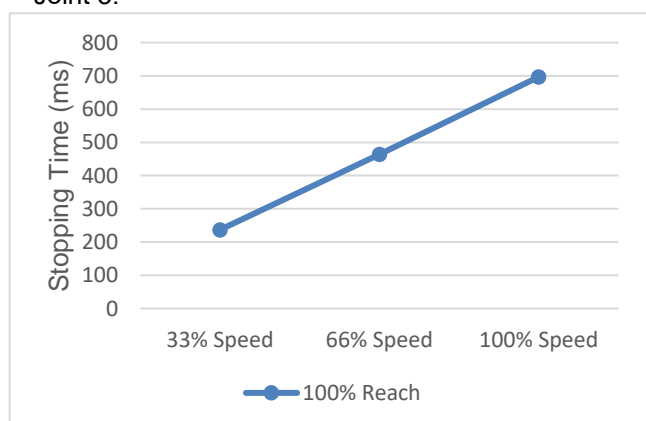


Joint 2 Type 2 Stopping Time

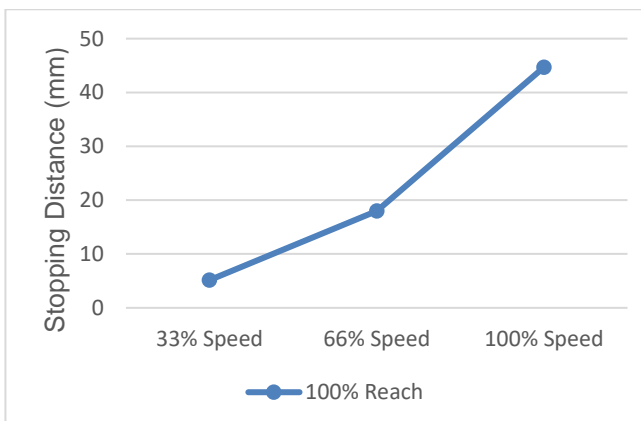


Joint 2 Type 2 Stopping Distance

Joint 3:



Joint 3 Type 2 Stopping Time



Joint 3 Type 2 Stopping Distance



NOTE

1. The unit of stopping distance is mm, 1 inch equals to 25.4 mm.
2. This data is test data, the data results are affected by the version.

Appendix 2: Safety Function Table

SF	Item	Description (CAB2.1)	Description (MiniCab)	Assessment Results	Response Time	Category
SF1	ESTOP with the ESTOP Button on the Control Stick	Pressing the Emergency Stop Button on the control stick will result in a category 1 stop. The robot immediately decelerates to stop, and the power supply of the robot will be cut off when all joints enter stand-still condition. If the two safety digital input signals differ, the emergency stop will be triggered.	Pressing the Emergency Stop Button on the control stick will result in a category 1 stop. The robot immediately decelerates to stop, and the power supply of the robot will be cut off when all joints enter stand-still condition. If the two safety digital input signals differ, the emergency stop will be triggered.	PL d/Cat. 3	250 ms	Cat. 1 stop
SF2	ESTOP with External Estop Button	This safety function is initiated by an external device using safety digital inputs. The category 1 stop is triggered when the external connections are LOW. The robot immediately decelerates to stop, and the power supply of the robot will be cut off when all joints enter stand-still condition. External emergency stop input can only be bypassed by short circuit. If the two safety digital input signals differ, the emergency stop will be triggered.	This safety function is initiated by an external device using safety digital inputs. The category 1 stop is triggered when the external connections are LOW. The robot immediately decelerates to stop, and the power supply of robot will be cut off when all joints enter stand-still condition. External emergency stop input can only be bypassed by short circuit. If the two safety digital input signals differ, the emergency stop will be triggered.	PL d/Cat. 3		Cat. 1 stop
SF3	Safeguard (Protective) Stop	This safety function is initiated by an external device using safety digital inputs. The category 2 stop is triggered when the external connections are LOW. Robot decelerates following the programmed trajectory, eventually all joints enter stand-still condition (while the robot remains enabled). Safeguard stop input can only be bypassed by short circuit. If the two safety digital input signals differ, the safeguard stop will be triggered.	This safety function is initiated by an external device using safety digital inputs. The category 2 stop is triggered when the external connections are HIGH. Robot decelerates following the programmed trajectory, eventually all joints enter stand-still condition (while the robot remains enabled). Safeguard stop input can only be bypassed by short circuit. If the two safety digital input signals differ, the safeguard stop will be triggered.	PL d/Cat. 3	350 ms	Cat. 2 stop
SF4	Joint Position Limits (Soft Axis Limits)	Each joint can have its own limit. Exceeding the joint position limit will result in a safety state.	Each joint can have its own limit. Exceeding the joint position limit will result in a safety state.	PL d/Cat. 3	250 ms	Cat. 1 stop

SF	Item	Description (CAB2.1)	Description (MiniCab)	Assessment Results	Response Time	Category
SF5	Joint Speed Limit	Each joint can have its own limit. Exceeding the joint speed limit will result in a safety state.	Each joint can have its own limit. Exceeding the joint speed limit will result in a safety state.	PL d/Cat. 3		Cat. 1 stop
SF6	Joint Torque Limit	Each joint can have its own torque limit, which is a factory setting and can't be configured by the user. Exceeding the joint torque limit will result in a safety state.	Each joint can have its own torque limit, which is a factory setting and can't be configured by the user. Exceeding the joint torque limit will result in a safety state.	PL d/Cat. 3		Cat. 1 stop
SF7	Joint Power Limit	Each joint can have its own power limit, which is a factory setting and can't be configured by the user. Exceeding the joint power limit will result in a safety state.	Each joint can have its own power limit, which is a factory setting and can't be configured by the user. Exceeding the joint power limit will result in a safety state.	PL d/Cat. 3		Cat. 1 stop
SF8	Power Limit	This function monitors the mechanical power of the robot's motion (sum of the product of torque and angular velocity for each joint). Limiting the mechanical power of the robot can reduce the collision forces in a collision, and this function may have an impact on the robot's motion speed. Exceeding the robot power limit will result in a safety state.	This function monitors the mechanical power of the robot's motion (sum of the product of torque and angular velocity for each joint). Limiting the mechanical power of the robot can reduce the collision forces in a collision, and this function may have an impact on the robot's motion speed. Exceeding the robot power limit will result in a safety state.	PL d/Cat. 3		Cat. 1 stop
SF9	TCP Speed Limit	Allowed upper limit for TCP (Tool Center Point) speed can be defined to prevent robot motion from exceeding such limit (excluding Hand-guided Mode). If the TCP speed exceeds the limit during robot motion, it will result in a safety state.	Allowed upper limit for TCP (Tool Center Point) speed can be defined to prevent robot motion from exceeding such limit (excluding Hand-guided Mode). If the TCP speed exceeds the limit during robot motion, it will result in a safety state.	PL d/Cat. 3		Cat. 1 stop
SF10 ⁱ	Tool Orientation Limit	Allowable range for tool orientation movements can be defined for the robot. If the tool orientation exceeds the specified range limit during motion, it will result in a safety state.	Allowable range for tool orientation movements can be defined for the robot. If the tool orientation exceeds the specified range limit during motion, it will result in a safety state.	PL d/Cat. 3		Cat. 1 stop
SF11	TCP Position Limit (Safety Planes)	Multiple safety planes can be defined to restrict the range of motion for the robot. If the robot's tool position exceeds the defined	Multiple safety planes can be defined to restrict the range of motion for the robot. If the robot's tool position exceeds	PL d/Cat. 3		Cat. 1 stop

SF	Item	Description (CAB2.1)	Description (MiniCab)	Assessment Results	Response Time	Category
		safety planes, it will result in a safety state.	the defined safety planes, it will result in a safety state.			
SF12 ⁱⁱ	TCP Position Mismatch Limit	TCP real position and instruction position are calculated and compared. It will result in a safety state if the error value exceeds the position mismatch limit.	TCP real position and instruction position are calculated and compared. It will result in a safety state if the error value exceeds the position mismatch limit.	PL d/Cat. 3		Cat. 1 stop
SF13	Hand-guided Mode TCP Speed Limit	Allowed TCP (Tool Center Point) speed limit for Hand-guided mode can be defined. If the TCP speed exceeds this limit in Hand-guided mode, it will result in a safety state.	Allowed TCP (Tool Center Point) speed limit for Hand-guided mode can be defined. If the TCP speed exceeds this limit in Hand-guided mode, it will result in a safety state.	PL d/Cat. 3		Cat. 2 stop
SF14	Collision Protection	Collision is estimated by multiple methods, such as joint torque, joint position mismatch and TCP position mismatch. Detection of collision will initiate a safety state.	Collision is estimated by multiple methods, such as joint torque, joint position mismatch and TCP position mismatch. Detection of collision will initiate a safety state.	PL d/Cat. 3	350 ms	Cat. 2 stop
SF15	Additional Emergency Stop Input	Configurable additional emergency stop safety digital input. This safety function is initiated by an external device using safety digital inputs. The category 1 stop is triggered when the external connections are LOW. Robot immediately decelerates to stop, and the power supply of robot will be cut off when all joints enter stand-still condition. If the two safety digital input signals differ, the emergency stop will be triggered.	Configurable additional emergency stop safety digital input. This safety function is initiated by an external device using safety digital inputs. The category 1 stop is triggered when the external connections are HIGH. Robot immediately decelerates to stop, and the power supply of robot will be cut off when all joints enter stand-still condition. If the two safety digital input signals differ, the emergency stop will be triggered.	PL d/Cat. 3	250 ms	Cat. 1 stop
SF16	Additional Safeguard Stop Input	Configurable additional safeguard stop safety digital input. This safety function is initiated by an external device using safety digital inputs. The category 2 stop is triggered when the external connections are LOW. Robot decelerates following the programmed trajectory, eventually all joints enter stand-still	Configurable additional safeguard stop safety digital input. This safety function is initiated by an external device using safety digital inputs. The category 2 stop is triggered when the external connections are HIGH. Robot decelerates following the programmed trajectory, eventually all joints enter stand-still condition (while the robot remains enabled).	PL d/Cat. 3	350 ms	Cat. 2 stop

SF	Item	Description (CAB2.1)	Description (MiniCab)	Assessment Results	Response Time	Category
		condition (while the robot remains enabled). If the two safety digital input signals differ, the safeguard stop will be triggered.	If the two safety digital input signals differ, the safeguard stop will be triggered.			
SF17	Safeguard Reset Input	Configurable safeguard stop state reset safety digital input. This safety function is initiated by an external device using safety inputs. Transitioning the external connections from LOW to HIGH will exit the protective stop state. If the two safety digital input signals differ, it will fail to reset the safeguard stop.	Configurable safeguard stop state reset safety digital input. This safety function is initiated by an external device using safety inputs. Transitioning the external connections from HIGH to LOW will exit the protective stop state. If the two safety digital input signals differ, it will fail to reset the safeguard stop.	PL d/Cat. 3		Reset from Cat. 2 stop
SF18	Reduced Mode Input	Configurable reduced mode safety digital input. This safety function is initiated by an external device using safety inputs. The reduced mode is triggered when the external connections are LOW. The reduced mode will have an impact on the status of the following safety function limit settings: TCP speed, TCP force, robot momentum, robot power. If the two safety digital input signals differ, the reduced mode will be triggered.	Configurable reduced mode safety digital input. This safety function is initiated by an external device using safety inputs. The reduced mode is triggered when the external connections are HIGH. The reduced mode will have an impact on the status of the following safety function limit settings: TCP speed, TCP force, robot momentum, robot power. If the two safety digital input signals differ, the reduced mode will be triggered.	PL d/Cat. 3		Reduced mode
SF19	Estop Button State Output	Configurable emergency stop status safety digital output. When the Emergency Stop Button on the control stick is pressed, the dual digital outputs are LOW. Note that emergency stop with External Estop Button and additional emergency stop input do not affect this output.	Configurable emergency stop status safety digital output. When the Emergency Stop Button on the control stick is pressed, the dual digital outputs are HIGH. Note that emergency stop with External Estop Button and additional emergency stop input do not affect this output.	PL d/Cat. 3		Two-channel output signals with high impedance state
SF20	System Estop State Output	Configurable emergency stop status safety digital output. When the robot enters an emergency stop state, the dual digital outputs are LOW. The emergency stops from the Estop Button on the control stick, ESTOP with External Estop Button, or additional emergency stop	Configurable emergency stop status safety digital output. When the robot enters an emergency stop state, the dual digital outputs are HIGH. The emergency stops from the Estop Button on the control stick, ESTOP with External Estop Button, or additional emergency stop inputs all have an impact on the output.	PL d/Cat. 3	250 ms	Two-channel output signals with high impedance state

SF	Item	Description (CAB2.1)	Description (MiniCab)	Assessment Results	Response Time	Category
		inputs all have an impact on the output.				
SF21	System Safeguard State Output	Configurable system safeguard stop status safety digital outputs. When the robot enters the protective stop mode, the dual digital outputs are LOW.	Configurable system safeguard stop status safety digital outputs. When the robot enters the protective stop mode, the dual digital outputs are HIGH.	PL d/Cat. 3	350 ms	Two-channel output signals with high impedance state
SF22	Robot Moving Output	Configurable motion status safety digital outputs. Whenever the robot is moving (motion underway), the dual digital outputs are LOW. Outputs are HIGH when there is no movement.	Configurable motion status safety digital outputs. Whenever the robot is moving (motion underway), the dual digital outputs are HIGH. Outputs are LOW when there is no movement.	PL d/Cat. 3		Two-channel output signals with high impedance state
SF23 ⁱⁱⁱ	Robot Not Stopping Output	Configurable motion status safety digital outputs. Whenever the robot is stopping (in the process of stopping or in a stand-still condition) the dual digital outputs are HIGH. When outputs are LOW, the robot is not in the process of stopping and not in a stand-still condition.	Configurable motion status safety digital outputs. Whenever the robot is stopping (in the process of stopping or in a stand-still condition) the dual digital outputs are LOW. When outputs are HIGH, the robot is not in the process of stopping and not in a stand-still condition.	PL d/Cat. 3	100 ms	Two-channel output signals with high impedance state
SF24	Robot Reduced Mode Output	Configurable reduced mode safety digital outputs. Whenever the robot is in reduced mode, the dual digital outputs are LOW.	Configurable reduced mode safety digital outputs. Whenever the robot is in reduced mode, the dual digital outputs are HIGH.	PL d/Cat. 3		Two-channel output signals with high impedance state
SF25 ^{iv}	Robot Not in Reduced Mode Output	Configurable not in reduced mode safety digital outputs. Whenever the robot is NOT in reduced mode, the dual digital outputs are LOW.	Configurable not in reduced mode safety digital outputs. Whenever the robot is NOT in reduced mode, the dual digital outputs are HIGH.	PL d/Cat. 3	350 ms	Two-channel output signals with high impedance state
SF26	TCP Force Limit	The safety function continuously calculates the torque allowed for each joint to stay within the defined force limit for the TCP. The joints control their torque output to stay within the allowed torque range. When the torque output exceeds the limit, it will result in a safety state.	The safety function continuously calculates the torque allowed for each joint to stay within the defined force limit for the TCP. The joints control their torque output to stay within the allowed torque range. When the torque output exceeds the limit, it will result in a safety state.	PL d/Cat. 3		Cat. 2 stop

SF	Item	Description (CAB2.1)	Description (MiniCab)	Assessment Results	Response Time	Category
SF27 ^v	3-Position Enable Input	Configurable 3-Position Enable safety digital input. This safety function is initiated by an external device using a safety input. The 3-Position enable limit is triggered when the external connections are LOW. If the two safety digital input signals differ, the 3-Position enable limit will be triggered.	Configurable 3-Position Enable safety digital input. This safety function is initiated by an external device using a safety input. The 3-Position enable limit is triggered when the external connections are HIGH. If the two safety digital input signals differ, the 3-Position enable limit will be triggered.	PL d/Cat. 3		Cat. 2 stop
SF28 ^{vi}	Momentum Limit	This function monitors the momentum of the robot's motion. Limiting the momentum of the robot can reduce the collision forces in a collision, and this function may have an impact on the robot's motion speed. Exceeding the robot momentum will result in a safety state.	This function monitors the momentum of the robot's motion. Limiting the momentum of the robot can reduce the collision forces in a collision, and this function may have an impact on the robot's motion speed. Exceeding the robot momentum will result in a safety state.	PL d/Cat. 3	250 ms	Cat. 1 stop


NOTE

i, ii, iii, iv, v, vi: advanced safety functions are only supported in the 1.7.1 JAKA App and above.



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